

**SHORT-TERM WILDLIFE RESPONSES TO
PONDEROSA PINE FOREST RESTORATION TREATMENTS
IN THE MOUNT TRUMBULL AREA, ARIZONA**

Annual Progress Report
October 1, 2001 – September 30, 2002

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EXECUTIVE SUMMARY

With the occurrence of large numbers of wildfires since 2000, forest restoration and management has become more socially and politically prominent. However, the importance of returning southwestern ponderosa pine forests to a pattern of ecological sustainability has long been recognized by forest scientists (Cooper et al. 1960), and restoration has been in the forefront of southwest forest management in the past decade. The Mount Trumbull Resource Conservation Area (RCA) serves as a multi-agency study site where scientists work jointly to determine the collective effects of a presettlement restoration prescription on forest health, including various species of wildlife.

The Arizona Game and Fish Department Research Branch has been studying the effects of the restoration prescription on mule deer (*Odocoileus hemionus*), western bluebirds (*Sialia mexicana*), herpetofauna, turkeys (*Meleagris gallopavo*), migrating songbirds, and Abert's squirrels (*Sciurus aberti*) on Mt. Trumbull since October 1997. We have studied macro and microhabitat use as well as general behavior with respect to treated, transition, and untreated portions of the study area. In this report, we review or list data collected and analyzed since 1997. With restoration efforts still in progress, we will not be able to fully determine associated effects until post-treatment data are available.

From 1997-2002, we focused on macro- and microhabitat use by mule deer. Additionally, this year we examined mule deer doe and fawn nutritional intake and fawn bedding characteristics. Our objective was to compare the nutritional analysis of fecal

pellets collected in treated and untreated areas. Fawn bedding characteristics were collected in all 3 treatments (treated, transition, or untreated) to examine vegetation use versus availability in the 3 stages.

We monitored 18 female mule deer on the Mt. Trumbull RCA study site from May 1 to September 30, 2002. The 244 locations we made helped further determine the extent of landscape scale habitat selection by does on Mt. Trumbull, as well as find fresh fecal pellet groups and bedded fawns. As with previous years, we recorded all locations on our Arc/Info database and overlaid these global positioning system locations on current vegetation and restoration stage maps. This winter, we completed the analysis of landscape scale habitat selection (on all years 1997-2002) and completed a draft manuscript.

To examine nutritional intake, we collected 35 doe pellet groups during parturition (May-June), and 42 during lactation (July – September). During the latter portion of lactation, we collected 12 fawn pellet groups. We also collected known mule deer food items during each period for caloric, fiber and trace mineral analysis. We collected 9 plants in treated and untreated areas during parturition and 16 in treated and 14 in untreated during lactation.

We measured characteristics of 26 fawn bedsites from mid-July through September 30, 2002. We measured 11 bedsites in treated, 3 in transition, and 12 in untreated habitats. To examine availability, we measured 15 random sites in each of the 3 restoration stages.

In 2002, we monitored 20 western bluebird nesting attempts in May and June; 15 were in treated areas, 2 in transition, and 3 in untreated habitats. We did not measure

Protocalliphora larva nor did we band any new birds. There was no second fledging event this summer, probably due to drought. During monitoring we confirmed 8 failed nests, 1 to predation, 1 was abandoned, the reason we documented dead nestlings in 10 other nests was unknown. We stopped monitoring nests after July 2nd.

Herpetofauna, turkey, squirrel and goshawk data were not collected this year. Collections are not expected to resume until restoration treatments are completed.

INTRODUCTION

Study objectives and methods are consistent with the previous 4 years unless otherwise noted. Detailed descriptions are found in the Second Annual Progress Report (1997-1998). Each wildlife group studied is detailed separately below, with the progress on data collection and analysis on each specific study objective reviewed.

MULE DEER

Summary of Research Progress

Year 6 (2002)

We continued to monitor the landscape scale habitat selection of transmitted female mule deer when heard in the treatment or control units of the Mt. Trumbull RCA. We started 2002 with 18 female mule deer on the winter range. On an aerial telemetry flight in February, we noted that 2 of the deer transmitters were on mortality and we assumed the does were dead. No attempt was made to retrieve the collars. Thirteen of the 16 winter range survivors returned to the study area. One doe continued to reside high on the south end of Mt. Trumbull as she has for the past 4 years. Two others did not move far enough north to be on the study area. To maintain our objective of 20 transmitted females, Wildlife Capture Services put 7 more collars on new female deer on July 5-7. One died within a week and another left the study area and was never located again, leaving a total of 18 monitored.

Mortality and Recruitment

Since September 2001, 2 does died while on the winter range and 1 died during monitoring this summer. The summer mortality occurred in late August and evidence indicated an illegal hunting injury. Using methods outlined by Pollack et al. (1989) to estimate survival probability, we estimated the 2002 rate as 90.9% survival for adult does. The capture mortality was not considered in the determination of a survival or mortality rate. The mean annual rate of survival for 1997-2002 was 88.5% and ranged from 76.5 to 100% estimated probability of survival.

We confirmed that 9 of the 18 does fawned, 7 with singles and 2 with twins resulting in a fawn:doe ratio of 61:100. We only confirmed 1 of the 11 fawns died before the end of our monitoring period.

LANDSCAPE SCALE HABITAT SELECTION

Objective: To determine 3rd order macro-habitat selection patterns of mule deer on the Mt. Trumbull RCA.

In 2002 we located 18 does 244 times between May 1 and September 30. We found 54 locations (22.1%) in treated areas, 105 (43%) in transition, and 85 (22.1%) in untreated habitats (Figure 1). Proportion of habitats available in 2002 was as follows: 15.6% treated, 32.1 % transition, and 52.2% untreated. Using Bonferroni confidence intervals, we determined that female mule deer selected treated and transition areas, and avoided untreated.

With all years combined (1997-2002), analysis of deer locations with respect to the proportion of restoration stages in each vegetation type available showed some consistent trends (Table 1). The only areas deer did not use as expected (avoided) were current condition forest types. Homogeneous ponderosa pine in 1998 and 2002, ponderosa-deciduous in 2001, ponderosa-pinyon-juniper in 1999 and 2002, and meadows located in current condition forests in 2002 were not used as available. Fully treated mixed ponderosa-deciduous forest was selected more than expected 3 of the 6 years it was available (2000-2002). Transition areas were selected in mixed ponderosa-deciduous in 1998 and meadows in transition areas in 1999. Small deer location samples in 1997 and 2000 ($n = 66$ and 111 respectively), coupled with the minimum number of

treatments of 7 in 1997 to the maximum of 14 in 2002 probably increased the risk of type II error (failure to detect a change).

By combining vegetation types and analyzing the proportion of mule deer locations with the availability of treatment stages only, selection patterns were clearer. Treated areas were selected more than expected 4 of 6 years, and transition areas were selected 3 of 5 years (Table 2). Current condition forests were used less than expected 4 of 6 years. The only year all restoration stages were used as expected was 2000. In 1997, treated areas were selected but transition areas were not available. Low sample size ($n < 111$) may have reduced chances of finding patterns in 1997 and 2000.

In 2002, 2 manuscripts regarding mule deer day beds and forage sites in current-condition and restoration-treated pine-oak forest were submitted for publication (Appendices 1 and 2).

MULE DEER NUTRITIONAL STATUS

Objective: To determine nutritional status of mule deer does on the Mt. Trumbull RCA.

Methods

To obtain fresh fecal pellets, transmittered does were watched until they left the area, and we attempted to collect pellet groups at that location. We also collected pellet groups from unmarked does when opportunities occurred. We attempted to collect all of the pellets in each group in a paper sack, and each group was labeled by doe ID, date and time collected, habitat type, and GPS location. In September, we began collecting fawn pellet piles in the same manner. Analysis of each pellet group to determine diet from

microhistological analysis, fecal DAPA, and fecal N (nitrogen) is currently being conducted at ASU East.

Known mule deer forages (McCulloch 1978) were collected in the middle of the gestation (June) and lactation period (August). We collected ≥ 70 g of ≥ 9 known deer plant foods in paper sacks and labeled with collection date, habitat type, and scientific name. We weighed each sample when it was collected and then air-dried them. After drying, plant collections were reweighed to obtain the dry weight and determine percent moisture from the wet:dry weight ratio. We hope to analyze each sample for energy (caloric value), % protein, % fiber, and trace minerals at the ASU East laboratory.

Data Collection

We collected 77 female mule deer pellet piles in the Mt. Trumbull RCA. We collected 35 pellet groups in treated areas and 42 groups in untreated areas. We also collected 12 fawn pellet piles, 6 from treated and 6 from untreated habitats.

Because we were not able to find female mule deer > 1 km from a treated-untreated boundary, we do not feel confident that pellets collected in treated areas do not represent conditions in untreated areas, and visa versa. Therefore, we will not be continuing the analysis to compare between treated and untreated areas. Rather, a graduate student at the ASU East is looking at the change in female mule deer diet and nutritional condition over the gestation and lactation period.

We collected 9 plant foods in treated and untreated habitats during gestation, and ≥ 15 during lactation. We hope that the nutritional values for these plant species may give us a better insight into differences between treated and untreated areas.

FAWN BEDSITE SELECTION

Objective: To determine fawn bedsite selection criteria in treated versus untreated

Areas on Mt. Trumbull RCA.

Methods

Beginning in July, we were more cautious during mule deer locations to aid in finding bedded fawns. When a fawn was located we would wait for it to evacuate, and then record the location, date, time, temperature 20 cm above the bedsite, temperature 1 m above the bedsite, slope, and aspect. Within 24 hours, the site was revisited, and vegetation was measured in each of the 4 cardinal directions along a 12.5 m line transect. Cover was measured at the following height intervals: 0 – 10 cm, 11 – 20 cm, 21 – 30 cm, 31 – 40 cm, 0.4 – 1.0 m, and 1.1 – 2.0 m. We read a visibility board at 10, 20, 30, 40, and 50 cm from 4-m distance at 1 m of height and determined concealment cover (distance at which 90 % of a fawn sized area is covered) in each cardinal direction. Canopy cover (hit or miss of canopy at each meter) was read along each transect, and we determined percent canopy cover at the bedsite by reading a spherical densiometer set 20 cm above the ground. Thermal cover was measured as the % of first meter of each line intercept covered by a plant ≥ 1 m tall.

Data Collection

We measured 26 fawn bedsites and 45 random sites. We measured 11 fawn bedsites in treated, 3 in transition and 12 in untreated areas and we measured 15 random sites in each of the 3 habitat types. Analysis has not been completed.

Table 1. Jacob's D values of avoidance or selection of vegetation type and restoration stage by year of female mule deer on Mt. Trumbull, Arizona, 1997-2002. An • indicates the proportion of locations and habitat availability were as expected as determined from 90% Bonferroni Confidence intervals. An empty cell indicates that habitat was not available that year.

HOMOGENOUS PONDEROSA PINE				PONDEROSA- DECIDUOUS			PONDEROSA- PINYON- JUNIPER			DECIDUOUS			MEADOW		
Yr	CC ^a	Tran ^b	Trtd ^c	CC	Tran	Trtd	CC	Tran	Trtd	CC	Tran	Trtd	CC	Tran	Trtd
97	•			•	•	•	•			•			•		
98	-0.46			•	0.6	•	•			•			•		
99	•			•	•	•	-0.29	•		•			•	0.81	
00	•	•		•	•	0.6	•	•		•			•	•	
01	•	•	•	-0.19	•	0.6	•	•		•	•	•	•	•	
02	-0.35	•	•	•	•	0.6	-0.37	•		•	•	•	- 0.57	•	•

^a CC=current condition forest

^b Tran = transition forest

^c Trtd = Treated

Table 2. Jacob's D values of avoidance or selection of vegetation type and restoration stage by year of female mule deer on Mt. Trumbull, Arizona, 1997-2002. An • indicates the proportion of locations and habitat availability were as expected as determined from 90% Bonferroni Confidence intervals. An empty cell indicates that habitat was not available that year.

Year (n =)	Current-condition	Transition	Treated
1997 (66)	•		0.55
1998 (236)	-0.63	0.6	0.58
1999 (143)	-0.34	•	0.53
2000 (111)	•	•	•
2001 (269)	-0.17	0.22	•
2002 (244)	-0.34	0.23	0.21

WESTERN BLUE BIRDS

Objective: To determine whether nesting success and parasitism of nestlings differs between untreated and treated forest on the Mt. Trumbull RCA.

Summary of Research Progress

Year 6 (2002)

In 2002 we documented clutch size, hatching dates, number of nestlings, fledging dates, and fledging success rates of 20 western bluebirds nesting attempts (Figure 2). Fifteen attempts were located in treated, 2 in transition, and 3 in untreated habitats. Sampling was not adequate to determine if clutch and brood size, fledgling or nesting success differed among treatments. Clutch sizes ranged from 1 – 5 eggs (Table 3), with an average of 2.7 nestlings/nest. We confirmed 8 failed nests (40 %), 1 of which was a predation, 2 fledged, and the fates of the remaining 10 attempts are unknown.

Because of the difficulty in finding and monitoring nests, we did not collect nest material nor perform *Protocalliphora* larva counts. We also did not band any additional bluebirds this or collect provisioning videography data.

The manuscript generated on the effects of restoration treatments on western bluebird nest success and infestation rates was printed in the June 2002 edition of *Restoration Ecology*.

Table 3. Western bluebird nesting data from Mt. Trumbull RCA during monitoring year 6 (2002).

Nest I.D.	Treatment	Number of Eggs	Number of Young	Location Date	Last Visit Date	Fate	Notes
RF0201	Treated	4	0	5/20/02	6/1/02	Failed	Predated
RF0201b	Treated	4	3	6/25/02	7/15/02	Fledged 2	In Cavity
RF0202	Treated	5	N/A	5/20/02	6/3/02	Unknown	Empty 6/25/02
RF0203	Treated	3	N/A	5/29/02	6/2/02	Unknown	Empty 6/25/02
RF0204	Treated	4	N/A	6/2/02	6/2/02	Unknown	Empty 6/25/02
RF0205	Treated	1	N/A	6/3/02	6/3/02	Unknown	Empty 6/25/02
RF0206	Treated	3	2	6/3/02	6/3/02	Part Failed	2 dead 6/25/02
LV0201	Treated	5	5	5/30/02	6/2/02	Part Failed	1 dead 6/26/02
TT0201	Treated	5	5	5/17/02	6/3/02	Unknown	Empty 6/26/02
TT0202	Treated	4	3	5/17/02	6/1/02	Unknown	Empty 6/26/02
TT0203	Treated	4	1	5/19/02	6/26/02	Part Failed	1 dead 6/26/02
TT0204	Treated	5	N/A	5/19/02	6/2/02	Unknown	Empty 6/25/02
TT0205	Treated	3	1	5/21/02	6/2/02	Part Failed	1 dead 6/25/02
TT0206	Treated	5	1	6/2/02	6/2/02	Part Failed	1 dead 6/25/02
TT0207	Treated	2	2	6/26/02	6/27/02	Fledged 2	None
SP0201	Transition	2	0	5/20/02	6/1/02	Failed	Abandoned
SP0202	Transition	4	4	6/2/02	6/2/02	Unknown	Empty 6/26/02
C0201	Untreated	5	N/A	5/30/02	6/3/02	Unknown	Empty 6/25/02
1377	Untreated	4	N/A	5/29/02	6/4/02	Unknown	None
EB2C	Untreated	2	0	05/31/02	6/25/02	Failed	Abandoned

PROVISIONING RATES OF NESTLINGS

Objective: To determine whether parental provisioning rates, and prey type differ between forest treatment status and nestling parasite burdens on the Mt. Trumbull RCA.

Data collected via videography between 1998-2000 is currently being analyzed. Data from the viewing will be analyzed for differential parental provisioning rates among forest treatment types and nest parasite loads.

REPTILES

Objective: To document the effects of forest restoration treatments on reptile

Abundance and demographics on the Mt. Trumbull RCA.

Summary of Research Progress

Year 6 (2002)

We did not collect any data on reptiles this year because few units containing sampling arrays have changed in treatment status. All data to date serve as pre-treatment data. Upon completion of treatments, reptile data collection will resume and subsequent analysis will continue.

A manuscript documenting abundance, demography, and reproductive success data for 2 lizard species in a restoration treatment forest was accepted for publication in the *Journal of Herpetology*, and is currently under revision (Appendix 3).

TURKEYS

Objective: To establish long-term surveys to monitor turkey population trends on the Mt. Trumbull RCA.

Summary of Research Progress

Year 6 (2002)

Turkey surveys are generally done simultaneously with deer capture efforts each year. However, because our capture effort was short and we specifically targeted deer in the control, turkey surveys were not conducted. We will begin surveys again once additional units have been treated.

MIGRANT SONGBIRDS

Objective: To document the effects of forest restoration treatments on migrant songbird abundance, diversity, and habitat use on the Mt. Trumbull RCA.

Summary of Research Progress

Year 6 (2002)

We did not conduct any additional songbird surveys during spring and fall migration periods this year. Data sets from previous years have been prepared for analysis. Post-treatment surveys of both the fall and spring migration periods will begin at the same survey points once Boundary, Springs, Nixon, Corner, North Slope, Hi-Lo, Cinder, Feral Pig, and North Sawmill units have been fully treated.

ABERT'S SQUIRRELS

Objective: To document the effects of forest restoration treatments on Abert's Squirrel feeding frequency and abundance estimates.

Summary of Progress

Year 6 (2002)

No data was collected on Abert's squirrels this year. Data collection will resume upon treatment of the Boundary, Springs, Nixon, Lo, and Cinder units.

NORTHERN GOSHAWK UPDATE

Because of lack of manpower, we did not search out and monitor goshawk nests in 2002.

Literature Cited

Cooper, C.F. 1960. Changes in vegetation, structure and growth of southwestern pine forests since European settlement. *Ecological Monographs* 30:129-164.

McCulloch, C. Y. 1978. Statewide deer food preferences. Arizona Game and Fish Department, Research Branch, Final Report, Phoenix, Arizona, pages: 1-29.

Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysis in telemetry studies: the staggered entry design. *Journal of Wildlife Management* 53:7-15.

Figure 1. Collared mule deer doe locations in the Mt. Trumbull RCA from October 1, 2001 through September 30, 2002.

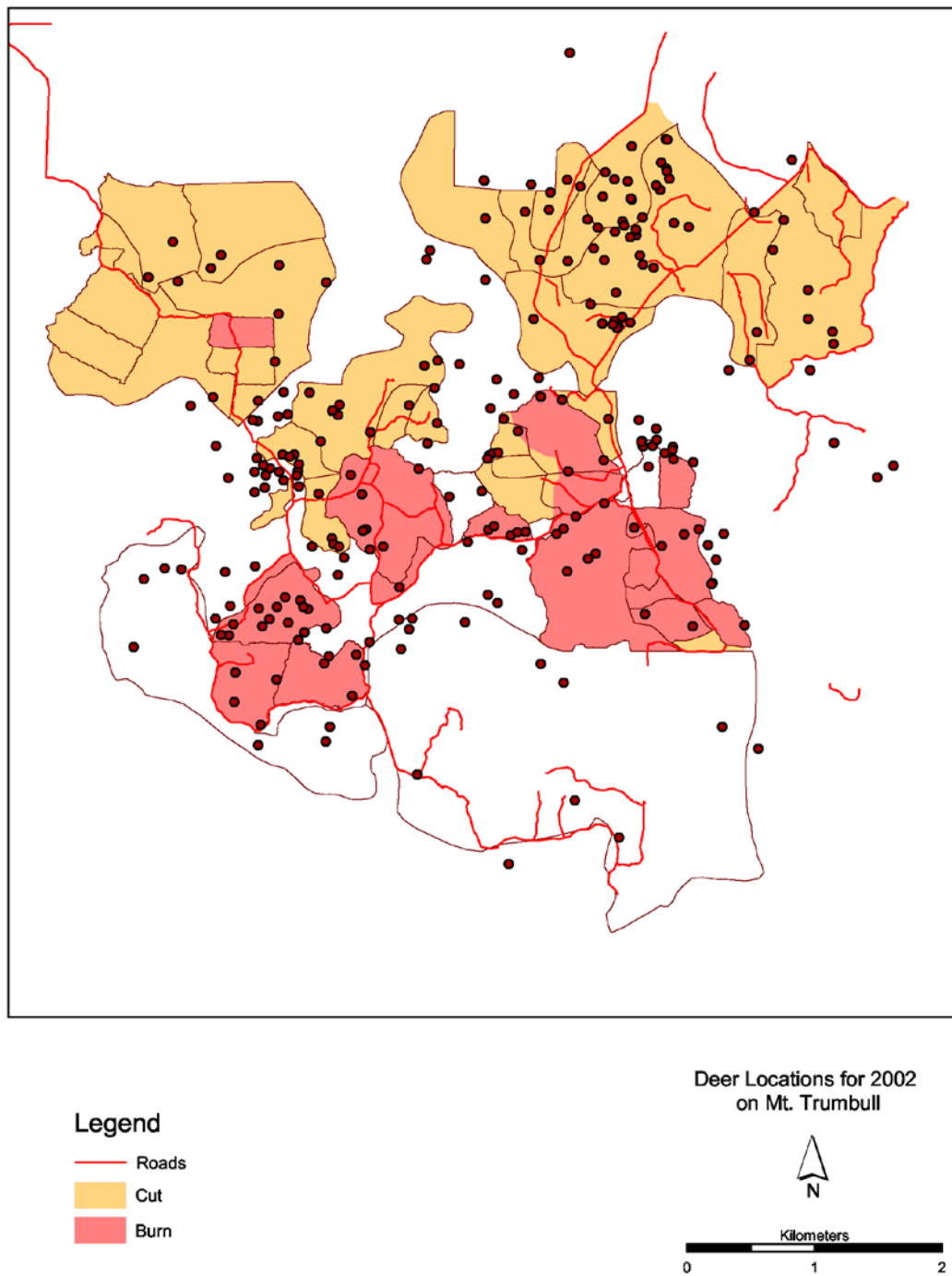
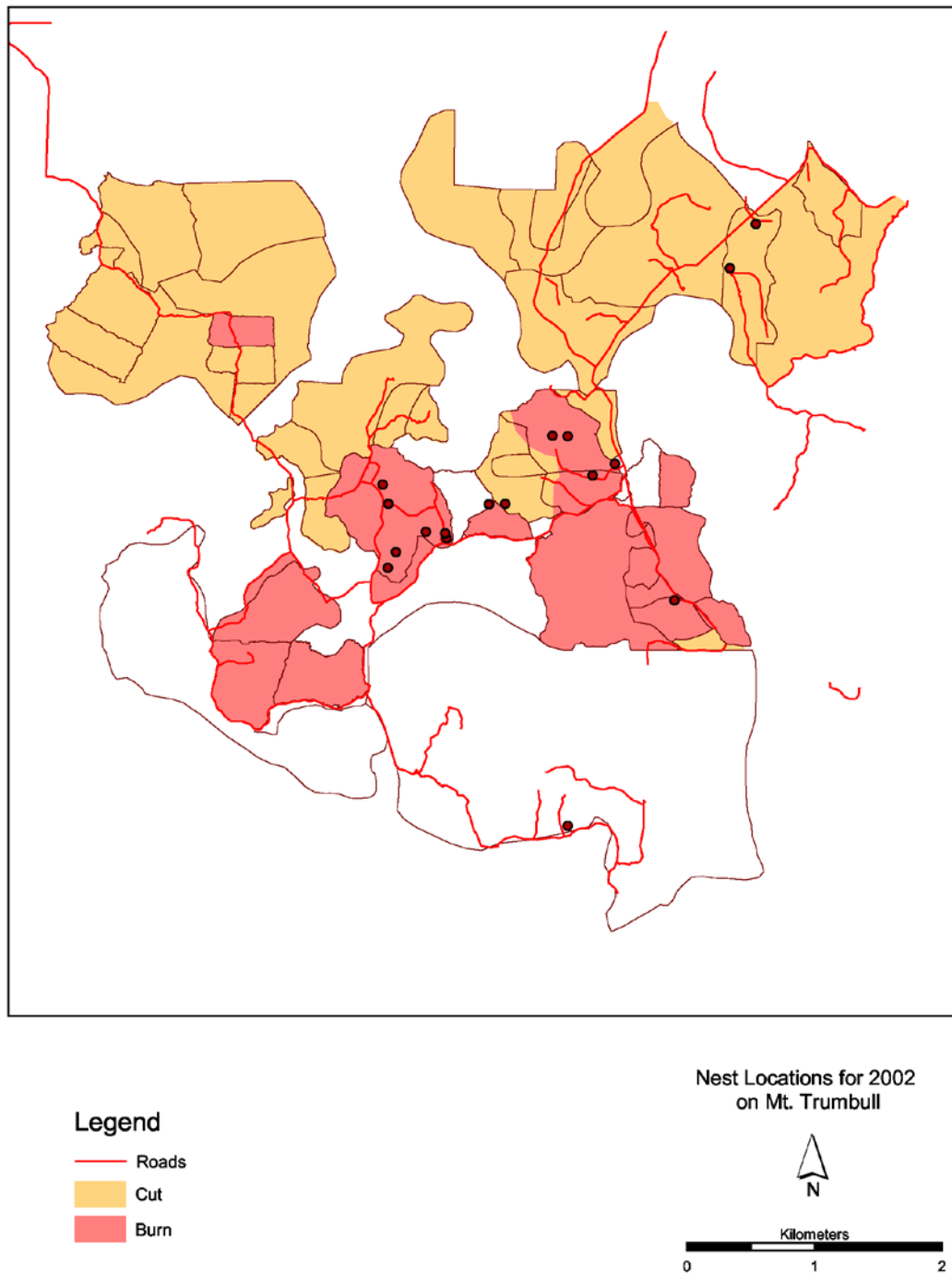


Figure 2. Western bluebird nest locations in Mt. Trumbull RCA from October 1, 2001 through September 30, 2002.



Appendix 1. Manuscript abstracts

CHARACTERISTICS OF MULE DEER DAY BEDS IN CURRENT-CONDITION
AND RESTORATION-TREATED PINE-OAK FOREST

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Abstract: We quantified micro-habitat (structure and micro-climate) at 236 mule deer day beds and an equal number of random locations during summers of 1998-2000 to evaluate day bed placement within current-condition and restoration-treated pine-oak forest. Objectives we addressed in this work were to: 1) identify important micro-habitat characteristics of day beds in current-condition forest, 2) evaluate relative availability of bed sites having these characteristics between forest types, 3) determine whether mule deer selected either forest type disproportionately while day bedding, and, 4) compare micro-habitat characteristics of day bed sites between forest types. Mule deer selected bed sites non-randomly in current-condition forest each year, with bed site temperature and canopy closure the most influential attributes in site selection. Availability of micro-habitat having attributes similar to those of current-condition forest day beds was reduced 50-100% each year in restoration-treated forest. However, mule deer continued to day bed in both forest types each year as expected based on proportional availability of total area of each forest type, and did so in restoration-treated forest in 1999 by utilizing a novel suite of micro-habitat features. Bed sites in each forest type had similar levels of midstory canopy closure. However, treated forest bed sites were significantly warmer in 1 year, were exclusively located under oaks, and were less well concealed in all years than current-condition forest beds, which were primarily located under conifers. Small stands of oak, the only dense patches retained in the restoration prescription we examined, provided marginal thermal and hiding cover for day bedding female mule deer. These differences may increase thermoregulatory stress and the potential for increased disturbance and predation of female mule deer and fawns during summer. We recommend retaining >0.04 ha patches of dense bedding/hiding cover within areas where both forest restoration and mule deer are management concerns.

CHARACTERISTICS OF MULE DEER FORAGE SITES IN CURRENT-CONDITION
AND RESTORATION-TREATED PINE-OAK FOREST

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Abstract: We quantified characteristics of 152 foraging micro-sites of female mule deer and 203 random locations during the fawn-rearing period in 1998-2000 to address questions about foraging use of restoration-treated pine-oak forest. Objectives we addressed in this study were to: 1) identify the suite of features that best characterized foraging sites in current-condition forest each year; 2) compare relative availability and diversity of forage micro-sites between current-condition and restoration-treated forest; 3) determine whether mule deer selected either forest type disproportionately for diurnal foraging; and, 4) compare consumption frequency forage items between forest types. Mule deer selected forage sites non-randomly in current-condition forest each year, with variables describing forage availability and diversity being influential attributes. In treated forest in 1998 and 1999, availability of forage increased by 66 and 31%, respectively, while forage diversity was increased in 1998. However, mule deer consumed shrubs more frequently in treated forest, and forbs and mushrooms more frequently in current-condition forest. Mule deer selected treated forest while foraging in only 1 year, demonstrating no preference in 2 years. The degree of forest-openness resulting from the treatment prescription we examined may preclude female mule deer from exploiting increased forage availability and diversity because of the need to keep fawns near hiding cover. Retention of patches of hiding cover may increase use of restoration-treated forest by female mule deer during summer.

LIZARD DISTRIBUTIONS AND REPRODUCTIVE SUCCESS IN A SOUTHWESTERN PONDEROSA PINE FOREST

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ABSTRACT- We collected abundance, demographic, and reproductive success data for two lizard species in a Northern Arizona ponderosa pine forest, a fire-dependent system, that has been unnaturally modified by fire suppression for the past century. During May – October of 1997 – 1999 we employed up to 70 pitfall arrays to sample lizards over 6,990 array-days. Captured lizards were sexed, measured, and uniquely marked, allowing estimates of abundance for three age classes and of reproductive success for each species. At each array we measured vegetation variables describing three spatial scales of resolution: macro-vegetative cover types, stand level forest structure, and ground cover – substrate types. We assessed differences in lizard response variables among vegetative cover types, stand structures, and substrate types by comparing 90% confidence intervals or with Mann-Whitney U tests. *Sceloporus graciosus* responded to habitat variation at all three spatial scales. Adult *S. graciosus* occurred in a wide variety of cover and stand types. However, reproductive success and hatchling abundance were highest in the most open cover (meadow) and stand (savannah) types, and were lowest in pure ponderosa cover and dense ponderosa stands. Juveniles were most abundant in areas containing a deciduous tree component in both cover and stand types. Adult females replaced themselves only in meadows, savannahs, and forest with a deciduous component, failing to replace themselves annually in all other forest cover and stand types. *Eumeces skiltonianus* adults and juveniles were least abundant in meadow cover types, but adult females replaced themselves each year in meadow and ponderosa-pinyon-juniper vegetative cover types and savannah stand types. Hatchlings displayed little sensitivity to cover or stand type variation, while juveniles again were abundant in deciduous cover and stand types. Both species were influenced by amount of duff groundcover present. However, *E. skiltonianus* occurred only in plots containing between 17% - 87% organic duff, and were thus absent from 20% of all plots sampled. We conclude that increased tree densities, canopy closure, and litter accumulation associated with long-term fire exclusion influenced distributions of both lizards. Furthermore, the highest-quality habitats present for these lizards were those most similar to those present prior to fire suppression activities, and areas containing a deciduous tree component.