2015 Annual Report

to the USDA Forest Service under Sponsor Award
#14-DG-11031600-055 for 2014 (NAU Projects 1002442-1002446) and
#15-DG-11031600-073 for 2015 (NAU Projects 1002742-1002747)

Submitted by:

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Summary

This report presents an integrated and coordinated series of actions for $2.4 million awarded to the ERI in Fiscal Years 2014 and 2015 under CFDA 10.694, Southwest Forest Health and Wildfire Prevention.

The information provided herein reflects our annual progress as of 07/01/2015 and comprises the final report for 2014 deliverables conducted under #14-DG-11031600-055 (NAU Projects 1002442-1002446). 2015 deliverables under #15-DG-11031600-073 for 2015 (NAU Projects 1002742-1002747) have just started.

All of the activities (deliverables) summarized in this report respond to land manager and stakeholder requests and needs. The deliverables are informed by best available science and scientific evidence which is translated into the language and product appropriate for the target audience. The ERI actively delivers information using a variety of approaches that includes individual and group presentations and discussions, to printed and electronically accessible fact sheets, short technical reports, longer white papers and management reports, and peer reviewed archival literature.

Annual Report to the **USDA Forest Service**
For 2014 & 2015

USFS FY14 Plan of Work - #14-DG-11031600-055

FY14 Deliverables (Final) - #14-DG-11031600-055

<table>
<tr><th colspan="2">Project 1: Science Support for Collaborative Restoration and Conservation</th></tr>
<tr><td>Deliverable</td><td>Status</td></tr>
<tr><td colspan="2">1.1) Provide Support for the Four Forest Restoration Initiative (4FRI), a Collaborative Forest Landscape Restoration Act project</td></tr>
<tr><td>a) Report on technical assistance for science and monitoring. This includes: small group leadership, assistance to help incorporate the adaptive management and monitoring plan into the final EIS, and monitoring plan implementation planning</td><td>a) Technical assistance for science and monitoring
• Vosick. 12/4/14. Assistance for the Public Meeting to discuss the FEIS. 40 participants
• Vosick and Waltz. 10/1-2/14 Assistance with visit from GAO Review and Field Tour
• Covington, W and D. Vosick. 1/20/15. Presentation on 4FRI to the Arizona State Senate Committee on Rural Affairs and the Environment.
• Vosick, D., 1/26/15, Presentation on 4FRI to the Working Session of the Flagstaff City Council and Coconino Board of Supervisors.
• Greco, B. Conducted conference call with A-S NF Forest Leadership Team regarding ERI support to 2nd 4FRI NEPA Planning process. January 28, 2015</td></tr>
<tr><td>b) Summarize in a Fact Sheet lessons learned about leadership and administrative assistance to the 4FRI steering committee</td><td>b) Esch, B.E. 2015. Fact Sheet: Administrative Support in Collaborative Forest Restoration. ERI Fact Sheets (Doc# 194). Ecological Restoration Institute, Northern Arizona University. 2 p. http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015014.dir/doc.pdf</td></tr>
<tr><td>c) Report on IT support for the 4FRI Website and BASECAMP (an online collaborative work space), Website and Administration</td><td>c) IT, Website and Administration Support
• IT and Website Support. Continued maintenance of the 4FRI Website.
• <u>Administrative Support for 4FRI includes</u>: Note-taking and coordination for Steering Committee Calls. Note-taking, coordination, site scheduling and management for General Meetings. Management of BASECAMP an internal on-line communication tool
➢ Steering Committee Calls: Generally occur on the 1st and 3rd Tuesday of the month and last 1.5 hours: 6/17/14; 7/15/14; 8/19/14; 9/2/14;</td></tr>
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	10/7/14; 10/21/14; 11/4/14; 11/18/14; 1/6/14; 2/3/15; 2/17/15; 3/10/15; 3/17/15; 4/7/15; 4/14/15; 5/5/15; 5/19/15; 6/9/15; 6/16/15. ➢ Stakeholder Meetings: 6/25/14; 7/23/14; 8/27/14; 9/24/14; 10/22/14; 12/11/14; 1/14/15; 2/25/15; 3/25/15; 4/22/15 ➢ Coordination for a Museum of Northern Arizona programs titled, *4FRI* and the Future of our Forests* Wednesday, April 30th. Over 100 people in attendance. • Co-Leadership of Stakeholder Group: Includes chairing meetings, agenda development, assisting with media requests, organizing field trips, support for public meetings, managing work flow, navigating conflicts and problem solving. Responsibilities also involved representing the stakeholders during the conflict resolution process. A co-chair serves a term of 6 months and substitutes or assists other co-chairs as needed. State funding is leveraged with federal funding to pay for co-leadership. ➢ SHG Meeting Lead on: 10/22/14; 12/11/14; 2/25/15; 3/25/15 • Other 4FRI Support Activities: ➢ Vosick and Waltz. 10/1-2/14 Assistance with visit from GAO Review and Field Tour ➢ Vosick. 12/4/14. Assistance for the Public Meeting to discuss the FEIS. 40 participants ➢ Covington, W and D. Vosick. 1/20/15. Presentation on 4FRI to the Arizona State Senate Committee on Rural Affairs and the Environment. ➢ Vosick, D., 1/26/15, Presentation on 4FRI to the Working Session of the Flagstaff City Council and Coconino Board of Supervisors meeting on 4FRI.

1.2) Provide scientific and technical support for other CFLRP pilots and emerging projects	
a) Deliverable: Report on activities to support the national CFLRP monitoring network i. The ERI will assist the CFLRP National Monitoring Network to hold (3) webinars in partnership with National Forest Foundation addressing monitoring barriers and lessons learned among all 23 funded CFLRP sites. ii. ERI staff will initiate and coordinate a Region 2 and 3 CFLRP Monitoring Network (outcome from R2/R3 CFLRP workshop) with (6) conference calls planned. Goals are shared lessons learned regarding adaptive management and monitoring plans and coordination of cross-site communication with the development of ecological indicator reports.	Deliverable a: i. Webinars • Waltz, A. 7/15/14. Webinar. CFLRP National Monitoring Network & Peer Learning: Meeting national ecological indicators • Waltz, A. 9/24/14. CFLRP Nat Mon Network & Peer Learning: Expert Panel reviews ii. Initiate and coordinate R2/R3 CFLRP Monitoring Network • Waltz, A. 2/2/15. Strategy planning with NFF on R2/R3 network - deferred to national workshop
b) Deliverable: Report on support for the national 5-year monitoring report required by Congress under the Collaborative Forest Landscape Restoration Act. i. ERI staff will participant with USFS Washington Office CFLRP Coordinator to develop and finalize a template for the CFLRP National Ecological Indicator (for 5-yr reporting) and roll out the template utilizing the CFLRP National Monitoring Network.	Deliverable b.i: • Waltz, A. 8/2/14-10/31/14. Panel Participant. National Indicator Expert Panel. • Waltz, A. 10/15/14-11/24/15. Work with USFS WO and TNC on CFLRP 5-yr report - 3 working calls • Waltz, A. 6/8/15. CFLRP National Ecological Indicator - steps for next reporting

Project 2: Information Analysis to Assist Evidence-Based Conservation	
Deliverable	**Status**
2.1) Complete one review based on information needs identified on page 50-51 in "Restoring Composition and Structure in Southwestern Frequent-Fire Forests: A science-based framework for improving ecosystem resiliency" (RMRS GTR-310) using an established analytical framework	
a) Deliverable: A systematic review addressing an information need. The review will be published to the ERI web site and delivered to practitioners.	a) Sánchez Meador, A., J. D. Springer, D.W. Huffman, J. E. Crouse, M. A. Bowker. "Ecological restoration treatments improve soil function in frequent-fire forests of the western United States: A systematic review". Internal Review and anticipated for submission to Restoration Ecology later in 2015. ERI Manuscript # 186.

Project 3: Ecological Monitoring and Evaluation for Adaptive Management	
Deliverable	**Status**
3.1) Develop and initiate new LEARN study in a mixed-conifer forest on the Coconino National Forest (Build from FY13)	
a) Work with Coconino National Forest to develop treatment alternatives and study questions	a) Huffman, D., Greco, B, Sensibaugh, M., Sanchez Meador, A. 12/1/2014. Met with the Mogollon Rim District staff (5-hour meeting) to discuss treatment alternatives, design, and the "path forward" for our mixed conifer LEARN study.
b) Summarize baseline data and provide to agency staff	b) Huffman, D., Greco, B, Sensibaugh, M., Sanchez Meador, A. 12/1/2014. Conducted presentation (PowerPoint and handouts) to provide an update on our work and summarize baseline data we collected last summer. Attendees were also provided more detailed summaries in electronic form for their NEPA specialist.
c) Summarize reference conditions and present findings in journal article, conference, or workshop	c) Presentation at the 2014 Society of American Foresters' National Convention, Session: Sustainability from a Forest Ecology and Silviculture Perspective. Rodman, K.C., Sanchez Meador, A.J., Huffman, D.W. & K.M. Waring. "Reference Conditions and Spatial Dynamics in Southwestern Mixed Conifer Ecosystems". 10/10/14. Salt Lake City, UT. Approximately 25-30 attendees.

<table>
<tr><td colspan="2">3.2) Quantify reference conditions for spatial patterns in warm/dry mixed conifer forests on the Coconino National Forest</td></tr>
<tr><td>a) One manuscript for peer-reviewed publication

b) Workshop and/or field visit for agency staff and interested stakeholders (e.g., 4FRI, Salt River Project, US Fish and Wildlife Service, Arizona Game and Fish, state and local government)</td><td>a) Rodman, K.C. 2015. Reference Conditions and Spatial Dynamics in a Southwestern Dry-Mixed Conifer Forest. MS Thesis. Northern Arizona University, Flagstaff. 173 p.

b) 3/24/2015. Workshop for Forest Service and State Agencies: “Mixed Conifer Forest Ecology: Emerging Science”. Flagstaff, AZ. 26 Attendees. Presentations included:
• Rodman, K. Assessing and analyzing mixed conifer spatial patterns in northern Arizona.
• Huffman, D. Reference conditions and fire history at Black Mesa.
• Springer, J. Effects of tree cutting and fire on understory vegetation in mixed conifer forests.
• Waltz, A. Treatment effectiveness of mixed conifer treatments in the Wallow Fire.
• Sanchez Meador, A. Overview of the mixed conifer LEARN project on Mogollon RD</td></tr>
<tr><td colspan="2">3.3) Wildlife responses to restoration and hazardous fuels reduction treatments</td></tr>
<tr><td>a) Cancelled as the result of reduced funds
b) Report on pretreatment conditions and progress of the Flagstaff Watershed Protection Project (FWPP) wildlife monitoring

c) Cancelled as the result of reduced funds</td><td>b) “Mexican Spotted Owl Habitat monitoring Flagstaff Watershed Protection Project (FWPP) Dry Lake Hills Area”. Progress report prepared by Huffman, D., J. Crouse, M. Stoddard, W. Chancellor, J. Roccaforte. Delivered to partners at U.S. Fish and Wildlife Service, US Forest Service, Greater Flagstaff Forests Partnership (GFPP) and the City of Flagstaff. Link to document</td></tr>
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<tr><th colspan="2">Project 4: Understanding and Solving the Economic, Social, and Political Issues and Opportunities of Ecological Restoration</th></tr>
<tr><td>Deliverable</td><td>Status</td></tr>
<tr><td colspan="2">4.1) Actions and a case study to increase understanding of innovative funding approaches for achieving forest restoration and wildfire risk reduction.</td></tr>
<tr><td>a) Provide technical support to implement innovative funding streams.
i. Deliverable: Report on activities to support implementation</td><td>a) Technical Support
• Vosick D. 2014. 10/9-10/14.Finding Solutions: Healthy Forests, Vibrant Economy. Moderated Panel on local impacts of fire and flooding. Provided conference summary and facilitated a Q and A at the conference. 200 people. Included weekly planning meetings.
• During calendar year 2014 and 2015 the ERI worked with Cori Dolan from the University of Arizona to facilitate a conversation between the Coronado National Forest and nonprofit organizations in Southeastern Arizona to identify ways to accelerate restoration on the Coronado National Forest. The Scope of work was to:
1. Serve as Lead Coordinator for Southern Arizona restoration funding effort, including convening partners, coordinating meetings and handling all administrative logistics.
2. In cooperation with the other members of the coalition, develop educational materials to explain the goals of and potential mechanisms for the innovative funding effort.
3. In cooperation with other members of the coalition, identify and interview a minimum of ten conservation leaders, business representatives, and elected officials in Southeastern Arizona to assess their reaction to the project and to uncover potential funding mechanisms that can be used to accelerate restoration.
4. Research the most promising funding mechanisms to determine their feasibility for use in Southeastern Arizona. Consider both the pros and cons of each mechanism, the timeline for initiation and implementation, and the costs associated with developing the mechanisms. Prepare this analysis in such a way that it can be used in a future workshop.</td></tr>
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	5. Assist the coalition and the Sky Island Alliance to plan and implement a regional workshop designed to describe the need for accelerated restoration in the Sky Islands, discuss funding mechanisms and build community understanding and support. All deliverables were completed except for assistance to support a workshop (# 5). The workshop was to be funded by the Sky Island Alliance. Due to budget issues and leadership changes at the Sky Island Alliance the workshop was cancelled. In a nutshell, educational materials were prepared, interviews conducted and funding mechanisms examined. Dealing with buffelgrass is the restoration identified as most important through interviews and conversations with the Forest Service. The Coronado is now working with the Sky Island Alliance to form a new nonprofit called Coronado Outdoors. This organization is anticipated to take over raising funds for restoration once it is up and running.
b) Compile a case study of local government and the Forest Service working together to leverage funding. In particular identify the essential components for successful partnerships including: appropriate and efficient financial instruments to transfer funds, mechanisms for establishing and executing appropriate roles and responsibilities and other details that will assist other communities replicate successful partnerships. i. Deliverable: Case Study	b) Working Title: *The Flagstaff Watershed Protection :Project – A Unique Community Partnership. Submitted by Mottek Lucas and in final production/press at ERI.* ERI Document #192
4.2) Analyze the relationship of fuels treatments and restoration on real estate values.	
a) Deliverable: Manuscript for publication b) Deliverable: Fact Sheet	a) Hjerpe, E, Y. Kim, L. Dunn. Forest Density Preferences of Homebuyers in the Wildland-Urban Interface. (ERI #186) Submitted to Ecological Economics, July 2015. b) Working Title: Real Estate Values and Wildfire, D. Vosick and Y.S. Kim (ERI# 191) Pending -- dependent on peer-review of publication referenced in item a, above.

Project 5: State, Tribal and Private Forestry - The All Lands Approach
Project eliminated April, 2014

Project 6: Services to the Intermountain West	
Deliverable	**Status**
6.1) Provide support to federal land managers with treatment planning and implementation	
a) Deliverable: Report on actions to support project assessments, data collection, treatment design, and use of best available science by federal land managers to achieve desired conditions and outcomes. i. 7 Field Trips	i. Field Trips ✓ Sensibaugh M, Stoddard M. Field trip and discussions with USFS Coronado NF (Safford Ranger District) personnel at the Hospital Flats site on the Piñaleno Ecosystem Restoration Project (PERP) ERI demonstration mark and RAP. May 19-21, 2014. Pinaleno Mtns. ✓ Sensibaugh, M.,Greco, B., Participated in a Field Trip to the Piñaleno Ecosystem Restoration Project (PERP) in conjunction with the SW Fire Science Consortium and made a presentation on "Ecological Restoration of Mixed Conifer Forests of the Southwest". Safford, AZ. June 7, 2014 42 participants ✓ Sensibaugh, M., Greco, B., Conducted a Field Trip with Prescott NF personnel to evaluate MSO PAC's and management strategies in the Greater Prescott area. Prescott NF, June 17, 2014 5 participants ✓ Greco, B., Sensibaugh, M., Field trip to evaluate Treatment Effects and Marking Prescriptions for the Rim Lakes Timber Sale", Black Mesa RD, A-S NF. Heber, AZ. June 17, 2014 13 participants ✓ Greco, B., Sensibaugh, M., Conducted a Field trip and presentations for the A-S NF Staff and NEPA Contractor on the Upper Rocky Arroyo Restoration Project (URAR) on the topic "Rapid Assessment Results of Evidence-based Restoration on the URAR Project". Lakeside, AZ. July 21, 2014. 17 participants. ✓ Covington, W, Greco, B., Sensibaugh, M., Vosick, D., Field trip with the Tonto NF Line Officers and Staff to review Reference Conditions and understory response to treatments on the Payson and Pleasant Valley RD's, Tonto NF. October 13, 2014 22 participants ✓ Greco, B., Sensibaugh, M. Field trip on the Rio Gordito Ecosystem Restoration Project area to train USFS personnel, Carson NF on "Evidence Based Restoration". Tres Piedras, RD, Carson NF. November 12, 2014. 5 participants.

	✓ Greco, B., Roccaforte, J.P., Field trip to the Mineral LEARN Sites with USFS Personnel from the W.O., R.O. and A-S NF to review fire effects from the San Juan Fire (2014) and participate in a video production of Lessons Learned for use by the USFS in national programs by the Wildfire Lessons Learned Center. A-S NF. 20 participants. August 17, 2014. http://www.youtube.com/playlist?list=PLTjug05B4KNvvloePSAFuvKOlKPZxWfhs ✓ Huffman, D., Sanchez-Meador, A., Roccaforte, J.P. Sensibaugh, M. – Coordinator: Field trip with Coconino NF personnel to design treatment prescriptions for the Mixed-conifer LEARN project. Mogollon Rim RD, Coconino NF. December 12, 2014, 11 participants. ✓ Huffman, D., Greco, B., Sensibaugh, M. Conducted Field Trip for A-S NF personnel to evaluate Pinon-Juniper and Grasslands within the Escudilla East Restoration Project near Springerville, AZ. March 11, 2015 8 participants.
ii. 2 Rapid Assessments (RAPS) presently planned on the Apache-Sitgreaves and Prescott National Forests. We are engaged in early discussions to establish a restoration treatment demonstration area on the Coronado National Forest	ii Rapid Assessments (RAPS) ✓ Greco, B., Sensibaugh, M. Conducted a Rapid Assessment for the "Upper Rocky Arroyo Restoration Project", Lakeside RD, A-S National Forest. Link to document ✓ Sensibaugh, M., Greco, B. Conducted a Rapid Assessment for "Tio Gordito Restoration Project", Tres Piedras RD, Carson NF Link to document
iii. Combination of 10 total services based on previous and anticipated demand that may include: workshops, technical assistance, science support and presentations	iii. Services ✓ Greco, B., Sensibaugh, M., Meeting and presentation to USFS A-S Personnel & public participants regarding a Rapid Assessment request from A-S FLT on the Upper Rocky Arroyo Restoration Project, Lakeside, AZ, May 8, 2014. 9 participants ✓ Greco, B., Presentation "Bridge Projects Monitoring Plan" to the Natural Resources Working Group (NRWG), Eagar, AZ. May 13, 2014 32 participants ✓ Greco, B., Developed a Monitoring and Adaptive Management Plan for the A-S "Bridge Restoration Projects". Springerville, AZ. May 13, 2014 ✓ Greco, B., Presentation on "The White Mountain Stewardship Project: Ten-year Report" to the NRWG, Show Low, AZ June 17, 2014 27 participants ✓ Sensibaugh M., Meeting and presentation(s), Greater Flagstaff Forest Partnership (GFFP); monthly meetings, 7-12 participants

	✓ Sensibaugh M., Meeting and discussion about permits and implementation of the Mogollon Rim LEARN project, Mogollon District and Coconino NF, June 9, 2014, 4 participants ✓ Sensibaugh M., meeting and presentation with Ben DuBois on the Prescott NF to coordinate details for the first RAP Trip, 6/10-14, Prescott, AZ. June 10, 2014. ✓ Greco, B., Presentation on "Integrating the A-S Bridge Monitoring Plan and the 4FRI Monitoring and Adaptive Management Plan" to the NRWG, Eagar, AZ. July 15, 2014 35 participants. ✓ Sensibaugh M., Meeting with Mogollon Rim District Ranger, Linda Wadleigh, regarding the Mogollon Rim Mixed-conifer LEARN project, Coconino NF, July 24, 2014 Flagstaff. 3 participants. ✓ Waltz, A. Presentation. Ft. Valley Research Symposium: Ft. Valley Experimental Forest. August 8, 2014. ✓ Greco, B. and J.P. Roccaforte. Participated in a formal USFS National Office facilitated review of the San Juan Fire (6/26-7/2 2014). Input and overview of the Mineral LEARN is reported in the "San Juan Fire Fuel Treatment Effectiveness Report" prepared by the Apache-Sitgreaves National Forest, Arizona. August, 2014. Link to Document ✓ Greco, B., Sensibaugh, M., Workshop for the Prescott NF Forest Supervisor, Staff & Bradshaw RD personnel, "Principles of Restoration and application in MSO PAC's & Territories", October 6, 2014. Prescott , AZ 10 participants ✓ Greco, B. Meeting with Neil Bosworth, Forest Supervisor, Tonto NF & Staff to determine content of a presentation at a future FLT meeting, Tonto NF. Phoenix, AZ October 17, 2014. 4 participants ✓ Greco, B., Sensibaugh, M., Presentation and meeting with Payson RD personnel regarding reference conditions and Rapid Assessment results on the Payson & Pleasant Valley RD's., Tonto NF. Payson, AZ October 27-28, 2014 5 participants ✓ Meador-Sanchez, A., Greco, B., Sensibaugh, M., Meeting with Tres Piedras District Ranger, Chris Furr to develop a strategy for science support to the Districts program in FY 2015. November 6, 2014 Flagstaff, AZ. 5 participants ✓ Greco, B., Sensibaugh, M. Conducted a Workshop on "Principles of Restoration & Reference Conditions of Southwestern Ecosystems". Tres Piedras RD, Carson NF. November 13, 2014. 21 participants.

	✓ Greco, B., Sent a copy of current research publications and the ERI Newsletter to each Line Officer in Region 3, and multiple Staff in the R.O. and each forest in the Region. Purpose of the information sharing was to ensure effective science transfer and communications regards response to USFS Needs Assessments across the Region. November 2014 ✓ Greco, B., Sensibaugh, M., Conducted a workshop for the Apache-Sitgreaves NF Escudilla East ID Team and Line Officers in Alpine, AZ. December 11, 2014. 22 participants.

6.2) Assist with USFS forest planning and implementation	
a) Deliverable: Report on actions to support forest planning, implementation, and integration of best available science in FLMP revisions. Specific support to be provided to the Apache-Sitgreaves, Tonto, Coconino and Kaibab Forest Plan revisions	✓ Greco, B., Assisted Tonto NF Forest Plan Revision Team by Presenting "Ecological Restoration and Fire: A Historical Perspective" at a public meeting in Payson, AZ May 21, 2014 140 participants. https://www.youtube.com/watch?v=qhKZEUT1dcc ✓ Greco, B., Sensibaugh, M., Participated with the Tonto NF FLMP Revision Team by Presenting "Ecological Restoration and Fire: A Historical Perspective" at a public meeting in Pleasant Valley, AZ, July 2, 2014. 55 participants. https://docs.google.com/file/d/0B1wq3f66mAw_enViS2dyakRSdkE/edit ✓ Greco, B., Provided Science –Findings and Reference Bibliography to the Tonto NF FLMP Revision Team regarding Restoration of Frequent Fire Forests and ecosystems on the Tonto NF. Phoenix, AZ. July 7, 2014 ✓ Greco, B., Sensibaugh M., Meeting with Payson RD District Ranger Angie Elam, and Timber Staff, to discuss ERI involvement with forest planning activities on the Payson Ranger District. July 7, NAU/ERI office, Flagstaff, AZ. 4 participants. ✓ Greco, B., Conference call with the Escudilla East Restoration Project to discuss possible support from ERI to provide a Rapid Assessment and Report for consideration in the Project EIS process. Alpine RD, Apache-Sitgreaves NF November 24, 2014 7 participants ✓ Greco, B., Conference call with the Tonto NF Forest Plan Revision Team regarding data collection priorities for Ponderosa pine structure changes, understory response patterns and fire regimes on the Tonto NF, November 26, 2014 9 participants ✓ Huffman, D., Sanchez-Meador, A., Sensibaugh, M., Greco, B., Meetings and Presentations to Coconino NF Staff and Line Officer (Mogollon Rim RD) on design of the Mixed conifer LEARN Study. Happy Jack, AZ. December 1, 2014 17 participants. ✓ Greco, B., Springer, J., Made presentations & participated in a coordination meeting with various organizations, hosted by the Coconino NF on "Ethnobotany Development through Restoration Treatments". Flagstaff, AZ. February 24, 2015. 8 participants. ✓ Greco, B., Sensibaugh, M., Presentation to Tonto NF Leadership and Forest Land Management Plan Revision Team with video conference participation by the R-3 Regional Office. "Summary Results of the Reference Condition and Fire Regime Rapid Assessment – Tonto NF". Phoenix, AZ. April 23, 2015 13 participants.

6.3) Provide Web support for ERI, SWERI, 4FRI	
a) Deliverable: Report on technical support for ERI, SWERI and 4FRI websites	• Web Accomplishments • ERI Web Analytics • 4FRI-AZPFC Webstats • SWERI Web Analytics Link to document
6.4) Translate biophysical and social-political-economic information for affected entities	
a) Deliverable: Editorial support for 1 white paper	a) Editorial Support for white paper i. FWPP assessment in progress (Mottek Lucas) ii. Brown, S.J. 2015. Administrative and Legal Review Opportunities for Collaborative Groups. ERI White Paper—Issues in Forest Restoration. Ecological Restoration Institute, Northern Arizona University and the Western Environmental Law Center. 12 p. http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015006.dir/doc.pdf
b) Deliverable: Editorial support for 2 working papers	b) Editorial Support for 2 working papers i. Egan, D. 2015. The 2012 Mexican Spotted Owl Recovery Plan Guidelines for Forest Restoration in the American Southwest. ERI Working Paper No. 33. Ecological Restoration Institute, Northern Arizona University. 11 p. http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015015.dir/doc.pdf ii. Kent, L.Y. 2014. An Evaluation of Fire Regime Reconstruction Methods.ERI Working Paper No. 32. Ecological Restoration Institute and Southwest Fire Science Consortium, Northern Arizona University. 15 p. (ERI#182) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2014037.dir/doc.pdf
c) Deliverable: 8 fact sheets	c) Fact Sheets i. Rocafforte, J.P. Fact Sheet: Planting to Restore Ponderosa Pine Sites Burned by High-Severity Fire. September, 2014 (ERI# 56) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2014035.dir/doc.pdf ii. Esch, B.E. 2015. Fact Sheet: Administrative Support in Collaborative Forest Restoration. ERI Fact Sheets. Ecological Restoration Institute, Northern Arizona University. 2 p. (ERI#194) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015014.dir/doc.pdf

	iii. Waltz, A.E.M. 2014. Effectiveness of Fuel Reduction Treatments: Assessing Metrics of Forest Resiliency and Wildfire Severity after the Wallow Fire, AZ. ERI Fact Sheets. Ecological Restoration Institute, Northern Arizona University. 2 p. (ERI# 183) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2014041.dir/doc.pdf iv. Fact Sheet: Forest Structure and Fuel Dynamics Following Ponderosa Pine Treatments, White Mountains, Arizona, USA. Roccaforte, J.P. 2015. Ecological Restoration Institute, Northern Arizona University. 2 p. (ERI#187) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015009.dir/doc.pdf v. Stoddard, M.T. 2015. Ecological and Social Implications of Employing Diameter Caps at a Collaborative Forest Restoration Project Near Flagstaff, Arizona. ERI Fact Sheets. Ecological Restoration Institute, Northern Arizona University. 2 p. (ERI# 188) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015017.dir/doc.pdf vi. Huffman, D.W. 2015. Fire History of a Mixed Conifer Forest on the Mogollon Rim, Northern Arizona, USA. ERI Fact Sheets. Ecological Restoration Institute, Northern Arizona University. 2 p. (ERI# 190) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015013.dir/doc.pdf vii. Bryant, T. 2015. Implications of Diameter Caps on Multiple Forest Resource Responses in the Context of the Four Forest Restoration Initiative. ERI Fact Sheets. Flagstaff, AZ: Ecological Restoration Institute, Northern Arizona University. 2 p. (ERI#189) http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015020.dir/doc.pdf viii. Pending #191. Working Title: Real Estate Values and Wildfire, D. Vosick and Y.S. Kim (dependent on peer-review of item a, above.)

6.5) Initiate and facilitate knowledge services and science support through field trips, filling information requests, and presentations for affected entities	
a) Deliverable: Report on actions to educate and support affected entities i. 5 Field Trips	i. Field Trips 1. Vosick, D. Field Trip to Gus Pearson Natural Area requested by SRP for the Western Water Policy Meeting. July 30, 2014. 12 Participants 2. Vosick, D. Field Trip to Gus Pearson for SRP. August 20, 2014. One participant. 3. Covington, WW and D. Vosick, Field Trip for Senator McCain staff (Nick Matiella). October, 31, 2014. One Participant. 4. W.W. Covington. Field trip with AZ Daily Sun enviro/science reporter Emery Cowan to GPNA to learn about restoration ecology and forest restoration science. April 7, 2015. One participant. 5. Vosick, D. Paul Orbuch, Caitlin Polihan and Jeff Whitney requested Flagstaff Tour to understand why the FWPP is so successful. April 14 and 15, 2015
ii. 10 Presentations	ii. Presentations ✓ Greco, B., Video interview by The International Wood Culture Society to provide education on "Ecological Restoration of Ponderosa Pine and the Natural Role of Fire" to an International audience. May 15, 2014 Link: http://www.woodculturetour.org/DestinationContentVideo.cfm?spots=147 ✓ Sensibaugh, M., Participation and presentations, on monthly basis as Board Member for the Greater Flagstaff Forests Partnership (GFFP). Flagstaff, AZ 7-12 participants. ✓ Greco, B., Presentation "Bridge Projects Monitoring Plan" to the Natural Resources Working Group (NRWG), Eagar, AZ. May 13, 2014 32 participants ✓ Greco, B., Presentation on "The White Mountain Stewardship Project: Ten-year Report" to the NRWG, Show Low, AZ June 17, 2014 27 participants ✓ Greco, B., Organized & facilitated a meeting & Conference call with 7 Federal, State & private entities to plan a Prescribed Fire Training Exchange (TREX) to be conducted 10/2014 in Northern AZ on Federal, State , TNC, City of Flagstaff, AZ and private lands. Made an on-line presentation on Prescribe Fire Exchange Programs in Northern Arizona in cooperation with the TNC Fire Learning Network. Flagstaff, AZ. July 28, 2014. 13 participants. ✓ Vosick D. 9/5/14. Assisted production crew for the Arizona Leadership Forum to produce a video on 4FRI at GPNA. 3 videographers/4 interviewees. September 5, 2014 ✓ Greco, B., Presentation on "Liability Requirements and Proposed

	Legislative Remedies for Prescribed Burns on Non-Federal Lands in Arizona" to the Southern Arizona Wildland Fire Coordination Group – Winter Meeting and the Altar Valley Conservation Alliance. Tucson, AZ. December 2, 2014 35 participants ✓ Vosick. Webinar on Forest Restoration for the Audubon Western Rivers Action Network. 17 participants. December 17, 2014 ✓ Greco, B. Made multiple presentations at the monthly NRWG and White Mountain Stewardship Monitoring Board meetings in 2014. Springerville, Eagar and Show Low, AZ. 15-40 participants at each meeting. ✓ Greco, B., Presentation to the 4FRI Collaborative Meeting regarding Bridge Project and 4FRI Monitoring Plans. Show Low, AZ. March 25, 2015. 35 participants. ✓ Greco, B. Presentation to the Arizona Prescribed Fire Council "FY 2014-2015 Council Accomplishments" Payson, AZ March 27, 2015 12 participants. ✓ Greco, B., Sensibaugh, M., Meeting with Trout Unlimited regarding Restoration treatments in Central Arizona and resultant effects on fisheries. Payson, AZ. April 9, 2015. ✓ Greco, B., Presentation to various organizations and city & county Government Official regarding the 4FRI Phase 2 NEPA process. Show Low, AZ. April 21, 2015. 27 participants ✓ Vosick, D. ASU Continuing Legal Education. Assisted in the planning and delivery of two day workshop for lawyers and other public officials on Fire and restoration. 40 participants. May 6 and 8, 2015. Provided information as reported in section iii below. Presentations were also made at the seminar titled The Wildfire Menace: Will the West Learn or Burn? How to learn from History Instead of Repeating It o Covington, W. "Fire, Forests, and Water: Historical and Anticipated Changes in Forests of the West" o Vosick, D. "Federal Forest Management: Barriers and Bridges to Restoring Forests."
iii. 10 Information requests, this is an estimate based on previous demand	iii. Information Requests ✓ Greco, B., Information request for ERI Fire Fact Sheet. The Nature Conservancy, Flagstaff Office. May 5, 2014 ✓ Greco, B., Request for assistance to review USDA Grant Funding Proposals, by Arizona Department of Forestry, May, 6, 2014 ✓ Greco, B., Submitted a letter of reference (per request) to Eastern AZ Resource Advisory Council for Integrated Biological Solutions, LLC for funding of the White Mountain Stewardship 10-Year report. May 22, 2014

	✓ Greco, B., Responded to an information request from The International Wood Culture Society" regarding "Wood Culture and Uses as Related to the Desert of the Southwest". June 17, 2014 ✓ Vosick, D. Phoenix Law Firm (Ken Hodson) asking about forest policy/possible forest policy seminar. June 27, 2014 ✓ Crouse, J., Greco, B. Responded to a request from the Apache County, AZ Natural Resources Director to provide Access to a Webinar and provide a summary of Federal Land Acreage for Apache & Navajo Counties (Webinar, Maps, Data summaries). June 26, 2014 ✓ Vosick, D. Beck Group (Roy Anderson) - Consulting firm in Portland, OR looking for info on SW industry. July 8, 2014 ✓ Vosick, D. KTAR Phoenix NPR affiliate. Interview regarding value of restoration treatments. July 8, 2014 ✓ Vosick, D. Request from Carl Fiedler for assistance with old logging photos for a new book. Put in touch with Cline Library, ERI covered cost of photos. July 8, 2014 ✓ Greco, B. Organized a meeting with NAU SOF (Dr. Yeon-Su Kim) and Mottek Consulting (Anne Mottek) to develop a strategy/proposal for completing the White Mountain Stewardship Ten-year Report (2004-2014). Flagstaff, AZ. July 9, 2014. 3 participants. ✓ Vosick, D. Assistance to Stephen Pyne assembling historical information about fire use at Mount Trumbull. July 19, 2014 ✓ Vosick, D. Ron Klawitter (SRP). Information to help understand the economic issues in the White Mountains. July 23 2014 ✓ Vosick, D.. Nat Lichten – WRI. Interviewed about the FWPP and the factors that made it successful. Was sent supporting materials including the Survey White paper and fact sheets. July 24th ✓ Greco, B., At the request of the Flagstaff Fire Department and the Greater Flagstaff Forest Partnership, provided input/support to the Learning Network Hub for the Fire Adapted Communities Program. (http://www.fireadapted.org) Flagstaff, AZ. August 4, 2014 ✓ Vosick, D. Art Babbott. Request for information about cable logging. Wally Covington, Abe Springer, Sharon Masek Lopez and Andrew Sanchez Meador consulted on the response. August 7, 2014 ✓ Vosick, D. Bruce Hallin. Request for information about the frequency of lightning at CC Cragin. Worked with Dave Huffman to provide a response and sent literature. August 22, 2014

	✓ Vosick, D. Jim Paxon. AZ Game and Fish - Economic Trend statistics for the timber industry in Arizona. Referred him to Patrick Rappold after reviewing selected literature. September 10, 2014 ✓ Dubay, T. Lisa Schnebly Heidinger. Request for assistance with photos of Abe Springer for a new book Lisa is writing for NAU. Provided Lisa with photos and photo credit info. September 10, 2014 ✓ Dubay T. Emery Cowan - AZ Daily Sun. New enviro reporter with AZ Daily Sun, Emery Cowan, met with Wally Covington and Diane Vosick to learn about ERI and local forest health issues. September 12, 2014 ✓ Dubay, T.. Carla Sandine. Wally Covington Video Interview about forests and 4FRI for a piece to run at the Arizona Leadership Forum on September 19th in Phoenix. 1200 people anticipated. September 19, 2014 ✓ Greco, B. and Vosick, D. Meeting with AZ (District 6) Senator Carlyle Begay to provide science publications and respond to his request for input regarding Carbon Sink Exchange options between the Navajo Tribal Council, State of Arizona & EPA. Flagstaff, AZ. October 15, 2014. ✓ Vosick, D. Met with Megan O'Grady, Stratus Consulting-Interview concerning FWPP and its contribution to creating a resilient community. October 21, 2014. ✓ Greco, B. Meeting with NAU SOF Professor David Auty to assist in his transition to NAU & provide a framework for cooperative studies with ERI. Flagstaff, AZ. October 22, 2014 ✓ Greco, B., Sensibaugh, M. Five telephone conference calls with USFS Personnel on the Carson NF in response to project Assessments, providing science support & technical assistance to Program Planning & Forest Plan Revision support from ERI. October & November, 2014 ✓ Vosick, D. Robert Breunig - Museum of NAZ requested ERI assistance in developing content and editing text for their Slide Fire Exhibit. December 2, 2014 ✓ Greco, B. Participated in the BLM Uinkaret Mountains Restoration Project Public NEPA Scoping Meeting to provide information and science support, requested by the St. George, Utah BLM Office. Flagstaff, AZ December 3, 2014 ✓ Vosick, D. Request from Scott Harger for ERI Working Papers. December 22, 2014 ✓ Dubay, T. Emery Cowan - AZ Daily Sun requested information on PIPO die-off predictions in face of climate change. January 5, 2015 ✓ Greco, B., Roccaforte J.P., Responded to a data request (Photos, Maps) from the USFS Lessons Learned Center regarding the

	Mineral LEARN sites impacted by the A-S NF San Juan Fire. January 15, 2015 ✓ Greco, B., Crouse, J., Responded to a request by R-3 Regional Ecologist Jack Triepke to set up an FTP site for ERU Data exchange. January 16, 2015 ✓ Greco, B., Presentation to the Natural Resources Working Group, "White Mountain Stewardship Contract – Ten Year Report Strategy", Eagar, AZ, January 20, 2015 32 participants. ✓ Greco, B. Conference call with A-S Leadership Team (Tom Osen-Lead) regarding Natural Resource Working Group integration with 4FRI Collaborative process. January 29, 2015. 7 participants ✓ Dubay, T. Pete Caligiuri – TNC requested permission to use a quote from Wally Covington's LiveScience op-ed on the Deschutes Forest Collaborative website along with a head shot of Dr. Covington. February 2, 2015 ✓ Greco, B. Presentation regarding "White Mountain Stewardship Contract and Restoration Outcomes" to Navajo County Board of Supervisors & Natural Resource Working Group. Show Low, AZ. February 17, 2015 27 participants. ✓ Greco, B., Sensibaugh, M., Conference call with tonto NF FLMP Revision Team to coordinate Ecological Response Units and Reference Condition Rapid Assessment on the Payson and pleasant valley RD's, Tonto NF. February 19, 2015 7 participants. ✓ Greco, B., Participated in a conference call with Tom Osen & Misc. A-S NF Staff to discuss the update to the Bridge Projects Monitoring Plan. February 19, 2015 5 participants. ✓ Greco, B., Conference call with Tonto NF FLMP Revision Team & Deputy FS Kerwin Dewberry to coordinate ERI support to the Tonto NF Forest Plan Revision Process. Phoenix, AZ March 11, 2015 5 participants. ✓ Greco, B., Sensibaugh, M., Conference call with Tessa Nicolet to coordinate Fire Regime data collection and modeling for the Carson & Tonto NF's. Payson, AZ March 23, 2015 3 participants. ✓ Dubay, T. Kevin Sullivan - Sedona Fire Dept. requested Wally Covington to appear in a video on community wildfire prevention and preparedness. April 17, 2015 ✓ Vosick, D. Information to the Federal Lands Subcommittee of the House Natural Resources Committee Hearing entitled "The Devastating Impacts of Wildand Fires and the Need to Better Manage our overgrown, fire-prone National Forests". April 23, 2015 ✓ Dubay, T. Steve Rosenstock - AZ Game and Fish Dep't requested photos to use in briefing materials that mention fire

	impacts to forest ecosystems and wildlife, and emphasize need for proactive restoration. April 25, 2015 ✓ Vosick, D. Kris Keifer requested validation of information pertaining to treatment effectiveness during the Wallow fire. April 27, 2015 ✓ Dubay, T. Caroline Pilkington-contractor for County/Co requested photos for a poster the county and city officials will be using in a presentation about forest restoration and inter-agency partnerships to protect communities in St. Louis. May 4, 2015 ✓ Vosick, D. ASU Continuing Legal Education. Assisted in the planning and delivery of two day workshop for lawyers and other public officials on Fire and restoration. 40 participants. May 6 and 8, 2015. Also gave presentations that are reported in section ii, above. ✓ Vosick, D. Chuck Podlak, Ofc of Senator Flake requested review of different national data sets and if they would be good for providing HFRA like requirements. May 12, 2015 ✓ Vosick, D. Chuck Podlak, Ofc of Senator Flake requested review of Senator Thune legislation and appropriateness for Arizona - engaged Paul Summerfelt, City of Flagstaff. May 12, 2015 ✓ Vosick, D. Matt Strickler, Ofc of Congressman Grijalva requested assistance for upcoming testimony on the need to stop fire borrowing. Referred him to Aumack, Falk and Barnwell as possibilities. May 14, 2015 ✓ Vosick, D. Terry T. Brady, Nordev LLC. Wanted link to our Workforce report after hearing interview on KJZZ. May 15, 2015 ✓ Sensibaugh, M., Participated in multiple monthly meetings as Chairman of the Board, for the Greater Flagstaff Forest Partnership. Flagstaff, AZ CY 2014-2015
6.6) Use media to educate the General Public	
a) Deliverable: 2 Newspaper articles	1) Covington, WW. Live Science. "Expert Voices: Op-Ed and Insights: The Two Wildfires Everyone Should be Talking About." August 22, 2014. http://www.livescience.com/47510-wildfire-prevention-is-science-not-art.html 2) Stevens, B. Flagstaff Business News. "The changing face of southwestern forests and forest products." November 1, 2014. http://www.flagstaffbusinessnews.com/the-changing-face-of-southwestern-forests-and-forest-products/?utm_source=FBN&utm_medium=WEB&utm_campaign=front_featured_title

Project 7: Duty 5 under the ACT. Provide annual progress reports	
Deliverable	**Status**
7.1) Complete annual progress report on June 30, 2014 **7.2)** Complete annual progress report on June 30, 2015	✓ Completed through July 30, 2014 ✓ Completed as Final Report for #14-DG-11031600-055

FY15 Deliverables (Progress) - #15-DG-11031600-073

Project 1: Science Support for Collaborative Restoration and Conservation from the Local to the Landscape Scale	
Deliverable	**Status**
1.1) Provide support for the Four Forest Restoration Initiative (4FRI), a Collaborative Forest Landscape Restoration Act project.	
a) Report on technical assistance to: the multi-party monitoring board; the Forest Service as EIS#1 proceeds to implementation; and, support for EIS#2 analysis. b) Report on activities completed as co-chair and assistance provided to create an efficient working relationship between the Natural Resources Working Group (NRWG) and the 4FRI Stakeholder Group. c) Report on IT support for the 4FRI Website and BASECAMP (an online collaborative work space) and administrative support including minutes and agendas.	Early stage of project – all deliverables are in progress.
1.2) Assist in the planning, coordination and delivery of a 1.5 day workshop for 4FRI Stakeholders and the Forest Service.	
a) Deliver workshop. b) Publish white paper that: compiles lessons learned, recommendations for the second analysis area, and a discussion of why the NEPA and Objection process worked (editorial support appears in deliverable 6.4)	Workshop completed May, 2015. White paper in progress.

1.3) Provide scientific and technical support for CFLRP pilots and emerging projects.	
a) Report on activities to support the national CFLRP monitoring network i. Report on responses to information requests. ii. Co-produce (with NFF) a webinar describing the outcomes of the 5-Year Monitoring Plan	a) Early stage of project – all deliverables are in progress.
b) Report on assistance to the National Forest Foundation and the Washington Office of the USFS to plan and deliver a national CFLRP conference. Discussions are underway for this conference. It is possible that the conference will actually occur in FY 2016.	b) National workshop tentatively scheduled for week of February 22, 2016

Project 2: Information Analysis to Assist Evidence-Based Conservation	
Deliverable	**Status**
2.1) Literature or Systematic Review of restoration treatments to restore Ponderosa Pine Forests with shrub understory.	
a) Completed review and draft manuscript or technical report. i. Presentation to appropriate staff from the Prescott, Tonto and Kaibab National Forests.	Early stage of project – all deliverables are in progress.

Project 3: Ecological Monitoring and Evaluation for Adaptive Management	
Deliverable	**Status**
3.1) Continue development of long-term study in a mixed-conifer forest on the Mogollon Rim Ranger District of the Coconino National Forest (build from FY14).	
a) Report on progress with: i. Coconino National Forest to complete NEPA requirements. ii. Coconino National Forest to develop treatment prescriptions. iii. Coconino National Forest to train crews and implement treatment marking.	Early stage of project – all deliverables are in progress.
3.2) Wildlife responses to restoration and hazardous fuels reduction treatments.	
a) Report on pretreatment conditions and progress of the Flagstaff Watershed Protection Project (FWPP) wildlife monitoring (in FY15 work will be at the Mormon Mountain site on the Coconino National Forest)	Early stage of project – all deliverables are in progress.
3.3) Examine the efficacy of wildfires managed for resource benefit to achieve desired conditions.	
a) Present findings at a professional conference, or a workshop for resource managers, or a stakeholder event. i. Initiate study – identify study fires, develop maps, develop study methodology, and seek field work permits. ii. Collect field data. iii. Analyze spatial and field-based data.	Early stage of project – all deliverables are in progress.
3.4) Test high-resolution spatial data for developing landscape reference conditions and analyzing forest management and disturbance dynamics. Include an analysis of cost effectiveness as compared to conventional approaches for determining landscape level reference conditions.	
a) Final Report and presentation at a national conference. i. Develop data layers. ii. Analyses performed at two sites along the Mogollon Rim (Black Mesa and LEARN Blocks 2-6).	Early stage of project – all deliverables are in progress.

3.5) Identify the appropriate metrics for monitoring landscape-scale desired conditions in fire-adapted forests, including, but not limited to, forest cover and opening proportions, spatial configuration, and group size. Assess how each metric performs at different scales. This work will be coordinated with Jamie Barbour and the Broad-scale Monitoring Project in Regions 2 and 3.	
a) Final Report or manuscript, presentation to 4FRI Stakeholder Group, presentation to CFLRP Peer Learning Group.	Early stage of project – all deliverables are in progress.
3.6) Re-measurement of study units in the San Juan Fire to determine the outcomes of different treatment approaches implemented prior to this mixed-severity fire and include in this analysis the survivability of trees.	
a) Presentation to land managers and Fact Sheet	Early stage of project – all deliverables are in progress.

Project 4: Understanding and Solving the Economic, Social and Political Issues and Opportunities of Ecological Restoration	
Deliverable	**Status**
4.1) Actions to increase understanding of innovative funding approaches for achieving forest restoration and wildfire risk reduction. These alternative funding approaches include the Northern Arizona Forest Fund (SRP and NFF) and emerging efforts to support the Coronado National Forest by creating an "opt-in" program for resorts in Southeastern Arizona.	
a) Report on actions that support the Northern Arizona Forest Fund and creation of an "opt-in" resort fee on the Coronado National Forest.	Early stage of project – all deliverables are in progress.
4.2) Continue to facilitate work force training development.	
Participants include industry (Campbell Global, Good Earth Power and New Pac Fiber), Community Colleges (Northland Pioneer College and Coconino Community College), Coconino County Employment Services, Northern Arizona University-School of Forestry, The Nature Conservancy, and the Arizona Department of Forestry. Work force training includes workforce readiness, retention, safety and harvest and manufacturing skills development. a) Report on actions and outcomes.	Early stage of project – all deliverables are in progress.

Project 5: State, Tribal and Private Forestry – The All-Lands Approach	
Deliverable	**Status**
5.1) Assist the Arizona Prescribed Fire Council.	
The mission and purpose of the Arizona Prescribed Fire Council is to serve as a forum for all prescribed fire practitioners (government, academic institutes, tribes, coalitions and individuals) in order to work collectively to promote, protect, conserve, and expand the responsible use of prescribed fire in Arizona's fire-dependent ecosystems. a) Deliverable: Report on technical support provided to the council and website services.	Early stage of project – all deliverables are in progress.
5.2) In collaboration with the Arizona State Forester and in consultation with the USFS Deputy Chief for State and Private Forestry, revise the Arizona Statewide Strategy to comport with the National Cohesive Strategy.	
a) Deliverable: Report on actions toward revising strategy. The ERI will seek leveraged funding to complement this action.	Early stage of project – all deliverables are in progress.
5.3) Consult with the tribes to assess how assistance can be provided to them in the face of limited financial resources. Priority will be given to work with tribes adjacent to the 4FRI landscape.	
a) Deliverable: Report on options to help serve tribes. Particular emphasis will be on tribes adjacent to the 4FRI landscape.	Early stage of project – all deliverables are in progress.

Project 6: Services to the Intermountain West	
Deliverable	**Status**
6.1) Provide support to federal land managers with treatment planning and implementation.	
a) Deliverable: Report on actions to support project assessments, data collection, treatment design, and use of best available science by federal land managers to achieve desired conditions and outcomes. i. A combination of 10 total services based on previous and anticipated demand that may include: workshops, technical assistance, science support, field trips, and presentations. ii. Three Rapid Assessments (RAPs) are presently planned to support landscape restoration projects at the forest level. The RAPs are site-based analyses of historic and current conditions designed to inform Purpose and Need and restoration treatment development. 1. Apache-Sitgreaves NF: Escudilla East Restoration Project (RAP) report 2. Prescott NF: Restoration Alternatives in MSO PACs (RAP) report 3. Carson NF: Tusas-San Antonio Restoration Project (RAP) report iii. We are finalizing establishment of a restoration treatment demonstration area on the Coronado National Forest.	Early stage of project – all deliverables are in progress.

6.2) Assist with forest planning and implementation by recommending best available science and program support.	
Science and timing of support are variable for each national forest based on its individual planning schedule. a) Deliverable: Report on actions to support forest plan revisions. i. Tonto National Forest: 1. Report on development of public participation process. 2. Report on data collection for assessment of reference conditions on the Payson and Pleasant Valley Ranger Districts. 3. Report on science and knowledge synthesis and translation and transfer of best available science to support assessment of current conditions and need for change. 4. Report on support, as requested, with public meetings, presentations, field trips and technical support in Forestry, Fuels, Watershed, and Fire program areas. ii. Carson National Forest: 1. Report on data collection to assess applicability of reference condition synthesis for assessment of current conditions and need for change. 2. Report on knowledge gaps with the forest to determine needs to provide science synthesis, translation, or transfer. iii. Santa Fe, Cibola, Prescott, Lincoln National Forests: 1. Report on outreach efforts to determine opportunities for ERI to provide best available science or other support to plan revision.	Early stage of project – all deliverables are in progress.

6.3) Provide website support for ERI, SWERI, 4FRI (see Project 5 for support to the Arizona Prescribed Fire Council).	
Science and timing of support are variable for each national forest based on its individual planning schedule. a) Deliverable: Report on technical support for ERI, SWERI, and 4FRI websites.	Early stage of project – all deliverables are in progress.
6.4) Translate biophysical and social-political-economic information for affected entities.	
a) Deliverable: Editorial support for a total of 3 white papers and or working papers i. White paper compiling lessons learned from 4FRI Retreat on May 27, 28 ii. Working paper on climate change and fire in the Southwest iii. Working paper on carbon cycling in southwestern forests b) Deliverable: 8 fact sheets that translate and summarize scientific papers and journal articles.	a) Editorial Support i. Early stage of project – all deliverables are in progress. ii. Kent, L.Y. 2015. Climate Change and Fire in the Southwest. ERI Working Paper No. 34. Ecological Restoration Institute and Southwest Fire Science Consortium, Northern Arizona University: Flagstaff, AZ. 6 p. http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2015016.dir/doc.pdf iii. In progress b) Fact Sheets – in progress
6.5) Initiate and facilitate knowledge services and science support for non-federal entities through field trips, filling information requests, and presentations for affected entities. These numbers may vary based on demand**.**	
a) Deliverable: Report on actions to educate and support affected entities. Provide a minimum of 12 services that may include field trips, presentations, and information requests.	• T. Dubay. June 25, 2015. Presentation to Centennial Forest campers on communicating effective PSAs titled "A Fierce Green Fire: Crafting an Effective and Persuasive Message for Environmental Conservation Public Service Announcements." 15 campers in attendance
6.6) Use media to educate the general public.	
a) Deliverable: 2 newspaper articles in response to fire events to education the general public about the need for forest restoration to restore frequent fire forests.	Early stage of project – all deliverables are in progress.

Project 7: Duty 5 under the ACT. Provide annual progress reports	
Deliverable	**Status**
7.1) Complete annual progress report on June 30, 2015	✓ Completed June 30, 2015

Appendices/Links

Mexican Spotted Owl Habitat Monitoring
Flagstaff Watershed Protection Project
Dry Lake Hills Area

Progress Report

Prepared by:
David W Huffman
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June 2015

Introduction

The Flagstaff Watershed Protection Project (FWPP) represents a unique partnership between the City of Flagstaff, the State of Arizona, and Coconino National Forest to help reduce hazardous forest fuels and potential for uncontrollable wildfire and flooding on approximately 10,544 acres of Coconino National Forest land. Two general areas of the Forest were identified for fuels reduction treatment -- Dry Lake Hills and Mormon Mountain. Much of this land is important habitat for the Mexican spotted owl (MSO), a federally threatened wildlife species. Habitat characteristics that are preferred by MSO for nesting and roosting include complex, multi-layered, mixed conifer and pine-oak forests on steep slopes. High quality habitat tends to have higher large tree densities and canopy cover, an abundance of large live trees and standing dead snags, and an abundance of large logs (Ganey and Balda 1994, Ganey et al. 1999, May et al. 2004). Although Mexican spotted owls are often found in forests with higher tree density and canopy cover, two primary threats to MSO populations are timber harvest (i.e., logging of larger trees) and stand-replacing wildfire.

The recently revised MSO Recovery Plan (USFWS 2012) describes how hazardous fuels treatments may be conducted within Protected Activity Centers (PACs), i.e., designated protected sites where owls have been observed (US Fish and Wildlife Service 2012). However, presently there is very little information regarding how owls may respond to fuels treatments. Essentially no research has been conducted to test MSO responses to alternative treatment prescriptions and intensities within PACs.

In collaboration with the US Fish and Wildlife Service (FWS), US Forest Service (FS), City of Flagstaff, and Greater Flagstaff Forests Partnership (GFFP), the Ecological Restoration Institute (ERI) at Northern Arizona University is helping to investigate MSO responses to changes in habitat characteristics associated with FWPP hazardous fuels treatments. Due to the importance of MSO conservation, findings from this work likely will serve as one benchmark for evaluating success of FWPP. In summer of 2014, the ERI initiated installation of forest structure, vegetation, and fuels monitoring plots, and collected pre-treatment data in the Dry Lake Hills (DLH) area of FWPP. Specific objectives of 2014 work were to do the following: 1) quantify forest structure, vegetation, and fuels characteristics in PACs before hazardous fuels reduction treatments are implemented; 2) quantify forest structure, vegetation, and fuels characteristics in reference PACs that will not be treated under FWPP; and 3) make data summaries available to USFWS researchers and US Forest Service staff for their analysis.

Funding for plot installation, data collection and analysis, and production of this pretreatment summary report was provided by FWPP bond funds (City of Flagstaff), Arizona Technology Research Initiative Funds (TRIF), and a USDA Forest Service grant (USDA-FS #14-DG-11031600-055) awarded to the Southwest Ecological Restoration Institutes (SWERI) under authorization of the Southwest Forest Health and Wildfire Prevention Act.

Methods

Study Sites

In summer of 2014 the ERI installed long-term monitoring plots and sampled attributes of forest structure, vegetation, and fuels within three PACs to be treated in Dry Lake Hills area of FWPP as well as three PACs that are to remain untreated (reference) and are located outside of FWPP (Figure 1). The three sampled PACs within FWPP were “Mt Elden”, “Orion Spring”, and “Schultz Creek”. The three Control PACs outside FWPP were “Little Springs”, “East Bear Jaw”, and “Snow Bowl”. PACs were 600-659 acres in size and ranged from 7,361 to 8,998 ft in elevation, with East Bear Jaw being the lowest in elevation and Orion Spring the highest (Table 1). Annual precipitation varies from approximately 20 to 31 inches across the six PACs. Soils are derived from primarily mixed igneous parent material, and are classified in the Alfisol and Mollisol soil orders (Table 1). Common forest overstory species include ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson.), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), limber pine (*Pinus flexilis* James), white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.), and quaking aspen (*Populus tremuloides* Michx.). Although limber pine and southwestern white pine co-occur in habitats across the study sites, they are difficult to distinguish from one another and may naturally hybridize (K. Waring personal communication). In this work, we did not attempt to separate the two species and categorized all as limber pine.

Field Sampling

To characterize forest structure, vegetation, and fuels, we established 21-36 long-term monitoring plots in each of the six PACs. We used a stratified random sampling design with an intensity of approximately one plot per 22 acres. Plot stratification was based on treatment type within PACs. Plots were randomly located within treatments using a geographic information system (GIS; ArcView 9.3).

In the field, we navigated to plot locations using handheld geographic positioning system (GPS) units. We used Garmin 12 GPS units that have a nominal accuracy of 15 m (root mean square error; rms). At each location, we drove a small piece (3/4” x 8”) of steel rebar into the soil to monument the plot for future relocation. On each piece of rebar, we affixed an aluminum tag, on which the site and plot number was embossed. We also nailed an aluminum reference tag to the base on a large, live tree nearby and embossed the distance and direction to the rebar on this tag. Tree reference information was recorded in an electronic database. Using the rebar as the center point, we sampled forest structure, and vegetation using nested, circular plots (Fig. 2). Within a 0.2-ac plot, we located "large" snags (standing dead trees ≥ 16 diameter at breast height (dbh; 4.5 ft above the ground surface). Each large snag was identified to species and measured for dbh and height. Within a nested 0.10-ac plot, we located all live trees ≥ 1 in dbh. Trees species was recorded and all live trees were measured for dbh, total height, and crown base height. Also with the 0.1-ac plot, we located large dead and down logs (≥16 inches diameter at stump height (dsh) measured at 40 cm above root collar) and measured dsh. Logs were measured if they had been once live trees rooted within the plot. Coarse woody debris (e.g., tree branches, chunks of wood, etc.) that could not be identified as an individual tree originating in the plot was not sampled. Numbered aluminum tags were nailed to all snags and trees in the plots.

In smaller nested plots (0.025-ac) centered on the rebar, we tallied small trees (< 1 inch dbh) and tree seedlings (< 4.5 ft height) (hereafter "regeneration"). For each of these tallied, we recorded species and condition (live or dead). We also tallied shrubs by species in these plots. We did not assign numbered tags to small trees, seedling.

On each plot, we sampled dead, woody, surface fuels on two 50-foot planar transects according to methods described in Brown (1974). The two transects were systematically oriented along south and west cardinal directions, respectively, radiating outward from the center point rebar. Woody fuels were tallied by the following moisture lag classes: 1) 1-hour (0.0.25 inches in diameter); 2) 10-hour (0.25-1.0 inches diameter); 3) 100-hour (1.0-3.0 inches diameter); and 4) 1000-hour (> 3 inches diameter). The largest class (1000-hour) was additionally subdivided into sound and rotten categories. Planar transects used for surface fuels measurements were also used to estimate canopy cover. On each transect, canopy cover "hits" (yes/no) were determined at 10 equally spaced points using a sighting tube-type densitometer. Thus, 20 canopy cover points were sampled on each plot.

Lastly, we collected digital photographs at each plot. Photos were taken from two cardinal points (north and east) on the boundary of the nested overstory plot. Photos were taken from points toward the center rebar. Digital photos and all data described above were archived and stored electronically on a data server at Northern Arizona University.

Analysis

For pretreatment summaries, we calculated means and standard deviations of forest structure, vegetation and fuels variables for individual PACs. Forest structure variables included trees ac^{-1}, basal area (BA; ft^2 ac^{-1}), large (> 16 in) snags ac^{-1}, large (>16 in) logs ac-1, density (no. ac^{-1}) of live shrubs and tree regeneration. We calculated mean relative importance (RI) index values for species within PACs following methods adapted from Curtis and McIntosh (1951). This index was calculated for each species as the relative density ((species trees ac^{-1}/total trees ac^{-1})*100) plus relative dominance ((species BA/total BA)*100). Thus, importance index values for each species within PACs ranged from 0 (not occurring) to 200 (completely monotypic). To classify composition of PACs based on importance values, we included overstory species with importance values > 20. We calculated canopy cover as: (no. canopy "hits"/20)*100. To provide baseline summaries for monitoring potential fire hazard, we calculated both crown and surface fuel loading. We used species-specific component biomass equations given in Ter-Mikaelian and Korzukhin. (1997) to calculate individual tree foliage mass, then summed these amounts to calculate crown fuel loading (kg m^{-2}) on plots. Note that crown fuel load is commonly expressed in Standard International units; however, conversion to English units is the following: 1 kg m^{-2} =

0.2048 lb ft^{-2}. We used equations in Brown (1974) to calculate woody surface fuel loading (t ac^{-1}) by moisture-lag class.

Data were summarized for each PAC in terms of habitat elements described in the MSO Recovery Plan (US Fish and Wildlife 2012). In addition, we also provide summaries for the nest core area of the Schultz Creek PAC (Appendix 1).

Results

Stand structure and vegetation

Tree species composition varies across the six PACs sampled (Table 1). Based on relative importance (RI) values, all with the possible exception of the Little Springs PAC, should be considered warm/dry mixed conifer forests (see Reynolds et al. 2013). For example, ponderosa pine is common (RI > 20) in all PACs except Little Springs. This species was more important than other species in Orion Spring, Schultz Creek, and East Bear Jaw PACs. Douglas-fir also was common and showed RI values > 20 in all PACs. This species had the highest relative importance in the Snowbowl PAC. White fir and limber pine were less important than ponderosa pine and Douglas-fir; however, white fir was more important than other species in the Mount Elden PAC. Limber pine was the most important species in the Little Springs PAC. Aspen occurred in all PACs except East Bear Jaw but was least important overall. Aspen showed RI values >20 in both the Little Springs and Snowbowl PACs (Table 1).

Tree density across the six PACs ranged from 253 trees ac^{-1} (Snowbowl) to 495 trees ac^{-1} (Little Springs) (Table 2). The Little Springs PAC was at least 49% greater in tree density than all other PACs sampled. Smaller trees (< 8 inches dbh) were more abundant than large size classes in all PACs (Fig. 3). Schultz Creek and East Bear Jaw PACs had the fewest numbers of large trees (> 16 inches and > 24 inches dbh) (Table 2). Basal area (BA) showed a similar pattern to tree density, and ranged from 97 ft^2 ac^{-1} (Schultz Creek) to 207 ft^2 ac^{-1} (Little Springs). BA among the other four PACs ranged 123-164 ft^2 ac^{-1} (Table 2). East Bear Jaw had noticeably lower percentages total BA comprised of large trees (> 16 inches dbh and > 18 inches dbh) than the other PACs (Table 2.). Canopy cover for all PACs except Little Springs (81%) was below 60% (Table 2). The Mount Elden PAC had the lowest canopy cover (46%).

Tree heights were variable across the six PACs (Fig. 4). Orion Spring, Little Springs, and Snowbowl PACs tended to have proportionally greater numbers of taller trees as well greater ranges (interquartile) of tree heights than the other three PACs. The Mount Elden and Schultz Creek PACs had the lowest tree height medians (20.3 ft and 22.3 ft, respectively), whereas the East Bear Jaw PAC had the smallest interquartile range (23.3 ft) of tree heights (Fig. 4).

Density of large (> 18 inches dbh) standing dead snags was similar and ranged 6.8-7.9 snags ac^{-1} across all PACs except East Bear Jaw, which showed only 4.2 snags ac^{-1} (Table 3). Density of large dead and down logs (> 18 inches dsh) was similar among PACs and ranged 11.5-15.5 ac^{-1} (Table 3).

Tree regeneration was by far highest (2476 ac^{-1}) in the Orion Spring PAC, and lowest (128 ac^{-1}) in the East Bear Jaw PAC (Table 3). Regeneration in the Orion Spring PAC was composed primarily of small (1-2-year-old) ponderosa pine seedlings. Ponderosa pine (5-1717 ac^{-1}) as well as Douglas-fir (18-565 ac^{-1}) regeneration was found in all PACs. White fir regeneration was found in meaningful numbers only in Mount Elden and Schultz Creek PACs (220 $ac^{-}1$ and 119 ac^{-1}, respectively), but was also observed in Orion Spring and East Bear Jaw PACs (32 $ac^{-}1$ and 1 ac^{-1}, respectively). Both limber pine (8-164 ac-1) and aspen (16-361 ac^{-1}) regeneration was found in all PACs except East Bear Jaw.

Shrub density ranged from 1194 individuals ac^{-1} (East Bear Jaw) to 4961 ac^{-1} (Snowbowl) (Table 3). Oregon grape (*Berberis repens*) was the most abundant shrub observed (371-4691 ac^{-1}) and was found in all six PACs. Other common shrubs included mountain snowberry (*Symphoricarpus oreophilus*), wild raspberry (*Rubus idaeus*), and Fendler's ceanothus (*Ceanothus fendleri*).

Fuel loading

Crown fuel loads across the six PACs ranged from 0.80 kg m^{-2} (Snowbowl) to 1.20 kg m^{-2} (Mount Elden) (Table 4) (for conversion to English units, see Methods *Analysis*). Crown fuel load of individual species within PACs generally followed orders of relative importance. One exception was the Little Springs PAC, within which Douglas-fir (0.65 kg m^{-2}) had a greater crown fuel load than limber pine (0.29 kg m^{-2}) (Table 4).

Dead woody surface fuels ranged from 15.9 t ac^{-1} (East Bear Jaw) to 237.8 t ac^{-1} (Little Springs) across the six PACs (Table 5). All PACs except Little Springs showed total woody surface fuel loads less than 65 t ac^{-1}. Thus, the total surface fuel load at Little Spring was more than 275% greater than any other PAC (Table 5). The high total value at Little Springs was due to larger amounts of coarse woody debris (CWD; i.e., wood pieces > 3 in (diameter), not necessarily logs of trees originating on the plot. See Methods *Field Sampling*). The Snowbowl PAC also showed larger amounts of CWD, relative to the other PACs (Table 5). Forest floor depths ranged from 1.1 in (Mount Elden and East Bear Jaw) to 2.1 in (Little Springs) across the six PACs (Table 5).

Discussion

Protected Activity Centers sampled in this work varied in terms of forest species composition, structure, and fuel loading. For example, among PACs to be treated as a component of FWPP, the Orion Spring PAC is primarily composed of relatively large ponderosa pine and Douglas-fir trees, with a dense understory of ponderosa pine regeneration. In contrast, the Schultz Creek PAC has proportionally more white fir in the overstory, smaller trees, and lower density of tree regeneration in the understory. Reference PACs showed similar variability, with the Little Springs and East Bear Jaw PACs apparently occupying opposite ends of an elevation/productivity gradient. At this time, it is unclear how this variability may affect baseline owl responses such as occupancy and fledging success.

Tree densities in PACs were similar to those in other warm/dry mixed conifer forests in northern Arizona. For example, Cocke et al. (2005) found 293-332 trees ac^{-1} in ponderosa pine and mixed conifer forests, respectively, on the south slopes of the San Francisco Peaks near the Dry Lake Hills area. Cocke et al. (2005) reported basal area to range 150-197 ft^2 ac^{-1}. Contemporary conditions reflect substantial structural changes compared with conditions occurring in the late 1800s (Cocke et al. 2005). These changes were likely brought on by interruption of surface fire disturbance regimes, and existing conditions warrant restoration and fuels reduction treatments. For example, Chancellor et al. (2013) found that the NEXUS fire behavior model predicted active crown fire for warm/dry mixed conifer forests with similar crown fuel loading in the White Mountains of Arizona. Differences among PACs in composition, structure, and fuel loading require site-specific prescriptions to effectively reduce fuel hazards while also attempting to maintain MSO habitat quality. Fuel hazard reduction prescriptions developed to address site-specific characteristics of the individual PACs will likely vary in several important ways, including treatment intensity, tree size class and species targets, and type (e.g., manual thinning and/or prescribed fire). To account for this variability, long-term monitoring forest dynamics and MSO responses in both FWPP PACs as well as untreated reference PACs is of critical importance.

Pretreatment data summaries presented in this report provide an initial baseline for monitoring, and can help in adapting treatment plans and future studies. Monitoring of both structural changes and effects of treatments on fuel loading can be assessed using these data.

Monitoring Recommendations

Work on this project led to two main recommendations for adjusting monitoring methods and measurements. The following adjustments will be made in future work:

1. Decrease minimum standing dead snag size to 11.8 inches (30 cm) dbh
2. Incorporate coarse woody debris (CWD) sampling. CWD should be tallied on 0.10-ac nested overstory plot in the following classes:
    a. Small logs: 3.3-9.7 ft (1.0-2.95 m) length, and 7.9-18 in (20.0-45.7 cm) diameter large end
    b. Medium logs: ≥9.8 ft (3.0 m) length, and 7.9-18 in (20.0-45.7 cm) diameter large end; Or, 3.3-9.7 ft (1.0-2.95 m) length and ≥18 in (45.7 cm) diameter large end
    c. Large logs: ≥9.8 ft (3.0 m) length, and ≥18 in (45.7 cm) diameter large end

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Table 1. Characteristics of Protected Activity Centers (PACs). Mount Elden, Orion Spring, and Schultz Creek are PACs that will received Flagstaff Watershed Protection Project (FWPP) treatments. Little Springs, East Bear Jaw, and Snowbowl PACs are outside of FWPP and will remain as untreated reference sites. Precipitation estimates, soil parent material, and soil order information is given in Miller et al. (1995). Overstory classification reflects importance values calculated in this report (see Methods *Analysis*).

PAC	Size (ac)	Elevation (ft)	Precipitation (in)	Parent material	Soil order	Overstory*
Mount Elden	630	7,546-8,816	20-28	Mixed igneous	Alfisol/Mollisol	ABCO/PIPO/PSME
Orion Spring	604	7,831-8,998	20-28	Mixed igneous	Alfisol/Mollisol	PIPO/PSME
Schultz Creek	659	7,430-8,537	20-28	Mixed igneous	Alfisol/Mollisol	PIPO/ABCO/PSME
Little Springs	608	8,221-8,821	20-31	Mixed igneous	Mollisol/Alfisol	PIFL/PSME/POTR
East Bear Jaw	600	7,361-8,396	20-28	Mixed igneous	Alfisol	PIPO/PSME
Snowbowl	604	8,093-8,895	24-28	Andesite/Basalt	Alfisol/Mollisol	PSME/PIPO/PIFL/POTR

* Tree species codes: ABCO (*Abies concolor*); PIFL (*Pinus flexilis*); PIPO (*Pinus ponderosa*); POTR (*Populus tremuloides*); PSME (*Pseudotsuga menziesii*)

Table 2. Attributes (means) of forest structure within Protected Activity Centers (PACs). Mount Elden, Orion Spring, and Schultz Creek are PACs that will received Flagstaff Watershed Protection Project (FWPP) treatments. Little Springs, East Bear Jaw, and Snowbowl PACs are outside of FWPP and will remain as untreated reference sites.

	PAC					
Structural Variable	Mount Elden	Orion Spring	Schultz Creek	Little Springs	East Bear Jaw	Snowbowl
Density						
Total (trees ac^{-1})	326	274	273	495	339	253
Trees ac^{-1} > 16 in	27.0	37.3	14.8	31.9	13.1	26.9
Trees ac^{-1} > 24 in	5.0	5.0	2.6	6.9	1.9	4.6
Basal Area						
Total (ft^2 ac^{-1})	135	164	97	207	123	141
Trees 12-18 in (%)*	39.9	34.0	31.6	34.2	34.4	35.9
Trees > 16 in (%)*	45.0	50.9	34.3	38.4	19.3	45.8
Trees > 18 in (%) *	36.9	39.2	26.7	27.6	11.8	34.5
Canopy cover						
Total (%)	46	54	49	81	51	59

* Percentage of total basal area comprised of trees within the size (diameter at breast height) ranges given.

Table 3. Density (mean no. ac^{-1}) of large snags, large logs, tree regeneration, and shrubs within Protected Activity Centers (PACs). Mount Elden, Orion Spring, and Schultz Creek are PACs that will received Flagstaff Watershed Protection Project (FWPP) treatments. Little Springs, East Bear Jaw, and Snowbowl PACs are outside of FWPP and will remain as untreated reference sites.

PAC	Large snags (> 18 inches dbh)	Large logs (> 18 inches dsh)	Tree regeneration	Shrubs
Mount Elden	7.8	13.0	503	3,976
Orion Spring	7.2	15.0	2,476	1,716
Schultz Creek	6.8	15.5	476	2,123
Little Springs	7.9	14.6	701	3,278
East Bear Jaw	4.2	11.5	128	1,194
Snowbowl	7.9	14.6	979	4,961

Table 4. Crown fuel loading (means (kg m^{-2}))* within Protected Activity Centers. Shown is total crown fuel loading along with amounts for major overstory species**. Total includes all species occurring on plots (major species, plus others occurring in low abundance).

		Species				
PAC	Total	ABCO	PIFL	PIPO	POTR	PSME
Mount Elden	1.20	0.61	0.03	0.32	0.00	0.24
Orion Spring	1.10	0.01	0.02	0.63	0.01	0.43
Schultz Creek	0.81	0.28	0.02	0.35	0.00	0.14
Little Springs	1.08	0.00	0.29	0.09	0.05	0.65
East Bear Jaw	0.93	0.00	0.00	0.75	0.00	0.17
Snowbowl	0.80	0.00	0.08	0.29	0.03	0.39

*Crown fuel loading is commonly given in metric units. Conversion to English units is: 1 kg m^{-2} = 0.2048 lb ft^{-2}.

** Tree species codes: ABCO (*Abies concolor*); PIFL (*Pinus flexilis*); PIPO (*Pinus ponderosa*); POTR (*Populus tremuloides*); PSME (*Pseudotsuga menziesii*)

Table 5. Surface fuels (means) within Protected Activity Centers (PACs). Mount Elden, Orion Spring, and Schultz Creek are PACs that will received Flagstaff Watershed Protection Project (FWPP) treatments. Little Springs, East Bear Jaw, and Snowbowl PACs are outside of FWPP and will remain as untreated controls.

PAC	Litter depth (in)	Duff depth (in)	1-hour ($t\ ac^{-1}$)	10-hour ($t\ ac^{-1}$)	100-hour ($t\ ac^{-1}$)	1000-hour sound ($t\ ac^{-1}$)	1000-hour rotten ($t\ ac^{-1}$)
Mount Elden	0.4	0.7	0.39	1.12	2.69	14.43	12.27
Orion Spring	0.3	1.0	0.21	0.64	1.82	15.06	9.54
Schultz Creek	0.2	1.1	0.13	0.88	3.49	8.40	12.09
Little Springs	0.6	1.5	0.34	0.99	2.49	98.72	135.28
East Bear Jaw	0.3	0.8	0.21	0.94	1.35	2.76	10.63
Snowbowl	0.3	1.5	0.11	0.66	2.62	23.39	36.51

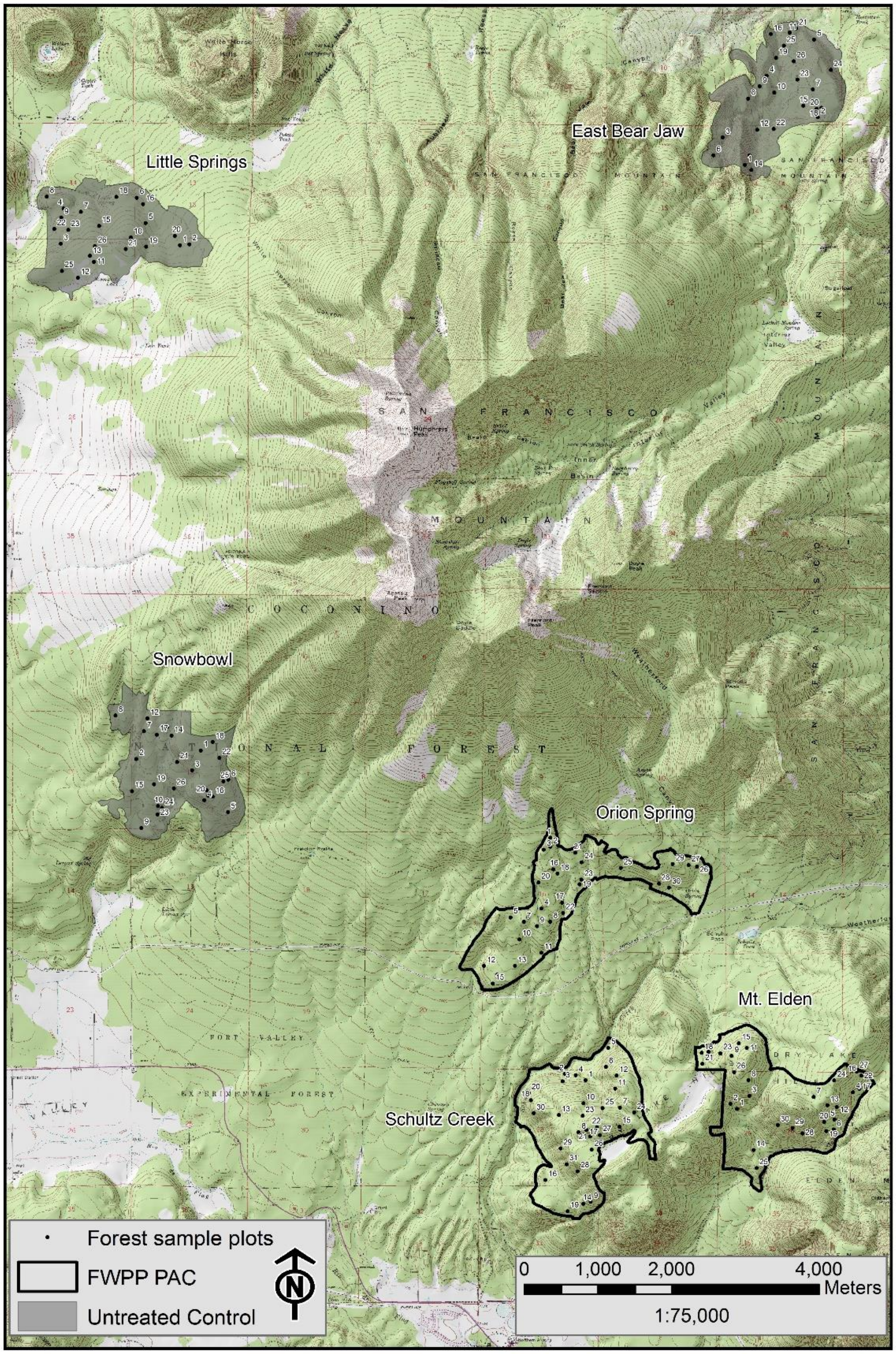

Figure 1. Map showing location of Protected Activity Centers (PACs) and long-term monitoring plots sampled by the Ecological Restoration Institute in 2014. PACs to be treated in the Dry Lake Hills area as a component of the Flagstaff Watershed Protection Project are shown (FWPP PAC) as well as PACs outside FWPP that will remain as untreated reference sites.

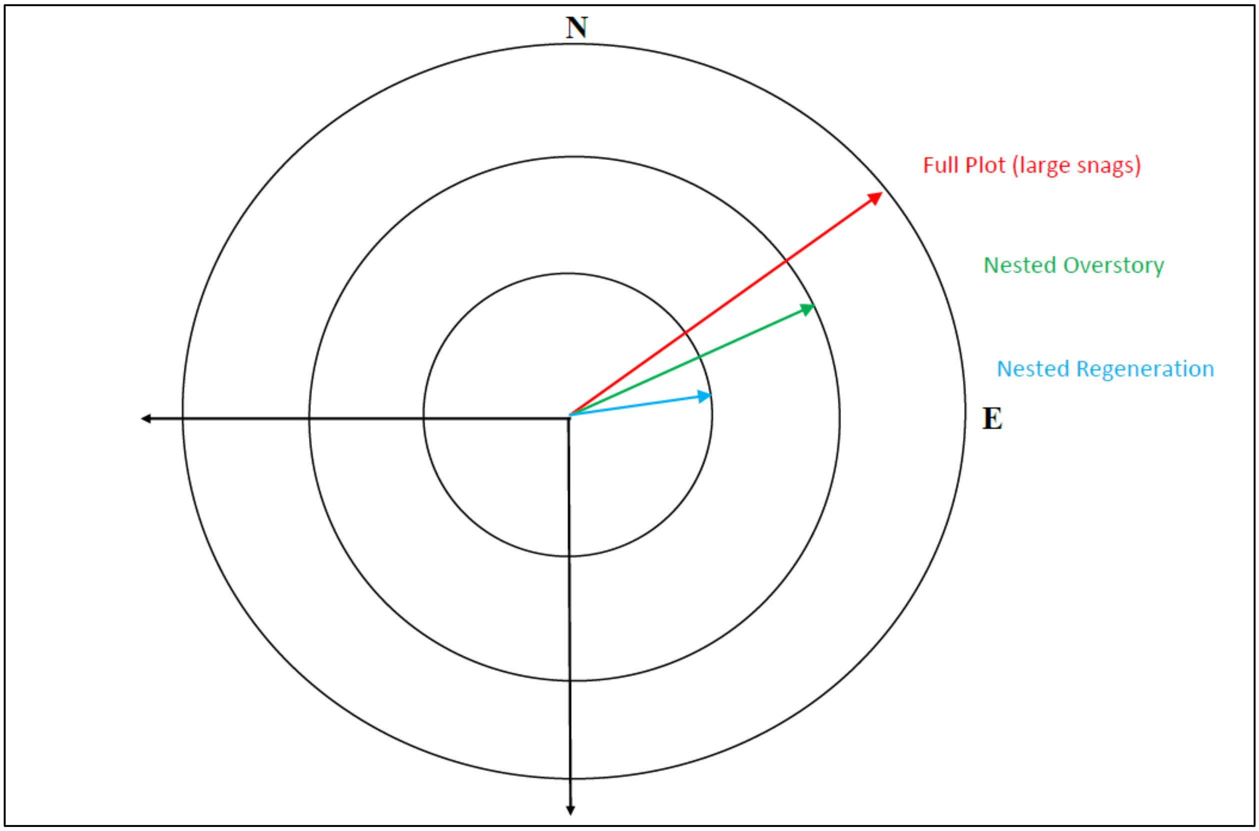

Figure 2. Diagram showing layout of plots used to sample large snags (Full Plot), overstory trees (Nested Overstory), and small trees, tree seedlings, and shrubs (Nested Regeneration). Also shown are two transects used to sample woody, surface fuels, and oriented along the south and west cardinal directions (solid black lines with arrows).

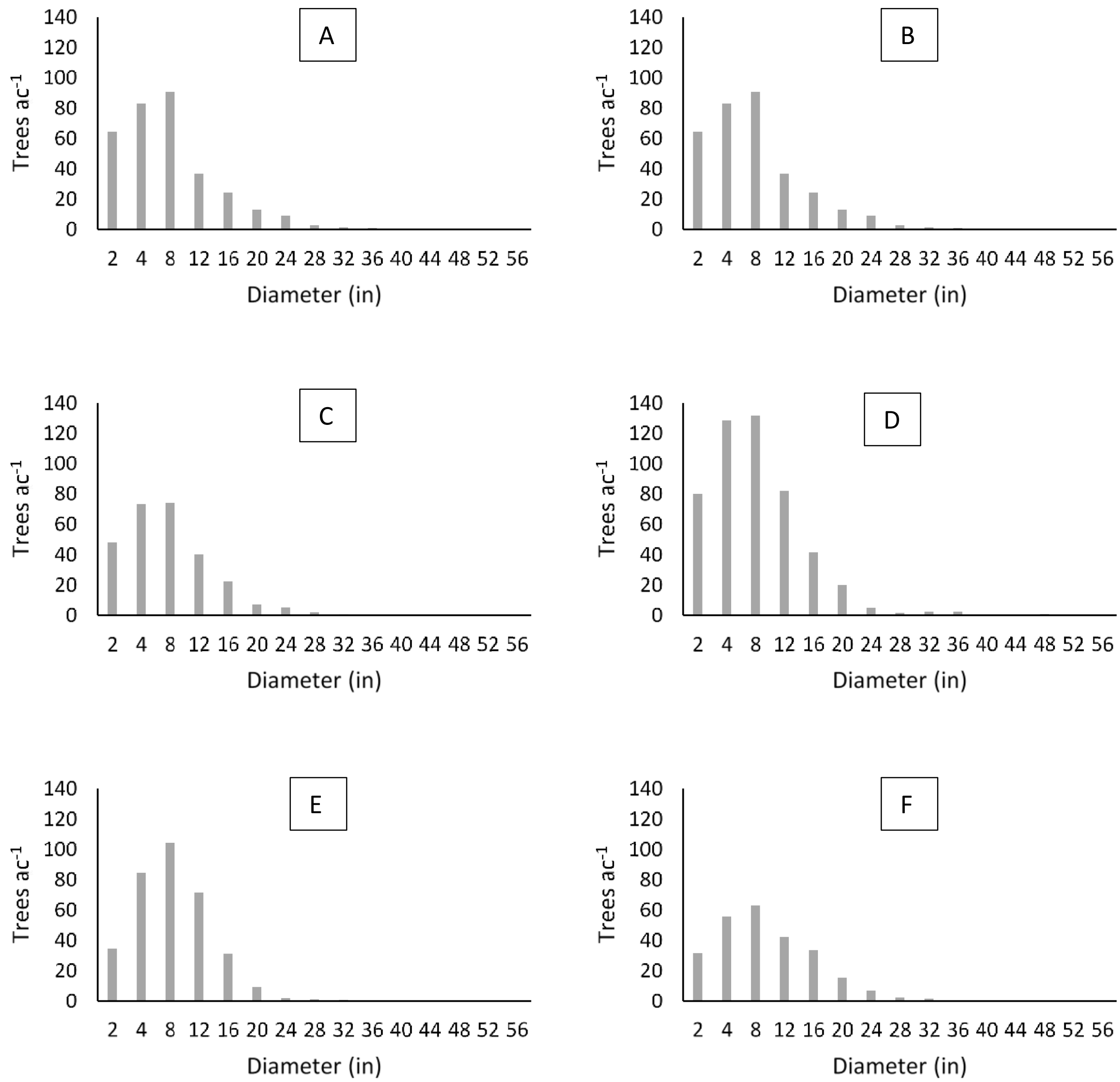

Figure 3. Tree diameter (diameter at breast height (dbh)) distribution within Protected Activity Centers. Mount Elden (A), Orion Spring (B), and Schultz Creek (C) are PACs that will received Flagstaff Watershed Protection Project (FWPP) treatments. Little Springs (D), East Bear Jaw (E), and Snowbowl (F) PACs are outside of FWPP and will remain as untreated reference sites.

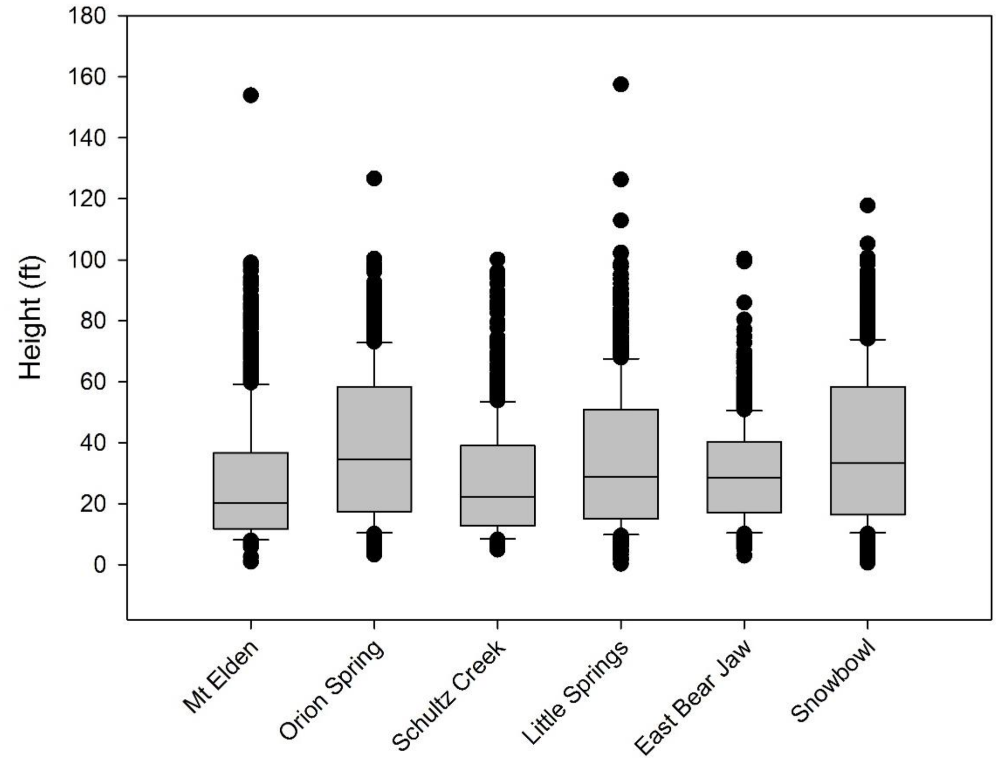

Figure 4. Distribution of tree heights (ft) within PACs. Box plots show median (horizontal line), data quartiles (box outline and bars), and outliers (filled circles). Mount Elden, Orion Spring, and Schultz Creek are PACs that will received Flagstaff Watershed Protection Project (FWPP) treatments. Little Springs, East Bear Jaw, and Snowbowl PACs are outside of FWPP and will remain as untreated reference sites.

Appendix 1. Means and standard deviations (SD) for forest structure and fuels variables within Schultz Creek PAC nest core area (n=6).

Variable	Mean	SD
Relative Importance: PIPO	33.3	33.6
Relative Importance: PSME	64.4	24.6
Relative Importance: PIFL	13.4	23.1
Relative Importance: ABCO	81	45.9
Tree density (no. ac^{-1})	445	168.6
Trees > 24 in (no ac^{-1})	1.7	4.1
Total BA (ft^2 ac^{-1})	110	34.4
Percent BA 12-18 in (%)	27.3	15.1
Percent BA > 16 in (%)	18.5	28.8
Percent BA > 18 in (%)	15	23.5
Snags > 16 (no. ac^{-1})	5	4.5
Logs > 16 (no. ac^{-1})	36.7	22.5
Crown fuel load (kg m^{-2})	1.1	0.31
Litter depth (in)	0.2	0.1
Duff depth (in)	1.1	0.4
Surface fuels 1-hr (t ac^{-1})	0.4	0.5
Surface fuels 10-hr (t ac^{-1})	1.5	1.7
Surface fuels 100-hr (t ac^{-1})	4.5	3.9
Surface fuels 1000-hr sound (t ac^{-1})	6.5	9.7
Surface fuels 1000-hr rotten (t ac^{-1})	16.9	27.4

Rapid Assessment Report

Upper Rocky Arroyo Restoration Project

Submitted by: Bruce Greco and Mark Sensibaugh

September 2014

Lakeside Ranger District

Apache-Sitgreaves National Forests

NORTHERN ARIZONA UNIVERSITY
Ecological Restoration Institute

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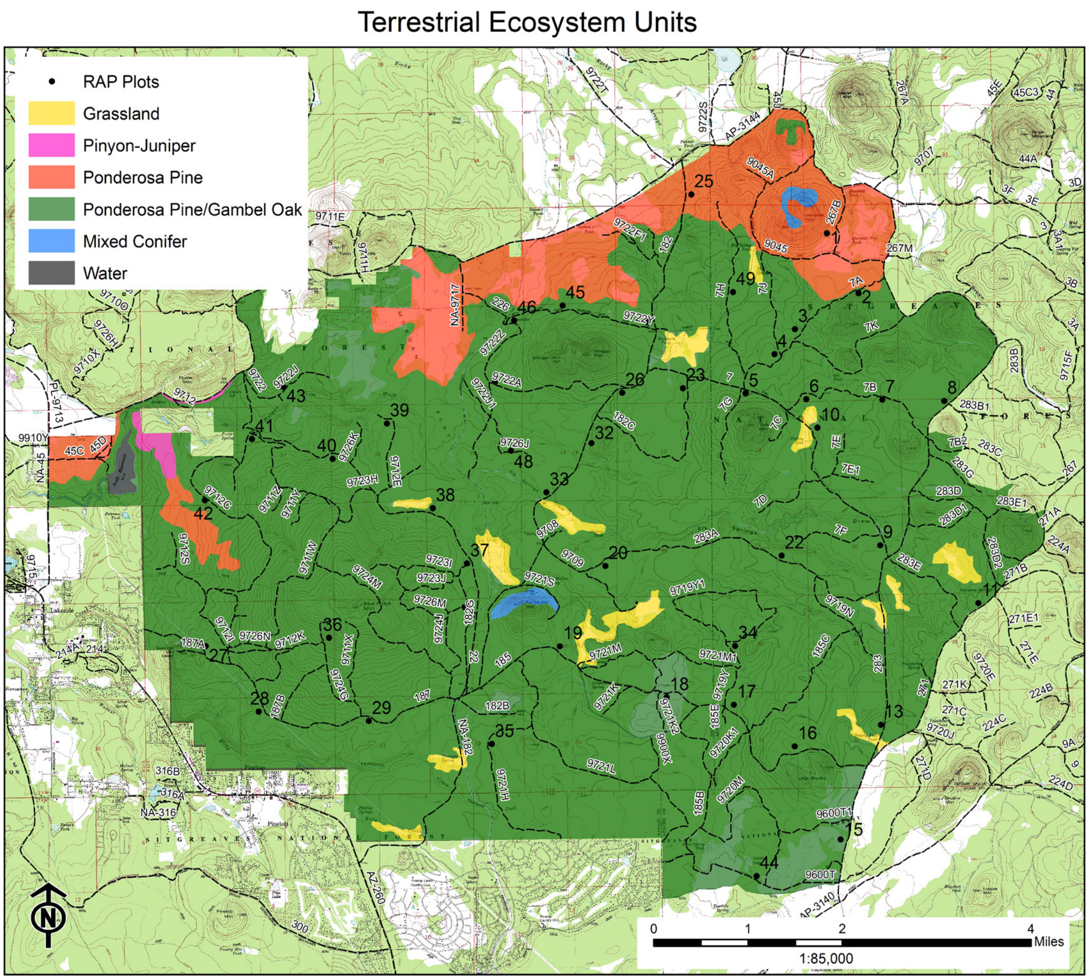
Introduction

FIGURE 1



The Upper Rocky Arroyo Restoration Project (URAR) is located on the Lakeside Ranger District, Apache-Sitgreaves National Forest (ASNF). The URAR project area covers a landscape of approximately 30,860 acres and is one of the ASNF's "Bridge the Gap" Projects identified in 2013 to help accelerate restoration treatments, to:

- Continue to provide restoration treatments on large, "at risk" landscapes,
- Provide wood fiber from tree thinning activities for wood-products industries in the White Mountain area,
- Help "bridge the gap" of treating large landscapes to reduce the threat of unwanted wildfire or other disturbances, while the larger 4FRI analysis is being completed, and
- Ensure watershed function and integrity is not adversely affected.

The project area is dominated primarily by ponderosa pine (*Pinus ponderosa*), with Gambel oak (Quercus gambelii), alligator juniper (*Juniperus deppeana*), Utah juniper (*Juniperus osteosperma*), one-seed juniper (Juniperus monosperma), piñon pine (*Pinus edulis*), white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), and aspen (*Populus tremuloides*) present as lesser species. The landscape is predominately relatively flat terrain interrupted by distinctive ephemeral drainages generally flowing northward in the Silver Creek Watershed with several volcanic cinder cones across the area. Generally, three Potential Natural Vegetation Types (PNV) are represented on the URA area, which include ponderosa pine, Madrean pine-oak, and piñon-juniper.

The Ecological Restoration Institute (ERI) was invited by the ASNF to collect site-specific historical ecological data for the URAR Project area to establish site-specific reference conditions (forest conditions that were in place 130–140 years ago when frequent fire was still a dominant component of the ecological system). These reference conditions would be used by the interdisciplinary team (IDT) as a point of reference for forest restoration project planning. To meet this need, ERI worked with the Lakeside Ranger District Ranger and staff to identify priority areas where data would be collected to establish reference conditions. ERI placed 49 individual study plots within the project area (Figure 1). The entire plot data collection was completed through a Rapid Assessment process and is documented in Appendix C of this report (Plot Data Summary Appendix C).

Data on other ecological conditions were not collected as part of this effort; however, some of these data, such as fire history, are available from other sources (see Historical Context, Appendix A) and included in this report.

Reference Conditions, Historical/Natural Range of Variability (HRV)

The term “reference conditions” is not well defined in ecological literature. One approach is to define reference conditions in the context of regionally representative conditions that are indicative of minimum or no anthropogenic stress. In this report, it is described as the “sustainable” condition of the environment prior to, or in the absence of, major human disturbances, and is used to describe a desired ecological state in describing or planning ecological outcomes. Reference conditions are developed from site-specific data and are limited to the spatial extent and sample area of that study. However, reference conditions can be established for a variety of systems at different scales (ponderosa pine reference conditions within URAR versus ponderosa pine reference conditions across the state of Arizona).

Evaluating reference conditions helps describe attributes of ecosystem structure, composition, and function that were associated with resilient and sustainable systems and can be used to inform ecological restoration objectives and implementation strategies. The natural range of variability (NRV) can be estimated by pooling reference conditions across sites within a forest type. Reference conditions for a forest type typically vary from site to site due to differences in factors such as soil, elevation, slope, aspect, and micro-climate and is manifested by variances in fire effects, tree densities, patterns of tree establishment and persistence, and numbers and dispersion of snags and logs. (USFS GTR-310). Natural variability in the composition and structure across sites in these forests results from and drives spatial differences in fire effects, plant species compositions, tree establishment patterns and densities, and the number and distribution of snags, logs, and woody debris. Recognition of within-and-among site variability is paramount for developing localized restoration objectives.

Plot data, which captures vegetative information associated with pre-European settlement conditions (reference conditions), collected over an area such as the URAR can be described as being within a range of historic or natural variation. For example, the historic range of variation (HRV) for ponderosa pine forests on URAR data plots averaged between 3–66 trees per acre. Determining the HRV of an area helps land managers visualize and describe what the forest structure looked like before frequent surface fires were disrupted across the project area. Reference information should serve as an aid in making informed decisions consistent with the evolutionary range of variability associated with individual forest types.

Species in a forest ecosystem evolved under its characteristic disturbance regime, resulting in a natural range of variability or the range of ecological and evolutionary conditions appropriate to an ecosystem (Landres and others 1999). Planning for proposed restoration treatments should include an understanding of forest reference conditions, or conditions known to be within the range of healthy ecosystem variability, in order to guide ecosystems back to resilient conditions where forest structure and functions are maintained over time.

The natural range of variability is a “best” estimate of a resilient and functioning ecosystem because it reflects the evolutionary ecology (low intensity, frequent fire systems) of these forests. Natural range of variability is therefore a powerful science-based foundation for developing a framework for restoring the composition and structure of forests (Moore and others 1999).

Utilizing Historic Reference Condition Data

When developing restoration options and objectives, one can utilize multiple sources of historic information to understand reference conditions including Historical/Natural Ranges of Variability (ranges of reference conditions for a specific ecosystem and time period), evidence-based data (natural archives of on-site data, dendrochronology, fire scars, etc.) and historical documentation (photos, interviews, journals, publications, etc.). These sources can be very helpful in understanding the ecological/evolutional processes for a given site or landscape.

Historical perspectives help inform the understanding of the dynamic nature of landscapes and provide a frame of reference for assessing modern patterns and processes by comparing existing conditions against HRV. According to Swetnam and others (1999), "Reference conditions may be used, along with current condition assessments, social and economic considerations, and other practical constraints, for the setting of achievable and sustainable management goals." The location, presence or absence, and species composition of stumps, snags, downed logs, and old trees, associated with historic frequent fire conditions, are reference conditions that provide a degree of unequivocal evidence of historical forest structure and composition. In southwestern ponderosa pine ecosystems, it has been repeatedly demonstrated that frequent, low intensity fires were primarily responsible for the maintenance of sustainable ecosystem conditions during historical (pre-settlement) times (Covington and Moore 1994).

In order to make informed decisions and determine the strategies that drive restoration treatments, it is helpful to know as much as possible about past forest conditions, especially the "reference conditions" that existed before forest structure and function were altered by Euro-American settlers. "Such conditions were not unchanging, but they sustained themselves across what has been called the 'natural range of variability.' They formed the 'evolutionary environment' of southwestern ponderosa pine trees—a fairly stable environment, in other words, in which … tree species and many other plants and animals evolved and adapted. Restoring conditions similar to those of the evolutionary environment is not a matter of trying to return to the past; rather, it is the only way to assure the long-term health of these forests into the future" (Falk 1990). By investigating multiple lines of historic evidence in comparison with current conditions, it will help establish a frame of reference for guiding desired outcomes.

It is important to emphasize that reference conditions are not the same as restoration goals. Some types of reference information—like understory vegetation, wildlife and the specific climatic conditions—are not available. Reference conditions alone do not provide a recipe for forest management, but they can help establish restoration and management objectives, informed by historical conditions. Reference conditions can help to:

1. Define what the original or ecologically sustainable condition (composition, structure, process, function) was compared to the present;
2. Determine what factors caused degradation (or departure from historic conditions);
3. Define what needs to be done to restore the ecosystem;
4. Develop criteria for measuring success of restoration treatments; and
5. Help in identifying ecological conditions that will restore ecological resilience in the face of changing climate and fire regimes (Egan and Howell 2001; ASNF LMP 2013).

The objective of the Rapid Assessment process, and providing the analysis of the data, is to inform management strategies that will facilitate the resumption of historical processes and functions, and enable a greater degree of ecosystem resiliency and sustainability. The rapid assessment data was utilized with other lines-of-evidence (primarily fire history data and associated research on frequent fire ponderosa pine ecological systems) to establish forested reference conditions. The importance of these data is captured in Forest Service Manual (FSM) 2000 – National Forest Resource Management, Chapter 2020 – Ecological Restoration and Resilience, section 2020.6 – Principles; where it states "Apply the following guiding principles when planning and implementing restoration projects: ….3. Knowledge of past and current ecosystem dynamics, current and desired conditions, climate change projections, and human uses is fundamental to planning restoration activities."

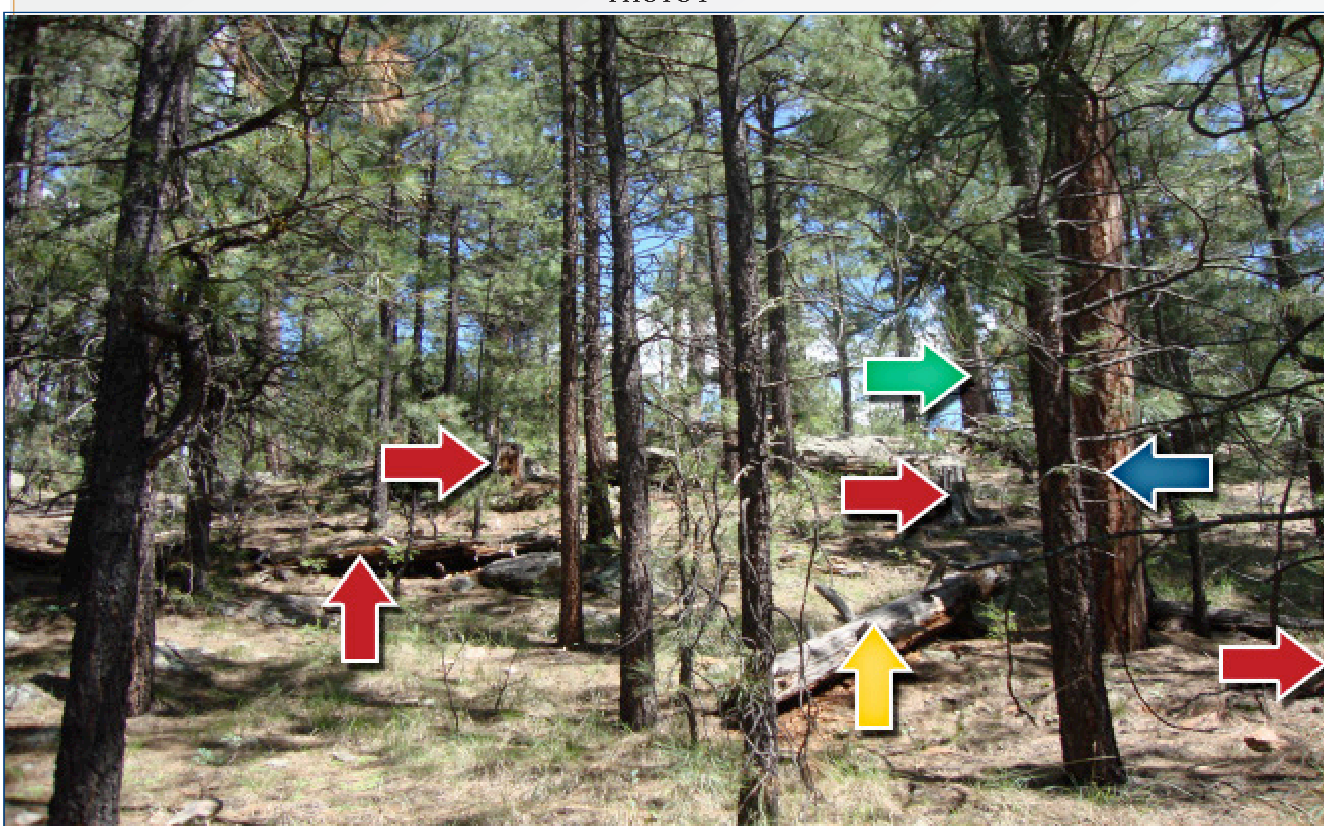
In all cases, restoration treatment objectives need to be site-specific, but area-specific reference conditions can be a particularly powerful tool when multiple lines of evidence are used to create a more complete picture than one type of evidence alone. The Ecological Restoration Institute (ERI) understands that returning to exact historical (pre-settlement) conditions on every acre is not practical, nor necessarily an achievable goal. There are multiple considerations including economic, cultural, social, or management factors that must be considered in determining restoration and treatment objectives and outcomes.

Methods

As part of the Rapid Assessment data collection on the URAR, the estimates of Historic Ranges of Variability (HRV) and Reference Conditions were determined primarily from physical evidence observed on each plot, but also derived from examining multiple lines of evidence based on historical ecology techniques such as written and oral historical records, historical photographs, early forest inventories and research, and dendrochronological studies. (Egan and Howell 2001), (See Appendix A: Historical Context of URAR).

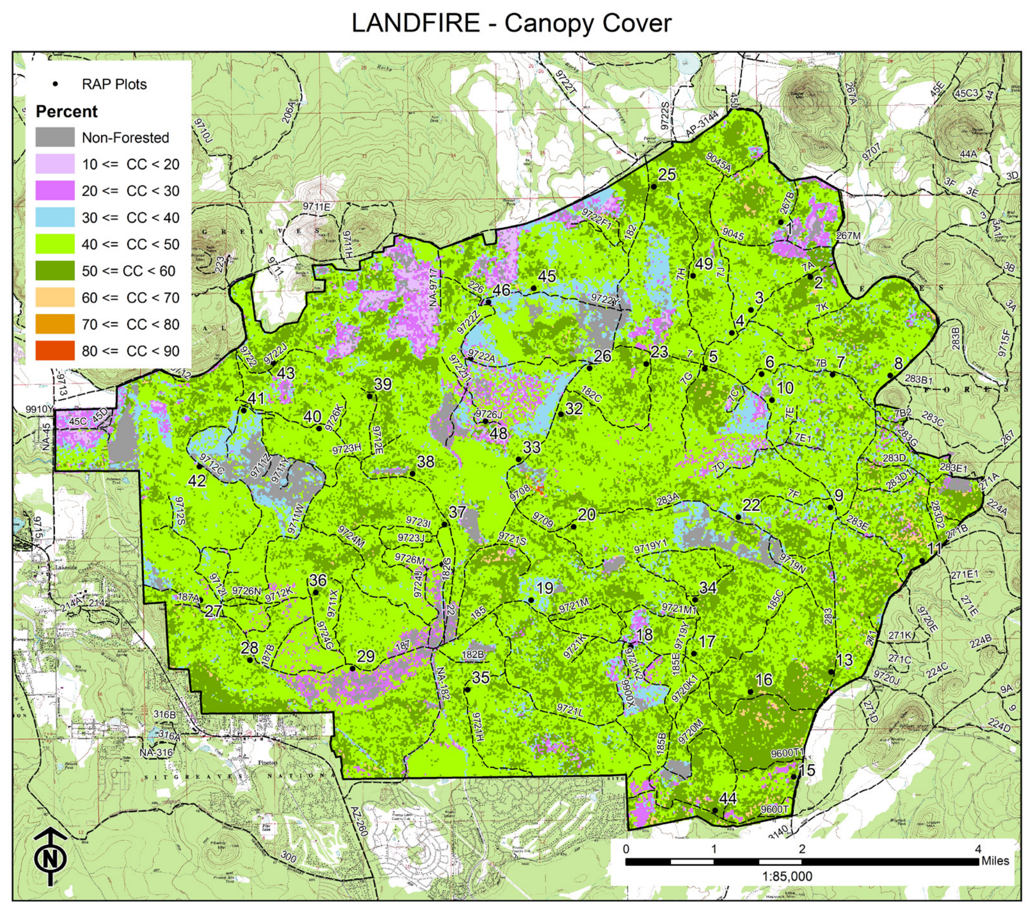
The URAR Rapid Assessment study included establishing 49 randomly selected plots within the project area, with emphasis on the terrain where management activities are more likely to occur (Figure 2). The study plots were 1 acre in size and were laid out in a square pattern (209 feet x 209 feet). Primarily, the northwest corner of each plot was located with a handheld GPS unit and was marked with rebar as

PHOTO 1



This photo shows evidence associated with the frequent fire forest. Evidence includes live trees greater than 130 years old (blue arrow), down logs from older trees (orange arrows), old cut stumps (red arrows), and old snags (green arrow). All tree species greater than 130 years old that are present on Study Plots (ponderosa pine, alligator juniper, Utah juniper, and Gamble oak) are included as evidence.

FIGURE 2



Canopy cover, when combined with other indicators, can provide valuable information for forest structural conditions and how current stands compare to a desired condition. However, canopy cover as a stand-alone metric does not provide an adequate tool for assessing the array of structural characteristics important in assessing historical context, or in setting desired conditions for restoring forest structure.

the plot establishment point, unless otherwise indicated on the data sheet. Within each plot, reference data were collected to establish the number of trees per acre, by individual species, which occupied the site prior to the disruption of the frequent fire regime, which is believed to have historically dominated and shaped this area ecologically. A summary of the evidence found and identified on each plot is shown in Appendix C. By using historic fire regime data previously collected by various researchers, and coring multiple trees across the study area to determine ages of the trees, the disruption of the fire regime in this area was determined to be about 1870.

To reconstruct structural characteristics of frequent fire stand densities, physical remains of old, dead trees (snags, stumps, downed logs, and stump holes) were located within the plots. Living trees in the plots were examined to determine if they germinated prior to the disruption of the frequent fire regime. The process for determining live trees associated with the frequent fire ecosystem, involved establishing a minimum age for these trees. Based on a review of previous fire history studies, it was determined that the minimum age was 144 years old (trees that had germinated in 1870 or earlier).

We then extracted increment cores from old, live (144 years old minimum) ponderosa pine trees on-site to establish a diameter that would represent the minimum age of pre-settlement trees. We utilized an 18-inch diameter at breast height (DBH) for ponderosa pine trees, a 10- inch diameter for Gamble oak and an 8-inch diameter minimum for alligator juniper trees, if the trees showed old tree characteristics, as pre-settlement age-diameter relationships. To account for possible diameter variation that might occur due to elevation, aspect, or other site conditions, we also extracted cores from a few trees at representative plots across the study area to confirm that the age-diameter determination was accurate for each species.

All live trees with a DBH greater than that for a 144-year-old tree that possessed old-tree characteristics (Appendix B) were counted as live trees associated with a frequent fire ecological system. These live, frequent fire system trees and tree evidences were tallied by species and density. In some previous studies, questions have been raised about the ability to accurately identify all the historical evidence with this rapid assessment reconstruction process. From one such study by Huffman and others titled "Ponderosa Pine Forest Reconstruction: Comparisons with Historical Data" (2001), the authors determined that forest structures are readily identified in the field after 90-plus years. In this study, missed trees resulted in an underestimated number of about 5.7% (about 1.7 trees per 30 trees).

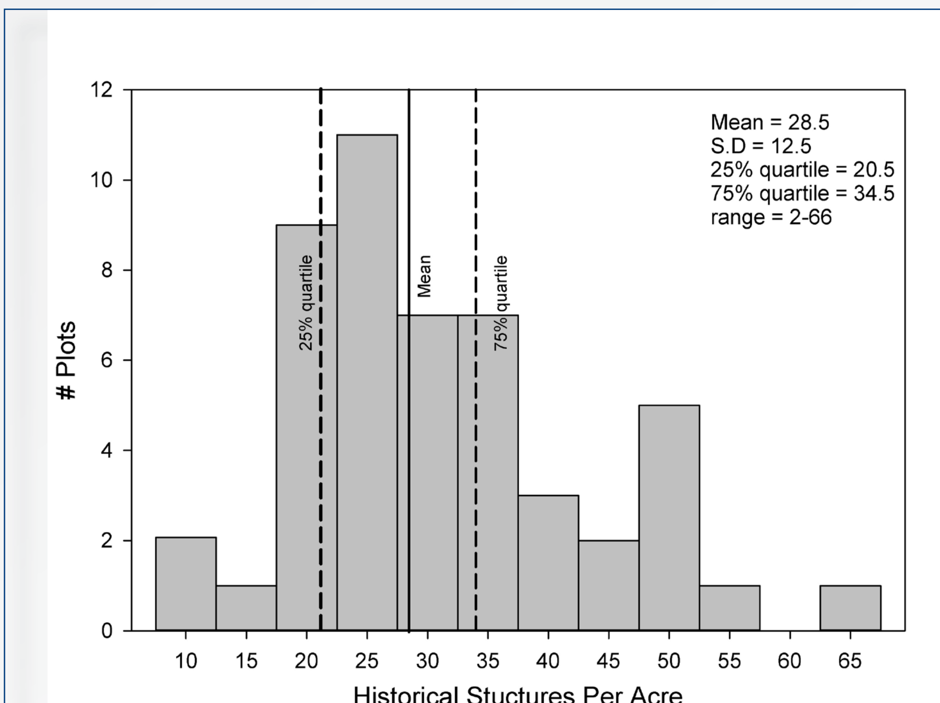
In addition to collecting data on tree reference conditions (trees per acre and species), four photos were taken at each plot to provide information on current forest structure, composition, and condition (ground vegetation and downed woody material). Also at each plot, data was collected on basal area (BA), presence or absence of dwarf mistletoe, estimated canopy cover (%), and general observations on historical stand structure and plot conditions. Specific data on the following ecological characteristics or conditions was not collected: trees per acre, tree heights, tree size distribution, downed woody material, soils, or understory vegetation. Additionally, we did not attempt to physically reconstruct the spatial arrangement of trees. The Terrestrial Ecosystem Unit (TES) from the report of the TES of the ASNF (USDA – FS 1986) was reviewed to help understand the vegetative structure characteristics of each plot and adjacent areas.

Tree Densities and Species Composition

Within the 49 plots sampled, the pre-settlement trees per acre (TPA) ranged from a low of three to a high of 66. The overall average for the areas sampled was 28.5 TPA (with a 95% Confidence Interval of 24.9–32.1 TPA (Figure 3)). The historic tree densities were generally much lower than the current tree densities found across the project area. Based on the collected data, there was not a significant difference in vegetative structure and historical tree density characteristics between the various TES units (Figure 4).

On the 49 study plots, most of the historic trees (trees that were in place prior to 1870) were ponderosa pine. A small number of pre-settlement Gambel oak and a variety of juniper species (alligator, Utah and one-seed) were present along the northern portion of the URAR Project area, on Blue Ridge and Springer Mountain areas, but with lesser amounts scattered throughout the project. The project area has some dry mixed conifer species located on north aspects of the cinder cones. Very few evidences of aspen were observed throughout the project, but predictably found in higher elevations in the southern portion of the project area; it appears that aspen was not widespread historically. However, it is likely that historical frequent fire conditions were more beneficial to aspen development than current conditions, and it is likely that restoration treatments, especially the re-introduction of fire to the landscape, will promote aspen regeneration in some areas.

FIGURE 3



Historical structures (trees older than 140 years) ranged from 3 to a high of 66 trees per acre (TPA) on the URAR plots. The average number of historical structures was 28.5 TPA which is similar to other frequent-fire sites in Northern Arizona.

PHOTO 2

Range of Pre-Settlement Trees: Pre-Settlement (Pre 1870) Evidence provides an excellent view of how vegetative structure became established; primarily in groups, with significant interspace between the groups that was free of regeneration due to maintenance by frequent fire. Approximately 90% of the study plots were within a Historic Range of Variability of 9 – 40 trees per acre.

Quantitative data was not collected on current stand conditions (current tree densities, heights, diameters, regeneration, species composition, etc.), but observations and comments were made at each plot to provide a general assessment. Current stand conditions can be summarized from the forest inventory and stand examination data at the Lakeside Ranger District office. Field Notes, observations and estimations, were made at each plot and can be found in the Plot Summary Data Summary document (Appendix C).

Tree data summary for URAR:

- Only ponderosa pine, Gamble oak, and juniper (alligator, Utah and one-seed) species were found on plots
    - All of these tree species were not represented in all plots
    - Ponderosa pine was present in all plots
- Ponderosa pine historical, frequent fire tree density ranged from 3–66 trees per acre (TPA)
- The average ponderosa pine historical, frequent fire, tree density was 24 TPA
    - The average oak historical, frequent fire tree density was 3 TPA
    - o The average juniper historical, frequent fire tree density was 1–2 TPA (1.2)
- The total historical, frequent fire trees (all species) per acre averaged 28 TPA
    - Historical, frequent fire tree density (all species) ranged from 3–66 TPA

Fire is the primary disturbance agent in many southwestern forests, and fire regimes are central to understanding an ecosystem's reference conditions and natural range of variability (Fulé and others 2003). Prior to human-influenced changes to the characteristic fire regime, the composition, structure, and spatial pattern in frequent-fire forests were maintained by frequent, low-severity fire through a functional relationship between pattern and process; that is, frequent low-severity fires resulted in forest structures that facilitated continued low-severity fire (Fitzgerald 2005). Ponderosa pine and dry mixed-conifer forests are characterized by a frequent low-severity fire regime with historic mean fire return intervals ranging from 2–24 years (Swetnam and Baisan 1996).

Frequent low-severity fire favors shade intolerant and fire-resistant tree species and open forest conditions with discontinuous crowns and minimal fuels build-up, often with tree groups separated by open interspaces with grass-forb-shrub communities. In contrast, longer fire return intervals permit seedling development to larger, more fire-resistant tree sizes and favor survival of less fire-resistant species (Fulé and Laughlin 2007).

PHOTO 3

In the absence of fire, this ponderosa pine regeneration has grown to fire-resistant sizes. If frequent fire continued to occur prior to the trees attaining fire-resistant size, the seedlings would likely not have survived.

Over time, shifting mosaics of tree groups and individual trees of varying ages were maintained within a grass-forb-shrub matrix by relationships among the severity and frequency of fire, presence of surface fuels (fuels on or near the surface of the ground), and tree regeneration sites that escaped fire (Larson and Churchill 2012). Extended fire-free periods may allow tree regeneration in areas not typically fire "safe" (Fulé and others 2009), resulting in temporal shifting of tree locations where new cohorts develop to fire-resistant sizes.

The historical spatial mosaic of tree groups, scattered individual trees, and openings in frequent-fire forests was maintained by interactions among the locations and types of fuels, the frequency and severity of fire, and tree regeneration and mortality patterns. (Reynolds and others 2013). Fire further shapes tree spatial patterns at varying scales through its influence on seedling survival, with variability in the severity, seasonality, and frequency of fire (Cooper 1960; Pearson 1950; Stephens and Fry 2005). Also, there was indication that historical frequent fires played a significant role in the structural development of the stands on the north sides of Elk Springs Draw and other drainages southeast of Morgan Flat.

Past disturbances (such as the McNary and Chipmunk fires) created large areas of continuous even-aged structure. There is now an excellent opportunity to re-establish the new vegetation on trajectories toward development of key compositional and structural elements by designing group structure and interspaces during treatment prescription development.

Existing conditions will influence treatment prescriptions, timing and options. Within the majority of the untreated or lightly treated stands, fire alone cannot be used to meet desired conditions, as managed fire may result in more variable forest density, sizes of groups, and greater distribution of age classes. It appeared that managed fire can be used over large areas of the URAR project area where adequate mechanical treatments have been implemented (as was evidenced by previous prescribed burns), but many areas are in need of mechanical thinning and current conditions will limit the use of fire as a stand-alone treatment to restore HRV characteristics. Depending on existing conditions, achieving the desired outcomes may require multiple treatments (e.g., mechanical treatments and fire) over long time periods.

There was compelling evidence throughout the URAR project that the absence of fire either after thinning treatments or frequent burning after initial prescribed burns has greatly facilitated dense regeneration of all species on many sites, greatly exceeding the HRV. This should be a significant factor when considering objectives, prescriptions, timing and sequence of treatments.

Alligator juniper sprouting from cutting and burning is prolific and will require a specific long-term strategy to halt the spread of this species across larger areas. However, research has shown that alligator juniper may be eliminated in ponderosa pine forests in which underburns occur at 3–7-year intervals (Kallender 1959). This frequency of fire will facilitate utilization of root reserves in the tree and will effectively aid in its mortality.

Ponderosa pine, Gamble oak, alligator juniper, and Utah juniper were the dominant tree species identified on the URAR project area. Several minor species (such as one-seed juniper, Rocky Mountain juniper, piñon-pine, Douglas-fir, white fir, southwestern white pine and aspen) are present in some areas of this project area, but were not encountered on any of the Rapid Assessment plots. All of the dominant tree species were encountered, but not all of these species were represented on all plots. These dominant tree species were also present historically, as old, large trees and evidences were located in multiple locations.

Live, large and old trees of the dominant tree species representative within the URAR project area are present, either in groups or individually placed. We assessed these "large-old" trees by methods of measuring bole or root collar diameters, depending on species, by observing old tree characteristics (Appendix B), and by utilizing an increment borer to determine the age of the tree. "Old" is relative to the trees species (Swetnam and Brown 1992): about 200 years in ponderosa pine (Kaufmann 1996), and 150 years in junipers and oaks. "Large" is also relative to tree species, but it can be roughly divided into two diameter groups: large trees in woodlands and large trees in forests. Large trees in woodlands are approximately 10 inches in diameter with some alligator juniper in excess of 36 inches in diameter and are made up primarily of piñon, juniper, and oak. Large trees in ponderosa pine dominated forests are generally 20 inches and greater in diameter. Generally, multiple-age classes in all species are represented across the project area.

Ponderosa Pine Dominated Sites

The most significant vegetative condition of the project area is the current tree density, which, in conjunction with the associated increased fuel loading and hazard, represents ecosystem health concerns and vulnerability to facilitate severe insect outbreaks and destructive, high-intensity crown fire. These conditions, if left untreated, will continue to degrade, ultimately resulting in a potentially undesirable consequence.

Current stand densities are significantly greater than historic conditions across the project area. Areas that have been mechanically thinned under the White Mountain Stewardship Contract have greatly reduced tree densities, but reference conditions (less than 66 TPA) are very uncommon. Historic group structure characteristics are also uncommon in treated areas due to the application of spacing-based objectives imbedded on basal area reduction prescriptions being applied. Previous emphasis of thinning from below and implementing set diameter limits have precluded the opportunity to achieve an uneven aged, group-like structure with adequate interspaces to approximate the HRV structure, composition and function within the foreseeable future in most areas.

Where the vegetative structure has been reduced due to harvest, much of the interspace has been lost (filled-in with tree regeneration) due to the absence of fire that has facilitated episodic regeneration survival of all common species present. Where managed fire has been applied following mechanical thinning treatments, prolific regeneration is common in the interspace component of most stands. Where periodic managed fire (3–7 year frequency) has occurred, future management options are greater for achieving restoration objectives and vegetative structure within HRV.

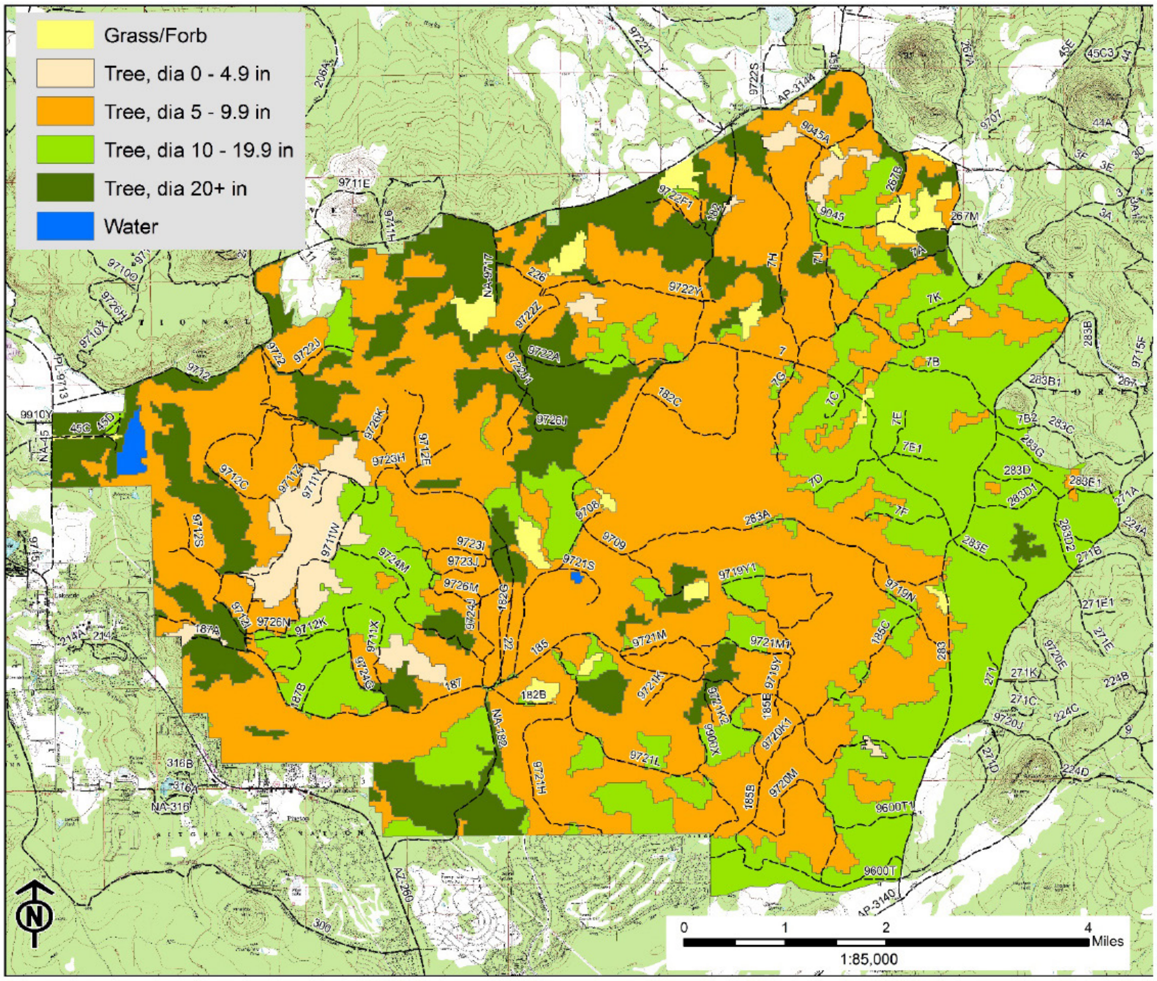
However, most site characteristics that support the productivity are such that future managed vegetative stocking could easily exceed HRV, but the potential tradeoffs should be carefully considered. For example, we observed several stands on the southern portion of the project where only a minimum of 20–24 historic evidences were found. These stands are on very productive sites that were commonly even-aged, less than 100 years old, with closed canopies, and carrying in excess of 180 BA. Some of these stands appeared to have similar characteristics: they evolved from historic, group-with-interspace dominated sites, had an interruption of frequent fire regimes, experienced significant stand replacing wildfire events, and were followed by an episodic regeneration event. Even though previous thinning and management investment has occurred, these stands are prone to crown-dominated fire events if further thinning (designed to reduce tree-crown continuity) followed by frequent fire reintroduction does not occur.

PHOTO 4

On many sites there is evidence of past dwarf mistletoe infection in the large, old trees due to the appearance of deformity in the tree boles, limbs and canopy (witches brooms, canopy thickness, multiple limb concentrations, mortality, etc.). However, it is notable that where mechanical thinning has occurred, there is little evidence of mistletoe fruiting bodies, etc., in the understory, even considering the 6-year life cycle of the pathogen. Localized mistletoe infections are most common, and have created pockets of dead trees that could eventually serve as regeneration sites. Some evidence of localized bug-killed groups also exist, from an endemic presence of a variety of insects.

In general, current stand conditions were estimated to range from 60 to more than 1,500 TPA, with all diameter classes represented through multiple age cohorts. There are 10 to 80 times as many trees across the landscape than we estimate were present in the historic, frequent-fire regime period. The age class diversity has shifted toward younger trees, due to a dramatic increase in the number of younger trees and encroachment of Gamble oak and juniper species. In addition to a significantly higher density of trees, some study plots demonstrated a shift in the species composition, with increased Gamble oak and juniper species where thinning has not been followed by periodic (3–7 years) managed fire. Similar to what has been documented for ponderosa pine forest vegetation dynamics in the Southwest (Arnold 1950; Laughlin and others 2005, 2011; Moore and Deiter 1992), the current stand densities have been associated with

R3 Mid-Scale Size



Evaluating vegetative characteristics such as canopy base height, can help assess current stand conditions.

a general encroachment of open areas by tree species and an overall reduction in understory vegetation (grasses, forbs, and shrubs). We observed species richness to be low on most plots. Increased shading from dense regeneration within the project has also reduced the amount of understory grass, forb and shrub layers that provide important food and hiding cover for wildlife, compared to what we know about historical conditions (Vankat 2013). Another effect of the high density of trees, that we observed, is the presence of an average 1 to 2-inch litter layer (sometimes this layer exceeds 5–6 inches) that virtually eliminates any current problems with soil erosion; however, it also precludes the development of robust ground vegetation (Cooper 1960; Korb and Springer 2003). We also noted a general increase in the amount of downed dead woody material, compared to what we know existed with frequent fire forest conditions.

Tree groups have changed due to larger dense pockets of younger trees today, and the separation of the tree groups by open, non-tree areas is limited. Historically, there were more uneven aged tree groups, and currently there are even-aged tree groups as well as dense tree groups that have several cohorts. Canopy cover was estimated to be in the 60–70 percent cover range for the majority of the sample sites. This is an indication of the large number of trees and lack of open areas. The average BA was 120 sq. ft. in the sampled plots, but we encountered areas where the BA was in excess of 250 sq. ft. Our observations of what the historic structure looked like and how current conditions vary from historic frequent fire conditions are captured in a series of photos taken on the study plots (Appendix D).

In summary, current conditions are very likely due to the disruption of the historic frequent fire regime during the last 130–140 years. As widely observed in forests across the Southwest, this has likely resulted in the dramatic increase in the number of trees per acre, a substantial decrease in the abundance and species of understory vegetation, and a loss of plant vigor and structure. The lack of frequent fire has also lowered the canopy base height, promoting the increased potential for crown fire development. Historically, much of the project area likely had a higher percentage of ground cover composed of grasses along with other understory species, including legumes and forbs. As the tree densities increased, understory plant cover declined. Prior to the exclusion of fire, the low density of trees within the interspaces promoted much higher forage production.

Woodland Species Sites

Alligator, one-seed, Utah, and Rocky Mountain juniper, piñon pine and Gambel Oak with scattered ponderosa pine occur mostly along the northern fringe of the URAR area. Utah and one-seed juniper most commonly are found in dense stands, but single trees were intermixed as elevations increase toward the Southern portion of the project area, except in the southwestern portion of the project area along Blue Ridge. Piñon-pines are generally intermixed as single trees, and no "old or large" trees were observed. Gambel oak was observed in various size groves throughout the woodland "zone" and historic evidences were common, suggesting the species has remained a dominant part of the vegetative structure in the area.

Historic evidences of alligator juniper, both live and dead, provided an impressive view of this species dominating certain areas for hundreds of years. Alligator juniper is noted for its slow growth rate. It ceases growth when moisture conditions are unfavorable but begins growing again with adequate moisture. This characteristic greatly enhances the ability of alligator juniper to survive in harsh, arid environments typical on the northern portion of the project area. A diameter growth rate of approximately 0.6 inches (1.5 cm) per decade is typical for young trees, with growth slowing to 0.4 inches (0.1 cm) per decade after the tree reaches 170 years of age (Medina 1987).

In comparison to historic evidence located on the URAR Project area, Piñon-juniper woodlands have been increasing in extent and densities, since pre-settlement times. It is evident that Alligator and Utah juniper, and other species have encroached into adjacent grasslands. A decrease in fire frequency and grazing patterns has often been cited as the probable cause of this increase (White 1965). Some past mechanical management efforts (pushing, chaining, burning, etc.) on the northern fringe of the project area have largely focused on removing the juniper "invasion," but with mixed results. On several locations where juniper species had been mechanically cut or where fire had impacted the tree, sprouting was common in trees generally below 6 inches in diameter at breast height (DBH). In ponderosa pine-woodland transition areas, there has been significant pine regeneration that occurred during recent past episodic events (30–40 years ago). These sites are void of additional pine regeneration, and where thinning treatments (primarily firewood harvest) has occurred, significant sprouting and new alligator regeneration has occurred. In consideration of historical frequent-fire effects in the area, re-introduction of frequent fire (3–7 year intervals) should be effective in maintaining, and possibly increasing, pine regeneration. If fire is not re-introduced on a periodic basis, it is probable that juniper species will continue to dominate these sites.

Drainages and Riparian Areas

Most intermittent drainages, including wet-bottom areas, have been encroached predominately by ponderosa pine. On the drier drainages (Elk Springs Draw, etc.), bunch-grass (Arizona fescue) and bluegrass species historically carried frequent fire into the vegetative structure by prevailing southwesterly winds, seen by evidence of multiple fire scars on every stump examined along the north and easterly slopes of the drainages.

Considerations and Possible Treatments

The intent of this assessment is not to provide specific management direction, but rather to compare historic conditions in relation to current conditions as an informational tool to consider in the strategic analysis of the URAR Project. Based on what we found with the historical conditions, we recommend the following considerations:

1. Previous harvest activities across the URAR Project area have reduced stand densities, based on past decisions identifying the desired objectives and outcomes. In many cases those treatments resulted in the perpetuation of an even-aged structure (reduction in structure heterogeneity) and the retention of an interlocking tree canopy that a) does not mitigate crown fire spread, b) limits the ability to facilitate HRV outcomes of an increased group-interspace effect and c) has propelled regeneration establishment due to the absence of managed fire. However, in view of the historical site potential, we concur with the decision and objective of accelerating subsequent treatments in the near future to achieve objectives that promote resilience, function and restoration of the project area.

2. The option of returning to pre-settlement conditions across the entire landscape is unrealistic. However, to address current fire and forest health concerns, it would be reasonable to consider restoring a significant amount of the URAR project area with elements of the historical composition, spatial structure, and age distribution within the tree-dominated landscape. The "Restoration Framework" descriptions and "Implementation Recommendations" identified in the Rocky Mountain Research Station General Technical Report RMRS-GTR-310 (which closely relate to the Region 3 Desired Conditions Framework for ponderosa pine and dry mixed conifer restoration), provides an appropriate set of objectives to accomplish as part of restoring the project area. The project specific HRV data provided in ERI's URAR Project Report and the implementation recommendations in GTR-310 can be combined to develop sound management objectives and prescriptions.

3. Consider reducing tree density closer to historical conditions in order to reduce fire, insect, and disease risks, and to improve overall ecosystem health and resiliency. The attached (Appendix E) historical (frequent fire) stand data could be considered as a reference in determining the desired future conditions and as a baseline for monitoring. If the historical average density of 3–66 trees per acre is too open for other management objectives, then adjust accordingly (e.g., adjust to 2–3 times the historical density). However, consider the historical conditions as they relate to resiliency (e.g., climate change), soil type, and re-establishing a more frequent fire regime. Further action of allowing fire to play a more natural role in the ecosystem, and maintaining the ability to re-enter the stands for subsequent treatments are important factors.

   The creation of adequate openings and interspaces will be critical to the establishment of understory vegetation that will allow managers to use fire as a maintenance/management tool and expand ecological benefits of the sites by improving wildlife habitats, food webs, nutrient cycling, etc.
   Creating canopy gaps will also reduce the risk for crown fire potential. Regardless of the historic tree group configurations we encountered, the one constant throughout the project area was the presence of openings between these tree groups, historically. Open areas were a key element of a properly functioning frequent fire ponderosa pine ecosystem in this area. The re-establishment of openings and their associated diverse ground vegetation will also benefit the wildlife community.

   We saw little mortality in large, old tree groups. There was a correlation between density of tree group crowns and surface fuels and lack of grasses. Consider strategic placement of restoration treatments to capitalize on the use of managed fire, under appropriate conditions, across broad landscapes.

4. Consider the re-introduction of frequent fire as a management tool for the project area. It will be essential to develop a strategy for using fire as a management tool to meet project objectives, including tree group placement and maintenance of interspaces across the project area. If openings are created and tree densities are reduced, there will be rapid re-establishment and growth of conifer regeneration, juniper, oak and other shrub species. Fire or some other form of treatment (mechanical) will be needed on a frequent basis to eliminate a return to current conditions and to allow grasses and forbs to

become established in the open areas. The re-establishment of a frequent fire program will help reduce the downed woody material, establish and maintain the open areas and diverse ground vegetation, and maintain forest resiliency. It will raise crown base height, mitigate the establishment of dense pockets of regeneration, and minimize large fire impacts. Based on historical occurrence of episodic regeneration establishment (1820, 1875, 1890, 1920, 1975, 2002, etc.) effective use of periodic fire will be critical in managing regeneration density and placement.

Low-intensity fires that consume surface fuels and raise crown base heights without affecting stand structure may reduce potential for crown fire while doing little to restore ecosystem health (Sensibaugh 2014). However, due to the presence of recent harvest-generated slash, increased regeneration, dense stocking and ladder fuels, some areas will require treatment timing mitigation for removal of fuels (slash, piles) and mitigation of the regeneration (through localized fire use or thinning) prior to additional harvest or introduction of broad-scale managed fire.

There will also be a need to monitor invasive/noxious weed populations prior to utilizing fire treatments. Although we did not encounter much aspen within the project area, the application of more frequent fire to the landscape should benefit the re-establishment of aspen in those areas where remnants exists.

5. Consider the possible adverse effects of incorporating a diameter cap on the ability to meet restoration goals given the current stand conditions. The need to re-establish groups and interspaces (openings), restore seeps, springs, and riparian areas, and to manage encroached grasslands are critical goals that might not be adequately met with a diameter cap. Arbitrary diameter caps can have unintended consequences such as interfering with the restoration of herbaceous openings and more natural spatial distribution of groups of trees important for wildlife habitat and forest health; also where unnaturally dense stands of larger post-settlement trees predominate, caps can limit fuel reduction efforts and therefore limit the re-establishment of surface fire (Abella and others 2006, Sanchez-Meador 2009). Utilizing a diameter cap can eliminate age groups from an existing stand (thinning from below), and its use trends toward even-aged management (Triepke and others 2011).

6. Promote the development of uneven aged tree groups. The existing stand conditions with multiple cohorts of pine regeneration provide an excellent opportunity to develop uneven aged tree groups. This recommendation along with those above will have positive effects on habitat improvement by providing more habitat diversity, structural variability, and opportunities for the expansion of food webs. Where trees are spatially aggregated, maintain interlocking or nearly interlocking crowns in mature and old groups and provide for variable tree spacing within groups; avoid thinning old tree groups.

7. Reduce or eliminate the tree encroachment into meadows and riparian corridors that has occurred since the disruption of the frequent fire regime. We noticed a significant amount of tree encroachment into these areas, which has reduced their historic function and role in habitat diversity, watershed function and forest heterogeneity. ERI recommends utilizing historic, frequent fire tree evidence as a guide to establish tree densities in these areas, by incorporating a 1:1, or a 1:1.5 replacement ratio.

8. Where spatial heterogeneity is desired, consider combinations of burns, intermediate and free thinning, and individual tree or small group selection cutting methods to create a heterogeneous structure of groups, single trees, and grass-forb-shrub interspaces. Once heterogeneity is established, consider maintaining the desired structure and spatial pattern with fire and/or single tree and small group selection harvest. Use historical evidence and biophysical capabilities to determine a site's mean and range (minimum, maximum) of trees per group and numbers and spacing of tree groups per area. Vary treatment prescriptions (cutting and/or fire) to create a mosaic of groups of trees, scattered single trees, and grass-forb-shrub interspaces.

   Manage young tree groups to create future variable tree spacing and interlocking crowns. Thin young tree-groups to facilitate development of desired within-group characteristics (e.g., variable tree spacing and interlocking or nearly interlocking crowns) in mid to old-aged tree groups. Grass-forb-shrub interspaces are generally larger on dry sites.

9. As basalt soils are dominant throughout the area, it was apparent that surface-rock outcrops played an important role, historically, in vegetative structure development. These areas appear to be sites that naturally limited fire impacts, potentially provided microsite attributes regarding increased moisture, and ultimately provided an adequate site for regeneration success. Considerations regarding future objectives of managing within the HRV, facilitating group structure retention or development, managing for uneven-aged characteristics, and the interaction of managed fire on these and adjacent sites are important factors to consider prior to developing broad-scale treatment prescriptions involving these areas.

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A. Historical Context

Historical Context of the Upper Rocky Arroyo Restoration Project Area

Well documented accounts of ecological conditions in the ponderosa pine forests of northern Arizona, including the White Mountains, by early explorers in 1540 (letter, Coronado to Mendoza, Aug. 3, 1540) and also by later groups conducting scientific trips in the White Mountains area, consistently describe "a vast forest of gigantic pines intersected frequently with open glades, sprinkled all over with mountains, meadows, and wide savannahs, to a wide-range of frequency and richness of grasses." With almost 150 years of various increased impacts, in most cases, these historic landscapes have been greatly altered. Detailed accounts of ecological conditions in the White Mountains area in the mid-1880s highlight "a mature forest with an overstory of trees aged in excess of 150 years old. The overwhelming impression that one gets from the older Indians and white pioneers of the Arizona pine region is that the entire forest was once more open and park-like than it is today; the forests were open, devoid of under-growth, and consisted in the main of mature trees, with practically no forest cover. Reproduction was present but not abundant, and in many areas was markedly deficient" (2).

In Arizona's White Mountains, many stands within ponderosa pine forests had been more open before the influx of settlers during the late 19th century, as documented by ERI (8). Research indicated that some pre-settlement ponderosa stands consisted of 20 to 40 large pines per acre, with abundant grass cover and open space beneath the tall canopy. Contemporary ponderosa pine forests in the southwestern U.S. commonly reached stand densities of 300 to 500 trees per acre of relatively small diameter trees.

In 1873, Lt. George Wheeler recorded his observation that "grass throughout the White Mountains was sparse, primarily a thin layer of perennial grasses, although it rarely approaches a turf." Coronado (Winship 1899) spoke "feelingly" of the difficulty of crossing the White Mountains, due to the lack of feed for their livestock, "… Of which we had great need, because our horses were so weak and feeble when they arrived" (3).

Research of frequent fire occurrence continues to indicate that fires started by lightning or Native peoples in the White Mountains, played a significant role in the development of the ponderosa forests, meadow integrity and interspace within the forest mosaic. Weaver (1951) analyzed the fire scars on sections of stumps collected at various sites in the area. "The most frequently burned tree showed an average interval of 4.8 years between fires, while the longest average interval between fires exhibited by any sample tree was 11.9 years" (4). Weaver's findings are consistent with data collected by researchers from the Ecological Restoration Institute (ERI) from sites along the Mogollon Rim (2013). For example, the pre-settlement (pre-1870) fire history for the Black Mesa mixed conifer study site, which analyzed 133 fire scar samples, showed that the composite mean fire occurrence interval ranged from 2–8.5 years.

Despite the frequency of surface fires, large crown fires were apparently rare. A fairly thorough search of the early literature failed to identify a single report of a large crown fire over 1,000 acres in Arizona before 1900. Wheeler (1878) reported that on the higher reaches of the Little Colorado River, "For less than 2 miles the grass is of the old crop, then begins the new and juicy growth of the year subsequent to the burning over by fires set by the Indians" (2). Lightning ignited fires undoubtedly were paramount as the main cause of wide-spread, frequent, low-intensity fires throughout the White Mountains, but documentation by Bell (1870) suggested the Apache Indians utilized fire extensively for a variety of objectives. Holsinger (1902) was convinced that, "These prehistoric aborigines must have exerted a marked influence upon the vegetation of the country. Their fires, and those of the historic races, unquestionably account for the open condition of the forest … these forests show, in certain localities, all classes of regrowth. The forests within their (Apache) domain … show a regrowth gradating into many past decades" (5).

These frequent fires helped keep seedlings at bay while encouraging grasses to thrive in the many open spaces between established groups of trees. Fire evidence from fire-scarred trees indicates that turn-of-the-century grazing practices and effective fire suppression had virtually eliminated surface fires by early 1900s. With the reduction in grass cover, fires could gain no foothold with which to travel through the forest.

The Black Mesa Forest reserve was established in 1898, and fire suppression was a key duty of forest officers. The age distribution of trees has been largely influenced by the extensive evidence/role of fire and the apparent infrequent occurrence of specific weather-related conditions necessary for the establishment of pine regeneration. Groups of large, old trees generally date from about 1839 and most are about 22–30 inches DBH. From study plots in the Pinetop, AZ area, Cooper (1957) found that "there were definite age classes that originated about 1875, about 1890, and possibly in other years; but on the whole, there was little regeneration between 1839 and 1909. Many of the present small pole stands started in 1909 and were followed by the extensive 1919 seedling establishment. Several older (age) classes can be clearly distinguished. Many trees became established in 1820 and others about 1975. A surprising number of the very large veterans in the old-growth forest can be dated about 1685."

"Early studies suggested that frequent fires were restricting the forests to produce no more than 40% of their potential growth, due to basal area restrictions. It is clear that the growth of pre-settlement forests did not reach their maximum potential productivity of the site. Natural fire thinned some sapling stands too severely, and killed occasional large trees. Growth of young pines has actually declined due to fire suppression, and overcrowding" (2).

The White Mountain Stewardship Contract (2004-2014) and Recent Management Factors

Ponderosa pine is the dominant forest type throughout the Upper Rocky Arroyo Restoration Project area (URA), and like ponderosa forests throughout much of the Southwest, these fire-adapted ecosystems have been altered from the effects of a century or more of fire exclusion, logging, and historically unregulated grazing. Current forest conditions in some areas have, in recent years, generally reverted from dense even-aged stocking and are on a trajectory towards historic ranges of natural variability due to mechanical and thinning treatments and re-introduction of prescribed fire. However, many forested areas are typified by overstocked stands containing 10 to 20 times the historic tree density, decreased tree vigor, a sporadic understory, and a susceptibility to uncharacteristic crown fire.

Since the formation of the Black Mesa Forest Reserve in 1898, various timber harvesting efforts have been employed through the years to improve the health and condition of the forest structure, as well as provide timber to help supply a robust woods products industry. A variety of harvesting systems, prescriptions, and management objectives through the years have created a wide array of forest conditions, in contrast to the historic range of variation in the forest composition and structure.

Blue Ridge Demonstration Project

The Natural Resources Working Group (NRWG) was formed in the mid-1990s as a result of a series of discussions between various elected officials, agency leaders, and environmental representatives due to concerns of forest conditions and the onslaught of unprecedented wildfires. One of the NRWG's first significant projects was a demonstration of various approaches to restoration and fuel reduction in a wildland-urban interface (WUI) area known as Blue Ridge, on the Lakeside Ranger District, Apache-Sitgreaves National Forests. The development of a demonstration site on Blue Ridge, as well as design and layout of treatment alternatives, was conducted in close collaboration between ASNF staff and the various stakeholders of the NRWG. Particular attention was paid to engaging the environmental activist community by implementing one treatment alternative based on guidelines developed by a consortium of regional environmental groups. The agency also signaled willingness to compromise with environmental groups by instituting a 16-inch diameter cap on treatments within the Blue Ridge Demonstration Project.

The demonstration also illustrated for many NRWG members the connections between utilization capacity and the ability to get restoration work done. Because of diminished local markets for small-diameter material, two initial offerings on the Blue Ridge projects received no bids. Treatments were implemented only after the project was scaled back and outside funds were obtained to conduct the thinning activities.

The Blue Ridge Demonstration Project began as the 17,000-acre Blue Ridge–Morgan Ecosystem Management Area on the Lakeside Ranger District of the Apache-Sitgreaves National Forests. It served as a demonstration of forest restoration activities through the implementation of three different treatment approaches across 7,000 acres and was developed collaboratively between the Natural Resources Working Group and the Apache-Sitgreaves National Forests.

The Environmental Assessment for the area was approved in 1997. In April 1997, the decision was made on the prescriptions and in September 1997 sections that included 1,000 acres were marked for thinning. The Morgan timber sale consisted of 650 acres and was the first section treated in 1997. The Morgan timber sale proceeded smoothly because the pulp mill in Snowflake, AZ was still paying for and utilizing Small Diameter Timber (SDT). In 1997 the pulp mill quit taking wood material and converted to a paper recycle mill. This presented a problem for the project because no bids were made on the remaining sections; there was no place to take SDT and the contracts stipulated removal of slash and SDT (6).

Three treatments and a control area were planned in the project:

- The USFS used a goshawk prescription, which is designed to protect and retain yellow pine by removing competing younger trees a distance of ? to one crown diameter, and creating foraging areas averaging 60–80 basal area (Technical Advisory Committee 2000). The USFS plan was designed to maintain viable habitat for the Mexican spotted owl and the northern goshawk. It involved leaving protective dense habitat around nesting sites then thinning more extensively in other areas. In what could be considered an example of the move from an extractive to a service-oriented approach, the USFS first had to contract for pre-commercial thinning. In 2000 the USFS paid $878,000 for the removal of trees less than 5 inches in diameter (4,900 acres); the creation of fuel breaks (200 acres); biodiversity monitoring (5,600 acres); and the introduction of prescribed burns.

- The Ecological Restoration Institute (ERI) at Northern Arizona University used a "pre-settlement restoration" prescription based on Ecological Restoration Marking Guidelines (7). The objective was to restore pre-settlement ponderosa pine forest structure, recreating as far as possible, the density, spatial distribution and variability of trees at the time of disruption of the frequent fire regime. The concept was to approximate historic conditions, when stands comprising predominately of large, old ponderosa pine tree groups, interspaces present between the groups, and a variety of tree age and sizes located throughout the forest. However, the ERI prescription was modified and agreement was made to start with a less rigorous thinning program to the site to avoid the need to go back and amend the existing environmental analysis done under NEPA guidelines.

- The third prescription was to be a "natural process restoration" prescription developed from guidelines proposed by environmental community representatives. The management technique prescribed by environmental NGOs, termed "natural processes restoration" focused on getting fire back in the system while maintaining viable wildlife habitat and a higher density forest (6).Natural process restoration was designed to go slower than other treatments, to be more cautious and conservative in thinning from below, and to retain a higher percentage of younger and smaller trees (Technical Advisory Committee 2000). However, local environmental groups did not have knowledge or experience in developing a prescription, so they solicited the assistance of the Southwest Forest Alliance. The Southwest Forest Alliance did not have the time to work on their section (marking) and had difficulties coming up with the prescription (Collins 2004).

In 2004, the Apache-Sitgreaves National Forest requested bids for the White Mountains Stewardship (WMS) Project—a 10-year, 150,000 acre project that would offer 5,000 to 20,000 acres of forest lands to contractors each year. Thus, to date, subsequent task orders, or units, have been treated throughout the URAR Project area, in addition to the Blue Ridge Demonstration Project. In several areas, the Desired

Condition of vegetative composition, structure and function has not been achieved and additional treatments involving mechanical thinning and managed fire are needed to meet the desired objectives.

In summary, the White Mountain Stewardship (WMS) Contract has treated many areas previously identified in the original NEPA documents needing Restoration treatments. There are additional acreages needing treatments, as well as re-entry into some WMS units to complete harvest objectives to meet desired outcomes. Limited wood-product industries, the economy, area impacts from the Rodeo-Chedeski and Wallow fires, and general capacity and funding limitations to meet the hazard reduction needs and provide wood-fiber, have all contributed to the current conditions that need restoration treatments in the URAR Project area.

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(6) Eagar Arizona Case Study, December 1-4, 2003, Dr. Toddi Steelman and Ginger Kunkel

(7) Covington, W.W. et.al. 1999. Ecological restoration marking guidelines for ponderosa pine restoration areas. Ecological Restoration Institute, Northern Arizona University.

(8) Friederici, P. (Ed.). 2003. Ecological Restoration of Southwestern Ponderosa Pine Forests. Washington, DC: Island Press.

B: Old Tree Characteristics

In addition to DBH, the following characteristics were utilized to help establish the pre-settlement trees in each plot:

Crown Shape: Transitional trees (trees that are trending toward old age; 150–200 years) have an ovoid shape—flattened top, full and rounded crowns. Old trees (>200 years) are flattened on the top, "bonsai" shape, sparse and open, and may be lopsided.

Live Crown Ratio: Transitional trees have moderate live crown ratio; perhaps half the trunk, beginning to self-prune. Old trees have small live crown ratio; often fire-pruned.

Branches: Transitional trees have dying fine branches in the interior of the crown, longer branches thickening. Old trees have few, but large branches.

Trunk shape: Transitional trees are beginning to loose taper. Old trees are columnar.

Bark: Transitional trees have orange or gray flakes with dark edges, shallow fissures, becoming smoother. Old trees have smooth, small flakes, pale orange or gray.

Likely Injuries: Transitional trees have relatively few injuries; possibly healed or mostly healed fire scars, lightning scars, and mistletoe. Old trees have fire scars, dead tops, broken branches, lightning scars, rot, burls, and exposed roots.

C. Plot Data Summary

The following spreadsheet displays the density and type of historic evidences found on each plot. The evidences are coded as follows: L = live tree, C = cut stump, S = snag, LG = log, and SH is a stump hole.

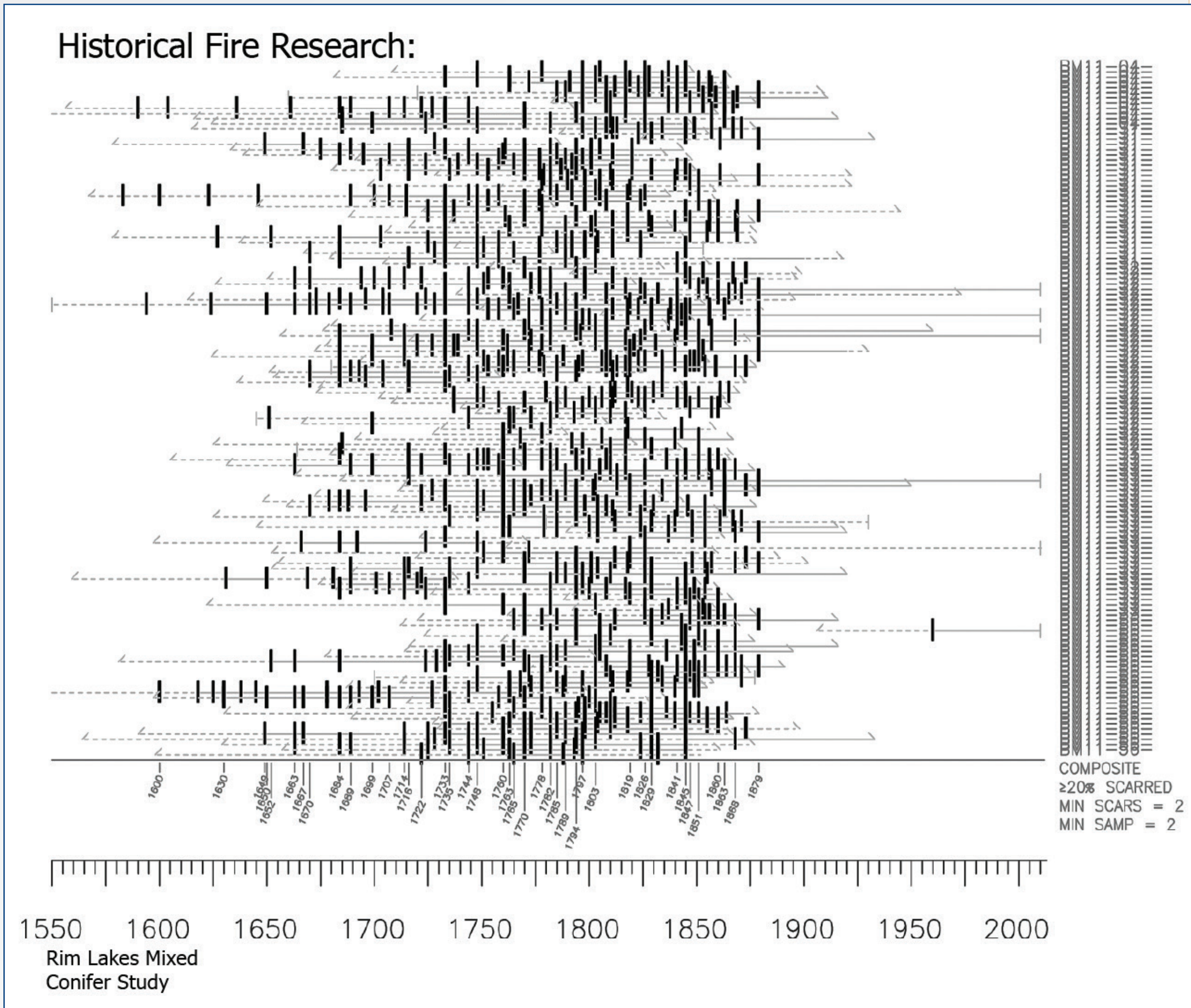
					PIPO					QUGA						JUDE				
	Plot #	L	S	C	LG	SH	Total	L	S	C	LG	SH	Total	L	S	C	LG	SH	Total	Grand Total
1	1-1	0	1	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
2	1-2	0	0	37	6	0	43	0	1	7	0	0	8	1	0	0	0	0	1	52
3	1-3	1	0	15	3	0	19	0	0	0	2	0	2	0	0	0	0	0	0	21
4	1-4	28	0	18	2	0	48	0	0	0	0	0	0	0	0	0	0	0	0	48
5	1-5	3	11	2	5	0	21	2	2	2	0	0	6	0	0	1	0	0	1	28
6	1-6	29	1	14	3	1	48	0	0	0	0	0	0	0	0	0	0	0	0	48
7	1-7	1	0	14	0	5	20	1	0	0	0	0	1	0	0	0	0	0	0	21
8	1-7	8	0	41	0	0	49	0	0	1	0	0	1	0	0	0	0	0	0	50
9	2-1	8	0	10	2	3	23	0	0	0	0	0	0	0	0	0	0	0	0	23
10	2-2	0	0	15	1	4	20	0	0	0	0	0	0	0	0	0	0	0	0	20
11	2-3	4	0	38	2	0	44	0	0	0	0	0	0	0	0	0	0	0	0	44
12	2-4	0	2	55	9	0	66	0	0	0	0	0	0	0	0	0	0	0	0	66
13	2-5	0	0	16	1	1	18	0	0	0	0	0	0	0	0	0	0	0	0	18
14	2-6	2	1	34	3	0	40	3	0	0	0	0	3	0	0	0	0	0	0	43
15	2-7	2	0	10	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	12
16	2-8	1	1	29	2	7	40	3	0	3	0	0	6	0	0	0	0	0	0	46
17	3-1	10	2	11	5	3	31	0	0	0	0	0	0	0	0	0	0	0	0	31
18	3-2	7	1	23	3	2	36	1	0	0	0	0	1	0	0	0	0	0	0	37
19	3-3	8	11	0	1	2	22	0	0	0	0	0	0	0	0	0	0	0	0	22
20	3-4	1	1	24	1	1	28	2	0	7	0	0	9	0	0	0	0	0	0	37
21	3-5	6	0	21	3	1	31	0	0	5	0	0	5	0	0	0	0	0	0	36
22	3-6	8	3	28	6	1	46	0	0	0	0	0	0	0	0	0	0	0	0	46
23	3-7	3	0	11	5	0	19	11	1	2	0	0	14	0	0	0	0	0	0	33
24	3-8	1	0	6	5	0	12	0	3	0	0	0	3	1	0	0	0	0	1	16
25	3-9	2	1	1	0	0	4	2	0	0	0	0	2	20	0	0	0	0	20	26
26	3-10	15	0	4	1	0	20	0	0	3	0	0	3	1	0	9	0	0	10	33
27	4-1	8	0	5	0	0	13	0	0	4	0	0	4	0	0	0	0	0	0	17
28	4-2	16	0	3	1	0	20	0	0	8	2	0	10	2	0	0	0	0	2	32
29	4-3	8	0	9	5	0	22	2	0	3	1	0	6	0	0	0	0	0	0	28
30	4-4	20	0	8	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	28
31	4-5	10	0	4	1	0	15	2	0	7	0	0	9	0	0	0	0	0	0	24
32	B-1-1	4	0	16	2	0	22	3	3	3	0	0	9	0	0	0	0	0	0	31
33	B-1-2	5	4	4	0	10	23	0	0	0	0	0	0	0	0	0	0	0	0	23
34	B-1-3	1	0	25	3	1	30	0	0	0	0	0	0	0	0	0	0	0	0	30
35	B-1-4	3	0	11	2	3	19	0	0	0	0	0	0	0	0	0	0	0	0	19
36	B-1-5	1	0	0	1	6	8	1	0	1	1	3	6	5	0	2	4	0	11	25
37	B-2-1	0	0	10	1	8	19	0	0	0	0	0	0	0	0	0	0	0	0	19
38	B-2-2	4	0	13	5	1	23	0	0	0	0	0	0	0	0	0	0	0	0	23
39	B-2-3	0	0	10	3	8	21	0	0	0	0	0	0	0	0	0	0	0	0	21
40	B-2-4	2	0	3	10	0	15	5	4	1	0	0	10	4	0	3	0	0	7	32
41	B-2-5	1	5	3	0	6	15	0	1	2	0	0	3	0	0	0	0	0	0	18
42	B-2-6	1	0	0	2	0	3	2	0	0	0	0	2	8	0	2	2	0	12	17
43	B-2-7	1	0	7	0	2	10	0	0	0	0	0	0	3	0	3	0	0	6	16
44	B-3-1	0	0	25	1	1	27	3	1	0	0	0	4	0	0	0	0	0	0	31
45	B-3-2	1	0	4	3	0	8	2	3	7	0	0	12	4	0	0	0	0	4	24
46	B-3-3	1	1	19	0	0	21	1	0	1	0	0	2	3	0	0	0	0	3	26
47	B-3-4	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
48	B-3-5	3	0	1	6	12	22	0	2	0	1	3	6	0	0	0	0	0	0	28
49	B-3-6	6	0	16	2	0	24	0	0	0	0	0	0	0	0	0	0	0	0	24
		244	48	674	118	89	1173	46	21	67	7	6	147	52	0	20	6	0	78	1398

1398 total
28.53061224 avg
12.5 Standard deviation
2-66 range
24.9-32.1 lower and upper 95%

L	342	24.46352 %			
S	69	4.935622 %	PIPO	1173	83.91 %
C	761	54.43491 %	QUGA	147	10.52 %
LG	131	9.370529 %	JUDE	78	5.579 %
SH	95	6.795422 %		1398	
	1398				

D. Plot Data Photo Summary: (SEE PHOTO FILE ON DATA DISK).

E. Historic Frequent Fire Study Results:



The chart shows the presettlement fire history of the Black Mesa RD mixed-conifer study site. Horizontal lines are wood samples from individual trees and vertical marks are fire scars from 133 samples from stumps, logs, snags & live trees.

** Fire scars represent 103 individual fire years between 1670 and 1879 A.D.*

** The composite mean fire occurrence interval ranged from 2 – 8.5 years*

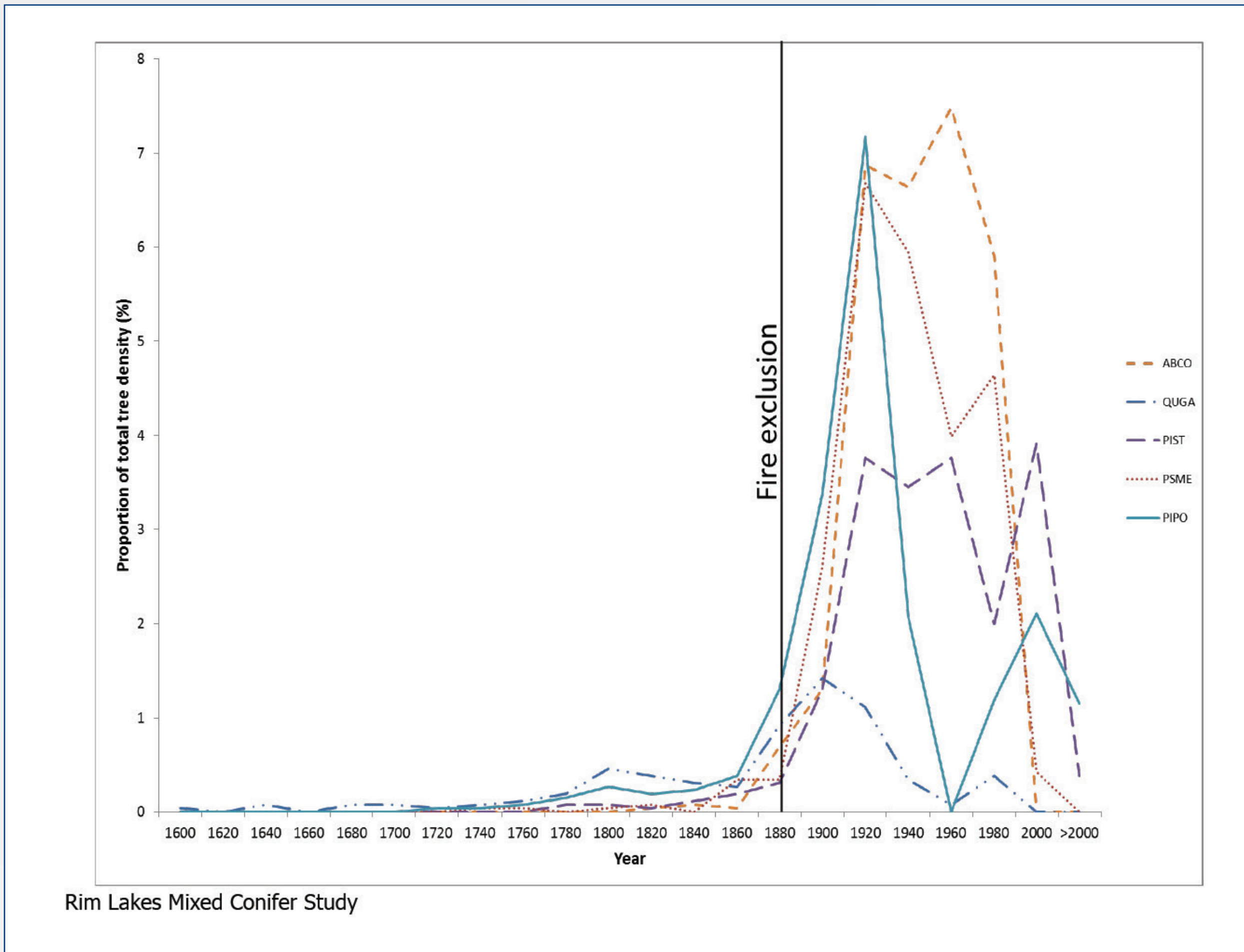


Chart depicting changes in species composition and density post-1870 exclusion of frequent fire.

The Ecological Restoration Institute is dedicated to the restoration of fire-adapted forests and woodlands. ERI provides services that support the social and economic vitality of communities that depend on forests and the natural resources and ecosystem services they provide. Our efforts focus on science -based research of ecological and socio-economic issues related to restoration as well as support for on-the-ground treatments, outreach and education.

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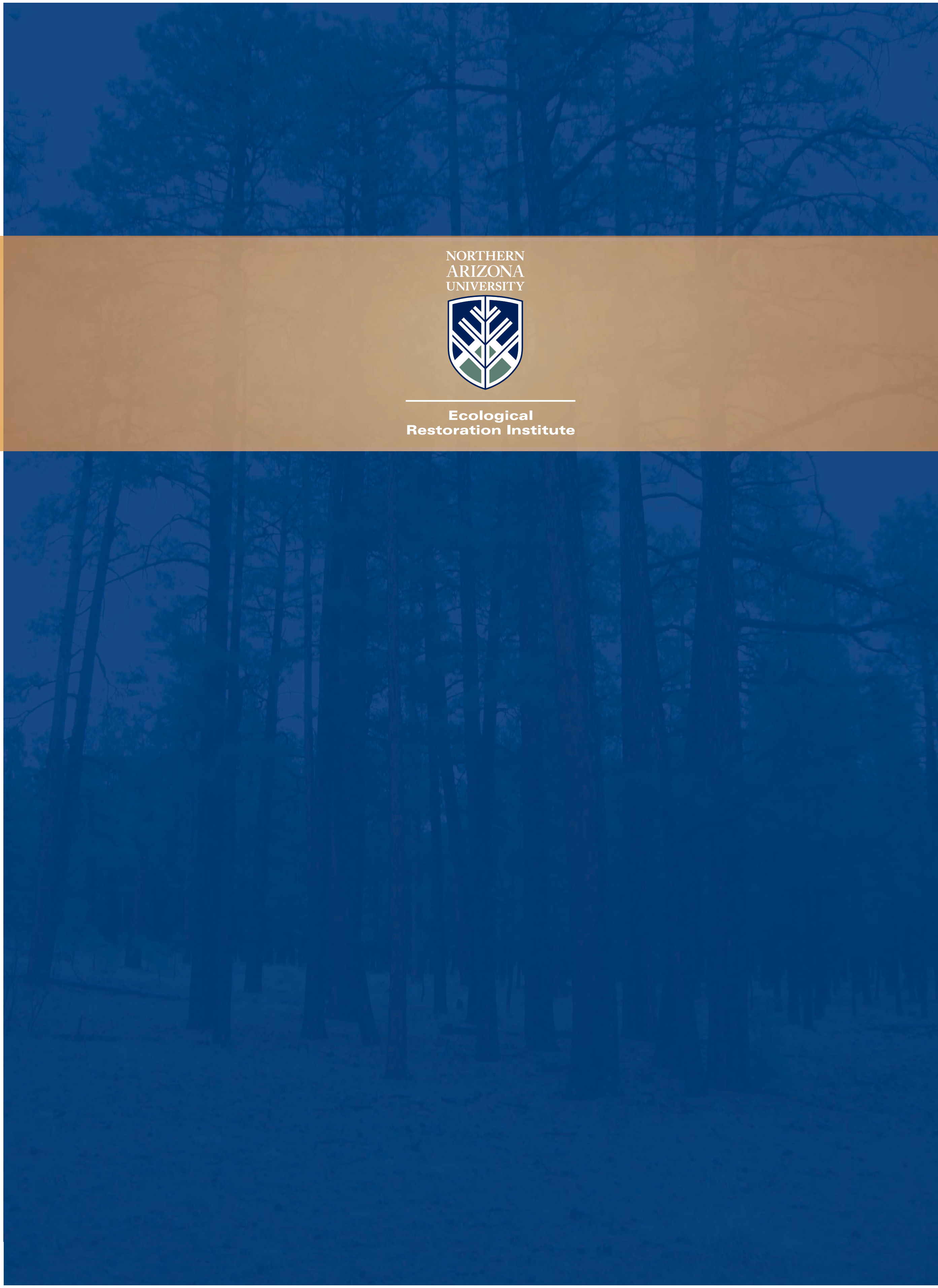
NORTHERN
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Ecological
Restoration Institute

Summary Report on Reference Conditions:

A Rapid Assessment of Historical / Natural Range of Variability (HRV)

For the

Tio Gordito Restoration Project

Tres Piedras Ranger District, Carson NF

December 2014

Report Prepared by:

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Introduction

The Tio Gordito Restoration Project (TGRP) is located on the Tres Piedras Ranger District of the Carson National Forest (CNF), and is adjacent to the community of Tres Piedras, New Mexico. The proposed project area is approximately 17,000 acres and is located primarily in the Rio Tusas and Arroyo Aguajede la Petaca 5th code watersheds. The main purpose of the TGRP is to:

- Move stand densities toward desired conditions that exhibit forest health, promote large tree development, and promote herbaceous understory richness as defined in the CNF Forest Plan.
- Reduce the risk of stand replacing crown fire by treating the forest to; reduce stand densities, canopy continuity, crown base heights, and creating more stand openness.
- Move stand conditions toward desired conditions that support Goshawk habitat.
- Where Mexican Spotted Owl (MSO) habitat types exist, treat them to meet the desired condition of stand density and forest structure consistent with the Carson Forest Plan and MSO Recovery Plan.
- Reduce the basil area on most stands to reduce bark beetle hazard, and selectively reduce the severity and continuity of dwarf mistletoe infection. (From Scoping Letter 11/26/13)

The project area is dominated primarily by ponderosa pine (*Pinus ponderosa*), with Gambel oak (Quercus gambelii; there are areas of Utah juniper (*Juniperus osteosperma*), one-seed juniper (Juniperus monosperma), piñon pine (*Pinus edulis*), white fir (*Abies concolor*), Douglas-fir (*Pseudotsuga menziesii*), and aspen (*Populus tremuloides*). The landscape is situated between the elevation of 6,800 and 10,000 feet, and is comprised of flat mesas, draws and drainages, ridges, and broad slopes. Generally, three Potential Natural Vegetation Types (PNV) are represented on the TGRP area, which include ponderosa pine, piñon-juniper, and aspen. There are a couple of areas where dry mixed conifer forest conditions exist, but they make up only a small percentage of the project area.

The Ecological Restoration Institute (ERI) was invited by the CNF to collect site-specific historical ecological data for the TGRP Project area to establish site-specific reference conditions (forest conditions that were in place 140–150 years ago when frequent fire was still a dominant component of the ecological system). These reference conditions would be used by the interdisciplinary team (IDT) as a point of reference for integrating General Technical Report RMRS-GTR-310 “Restoring Composition and Structure in Southwestern Frequent Fire Forests: A Science-based Framework for Improving Ecosystem Resiliency” (GTR-310), into forest restoration project planning. To meet this need, ERI worked with the Tres Piedras District Ranger and staff to identify where data would be collected to establish reference conditions.

The result was identified across the entire project. To collect this information, ERI placed individual, one acre, historical tree data plots, to evaluate the Historic Range of Variability compared to current conditions, and conducted other rapid reference condition assessments within the project area. The entire project area was assessed thru this process, and this report is a summary of the data and information that was collected. Data on other ecological conditions were not collected as part of this effort; however, some of these data, such as fire history, are available from other sources and are included in this report.

Reference Conditions, Historical /Natural Range of Variability (HRV)

The term “reference conditions” is not well defined in ecological literature. One approach is to define reference conditions in the context of regionally representative conditions that are indicative of minimum or no anthropogenic stress. In this report, it is described as the “sustainable” condition of the environment prior to, or in the absence of, major human disturbances, and is used to describe a desired ecological state in describing or planning ecological outcomes. Reference conditions are developed from site-specific data and are limited to the spatial extent and sample area of that study. However, reference conditions can be established for a variety of systems at different scales (ponderosa pine reference conditions within TGRP versus ponderosa pine reference conditions across the State of New Mexico).

Evaluating reference conditions helps describe attributes of ecosystem structure, composition, and function that were associated with resilient and sustainable systems and can be used to inform ecological restoration objectives and implementation strategies. The natural range of variability (NRV) can be estimated by pooling reference conditions across sites within a forest type. Reference conditions for a forest type typically vary from site to site due to differences in factors such as soil, elevation, slope, aspect, and micro-climate and is manifested by variances in fire effects, tree densities, patterns of tree establishment and persistence, and numbers and dispersion of snags and logs. (USFS GTR-310). Natural variability in the composition and structure across sites in these forests results from and drives spatial differences in fire effects, plant species compositions, tree establishment patterns and densities, and the number and distribution of snags, logs, and woody debris. Recognition of within-and-among site variability is paramount for developing localized restoration objectives. (Huffman and others, 2012).

Plot data and rapid HRV assessments, which capture vegetative information associated with pre-European/Hispanic settlement conditions (reference conditions), collected over an area such as the TGRP can be described as being within a range of historic or natural variation. For example, the historic range of variation (HRV) for ponderosa pine forests on TGRP data plots varied between 5-15 trees per acre (TPA) on the lower elevation, dryer sites to 35-45 TPA on the higher elevation and wetter sites. Determining the HRV of an area helps land managers visualize and describe what the forest structure looked like before frequent surface fires were disrupted across the project area. Reference information should serve as an aid in making informed decisions consistent with the evolutionary range of variability associated with individual forest types.

Species in a forest ecosystem evolved under its characteristic disturbance regime, resulting in a natural range of variability or the range of ecological and evolutionary conditions appropriate to an ecosystem (Landres and others 1999). Planning for proposed restoration treatments should include an understanding of forest reference conditions, or conditions known to be within the range of healthy ecosystem variability, in order to guide ecosystems back to resilient conditions where forest structure and functions are maintained over time.

The natural range of variability is a “best” estimate of a resilient and functioning ecosystem because it reflects the evolutionary ecology (low intensity, frequent fire systems) of these forests. Natural range of variability is therefore a powerful science-based foundation for developing a framework for restoring the composition and structure of forests (Moore and others 1999).

Methods

Because of time constraints, and the desire on the part of the district to collect HRV information across the entire project area, the Rapid Assessment data collection on the TGRP consisted of both; random one acre fixed plots (209’X209’), and random field observations designed to validate the field plots. These estimates of Historic Ranges of Variability (HRV) and Reference Conditions were determined from physical tree evidence observed on each plot, or field observation point. Directions for the establishment of the one acre fixed plot are found in Appendix A.

By using historic fire regime data previously collected by various researchers, the disruption of the fire regime in this area was determined to be around 1870. Based on this, we then extracted increment cores from old, live (144 years old minimum) ponderosa pine trees on-site to establish a diameter that would represent the minimum age of pre-settlement trees. We utilized an 19-inch diameter at breast height (DBH) for ponderosa pine trees, an 8-inch diameter minimum for juniper and piñon pine trees, if the trees showed old tree characteristics, as pre-settlement age-diameter relationships. Because of the lack of larger diameter Gamble oak trees we did not establish a minimum diameter for this species. To account for possible diameter variation that might occur due to elevation, aspect, or other site conditions, we also extracted cores from a few trees at representative plots across the study area to confirm that the age-diameter determination was accurate for each species.

To reconstruct structural characteristics of frequent fire stand densities, physical remains of old, dead trees (snags, stumps, downed logs, and stump holes) were located within the plots, and tallied. Living trees in the plots were examined to determine if they germinated prior to the disruption of the frequent fire regime. All live trees with a DBH greater than that for a 144-year-old tree that possessed old-tree characteristics (Appendix B) were counted as live trees associated with a frequent fire ecological system. These live, frequent fire system trees and tree evidences were tallied by species and density. In some previous studies, questions have been raised about the ability to accurately identify all the historical evidence with this rapid assessment reconstruction process. From one such study by Huffman and others titled “Ponderosa Pine Forest Reconstruction: Comparisons with Historical Data” (2001), the authors determined that forest structures are readily identified in the field after 90-plus years. In this study, missed trees resulted in an underestimated number of about 5.7% (about 1.7 trees per 30 trees).

In addition to collecting data on tree reference conditions (trees per acre and species), several photos were taken at each plot to provide information on current forest structure, composition, and condition (ground vegetation and downed woody material). Also some data was collected on basal area (BA), presence or absence of dwarf mistletoe, estimated canopy cover (%), and general observations on historical stand structure and plot conditions. Specific data on the following ecological characteristics or conditions was not collected: trees per acre, tree heights, tree size distribution, downed woody material, soils, or understory vegetation. Additionally, we did not attempt to physically reconstruct the spatial arrangement of trees. The Terrestrial Ecosystem Unit (TES) data for the Carson National Forest can also be used as a supporting document to understand HRV for the project area.

Results

Tree Densities and Species Composition

ERI determined that there were six key vegetation types across the project area that should be summarized from an HRV context. They were; Ponderosa pine/Gamble oak, dry mixed conifer, aspen, Piñon – juniper, encroached riparian/meadow areas, and grassy mesas. A summary of these vegetation types follows:

Ponderosa pine/Gamble oak

The majority of the TGRP area is Ponderosa pine intermixed with Gamble oak; approximately 13,523 acres. Historically, under a frequent fire regulated system these stands had a significantly fewer number of trees. Most, if not all, of the ponderosa pine forests within the planning area appear to have been characterized by frequent low-intensity surface fires. The fires played a key role in maintaining open stand structures with larger, un-even aged, clumped trees and some individual tree structure, as well as abundant herbaceous growth in the open areas between clumps (Covington, W.W., and Moore, M.M. 1994.). These fires probably consumed grass, dead leaves, and dead woody material. They also probably resulted in the mortality of small pines and the aboveground portions of Gamble oak, shrubs and herbs, but rarely killed large trees or belowground parts of Gamble oak, shrubs and herbs.

Across the project area we found historic tree densities ranged between 5-15 TPA on the lower elevations, dryer sites, to 25-45 TPA on the higher elevation and wetter sites. The average historic tree density across the project was in the 20-35 TPA range. The majority of these trees were arranged in smaller tree groups less than a quarter of an acre in size. We found heterogeneity in the tree groups; fluctuating between less than a tenth of an acre up to a third of an acre in size. We did not encounter any large historic tree groups (>1/2 acre). There were often individual presettlement (historical) trees interspersed between the historical tree groups. The average trees per group was 5-8 trees. Interspaces between tree groups varied in size and configuration but an estimated 50-75 % of the landscape was open with grass-forbs, woody shrubs, or gamble oak clumps.

The gamble oak component within the project area occurred more as small trees or as a tall shrub. The clonal nature of the Gamble oak manifested itself across the project area in a clumped distribution of stems with some dense shrub patches. We did find one area where we located some old gamble oak tree stumps, but the majority of the oak was in the form of small trees or shrub stands. Stem diameters were in the 1”-5” range, and the size of the clumps or patches ranged from less than a tenth of an acre up to a half of an acre in size. We found Gamble oak intermixed with the piñon-juniper as well as the pine. We believe, under the frequent fire regime there were similar gamble oak patches but their numbers, size, and densities were likely reduced as a result of the fire return interval.

Dry Mixed Conifer

There are only a few areas where we encountered the mixed conifer vegetation type. The project area only contains about 96 acres of mixed conifer (MC). We found the same historic frequent fire evidence within the MC stands we examined. Our data indicated that these sites historically, had a fewer number of trees, and the predominate species were Ponderosa pine (PP) and Douglas fir (DF) with some scattered aspen clones and a few white fir. The tree groups consisted of both DF and PP trees. The trees were arranged in small groups with some individual trees present. Historically, the aspen was located in clones, some of which no longer exist today and have been completely over taken with conifer trees. Plot data showed about 30-35 TPA were established historically, with the majority of the trees being Douglas fir, followed closely by Ponderosa pine (about a 60/40% ratio). The tree groups varied in size, but they were generally smaller in size; 5-10 TPA average, from less than a twentieth of an acre acre to a quarter of an acre in size. The tree groups were interspersed with open grass, forb, and shrub non-treed interspaces.

Historically, fire occurred in some mixed conifer forests as often as every 2-20 years, which is as frequent as in many ponderosa pine forests. Other mixed conifer forests, often on moister sites, likely burned less frequently but with greater severity. Fire, together with the other disturbance types, created patches of tree mortality to form canopy openings. These opening resulted in diverse environments — shaded and sunny — for understory vegetation. Changes to mixed conifer forests since Euro-American settlement beginning in the 1800s have included the introduction of livestock and exotic species, the removal of upper food-web predators, fire exclusion, increased fuel loads, reduced sunlight on the forest floor, and decreased proportional abundance of fire-tolerant trees such as ponderosa pine (Covington et al. 1994, Knapp et al. 2013).

Understanding influences of silvicultural, fuel reduction, and restoration treatments involving tree cut-ting and fire is fundamental to man-aging mixed conifer forests, coupled with knowledge of effects of wildfires that are likely eventual outcomes of passive management. (Abella, S., Springer, J. 2014)

Currently, these stands are densely stocked, with a significant shift towards shade tolerant species in the understory. It is difficult to locate Ponderosa pine regeneration, and the majority of the regeneration is white fir. The intermediate sized trees are mostly Douglas fir, white fir, with some Ponderosa pine. The majority of the interspace s have been filled in with conifer trees.

Aspen

The aspen within the project area can only be found on about 400 acres and it occupies an elevation range of 8,800-9,000 feet. Most of the stands are located as small stringers within the drainages (mostly north aspect). There are a few isolated aspen clones across the landscape. The amount and purity of the aspen has been reduced as a result of the disruption of the frequent fire regime. Historically, frequent fire promoted the maintenance of aspen across the project area, and it is likely that restoration treatments, especially the re-introduction of fire to the landscape, and elimination of the competing conifer species will promote aspen regeneration in some areas.

Within the existing aspen stands, little historical conifer tree evidence was found, indicating that frequent fire greatly reduced the conifer encroachment that is happening currently. We found several areas where dead and down aspen was over-topped by conifer trees. Most of these areas were on the edge of existing aspen stands, an indication that the amount of aspen within the project area was significantly greater in the past.

Piñon – juniper

The piñon – juniper type occupies the lower elevations of the project area, and takes in about 850 acres. The most common species in this forest cover type is two needle piñon pine, one-seed and Rocky Mountain Juniper. The current conditions of these stands are such that the understory consists mostly of younger piñon pine and juniper trees, big sagebrush, gamble oak, ponderosa pine and some mountain mahogany. There is very little grass and forb cover, and most of these areas do not have what would be categorized as openings. The over story is comprised of mid-aged to older piñon pine and juniper, with a few scattered old ponderosa pine trees. Even though significant ponderosa pine regeneration is present in the interspaces, the objective to feature ponderosa pine over piñon-juniper species would likely produce marginal results in the long-term.

When we examined this forest type, we looked at these areas to identify trees that were older than 145 years, and found scattered piñon pine and juniper trees with some individual ponderosa pine that present historically (prior to 1870). Indications are the majority of these areas were open grassy/ sage brush savannas that had scattered trees and some scattered gamble oak clumps. We found limited evidence, but believe that frequent fire also burned across these areas similar to the rest of the TGRP area. This frequent fire allowed only scattered trees to survive, and based on literature review, kept the sagebrush from over taking the grass openings.

Current conditions are such that many management options exist. These stands could be returned to open savannas, though it might take several cycles to get the grass component fully restored. With the current dominance of piñon pine and juniper, it is possible to manage these sites for a woodland forest. Also, if management objectives were identified to feature piñon over juniper, strategies could be developed to accomplish that result. There are woodland stands in the area (There are piñon patches around Cajilon N.M. that are 200-300 years old [Huffman et.al. 2008]) where landscape conditions precluded frequent fire allowing the development of woodlands. From a reference conditions perspective, it would be appropriate to return these areas to more open savanna like conditions.

Encroached riparian/meadow areas

The project area has multiple drainages and draws, many of which were open, grassy, meadow-like corridors. Our review of these areas indicated that there was minimal historical tree evidence and frequent fire likely prohibited the survival of tree seedlings, and promoted the maintenance of a mostly grass/forb habitat.

Currently, a majority of these areas are experiencing tree invasion and a general loss of the grass cover. The disruption of the frequent fire combined with the loss of the grassy vegetation (mostly from grazing), has resulted in the reduction of the size of these meadow-like corridors from encroachment, the loss of mesic habitat conditions, and increased erosion.

Many of these meadow areas provided excellent habitat for grazing ungulates and other key wildlife species in the past. Due to extensive use and impacts from cattle and wildlife and conifer encroachment in these areas, significant deterioration will continue, without mitigating intervention. As adjacent vegetative structure is reduced along with the existing tree encroachment in the meadows, a net-increase in understory ground cover will be realized, some grazing impacts can be decreased, and overall watershed function can be improved in these sites.

Grassy mesas

There were two larger areas we evaluated that historically were grassy mesas. These areas are on the South west portion of the project area, in the vicinity of Red Mesa. In evaluating the historical tree evidence in these areas, we did not locate any evidence of these sites being occupied by conifer or PJ trees. Indications are; historically, these flat mesas were frequently burned to the point that tree survival was rare, resulting in a pure grass/shrub habitat. Today there is a significant amount of tree establishment, in some areas to the point of creating young stands of pine and juniper. It is easy to delineate these areas by evaluating the tree ages of the current vegetation. Any large mesa areas where trees are encountered, where the majority are less than 120 years old, and areas where post frequent fire encroachment has occurred.

Fire History

Fire is the primary disturbance agent in many southwestern forests, and fire regimes are central to understanding an ecosystem's reference conditions and natural range of variability (Fulé and others 2003). Prior to human-influenced changes to the characteristic fire regime, the composition, structure, and spatial pattern in frequent-fire forests were maintained by frequent, low-severity fire through a functional relationship between pattern and process; that is, frequent low-severity fires resulted in forest structures that facilitated continued low-severity fire (Fitzgerald 2005). Ponderosa pine and dry mixed-conifer forests are characterized by a frequent low-severity fire regime with historic mean fire return intervals ranging from 2–24 years (Swetnam and Baisan 1996).

Frequent low-severity fire favors shade intolerant and fire-resistant tree species and open forest conditions with discontinuous crowns and minimal fuels build-up, often with tree groups separated by open interspaces with grass-forb-shrub communities. In contrast, longer fire return intervals permit seedling development to larger, more fire-resistant tree sizes and favor survival of less fire-resistant species (Fulé and Laughlin 2007).

Over time, shifting mosaics of tree groups and individual trees of varying ages were maintained within a grass-forb-shrub matrix by relationships among the severity and frequency of fire, presence of surface fuels (fuels on or near the surface of the ground), and tree regeneration sites that escaped fire (Larson and Churchill 2012). Extended fire-free periods may allow tree regeneration in areas not typically fire "safe" (Fulé and others 2009), resulting in temporal shifting of tree locations where new cohorts develop to fire-resistant sizes.

The historical spatial mosaic of tree groups, scattered individual trees, and openings in frequent-fire forests was maintained by interactions among the locations and types of fuels, the frequency and severity of fire, and tree regeneration and mortality patterns. (Reynolds and others 2013). Fire further shapes tree spatial patterns at varying scales through its influence on seedling survival, with variability in the severity, seasonality, and frequency of fire (Cooper 1960; Pearson 1950; Stephens and Fry 2005).

Throughout the TGRP analysis area, there was indication that historical frequent fires played a significant role in the structural development, and maintenance, of the vegetation. We did not locate any project specific fire study data, however in a review of other pertinent fire research that would correspond to the project area we feel confident in concluding frequent surface fires burned across the landscape at periodic intervals less than twenty-five years.

Considerations and Possible Treatments

The intent of this assessment is not to provide specific management direction, but rather to compare historic conditions in relation to current conditions as an informational tool to consider in the strategic analysis of the TGRP. Based on what we found with the historical conditions, we recommend the following considerations:

1. The option of returning to pre-settlement conditions across the entire landscape is unrealistic. However, to address current fire and forest health concerns, it would be reasonable to consider restoring a significant amount of the TGRP area with elements of the historical composition, spatial structure, and age distribution (uneven aged) within the tree-dominated landscape. The “Restoration Framework” descriptions and “Implementation Recommendations” identified in the Rocky Mountain Research Station General Technical Report RMRS-GTR-310 (which closely relate to the Region 3 Desired Conditions Framework for ponderosa pine and dry mixed conifer restoration), provides an appropriate set of objectives to accomplish as part of restoring the project area. The project specific HRV data provided in this report and the implementation Recommendations in Publication GTR-310 can be combined to develop sound management objectives and prescriptions.

2. Consider reducing tree density closer to historical conditions in order to reduce fire, insect, and disease risks, and to improve overall ecosystem health and resiliency. The summary of the historical (frequent fire) stand data could be considered as a reference in determining the desired future conditions and as a baseline for monitoring. If the historical average density of 25-35 trees per acre is too open for other management objectives, then adjust accordingly (e.g., adjust to 2–3 times the historical density). However, consider the historical conditions as they relate to resiliency (e.g., climate change), soil type, and re-establishing a more frequent fire regime. Further action of allowing fire to play a more natural role in the ecosystem, and maintaining the ability to re-enter the stands for subsequent treatments are important factors.

The creation of adequate openings and interspaces will be critical to the establishment of understory vegetation that will allow managers to use fire as a maintenance/management tool and expand ecological benefits of the sites by improving wildlife habitats, food webs, nutrient cycling, etc. Creating canopy gaps will also reduce the risk for crown fire potential. Regardless of the historic tree group configurations we encountered, the one constant throughout the project area was the presence of openings between these tree groups, historically.

Open areas were a key element of a properly functioning frequent fire ponderosa pine ecosystem in this area. The re-establishment of openings and their associated diverse ground vegetation will also benefit wildlife. We saw little mortality in large, old tree groups. There was a correlation between density of tree group crowns and surface fuels and lack of grasses. Consider strategic placement of restoration treatments to capitalize on the use of managed fire, under appropriate conditions, across broad landscapes.

Even though the current Proposed Action has the majority of the project area being treated with a burn only treatment, consider modifying the analysis to include mechanical treatment on a larger portion of the project area as it will be difficult to accomplish HRV conditions with a burn only treatment. Within the majority of the untreated or lightly treated stands, fire alone cannot be used to meet the projects Purpose and Need/Desired Conditions (March 6, 2014 Scoping Letter), as managed fire only, may result in less modifications to forest density, sizes of groups, and greater distribution of age classes at the fine scale. In the untreated stands, fire-only treatments will not be able to accomplish tree thinning, creation of small tree groups and a heterogeneity of interspaces that were associated with the historical conditions. It appears that managed fire can be used over areas of the TGRP where adequate mechanical treatments have been implemented, but many areas are in need of mechanical thinning and current conditions will limit the use of fire as a stand-alone treatment to restore HRV characteristics. Depending on existing conditions, achieving the desired outcomes may require multiple treatments (e.g., mechanical treatments and fire) over long time periods.

3. Where spatial heterogeneity is desired, consider combinations of burns, intermediate and free thinning, and individual tree or small group selection cutting methods to create a heterogeneous structure of groups, single trees, and grass-forb-shrub interspaces. Once heterogeneity is established, consider maintaining the desired structure and spatial pattern with fire and/or single tree and small group selection harvest. Use historical evidence and biophysical capabilities to determine a site's mean and range (minimum, maximum) of trees per group and numbers and spacing of tree groups per area. Vary treatment prescriptions (cutting and/or fire) to create a mosaic of groups of trees, scattered single trees, and grass-forb-shrub interspaces.

Manage young tree groups to create future variable tree spacing and interlocking crowns. Thin young tree-groups to facilitate development of desired within-group characteristics (e.g., variable tree spacing and interlocking or nearly interlocking crowns) in mid to old-aged tree groups. Grass-forb-shrub interspaces are generally larger on dry sites.

4. Consider the re-introduction of frequent fire as a management tool for the entire project area. It will be essential to develop a strategy for using fire as a management tool to meet project objectives, including tree group integrity and protecting old trees and maintenance of interspaces across the project area. If openings are created and tree densities are reduced, there will be rapid re-establishment and growth of conifer regeneration, juniper, oak and other shrub species. Fire or some other form of treatment (mechanical) will be needed on a frequent basis to eliminate a return to current conditions and to allow grasses and forbs to become established in the open areas. The re-establishment of a frequent fire program will help reduce the downed woody material, establish and maintain the open areas and diverse ground vegetation, and maintain forest resiliency. It will raise crown base height, mitigate the establishment of dense pockets of regeneration, and minimize large fire impacts.

Based on historical occurrence of episodic regeneration establishment (1820, 1875, 1890, 1920, 1975, 2002, etc.) effective use of periodic fire will be critical in managing regeneration density and placement. Low-intensity fires that consume surface fuels and raise crown base heights without affecting stand structure may reduce potential for crown fire while doing little to restore ecosystem health (Sensibaugh 2014). However, due to the presence of recent harvest-generated slash, increased regeneration, dense stocking and ladder fuels, some areas will require treatment timing mitigation for removal of fuels (slash, piles) and mitigation of the regeneration (through localized fire use or thinning) prior to additional harvest or introduction of broad-scale managed fire. There will also be a need to monitor invasive/noxious weed populations prior to utilizing fire treatments. Although we did not encounter substantial aspen within the project area, the application of more frequent fire to the landscape should benefit the re-establishment of aspen in those areas where remnants exists. It will also curtail conifer encroachment in existing aspen stands.

5. Consider the possible adverse effects of incorporating a diameter cap on the ability to meet restoration goals given the current stand conditions. The need to re-establish groups and interspaces (openings), restore seeps, springs, and riparian areas, and to manage encroached grasslands are critical goals that might not be adequately met with a diameter cap. Arbitrary diameter caps can have unintended consequences such as interfering with the restoration of herbaceous openings and more natural spatial distribution of groups of trees important for wildlife habitat and forest health; also where unnaturally dense stands of larger post-settlement trees predominate, caps can limit fuel reduction efforts and therefore limit the re-establishment of surface fire (Abella and others 2006, Sanchez-Meador 2009). Utilizing a diameter cap can eliminate age groups from an existing stand (thinning from below), and its use trends toward even-aged management (Triepke and others 2011).

6. Promote the development of uneven aged tree groups. The existing stand conditions with multiple cohorts of pine (and Douglas fir in the dry mixed conifer stands) regeneration provide an excellent opportunity to develop uneven aged tree groups. This recommendation along with those above will have positive effects on habitat improvement by providing more habitat diversity, structural variability, and opportunities for the expansion of food webs. Where trees are spatially aggregated, maintain interlocking or nearly interlocking crowns in mature and old groups and provide for variable tree spacing within groups; avoid thinning old tree groups.

7. Reduce or eliminate the tree encroachment into meadows, aspen clones, mesas, and riparian corridors that has occurred since the disruption of the frequent fire regime. We noticed a significant amount of tree encroachment into these areas, which has reduced their historic function and role in habitat diversity, watershed function and forest heterogeneity. ERI recommends utilizing historic, frequent fire tree evidence as a guide to establish tree densities in these areas, by incorporating a 1:1, or a 1:1.5 replacement ratio where historic tree evidences are encountered.

8. When considering the various approaches to achieving Ecological Restoration and understanding the associated principles such as Evidence-based restoration, reference conditions and Historic Range of Variability (HRV), physical treatment demonstration examples can be very effective. The ERI continues to be very interested and committed to assisting the USFS with establishing a Restoration demonstration site in Northern New Mexico. These sites can be very effective in various education, training, monitoring and consensus-building objectives. We welcome the opportunity to assist the Tres Piedras RD design and implement a demonstration treatment in the future, if desired.

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Appendices:

A: Plot Instruction Sheet for the Tio Gordito Project

Specific Data:

1. Use GPS to navigate to the plot point. Determine if plot point will be in the NW corner of the plot or not – record corner of GPS point location.
2. Create a one acre transect plot off of plot point (209 ft. X 209 ft.), using a compass and a distance measuring device (tape or hip chain). The primary person will run the plot boundary

lines (for 1 acre block), using; flagging to mark line location when needed and pin flags to mark historical tree evidence along boundary. The secondary person will grid the plot, marking all frequent fire era (presettlement) trees (>144 years old) and tree evidences within this area with pin flags. Once the plot has been established, the primary person will assist with the marking of all frequent fire era tree evidences with pin flags. Once all the tree evidences have been marked, they will be tallied (see below) on the data sheet as the pin flags are pulled.

   a. Note the process of plot establishment is a critical aspect of getting accurate data. Accuracy in laying out straight lines, 90 degree angles, and accurately measured distances is important and care must be taken to accurately establish the one acre plot.
   b. Note: if the terrain dictates (very steep); rather than establishing a one acre block, a transect could be run on the contour – see transect instructions below.

3. Within the plot, locate and mark (with pin flags) all tree evidence associated with the frequent fire period (live trees > 145 years old; snags, cut stumps & logs that would represent trees that were established prior to 1870; and old stump holes). Use the old tree characteristics sheet and tree diameter (trees>19 inches), to determine qualifying live trees. Boar live trees that cannot be determined from visual inspection.
4. Using the data sheet, record the following data for each evidence:
   a. Species; using the 4 letter species code (PIPO for ponderosa pine, etc.).
   b. Condition code;
      i. Live tree (L)
      ii. Snag (S)
      iii. Cut stump (C)
      iv. Log (LG)
      v. Stump hole (SH)
   c. Tally by species and condition (using dot count); (i.e. 6 PIPO, L, trees; 2 PIPO, S, trees; etc.).
   d. On the sheet, group each species/codes for ease in recording data (PIPO-L, PIPO-C, PIPO-LG, PSME-L, PSME-C, PSMELG, etc.).
5. Take 4 photos, cardinal directions, outward from plot point (GPS point, usually NW corner of plot unless noted), trying to capture general stand conditions. Record the camera number and picture numbers taken at each plot.
6. Record: date, plot #, and crew initials, on the tally sheet for each specific plot.

<u>General Data; make general notes on the data sheet for the following as it pertains to the plot location:</u>

1. Comments on historic stand structure to the extent it can be assessed; tree spatial distribution (groupyness/individual tree, and configuration of interspaces), tree species, size classes.
2. Comments on current stand structure based on visual assessment; tree spatial distribution (groupyness/individual tree, and configuration of interspaces), tree size and age classes, vertical and horizontal tree structure (i.e. multi-storied, even aged, etc. – photos should capture this as well).
3. Describe average understory conditions; composition (grass, shrubs and forbs,) production, and density.

4. General aspect; N, S, E, W, NE, etc., or flat.
5. Average slope; %, note if estimated or measured.
6. Average canopy cover; note if estimated or measured.
7. Average BA; at plot center, measured 20 BAF.
8. Mistletoe; general comments on presence/ absence and extent.
9. General comments on fuel loading (i.e. high, moderate or low; dead and down material).
10. A general comment on plot conditions as it relates to data collection; i.e. plot has an old skid trail through it (if applicable).
11. Assessment of fire scares; GPS good ones, and evidence of past fire activity.

General Comments on Forest Conditions Between Plots:

1. Make notes (and if significant take pictures) of unique or different forest conditions you encounter navigating between plots like:
    a. Aspen presence or absence and general conditions (i.e. remints of old aspen clones, or scattered aspen stands with conifer encroachment).
    b. Notes on different "stand conditions" if they exists; like plot was on a N. facing slope with some mixed conifer species, but the majority of the landscape around the plot is pine – oak (different than the plot).
    c. Any excessive tree mortality (pockets of bug kill, etc.).
    d. Recent fire activity (within last 5 years) if any.
    e. Unique wildlife components or sightings.
    f. Other; good fire scares (get GPS locations), noxious weed populations, and items that might have relevance from a management standpoint.

Specific Data for Running a Transect:

1. Use GPS to navigate to the plot point. Determine plot transect bearing based on terrain (across slope), and record it on the plot sheet.
2. Create a one acre transect plot off of plot point (66'X 660 ft.), following bearing, using a compass and hip chain (or other measuring device). The primary person will run the transect line (compass bearing), using; flagging to mark line location when needed and pin flags to mark frequent fire era trees along the boundary. They will also record all tree data for the transect. The secondary person will run a parallel line 66' away and grid the area between the two lines. The area between the two lines will serve as the plot and all frequent fire era trees (presettlement trees) (>145 years old) and tree evidences within this area will be tallied (see below). As borderline tree evidences are encountered along the secondary plot line; make a call as to whether the evidence is in or out and measure accordingly.
    a. Note this process (plot establishment) is the most critical aspect of getting accurate data. Accuracy in laying out straight lines, 90 degree angles, and accurately measured distances (the 66') is important and care must be taken to accurately establish the one acre plot.
    b. Note: if the terrain dictates; the transect could be run for half the distance (330' or 33') then reversed (just offset the original line), back to the starting point.

3. Within the plot, locate and record all tree evidence associated with the frequent fire period (live trees > 145 years old; snags, cut stumps & logs that would represent trees that were established prior to 1870; and old stump holes). Use the old tree characteristics sheet and tree diameter (trees>18 inches), to determine qualifying trees. Boar trees that cannot be determined from visual inspection.
   a. Note where pin flags are not being used to mark all the trees, care must be taken to assure tree evidence is not missed or double counted.
4. Using the data sheet, record the same data outlined above for each evidence.
5. Take 4 photos, cardinal directions, outward from plot point (GPS point), trying to capture general stand conditions. Record the camera number and picture numbers taken at each plot.
6. Record: All data described above under one acre block based on what is encountered in the transect.

B: Old Tree Characteristics

In addition to DBH, the following characteristics were utilized to help establish the pre-settlement trees in each plot:

Crown Shape: Transitional trees (trees that are trending toward old age; 150–200 years) have an ovoid shape—flattened top, full and rounded crowns. Old trees (>200 years) are flattened on the top, "bonsai" shape, sparse and open, and may be lopsided.

Live Crown Ratio: Transitional trees have moderate live crown ratio; perhaps half the trunk, beginning to self-prune. Old trees have small live crown ratio; often fire-pruned.

Branches: Transitional trees have dying fine branches in the interior of the crown, longer branches thickening. Old trees have few, but large branches.

Trunk shape: Transitional trees are beginning to loose taper. Old trees are columnar.

Bark: Transitional trees have orange or gray flakes with dark edges, shallow fissures, becoming smoother. Old trees have smooth, small flakes, pale orange or gray.

Likely Injuries: Transitional trees have relatively few injuries; possibly healed or mostly healed fire scars, lightning scars, and mistletoe. Old trees have fire scars, dead tops, broken branches, lightning scars, rot, burls, and exposed roots.

The Ecological Restoration Institute is dedicated to the restoration of fire-adapted forests and woodlands. ERI provides services that support the social and economic vitality of communities that depend on forests and the natural resources and ecosystem services they provide. Our efforts focus on science -based research of ecological and socio-economic issues related to restoration as well as support for on-the-ground treatments, outreach and education.

Ecological Restoration Institute, P.O. Box 15017, Flagstaff, AZ 86011, 928.523.7182, FAX 928.523.0296, www.nau.edu/eri

NAU is an equal opportunity provider. This research was funded by a grant from the USDA Forest Service.

San Juan Fire
Fuel Treatment Effectiveness Report
Apache-Sitgreaves National Forest
Arizona

Incident Dates: June 26-July 2, 2014

"The prior fuel treatments allowed for safe firefighting."

Buck Wickham
Operations Section Chief

Contents

Figure 1

Figure 2

Photos show burnout operations on the San Juan Fire being conducted on June 30 (Figure 1) and on June 29 (Figure 2).

Overall, the fuel treatments that were encountered by this fire performed as designed by reducing fire intensities. This allowed firefighters to work in a safer environment where their suppression efforts could be successful.

1. Introduction

The San Juan Fire started June 26, 2014 on the White Mountain Apache Reservation and entered the Apache-Sitgreaves National Forest soon after detection. The fire is suspected to be person-caused.

Fire behavior on the incident's first two days was influenced by strong southwest winds of 15 mph with gusts to 25 mph and extremely dry fuel conditions resulting from long-term drought.

Evacuations were issued on the fire's first evening by Apache County for the subdivisions of Red Cabin Ranch, with seven homes, and Whiting Homestead, with 12 homes and a total of 27 structures.

The next day, the Carlock Ranch, with one home and several outbuildings, was also evacuated.

Figure 3 – The wind-driven San Juan Fire on its first day.

Containment efforts were largely successful with the last day of significant fire spread on July 1. Monsoon rains arrived on July 2 which prompted the lifting of evacuation orders. Final fire size was 6,975 acres.

Fuel Treatments Reduce Fire Intensities

Overall, the fuel treatments that were encountered by this fire performed as designed by reducing fire intensities. This allowed firefighters to work in a safer environment where their suppression efforts could be successful.

The fire's forward spread was largely halted by the end of the second day—despite continued high winds—in large part due to the success of burnout operations in areas where previous thinning and prescribed burning had occurred.

VIDEO

See Jeremy Human, Forest Fuels Specialist, Apache-Sitgreaves National Forest, describe the actions taken on the fire's first day. On the San Juan Fire, Human served as the Incident Commander on the Type 3 Incident Management Team and was the Operations Section Chief Trainee for the Type 2 Incident Management Team.

SJHumanDay1
(https://youtu.be/_lcr_st1Hzk)

The San Juan Fire's negative impacts on Forest resources were greatly reduced due to these previous fuel treatments—coupled with the conscientious efforts on the part of firefighters to conduct fire suppression activities aimed at reducing fire intensities.

The overall, cumulative outcome of these actions became a final fire footprint that experienced some high-severity fire, but with the majority of the fire burning at low to moderate severity that resulted in the protection of forest stand conditions.

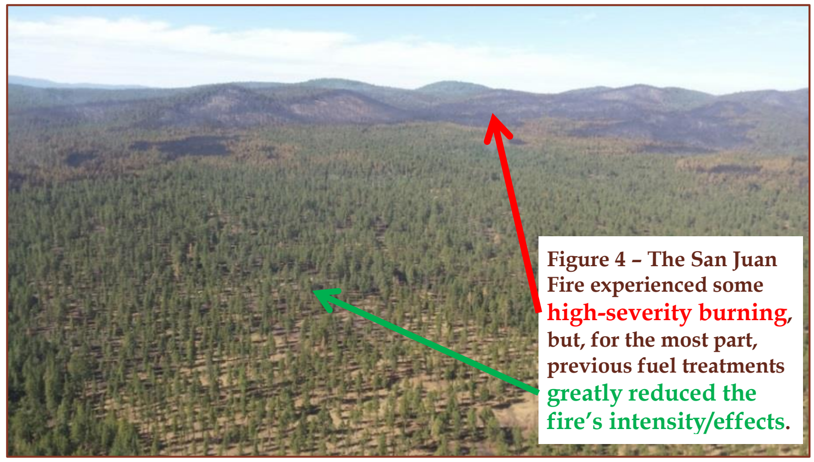


Figure 4 – The San Juan Fire experienced some high-severity burning, but, for the most part, previous fuel treatments greatly reduced the fire's intensity/effects.

VIDEO

See Jeremy Human, Forest Fuels Specialist, Apache-Sitgreaves National Forest, describe how fuel treatment areas helped suppression actions on the San Juan Fire. Human served as the fire's IMT3 IC and the IMT2 Operations Section Chief Trainee.

SJHumanTreatments

(http://youtu.be/7ykq2eII7mg)

The impacts of the San Juan Fire on the Forest resources were greatly reduced as a result of the previous fuel treatments, in addition to the conscientious effort on the part of firefighters to conduct fire suppression activities in a way that reduced fire intensities.

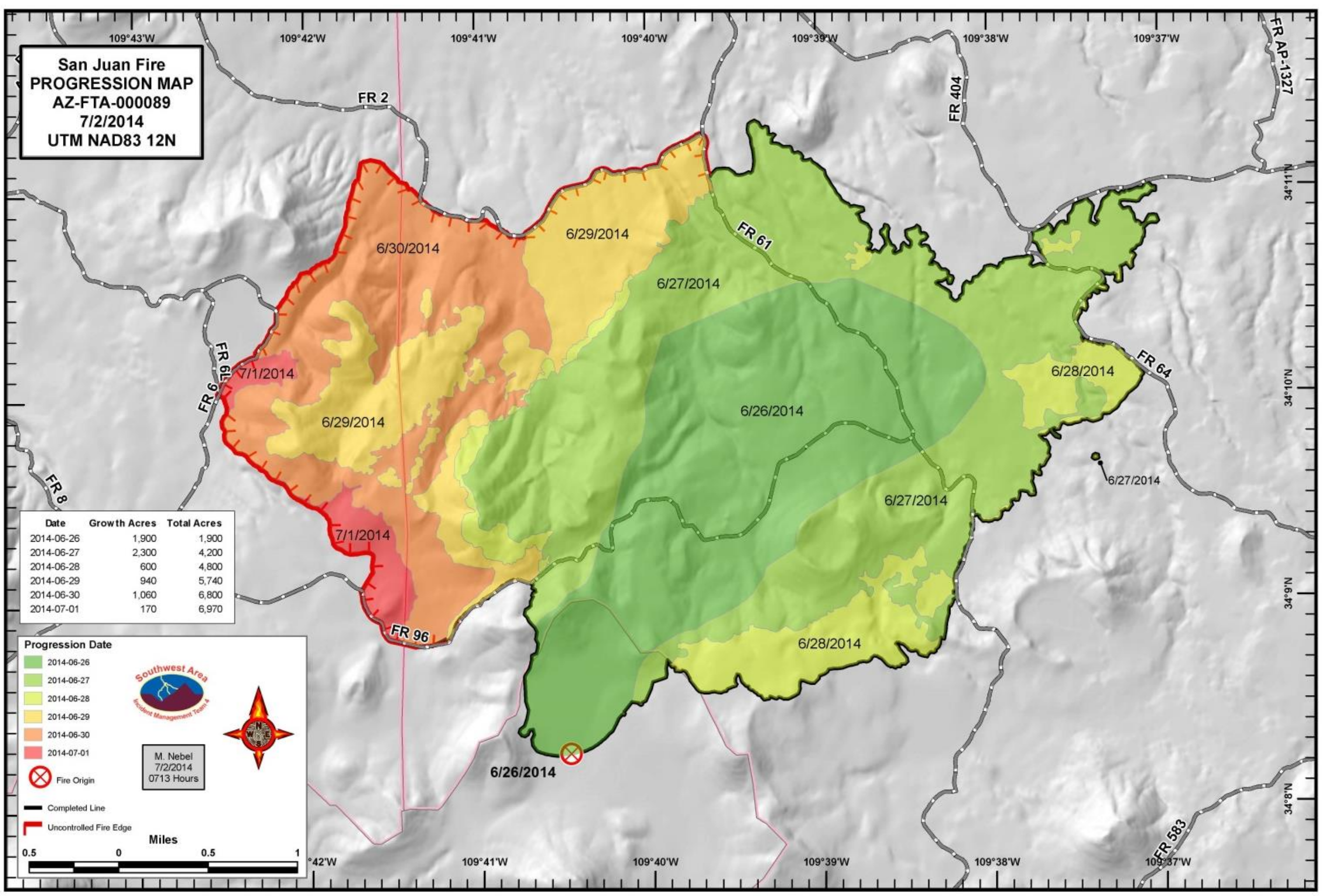


Figure 5 – Fire Progression Map of the San Juan Fire—from June 26 through July 1, 2014.

2. Fire Environment

A. Fire Weather

A low pressure system that dominated the weather pattern for the first two days of the San Juan Fire brought strong, gusty southwest winds on June 26-27. By June 28 an upper level ridge formed which reduced wind speeds but also brought warmer temperatures and drier relative humidity. Beginning on June 29, the fire's fourth day, the first signs of the annual monsoons were observed with increased cloud cover and higher relative humidity. Rainfall began on July 2 and continued for the next several weeks.

Observations taken from the Lakeside RAWS for June 26

(This RAWS is located approximately 15 miles east of the San Juan Fire.)

- Maximum Temperature: 85 degrees
- Minimum Relative Humidity: 6 percent
- Wind Speed and Direction: South-Southwest at 11 mph, with gusts to 23 mph

B. Fuel Conditions

Two primary vegetative communities were impacted by the San Juan Fire. First, the area immediately impacted at the higher elevations around Juan Garcia Mountain is generally a mixed-conifer community dominated by a mix of spruce, white fir, Douglas fir, and aspen. The remainder of the fire area below these higher elevations is primarily ponderosa pine with some oak and brush components. When looking at the fuel profile of the fire, multiple fire regimes are represented. The mixed conifer ecosystems are adapted to mixed-severity fire on a 35-100 year interval; while the ponderosa pine ecosystem is adapted to low-severity fire on a 0-35 year interval.

Live fuel moistures taken southeast of the fire's origin were 87 percent for ponderosa pine, which is typically dry for pre-monsoon conditions in this area. For the dead fuels, the Fire Behavior Analyst estimated the following: 1-hour fuel moisture: 2 percent; 10-hour fuel moisture: 3 percent; 100-hour fuel moisture: 5 percent; and 1000-hour fuel moisture: 6 percent. The computed National Fire Danger Rating System (NFDRS) 1000-hour fuels were also estimated below 7 percent which is in agreement with the Fire Behavior Analyst's estimates and indicates critically dry conditions. The Energy Release Component (ERC) from the Lakeside RAWS indicates 97th percentile conditions which approached all-time worst conditions for that station (Figure 6).

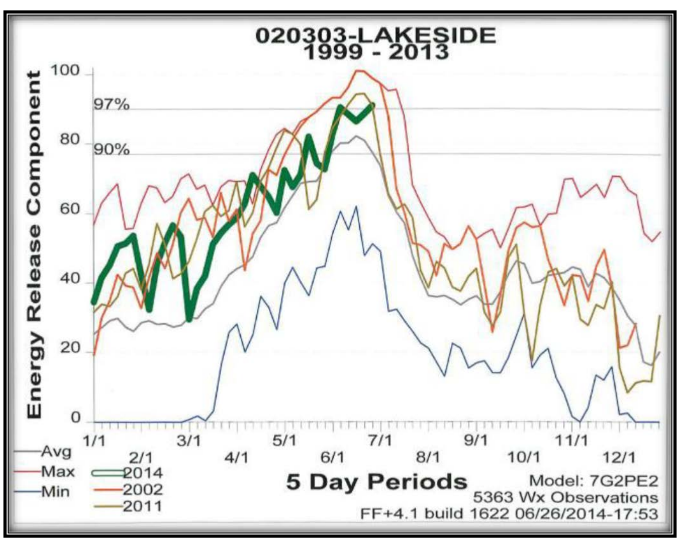


Figure 6 – ERC from Lakeside RAWS.

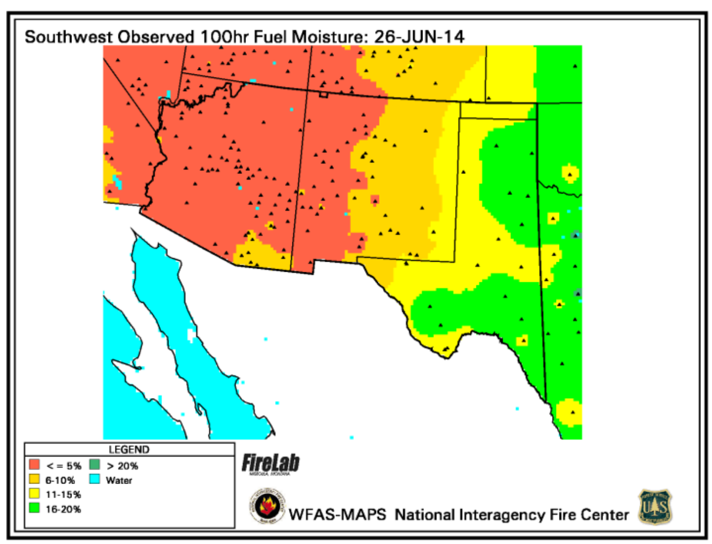


Figure 7 – Observed 100-hour fuel moisture for June 26, 2014.

Figure 8 – Ponderosa pine burnout operation on the San Juan Fire.

VIDEO

See Jerry Drury, Natural Resources Staff Officer, Apache-Sitgreaves National Forest, provide an overview of the White Mountain Stewardship Project:

http://bit.ly/SJDruryWhiteMt

Figure 9 – High-severity fire effects shown on the mixed conifer stands on the San Juan Fire.

Fuel treatments have occurred over a significant proportion of the area, primarily in ponderosa pine dominated stands to reduce the risk of damage or loss associated with wildfire and to restore the health and function of these fire-dependent ecosystems.

3. Narrative/Chronology

June 26

The San Juan Fire starts in grass on San Juan Flat at 1145 hours. In the afternoon, high temperatures range from the upper-70s to mid-80s. Relative humidity reaches 10-20 percent. The fire is being pushed to the northeast by southwest 20-25 mph winds, with gusts of 32 mph.

As the fire moves into ponderosa pine it starts to exhibit single/group tree torching and spotting. Once the fire burns into a mixed conifer stand it becomes a running crown fire burning northeast along Pulcifer Creek and the Forest Road 96 corridor until it crosses Forest Road 61 to the northeast. A Type 2 Incident Management Team is ordered. An in-brief is scheduled for the next morning at 0900.

June 27

The fire continues burning to the northeast, northwest and southeast as the strong southwest winds continue to affect fire behavior. In the afternoon, high temperatures range from the upper-70s to lower-80s. Relative humidity ranges from 15-20 percent.

Where the fire burns into established fuel treatments, fire behavior dramatically changes from a crown fire with spotting to a ground fire with 8- to 10-foot flame lengths. An in-briefing is conducted by the Fort Apache Bureau of Indian Affairs, White Mountain Apache Tribe, and Apache-Sitgreaves National Forest. Transition from the Type 3 Incident Management Team occurs at 2000. The fire is 5,000 acres and is 0 percent contained.

June 28

A ridge of high pressure begins to build from the southwest. Afternoon temperature ranges in the 80s, with lower relative humidity (12-20 percent). The wind event of the last two days has ended. The fire becomes more terrain and fuel driven. Fire behavior also moderates with the decrease in winds.

The fire burns to the south toward Gillespie Flat and east toward Mineral Creek. The fire is divided into six divisions: A,D,G,V, W, and Z. In addition, a Structure Protection Group is created to address the private inholdings at Red Ranch Cabin, Carlock Ranch, and Whiting Homestead.

> *"Treatments allowed us to go direct versus indirect on the fire's first day, in part because we were able to hold easier and spots were easier to catch."*
>
> **Ben Plumb**
> **Division Z Supervisor**

Fuel Treatments Factored into Suppression Strategy

On June 28, the higher elevation and mixed conifer areas of the fire's containment lines do not hold through the burn period. This prompts a reassessment of that strategy in favor of a more indirect approach that uses existing roads and fuel treatments to support burnout operations in Divisions A and D.

Control features are located adjacent to vegetation treatments accomplished under White Mountain Stewardship and wildlife habitat improvement projects.

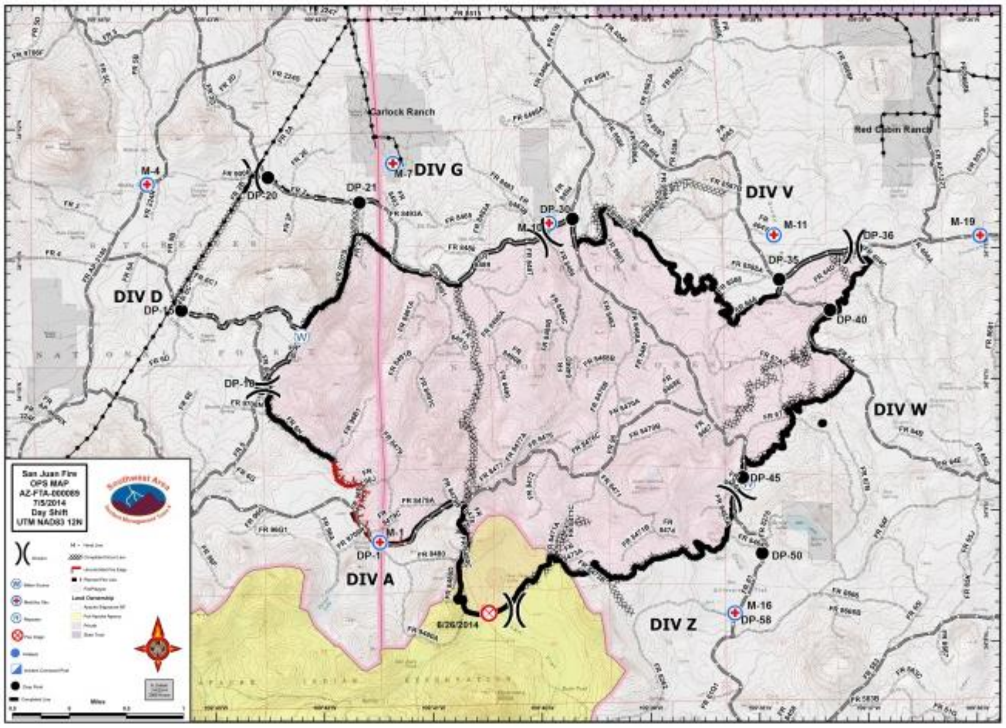


Figure 10 – July 5 operational map of the San Juan Fire.

These wildlife habitat projects were funded, in part, by the Rocky Mountain Elk Foundation.

From the Type 2 Incident Management Team's perspective, the treatments were strategic in aiding suppression efforts, thus providing for safe and effective control of the fire and minimizing undesirable effects to the natural resources. Most importantly, these treatment areas increased the margin of safety for firefighting personnel.

Night shift is established to hold and patrol burning operations.

From the Type 2 Incident Management Team's perspective, the treatments were strategic in aiding suppression efforts, thus minimizing fire size and undesirable effects to the natural resources. Most importantly, these treatment areas increased the margin of safety for firefighting personnel.

June 29

The first signs of monsoonal moisture are observed with scattered afternoon cumulus. Afternoon temperature is in the 80s, with relative humidity at 15-25 percent. Division G initiates a burnout operation along Forest Road 2, taking advantage of a favorable northwest wind.

In the late afternoon, an aerial ignition operation is initiated in the mixed conifer vegetation types on three knobs east of Drop Point 10 to allow the fire to back downslope toward Divisions A/D/G. The objective of this aerial ignition operation is to moderate fire behavior in these areas to reduce the fire's negative effects and aid suppression efforts.

Fire behavior on the other areas of the incident consists of smoldering and creeping in the duff and stump holes. The fire is now 5,700 acres and is 5 percent contained.

June 30

The afternoon cumulus field becomes more extensive as the monsoonal flow continues to increase—but no thunderstorms develop. Afternoon temperatures range from the mid-80s to lower-90s. Relative humidity is in the teens in the afternoon. Divisions A/D/G continue burnout operations—staying even with the backing fire from the previous night's aerial ignitions. The Structure Protection Group remains in place. The night shift is staffed. The fire is 6,300 acres and is 5 percent contained.

> *"Treatments allowed for buffer. We could go pick up spots. Without those treatments there would have been no way to hold our burnout."*
>
> **David Raney**
> **Division A Supervisor**

July 1

This is the first day of monsoonal thunderstorm activity across the area, with temperatures ranging from the mid-80s to the low-90s and relative humidity in the low to mid-teens. The storm activity moved primarily south of the fire and did not impact the fire area. Division A and D completed burnout operations. Some single/group tree torching is observed in concentrations of ponderosa pine reproduction with mostly low-fire behavior activity. All other divisions are in mop-up phase. Today's night shift is the last one for this incident. Demobilization of resources begins. The fire is 6,975 acres and is 15 percent contained.

> *"Without the treatment, we wouldn't have been there."*
>
> **Barry Green**
> **Division V Supervisor**

July 2

July 2 is the second day of the monsoonal push. The fire area is impacted with thunderstorms and showers. Any further fire behavior is minimal, consisting mostly of smoldering and creeping in the duff layers. There is no change in fire acreage. On July 2, containment is increased to 70 percent. (From July 3-6, fire behavior is minimal. All divisions are in the rehabilitation phase. On July 5, the fire is 95 percent contained. It is contained/controlled on July 17 and is pronounced officially out on July 31.)

VIDEO

HumanSJBurnouts

(http://youtu.be/hWOqDas_BUE)

Jeremy Human, Forest Fuels Specialist for the Apache-Sitgreaves National Forest, points out how prior fuel treatments helped suppression strategies and successful firefighting efforts on the San Juan Fire. Human served as the fire's IMT3 IC and the IMT2 Operations Section Chief Trainee.

Figure 11 – Burn-out operations on June 30 on the San Juan Fire.

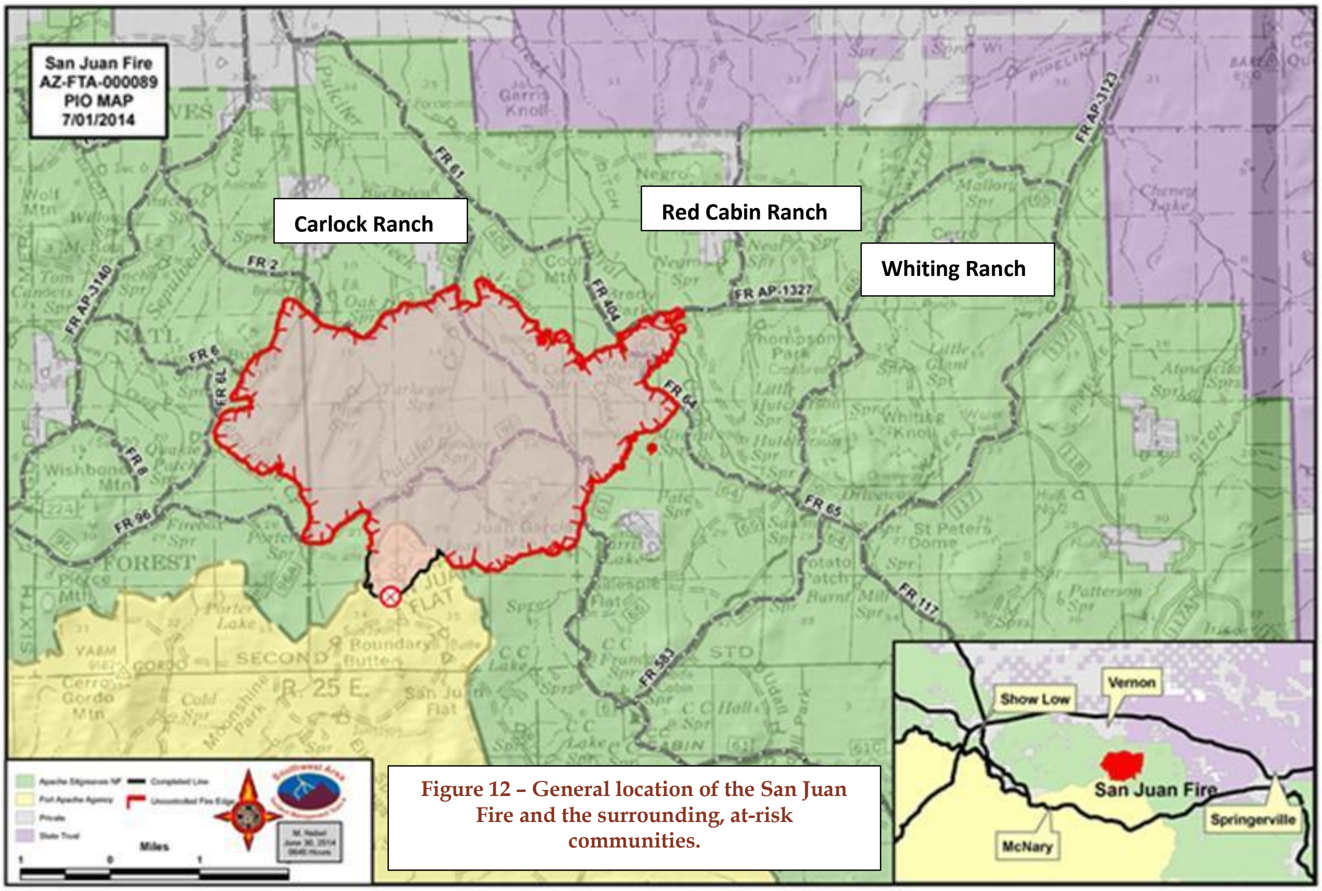


Figure 12 – General location of the San Juan Fire and the surrounding, at-risk communities.

4. Potential Consequences

The potential negative consequences that could have resulted from the further spread of the San Juan Fire are worth noting.

Several private ranches are located within one-day's perimeter growth of where the fire was eventually stopped. Moreover, if the fire's progression had not been stopped, it could have potentially impacted the community of Vernon (Figure 12) as well as the Red Cabin Ranch and Whiting Homestead subdivisions, and Carlock Ranch.

In addition, the negative impact to vegetative communities and wildlife habitat could have been substantially greater than what was actually experienced. Mexican Spotted Owl, Northern Goshawk and Apache (Arizona) Trout are some of the species of concern known to inhabit the area. In addition, a number of "highly desirable" game species inhabit the fire area, including deer, elk, and antelope.

Therefore, if the San Juan Fire had burned under higher severity over a larger portion of the landscape, its consequences could have been much more severe.

> *"Basically, the treatment areas helped stop the fire's spread so it didn't impact the Red Cabin Ranch private subdivision. It is super obvious that—without those treatments—the fire would have spread into Red Cabin."*
>
> **Barry Green**
> **Division V Supervisor**

5. Fuel Treatment Effectiveness

Generally speaking, the fuel treatments encountered by the San Juan Fire were effective at modifying fire behavior. Furthermore, these fuel treatment areas proved to be instrumental in providing fire managers with opportunities to contain the fire in a safe and effective manner while simultaneously limiting the fire's potential negative effects on natural resources, the surrounding communities and their infrastructure.

Fire behavior observed by firefighters at the scene—as well as estimates of fire severity taken after the fire (Figure 13; Table 1)—confirm that the treated areas performed as designed by not supporting sustained crown-fire even under extreme burning conditions.

As the San Juan Fire transitioned from untreated mixed conifer to treated ponderosa pine, fire behavior also transitioned from intermittent and sustained high-intensity crown fire in the untreated stands to a low-moderate intensity surface fire in the treated stands.

Thus, firefighters were able to utilize the road system within the treated stands to implement their burnouts. These burnout operations limited the forward progress at the head of the fire the day after the fire started.

VIDEO

See Tessa Nicolet, Regional Fire Ecologist with the U.S. Forest Service's Southwestern Region, explain what this map tells us about the San Juan Fire's behavior—and how this affected fire suppression actions:

http://bit.ly/SJTessaSeverityMap

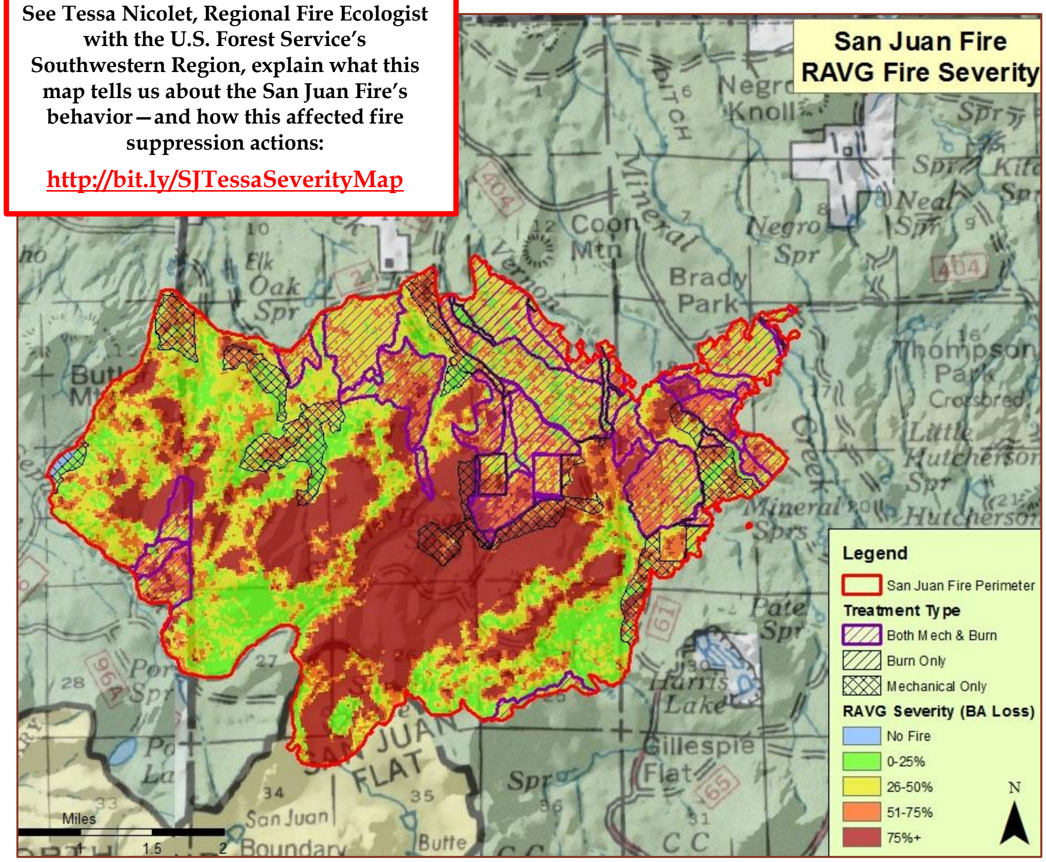


Figure 13 – Map of the San Juan Fire "Rapid Assessment of Vegetation Condition after Wildfire" (RAVG). RAVG products are generated to provide information that can assist post-fire vegetation management planning designed to address a number of management objectives.

% of San Juan fire areas in each RAVG severity class			
RAVG (% BA Loss)	% of Entire Fire Area	% of San Juan Fire Perimeter with NO Treatments	% of San Juan Fire Perimeter with Treatments
Low 0-25%	14	16	11
Moderate 26-50%	35	29	45
Mod/High 51-75%	21	16	31
High >76%	29	38	13

% of Ponderosa Pine vegetation types in each RAVG Severity class			
RAVG (% BA Loss)	% of all Ponderosa Pine	% of Ponderosa Pine Areas with NO Treatments	% of Ponderosa Pine Areas with Treatments
Low 0-25%	13	17	11
Moderate 26-50%	47	44	49
Mod/High 51-75%	28	22	31
High >76%	12	18	9

Table 1– This table presents a comparison of preliminary RAVG (Rapid Assessment of Vegetation Condition after Wildfire) results for the entire San Juan Fire area by treatment type, as well as for the ponderosa pine-dominated vegetation types where the majority (82%) of all fuel treatments took place. Overall, much less of the areas that had received fuel treatments burned with high severity than those that did not receive fuel treatments.

A. Research Study Sites

One fortunate aspect of the San Juan Fire is that it burned through a series of experimental study sites established by the Ecological Restoration Institute (ERI) at Northern Arizona University.

As a result, we now have a much more precise side-by-side comparison of fuel treatment effectiveness of two different approaches to fuel treatments as compared to a control or untreated site. These study sites were initially established to facilitate long-term monitoring of these types of treatments. It is therefore especially informative to observe and study the impacts of an actual wildfire under peak burning conditions on such intensively monitored sites.

The key objectives of this long-term study are to:

- Quantify site-specific reference conditions using dendro-ecological reconstruction methods.
- Analyze effects of elevation on historical changes in forest structure and fire behavior.
- Compare the effects of alternative restoration treatments.

Known as the "A-S Mineral Study Site", the study design consists of:

- Four study blocks located in ponderosa pine dominated sites.
- Each block contains three side-by-side treatment units (each unit approximately 32 acres in size):
  - Control (no treatment) Unit
  - Burn Only (broadcast burn with no mechanical thinning) Unit
  - Full Restoration (mechanical thinning, piling, and burning) Unit
- Elevation gradient ranging from 7,800 to 8,200 feet.
- Initially measured in 2002.
- Treatments completed in fall 2008.
- Re-measured in 2009 and again in 2013.

Figure 14 – A-S Mineral Study Site's thin and burn treatment (aka "Full Restoration") shown after the passage of the San Juan Fire. This photo, taken within weeks of the fire, shows how very little overstory damage has occurred and ground cover vegetation is recovering. (Ecological Restoration Institute)

Figure 15 – A-S Mineral Study Site's burn-only treatment area after the passage of the San Juan Fire. Notice more tree stems in this photo than in the "Full Restoration" treatment photo above (Figure 14). While fire behavior was moderated here, it appears there was more mortality due to scorch than experienced on the "Full Restoration" treatment area. (Ecological Restoration Institute)

Figure 16 – A-S Mineral Study Site's control (no treatment) site after the passage of the San Juan Fire. Almost complete mortality occurred with most of the trees onsite being either consumed or completely scorched. (Ecological Restoration Institute)

VIDEO

http://bit.ly/SJGrecoRestoration

The ERI's
Three Side-By-Side Treatment Units

Standing on site in the aftermath of the San Juan Fire, Bruce Greco, Director of Outreach for the Ecological Research Institute, describes the significance of ERI's three "Long-Term Ecological Restoration Plots".

Bruce Greco

The Combination of Thinning and Burning Treatments Proved Most Effective

Inside one of the A-S Mineral Study Site study blocks, the San Juan Fire impacted all three treatments types (control; thin and burn; and burn only). From the visual indicators at this study site, it appears that the combination of thinning and burning was the most effective for reducing fire intensities and protecting forested tree cover (Figure 14).

The burn-only treatment moderated fire behavior as compared to the no treatment-control unit (Figure 16), but not as effectively as the mechanical and burn unit. Considerable tree mortality due to severe scorch is still evident in the burn-only treatment area (Figure 15).

ERI investigators speculate that the 2008 prescribed fire treatment was effective at scorching the lower portion of the trees and raising the base of the tree crowns. However, this treatment was not as effective at removing individual trees to reduce overall tree densities. Hence, the result of the burn-only treatment was a closed canopy stand with the canopy base height raised. Even so, this burn-only treatment area became a much denser stand than what was produced by the combination treatment of mechanical thinning and burning.

Both treatments were superior to the control (no treatment) unit in which high-severity fire prevailed, causing almost complete mortality throughout the stand.

For a more complete discussion of the A-S Mineral Study Site, see:

http://nau.edu/ERI/Research/Ecological-Research/Arizona/Apache-Sitgreaves/

Figure 17 – Nighttime burn-out operations on the San Juan Fire.

"The San Juan Fire provided lessons about how treated areas did what they were designed to do: slow a fire's advance and restore a forest's natural ability to self-regulate. How a wildfire behaves when it reaches a treatment area is a good test of how those treatments work. Fire crews and incident management teams reported that when the fire burned into areas that had been thinned, it burned with low severity and on the ground, not in treetops. The dry, frequent-fire forests of the West evolved with this type of fire, a slow-moving, low-severity surface fire that would remove young trees and revitalize understory grasses and forbs. Anecdotal evidence from the San Juan Fire also suggests that the previously treated areas allowed fire crews to safely conduct burn-out operations, thus enabling them to manage and control the fire."

Wally Covington, Director
Ecological Restoration Institute;
Regents' Professor of Forest Ecology,
Northern Arizona University

From his Aug. 22, 2014 article in *LiveScience's* "Expert Voices – Op-Ed and Insights"
http://www.livescience.com/47510-wildfire-prevention-is-science-not-art.html

6. Lessons Learned

Facilitated Learning Analysis

In September 2014—three months after the San Juan Fire—resource specialists and fire managers from the Apache-Sitgreaves National Forest along with researchers from the Ecological Restoration Institute at Northern Arizona University met for a Facilitated Learning Analysis.

Prior to this Facilitated Learning Analysis, all participants had visited the San Juan Fire site on numerous occasions. Thus, all participants had time to formulate opinions from their observations of how their resource area was affected by the San Juan Fire.

During the Facilitated Learning Analysis, each participant was asked what they learned from the San Juan Fire and associated fuel treatment projects, both in terms of actions and activities they would do again because they worked well, as well as actions and activities they would do differently because they believe there is room for improvement based on what they observed.

The following section highlights the observations and wisdom shared by these participants.

A. Fisheries

1. Lesson

No treatment also has consequences.

Don't think that by not treating something means it will not undergo change. Doing nothing is still a decision with its own consequences.

Across the country, resource managers often implement "Do Not Treat" buffers as a means of protecting streams and riparian areas from the impacts of treatments such as thinning or prescribed burning. But in a fire-prone landscape where an encounter with a wildfire is practically inevitable, these buffers can act like a fuel corridor, potentially putting aquatics at even *more* risk when wildfires eventually occur.

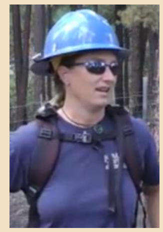
This negative effect was apparent on Arizona's 2011 Wallow Fire in which entire reaches of some streams and tributaries were lost as the buffered area burned with higher intensity and severity than the surrounding treated area.

VIDEO

http://bit.ly/SJStephStreams

Lessons Learned on Stream Buffers

Extending Treatments to Stream Banks can Improve Aquatic Habitat for the Long Term



Listen to and see, on site, Stephanie Coleman, Aquatics Program Manager for the Apache-Sitgreaves National Forest, describe how prior fuel treatments that extended to the banks of Mineral Creek reaped positive results when the San Juan Fire burned through this area.

Stephanie also discusses how the overall combination of thinning and prescribed fire benefited Mineral Creek's riparian areas.

Figure 18 – The Apache Trout, listed as a "Threatened" species under the Endangered Species Act, resides in Mineral Creek. Prior thinning and prescribed fire along Mineral Creek will benefit habitat for this species.

In contrast, on the San Juan Fire where slope and existing vegetation allowed treatments to extend to the banks of Mineral Creek (that hosts the Apache Trout, a "Threatened" species under the Endangered Species Act), low-severity fire resulted that actually invigorated riparian vegetation and left residual trees for shading and future large-woody debris. These conditions will now improve the habitat for aquatics in the long term.

2. Lesson

Implement treatments as close to streams as possible.

If riparian conditions and terrain/topography allow, managers should treat as close to the stream as possible to offer protection to aquatic and riparian habitats and break-up those fuel corridors that can threaten the entire stream if a wildfire occurs.

B. Wildlife

"Overall, the effects of the San Juan Fire will be a net energy gain back into the system. From a wildlife perspective, that's important."

Mike Godwin
Field Supervisor
Arizona Game and Fish Department

Lesson

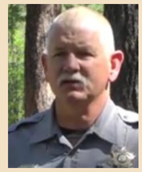
Tilting the odds in our favor.

Treating the vegetation doesn't guarantee wildlife habitat will improve, but it sets the stage for improvement and tilts the odds in our favor. The amount and duration of moisture is the most critical component in the Southwest—and only Mother Nature controls this function.

VIDEO

http://bit.ly/SJMikeEffects

Lessons Learned on Wildlife Habitat Improvement



Mike Godwin, Field Supervisor with the Arizona Game and Fish Department, discusses how we are setting the stage for the key phases that will provide the recruitment of the vital browse, forbs, and grass species that will benefit wildlife habitat.

Godwin also points out the observed effects of the San Juan Fire, including the return of some browse species that have been absent here for several years.

C. Soils-Hydrology

Lesson

Design criteria for future projects.

Keeping a viable overstory canopy and reducing surface fuels to help ensure that a passing wildfire does not burn exceedingly hot should be design criteria for future projects.

The treated areas that were intersected by the San Juan Fire were effective in reducing soil loss from the San Juan Fire because:

- There were still living trees left after the fire, and
- There was still some residual ground cover after the fire's passage, thus
- Both of these conditions help to intercept precipitation and minimize soil loss.

VIDEO

http://bit.ly/SJEricSoils

Lessons Learned on Soils and Hydrology

Eric Robertson, Soil Scientist with the Apache-Sitgreaves National Forest, discusses how fire effects above the ground are important considerations for determining potential soil loss.

In this on-site interview, Robertson also points out the new grasses that are establishing post-fire, as well as the stands that received 100 percent mortality. He explains the ramifications of both of these conditions.

On the San Juan Fire, some treated sites favored low-severity wildfire which is favorable for long-term soil productivity. This is clearly illustrated in the Burned Area Reflectance Classification (BARC) maps (Figure 19) and Table 2 (both on next page).

From a soil productivity standpoint, when the San Juan Fire burned into the treated stands it returned nutrients to the soil *without* heating the soil in excess. This is a significant, positive outcome.

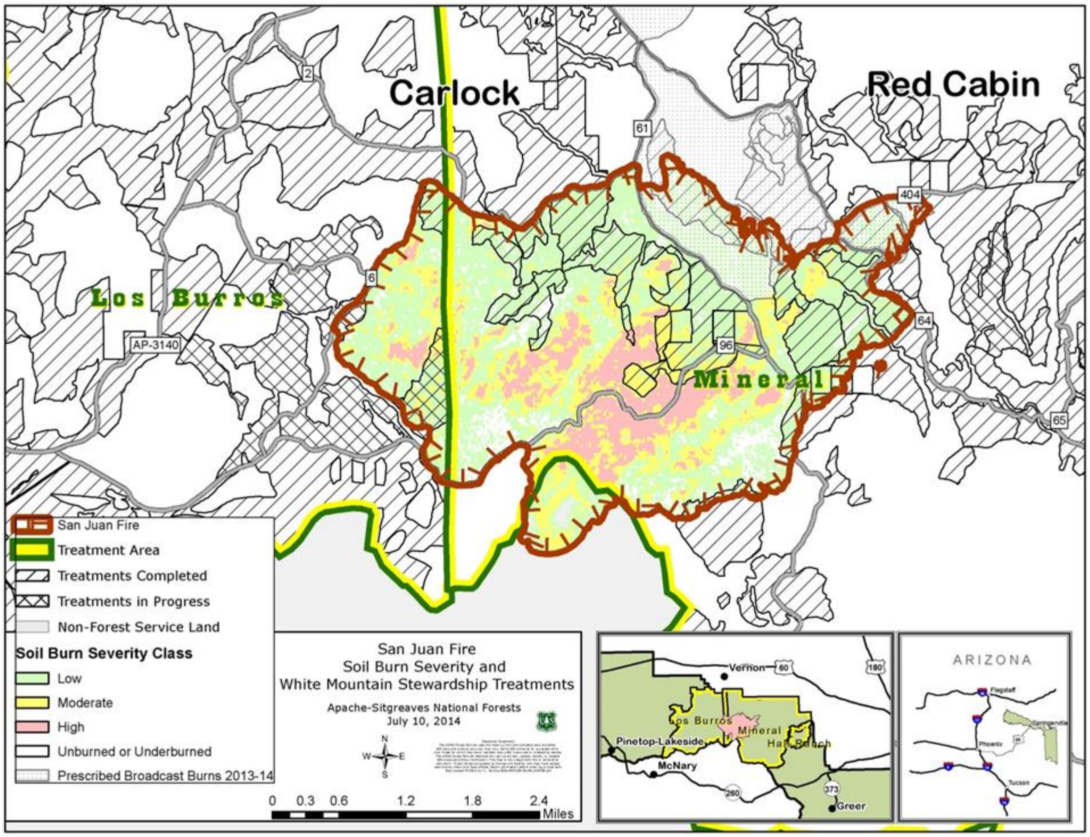


Figure 19 – Map of the San Juan Fire Burned Area Reflectance Classification (BARC). BARC is a satellite-derived data layer of post-fire vegetation condition. The BARC has four classes: High, Moderate, Low, and Unburned. A majority of the high-severity areas on the map are coincident with the areas that did not have a vegetation treatment applied. Conversely, in the areas in which vegetation treatments were applied, the burn severity is classed as Moderate, Low, or Unburned.

Percent of San Juan Fire Area in each BARC Fire Severity Type by Treatment Type			
BARC Severity	**% of Entire Fire Area**	**% of Areas with NO Treatment**	**% of Areas with Treatment**
Unburned	11	12	10
Low	61	48	83
Moderate	21	30	7
High	6	10	0

Table 2 – Comparison of preliminary BARC (Burned Area Reflectance Classification) results for the San Juan Fire. Burned area soil severity drops off significantly in treated areas.
Less Fuel = Less residence time = Less negative soil effects.

D. Timber

1. Lesson

Plan on Possible Re-Mark after First Cut as You May Be Surprised How Much Material Needs to Come Out.

> *"There's no sense in trying to get it perfect the first time. Just factor in that you will need some practice to get the feel for marking. Therefore, plan to re-mark some units as needed—especially when you are first getting started."*
>
> **Raymond Rugg, Zone Timber Staff**
> **Apache-Sitgreaves National Forest**

Raymond Rugg, Zone Timber Staff, Apache-Sitgreaves National Forest, explains how when they started marking these treatment units, their first entries tended to not take out as much as needed. He said that when you paint each cut tree, the visual impact to the eye is that everything looks painted—and you therefore think that you've gone too far.

"But after the cut, a lot is still left," Rugg points out. "Often times it was way more than we wanted to be left."

2. Lesson

If a Higher Basal Area (More Trees) is Desired, a Groupy/Clumpy Prescription May Help Reduce Crown Fire Spread Better than a Uniform Prescription.

In some cases, the treatment called for more trees to be left than what was thought ideal to reduce the crown fire threat. Raymond Rugg, Zone Timber Staff, Apache-Sitgreaves National Forest, explained how they discovered that they could help mitigate this by using a groupy/clumpy prescription—leaving patches of tighter-spaced trees isolated by greater distances to neighboring groups or patches.

Many people believe this becomes a more aesthetically pleasing landscape than a more uniform forest cover. While effective, it can be more difficult to implement a groupy/clumpy prescription due to the higher training needed to layout these more complex arrangements.

3. Lesson

In these Forest Types, Diameter Caps Less than 12 Inches Make for Ineffective Fuel Treatments.

Raymond Rugg, Zone Timber Staff, Apache-Sitgreaves National Forest, said that 12-inch cap limits didn't take enough trees out. The result was often a mostly closed canopy with little space between trees. Besides stressing out the competing trees, this also reduced understory grass/forb production.

"By not taking out enough, these forested areas were less likely to burn in a low-intensity surface fire and more disposed to burn in a higher-intensity crown fire," Rugg explains.

While the intention of retaining the forested appearance of the landscape is the primary reason we impose these caps, Rugg cautions that we need to be careful in the future that we don't make the cap too small—less than 12 inches. This can place the entire stand at risk.

Rugg says that a larger cap and a more varied marking scheme can be the answer as there is significant value in creating diversity of age classes to perpetuate the stand over time while still creating separation between tree canopies to allow more light to reach the forest floor and improve understory conditions.

E. Fire Ecology

Prescribed Fire Treatments Need to Follow Mechanical Treatments

1. Lesson

Treatments that approximate historical conditions and include evidence-based thinning treatments plus repeated surface fire can be an effective way to restore ecosystem structure and function while reducing crown fire hazard.

Generally speaking, areas where we used prescribed fire as a follow-up treatment to thinning experienced less burn severity from the San Juan Fire than those areas where we only used thinning or only used prescribed fire.

When we only thinned, we didn't get rid of the fine fuels (needles/twigs) that make up so much of the fuel bed. Intensities, therefore, tended to be higher. When we only prescribe burned, the overgrown condition of the stand forced us to burn at very low burning conditions to avoid damaging the entire stand. Thus, we burned the small material but didn't really get rid of the excess trees in these overstocked stands. The San Juan Fire may have done some of that work for us.

Goal: Modify Ecosystem Function

The lesson here is that when we say the intent of our treatment is "Full Restoration" in dry-site ponderosa pine in the Southwest, we need to be clear that our goal is to modify not just the structure, but also the function of the ecosystem to accept wildfire events like the San Juan Fire.

Mechanical thinning can help us restore the structure sooner by removing excess vegetation. However, that system is not restored until it is maintained by regular, recurring fire episodes. On future projects, managers need to ensure that they factor this fire regime principle into their design. They need to realize that the desired end-state is not just getting the thinning done to change the structure, but also includes getting fire back into the landscape on a regular basis.

A forest that can accept fire on regular, recurring basis is really what defines the success of a restoration treatment in the ponderosa pine regions of the Southwest.

Correct Perspective: How Fire Affects Long-Term Ecosystem Health

2. Lesson

Don't let the immediate visual impact of the burned area trick you into believing that the impacts of a fire are worse than they really are. Focus on what the fire leaves behind—not what it takes.

If the desired condition for an area is to have 75 percent fewer trees and a fire comes through removing all but 25 percent of the trees, the immediate visual impact may lead you to believe that the results are negative because your initial impression is: *"everything is burned"*.

VIDEO

http://bit.ly/SJTessaHighSeverity

The Benefits of High-Severity Fire

Tessa Nicolet, Fire Ecologist for the U.S. Forest Service's Southwestern Region, discusses how high-severity fire can serve as a positive influence for long-term ecosystem health.

In the future, expect that once the shock wears off from seeing a lot of burned area and you realize there's still 25 percent of the trees that are going to survive, you might eventually conclude that the fire's outcome wasn't all that bad. In fact, this result may have been a positive influence for long-term ecosystem health.

F. NEPA Planning

Lesson

Each project is individual. Thus, the plan/prescription should be flexible enough to allow for selecting the appropriate "tool" for the site-specific conditions.

There are no "one-size-fits-all" treatment prescriptions.

That's why resource specialists need to utilize all the available "tools" and customize the treatment to the needs of each specific area. In doing so, resource specialists need to communicate with other specialists, discuss options related to equipment, contracting, timing constraints, fire effects, and various other considerations in conjunction with the project's objectives and priorities.

Above all, during their current planning, managers and resource specialists must be prepared to deviate from what has been done in the past, be diligent in monitoring as implementation occurs, and be flexible as the project is implemented to ensure adaptations can occur as necessary—according to the monitoring.

VIDEO

http://bit.ly/SJStephTool

The Most Important Message: Using the Flexibility in NEPA to Choose the Correct "Tool" from Your Toolbox

Stephanie Coleman, Aquatics Program Manager for the Apache-Sitgreaves National Forest, points out the importance of determining the appropriate treatment tool.

G. Collaborative Relationships and Communications

1. Lesson

Ensuring positive effects on the land requires common interests among many stakeholders, a source of funding, and—even more importantly—a willingness to take calculated risks for the benefit of the resource.

Treatment design begins with finding the intersection of common interests or goals among various collaborators.

Subsequently, and most importantly, there must be trust in the fire managers to implement the treatments in a manner that provides this collaboration with the most efficient and effective use of their resources that achieves those common goals.

VIDEO

http://bit.ly/SJMikePartners

Partnerships Help Accomplish Management Objectives on the Ground

Mike Godwin, Field Supervisor with the Arizona Game and Fish Department, discusses how his agency's "Habitat Partnership Committee Process" is helping to implement wildlife habitat improvement projects on the ground.

Godwin praises the Apache-Sitgreaves National Forest fire managers for their willingness to take calculated risks to ensure that wildlife habitat objectives are achieved.

2. Lesson

As line officers and program managers, we still have room to improve how we communicate the key messages regarding our fire management programs. We must continue to emphasize that: 1) wildfires can be beneficial as well as destructive; 2) cutting trees alone does not necessarily protect the forest from wildfire, it takes follow-up treatment with fire to complete the job; and 3) if we are to maintain the investment that we've made over the past decade, we must increase our prescribed burning program.

To garner support for our fire management programs, we must dispel these three commonly held myths:

1. All wildfires are bad.
2. Cutting trees alone restores landscapes and reduces fire potential, thus prescribed fire isn't necessary.
3. Safe prescribed burning can only happen in the early spring and late fall.

To counter these myths, our communications—both internally and externally—need to emphasize:

1. The positive effects that can result from wildfires, not just the negative effects.
2. The importance of prescribed fire in finishing the job after cutting to create the most effective fuel treatments possible.
3. The feasibility of conducting prescribed burning in late spring or even summer, especially in previously treated areas that have light fuel loadings and are less likely to cause control problems even with hotter/drier conditions (as was witnessed with fire behavior in treated areas on the San Juan Fire).

Beware of the Tendency to Emphasize Mechanical Thinning Over Prescribed Fire When Using Stewardship Contracting as a Funding Tool

Too often we hear our message repeated back to us that our goal on the Apache-Sitgreaves National Forest is removing trees.

In the future, we should emphasize that returning fire to the landscape is our goal and that removing trees is one way we can help make that happen.

Programs with heavy dependence on stewardship contracting—such as the program that we have—tend to focus our message on the mechanical thinning aspects of the program. However, there is a hazard in this. As a result, we tend to lose the prescribed burning message.

When stewardship contracting is your main vehicle for funding your projects, be aware that you need to spend more time communicating about your end-goal—creating forested areas that can and do regularly accept fire. Furthermore, always remember that stewardship contracting is simply a means for helping us use the value of the timber products to do this work in a more economical and cost effective way.

H. Prescribed Fire

1. Lesson

Fuel treatments that recently experienced broadcast prescribed fire were the most effective.

2012 Coon Mountain Prescribed Fire Enabled Immediate Containment of the San Juan Fire

One of the most notable outcomes of the San Juan Fire was the fact that—even under extreme burning conditions—because the head of the fire ran into an area that had been thinned and recently burned as part of a wildlife and fuel reduction project, the fire was able to be contained almost immediately. This specific fuel treatment project was the 2012 Coon Mountain Prescribed Fire that had reduced hazardous fuels and removed decadent brush.

While such a dramatic effect is highly unusual, it does illustrate the effectiveness of frequently recurring prescribed fire and the management of wildfires to encourage low- or moderate-intensity fire on a regular basis as opposed to a program of fire exclusion—which will eventually encourage high-intensity fire to occur.

VIDEO

http://bit.ly/SJRobRxEffects

Rob Lever, District Fire Management Officer for the Apache-Sitgreaves National Forest, discusses how the head of the San Juan Fire burned into the site of the 2012 Coon Mountain Prescribed Fire.

Lever explains how areas treated by thinning, pile burning, and broadcast burning were the most effective in knocking down the San Juan Fire. This suite of treatments also helped the firefighters with their suppression tactics and strategies.

2. Lesson

Broadcast burning is an effective means to mitigate control problems associated with pile burning.

Many of the treatment units associated with the San Juan Fire resulted in slash piles scattered throughout the unit. The traditional burning techniques were then implemented—to wait for snow or significant rain and then light these individual piles.

Figure 20 – Final phase of treatment-broadcast burn in 2012 on the Coon Mountain Prescribed Fire.

Often times, Apache-Sitgreaves National Forest managers found that considerable effort was invested trying to maintain control of these piles days or weeks after they were ignited as drier conditions sometimes caused these fires to creep into the areas between piles.

To mitigate this, they discovered that it was more effective to simply broadcast burn the area—including burning the fuels in-between the piles. By doing this, they reduced the amount of time and effort required to monitor and patrol the treatment area as piles could continue burning for weeks but the chance of escape was minimal. Furthermore, patrol and monitoring could be concentrated around a perimeter instead of throughout the entire unit—as they had previously been doing.

3. Lesson

Recently burned areas—whether by prescribed fire or other wildfires—present fire control opportunities.

The areas where prescribed fire had recently been implemented were very effective barriers to fire spread. Where the San Juan Fire entered the Coon Mountain Prescribed Fire area, the fire stopped on its own in many places and was very easy to control.

The lesson here is that we should think of recently burned areas—whether by prescribed fire or wildfire—as potential opportunities for anchor points for future prescribed fires or control features for wildfire response.

While fuel loads are recovering and will limit the risk of escape and increase the safety margin for firefighters, the San Juan Fire area presents a great opportunity for the initiation of prescribed fires for the next few years.

It also represents a great opportunity to possibly allow a naturally ignited fire to burn into the San Juan Fire area. This would remove excess fuel and perform fire's essential role in this ecosystem while also allowing for safe and effective fire control—even for a fire that is allowed to grow to achieve desirable resource benefits.

4. Lesson

The San Juan Fire taught us that that there might be opportunities to be successful at prescribed burning in mixed conifer fuels if we're willing to accept mixed severity results.

Tactics on the San Juan Fire were very similar to how a prescribed fire would be conducted. Ridge tops were ignited in the evening, or at night, allowing fire to back-down with lower intensity. In addition, the road system in surrounding open ponderosa pine was relied upon as the primary control feature. This allowed the fire in mixed conifer to back down to those more open stands where it was easier and safer to control.

The patchy nature of the San Juan Fire in those previously untreated mixed conifer stands was to be expected: both a few areas of high-severity crown fire along with areas of moderate to low-severity fire.

5. Lesson

The San Juan Fire also taught us that our window of opportunity for conducting prescribed fire may be larger than we previously thought.

Treated stands that do not have the kind of heavier fuel loadings that have traditionally caused problems will most likely burn under hotter and drier conditions.

The San Juan Fire burned during some of the most critical fire weather conditions this area has ever experienced, yet the fuel conditions allowed fire managers to control the fire using burnout techniques much the same way we would use if we were igniting this as a prescribed fire.

In addition, there is better smoke dispersion in the summer, so folks have yet to reconcile prescribed fire and restrictions occurring concurrently.

6. Lesson

It is vitally important to treat with prescribed fire soon after mechanical treatment and then continue frequent prescribed fire to maintain the investment you just made to thin the stand in the first place.

"It is far more economical to treat with fire early and often than to wait too long and find out you now have a fuel bed that is going to require another mechanical entry."

Rob Lever, District Fire Management Officer
Apache-Sitgreaves National Forest

VIDEO

http://bit.ly/SJRobMaintain

Rob Lever, District Fire Management Officer for the Apache-Sitgreaves National Forest, explains why it's important to maintain fuel treatments—especially fire— to preserve their effectiveness.

If implementing prescribed fire is postponed too long, it becomes increasingly difficult to remove the target trees.

Once these trees get to about head-height, a fire that is mostly fueled by grass and needle cast probably won't kill the trees.

Therefore, even though you may not have a critical wildfire condition for several more years, you already have a condition in which you will need to come back in with expensive mechanical treatment to remove the excess trees.

I. Wildfire Response

1. Lesson

The presence of numerous fuel treatment areas allowed fire managers to respond to the San Juan Fire in a way that resulted in lessening the severity of the effects on the land, a safe environment for firefighters, and proved to be—both in terms of potential damages and firefighting expenditures—far less costly.

Some of the specific outcomes observed on the San Juan Fire included:

1. Treatments allowed for increased firefighter and public safety. Firefighters engaged a fire that was at lower intensity than if treatment had not occurred. The fire was controlled before it encountered private property.
2. Due to the presence of thinned areas and the recent Coon Mountain Prescribed Fire, the head (or forward spread) of the San Juan Fire was caught before either the east or west flanks were contained.

VIDEO

http://bit.ly/SJLessons

Three Key Lessons

Tessa Nicolet, Fire Ecologist for the U.S. Forest Service's Southwestern Region, explains three key lessons we learned from the San Juan Fire's burn effects and how treatments enabled specific suppression actions.

Rob Lever, District Fire Manager Officer on the Apache-Sitgreaves National Forest, also discusses how the suite of prior fuel treatments allowed firefighters on the San Juan Fire to focus on controlling the fire—rather than having to also protect homes.

3. Because the firefighting ground forces and engines could hold the head of the San Juan Fire, less aerial-applied retardant was necessary on this incident.
4. Treatments allowed for both direct attack fire suppression tactics—in which suppression forces could safely engage the fire as necessary—as well the ability to utilize indirect tactics to stop the fire in pre-identified strategic locations. This allowed firefighters more options to go on the offensive and control the fire, rather than having to implement point protection strategies in a more defensive mode.
5. These prior treatment areas also made it easier for firefighters to find and pick up spots.

2. Lesson

While firefighters on the San Juan Fire had to employ more patience than "normal", the end result was well worth it.

Because of the condition of the treated areas, fire managers were not concerned with the fire making a substantial run. This allowed these managers time to plan and conduct a slow, methodical burn-out operation which brought the main fire out to control lines slowly, under moderate burning conditions, over the course of several days in order to fully contain the fire.

The temptation for firefighters is to fire-off the containment lines quickly to enable the fire to be controlled as soon as possible. If this tactic would have occurred on the San Juan Fire, the result would have been a far more damaging, higher-intensity fire.

In conclusion, if weather conditions and the situation allow for it, it is a good practice to manipulate the timing and techniques used during firing operations to improve fire outcomes rather than causing more damage because we were in a rush to suppress the fire as rapidly as possible.

To learn more
about the San Juan Fire or fuel treatments on the
Apache-Sitgreaves National Forest, please contact:

Jeremy Human, Forest Fuels Specialist,
Apache-Sitgreaves National Forest
Telephone – 928-333-6320

This fuel treatment effectiveness assessment was conducted by:

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U.S. Forest Service, Southwestern Region; Payson, Arizona

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Videos recorded and edited by:
Josh McDaniel, Fire Science Editor, Wildland Fire Lessons Learned Center
with support from the Southwest Fire Science Consortium – http://swfireconsortium.org/

We wish to thank the following people for their help and support in producing this assessment:

Apache-Sitgreaves National Forest
Paul Brown, Ed Collins, Stephanie Coleman, Jerry Drury, Mark Empey, Jeremy Human, Rob Lever, Marcia Pfleiderer, Eric Robertson, Raymond Rugg

Incident Responders
Ben Plumb, Dave Raney, Dave Reisner, Buck Wickham

Ecological Restoration Institute
Bruce Greco, John Paul Roccaforte

Arizona Game and Fish Department
Mike Godwin

Web Accomplishments: *July 1, 2015–June 30, 2015*

4Fri.org Accomplishments

- Updated site content including meeting minutes, agendas, maps, and other pertinent materials.
- Updated calendar and event locations
- Provided updates on site on important 4Fri related news, news articles, and press releases
- Streamlined content to make important information more readily accessible to users
- Added an interactive 4FRI map tracking acres treated

NAU.edu/ERI Accomplishments

- Added current /relevant ecological related news articles
- Updated the site with current ERI publications including journal articles, ERI working papers, ERI Fact Sheets, and technical papers
- Added relevant events and conferences
- Developed a press specific landing page on the site to answer frequently answered questions of the media, provide high resolution photographs for press members and direct press members with further inquiries to the appropriate person

SWERI Accomplishments

- Revised the home page content to make the content more relevant to users
- Revised, updated, and expanded the broad scale monitoring section
- Streamlined and redesigned the page layout and improved page graphics

AZPFC.org

- Added new events and posts to keep users informed about topics relevant to the council
- Updated board member information as needed
- Created an online voting mechanism for people to vote for board members
- Reported out the voting results and updated the site regarding the board member election
- Created an online registration mechanism for the TREX conference

Parashant

- Created a password protected file repository for members of the site to upload and organize various Parashant related files

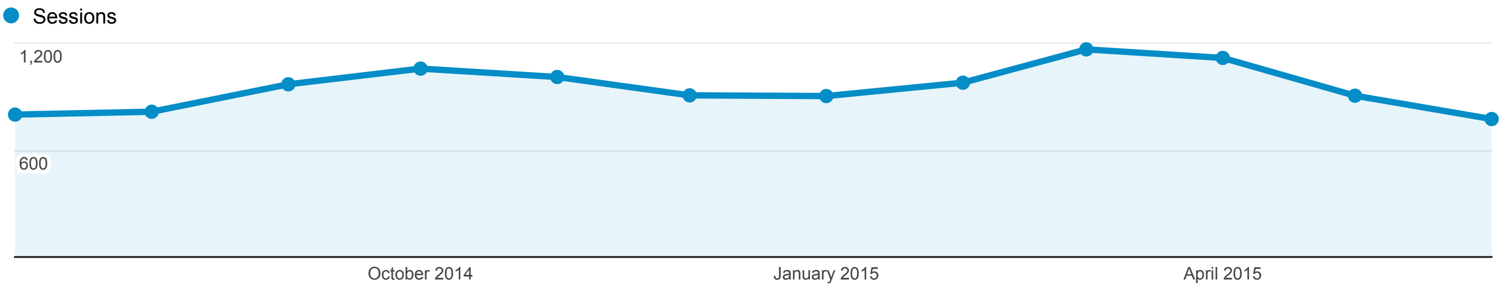
Audience Overview

Jul 1, 2014 - Jun 30, 2015

You are using a filtered view, which may cause your Users count to be inaccurate. Learn more

All Sessions
100.00%

Overview



Sessions
11,399

Users
5,810

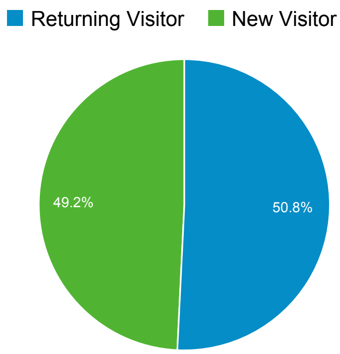
Pageviews
24,596

Pages / Session
2.16

Avg. Session Duration
00:02:08

Bounce Rate
57.33%

% New Sessions
49.23%



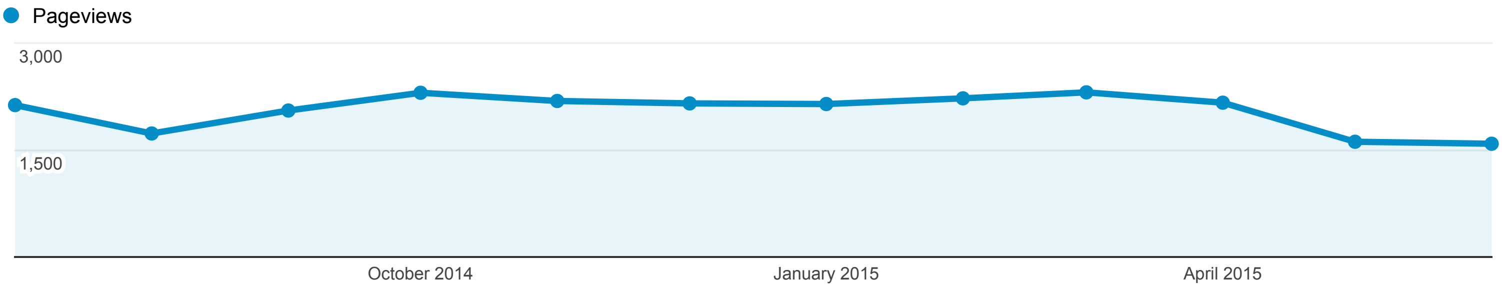
	Language	Sessions	% Sessions
1.	en-us	10,620	93.17%
2.	en-gb	156	1.37%
3.	es	91	0.80%
4.	en	80	0.70%
5.	en-ca	40	0.35%
6.	pt-br	33	0.29%
7.	zh-cn	33	0.29%
8.	es-es	29	0.25%
9.	de	23	0.20%
10.	en-au	22	0.19%

Overview

Jul 1, 2014 - Jun 30, 2015

All Sessions
100.00%

Overview



Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
24,596	20,452	00:01:48	57.33%	45.95%

	Page	Pageviews	% Pageviews
1.	/ERI/	4,255	17.30%
2.	/eri/	1,941	7.89%
3.	/ERI/Directory/Directory-List-View/	1,300	5.29%
4.	/ERI/Directory/	1,092	4.44%
5.	/ERI/Publications-Media/	1,032	4.20%
6.	/ERI/Directory/Directory-Dept-View/	622	2.53%
7.	/ERI/Research/	582	2.37%
8.	/ERI/Publications-Media/Recent-ERI-Publications/	491	2.00%
9.	/ERI/Restoration-Information/	452	1.84%
10.	/ERI/Resources/For-Policymakers/Effects-Of-Thinning/	389	1.58%

4FRI-AZPFC Web Stats

4FRI.ORG Web Stats					
Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jul-14	920	1,859	4,546	30,119	2.32 GB
Aug-14	882	1,677	3,479	25,820	1.80 GB
Sep-14	969	1,635	3,966	29,383	1.72 GB
Oct-14	1,160	1,995	5,697	33,223	1.84 GB
Nov-14	1,145	1,803	4,184	37,174	1.73 GB
Dec-14	1,186	1,524	3,172	36,566	1.78 GB
Jan-15	1,256	1,596	3,776	34,557	2.03 GB
Feb-15	1,023	1,328	3,422	29,704	1.76 GB
Mar-15	1,253	1,640	3,246	31,615	3.05 GB
Apr-15	1,326	2,204	5,343	34,907	2.10 GB
May-15	1,103	1,958	4,350	29,796	1.74 GB
Jun-15	1,090	1,475	3,612	26,463	2.11 GB

4Fri Top 5 Visited Pages
Home Page
/fire_reintroduction.html
/stakeholders.html
/meetings.html
/maps.html

AZPrescribedFireCouncil.org					
Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jul-14	538	859	2,972	12,833	243.25 MB
Aug-14	380	664	2,361	8,795	226.06 MB
Sep-14	484	798	2,854	11,026	271.00 MB
Oct-14	392	969	3,827	9,579	206.18 MB
Nov-14	409	907	3,692	10,059	177.76 MB
Dec-14	1,050	1,567	4,915	12,136	197.31 MB
Jan-15	1,143	1,798	3,940	11,053	231.16 MB
Feb-15	886	1,270	3,539	7,873	128.40 MB
Mar-15	1,118	1,474	3,635	9,965	167.39 MB
Apr-15	903	1,260	2,464	6,467	107.96 MB
May-15	362	762	1,644	6,544	129.70 MB
Jun-15	352	584	1,779	5,617	100.29 MB

AZPFC Top 5 Visited Pages
Home
Feed
About
Event/Prescribed-Fire-Training-Exchange
News

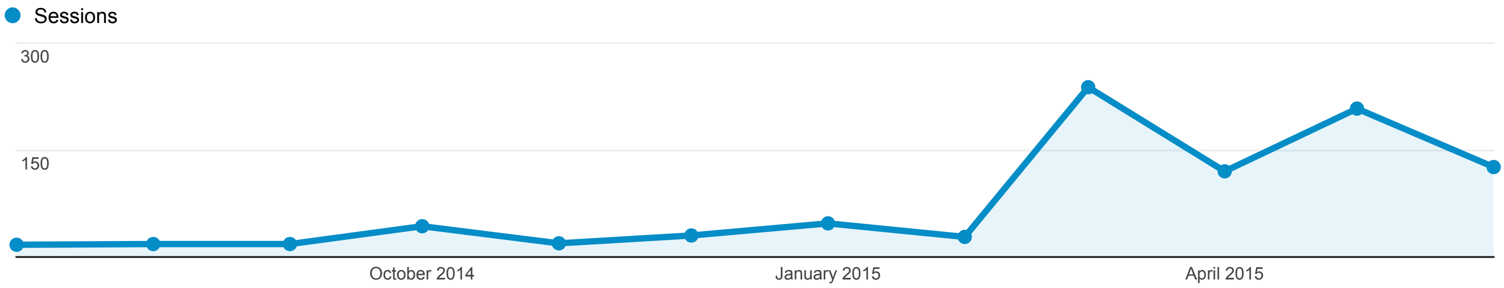
SWERI Web Analytics: Access to SWERI website over time

Audience Overview

Jul 1, 2014 - Jun 30, 2015

All Sessions
100.00%

Overview



Sessions
912

Users
810

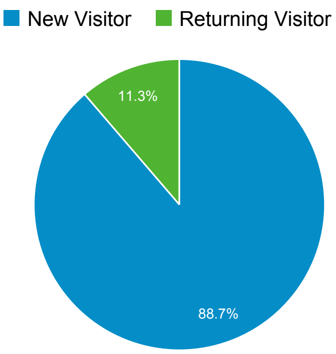
Pageviews
1,399

Pages / Session
1.53

Avg. Session Duration
00:00:56

Bounce Rate
69.41%

% New Sessions
88.71%



	Language	Sessions	% Sessions
1.	(not set)	453	49.67%
2.	en-us	388	42.54%
3.	en	19	2.08%
4.	ru	16	1.75%
5.	de	12	1.32%
6.	en-gb	4	0.44%
7.	de-de	3	0.33%
8.	es	3	0.33%
9.	hu-hu	3	0.33%
10.	et	2	0.22%

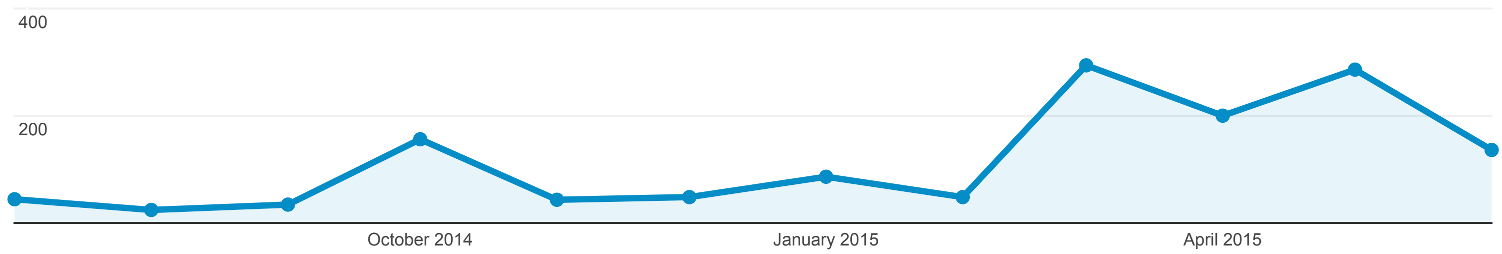
SWERI Web Analytics: Page Views over Time

Overview

Jul 1, 2014 - Jun 30, 2015

All Sessions
100.00%

Overview



Pageviews	Unique Pageviews	Avg. Time on Page	Bounce Rate	% Exit
1,399	1,174	00:01:37	69.41%	62.40%

	Page	Pageviews	% Pageviews
1.	/	932	66.62%
2.	/team.html	70	5.00%
3.	/newsstories/cutting_edge.html	60	4.29%
4.	/BroadscaleMonitoring.html	49	3.50%
5.	/dfc_wksp.html	46	3.29%
6.	/index.html	42	3.00%
7.	/legislation.html	39	2.79%
8.	/reviews.html	36	2.57%
9.	/contactus.html	20	1.43%
10.	/maps.html	16	1.14%

Audience Overview

Jul 1, 2014 - Jun 30, 2015

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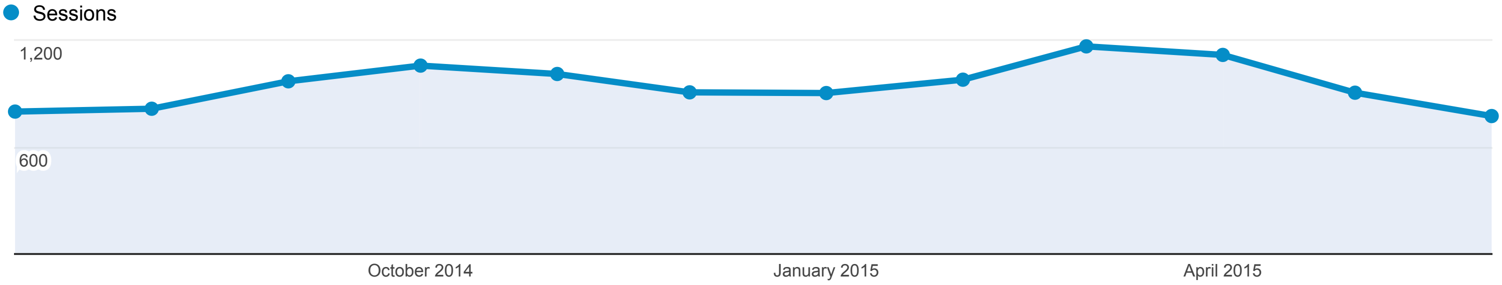
All Sessions
100.00%

Overview



Sessions	Users	Pageviews
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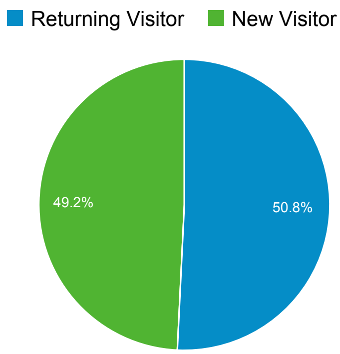
Pages / Session	Avg. Session Duration	Bounce Rate
2.16	00:02:08	57.33%

% New Sessions
49.23%



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9.	de	23	0.20%
10.	en-au	22	0.19%

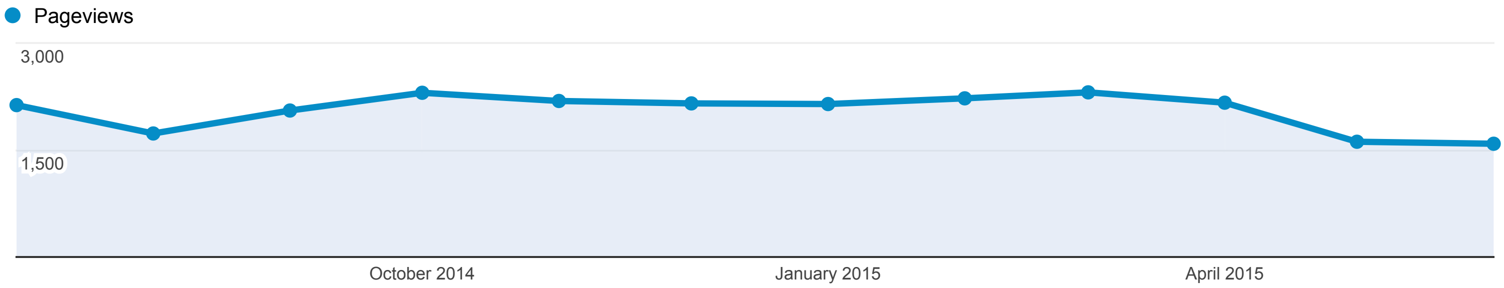
ERI Web Analytics: Demonstrates page views received over time

Overview

Jul 1, 2014 - Jun 30, 2015

All Sessions
100.00%

Overview



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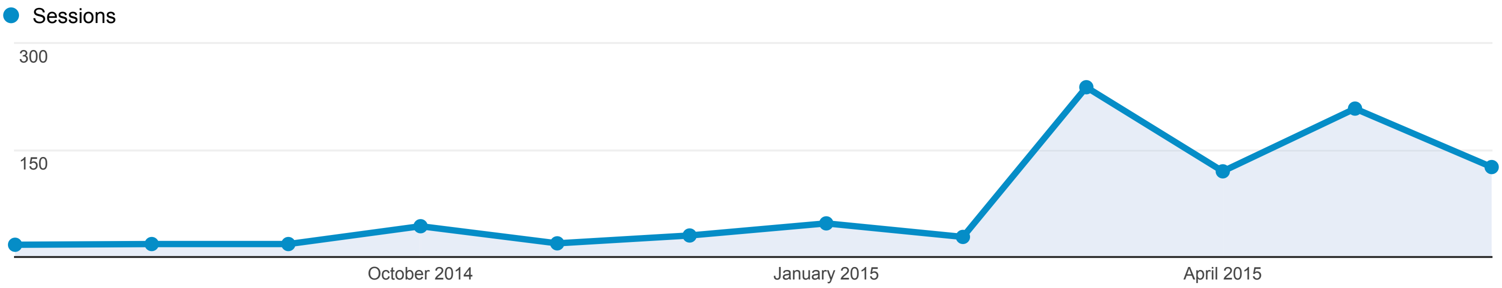
SWERI Web Analytics: Access to SWERI website over time

Audience Overview

Jul 1, 2014 - Jun 30, 2015

All Sessions
100.00%

Overview



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Users
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Pages / Session
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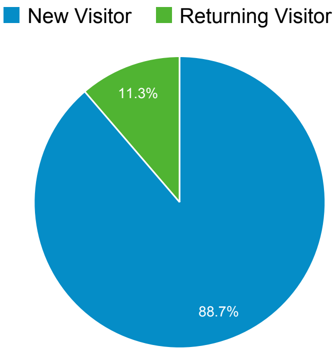

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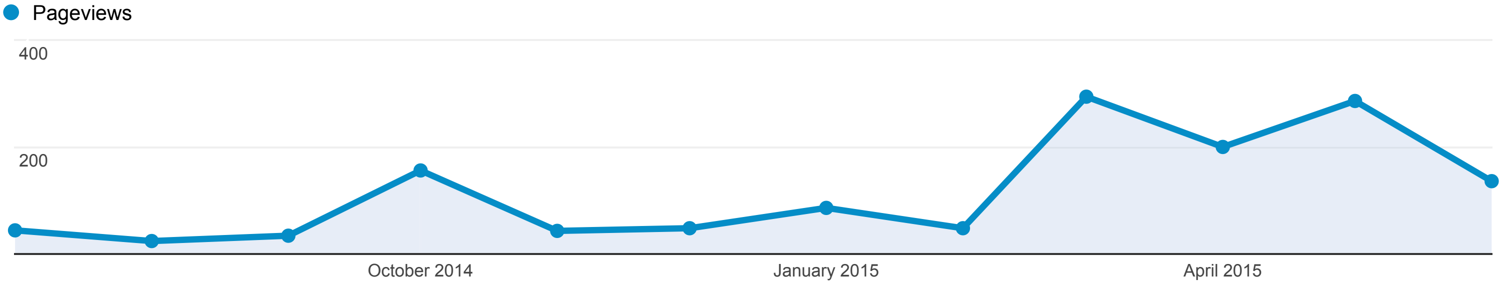
SWERI Web Analytics: Page Views over Time

Overview

Jul 1, 2014 - Jun 30, 2015

All Sessions
100.00%

Overview



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9.	/contactus.html	20	1.43%
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