

The Ecological Restoration Institute at Northern Arizona University

Accelerating Restoration and Resiliency in the West

Fiscal Year 2021 Work Plan

June 16, 2021

Introduction

In 2004, Congress passed the Southwest Forest Health and Wildfire Prevention Act ([PL108-317](#); hereby referred to as the Act) that established three university-led Southwest Ecological Restoration Institutes in Arizona, New Mexico, and Colorado. The Act was a result of congressional recognition, led by US Senator Jon Kyl from Arizona, that objective, practitioner-oriented science was needed to accelerate forest restoration. At the time, confidence in Forest Service management was low, leading to objections and litigation that confounded forest management. Senator Kyl viewed the objectivity of university-based knowledge as a cornerstone for building public support for action.

In 2019, the Ecological Restoration Institute's leadership team updated ERI's 5-year strategic plan. Since the 5-year strategic plans match congressional review time periods, the ERI took this opportunity to better align our work plan project areas with our long-term strategic planning. Additionally, the [2020–2024 Strategic Plan](#) was timely as it captured the transition from Dr. Wally Covington through the hiring of our new Executive Director, Dr. Andrew Sánchez Meador. The revised strategic plan matches the original intent of the ERI and its commitment to fulfilling the Duties and Purposes of the Act, which include: 1) developing, researching, and monitoring treatments to reduce the risk of severe wildfires and improve the health of dry forest and woodlands; 2) synthesizing and adapting scientific findings for affected entities¹ to implement treatments on a landscape scale; 3) translating and transferring knowledge to all affected entities; 4) assisting all affected entities to implement treatments using best adaptive management practices and, 5) provide a report on all deliverables. The ERI's mission is to serve diverse audiences with objective science and implementation strategies that support ecological restoration and climate adaptation on western forest landscapes. To build this year's work plan:

- Staff coordinated with the Colorado Forest Restoration Institute and the New Mexico Forest and Watershed Restoration Institute to identify and meet cross-region and national needs.
- Staff coordinated with SWERI Program Manager Buck Sanchez to better understand Region 3 needs and opportunities. Topics included assistance to meet existing and anticipatory monitoring needs and efforts to better understand the benefits and constraints to wood certification on federal lands.
- We examined West-wide monitoring strategies for broader Forest Service incorporation of adaptive management.
- Staff consulted with the Forest Products Modernization (FPM) team at the Washington Office (WO) regarding modernization and innovation implementation. We continued work with partners, like The Nature Conservancy, to fill gaps in innovative use of digital marking that are important to industry.

¹ An affected entity is defined in PL108-317 as: land managers, stakeholders, concerned citizens; and, the States of the interior West, including political subdivisions of the States.

- Staff participated and continued conversations with the Resource Integration Management Coordination team in the WO to better inform our monitoring and adaptive management work.
- Across Region 3, staff consulted with the regional office (ecologist and climate change coordinator), forest-level staff on the Tonto, Prescott, Coconino, and Kaibab national forests, and the 4FRI Implementation Team to determine management support.
- Staff identified ongoing Collaborative Forest Landscape Restoration Program (CFLRP) needs in consultation with Lindsay Buchanan (CFLRP Coordinator) and CFLRP stakeholders from pilots across the intermountain West.
- Staff validated with stakeholders and 4FRI Forest Service staff the importance of ongoing ERI technical and administrative services to the 4FRI Stakeholder Group.
- Staff consulted with the Intertribal Timber Council, representatives from individual tribes including the Navajo, White Mountain Apache, Mescalero, and Hualapai, and the regional office (John Waconda and Yolynda Begay), forest tribal liaisons, and the Bureau of Indian Affairs at the regional and central office levels to identify strategic opportunities to assist tribes.
- Staff discussed ways to improve biomass utilization opportunities with the regional office (Buck Sanchez) and WO (Julie Tucker).
- Staff responded to literature gaps identified from past work plan efforts, including systematic reviews, and evaluation of long-term monitoring sites.
- Staff worked with managers, scientists, policy makers, and various agency partners to identify both current and anticipated science needs. The ERI uses various strategies, including long-term monitoring, manager and public surveys, analysis of landscape-scale remote sensing data, and implementation of new studies to provide timely, actionable science-based information.

Project Summaries

To align with ERI's new 5-year strategic plan, the ERI proposes six interdisciplinary project categories for Fiscal Year 2021 (FY21). While the categories have changed from the FY20 work plan, they are more consistent with the purposes and duties of the Act.

Our FY21 projects help support current Forest Service initiatives, including Shared Stewardship; support tribal implementation of 638 ([PL93-638](#)) agreements and biomass utilization; advance wood utilization from restoration projects; and address climate change impacts and adaptation opportunities available to federal land managers.

Project 1 – Restoration and climate adaptation knowledge development and transfer (Fulfills duties under the Act: 1, 2, and 3). In FY21, the ERI will monitor climate-related changes in forest structure and composition along a steep elevation gradient and study effects of fuel reduction treatments on understory plant community characteristics in pinyon-juniper woodlands. In addition, research staff will analyze interacting effects of restoration treatments and climate on understory communities using data from an extensive monitoring network of long-term study sites.

Project 2 – Apply ERI expertise to restoration implementation at appropriate scales (Fulfills duties under the Act: 2, 3, and 4). In this project area, the ERI applies interdisciplinary expertise to address barriers and challenges to restoration implementation, at scales appropriate for enhancing resiliency for forested landscapes and human communities.

Project 3 – Foster and support partnerships (*Fulfills duties under the Act: 2 and 3*). The ERI convenes and facilitates discussions that advance restoration knowledge development and application across boundaries and at landscape scales.

Project 4 – Integration and engagement with tribal land restoration (*Fulfills duties under the Act: 2, 3, and 4*). The ERI, with Northern Arizona University, is committed to facilitating the exchange of restoration knowledge between and among tribal and federal partners.

Project 5 – Science and policy application and interpretation (*Fulfills duties under the Act: 3 and 4*). The ERI develops workshops, field trips, and focus groups to work with all affected entities for shared science delivery, and implementation of state and federal agency strategic goals.

Project 6 – Communication and outreach (*Fulfills duties under the Act: 3*). The ERI is proud to be a known expert in forest restoration science and implementation. To meet the duties of the Act, we promptly respond to media requests, community information needs, policy questions, and practitioner information requests on a weekly basis.

Project Descriptions and Deliverables

Project 1: Restoration and climate adaptation knowledge development and transfer

Project 1 describes ERI’s work to address existing and emerging biophysical and social science needs related to issues such as restoration treatment effectiveness, climate impacts on forests, and understudied forest ecosystems. Efforts in this project include analysis of long-term monitoring data collected on field plots, manager and public surveys, analysis of landscape-scale remote sensing data, and implementation of new studies to investigate key questions aimed at accelerating the pace and scale of restoration. Science delivery of critical information to land managers and other stakeholders is completed through peer-reviewed technical publications, working papers, fact sheets, conferences, and workshops to best meet the requirements of a wide audience of practitioners, researchers, and policy makers.

In dry forest ecosystems of the western US, understory plant communities account for high proportions of total biodiversity and are pivotal in their influence on ecological function and processes. In addition, community characteristics, such as species composition and dominance, are sensitive to varying environmental conditions that come with natural disturbance, restoration treatments that are focused on tree thinning and prescribed fire, and changing climate. For these reasons, information gained from long-term monitoring of understory changes with and without restoration treatments can be highly valuable for planning and adaptive management. In FY21 (Project 1.1), the ERI will complete an analysis of understory data collected over a span of 20 years across a network of ERI restoration study sites ([LEARN – Long-term Ecological Assessment and Restoration Network](#)). The focus of this work will be to evaluate treatment effectiveness for enhancing plant diversity and abundance and assessing impacts of treatments and climate on sensitive species.

In addition to shifting composition and abundance of understory communities, climate warming is expected to also drive major changes in forest overstory structure. Mortality of dominant tree species and migration of species to new habitats are coarse-level changes that are expected to be most clearly observed in transition zones where species occur at their environmental limits. To date, there are few details concerning microsite conditions where these changes are occurring, rate of change for various species, or the role of disturbances in driving species migration. Such information could help managers refine strategies for promoting ecological resilience and adapting management to new forest conditions. In FY21 (Project 1.2), the ERI will capitalize on an extensive array of monitoring

plots that we established along a steep elevation gradient in 2000–2003, and initiate plot remeasurements to assess patterns of tree mortality and regeneration in ponderosa pine forests at lower elevations to bristlecone pine communities at upper elevations. This unique landscape analysis will require a multi-year approach. Interim information produced in this project will be highly valuable for local and regional managers concerned with impacts of climate change on forests landscapes and wilderness management.

Pinyon-juniper (PJ) ecosystems cover vast extents of southwestern landscapes, but this forest type is highly variable in structure and function, and presently there is high interest among managers concerning restoration and fuels management appropriate for PJ. A particular concern centers on management of thinning slash and potential for unintended tree mortality due to bark beetle (*Ips* spp.) attraction to fresh coarse woody debris. Previous research has shown that slash left on site can help restore understory plant community abundance, but slash may also serve as host to bark beetles.

In FY21 (Project 1.3), the ERI will collaborate with Dr. Andy Graves (Forest Health Protection, NM Zone) to examine effects of thinning and alternative slash treatments on forest structure, subsequent bark beetle attack, and understory community responses. Information generated from this work will help managers when considering timing of fuel reduction treatments and tradeoffs that may be associated with meeting restoration goals.

In other FY21 work (projects 1.4, 1.5), the ERI will help support Dr. Chris Guiterman, research ecologist at Three Pines Forest Research, LLC, in a region-wide fire history analysis, and Alex Spannuth (Kaibab National Forest) in determining effective monitoring approaches for evaluating treatment and wildfire outcomes. Although the ERI is assuming more of a support role in these projects, information resulting from this work will be highly valuable to managers of southwestern forests.

It is increasingly common for forest managers to use naturally ignited wildfires, or resource objective (RO) fires, to accomplish land management and ecological restoration objectives. At the same time, RO fire use is increasingly promoted from a policy perspective as a tool to increase the pace and scale of restoration. In FY21, we seek to complement the ecological research on RO to add a social component to better understand how manager perspectives on RO fires manifest in ecological outcomes. Because the use of RO fire is guided by policy and interpreted differently by managers in different landscapes, we surmise that the ecological outcomes of RO fires are largely a reflection of how RO policy and acceptable levels of risk are interpreted by managers on the ground. This work will help inform policy direction and guidance to ensure the most effective use of RO fires for accomplishing ecological restoration objectives.

In order to increase the pace and scale of forest restoration treatments to reduce the risk of catastrophic fire, it is also important to understand public perceptions of forest aesthetics and management effects. The scenic beauty index provides a long-standing, existing method for assessing the scenic beauty or perceived aesthetic of forested areas. However, the methods do not capture the full range of forest conditions increasingly prevalent in the Southwest, including landscapes degraded by catastrophic fire or landscapes that have undergone different management interventions. Therefore, updates are needed to recalibrate measures of scenic beauty to capture existing and potential future forest aesthetic conditions. This can then be used to assess public perceptions of different forest conditions and forest management actions. The ERI has a vast reserve of plot data that can be used to begin to update measures of scenic beauty. In FY21, we propose to inventory this data with the goal of using it to update scenic beauty measures and assess public perceptions of forest aesthetics and management effects to inform public education and outreach in FY22.

Project 1: Restoration and climate adaptation knowledge development and transfer	
<i>Fulfills duties under the Act: 1, 2, 3</i>	
Action	Requestor/Anticipatory
1.1) Multi-site understory response to treatment analysis	<u>Requestor:</u> Forest Service – multiple units <u>Outcome:</u> Monitoring impacts of restoration treatments; long-term treatment effectiveness; will inform future planning
1.2) San Francisco Peaks Ecosystem Monitoring Plot Array remeasurement	<u>Requestor:</u> Anticipatory <u>Outcome:</u> Long-term monitoring impacts of drought and climate change; will inform future planning
1.3) Mt. Taylor (NM) pinyon-juniper thinning and slash treatments	<u>Requestor:</u> Andy Graves, Forest Service Forest Health Protection NM Zone Lead <u>Outcome:</u> Monitoring impacts of PJ slash treatments; will inform future management
1.4) Southwest fire history meta-analysis	<u>Requestor:</u> Forest Service – multiple units <u>Outcome:</u> Anticipatory – synthesis of Southwest fire history to measure variability; will inform desired conditions
1.5) North Kaibab fire and restoration	<u>Requestor:</u> Kaibab National Forest, North Kaibab District <u>Outcome:</u> Tools for landscape-scale treatment effectiveness; will inform future planning
1.6) Human dimensions of resource objective fires	<u>Requestor:</u> Anticipatory <u>Outcome:</u> Will inform future policy
1.7) Updates to scenic beauty index	<u>Requestor:</u> Multiple stakeholders, elected officials, AZ municipalities, Forest Service <u>Outcome:</u> Will inform future planning
1.8) Systematic review and science summary	<u>Requestor:</u> Anticipatory <u>Outcome:</u> Will inform future planning

1.1) Multi-site understory response to treatments analysis. Information from this study will help managers better understand long-term understory changes related to tree thinning, prescribed fire, and climate. This two-year project was initiated in FY20 and is examining changes in understory plant communities across the ERI’s LEARN network of treatment test sites. The focus of this year’s collection is on the responses of perennial forb species.

Requestor: Forest Service – multiple units

Outcome: Long-term treatment effectiveness; to inform future planning

Deliverables:

- a) Technical report
- b) Professional presentation, webinar, or workshop

1.2) San Francisco Peaks ecosystem monitoring plot array remeasurement. This work will fulfill several ERI strategic goals related to analyzing landscape processes, climate change effects, and understudied ecosystems. The overarching aim of this effort will be to provide information to assist managers in planning for climate change and landscape-scale restoration. In addition, this project will help local managers to identify goals for managing a wilderness landscape of major importance to the Flagstaff community.

Requestor: Anticipatory

Outcome: Long-term monitoring to capture drought and climate change impacts across an elevation gradient; will inform future planning

Deliverable:

a) Progress report

1.3) Mt. Taylor (NM) pinyon-juniper thinning and slash treatments. Empirical data are needed to better understand effects of various thinning slash management options on tree mortality and associated ecological responses in pinyon-juniper ecosystems. This project will be conducted as an ERI collaboration with Forest Service Forest Health Protection (FHP) NM Zone Lead Andy Graves using an experimental design established in 2019. Work may include field data collection on understory and fuels responses, reconstruction analysis, and/or analysis of other data collected by the New Mexico Forest and Watershed Restoration Institute or other entities.

Requestor: Andy Graves, FHP, New Mexico Zone Lead

Outcome: Slash management treatment effectiveness, to inform future planning

Deliverable:

a) Progress report on data collection.

1.4) Southwest fire history meta-analysis. In the project, the ERI will collaborate with Dr. Chris Guiterman to conduct a meta-analysis of fire history data (fire scar records) from across the southwestern United States. Questions related to factors driving variation in fire regime parameters will be addressed.

Requestor: Forest Service – multiple units

Outcome: Synthesis of Southwest fire history to measure variability; will inform desired conditions

Deliverables:

a) Technical report

b) Professional presentation, webinar, or workshop

1.5) North Kaibab fire and restoration. In this project we will partner with the North Kaibab District of the Kaibab National Forest to compare forest treatment approaches for meeting desired conditions and test state-of-the-art monitoring techniques such as lidar and structure from motion digital aerial photography.

Requestor: Kaibab National Forest, North Kaibab District

Outcome: Appropriate and available tools for landscape-scale treatment effectiveness, to inform future planning

Deliverable:

a) Literature review and synthesis of monitoring techniques

1.6) Human dimensions of resource objective fires. The use of RO fire is guided by policy but is interpreted differently by managers in different landscapes. We surmise that the ecological outcomes of RO fires are largely a reflection of how RO policy and acceptable levels of risk are interpreted by managers on the ground. In FY21 we seek to better understand the impacts of policy and guidance interpretation on how managers implement the use of RO fires in federal, state, and tribal lands. In future years, we will compare these findings with ERI ecological research on RO fires to better understand how policies to implement RO fires manifest in ecological outcomes. This work will help inform policy direction and guidance to ensure the most effective use of RO fires for accomplishing ecological restoration and climate adaptation objectives.

Requestor: Anticipatory – examines the efficacy of current and proposed policy directions

Outcome: Understanding policy interpretation and effectiveness; will inform future policy

Deliverable:

- a) A report summarizing policies for the use of RO fires across different jurisdictions and preliminary findings about how managers interpret those policies.

1.7) Updates to scenic beauty index. The public’s perceptions of forest aesthetics and land management actions strongly influence public stakeholders’ response to federal land management actions. There are existing methods for assessing forest aesthetic conditions, or scenic beauty; however, those methods do not capture the full range of forest conditions increasingly prevalent in the Southwest today, including landscapes degraded by catastrophic fire or landscapes impacted by different management interventions. Therefore, updates are needed to recalibrate measures of scenic beauty to capture existing and potential future forest aesthetic conditions and better understand public perceptions of current forest conditions. This will be a multi-year project and involve partnership with NAU School of Forestry faculty. In FY21, we propose to inventory the ERI large photographic data set with the goal of using it to update scenic beauty measures.

Requestor: Multiple affected stakeholders, including elected officials, AZ municipalities, and Forest Service

Outcome: Updates to public perceptions for better understanding of responses to today’s conditions and threats; to inform future planning

Deliverable:

- a) Report on progress on the development of a photo series to inform a public perceptions survey.

1.8) Systematic review and science summary. The ERI assesses the best available scientific information (BASI) to develop systematic reviews and technical summaries to address restoration-based management questions. Products can be 1 or 2-year processes, depending on the question.

Requestor: Anticipatory, with Southwest Fire Science Consortium and CFRI

Outcome: Synthesis of expected climate-informed future wildfire patterns; will inform future planning

Deliverables:

- a) Peer-reviewed journal article submitted based on FY20 systematic review analysis on wildfire severity with climate change
- b) Webinar on FY20 systematic review

Project 2: Apply ERI expertise to restoration implementation at appropriate scales

Landscape-scale forest restoration is a primary focus of policy makers, land managers, and the communities they both serve. Achieving landscape change is achieved only by integrating efforts at multiple scales and across multiple disciplines. The ERI has long championed forest restoration at scales appropriate to the ecological disturbances and threats that our public lands face. In 2021, we will address science gaps and information needs across disciplines to further advance restoration implementation at appropriate scales.

Landscape-scale forest restoration efforts have been supported through targeted funding, including congressional acts (e.g., CFLRP) and specialized programs (e.g., “Joint Chiefs” programs). These investments have served as experiments to largely assess whether a restoration timber product-based model can support restoration at the scale needed to mitigate for catastrophic wildfire and climate change. These projects to date have not included the inherent value to society and communities from a restored acre. We propose a pilot study to assess a return on investment, using multiple ecosystem service valuations and avoided wildfire costs, to better evaluate the return on investment from restoration treatments on federal lands.

Beginning in 2017, the ERI began working in partnership with the Forest Service—including the Forest Products Modernization Team, The Nature Conservancy, and other partners to advance modernization, innovation, and learning—to increase efficiency and lower cost during treatment preparation and implementation. This combined effort became a showcase for new approaches that are now finding their way into forest operations across 4FRI and the region. The ERI will continue to facilitate the co-development of technologies and processes that advance modernization of forest restoration implementation.

Implementation of these projects in the Southwest has yet to produce a robust private sector model to accelerate restoration. The ERI works to create strategies to economically and efficiently utilize small wood and biomass resulting from restoration treatments. The ERI leverages successful competitive grants that fund much of the work under this research area. After successful completion of the 2019 [*Chip-and-Ship*](#) pilot project evaluating the operational logistics of railroad transportation, we are continuing to implement this concept at a broader scale. Federal funds from this work plan will map out the existing railroad network in the US Southwest and evaluate railroad transportation logistics to supply small-diameter wood and biomass to both domestic and foreign markets. This work plan also supports the partnership and coordination needs of ERI’s forest operations and biomass program. There is a need to run this work over multiple years, as there is a West-wide need for evaluation of rail capacity and opportunities.

Project 2: Apply ERI expertise to restoration implementation at appropriate scales	
<i>Fulfills duties under the Act: 2, 3, 4</i>	
Action	Requestor/Anticipatory
2.1) Industry and biomass utilization	<u>Requestor</u> : Multiple stakeholders, state and local municipalities, forest product businesses <u>Outcome</u> : Rural economic development to benefit sustainable land management; expanding markets for wood; informing job training needs
2.2) Facilitate the development and integration of new technologies to advance restoration implementation	<u>Requestor</u> : Forest Service Forest Products Modernization Team, The Nature Conservancy <u>Outcome</u> : Lessons learned; informing future implementation processes
2.3) Understanding the return on investment from restoration treatments	<u>Requestor</u> : 4FRI Chief Executive, policy makers <u>Outcome</u> : Additional project evaluation methods through a return on investment analysis; will inform accomplishment reporting and economic and non-market outcomes
2.4) Landscape prioritization and strategic implementation	<u>Requestor</u> : Anticipatory <u>Outcome</u> : Landscape-scale prioritizations; increase efficiencies; inform implementation and fire incident response planning

2.1) Industry and biomass utilization. This ERI program area is directed by Dr. Han-Sup Han. These projects are mostly supported by a mix of external grant and state funding. For example, the SWERI Wood Utilization Team, funded through the USDA Woody Biomass Grant, will support efforts to better understand wood certification needs and opportunities, led by the New Mexico institute. The federal work plan will support this broad program area in three key project areas, which include:

- a) Forest Operations Training Center. The training center is supported by external grants; however, the ERI will provide additional support for partnership development and communication, including coordination with state agencies and elected officials, press releases, etc.

Requestor: State and local municipalities

Outcome: Rural economic development that benefits sustainable federal land management needs

Deliverable:

- i. Report on support

- b) Railroad transportation of woody biomass: a follow-up study to identify railroad sidings throughout the southwestern US that could provide access to distant markets for forest restoration byproducts.

Requestor: Multiple stakeholders, including local communities and forest products businesses

Outcome: Expanding markets for wood and biomass and rural economic development

Deliverables:

- i. Peer-reviewed journal article
- ii. Fact sheet

- c) Contracting business survey work in the Southwest to characterize the current capacity of the contracting business industry and assess needs for training for the heavy equipment operators and truck drivers.

Requestor: State and local municipalities

Outcome: Forest operation capacity assessment, to inform job training needs

Deliverables:

- i. White paper
- ii. Fact sheet

2.2) Facilitate the development and integration of new technologies to advance restoration implementation. In FY20, the ERI is adding capacity to the development of a Digital Timber Sale Manager (DTSM) pilot, which is a digital silvicultural walkthrough application, for use within the Four Forest Restoration Initiative (4FRI) project in partnership with The Nature Conservancy and Forest Service, including the Forest Products Modernization Team. In FY21, the ERI will continue convening and facilitating the development of the DTSM pilot, as well as capturing and communicating the lessons learned from the pilot that may serve as a guide for the integration of new technologies in Forest Service implementation processes beyond the 4FRI area.

Requestor: Forest Service Forest Products Modernization Team, The Nature Conservancy

Outcome: Lessons learned from innovative project planning, to inform future implementation processes

Deliverables:

- a) Technical report
- b) Professional presentation, webinar, or workshop

2.3) Understanding the return on investment from restoration treatments. Using multiple ecosystem service valuations, ERI research on treatment effectiveness, and full cost accounting measures of previous wildfires, the ERI will work with an economist to conduct a pilot study of potential avoided wildfire costs through restoration treatments. The project will work to synthesize the costs of wildfire and assess the potential return on investment from restoration treatments to begin to better quantify the economic and non-market benefits of restoration treatments versus the economic impacts of wildfire suppression and mitigation on federal lands.

Requestor: 4FRI Chief Executive and policy makers

Outcome: Economic measures of the potential avoided costs of wildfire to help quantify the return on investment in restoration treatments to inform accomplishment reporting and economic outcomes.

Deliverable:

- a) Report on progress to include: a determination of a pilot project landscape, a synthesis of wildfire costs, ecological information about wildfire effects in areas that burned with and without restoration treatments, and an analysis of potential avoided wildfire costs resulting from restoration treatments.

2.4) Landscape prioritization and strategic implementation. As project planning increases to millions of acres in scale, there is a need for strategic prioritization and planning to implement restoration treatments. By incorporating landscape features and past disturbances that influence landscape fire potential, mechanical and fire treatment implementation can be optimized to efficiently reach desired conditions. There is potential to work across the SWERI, including collaboration with CFRI (PODs and other CFRI work) to address a 4FRI need.

Requestor: Anticipatory

Outcome: Landscape scale prioritizations to increase efficiencies and inform implementation and fire incident response planning.

Deliverable:

- a) Report on progress to include: identification of landscape, data layers needed for strategic prioritization or optimization, and partner roles.

Project 3: Foster and support partnerships. Convene and facilitate discussions that advance restoration knowledge development and application across all lands.

The ERI serves as a boundary organization to advance restoration and resiliency of forest and woodlands in the West. In addition to science translation, developing, facilitating, and supporting partnerships and collaborations advances forest restoration at appropriate scales and across ownership boundaries.

In northern Arizona, our Forest Service and collaborative partners have developed and approved more than a million acres for restoration treatments. In FY21, ERI staff will contribute leadership and technical support to the Four Forest Restoration Initiative (4FRI) Forest Service team and stakeholder group to continue planning efforts on the Rim Country EIS, to better understand and communicate implementation barriers and achievements, and to monitor and assess adaptive management needs from implemented stands.

While the 4FRI collaborative was not selected for CFLRP reauthorization, the ERI continues to work with CFLRP coordinators, USDA Forest Service personnel, and partners to develop a core set of national-level ecological and socio-economic monitoring questions and indicators that will be required for all new projects selected during FY2021 and FY2022. One core component of the CFLRP monitoring strategy relates to monitoring collaborative governance. The Forest Service increasingly relies on collaborative approaches to realize national-level policy goals. Yet, a systematic approach to monitoring and evaluating attributes of collaborative governance and capacity is lacking.

The ERI is pleased to help implement the national focus on Shared Stewardship. In FY21, this includes developing a partnership with the new Arizona Department of Forestry and Fire Management (DFFM) wood products industry developer to expand relationships with the forest products industry in Arizona and conduct strategic planning for biomass utilization. The ERI will also assist in an analysis to identify acres eligible for Good Neighbor Authority agreements in Arizona, and assist DFFM to develop monitoring protocols to evaluate treatments on state lands.

Project 3: Foster and support partnerships	
<i>Fulfills duties under the Act: 2, 3</i>	
Action	Requestor/Anticipatory
3.1) Support and science delivery for the 4FRI collaborative project	<u>Requestor:</u> Forest Service and northern Arizona stakeholders <u>Outcome:</u> Best available science for landscape restoration, monitoring assistance, and effective science collaboration
3.2) Facilitate the development and integration of new technologies to advance restoration implementation	<u>Requestor:</u> Forest Service CFLRP Coordinator Lindsay Buchanan <u>Outcome:</u> A national monitoring indicator for collaborative resiliency
3.3) Support for Shared Stewardship	<u>Requestor:</u> Forest Service, AZ State DFFM, and Flagstaff Fire District <u>Outcome:</u> Increased shared stewardship across Arizona
3.4) SWERI partnership and across-region science delivery	<u>Requestor:</u> Forest Service, all affected entities <u>Outcome:</u> Shared landscape restoration best practices

3.1) Support and science delivery for the 4FRI collaborative project. The ERI has provided leadership, administration, and science support to the 4FRI collaborative project since the 2009 request for proposals. The 4FRI project was not selected for the national CFLRP reauthorization; however, this does not mean the collaborative and Forest Service project is ending.

Requestor: Forest Service and northern Arizona stakeholders

Outcome: Use of best available science for landscape restoration, monitoring assistance, and effective collaborative operations

Deliverables:

- a) Report on leadership activities for 4FRI Stakeholder Group and working groups
- b) Report on administrative support to facilitate effective collaborative operations; and IT support for the 4FRI website and BASECAMP; and administrative support
- c) Technical report on science support to 4FRI implementation of spatial heterogeneity and restoration desired conditions. This project continues work (builds on FY19 and FY20 work plan items) with 4FRI implementation teams to quantify and test metrics of restoration success that can be incorporated by implementors (silviculturists, timber sale administrators, and operators) and be used in 4FRI monitoring. Includes tests of tree group definitions in marking and tablet layout units.

3.2) Socio-economic monitoring and science delivery for the USDA Collaborative Forest Landscape Restoration Program. The ERI will collaborate with CFRI and NMFWR to 1) conduct a systematic review of the ways in which collaborative governance approaches in public lands and resources contexts are monitored and evaluated; and 2) develop and deploy a pilot assessment of collaborative governance to the Northern Blues CFLRP. This project will leverage national collaborative work for direct application to our West-wide audience, thus deepening the SWERI impact.

Requestor: Forest Service CFLRP Coordinator Lindsay Buchanan

Outcome: Capture best practices for effective and inclusive collaborative governance; and develop a monitoring tool for existing and future collaborative efforts on federal lands

Deliverables:

- a) Report or manuscript on systematic review findings
- b) Collaborative governance assessment tool and report on findings

3.3) Support for Shared Stewardship. Support to the Arizona Department of Forestry and Fire Management (DFFM) in implementing the Governor's Healthy Forest Initiative. The ERI will assist in creating greater state capacity to reduce wildfire fuels around our communities, making greater use of partner capacity to reduce wildfire fuels, and increasing partnerships to reduce wildfire risks on federal lands neighboring our communities. In addition, the ERI partners with DFFM Northern District, and local municipal fire stations.

Requestor: Forest Service, AZ State DFFM, and Flagstaff Fire District

Outcome: Increased shared stewardship across Arizona

Deliverable:

- a) Report on support to DFFM

3.4) SWERI partnership and across-region science delivery. The three SWERI institutes are uniquely positioned to synthesize and share science outreach and delivery. Following our Covid year, the SWERI will implement a spring 2022 cross-SWERI workshop to focus on landscape megafires, recent and 20 years post, with climate change. Partners include all SWERI, R3, R2, and state forestry. Cross-SWERI opportunities are also captured in Projects 1 and 2.

Requestor: Forest Service, all affected entities

Outcome: Shared landscape restoration best practices among diverse geographies and collaborative models

Deliverable:

- a) March 2022 SWERI workshop; location TBD

Project 4: Integration and engagement with tribal land restoration

The ERI initiated a Native American Forestry and Range Restoration Program in 2018. During the last two years, the ERI has conducted outreach and conversations to identify needs and opportunities among numerous tribal representatives. A recent example includes the multi-partner effort, Wood for Life (WFL), that developed in the last year to provide firewood to Navajo, Hopi, and San Juan Southern Paiute homes. In FY21, the ERI is proposing to work with the WFL partnership to help identify and articulate fuelwood needs on tribal lands, assess capabilities, facilitate establishing tribal partnerships, and document barriers, opportunities, and lessons learned from the WFL partnerships.

Additional work with tribal partners will focus on Shared Stewardship opportunities that may develop due to new contracting authorities and new initiatives promoting biomass utilization. Work

in FY21 will include a workshop to exchange restoration knowledge among tribal members and with their federal neighbors. Work will also continue to engage tribes in cross-boundary biomass utilization pilots. Other requests include advising the Forest Service on use of newly authorized 638 contracting authorities and request from tribes for technical assistance.

Project 4: Integration and engagement with tribal land restoration	
<i>Fulfills duties under the Act: 2, 3, 4</i>	
Action	Requestor/Anticipatory
4.1) Wood for Life project	<u>Requestor</u> : Navajo and Hopi nations, Forest Service, The Nature Conservancy, and National Forest Foundation <u>Outcome</u> : Support and meet tribal fuelwood needs through restoration biomass utilization
4.2) Tribal Forest Protection Act (TFPA)/638 authorities and biomass utilization pilot projects	<u>Requestor</u> : Forest Service, southwestern tribal nations <u>Outcome</u> : Identify best practices to utilize new cross-boundary authorities
4.3) Engage with tribal partners to identify and exchange existing ecological questions or gaps	<u>Requestor</u> : Anticipatory <u>Outcome</u> : Grow tribal partnerships; exchange restoration needs; address science gaps
4.4) Tribal forestry workforce development	<u>Requestor</u> : Indian Forest Management Assessment Team, Intertribal Timber Council <u>Outcome</u> : Tribal Forestry Student Summit; connect workforce needs with emerging tribal graduates

4.1) Wood for Life project. The ERI will continue to work in partnership with the National Forest Foundation, The Nature Conservancy, the Forest Service, and tribal partners to evaluate needs and assess capabilities to formalize and sustain the Wood for Life program. Wood for Life is a tribal fuelwood program that utilizes biomass produced from restoration projects in the 4FRI and Flagstaff Watershed Protection Project footprints. The ERI will support Wood for Life capacity needs (e.g., grant proposals, communication briefs, after action reviews, etc.) to increase sustainability of the project, as well as help to review and evaluate existing program efforts to inform learning and future processes.

Requestor: Navajo and Hopi nations, Forest Service, The Nature Conservancy, and National Forest Foundation

Outcome: Utilization of restoration biomass to support and meet tribal societal fuelwood needs

Deliverables:

- a) Report on progress
- b) Two (2) presentations to and with partners on Wood for Life

4.2) Tribal Forest Protection Act (TFPA)/638 authorities and biomass utilization pilot projects.

The ERI will assist tribal partners in scoping biomass utilization opportunities.

Requestor: Forest Service, southwestern tribal nations

Outcome: Best practices to utilize cross-boundary opportunities with newer authorities

Deliverable:

- a) Report on progress

4.3) Engage with tribal partners to identify and exchange existing ecological questions or gaps.

The ERI has initiated partnerships with the San Carlos Apache and Hualapai tribal nations and will expand those partnerships to exchange restoration information and develop a science needs assessment.

Requestor: Anticipatory

Outcome: Develop and grow tribal partners to exchange restoration science needs, through an assessment with tribal nation partners

Deliverable:

- a) Needs assessment of restoration science partnership opportunities

4.4) Tribal forestry workforce development. The ERI is working with national partners to address tribal forestry workforce capacity needs and development opportunities. Action is needed to implement the recommendations of the Indian Forest Management Assessment Team III Workforce Development Strategic Plan. The ERI is the primary organizer for a Tribal Forestry Student Summit to be hosted on the NAU campus. This summit was postponed to a date in 2022. Planning for the event will continue through 2021.

Requestor: Indian Forest Management Assessment Team, Intertribal Timber Council

Outcome: A Tribal Forestry Student Summit to connect workforce needs with emerging tribal graduates

Deliverable:

- a) Report on the 2021 Tribal Student Summit (may be delayed until safe for large, in-person conferences)

Project 5: Science and policy application and interpretation

The ERI mission is to serve diverse audiences with objective science and implementation strategies; this is our strength, and delivering actionable science is a component of every project we design. Activities in Project 5 capture our work to specifically bridge knowledge development to knowledge in practice. In FY21 we will: partner and support federal land managers through Rapid Assessments (RAPs), workshops, and field trips (Project 5.1). For this work plan, we include a focused project and deliverable on our R3 climate adaptation project with the R3 climate coordinator and ecologist (Project 5.2). This effort integrates R3 direction with the USDA climate resources available to provide adaptation strategies to forests in an easy to access, defensible product.

With the addition of our forest operations and biomass program and our tribal program, there is an increased need to translate and transfer best available science information to industry and forestry practitioners. An effective way to address a current management or policy issue is through our working papers, white papers, and fact sheets. These publications synthesize research to provide clear, concise explanations of biophysical (working papers) or socio-economic (white papers)

restoration topics. Management and policy implications are outlined so that practitioners or elected officials can make quick, informed decisions. Our commitment to putting knowledge into the hands of all affected entities is one of the unique services provided by the ERI and what distinguishes us from traditional academia.

Project 5: Science and policy application and interpretation	
<i>Fulfills duties under the Act: 3, 4</i>	
Action	Requestor/Anticipatory
5.1) Provide support to federal land managers with field trips, technical assistance, rapid assessments, learning workshops, and presentations	<u>Requestor:</u> Forest Service leadership, specialists, fire professions, boundary organizations <u>Outcome:</u> Advance and share landscape restoration best practices; transfer of best available science
5.2) Climate Adaptation Strategy in the Southwestern Region	<u>Requestor:</u> Forest Service Region 3 Climate Coordination, Ecologist <u>Outcome:</u> Practical climate adaptation strategies for Forest Service practitioners
5.3) Translate and summarize scientific and journal articles for land managers and affected entities	<u>Requestor:</u> Land managers, stakeholders, Southwest Fire Science Consortium, federal agency ID teams, decision and policy makers <u>Outcome:</u> Science synthesis briefs; best available science to practitioners

5.1) Provide support to federal land managers with field trips, technical assistance, rapid assessments, learning workshops, and presentations. The ERI works closely with Forest Service partners at the district, forest, and regional scales to assess science needs and meet science questions with summaries of existing science. To reach broader audiences, we partner with other boundary organizations to utilize West-wide webinar and workshop venues for science dissemination. We also facilitate field discussions among Forest Service and other affected entities.

Requestor: Forest Service leadership, specialists, fire professions, boundary organizations

Outcome: Advance and share landscape restoration best practices through Rapid Assessments of landscape conditions, workshops, field trips, transfer of best available science among diverse geographies and collaborative models

Deliverables:

- a) Up to two (2) Rapid Assessments (RAPs) to provide localized or regional data summaries. (Santa Fe, pushed from Covid year)
 - i. San Juan Canyon, Santa Fe NF final report
 - ii. TBD in response to requests
- b) Up to two (2) workshops to meet science exchange or delivery needs within or among national forests and partners
- c) Up to two (2) field trips to meet science exchange or delivery needs within or among national forests and partners

- d) Two (2) webinars in partnership with science-to-manager series, including the Southwest Fire Science Consortium, Rocky Mountain Research Station Science Delivery, or National Forest Foundation.

5.2) Climate Adaptation Strategy in the Southwestern Region. The ERI with Region 3 and federal research partners will utilize projects from FY20 climate adaptation workshops and focal groups to develop a web-based and hard-copy technical guide to climate adaptation strategies.

Requestor: Forest Service Region 3 Climate Coordination, Ecologist

Outcome: Development and communication of practical climate adaptation strategies for Forest Service practitioners

Deliverables:

- a) Two to four (2-4) focus groups to inform R3 climate adaptation strategy
- b) Draft framework and outline for a Climate Adaptation technical guide
- c) Draft Climate Adaptation communication plan for education webinar/workshop series

5.3) Translate and summarize scientific and journal articles for land managers and affected entities. The ERI develops white papers that address socio-economic policy issues and working papers that summarize science application for land managers. Fact sheets are two-page, brief summaries of peer-reviewed science and Topics in Restoration and Resiliency papers explore a broad restoration topic, like what fire scars tell us about the past and what to expect after restoration, written for a general audience.

Requestor: Land managers, stakeholders, Southwest Fire Science Consortium, federal agency ID teams, decision and policy makers

Outcome: Science synthesis briefs for busy practitioners and policy-makers

Deliverables:

- a) Three (3) White and/or Working papers, potential topics to include:
 - i. White Paper: Analysis of the cost of restoration thinning treatments. How much do treatments cost? What is typical? What are the main drivers?
 - ii. Working Paper: Evidence for widespread changes in structure, composition, and fire regimes of western North American forests (synthesis paper of Haggmann et al. (2021) journal article)
 - iii. Working Paper: Adapting western US forests to wildfires and climate change: Ten misconceptions (synthesis paper of Prichard et al. (2021) journal article)
- b) Six to eight (6–8) Fact Sheets and/or Topics in Restoration and Resiliency papers

PROJECT 6: Communication and outreach. Media, community outreach, and information requests.

The ERI is a recognized expert in the restoration of fire-adapted forests across the western US. Our authorizing legislation details the importance of effectively translating and communicating evidence-based findings to a diverse audience. The ERI recently increased our web delivery capacity with a revised, modern website and a powerful, searchable e-library. We also maintain websites for our collaborative partners (4FRI) and SWERI. In our rapidly changing times and need for real-time communication, our information sharing has expanded into social media outlets like Twitter and

Facebook. Through these mediums, the ERI continues to explore and advance innovative communication methods with our growing number of followers. These services have become more needed in the year of Covid-19; this year, we will introduce and test two new online delivery methods of best available science (Project 6.1).

The ERI also serves as an expert for print, radio, internet, and broadcast media. Often, the level of requests to the ERI depend on the local, regional, and national level of discourse on subjects including wildfire, climate change, and landscape sustainability. On average, ERI staff receive approximately 20–30 media requests a year. Our outreach efforts are multi-faceted, with media coverage on the science that informs these critical issues being an important communication piece for shaping the public discourse on wildfire and forest health (Project 6.3).

For more than 20 years, the ERI has served as an objective resource for our land management partners, government agencies, non-government organizations, and our community. Staff from all ERI program areas receive regular requests for information, technical support, and knowledge resources. In FY21, we expect to continue to increase our responses to these requests. In the past five years, we have exceeded information request goals, and as a result we plan to provide at least 40 information request services to all affected entities throughout the fiscal year (Project 6.4).

Project 6 and its deliverables capture the unique services that ERI provides. This suite of outreach and communication services is what distinguishes us from conventional academic units.

Project 6: Communication and outreach	
<i>Fulfills duties under the Act: 3</i>	
Action	Requestor/Anticipatory
6.1) Social media and innovative science delivery	<u>Requestor:</u> Anticipatory <u>Outcome:</u> Broaden, grow audience reach using innovative, interactive tools
6.2) Provide website support for the ERI, SWERI, and 4FRI to best meet deliverables	<u>Requestor:</u> All affected entities, 4FRI Stakeholder Group, SWERI <u>Outcome:</u> Science updates and information repository
6.3) Media outreach and engagement	<u>Requestor:</u> All affected entities <u>Outcome:</u> Science synthesis briefs
6.4) Science support, knowledge resource services to federal and non-federal entities	<u>Requestor:</u> Land managers, state forestry agencies, local government, elected officials, and community organizations <u>Outcome:</u> Knowledge to inform action; raise awareness, support for restoration
6.5) Report on FY21 Work Plan activities to SWERI Program Manager	<u>Requestor:</u> SWERI Program Manager <u>Outcome:</u> Final Report

6.1) Social media and innovative science delivery. In FY21, the ERI will develop and test a social media campaign on Twitter/Facebook to increase engagement with our online audience/followers. The goal will be to increase traffic to our website resources, online publications. Additionally, the ERI will expand web delivery to include video media. We will develop a short video on a restoration topic or research area and post it to the website and on social media.

Requestor: Anticipatory

Outcome: Increase audience reach with innovative and interactive social media tools

Deliverables:

- a) Media campaign link and Google analytic summaries
- b) Video on website and Google analytic summaries

6.2) Provide website support for the ERI, SWERI, and 4FRI to best meet deliverables

Requestor: All affected entities, 4FRI Stakeholder Group, SWERI

Outcome: Science updates and information repository for all affected entities

Deliverables:

- a) Report on actions. Includes website analytic reports on each website's user site visits and engagement metrics.

6.3) Media outreach and engagement. Support the education of the general public through media outreach.

Requestor: All affected entities

Outcome: Science synthesis briefs for busy practitioners and policy-makers

Deliverables:

- a) Ten (10) media interviews
- b) Ten (10) media articles

6.4) Science support, knowledge resource services to federal and non-federal entities. These activities include filling information requests, technical assistance, field trips, and presentations.

Requestor: Land managers, state forestry agencies, local government, elected officials, and community organizations

Outcome: Knowledge to inform action; raise awareness and support for restoration

Deliverables:

- a) A minimum of 40 services or activities

6.5) Report on FY21 Work Plan activities to SWERI Program Manager

Deliverable:

- a) FY21 Final Report

FY21 Budget

Project	1	2	3	4	5	6	
Description	Restoration and Climate Adaptation Knowledge Development and Transfer	Apply ERI expertise to Restoration Implementation at Appropriate Scales	Foster and Support Partnerships	Integration and Engagement with Tribal Land Restoration	Science and Policy Application and Interpretation	Communication and Outreach	Total
Personnel:	\$ 662,993	\$ 161,066	\$ 157,139	\$ 202,987	\$ 198,029	\$ 229,102	\$ 1,611,316
Outside Services:	\$ 47,000	\$ 41,000	\$ 15,000	\$ -	\$ -	\$ -	\$ 103,000
Travel:	\$ 23,708	\$ 3,165	\$ 13,041	\$ 7,030	\$ 13,946	\$ 4,420	\$ 65,310
Operations & Supplies:	\$ 15,844	\$ 3,272	\$ 5,638	\$ 1,624	\$ 9,530	\$ 2,647	\$ 38,555
Total Direct Costs:	\$ 749,545	\$ 208,503	\$ 190,818	\$ 211,641	\$ 221,505	\$ 236,169	\$ 1,818,181
Indirects:	\$ 74,955	\$ 20,850	\$ 19,082	\$ 21,164	\$ 22,151	\$ 23,617	\$ 181,819
Total Project Costs:	\$ 824,500	\$ 229,353	\$ 209,900	\$ 232,805	\$ 243,656	\$ 259,786	\$ 2,000,000