



National Park Service Southern Arizona Parks Group Fire Ecology Annual Report Calendar Year 2025

Gabriel De Jong – Fire Ecologist, Saguaro National Park



Open ponderosa pine woodland on the east slope of Mica Mountain, overlooking the Little Rincon, Winchester, and Little Dragoon mountain ranges to the east. Picture by Gabriel De Jong, NPS Fire Ecologist.

The National Park Service (NPS) Division of Fire and Aviation Management relies on science and long-term monitoring to inform an adaptive management approach for assessing and improving fire management programs and activities at park units. Adaptive management, along with policies, standards, and responsibilities for monitoring are described in Chapter 8 of [Reference Manual 18](#). The NPS Fire Ecology Program is responsible for the collection, analysis, and interpretation of fire effects monitoring data for park managers to use for program evaluation and decision making. This annual report is intended to partially fulfill reporting requirements for the Fire Ecology Program and does not constitute a complete analysis of any NPS fire management program or activity. Additional interpretation and reporting can be found in previous annual reports at [NPS DataStore](#) or by contacting the author(s) of this report.

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A. Summary

In 2025, the Fire Ecology program for southern Arizona parks continued its mission to integrate the most current, science-based information into all relevant aspects of fire and fuels management.

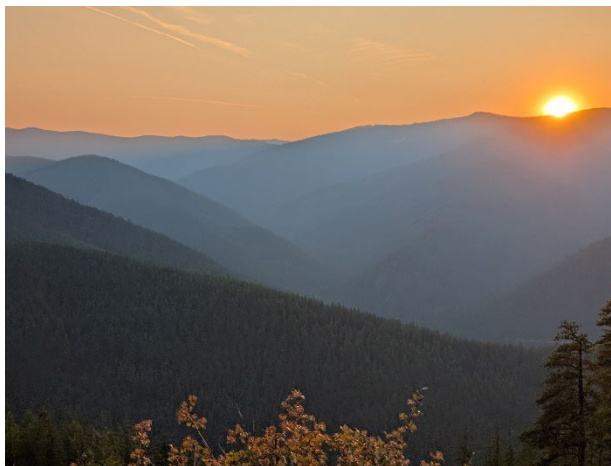
The fire ecologist completed a significant QAQC effort focusing on the ponderosa pine (PIPO) dataset for SAGU. This dataset represents the largest and longest-running fire effects monitoring effort within the Southern Arizona Parks Group, representing 28 permanent plots and reads dating back to 1990. The surface fuels and tree data collection protocols were thoroughly checked for errors and corrected as necessary. This allowed De Jong to analyze the data and assess whether the original fire management objectives were met. The results are presented in Section B of this report.

The fire ecology program was grateful to have Scientists in Parks (SIP) assistant, Justin Sontag, complete his year-long project assessing long-term vegetation changes at Chiricahua National Monument (CHIR) following the Horseshoe Two fire (2011). This was a successful collaborative project between CHIR Natural Resources, the Sonoran Desert Network, and Southern Arizona Fire & Aviation Management. A brief overview of this project is presented in Section C of this report.

In the spring of 2025, the fire ecologist joined the Saguaro National Park (SAGU) Wildfire Module (WFM) to assist with prescribed fire implementation at Big Thicket National Preserve (BITH) in east Texas. The fire ecologist served as FEMO (Fire Effects Monitor) during the single burn operation during this assignment. De Jong rejoined SAGU WFM when they responded to the Cedar and Cody wildfires in mid-May, which threatened the town of Oracle, AZ, in the foothills of the Catalina Mountains. In mid-August, the fire ecologist filled in again with the SAGU WFM as they were assigned to wildfires at Yellowstone National Park and on the Kootenai National Forest (Cone Cabin and Cub Creek fires, respectively).

No fire effects plots were read in southern Arizona parks in 2025. Nine FMH plots that were up for monitoring at SAGU were scheduled to be read in mid-October, but due to the federal government lapse in appropriations that effort had to be postponed. We had several collaborators lined up to assist with this effort, including Zion National Park fire effects staff and USGS staff assisting with Terrestrial Laser Scanning (TLS). These plot reads will be rescheduled for spring of 2026.

After many years without it, live fuel moisture data were once again collected in southern AZ parks, with the fire ecologist leading that effort. This was once standard practice in our parks and was used to determine—among other things—the optimal windows for prescribed fire based on



Sunset along the Bitterroot Mountain Range on the Kootenai National Forest, Montana. Photo taken while the fire ecologist and the SAGU WFM responded to the Cub Creek fire in August 2025. Photo by Gabriel De Jong.

conditions on the ground. The fire ecologist recruited help from SAGU Natural Resources and the SAGU WFM and successfully collected new data at SAGU (multiple collection areas in the lower and upper Chimenea unit and several in Mica Bowl) and at Coronado National Memorial (CORO).

The fire ecology program is looking forward to having an Ecology Assistant working with us in 2026, through the SIP program. Thomas Narramore accepted the position and will join us in April. His project will focus on data QAQC, analysis, fuels mapping, fuels project planning, fire behavior modeling, and field data collection at SAGU. The Sonoran Desert Network graciously agreed to collaborate with us on this project by providing housing and mentoring assistance for Thomas.

B. Monitoring Results and Recommendations

Ponderosa Pine Monitoring Type Management Objectives Analysis for SAGU

Purpose

This analysis addresses the specific objectives that were originally developed for the ponderosa pine forest and woodland monitoring type (PIPO) at SAGU. While there are many important questions that could be addressed using this dataset, the analysis reported here focuses on this original set of management objectives (as documented in FMH-4s). These analyses, along with others we expect to conduct in 2026, will not only be instrumental in addressing management questions and providing recommendations for the fire program, but will also help evaluate the effectiveness and relevance of the fire effects monitoring protocols currently and historically employed at SAGU.

The following were the objectives defined for PIPO management areas:

1. Reduce fuel loading by 30-60% 1 year post burn
2. Reduce pole size tree density by 30-50% 2 years post burn
3. Less than or equal to 15% overstory tree mortality 2 years post burn
4. Maintain tree density above 163 trees/acre
5. Increase or maintain native herb cover and diversity 5+ years post burn

Background

The PIPO dataset includes 28 FMH Forest Plots established between 1990 and 1998. Most are in the Mica Bowl complex of burn units (Duckbill, Man Head, Mica Meadow, Mica Mountain, Manning, Bonita, and Devil's Bathtub; n = 24), with a few also in the Saddle (n = 1) and Chimenea (n = 3) burn units. All plots in this analysis had burned at least once since they were installed, with many receiving multiple treatments with prescribed fire, experiencing wildfire(s), or a combination of both since establishment.

Because of its long history, the PIPO dataset has been managed by different NPS staff, has undergone changes in protocols, and has been subjected to varying, and at times insufficient, levels of QAQC and analysis. In 2025, the Fire Ecologist performed thorough QAQC on the tree data and surface fuels protocols in the PIPO dataset, using methods recently developed Eva

Degan (Scientists in Parks intern, 2023-2024) and summarized in the 2024 Fire Ecology Report (<https://irma.nps.gov/DataStore/DownloadFile/715091>). The analysis presented here is part of a larger effort to come to reliable, data-driven conclusions from this long-term monitoring dataset, in a thorough and transparent manner.

Methods

All statistical analyses were conducted in R using common packages for mixed effects modeling, including LMER, GLIMER, and GLMMTMB. All models included monitoring status as a fixed effect and macroplot as a random intercept to account for repeated measures. Model diagnostics were performed using the DHARMA package. Tukey-adjusted pairwise comparisons were used for all post-hoc tests. Percent changes presented in figures and tables are based on predicted marginal means from the statistical models. For a summary table of results see Appendix C.

Results and Discussion

Objective 1: Reduce surface fuel loading by 30-60% 1 year post burn

Objective 1 Result: Objective met

The overall effect of monitoring status on total surface fuel load was significant (*Type III F test*: $F_{27,302}^* = 16.46, p < 0.001$) (Fig. 1). The changes in total surface fuel loads one year post fire were within desired parameters for plots that experienced one fire (-55%), two fires (-40%), or

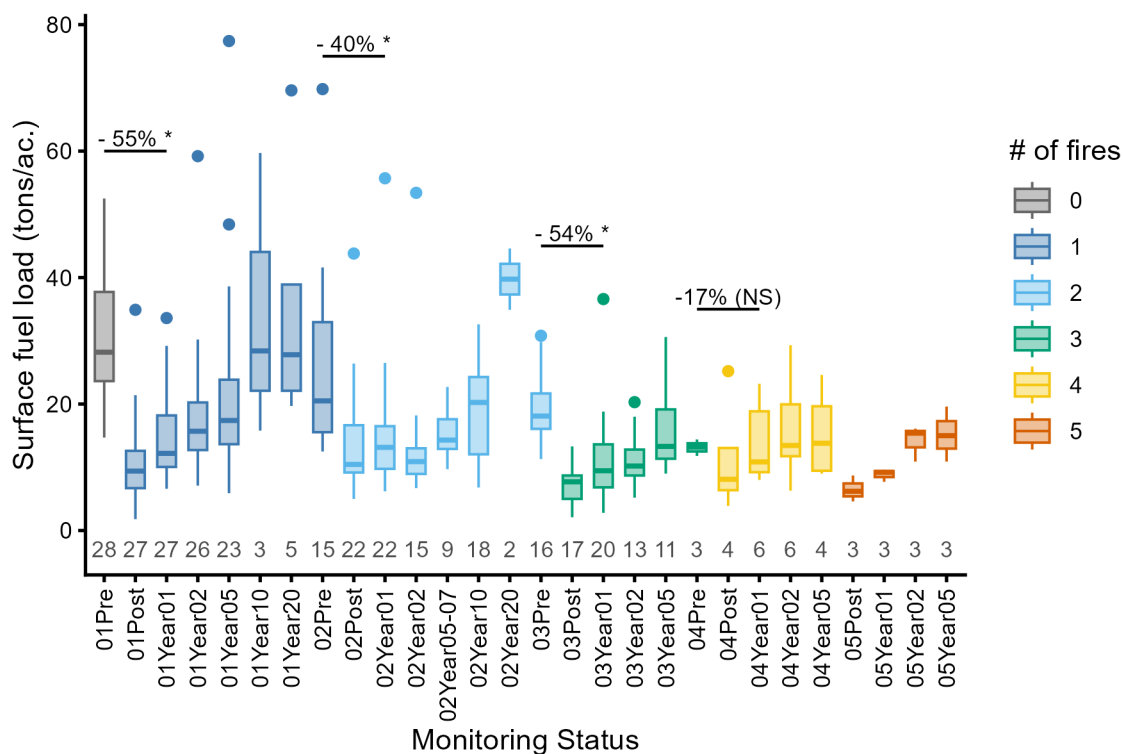


Figure 1. Distributions of total surface fuel loads (tons/ac.) per plot, by monitoring status. Percent changes are based on predicted marginal means from statistical models. Numbers in grey below the box plots are sample sizes. * = statistical significance at $p < 0.001$

three fires (-54%), and these were all statistically significant (Fig. 2). No significant changes in surface fuel loads were detected in plots that experienced a 4th fire (ratio = 0.78, $p = 1.00$). There were three plots that burned a 5th time; however, no analysis was performed for these plots because no suitable pre-fire reads existed in the dataset.

Model design

Total surface fuel loads were modeled using a lognormal distribution. We used a Type III F-test with Satterthwaite-approximate degrees of freedom to assess overall significance of Monitoring Status in the model. Diagnostics demonstrated good overall fit.

Discussion

Fire was effective in reducing total surface fuel loads and the magnitude of change was within the desired condition.

As plots experienced longer periods without fire, the expected trend of increasing fuel loads was clearly observed. Plots with only one fire and no reoccurring fire for 10 or more years had fuel loads that closely resembled the pre-fire, baseline condition (01Pre). Plots that burned twice, but then went 10 years without fire, had surface fuel loads that more closely resembled the most recent pre-fire read (02Pre) (ratio = 1.32, $p = 0.89$), but these plots still tended to have lower fuel loads compared to baseline (ratio = 1.80, $p < 0.001$). This suggested that in our ponderosa pine communities at SAGU, a prescribed fire regime with an average return interval of less than 10 years – preferably between 5 and 10 years – is expected to maintain the desired, lower surface fuel loads. This agreed with dendrochronology research that examined the historical fire regime, pre-fire-suppression-era (approx. 1700-1900 CE), in the ponderosa pine communities of southern Arizona sky islands (Swetnam and Baisan 1996).

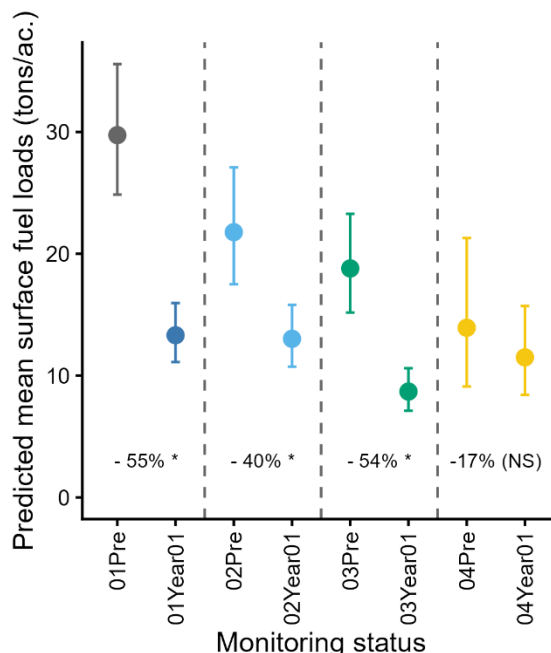


Figure 2. Predicted marginal means for total surface fuel loads (dots), with 95% confidence intervals (bars). * = changes that were statistically significant at $p < 0.001$

Objective 2: Reduce pole size tree density by 30-50% 2 years post fire

Objective 2 Result: Objective met

Overall, pole tree density differed significantly between monitoring statuses (likelihood ratio test: $\chi^2 = 191.9$, $df = 27$, $p < 0.0001$) (Fig. 3). The largest and only significant change in pole tree density occurred after the first fire (01Pre to 01Year01) (Fig. 3). The predicted mean pole density declined by 44%, which met the desired change (Fig. 4). Despite there not being significant changes detected in later post-fire periods, it is evident that the effect from the first fire persisted for many years and successive fires maintained a lower pole tree density compared to baseline (Table 1).

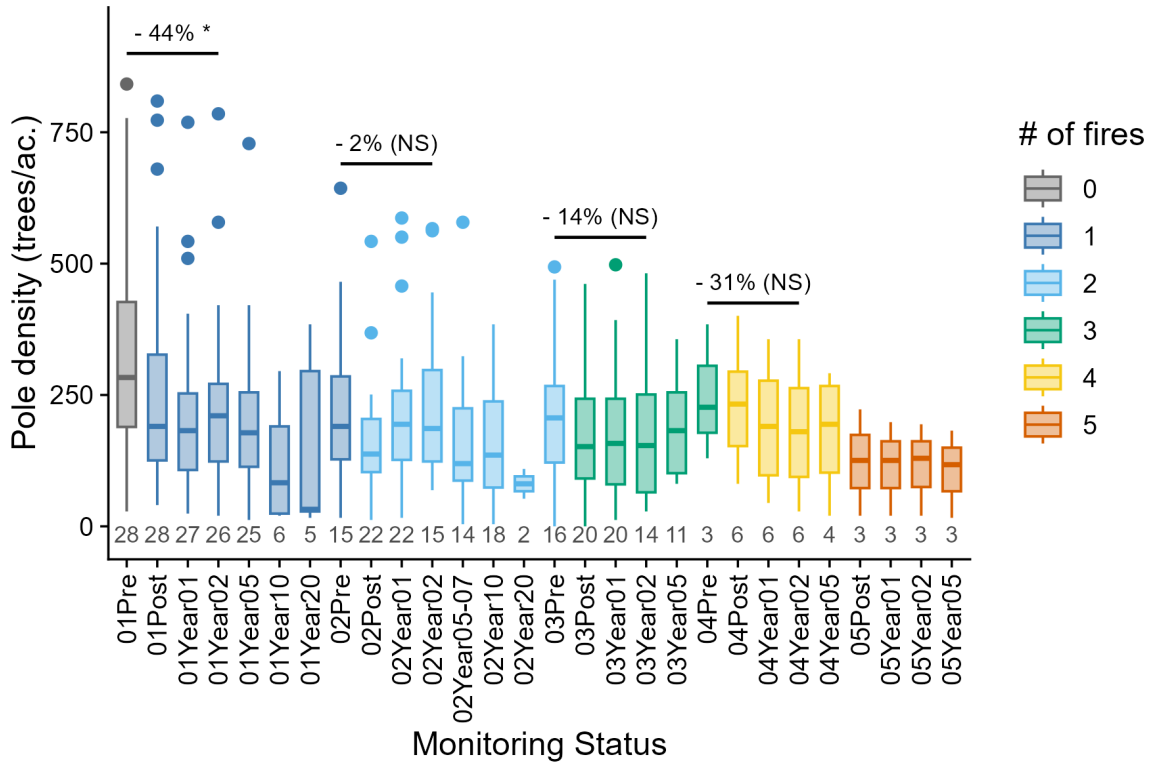


Figure 3. Distributions of pole tree density per plot (trees/ac.) by monitoring status. Percent changes are based on predicted marginal means changes from statistical models (* denotes statistical significance at $p < 0.001$). Numbers in grey below the box plots are sample sizes.

Model design

Pole tree density was modeled using a zero-inflated, negative binomial distribution, with quadratic parameterization. We compared the zero-inflated model to a non-zero inflated model, and the former had a much lower AIC ($\Delta\text{AIC} = -21$), indicating better fit. Similarly, inclusion of monitoring status in the model greatly improved model fit compared to the null model ($\Delta\text{AIC} = -183$). Model diagnostics indicated no issues with overdispersion or outliers but did pick up significant quantile deviations in the DHARMA residuals versus the rank transformed predictions. Overall, the model we chose performed the best among reasonable alternatives.

Discussion

Fire was effective in reducing pole tree stem density in ponderosa pine communities, especially following the first occurrence of prescribed fire or wildfire. While we didn't observe similar reductions in pole tree density in follow-up, successive fires, the desired lower stem density was effectively maintained. We would expect continued gradual reductions in pole density as more fire occurs in this community.

Table 1. Results for post hoc tests analyzing pole tree density, comparing baseline to many years post-fire, both with and without successive fires. Tukey-adjusted method used for p-values.

Contrast	Ratio	p-value
01Pre – 01Year10	3.63	< 0.0001
01Pre – 02Year10	2.28	< 0.0001
01Pre – 03Year05	2.14	< 0.0001
01Pre – 04Year05	4.66	< 0.0001
01Pre – 05Year05	6.53	< 0.0001

One important variable that could help interpret these results is fire severity, which was highly variable in plots following the first fire and tended to be higher severity compared to later fires (Fig. 5). The lack of statistically significant changes in plots that experienced more fires may be due to smaller sample sizes. Overall, areas that received more fire resulted in lower pole tree density and reduced plot-to-plot variability. However, as more areas receive more planned and unplanned fires, we may or may not see these trends reinforced.

Objective 3: Less than or equal to 15% overstory tree mortality 2 years post burn

Objective 3 Result: Objective met

There were no statistically significant declines in overstory tree densities following fire, regardless of which pre- and post-fire monitoring statuses were compared (Fig. 6). Between some monitoring statuses, the central tendency of overstory density per plot appeared to increase, but post hoc tests did not find these to be significant. For example, comparing 02Pre and 02Year10 (with adequate sample sizes per group) the central tendency increased, yet no statistically significant change was detected (ratio = 0.89, $p = 1.00$).

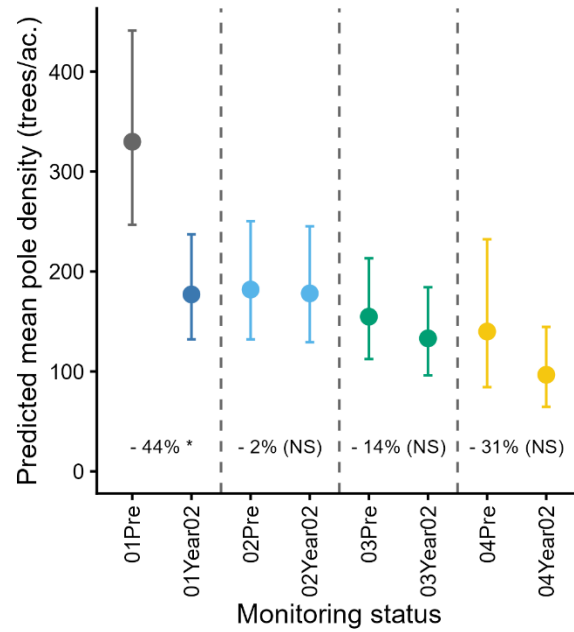


Figure 4. Predicted marginal means for pole tree density (dots), with 95% confidence intervals (bars). * = pre-fire to 2 years post-fire changes statistically significant at $p < 0.001$

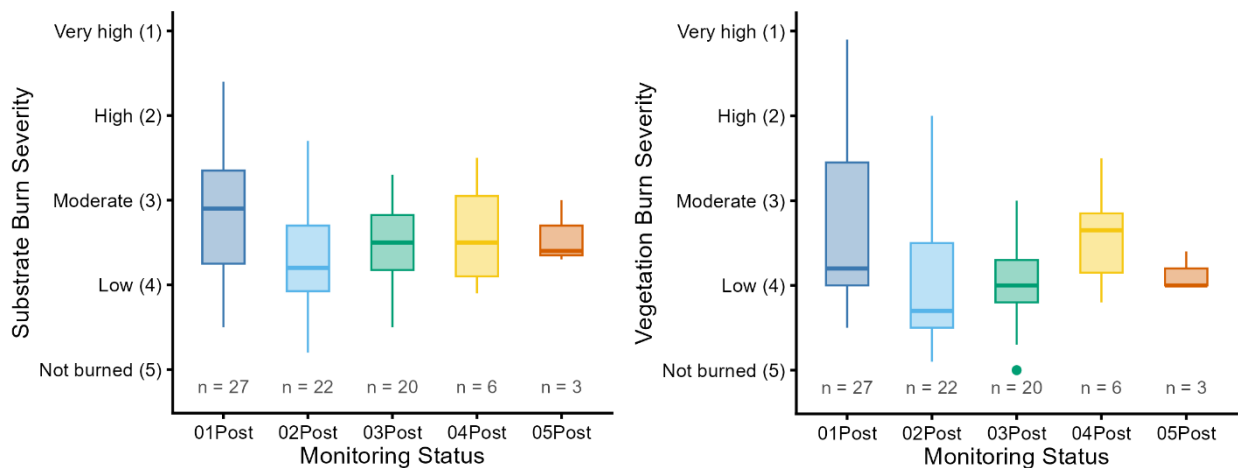


Figure 5. Distributions of immediate post-fire burn severities per plot, for substrate (left) and vegetation (right).

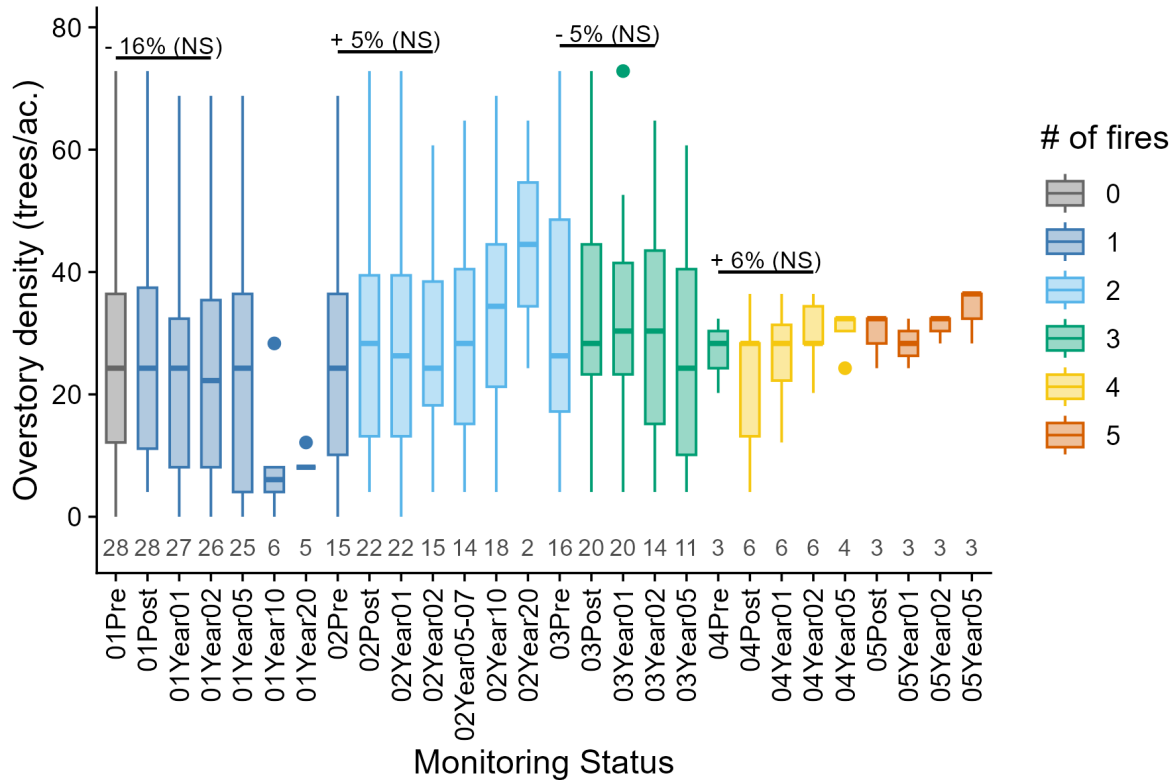


Figure 6. Distributions of overstory tree density per plot (trees/ac.) by monitoring status. Percent changes are based on predicted marginal means from statistical models. Numbers in grey below the box plots are sample sizes.

Model design

Overstory tree density was modeled using a zero-inflated, negative binomial, mixed-effects model, using quadratic parameterization. We compared the zero-inflated model to a non-zero inflated model, and the former had a much lower AIC ($\Delta\text{AIC} = -26.0$), indicating better fit. Similarly, inclusion of monitoring status in the model greatly improved model fit compared to the null model ($\Delta\text{AIC} = -32.7$). Model diagnostics indicated no issues with overdispersion or outliers but did pick up significant quantile deviations in DHARMA residuals versus the rank transformed predictions. Overall, the model we chose performed the best among reasonable alternatives.

Discussion

Fire had little to no effect on overstory tree mortality among plots in the ponderosa pine community, which was the desired management outcome. This result is unsurprising, as mature ponderosa pine trees are well known for being resistant to fire, especially under repeated, low to moderate intensity surface fires.

Objective 4: Maintain tree density above 163 trees/acre

Results: Objective partially met

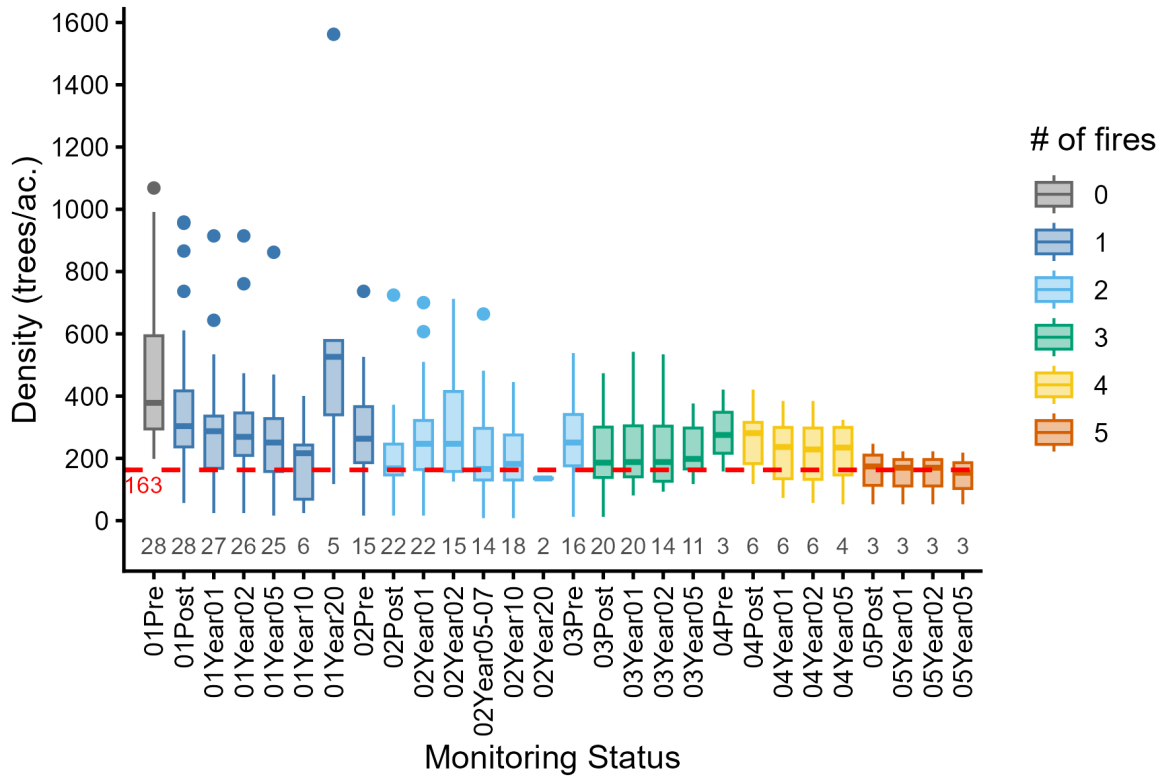


Figure 7. Distributions of tree density (all trees) per plot (trees/ac.), by monitoring status. The red dashed line is the lower threshold value for the desired future condition (trees/ac. > 163). Numbers in arev below the box plots are sample sizes.

Overall, tree density differed significantly between monitoring statuses (likelihood ratio test: $\chi^2 = 10,012$, $df = 27$, $p < 0.001$) (Fig. 7). The predicted means for post-fire monitoring statuses were lower compared to baseline (Fig. 8). Looking at the predicted marginal means and 95% confidence intervals compared to the threshold, we found that the desired condition was met for 01Pre through 03Pre monitoring statuses. For monitoring statuses 03Year02 and beyond, the confidence intervals overlapped the threshold or were entirely below 163 trees/ac.

Model design

Tree density (poles + overstory) was modeled using a Poisson distribution (log link). Model diagnostics indicated no issues with overdispersion or outliers. Some quantile deviations were detected in DHARMA residuals versus predicted values, but overall performance was deemed good enough to proceed.

Discussion

Based on the results, we can only conclude that the desired condition for tree density was met after the first two fires. The greatest reduction in tree density occurred after the first burn. Plots that burned more than two times experienced continued, gradual declines in tree density and were not above the desired threshold density. Some caution should be used in interpreting these results, as the sample sizes represented in the higher fire count categories were relatively small. As more of these the PIPO experience three or more fires, we may see different results. Continued monitoring is recommended.

Program Recommendations

Fire Management

The current target fire return interval of 7-9 years with low to moderate intensity severity achieved most of the desired objectives in the ponderosa pine community. Pole tree density was reduced and maintained at lower levels if burned frequently enough. Similarly, surface fuel loads were reduced and kept at lower levels if burned again in less than 10 years. Importantly, overstory tree density was maintained in the desired state, indicating that fire was not significantly increasing mortality. Areas that did not see fire for 10 or even 20 years were trending towards or had reverted to pre-treatment conditions. It remains to be seen if we can maintain the desired 163 or more trees per acre in the ponderosa pine community with more than two successive fires occurring within desired return intervals. We should continue to monitor tree structure to assess whether this objective is met in the long term.

Monitoring

The surface fuel and tree monitoring protocols for PIPO are robust and effective at demonstrating achievement or non-achievement of the desired objectives in this community. If time, funding, and staffing levels allow, continued use of FMH plots and protocols for monitoring in PIPO is a proven way forward for the monitoring program at SAGU. We did not analyze herbaceous species cover and diversity, as proper QAQC had not yet been performed on that dataset in time for this report, but we plan on completing this assessment in 2026.

C. Research, Planning, and Communication

Monitoring Plans

Monitoring plans for some southern Arizona parks were drafted in the early 2000s but were never finalized. The fire ecologist intends on continuing use of established monitoring protocols and schedules, while assessing potential alternatives, primarily through piloting (e.g., TLS). Once the existing fire effects monitoring datasets are fully vetted and analyzed, the Fire Ecology and Fire Effects programs will be in a better place to make necessary changes and develop comprehensive monitoring plans.

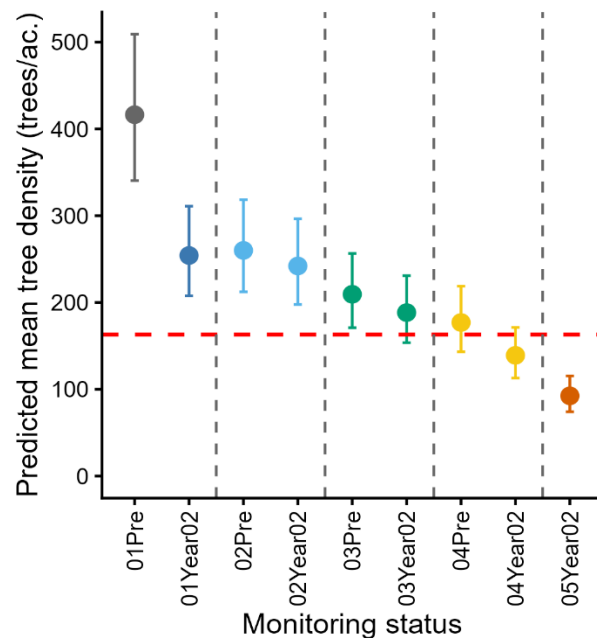


Figure 8. Predicted marginal means for tree density (dots), with 95% confidence intervals (bars). The red horizontal dashed line is the lower threshold for the desired density: trees/ac. > 163.

Reserve Fund Research

No new research projects were funded in 2025. One project that NPS funded in 2022 at SAGU was completed in spring of 2025. A short summary of this research is presented here. For the full results see the final report linked in Appendix D. Additionally, the research team presented their findings during a Southwest Fire Science Consortium webinar (recording: <https://www.swfireconsortium.org/>), created a StoryMap ([link](#)), and an informative brochure.

The research questions addressed were:

- 1) How do fire and climate affect the survival and growth of aspen and Chihuahua pine?
- 2) How can ecological data and future fire-climate scenarios be applied to guide management decisions on fire use?

The first question was investigated by assembling existing information on fire regimes, climate sensitivity, and monitoring, and by collecting new tree ring samples at SAGU. The second question was addressed by applying climate-sensitive models of fire and forest growth, using the Climate-Forest Vegetation Simulator, and examining outcomes over the next 50 years under different fire-climate scenarios.

The dendrochronology results found that aspen growth peaked in the early 2000s and then declined slightly afterwards. There was a positive correlation between aspen growth and precipitation from September to December of the previous year and March to May of the current year. Additionally, aspen growth was negatively correlated with maximum temperature. Chihuahua pine growth was highly variable; no long-term trends were detected. Growth was positively correlated with precipitation over a longer period compared to aspen, from September of the previous year through April of the current year. There was a strong negative correlation between Chihuahua pine growth and maximum temperature, especially from April to July of the current year. Analyses also suggested that Chihuahua pine is sensitive to short-term moisture availability.

Fire and climate modeling projected future declines in Aspen with drier and warmer climate, especially if wildfires occur. Models for Chihuahua pine indicated a greater ability to persist compared to aspen, but it was sensitive to drought with frequent fire, indicating it may struggle under future climate-fire scenarios, perhaps more than previously thought.

Management Recommendations

This study emphasized the need for adaptive management, given the different species' responses to climate and fire. Aspen should be monitored to ensure it regenerates properly following future disturbances. Targeted interventions for this species may be necessary, by locating suitable refugia and deliberately planting aspen in those. Limiting high intensity fire would greatly



View of Rincon Peak, looking south from Reef Rock on Mica Mountain. A small patch of aspen can be seen in the foreground (lighter green foliage). Photo by Gabriel De Jong.

benefit both species. Low to moderate intensity surface fires are likely necessary for long-term persistence of Chihuahua pine. Fire and resource management should consider moisture retention strategies in these communities, as both species were demonstrated to be sensitive to drought, especially with additional stressors, like fire disturbance.

Focused Condition Assessment: Vegetation response to Horseshoe Two wildfire

In summer of 2024, a Scientists in Parks (SIP) intern, Justin Sontag, began working with Chiricahua National Monument (CHIR) Natural Resources staff, the Sonoran Desert Network (IMR, SODN), and Southern Arizona Parks Fire and Aviation Management to assess long-term vegetation responses to the Horseshoe Two wildfire, which burned 85% of the monument in 2011. The fire had mixed effects overall, but particularly in upland areas there were severe effects. In the immediate aftermath of the fire, NPS funded research by Dr. Helen Poulos and collaborators (Poulos et al. 2021) to assess some of the immediate and short-term (4-7 year post fire) vegetation responses. This research highlighted that many native conifer species declined in density and cover post fire, transitioning many communities to oak-manzanita-grass. The fire, as well as ongoing drought, were likely driving forces for this shift. We decided to leverage monitoring data from Fire Effects monitoring and SODN's vegetation monitoring program to examine long-term vegetation trends, 10 or more years post fire.

The objectives were to:

- 1) Evaluate vegetation change post Horseshoe Two, at species and community levels
- 2) Explore trends in non-native grass invasion
- 3) Identify important ecological drivers of invasion and vegetation change

We found that post Horseshoe Two, there was an increase in grass cover, largely due to an increase in Lehmann's lovegrass (*Eragrostis lehmanniana*), a non-native invasive species. This species also increased its distribution within the park, spreading from lower elevations into mid- and in some cases high-elevation communities. Elevation, hillshade, slope, and fire severity were important predictors of Lehmann's lovegrass distribution, with it more likely to occur in low- to mid-elevations within the park, intermediate levels of sun exposure (not heavily shaded, not too sun-exposed), and areas that burned with low to mid-severity. Similar relationships were found with Lehmann's lovegrass cover.

Pinyon pine and oak cover both declined significantly post fire. Pinyon pine persisted in areas that had high rock cover and presumably were more sheltered/protected from the fire. In non-rocky areas, which experienced the largest decline in pinyon pine cover, levels remained very



Upland community at CHIR in 2024, 13 years post-Horseshoe Two wildfire. In high fire severity areas, mortality of conifer species was high, causing a shift to oak-manzanita-grass. Photo by Gabriel De Jong.

low 10 or more years post fire. In contrast, oak cover was strongly trending towards a full recovery.

Management implications

We found evidence that the vegetation shift observed in the years shortly after Horseshoe Two – towards more oak-shrub-grass communities – persisted 10-13 years post fire. Also, Lehmann's lovegrass increased significantly in distribution and cover in the post fire environment. Natural resource management should consider targeted invasive species control, especially in areas where the species is still invading (experiencing exponential population growth). Management should further consider how these vegetation changes, along with climate futures, might impact fire regimes in this sky island ecosystem and adapt plans as necessary. With increased likelihood of drought, higher temperatures, and potentially more frequent and intense fire, park management should consider what priority resources could be adversely impacted and take action to mitigate risks.

D. Future Direction

The following are expected to be major focus areas for the fire ecologist in 2026:

1. *Monitoring*: The nine PIPO fire effects plot reads that were missed in 2025 will be read in the spring or summer of 2026. The intent is to bring in a fire effects crew to assist with this effort, including USGS staff to help with TLS. No additional plots are up for monitoring at SAGU or CHIR. We will establish new monitoring plots at CORO for upcoming planned burns. The intent is to pilot the use of TLS at CORO for fire effects monitoring. CORO is a perfect testbed for this, as fuels management staff on the Sierra Vista Ranger District (USFS, Coronado National Forest) have been collecting TLS data in the vicinity of CORO for nearly 5 years. The models they have developed, specifically for oak-juniper savanna communities, are some of the most accurate in the United States, which means we will only have to collect a scaled down set of data in the field (Tier 1) along with the pre- and post-treatment scans.
2. *Data QAQC and analysis*: We will continue to conduct QAQC on fire effects monitoring datasets for SAGU and CHIR. Specific focus will be paid to the shrub and herbaceous protocols at both parks, as well as all protocols for QUHY and QUAR monitoring types at SAGU. We will then analyze and assess outcomes from past fires, both planned and unplanned, against the original management objectives set up for these burn units and monitoring efforts. The Ecology Assistant (SIP) will play a significant role in these efforts, under the guidance of the fire ecologist.
3. *Monitoring plans*: With data QAQC and analysis nearing completion for southern Arizona parks, and low demand for new reads in existing FMH plots, the Fire Ecology program will be in an ideal position to begin drafting monitoring plans for SAGU, CHIR, and CORO. The fire ecologist will dedicate time to drafting these in 2026.
4. *Fuels treatment planning and compliance*: Important compliance work for future fuels treatments is currently underway at SAGU, CHIR, and CORO. The fire ecologist expects to spend a significant amount of time working with park resource staff to ensure that these efforts move forward towards implementation. Activities may include reviewing updated Biological Assessments and USFWS consultations, reviewing burn plans, and

updating monitoring plans, among others. Additionally, the Ecology Assistant, working with the fire ecologist, will be engaged in work that will assist in planning for future prescribed fire units in the Rincon Mountains at SAGU.

5. *Live fuel moisture monitoring*: With several fuels-centric staff positions currently vacant, including the zone fuels specialist, the fire ecologist plans to keep some of this critical work moving forward. In 2025, the fire ecologist began collecting live fuel moisture data from several southern Arizona parks, after years of no such data being collected. Live fuel moisture data collection is a necessary component for prescribed fire implementation. Additionally, these data will assist fire management staff in understanding ideal seasonality for prescribed fire use. Our ideal burn windows have likely already shifted compared to 30+ years ago and are expected to continue changing under future climate conditions. The fire ecologist successfully recruited park staff and others to help in this effort in 2025 and will continue this work until it can be handed off to a fuels-focused staff member.

E. References, Links, and Additional Reading

- Poulos, H. M., Freiburger, M. R., Barton, A. M., & Taylor, A. H. (2021). Mixed-severity wildfire as a driver of vegetation change in an Arizona Madrean Sky Island system, USA. *Fire*, 4(78). <https://doi.org/10.3390/fire4040078>
- Swetnam, Thomas W.; Baisan, Christopher H. 1996. Fire histories of montane forests in the Madrean Borderlands. Pages 15-36 in: Ffolliott, Peter F.; DeBano, Leonard F.; Baker, Malchus B.; Gottfried, Gerald J.; Solis-Garza, Gilberto; Edminster, Carleton B.; Neary, Daniel G.; Allen, Larry S.; Hamre, R. H. (technical coordinators). Effects of fire on Madrean Province ecosystems: a symposium proceedings. General Technical Report RM-GTR-289. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Appendix A. Staffing and Accomplishments

Complete the staffing and personnel development information for fire ecologist and monitors (Table A-1). Include fire training (e.g., S-290, RX-310), NPS training, distance learning or on-campus college credit, technology training, NWCG task books initiated or completed, conferences attended, etc., details and temporary assignments, and other development activities.

Table A-1. Fire Ecology Staffing 2025

Ecologist and Monitors	Position	Appointment Length	Training and Development
Gabriel De Jong	Fire Ecologist	PFT	Annual Fire Refresher to retain FFT2 certification, IMR Fuels Workshop (Santa Fe, NM), Clifton Strengths Assessment, R+FFI Working Group and workshops, Workshop: Spurring Innovation in Adaptation to Altered Fire Regimes

Table A-2. Fire Ecologist 2025 Accomplishments/Focus Areas

Category	Percent Time	Accomplishments and/or areas of activities
Planning	10%	FMP updates for S AZ Parks, Section 7 consultation/BA review for CORO Rx Units, burn plan development and review for CORO, Meetings with Resource staff for CHIR/CORO compliance needs, Meetings and burn plan review for Border-1 Rx Unit (USFS, Sierra Vista District at CORO)
Presentations	2%	Developed presentation for "R for Data Visualization" Workshop organized by the R+FFI working group
Meetings/task groups	10%	Regional Fuels, FMO and Fire Ecology calls, LT meetings at SAGU, All Staff Meetings at SAGU, R+FFI Working Group meetings, Weekly SIP check-ins, fire-related webinars
Wildfire assignments	12%	Fill-in with the SAGU WFM on the Cody Fire in the Catalina Mts, near Oracle, AZ. Fill-in with the SAGU WFM on two wildfires: Cone Cabin (YELL) and Cub Creek (Kootenai National Fores, MN).
Prescribed fire/fuels treatment projects	2%	FEMO on prescribed fire at BITH with SAGU WFM
Research	0%	NPS Reserve Fund Research Request, JFSP, other
Field work/data collection	10%	Live fuel moisture data collection at SAGU and CORO, Rare Plant Surveys at SAGU, planning for SAGU plot reads
Data management	23%	QAQC for PIPO dataset at SAGU, QAQC for ARPU and BOGR plots at CHIR, managing data in FFI
Data analysis	15%	Analysis of PIPO dataset for SAGU, analysis of ARPU and BOGR plots at CHIR for SIP project
Supervision/admin tasks	10%	Hiring Ecology Assistant (SIP) for 2026, mentoring SODN/CHIR SIP intern, payroll, travel authorization/vouchers, purchasing
Training	1%	Annual Fire Refresher to retain FFT2 certification

Category	Percent Time	Accomplishments and/or areas of activities
Miscellaneous	5%	Developed a Survey123 for live Fuel Moisture Data collection, R code development for visualizing RAWS station data (NFDRS) for S AZ Parks, GIS maps and spatial layer development for S AZ Parks, reviewing scientific literature

Appendix B. History of Fire Effects Monitoring Plots

If [Table 1](#) in the summary section does not include all fire effects plots established, complete Table B-1.

Table B-1. All Fire Effects Plots Established

Park	Monitoring Unit	Plot Type (FMH Forest/Brush/Grass plot, photo point, Rapid Assessment, CBI, etc.)	Years Data Collected (start-end)	Total Plots
Coronado NM	Grassland (disturbed)	FMH Grass plot	2009 - 2017	15
Chiricahua NM	Blue grama	FMH Brush plot	1988 - 2023	10
Chiricahua NM	Manzanita	FMH Brush plot	1998 - 2023	10
Chiricahua NM	Emory oak	FMH Forest plot	1988 - 2023	13
Chiricahua NM	Ponderosa pine	FMH Forest plot	1988 - 2022	9
Saguaro NP	Chihuahuan pine	FMH Forest plot	2000 - 2016	7
Saguaro NP	Ponderosa pine	FMH Forest plot	1990 - 2024	28
Saguaro NP	Douglas-fir	FMH Forest plot	1990 - 2023	10
Saguaro NP	Arizona oak (Pine-Oak Forest)	FMH Forest plot	1999 - 2019	12
Saguaro NP	Silverleaf oak	FMH Forest plot	1997 - 2014	3
Saguaro NP	Arizona oak (woodland)	FMH Forest plot	1998 - 2008	9
Total				126

Appendix C. Summary table of PIPO Management Objectives and Monitoring Results

Unless otherwise stated, percent changes are based on predicted marginal means from statistical models. Where objectives defined for a specific time window, results were assessed for each prescribed fire or wildfire event and the stated post fire period.

Monitoring Unit	Management Objective	Monitoring Results (w/level of certainty)	Progress Towards Meeting Objectives
<i>Ponderosa Pine Forest and Woodland</i>	Maintain tree density above 163 trees/ac.	Confidence intervals for tree density: 01Pre: CI = 340 – 509 ($n = 28$) 01Year02: CI = 207 – 310 ($n = 26$) 02Year02: CI = 197 – 296 ($n = 15$) 03Year02: CI = 154 – 241 ($n = 14$) 04Year02: CI = 113 – 171 ($n = 6$) 05Year02: CI = 74 – 115 ($n = 3$)	Partially achieved
	$\leq 15\%$ overstory tree (DBH $\geq 15\text{cm}$) mortality 2 years post burn	Change in overstory tree density: 01Pre – 01Year02: -16% (NS) 02Pre – 02Year02: + 5% (NS) 03Pre – 03Year02: - 5% (NS) 04Pre – 04Year02: +6% (NS)	Objective achieved
	Reduce pole tree density by 30-50% 2 years post burn	Change in pole tree density: 01Pre – 01Year02: - 44% ($p < 0.001$) 02Pre – 02Year02: - 2% (NS) 03Pre – 03Year02: - 14% (NS) 04Pre – 04Year02: - 31% (NS)	Objective achieved
	Reduce fuel loading by 30%-60% 1 year post burn	Change in total surface fuel load: 01Pre – 01Year01: - 55% ($p < 0.001$) 02Pre – 02Year01: - 40% ($p < 0.001$) 03Pre – 03Year01: - 54% ($p < 0.001$) 04Pre – 04Year01: - 17% (NS)	Objective achieved
	Increase or maintain native herb cover and diversity 5+ years post burn	Unanalyzed. QAQC for shrub and herbaceous species protocols is ongoing.	TBD

Appendix D. Reserve Fund Final Report

Please see Appendix D that accompanies this document for a final report on the research project titled: Fire and climate interactions on forest resilience.