a. ***Date Submitted:*** May 18th, 2026

b. ***Project Title:*** **Evaluating Vegetation Change, through an Eco-Cultural Approach, in Vulnerable, Long-Term Communities, to Enhance Wildfire Resilience and Riparian Protection in California Forest Landscapes**

c. ***Project #*** (leave blank; to be assigned by EMC)

d. ***Principal Investigator(s) (PI):***

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Kootzaduka'a Tribe in Mono County

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j. Project Description. In less than 2,000 words, provide a problem statement, research question, description of methods, including analysis and interpretation, and identified monitoring location(s).

Include:

i) Project Duration (Years/Months): 3 Years

ii) Background and Justification:

Advancements in big data-driven geospatial analytics, artificial intelligence, and machine learning are transforming forest and land management practices by enabling new approaches to analyzing, modeling, and simulating the complex interrelationships among wildfire risk, ecological processes, and watershed conditions to support more resilient and adaptive management outcomes (Jain et al., 2020; Amoah-Nuamah et al., 2025; Wang et al., 2025; Ejaz & Choudhury, 2025). However, environmental and land management data are often collected and applied through top-down approaches, where decisions regarding data collection, interpretation, and implementation are primarily driven by agencies, technical experts, and institutional decision-makers, who may not possess the same long-term lived experience and place-based knowledge of the landscapes being studied and managed.

Vulnerable, long-term communities are the most impacted by vegetation management, particularly evident in fire outcomes: occurrence, location, intensity, and spread. The terms "vulnerable" and "long term" indicate two qualifiers. a) They are subject to socio-economic and health inequities, making them structurally vulnerable to displacement. b) They have a long-term collective perspective on landscape change, existing as a community from before US Statehood, often speaking or currently revitalizing Indigenous languages. How these communities see vegetation change in their area over time directly translates into management, or lack of management, and heightened risk. Vegetation categories and their changes over time are key to resilient vegetation management.

Vegetation categorization is understood in the context of the language of the community, considering long-term care of vegetation resources by way of revitalizing traditional methods and centering the community's historical relation with the land. Literature produced by vulnerable, long-term communities is a testament to changes in vegetation management since before statehood and also provides critical information on pre-20th-century vegetation management techniques. In this way, Indigenous language literature provides a critical context for adaptive, place-based, and resilient forest management strategies. This can be scaled and applied across diverse forest landscapes throughout California (Lake & Tripp, 2024; Rakova & Winter, 2020; Anh et al., 2024; Martinez et al., 2023).

Vegetation change reveals a shift in forest management and fire risk. The project team considered changes between historic California Forest Service Maps, produced in the 1920s-1950s, and more recent 2015 CalVeg Vegetation maps. These historic maps are evaluated in terms of the recent 2015 geospatial satellite vegetation maps produced by CalVeg. By comparing modern vegetation data with historic vegetation data mapped for the same area, we can understand vegetation change. This is increasingly becoming the priority of scholarship and practice in this area. (Keeley, 2002; Anderson, 2005; Long et al., 2021; Adam et al., 2022; Tom et al., 2023; Martinez et al., 2023; Marks-Block et al., 2021, Waxman 2025).

Building upon this body of knowledge, the project team has undertaken foundational collaborative work with the Pinoleville Pomo Nation in Mendocino County and the Kootzaduka'a Tribe in Mono County. These two communities are situated in vastly different ecological regions with vastly different colonial histories. However, both are vulnerable, long-term communities that are severely impacted by vegetation changes and wildfire hazards. These two communities are acutely aware of change from the pre-state and historic periods and those of today, exacerbated by intensified human activities and climate change, and thus are pivotal for forest resilience and riparian ecosystem function going forward.

iii) Objectives and Scope

These efforts have laid the groundwork and revealed important opportunities to strengthen forest and riparian management strategies by identifying areas where wildfire risk reduction, vegetation management, and riparian protection goals align. In particular, the integration of geospatial analysis and community-based literature has strong potential for developing more adaptive, place-based approaches to wildfire resilience and Watercourse and Lake Protection Zone (WLPZ) management.

Building upon these initial efforts, the proposed research will focus on Mendocino County and Mono County, representing distinct ecological, cultural, wildfire, and hydrologic contexts within two of California's forest landscapes. **The overarching goal of the project is to develop an eco-cultural resilience assessment framework that applies advanced geospatial science in multivariable ecological modeling and covariance studies, driven by the meaning of vegetation change and vegetation categorization by host vulnerable, long-term communities, to better understand wildfire resilience, riparian ecosystem protection, and adaptive long-term forest management across two unique California forest landscapes.**

iv) Research Methods. Describe the methods for collecting, analyzing, and interpreting the data.

The project will combine **textual analysis in a community context, advanced geospatial science, presentation, and dynamic feedback with community partners, and collaborative field-based ecological assessment** to compile comprehensive datasets that integrate both scientific environmental data and culturally informed ecological knowledge. Together, these methods will support the development of adaptive, place-based strategies for wildfire resilience, riparian ecosystem protection, and long-term forest stewardship.

Mendocino County and Mono County represent distinct ecological, hydrologic, cultural, and wildfire contexts within California's diverse forest environments. These case studies will provide a comparative foundation for developing generalizable findings, ecological models, and adaptive management strategies that can inform improved forest and riparian management practices across diverse regions of California.

1. **Textual analysis in community context:** Working together in the community context, textual analysis contributes to understanding vegetation categories and how these vegetation categories have changed. This suggests indices by which to map statistical

values, usually in terms of vegetation, risk, and habitation. Canopies in the area of watercourses are also considered in terms of historic habitation and traditional vegetation management, along with development, agriculture, and grazing in the last century (Beller, Saloman, Grossinger, 2010). This analysis is done through perspective-based collage and topographic section elevation, translating textual narrative into planometric measurable index.

2. **Advanced geospatial science (multivariable ecological modeling and covariance study):** is applied to measured indices to understand vegetation change over time. The project team from recent fire perimeters in the area will conduct statistical analysis to consider how watercourse channels, watershed sedimentation, floodplain fuels, and hillside fuels are impacted by hill aspect, slope, fire regime, and ultimately vegetation change. Historical California Forest Service Vegetation Type Mapping (VTM) records, contemporary CalVeg vegetation datasets, satellite imagery, airborne remote sensing data, UAV-based multispectral and LiDAR surveys for data gaps and areas requiring newly collected information, digital elevation models, hydrologic datasets, wildfire history records, and topographic variables such as slope, aspect, and watershed conditions. Potential geospatial tools used in the study may include, but are not limited to ESRI ArcGIS Pro, ArcGIS GeoAI, Google Earth Engine ML, Trimble eCognition, ERDAS Imagine, Pix4D products, etc.

   The effect of weather events, particularly Diablo Winds, in the Coast Range, is calculated in terms of specific vegetation categories in specific spatial contexts. With aggregate risks, cost-benefit analysis results in particular prescriptions for vegetation management in low-risk seasons. The result provides a statistical case for landscape stewardship and care that is relevant to the site community.

3. **Presentation and dynamic feedback with community partners** is conducted to propose a particular case for historical and proposed landscape management regarding a specific vegetation site, with knowledge of specific vegetation outcomes. These models will evaluate the relationships among vegetation patterns, fire behavior, topography, riparian conditions, and watershed processes in supporting wildfire resilience and Watercourse and Lake Protection Zone (WLPZ) protection.

v) Scientific Uncertainty and Geographic Application. Please consult Section 3.1 of the EMC Strategic Plan the specific geographic locations, counties, or regions of the state to which this project may have benefits; if benefits are anticipated to apply across the state, indicate "statewide". If the benefits are also anticipated to occur outside of the state, please explain. Projects may occur on sites under any kind of land ownership, but research results must be relevant to private timberlands. 10 for further information. Indicate

The research will be conducted in two study areas in Mendocino County and Mono County, respectively.

The first study area is in Mendocino County in the coastal inland of California, specifically regarding the area of Mendocino County that is between 20km and 60km from the ocean. This area has a specific fire regime and vegetation history. This area has considerable public and private timberlands, particularly former grassy woodland (as indicated on Wieslander Forest Service Maps surveyed between 1928 and 1960), now with douglas fir encroachment, as well as former grassy woodland and oak woodland (as indicated on Wieslander Forest Service Maps surveyed between 1928 and 1960), now with considerable woodland sage encroachment.

The second study area is in Mono County in the Eastern Sierra, focusing specifically on lands owned, stewarded, or co-managed by the Mono Lake Kootzaduka'a Tribe and its partner organizations within the eastern Sierra Nevada and Mono Basin region near Lee Vining. These areas include culturally significant forest, meadow, wetland, and riparian landscapes associated with the tribe's ongoing ecological stewardship and cultural revitalization efforts, including the 160-acre Tubbe Nobe property acquired through a partnership between the tribe's Indian Community Cultural Preservation Association and the Eastern Sierra Land Trust (ESLT).

vi) Collaborations and Project Feasibility

Prior efforts of the PIs have included comparative analysis of historic California Forest Service Vegetation Type Mapping (VTM) records and contemporary CalVeg datasets, participatory mapping, remote sensing, GIS, LiDAR analysis, and field-based documentation of culturally significant habitats and traditional stewardship practices. Co-PI Waxman's historic maps of California vegetation are published through the Bioscience, Natural Resources, and Public Health Library at the University of California, Berkeley (Waxman, 2025). Additional collaborative efforts with the Mono Lake Kootzaduka'a Tribe and the National Park Service Rivers supported Indigenous-led ecological stewardship, cultural revitalization, and climate resilience planning in the eastern Sierra Nevada (LEAD Studio, 2024). These efforts have established a strong foundation for evaluating how advanced geospatial science and Indigenous knowledge systems can be integrated to improve wildfire resilience and Watercourse and Lake Protection Zone (WLPZ) management across California forest landscapes.

As Co-Principal Investigator, Dr. Li will provide overall leadership, coordination, and oversight of the research, geospatial analysis, and community engagement processes from project initiation through final dissemination. Drawing upon experience participating in and managing more than $2.5 million in externally funded research and planning activities, Dr. Li will lead the literature review, precedent studies, data collection and integration, geospatial analysis, ecological modeling, and planning components necessary to support equitable partnerships with Indigenous communities and the development of community-informed and scientifically grounded forest and riparian management strategies. Dr. Li will also oversee stakeholder engagement, interdisciplinary collaboration, and synthesis of findings into scalable frameworks for wildfire resilience and Watercourse and Lake Protection Zone (WLPZ) management.

As Co-Principal Investigator, Dr. Waxman will contribute expertise in historical vegetation analysis, participatory mapping, and community-engaged landscape studies. Building upon his prior work involving historic California Vegetation Type Mapping (VTM) analysis and landscape change research, he will support project planning, archival and geospatial data analysis, field investigations, Tribal engagement, comparative vegetation analysis, and interpretation and dissemination of findings with community and research partners.

k. Critical Question Theme and Forest Practice Rules or Regulations

Addressed. Please identify the Critical Questions by number and letter (as identified in the EMC Research Themes and CMQs), and the related regulations by number. Clearly describe how your project will address these questions and the efficacy of each regulation.

While any compelling research that addresses Effectiveness Monitoring Committee (EMC) Research Themes and/or Critical Monitoring Questions (CMQs) are eligible for funding, the EMC has prioritized SIX (6) CMQs for Fiscal Year (FY) 2026/2027:
Are the California Forest Practice Rules (FPR) and related regulations effective in…

1) … managing Watercourse and Lake Protection Zone Riparian Function (WLPZs) to reduce or minimize potential fire behavior and rate of spread? (Question 1h)

Areas of encroachment of Douglas Fir in Oak Woodland are generally north-facing slopes, from the creek side up to the ridgeline. The areas of encroachment of Dense Chaparral in Grassy Woodland are generally south-facing slopes from the ridgeline down to the creek side. Through analysis of texts on the subject of riparian areas with these vegetation types, along with statistical analysis of the covariance factors of riparian areas that overlap several different vegetation categories, it is possible to better understand contextual risk factors of two different vegetation types that meet in a riparian zone.

2) … minimizing management-related sediment delivery from forest management activities to watercourse channels at the watershed and sub-watershed level in managed watersheds? (Question 2a)

The project team will work backwards from recent fire perimeters in the area through statistical analysis to consider how watercourse channels, watershed sedimentation, floodplain fuels, and hillside fuels are impacted by hill aspect, slope, fire regime, and ultimately vegetation change. In Mendocino County, our proposed research considers the area of the East Fork Russian River in some detail, connected to sedimentation in Lake Mendocino, with a complete understanding of the pre-dam landscape, soil, and topography. This waterway is also affected by Gravelly Valley's Lake Pillsbury and questions of fish passage, sedimentation, stream flow, and surrounding fire-affected mountains. In Mono County, Mono Lake and tributary streams have shifted considerably in the last century due to extensive development. The name Kootzaduka'a refers to a traditional food, the brine fly pupae, which reside in Mono Lake.

3) … managing fuel loads, vegetation patterns, and fuel breaks for fire hazard reduction? (Question 6c)

In Mendocino County, our research proposes deriving a better understanding of the encroachment of Douglas Fir into areas historically mapped as Oak Woodland zones. Often, these areas are adjacent to areas that have transitioned from Grassy Woodland to Oak Woodland or Woodland Sage. In other words, they become denser and develop a robust ground-cover of sizable shrub-like vegetation. This is an explosive fire risk. The boundaries between these sections of measured vegetation are often ridgelines or creeks, both of which act as a potential fire spread barrier.

4) … managing forest structure and stocking standards to promote wildfire resilience? (Question 6d)

Our research proposes an analysis of the 19th century and early twentieth century vegetation category described by the Forest Service as "Grassy Woodland." This category in historic Forest Service maps in the Coast Range is made up of *D' Quercus douglasii, D G Pseudotsuga menziesii, Quercus garryana, Dp A Diplacus puniceus, Quercus agrifolia, Dp D' Diplacus puniceus, Quercus douglasii, S A Pinus lambertiana, Quercus agrifolia, V Quercus lobata, W D' Quercus wislizenii, Quercus douglasii.* All of these plants, except Diplacus, are considered nut-food trees. This should underscore how important it is to work closely with vulnerable, long-term communities. These communities are not only subject to fire risk; they also historically are involved in the management of these nut-food "Grassy Woodlands" which have increasingly filled with explosive chaparral.

6) … improving overall forest wildfire resilience and the ability of forests to respond to climate change (e.g., in response to drought or bark beetle; reducing plant water stress) and variability, and extreme weather events (evaluate ecosystem functional response to fuel reduction and forest health treatments)? (Question 12a)

To address forest wildfire resilience, this proposal takes a social design-based, landscape architectural approach. With long-term communities, we build a dynamic team-based community-driven approach to forest management. By cultivating a research method that improves the ways of seeing vegetation change over time, we create a system of social resiliency for landscape management over time, based on meaningful engagement with local residents.

l. Requested Funding. Please provide the total amount of funding requested from the EMC, broken down by year of expenditure (by FY, i.e., from July 1 through June 30 of each year), with a brief justification of costs not to exceed 200 words.

The project requests a total budget of **$250,000** over three years (2026–2029):

- **$70,000** for Year 1 (July 1, 2026–June 30, 2027),
- **$100,000** for Year 2 (July 1, 2027–June 30, 2028), and
- **$80,000** for Year 3 (July 1, 2028–June 30, 2029).

Project costs include salaries and fringe benefits for PIs and research assistants, travel, data collection, computer services, consultant support, materials and supplies, and community engagement activities necessary to support project implementation, analysis, and outreach through all three years. Publication costs are included in Years 2 and 3 to support the dissemination of research findings. The budget also includes miscellaneous expenses and a 15% indirect cost rate to support institutional administrative and operational needs for all three years.