Sponsored Projects Office
University of California, Berkeley
1608 Fourth Street, Suite 220
Berkeley, CA 94710-1749

Principal Investigator: [redacted]
Sponsor: **California Department of Forestry and Fire Protection**
Project Title: **A critical evaluation of Forest Practice Regulation's capacity to accommodate forest restoration and resilience targets**
Reference: **34832**

We are pleased to submit the enclosed proposal on behalf of The Regents of the University of California Berkeley Campus. Should this proposal be funded, award documents should be issued using the information provided below. Please contact the undersigned if you have any questions or need additional information regarding this proposal.

Endorsed for the Regents by:

10/25/2022

[redacted]

AWARDS SHOULD BE MADE TO:	CHECKS SHOULD BE MADE PAYABLE TO:
The Regents of the University of California	**The Regents of the University of California**
c/o Sponsored Projects Office [redacted]	CHECKS SHOULD BE SENT TO: Contracts & Grants Accounting [redacted]

Project# EMC-2022-004

October, 2022

A critical evaluation of the Forest Practice Regulation's capacity to accommodate forest restoration and resilience targets

[redacted], Assistant Professor of Cooperative Extension, UC Berkeley

[redacted] UC Agriculture and Natural Resources Forestry Advisor, Plumas County

[redacted] Adjunct Professor of Forest Science, UC Berkeley and Forest Scientist, USFS Pacific Southwest Research Station

Project Duration and Dates: 05/23 – 12/24

"If forests that historically had frequent-fire disturbance regimes were characterized by minimal competition, many current post-treatment targets are probably misaligned with creating resilience…

Instead of 35% representing a *minimum* stocking level, our analysis suggests that it may more appropriately represent a *maximum* stocking level."

-North et al. 2022. Forest Ecology and Management

Background and Justification

Forest restoration and resilience are commonly stated goals in dry mixed conifer forests of the Sierra Nevada and Southern Cascades, including in the agreement for Shared Stewardship of California's Forest and Rangelands between the state of California and the USDA Forest Service, PSW Region. To be useful as goals that guide current practice, however, these goals need to be defined with specific targets of achieving certain forest structures at the stand level. The processes and treatment schedules that will sustain the structures, once achieved, also need to be articulated in silvicultural prescriptions that cover time frames long enough to be relevant at the temporal scales of forest development. A growing set of studies have been done that could enable managers to conduct restoration and resilience treatments with more clarity and less ambiguity. These studies come from the discovery and subsequent publication of archived historical forest inventory data, and have been used to quantify forest structure under historic climatic and disturbance regimes. Numerous studies have been done for dry mixed conifer forests with frequent, low severity fire regimes where forest structures have changed dramatically as a result of fire suppression. Such datasets are particularly valuable because the observations are free of the biases that come from other forms of reconstructions such as photographs, oral accounts, and backwards modeling. In addition, historic inventories are particularly powerful because these original inventories are plot-based and provide statistically robust estimates of forest stocking metrics like basal area and relative density (e.g. Collins et al. 2015; Stephens et al. 2015). In other words, we can calculate the structures of the past using the presently common metrics of today.

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While an ecological framework for the concept of using historical data to guide treatments has been suggested (North et al. 2022), there are still no meta-studies that have provided an evaluation of how the collective of these reconstructed studies can be used on a practical level to guide management. To be useful for mangers broadly, the various studies need to be compiled and summarized as one body of work, similar to Tamm Reviews that are focused on applying to potential policy changes (e.g. Hessubrg et al 2016). This would provide critical information about the variability among regions (e.g. southern v. northern Sierra Nevada) and forest types (e.g. mixed conifer versus pine dominated forests). Of further value will be up-to-date guides on the use of competition indices (e.g. Stand Density Index) to manage stand level stocking. Finally, and arguably most importantly for practicing foresters, the studies have not been put into an applied context that considers the various practical constraints that exist or that may be modified to allow the studies to be used.

There are two management-specific contexts that need to be considered:

1. **Context of regulations.** Many of the studies suggest that, if historical structures were to be restored, they would often be in conflict with current regulations or guidelines on both federal and private forestland. This is because most regulations and guidelines have been applied within the context of protecting the habitat and long-term growth-and-yield timber value that tends to be associated with *high* forest density. Regulations and guidelines tend not to protect values of high tree vigor and within-stand spatial complexities that are associated with *low* forest density.

2. **Context of forest management.** Managing for resilience and restoration involves long-term planning and defining subsequent silvicultural objectives, strategies, and tactics. Reducing canopy densities to the levels that were sustained under a frequent fire regime dominated by lightning ignitions and ubiquitous Indigenous land management would have dramatic implications for long-term silvicultural planning. Disturbances that create sparse canopies, even when they are dominated by large trees, inevitably lead to either the initiation of a new cohort of shrubs and trees or the release of an existing one. This pattern is so well understood that the California Forest Practice rules rely on it as an acceptable regeneration method (i.e. *shelterwood,* Title 14 CCR 913.1). This method, if done in a manner to meet the rules' intent, is designed to create single-aged stands that are dissimilar to the multi-aged structures that were once maintained by historic fire regimes (Safford and Stevens 2017). If the method is used but is not done in a manner that meets the rules' intent, then the result can be either a high graded stand vulnerable to high severity fire (York 2015), or a stand of sparse large trees with a dense mid-story. The forests of the past had a mechanism for avoiding structures such structures. Low intensity fires maintained low tree density structures, keeping small-tree densities and shrubs from developing while allowing enough survival to replace large trees (York et al. 2022). With that mechanism gone, either the periodic use of prescribed fire or non-fire silvicultural treatments targeted to create desired structures are the only options for avoiding the loss of the restoration and resilience gains that have been made. Thus regulations need to be evaluated, not just by identifying conflicts with creating restored structures presently, but also within the context of maintaining and enhancing them in the future (Figure 1).

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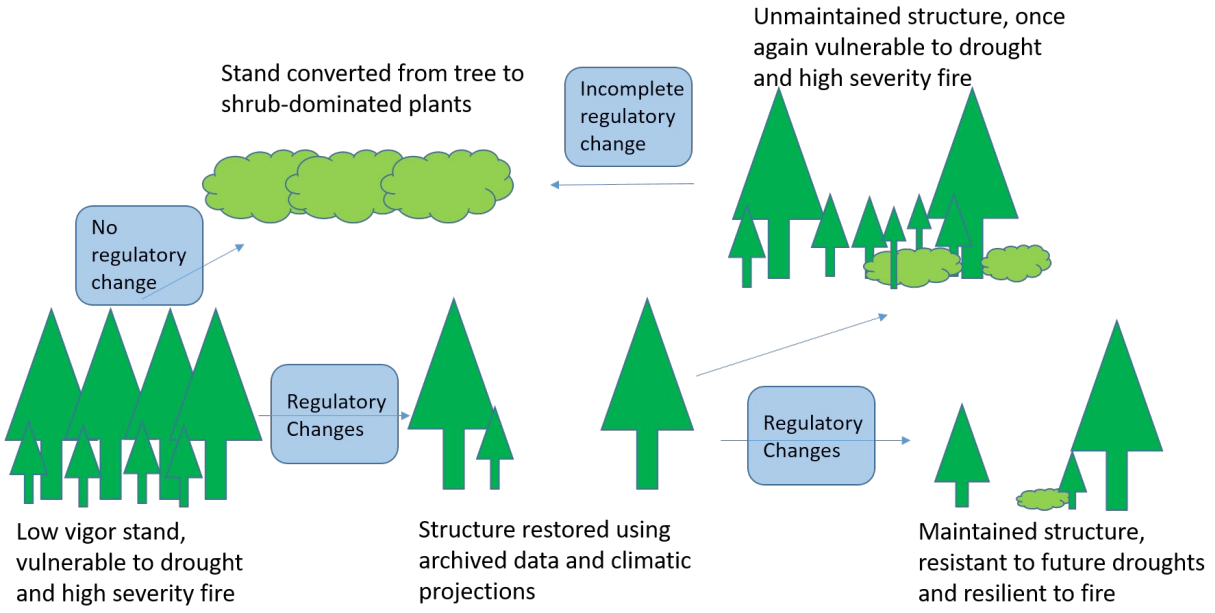

Figure 1. The potential influence of forest practice regulations on facilitating the creation and maintenance of restored forest structures that are resistant to shrubland conversion.

Research Questions, Objectives, and Scope

California forest practice regulations rely heavily on basal area as the primary metric for retention requirements during any selection or thinning harvest (e.g. Title 14 CCR 913.2(a)(2)(A); CCR 913.3(a)(1)(A)). Basal area is a useful metric because it is easy to measure and it is correlated with the leaf area, which is the most precise measure of stocking. However, a single basal area metric can represent various forest structures of differing size and stocking per acre, and the relationship between basal area and leaf area is non-linear. As managers look to use historical, fire-maintained structures as a reference for developing prescriptions focused on restoration or concepts of resilience, they find limitations in using basal area on its own and they find conflicts between the ideal of restoration and the intent of the Forest Practice Rules (FPR's). Historic basal areas that have been discovered are often far below those suggested currently in the FPR's, which intend to maintain high levels of growth and yield for timber production (Title 14 CCR 913.11). For example, Collins et al.'s (2015) historical data suggested an average basal area of ranging between 43-131 ft2/acre in dry mixed conifer forests. This level of stocking conflicts with retention standards in the FPR's in several instances.

Furthermore, recent studies (Goodwin et al. 2020; Bernal et al. 2022) have suggested that stocking targets may still be too high given an objective of resisting predicted climatic stress. To date, however, a compilation of the results of these studies has not been done and put into a context of the Forest Practice Regulations. We are proposing to provide this compilation and critical analysis. This would also inform applied practices by mid-size industrial and non-industrial private forest managers who are interested in applying restoration treatments and preparing stands for the future climate.

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In this proposal, we are interested in critically examining (we mean "critical" in its productive, and not negative sense) how current Forest Practice Regulations can facilitate or preclude meeting forest restoration and resilience desired condition targets as defined by research on historic forest inventory datasets. Specifically, we aim to compile the range of historical forest stocking measures from the best available research for these ecosystems, compare this range to current Forest Practice Rules for the dry mixed conifer forests in California, and explore the silvicultural methods to reach these restoration and resilience targets. Study questions include:

1. What is the distribution of basal areas and relative stand densities that have been found by forest type?

2. How do the Forest Practice Regulation standards for basal area and large tree retention either conflict with or are compatible with stand structure metrics (e.g. relative density, basal area, trees per acre, and QMD) of historical reconstruction studies?

3. Through converting available data into Relative Stand Density Index and through growth and yield modelling of case-study data, what are the potential growth and yield impacts of using historical structure and drought resistance as an alternative retention target? How might retaining riparian areas as areas of higher stocking density increase stand-level yield?

4. What are the long-term management implications for maintaining restored forest structures once they are achieved?

Methods

Our proposal would rely on a literature review and synthesis of the available research using historical forest inventories to compile a range of variability. This would also include outreach and discussion with forest managers who are trying to meet restoration goals through current FPRs as well as any necessary collaboration with the Board of Forestry management committee. To accomplish this, we propose to fund a Master of Forestry student to work one summer and two semesters. They will compile relevant studies into a table that describes study sites, forest types, time period of data collection, density, basal area, diameter, and SDI. The FPR's will be overlaid with the distributions of data to reveal the extent to which retention targets that aimed for historical conditions conflict with the FPR's.

Considering the implications of Bernal et al. (2022), a scenario exercise will be used that assumes that historical basal area needs to be reduced even further- by 25% in order to avoid undesired drought-related mortality. Growth and yield modeling will be used to demonstrate the "cost" of maintaining stocking levels that are conventionally thought of as unproductive with respect to long-term growth and yield. The targeted publication is California Agriculture, which encourages applied studies such as this. A future publication, should the project be extended, could include a TAMM review in Forest Ecology and Management.

Importantly, our methods include a direct outreach component to forest managers. We will conduct outreach by establishing two field demonstration sites. The sites will be chosen to include mature forest stands that are adjacent to riparian areas. Uphill of the riparian areas, we will conduct a demonstration mark that reduces density to historical conditions and to conditions that are predicted to be necessary for maintaining vigor in a future drought-stressed climate. The riparian area will also be marked, demonstrating the option of maintaining some wetter sites with higher density. Further outreach will

occur via a targeted UC ANR publication about the tools that can be used to develop marking guidelines. This will focus on how standard forest inventory can be used to calculate SDI and how marking guidelines can be developed.

Scientific Uncertainty and Geographic Applicability

We believe this research aligns well with the efforts of the Board of Forestry's Management Committee to understand how current regulations of forest stocking may or may not be compatible with restoration targets or desired resilience conditions for California forests in the 21st century. Defining quantified restoration and resilience targets, and comparison to Forest Practice Rules are not only important for clear translation of science to management objectives and silvicultural prescription targets, but also to inform the critical monitoring questions prioritized by the EMC: 6c & 8b. We believe this endeavor will inform how well FPRs meet desired forest structure and fuel profiles that is more resistant and resilient to compounding tree mortality and wildfire disturbances (6c). This research also can inform desired conditions and management strategies for uneven-age late seral stands that are not only resistant to wildfire but provide resiliency of large diameter pine tree distributions, the "ecological backbones" of late seral forest ecosystems.

The applicability of this research would be broad across the frequent fire, dry mixed conifer forests in California (i.e. the Northern and Southern Districts defined in the Forest Practice Rules) which are most vulnerable to negative and compounding impacts from uncharacteristic drought and wildfire effects.

Critical Questions and Forest Practice Regulations Addressed

A well-established body of scientific literature argues that contemporary forests are far denser and more vulnerable to high severity fire than during historic conditions, and consequently in great need of forest restoration at landscape scales. The Shared Stewardship agreement between the State of California and the USDA Forest Service acknowledges this need and sets forth a plan wherein forests regulated by the state would be restored to improve resilience. Fundamental to this effort is defining metrics of forest resilience and examining how these objectives can or cannot be achieve under the current Calif. FPRs. This would include exploring how certain FPR guidance for silvicultural techniques such as shelterwood, group selection, and selection thinning may or may not facilitate resilience restoration targets.

In addition, a growing body of science suggests that climate and subsequent levels of "normal" stocking may change throughout the century. This project also explores how contemporary FPR guidance may or may not be aligned with mid-century projections of forest sustainability and how past and present levels of stocking will compare with the coming future.

Collaborator Roles and Project Feasibility

Our team of principal investigators and collaborators are well engaged in the developing past and current research investigating historic forest structure and what this means for forest restoration and resilience in California. Our team includes university academics and extension professionals who understand the applied nature of the science and what this means for forest managers and practitioners on the ground. We are registered professional foresters who also have relationships with forest managers and have an acute understanding of the forest practice rules. [redacted] would be responsible for supervising the graduate student. [redacted] would be responsible for extension of findings to agency and land managers. [redacted] would serve as additional technical guidance and

review. As a collaborators, [redacted] bring extensive research in this subject area as well as research relationships with relevant industrial and non-industrial private land managers. We believe this project can be feasibly accomplished with graduate student and academic mentorship (which we are providing in-kind) within approximately a year, and that this could be well coordinated with the Board of Forestry Management committee's investigations on forest stocking guidelines.

Project Deliverables

- The graduate student research support will be dedicated to a Master of Forestry (MF) student, providing one extra year (beyond the four years provided by an undergraduate degree) of experience toward a Registered Professional Forester license. The MF program is the only one that exists in California. Most MF students from UCB go on to become RPF's, which are in extremely high demand in the forestry sector.
- Our primary goal is to publish an applied article in California Agriculture targeted toward practicing foresters and policy makers. This will provide the foundation for additional extension and outreach products in the future, and may also reveal new study directions.
- We plan to deliver an ANR-published guide to translating standard forest inventory data into Stand Density Index targets and creating marking guidelines. This will provide the "nuts and bolts" of how to use our study results on the ground.
- Using summer field work, we plan to develop demonstrations at sites in the Southern and Northern Districts, visualizing the marking and conversion of a well-stocked stand for restoration and resilience. At the Southern District site, the demonstration area will be located uphill of a riparian fuel treatment site. This will juxtapose thinning to very low densities versus moderate densities in riparian areas.
- We will use this study as an opportunity to propose a field trial of an idealized approach to using archived data and SDI to both create and maintain resilient structures. This will involve proposing a new experimental forest designation to the CA Board of Forestry. The designation will be proposed at Flatwoods Research Forest in Shasta County, a new site within the Berkeley Forests network of research forests.
- We plan to provide field tours in the fall of 2024 in both the Southern and Northern Districts, targeted toward professionals. These will provide both ecological frameworks and practical field content, provided by our team of researchers and Registered Professional Foresters.

Activity or Deliverable	Type	**Year 1 (07/22-06/23)**	**Year 2 (07/23-06/24)**	**Year 3 (07/24-06/25)**
Propose experimental forestland designation to BOF	Activity	X		
Interview professionals who are using SDI for stocking control	Activity	X		

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Publish guide for using SDI	Deliverable		X	
Compile publications of historical data	Activity		X	
Use G+Y modelling with case-study data	Activity		X	
Develop field demonstrations of marking for tree vigor with SDI	Deliverable			X
Field tours	Deliverable			X
Manuscript submitted to journal	Deliverable			X
MF degree/experience toward RPF license	Deliverable			X

Requested Funding

Category	**Description**	**Year 1 (07/22-06/23)**	**Year 2 (07/23-06/24)**	**Year 3 (07/24-06/25)**	**Total**
Personnel salaries and wages	GSR, Fall 24, Summer 24, Spring 25, and PI 0.4 mo in Year 3		$20,090	$24,930	$45,020
Fringe benefits	Student CBR at 2.8%, 2 semesters Tuition Remission, Academic CBR at 35.4%		$11,508	$13,597	$25,105
Contractual expenses					
Operating expenses					
Travel	Travel and housing, Year 3			$3,000	$3,000
Other	GAEL at 1.75% of salaries		$352	$436	$788
Indirect cost	15% of TDC		$4,793	$6,294	$11,087
EMC Funding requested					
Total Budget			**$36,743**	**$48,257**	**$85,000**

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Additional Required Forms

EIN: [redacted]

References

Bernal, A.A. Stephens, S.L., Collins, B.M., Battles, J.J. 2022. Biomass stocks in California's fire-prone forests: mismatch in ecology and policy. Envir. Res. Let. 044047

Collins, B.M., Lyderson, J.M., Everett, R.G., Fry, D.L., Stephens, S.L. 2015. Novel characterization of landscape level variability in historic vegetation structure. Ecol. Appl. 25(5): 1167-1174

Goodwin, M.J., North, M.P., Zald, H.S.J., Hurteau, M.D., 2020. Changing climate reallocates the carbon debt of frequent-fire forests. Glob. Change Biol. 26 (11), 6180–6189

Hessburg, P.F., Miller, C.J, et al. 2019. Climate, environment, and disturbance history govern resilience of western North American Forests. Front. Ecol. Evol. 7, 239

North, M.P., Tompkins, R.E., Bernal, A.A., Collins, B.M., Stephens, S.L., York, R.A. 222. Operational resilience in western US frequent-fire forests. Forest Ecology and Management 507: 120004

Safford, H.D. and Stevens, J.T., 2017. Natural range of variation for yellow pine and mixed-conifer forests in the Sierra Nevada, southern Cascades, and Modoc and Inyo National Forests, California, USA. *Gen. Tech. Rep. PSW-GTR-256. Albany, CA: US Department of Agriculture, Forest Service, Pacific Southwest Research Station. 229 p., 256*.

Stephens, S.L., Lydersen, J.M., Collins, B.M., Fry, D.L., Meyer, M.D., 2015. Historical and current landscape-scale ponderosa pine and mixed conifer forest structure in the southern Sierra Nevada. Ecosphere 6 (5), art79.

UNIVERSITY OF CALIFORNIA, BERKELEY

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SPONSORED PROJECTS OFFICE
[redacted]

[redacted]

August 8, 2012

ASSOCIATE DIRECTORS—SPONSORED PROJECTS OFFICE

Delegation of Authority 2569—To Solicit and Accept or Execute Certain Extramural Grants and Contracts

In accordance with the attached redelegations of authority, including the August 1, 2012 redelegation to the Director—Sponsored Projects Office, I redelegate to the Associate Directors of the Sponsored Projects Office the authority to solicit and accept or execute certain extramural grants and contracts in an amount not to exceed $10,000,000 in direct costs in any one project year, subject to the limitations articulated in the attached letter re: Delegation of Authority 2569 dated June 29, 2012 to the Vice Chancellor for Research.

This redelegation is effective immediately and may not be redelegated.

Sincerely,

[redacted]

Director

I concur with this redelegation.

[redacted]

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[redacted]

Professor of Physics
Professor of Materials Science and Engineering

[redacted]

June 29, 2012

DA 2569

VICE CHANCELLOR FOR RESEARCH

RE: Delegation of Authority 2569 – To Solicit and Accept or Execute Certain Extramural Grants and Contracts

In accordance with President Yudof's letter to Chancellors of April 19, 2012, and Standing Order 100.4(dd), I am redelegating to you, as the Vice Chancellor – Research, the authority to solicit and accept or execute certain extramural grants and contracts in an amount not to exceed $10,000,000 in direct costs in any one project year, subject to the limitations below.

You may not execute contracts or grants that exceed the following direct costs:

a. $10,000,000 in direct costs in any one project year for contracts and grants where the campus is prime awardee and the sponsor is a federal or a State of California agency; or

b. $10,000,000 in direct costs in any one project year for subawards from higher education institutions or a State of California agency for which the source of funds is an award from a federal or State of California agency; or

c. $5,000,000 in direct costs in any one project year for contracts or grants except as specified above.

This delegation does not include the authority to solicit, accept, or execute documents that:

a. Contain provisions falling within the restrictions and limitations set forth in Standing Order 100.4 (dd). In particular, with regard to this delegation, note that Standing Order 100.4 (dd) requires specific authorization by The Regents for:

   1. Exceptions to approved University programs and policies or obligations on the part of the University to expenditures or costs for which there is no established fund source or which requires the construction of facilities not previously approved.

   9. Agreements by which the University assumes liability for conduct of persons other than University officers, agents, employees, students, invitees, and guests. In circumstances where it is deemed necessary by the President, in consultation with the General Counsel, to indemnify non-University persons who have agreed at the University's request to serve as advisors on operational matters for conduct within the scope of their role as advisors, the President is authorized to provide for defense

and indemnification. This restriction does not apply to agreements under which the University assumes responsibility for the condition of property in its custody.

b. Include an unapproved arrangement for indirect costs which changes the rates or the bases thereof as promulgated by the President;

c. Require approval by the President or designee; or

d. Provide support for the sole purpose of constructing research facilities. For projects which include both a research and construction component, the contracts, grants and other documents must also be approved by University officials retaining the delegation of authority for construction projects, and must be in full compliance with the requirements separately required in that delegation.

For purposes of this delegation, the term "grant" includes grants from private source, but excludes gifts as defined in the Guidelines for Review of Gifts/Grants for Research issued by the President on July 8, 1980.

Campus procedures for preparation of proposals for extramural support and acceptance of grants or execution of contracts shall be in accordance with the University of California Contract and Grant Manual and with supplementary instructions as may be issued by the Office of the President.

Critical factors in processing contracts and grants are a review for legal sufficiency, compliance with University policies, and coordination with other campus offices and functions as appropriate, including legal counsel, risk management, and intellectual property managers.

This redelegation is effective as of April 19, 2012 and supersedes Delegation of Authority 2036 issued on April 3, 2008 and may be redelegated further. If you do redelegate, you must send a copy of the redelegation to the Office of Ethics, Risk and Compliance Services.

Please contact Campus Delegations Coordinator [redacted] Office of Ethics, Risk and Compliance Services, at [redacted] with any concerns you may have regarding this delegation of authority.

Yours sincerely,

[redacted]

Attachments: [redacted] letter of April 19, 2012 (DA 2569)
Redelegation letter of April 25, 2008 (DA 2036)

cc: [redacted]

University of California
Agriculture and Natural Resources
Cooperative Extension: Plumas, Sierra, & Lassen Counties

October 18, 2022

Sponsored Projects Office
University of California, Berkeley

[redacted]
Associate Professor of Cooperative Extension & Adjunct Associate Professor of Forestry
Environmental Science, Policy, & Management; College of Natural Resources
University of California, Berkeley

Re: CALFIRE Effectiveness Management Committee Proposal (Project# EMC-2022-004): A critical evaluation of the Forest Practice Regulation's capacity to accommodate forest restoration and resilience targets

Dear Sponsored Projects Office,

As a cooperative extension forester and natural resources advisor, I will serve as a UC ANR collaborator with [redacted] on the CALFIRE Effectiveness Management Committee Proposal (Project# EMC-2022-004): A critical evaluation of the Forest Practice Regulation's capacity to accommodate forest restoration and resilience targets.

This proposal builds on our past collaborative research: North, M.P., Tompkins, R.E., Bernal, A.A., Collins, B.M., Stephens, S.L. and York, R.A., 2022. Operational resilience in western US frequent-fire forests. Forest Ecology and Management, 507, p.120004.

I am committed as a collaborator on all aspects of the project including conceptual design, implementation, project deliverables, and extension of results to pertinent forest management clientele.

Should you have any questions or need for more information, please don't hesitate to contact me.

Sincerely,
[redacted]

[redacted]
Cooperative Extension Forester and Natural Resources Advisor, Registered Professional Forester [redacted]
University of California Agriculture & Natural Resources, Cooperative Extension
Plumas, Sierra, and Lassen Counties
[redacted]

[redacted]