

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

Annual Progress Report
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EXECUTIVE SUMMARY

Ponderosa pine (*Pinus ponderosa*) forests of the southwestern U.S. have changed dramatically over the past century, primarily in response to grazing, logging, and fire exclusion pressures (Covington and Moore 1994). These activities have resulted in homogeneous forests consisting primarily of small diameter ponderosa pines. These homogeneous, dense forests are stressed by competition for resources, bark beetle infestations, and high risk of catastrophic wildfire. In an attempt to improve ecosystem functions within ponderosa pine forests, restoration prescriptions are currently being implemented at varying scales throughout the southwestern U.S. (Covington et al. 1997, Allen et al. 2002). These restoration treatments, which modify the existing homogeneous forest structure, will affect wildlife species, and other components of the ecosystem, in various ways (Allen et al. 2002).

The Arizona Game and Fish Department partnered with the Bureau of Land Management and the Ecological Restoration Institute at Northern Arizona University in 1996 to investigate wildlife responses to forest restoration on the Grand Canyon-Parashant National Monument in northwestern Arizona. Restoration treatments were initiated in 1997 in the Mount Trumbull area. This report details the seventh season of field research on short-term wildlife responses to forest restoration.

In 2003, we continued our research on mule deer (*Odocoileus hemionus*), western bluebirds (*Sialia mexicana*), lizards, wild turkeys (*Meleagris gallopavo*), migrating songbirds, and tassel-eared squirrels (*Sciurus aberti*). In addition, we collected information on nesting northern goshawks (*Accipiter gentilis*) in the study area. There are a few plots that have not received the initial phase of restoration treatments. Until these are completed, we cannot evaluate changes in populations of wild turkeys, migrating songbirds, or tassel-eared squirrels. Therefore, in 2003 we focused our efforts on mule deer habitat selection and western bluebird nestling development and fledgling survivorship in restoration treated forests. We also conducted a preliminary study on lizard abundance in association with different stages of restoration treatments.

In spring, AGFD personnel submitted two manuscripts from Mt Trumbull research on mule deer day-bed and foraging sites (Germaine et al. *In Press*) and landscape habitat selection (Cunningham et al. *In Progress*) to peer-reviewed journals. Abstracts from these manuscripts are provided at the end of the mule deer section. To improve our understanding of mule deer landscape habitat selection and home ranges in restoration treated forests, we captured and outfitted 15 female mule deer with GPS store-on-board collars. The collars are programmed to record one position every five hours from 15 May through 31 October for the 2003-2005 field seasons. When we retrieve the collars after 25 September 2005, there will be more than 3000 position locations stored for each deer. These data will be analyzed at that time to evaluate home range, temporal, and circadian patterns in mule deer responses to restoration.

In previous research in the Mt Trumbull area, Germaine and Germaine (2002) found nest success of western bluebirds in treated habitat was significantly greater than in untreated habitats. However, they also found that infestation rates of the ectoparasite *Protocalliphora* sp. were greater in nests in restoration treated habitats. Therefore, although bluebirds nesting in

restoration treated habitats were more likely to produce fledglings, these fledglings might be in poorer condition, as a result of higher parasitism in the nest, than their counterparts in untreated habitats. If nestlings are in such poor condition that survival during the critical post-fledge period is compromised, then restoration-treated habitats may not, in fact, be higher quality habitat for nesting western bluebirds despite the higher observed nest success. High parasitism rates may result in suppressed nestling development (Møller 1997, Gebhardt-Heinrich and Richner 1998, Heeb et al. 1999, Saino et al. 2002), increased parental provisioning rates (Tripet and Richner 1997), and/or high mortality rates of fledglings (Arendt 1985). In 1998-2000, AGFD personnel collected data on parental provisioning rates of infested western bluebird nests. These data are currently being analyzed.

This year, we began researching the effects of nest parasitism on western bluebird nestling development and fledgling survivorship. We monitored nestling development of 61 nestlings from 15 nests. During the nestling period, nestlings were weighed and measured for structural size. To track western bluebird fledgling survivorship, we attached radio transmitters to 18 fledglings 1-2 days prior to fledging. Fledglings were tracked for the life of the transmitter (mean=21 days) or until they dropped the transmitter (mean=18 days). Survivorship for the first two weeks post-fledging was 88% for the 2003 field season. Within 2-3 days after the young fledged, we collected nests and nest contents to count nest parasites.

Also this year, Germaine et al. (*In Press*) analyzed lizard-habitat associations using pre-restoration treatment data. This manuscript was accepted by the Journal of Herpetology and is scheduled for publication in the December 2003 journal. The abstract of this paper can be found at the end of the lizard section.

During 2003, we opened 12 arrays, four in each of treated, transitional, and untreated habitats. We captured 87 western sagebrush lizards, *Sceloporus graciosus*, and 16 western skinks, *Eumeces skiltonianus*. Our results from this field season suggest abundance of these two lizard species differ little among habitat types. We suspect this a result of a small sample size, rather than a lack of a response to restoration treatments by lizards. It is interesting to note that two of the four arrays in treated habitats failed to capture a single lizard during the entire field season. Both of these arrays were in areas where the severity of the restoration prescribed fire was high. We are unsure whether fire severity is related to our failure to capture lizards at these arrays; however it is one possible explanation that warrants further exploration in the future.

We located two breeding pairs of northern goshawks on the study area in 2003. One pair nested in the southeast corner of the Control plot and the other nested in the Corner plot. Both pairs successfully fledged one young.

We did not collect additional data on migrating songbirds, wild turkeys or tassel-eared squirrels in the 2003 field season. We did, however, evaluate the association of migrating songbirds with ponderosa pine forest gradients using pre-treatment data. These results are presented in a manuscript that is to be submitted to the peer-reviewed journal, *The Condor*, in December. A draft abstract of this paper follows the migratory songbirds section.

INTRODUCTION

The 2003 Arizona Game and Fish Department Annual Report marks the seventh year of research on short-term wildlife responses to forest restoration in the Mt Trumbull area in northwestern Arizona. The Bureau of Land Management, through the Ecological Restoration Institute at Northern Arizona University, provided funding for this research. The Arizona Game and Fish Department also provided funds through the Heritage Program. This report covers the period from October 1, 2002 to September 30, 2003.

Our goal for this field season was to continue our assessment of wildlife habitat selection and associations in restoration-treated habitats. In 2003, we focused on mule deer, western bluebirds, and lizards. We also documented nest success of breeding northern goshawks. Study objectives and methods are included in each species section, which follow in this report. Our objectives and methods are not always consistent with the original study design, which is described in detail in the second annual AGFD report, because a few of the key plots remain to be fully treated.

Field personnel collected data from mid-May through September 2003. The 2003 AGFD field crew consisted of Steve Carpenedo, Chris Seck, Dan Kaminski, Elizabeth Ray and Catherine Wightman. Tyler Gehr, of Wildlife Capture Services, captured the mule deer. BLM interns and AGFD wildlife technicians assisted with bluebird tracking.

MULE DEER

Previous research at Mt Trumbull suggests that mule deer are responding favorably to restoration treatments during the day. In a landscape analysis, Cunningham et. al (*In Progress*) found that mule deer selected treated and transitional areas disproportionately to untreated areas. They suggested this was a result of increased forage in treated areas. Results from a parallel study (Germaine et. al *In Press*) support this hypothesis. They found that mule deer selected restoration-treated areas for foraging sites. Mule deer may be expected to select the denser, current condition forests for day-bedding, however, Germaine et al. (*In Press*) found no evidence of selection for day bed sites at the scale of the restoration treatments. This previous research on mule deer at Mt Trumbull focused on deer movements within the study area boundaries and daylight hours. Abstracts from submitted manuscripts are provided at the end of this section.

In 2003, we focused on improving our understanding of home range and temporal changes in mule deer habitat selection in response to forest restoration. Our objectives included:

- a. To describe the proportion of treated and untreated forests in mule deer home range and core use areas,
- b. To evaluate habitat selection associated with home ranges and core use areas,
- c. To evaluate whether female mule deer select different habitats during the fawning period,
- d. To evaluate whether there is a circadian pattern to habitat selection.

Methods

We captured 15 female mule deer and outfitted them with Global Positioning System (GPS) collars in 2003. Each collar is equipped with a standard VHF transmitter and GPS unit. The GPS collars are programmed to record one location every five hours from the 16th of May to the 31st of October. During the winter months, when we expect mule deer to leave the study area, the GPS collars collect one location each week. The collars are programmed to automatically release on 25 September 2005. This will provide us with three years of data on mule deer habitat locations.



We delineated four strata on the study area (Fig 1) and set capture quotas per stratum to obtain a representative sample across the study area. Three of the four strata (A,C,D) contain water catchments where deer are likely to congregate. The fourth stratum (B) makes up the central portion of the study area. We attempted to capture five deer in stratum B and three to four deer in each of the remaining strata.

We began tracking collared mule deer on July 10 and tracked each deer approximately once a week through conventional radio telemetry methods. The purpose of locating each female was

to determine the reproductive success of each deer. During tracking observations, we also collected data on the habitat type for each location, treatment status, and activity.

Results and Discussion

We captured 15 female mule deer from the 6 June to 3 August. Two deer were captured in Stratum A, five in stratum B, five in stratum C and three were captured in Stratum D (Fig. 1). Twelve of the 15 collared females (80%) had fawns in 2003. Mean productivity of collared deer was 1.07 (± 0.2 SE) fawns. Our tracking observations suggest that collared deer were relatively evenly distributed across the study area (Fig. 2).

In general, we observed each female 2-3 times to determine whether she had fawns. We recorded 26 independent visual confirmations of mule deer and determined the activity of deer at 23 of these (Table 1). Although the majority of total observations were in untreated habitats, a large majority of the browse locations were in restoration-treated habitats.

In addition, we determined the status of mule deer that were collared during previous years on the study area. Twenty deer collared prior to 2003 were alive at the end of the 2002 field season. In 2003, 10 of these deer were alive, one was dead, and nine were not located.

This field season, we met our goal of capturing 15 mule deer and determining the breeding status of each collared deer. Our sample of mule deer was relatively evenly distributed across the study area and should provide a representative sample of mule deer habitat selection in the Mt Trumbull area. We will conduct data analyses when we retrieve the GPS collars in 2005.

Table 1. Collared mule deer locations and activities by restoration treatment status (%) on the Mt Trumbull Study Area in 2003

	n	Treated	Transitional	Untreated
All Observations	26	26.9	30.8	42.3
Browse Observations	7	72.4	14.3	14.3
Bedded Observations	16	12.5	31.3	56.3

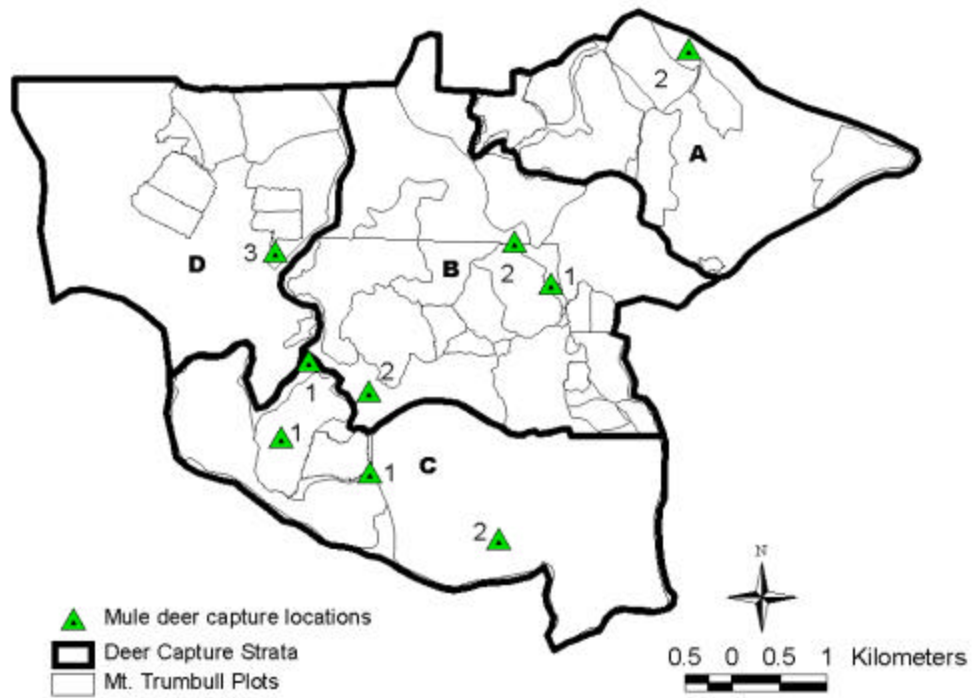


Figure 1. Mule deer capture locations and strata at Mt Trumbull, Arizona in 2003. Numbers next to capture locations indicate the number of deer captured at each location.

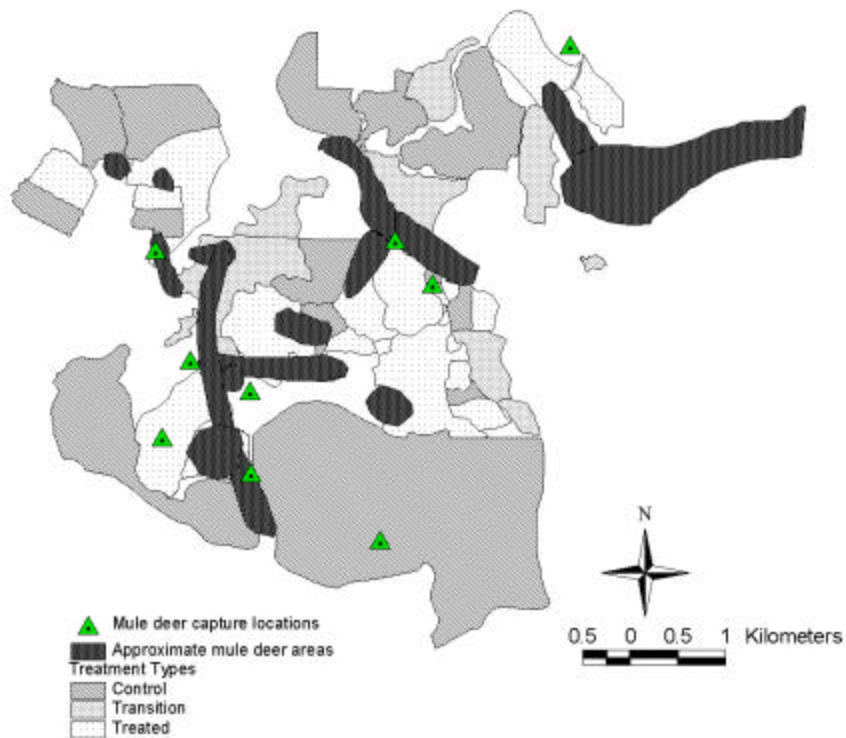


Figure 2. General tracking locations of 15 mule deer at Mt Trumbull, Arizona in 2003.

Abstracts

Cunnigham, S.C., S.S. Germaine, H.L. Germaine, and S.R. Boe. *In Progress*. Landscape habitat selection in a partially restored ponderosa pine forest by female mule deer in northwest Arizona. Submitted to Restoration Ecology.

Southwest ponderosa pine (*Pinus ponderosa*) forests have become dense with small young trees, herbaceous productivity has declined, and forest floor fuels have accumulated. Crown fire danger has increased, prompting increased awareness and commitment to restore conditions to presettlement tree density. We studied landscape scale habitat selection of female mule deer (*Odocoileus hemionus*) from 1997 through 2002 in a partially restored ponderosa pine forest in northwest Arizona. By comparing proportion of female mule deer locations to availability of treatment stages and 5 vegetation types we found some consistent trends. Treated mixed ponderosa-deciduous forest and meadows within treated areas were selected most often. With vegetation types pooled, treated areas were selected 4 of 6 years and transition areas were used more than available 3 of 5 years. We assumed selection was due to increased forage availability. Conversely, current condition vegetation types were not used as expected 4 of 6 years. Greater than 80% of female mule deer locations were in treated areas < 2.5 years old. Tradeoffs between enhanced forage availability and decreased bed and hiding cover may simultaneously influence female mule deer use of restoration treated forest. Leaving additional patches of dense hiding cover may increase use of treated area by female mule deer.

Germaine, S.S., H.L. Germaine, and S.R. Boe. *In Press*. Characteristics of Mule Deer Day-Bed and Forage Sites in Current Condition and Restoration-Treated Ponderosa Pine Forest. Wildlife Society Bulletin.

We characterized micro-habitat (structure and micro-climate) at 236 mule deer (*Odocoileus hemionus*) day-beds, 152 diurnal forage sites, and 439 random locations during summers of 1998-2000. Our objectives were to: 1) identify important micro-habitat characteristics of day-beds and forage sites in untreated forest, 2) compare relative availability of bed and forage sites having these characteristics between forest types, 3) determine whether mule deer selected either forest type disproportionately for these activities, and, 4) compare characteristics of day-bed and forage sites between forest types. Mule deer selected bed and forage sites with specific characteristics in untreated forest each year. Site temperature and canopy closure were the most influential attributes in bed site selection, while forage availability best described forage sites. Availability of characteristic day-bed micro-habitat was reduced 50-100%, while forage characteristics increased 31-66% each year in treated forest. Foraging mule deer selected treated forest in one year, demonstrating no preference in two. Mule deer continued to use day-beds in both forest types each year as expected based on proportional area of each forest type, but did so in 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, but treated forest bed sites were warmer in 1 year, exclusively located under oaks rather than conifers, and less concealed than untreated forest beds. Small oak stands were the only dense patches retained in the restoration prescription we examined, and provided marginal thermal and hiding cover for day-bed use by 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 and hiding cover in areas where both forest restoration and mule deer are management concerns.

WESTERN BLUEBIRDS

In their investigations on the effects of forest restoration on nesting success of western bluebirds, Germaine and Germaine (2002) found that nesting success was higher in treated areas than in untreated areas. However, they also found that nest infestations by the blowfly parasite, *Protocalliphora sialia*, were greater in the treated areas. Previous research has suggested that high parasite loads may alter provisioning rates by the adults (Tripet and Richner 1997), cause poor nestling body condition (Møller 1997, Gebhardt-Heinrich and Richner 1998, Heeb et al. 1999, Saino et al. 2002), and/or reduce post-fledgling survivorship (Arendt 1985). Therefore, although nest success was higher in restoration-treated habitats, these habitats may not be higher quality if high parasite loads compromise the fitness of the fledglings. In 2001, we identified a second nest parasite, *Cimicid* sp., infesting western bluebird nests on the study area. Data on adult provisioning rates, collected in 1998-2000, are currently being analyzed.

In 2003, we continued research on the effect of nest parasites on western bluebird fitness. Our objectives included:

- a. to continue to evaluate the effects of forest restoration treatments on western bluebird nest success,
- b. to evaluate the effects of nest parasites on nestling growth curves,
- c. to evaluate the effects of nest parasites on post-fledgling survivorship.

Methods

We searched for nesting western bluebirds within treated, transitional, and untreated plots from May 21 through July 6. We monitored active nests approximately every three days. We spent 100.5, 21.2, and 78.6 hours nest searching in treated, transitional, and untreated habitats, respectively. At each nest, we collected data on clutch size, hatching success, and fledging success. We used the Mayfield Method (Mayfield 1962, 1975) to calculate nest success and productivity among treatment types. In August, we collected vegetation data at all monitored nests according to sampling protocol in Germaine and Di Orio (2001).

To access nestling bluebirds and nest materials, we drilled all accessible nest trees and inserted a removable plug. Using this method, we had continued access to the nest cavity. To obtain the most representative sample of parasite loads, we collected nests and nest materials 1-2 days after the young fledged (Neil Cobb, pers. comm.). We froze all collected nests and will count parasites by species in winter 2003-04.



We collected body condition measurements from all accessible nests approximately every three days during the nestling period. On the first visit, we gave each nestling a unique color band combination for future identification. For each nestling, we recorded age, sex, tarsus width and length, length of primary 6, length of rectrice 1, wing cord, and weight. We measured right and left sides.

To obtain fledgling survivorship estimates, we attached VHF transmitters to two randomly selected fledglings in each sampled nest 1-2 days before fledgling. Tracking was conducted for the life of the fledgling or transmitter battery (~21 days). We tracked fledglings twice a day and recorded data on their distance from nest of origin, activity and substrate. Because fledglings from the same nest are not independent samples, we averaged fledgling data within nests.



Results and Discussion

We monitored 30 bluebird nests in treated (n=23), transitional (n=4), and untreated habitats (n=3; Fig. 3). None of the nests monitored in transitional habitat failed and none in untreated habitats succeeded (Table 2). Thus, Mayfield (1975) probabilities of bluebird nest success and productivity were highest in transitional habitats and lowest in untreated habitats (Table 3). We have a small sample size for nests in these two habitat types; therefore, our estimates of nest success and productivity may be biased. We do believe, however, that the trend of reproductive success among habitats may be representative of differences among habitat types. Predation on our monitored nests was rare throughout the study area; rates were 4%, 0% and 0% in treated, transitional, and untreated habitats, respectively.

We collected nestling body condition measures on 61 nestlings at 15 nests in treated (n=14) and transitional (n=1) habitats. Nestlings from 10 nests were from a first clutch and nestlings from five nests were from a second clutch. Nestlings from first clutches tended to be heavier at the same age than nestlings from second clutches (Fig. 4). For example, average weight of nestlings at 19 days old in clutch one was 26.6 ± 0.6 and in clutch two was 25.7 ± 0.4 . Nestlings from second clutches initiated development of primary 6 approximately two days later than nestlings from first clutches (Fig. 5). This may be a result of increased foraging opportunities earlier in the breeding season and indicates that we should include clutch status in our analyses of nest parasitism on nestling development. We will collect another year of data before initiating these analyses.

We attached transmitters to 15 fledglings from eight nests in treated (n=7) and transitional (n=1) habitats. We recorded 187 post-fledgling locations from June 9 to August 12. Two individuals from different nests in treated habitats were depredated after fledging, which indicates an overall survival rate of 88% during a 19 day post-fledge period.

None of the fledglings that we monitored moved into untreated habitats after fledging, although we sometimes found them at the edge of untreated habitats. For the first eight days after fledge, fledglings tended to stay within 100 m of their nest (Fig. 6). After eight days, however, individuals from second clutches began moving greater distances (max=600 m), while individuals from first clutches remained relatively close to the natal nest (max=155 m). These observations provide additional support for including clutch status as a variable in data analyses. We will collect another year of data before initiating survivorship analyses.

Table 2. Measures of reproductive success of western bluebirds in current-condition (untreated), transitional, and restoration-treated Ponderosa Pine forests at Mt Trumbull, Arizona, 1998-2003.

	1998	1999		2000		2001		2002		2003			
	Untreated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Transition	Treated	Untreated	Transition	Treated
Number of Nests ^{1c}	8	11	9	17	19	5	27	3	2	15	3	4	23
Clutch Size	*	5.2±0.3 ^b	5.0±0.3	4.4±0.2 ^b	4.6±0.2	4.7±0.3 ^b	4.1±0.3	3.7±0.9	3.8±1.0	3.8±0.3	3.7±0.7	3.7±0.7	4.5±0.3
Number of Nestlings	3.8±0.4	4.3±0.3 ^b	4.1±0.2	3.3±0.4 ^b	4.2±0.3	2.2±1.0 ^b	2.9±0.3	0	2.0±2.0	2.3±0.5	2.0±1.0	3.7±0.7	4.3±0.2
Number of Fledglings	2.8±0.7	2.1±0.6 ^a	4.1±0.2	1.8±0.4 ^a	3.2±0.4	1.6±1.0 ^b	2.5±0.3	0	0	0.5±0.3	0	3.3±0.4	2.7±0.4

* Data not collected, !=sample sizes may differ among variables, **a**=untreated and treated values differed at alpha = 0.5 in t- or Mann-Whitney *U* test, **b**=no difference; **c**=not tested

Table 3. Mayfield (1975) estimates of nest success and productivity in current-condition (untreated), transitional, and restoration-treated ponderosa pine forests at Mt. Trumbull, AZ in 2003.

	n	Nest success (%)	Productivity ^a
All Nests	30	0.532	2.46
Treated Nests	23	0.632	1.94
Transitional Nests	4	1.00	3.33
Untreated Nests	3	0.01	0

^aproductivity=number of young fledged per pair per season

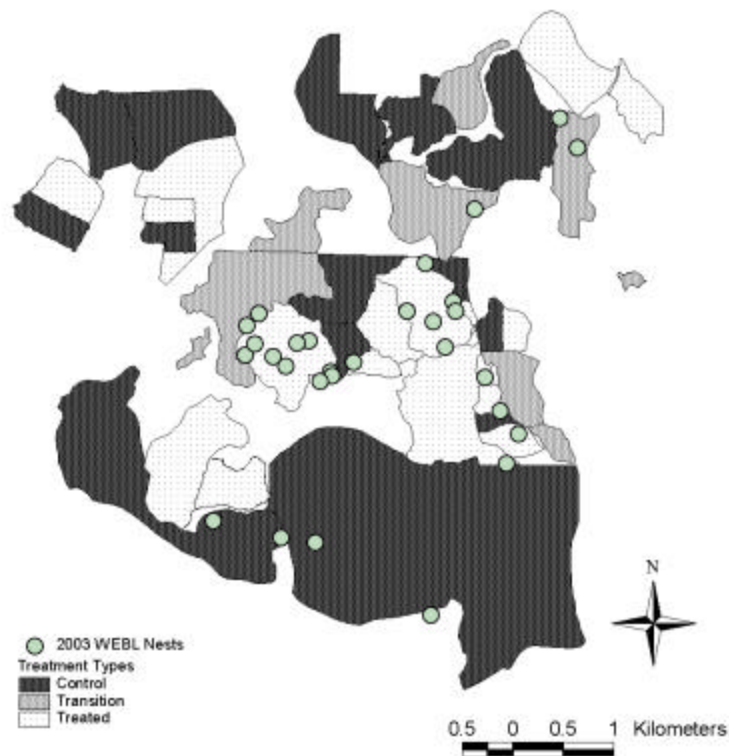


Figure 3. Western bluebird nest locations in 2003 in restoration-treated, transition, and current-condition (control) ponderosa pine forests in the Mt Trumbull area, Arizona.

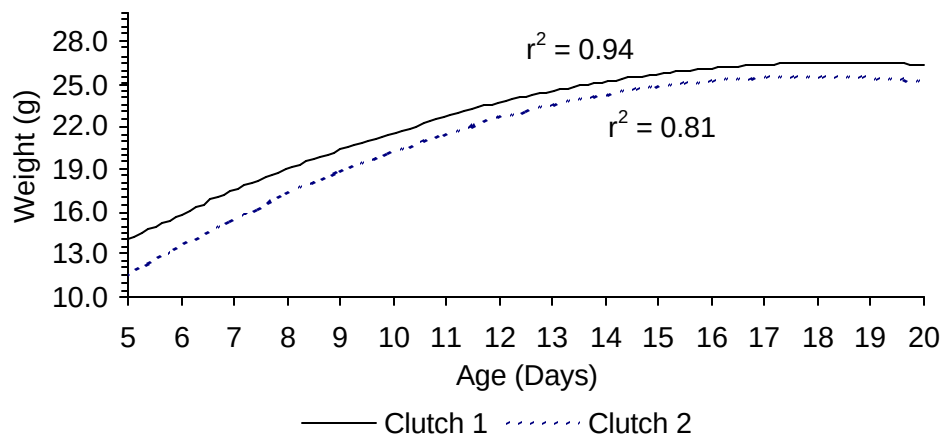


Figure 4. Mean weight of western bluebird nestlings by age from first and second clutches on Mt. Trumbull, Arizona in 2003.

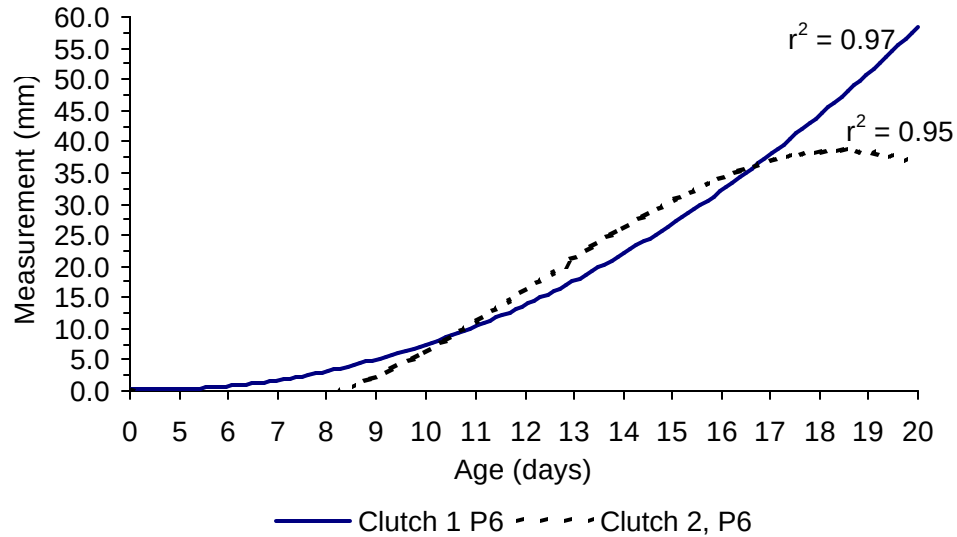


Figure 5. Development of primary 6 (P6) of western bluebird nestlings from first and second clutches on Mt Trumbull, Arizona in 2003

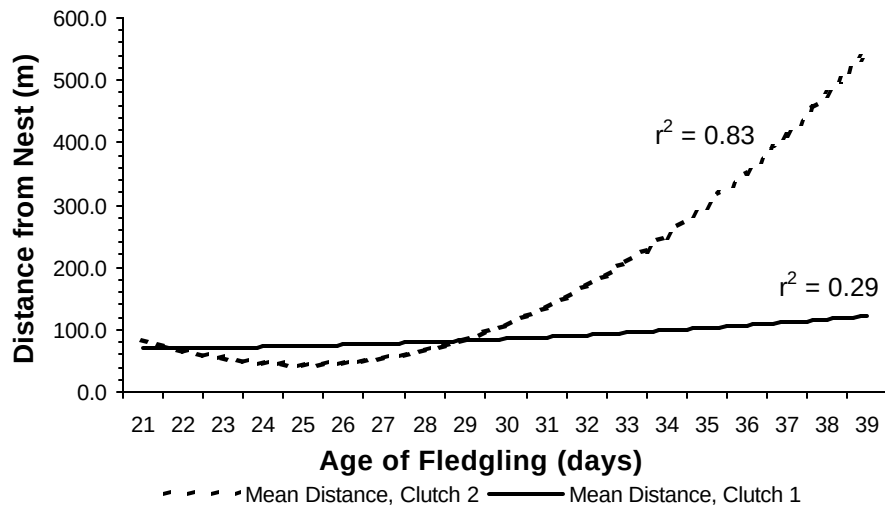


Figure 6. Mean distance from nest traveled by fledglings from first and second clutches at Mt Trumbull, Arizona in 2003

LIZARDS

In 1997-1999, Germaine and Germaine (*In press*) collected data on lizard distribution, abundance and habitat associations at Mt. Trumbull. All data were collected prior to initiation of restoration treatments. Western sagebrush lizards, *Sceloporus graciosus*, and western skinks, *Eumeces skiltonianus*, were the most abundant species, respectively. They also recorded eastern fence lizards, *Sceloporus undulates*, and plateau striped whiptails, *Cnemidophorus velox*, in low numbers. They found that lizard distributions are positively associated with deciduous cover and open forest stands, which suggests that restoration treatments may be beneficial to lizard populations. An abstract of this paper, accepted by the Journal of Herpetology, follows this section.

Restoration treatments are initiated but not completed at several areas within the study area. Because of political and logistical issues, some of these plots have remained partially treated (transitional) for several seasons. On the Mt Trumbull study area, transitional plots have been cut but not burned, and therefore, have a high volume of downed wood. The effect, if any, of these transitional plots on lizard populations is unknown.

In 2003, we began a pilot study to assess the effects of partially restored forests on lizard populations. Our objectives included:

- a. To compare lizard species abundance among treated, transitional, and untreated forest habitats,
- b. To evaluate lizard productivity among treated, transitional, and untreated forest habitats.

Methods

Initial restoration treatments were completed on several plots from one to five years ago. Lizards on recently treated plots may be responding to the disturbance of restoration activities, such as thinning and burning, rather than the result of restoration treatments. Therefore, we attempted to remove the effect of disturbance from the treated plots by considering habitats as treated only if they were treated two or more years ago. Transitional habitats include those areas where some thinning has occurred, but broadcast burns have not yet been applied. Untreated habitats include all areas where there have been no restoration activities. To assess differences in habitat among treatment types, we measured habitat characteristics at each array according to protocol established by Germaine (1998).

We operated four randomly selected pitfall array traps in each habitat type. AGFD personnel installed arrays in 1997. A detailed description of array design can be found in Germaine and Germaine (*In Press*). We checked arrays every three to six days, except for one two-day and one seven-day interval. If we expected check intervals to be greater than six days, we closed the traps.



For each lizard captured, we collected the following information: species, sex, age, snout to vent length, tail

length and condition, and weight. We toe-clipped each lizard with a unique combination for future identification. We categorized *S. graciosus* and *E. skiltonianus* as hatchlings, juveniles, or adults using guidelines published in Tinkle (1993) and Fitch (1954), respectively. We compared mean abundance of each lizard species among treatment types using ANOVA analysis.

Results and Discussion

We opened traps for 86 days from 31 May to 22 September. Our mean trap check interval was 4.3 days (range 2-7). We captured 103 lizards of two species, *Sceloporus graciosus* (n=87) and *Eumeces skiltonianus* (n=16). *S. graciosus* were approximately 5.4 times more abundant than *E. skiltonianus*. Our recapture rates for *S. graciosus* were low; we recaptured 7% of *S. graciosus* in untreated habitats and recaptured none in treated or transitional habitats. We recaptured 20% of *E. skiltonianus* in treated habitats, 12.5% in transitional habitats and had no recaptures in untreated habitats.

In pitfall arrays we also captured one nightsnake, *Hypsiglena torquata*, two long-tailed voles, *Microtus longicaudus*, one deer mouse, *Peromyscus maniculatus*, 115 jerusalem crickets, and 16 wolf spiders. We captured no additional lizard species.

We found higher variation in lizard abundance within habitat types than among habitats types (Table 4). This may indicate there is no difference in lizard abundance among treatment types or our sample size was too small to detect a difference. We believe it may be the latter because within each treatment type we caught the majority of lizards at one array. For example, for *S. graciosus*, we caught 64% at one array in untreated habitats, 75% at one array in transitional habitats, and 100% at one array in treated habitats. We caught no lizards of either species at two arrays in treated habitats and one array in transitional habitat.

Among captured *S. graciosus*, 25 were adults, 11 were juveniles, 36 were hatchlings and 15 escaped before we were able to obtain an accurate measure of age. We identified the sex of 21 adult *S. graciosus*, 11 females and 10 males. Among *E. skiltonianus*, five were adults, five were juveniles, and 6 were hatchlings. We did not attempt to sex *E. skiltonianus*.

Table 4. Mean ($\pm$ SE) abundance of western sagebrush lizards, *Sceloporus graciosus*, and western skinks, *Eumeces skiltonianus*, in restoration-treated, transitional, and current-condition (untreated) forests at Mt Trumbull, AZ in 2003.

	Treated	Transition	Untreated	F _(2,9)	P
<i>S. graciosus</i>	6.5 $\pm$ 6.5	5.0 $\pm$ 3.4	10.25 $\pm$ 5.5	0.26	0.78
<i>E. skiltonianus</i>	1.3 $\pm$ 0.8	2.0 $\pm$ 1.1	0.8 $\pm$ 0.3	0.61	0.57

The lack of lizards at two arrays in treated habitats is of particular interest. These two arrays were in the Rye Flat plot that was treated in 2001. Rye Flat experienced a relatively high severity fire during the prescribed burn process (S. Germaine, pers.comm.). Grazing pressure was also relatively high near these arrays in 2003. The other two arrays in treated habitats where lizards were captured, EB1 and EB2, were treated in 1999 and had lower intensity prescribed fires. Grazing pressure was high at EB2 in 2003. It is possible that the combined disturbance of grazing, thinning and fire, especially a high severity fire, is sufficient to cause localized extirpations of lizards. We expect that lizards will eventually re-colonize these areas, and that restoration treatments may ultimately be beneficial to *S. graciosus* and *E. skiltonianus*. We hope to investigate the immediate short-term effects of restoration activities on lizard populations in more detail in future research at Mt Trumbull.

Abstract

Germaine, S.S. and H.L. Germaine. *In Press*. Lizard Distributions and Reproductive Success in a Ponderosa Pine Forest. J. Herpetology December 2003 issue.

We assessed relative abundance, demographic, and reproductive success data for two lizard species in a Northern Arizona ponderosa pine forest, a fire-dependent system unnaturally modified by fire suppression over the past century. During May - October of 1997 - 1999 we employed up to 70 pitfall arrays to sample lizards over 6,990 array-days. At each array we described macro-vegetative cover, stand, and micro-habitat characteristics. *Sceloporus graciosus* responded to habitat variation at all three spatial scales. Adult *S. graciosus* was widely distributed among cover and stand types. However, reproductive success and hatchling abundance were highest in the most open cover (meadow) and stand (savannah) types, and lowest in pure ponderosa cover and dense ponderosa stands. Adult females replaced themselves annually only in meadows, savannahs, and forest with a deciduous component. *Eumeces skiltonianus* adults and juveniles were least abundant in meadows, but females replaced themselves each year in meadow and ponderosa-pinyon-juniper vegetative cover and in savannahs. Hatchlings were least abundant in intermediate- and high-density ponderosa stands, while juveniles of both species were most abundant in areas containing a deciduous tree component. Both species were present in plots having lower percent duff groundcover than at plots containing no lizards. Increased tree densities, canopy closure, and litter accumulation influenced distributions of both lizards. Furthermore, abundance and reproduction in these lizards were generally optimized in habitat with features most similar to that present prior to fire suppression activities, and in areas containing a deciduous tree component.

NORTHERN GOSHAWKS

In 2003, we surveyed for northern goshawks on the study area from 2 June to 14 July. Survey protocol followed Kennedy and Stahlecker (1993). We used the 300 m interval grid points established by the Ecological Restoration Institute at Northern Arizona University for our broadcast calls.

We found and monitored two breeding pairs of northern goshawks, one in the Corner plot and one in the southeast corner of the Control plot. One young fledged from each nest in mid-July. In addition, we had several casual observations of a northern goshawk in the Mt Logan area. We are unsure whether this was an individual from a third pair or an individual from one of the known pairs.

We hope to continue monitoring northern goshawks at Mt Trumbull in future years. In particular, we are interested to research northern goshawk foraging ecology in response to restoration treatments. In cooperation with the Bureau of Land Management, we are currently soliciting funding for this research.

MIGRATORY BIRDS

We collected no additional data on migratory birds during the 2003 field season. We will collect our post-treatment data for comparison when the Spring, Nixon, Corner, North Slope, Hi-Lo, Feral Pig and North Sawmill units have been cut and burned.

We are in the process of analyzing the migratory bird data collected in spring and fall 1998-2000 to assess bird-habitat associations in current-condition ponderosa pine forests during the migration seasons. We expect to submit a manuscript of this research to the peer-reviewed journal, *The Condor*, in December 2003. A draft abstract is included below.

Abstract

THIS IS A DRAFT – PLEASE DO NOT CITE

Wightman, C.S. and S.S. Germaine. *In Progress*. Influence of ponderosa pine forest structure on bird communities during the migration seasons. To be submitted to Condor.

Little is known about the relationship of bird communities and ponderosa pine (*Pinus ponderosa*) forest structure during the migration seasons, despite the recent emphasis on restoration of these habitats in the Southwest. We evaluated differences in bird community composition and diversity during the fall and spring migration seasons along habitat gradients in a mixed ponderosa pine forest in northern Arizona. During spring and fall, the relationship of bird abundance to forest habitat gradients was similar to reported habitat relationships in the breeding season. For example, old-growth ponderosa pine obligates, such as the Pygmy Nuthatch (*Sitta pygmaea*), were associated with the pure ponderosa pine forest gradient, while Pinyon-Juniper (*Pinus edulis-Juniperus osteosperma*) specialists, such as Juniper Titmouse (*Baeolophus inornatus*) and Black-throated Gray Warbler (*Dendroica nigrescens*), were strongly associated with a pinyon-juniper gradient. We suggest that migrants may be staying within their broad breeding habitat types because they can forage more efficiently in these “familiar” habitats. In fall, species richness, species diversity, ground foragers, long distance migrants, and residents were positively associated with an increase in the deciduous forest component. Ground foragers and short distance migrants were negatively associated with a pinyon-juniper forest gradient. In spring, species evenness and ground foragers were positively associated with an increasing deciduous gradient and long distance migrants were negatively associated with a pinyon-juniper gradient. Increased cover and foraging opportunities in open pine forests with a deciduous component is probably, in part, responsible for the increased abundance and diversity associated with this habitat gradient. Our results suggest that forest management activities, such as restoration, that increase forest heterogeneity along a pine-deciduous gradient will benefit many ponderosa pine bird species during the migration seasons.

TASSEL-EARED SQUIRRELS

We collected no additional data on tassel-eared squirrels during the 2003 field season. Our pre-treatment data, collected in 1997-1999, will be compared against post-treatment data when the Spring, Lo and Nixon units have been cut and burned.

WILD TURKEYS

We collected no data on wild turkeys during the 2003 field season. To accurately monitor turkey populations and assess habitat selection in response to restoration treatments, we will need additional resources that are specifically allocated for this work.

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