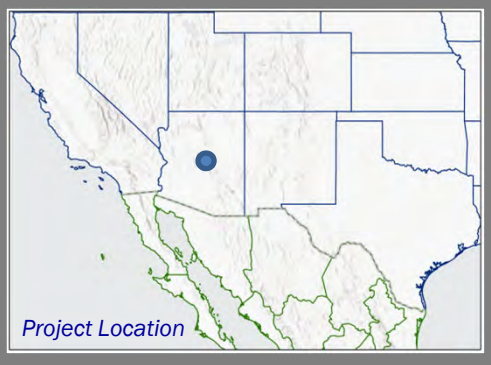
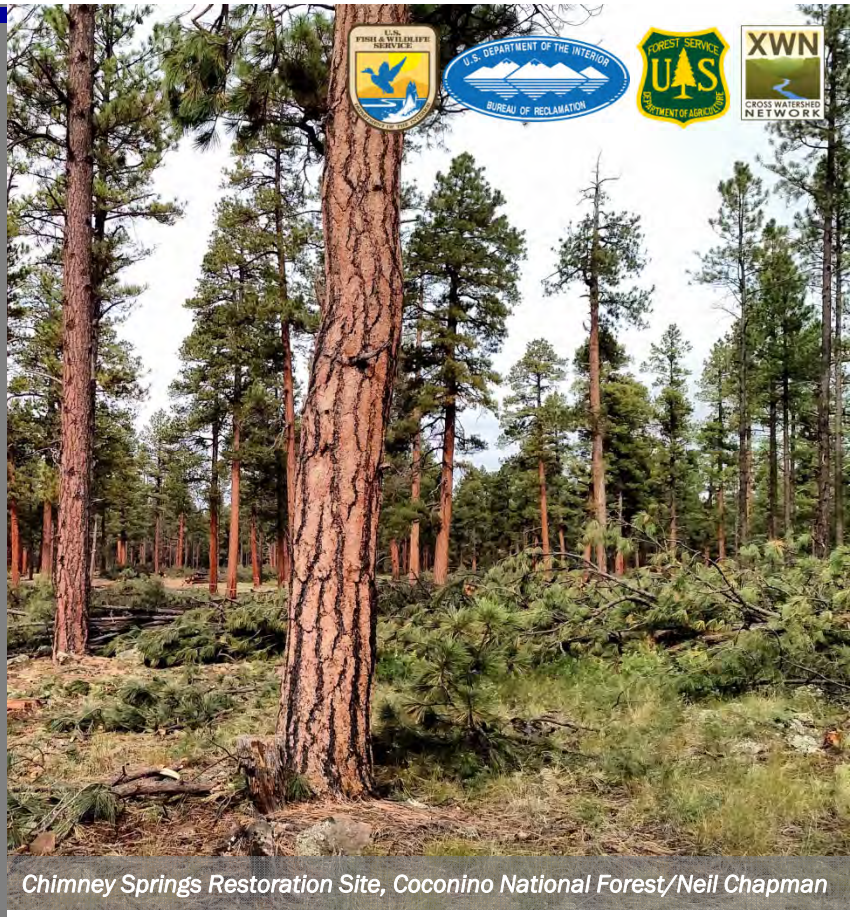
ACTIONABLE SCIENCE

Modeling Forest Thinning Effects on Water Yield for the Four Forest Restoration Initiative

The Nature Conservancy Arizona

The Four Forest Restoration Initiative (4FRI) will accelerate the use of mechanical thinning and prescribed burns across four national forests to treat 238,000 ha in Arizona over the next ten years. The objective of the 4FRI project is to re-establish historic forest structure patterns and composition to promote forest resiliency and river flows within the forests. This project is an evaluation of the effects of climate variability and forest thinning on watershed-scale runoff in the Salt and Verde watersheds of central Arizona, which supply water to the Phoenix metro area. This is a major management implication of the implementation of 4FRI.





Chimney Springs Restoration Site, Coconino National Forest/Neil Chapman

KEY ISSUES ADDRESSED

Persistent drought conditions have impacted water-dependent habitats and species, including humans, within and downstream of forests in Arizona and New Mexico. Warming is amplifying the size and severity of wildfire and drought-related forest die-offs while decreasing snowpacks and water yields. Communities in the western U.S. are facing projected critical water shortages. Climate conditions, coupled with unsustainable water management practices, have caused river flows to diminish, or in some cases, be lost entirely. The interacting impacts of forest management and climate change on downstream water availability must be quantified in order to make informed decisions about forest management.

PROJECT GOALS

- Assess how the pace and extent of ponderosa pine forest thinning and variation in climate affect runoff in the Salt and Verde watersheds
- Explore the effects of mechanical thinning to improve forest resilience
- Use forest runoff models to estimate additional annual runoff that would result from mechanical thinning

FIRE AND WATER

Severe wildfires and drought have caused tree die-offs across the Southwest. Forest thinning at large scales could increase water availability, sustaining forests and the ecosystem services they provide.

Post-Fire Understory Regeneration in a Thinned Stand/Sue Sitko

PROJECT HIGHLIGHTS

Forest Management Scenarios: Forest restoration scenarios were based on thinning prescriptions of ponderosa pine forests from the US Forest Service implementation of 1st phase of 4FRI and extrapolated to ponderosa forests across Salt-Verde watershed where mechanical thinning is suitable. Thinning treatments were simulated over 200,000 – 400,000 hectares of ponderosa pine forests across 15, 25, and 35 years.

Climate Variability: Forest thinning and runoff were simulated under the wettest and driest conditions recorded in historical climate data in the study region. Total winter precipitation was summed across October to April for every year from 1900-2012 using a modeled dataset. Mean winter precipitation was calculated for 15-, 25-, and 35-year restoration intervals and used to simulate droughts and periods of increased rainfall.

Forest Treatment Runoff Model: Researchers modified a forest runoff model developed from empirical data collected in the Beaver Creek experimental sub-watersheds in the Verde basin, where forest management effects on flow were measured. The final model included three independent variables to predict annual flow: winter precipitation (Oct-Apr), change in forest basal areas due to thinning, and years since thinning treatment.

Collaborators and Funding Partners

- US Forest Service 4FRI program
- Personnel at Coconino, Kaibab, Tonto and Apache-Sitgreaves National Forests
- Researchers at Northern Arizona University and University of Arizona

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Photos courtesy of The Nature Conservancy

LESSONS LEARNED

Forest thinning at larger scales could measurably increase runoff in ponderosa pine forests in both dry and wet periods. Models estimated that forest thinning would increase runoff from ponderosa pine forests by approximately 20%.

The increases in runoff would likely improve conditions for water-dependent species in riparian areas and aquatic ecosystems, which are vulnerable to seasonal low flows. Increases in water yields could also benefit downstream communities which are dependent on water provision from ponderosa pine forests.

Consistent with historical experiments, the model suggested that thinning effects on runoff are transient as forests recover. Six years after thinning occurs, runoff is projected to return to near pre-treatment levels.

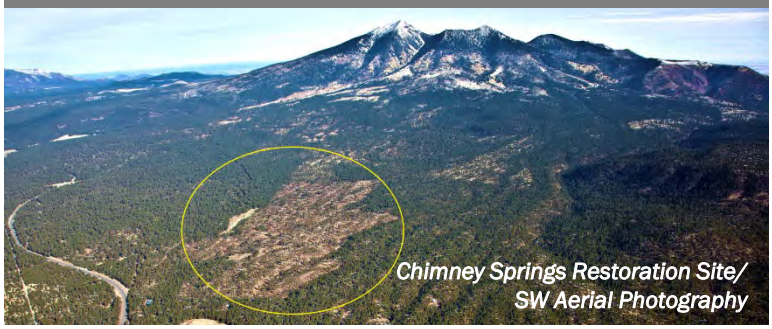
NEXT STEPS

- Build upon current forest management knowledge to reduce uncertainties in how forests will respond to future climate
- Explore other management tools such as prescribed burning that restore forest resilience, since the effects of forest thinning are temporary
- Develop modeling scenarios that measure the effects of follow-up treatments on maintaining increased runoff benefits of thinning

PROJECT RESOURCES

For more information on this project, contact Marcos Robles: mrobles@tnc.org

For additional project resources and case studies, visit the Collaborative Conservation and Adaptation Strategy Toolbox: WWW.DESERTLCC.ORG/RESOURCE/CCAST



Chimney Springs Restoration Site/ SW Aerial Photography