STANFORD UNIVERSITY
Office of Sponsored Research
[redacted]

July 03, 2023

California Department of Forestry and Fire Protection

Sponsor Reference: EMC-2023-004
Stanford Reference: SPO 309054

Title: Evaluating California oak woodland forest management and its cumulative impacts on wildlife habitat
Principal Investigator: Tadashi Fukami
Period: 12/01/23 - 03/31/26
Amount Requested: $ 115,122.00

On behalf of Stanford University, it is a pleasure to submit the attached proposal requesting new funding support. The proposal and supporting materials are enclosed and incorporated by reference.

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In the event of an award, Stanford should be identified as "The Board of Trustees of the Leland Stanford Junior University", a body having corporate powers under the laws of the State of California. Notwithstanding any terms of the proposal, Stanford University reserves the right, prior to the acceptance of an award, to negotiate terms and conditions in accordance with Stanford University policy.

Thank you for your consideration of this proposal and should you require additional information, please feel free to contact me.

Sincerely,

Ryan Tipsword
Office of Sponsored Research
Contract and Grant Officer
[redacted]

Effectiveness Monitoring Committee
Full Project Proposal Form

Deadline for Submission: ***July 5, 2023***

Project #: EMC-2023-004 **Date:** July 5, 2023

Project Title: Evaluating California oak woodland forest management and its cumulative impacts on wildlife habitat

Principal Investigator:

Dr. Tadashi Fukami, Department of Biology, Department of Earth System Science - Stanford University [redacted]

Collaborators:

Dr. Sheena Sidhu, Jasper Ridge Biological Preserve - Stanford University, [redacted]

Dr. Elizabeth Hadly, Jasper Ridge Biological Preserve, Department of Biology, Department of Earth System Science - Stanford University, [redacted]

Dr. Jorge Ramos, Jasper Ridge Biological Preserve - Stanford University, [redacted]

Dr. Laureano Gherardi, Department of Environmental Science, Policy, and Management - University of California Berkeley, [redacted]

Contact Information:

Dr. Sheena Sidhu, Jasper Ridge Biological Preserve - Stanford University, [redacted]

Duration (Years/Months):

12/01/2023 - 03/31/2026

Dear Effectiveness Monitoring Committee,

Thank you for the invitation to submit a full proposal. Responses to suggestions provided by the EMC in Full Project Proposal invitation letter can be found in the following sections.

1. *Provide additional detail on the project nexus to the Forest Practice Rules (FPRs) and adaptive management; in particular, clarify how the dusky-footed woodrat is a useful indicator for ecosystem health.*

   More information about the dusky-footed woodrat has been added to section 1- Background and Justification in the background subsection, on page 4.

2. *Clarify the treatments and what tree species will be removed.*

   Details have been added to section 4- Research Methods, on page 9.

3. *Identify how this research will be geographically applicable to other geographic areas.*

   Details have been provided in section 5- Scientific Uncertainty and Geographic Application, on page 11.

4. *Explain how this research will effectively address cumulative effects.*

   A further explanation is summarized as “a study to track the cumulative impact on woodrats and their habitat in oak woodland following different forest health fuel reduction treatments by looking into several ecosystem layers including trees, understory, canopies, herbaceous vegetation, and soil.”
   This is included in the proposal in Section 1- Background and Justification, on pages 3 & 4, and Section 3- Critical Question, on page 6.

5. *Provide maps of forest types in the full project proposal and indicate surrounding land uses.*

   A map has been included as Appendix A on page 17.

Thank you for your consideration.

Sheena Sidhu, PhD

Staff Scientist
Jasper Ridge Biological Preserve
Stanford University

FULL PROPOSAL

Evaluating California oak woodland forest management and its cumulative impacts on wildlife habitat

1. Background and Justification

Justification:
The Science Advisory Panel of the California Wildfire and Forest Resilience Task Force (WFRTF) developed a series of regional profiles based on interviewing experts in land management regarding the needs of wildfire and forest management. One of the top concluding recommendations for the California Central Coast is to *"continue research to understand past, current, and future resilience of native ecosystems"* (Andreozzi et al. 2003). This is because Central Coast land management must contend with threats such as climate change, pathogen pressure, land use change, and invasive species.

Within the complexity of this Central Coast landscape, oak woodlands are culturally and ecologically important, with 1.6 million acres in the region of the 13 million acres state-wide (Gaman & Firman 2008). Open spaces are managed by numerous landowners, both private and public, many of which have small, forested areas adjacent to dense urban communities (Andreozzi et al. 2003). There is a general interest in "catching up" on delayed forest management after decades of low prioritization, and to practice management with an interest in ecological sensitivity and natural resource protection, especially in regard to climate change adaptation. With social pressure due to fire risk, land managers are moving forward with various forest management treatments but without the time or resources to evaluate their effectiveness in impacting ecosystem structure, functioning, and cumulative impacts, particularly for wildlife habitat.

The need for monitoring the forest management in oak woodlands of the Central Coast dovetails with the Effectiveness Monitoring Committee (EMC) goal of understanding the effectiveness of the California Forest Practice Rules (FPRs). Broadly, this interest matches Question 12a of the EMC Critical Monitoring questions:

> *"Are the FPRs and associated regulations effective in improving overall forest wildfire resilience and the ability of forests to respond to climate change and variability, and extreme weather events (evaluate ecosystem functional response to fuel reduction and forest health treatments)?"*

Here we propose an experimental study to evaluate forest management of oak woodlands within a spectrum of vegetation retention treatments and to measure the impact on forest health (structure and function) using the dusky-footed woodrat as a bioindicator. Cumulative impacts of forest health treatments will encompass studying levels of organization from woody and herbaceous strata to soil processes and small mammals over the short and long-term.

Background:
The San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*) is endemic to the San Francisco Bay Area of the California Central Coast. Its habitat is in the canopy coverage of oak woodlands, chaparral, shrubland, and coniferous forest communities, with a preference of dense, protective undergrowth to construct nests (Murray and Barnes 1969). Complex nests are

constructed of woody debris that can reach 2.5m wide and 1.8m tall, which serve as shelter for a single adult or female woodrat and her pups (Hooven 1959).

As a CDFW species of special concern, risk mitigation tactics for woodrats include avoidance, buffers, habitat enhancement, and translocation. Typically, Central Coast forest management practitioners use buffers or avoidance. However, it is not always possible to discern if mitigation is successful in avoiding nest disturbance because it can be difficult to evaluate occupancy from nest structure alone, and woodrat activity is generally nocturnal, which restricts easy long-term monitoring due to resource and capacity limitations. In this proposed research project, we will invest in closely monitoring dusky-footed woodrat nests and additional ecological variables in order to evaluate forest health after vegetation management treatments.

Small mammals can serve as useful bioindicators of forest health because they interact with multiple species and respond to environmental complexity (Pearce & Venier 2005). Specific woodrat interactions include: being an important source of prey, responding to disturbances, and modifying the landscape as ecosystem engineers, which creates new habitat for other species (Abad et al. 2020). As generalists, woodrats feed on a variety of vegetation, including tree seedlings (Hooven 1959). It is notable that woodrats respond to understory, with positively correlated abundance (Hamm & Diller 2009). Close observations of individual dusky-footed woodrats at UC Hastings Reserve found that these small mammals do not always use the most efficient path home on the ground, but instead use trails over continuous wood and logs to return to the nest and can even be hindered by small obstacles (Linsdale and Tevis 2022). However, woodrats are tolerant of some disturbance, such as prescribed understory fire, which likely does not significantly alter populations given proper management of habitat structure (Lee & Tietje 2005). Given these characteristics, we propose a study to track the impact on woodrats and their habitat in oak woodland following different forest health fuel reduction treatments by looking into several ecosystem layers including trees, understory, canopies, herbaceous vegetation, and soil. This information would be informative to support the EMC in evaluating FPRs specifically for research themes 7, 9, & 10 in the short-term, and 11 & 12 in the long-term. How the project will specifically address Critical Questions is expanded further in section 3 below.

2. Objectives and Scope

The proposed research project broadly addresses EMC's prioritized Critical Monitoring question 12a evaluating *"are the FPRs and associated regulations effective in improving overall forest wildfire resilience and the ability of forest to respond to climate change and variability, and extreme weather events (evaluate ecosystem functional response to fuel reduction and forest health treatments)?"* from research theme 12. Specific research themes addressed include: Wildlife Habitat – species and nest sites (theme 7), Wildlife Habitat – Cumulative Impacts (theme 9), Wildlife Habitat – Structure (theme 10), as well as hardwood values (theme 11). This project will address EMC critical monitoring questions that have not been previously funded by the grants program, under themes 7, 10 and 11.

The proposed project has two overarching research objectives that will be addressed through an experimental design:

1) Measuring vegetation changes across a spectrum of forest management and fuel reduction practices in an oak woodland to quantify habitat changes and disturbance
2) Evaluating the impact of fuel reduction activities on forest health
    2a) by monitoring dusky-footed woodrats
    2b) by monitoring ecosystem variables

The project scope will be focused on oak woodland, dominated by coastal live oak, which is representative of the ecotype primarily found throughout the California Central Coast, but also other regions of the state (Andreozzi et al. 2003). As identified by the EMC's Research Themes and Critical Monitoring Questions plan, critical questions related to oaks are understudied and research is needed to understand how FPRs and associated regulations are effective in retaining oaks and oak wildlife habitat.

We will use the dusky-footed woodrat as a bioindicator species. *Neotoma fuscipes annectens*, while endemic to the San Francisco Bay Area, is similar to other woodrat species and small mammals in terms of habitat requirements and ecosystem function. Woodrats impact the forest as ecosystem engineers with many other vertebrates, invertebrates, plants, and lichens thriving on the habitat and microclimates created by their nest structures, which have been observed to persist for decades (Whitford & Steinberger 2010, Campos et al. 2019). They are dependent on oaks for their food, habitat, and nest building material (Horton & Wright 1944) and a protective understory for persistence (Hamm & Diller 2009).

Figure 1A: Identified dusky-footed woodrat nest, marked for long-term monitoring. Figure 1B: Night camera image of dusky-footed woodrat outside nest. Images collected June 2023 at JRBP.

This study will be conducted on private research lands within an oak woodland representative of oak woodlands in the Central Coast and similar to oak woodlands and oak forests across the state. The study will examine the impacts of forest management practices by comparing across a spectrum of fuel reduction practice (vegetation retention at high, medium, low, and control levels- details provided in Research Methods section 4 below). We will monitor the cumulative impacts of vegetation removal on woodrats and their habitat over the short and long term to evaluate how variations in forest management affect wildlife habitat.

3. Critical Questions and Forest Practice Regulations Addressed

This project will broadly support addressing the thematic critical monitoring question 12a: *Improving overall forest wildfire resilience and the ability of forests to respond to climate change and variability and extreme weather events (evaluate ecosystem functional response to fuel reduction and forest health treatments)?*

The project will specifically address the following critical monitoring questions- see below for each Research Theme, critical monitoring question, regulation, and how the project addresses the monitoring questions:

Research Theme 7: Wildlife Habitat - Species and Nest Sites

- *Critical Monitoring Question: Are the FPRs and associated regulations effective in protection of nest sites?*
- *Regulations: 919.12 - General protection of nest sites, and sensitive species classification*

This project will evaluate how different levels of vegetation removal affect dusky-footed woodrats, which are a species of special concern. Specifically, we will be tracking nest sites before management practices are implemented and then follow tracking through at least for the duration of the project (3 years). We will be evaluating if the current common practice in the Central Coast of approximately a 10ft buffer around woodrat nests is adequate in protecting the species and if there is variation in woodrat persistence depending of level of vegetation removal. The data collected will also evaluate habitat quality through measuring components of vegetation structure and function.

Research Theme 9: Wildlife Habitat - Cumulative Impacts

- *Critical Monitoring Question: Are FPRs and associated regulations effective in (a) characterizing and describing terrestrial wildlife habitat and ecological processes? (b) avoiding significant adverse impacts to terrestrial wildlife species?*
- *Regulations: 919 - Wildlife Protection Practices*

In this project, we will be tracking the cumulative impact on woodrats and their habitat in oak woodland by looking into several ecosystem layers including trees, understory, canopy, herbaceous vegetation, and soil, with these changes tracked over time. This will allow us to evaluate wildlife habitat of a small mammal in response to a variety of different forest management practices. Through the comparison of high, medium, low, and no vegetation reduction combined with camera tracking of nest occupancy over time, we will be able to evaluate if level of treatment or disturbance impacts this wildlife species.

Research Theme 10: Wildlife Habitat - Structure

- *Critical Monitoring Questions: Are the FRPs and associated regulations effective in retaining (b) native oaks where required to maintain wildlife habitat?*
- *Regulations:*
    - *959.15 Protection of Wildlife Habitat*
    - *Technical Rule Addendum No. 2 wherein hardwood cover is recognized as a significant biological factor in cumulative impacts assessment.*
    - *897- Implementation of Act Intent: forest management shall production or maintenance of forests which are healthy and naturally diverse, with a mixture of trees and understory plants.*

This study will be conducted in an oak woodland where we will monitor both wildlife habitat structure and function by measuring changes in trees, understory, canopy, vegetation, and soil, and relating it small mammal persistence and changes over time.

Research Theme 11: Hardwood Values

- *Critical Monitoring Questions: Are the FRPs and associate regulations effective in retaining (b) native oaks where required to maintain wildlife habitat?*
- *Regulations:*
    - *959.15 Protection of Wildlife Habitat*
    - *Technical Rule Addendum No. 2 wherein hardwood cover is recognized as a significant biological factor in cumulative impacts assessment.*
    - *897- Implementation of Act Intent: forest management shall production or maintenance of forests which are healthy and naturally diverse, with a mixture of trees and understory plants.*

Aligned with research theme 10: This study will be conducted in an oak woodland where we will monitor both wildlife habitat structure and function by measuring changes in trees, understory, canopy, vegetation, and soil, and relating it small mammal persistence and changes over time.

Research Theme 12: Resilience to Disturbance in a Changing Climate

- *Critical Monitoring Questions: Are the FRPs and associate regulations effective in*
  (c) meeting ecological objectives and adaptation to future climate?
  (d) maintaining or recruiting adequate amounts of early- and mid-seral wildlife habitats which are well adapted to future climate?
- *Regulations:*
  - *California Environmental Quality Act*
  - *Fish and Game Code 1850*

This research is proposed to be a short-term (3 year) monitoring effort with the object that it will launch much-needed monitoring of oak woodlands, where monitoring is often an overlooked activity relative to the pace of forest management project implementation, particularly in the Central Coast. We expect that research theme 12 will be addressed through long-term monitoring efforts, with preliminary and eventual long-term results to be shared with EMC and other land managers to inform how forest management can be accomplished in an ecological framework to adapt to climate change.

4. Research Methods

Treatment and Plot Setup:
The project will be conducted on the private land of Jasper Ridge Biological Preserve (JRBP), a low ridge in the eastern foothills of the Santa Cruz Mountains, within the WUI of the San Francisco Bay peninsula about 4 miles west of the main Stanford University campus, in San Mateo County, CA. Researchers of this proposal will have full access and control to monitor the study sites and evaluate the impact of forest management that will be implemented at the preserve in summer 2023.

The JRBP fuel reduction and forest management treatments will be implemented along the perimeter of the preserve, starting from the fence line and extending in 400ft over approximately 94 acres. Fuel reduction treatments in the oak woodland will be divided into bands of decreasing vegetation removal moving away from the fence line. The spectrum of treatments will span similar vegetation reduction practiced in the Central Coast region. Treatments will be applied as follows to each band, varying in distance from the fence line (see figure 2):

- Band 1 (0 - 100ft): 80% vegetation removal, 20% retention
- Band 2 (100 - 200ft): 50% vegetation removal, 50% retention
- Band 3 (200 - 300ft): 30% vegetation removal, 70% retention
- Band 4 (300 - 400ft): no vegetation removal [control area]

All treatments will follow the general prescription of understory thinning and 20ft canopy spacing. Specifically, hired contractors will hand cut all brush greater than 12 inches in heigh including but not limited to the following species: chamise (*Adenostoma fasciculatum*), toyon (*Heteromeles arbutifolia*), coyote brush (*Baccharis pilularis*), and poison oak (*Toxicodendron diversilobum*). Trees will be limbed to 8ft, and snags less than 9.9in dbh will be hand-thinned. Trees 11.5in dbh and greater will be left, with no cut of Blue Oak (*Quercus douglasii*), Black Oak *(Quercus kelloggii),* Valley Oak *(Quercus lobata),* Coast Live Oak *(Quercus agrifolia)*. For trees up to 11.4in dbh, tree removal will be selected for spacing at 20ft, with priority to primarily leave

the larger trees with the largest crowns, best crown ratio that is free of disease or damage of Black Oak *(Quercus kelloggii),* Blue Oak (*Quercus douglasii*), Valley Oak *(Quercus lobata),* Coast Live Oak *(Quercus agrifolia),* and secondarily leave California buckeye (*Aesculus californica),* California Bay Laurel *(Umbellularia californica),* and Douglas Fir *(Pseudotsuga Menziesii).*

F gure 2: Aer a mage of exper menta area. Approx mate y 20-acre oak wood and ocated at the SE port on of Jasper R dge B o og ca Preserve. Mon tor ng bands w be p aced n each band that covers a spectrum of vegetat on remova , w th each band 100ft across, beg nn ng at the fence ne. Band 1: 80% vegetat on remova , Band 2: 50% vegetat on remova , Band 3: 30 vegetat on remova , Band 4: no vegetat on remova .

Treatments will be conducted after woodrat breeding season (April through mid-July). Disturbance of the nests will be minimized by hand-treatment only (no heavy equipment) used around nest sites, with a buffer approximately 10ft around the nest, following the common practices of forest management implemented by land managers of the Central Coast.

In an approximate 20-acre oak woodland area, 30ft x 30ft monitoring plots will be placed in 5 pairs in each treatment band centered around active nests that have been constructed by woodrat next to an oak tree (see image of figure 1a).

Table 1: summary of monitoring plots placed in each forest management treatment.

Band	# Control Plots	# Treatment Plots
Band 1 (0 - 100ft)	5	5
Band 2 (100 - 200ft)	5	5
Band 3 (200 - 300ft)	5	5
Band 4 (300 - 400ft)	5	--

Woodrat nest occupancy will be determined by setting camera traps for 4 nights to observe activity prior to plot selection. Nest sites have already been previously recorded between 2022-2023. Beginning May 2023, we started tracking nest activity via camera traps (see figures 1 & 3) by placing trail cameras at each nest for 4 consecutive nights to determine activity, with continuing monitoring in progress. The assessment of nest activity will allow us to correctly identify occupied nests for plot establishment and will also allow us to track occupancy and population changes overtime in the management area.

Data Collection:
Each plot will be monitored prior to treatment (summer 2023), and following treatment for at least the duration of this project (spring 2026). This will be the short-term monitoring window, with the intention to continue monitoring long-term for subsequent years.

F gure 3: Ident f ed dusky-footed woodrat nests between the fence ne and 500ft w th the preserve, recorded 2022-2023 (wh te po nts). Act ve nests as observed v a camera traps p aced for 4 consecut ve n ghts as of May-June 2023 (p nk po nts).

Objective 1) Measuring vegetation changes to quantify disturbance.
We will quantify and evaluate fuel reduction and forest management in each band by measuring vegetation changes. This will be accomplished by methods of a modified Brown's transect and Tree & Snag Inventory. Variables to be measured include:

- Tree count and dbh measures
- height/height to crown base
- Trees per plot by class size, species inventory
- Downed woody debris
- Litter and duff depth

Additionally, changes to canopy and understory will be captured with aerial images, and hemispherical canopy photos.

Objective 2) Evaluating the impact of fuel reduction activities on forest health.
We will prioritize measuring a subset of many possible variables to evaluate forest health, especially as it relates to dusky-footed woodrat habitat quality in oak woodland ecosystems (research themes 11 & 12).

2a) Monitoring dusky-footed woodrats
Woodrat nest occupancy will be monitored using camera traps placed within each plot to observe the focal nest and nest activity. We will also continue to monitor nests throughout the whole treatment area (shown on figure 3).

2b) Monitoring ecosystem variables
Following the research themes of Wildlife Habitat – species and nest sites (theme 7), Cumulative Impacts (theme 9), and Structure (theme 10), we will measure variables that inform evaluating ecosystem structure, functioning, and cumulative impacts. Variables to be measured include:

- Plant diversity, particularly invasive species using CNPS Relevé and Rapid Assessment Protocols
- Plant biomass by species, including aboveground and belowground components

- Soil carbon, both particulate and mineral associated fractions
- Soil microbial biomass and diversity
- Wildlife activity: acoustic monitoring and point bird counts at each plot site
- Pathogen presence by connecting observations to ongoing SOD monitoring

Data Analysis:
We will use nested mixed effect models in order to account for fixed and random effects. Plot scale disturbance treatment will be nested within disturbance bands and included as fixed effects whereas individual plots and transects will be included as random effects to account for the repeated measures nature of our experimental design.

5. Scientific Uncertainty and Geographic Application

This research project has been inspired through ongoing conversations with landowners and land managers in the Central Coast region who are looking for science-based approaches to natural resource protection and ecologically sensitive forest management where there has been a critical gap (Andreozzi et al. 2003). Specifically, oak woodland forest management is understudied relative for FPRs and in need of evaluation, as identified by the EMC's Research Projects and Critical Monitoring Questions report, under theme 11.

In the Central Coast, our peer practitioners express uncertainty in mitigation practices for the dusky-footed woodrats and other small mammals, which have been difficult to monitor long-term, which coincides with theme 10. Given our understanding of practitioner needs and requests for scientifically informed practices as highlighted by the EMC, we believe this project is valuable for evaluating forest management practices.

Additionally, the design of this experimental study on private lands in the space of a biological preserve overseen by the researchers will allow us to compare differences among the varying treatments in a more controlled way than comparing across existing implementations with various land managers and treatment types. While there are certainly some benefits in larger-scaled experiments across multiple landowners, where scale can help detect statistically significant differences where there is high environmental variation, here we propose a complementary approach at a smaller scale in one area that will help to mitigate for some of the variability often found in experiments designed in natural systems. This small scaled but controlled experimental design will allow us to "level up" on observation-only studies. We do consider this an appropriate scale as determined by experience of collaborators Drs. Gherardi, Ramos, and Sidhu based on previous similar studies examining long-term changes resulting from environmental disturbances.

This study has also been designed to be quickly modified if a rare or large monitoring event is to occur, such as a fire through the study area. If such an event occurs, we will be able to quickly pivot to collect post-event data. The metrics and methods will be similar to ones outlined in this proposal although we will alter collection timing to immediately (approximately 1 month after the fire), and then subsequently every 3 months to capture short-term changes in the ecosystem. Because we are applying an experimental design with the treatments of varying degrees of vegetation reduction, a fire event would allow us to evaluate effectiveness of forest management in a useful way to help prepare for future fires. This data would still be for the overall goals of the EMC and the strategic goals in determining the effectiveness of FMP.

As shared above, this research project has been developed out of regular engagement with fellow regional land managers through Santa Cruz Mountain Stewardship Network, of which JRBP is a member. Collectively, land managers have conveyed a need for long-term monitoring and study of impacts on woodrats but have been resource limited. For this reason, the research outcomes of this project will be immediately applicable to private and public lands with similar ecotypes in the Central Coast region and will also be informative to similar oak woodland forests throughout the state. The impact of dusky-footed woodrats can be extrapolated to other small mammals who play similar ecosystem roles. Further, some of the information about dusky-footed woodrats in these oak woodland systems could be extrapolated to support research theme 7 focusing on the Northern Spotted Owls (*Strix occidentalis caurina)* in conifer forests, of which woodrats are a major prey species (Ward et al 1998, Thome et al. 1999).

Outcomes of this research will: a) help to fill a critical gap for Central Coast oak woodland forest management, b) inform science-based practices for mitigating impacts to woodrats, and c) be broadly applicable beyond the region to practitioners managing for oak woodlands and small mammals.

6. Collaborations and Project Feasibility

Collaborators:
The project will be led in collaboration by Jasper Ridge Biological Preserve (JRBP) staff scientist, Dr. Sheena Sidhu, and UC Berkeley professor Dr. Laureano Gherardi, with oversight from JRBP executive director, Dr. Jorge Ramos. professors Dr. Tadashi Fukami and Dr. Elizabeth Hadly will provide faculty and research oversight to all collaborators.

The project was designed by Hadly, Sidhu, Gherardi, and Ramos. Sidhu will be responsible for treatment implementation (pre-award period, summer 2023). Data will be collected by Sidhu, , and seasonal field technicians supported through this funding. Analysis will be conducted by Sidhu and Gherardi, with support from Fukami and Hadly. On-site supervision will be provided by Ramos, with overall research oversight by Fukami and Hadly.

Project Feasibility:
All collaborators and JRBP staff are experienced in designing, implementing, and completing field research related to ecology and stewardship, with a record of scientific publications. All salaries are fully funded, with additional funding requested only for field technicians to carry out the work under the direction of the collaborating team. All field work will be at Jasper Ridge Biological Preserve with full land management control of the private land by Stanford University. Forest management treatments will be applied prior to the grant award period through university funding for fire risk management. JRBP has served as a field site for multiple large-scale field research projects over its 50 years, with a permanent support staff, and basic reusable supplies and equipment for managing and implementing field work. Given our experience and basic support structure, we are confident in carrying out this project to completion.

This is a monitoring project that will be carried out in the short-term for the duration of this funding request (Dec 2022-March 2023), with the goal of continuing this project for long-term monitoring of at least 10 years. This funding will allow us to launch much-needed monitoring of oak woodlands, where monitoring is often an overlooked activity relative to the pace of forest management project implementation. By showcasing the value of this monitoring in this short-term, we expect we will be able to secure resources for monitoring to continue this project for the long-term.

The project has been designed with input from other regional land managers, with questions identified through discussions lead by Sidhu, a leader of the Santa Cruz Mountain Stewardship Network (SCMSN) Monitoring subgroup. Dr. Sidhu is experience in applied research and has designed projects that address immediate stakeholder needs, which includes ensuring outputs are useful and get delivered to stakeholders. In this case, this project team would ensure that the results of this project would firstly be shared with the EMC to support evaluation of FMP. Dissemination of project progress and results would also be shared with land managers and practitioners of the SCMSN which includes employees of San Mateo County Park, Santa Cruz County Parks, State Parks, San Mateo Resource Conservation District, Resource Conservation District of Santa Cruz County, Midpeninsula Open Space District, Peninsula Open Space District, San Mateo Fire Safe Council, Santa Clara Fire Safe Council, timber industry staff, and other private landowners, in addition to other practitioners of the Central Coast who occasionally meet to discuss projects and forest management practices. The project team will also identify opportunities at share results local, regional, and state-wide scientific meetings through presentations, white papers, and scientific publications.

7. Project Deliverables

Outcomes of this research will: a) help to fill a critical gap for Central Coast oak woodland forest management, b) inform science-based practices for mitigating impacts to woodrats, and c) be broadly applicable beyond the region to practitioners managing for oak woodlands and small mammals. See Timeline below for table of activities and deliverables (next page).

Activities/Deliverables/Timeline	Type		Year 0 (6/1/23 - 11/30/23)				Year 1 (12/1/23 - 11/30/24)				Year 2 (12/1/24-11/30/25)				Year 3 (12/1/23-3/21/26)				Ongoing			
	Act.	Del.	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Establish Study Sites																						
Complete Forest Health Treatment	X																					
Being immediate post-treatment monitoring	X																					
Organize Data	X																					
Being preliminary analysis	X																					
Prepare for year 1	X																					
Collect monitoring data	X																					
Organize Data	X																					
Data Analysis	X																					
Update funders and stakeholders		X																				
Present updates initial updates to regional land managers		X																				
Prepare for year 2	X																					
Collect monitoring data	X																					
Organize Data	X																					
Data Analysis	X																					
Update funders and stakeholders		X																				
Present updates initial updates to regional land managers		X																				
Prepare for year 3	X																					
Collect monitoring data	X																					
Organize Data	X																					
Data Analysis	X																					
Update funders and stakeholders		x																				
Present updates initial updates to regional land managers		X																				
Present to EMC		X																				
Write white paper for land manager immediate use		X																				
Determine long-term (3+ years) monitoring plan and funding	X																					
Prepare and submit manuscripts		X																				

Key: W= w nter (Jan Mar), Sp=spr ng (Apr Jun), Su=summer (Ju Sep), F=fa (Oct Dec). Ac=Act v ty, De =De verab e

8. Project Timeline

This project is conceived to be a long-term monitoring plan with initial funding to support the first three years with plans to secure future funding either through re-applying for funding through EMC in future Requests for Proposals or other funding sources. We will be exploring multiple avenues for funding and considering both internal and external funding to support the long-term monitoring effort.

9. Requested Funding

Total request: $115,122

Category	Description	Year 1 (12/1/23 - 11/30/24)	Year 2 (12/1/24 - 11/30/25)	Year 3 (12/1/23 - 3/31/26)	Total
Personnel Salaries and Wages	PI - annua (12 months)	$2020	$2081	$707	$4808
	F e d Tech 1- seasona (3 months)	$16,189	$16,189	0	$32,378
	F e d Tech 2 - season (3 months)	$16,189	$16,189	0	$32,378
Fringe Benefits	PI - annua (12 months) 30.90%	$624	$643	$218	$1485
	F e d Tech 1- 1 season (3 month) 6.8%	$5002	$5152	0	$10,154
	F e d Tech 2 - 1 season (3 months)	$5002	$5152	0	$10,154
Travel	Trave (m eage rate $0.655 and to costs)	$230	$230	0	$460
Operating Expenses	Supp es: f e d supp es	$6000	$2000	0	$8000
Other costs	Pub cat ons and outreach			$2000	$2000
Indirect	12%, Negot ated rate between Stanford and Board of Forestry	$6151	$5833	$351	$12,335
Total Cost		$57,407	$54,439	$3276	$115,122
Total EMC Funding Request		**$57,407**	**$54,439**	**$3276**	**$115,122**

Budget Justification

Justification overview:
Funding will primarily be used to support field technicians (to be hired, names TBD) for two seasons, with a small amount to PI Dr. Tadashi Fukami, and additional funding for field

supplies, result dissemination and outreach (publications and papers). The PI has determined that this is a major project and per the Uniform Guideline is direct charging the administrative expenses to this project. All effort and expenses charged to this project will be for services specific to the project, and not for general support of the academic activities of the faculty or department. In addition, effort charged to this project can be specifically identified to the project. Total requested: $115,122, includes 12% indirect costs.

Personnel total = $92,327
This budget was constructed for the period 12/1/23 to 3/31/26. All effort and expenses charged to this project will be for services specific to the project and not for the general support of the academic activities of the faculty or department. According to guidelines approved by Stanford University, a cost-of-living increase of 3% was assumed for salaries and a 3% inflation rate was assumed for all other categories except where noted. These increases have been projected into all years of the budget. The fringe benefit rates are 28.7% for faculty and staff plus 2.2% TGP, 25.1% for postdoctoral affiliates, 5.9% for graduate students, and 6.9% for temporary/casual personnel. The budgeted salary amount for staff includes 8.8% vacation accrual/disability sick leave (DSL) for exempt employees and 8.8% for non-exempt employees. The vacation accrual/DSL rates will be charged at the time of the salary expenditure. No salary will be charged to the award when the employee is on vacation.

- 2 Seasonal field technicians
    - 3 months full time (40hrs/week), 25% effort
    - Base salary $64,752
  - Year 1 =$21,191 x 2 technicians at 25% (3 months) = $42,382
  - Year 2= $21,826 x 2 technicians at 25% (3 months) = $43,652
- PI, Tadashi Fukami
    - Annual, 1% effort for 2.25 years
    - Base salary $202,017
  - Year 1 = $2644 at 1% (12 months)
  - Year 2 = $2724 at 1% (12 months)
  - Year 3 = $925 at 0.33% (4 months)

Supplies total = $6000
Funding request for basic field/forestry supplies, which include flagging, plot markers, camera traps for small mammal tracking, SD cards for cameras, PPE (such as Tyvek suits for field technicians working in dense poison oak, gators, gloves), measuring tools for vegetation and fuels, soil and vegetation sampling vials and bags, acoustic monitoring equipment, etc.

- Year 1 = $6000
- Year 2 = $2000

The fuel reduction and forest management treatment (ie. experimental design) will have already been applied prior to the award period (summer 2023) as planned through Stanford University's campus-wide Wildfire Management Plan on its private land, so no funding is requested for treatment implementation.

Publication total = $2000
$2000 for costs related to publications, white papers, and outreach materials.

Travel total = $460

Travel costs to attend meetings to disseminate information and results from project (within California) and travel to meet with project partner, Berkeley, CA.

- Costs divided evenly between year 1 and year 2
    - 610 miles at $0.655 mileage reimbursement rate = $400
    - Tolls $60

Indirect costs at 12%

12% is negotiated rate between Stanford and California Board of Forestry and Fire (CAL FIRE)

- Modified Total Direct Costs = $102,787
- Indirect Costs = $12,335
- Total request = $115,122

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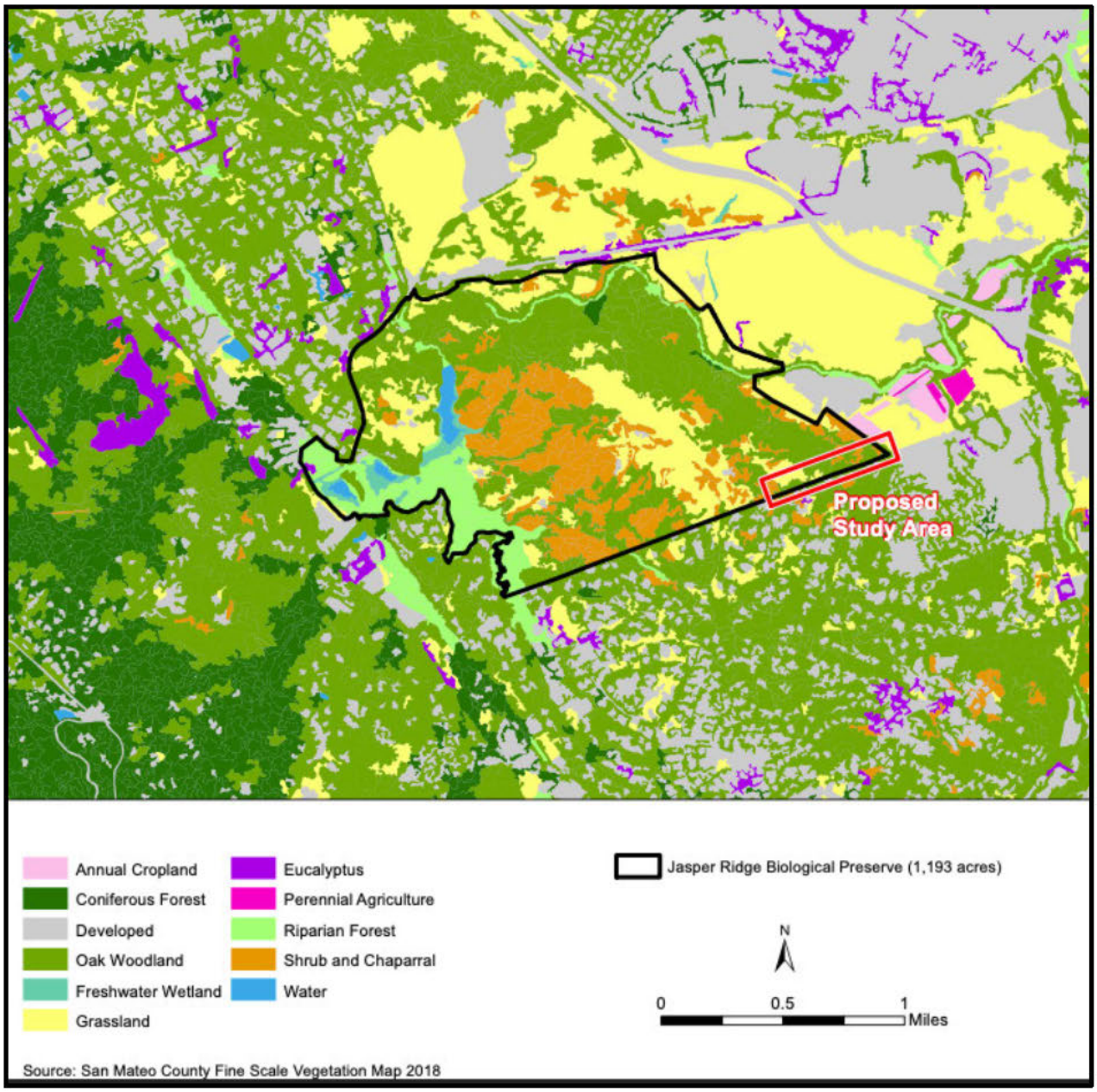
Appendix A: Forest and vegetation types surrounding Jasper Ridge Biological Preserve (JRBP).

Land use description: JRBP is located in the foothills of the Santa Cruz Mountains in the San Francisco Bay peninsula, within the San Francisquito Watershed. The preserve is situated in the WUI (Wildland Urban Interface), with dense urban areas to the NE and E, developed suburban areas to the N, NW and S. Forested lands occupy most of the area to the W, with some development. Directly E of JRBP, near the proposed study area, there is also agricultural and grasslands.



Berkeley
UNIVERSITY OF CALIFORNIA

Laureano A. Gherardi
Assistant Professor
Department of
Environmental Science,
Policy and Management
[redacted]

RE: Letter of Support for project titled *Evaluating California oak woodland forest management and its cumulative impacts on wildlife habitat* submitted by Jasper Ridge Biological Preserve to the Effectiveness Monitoring Committee of the Board of Forestry and Fire

Dear Kristina Wolf,

In response to overdue forest management needs and perceived fire risk in the region, private and public land managers of the Santa Cruz Mountains have been increasing the pace of forest management activities. Management strategies are broadly science-based developed from similar forest management activities across the state and country, however, there is relatively limited information about forest management specific Santa Cruz Mountain ecosystems, particularly with respect of long-term monitoring and evaluating outcomes.

In collaboration with the faculty director, executive director, and staff of Jasper Ridge Biological Preserve at Stanford University, we have identified a set of research questions to monitor forest management practices that will be particularly beneficial in evaluating current approaches and then broadly applicable to oak woodland forest management and small mammal wildlife habitat. In particular, we will be focused on wildlife habitat via studying the San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*) in oak woodlands. With JRBP (Stanford University) being both a private landowner and research institution in the WUI, it is particularly well positioned to undertake this research.

The San Francisco dusky-footed woodrat is endemic to the San Francisco Bay Area of the California Central Coast, including the Santa Cruz Mountains. As a CDFW species of special concern, risk mitigation tactics for woodrats include avoidance, buffers, habitat enhancement, and translocation. Typically, Santa Cruz Mountain forest management practitioners use buffers or avoidance. However, it is not always possible to discern if mitigation is successful in avoiding nest disturbance because it can be difficult to evaluate occupancy from nest structure alone, and woodrat activity is generally nocturnal, which restricts easy long-term monitoring due to resource and capacity limitations. We are proposing a project at Jasper Ridge to monitor dusky-footed woodrat nests and related ecological variables to evaluate ecosystem health after forest management and fuel reduction treatments. Following woodrats is particularly informative because Woodrats can serve as bioindicator species by responding to disturbances and interact with multiple species in oak woodlands.

I am committed to being a collaborator on this project. Given my background in ecosystem ecology am enthusiastic to participate in this project.
Sincerely yours,

Laureano A. Gherardi PhD

[redacted]

6/29/23

RE: Letter of Support for project titled *Evaluating California oak woodland forest management and its cumulative impacts on wildlife habitat* submitted by Jasper Ridge Biological Preserve (JRBP) to the Effectiveness Monitoring Committee of the Board of Forestry and Fire

Dear Kristina Wolf,

On behalf of the Santa Cruz Mountains Stewardship Network (SCMSN), I write to express our support of the project submitted by Jasper Ridge Biological Preserve of Stanford University to the Effectiveness Monitoring Committee, titled *Evaluating California oak woodland forest management and its cumulative impacts on wildlife habitat.* With Stanford University being both a private landowner and research institution located in the WUI, we recognize it is particularly well positioned to undertake this research. We believe that the research outcomes of this project will be immediately applicable to private and public lands with similar ecotypes in the Central Coast region and informative to similar landscapes throughout the state.

In our region, private and public land managers of the Santa Cruz Mountains have been increasing forest management activities in response to overdue forest management needs and perceived fire risk. Management strategies are broadly science-based developed from similar forest management practices across the state and country, however, there is relatively limited information about forest management specific to Santa Cruz Mountain ecosystems, particularly with respect of long -term monitoring and evaluating outcomes.

Multiple private and public land managers who are members of the SCMSN regularly meet in both large and small groups to discuss management strategies and collaborative opportunities. One of the small groups of the SCMSN is the Forest Monitoring group. Through a series of conversations, land managers have identified monitoring needs for our region to evaluate and potentially improve current practices. One specific topic is the impact of forest management on woodrat nest. This is particularly interesting for oak woodlands, which are an understudied forest system.

The San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*) is endemic to the San Francisco Bay Area of the California Central Coast, including the Santa Cruz Mountains. As a CDFW species of special concern, risk mitigation tactics for woodrats include avoidance, buffers, habitat enhancement, and translocation. Typically, Santa Cruz Mountain forest management practitioners use buffers or avoidance. However, it is not always possible to discern if mitigation is successful in avoiding nest disturbance because it can be difficult to evaluate occupancy from nest structure alone, and woodrat activity is generally nocturnal, which restricts easy long-term monitoring due to resource and capacity limitations. Researchers at Jasper Ridge propose to closely monitor dusky-footed woodrat nests and related ecological variables to evaluate ecosystem health after forest management and fuel reduction treatments. Following woodrats is particularly informative because Woodrats can serve as bioindicator species by responding to disturbances and interacting with multiple species in oak woodlands.

We understand that the Effectiveness Monitoring Committee (EMC) is looking for projects that cover key research themes and critical monitoring questions. The SCMSN is supportive of this research project and opportunity because it meets both the needs of the EMC as well as our region's forest management practitioners. We believe this project will be beneficial to the Santa Cruz Mountains and Central Coast, and as well as contribute to a better state-wide understanding of management impacts on wildlife habitat in oak woodlands.

Sincerely,

Dylan Skybrook, Network Manager