Climate Trend Summaries for the National Forests in California

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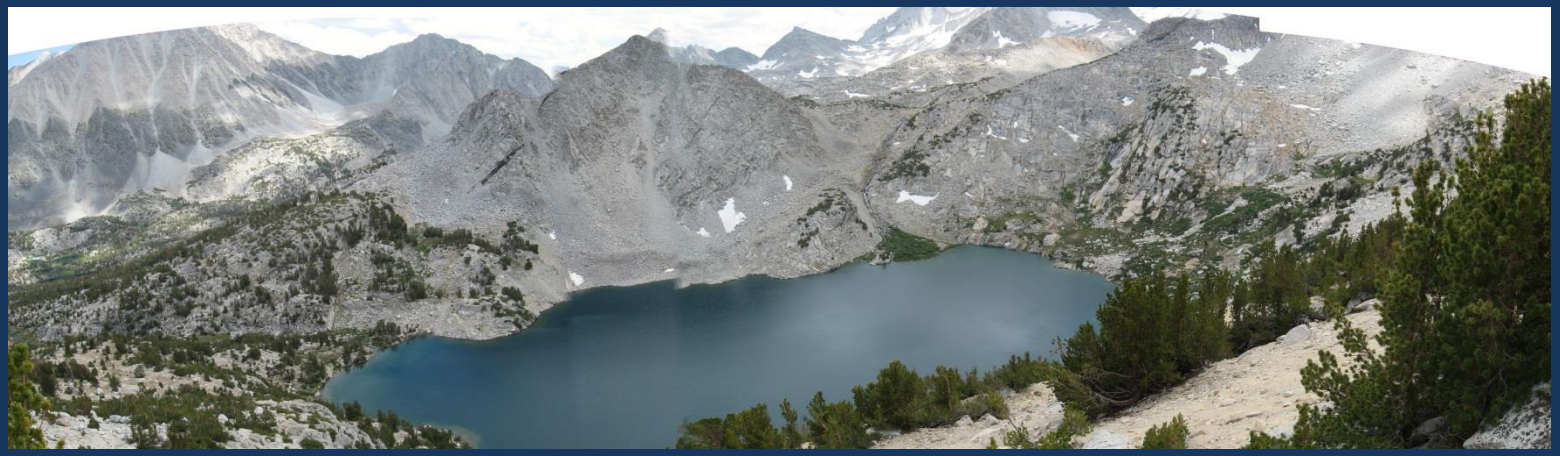
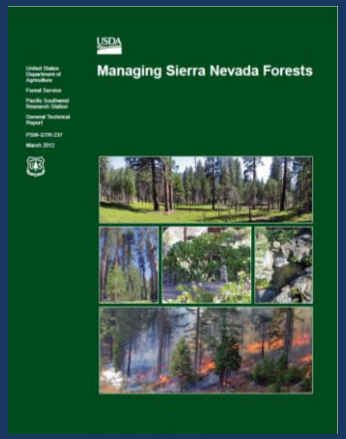
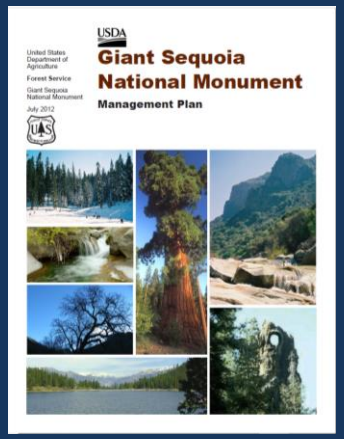


Background

- Produced by Region 5 Ecology Program
  - First versions produced in 2010-2012
    - Supported planning efforts (Giant Sequoia NM)
  - Created for all national forests in R5
  - Originally Chapter 3 in PSW-GTR-237*
  - Newest versions just released

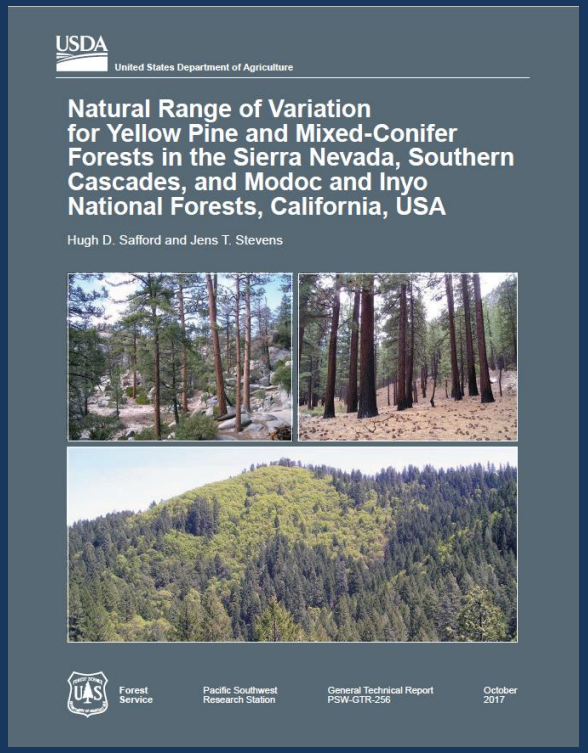


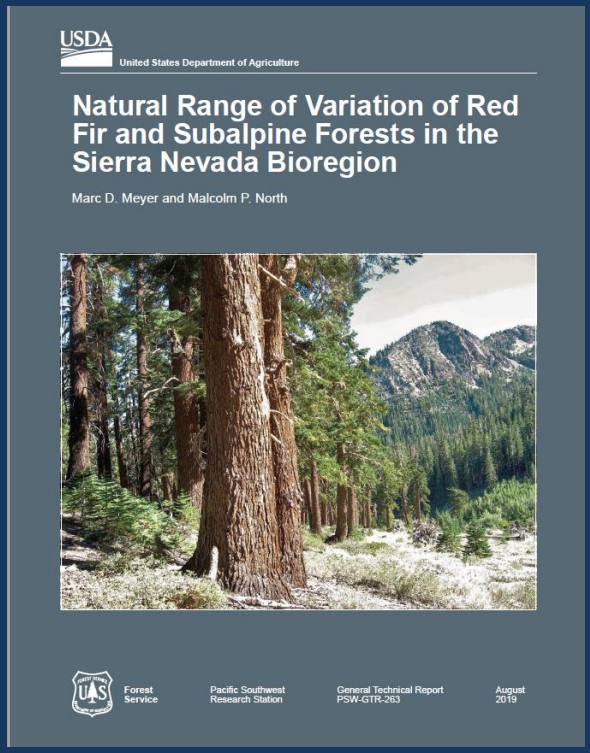


*Safford, H., North, M., and M. Meyer 2012. Climate Change and the Relevance of Historical Forest Conditions. PSW-GTR-237.

Background

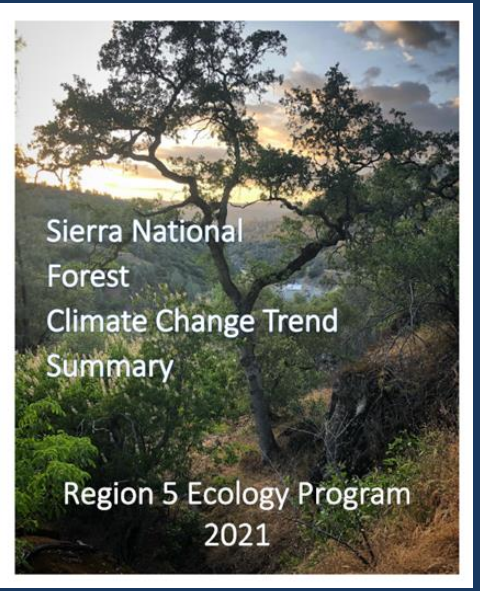
- Related Natural Range of Variation GTRs
  - Yellow pine and mixed conifer, GTR-256
  - Red fir and subalpine, GTR-263

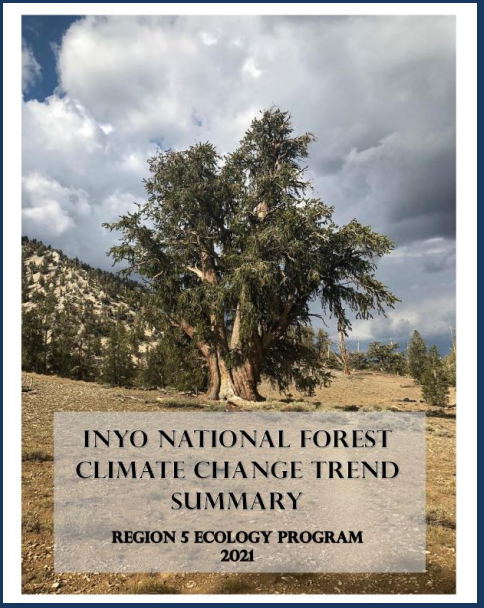




Purpose

- Purpose of Reports
  - Summarize current and future projected patterns in climate and their effects to natural resources
- Authors (Inyo, Sierra, Sequoia NFs)
  - Amarina Wuenschel, Becky Estes, Shana Gross, Kyle Merriam, Laura Wolf, Hugh Safford, Michelle Coppoletta, Sarah Sawyer, Zack Steel, Marc Meyer, Ramona Butz, Gabrielle Bohlman, Nicole Molinari, Sarah Hennessey



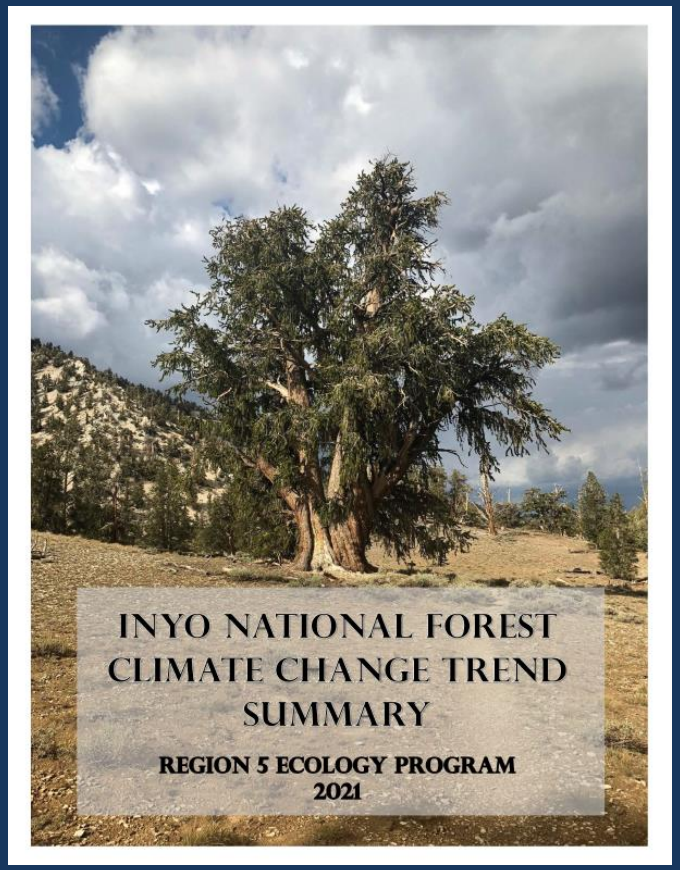


Application

- Forest Plan Revision
- Training USFS and other staff
- Informing project NEPA
- USFS climate change scorecards
- Climate change vulnerability assessments
- Information to external partners

Topics Covered

- Main Topics
  - Climate
  - Hydrology
  - Fire regimes
  - Vegetation
  - Wildlife
- Historical & future trends
- Bioregional & local trends*

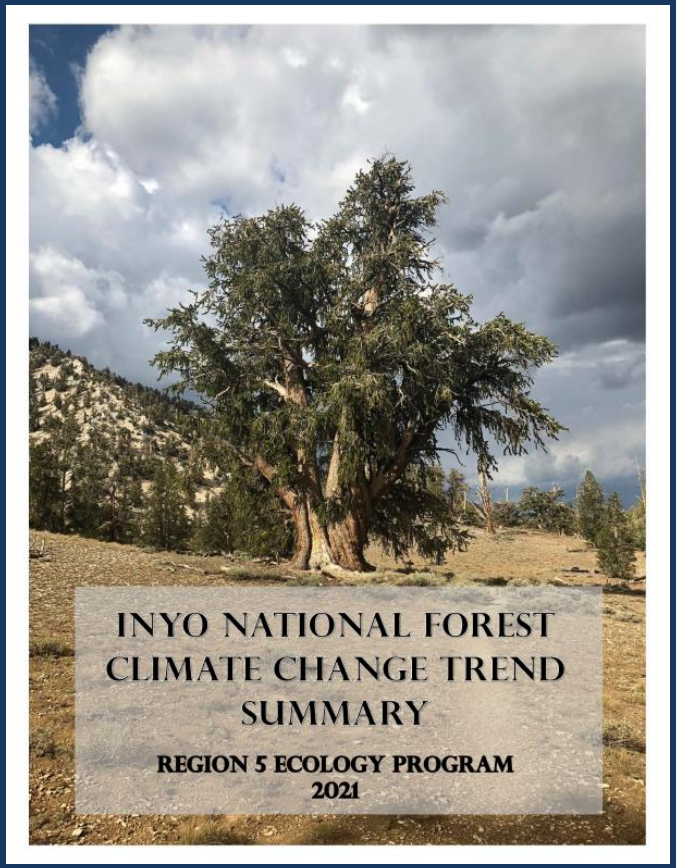


*Most patterns & trends are based on the bioregional scale or larger, and more local patterns for an individual national forest may be quite different.

Topics Covered

- Main Topics
  - Climate – local & bioregional
  - Hydrology
  - Fire regimes
  - Vegetation
  - Wildlife

  (Hydrology, Fire regimes, Vegetation, Wildlife: bioregional)
- Historical & future trends
- Bioregional & local trends*



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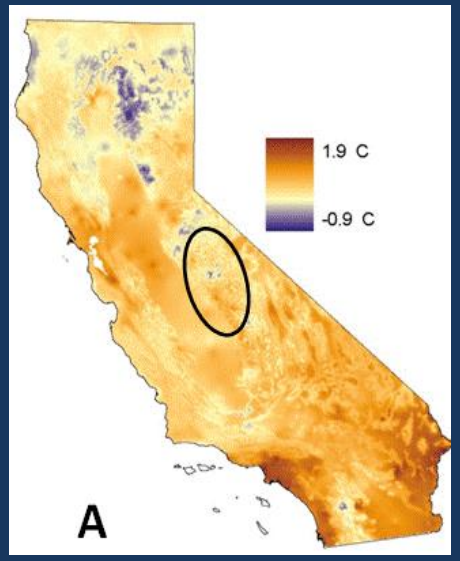
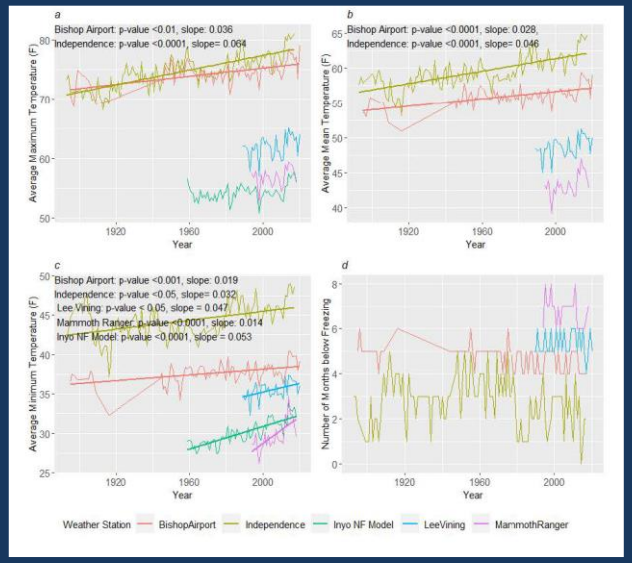
Recent Climate Trends*

- Increasing temperature 3.5-5.8^{o} F since 1890s
  - Frost-free period lengthened 2 to 3 months
  - Greatest increase in nighttime temperatures
  - Apparent at local (Inyo NF) and bioregional scales

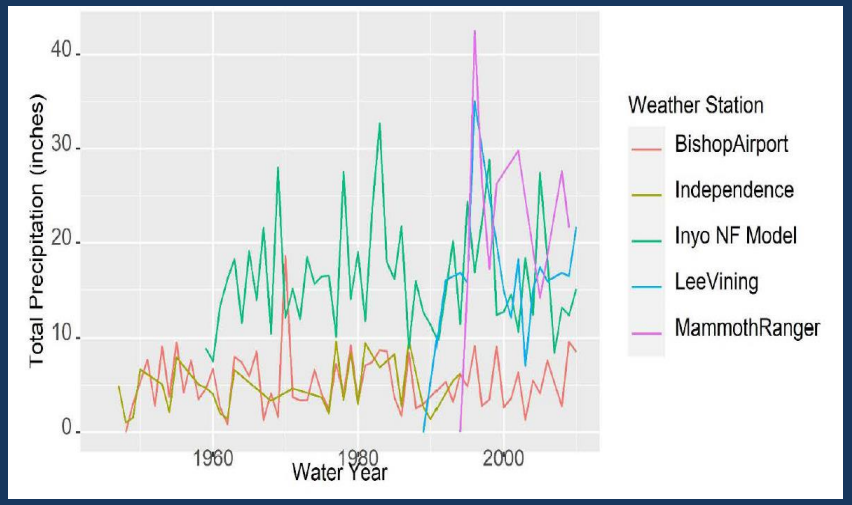


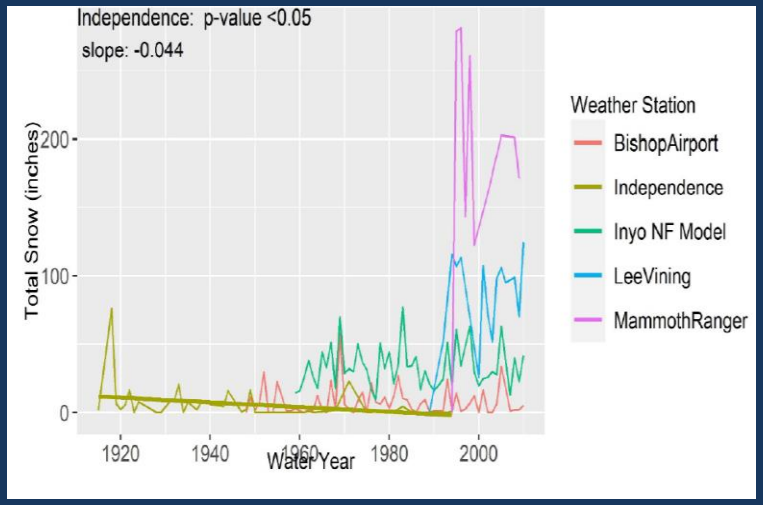


*Pattern observed across the entire Sierra Nevada

Recent Climate Trends*

- Droughts generally more common
- No consistent change in average precipitation
  - But greater variation in interannual precipitation over time



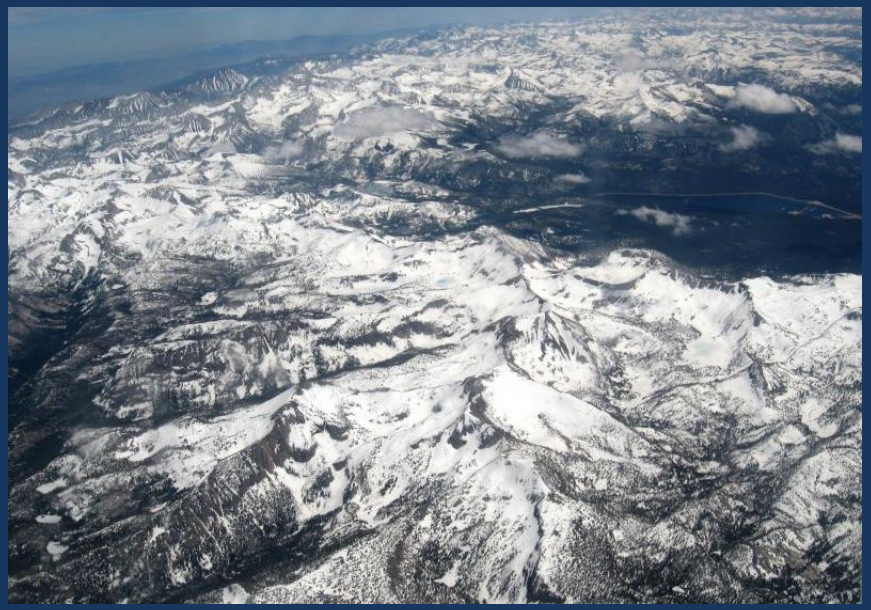


*Pattern observed across the entire Sierra Nevada

Recent Hydrological Trends

(<6500 feet elevation in Sierra Nevada)*

- Peak runoff and streamflow have shifted earlier in the year due to earlier snowmelt timing
- Snowmelt now occurs ~10-15 days earlier compared to early 1900s

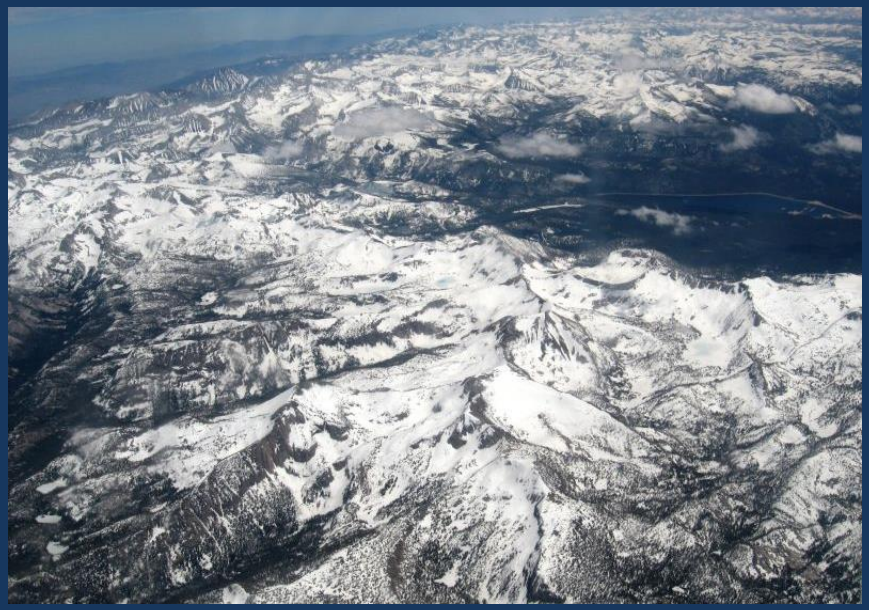


*Predicted trends for the entire Sierra Nevada, primarily on the west slope

Recent Hydrological Trends

(<6500 feet elevation in Sierra Nevada)*

- Decreased groundwater storage in 2012-2016 drought
  - More storage lost by evapotranspiration than recharged through precipitation



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Future Climate & Snowpack Trends*

- Temperatures will increase significantly by 2100
  - Winter temp. by 2-4^{o} F
  - Summer temp. by 4-8^{o} F

*Predicted trends for the entire Sierra Nevada

Future Climate & Snowpack Trends*

- Temperatures will increase significantly by 2100
  - Winter temp. by 2-4^{o} F
  - Summer temp. by 4-8^{o} F
- Precipitation highly uncertain and more variable
  - amplitude, frequency, duration of extreme events
- Mid-elevation snowpack predicted to decline 30-65% by end of century (~4000-8000 ft elev.)

*Predicted trends for the entire Sierra Nevada

Putting Climate Projections into Context

- The last time global temperatures changed 4-5°F was the Pleistocene (20,000 years ago)
  - Much of Southern Sierra upper montane was covered in hundreds of feet of ice
  - Death Valley was under a deep lake (600 feet depth)
  - And these temperature changes were in the opposite direction!

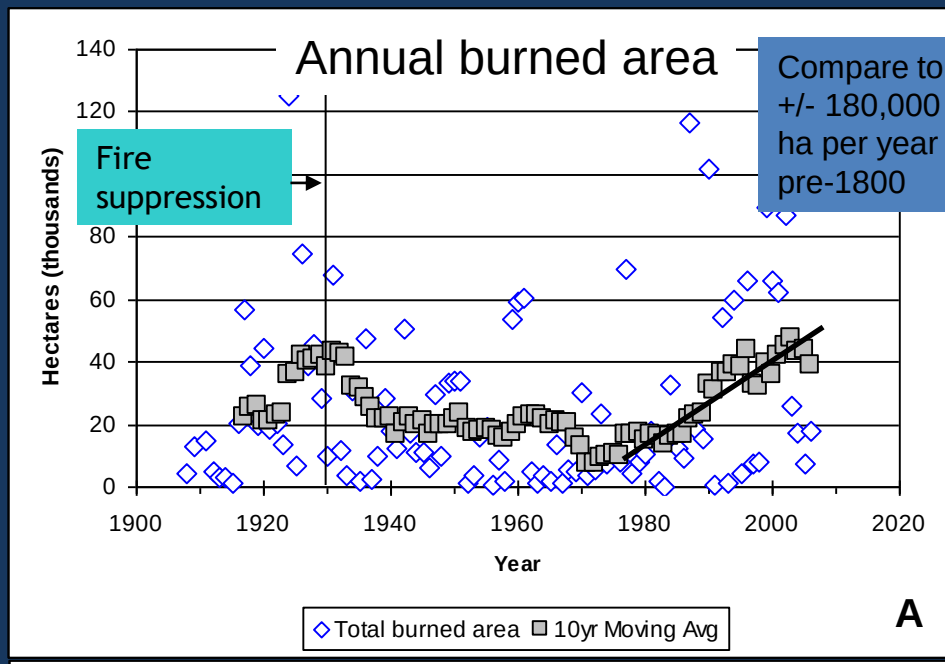
Putting Climate Projections into Context

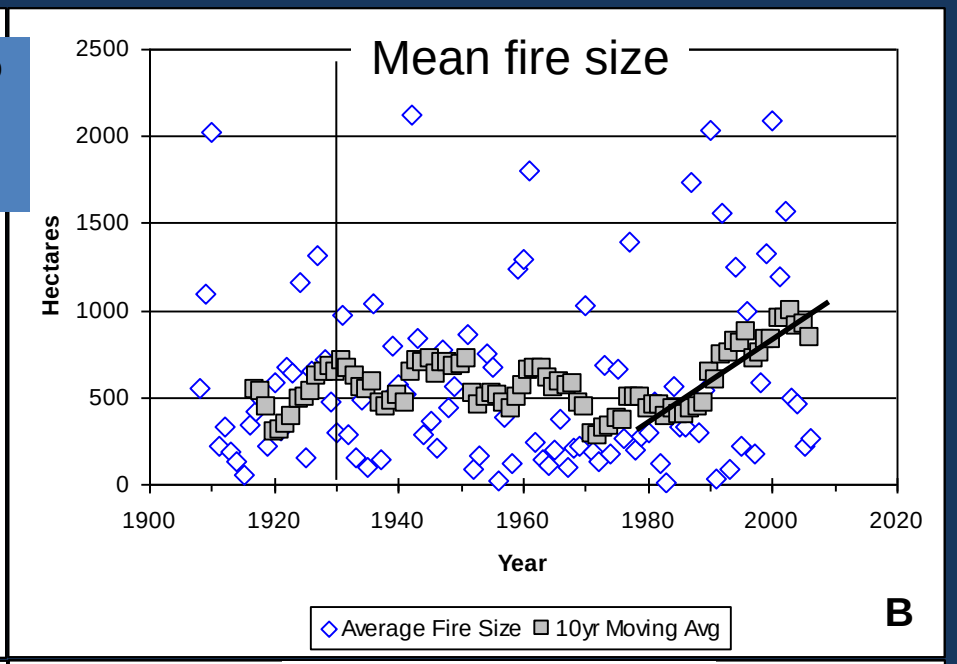
- Mid-Holocene (5000-8000 ybp) – 1.5° F warmer
- Mid-Eocene (45 million ybp) – Similar to 2100 projections

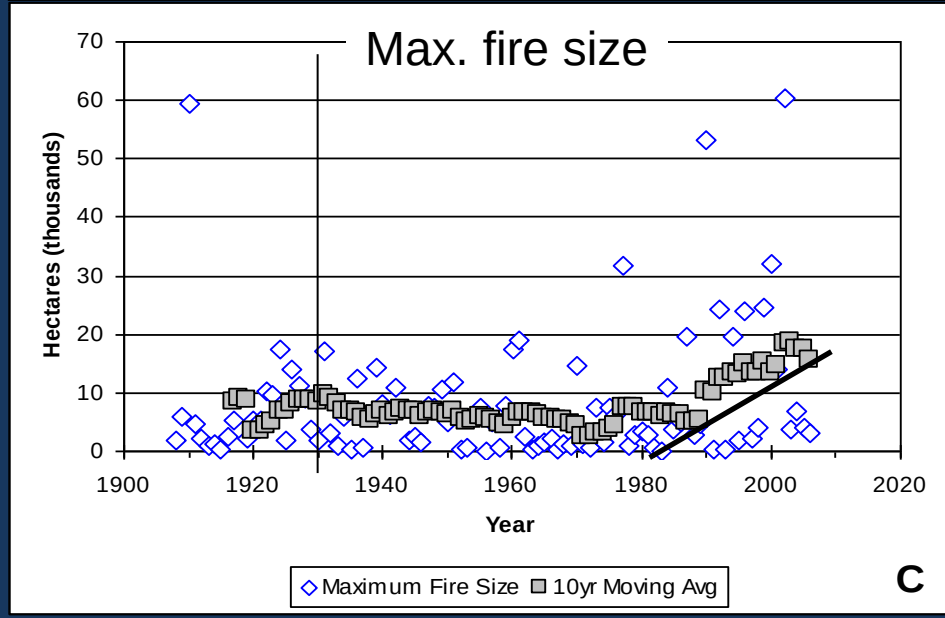
Recent and Projected Future Changes in:

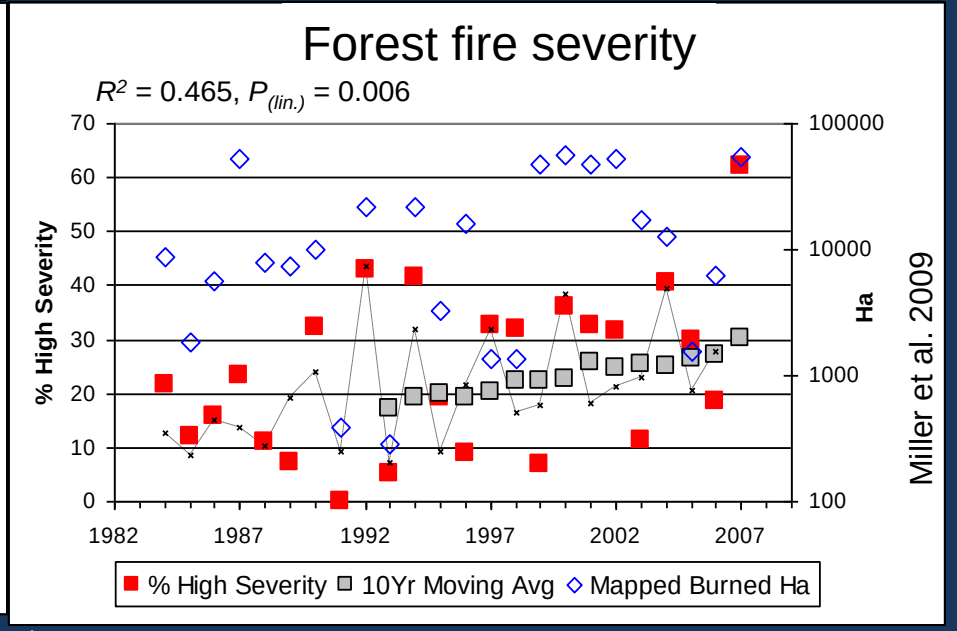
- Wildfires
- Vegetation
- Wildlife

*Sierra Nevada: recent trends in fire area and severity**





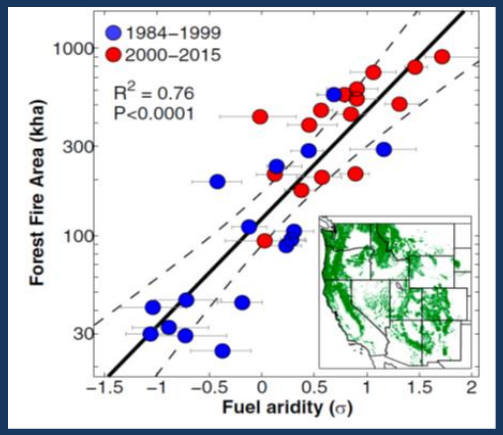




*All Figures from Miller et al. (2009) published in *Ecosystems*

Wildfire Summary

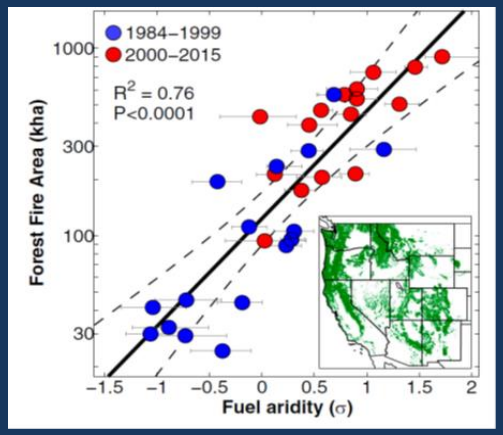
- Wildfires are becoming larger, more frequent, and higher severity in Sierra Nevada forests
- Patterns also apparent statewide and in the western U.S.



Source: Abatzoglou and Williams 2016

Wildfire Summary

- Models project increases in wildfire activity and intensity in the Sierra Nevada in 21st century
  - Driven by increases in fuel aridity, decreased snow cover, increased temperature, and other factors (e.g., tree mortality)
- Largest wildfires occurred in the last decade



Source: Abatzoglou and Williams 2016

Recent Vegetation Changes

- Loss of yellow pine dominated forest
- Expansion of shade tolerant conifers
- Loss of blue oak woodland*

Legacy forest management (logging, fire suppression)

*Recent patterns were observed exclusively on the western slope of the Sierra Nevada

Recent Vegetation Changes

- Increase in hardwood dominated forests*
- Loss of subalpine and alpine vegetation
- Expansion of subalpine trees into previous permanent snowfields

Climate warming related patterns

*Recent patterns were observed exclusively on the western slope of the Sierra Nevada

Conversion of Forest to Shrublands and Non-native Grasslands

Pilot Fire (1999; STF) Ponderosa pine forest converted to chaparral

Birch Fire (2002; INF) Pinyon pine woodland converted to arid shrubland/ cheatgrass

Projected Vegetation Changes

- Losers: YPMC forests, red fir & subalpine forests, and alpine vegetation
- Winners: annual grasslands
  - Initial increase in shrublands but decreases with conversion to annual grasslands
- Unknowns
  - Possible increase in mixed woodlands and arid shrublands

Wildlife Recent Changes

- Many mammal species shifted upward in elevation
  - alpine chipmunk
- Many other species showed no changes
- Closely-related species responded idiosyncratically to changes in climate and vegetation

Alpine chipmunk (Photo Credit: National Wildlife Federation)

Wildlife Recent Changes

- Most upwards range shifts for high-elevation species is consistent with predicted climate warming
- Changes in lower- to mid-elevation species' ranges are most likely the result of fire exclusion

Pika (Photo Credit: Ecological Society of America)

Projected Wildlife Changes

- Pacific fisher and marten are highly sensitive to climate change
  - Both species will experience the greatest range contraction in the southern Sierra Nevada

Projected Wildlife Changes

- Pacific fisher and marten are highly sensitive to climate change
  - Both species will experience the greatest range contraction in the southern Sierra Nevada

- 60% of coniferous bird species will exhibit substantial range reductions, including Great gray owl
- 66% of CA native flora will experience >80% range reduction*

*By the end of the 21st century

Caveats to Projected Changes

- Model often use simplistic assumptions and downscaled climate projections
  - Species distribution “climate-envelope” models
- Consequently, projections for individual species have high uncertainty
  - Greater certainty for broader vegetation changes

*By the end of the 21st century

Climate Trend Summaries

- Available on Region 5 Ecology Program external website:
  - https://www.fs.usda.gov/detail/r5/plants-animals/?cid=stelprdb5427254

Additional Climate Change Resources

- Many other online resources:
  - USDA California Climate Hub
  - USFS Climate Change Resources Center
  - CalAdapt
  - Climate Adaptation Knowledge Exchange
  - 6th IPCC Report (2021)

Climate change projections are depressing!
So…What can be done?

2020 Creek Fire landscape, Sierra NF

1. Ecological Restoration

- Builds resilience and adaptive capacity that reduces impacts of stressors
  - Decades of scientific evidence (e.g., North et al. 2022*)
- Most effective when implemented at larger landscape scales
  - Tens of thousands of acres

*North et al. 2022. Operational resilience in western US frequent-fire forests. Forest Ecology & Management

1. Ecological Restoration

- Some examples
  - Reduce forest density and fuels
  - Reestablish natural fire regimes
  - Restore forest structural heterogeneity
  - Enhancing native biodiversity & wildlife habitat

2. Shared Stewardship

- Form robust partnerships to increase capacity and effectiveness
  - Collaborative efforts (e.g., ESCCRP)
  - Science-management partnerships
  - All lands approach

3. Experiment, Learn, and Adapt

- As conditions change, new approaches needed
  - Pyrosilviculture (North et al. 2021)
- Monitoring and research are key to learn and adapt

*North et al. 2021. Pyrosilviculture Needed for Landscape Resilience of Dry Western United States Forests. Journal of Forestry