THE UNIVERSITY OF

ARIZONA

Mt. Graham Red Squirrel Monitoring Program

2013 Annual Report

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EXECUTIVE SUMMARY

In 2013, 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.

Overall annual mean mushroom production in 2013 (268.8 kg/ha) was nearly 2 times greater than in 2012 (140.9 kg/ha). The 2013 mushroom crop ranked 6th of 20 years since data collection began in 1994. Overall seed production for 2012 (1 year delay in reporting due to methodology), 10216.5 ($\bar{x}$ 1000 seeds/ha) was the third largest crop observed in 20 years since data collection began in 1993, and was several orders of magnitude larger than the seed crop in 2011, 5.9 (1000 seeds/ha) .

Overwinter survival, calculated as animals surviving from December 2012 to June 2013, was 65.2% in transitional (TR) habitat (15 of 23 squirrels surviving) and 50% (10 of 20 squirrels surviving) in spruce-fir (SF) habitat. Of the 10 marked (radio collars and/or ear tags) squirrels in December 2012 on the monitored areas, by June 2013, 8 were alive, 1 was a confirmed mortality (likely avian predation), and 1 had disappeared, fate unknown. Twelve litters were confirmed on or near the monitored areas in 2013. From these 12 litters, 36 juveniles were known to have emerged from natal nests.

A complete census of the study areas was made in March, June, September, and December 2013. Squirrel populations in December 2013 (53 adults/subadults) were higher than the previous December (43 adults/subadults). In TR habitat, the number of squirrels increased throughout the year, however for SF habitat, a population decrease was seen between the September and December censuses. The total number of squirrels on all monitored areas in December 2012 (53 adults/subadults) was the highest since June 2002 (61: 34 adults + 27 juveniles).

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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 2013, the MGIO site consisted of three operating facilities, the Vatican Advanced Technology Telescope (VATT), the Sub-Millimeter Telescope (SMT), and the Large Binocular Telescope (LBT), a maintenance and generator building, and a 3.2 km access road (FR 4556). Herein, we report on the monitoring efforts from 1 January to 31 December 2013.

All use of terms *red squirrel* or *squirrel* refers to the Mt. Graham red squirrel unless otherwise noted. No part of this report may be used or reproduced in any form without the written permission of the Monitoring Program Director, Dr. John L. Koprowski, School of Natural Resources & the Environment, Wildlife Conservation and Management, University of Arizona, Tucson, Arizona, 85721.

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 m 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 (C.C. 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 reoccupied, 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 is 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 2012 crop were collected from the seed traps in June 2013. 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 1 m by 100 m (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 (2) and SFN (1). Mushrooms (epigeous or above-ground fungi) were collected at these 20 sites (Figure 1) from late July through late September 2013. Mushrooms in 2013 were collected on north-south transects. 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 to the nearest 0.1 g. 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 ($n < 100$).

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 (Appendix A) in addition to the current year's mushroom data (Tables 4, 5).

Population Biology

Midden Occupancy

Census data were used to determine number and distribution of occupied middens on each monitored area. In March, June, September, and December 2013, 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 2013, 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 on the monitored areas. During a complete census in December 2012, the number of occupied middens and the identity of resident squirrels were determined. December 2012 occupancy was then compared to occupancy for June 2013. 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 the following 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 2013, 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) and Arizona Game and Fish Department (SCP-2013: 587510), 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., style 1005-1) threaded with colored plastic washers (National Band & Tag Co., ⅜" diameter, style 1842) and affixed to ears for easy distance identification. Radio collars (Wildlife Materials Inc., model SOM2190) were fitted on some adult (collar weight ~7 g) and juvenile animals (collar weight ~5 g). Squirrels were released at the capture site.

Mapping

All middens and most other physical features on the monitored areas were previously mapped using GPS with an accuracy of ± 5 m. Any new GPS data (middens, nests, etc.) were collected using GeoXM or GeoXT units 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 3.3 (ESRI 2002).

Weather Data

Weather data were collected using a Weather Monitor II station (Davis Instruments, www.davisnet.com) located at the Biology Camp (32" 41' 51.47 N, 109" 54' 20.28 W), adjacent to the TRC. The station records air temperature, wind speed, wind direction, rainfall, relative humidity and barometric pressure. Data are averaged at 60 min intervals and minimum, maximum and mean values are recorded. 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 IBM SPSS statistical software (Ver. 19, www.spss.com). 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

2012 *Conifer Seed Production*

Data collection for seed crops began in 1993 and is currently reported as the mean number of 1000 *filled* seeds per hectare. If years are ranked from highest (1) and lowest (20), the total 2012 seed crop ranked 3 of 20. Corkbark fir was the most abundant (in numbers) seed in 2012, and was the second highest crop seen since 1993. Douglas-fir was the second most abundant seed in 2012 and was the second highest crop seen since 1993. Engelmann spruce was the least abundant seed in 2012, however, spruce was the fourth highest crop seen since 1993. The 2012 overall mean seed crop was 10216.5 (1000 seeds/ha), several orders of magnitude larger than the seed crop in 2011, 5.9 (1000 seeds/ha) (Table 3, Figures 2a-c, Appendix A).

2013 *Mushroom Production*

Overall annual mushroom production (sum of $\bar{x}$ wet weight for all areas) in 2013 was 268.8 kg/ha, nearly 2 times larger than in 2012 (140.9 kg/ha). The 2013 mushroom crop ranked 6th highest of 20 years since data collection began in 1994. Production increased in both TR and SF habitats in 2013 as compared to 2012 (Figure 3). In 2013, mushroom production ($\bar{x}$ wet weight) was significantly greater on TRN area than TRC (Table 4). However, when mushroom production was compared within SF habitat and between TR and SF habitats, no differences were found (Table 4). On TRC, three genera, *Russula, Cortinarius*, and *Clitocybe* accounted for 71% of production. On TRN, *Russula, Pholiota*, and *Clitocybe* accounted for 80% of total production. *Russula, Amanita,* and *Auricularia* accounted for 70% of the production on SFC. On SFN, *Lactarius, Russula,* and *Cortinarius* accounted for 73% of the total production (Table 5).

Population Biology

Midden Occupancy

Four quarterly censuses (Mar, Jun, Sep, Dec) of all middens on or near monitored areas were conducted in 2013 (Appendix B). From December 2012 to December 2013, the number of red squirrels increased, from 43 to 53. On TRC, the highest number of squirrels (27 adults/subadults) was in December 2013, and the lowest number was 14 adults in June. The highest numbers on TRN were in December (17 adults/subadults) and the lowest was 11 adults in March. The highest number of squirrels on SFC was in June (14 adults) and the lowest was 6 adults/subadults in December. On SFN, the highest number (7 adults) was in March and the lowest was 3 adults/subadults in December (Figure 4, Appendix B, C, D). The total number of squirrels on the monitored areas in September 2013 (56 adults/subadults) was the highest found since June 2002 (61: 34 adults + 27 juveniles) (Figure 5). For TR habitat, the number of squirrels increased throughout the year, however for SF habitat, a population decrease was seen between September and December 2013 (Figure 5).

In 2013, 6 new middens were located in TR habitat and 5 middens that were previously removed from regular censusing due to historically low occupancy became reoccupied. In SF habitat there were no changes in the number of middens (Appendix B). In June and December of 2013, 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 2012-2013 did not differ among areas (Table 7); survival was 65.2% (15 of 23 squirrels surviving) in TR habitat and 50% (10 of 20 squirrels surviving in SF habitat. For comparison, survival from the previous winter, 2011-2012, was 46% (6 of 13 squirrels surviving) in TR habitat and 25% (2 of 8 squirrels surviving) in SF habitat. There were 10 marked squirrels on the monitored areas in December 2012, and by June 2013, 8 were known alive, 1 was a confirmed mortality (likely avian predation), and 1 had disappeared, fate unknown.

Overwinter survival may be overestimated because a midden may be occupied in the spring by a different squirrel of the same sex. Such a change in occupancy can not be detected among

unmarked squirrels. However, this potential overestimate is minimal in recent years as many squirrels on the monitored areas are ear-tagged and radio-collared for unique identification.

Reproductive Activity and Success

In 2013, no breeding chases were observed on the monitored areas, however, 5 chases were seen on nearby study areas indicating breeding activity from at least early March through mid May (Appendix E-1). Based on information from census and trapping records, many resident adult males had testes scrotal throughout the year. In addition, at least two young of the year subadult males had testes scrotal by late 2013.

From May through August, several females seen or trapped during these months were found to be either pregnant or lactating. The first lactating females were observed the first week May and the latest was observed on 22 August. Direct evidence of 12 litters (36 juveniles emerged from natal nests) was documented on or near the areas during censuses or other activities. Litters were confirmed from early June through mid August (Appendix E-2).

Trapping and Marking

By December 2013, 15 of the 61 resident squirrels on or near monitored areas were fitted with colored ear tags and radio-collars (Appendix B). In addition, 19 of the 36 juveniles known on or near monitored areas throughout the year, were trapped at natal middens, once they were large enough to be exploring on the ground (>115g body weight). Juveniles were then fitted with small numbered metal ear tags with colored plastic washers and small expandable radio collars (mean weight 5 g) to aid in the collection of dispersal information.

Mapping

No significant changes in maps of the monitored areas were made in 2013, 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 from January - December 2013 from the Biology Camp weather station (TR habitat). From available data, maximum temperature recorded was 25.6 °C in June and the minimum temperature recorded was -20.8 °C in January. The maximum average monthly temperature was 15.7 °C in June and the minimum average monthly temperature was -4.0 °C in February (Appendix F-1). The maximum total monthly rainfall was recorded in July, at 132.2 mm and no rain was recorded (during snow free months) in April and October (Appendix F-1). Snow depth was recorded from nine pairs of snow poles. The average ***accumulated*** snow depth from

December 2012 - April 2013 ranged from 0.0 cm to 78.0 cm (Appendix F-2). For comparison, average accumulated snow depths for the previous winter (November - April 2012), ranged from 5.0 cm to 76.0 cm. Data on wind chill temperatures, wind direction and speed, humidity, and barometric pressure were also collected (Appendix F-1).

Insect Outbreaks on Monitored Areas

Based on information from USFS Forest Health websites (see below), activity of bark beetles (*Dryocoetes confusus*, *Dendroctonus rufipennis*, *D. pseudotsugae*, and *D. brevicomis*) in Graham County was minimal in 2013. For detailed information on forest health and continuing research on insect infestations, please contact the USFS Southwestern Region Entomology and Pathology Office in Flagstaff, AZ.
http://www.fs.usda.gov/main/r3/forest-grasslandhealth
and
http://foresthealth.fs.usda.gov/portal

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4. Koprowski, J. L., S. L. Doumas, M. J. Merrick, B. Oleson, E. E. Posthumus, T. G. Jessen, and R. N. Gwinn. 2013. It's lonely at the top: Biodiversity at risk to loss from climate change.

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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.

	Transition habitat		Spruce-fir habitat		
Event and Date	Construction [1]	Non-construction	Construction	Non-construction	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

1 Construction areas are ≤ 300 m from Mt. Graham International Observatory or access road. Non-construction areas are sites outside this boundary established for comparison.

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.

Genus	Source
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, **2012**, 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 (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	1567.8	40.3	2298.5	59.0	26.6	0.7
TRN	4	2449.9	83.8	466.6	16.0	6.6	0.2
SFC	5	2543.8	94.2	15.9	0.6	141.2	5.2
SFN	6	202.1	28.9	228.7	32.7	268.8	38.4
TR Habitat	9	1959.9	56.6	1484.3	42.9	17.7	0.5
SF Habitat	11	1266.5	78.7	132.0	8.2	210.8	13.1

Table 4. Mean annual mushroom production, **2013**, 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	41.0 ± 6.8	4.6 ± 0.7
TRN	4	120.5 ± 24.7	13.3 ± 2.6
SFC	5	51.6 ± 14.4	5.3 ± 1.4
SFN	6	55.7 ± 20.7	5.6 ± 2.0
TR Habitat	9	76.3 ± 17.6	8.5 ± 1.9
SF Habitat	11	53.8 ± 12.5	5.5 ± 1.2

Wilcoxon test within TR:

Wet Weight	*Z = 2.33*	**P = 0.02**
Dry Weight	*Z = 2.08*	**P = 0.04**

Wilcoxon test within SF:

Wet Weight	*Z = 0.09*	P = 0.93
Dry Weight	*Z = 0.00*	P = 1.00

Wilcoxon test between TR and SF:

Wet Weight	*Z = 1.14*	P = 0.25
Dry Weight	*Z = 1.29*	P = 0.20

Table 5. Mean annual mushroom production (wet weight kg/ha), 2013, 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	3.60	8.8	2.96	2.5	15.01	29.1	9.51	17.1
Auricularia	3.64	8.9	0.85	0.7	5.76	11.2	0.62	1.1
Boletus	0.63	1.5	0.00	0.0	0.00	0.0	0.00	0.0
Clavaria	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Clitocybe	8.11	19.8	14.89	12.4	2.93	5.7	3.34	6.0
Cortinarius	8.96	21.9	7.38	6.1	4.80	9.3	10.01	18.0
Gastroid sp.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Hydnum	0.00	0.0	<0.01	0.0	0.00	0.0	0.00	0.0
Lactarius	1.70	4.2	7.69	6.4	1.76	3.4	18.36	32.9
Leccinum	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Lycoperdon	1.27	3.1	5.06	4.2	2.04	3.9	1.38	2.5
Pholiota	0.00	0.0	23.26	19.3	0.00	0.0	0.00	0.0
Ramaria	1.25	3.1	0.21	0.2	4.00	7.8	0.09	0.2
Russula	11.82	28.8	58.20	48.3	15.26	29.6	12.30	22.1
Suillus	0.00	0.0	0.00	0.0	0.00	0.0	0.13	0.2
Total	40.98		120.50		51.56		55.74	

Table 6. Number and percent of available middens occupied by Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2013, 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	45	14	31.1	52	27	51.9
TRN	33	10	30.3	36	17	47.2
SFC	30	14	46.7	30	6	20.0
SFN	19	6	31.6	19	3	15.8
TR Habitat	78	24	30.8	88	44	50.0
SF Habitat	49	20	40.8	49	9	18.4
TR + SF	127	44	34.6	137	53	38.7

Comparison of midden occupancy within habitats on RSMP study areas, June and December 2013.

JUNE *(Chi Square)*			
within TR	$\chi^2 = 0.006$	df = 1	P = 0.939
within SF	$\chi^2 = 1.096$	df = 1	P = 0.295
DECEMBER *(Chi Square)*			
within TR	$\chi^2 = 0.188$	df = 1	P = 0.665
within SF *(Fisher's exact test*)*			P = 1.000

* Used due to small sample sizes for December within SF habitat.

Table 7. Overwinter survival of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2012 - 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

	Number of Squirrels	Number of Squirrels Surviving	
Area/Habitat	Dec 2012[1]	Jun 2013	% Survival
TRC	15	10	66.7%
TRN	8	5	62.5%
SFC	12	6	50.0%
SFN	8	4	50.0%
TR Habitat	23	15	65.2%
SF Habitat	20	10	50.0%

*Fisher's Exact Test**	
within TR	P > 0.999
within SF	P = 0.999
between habitats	P = 0.365

* Used due to small sample sizes.

[1] Of the 43 animals resident on the areas in Dec 2012, 10 were radio collared and/or ear-tagged thus enabling unique identification. By Jun 2013, 8 of these animals were alive, 1 was confirmed dead and 1 had disappeared, fate unknown. The number of marked animals in the population increases the accuracy of survival calculations.

Figure 1. Map of study areas, December 2013, University of Arizona Red Squirrel Monitoring Program, Pinaleño Mountains, Graham County, Arizona.

(1 map removed)

Figure 2a. Corkbark fir (*Abies lasiocarpa* var. *arizonica*) seed fall, 1993 - 2012, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. **Scales are different for figures 2a-c**.

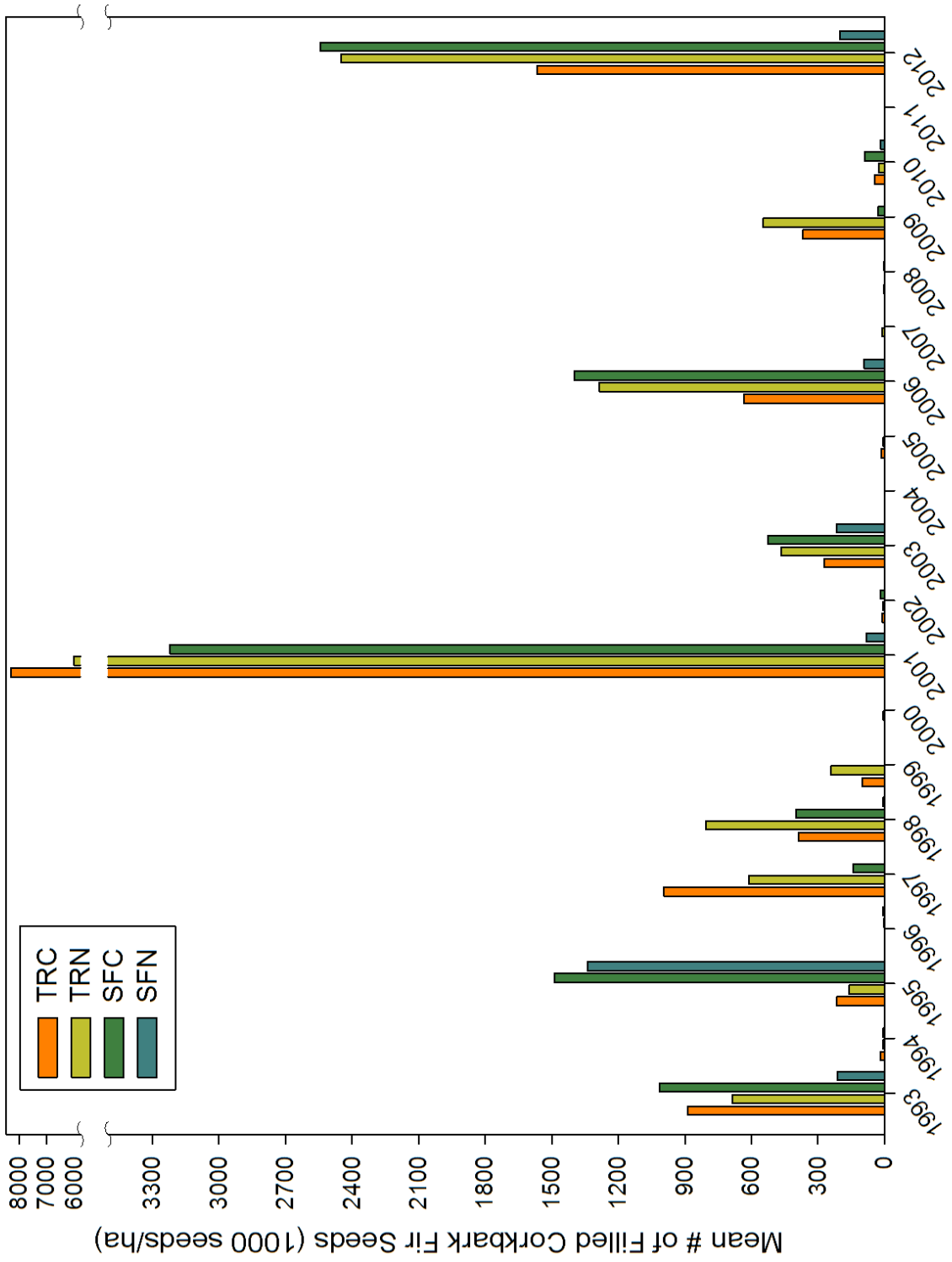


Figure 2b. Douglas-fir (*Pseudotsuga menziesii*) seed fall, 1993 - 2012, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. **Scales are different for figures 2a-c.**

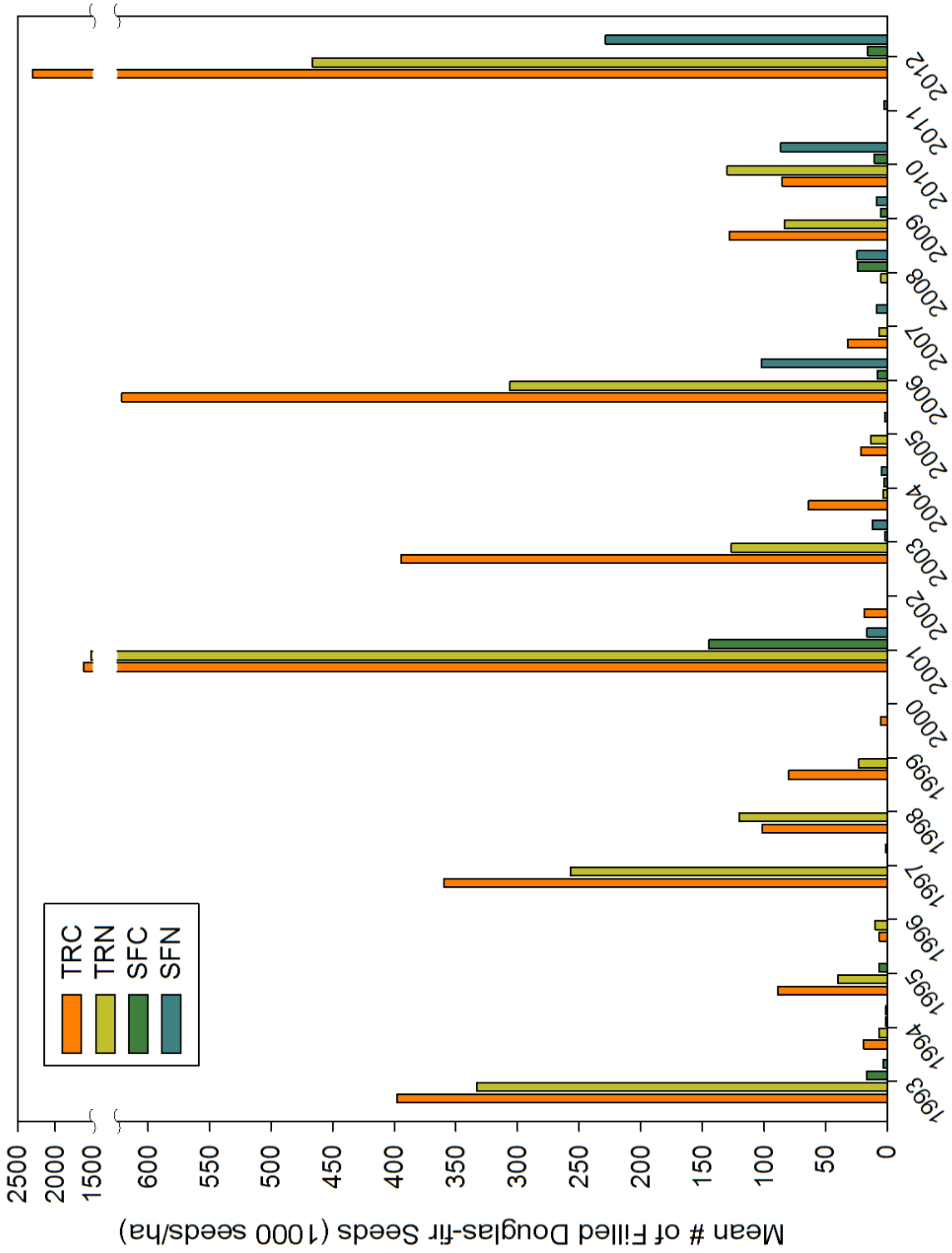


Figure 2c. Engelmann spruce (*Picea engelmannii*) seed fall, 1993 - 2012, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. **Scales are different for figures 2a-c.**

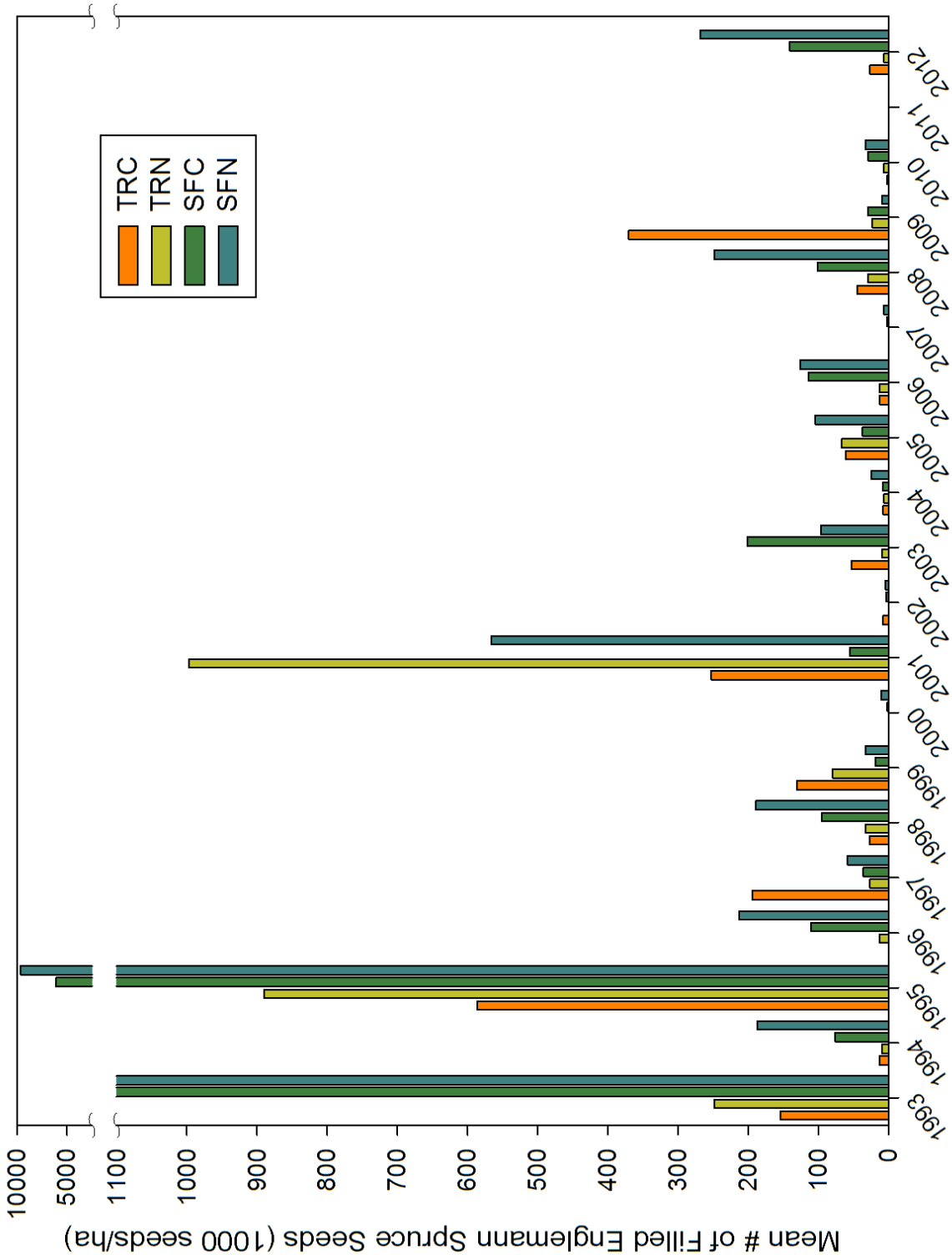


Figure 3. Mushroom crops by habitat, 1994 - 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

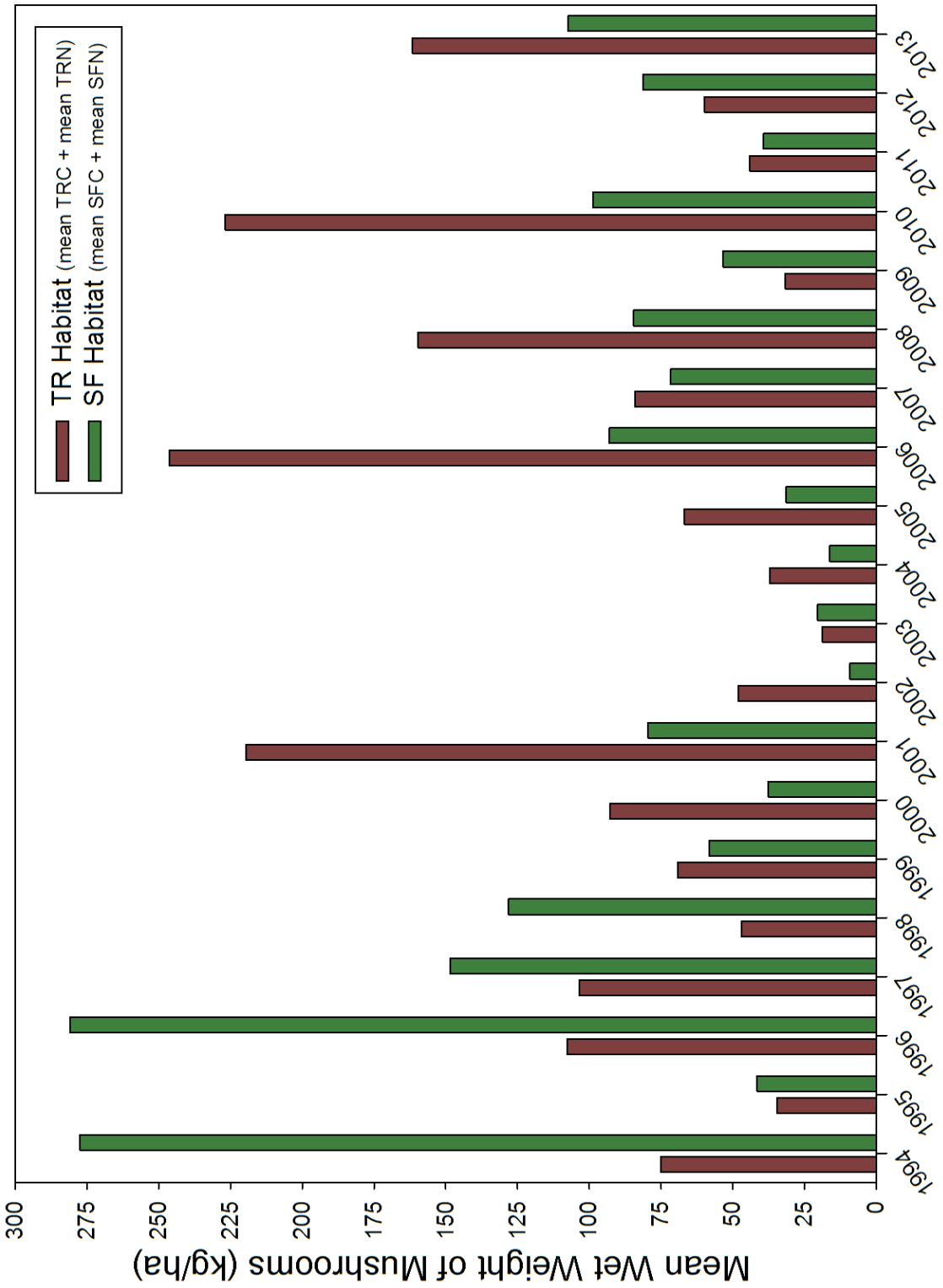


Figure 4. Quarterly Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles), March 2009 - December 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

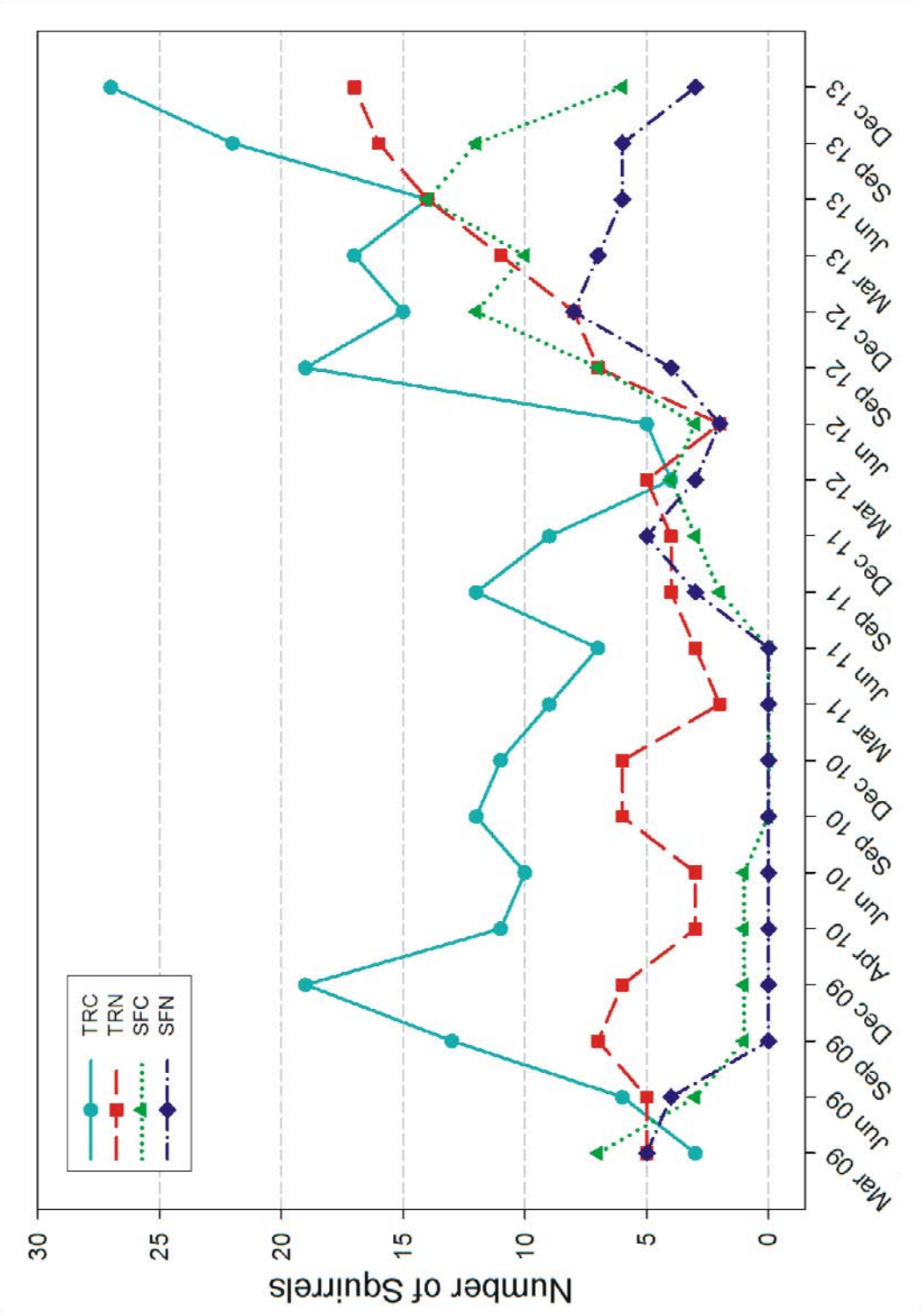
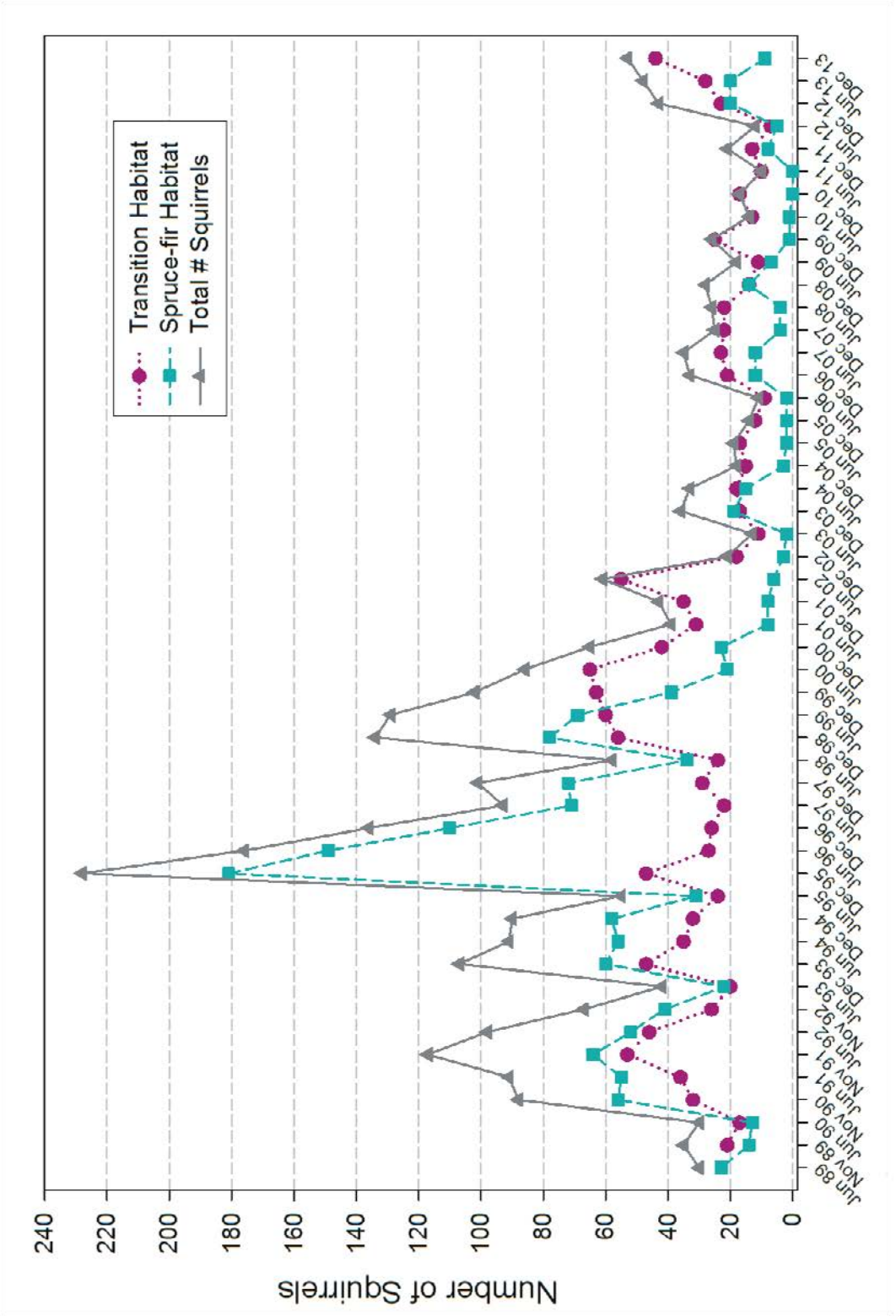


Figure 5. Summer and winter Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles), by habitat, June 1989 - December 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.



Appendix A. Mean number of seeds (filled) for **2012** and mushrooms (wet weight and dry weight) for **2012**, 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	$\bar{x}$ 1000 seeds/ha	$\bar{x}$ 1000 seeds/ha	$\bar{x}$ 1000 seeds/ha	$\bar{x}$ 1000 seeds/ha	$\bar{x}$ ww kg/ha	$\bar{x}$ dw kg/ha
TRC	5	1567.8	2298.5	26.6	3892.9	21.3	2.8
TRN	4	2449.9	466.6	6.6	2923.1	38.4	3.8
SFC	5	2543.8	15.9	141.2	2700.9	59.1	6.2
SFN	6	202.1	228.7	268.8	699.6	22.1	2.3
TR	9	1959.9	1484.3	17.7	3461.9	28.9	3.3
SF	11	1266.5	132.0	210.8	1609.3	38.9	4.1

Appendix B: Midden occupancy records, 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

KEY

For Midden Numbers:

###[89*]	Midden Number['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, subadult 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 the 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), 2013				
Midden	Mar	Jun	Sep	Dec
1102[89]	S	♂	♂	♂
1103[89]	S	N	♂	S
1104[89]	Y	P	S	S
1111[89]	N	N	N	N
1112[89*]	P	P	N	N
1113[89]	N	N	♂	S
1115[89]	N	N	N	N
1116[89]	N	S	N	N
1118[89]	♂ (Wsq/Rsq RC 1036)	♂ (Wsq/Rsq RC 1036)	♂ (Wsq/Rsq RC 1036)	♂ (Wsq/Rsq RC 1036)
1121[89*]	N	Y	N	S
1131[90*]	Y	♀ (Psq/Psq RC 1079)	♀ (Psq/Psq RC 1079)	♀ (Psq/Psq RC 1079)
1134[91*]	reoccupied [1]		S	S
1144[91*]	S	P	P	N
1147[91*]	S	Y	♀	S
1149[91*]	N	N	N	N
1151[91*]	N	N	N	N
1153[92*]	N	N	♀ (W/O RC 1130)	♀ (W/O RC 1130)
1154[92*]	N	N	N	♂ (Y/O 1143)
1156[93*]	S	♂	♂ (Bsq/Ysq RC 1100)	♂ (Bsq/Ysq RC 1100)
1160[96*]	♀ (none/Bsq RC 968)	♂	♂ (O/G 1144)	♂ (O/G 1144)
1162[96*]	N	N	N	N
1163[98*]	♀ (B/Y RC 958)	♀ (B/Y RC 958)	♀ (B/Y RC 958)	♀ (met/Y RC 958)
1164[98*]	♀ (Gsq/Wsq RC 1071)	♀ (Gsq/Wsq RC 1071)	♀ (Gsq/Wsq RC 1071)	♀ (met/Wsq RC 1071)
1167[98*]	♀ (R/B RC 1010)	♀ (R/B RC 1010)	♀ (R/B RC 1010)	♀ (met/B RC 1010)
1168[98*]	N	N	N	N
1169[98*]	N	N	N	N
1170[98*]	♀	♂	Y	♂
1171[98*]	N	N	N	N
1172[90*]	N	P	N	N
1173[99*]	N	N	N	N
1174[99*]	reoccupied [1]			S
1175[99*]	reoccupied [1]		♂	N
1177[99*]	♀ (Osq/Ysq RC 939)	♀ (Osq/Ysq RC 939)	♀ (Osq/Ysq RC 939)	S
1179[99*]	N	N	N	N

Transition Construction Area (TRC), 2013				
Midden	Mar	Jun	Sep	Dec
1180[99*]	N	N	N	N
1182[02*]	N	N	N	N
1183[04*]	N	N	N	N
1184[04*]	N	N	N	S
1185[05*]	N	N	♂	N
1186[05*]	N	N	P	N
1187[05*]	N	N	P	N
1188[10*]	N	N	P	N
1189[10*]	S	N	♀	S
1190[10*]	♀ (Psq/Psq RC 1079)	N	♀ (O/W RC 1096)	♀ (O/W RC 1096)
1191[10*]	N	N	N	N
1192[11*]	P	N	N	N
1193[12*]	S	P	S	S
1194[13*]	new midden		♂	S
1195[13*]	new midden			S
1196[13*]	new midden	Y	P	N
1197[13*]	new midden			S
1198[13*]	new midden			♀
# Mid	44	45	48	52
# Occ	17	14	22	27
% Occ	38.6%	31.1%	45.8%	51.9%
# Sq	17	14	22	27

1 Midden was previously removed from regular censusing due to low occupancy. Was discovered to be reoccupied and is now added back to regular censusing.

Transition Non-Construction Area (TRN), 2013				
Midden	Mar	Jun	Sep	Dec
2202[89]	N	N	N	S
2203[89]	N	N	♀ (Rsq/Rsq 1124)	♀ (Rsq/Rsq 1124)
2204[89]	S	P	P	N
2205[89]	N	N	N	N
2206[89]	S	S	♂ (NAT) 2	♂
2208[89*]	N	N	N	S
2210[90]	N	N	N	N
2211[90*]	♀ (Rsq/Bsq RC 1035)	♀ (Rsq/Bsq RC 1035)	♀ (met/Bsq RC 1035)	♀ (met/Bsq RC 1035)
2215[90*]	N	N	N	N
2216[90*]	S	P	Y	N
2217[90*]	N	N	N	N
2218[91*]	N	♀ + 4J	♀	S
2219[91*]	S	Y	S	N
2223[91*]	N	N	♂	S
2227[95*]	N	N	N	N
2229[96*]	N	N	♂ (NAT) 3	S
2230[96*]	N	N	N	N
2234[97*]	N	N	N	N
2235[98*]	N	N	N	N
2236[98*]	♂	♂	♂ (Bsq/Osq 1122)	♂ (Bsq/Osq 1122)
2237[98*]	N	N	N	N
2238[98]	Y	Y	Y	♀
2239[98]	reoccupied [1]		♀	S
2240[98]	reoccupied [1]		♂	Y
2241[98*]	N	N	N	N
2242[98*]	N	N	N	N
2244[99*]	S	S	♂	S
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*]	S	S	♀	♂
2253 [09*]	Y	♂	S	S
2255 [11*]	N	N	N	N

Transition Non-Construction Area (TRN), 2013				
Midden	Mar	Jun	Sep	Dec
2256 [12*]	♀ (W/Y RC 1006)	♂	♀	♂
2257 [13*]	new midden			S
# Mid	33	33	35	36
# Occ	11	10	16	17
% Occ	33.3%	30.3%	45.7%	47.2%
# Sq	11	10 + 4J	16	17

1 Midden was previously removed from regular censusing due to low occupancy. Was discovered to be reoccupied and is now added back to regular censusing.

2 Male at midden 2206 has a natural mark: rip in left ear.

3 Male at midden 2229 has a natural mark: part of tail missing.

Spruce-Fir Construction Area (SFC), 2013				
Midden	Mar	Jun	Sep	Dec
3002[95*]	Y	♂	♀	S
3020[96*]	S	♀	P	P
3022[96*]	N	♀	Y	N
3028[99*]	N	♀	N	N
3033[12*]	N	N	N	N
3034[12*]	♀	♀	♀	S
3035[13*]	Y	S	Y	N
3036[13*]	S	♀	S	S
3303[94*]	N	N	N	N
3310[95*]	♀	♂	S	♂
3311[95*]	Y	♀	♀	N
3312[95*]	N	N	N	P
3314[95*]	N	N	N	N
3323[95*]	N	♀	S	P
3328[95*]	N	N	N	N
3330[95*]	N	N	N	N
3341[95*]	N	N	N	N
3346[95*]	Y	♀	S	S
3348[95*]	N	♀	Y	N
3360[86]	N	P	N	N
3362[86]	Y	N	N	N
3365[86]	N	N	N	N
3366[86]	S	Y	♂	N
3370[86]	N	N	N	N
3371[87]	N	N	N	N
3372[89]	N	N	N	N
3374[89]	N	N	N	P
3378[90*]	P	♀	Y	S
3382[91*]	N	N	N	N
3394[93*]	N	N	N	N
# Mid	30	30	30	30
# Occ	10	14	12	6
% Occ	33.3%	46.7%	40.0%	20.0%
# Sq	10	14	12	6

Spruce-Fir Non Construction Area (SFN), 2013				
Midden	Mar	Jun	Sep	Dec
4000[95*]	Y	N	N	N
4010[95*]	N	N	N	N
4026[09*]	P	N	P	N
4027[12*]	Y	Y	S	N
4400[89]	N	N	N	N
4417[95*]	N	N	N	N
4465[90*]	Y	Y	Y	N
4466[87]	P	N	N	N
4467[87]	N	♂	S	S
4469[87]	Y	♂	♂	N
4470[87]	N	N	N	N
4471[87]	S	Y	Y	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]	Y	P	Y	♀
4488[91*]	P	N	N	N
4491[91*]	Y	Y	N	S
# Mid	19	19	19	19
# Occ	7	6	6	3
% Occ	36.8%	31.6%	31.6%	15.8%
# Sq	7	6	6	3

Off-Area Midden Occupancy, 2013				
Midden	Mar	Jun	Sep	Dec
TRC Area				
5101[89]	Y	♂	S	S
5102[98*]	Y	♂	S	♀
5103[99*]	N	N	N	P
5104[99*]	N	N	N	N
5105[02*]	N	N	N	N
5106[02]	N	N	S	N
5107[02]	N	N	N	P
5118[94*]	N	N	N	N
5119[89*]	♂ (Wsq/Ysq RC 1081)	♂ (Wsq/Ysq RC 1081)	S	S
5121[89*]	N	N	♀	S
5125[89*]	N	N	N	N
5126[91]	N	N	N	N
5145[91*]	N	N	N	N
5150[91*]	♀ (G/Y RC 948) + ♀ (Wsq/Ysq RC 1092) 2	♀ (G/Y RC 948) 2	♂ (O/O RC 1129)	N
5155[93*]	Y	♀ (Bsq/Rsq 1075)	♀ (Bsq/Rsq 1075)	♀ (Bsq/Rsq 1075)
5157[93*]	P	P	S	♂
5159[12]	♂ (met/Y RC 964)	♂ (met/Y RC 964)	♂ (met/Y RC 964)	♂ (met/Y RC 964)
TRN Area				
5200[93*]	S	S	♂	S
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]	Y	P	N	N
5361[96*]	N	N	N	N
5377[87]	reoccupied [1]		S	N
SFN Area				
5405[87]	N	N	N	N
5413[95*]	N	N	N	N

Appendix B - Off-Area (cont.)

1 Midden was previously removed from regular censusing due to low occupancy. Was discovered to be reoccupied and is now added back to regular censusing.

2 Adult ♀948 and sub-adult ♀1092 (daughter of ♀948 in 2012), were living together in midden 5150. They were observed several times together and co-nested together regularly. The collar of ♀1092 was found on 6 June 2013, but no remains or other signs of predation were located. She was not seen thereafter and her fate is unknown.

Appendix C. Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles at maternal middens), March 2009 - December 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Date	TRC	TRN	SFC	SFN	TOTAL
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 + 7 Juv	4 + 2 Juv	0	0	9 + 9 Juv
Dec 2010	11	6	0	0	17
Mar 2011	9	2	0	0	11
Jun 2011	7	3	0	0	10
Sep 2011	9 + 3 Juv	4	2	3	18 + 3 Juv
Dec 2011	9	4	3	5	21
Mar 2012	4	5	4	3	16
Jun 2012	5	2	3	2	12
Sep 2012	11 + 8 Juv	7	3 + 4 Juv	4	25 + 12 Juv
Dec 2012	15	8	12	8	43
Mar 2013	17	11	10	7	45
Jun 2013	14	10 + 4 Juv	14	6	44 + 4 Juv
Sep 2013	22	16	12	6	56
Dec 2013	27	17	6	3	53

Appendix D: Quarterly occupancy maps for Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), March, June, September, and December 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

(12 maps removed)

Appendix E: Reproductive success of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2013 on or near [1] 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.

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1 Reproductive success notes for squirrels at middens ≥ 100 m 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 - 2013

Descriptions of mating chases observed in 2013, Pinaleño Mountains, Graham County, Arizona. There were no breeding chases observed on the University of Arizona Red Squirrel Monitoring Program study areas in 2013, however information on breeding chases in other areas of the Pinaleño Mountains is included here to provide a general time frame for red squirrel breeding activity.

Date	Location	Notes
10 Mar 2013	midden 8022 shift	At about 1700h, marked adult males 1093, 1074, 1048, and 1008 were seen chasing each other and resident female 1037.
4 Apr 2013	midden WP82 shift	At about 1500h, 5 to 6 unmarked males were seen chasing each other and an unmarked female resident.
3 May 2013	midden 8610	At about 1100h, resident marked female 1002 present, with 3 unmarked males nearby, mostly chasing each other.
13 May 2013	midden 8051 shift	At about 1700h, an unmarked female, marked male 1041, an unidentified marked male (metal/metal ear tags only), and at least 1 more unmarked male all engaged in chases, with occasional buzz calls heard.
16 May 2013	midden 8622	At about 1530h, resident unmarked estrus female present, with at least 5 unmarked males in midden area, chasing and buzz calling.

Appendix E-2: Litters observed in 2013 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 Appendix C).

Mother ID	Midden/Nest	Date Litter 1st Seen	Juvenile ID	Notes
898	18302	6 Jun 13	♀1134 RC [1]	no visual or signal detection after early Dec 2013, fate is unknown
			♀1135 RC	radio signaling from nest Oct 13, no visual after fate is unknown
			♂1136 RC	dispersed, known alive Dec 13
			♀1137 RC	dispersed, known alive Dec 13.
939	1177sh/11042	5 Aug 13	♀1133 RC	Dispersed nearby, was observed with symptoms of serious illness. On authority of USFWS, animal was removed alive from mountain and transferred to USFWS official.
			♂? unmk	possibly dispersed to new nearby midden, but uncertain.

Mother ID	Midden/Nest	Date Litter 1st Seen	Juvenile ID	Notes
948	5150 area	9 Jul 13	♀1099 RC	confirmed mortality, depredation - 29 Jul 13.
			♂1129 RC	confirmed mortality, depredation - 15 Oct 13.
958	1190/11192	29 Jun 13	♂1095 RC	animal observed with disease symptoms, removed radio collar as per instructions of USFWS. Animal was not seen after 15 Sep 13.
			♂1096 RC	settled in natal midden, known alive Dec 13.
			♀1097 RC	confirmed mortality, depredation - 27 Jul 13.
			♀1098 RC	confirmed mortality, depredation - 24 Jul 13.
960	8060	28 Jun 13	♀ unmk	unmarked older juvenile was observed nest building near midden 8060 and vocalizing with ♀960. An unmarked older juvenile was also observed entering a nest with ♀960.
1010	1167 shift	20 Jun 13	♀1101 RC	confirmed mortality, depredation - 27 Jul 13.
			♀1102 RC	No visual or signal detection after 22 Jul 13, fate unknown
			♀1130 RC	dispersed, known alive Dec 13.
			♂unmk	observed playing with ♀1130, fate unknown
1035	2211	18 Jun 13	♀1123	ear tags only, animal killed by car 14 Jul 13.
			♀1124 RC	dispersed, known alive Dec 13.
			♂unmk	fate unknown
1037	8022shift	10 Jun 13	♂1106 RC	collar only found on 9 Aug 13, fate unknown.
			♀1108 RC	no visual or signal detection after 6 Aug 13, fate unknown
			♀1109 RC	collar signaling from nest after 23 Jul 13, no visual, fate unknown
			1 unmk	fate unknown
1043	8615 (BC road)	13 Aug 13	3 unmk	fates unknown
1051	8043 shift	9 Aug 13	♀1140 RC	no visual or signal detection after 9 Sep 13, fate unknown
			2 unmk	fates unknown
1105	8048	9 Aug 13	2 unmk	fates unknown
♀unmk	2218	6 Jun 13	4 unmk	fates unknown

1 RC indicates the juvenile was fitted with a small radio collar to allow collection of dispersal information. See methods section for details on collar.

Appendix F. Weather information, January - December 2013, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

F-1: Monthly weather summaries*

F-2: Accumulated snow depths

*Due to various hardware and software problems, data is missing for the following periods in 2013:
7 May - 11 May
16 Sep - 11 Oct
Dec 16 - Dec 31

Appendix F-1: Monthly weather summaries - 2013, Biology Camp

Biology Camp Weather Summary

Date: Jan 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-20.800	702.600	22.000	-28.700	0.000	0.000	-23.200	0.000
Avg	-3.056	713.895	67.117	-9.191	0.390	0.730	-3.456	
Max	7.100	721.800	100.000	4.700	1.800	3.220	7.100	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: West South West

Date: Feb 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-15.400	697.600	16.000	-21.600	0.000	0.000	-18.200	0.000
Avg	-3.964	710.797	63.084	-11.259	0.160	0.298	-4.142	
Max	8.800	721.800	100.000	1.500	1.800	3.220	8.800	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Mar 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-9.100	705.100	21.000	-20.400	0.000	0.000	-11.600	0.000
Avg	2.562	715.202	51.253	-7.278	0.265	1.002	2.417	
Max	13.400	723.300	100.000	-1.300	2.200	8.050	13.400	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Apr 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-9.000	698.400	18.000	-23.200	0.000	0.000	-9.600	0.000
Avg	4.274	713.785	48.039	-6.882	0.301	1.136	4.112	
Max	16.800	720.900	100.000	1.100	2.700	9.660	16.800	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: West

Appendix F-1 (cont.):

Biology Camp Weather Summary

Date: May 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-0.800	711.500	19.000	-16.500	0.000	0.000	-0.800	0.000
Avg	9.262	717.619	43.177	-3.609	0.236	0.914	9.253	
Max	19.400	723.000	100.000	7.800	1.300	4.830	19.400	0.600
Total								1.600
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South West

Date: Jun 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	6.800	717.600	16.000	-11.900	0.000	0.000	6.800	0.000
Avg	15.696	721.222	35.883	-0.149	0.120	0.466	15.696	
Max	25.600	726.500	82.000	11.200	1.300	4.830	25.600	0.400
Total								0.600
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Jul 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	7.600	717.500	50.000	6.400	0.000	0.000	7.600	0.000
Avg	13.299	721.664	87.719	11.109	0.092	0.355	13.299	
Max	22.300	725.800	100.000	17.500	1.300	4.830	22.300	22.000
Total								132.200
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Aug 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	6.800	718.100	48.000	3.100	0.000	0.000	6.800	0.000
Avg	12.591	721.274	87.134	10.319	0.043	0.171	12.591	
Max	20.400	723.900	100.000	15.700	0.900	3.220	20.400	10.400
Total								98.600
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Appendix F-1 (cont.):

Biology Camp Weather Summary

Date: Sep 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	6.500	713.100	60.000	5.400	0.000	0.000	6.500	0.000
Avg	11.599	718.388	89.003	9.707	0.037	0.146	11.599	
Max	18.700	722.500	100.000	15.500	0.900	3.220	18.700	4.200
Total								30.800
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

West North West

Date: Oct 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-2.800	708.800	17.000	-21.400	0.000	0.000	-3.400	0.000
Avg	4.912	714.194	51.648	-5.098	0.379	1.426	4.841	
Max	13.300	718.600	100.000	4.500	1.300	4.830	13.300	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: North

Date: Nov 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-8.400	705.300	14.000	-20.000	0.000	0.000	-8.400	0.000
Avg	2.360	713.647	73.106	-3.050	0.410	1.530	2.147	
Max	11.400	721.700	100.000	5.000	3.100	11.270	11.400	2.400
Total								22.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: West

Date: Dec 2013

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-14.500	703.500	17.000	-23.700	0.000	0.000	-16.500	0.000
Avg	-2.147	711.263	67.137	-8.887	0.633	2.346	-2.739	
Max	8.400	718.900	100.000	2.200	1.800	6.440	8.400	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

F-2: ***Accumulated*** snow depths on the monitored areas for Winter 2012- 2013.

Snow Depth Summary

Snow Year Year	*Month*	*Habitat*	*Location*	*Avg Depth (cm)*	*Min Depth (cm)*	*Max Depth (cm)*	*Avg. % Cover*	*# of Readings for Avg.*
2012-2013								
2012	Dec	Transition	Clearing	47.6	44	50	100.0	5
2012	Dec	Transition	Forest	51.3	47	58	100.0	3
2013	Jan	Transition	Clearing	53.3	42	65	100.0	9
2013	Jan	Transition	Forest	59.7	46	75	100.0	6
2013	Feb	Transition	Clearing	59.3	42	83	100.0	8
2013	Feb	Transition	Forest	56.7	33	87	96.4	7
2013	Mar	Spruce-fir	Clearing	78.0	61	95	100.0	2
2013	Mar	Spruce-fir	Forest	58.3	42	68	100.0	3
2013	Mar	Transition	Clearing	51.1	0	88	87.0	10
2013	Mar	Transition	Forest	48.5	0	87	98.3	6
2013	Apr	Transition	Clearing	0.0	0	0	3.3	3
2013	Apr	Transition	Forest	0.0	0	0	0.0	2
		Averages for Snow Year		47.0	29.8	63.0	82.1	***Sum # Readings***
			Std Dev	23.34				64
			SE of Mean	2.92				