Final Report, Joint Fire Science Program Project No. 01B-3-3-05

Project Title: Fuel reduction effects on a key Sierra food web
Project Location: Teakettle Experimental Forest, Sierra National Forest, Fresno Co., CA and Yosemite National Park
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Brief Description of Project
Using a full-factorial experimental design, this project examined the effects of prescribed burning and mechanical thinning on the food web interactions among small mammals, truffle-producing ectomycorrhizae, and dominant forest trees in Sierra Nevada mixed-conifer forests. At Teakettle, we examined truffle abundance as well as the capture rates, microhabitat use, and truffle consumption by small mammals in replicate plots before and after fuel reduction treatments. In Yosemite National Park, we examined the potential effect of prescribed burning on nest tree use by northern flying squirrels, the main prey of California spotted owls. Our research focus was to determine pre-treatment reference conditions and post-treatment effects on a key food web in the Sierra Nevada to assist managers in evaluating the ecological effect of fuel reduction plans.

Summary of Findings at Teakettle Experimental Forest:
Post-treatment effects:

- Truffle frequency, biomass, and species richness were lower in thinned or burned plots than controls, as was the frequency and generic richness of truffles in the diet of small mammals. Truffle frequency, biomass, and species richness, and truffle consumption by lodgepole chipmunks were lower in heavily thinned and thinned and burned plots than those exclusively burned. These results suggest that either thinning or burning can reduce short-term truffle production and consumption, and potentially the dispersal of ectomycorrhizal spores by small mammals. Moreover, truffles decreased with treatment intensity, suggesting heavy thinning and higher burn intensity, particularly when applied together, can significantly affect short-term truffle abundance and small mammal consumption.
- The probability of flying squirrel capture was greater with increased canopy cover in mechanically-thinned stands and increased litter depth in burned stands. Greater canopy cover may provide protection from predators and thicker litter layers may harbor a greater abundance of truffles, a primary food of northern flying squirrels.
- Although burning and thinning caused significant changes in forest structure, neither treatment had a significant effect on the capture rate or most demographic parameters of lodgepole chipmunks. Body mass of males and the ratio of males to females both decreased following burning. Body mass and percentage reproductive females were positively correlated with the total number of white fir cones produced across treatments and years, possibly reflecting a positive association between chipmunk reproduction and food availability in treated mixed-conifer stands. These results suggest that prescribed burning and mechanical thinning may have minor or no short-term effects on the capture rate and demography of lodgepole chipmunks in mixed-conifer forests of the Sierra Nevada, but effects over longer periods still require investigation.

Pre-treatment reference conditions:

- Flying squirrels selected nest trees that were larger in diameter and taller than random trees. Snags were used more often than live trees relative to their availability. Nest trees were usually close to riparian habitat; 86% of nest trees were <150 m from a perennial creek. Flying

squirrels selected red fir and avoided incense cedar. These results suggest that flying squirrels of the Sierra Nevada may require large trees and snags within 150 m of perennial creeks for their critical habitat needs. Fuel management plans that retain these key habitat structures may provide key nest sites for the northern flying squirrel.

- Truffle diversity, biomass, and frequency were greater in riparian than upland sites. Species composition of truffles also was different between sites with a high number of species were restricted to riparian habitat. Log density, tree proximity, and soil moisture may influence truffle production in these habitats. Fire and fuel management that buffers riparian areas from intensive disturbance may protect these productive habitats.
- Northern flying squirrels and lodgepole chipmunks were frequent consumers of a similar, diverse assemblage of fungal taxa and that consumption was proportional to seasonal differences in availability. For the more strongly mycophagist northern flying squirrel, however, diet had a greater proportion of select fungal taxa and avoidance of less desirable taxa.

Summary of Findings at Yosemite National Park:

- Flying squirrels selected nest trees that were larger in diameter and taller than either large nearest-neighbor or random trees. Flying squirrels showed no tree species preference but used snags more often than live trees relative to their availability. Nest trees were not closer to perennial creeks than random trees. Results suggest that northern flying squirrels of Yosemite National Park may require large trees and snags for their habitat needs, but unlike more xeric parts of the extreme southern Sierra Nevada they may not be constrained by proximity to perennial streams.
- Truffle frequency, biomass, and species richness were greater at sites unburned for >80 years than sites that were prescribed burned 5-15 years ago in Yosemite National Park. However, overall truffle diversity across the forest landscape may increase with prescribed burning, providing more diverse food resources for small mammals. Results from this research are ongoing and will be completed by September 2006.

Proposed	Delivered/Status
Annual progress reports	Completed
Publications in scientific journals	Meyer, M. D., D. A. Kelt, and M. North. Microhabitat associations of northern flying squirrels in burned and thinned forest stands of the Sierra Nevada. *In press* in *American Midland Naturalist*. Meyer, M. D., M. P. North, and D. A. Kelt. Nest trees of northern flying squirrels in Yosemite National Park. *In press* in *The Southwestern Naturalist*. Meyer, M. D., M. North, and D. A. Kelt. 2005. Short-term effects of fire and forest thinning on truffle abundance and consumption in the southern Sierra Nevada of California. *Canadian Journal of Forest Research* 35:1061-1070. Meyer, M. D., D. A. Kelt, and M. North. 2005. Fungi in the diets of northern flying squirrels and lodgepole chipmunks in the Sierra Nevada. *Canadian Journal of Zoology* 83:1581-1589. Meyer, M. D., D. A. Kelt, and M. North. 2005. Nest tree ecology of northern flying squirrels in the southern Sierra Nevada. *Journal of Mammalogy* 86:275-280. Meyer, M. D., and M. North. 2005. Truffle abundance in riparian and upland forests of California's southern Sierra Nevada. *Canadian Journal of Botany* 83:1015-1020. Izzo, A. D., M. D. Meyer, J. M. Trappe, M. North, and T. Bruns. 2005. Hypogeous ectomycorrhizal fungal species on roots and in small mammal diet in a mixed-conifer forest. *Forest Science* 51:243-254. Meyer, M. D., D. A. Kelt, and M. North. Short-term effects of burning and thinning on capture rates of lodgepole chipmunks (*Neotamias speciosus*) in the Sierra Nevada of California. *In review.*
General Technical Report	North, M., B. Oakley, J. Chen, H. Erickson, A. Gray, A. Izzo, D. Johnson, S. Ma, J. Marra, M. D. Meyer, K. Purcell, T. Rambo, D. Rizzo, B. Roath, and T. Schowalter. 2002. Vegetation and ecological characteristics of mixed conifer and red fir forests at Teakettle Experimental Forest. *U. S. Forest Service PSW-General Technical Report* PSW-GTR-186.
Website	Information related to publications, presentations, and data provided on [http://teakettle.ucdavis.edu].
Fact Sheet	See enclosed fact sheet: North, M., M. Meyer, and D. Kelt. Small mammal and truffle response to burning in mixed-conifer forest. Pacific Southwest Research Station Sierra Nevada Research Center fact sheet.
National Conference Presentations	Meyer, M. D., M. North, and D. A. Kelt. Microhabitat associations of northern flying squirrels in burned and thinned forest stands of the Sierra Nevada. To be presented at the 2006 Annual Meeting of the Association for Fire Ecology, San Diego, California. Meyer, M. D., M. North, and D. A. Kelt. Forests, fungi, and small

	mammals: the impacts of fire and forest thinning on truffle production and consumption. Presented at the 2004 Annual Meeting of the Ecological Society of America (Organized Oral Session), Portland, Oregon. Meyer, M. D., D. A. Kelt, and M. North. Impact of fire and thinning on truffle production and consumption in a Sierra Nevada mixed-conifer and red fir forest. Presented at the 2002 Annual Meeting of the Association for Fire Ecology, San Diego, California.
Regional Presentations	Meyer, M. D., D. A. Kelt, and M. North. Nest tree ecology by northern flying squirrels in the southern Sierra Nevada and its implications for conservation. Presented at the 2004 Annual Meeting of the Bay Area Conservation Biology Symposium, Davis, California. Meyer, M. D., D. A. Kelt, and M. North. The importance of riparian habitat to northern flying squirrels at the Teakettle Forest. Presented at the 2002 Sierra Nevada Science Symposium, Lake Tahoe, CA.
University presentations	Meyer, M. D. M. North, and D. A. Kelt. Forests, fungi, and small mammals: the impact of fire and forest thinning on a tri-trophic mutualism. Invited presentations given at the California State University Sacramento Department of Biology Colloquium Speaker Series and the University of California Davis Experimental Topics in Ecological Research Seminar. Fall 2005.
Site Presentations/Tours	Meyer, M. D. The importance of prescribed burning for small mammals and fungi in Yosemite National Park. Presented on site in Yosemite National Park to the Merced Union High School District in June 2005 and 2006.
Multimedia presentations	The Teakettle Experiment: Fire and Thinning effects on Mixed-Conifer Ecosystems. A 37-slide presentation of the Teakettle Experiment with details of different ecosystem components and summary for forest managers, silviculturists, and fire management officers by M. North. Script for film and interactive DVD “Fire and forest health” by Malcolm North, Stephen Most and Janice Bowen. Film to be completed in November 2006.
New Items (not initially proposed) being pursued, partially attributable to JFSP funding	Expanding work examining the mid-term effects of prescribed burning on truffle biodiversity in Yosemite National Park. Work in progress to be completed in September 2006.