COLORADO FOREST RESTORATION INSTITUTE 2021 ANNUAL REPORT

COLORADO FOREST
RESTORATION INSTITUTE
COLORADO STATE UNIVERSITY

The Colorado Forest Restoration Institute (CFRI) was established in 2005 as an application-oriented, science-based outreach and engagement organization hosted at Colorado State University. Along with centers at Northern Arizona University and New Mexico Highlands University, CFRI is one of three Institutes that make up the Southwest Ecological Restoration Institutes, which were authorized by Congress through the Southwest Forest Health and Wildfire Prevention Act of 2004. We develop, synthesize, and apply locally-relevant, actionable knowledge to inform forest management strategies and achieve wildfire hazard reduction goals in Colorado and the Interior West. We rigorously and objectively integrate the best-available scientific information into decision-making through collaborative partnerships involving researchers, land managers, policy makers, interested and affected stakeholders, and communities. CFRI holds itself to high standards of scientific accuracy and aims to promote transparency in the production and communication of science-based information. Always carefully evaluate sources for appropriateness and rigor before applying in your own work.

CSU Land Acknowledgment: Colorado State University acknowledges, with respect, that the land we are on today is the traditional and ancestral homelands of the Arapaho, Cheyenne, and Ute Nations and peoples. This was also a site of trade, gathering, and healing for numerous other Native tribes. We recognize the Indigenous peoples as original stewards of this land and all the relatives within it. As these words of acknowledgment are spoken and heard, the ties Nations have to their traditional homelands are renewed and reaffirmed. CSU is founded as a land-grant institution, and we accept that our mission must encompass access to education and inclusion. And, significantly, that our founding came at a dire cost to Native Nations and peoples whose land this University was built upon. This acknowledgment is the education and inclusion we must practice in recognizing our institutional history, responsibility, and commitment.

Document Development: The annual report is produced each year in accordance with the fifth (5) duty of the the 2004 Southwest Forest Health and Wildfire Prevention Act (Public Law 108-317). This annual report provides information about accomplishments of the Colorado Forest Restoration Institute at Colorado State University for calendar year 2021 for deliverables approved by the Southwest Ecological Restoration Institutes Executive Team and funded under the Act. Information in this report was compiled by Brett Wolk, Tony Cheng, and Camille Stevens-Rumann. Hannah Brown completed document layout and publishing.

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Authors: Brett Wolk[1],Tony Cheng[1], and Camille Stevens-Rumann[1]

1. Colorado Forest Restoration Institute, Department of Forest and Rangeland Stewardship, Colorado State University, Fort Collins, CO

Cover photo credit: Kat Morici

BACKGROUND

The Colorado Forest Restoration Institute (CFRI) at Colorado State University (CSU) strives to address complex forest and fire management values to enhance resilience of increasingly vulnerable forested landscapes and communities. CFRI projects support the development of frameworks to assist communities, managers, and policy makers as they work to increase forest resiliency by combining strategies from ecological restoration and wildfire risk reduction. We also support adaptive management processes by monitoring outcomes of forest treatment and communicating results to stakeholders. The goal is to support fires that can serve their natural role in renewing forests while mitigating social and economic losses and costs. Forest managers, users, and other affected stakeholders must be able to access and apply locally relevant science-based knowledge to communicate and strategically identify where and what kinds of restoration and wildfire risk reduction can provide the most bang for the buck. Federal and university researchers produce scientific information about forest and fire ecology, but their mission is rarely to engage with managers and stakeholders to integrate these findings into local collaborative work, project planning, analyses, design, and monitoring or adapting future plans. Conversely, managers and stakeholders rarely have sufficient time and expertise to access, interpret, and localize scientific findings to inform effective forest restoration. Managers and stakeholders face complex tradeoffs and management decisions as they work towards a future forest that will align with desired conditions and continue to provide ecosystem services. Entities like CFRI that are specifically directed to act as bridges and translators between research and management are crucial, as they can operationalize science to be useful in action.

To address the need for boundary-spanning organizations, the Southwest Forest Health and Wildfire Prevention Act was enacted by Congress in 2004 (Public Law 108-317). The act authorized the establishment and federal funding support for university-based institutes, which have been established in Arizona, Colorado, and New Mexico. As specified by the Act, the duties of each Institute are to:

> (1) Develop, conduct research on, transfer, promote, and monitor restoration-based hazardous fuel reduction treatments to reduce the risk of severe wildfires and improve the health of dry forest and woodland ecosystems in the interior West;
> (2) Synthesize and adapt scientific findings from conventional research to implement restoration-based hazardous fuel reduction treatments on a landscape scale using an adaptive ecosystem management framework;
> (3) Translate for and transfer to affected entities any scientific and interdisciplinary knowledge about restoration-based hazardous fuel reduction treatments;
> (4) Assist affected entities with the design of adaptive management approaches (including monitoring) for the implementation of restoration-based hazardous fuel reduction treatments; and
> (5) Provide peer-reviewed annual reports.

Per the fifth (5) duty of the act, this annual report provides information about accomplishments of the Colorado Forest Restoration Institute (CFRI) at Colorado State University for calendar year 2021 for deliverables approved by the Southwest Ecological Restoration Institutes (SWERI) Executive Team and funded under the Act. In 2021, CFRI had three active agreements under the Act. Deliverable accomplishments for each are included in this report:

- FY19 CFRI annual work plan, active 7/1/2019 through 9/30/2021.
- FY20 CFRI annual work plan, active 7/1/2020 through 9/30/2022.
- FY21 CFRI annual work plan, active 7/1/2021 through 12/31/2021

ORGANIZATION

CFRI is hosted in the Department of Forest and Rangeland Stewardship, one of five academic departments in the Warner College of Natural Resources at Colorado State University. Tony Cheng is Professor in the Forest and Rangeland Stewardship department and serves as the director of CFRI. Dr. Cheng has been director since April 2008. In calendar year 2021, CFRI had twenty-two full-time employees (including Dr. Cheng) and approximately twenty-seven part-time or seasonal employees. Our staffing increased by 8 full-time employees over the last year. Our seasonal and part time employees included undergraduate students, graduate students, and non-student staff. All CFRI employees report to Dr. Cheng. In turn, Dr. Cheng reports to the head of the Forest and Rangeland Stewardship department. Heads of all departments in the Warner College report to the college's Dean. In addition to staff who hold their primary appointment with CFRI, we leverage other CSU faculty, staff, and graduate students to add their specialized expertise for our projects on an as needed basis.

ACCOMPLISHMENTS

Funding

CFRI funding comes from allocated dollars through the SWERI-approved work plan, agreements with federal and state government and nongovernmental sources, competitive research grants, and charitable gifts. SWERI workplan funding is used to incubate and support innovative new ideas, to augment existing CFRI agreements and projects where significant value can be added, and to support knowledge transfer and application between projects and partners. Significant increase in SWERI federal appropriations for 2021 allowed the three Institutes to achieve funding equity for the first time, empowered us to be responsive to an emerging wildfire crisis, and expanded our impact across the region. We create a bridge between research and management, multiplying the impact of applied research and leveraging deep engagement in place-based local monitoring and adaptive management processes to share cumulative broader impacts throughout the Intermountain West. Many of our agreements span multiple years. As a snapshot of our funding, the table below includes all funding sources and agreements signed during calendar year 2021 with CFRI staff as the Principle Investigator. CFRI staff leverage additional funding by participating as co-Principle Investigators and collaborators in additional projects not listed here, which further expands our funding and impact.

Source	Project Title	Agreement Number	Amount
USDA Forest Service - Rocky Mountain Region	Developing and Applying Outcome Based Measures With U.S. Forest Service Region 2 Watershed Partnerships	21-CS-11020000-002	$180,000
US Forest Service, Grand Mesa-Uncompahgre-Gunnison National Forests	Science-Based Support to Inform Collaborative Adaptive Management on the GMUG, MOD 1	20-CS-11020400-035	$41,000
USDA Forest Service - Rocky Mountain Region	Regional PODs strategery, MOD 1	20-CS-11020000-025	$100,000
US Forest Service, Southwest Region	Colorado Forest Restoration Institute, FY21	21-DG-11030000-018	$2,000,000
US Forest Service, Grand Mesa-Uncompahgre-Gunnison NF	Monitoring Ecological, Social, and Economic Effects of the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project, MOD 4	17-CS-11020400-023	$12,500
US Forest Service, Rocky Mountain Research Station	Restoring resiliency in coniferous forests of the western united states (MOD 1)	19-JV-11221633-198	$20,000
The Nature Conservancy, Fire Learning Network	Fire Planning and Capacity Building Support		$25,000
US Forest Service, Rocky Mountain Research Station	Restoring resiliency in coniferous forests of the western united states (MOD 2)	19-JV-11221633-198	$35,000
		TOTAL	$2,413,500

In the past five years, CFRI has been successful at leveraging SWERI annual work plan funding to procure additional funds for support of project development, planning, monitoring, and adaptive management on federal (primarily National Forest Systems lands) and non-federal lands. The table below shows these amounts as evidence of the value added by CFRI to the federal SWERI annual workplan funding:

Year	Work Plan Funding ($thousands)	Additional funded projects (federal, state, non-gov't) ($thousands)	State funding ($thousands)
2017	150	981	423
2018	450	698	512
2019	750	890	595
2020	1,100	1,036	672
2021	2,000	414	1,051
TOTAL	4,450	4,019	3,253

State Support

The State of Colorado, through its support to Colorado State University, provides financial support for CFRI facilities and administration in the form of reduced indirect cost recovery on CFRI federal awards, as well as 9 months of faculty salary to Tony Cheng to serve as Director of CFRI, and 2.75 months of faculty salary to Camille Stevens-Rumann to serve as Assistant Director of CFRI. In 2021, this support totaled approximately $1,051,265.

Project deliverables

Following is a report on deliverables under three agreements active during calendar year 2021 that were authorized through the Southwest Ecological Restoration Institutes (SWERI) development and executive team workplan approval process for the Colorado Forest Restoration Institute to carry out the duties described in the Act:

For FY19 agreement number 19-DG-11031600-062, CFRI reports the following cumulative accomplishments toward each project deliverables in the work plan for dates while the agreement was active, including July 1st, 2019 through September 30th, 2021:

Deliverable	Status of Deliverables
Project 1. Supporting strategic prioritization, monitoring, and adaptive management of cross boundary wildfire risk co-management strategies to operationalize the Shared Stewardship approach.	
1.1) Document and report on 2-4 successful examples of science based Shared Stewardship implementation in forests of the intermountain West.	CFRI staff Mike Caggiano and Ben Gannon helped develop content, provided data, as well as provided feedback on overall directions for a storymap produced in partnership with the RMRS Wildfire Risk Management Science Team, titled: *Strategic, Cross-Boundary Wildfire Response Planning Enhancing preparedness, communication, and safety.* https://arcg.is/04nPGb

CFRI personnel Tony Cheng and Brett Wolk co-authored study on social understanding and support for cross-boundary forest wildfire risk reduction: Roberts, R., K.W. Jones, E. Duke, X. Shinbrot, E.E. Harper, E. Fons, A.S. Cheng, and B.H. Wolk. 2019. Stakeholder perceptions and scientific evidence linking wildfire mitigations to societal outcomes. *Journal of Environmental Management* 248:109286 (online). https://doi.org/10.1016/j.jenvman.2019.109286

CFRI Director Tony Cheng co-authored case study of cross-boundary forest watershed governance: Huber-Stearns, H.R., C.A. Schultz, and A.S. Cheng. 2019. A multiple streams analysis of institutional innovation in forest watershed governance. *Review of Policy Research* 36(6):781-804. DOI: 10.1111/ropr.12359 |

1.2) Assist in the identification and facilitation of partnership engagement in a Colorado all-lands wildfire risk assessment process led by USFS Region 2. This includes working with targeted partners to identify the High Values, Resources, and Assets (HVRA's) that will help frame the risk assessment outputs.	On December 5, 2019, CFRI staff (Cheng, Wolk, Caggiano, Gannon, Beeton) organized and hosted a Colorado All-lands Risk Assessment meeting with USFS Region 2 fire staff Brian Keating and Sarah Synowiec, USFS Washington Office staff Jim Menakis and Rick Stratton, Pyrologics, and Colorado State Forest Service Jeff Underhill, Kristin Garrison, and Amanda Fordham. The goals of the meeting were to: 1) Discuss and develop a strategy for the partnership engagement aspect of the HVRA component of the risk assessment process; and 2) Discuss the role of CFRI to serve as a "non-agency" partner who can help all agencies both identify and engage with the appropriate level of partnership involvement we need to be successful. CFRI staff Mike Caggiano has led continued engagement with USFS Rocky Mountain Region fire planning staff to develop risk assessment processes and frameworks. This has resulted in co-development of a regional fire management strategy and process for deploying risk assessments and Potential Operational Delineations (PODs) to all national forests and adjacent landscapes across all states in Region 2.
1.3) Advise the Colorado State Forest Service with applying and interpreting prioritization tools to inform their Statewide Forest Action Plan revision.	In spring of 2020, multiple CFRI staff reviewed a Forest Action Plan draft and provided written and oral feedback to improve the final plan. At the request of CSFS leadership and in coordination with CSU Department of Forest and Rangeland Stewardship, CFRI co-developed and co-lead a 3 part virtual workshop for all CSFS staff November 12th, 13th, and 19th, 2020. The goal of the workshops were to introduce CSFS staff to the new FAP planning framework, and facilitate their ability to interpret and apply the FAP within various job duties across the agency. The workshop included breakout groups that involved over 14 CFRI staff serving as facilitators and note takers to empower CSFS staff to use the FAP framework in their project and activity planning. CFRI developed and conducted a post-workshop survey to assess continued training and resource needs for CSFS staff and their partners to successfully implement the FAP, and has developed a working group with CSFS and FRS staff to coordinate follow up activities in 2021. A summary of the process and CFRI engagement is found here: https://warnercnr.source.colostate.edu/newly-published-csfs-forest-action-plan-takes-immediate-action/
1.4) Working with RMRS, support development, implementation, and integration of cross boundary landscape planning and prioritization tools	CFRI supported the development, implementation, and integration of spatial fire management strategies in close partnership with the RMRS Wildfire Risk Management Science Team, and coordinated with USFS Region II fire staff and the USFS Washington Office on strategies for POD workshop facilitation and implementation. Many of these efforts were co-developed and co-funded with RMRS partners. CFRI Staff facilitated the initiation and/or continued development and application of PODs across several landscapes:

in 2-4 new landscapes, with a focus on linking spatial fire planning (PODS) with prioritization of forest and fuels management objectives (e.g. RADS, RESTSIM, etc.) across multiple scales of planning and implementation.	- Carson and Santa Fe National Forests in New Mexico and adjacent non-USFS landscapes. - Medicine Bow-Routt National Forest in Colorado and Wyoming and adjacent non-USFS landscapes. - Rio Grande National Forest in Colorado and adjacent non-USFS landscapes. - San Juan National Forest in Colorado and adjacent non-USFS landscapes. In response to the large wildfires across Colorado in 2020, CFRI staff Ben Gannon provided custom risk modeling for the USFS RMRS Risk Management Assistance team assigned to Cameron Peak and Williams Fork fires in Aug/Sept 2020 via Dale Deiter and Rick Stratton. In partnership and co-funded with RMRS and CSU colleagues, we published applied research papers supporting the development of cross boundary landscape planning tools and new research linking fire management strategies with integrated natural resource planning methods: Gannon, BM, Thompson, MP, Deming, KZ, Bayham, J, Wei, Y, O'Connor, CD (2020). A Geospatial Framework to Assess Fireline Effectiveness for Large Wildfires in the Western USA. Fire 3, 43. https://www.mdpi.com/2571-6255/3/3/43 Gannon, BM, Wei, Y, & Thompson, MP (2020). Mitigating Source Water Risks with Improved Wildfire Containment. Fire 3 (3), 45. doi.org/10.3390/fire3030045 https://www.mdpi.com/2571-6255/3/3/45 Kampf, Stephanie K, Gannon, Benjamin M, Wilson, C, Saavedra, F, Miller, ME, Heldmyer, A, Livneh, B, Nelson, P, MacDonald, L. PEMIP: Post-fire erosion model inter-comparison project. Journal of Environmental Management 268. https://doi.org/10.1016/j.jenvman.2020.110704
1.5) Complete 2 written summaries documenting case study examples describing the application of prioritization methodologies, approaches, and planning processes being used to enhance co-management of fire risk. Focus on lessons	Completed CFRI publication summarizing process and lessons learned collaboratively integrating multiple prioritization models in a single landscape: Caggiano, MD (2019). Northern Colorado Fireshed Model Prioritization and Project Planning Workshop. CFRI-1915. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/03/Caggiano_NoCo_Fireshed_Model_Comparison_Report.3.11.20.pdf In Progress, CFRI staff have conducted follow up interviews with participants and are writing up case study and lessons learned from CFRI's engagement leading risk assessment and prioritization process with Envision Chaffee County collaborative group. The writeup has been delayed due to complications with the COVID-19 Pandemic. CFRI staff contributed to a summary of outcomes from the planning process,

learned that provide guidance for diverse stakeholders to assess what risk assessment and prioritization tools are appropriate for different planning and evaluation purposes. The case studies will be coordinated with ERI to augment their West-wide inventory to determine if and how these tools are being used more broadly to inform restoration and all-lands management planning and implementation.	available on the Envision Chaffee County website: https://mk0envisionchafrnvlf.kinstacdn.com/wp-content/uploads/2020/04/SummaryBooklet.for-Email-copy.pdf
1.6) Deliver 2-4 presentations, meetings, peer to peer learning events, etc. to report on the range of methodologies, approaches, and planning processes being used to enhance co-management of wildfire risk in the western US to Forest, Regional, and Washington Office units, water providers, watershed coalitions, forest collaboratives, or other affected entities.	September 25th, 2019, CFRI staff Brett Wolk, Ben Gannon, and Andrew Slack met with Jefferson County Open Space staff in Golden, Colorado, to discuss landscape planning and prioritization tools, and collaborative processes for implementing them. (Contact: Drew Rayburn). December 11th, 2019, CFRI staff Brett Wolk, Tony Cheng, and Kat Morici met with Colorado Department of Natural Resources assistant director Tim Mauck, and staff Amy Moyer and Angela Boag to discuss fuel treatment effectiveness and operationalizing a Shared Stewardship strategy with the state of Colorado. December 17th, 2019, CFRI staff Mike Caggiano delivered a presentation and discussion at the New Mexico Collaborative Forest Restoration Program annual meeting sharing lessons learned from his work on cross-boundary burning efforts. Over 100 diverse stakeholders were in attendance. Presentation titled: "Supporting cooperative burning in New Mexico: The Collaborative Forest Restoration Program". CFRI staff Mike Caggiano has participated in development of New Mexico Shared Stewardship planning efforts and advised New Mexico state forestry about approaches for integrating PODs into fire management plans and the New Mexico shared stewardship agreement.

	CFRI staff Mike Caggiano delivered a presentation on WUI home loss & PODs on June 12, 2020, at the virtual monthly meeting of the West Region Wildfire Council speaker series to an audience of 25+ people.
1.7) Produce 3-5 training resources (technical briefs, blog posts, videos, etc.) to facilitate the broader application of analytical tools and collaborative planning processes that support strategic investments in cross boundary forest and fire management.	Caggiano, MD, Brown H (2020). Using PODs on Your Forest. CFRI-2005. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/10/Using-PODs-on-Your-Forest.pdf Caggiano, MD, O'Connor, CD, & Sack, RB (2020). Potential Operational Delineations and Northern New Mexico's 2019 Fire Season. CFRI-2002. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/02/Caggiano_PODs-New-Mexico-Case-Study-2.14.20.pdf Published science brief: Brown, H. We need to Reintroduce Fire in Fire Adapted Ecosystems. CFRI-SB-1903. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/01/Reintroducing-fire-in-fire-adapted-ecosystems.pdf With additional funding from the Rocky Mountain Research Station through 16-JV-11221631-139, co-developed and co-published Connected Science brief: *When the Fire Starts: A Science-Based Framework for Risk-Based Incident Response.* https://www.fs.usda.gov/rmrs/documents-and-media/when-fire-starts-science-based-framework-risk-based-incident-response
Project 2. Supporting knowledge transfer of monitoring, adaptive management strategies, and outcomes for collaborative forest landscape restoration and resilience	
2.1) Produce and disseminate between 1-3 technical documents regarding multi-party monitoring strategies and results for the Front Range Collaborative Forest	Completed publication and distributed printed copies to stakeholders describing monitoring and implementation strategies for mulching in Colorado Front Range: Wolk, BH, Stevens-Rumann, CS, Battaglia, MA, Wennogle, C, Dennis, C, Feinstein, JA, Garrison, K, and Edwards, G (2020). Mulching: A knowledge summary and guidelines for best practices on Colorado's Front Range. CFRI-2001. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/02/FRRT-Mulching-Knowledge-Summary-and-Implementation-Guidelines-1.16.20.pdf. CFRI staff Brett Wolk lead a discussion of the findings at the February 2020 Front

Landscape Restoration Project.	Range Roundtable meeting and disseminated printed copies of the report to meeting attendees.
2.2) Produce and disseminate 1-3 technical documents regarding multi-party monitoring strategies and results for the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project.	Completed report: 2019 Uncompahgre Plateau Collaborative Forest Landscape Restoration Project: Forestry Internship Program (FIP) Progress Summary. https://cfri.colostate.edu/wp-content/uploads/sites/22/2019/10/FIP-Progress-Summary.pdf
2.3) Conduct and report on at least one field-based workshop per Colorado CFLR project (2) to review and deliberate treatment effects and desired conditions.	Field based workshops did not occur during 2020 due to the COVID-19 Pandemic. Additional effort was put towards enhancing the Front Range CFLRP Monitoring JAM Session with recorded videos of monitoring data for collaborative members to view at their convenience.
2.4) Convene stakeholders, compile and analyze monitoring data, and support reporting for 10 year accomplishments with Front Range and Uncompahgre Plateau CFLR projects.	Uncompahgre Plateau CFLR: CFRI staff have cleaned data for analysis, and are in communication with GMUG CFLRP coordinator Todd Gardner. CFRI attempted to convene stakeholders, but have determined along with Todd Gardner that there is little interest amongst stakeholders to have annual meeting and participate in reporting. Front Range CFLR: Continue coordinating with Jim Gerleman and Kevin McLaughlin (Front Range CFLRP coordinators) to organize data and contribute to reporting as needed. In lieu of 10 year reporting, effort of multiple CFRI staff was put towards co-leading the convening of stakeholders, data analysis, and writing of an application for the new round of CFLRP funding. The application was selected for 3rd tier funding status.
2.5) In collaboration with the other SWERI institutes, convene a workshop with land managers, researchers, and their stakeholders to develop strategies that facilitate the application of lessons learned from collaborative forest	The workshop was held March 2-4th, 2020 in Albuquerque, New Mexico, and attended by more than 150 land management representatives from 55 federal and state agencies, non-profits, environmental groups, universities, and community collaboratives. Participants discussed lessons learned, shared success stories, learned about science-based tools, and networked over three days in Albuquerque. CFRI co-lead the workshop planning, organizing, facilitation, and post workshop wrap-up with the other SWERI institutes, National Forest Foundation, and Forest Stewards Guild staff. Workshop website: https://sweri.eri.nau.edu/cross-boundary-workshop-wrap-up/

landscape management planning, implementation, monitoring, and adaptive management in the intermountain west and southwest.	Workshop outcomes and summary document: Southwest Ecological Restoration Institutes (SWERI) (2020). 2020 Cross-Boundary Restoration Workshop Summary: Advancing all-lands restoration in New Mexico, Arizona, Colorado, and surrounding states. ERI Workshop Report. https://cdm17192.contentdm.oclc.org/digital/collection/p17192coll1/id/1066/rec/4
2.6) Working with the Rocky Mountain Research Station, document, produce, and disseminate 1-3 applied scientific publications that leverage data and adaptive management process from collaborative forest landscape management projects.	In Collaboration with local and national Natural Resource Conservation Service (NRCS) staff, published paper that leveraged concepts and monitoring data from Front Range collaborative adaptive management processes: Cannon, JB, Gannon, BM, Feinstein, JA, Padley, EA, Metz, LJ (2020). Simulating spatial complexity in dry conifer forest restoration: implications for conservation prioritization and scenario evaluation. Landscape Ecology 35, 2301–2319 (2020). https://doi.org/10.1007/s10980-020-01111-8

Leveraged data from the state of Colorado Wildfire Risk Reduction Grant program and published paper: Cheng, AS & Dale, L (2020). Achieving Adaptive Governance of Forest Wildfire Risk Using Competitive Grants: Insights From the Colorado Wildfire Risk Reduction Grant Program. Review of Policy Research. https://doi.org/10.1111/ropr.12379 https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/08/ropr.12379.pdf |
| 2.7) Convene and report on between 3-5 webinars or peer to peer learning events documenting and distributing monitoring methods, results, and adaptive management processes to multi-stakeholder forest landscape management initiatives focused on forest health, wildfire risk mitigation, or watershed protection. | November 21, 2019, CFRI staff Brett Wolk and Tyler Beeton presented lessons learned and best practices for collaborative forest landscape restoration on the USDA Forest Service CFLR all hands webinar.

April 15th, 2020, CFRI staff Tyler Beeton and Tony Cheng virtually attended, co-authored presentation, and facilitated breakout group meeting on best practices and lessons learned to sustain collaborative resilience at the Idaho forest restoration partnership workshop entitled, evolving forest collaboration: expanding shared stewardship of Idaho's Forests.

June 12th, 2020, CFRI staff Tyler Beeton presented at 10 Years of CFLRP Lessons Learned Peer Learning Webinar on findings from Collaborative Resilience White Paper.

CFRI staff contributed to the national CFLRP program 10 year synthesis project of Results and Lessons Learned Summary Series, regularly participating in meetings and doing the work of small subteams to compile and present information, leveraging our expertise and knowledge from engagement in several CFLRP projects across the West. |

	- CFRI staff were active participants in CFLRP working groups and meetings to develop metrics around monitoring outcomes, collaborative governance, and other national work groups. - Staff participated in a core team to develop, compile, and write the CFLRP Results and Lessons Learned Summary Series in collaboration with USFS partners. https://www.fs.fed.us/restoration/documents/cflrp/CFLRP_LessonsLearnedCompiled20201016.pdf
Project 3. Translating ecologically-based forestry principles into practice	
3.1) In coordination with the Rocky Mountain Research Station, develop, produce, and deliver 2-4 workshops supporting applications of forest restoration principles.	A workshop to apply concepts for tree marking and project layout is in the planning stages, but has been delayed due to COVID-19 restrictions on in-person workshops and events. In collaboration with Rocky Mountain Research Station Wildfire Risk Management Science Team, multiple CFRI staff are actively participating in the planning and coordination for an online workshop on Potential Operational Delineations titled: PODs: Collaborative Fire Planning Workshop, scheduled for February 24-25, 2021. The workshop is expected to attract 500 participants from across the country to engage in discussion and training to better integrate principles of forest restoration and natural resource planning with fire management strategies.
3.2) Convene, deliver, and report on 4-6 peer to peer learning exchanges or presentations to deliver localized forest restoration science to place based restoration organizations, planners, or leadership and high level decisionmakers.	CFRI staff Marin Chambers, Tony Cheng and Brett Wolk co-organized and delivered the presentation, "Collaborative Adaptive Management case studies", at the San Juan Headwaters Forest Health Partnership's Science Forum, February 21, 2020. Marin Chambers, Tony Cheng, and Brett Wolk presented Rangeland on multiple collaborative monitoring and adaptive management projects, and facilitated discussion with Science Forum participants about opportunities and constraints to implement collaborative adaptive management for San Juan Headwaters Forest Health Partnership projects. CFRI Director was invited by Colorado US Senator Cory Gardner to present to USDA Secretary Sonny Perdue and Sen. Gardner on June 19, 2020, Empire, Colorado, about the Northern Colorado Fireshed Collaborative about localizing forest restoration and wildfire risk management science to increase pace and scale of treatments to mitigate the behavior and effects of large severe wildfire. CFRI staff Hannah Brown collaborated with CSU Forest and Stewardship Department communications staff to write an article for the CSU Source that reported back to Colorado State University and Warner College community about the peer-to-peer learning exchange that took place at the 2020 SWERI Cross-Boundary Restoration Workshop. https://warnercnr.source.colostate.edu/csu-institute-workshop-brings-western-land-managers-together/

	CFRI staff Kat Morici delivered the presentation "Prescribed Fire Monitoring on the Front Range" at the virtual Landscape Restoration Team JAM session on October 15th, 2020.
3.3) Develop, produce, and distribute 3-5 science briefs, and create multimedia resources such as videos, ESRI story-maps, etc., that facilitate application of science based strategic cross-boundary forest restoration principles in Colorado frequent fire forests.	Published science brief: Brown, H. Cutting Down Trees isn't Always a Bad Thing. CFRI-SB-1901. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/06/Cutting-Down-Trees-Isnt-Always-a-Bad-Thing.pdf Published science brief: Brown, H. The Complexity of Forest Science and Management. CFRI-SB-1902. https://cfri.colostate.edu/wp-content/uploads/sites/22/2019/10/Complexity-of-Forest-Science-and-Management.pdf Published briefing paper on incorporating traditional science with different perspective into planning processes: Brown, H. "It's about the people": A Reflection and Reading List. CFRI-SB-1904. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/02/Its-about-the-people-reflection-and-reading-list.pdf CFRI staff Marin Chambers development content and appeared in an 8 minute video produced by Local Motives titled: What do the wildfires of today mean for the forests of tomorrow? Video link: https://www.youtube.com/watch?v=i7BZq6APVeQ
3.4) Collaborating with Rocky Mountain Research Station and partners, facilitate improving existing websites and/or building a new website to host information that facilitates application of forest restoration principles in Colorado frequent fire forests.	In coordination with RMRS and a larger forest restoration collaborative group, efforts were redirected away from developing a website to host comprehensive information for Front Range forest ecology and management. Funds were redirected to CFRI staff to perform major upgrades and regular content updates to the CFRI website https://cfri.colostate.edu/ have been added, including: - A Geospatial Portal was developed and added to the CFRI website to host internal and publicly available spatially-explicit data and tools that provide relevant information for planning, assessment, monitoring, and adaptive management. https://cfri.colostate.edu/cfri-geospatial-database/cfri-planning-links/ - Regular posting of CFRI publications to facilitate sharing and application of forest restoration principles by partners. https://cfri.colostate.edu/publications/ - Many of our "collaborations" pages were updated and expanded to better describe CFRI's engagement with collaborative groups around the region, and how we work to incorporate science with local knowledge to move cross boundary shared stewardship forest restoration principles forward. https://cfri.colostate.edu/projects/

3.5) Working with the Rocky Mountain Research Station, co-produce and disseminate 1-3 applied scientific publications to inform collaborative planning, implementation, monitoring, and/or adaptive management of restoration principles for ponderosa pine forest types in Colorado.	Working with Mike Battaglia, RMRS research silviculturist, published study describing implications of restored forest structures on tree regeneration growing environments. The study was conducted within the Colorado Front Range CFLRP Upper Monument Creek project. Cannon, JB, Tinkham, WT, DeAngelis, RK, Hill, EM, and Battaglia, MA. (2019) Variability in Mixed Conifer Spatial Structure Changes Understory Light Environments. Forests 10 (11) doi:10.3390/f10111015. https://cfri.colostate.edu/wp-content/uploads/sites/22/2019/11/Cannon_et_al_Variability.pdf

Co-produced and co-funded with Rocky Mountain research Station, Rocky Mountain Tree Ring Research, and CFRI. Connected Science: Looking into the Past: How reconstructing historical forest conditions can help future restoration efforts. https://www.fs.usda.gov/rmrs/documents-and-media/looking-past-how-reconstructing-historical-forest-conditions-can-help-future-0 |
| 3.6) Complete 1-3 written reports that document the application of forest restoration principles for forest types other than ponderosa pine and dry mixed conifer forests, such as Gambel oak, wet mixed conifer, or subalpine forests. | Published briefing paper with original artwork depicting fire and restoration in different forest types: Brown, H, Chambers, ME, Stevens-Rumann, CS, Edwards, G (2020). Fire behaves differently in different forest types. CFRI-2007. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/01/FireEd-Infographic-Web_Print-1.pdf

In progress, a Knowledge Synthesis is being developed in response to the San Juan Headwaters Forest Health Partnership (SJHFHP) request in 2019 to CFRI to compile and synthesize current and best available science for mixed conifer forest ecology to inform future management efforts and research needs with specific information relating to the San Juan Mountain Region. |
| **Project 4. Supporting planning, monitoring, and adaptive management to improve fuel treatment effectiveness and forest resilience under changing precipitation and rising temperatures.** | |
| 4.1) Document and report on 2-4 monitoring methods, and collect monitoring data that facilitates leveraging existing monitoring networks to enhance fuel treatment effectiveness and maximize fuel treatment longevity. | CFRI developed remote sensing monitoring methods to quantify ecological changes in both forest canopy openings and forest tree group sizes and arrangement before and after management activities. Methods reported in: Slack, AW, Wolk, BH, Stevens-Rumann, CS, Brown, HLC, Barrett, KJ, Mueller, SE, Hunter, TM, Morici, KE, & Warnick, KJ (2021). *Upper South Platte Watershed Monitoring Report: Learning from forest restoration projects to advance landscape resilience and collaboration*. CFRI 2103. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/04/Upper-South-Platte-Monitoring-Report-2021_Web.pdf

Improved CFRI "mothership" and "simple plot" field based ecological effectiveness monitoring methods to better capture tree regeneration |

	and saplings in order to quantify changes in ladder fuels and better measure fuel treatment longevity. CFRI leveraged SWERI funding to collect ecological effectiveness monitoring data at Pole Hill management sites in northern Colorado in partnership with the Peaks to People Water Fund and the Big Thompson Conservation District. CFRI staff worked with Big Thompson foresters to integrate project inventory data with ecological effectiveness monitoring to leveraging resources, improving project planning, and enhance forester understanding of effective treatment methods.
4.2) Develop, document, apply, and report on prescribed fire monitoring methods for Colorado forests.	CFRI staff Mike Caggiano and Kat Morici attended the Colorado Prescribed Fire Council meeting in Durango, Colorado, September 2019, and shared CFRI monitoring methods and results with stakeholders. Caggiano continued to engage with the Prescribed Fire Council throughout 2020. Prescribed fire monitoring methods were developed and applied at the Elk Fire in Northern Colorado during fall 2019. Results were shared by CFRI staff Kat Morici with stakeholders via zoom August 6th, 2020, during a workshop titled: Learning from Burning: Science and Monitoring Outcomes from the Elkhorn Unit 4 Prescribed Fire. Video recording of workshop: https://www.youtube.com/watch?v=vwVWkOErfBQ A written report of results and methods are forthcoming. Developed and published ESRI storymap on CFRI website describing cross boundary prescribed fire monitoring and implementation efforts in Northern Colorado: *Prescribed Fire in Northern Colorado and The Colorado Forest Restoration Institute.* Benjamin Markle, Nov 25, 2020. https://storymaps.arcgis.com/stories/1d03a9c78dfe4f6681ab4eef42403 56d
4.3) Complete 1-3 reports summarizing fuel treatment effectiveness and treatment longevity in forest types in Colorado and the intermountain west.	CFRI staff Marin Chambers published paper analyzing post fire tree regeneration patterns across the Southwest and longevity of fire footprints as fuel treatments: Rodman, KC, Veblen, TT, Battaglia, MA, Chambers, ME, Fornwalt, PJ, Holden, ZA, Kolb, TE, Ouzts, JR, Rother, MT (2020). A changing climate is snuffing out post-fire recovery in montane forests. Global Ecol Biogeogr. 2020;00: 1–13. https://doi.org/10.1111/geb.13174

4.4) Provide technical assistance and training in monitoring data collection, analysis, and/or application of results for assessing monitoring data trends for the Colorado State Forest Service and 2-4 additional organizations or forest, fire, or watershed collaborative groups.	Ongoing conversation with CSFS staff Wilf Previant and Zach Mellema to coordinate monitoring sampling methods and analysis technique, including tablet data collection and processing. Communicated with Program Manager Diana Selby to provide feedback for the Forest Restoration and Wildfire Risk Reduction Grant advisory committee on fuel treatment effectiveness and allocation of resources for effective grant program outcomes. CFRI staff Brett Wolk and Kat Morici discussed monitoring findings with the full FRWRM program advisory committee January 9th, 2020, to help inform effective allocation of program funds.

Provided Daniel Bowker (Coalition for the Poudre River Watershed) with a basic summary and interpretation of results of CFRI monitoring plots that burned in the Red Feather unit 28 RX. This information was presented at a public field tour of prescribed fires in the Red Feather area. CFRI has provided Bowker with monitoring protocols, datasheets, and advised on analysis of data using Forest Vegetation Simulator analysis programs.

CFRI staff shared protocols and data collection templates, and provided training on protocol development, data collection, and analysis techniques with the Boulder Valley and Longmont Conservation Districts and local Colorado State Forest Service staff with the goal to build monitoring capacity of other agencies and enhance forest inventory protocols for developing improved forest management plans on private lands. Inventory monitoring protocols were modified to include collection of adequate data to estimate changes in fire risk using Forest Vegetation Simulator fire behavior modeling. |
4.5) Work with 1-2 forest collaborative groups to develop and document forest management strategies that balance fire risk reduction and forest resilience under changing precipitation patterns and rising temperatures.	CFRI staff Marin Chambers attended and contributed to a Colorado State Forest Service Forest Action Plan Climate Adaptation Workshop and provided a review of Forest Action Plan drafts to help integrate climate adaptation strategies into the FAP. Chambers and CFRI Staff Camille Stevens-Rumann have continued engagement with CSFS on climate adaptation strategies, including multiple workshops and ongoing communication to facilitate developing an Assisted Silviculture for Climate Change field learning site at the State Forest State Park in partnership with RMRS and CSU Department of Forest and Rangeland Stewardship.
Project 5: Supporting Collaborative Capacity-Building and Peer-Learning	
5.1) Conduct, convene, organize, and report on	Organized a FireLab meeting October 10th, 2019, in Fort Collins Colorado, including 40+ people from academic institutions, federal and non-federal agencies, and non-governmental place based collaborative

between 7-9 site visits, peer to peer learning events, webinars, or workshops that bring together research scientists from RMRS, other federal agencies, and universities with participants of place-based forest collaboratives to transfer knowledge about, and assist in the development of, science-based methods for collaborative assessment, monitoring, and adaptive management.	group leaders. Mike Caggiano (CFRI Research Associate), Katie Donahue (USFS), and James White (USFS) delivered a presentation about Potential Operational Delineations (PODS) and their development for the Arapaho-Roosevelt National Forest. Organized a FireLab meeting December 17th, 2019, in Fort Collins Colorado, including 40+ people from academic institutions, federal and non-federal agencies, and non-governmental place based collaborative group leaders. CFRI staff Ben Gannon delivered a presentation discussing wildfire risk reduction strategies to protect drinking water supplies. Presentation title: "Murky waters: adding rigor to wildfire-water supply risk assessment". CFRI staff Stephanie Mueller participated in a special session on forest resilience to fire and climate at the Association for Fire Ecology 8th International Fire Congress, November 18-22, 2019, Tucson, AZ. Stephanie delivered a presentation titled: "Climate relationships with increasing wildfire in the southwestern US from 1984 to 2015". CFRI staff Katarina Warnick organized and facilitated CFRI Science Friday peer to peer learning events to make forest science accessible to diverse audiences and connect research scientists and university students/young professionals. The series included a mix of in-person and web-based meetings. - January 2020: How to build your CV, presented by Marin Chambers, Katarina Warnick, and Hannah Brown. - February 2020: Evaluating Information and Improving Scientific Literacy, presented by Hannah Brown. - September 2020: Examining the impact of two prescribed fires on forest structure, fuel arrangement, and predicted wildfire behavior at Ben Delatour Scout Ranch using field data collected by CFRI field monitoring crews, presented by Kat Morici. - October 2020: How CFRI monitoring data goes from numbers collected in the field to a resource for managers and a tool to advance Adaptive Management in the Upper South Platte region of Colorado. Presented by Tori Hunter and Andrew Slack. - November 2020: Shifting plant communities in response to disturbances: both human and natural. Presented by Camille Stevens-Rumann. Camille Stevens-Rumann (CFRI) was featured in a podcast for the Association for Fire Ecology on January 5, 2020 titled "Tree Regeneration in the Western US," available here: https://fireecology.org/feco-podcast/7

	Camille Stevens-Rumann delivered presentation, "Forest changes following wildfires and climate change" at Yale University Spring Seminar, Yale School of Forestry. February 2020, New Haven, CT.
	Camille Stevens-Rumann delivered the presentation "Managing for resilience?" at SWCASS Ecosystem Resilience, University of Arizona, Tucson AZ, in May of 2020.
	Camille Stevens-Rumann contributed to the June 2020 "Deep Dive" event held virtually by the Northwest Climate Adaptation Science Center, with 80+ participants.

For agreement number 20-DG-11030000-008, CFRI reports the following cumulative accomplishments toward each project deliverables in the work plan for dates while the agreement was active, including June 1st, 2020 through December 31st, 2021:

Deliverable	Status of Deliverables
Project 1: Supporting strategic prioritization, monitoring, and adaptive management of cross boundary wildfire risk co-management strategies to operationalize the Shared Stewardship approach.	
1.1 Continue to assist in the identification and facilitation of partnership engagement in a Colorado all-lands wildfire risk assessment process led by USFS Region 2. This includes working with targeted partners to identify the High Values, Resources, and Assets (HVRA's) that will help frame the risk assessment outputs.	CFRI staff Mike Caggiano has led continued engagement with USFS Rocky Mountain Region fire planning staff (Contact: Brian Keating) to develop risk assessment processes and frameworks. The all lands Colorado wildfire risk assessment has been delayed due to contractor data processing timelines and focused efforts towards other existing risk assessment and prioritizations. With delays in the USFS R2 risk assessment, efforts have been re-directed to participating in a Colorado Shared Stewardship working group, advising on best practices to gather information about HVRA's and priorities of forest and watershed collaborative groups around the state, and framing the assessment process for the group. CFRI staff participated in Colorado All-Lands Wildfire Hazard and Wildfire Risk Assessment - Response Functions/Relative Importance workshop meetings on July 13th and July 21st, 2021. CFRI Leadership Tony Cheng, Brett Wolk, and Camille Stevens-Rumann, and other staff as appropriate have coordinated and participated in monthly meetings with Rocky Mountain Region leadership to develop shared strategic directions, share lessons learned from monitoring outcomes, hear needs of regional office staff, and develop shared projects.
1.2 In coordination with the Colorado State Forest Service, support cross boundary application of the updated Statewide Forest Action Plan.	Following the November, 2020, 3 day Forest Action Plan introduction workshop for CSFS staff that was co-organized and co-lead by CFRI staff, CFRI created a regular working group with CSFS staff and CSU Forest and Rangeland Stewardship staff to continue assessing FAP implementation and future training needs to support Forest Action Plan implementation. The group has met quarterly in 2021 to facilitate information sharing and applications of FAP by CSFS staff and their partners. Future workshops and trainings are under development to highlight FAP applications that integrate climate change considerations into forest planning and implementation.
1.3 Participate in the Colorado Natural Resources Conservation Service Forest Advisory Committee to develop	CFRI staff Brett Wolk participated in all NRCS Forest Advisory Committee meetings for 2021, including May 27th and September 15th, to support coordinating efforts and contribute expertise towards developing statewide priorities for NRCS forestry conservation programs.

priorities and advise on strategic prioritization of NRCS forestry conservation practices across the state.	
1.4 Working with RMRS, continue to support development, implementation, and integration of cross boundary landscape planning and prioritization tools in 2-4 landscapes, with a focus on linking spatial fire planning (PODS) with prioritization of forest and fuels management objectives (e.g. RADS, etc.) across multiple scales of planning and implementation.	CFRI continued to support the development, implementation, and integration of spatial fire management strategies in close partnership with the RMRS Wildfire Risk Management Science Team, and coordinated with USFS Region II fire staff and the USFS Washington Office on strategies for POD workshop facilitation and implementation. Many of these efforts were co-developed and co-funded with RMRS partners. CFRI Staff facilitated the initiation and/or continued development and application of PODs across several landscapes: - Carson and Santa Fe National Forests in New Mexico and adjacent non-USFS landscapes. - Medicine Bow-Routt National Forest in Colorado and Wyoming and adjacent non-USFS landscapes. - Rio Grande National Forest in Colorado and adjacent non-USFS landscapes. - San Juan National Forest in Colorado and adjacent non-USFS landscapes. - Ashley National Forest in Utah and adjacent non-USFS landscapes. CFRI staff Ben Gannon engaged in a months long process with Envision Chaffee County Recreation and Balance committee to develop and implement Wildlife Decision Support Tools for Recreation. This involved a series of meetings and custom decision support modeling that integrates strategies to maximize recreation opportunities while minimizing impacts, enhance wildlife habitat characteristics, and integrate wildfire risk reduction planning in the upper Arkansas valley. - Wildfire Decision Support Tools for Recreation, 2021. https://envisionchaffeecounty.org/wp-content/uploads/2021/04/ChaffeeRecPlanforWildlifeTools_2021F.pdf Results of the technical analysis are summarized in Chaffee County Outdoor Recreation Management Plan, adopted by Chaffee County, and are available on the Envision Chaffee County website Recreation Management section https://envisionchaffeecounty.org/our-tools/ CFRI staff Brett Wolk and Stephanie Mueller continued engagement with Envision Chaffee County, including translating landscape analysis into local forestry prescriptions, mapping, and GIS data management to support implementation of their updated Community Wildfire Protection Plan and Outdoor Recreation Management Plan that are driven by CFRI Risk Assessment and Decision Support outcome based planning prioritization tools.

	Funded by a separate agreement from the Pike San Isabel National Forest, CFRI staff Brett Wolk and Allie Rhea facilitated strategic risk assessment and decision support for an update to the Lake County Community Wildfire Protection Plan. CFRI leveraged this annual workplan funding for several other CFRI staff to share lessons learned from engagement in other similar projects around the state, contribute fire behavior modeling, and facilitate small group discussions at several workshops with the Lake County Forest Health Council to develop shared goals, objectives, and outcome based priorities with the group.
	CFRI staff Brett Wolk and Stephanie Mueller worked with partners in southwest Colorado to build their capacity for implementing Risk Assessment and Decision Support tools on the San Juan National Forest to support the Southwest Environmental Impact Fund and Dolores Watershed and Resilient Forest Collaborative, in an effort to better link spatial fire planning with outcome based prioritization of forest and fuels management strategies. This included regular communication about best practices and sharing information about similar groups across Colorado including Chaffee and Lake County Community Wildfire Protection Plan updates, the Upper South Platte Partnership, and NoCo Fireshed Collaborative, among others.
	Published paper supporting the development of cross-boundary landscape planning tools: Caggiano, MD, Hawbaker, TJ, Gannon, BM, & Hoffman, CM (2020). Building Loss in WUI Disasters: Evaluating the Core Components of the Wildland–Urban Interface Definition. Fire, 3, 73. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/01/Caggiano-et-al-building-loss.pdf
1.5 Develop tools to streamline collaborative spatial fire planning analytical processes that facilitate updating and maintaining existing mapping and prioritization efforts. Implement data and analytical updates on 2-4 landscapes where PODS or other prioritization methods have already been developed and implemented.	CFRI staff Ben Gannon developed POD summary geodatabase and POD atlas products in collaboration with the RMRS Wildfire Risk Management Science Team. The POD Atlas was applied with the Carson National Forest and Santa Fe National Forest in their POD workshops to help consolidate information and update spatial fire planning strategies with the latest data. Published paper on PODs atlas methods: Thompson, MP, Gannon, BM, Caggiano, MD, O'Connor, CD, Brough, A, Gilbertson-Day, JW & Scott, JH (2020). Prototyping a Geospatial Atlas for Wildfire Planning and Management. Forests 11, 909. https://www.mdpi.com/1999-4907/11/9/909

| 1.6 Deliver 2-4 presentations, meetings, peer to peer learning events, etc. to report on the range of methodologies, approaches, and planning processes being used to enhance co-management of wildfire risk in the western US to USFS Forest, Regional, and Washington Office units, Colorado Department of Natural Resources, water providers, watershed coalitions, forest collaboratives, Congressional members and staffs, or other affected entities. | Along with colleagues from Bureau of Land Management and USFS national fire planner, CFRI staff Mike Caggiano and Ben Gannon organized and led a Cross Boundary Wildfire Planning workshop at the 2020 New Mexico Wildland Urban Fire Summit, October 2020.

CFRI staff Mike Caggiano co-delivered a webinar presentation with RMRS colleague Kit O'Connor and Carson National Forest AFMO Jamie Long for Southwest Fire Science Consortium. The webinar was titled: Potential Operational Delineations: On the Ground Experiences and Future Directions. November 19, 2020. Video recording here: https://www.youtube.com/watch?v=aVpBq6wWC9g

CFRI staff Tony Cheng and Brett Wolk served as panelists for the First Annual Wildfire Summit, organized by Rep. Joe Neguse, to bring together stakeholders from around the state to discuss problems associated with wildfire and seek collaborative solutions. Cheng and Wolk served on separate panels, provided examples of on the ground solutions, and discussed policy directions. Summit was held virtually February 18th, 2021, and included introduction by Rep. Neguse, Colorado Senators Bennett and Hickenlooper, and Colorado Governor Polis.

Presented poster: Gannon, BM, Thompson, MP, Caggiano, MD, O'Connor, CD, Brough, A, Gilbertson-Day, JW, Scott, JH (2021). Geospatial analysis and mapping tools to operationalize spatial fire planning. 16th International Wildland Fire Safety Summit & 6th Human Dimensions of Wildland Fire Conference, May 2021, Virtual Conference. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/06/Gannon_POD_Tools_poster.pdf

CFRI staff Brett Wolk delivered presentation and facilitated discussion on prioritization methods for a combined meeting of Dolores Watershed And Resilient Forest Collaborative and 4 Rivers Collaborative, titled "Risk Assessment and Decision Support (RADS) Framework and Modeling Process". Virtual, 6-23-2021. https://cfri.box.com/s/kugp6co0vugy2vr5sjdhnege29ojzcpi

Jarod Dunn and Brett Wolk delivered presentation and facilitated discussion on prioritization methods for a meeting of newly formed collaborative group in Gunnison, Colorado, titled "Risk Assessment and Decision Support (RADS) Framework and Modeling Process". Virtual, 7-30-2021. https://cfri.box.com/s/1gexsm4imlfjb94fmyu9r47fpjl03idw |
| 1.7 Produce 4-6 training resources (technical briefs, blog posts, webinars, etc.) to facilitate the broader understanding and | As a member of the Rocky Mountain Research Station Wildfire Risk Management Science Team, CFRI staff co-developed workshop agenda and material, presented information, and CFRI staff facilitated breakout groups for an online workshop on Potential Operational Delineations titled: PODs: Collaborative Fire Planning Workshop, February 24-25, 2021. The workshop attracted around 500 participants from across the country |

application of analytical tools and collaborative planning processes that support strategic investments in cross boundary forest and fire management. Focus on documenting lessons learned that provide guidance for diverse stakeholders to assess what risk assessment and prioritization tools are appropriate for different planning and evaluation purposes.	to engage in discussion and training to better integrate principles of forest restoration and natural resource planning with fire management strategies. https://www.fs.usda.gov/rmrs/groups/wildfire-risk-management-science-team/potential-operational-delineations-pods#Workshop Videos of the February 2021 PODs workshop, including case study examples to demonstrate strategic cross-boundary forest and fire management and for use in training, are available on the workshop website and posted on Vimeo https://vimeo.com/showcase/8231822 CFRI staff Tyler Beeton and Katarina Warnick wrote and published a blog post summarizing outcomes and applications from the 2021 Collaborative Fire Planning Workshop. Blog titled: Changing the Game: Using Potential Wildfire Operational Delineation (PODs) for a Better Future with Fire. April 29, 2021. https://fireadaptednetwork.org/changing-the-game-with-pods/ As a member of the Rocky Mountain Research Station Wildfire Risk Management Science Team, CFRI staff contribute to development and planning, lead meetings, and engage in the PODs User Community. This is a training resource that provides a forum for fire managers to connect directly with each other and share lessons learned amongst peers. This included two web meetings in 2021, in April and November, that included multi-day workshops to provide training resources for fire professionals across the country and attended by several hundred individuals during each session. https://www.fs.usda.gov/rmrs/potential-operational-delineations-pods
Project 2: Supporting knowledge transfer of monitoring, adaptive management strategies, and outcomes for collaborative forest landscape restoration and resilience	
2.1) Produce and disseminate between 2-4 technical documents regarding multi-party monitoring strategies and results from collaborative forest landscape management projects.	Published two papers highlighting results from Colorado Front Range CFLRP projects: Barrett, KJ, Cannon, JB, Schuetter, AM, Cheng, AS (2021). Effects of collaborative monitoring and adaptive management on restoration outcomes in dry conifer forests. *Forest Ecology and Management 488*. https://doi.org/10.1016/j.foreco.2021.119018 Cannon, J. B., Warnick, K. J., Elliott, S., and Briggs, J. S.. 2022. Low- and moderate-severity fire offers key insights for landscape restoration in ponderosa pine forests. Ecological Applications 32(2). https://doi.org/10.1002/eap.2490

2.2) Conduct and report on at least one field-based workshop per Colorado CFLR project to review and deliberate treatment effects and desired conditions.	CFRI staff helped plan and lead a field trip for the Front Range CFLR Landscape Restoration Team on August 11, 2021. Multiple CFRI staff participated to provide transportation, as well as contribute knowledge of local placed-based collaborative outcomes along the Front Range and beyond. CFRI staff Kevin Barrett produced analysis of pre- and post-treatment stand structure, composition, and changes in wildfire risk, and led discussions of adaptive management actions with the group based on the analysis and review of past treatments. CFRI staff communicated with Uncompahgre Plateau CFLRP partners, and there was no desire or stated need for a field trip in 2021.
2.3) In coordination with CFLRP Program Administrators and other SWERI Institutes, produce 2-4 reports or briefing papers documenting forward looking lessons learned from the CFLRP program in order to facilitate knowledge transfer to newly awarded CFLRP projects.	In collaboration with USFS staff and national leads for the CFLR program, published paper: Beeton, TA, Cheng, AS, & Colavito, MM (2020). Developing and sustaining collaborative resilience in the face of change: A review of the Collaborative Forest Landscape Restoration Program projects. CFRI-2003. https://cfri.colostate.edu/wp-content/uploads/sites/22/2020/08/CFLRP-Developing-and-sustaining-collaborative-resilience.pdf In collaboration with SWERI staff from the Ecological Restoration Institute, conducting an analysis of adaptive capacity, actions, and barriers among collaborative forest restoration groups in the United States. This report is targeted for publication in a peer-reviewed science journal, as well as short briefs and fact sheets to make findings more accessible to audiences throughout the CFLRP and other forest and watershed collaborative groups.
2.4) In collaboration with the other SWERI institutes, USFS, and other partners, convene a regional Cross-Boundary Landscape Restoration workshop, or series of smaller workshops, with land managers, researchers, and their stakeholders to develop strategies that facilitate the application of lessons learned from collaborative forest landscape management planning, implementation, monitoring, and adaptive management	CFRI staff are co-leading planning for a Cross Boundary Landscape Restoration workshop scheduled for March 7-10th, 2022, at Colorado State University in Fort Collins, Colorado. Throughout much of 2021 CFRI staff Brett Wolk, Angela Hollingsworth, Brooke Simmons, Hannah Brown, and others participated in regular planning meetings every 2 weeks to develop the workshop agenda and logistics, with additional subgroup work developing specific workshop aspects and logistics. CFRI staff secured a meeting venue at Colorado State University, developed the registration website, and is overseeing all financial and logistical considerations for the workshop. The planning team includes multiple representatives from all three SWERI's, as well as representatives from USFS Rocky Mountain Research Station, Forest Stewards Guild, National Wildland Fire Cohesive Strategy, National Forest Foundation, Trees, Water & People, and others.

in the intermountain west and southwest.	
2.5) Working with the Rocky Mountain Research Station, document, produce, and disseminate 2-4 applied scientific publications that leverage data and adaptive management process from collaborative forest landscape management projects and wildfire risk co-management strategies.	In collaboration with Matt Thompson, RMRS scientist, published paper: Gannon BM, Thompson MP, Wei Y (2020). An Operationally Relevant Framework for Mapping Spot Fire Transmission Potential. Environmental Sciences Proceedings 3(1):13. https://doi.org/10.3390/IECF2020-08001 Caggiano, MD, Beeton, TA, Gannon, BM, White, J (2021). The Cameron Peak Fire: Use of Potential Operational Delineations and Risk Management Assistance Products. CFRI-2106. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/06/CameronPeakFirePODsReport.pdf CFRI staff Ch'aska Huayhuaca co-authored publication: Wilkins, K., Pejchar, L., Carroll, S. L., Jones, M. S., Walker, S. E., Shinbrot, X., Huayhuaca, C., Fernandez-Gimenez, M., & Reid, R. S. (2021). Collaborative conservation in the United States: A review of motivations, goals, and outcomes. Biological Conservation, 259, 109-165. https://doi.org/10.1016/j.biocon.2021.109165
2.6) Convene and report on between 4-6 webinars, presentations, or peer to peer learning events documenting and distributing monitoring methods, results, and adaptive management processes to research colleagues or multi-stakeholder forest landscape management initiatives focused on forest health, wildfire risk mitigation, or watershed protection	Andrew Slack helped convene, attended, and reported monitoring methods and results at monthly meetings with the Upper South Platte Partnership Management and Science team throughout 2021. This includes co-developing methods to monitor changes in forest wildfire risk and forest resilience, sharing results, facilitating adaptive management with place based partners, and serving on a core group to develop goals for the partnership. Monitoring methods include both field-based plot sampling as well as remote sensing techniques. Kat Morici presented to the Upper South Platte Partnership to share prescribed fire monitoring methods and results during a meeting of the Management and Science team, February 4th, 2021. Andrew Slack and Hannah Brown presented results and key takeaways from interviews and discussions with Upper South Platte Partnership partners assessing past forestry projects and outcomes of adaptive management processes within the group. April 1st, 2021 (virtual). Kat Morici met with staff of the Big Thompson Watershed Coalition on September 3, 2020, to discuss how to use field monitoring data in the Forest and Fuels Extension to the Forest Vegetation Simulator. Marin Chambers trained Calwood Educational Center students and staff in fire and forest ecology, CFRI monitoring protocols, and basic forestry field measurements during a course focused on engaging high school students from underrepresented backgrounds in natural resources, August 5, 2021.

Project 3. Translating ecologically-based forestry principles into practice	
3.1) Working with the Rocky Mountain Research Station, co-produce and disseminate 1-3 applied scientific publications to inform collaborative planning, implementation, monitoring, and/or adaptive management of restoration principles for ponderosa pine forest types in Colorado.	With RMRS and other colleagues, CFRI staff Camille Stevens-Rumann contributed to TAMM review publication. Leveraging additional funding from The Nature Conservancy Fire Learning Network program, CFRI staff Marin Chambers also contributed to the publication. Stevens, JT, Haffey, CM, Coop, JD, Fornwalt, PJ, Yocom, L, Allen, CD, Bradley, A, Burney, OT, Carril, D, **Chambers, ME**, Chapman, TB, Haire, SL, Hurteau, MD, Iniguez, JM, Margolis, EQ, Marks, C, Marshall, LAE, Rodman, KC, **Stevens-Rumann, CS**, Thode, AE, & Walker, JJ (2021). Tamm Review: Postfire landscape management in frequent-fire conifer forests of the southwestern United States. Forest Ecology and Management, 502, 119678. https://doi.org/10.1016/j.foreco.2021.119678 Working with the RMRS and leveraging funding from a Joint Venture Agreement with RMRS Science communication and Application staff, we are in progress analyzing interview data and assessing effectiveness of science co-development and communication efforts associated with RMRS-GTR-373 *Principles and practices for the restoration of ponderosa pine and dry mixed-conifer forests of the Colorado Front Range*.
3.2) Complete 1-3 written reports that document the translation and application of forest restoration principles for forest types other than ponderosa pine and dry mixed conifer forests, such as Gambel oak, Aspen, wet mixed conifer, or subalpine forests.	A Knowledge Synthesis was developed in response to the San Juan Headwaters Forest Health Partnership (SJHFHP) request in 2019 to CFRI to compile and synthesis the current best available science for mixed conifer forests. Marin Chambers of CFRI and Mountain Studies Institute staff collaborated to create this knowledge synthesis with additional authorship from USDA-Rocky Mountain Research Station and USDA-Forest Service staff. Developed between 2019 and 2021 with engagement and input from the SJHFHP and the San Juan National Forest via collaborative discussions and field trips, the purpose of the presentation and paper is to compile and synthesize current and best available science for mixed conifer forest ecology to inform future management efforts and research needs with specific information relating to the San Juan Mountain Region. Remke, M.J., Chambers, M.E., Tuten, M.C, Pelz, K.A., 2021. Mixed Conifer Forests in the San Juan Mountain Region of Colorado, USA: The Status of Our Knowledge and Management Implications. Colorado Forest Restoration Institute. CFRI-2110. https://cfri.colostate.edu/wp-content/uploads/sites/22/2022/03/MixedConiferForests_Chambers_Remke_Dec2021_FINAL.pdf The report was collaboratively developed and presented with San Juan Headwaters Forest Health Partnership members December 8th, 2021. A video of the presentation can be found on the Mountain Studies Institute YouTube channel https://www.youtube.com/watch?v=W-awZdqTfyw Published paper: Schapira, Z., Stevens-Rumann, C., Shorrock, D., Hoffman, C., & Chambers, A. (2021). Beetlemania: Is the bark worse than the bite? Rocky Mountain subalpine forests recover differently after

	spruce beetle outbreaks and wildfires. *Forest Ecology and Management*, *482*, 118879. Published paper: Schapira, Z. H., Stevens-Rumann, C. S., & Shorrock, D. (2021). Subalpine tree seedlings: Assessing aging methodology and drivers of establishment. *Forest Ecology and Management*, *497*, 119516.
3.3) Develop a technical brief, and report to USFS Rocky Mountain Regional Office staff demonstrating how GTR-373 planning frameworks and ecological concepts can streamline planning for large landscapes (1 million+ acre planning areas) to improve forest restoration and fuels treatment programs.	Brett Wolk delivered virtual presentation and served as panelist for discussion with USFS Rocky Mountain Region Leadership Team meeting. Presentation titled "Knowledge Co-Production Tools and Forward Looking Strategies for Shared Stewardship." 8-18-2021. https://cfri.box.com/s/qjg60qs83npinmdgwagmxokcxcw1f7qd
3.4) In coordination with the USFS Rocky Mountain Region and Rocky Mountain Research Station, convene a working group and report on opportunities to translate climate vulnerability assessments into actionable climate adaptation strategies that are accessible for use in treatment unit or USFS District level prescriptions or adaptive planning processes.	CFRI staff Tyler Beeton and Stephanie Mueller convened quarterly meetings with USFS Rocky Mountain Region planning staff Ruth Esperance and regional ecologist and climate change coordinator Donna Shorrock to assess needs and opportunities to translate climate change vulnerability into forest plan revision, monitoring, and evaluation, as well as fire management strategies and risk based strategic planning frameworks. In collaboration with Ecological Restoration Institute and others, CFRI staff Andrew Slack, Hannah Brown, and Tyler Beeton helped facilitate discussions for the USFS Region 3 Climate Adaptation Workshop held virtually March 9th, 2021. CFRI staff contributed climate change adaptation science during the workshop discussions and facilitated breakout groups. Lessons learned from this experience will help better apply climate adaptation strategies with Region 2 staff and partners.

3.5) Collaborating with Rocky Mountain Research Station and partners, improve existing websites and/or build a new website to host information that facilitates application of forest restoration principles in Colorado frequent fire forests.	In coordination with RMRS Science Application and Communication staff, and a larger Front Range forest restoration collaborative group, efforts were redirected away from developing a website to host comprehensive information for Front Range forest ecology and management. Funds were applied to CFRI staff to perform major upgrades and regular content updates to the CFRI website https://cfri.colostate.edu/ have been added, including: - Formatting, layout, and regular posting of CFRI publications to facilitate sharing and application of forest restoration principles by partners. https://cfri.colostate.edu/publications/ - Many of our "collaborations" pages were updated and expanded to better describe CFRI's engagement with collaborative groups around the region, and how we work to incorporate science with local knowledge to move cross boundary shared stewardship forest restoration principles forward. https://cfri.colostate.edu/projects/ In addition to website upgrades, CFRI staff developed a strategy for communicating information to facilitate application of forest restoration principles using social media channels, and invested in software to more effectively coordinate information across multiple social media channels.
3.6) In coordination with the Rocky Mountain Research Station, develop, produce, and deliver 1-3 workshops or trainings to support applications of forest restoration principles into practice.	In coordination with Rocky Mountain Research Station staff, CFRI staff Marin Chambers helped organize and facilitate a field workshop on April 2nd, 2021, with Boulder County Parks and Open Space to examine impacts of the 2020 Calwood fire. A group of RMRS, CFRI, Colorado State University, US Forest Service, Boulder County Parks and Open Space staff, and other forest managers participated to discuss fire interactions with forest restoration treatments on Boulder County property to support future application and adaptation of forest restoration principles under changing climates and wildfire behavior. CFRI staff Andrew Slack helped guide the Saint Vrain Forest Health Partnership to apply concepts from RMRS-GTR-373 Principles and Practice of Forest Restoration on the Colorado Front Range to help the group develop desired conditions and adaptive management framework in the watershed. This included a series of 16 meetings and field trips with the Saint Vrain science committee. Funds from this agreement were leveraged with funds from the Arapaho Roosevelt National Forest that supported additional CFRI staff Ch'aska Huayhuaca-Frye, Mike Caggiano, and others to regularly engage in coordination and facilitation of the Northern Colorado Fireshed Collaborative.

3.7) Develop, produce, and distribute 2-4 technical briefs or multimedia resources such as videos, ESRI story-maps, etc., that facilitate application of science based strategic forest restoration principles in Colorado frequent fire forests.	January 12th, 2021, Marin Chambers is featured in Peak Facilitation video series Cocktails and Collaboration episode 3 to discuss the role of science in collaborative forest restoration discussions. Video here: https://www.youtube.com/watch?v=gMnnUqsYlmI Camille Stevens-Rumann delivered online podcast, "Awareness of the Spread, Fire Ecology," as part of Warner College of Natural Resource Podcast series, Season 3 Episode 1 (Fall 2020), available here: https://warnercnr.colostate.edu/tune-into-nature-a-warner-college-podcast/season-3/
Project 4. Supporting planning, monitoring, and adaptive management to improve fuel treatment effectiveness and forest resilience under changing precipitation and rising temperatures.	
4.1) Support the collection, data management, analysis, and reporting for monitoring data at 1-3 forestry projects, focusing on building prescribed fire monitoring knowledge and capacity within Colorado, conducting project scale remote sensing analysis, and/or leveraging existing monitoring networks to collect longer term data that enhances knowledge of fuel treatment effectiveness and maximize fuel treatment longevity.	Following the 2020 wildfires in Colorado and southern Wyoming, with nearly 800,000 acres burning across the area, CFRI dedicated significant resources to opportunistically leverage the learning opportunity presented by these fires and provide actionable knowledge for managers and policymakers about the post fire environment. - CFRI staff Marin Chambers and Camille Stevens-Rumann developed new post-fire monitoring and research methods to better understand short and long term understory vegetation trajectories and forest development following the Cameron Peak fire and other Colorado fires in 2020. Kate Weimer was hired as a graduate student and supervised a field crew collecting field data during the summer of 2021. - CFRI supported Camille Stevens-Rumann and graduate student Michael McNorville to develop new methods and collect field data measuring soil ecology in post fire environments within the Cameron Peak wildfire. - In collaboration with CSU research scientist Tony Vorster, to better measure wildfire severity and interactions of fuels treatments and wildfires, CFRI staff co-designed a protocol and collected burn severity data in several of the wildfires that burned in 2020, including the Cameron Peak fire. In collaboration with the Upper South Platte Partnership, CFRI staff collected and analyzed post-treatment monitoring data on private lands fuels treatments conducted at Roller Ranch. CFRI staff Andrew Slack developed dendrochronological monitoring methods and collected field data to better describe long term individual tree resilience and growth responses to thinning and prescribed fire treatments. Data was collected in Jefferson County Open Space, and tree cores were processed in the lab at CSU.

4.2) Document and report on 2-4 monitoring methods to make monitoring protocols more accessible and transparent for other organizations to apply and understand. This includes plot based field monitoring, remote sensing techniques, and/or data management strategies.	Published report evaluating field based monitoring methods and remote sensing techniques to measure prescribed fire treatment effectiveness. Morici, KE, Gannon, BM (2021). Elkhorn 4 Prescribed Fire Monitoring Report. CFRI-2108. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/09/2021-Elkhorn-4-RX-Monitoring-Report-1.pdf CFRI staff Allie Rhea continued development and implementation of modeled post-fire erosion monitoring methods using CFRI's Watershed Erosion Simulation Treatment Tool (WESST) to inform watershed health monitoring and post-fire prioritization of erosion control measures. This included a restructured post-fire erosion model to integrate continuous remote sensing dNBR products, rather than classified soil burn severity, which allows for continuous vegetation and soil adjustments and reduces the importance of the somewhat arbitrary threshold between severity classes, enhancing application of monitoring results. Allison Rhea presented post-fire erosion modeling methods and results as a part of the Cameron Peak Fire expert panel at the Colorado Wildland Fire Conference, Grand Junction, Colorado, on Sept 22, 2021. Allison Rhea also presented post fire watershed modeling methods at the CSU Geospatial Centroid seminar series, titled: How GIS was used in post-fire recovery and modeling after the Cameron Peak Fire. October 26th, 2021. Video of presentation available here: https://www.youtube.com/watch?v=Z_xPwHEv_2g CFRI staff began efforts to create a monitoring handbook in order to document our ecological monitoring methods using both field and remote sensing techniques. This will increase transparency, but also will serve as a training tool to build capacity for other organizations around the state and West to implement monitoring protocols within a collaborative adaptive management framework. In an effort to increase the accessibility of CFRI's monitoring protocols and methods to managers, the CFRI spatial imagery team began working on an effort to turn the complex statistical analysis code for the landscape spatial heterogeneity gap and canopy analyses into easy to use tools in ArcGIS. We worked intensively with Colorado State Forest Service district staff Matt Piscopo and others to develop methods and processes most applicable to inform management decisions. This project will continue into the new year and will be incorporated into CFRI's monitoring handbook.
4.3) Complete 1-3 technical reports summarizing fuel treatment effectiveness and treatment longevity in forest types in	CFRI provided funding, hired and trained field crews, and technical assistance for research study investigating tree regeneration and growth to inform reforestation and treatment longevity under changing climates: Carroll, C. J. W., Knapp, A. K., and Martin, P. H.. 2021. Higher temperatures increase growth rates of Rocky Mountain montane tree seedlings. Ecosphere 12(3):e03414. https://doi.org/10.1002/ecs2.3414

Colorado and the intermountain west.	Morici, K. E., & Bailey, J. D. (2021). Long-Term Effects of Fuel Reduction Treatments on Surface Fuel Loading in the Blue Mountains of Oregon. Forests, 12(10), 1306. https://doi.org/10.3390/f12101306 Slack, A. W., Kane, J. M., & Knapp, E. E. (2021). Growth and defense inform large sugar pine (Pinus lambertiana) mortality in a fire-excluded forest of the central Sierra Nevada. *Trees*, *35*(3), 1053-1063. https://doi.org/10.1007/s00468-021-02098-8
4.4) Conduct a pilot analysis and application of methods to assess value of different treatments relative to costs with USFS Regional and Washington Office planning and timber program staff.	CFRI staff Jarod Dunn engaged with USFS staff and colleagues on developing tools to monitor treatment costs and estimate benefits relative to different factors such as NEPA planning process and treatment budget line item funding source. After connecting with multiple people in the USFS Washington Office and others around the region and country, it was determined that the data on treatment costs and documentation needed to proceed with this analysis was not available in USFS corporate databases or other accessible locations.
4.5) Provide technical assistance and training to build capacity for monitoring data collection, analysis, and/or application of results for assessing monitoring data trends for the Colorado State Forest Service and 1-3 additional organizations or forest, fire, or watershed collaborative groups.	CFRI staff continue to coordinate with the Colorado State Forest Service to build capacity for monitoring and adaptive management capacity. We coordinated with CFRI Forest Restoration and Wildfire Risk Reduction monitoring coordinator Zach Mellema to continue aligning monitoring methods and sites monitored. CFRI staff continue communicating with CSFS Science and Data lead Amanda West-Fordham about opportunities for integrating remote sensing monitoring methods into CSFS project evaluations. CFRI staff Camille Stevens-Rumann coordinated with CSU Extension to host a student intern that worked with CSFS to increase science application capacity in 2021. With CSFS staff lacking monitoring and data application capacity, CFRI staff have advised on staffing needs for CSFS to bolster capacity through both a CSFS dedicated field monitoring position and multiple CSFS Community Wildfire Protection Plan coordinator positions to help integrate landscape monitoring data into planning with community groups. CFRI staff Andrew Slack, Kat Morici, and Brett Wolk worked with the Longmont Conversation District to develop a monitoring strategy for non-federal lands management and forest management plan development. This included co-developing a monitoring protocol and providing training resources for conservation district staff to implement the inventory and monitoring protocols. CFRI staff Brett Wolk and Stephanie Mueller contributed to Chaffee Chips and Envision Chaffee County helping to translate landscape plans and apply data to local treatment prescriptions. CFRI provided a template for tracking accomplishments with GIS to facilitate monitoring outcomes across the entire county.

4.6) Conduct a needs assessment for post fire reforestation that examines the capacities, constraints, and desired conditions for re-planting high severity burn scars in frequent fire forests of the Southwest under anticipated changing future climatic conditions.	CFRI staff met with federal and non-federal managers in the field multiple times following 2020 wildfires and sustained communication to assess information gaps and monitoring needs and to create collaborative learning opportunities. This culminated in a workshop, co-hosted with RMRS, bridging needs of managers and researchers, held in April, 2021. A summary of the workshop outcomes and needs is available here: Chambers, ME, Rhoades, CC, Brown, H (2021). Post-fire Tree Regeneration and Forest Recovery Workshop Summary. CFRI-2105. https://cfri.colostate.edu/wp-content/uploads/sites/22/2021/06/Post-fire-Tree-Regeneration-and-Forest-Recovery-Workshop-Summary.pdf
Project 5: Supporting Collaborative Capacity-Building and Peer-Learning	
5.1) Conduct, convene, organize, and report on between 8-10 site visits, peer to peer learning events, webinars, or workshops that bring together research scientists from RMRS, other federal agencies, and universities with participants of place-based forest collaboratives to transfer knowledge about, and assist in the development of, science-based methods for collaborative planning, assessment, monitoring, and adaptive management.	Camille Stevens-Rumann (CFRI) co-delivered online webinar with colleagues J. Coop and S. Parks (RMRS) titled "Forest type conversions: how are our landscapes changing" for the North American Congress for Conservation Biology. Virtual, July 2020.

CFRI staff helped co-organize the semi-annual Colorado Forest Collaboratives Summit, August 5, 2020 (virtual conference). CFRI Director Tony Cheng delivered presentation, "Statewide network and capacity resources for forest collaboratives: Oregon example" to seed discussion and follow-up actions for Colorado's forest collaboratives.

CFRI staff Ben Gannon delivered presentation and lead discussion with Long's Peak Society of American Forester's Meeting: Wildfire risk to water supplies and prioritizing forest management – (August 20, 2020)

Delivered presentation: Creating inclusive and actionable community wildfire protection plans. Co-presented by Ben Gannon (CFRI) and Megan Matonis (Forest Stewards Guild), Colorado Wildland Fire Conference – Virtual (September 2020).

In November of 2020, Camille Stevens-Rumann (CFRI) delivered a presentation titled "Post-fire tree regeneration in a changing world" for a virtual graduate seminar at Northern Arizona University School of Forestry

Ben Gannon delivered presentation titled: An operationally relevant framework for mapping spot fire transmission potential. 1st International Electronic Conference on Forests – Virtual (November 2020). https://sciforum.net/paper/view/8001

CFRI Assistant Director Brett Wolk participated as an expert panelist with USFS Regional Office staff, Colorado State Forest Service, and Denver |

| | Water, November 18th, 2020, on a virtual tour discussing how forest management activities are used improve watershed resilience at the Water in the West symposium. The audience included journalists, K-12 educators, corporate executives, and restoration practitioners. Video link: https://www.youtube.com/watch?v=gwk8LTLvLMU

CFRI personnel Marin Chambers, Tony Cheng and Brett Wolk participated in a peer-learning exchange with forest collaboratives in Arizona and New Mexico December 10, 2020 and delivered presentation, "Adaptive management case studies".

Marin Chambers provided expertise for National Climate-Fire Synthesis workshop, convened and organized by The Nature Conservancy: Estimating the Climate Mitigation Potential of Colorado's Natural and Working Lands. Virtual, January 6th, 2021.

CFRI Co-convened and co-organized a webinar series titled Forests, Fire, and People, with the Institute for Science and Policy at the Denver Museum of Nature and Science and the Center for Collaborative Conservation. This 4 part series in March and April 2021 included invited experts exploring different aspects of wildfire for a general public audience. CFRI staff Camille Stevens-Rumann lead a webinar discussing the latest science on the ecology of forest wildfire ecology and management, and Tony Cheng lead a webinar discussing the future of western wildfires and future policy challenges and solutions. Videos of presentations available on DMNS website: https://institute.dmns.org/perspectives/series/forests-fires-and-people/

CFRI staff contributed to a Colorado Wildfires 2020 webinar series hosted by the Southern Rockies Fire Science Network, Forest Stewards Guild, Graduate Degree Program in Ecology at CSU, and CSU Department of Agricultural Biology. Webinars were broadcast for a wide range of CSU affiliates and collaborative partners (average 100+ attendees). Planning occurred in fall 2020, with webinars occurring January through April 2021. https://mcusercontent.com/2263fe298f4df255d22b80097/files/bf72cb29-bfe6-4773-8e03-522a92d5693e/ECOL_592_Announcement_New.01.pdf?mc_cid=e902712c0e&mc_eid=c2e4c64c65
CFRI staff led 4 different presentations in the series.
- Camille Stevens-Rumann: Overview of fire ecology.
- Tony Cheng: History forest/fire management and policy.
- Mike Caggiano and Richard Thorpe (Fort Collins City Utilities): Fire effects on ecosystem services.
- Marin Chambers and Chuck Rhoades (USFS RMRS): Cameron Peak & East Troublesome fires: Short-term post-fire land management. |

For agreement number 21-DG-11030000-018, CFRI reports the following cumulative accomplishments toward each project deliverables in the work plan for dates while the agreement was active, including July 1st, 2021 through December 31st, 2021:

Deliverable	Status of Deliverables
Project 1. Develop and deploy outcomes-based, climate-forward decision support for Shared Stewardship of forest landscape resilience and co-managing wildfire risk.	
1.1 Working with USFS Region 2, continue to assist in co-developing and facilitating partnership engagement for regional or state of Colorado all-lands wildfire risk assessment processes with land and fire managers across jurisdictions and ownerships. This includes working with targeted partners to identify Highly Valued Resources and Assets (HVRA's) and climate change considerations that will help frame the risk assessment outputs.	CFRI staff remain in contact with USFS Rocky Mountain Region 2 fire and fuels staff to facilitate application of the Colorado All-Lands wildfire risk assessment when final data products are available. CFRI Leadership Tony Cheng, Brett Wolk, and Camille Stevens-Rumann, and other staff as appropriate have coordinated and participated in monthly meetings with Rocky Mountain Region leadership to develop shared strategic directions, share lessons learned from monitoring outcomes, hear needs of regional office staff, and develop shared projects.
1.2 In coordination with the Colorado State Forest Service, support cross boundary application of the updated Statewide Forest Action Plan.	In Progress, co-developing a plan with CSFS staff to continue supporting Forest Action Plan implementation into the next year.
1.3 Participate in the Colorado Natural Resources Conservation Service Forest Advisory Committee to develop priorities and advise on strategic prioritization of NRCS forestry conservation practices across the state.	In Progress, CFRI staff have stayed in contact with NRCS Forest Advisory Committee members and plan to continue contributing to NRCS statewide efforts in the coming year.

1.4 Working with RMRS and FAM, continue to support development, implementation, and integration of cross boundary landscape planning and prioritization tools in 4 - 6 landscapes, with a focus on linking spatial fire planning (PODS) and climate change considerations with outcome-based prioritization of forest and fuels management objectives (e.g. RADS, etc.) across multiple scales of planning and implementation.	CFRI staff initiated contact, are organizing collaborative partners, and developing analytical products to facilitate PODs workshops for the Boise National Forest and Caribou-Targhee National Forest in early 2022.
1.5 Continue supporting partners to apply tools to streamline collaborative spatial fire planning analytical processes that facilitate updating, refining, and maintaining <u>existing</u> mapping and prioritization efforts on 4-6 landscapes where PODS or other prioritization methods have already been developed and applied.	In Progress, CFRI staff plan to continue updating PODs where they already exist by coordinating data updates with RMRS partners, local forest staff, and other non-forest service collaborators where PODs are developed in cross-boundary landscapes.
1.6 Deliver 8-12 presentations at professional meetings, peer to peer learning events, academic-oriented conferences, and policy-maker briefings to report on the range of methodologies, approaches, and planning processes being used to enhance co-	CFRI staff Brett Wolk delivered presentation as invited guest for discussion with Rural Voices for Conservation Coalition governance strategies for large landscape partnerships peer learning group. Presentation titled: titled: "Knowledge Co-Production Tools To Align Collaborative Actionable Knowledge." September 8th, 2021. https://cfri.box.com/s/03538i94lgn07hddsv9h4yettk2bg5qk The video of this presentation has been shared widely amongst collaborative partners in the Pacific Northwest to facilitate broader understanding of CFRI experience applying spatial analytical tools in a social collaborative context.

Mike Caggiano organized and moderated a panel discussion, in coordination with RMRS and other partners, to explore applications and |

management of wildfire risk in the western US.	outcomes of pre-fire planning strategies at the Colorado Wildland Fire Conference titled "Potential Operational Delineations: Use and Development in Colorado." Grand Junction, Colorado, September 23rd, 2021. Ch'aska Huayhuaca, along with co-presenters Forrester, C. and Wegert, S. delivered presentation titled: Linking Community & Science Through Landscape-Scale Forest Restoration Planning in the St. Vrain Watershed. Colorado Wildland Fire Conference, Grand Junction, CO, Sept. 23, 2021.
1.7 Working closely with partners such as the RMRS Wildfire Risk Management Team and the other SWERI institutes, produce 2-4 technical documents or applied scientific publications that document lessons learned through deployment of spatial analytical decision support processes across the West.	In Progress. CFRI staff, in collaboration with the other SWERI's, are working on a survey of managers across the western USA about applications of PODs framework and USFS Risk Management Assistance products to inform decisions during active wildfire incidents, as well as applications of PODs to inform non-wildfire incident planning efforts.
1.8 Produce 4-6 communication and outreach resources (technical briefs, blog posts, webinars, etc.) to facilitate the broader understanding and application of analytical decision support tools and collaborative planning processes that support strategic investments in cross boundary forest and fire management. Focus on documenting lessons learned that provide guidance for diverse stakeholders to assess what risk assessment and prioritization tools are appropriate for different planning and evaluation	In Progress.

purposes, including translating information into languages other than English and increasing accessibility to people from diverse backgrounds.	
Project 2. Support knowledge transfer, integration, and application of climate-forward assessment, monitoring, and adaptive management strategies to enhance the capacity of affected entities and their partners for collaborative, cross-boundary forest landscape restoration and climate adaptation planning.	
2.1 Produce and disseminate between 2-4 technical documents regarding multi-party monitoring strategies and results from collaborative forest landscape management projects.	In Progress.
2.2 Conduct and report on between 3-5 field-based workshops for multi-stakeholder collaboratives to review and deliberate treatment effects and desired conditions.	In progress.
2.3 In coordination with National Restoration Planning and CFLRP Program administrators and other SWERI Institutes, develop, deploy, and report on the effectiveness of "collaboration resilience" assessment methodologies for projects selected for the CFLRP program to support program reporting and adaptive management.	Tyler Beeton and other CFRI staff engaged with collaborative members in southwest Colorado and northern New Mexico to develop and implement a collaborative governance indicator with the Rio Chama and Southwest Colorado CFLRP. CFRI staff Tyler Beeton and others engaged numerous times with the Northern Blues CFLRP and All-Lands partnership to facilitate development and application of survey based collaboration indicator framework to help the group develop a collaborative baseline and inform the national CFLRP monitoring strategy. CFRI staff also began engagement with the Mountain Studies Institute and others on ways to integrate a similar collaborative governance survey into the 2-3-2 Partnership and Rio Chama CFLRP in the coming year to meet their CFLRP requirements for monitoring and inform their collaborative process moving forward.

2.4 In collaboration with the other SWERIs, USFS, and other partners, convene a regional cross-boundary landscape restoration workshop or series of smaller workshops, with land managers, researchers, and their stakeholders focused on applications of and lessons learned across a range of topics advancing management planning, implementation, monitoring, and adaptive management in the Intermountain West and Southwest.	In progress, CFRI staff are co-leading planning for a Cross Boundary Landscape Restoration workshop scheduled for March 7-10th, 2022, at Colorado State University in Fort Collins, Colorado. CFRI staff secured a meeting venue at Colorado State University, developed the registration website, and is overseeing all financial and logistical considerations for the workshop.
2.5 Working with the Rocky Mountain Research Station, document, produce, and disseminate 2-4 applied scientific publications that leverage data, results, and adaptive management processes from broad-scale monitoring, collaborative forest landscape management, wildfire risk co-management approaches, and/or post-fire, climate-forward forest recovery and resilience research.	In Progress.
2.6 Convene and report on between 4-6 webinars, presentations, or peer to peer learning events documenting and distributing monitoring methods, results, and adaptive management processes to research	Huayhuaca, C. (2021, Nov. 5). Defining Collaboration: insights from the Atlas of Collaborative Conservation in Colorado. Invited presentation for US Fish and Wildlife Service Science Applications Community of Practice, virtual.

colleagues or multi-stakeholder forest landscape management initiatives focused on forest health, wildfire risk mitigation, and/or post-fire watershed risk reduction and forest recovery and resilience.	
Project 3. Monitor and evaluate outcomes of cross-boundary collaborative forest landscape restoration, wildfire risk reduction, and climate adaptation programs and projects.	
3.1 Support the collection, data management, analysis, and reporting for monitoring data for between 3-5 forest restoration or fuel treatment projects, with specific emphasis on: a. Monitoring the effectiveness of mechanical and/or prescribed fire forest treatments on desired outcomes and conditions; b. Conducting project to landscape scale remote sensing analysis to produce outcome measures of the resilience of forest conditions to potential large fires and climate change; c. Developing more robust cost-benefit analyses to compare treatment costs with a range of outcomes measures; d. Leveraging existing monitoring networks to collect longer term data that enhances	In Progress, CFRI staff anticipate continuing to support monitoring efforts in 2022 with the Upper South Platte Partnership, post-fire vegetation community development following several wildfires throughout Colorado and the Interior West, monitoring methods to better describe long term individual tree resilience and growth responses to thinning and prescribed fire treatments, and landscape monitoring metrics of cumulative wildfire risk reduction for place-based cross boundary collaborative forest and watershed management groups.

knowledge of long-term post-treatment and post-fire forest conditions as the climate changes.	
3.2 Document and report on 2-4 monitoring methods to make monitoring protocols more accessible and transparent for other organizations to apply and understand. This includes plot-based field monitoring, remote sensing landscape monitoring techniques, socio-economic monitoring approaches, and/or data management strategies.	In Progress, CFRI continues development of a monitoring handbook to make field based and remote sensing monitoring protocols more accessible to a wider audience. Effort will also be dedicated to improving documentation of data management frameworks and strategies for collaborative monitoring efforts.
3.3 Complete 2-4 technical reports summarizing monitoring results regarding the effect of forest vegetation treatment on achieving desired forest resilience goals, fuel treatment interactions with wildfires, post-fire forest and watershed recovery, and socio-economic aspects of forest restoration and wildfire risk reduction actions.	In Progress.
3.4 Provide between 2-4 technical assistance and training modules to build capacity for monitoring data collection, analysis, and/or application of results for assessing monitoring data trends for the Colorado State Forest Service and 1-3	In Progress, CFRI staff have maintained communication with CSFS leadership and staff in Science and Data, and Forest Planning and Implementation divisions to coordinate and leverage CFRI expertise and resources to help inform CSFS intention to hire additional monitoring and adaptive management capacity.

additional support organizations or forest, fire, or watershed collaborative groups.	
Project 4. Climate-forward decision support for post-fire recovery and restoration.	
4.1 Based on post-fire needs assessment activities in FY20 work plan, develop, deploy, and report on pilot decision support methodology to inform operational, climate-forward reforestation strategies.	In Progress.
4.2 Co-convene, facilitate, and report on between 2-4 field workshops involving forest and watershed managers, and interested and affected stakeholders, to examine post-fire reforestation successes and failures, and strategies for climate-forward post-fire forest recovery.	In Progress.
4.3 Develop, deploy, and report on post-fire erosion risk analysis and priority investment decision support methods for watershed values-at-risk for between 2-4 catchment areas.	In Progress.
Project 5: Translate science principles into practice.	
5.1 Co-convene, facilitate, and report on between 6 – 10 science delivery products (i.e., fact sheets, technical briefs) spanning high-demand topic areas identified by affected	In Progress.

entities, including, but not limited: a. Practitioner-focused lessons learned for restoring Ponderosa pine and dry mixed-conifer forests in the Southwest and Colorado Front Range, based on RMRS-GTR-310 and RMRS-GTR-373, respectively. b. Lessons learned from applications of risk assessment decision support methodologies to prioritize forest restoration and wildfire risk management actions at multiple scales, from Community Wildfire Protection Plans to large watersheds encompassing multiple ownerships and jurisdictions to regional or national programs. c. Lessons learned from applications of the Potential Operational Delineations (PODs) framework to advance pre-fire fuel treatment planning and cross-boundary wildfire response. d. Methods and best practices to enhance collaborative resilience for cross-boundary shared	

	stewardship of high-priority landscapes. e. Operationalizing climate change decision support tools to inform forest landscape planning and wildfire risk assessments.	
5.2 Develop, maintain and regularly update CFRI online platforms and social media to communicate latest science applications that produced outcomes from forest restoration and wildfire risk management projects and programs.	CFRI staff have developed a plan to improve organization and search function on the CFRI Publications webpage, improve organization and information About CFRI, and continue growing social media strategies and coordinated stories to deliver relevant information that informs forest restoration and wildfire risk reduction projects and programs.	
5.3 Synchronize science application and communication events with other SWERIs, Fire Science Exchange Networks, RMRS, and other research entities that feature between 2-4 case studies of ways in which managers and their stakeholders actually used scientific results and decision support methodologies to produce measurable outcomes. These may include, but not limited to: webinars, story maps, or multi-media expositions.	In Progress.	
6. Collaborative capacity-building and peer-learning across diverse perspectives		
6.1 Conduct, convene, organize, and report on between 8-10 site visits, peer to peer learning events, webinars, or	Camille Stevens-Rumann delivered an invited keynote talk titled Fungi through the flames: understanding fungi response to fire. Telluride Mushroom Festival, August 2021, Telluride, Colorado.	

workshops that bring together research scientists from RMRS, other federal agencies, and universities with participants of place-based forest collaboratives to transfer knowledge about, and assist in the development of, science-based methods for collaborative planning, assessment, monitoring, and adaptive management.	Camille Stevens-Rumann delivered a talk with co-authors Jonathan Coop (Western State University), Sean Parks (USFS Rocky Mountain Research Station), and Susan Pritchard (U. Washington) titled: Wildfire-driven conversion and metrics for regeneration failure. Ecological Society of America conference, August 6th, 2021. Camille Stevens-Rumann delivered an invited talk titled "Quantifying forest resilience in an era of change." Biology Department Fall Seminar, University of New Mexico, September 2021. Ch'aska Huayhuaca coordinated roundtable presentations and moderated a panel discussion with collaborative partners from Fire Adapted Colorado, NRCS, The Nature Conservancy, and Mountain Studies Institute titled: Community Capacity for Collaboratives. Western Governors' Association: Working Lands, Working Communities Workshop, Denver, CO, United States. Oct. 7, 2021. Camille Stevens-Rumann participated as panelist on the Colorado State University Climate Adaptation Partnership Panel discussion, open to the public, titled: Fire Climate Adaptation Challenges. October 2021, Fort Collins, Colorado.
6.2 Conduct a needs assessment that examines the capacities, constraints, and opportunities for CFRI to implement an internship program focused on building collaborative capacity, enhancing peer to peer learning, and/or providing workforce training for traditionally underrepresented populations in forestry and fire collaborative adaptive management processes.	An initial, informal assessment of CFRI capacity identified a need for additional CFRI staff education and shared understanding of diversity, equity, and inclusion principles in order to effectively develop a program to better serve outside partners. In the fall of 2021, CFRI worked with experts from the CSU Warner College of Natural Resources office of Diversity and Inclusion to host a workshop for CFRI staff to develop a shared understanding of Diversity, Equity, and Inclusion amongst staff. Following the workshop, a CFRI team was formed around Diversity, Equity, Inclusion, and Social Justice to increase understanding and practice of DEI principles within CFRI and carry out a needs assessment of capacities, constraints, and opportunities for CFRI to better incorporate traditionally underrepresented populations and individuals in forestry and fire research and collaborative adaptive management.