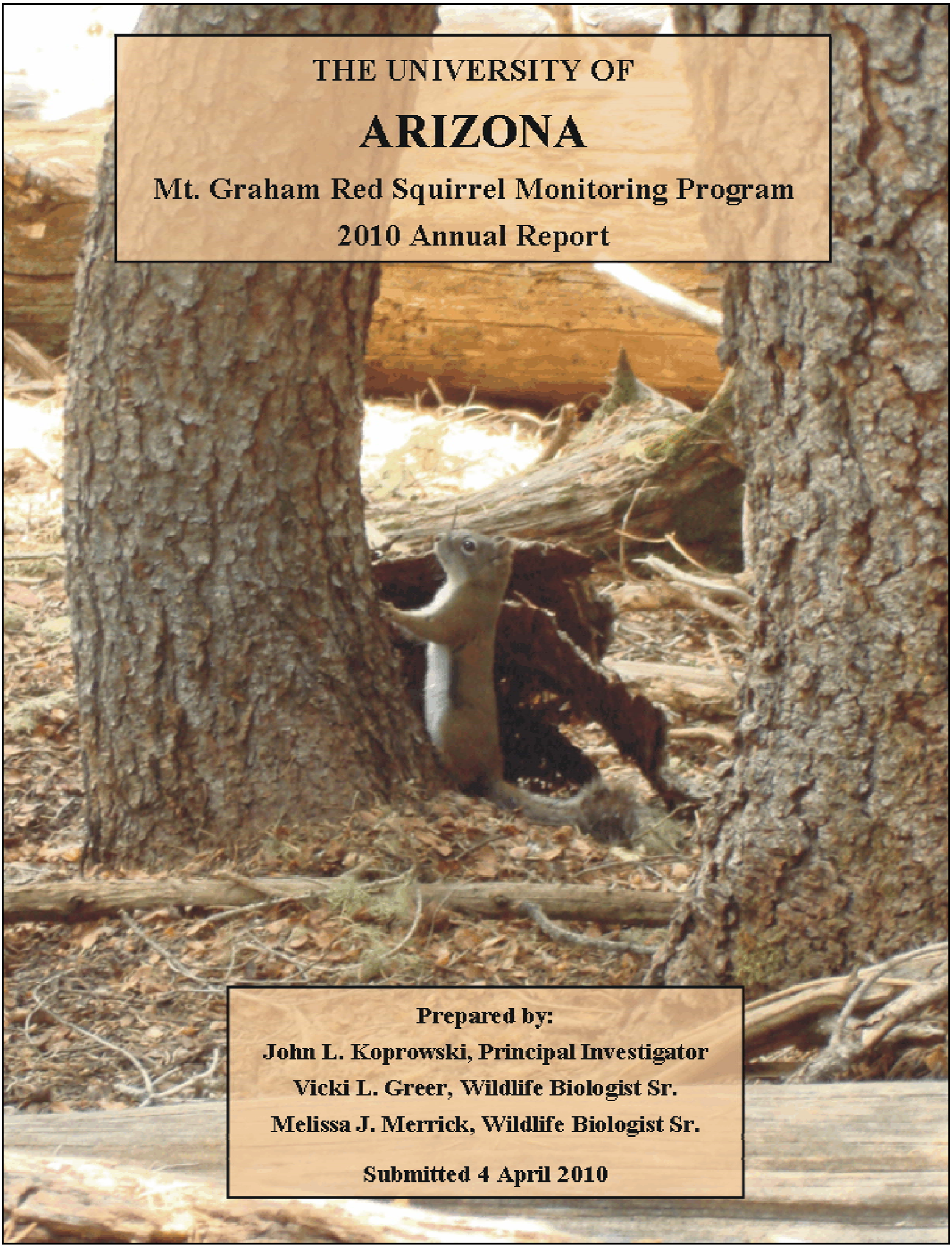

THE UNIVERSITY OF

ARIZONA

Mt. Graham Red Squirrel Monitoring Program

2010 Annual Report

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EXECUTIVE SUMMARY

In 2010, the University of Arizona Mt. Graham Red Squirrel Monitoring Program continued efforts to document aspects of red squirrel population biology and food resources in the established study areas around the Mt. Graham International Observatory in the Pinaleño Mountains, Graham County, Arizona. A complete census of the study areas was made in April, June, September, and December 2010.

Overall annual mean mushroom production in 2010 was nearly 4 times greater than in 2009, ranked 4th highest crop of 17 years since data collection began in 1994. Seed production for 2009 (1 year delay in reporting due to methodology), was 2.5 times greater than in 2008, and the 2009 seed crop ranked 8th out of 17 years since data collection began in 1993.

Overwinter survival, calculated as animals surviving from December 2009 to June 2010, was low in TR habitat (16%, 4 of 25 squirrels) and 100 % (1 of 1 squirrel) in SF habitat. Of the 11 marked squirrels in December 2009 on the monitored areas, by June 2010, 3 were alive, 2 were confirmed mortalities (likely avian predation), and 6 had disappeared, fate unknown. A greater percentage (~50%) of the middens occupied in December 2009 remained occupied in June 2010, but by different squirrels. The winter of 2009-2010 was more severe than recent past winters, snow depths were the highest seen since 1993, and snow remained on the ground in some places until June 2010. Ten litters were confirmed on or near the monitored areas in 2010. From these 10 litters, 25 juveniles were known to emerge from natal nests.

Squirrel populations in December 2010 (17 Adults/Subadults) were lower than the previous December (26 Ad/SA). The 2010 squirrel populations in TR habitat remained fairly steady throughout the year (~10-12 squirrels). There was only one squirrel/occupied midden in SF habitat, April and June in SFC. By the end of 2010, there were no squirrels detected in SF habitat. By December 2010, there were 5 additional squirrels at middens near the monitored areas (within 100m).

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INTRODUCTION

The Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) is the southernmost subspecies of the wide-ranging red squirrel and is endemic to the Pinaleño (Graham) Mountains of southeastern Arizona (Hoffmeister 1986). Believed restricted to ≤ 12200 ha of mixed-conifer and spruce-fir forest at elevations > 2360 m (Hatten 2000), Mt. Graham red squirrels were federally protected as endangered in 1987 with critical habitat defined in 1990 and a recovery plan published in 1993 (United States Fish and Wildlife Service 1993). The University of Arizona's Mt. Graham Red Squirrel Monitoring Program (RSMP) was established in 1989 to meet the requirements of the Mount Graham International Observatory (MGIO) Management Plan (USDA Forest Service 1989) by monitoring the population of this endangered species in the highest peaks of the Pinaleño Mountains near the MGIO (32° 42' N, 109° 53' W). In 2010, the MGIO site consisted of two operating facilities, the Vatican Advanced Technology Telescope (VATT) and the Sub-Millimeter Telescope (SMT), a maintenance and generator building, and a 3.2 km access road (FR 4556). Construction activities at the Large Binocular Telescope (LBT) in 2010 were mainly interior instrument installation. Herein, we report on the monitoring efforts from 1 January to 31 December 2010.

All use of terms *red squirrel* or *squirrel* refers to the Mt. Graham red squirrel unless otherwise noted.

Study Area

Four areas were defined in the vicinity of the MGIO to monitor red squirrel populations (Figure 1) and include two forest habitat types: transitional (TR) or mixed conifer forest and spruce-fir (SF) forest. The TR habitat, between 2680 and 3050 m elevation, is composed of Engelmann spruce (*Picea engelmannii*), corkbark fir (*Abies lasiocarpa* var. *arizonica*), Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), southwestern white pine (*P. strobiformis*) and aspen (*Populus tremuloides*). The SF habitat, ≥ 3050 m elevation, is composed of Engelmann spruce and corkbark fir. In each habitat type, an area within 300 m of the telescope sites and access road was defined as the *construction* area (TRC, SFC). For comparison, a *non-construction* area beyond 300 m from the MGIO or the access road was defined in each habitat (TRN, SFN). The size of monitored areas has changed several times due to construction and fire events (Table 1).

METHODS

Red squirrels cache conifer cones in locations known as middens. Middens are easily recognized by presence of cached cones and piles of discarded cone scales. The RSMP defines a midden site as a circular area with 10 m radius surrounding the center of the primary cache site. Because red squirrels are territorial and generally solitary, counts of occupied middens provide a reasonably accurate estimate of population size (Smith 1968; Vahle 1978).

All known midden sites are marked with numbered metal tags, and black and orange striped flagging. During censuses or other monitoring duties, new activity areas that have the potential to become new middens are often located. Feeding sign, caching and squirrels are seen at these areas. Activity areas are assigned a temporary number and are revisited to assess sign and the presence of a squirrel during the next quarterly census. If conditions warrant, an activity area will be upgraded to a midden and added to the regular quarterly censuses. If no improvement occurs in the two quarterly censuses following initial location, the activity area is removed.

Prior to 2003, at the end of each calendar year, a list of middens to be removed from regular censusing was compiled. If a midden had been censused for at least three years (12 censuses), including at least one good seed crop (better than the mean seed crop over the study period), and was not occupied during that time, the midden was removed from the list for regular censusing and revisited only each December. If any removed middens became re-occupied, the sites are returned to the list for regular census. However, in 2003, because a large number of middens were removed in some areas as a result of insect damage, we began visiting all removed middens during each census. This change was made so as not to leave large parts of the monitored areas unvisited for an entire year. Removed middens, if still unoccupied, are simply checked off a tally sheet, while complete notes are taken on middens considered to be in the regular census.

Red Squirrel Food Resources

Conifer Seed Production

The RSMP began collecting quantitative data in the early 1990s, to determine the abundance of major red squirrel food resources: conifer seeds (1993) and mushrooms (1994). In July 2004, 14 of the original seed plots in SFC (7) and SFN (7) were in areas destroyed by the Nuttall Fire. We added 3 new plots in late summer 2004 (SFC - 2, SFN - 1) in remaining unburned areas. Therefore, seed production for 2009 was estimated from 20 seedfall plots distributed among the monitored areas (Figure 1). Three 0.25 m^2 seed traps were randomly placed within a 10 m x 10 m plot at each location. Seeds from the 2009 crop were collected from the seed traps in June 2010. Conifer seeds contained in each trap were separated by species and individually tested to determine the proportion of seeds that were “filled” (most likely to be viable). A filled seed leaves an oily spot on clean paper when squashed. This method is likely to underestimate total number of viable seeds because some seeds may have been preyed upon within the seed trap. Estimates of seedfall for each tree species were calculated as the average number of viable seeds from all three traps on each plot. Seeds of white pine and ponderosa pine are not readily dispersed by wind due to their large size. As a result,

seed crops of these species are under represented in seed trap samples. Both species may be important local food supplies for red squirrels, but at present no reliable method exists to estimate size of seed crops.

Mushroom Production

As in previous years, mushrooms were collected from plots 1m by 100m (0.01 ha) at two week intervals during periods of mushroom production. Fourteen of 28 food resource plots were destroyed in the Nuttall Fire in July 2004, however, three new plots were established in remaining unburned areas on the SFC and SFN. Mushrooms (epigeous or above-ground fungi) were collected at these 20 sites (Figure 1) from early-August through late September 2010. Since 2007, mushrooms are collected from east-west oriented plots, instead of north-south as in 2002-2006. We alternate plot collection orientation every five years in order to avoid possible impacts of long-term harvest on plots. Prior to beginning the alternating orientations, we collected mushrooms from both east-west and north-south plots in 2001 and detected no significant differences in weight, number, or diversity of mushrooms between the two orientations. Collections were restricted to genera of mushrooms used by red squirrels on Mt. Graham or in other regions (Table 2). Collected mushrooms were separated by plot and genus, and weighed wet. For most genera, dry weight was calculated by multiplying wet weight by a wet weight/dry weight ratio determined from previous samples on Mt. Graham. Dry weights were measured directly for genera with small numbers of specimens previously collected ($n < 50$).

Because seeds for a given year are not collected and analyzed until the following spring, seed data are delayed by one year. For comparison, the previous year's seed and mushroom data are reported in addition to the current year's mushroom data.

Population Biology

Midden Occupancy

Census data were used to determine number and distribution of occupied middens on each monitored area. In April, June, September, and December 2010, all middens were visited at least once to determine occupancy. If a midden appeared to be occupied based upon feeding sign (cone scales, dried mushrooms, and conifer clippings) or caching, every attempt was made on subsequent midden visits to observe the resident and to determine its sex, age, and reproductive condition. In 2010, most animals on or near monitored areas were ear-tagged and many were fitted with radio collars, further assisting census efforts.

All middens on the monitored areas were classified as either occupied, unoccupied, or possibly occupied, with each occupied midden representing one squirrel (except for females with dependent juveniles). A midden was considered unoccupied when no squirrel or squirrel sign was present. A midden was considered possibly occupied when red squirrel sign was found but sign was insufficient to clearly indicate occupancy. Possibly occupied middens were considered to be unoccupied when determining population size. Population size estimates are conservative and

represent the minimum number known alive (Krebs 1966). Differences in midden occupancy among study areas were compared using data from June and December.

Overwinter Survival

Overwinter survival was estimated for squirrels in the monitored areas. During a complete census in December 2009, the number of occupied middens and the identity of resident squirrels were determined. December 2009 occupancy was compared to occupancy for June 2010. For unmarked animals, a squirrel was considered to have survived winter if it was a resident of a midden in December and that same midden was found to be occupied by a squirrel of the same sex in June. In addition, if the midden was listed as occupied based on sign or a squirrel of unknown sex was seen, this was also counted as a surviving individual. For marked squirrels, survival was generally known with a fair degree of certainty using available trapping and telemetry information.

Reproductive Activity and Success

In 2010, we recorded breeding condition of adult male and female squirrels, and litter size when observed. By examining the squirrel's condition through trapping efforts or binoculars, we determined reproductive status of females as non-reproductive (small unpigmented teats), reproductive (vulva visibly swollen or appearance of pregnancy), lactating (swollen, elongated teats with surrounding alopecia), recently lactating (elongated black tipped teats), or lactating in past seasons (small black tipped teats). We determined reproductive status of male squirrels during trapping or visual assessment as testes non-scrotal (non-reproductive) or testes scrotal (reproductive).

Trapping and Marking

In accordance with permits issued by United States Fish and Wildlife Service Endangered Species (TE041875-0)and Arizona Game and Fish Department (SP575549), using accepted methods (Koprowski 2002), we trapped red squirrels using wire-mesh box-type live traps (Tomahawk Co., model 201), baited with peanuts and/or peanut butter. Once captured, we transferred squirrels to a cloth-handling cone for marks and measurements. We tagged squirrels with small numbered metal ear-tags (National Band & Tag Co., #1 Monel) threaded with colored plastic washers (National Band & Tag Co., ⅜" diameter) and affixed to ears for easy distance identification. We also fitted adult and juvenile animals with radio collars (Wildlife Materials Inc., SOM2190). Squirrels were released at the capture site.

Mapping

All middens and other physical features on the monitored areas were previously mapped using GPS with an accuracy of ± 5m. New GPS data (nests, habitat plots, etc.) were collected using a GeoExplorer II system from Trimble Navigation, Inc. Readings were taken within 5 m of the location center. Final GPS locations were based on an average from a minimum of 200 three-dimensional data points. Locations were differentially corrected using base station (Continuously Operating Reference Station, CORS-COT1, Tucson, Arizona). Maps were produced using Arc-View 3.2 (ESRI 1995).

Weather Data

Weather data were collected using two Davis Instruments weather stations. One station was located along the abandoned Forest Service road north of Emerald Peak (32" 42' 14.25"N, 109" 53' 17.06" W) on the SFC; the other was located at the Biology Camp (32" 41' 51.47 N, 109" 54' 20.28"W), adjacent to the TRC. Stations record air temperature (high, low, and average), wind speed, wind direction, rainfall, relative humidity and barometric pressure. Data were averaged at 60-min intervals. Snow depth (cm) was recorded from five snow pole pairs located in SF habitat, one pair at the 3050 m level on the access road, and three snow pole pairs in TR habitat. Each pair consists of a pole in a clearing or canopy opening and a second pole nearby in the forest.

Statistical Analyses

All statistical analyses were conducted using standard tests found in SAS, StatsDirect, or SPSS statistical software. Because sample sizes were sometimes small due to endangered status, significance for statistical tests was implied when $P \leq 0.05$ and potential biological significance was noted when $P < 0.10$.

RESULTS

Red Squirrel Food Resources

2009 Conifer Seed Production

Data collection for seed crops began in 1993. If years are ranked from highest (1) and lowest (17), the total 2009 seed crop ranked 8 of 17. Corkbark-fir was the most abundant (in numbers) seed in 2009, the eighth highest crop seen since 1993. The Douglas-fir crop ranked 6 of 17, while the Engelmann spruce crop (13 of 17) was one of the lower crops seen since 1993. The 2009 overall average seed crop was 1267.5 (1000seeds/ha), 2.5 times greater than the seed crop in 2008, 489.3 (1000seeds/ha); (Table 3, Figures 2a-c, Appendix A).

2010 *Mushroom Production*

Overall annual mean mushroom production in 2010 was nearly 4 times higher than in 2009, and ranked 4th highest of 17 years since data collection began in 1994. Production increased in both TR and SF habitats in 2010 as compared to 2009, especially in TR habitat, which was over 7 times higher (Figure 3). In 2010, mushroom production ($\bar{x}$ wet weight) did not differ within TR habitat, but SFC had significantly greater production than SFN. Overall, TR habitat had a little over double the mushroom production of SF habitat (Table 4). On TRC, three genera, *Russula, Ramaria,* and *Lactarius* accounted for 58% of production. On TRN, *Russula, Cortinarius,* and *Leccinum,* and accounted for 76% of total production. *Russula, Amanita,* and *Lactarius* accounted for 77% of the production on SFC. On SFN, *Russula, Amanita,* and *Lactarius* accounted for 64% of the total production (Table 5).

Population Biology

Midden Occupancy

Four quarterly censuses (April, Jun, Sep, Dec) of all middens on or near monitored areas were made in 2010 (Appendix B). The first census of the year was conducted in April instead of March due to deep snow conditions, midden tags and flags were covered by snow. From December 2009 to December 2010, the number of red squirrels decreased, from 26 to 17. On TRC, the highest number of squirrels (5Ad + 7J) was in September 2010, and the lowest number was 10 Ad in June. The highest numbers on TRN were in September (4Ad + 2J) and December (6Ad/SA) and the lowest was 3 Ad in April and June. The highest number of squirrels on SFC was in April and June (1 Ad) with no squirrels in September and December. On SFN, no squirrels or occupied middens were detected during 2010 census checks (Figure 4, Appendix B, C, D). The 2010 squirrel populations in TR habitat remained fairly steady (~10-12 squirrels) throughout the year, while only one red squirrel / occupied midden was found in SF habitat in 2010 (Figure 5, Appendix C).

In 2010, 3 new middens were located in TR habitat (Appendix B). In June and December of 2010, the proportion of middens occupied did not differ within TR and SF habitats (Table 6).

Overwinter Survival

The number of squirrels that survived the winter of 2009-2010 did not differ among areas (Table 7); survival was 16% (4 of 25 squirrels) in TR habitat and 100% (1 of 1 squirrel) in SF habitat. For comparison, survival from the previous winter (2008-2009) was 64% in TR habitat and 28% in SF habitat. Of the 11 marked squirrels on the monitored areas in December 2009, by June 2010, 3 were alive, 2 were confirmed mortalities (likely avian predation), and 6 had disappeared, fate unknown. A greater percentage (~50%) of the middens occupied in December 2009 were occupied in June 2010, but by different squirrels. The winter of 2009-2010 was more severe than recent past winters, snow depths were the highest seen since 1993, and snow remained on the ground in some places until June 2010. The length and severity of the 2009-2010 winter season may have had a negative impact on squirrel survival.

Overwinter survival may be overestimated because a midden may be occupied in the spring by a different squirrel of the same sex. This mortality can not be detected among unmarked squirrels. However, this potential overestimate is minimal as most squirrels on the monitored areas are ear-tagged and radio-collared for unique identification.

Reproductive Activity and Success

In 2010, three breeding chases involving squirrels resident on or near the monitored areas were observed, in April to early June (Appendix E-1). Based on information from census and trapping records, most resident adult males were scrotal from March through late June, with a few males still scrotal into September.

From June through September, several females seen or trapped during these months were found to be either pregnant or lactating. The first lactating female was observed 3 June and the latest was on 4 November. Direct evidence of 10 litters (25 juveniles) was seen on or near the areas during censuses or other activities. Litters were confirmed from early August through early November. The November litter was the first confirmed case of a female rearing 2 litters to emergence from the nest in one season. Based on trapping and field observations, a few females who were lactating or pregnant in early summer may have lost their litters, as by later in the summer they were not lactating and no litters were ever detected (Appendix E-2).

Trapping and Marking

By the end of 2010, the majority of resident squirrels on or near monitored areas were fitted with colored ear tags and radio-collared (Appendix B). In addition, 17 of the 25 juveniles on or near monitored areas were caught at natal middens, once they were large enough to be exploring on the ground (>115g body weight), and fitted with small numbered metal ear tags with colored plastic washers and small expandable radio collars (mean weight 6g) to aid in the collection of dispersal information.

Mapping

No significant changes in maps of the monitored areas were made in 2010, as all major features (middens, roads, trails, construction areas, etc.) have been mapped in previous years. New nests or habitat plots were GPS located and added to databases and maps.

Weather Data

Weather data were collected for 2010 from only the Biology Camp weather station (TR habitat), as several power and equipment failures at the Emerald Peak station (SF habitat) caused loss of data. From available data, maximum temperature recorded was 25.2°C in August and the

temperature was 13.7°C in July and the minimum average monthly temperature was -3.4°C in January (Appendix F-1). The maximum total monthly rainfall was recorded in July, at 173.8 mm and November was the driest month at 0.2 mm (Appendix F-1). Snow depth was recorded from nine pairs of snow poles. The average accumulated snow depth from December 2009 - May 2010 ranged from 21.7 cm to 222.0 cm (Appendix F-2). For comparison, average accumulated snow depths for the previous winter (November 2008 - March 2009), ranged from 1.3cm to 104.8cm. Data on wind chill temperatures, wind direction and speed, humidity, and barometric pressure were also collected (Appendix F-1).

Insect Outbreaks on Monitored Areas

Infestations of bark beetles (*Drycoetes confusus* and *Dendroctonus rufipennis*) continued on parts of the monitored areas in 2010, although to a lesser degree than in previous years. Spruce aphid (*Elatobium abietinum*) were seen, but in much reduced numbers. For a detailed report on forest health and continuing research on the insect infestations, please contact the USFS Southwestern Region Entomology and Pathology Office in Flagstaff, AZ.
http://www.fs.fed.us/r3/resources/health/

PUBLICATIONS

Peer-reviewed Articles

2010

Leonard, K.M., and J.L. Koprowski. 2010. Effects of fire on endangered Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*): responses of individuals with known fates. The Southwestern Naturalist, 55(2): 217-224.

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Merrick, M.J., J.L. Koprowski, R.N. Gwinn, G.H. Palmer, and C.A. Zugmeyer. 2011. Status of red squirrels in Guadalupe Mountains National Park, Texas. The Southwestern Naturalist, 56(1): 24–28.

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Blount, S.J. and J.L. Koprowski. 2011. Small mammal response to post-fire conditions: case of the Mount Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*). Southwestern Naturalist, In press.

Ramos-Lara, N., J.L. Koprowski. 2011. Communal nesting behavior in Mearns's squirrels (*Tamiasciurus mearnsi*). Southwestern Naturalist 56: In press.

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Table 1. Changes in size of study areas due to construction and fire events, University of Arizona Red Squirrel Monitoring Program, Pinaleño Mountains, Graham County, Arizona. All area measures are in hectares.

Event and Date	TRC	TRN	SFC	SFN	All Areas
September 1989	85.19	20.86	88.28	104.81	299.14
LBT Site Expansion 1993	85.19	20.86	100.42	104.81	311.28
After Clark Peak Fire April 1996	51.12	20.85	75.90	104.81	252.68
After Nuttall Fire July 2004	51.12	19.81	58.49	34.14	163.56

TRC = transitional forest in construction zone,
TRN = transitional forest outside of construction zone,
SFC = spruce-fir forest in construction zone,
SFN = spruce-fir forest outside of construction zone.

Table 2. Mushroom genera known to be food resources of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), collected from the food resource plots on University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

MUSHROOM GENUS	SOURCE(S)
Amanita	Buller 1920, M.C. Smith 1968
Auricularia	Monitoring Program personal observations
Boletus	Buller 1920, C.C. Smith 1968, M.C. Smith 1968
Clavaria	M.C. Smith 1968
Clitocybe	Monitoring Program personal observations
Cortinarius	C.C. Smith 1968, Froehlich 1990, Uphoff 1990
Gastroid sp.	Monitoring Program personal observations, States 1990
Hydnum	C.C. Smith 1968, M.C. Smith 1968
Lactarius	Buller 1920, C.C. Smith 1968
Leccinum	Monitoring Program personal observations
Lycoperdon	Monitoring Program personal observations
Pholiota	C.C. Smith 1968
Ramaria	Monitoring Program personal observations
Russula	M.C. Smith 1968, C.C. Smith 1968
Suillus	C.C. Smith 1968

Table 3. Mean filled conifer seed production, 2009, on University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. The percent column represents the proportion of each seed species on an individual area (i.e. the proportions add across rows).

		Corkbark fir		Douglas-fir		Engelmann spruce	
Area/Habitat	# plots	$\bar{x}$ 1000 seeds/ha	%	$\bar{x}$ 1000 seeds/ha	%	$\bar{x}$ 1000 seeds/ha	%
TRC	5	370.6	69.2	127.8	23.9	34.6	6.5
TRN	4	546.5	83.7	83.2	12.7	23.2	3.6
SFC	5	29.3	45.9	5.3	8.3	29.2	45.8
SFN	6	0.0	0.0	8.9	50.0	8.9	50.0
TR Habitat	9	448.8	76.4	108.0	18.4	29.5	5.0
SF Habitat	11	13.3	34.4	7.2	18.7	18.1	46.9

Table 4. Mean annual mushroom production, 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Area/Habitat	n	$\bar{x}$ wet weight ± SE (Kg/ha)	$\bar{x}$ dry weight ± SE (Kg/ha)
TRC	5	124.2 ± 14.0	14.2 ± 2.3
TRN	4	102.6 ± 30.4	10.3 ± 3.0
SFC	5	65.0 ± 8.6	7.1 ± 0.9
SFN	6	33.7 ± 8.8	3.7 ± 0.9
TR Habitat	9	114.6 ± 14.9	12.5 ± 1.8
SF Habitat	11	47.9 ± 7.7	5.2 ± 0.8

Wilcoxon test within TR:

Wet Weight	*Z = -0.12*	P = 0.90
Dry Weight	*Z = -0.86*	P = 0.39

Wilcoxon test within SF:

Wet Weight	*Z = 1.73*	P = 0.08
Dry Weight	*Z = 2.10*	**P = 0.04**

Wilcoxon test between TR and SF:

Wet Weight	*Z = 2.74*	**P = 0.01**
Dry Weight	*Z = 2.74*	**P = 0.01**

Table 5. Mean annual mushroom production (wet weight Kg/ha), 2010, of selected mushroom genera known to be food resources for red squirrels (*Tamiasciurus hudsonicus grahamensis*), University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. The percentages of the three most available genera on each area are in red.

	TRC		TRN		SFC		SFN	
Genus	$\bar{x}$ Kg/ha	%	$\bar{x}$ Kg/ha	%	$\bar{x}$ Kg/ha	%	$\bar{x}$ Kg/ha	%
Amanita	8.48	6.8	7.51	7.3	8.93	13.7	6.85	20.3
Auricularia	1.51	1.2	1.31	1.3	0.42	0.6	0.99	2.9
Boletus	7.96	6.4	0.00	0.0	4.14	6.4	2.87	8.6
Clavaria	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Clitocybe	7.09	5.7	2.07	2.0	4.24	6.5	3.96	11.8
Cortinarius	6.59	5.3	14.39	14.0	3.61	5.6	2.12	6.3
Gastroid sp.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Hydnum	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Lactarius	24.90	7.9	8.06	7.9	4.26	6.6	4.77	14.2
Leccinum	0.45	0.4	12.00	11.7	0.00	0.0	0.00	0.0
Lycoperdon	3.74	3.0	2.51	2.5	2.74	4.2	2.09	6.2
Pholiota	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Ramaria	17.03	13.7	1.89	1.8	0.00	0.0	0.00	0.0
Russula	45.72	36.8	52.01	50.7	36.70	56.4	10.00	29.7
Suillus	0.68	0.6	0.84	0.8	0.00	0.0	0.00	0.0
Total	124.20		102.60		65.02		33.66	

Table 6. Number and percent of available middens occupied by Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

	June			December		
Area/Habitat	# middens	# occupied	% occ	# middens	# occupied	% occ
TRC	41	11	26.9	43	11	25.6
TRN	31	3	9.7	32	5	15.6
SFC	24	1	4.2	24	0	0.0
SFN	17	0	0.0	17	0	0.0
TR Habitat	72	14	19.4	75	16	21.3
SF Habitat	41	1	2.4	41	0	0.0
TR + SF	110	15	13.6	116	16	13.8

Chi Square:

JUNE

within TR	$\chi^2 = 2.58$	df = 1	P = 0.108
within SF*			P = 1.000

DECEMBER

within TR	$\chi^2 = 1.08$	df = 1	P = 0.298
within SF			---

* Fisher's Exact Test was used due to small sample sizes.

Table 7. Overwinter survival of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2009 - 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

	Number of Squirrels	Number of Squirrels Surviving	
Area/Habitat	Dec 2009[1]	Jun 2010	% survival
TRC	19	3	15.8
TRN	6	1	16.7
SFC	1	1	100.0
SFN	0	0	--
TR Habitat	25	4	16.0
SF Habitat	1	1	100.0

Fisher's Exact Test*	
within TR*	P >0.999
within SF*	---
between habitats*	P =0.192

* Fisher's Exact test was used due to the small sample size (any cell with values less than 5).

[1] Of the 26 animals resident on the areas in Dec 09, 11 were ear-tagged and/or radio collared thus enabling unique identification. By Jun 10, 3 of these animals were alive, 2 were confirmed dead (likely avian predation) and 6 had disappeared, fate unknown. The large proportion of marked animals in the population increases the accuracy of survival calculations.

(Figure 1. Map removed)

Figure 2a. Corkbark fir (*Abies lasiocarpa* var. *arizonica*) seed fall, 1993 - 2009, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Note: scales are different for figures 2a-c.

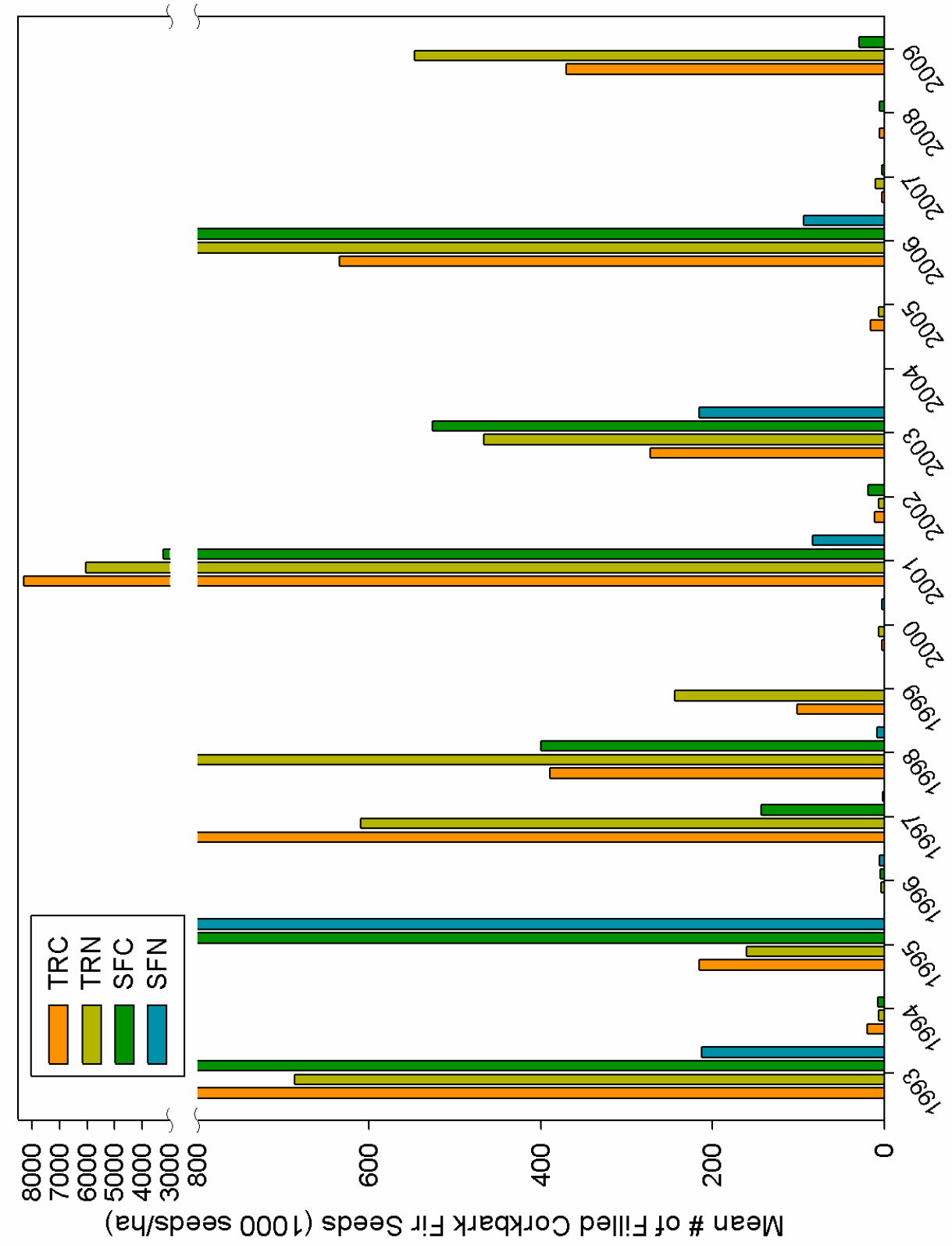


Figure 2b. Douglas-fir (*Pseudotsuga menziesii*) seed fall, 1993 - 2009, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Note: scales are different for figures 2a-c.

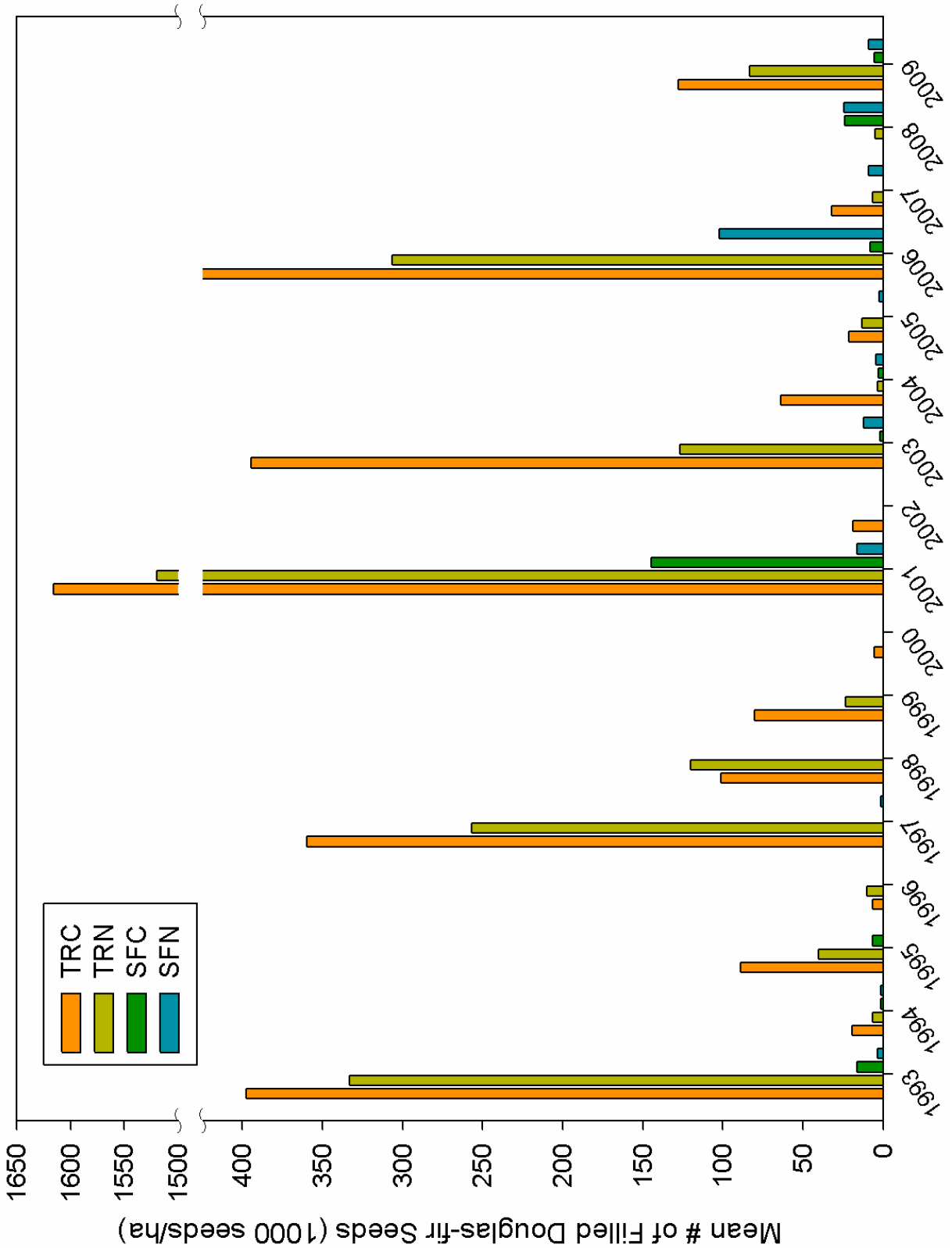


Figure 2c. Engelmann spruce (*Picea engelmannii*) seed fall, 1993 - 2009, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Note: scales are different for figures 2a-c.

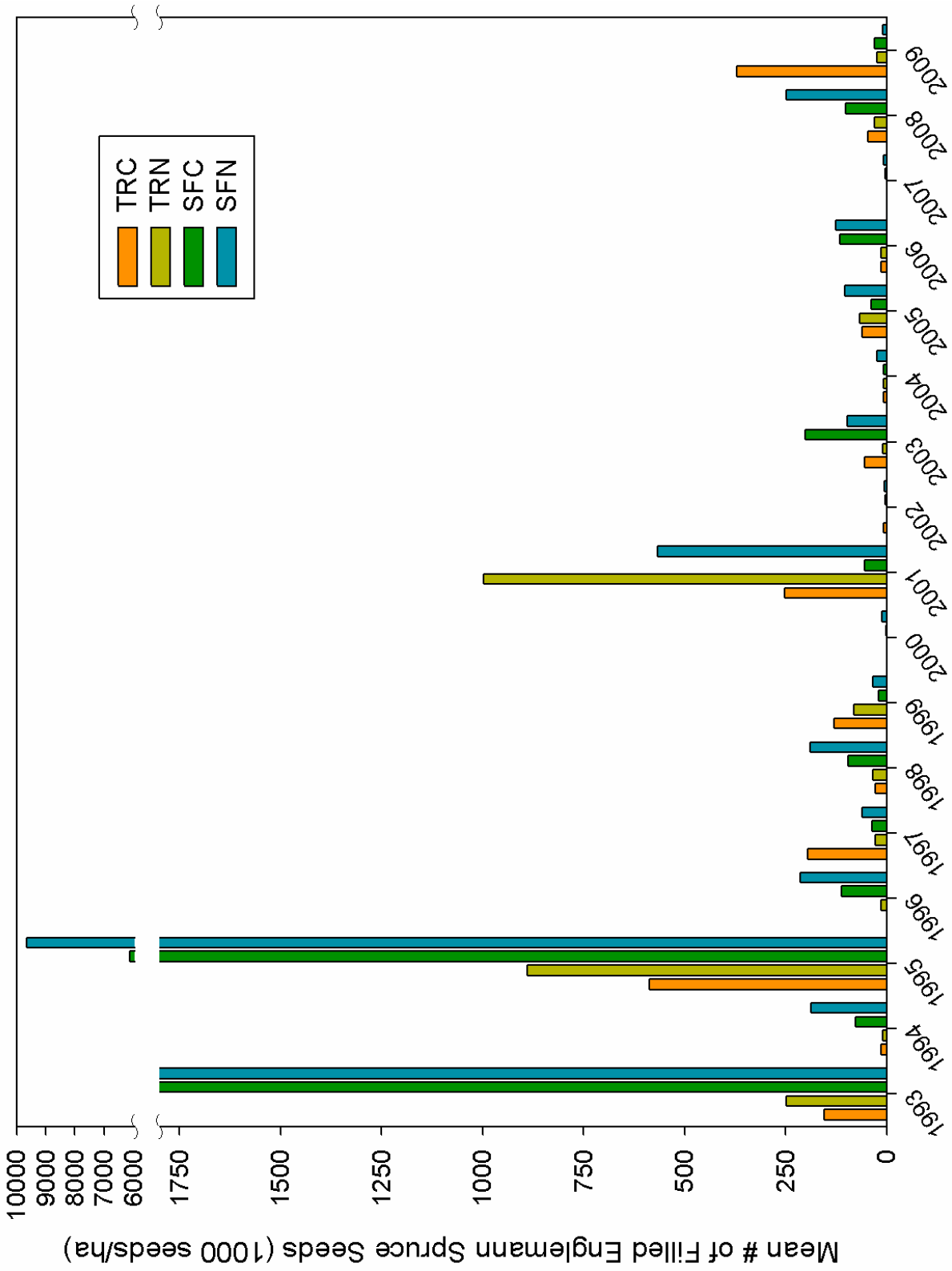


Figure 3. Mushroom crops by habitat, 1994 - 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

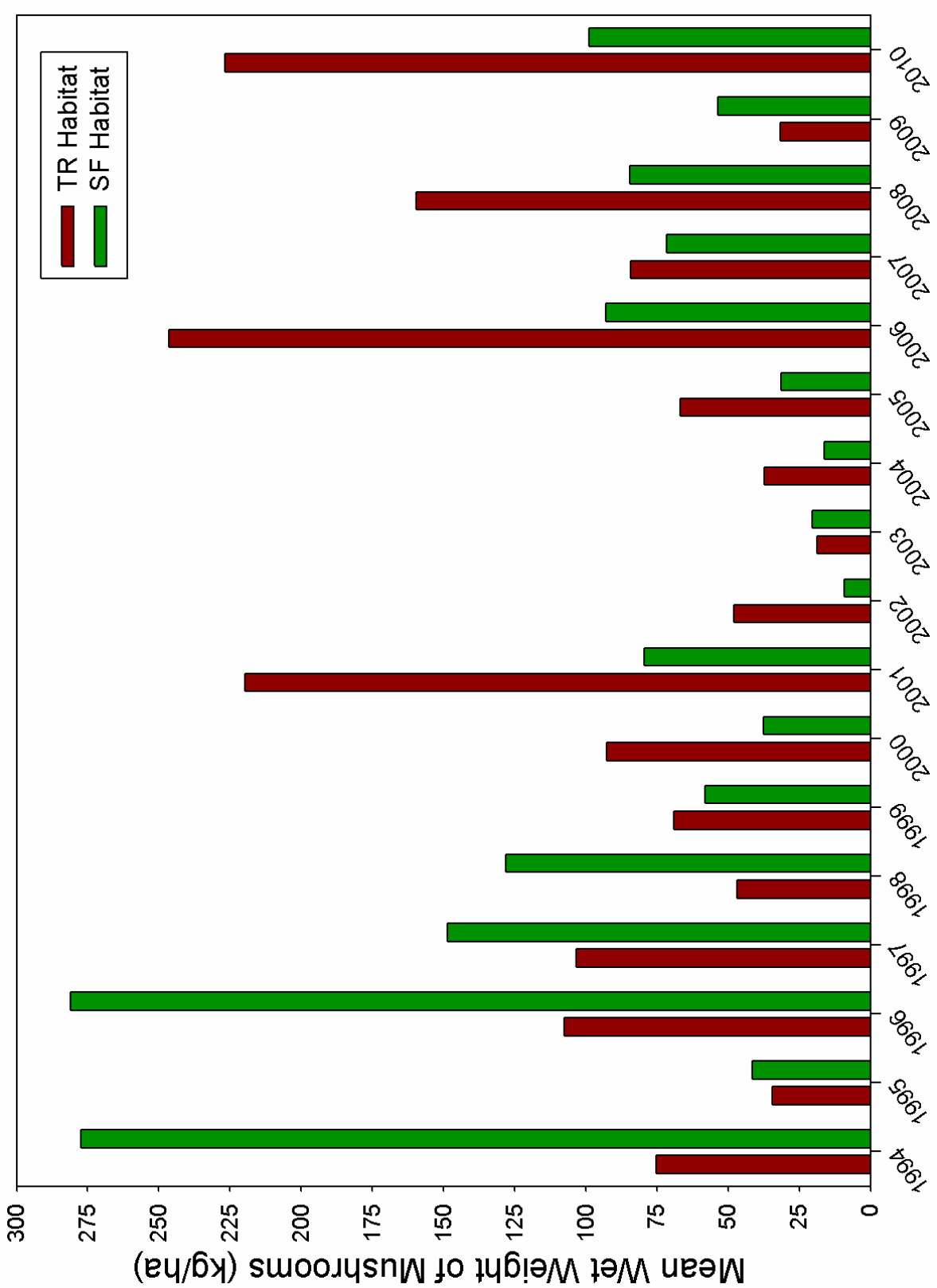


Figure 4. Quarterly Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles), March 2006 - December 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

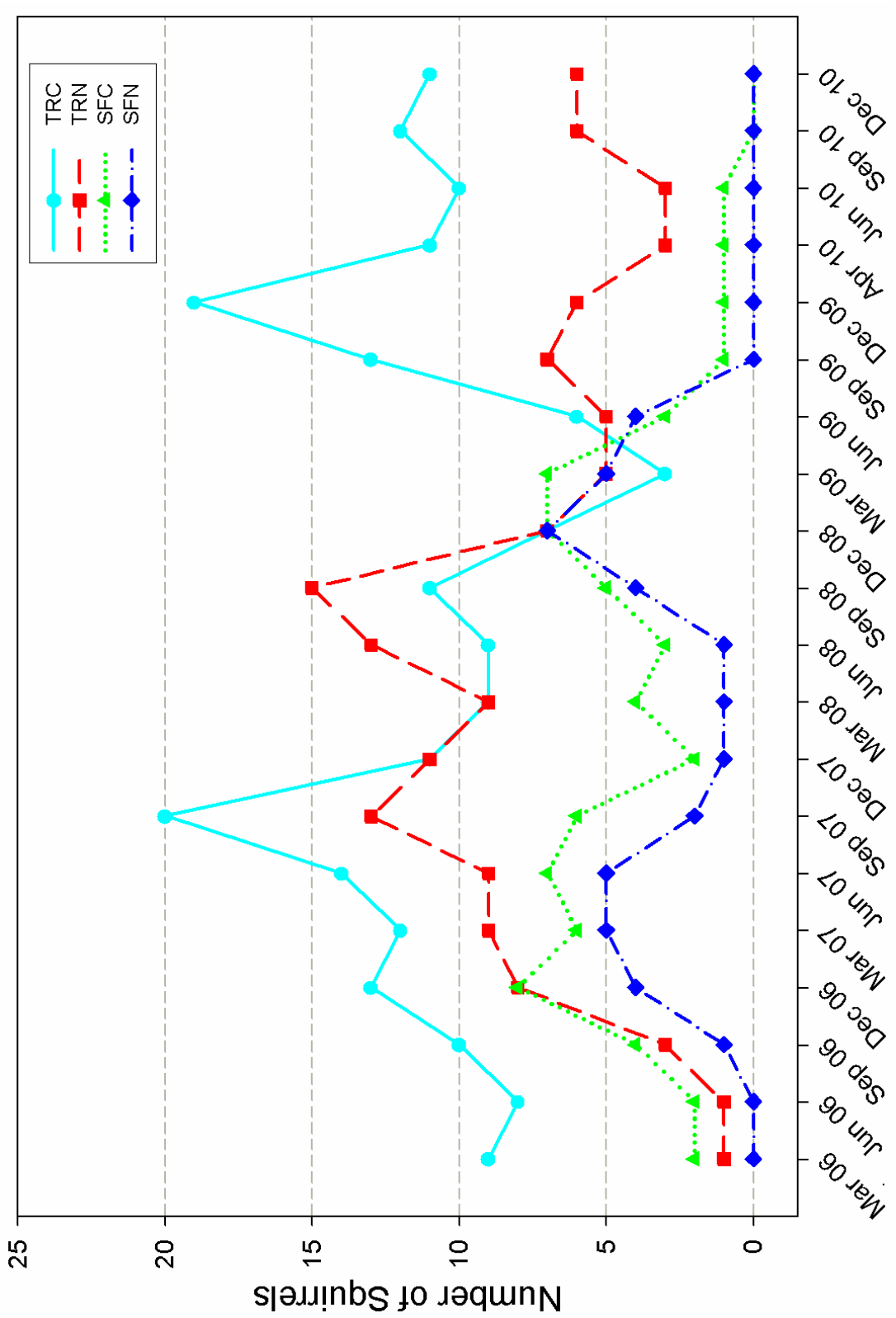
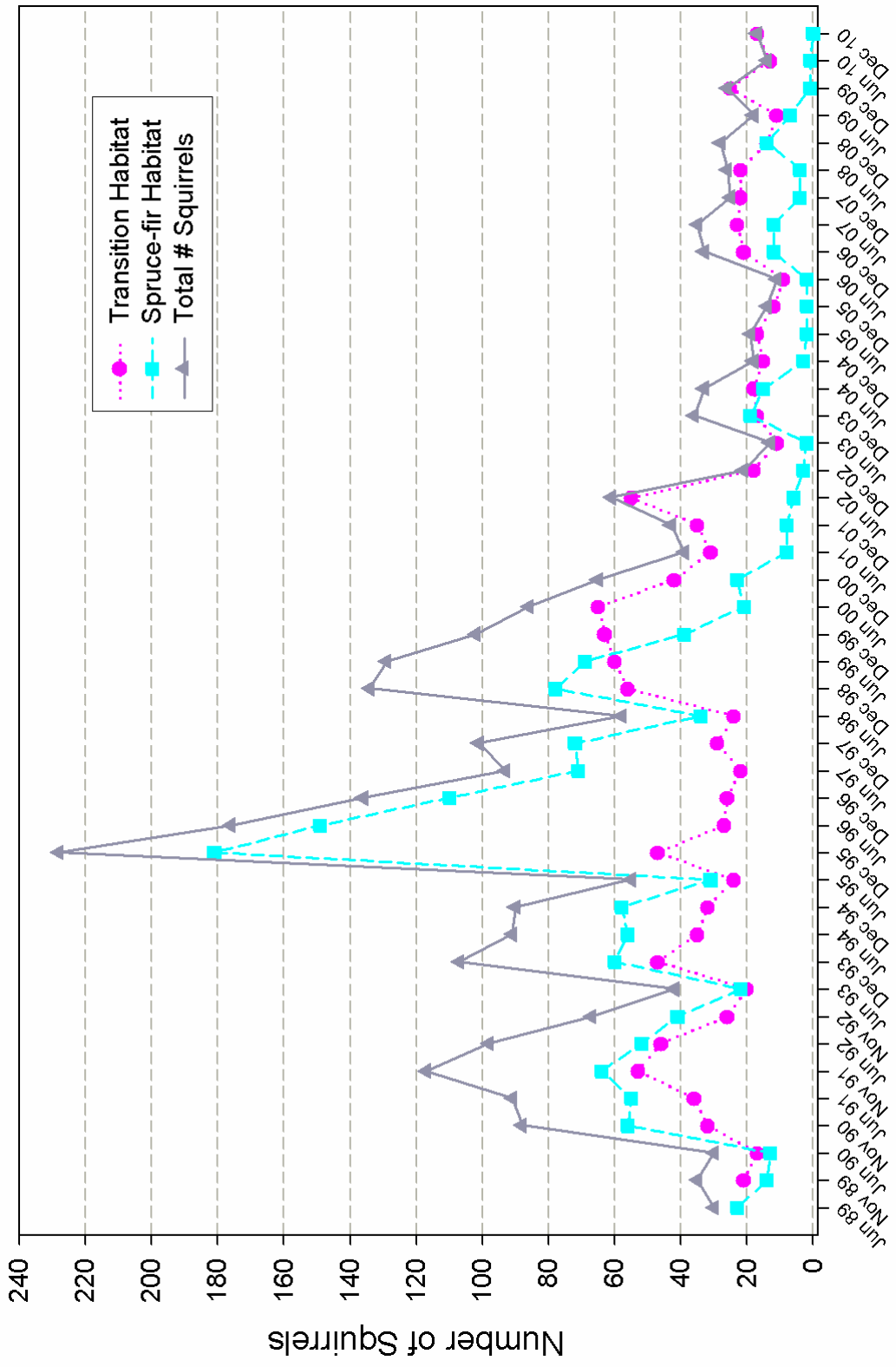


Figure 5. Summer and winter Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles), by habitat, June 1989 - December 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.



Appendix A. Annual conifer seed and mushroom production, 2009, on University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Appendix A-1: Mean number of seeds (filled) and weights for **2009** seeds and **2009** mushrooms, by area and habitat on University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

		Corkbark Fir	Douglas-fir	Englemann Spruce	Total Seeds	Total Mushrooms	
AREA	N	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	ww Kg/ha	dw Kg/ha
TRC $\bar{x}$	5	370.6	127.8	34.6	535.6	13.1	1.4
TRN $\bar{x}$	4	546.5	83.2	23.3	652.9	18.5	1.9
SFC $\bar{x}$	5	29.3	5.3	29.2	63.8	51.9	5.3
SFN $\bar{x}$	6	0.0	8.9	8.9	17.7	1.6	0.2
TR $\bar{x}$	9	448.8	108.0	29.5	587.7	15.5	1.6
SF $\bar{x}$	11	13.3	7.2	18.1	38.7	24.5	2.5

Appendix B: Midden occupancy records, 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

KEY

For Midden Numbers:

###^{89*}	Midden Number$^{\text{'Year Found'}}$ '*' following year indicates a newly established midden

For Monthly Occupancy cells:

N	Not Occupied
P	Possibly Occupied, Red Squirrel sign found but unsure of residency
Y	Occupied, Red Squirrel sign indicates resident
S	Occupied, Red Squirrel sighted
♀	Occupied, Adult female Red Squirrel
♂	Occupied, Adult male Red Squirrel
J	Occupied, Juvenile Red Squirrel sex unknown
SA	Occupied, Sub-adult Red Squirrel
♀ (R/R RC 101)	Squirrel is tagged (letters indicate ear tag colors - left ear/right ear, numbers indicate RSMP Animal ID) [B = blue, G = green, M = metal, O = orange, P = pink, R = red, Y = yellow, W = white n = none, -- = rip] [RC = radio collar] [tag shape is round unless noted: sq = square, tr = triangle]
NAT	Squirrel is naturally marked - ear notch, short tail, etc.
-	Midden not checked, no data
♀L	Adult female Red Squirrel, lactating
♀+'#'	Adult female Red Squirrel with "#" juveniles

Note: Beginning with this 2009 Annual Report, middens that have been removed from regular censusing due to permanent fire damage or low occupancy, are no longer listed in Appendix B. Please refer to the 2008 Annual Report for a complete list of these middens.

Transition Construction Area (TRC), 2010				
Midden	Apr[1]	Jun	Sep	Dec
1102[89]	N	N	P	S
1103[89]	Y	S	N	N
1104[89]	N	N	N	N
1106[89]	N	N	N	N
1111[89]	N	N	N	N
1112[89*]	N	N	N	N
1113[89]	♂	♀ (Wsq/Bsq RC 942)	♀ (Wsq/Bsq RC 942) + 3J	♀ (Gsq/Wsq RC 977) 4
1115[89]	N	N	N	N
1116[89]	N	N	N	N
1118[89]	♂ (P/P RC 915)	♂ (P/P RC 915)	♂ (P/P RC 915)	♂ (P/P RC 915)
1121[89*]	N	N	N	N
1131[90*]	♂ (O/W RC 929)	Y [2]	N	P
1144[91*]	Y	P	N	N
1147[91*]	N	N	N	N
1149[91*]	N	P	N	N
1151[91*]	N	N	N	N
1153[92*]	♀ (P/B RC 743)	♀ (P/B RC 743)	N [3]	N
1154[92*]	♂	♀ (Wsq/Wsq RC 943)	N	N
1156[93*]	P	♂ (G/B 946)	N	♀ (Osq/Ysq RC 939)
1160[96*]	♂ (Bsq/Wsq RC 934)	P	P	♂ (Bsq/Osq RC 976)
1162[96*]	N	N	N	N
1163[98*]	N	P	N	♀ (Psq/Bsq RC 968)
1164[98*]	♀ (P/R RC 933)	♂ (Bsq/Wsq RC 934)	♀ (Wsq/Wsq RC 943) + 3J	♀ (B/Y RC 958)
1167[98*]	N	N	N	S
1168[98*]	N	N	N	N
1169[98*]	N	N	N	N
1170[98*]	P	P	N	N
1171[98*]	N	N	N	N
1172[90*]	N	N	S	N
1173[99*]	N	N	N	N
1177[99*]	♀	♀ (Osq/Ysq RC 939)	♀ (Osq/Ysq RC 939) + 1J	N
1179[99*]	N	N	N	N
1180[99*]	N	N	N	N
1182[02*]	N	N	N	N

Transition Construction Area (TRC), 2010				
Midden	Apr[1]	Jun	Sep	Dec
1183[04*]	N	N	N	N
1184[04*]	N	N	N	N
1185[05*]	N	N	N	N
1186[05*]	N	N	N	N
1187[05*]	N	N	N	N
1188[10*]	P	P	N	P
1189[10*]	♀	♀ (Psq/Osq RC 940)	N	♂
1190[10*]	New midden - Dec 10			♀ (Wsq/Wsq RC 943)
1191[10*]	New midden - Dec 10			♂ (W/G RC 962)
# Mid	41	41	41	43
# Occ	11	10	5	11
% Occ	26.9%	24.4%	12.2%	25.6%
# Sq	11	10	5 + 7J	11

1 The first census of 2010 was conducted in April instead of March due to deep snow conditions. Midden flagging and tags were not visible as they were covered by snow.

2 Male 929 was suspected to be dead in May, as telemetry signal was stationary. On 1Jun10, the dried skeletal remains were found at the base of a nest snag under the snow. The cause of death was unknown. A new male (944) was trapped at 1131 on 21May10, but was not seen or signal detected afterwards. During the Jun 10 census, midden 1131 still appeared to be occupied based on sign, but a resident was not seen.

3 The collar of female 743 was found on the ground on 19Aug10. There were no remains or signs of predation evident. Female 743 had been confirmed on 16Aug10 to have at least 2 juveniles not yet emerged from the maternity nest (vocalizations heard in nest when mother was away). Female 743 was not seen after the collar was found and the juveniles were not detected at the maternity nest. Their fate remains unknown.

4 By Dec 10 census, female 942 had moved to midden 5155shift and her daughter, female 977, had moved to midden 1113. They were detected co-nesting a few times.

Transition Non-Construction Area (TRN), 2010				
Midden	Apr[1]	Jun	Sep	Dec
2202[89]	N	N	N	N
2203[89]	N	N	N	N
2204[89]	N	N	♀ (Rsq/Rsq RC 941) + 1J [2]	♀ [4]
2205[89]	N	N	N	N
2206[89]	N	N	N	N
2208[89*]	N	N	N	N
2210[90]	N	N	N	N
2211[90*]	N	N	N	N
2215[90*]	N	N	N	N
2216[90*]	N	P	N	N
2217[90*]	N	N	N	N
2218[91*]	N	N	N	N
2219[91*]	N	N	N	N
2223[91*]	N	N	N	N
2227[95*]	N	N	N	N
2229[96*]	N	N	N	N
2230[96*]	N	N	N	N
2234[97*]	Y	P	P [3]	♀ (R/B RC 950) [3]
2235[98*]	N	N	N	N
2236[98*]	N	N	N	N
2237[98*]	N	N	N	N
2238[98]	N	N	N	N
2241[98*]	N	N	N	P
2242[98*]	N	N	N	♂(Rsq/Psq RC 974) + ♀ [4]
2244[99*]	♂	♂	S	N
2246[99*]	N	N	N	N
2248[99*]	N	N	N	N
2249[99*]	N	N	N	N
2250[00*]	N	N	N	N
2252 [08*]	N	♀ (Rsq/Rsq RC 941)	N [2]	♀ (Rsq/Rsq RC 941)
2253 [09*]	♀ (Gsq/Bsq RC 778)	♀ (Gsq/Bsq RC 778)	♀ (Gsq/Bsq RC 778) + 1J [3]	♀ (Gsq/Bsq RC 778)
2254 [10*]	new midden - Sep 10		♂	N
# Mid	31	31	32	32
# Occ	3	3	4	5
% Occ	9.7%	9.7%	12.5%	15.6%
# Sq	3	3	4 + 2J	6

Appendix B - TRN (cont.)

1 The first census of 2010 was conducted in April instead of March due to deep snow conditions. Midden flagging and tags were not visible as they were covered by snow.

2 Female 941 was re-located on 19Sep10 (her collar was not signaling since July), at midden 2204sh. She was with an older female juvenile, who was also trapped and radio-collared (♀ 956). On 20Nov10, the radio collar and remains of female 956 were found. By Dec 10 census, female 941 had moved back to midden 2252.

3 A larger juvenile female was (♀ 950) was located with her mother ♀778 on 5Sep10. Female 950 seemed to be exploring away from maternity nest near 2253 (12132) towards midden 2234, but was still spending time and co-nesting with mother. Female 950 had more clearly established herself at midden 2234 later in the fall, but continued to co-nest with her mother.

4 Female 778 was confirmed to have a second litter for 2010, when 4 older juveniles were found in mid-November in the area of middens 2241/2242. The juveniles appeared to be semi-independent, but overlapping in activity areas and nesting near her. Two males (974 and 975) were trapped and radio collared and the two other siblings (both females) were not caught. Remains of male 975 (likely avian predation) were found shortly after collaring. Male 974 remained in the area around 2242, and at least one unmarked female was seen with him a couple of times in Nov and Dec. It is possible that the young unmarked female living at midden 2204shift in Dec is the other female, but this is speculation based on sighting locations and dates, and behavior.

Spruce-Fir Construction Area (SFC), 2010				
Midden	Apr[1]	Jun	Sep	Dec
3020[96*]	N	N	N	N
3028[99*]	N	N	N	N
3303[94*]	N	N	N	N
3310[95*]	Y [2]	Y [2]	N	N
3311[95*]	N	N	N	N
3312[95*]	N	N	N	N
3314[95*]	N	N	N	N
3323[95*]	N	N	N	N
3328[95*]	N	N	N	N
3330[95*]	N	N	N	N
3341[95*]	N	N	N	N
3346[95*]	N [2]	N	N	N
3348[95*]	N	N	N	N
3360[86]	N	N	N	N
3362[86]	N	N	N	N
3365[86]	N	N	N	N
3366[86]	N	N	N	N
3370[86]	N	N	N	N
3371[87]	N	N	N	N
3372[89]	N	N	N	N
3374[89]	N	N	N	N
3378[90*]	N	N	N	N
3382[91*]	N	N	N	N
3394[93*]	N	N	N	N
# Mid	24	24	24	24
# Occ	1	1	0	0
% Occ	4.2%	4.2%	0%	0%
# Sq	1	1	0	0

1 The first census of 2010 was conducted in April instead of March due to deep snow conditions. Midden flagging and tags were not visible as they were covered by snow.

2 Midden 3310shift looked occupied during the Apr census based on sign (scales on snow, clipped branch tips, digging), but a red squirrel was not observed at the midden. An unmarked red squirrel was seen running on the snow near midden 3345 (no signs of occupancy), but was not found again. This squirrel may have been the 3310shift resident, but not confirmed. During the Jun census, there were still some sign at 3310shift that indicated occupancy, but no resident was observed.

Spruce-Fir Non Construction Area (SFN), 2010				
Midden	Apr[1]	Jun	Sep	Dec
4000[95*]	N	N	N	N
4010[95*]	N	N	N	N
4016[96*]	N	N	N	N
4026[09*]	N	N	N	N
4400[89]	N	N	N	N
4417[95*]	N	N	N	N
4465[90*]	N	N	N	N
4467[87]	N	N	N	N
4469[87]	N	N	N	N
4470[87]	N	N	N	N
4471[87]	N	N	N	N
4472[87]	N	N	N	N
4473[87]	N	N	N	N
4474[86]	N	N	N	N
4477[87]	N	N	N	N
4484[86]	N	N	N	N
4491[91*]	N	N	N	N
# Mid	17	17	17	17
# Occ	0	0	0	0
% Occ	0	0	0	0
# Sq	0	0	0	0

1 The first census of 2010 was conducted in April instead of March due to deep snow conditions. Midden flagging and tags were not visible as they were covered by snow.

Off-Area Midden Occupancy, 2010				
Midden	Apr[1]	Jun	Sep	Dec
TRC Area				
5101[89]	♂	♂ (Osq/Wsq RC 938)	♂ (Osq/Wsq RC 938)	♂ (Osq/Wsq RC 938)
5102[98*]	N	N	N	N
5103[99*]	N	N	N	N
5104[99*]	N	N	N	N
5105[02*]	N	N	N	N
5106[02]	N	N	N	N
5107[02]	N	N	N	N
5118[94*]	N	N	N	♀ (G/Y RC 948) 2
5119[89*]	N	P	Y	♂ (Psq/Wsq RC 967)
5121[89*]	N	N	N	N
5125[89*]	N	N	N	N
5126[91]	N	N	N	N
5145[91*]	N	N	N	N
5150[91*]	♂ (Psq/Bsq RC 904)	Y	♀ (G/Y RC 948) + 3J 2	♂ (Psq/Gsq RC 966) 2
5155[93*]	♂ (Osq/Psq RC 935)	♂ (Osq/Psq RC 935)	Y	♀ (Wsq/Bsq RC 942)
TRN Area				
5200[93*]	♂	Y	P	N
5201[99*]	N	N	N	N
5203[00*]	N	N	N	N
5221[91*]	N	N	N	N
5231[96*]	N	N	N	N
5232[96*]	N	N	N	N
SFC Area				
5311[95*]	N	N	N	N
5313[95*]	N	N	N	N
5350[86]	N	N	N	N
5361[96*]	N	N	N	N
SFN Area				
5405[87]	N	N	N	N
5413[95*]	N	N	N	N

1 The first census of 2010 was conducted in April instead of March due to deep snow conditions. Midden flagging and tags were not visible as they were covered by snow.

2 Female 948 had 3 known juveniles confirmed in late Sep, (♂957, ♂961, ♂966), all were captured and radio collared. Female 957 disappeared in early Oct, her fate unknown. Male 961 had dispersed to midden WP233 in the Ash Creek drainage by the end of Oct. Male 966 remained around the natal nest at 5150sh (15105) through Dec, overlapping activity areas and co-nesting with mother 948.

Appendix C. Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles at maternal middens), March 2006 - December 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Date	TRC	TRN	SFC	SFN	TOTAL
Mar 2006	9	1	2	0	12
Jun 2006	8	1	2	0	11
Sep 2006	10	3	4	1	18
Dec 2006	13	8	8	4	33
Mar 2007	12	9	6	5	32
Jun 2007	14	9	7	5	35
Sep 2007	17 + 3J	13	6	2	38 + 3J
Dec 2007	11	11	2	2	26
Mar 2008	9	9	4	1	23
Jun 2008	9	13	3	1	26
Sep 2008	11	8 + 6J	5	4	28 + 6J
Dec 2008	7	7	7	7	28
Mar 2009	3	5	7	5	20
Jun 2009	6	5	3	4	18
Sep 2009	13	7	1	0	21
Dec 2009	19	6	1	0	26
Apr 2010	11	3	1	0	15
Jun 2010	10	3	1	0	14
Sep 2010	5 + 7J	4 + 2J	0	0	9 + 9J
Dec 2010	11	6	0	0	17

Appendix D: Quarterly occupancy maps for Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) April 2010 - December 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

(maps removed)

Appendix E: Reproductive success of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2010, on or near* University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

E-1: Mt. Graham red squirrel breeding chases on or near the study areas.

E-2: Mt. Graham red squirrel litters seen on or near the study areas.

* Reproductive success notes for squirrels at middens ≥ 100m from study area boundaries (numbered in 5000s and 8000s) are included for anecdotal information only. Litters at these middens are not counted in population totals for the Monitoring Program study areas.

Appendix E-1: Breeding Chases Observed - 2010

Descriptions of mating chases observed in 2010 on or near the University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Date	Midden	Notes
3 Apr 10	8008	Males 929 and 786, and females 932 and an unmarked female were seen in a breeding chase in the area of midden 8008. There were several chases in the trees and buzz calls were heard.
16 Apr 10	8034	Males 915, 904, possibly male 880, and possibly female 897 (not 100% sure of identification), were seen in the area of midden 8034. Lots of chasing in trees, with squeak vocalizations.
7 Jun 10	1113	Male 935, Females 939 and 942, plus one unmarked squirrel of unknown sex, were seen in the area of midden 1113. There were several chases on the ground and in the trees, with bark vocalizations.

Appendix E-2: Litters observed in 2010 on or near University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Only litters on the monitored areas during census months are counted in the quarterly population totals (see Appx. C).

Date	Midden	Notes
16 Aug 10	1153	***2 juveniles*** (at least) were confirmed for Female 743 when vocalizations were heard in the cavity of nest 11025. The juveniles were not observed outside of the cavity. On 19 Aug 10, the collar of Female 743 was found on ground south of midden 5101. There were no signs of predation. We observed at nest 11025 several times, but neither Female 743 or any juveniles were seen again.
16 Aug 10	2253	***1 juvenile*** was seen in nest 12020 with Female 778. A female juvenile (950) was trapped at the nest on 5 Sep 10. This female stayed in the vicinity of her mother until late fall when she seemed to settle and begin caching cones at nearby midden 2234. Female 778 and Female 950 co-nested together several times.
4 Sep 10	8006	***3 juveniles***, still small, seen exploring on nest 18177, mother is female 898. Trapped and radio collared all three (Female 959, Female 955, Male 954). By Dec, the two females had established middens in the natal area (959 at 8053, 959 at 8054), but the male was known to have dispersed to Webb Peak in early Oct. 30 Oct 10, remains and collar of Male #954 were found, apparent raptor kill. Mother 898 was living at 8055 in Dec 10.
16 Sep 10	11193	***1 juvenile*** was seen with mother, Female 939 at this nest near midden 1167. The juvenile was not caught in 2010 for marking. Female 939 was off-air for some periods of fall 2010 (collar was chewed by juvenile), but we suspect they nested together at 11050 and 11121. By Dec, an unmarked YOY was resident at midden 1167 and mother 939 was resident at midden 1156. (Note: young male was trapped and radio collared at midden 1167 in Mar 11 980, he and Female 939 were detected co-nesting).
19 Sep 10	12129	***1 juvenile*** was seen with mother, Female 941 at nest in area of midden 2204shift. The juvenile female was also trapped and radio-collared, 956. A second unmarked older juvenile of similar size was seen several times in the area, and may have been a second offspring, but this was not confirmed. By Dec, Female 941 was living at midden 2252, and the remains and collar (likely raptor kill) of female 956 were found on 20 Nov 10.

Appendix E-2 (cont.):

19 Sep 10	11097	***3 juveniles***, still small, were trapped with mother, Female 943 in the area of midden 1164. All of the juveniles were trapped and radio-collared (Female 958, Male 962, Male 965). By Dec, mother 943 had settled back at midden 1190, Male 962 was across the dirt road to the W at midden 1160, Female 958 remained in the natal area at midden 1164, and male 965 had dispersed to the area of the Southern AZ Bible Camp area, several kilometers to the NE.
19 Sep 10	15109	***3 juveniles*** confirmed for female 948 in area of midden 5150shift. All three juveniles were trapped and radio collared (Female 957, Male 966, and Male 961). The signal for female 957 was not heard after early October (Note: collar was found under snow near midden 1113, 7Jan11, no signs of predation). By Dec, Male 966 stayed in area of maternity nest 15109, with mother 948 nearby at midden 5118shift. These two squirrels co-nested together several times at nest 15109. Male 961 dispersed to a midden in the Ash Creek drainage (WP233).
19 Sep 10	8007	***4 juveniles*** confirmed for Female 928. The juveniles were small size and staying close to the cavity in nest 18175. Three of the 4 juveniles were trapped and radio collared (Female 960, Female 963, and Male 964). By Dec census, Females 960 and 963 were staying together around nest 18175, Male 964 was living at midden 8036, and mother Female 928 was living at 8007.
25 Sep 10	11194	***3 juveniles***, still small and staying near cavity, were observed at nest 11194 (near midden 1112), mother was Female 942. By Dec, only one of the juveniles had been trapped and radio-collared, Female 977. She and mother 942 co-nested together at nest 15119 near midden 5155shift.

Appendix E-2 (cont.):

7 Nov 10	2242 area	***4 juveniles.*** Confirmed second litter. Trapped Female 778 to replace bad radio collar and discovered she was lactating again. Followed her to the area of midden 2242 and located 2 older juveniles playing in the drainage. Female 778 was observed entering and exiting a nest where the juveniles were later seen. Observed 4 older juveniles on 13 Nov 10, trapped 2 males (974, 975), and thought the remaining two were females. The remains of male 975 were found shortly after collaring, apparent raptor predation. By Dec census, Female 778 was mostly back around midden 2253 and co-nested several times with daughter 950 from first 2010 litter. Male 974 and 1 unmarked female remained together at midden 2242. It is possible that the unmarked young female at midden 2204 in December is the other sibling, but just speculation.

Females who were observed pregnant or lactating, but never had litters confirmed.

21 Jul 10	18259	Female 947 was found to be lactating and was observed taking nest material into cavity in 18259. Re-captured to replace collar on 3 Sep 10, she did not appear to be lactating. The fate of her litter is unknown.
4 Jun 10	1189	Female 940 was likely pregnant when she was captured for a weight and radio check. She was not seen and her radio signal was not detected after late Jun, and her fate is unknown.
21 July 10	18009	Female 897 was in late pregnancy when trapped. She was observed as lactating in late Jul. Nothing was seen during nest observations during Aug. Believe the radio collar was signaling in nest by 4 Sep. No confirmed sighting of Female 897 was made thereafter.

Litters on Merrill Peak Study area (not included in population totals)

11 Jul 10	18489	***3 juveniles***, exploring in trees, but not coming down to ground at nest 18489 (MP area). Mother was Female 945. After late Jul, the signal for Female 945 was not heard, neither she or the juveniles were observed again.
8 Aug 10	18491	***3 juveniles*** and their mother (unmarked) were observed at nest 18491 (MP area). None of the animals were trapped during several attempts. 11 Sep 10, observed one larger juvenile entering nest 18491.

Appendix F. Weather information, January - December 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

F-1: Monthly weather summaries

F-2: Accumulated snow depths

Note: There were several technical issues at the Emerald Peak weather station. As a result, there is no 2010 data available for that station.

Appendix F-1: Monthly weather summaries, Biology Camp

Biology Camp Weather Summary

Date: Jan 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-12.100	692.900	27.000	-19.000	0.000	0.000	-16.800	0.000
Avg	-3.453	703.597	77.774	-7.327	1.111	2.029	-4.915	
Max	6.100	709.400	100.000	0.600	2.700	4.830	6.100	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West South West

Date: Feb 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-9.200	701.900	24.000	-20.300	0.000	0.000	-12.700	0.000
Avg	-0.711	707.837	57.538	-8.842	0.992	1.814	-1.740	
Max	8.200	714.500	100.000	-1.100	3.100	5.630	8.200	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West

Date: Mar 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-4.300	702.100	19.000	-17.200	0.000	0.000	-6.300	0.000
Avg	3.073	708.568	42.351	-8.818	0.846	3.120	2.478	
Max	12.000	712.400	58.000	-4.300	2.200	8.050	12.000	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West South West

Appendix F-1 (cont.):

Biology Camp Weather Summary

Date: Apr 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-10.400	695.400	28.000	-17.100	0.000	0.000	-11.600	0.000
Avg	2.110	706.101	64.485	-4.562	0.633	2.338	1.688	
Max	12.200	713.100	100.000	5.200	2.700	9.660	12.200	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West

Date: May 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-6.800	698.300	17.000	-22.200	0.000	0.000	-8.800	0.000
Avg	7.386	708.950	41.284	-5.608	0.582	2.166	7.166	
Max	20.100	714.200	98.000	2.800	2.200	8.050	20.100	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West

Date: Jun 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	0.800	710.900	18.000	-8.800	0.000	0.000	0.800	0.000
Avg	13.670	723.925	46.132	1.438	0.206	0.801	13.667	
Max	25.200	732.100	100.000	13.100	1.300	4.830	25.200	1.400
Total								2.400
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West

Appendix F-1 (cont.):

Biology Camp Weather Summary

Date: Jul 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	5.300	724.900	27.000	-1.100	0.000	0.000	5.300	0.000
Avg	13.616	728.564	84.297	10.634	0.149	0.567	13.614	
Max	22.900	733.600	100.000	17.200	1.800	6.440	22.900	22.000
Total								173.800
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: South East

Date: Aug 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	7.200	722.800	57.000	2.100	0.000	0.000	7.200	0.000
Avg	13.249	728.333	89.003	11.310	0.056	0.214	13.248	
Max	22.200	731.600	100.000	16.600	1.300	4.830	22.200	13.200
Total								87.400
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: South East

Date: Sep 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	3.200	719.300	29.000	-5.700	0.000	0.000	3.200	0.000
Avg	11.915	726.654	74.828	7.128	0.087	0.340	11.915	
Max	19.900	731.400	100.000	14.800	1.300	4.830	19.900	12.800
Total								62.800
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: North West

Appendix F-1 (cont.):

Biology Camp Weather Summary

Date: Oct 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-2.800	716.800	25.000	-13.400	0.000	0.000	-2.800	0.000
Avg	6.574	725.056	72.853	1.534	0.196	0.742	6.544	
Max	19.300	731.200	100.000	9.000	1.800	6.440	19.300	5.600
Total								16.600
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: North

Date: Nov 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-13.400	709.100	11.000	-28.900	0.000	0.000	-16.600	0.000
Avg	0.958	721.710	47.432	-10.373	0.536	1.990	0.543	
Max	12.400	731.000	100.000	0.500	2.200	8.050	12.400	0.200
Total								0.200
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: West

Date: Dec 2010

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-1.800	723.400	11.000	-24.500	0.000	0.000	-2.600	0.000
Avg	4.845	726.081	35.317	-10.593	0.540	1.996	4.591	
Max	11.500	729.100	77.000	0.100	2.200	8.050	11.500	0.200
Total								0.200
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominent Wind Direction: South East

F-2: Accumulated snow depths on the monitored areas for Winter 2009-2010.

Snow Depth Summary

Snow Year Year	Month	Habitat	Location	Avg Depth (cm)	Min Depth (cm)	Max Depth (cm)	Avg. % Cover	# of Readings for Avg.
2009-2010								
2009	12	Spruce-fir	Clearing	58.2	45	75	100.0	5
2009	12	Spruce-fir	Forest	49.8	40	58	100.0	6
2009	12	Transition	Clearing	31.8	18	47	100.0	9
2009	12	Transition	Forest	33.9	19	47	100.0	7
2010	1	Transition	Clearing	50.7	42	58	100.0	3
2010	1	Transition	Forest	51.5	45	58	100.0	2
2010	2	Spruce-fir	Clearing	220.0	220	220	100.0	1
2010	2	Spruce-fir	Forest	205.0	205	205	100.0	1
2010	2	Transition	Clearing	169.3	150	186	100.0	3
2010	2	Transition	Forest	166.5	151	182	100.0	2
2010	3	Spruce-fir	Clearing	222.0	141	270	100.0	3
2010	3	Spruce-fir	Forest	204.3	180	233	100.0	3
2010	3	Transition	Clearing	180.6	152	210	100.0	5
2010	3	Transition	Forest	182.7	167	207	100.0	3
2010	4	Spruce-fir	Clearing	149.5	85	183	100.0	4
2010	4	Spruce-fir	Forest	151.3	133	185	100.0	4
2010	4	Transition	Clearing	126.4	58	176	100.0	5
2010	4	Transition	Forest	144.0	103	182	100.0	4
2010	5	Transition	Clearing	21.7	0	68	41.7	6
2010	5	Transition	Forest	45.8	0	83	68.8	4
		Averages for Snow Year		123.2	97.7	146.7	95.5	Sum # Readings
			Std Dev	71.75				80
			SE of Mean	8.02				