PROJECT TITLE: Mastication - A Complex Story: Understanding the effects of mastication and mulch-mastication on understory vegetation and wildlife populations

BACKGROUND and PURPOSE: As wildfires have increased in size, frequency and severity in the Sierra Nevada, federal, state, and local land management planning has increasingly focused on landscape-scale fuel reduction projects. A decade ago, mastication occurred primarily along roadway edges, but since that time, changes to methods, equipment, and fire risks have propelled mastication and other understory fuel reduction techniques to be applied across thousands of acres in almost every county in the Sierra Nevada. The Sierra Nevada evolved under frequent natural wildfire and cultural burning that were largely suppressed by the early 1900s. Population booms and expansion of development into the conifer zone have made returning to a pre-European settlement model of fire on the landscape largely impossible and even modest use of prescribed fire has been challenging. Although prescribed and cultural fire are the gold standards for reproducing the ecological systems of the Sierra Nevada's fire-evolved forests, mechanical fuel reduction methods are critical for reducing risk to communities while maintaining ecological, agricultural, and commercial value of remaining mature Sierran forests (Odland et al. 2021, Stephens et al. 2023).

As mastication efforts expand exponentially and new methods are developed, questions about their short- and long-term effects on plants and wildlife, their efficacy in reducing fuels, and risks of spreading invasive species remain inadequately assessed. Understanding the effects of, and differences between, varying mastication methods on understory plants and wildlife is critical for ensuring that ongoing and future fuel reduction efforts across the region remain compatible with conservation goals to the extent possible (Jain et al. 2018).

Standard mastication that cuts vegetation at or near the ground surface and leaves shredded material behind reduces understory and mid story vegetation with relatively less soil disturbance, erosion, loss of non-target plants, and invasive plant spread. However, more fuel remains on the forest floor, decomposition may take longer, and some target shrubs (e.g., *ceanothus*) may bounce back rapidly and create fuel ladders (but also wildlife habitat) quickly (Collins et al. 2007, Jain et al 2018). With mulch-mastication, in contrast to standard mastication, the blade of the equipment is directed into the soil so that shredded woody debris is mixed into the soil, thus reducing surface fuels and speeding decomposition of debris. This method may also slow the re-growth of base sprouting target shrubs, but also may negatively impact non-target plants important for wildlife and cultural uses. Greater exposed soil may create opportunities for native grasses and forbs to establish in a manner more similar to a post-fire landscape, however invasive weeds may also have similar opportunities (Kane et al. 2010).

By comparing plant and wildlife response between standard and mulch mastication we will focus on FHRP priority topic 3: *"Methods of ecological monitoring to continually evaluate effectiveness, impacts, and benefits of vegetation treatments at various scales including: practical and meaningful monitoring of vegetation treatment effectiveness over broad scales; monitoring of vegetation treatment co-benefits (i.e., wildlife habitat, carbon, water availability, water quality, hydrogeomorphic hazard reduction, etc.); and, ecological monitoring frameworks for chapparal and shrubland vegetation types."*

PROJECT DESCRIPTION: We will: 1) assess and compare responses of understory vegetation and wildlife to standard mastication and mulch mastication during the decade after treatment; 2) identify direction and magnitude of short- and long-term response by a wide variety of plant and wildlife taxa; 3) evaluate and compare the duration of reduced fuel loading resulting from standard mastication and mulch mastication. Our intent is to provide science-based recommendations on best practices for mastication treatments that meet fire risk reduction objectives while minimizing harms and maximizing benefits to understory plants and wildlife.

We will measure vegetation and wildlife response across treated (standard mastication, mulch mastication) and untreated areas of varying ages (years since treatment) to assess short- and long-term variation in vegetation, fuels and wildlife use. Our primary study design will deploy surveys with multiple replicates across untreated areas and areas that are 0-10 years post treatment. Where possible we will establish additional study plots in locations where we can monitor both before and after treatments expected during the funded project duration. We will work closely with existing partners already implementing fuel reduction projects including the Upper Mokelumne River Watershed Authority (UMRWA), Eldorado and Stanislaus National Forests, Lake Tahoe Basin Management Unit, BLM Mother Lode Field Office, and CDFW within Amador, Eldorado, Calaveras, Alpine, Stanislaus and Placer Counties.

We will use protocols similar to those we developed to assess aspen restoration efforts (Loffland 2023) and post fire treatments (Loffland et al 2017, 2021, Cole et al. 2019, 2020) and fuel reduction treatments (Cole et al. 2025; Table 1). We will implement a stratified random sampling design to establish approximately 360 monitoring locations across treatment units of varying age, as well as untreated areas. We will conduct vegetation surveys at each monitoring location using a standard 30m belt transect (Jones et al. 2005) and/or nested plots (Keeley et al. 2003) to measure vegetation understory, mid-story, and overstory cover, DBH, shrub height, and size class composition by each shrub and tree species. Fuel depth and cover (litter, 10hr, 100hr, 1000hr) and forb cover by species will be recorded within 1x1m plots embedded within each belt transect. This study design will allow us to assess the range of conditions across mastication projects of varying age for shrub species typically targeted for fuels reduction (*Ceanothus spp.*, manzanita, etc.), as well as other non-target species important as food, hiding cover or nesting cover for wildlife (e.g., bitterbrush, chokecherry, chinquapin). We will simultaneously be able to assess response of shrub and forb species of cultural significance (elderberry, gooseberry, western hazel, snowberry, wild strawberry, willow). Additionally, because the introduction of invasive plants is an ongoing concern for fuel treatments, vegetation transects will also capture data for these plants as well (e.g., cheat grass, Klamath weed, scotch broom, yellow star thistle).

Table 1. Proposed monitoring elements and methods

Monitoring Element	**Method**
Woody plant cover, frequency, size class	Belt transect, nested plots
Herbaceous, Cultural, and invasive plants	Rooted frequency plot (w/in belt transect)
Fuel depth and 10,100, 1000 hour fuel cover	1x1m cover plot (w/in in belt transect)
Nongame and game bird abundance	Unlimited distance Point count
Deer presence, timing of use	Pellet count (w/in belt transect)
Bumble bee abundance and floral selection	20m radius circular plot

We will co-locate wildlife survey plots at vegetation belt transects. Field biologists will conduct point count surveys with distance sampling and discrete time intervals (to facilitate estimating detection probability) to assess bird species abundance and diversity for non-game and game species (Loffland et al. 2011, Loffland et al 2023). Focal bird species that will be monitored using point count methods will include gamebird species (Mountain Quail, California Quail, Sooty Grouse, Wild Turkey, Band-tailed Pigeon) and dozens of non-game bird species associated with forest understory vegetation and chapparal (e.g. Green-tailed Towhee, Fox Sparrow, Spotted Towhee, Nashville's Warbler, Orange-crowned Warbler, Lazuli Bunting, Dark-eyed Junco) and those that forage on fruit-producing shrubs and trees (e.g., Western Bluebird, Mountain Bluebird, Townsend's Solitaire, Hermit Thrush, Black-headed Grosbeak). Belt transects used for vegetation monitoring will also be used for pellet counts to estimate deer abundance and timing of use. At the same survey locations, non-lethal pollinator surveys will assess floral resource use and treatment response by pollinator populations, primarily focusing bumble bees and monarch butterflies (Loffland et al. 2017, Cole et al. 2025). Pollinator surveys will record the

diversity and abundance of bumble bees (including state and federal special status species), and determine which plants they use preferentially; and also count numbers of monarch butterflies within plots. Where possible, we will coordinate with CDFW's Corridor Program to co-locate our surveys with their wildlife cameras/game monitoring stations to facilitate data sharing.

EXPECTED IMPACT: By providing critical data about efficacy of mulch and standard mastication methods and their effects of plants and wildlife this project will help land managers more efficiently plan and implement fuels reduction projects and thereby will meet the following goals of the 2021 California Wildfire and Forest Resilience Action Plan: "*Goal 1: increase the pace and scale of forest health projects" and "Goal 3: manage forests to achieve the state's economic and environmental goals"*. IBP staff presented this research concept to Lake Tahoe area biologists at the Basin Interagency Group (BIG) meeting in late 2025 and received feedback that there is a great need to better understand impacts when preparing NEPA and CEQA planning documents. This project concept was also discussed within the Amador Calaveras Consensus Group (ACCG), Monitoring Workgroup during development of landscape scale monitoring plans. Funding of this project would also allow IBP to fully collaborate with CDFW partners (Sara Holm, Helayna Pera, Shelly Blair) studying deer and bear of roadside fuel reduction units. This project will build upon IBPs successful and ongoing work monitoring bird and insect pollinator population responses to fuels and fire management efforts across California's forests (e.g., Siegel and DeSante 2003, Tingley et al. 2016, Stillman et al. 2023, Loffland et al 2017, Cole et al 2019, 2020, 2025, Montgomery et al. 2021, 2026). We also will engage 1-2 Tribes by identifying key cultural plants and utilizing tribal crews, if available (we have reached out to our existing partners at the Washoe Tribe of Nevada and California, and The Buena Vista Rancheria of Me-Wuk Indians). We will disseminate knowledge to stakeholders through 1 recorded webinar at the ACCG General Meeting, a live presentation at the Western Section Wildlife Society Meeting, and peer-reviewed scientific paper.

STATEMENT OF QUALIFICATIONS: PI: Helen Loffland, MSc. is a staff biologist with The Institute for Bird Populations (IBP). She has over 20 years of experience with study design and monitoring of riparian restoration projects in the Sierra Nevada. She co-led studies assessing pollinator response to forest treatments on the Eldorado and Siskiyou NFs and recently implemented an aspen project in Amador and Calaveras Counties mapping 1,000+ ac. of aspen, 150+ vegetation, bird and bee monitoring transects and plots. **Rodney Siegel, Ph.D**., has served as Executive Director of The Institute for Bird Populations since 2008. He has published approximately 90 papers in peer-reviewed journals, mostly focused on ecology and conservation of Sierra Nevada birds. **Graham Montgomery**, **Ph.D.**, is a postdoctoral researcher at IBP studying bumble bee floral resource use and population dynamics. He has published multiple per-reviewed papers focused on bird-insect resurveys, insect population monitoring, declines and variability. **Becky Estes, Ph.D.,** is a member of the USDA Forest Service Region 5 Ecology Program, a boundary-spanning organization that provides expertise fundamental to sustainable, science-based, multiple-use land management in the Pacific Southwest Region. Priority focal areas for the Region 5 Ecology Program include postfire restoration, climate adaptation, and inventory and monitoring.

TIMELINE and BUDGET NARRATIVE: Project timeline will begin with partner coordination, project planning and spatially explicit sampling design in 2027 and progress to field data collection in 2028 and 2029, with a final report and submission-ready manuscript completed by December 2030. Permanent employee costs for 3 staff members including salary plus benefits at 42% of salary, and 5 seasonal employees for 2 field seasons including pay and benefits at 15% of pay, amount to $435,992. Field housing, vehicle rentals and fuel for 2 field seasons are estimated at $43,750. Scientific and field supplies (e.g., tablets, GPS) are estimated at $12,600. Total direct cost is $492,392, indirect cost at 20% (adjusted down from a NICRA of 33%) of direct costs is $98,468, and total project cost is $590,810.

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