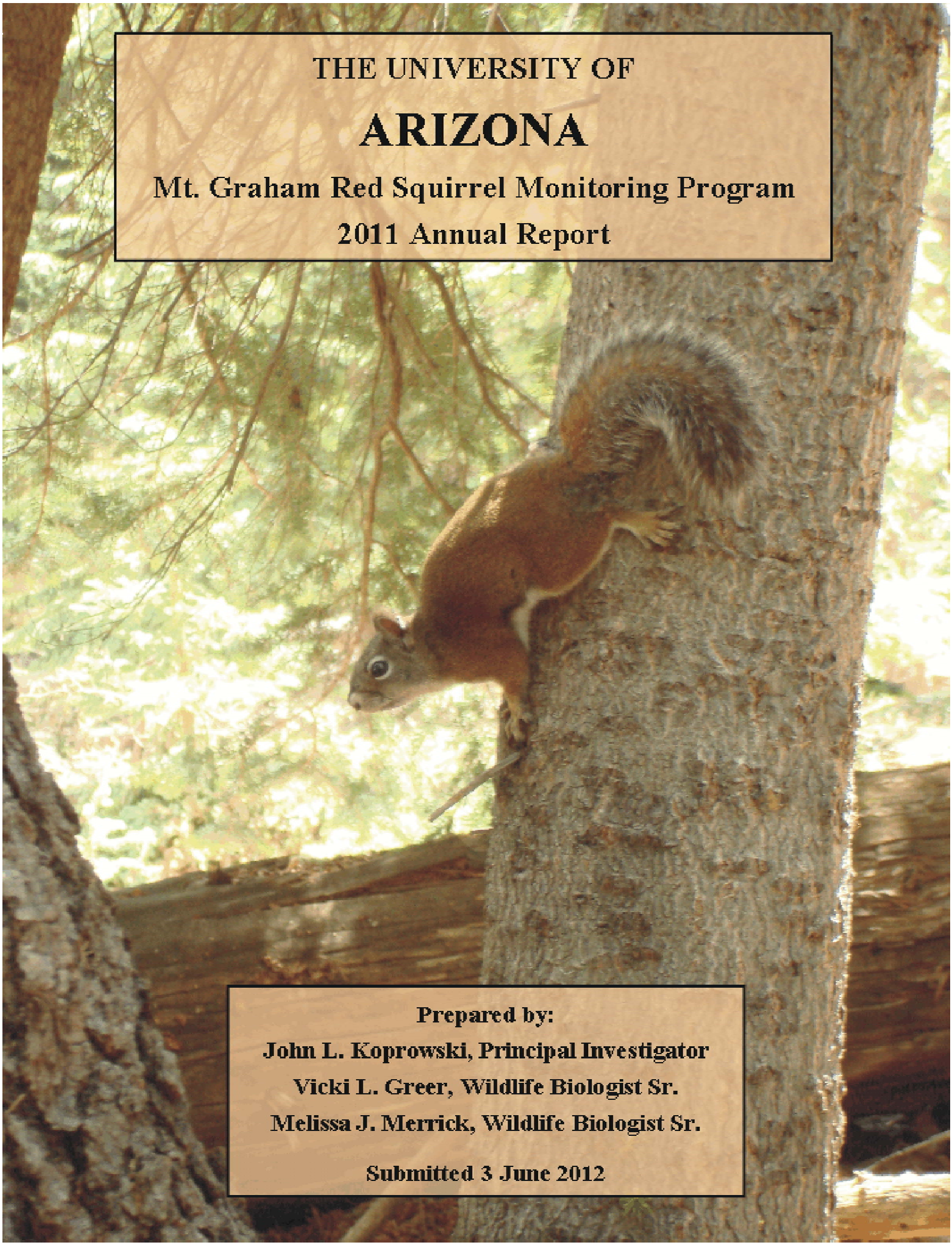

THE UNIVERSITY OF

ARIZONA

Mt. Graham Red Squirrel Monitoring Program

2011 Annual Report

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EXECUTIVE SUMMARY

In 2011, 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 March, June, September, and December 2011.

Overall annual mean mushroom production in 2011 was nearly 4 times smaller than in 2010, ranked 14th highest crop of 18 years since data collection began in 1994. Seed production for 2010 (1 year delay in reporting due to methodology), was just over 2 times smaller than in 2009, and the 2010 seed crop ranked 10th out of 18 years since data collection began in 1993.

Overwinter survival, calculated as animals surviving from December 2010 to June 2011, was 56% TR habitat (9 of 16 squirrels) and in SF habitat, there were no middens occupied in December of 2010. Of the 12 marked squirrels in December 2010 on the monitored areas, by June 2011, 6 were alive, 2 were confirmed mortalities (likely avian predation), and 4 had disappeared, fate unknown. Eleven litters were confirmed on or near the monitored areas in 2011. From these 11 litters, 25 juveniles were known to emerge from natal nests.

Squirrel populations in December 2011 (21 Adults/Subadults) were higher than the previous December (17 Ad/SA). The 2011 squirrel populations in TR habitat remained fairly steady throughout the year (~9-12 squirrels). In SF habitat, there were no squirrels detected in the March and June censuses, but by December, there were 8 squirrels living in the upper elevation study areas.

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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 2011, 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 2011 were mainly interior instrument installation. Herein, we report on the monitoring efforts from 1 January to 31 December 2011.

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 2010 crop were collected from the seed traps in June 2011 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 early October 2011. 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 March, June, September, and December 2011, 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 2011, 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 2010, the number of occupied middens and the identity of resident squirrels were determined. December 2010 occupancy was compared to occupancy for June 2011. 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 2011, 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 (SP690895), 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

2010 Conifer Seed Production

Data collection for seed crops began in 1993. If years are ranked from highest (1) and lowest (18), the total 2010 seed crop ranked 10 of 18. Douglas-fir was the most abundant (in numbers) seed in 2010, the sixth highest crop seen since 1993. The corkbark fir crop ranked 10 of 18, while the Engelmann spruce crop (14 of 18) was one of the lower crops seen since 1993. The 2010 overall average seed crop was 564.1 (1000seeds/ha), just over two times smaller than the seed crop in 2009, 1267.5 (1000seeds/ha); (Table 3, Figures 2a-c, Appendix A).

***2011** Mushroom Production*

Overall annual mean mushroom production in 2011 ($\bar{x}$ Kg/ha wet weight = 83.16) was nearly 4 times smaller than in 2010 ($\bar{x}$ Kg/ha wet weight = 325.50) , and ranked 14th lowest of 18 years since data collection began in 1994. Production decreased in both TR and SF habitats in 2011 as compared to 2010 (Figure 3). In 2011, mushroom production ($\bar{x}$ wet weight) did not differ among the four study areas (Table 4). On TRC, three genera, *Auricularia, Russula,* and *Cortinarius* accounted for 67% of production. On TRN, *Russula, Cortinarius,* and *Clitocybe,* and accounted for 84% of total production. *Clitocybe, Amanita,* and *Russula* accounted for 85% of the production on SFC. On SFN, *Cortinarius, Amanita,* and *Russula* accounted for 68% 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 made in 2011 (Appendix B). From December 2010 to December 2011, the number of red squirrels increased, from 17 to 21. On TRC, the highest number of squirrels (9Ad + 3J) was in September 2011, and the lowest number was 7 Ad in June. The highest numbers on TRN were in September (4Ad) and December (4 Ad/SA) and the lowest was 2 Ad in March. The highest number of squirrels on SFC was in December (3 Ad/SA) with no squirrels in March and June. On SFN, the highest number (5 Ad/SA) was in December with no squirrels in March and June (Figure 4, Appendix B, C, D). The 2011 squirrel populations in TR habitat remained fairly steady (~9-12 squirrels) throughout the year, while there were ~3-5 occupied middens in SF habitat in fall/winter 2011, where there were no occupied middens earlier in the year (Figure 5, Appendix C).

In 2011, 2 new middens were located in TR habitat (Appendix B). In June and December of 2011, 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 2010-2011 did not differ among areas (Table 7); survival was 56% (9 of 16 squirrels) in TR habitat and there were no middens occupied in winter 2010-2011 in SF habitat. For comparison, survival from the previous winter (2009-2010) was 16% (4 of 25 squirrels) in TR habitat and 100% (1 of 1 squirrels) in SF habitat. Of the 12 marked squirrels on the monitored areas in December 2010, by June 2011, 6 were alive, 2 were confirmed mortalities (likely avian predation), and 4 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. 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 2011, three breeding chases involving squirrels resident on or near the monitored areas were observed, in early to late March (Appendix E-1). Based on information from census and trapping records, most resident adult males were scrotal from February through early June.

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 2 June and the latest was on 4 August. Direct evidence of 11 litters (25 juveniles) was seen on or near the areas during censuses or other activities. Litters were confirmed from early June through early September (Appendix E-2).

Trapping and Marking

By the end of 2011, 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 2011, 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 2011 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 25.9°C in June and the minimum temperature recorded was -17.9°C in December. The maximum average monthly temperature was 14.3°C in June and the minimum average monthly temperature was -4.9°C in December (Appendix F-1). The maximum total monthly rainfall was recorded in August, at 76.8 mm and no rain was recorded (during snow free months) in April and May (Appendix F-1). Snow depth was recorded from nine pairs of snow poles. The average accumulated snow depth from January - March 2011 ranged from 18.0 cm to 59.0 cm (Appendix F-2). For comparison, average accumulated snow depths for the previous winter (December 2009 - May 2010), ranged from 21.7 cm to 222.0 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* and *Dendroctonus rufipennis*) in Graham County was very low in 2011. Spruce aphid (*Elatobium abietinum*) defoliations were observed, but limited to small areas. 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://www.foresthealth.info/portal/

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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, 2010, 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	45.2	34.0	85.3	64.1	2.6	2.0
TRN	4	26.5	16.3	129.9	79.7	6.6	4.0
SFC	5	90.6	69.4	10.6	8.2	29.3	22.4
SFN	6	17.7	12.8	86.6	63.0	33.3	24.2
TR Habitat	9	36.9	25.2	105.1	71.8	4.4	3.0
SF Habitat	11	50.8	37.8	52.1	38.7	31.5	23.4

Table 4. Mean annual mushroom production, 2011, 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	14.1 ± 2.8	1.5 ± 0.3
TRN	4	29.9 ± 6.8	3.3 ± 0.3
SFC	5	19.7 ± 5.1	2.5 ± 0.8
SFN	6	19.5 ± 5.0	2.0 ± 0.5
TR Habitat	9	21.1 ± 4.2	2.3 ± 0.5
SF Habitat	11	19.6 ± 3.4	2.2 ± 0.4

ANOVA (among all 4 areas) - wet weight

F = 1.52 df = 3 P = 0.25

ANOVA (among all 4 areas) - dry weight

F = 1.58 df = 3 P = 0.23

Table 5. Mean annual mushroom production (wet weight Kg/ha), 2011, 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	0.64	4.5	0.00	0.0	4.85	24.7	3.65	18.7
Auricularia	3.63	25.7	0.43	1.4	0.00	0.0	0.00	0.0
Boletus	0.00	0.0	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	1.89	13.4	6.25	20.9	8.19	41.6	2.15	11.0
Cortinarius	2.38	16.8	9.00	30.1	0.62	3.2	6.25	32.0
Gastroid sp.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Hydnum	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Lactarius	1.41	10.0	0.65	2.2	1.15	5.8	3.31	17.0
Leccinum	0.36	2.6	0.00	0.0	0.00	0.0	0.80	4.1
Lycoperdon	0.40	2.9	0.57	1.9	1.18	6.0	0.62	3.2
Pholiota	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Ramaria	0.00	0.0	2.20	1.5	0.00	0.0	0.00	0.0
Russula	3.40	24.1	9.85	33.0	3.67	18.7	2.00	10.1
Suillus	0.00	0.0	0.88	2.9	0.00	0.0	0.76	3.9
Total	14.12		29.86		19.66		19.52	

Table 6. Number and percent of available middens occupied by Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2011, 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	43	7	16.3	44	9	20.5
TRN	32	3	9.4	33	4	12.1
SFC	24	0	0.0	24	3	12.5
SFN	16	0	0.0	16	5	31.3
TR Habitat	75	10	13.3	77	13	16.9
SF Habitat	40	0	0.0	40	8	20.0
TR + SF	115	10	8.7	117	21	17.9

Chi Square:

JUNE

within TR	$\chi^2 = 0.73$	df = 1	P = 0.391
within SF			---

DECEMBER

within TR	$\chi^2 = 2.12$	df = 1	P = 0.146
within SF	$\chi^2 = 1.02$	df = 1	P = 0.312

Table 7. Overwinter survival of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2010 - 2011, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

	Number of Squirrels	Number of Squirrels Surviving	
Area/Habitat	Dec 2010[1]	Jun 2011	% survival
TRC	11	7	64.0
TRN	5	2	40.0
SFC	0	0	--
SFN	0	0	--
TR Habitat	16	9	56.3
SF Habitat	0	0	--

Fisher's Exact Test*	
within TR*	P = 0.596
within SF	---
between habitats	---

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

[1] Of the 16 animals resident on the areas in Dec 2010, 12 were ear-tagged and/or radio collared thus enabling unique identification. By Jun 2011, 6 of these animals were alive, 2 were confirmed dead (likely avian predation) and 4 had disappeared, fate unknown. The large proportion of marked animals in the population increases the accuracy of survival calculations.

(Pg 19: Figure 1. map removed)

Figure 2a. Corkbark fir (*Abies lasiocarpa* var. *arizonica*) seed fall, 1993 - 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Note: scales are different for figures 2a-c.

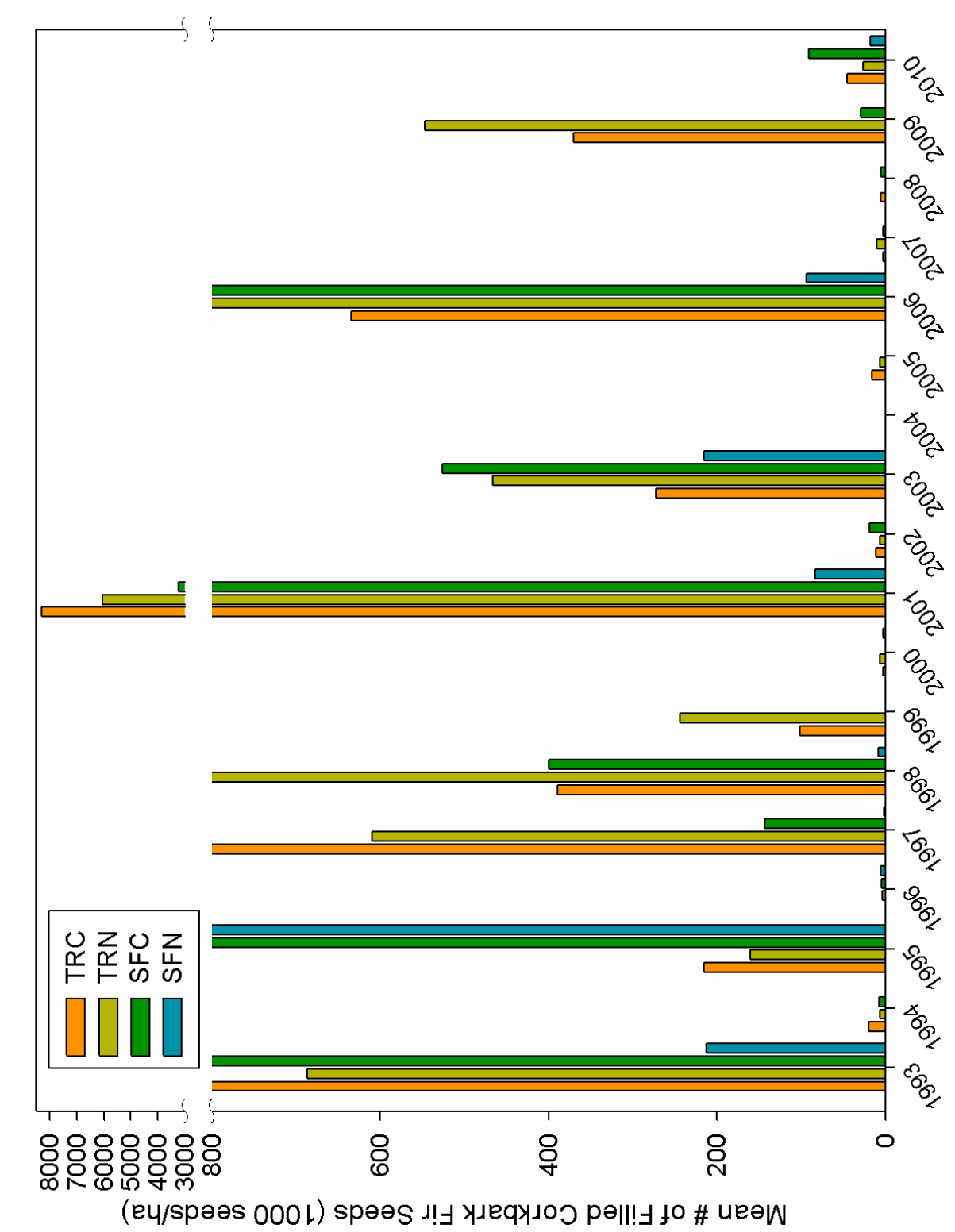


Figure 2b. Douglas-fir (*Pseudotsuga menziesii*) seed fall, 1993 - 2010, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Note: scales are different for figures 2a-c.

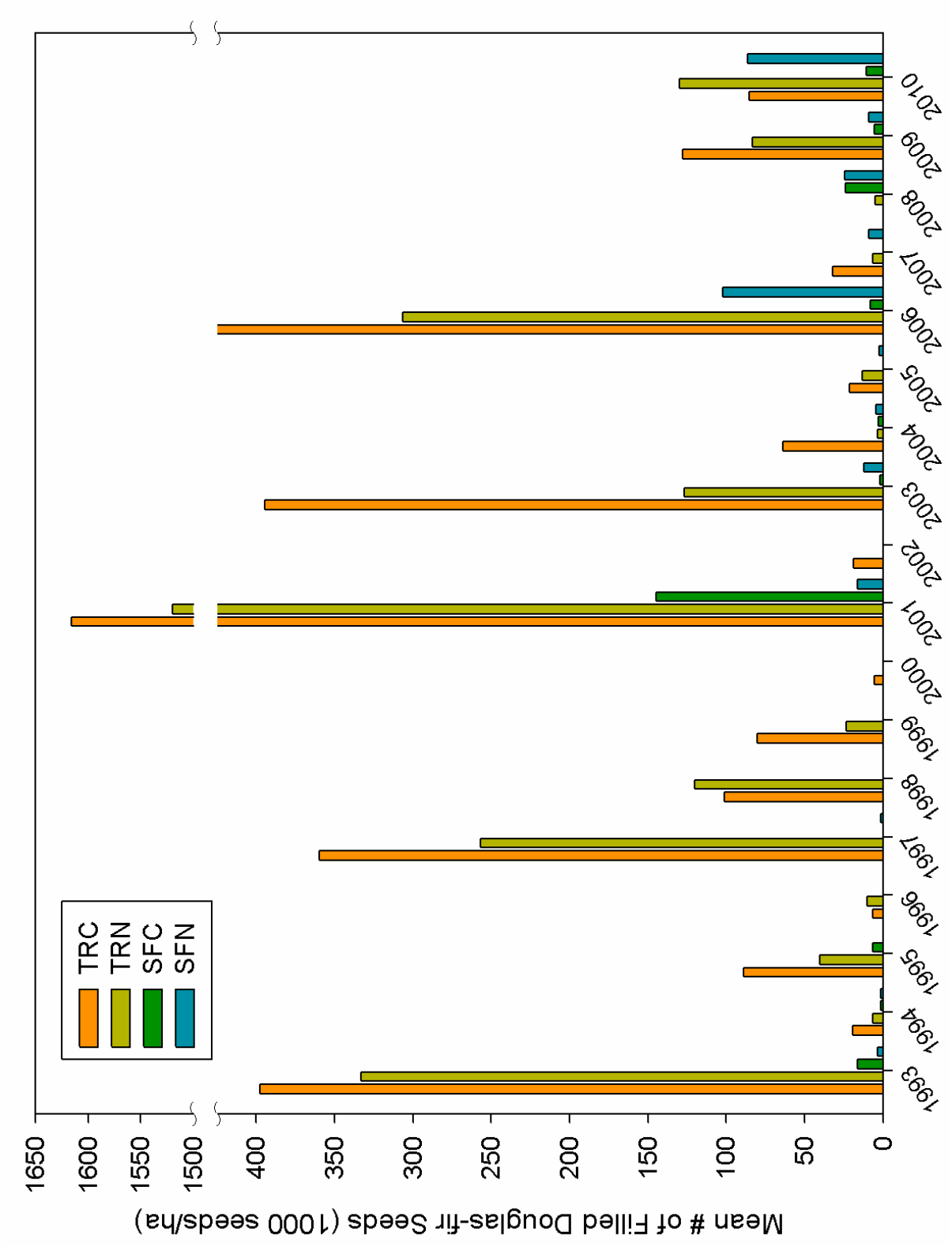


Figure 2c. Engelmann spruce (*Picea engelmannii*) seed fall, 1993 - 2009, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona. Note: scales are different for figures 2a-c.

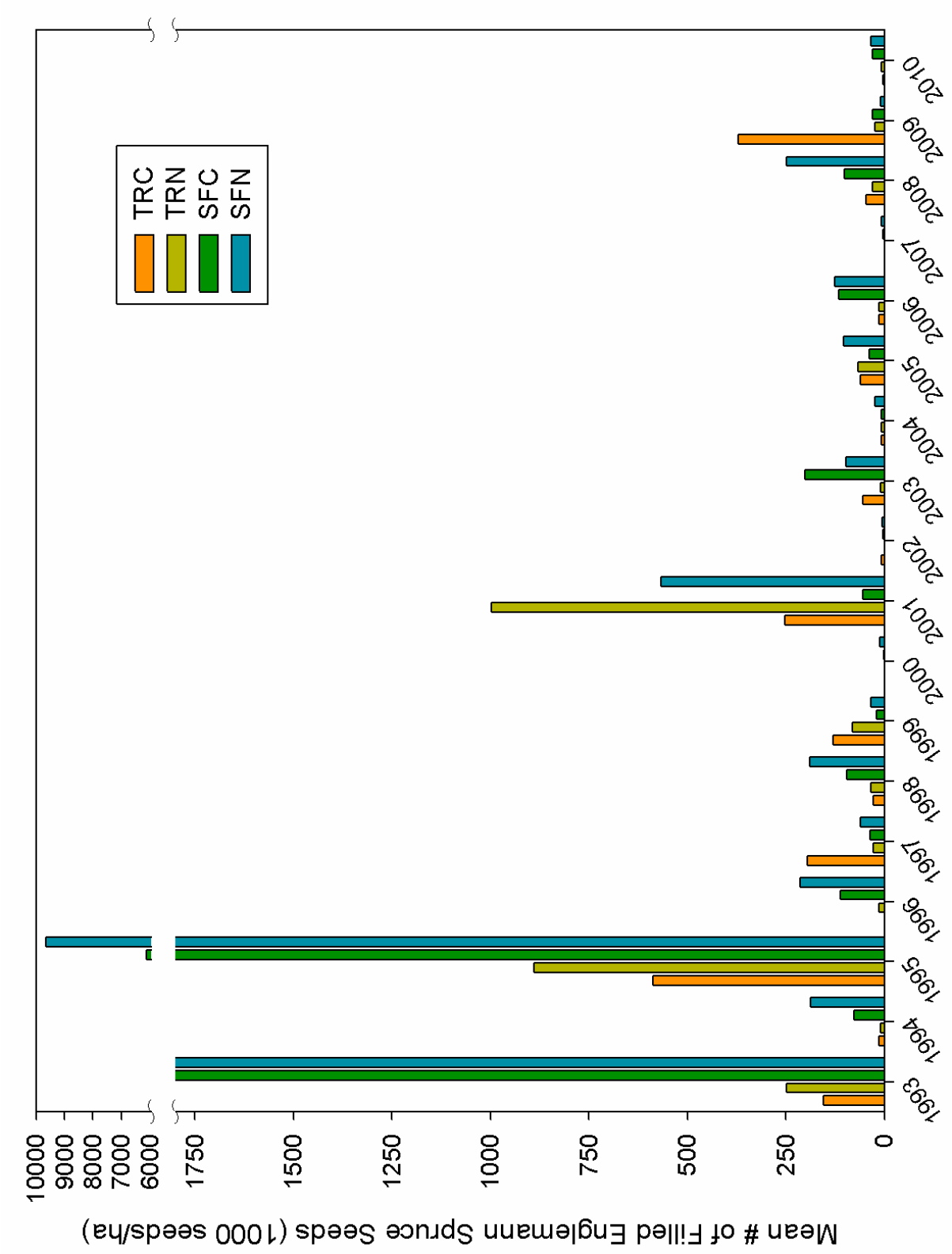


Figure 3. Mushroom crops by habitat, 1994 - 2011, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

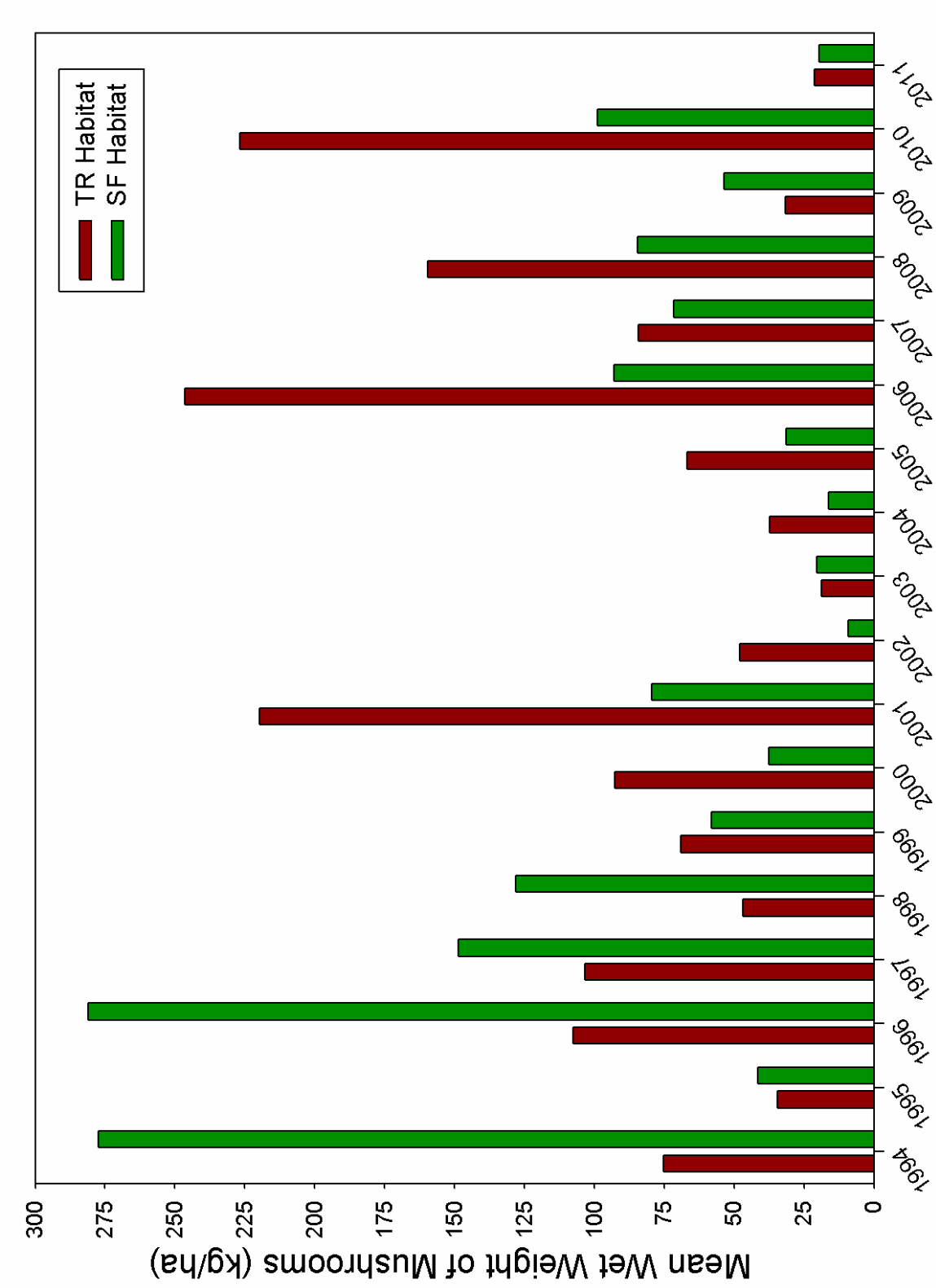


Figure 4. Quarterly Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles), March 2007 - December 2011, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

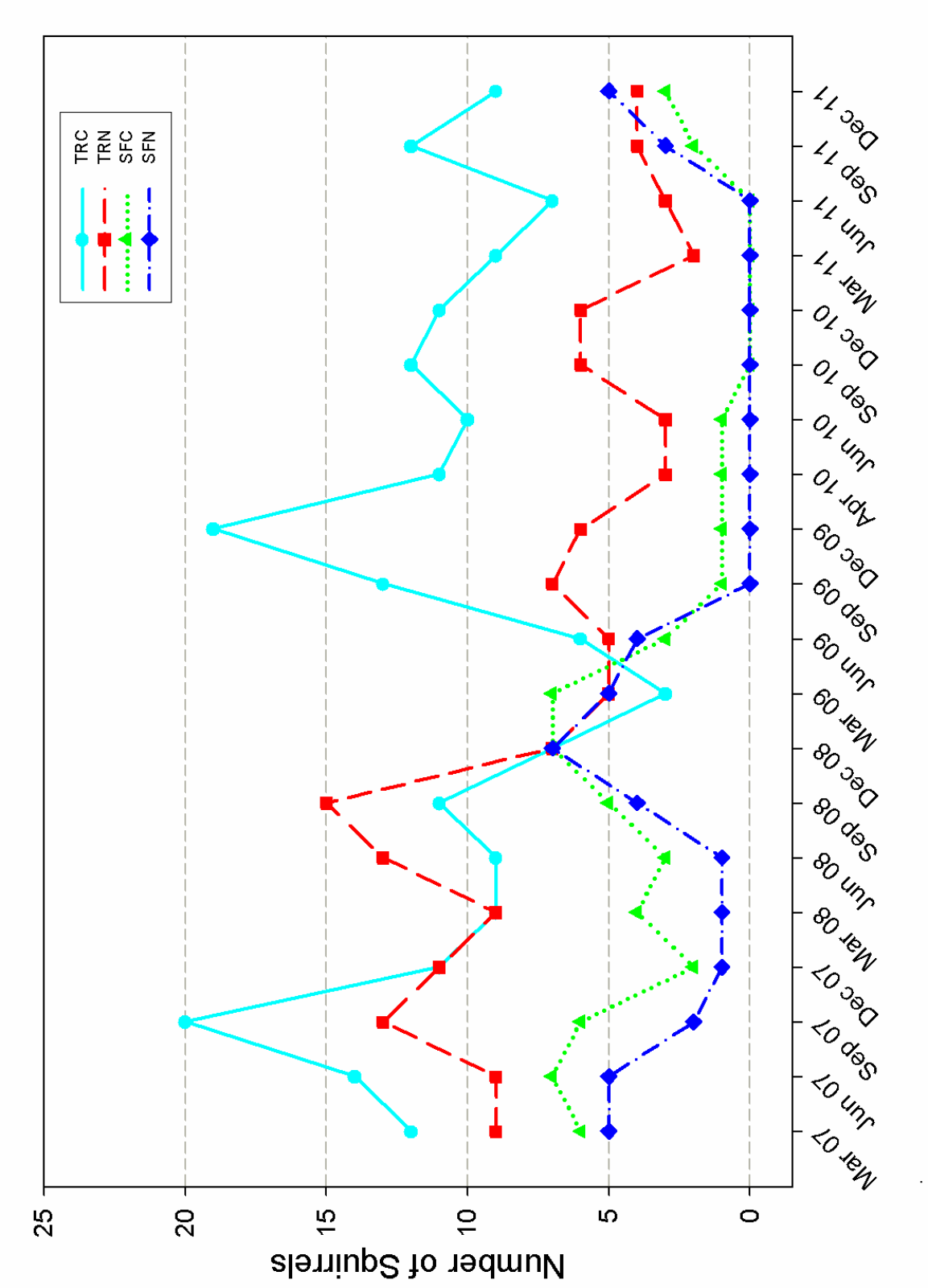
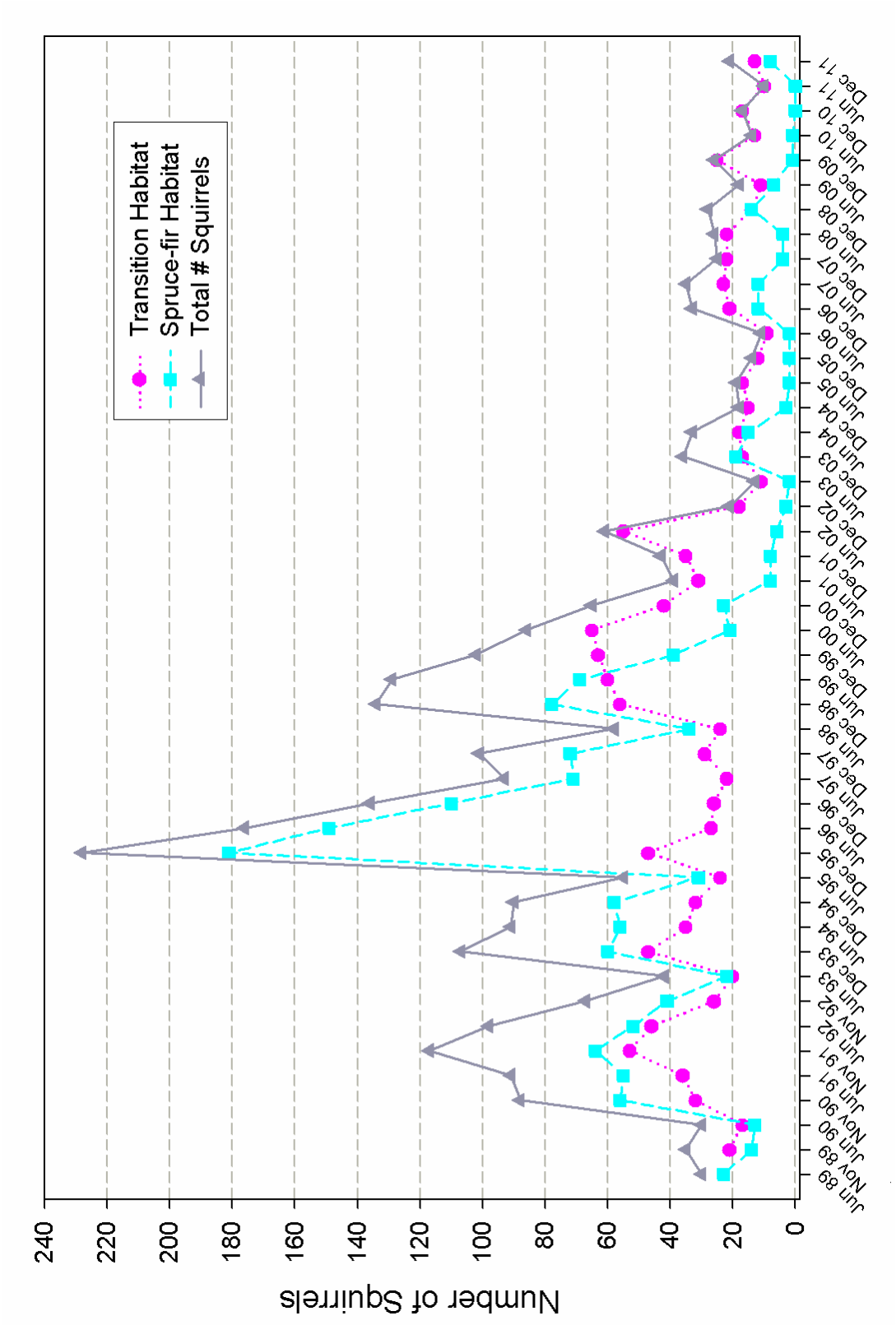


Figure 5. Summer and winter Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles), by habitat, June 1989 - December 2011, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona



Appendix A. Mean number of seeds (filled) for **2011** and mushrooms (wet weight and dry weight) for **2011**, 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	0.0	0.0	0.0	0.0	14.1	1.5
TRN	4	0.0	3.3	0.0	3.3	29.9	3.3
SFC	5	0.0	2.6	0.0	2.6	19.7	2.5
SFN	6	0.0	0.0	0.0	0.0	19.5	2.0
TR	9	0.0	1.5	0.0	1.5	21.1	2.3
SF	11	0.0	1.2	0.0	1.2	19.6	2.2

Appendix B: Midden occupancy records, 2012, 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), 2012				
Midden	Mar	Jun	Sep	Dec
1102[89]	N	♀ (W/Y RC 1006)	S	S
1103[89]	N	N	N	N
1104[89]	N	N	Y	N
1111[89]	N	N	N	N
1112[89*]	N	N	N	N
1113[89]	N	N	N	N
1115[89]	N	N	N	N
1116[89]	N	N	P	P
1118[89]	♀ (B/Y RC 958)	♀ (B/Y RC 958)	♂ (Wsq/Rsq RC 1036)	♂ (Wsq/Rsq RC 1036)
1121[89*]	N	N	N	S
1131[90*]	N	N	N	Y
1144[91*]	N	N	N	N
1147[91*]	N	N	N	Y
1149[91*]	N	♂ (Wsq/Rsq RC 1036)	N	N
1151[91*]	N	N	N	N
1153[92*]	N	N	N	P
1154[92*]	N	N	N	♀ (Bsq/Rsq RC 1075)
1156[93*]	♀ (Osq/Ysq RC 939)	N	N	S
1160[96*]	N	N	P	♀ (none/Bsq RC 968)
1162[96*]	N	N	N	N
1163[98*]	N	N	N	♀ (B/Y RC 958)
1164[98*]	♀ (none/Bsq RC 968)	♀ (none/Bsq RC 968)	♀ (Gsq/Wsq RC 1071)	♀ (Gsq/Wsq RC 1071)
1167[98*]	N	N	♀ (R/B RC 1010)	♀ (R/B RC 1010)
1168[98*]	N	N	N	N
1169[98*]	N	N	N	N
1170[98*]	N	N	S	S
1171[98*]	N	N	Y	P
1172[90*]	N	N	N	N
1173[99*]	N	N	N	N
1177[99*]	N	N	♀ (Osq/Ysq RC 939)	♀ (Osq/Ysq RC 939)
1179[99*]	N	N	N	N
1180[99*]	N	N	N	N
1182[02*]	N	N	P	N
1183[04*]	N	N	N	P

Transition Construction Area (TRC), 2012				
Midden	Mar	Jun	Sep	Dec
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*]	N	N	N	N
1189[10*]	♂	N	Y	S
1190[10*]	N	N	♀ (B/Y RC 958) + 3J [1]	♀ (Psq/Psq RC 1079)
1191[10*]	N	N	♀ (none/Bsq RC 968) + 5J [2]	P
1192[11*]	P	♀ (Osq/Ysq RC 939)	P	N
1193[12*]	new midden			P [3]
# Mid	43	43	43	44
# Occ	4	5	11	15
% Occ	9.3%	11.6%	25.6%	34.1%
# Sq	4	5	11 + 8J	15

1 Two of the three juveniles were trapped and marked: ♀1075, ♀1079

2 Four of the 5 juveniles were trapped and marked: ♂1076, ♀1077, ♂1078, ♀1080

3 This midden was established by SA ♂1076 in early November, with many 100s of cached cones. However, ♂1076 was depredated (likely raptor) on or near 13 Dec 12. It was unclear if the midden had a new resident by the end of the month , so occupancy was designated as possible.

Transition Non-Construction Area (TRN), 2012				
Midden	Mar	Jun	Sep	Dec
2202[89]	N	N	N	N
2203[89]	N	N	N	N
2204[89]	N	N	Y	♂
2205[89]	N	N	N	N
2206[89]	P	P	S	N
2208[89*]	N	N	N	N
2210[90]	N	N	N	N
2211[90*]	Y	♀ (Rsq/Bsq RC 1035)	♀ (Rsq/Bsq RC 1035)	♀ (Rsq/Bsq RC 1035)
2215[90*]	N	N	N	N
2216[90*]	♂ (Ysq/Psq RC 1034)	P	N	S
2217[90*]	N	N	N	N
2218[91*]	N	N	N	N
2219[91*]	N	N	N	S
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*]	N	N	N	N
2235[98*]	N	N	N	N
2236[98*]	♀ (Rsq/Bsq RC 1035)	♂ (Ysq/Psq RC 1034)	N	P
2237[98*]	N	N	N	N
2238[98]	N	N	N	N
2241[98*]	N	N	P	N
2242[98*]	N	N	N	N
2244[99*]	Y	N	Y	♂
2246[99*]	N	N	N	N
2248[99*]	N	N	N	P
2249[99*]	N	N	N	N
2250[00*]	N	N	N	N
2252 [08*]	N	N	S	♀
2253 [09*]	N	N	S	♂
2255 [11*]	♂ (Ysq/Gsq RC 997)	N	N	N
2256 [12*]	new midden		♀ (W/Y RC 1006)	♀ (W/Y RC 1006)
# Mid	32	32	33	33
# Occ	5	2	7	8
% Occ	15.6%	6.3%	21.2%	24.2%
# Sq	5	2	7	8

Appendix B - TRN (cont.)

Spruce-Fir Construction Area (SFC), 2012				
Midden	Mar	Jun	Sep	Dec
3002[95*]	reoccupied [1]			S
3020[96*]	N	P	N	♀
3022[96*]	reoccupied [1]	S	N	Y
3028[99*]	N	N	N	N
3033[12*]	new midden			Y
3034[12*]	new midden			♀
3303[94*]	N	N	N	N
3310[95*]	♂ (Bsq/none RC 934)	S [2]	Y	♂
3311[95*]	N	N	N	S
3312[95*]	N	N	N	N
3314[95*]	N	N	N	N
3323[95*]	Y	N	P	N
3328[95*]	N	N	N	N
3330[95*]	N	N	N	N
3341[95*]	N	N	N	N
3346[95*]	N	N	N	S
3348[95*]	N	N	N	N
3360[86]	N	N	N	♀
3362[86]	N	N	N	N
3365[86]	N	P	Y	Y
3366[86]	Y	N	N	Y
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*]	Y	♀	♀ + 4J	Y
3382[91*]	N	N	N	N
3394[93*]	N	N	N	N
# Mid	24	25	25	28
# Occ	4	3	3	12
% Occ	16.7%	12.0%	12.0%	42.9%
# Sq	4	3	3 + 4J [3]	12

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 934 was last located in early Jun 12 about 250m SE of 3310. No radio signal heard after; fate of squirrel unknown.

3 Three older juveniles were observed about 50m W-SW of the Vatican telescope. No middens in the area were occupied and juveniles were not seen again on subsequent observations. They are not included in the population total for Sep 12.

Spruce-Fir Non Construction Area (SFN), 2012				
Midden	Mar	Jun	Sep	Dec
4000[95*]	N	N	N	N
4010[95*]	N	N	N	N
4026[09*]	P	N	N	Y
4027[12*]	new midden		S	S
4400[89]	N	N	N	P
4417[95*]	N	N	N	N
4465[90*]	N	N	S	P
4466[87]	reoccupied [1]			S
4467[87]	P	Y	S	N
4469[87]	P	N	P	S
4470[87]	N	N	N	N
4471[87]	Y	N	N	S
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	N	♂
4488[91*]	reoccupied [1]			♀
4491[91*]	♀	♂	S	♀
# Mid	16	16	17	19
# Occ	3	2	4	8
% Occ	18.8%	12.5%	23.5%	42.1%
# Sq	3	2	4	8

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.

Off-Area Midden Occupancy, 2012				
Midden	Mar	Jun	Sep	Dec
TRC Area				
5101[89]	♀ (W/Y RC 1006)	P	Y	♂
5102[98*]	N	N	N	P
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	S	N
5119[89*]	N	N	N	♂ (Rsq/Ysq 1084)
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*]	♀ (G/Y RC 948)	♀ (G/Y RC 948)	♀ (G/Y RC 948)	♀ (G/Y RC 948)
5155[93*]	P	♂ (Bsq/Osq RC 976)	N	♂
5157[93*]	♀ (R/B RC 1010)	♀ (R/B RC 1010)	P	S
5159[12]	new midden		♂ (met/Y RC 964)	♂ (met/Y RC 964)
TRN Area				
5200[93*]	Y	♀ (B/P RC 1042)	P	S
5201[99*]	N	N	N	N
5203[00*]	N	N	N	N
5221[91*]	♂ (Y/Y 1038)	♂ (Y/Y 1038)	S	N
5231[96*]	♂ (Psq/Gsq RC 1033)	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	S
5361[96*]	N	N	N	N
SFN Area				
5405[87]	N	N	N	N
5413[95*]	N	N	N	N

Appendix C. Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles at maternal middens), March 2008 - December 2012, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Date	TRC	TRN	SFC	SFN	TOTAL
Mar 2008	9	9	4	1	23
Jun 2008	9	13	3	1	26
Sep 2008	11	8 + 6 Juv	5	4	28 + 6 Juv
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 + 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

Appendix D: Quarterly occupancy maps for Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), March, June, September, and December 2012, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

(pgs 35-46: maps removed)

Appendix E: Reproductive success of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*), 2012, 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 - 2012

Descriptions of mating chases observed in 2012 on or near the University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

Date	Location	Notes
15 May 2012	55 m W of nest 18048	Between 18:00 and 19:30 a breeding chase was observed. At least 4 animals were involved: an unmarked female, unmarked squirrel of unknown sex, marked ♂ 964, and marked ♂ 1031.

Appendix E-2: Litters observed in 2012 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	18351	4 Jul 12	♂1046 RC [1]	Dispersed, known alive in Nov 12. [2]
			♂1047 RC	Dispersed, known alive in Nov 12. [2]
			♂1050 RC	Dispersed, known alive Dec 12.
			♀1052 RC	No visual or signal detection after Aug 12, fate is unknown.
939	1153/11050	18 Jul 12	♂1053 RC	No visual or signal detection after Aug 12, fate is unknown.
			♂1054 RC	Dispersed, known alive in Nov 12. [2]
			♂1055 RC	Dispersed, no visual or signal detection after Sep 12, fate is unknown.
948	5150/15105	2 Nov 12	♂1081 RC	Dispersed, known alive Dec 12.
			♀1082 RC	Dispersed, confirmed mortality (likely raptor), 13 Dec 12.
			1 unmarked	Fate is unknown.
958	11041	8 Sep 12	♀1075 RC	Dispersed, known alive Dec 12.
			♀1079 RC	Dispersed, known alive Dec 12
			1 unmarked	Fate is unknown.
959	18265	2 Jul 12	♀1049 RC	Dispersed, last known alive Nov 12, collar signaling from a nest in Dec 12, fate is unknown.
			♂1067 RC	Dispersed, known alive Dec 12
			♂1074 RC	Dispersed, known alive Dec 12
			1 unmarked	Fate is unknown.

Mother ID	Midden/Nest	Date Litter 1st Seen	Juvenile ID	Notes
959	18265	6 Oct 12	2 unmarked	*Second litter confirmed for F959* (possible 3rd juvenile in litter). Two juveniles were again seen with F959 on 19 Oct 12, their fate after this date is unknown.
968	11207	25 Jun 12	♀1071 RC	Settled near natal area, known alive Dec 12.
			1 unmarked	Fate is unknown.
968	11142	20 Sep 12		*Second litter confirmed for F968.*
			♂1076 RC	Dispersed, confirmed mortality (likely raptor), 13 Dec 12.
			♀1077 RC	No visual after Sep 12, collar signaling from a nest, fate is unknown.
			♂1078 RC	Settled near natal area, known alive Dec 12.
			♀1080 RC	Last seen near natal area in Nov 12, collar stopped signaling, fate is unknown
			1 unmarked	Fate is unknown.
981	18235	26 Jun 12	♂1045 RC	Dispersed, known alive Dec 12.
			♂1048 RC	Dispersed, known alive Dec 12.
			♀1051 RC	Dispersed, known alive Dec 12.
1010	15141	3 Sep 12	3 unmarked	Attempts at trapping this litter (possible 4th juvenile in litter), were unsuccessful.
1035	2211/11213	4 July 12	2 unmarked	Observed 1 juvenile depredated by Cooper's Hawk (*Accipiter cooperii*) on 6 Jul 12. Fate of the second juvenile is unknown.
1037	8022shift	24 Aug 12	♀1072 RC	No visual or signal detection after Aug 12, fate unknown.
			♂1073 RC	Dispersed, collar only (no remains) found 13 Oct 12, fate is 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.

2 These animals dispersed to areas inaccessible after Nov 2012 due to winter snows. In spring 2013, the last known location for these animals will be visited to try and determine their fate.

Appendix F. Weather information, February - December 2012, University of Arizona Red Squirrel Monitoring Program study areas, Pinaleño Mountains, Graham County, Arizona.

F-1: Monthly weather summaries. There is no January 2012 data due to a battery failure on the weather station.

F-2: Accumulated snow depths

Appendix F-1: Monthly weather summaries, Biology Camp

Biology Camp Weather Summary

Date: Feb 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-8.400	704.800	27.000	-19.300	0.000	0.000	-9.600	0.000
Avg	-0.003	712.687	58.000	-7.908	0.541	1.013	-0.310	
Max	7.100	716.300	100.000	-1.400	1.800	3.220	7.100	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: North

Date: Mar 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-11.600	699.800	18.000	-21.300	0.000	0.000	-13.700	0.000
Avg	-0.327	711.972	48.018	-11.586	0.697	1.290	-0.973	
Max	10.700	718.700	98.000	-3.900	2.700	4.830	10.700	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: West

Date: Apr 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	2.000	712.300	17.000	-17.500	0.000	0.000	2.000	0.000
Avg	9.485	717.239	41.003	-3.733	0.412	0.775	9.443	
Max	19.400	721.200	85.000	5.100	1.800	3.220	19.400	0.000
Total								0.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: May 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-0.300	712.400	18.000	-14.300	0.000	0.000	-0.300	0.000
Avg	9.233	716.885	40.322	-4.607	0.358	0.683	9.220	
Max	18.900	721.500	100.000	5.800	1.800	3.220	18.900	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: Jun 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	6.400	715.500	17.000	-11.400	0.000	0.000	6.400	0.000
Avg	15.278	720.213	41.968	1.274	0.274	0.519	15.278	
Max	25.200	725.400	100.000	14.600	1.800	3.220	25.200	1.600
Total								2.600
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Jul 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	6.800	718.000	32.000	0.800	0.000	0.000	6.800	0.000
Avg	12.905	721.258	83.730	9.835	0.248	0.470	12.902	
Max	24.100	724.000	100.000	14.700	1.800	3.220	24.100	6.600
Total								42.800
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Aug 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	7.400	716.700	35.000	3.800	0.000	0.000	7.400	0.000
Avg	13.763	721.043	79.914	9.960	0.092	0.178	13.763	
Max	24.200	725.500	100.000	15.200	1.800	3.220	24.200	3.400
Total								26.000
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Date: Sep 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	3.400	717.400	48.000	-2.200	0.000	0.000	3.400	0.000
Avg	10.649	720.230	92.012	9.236	0.226	0.423	10.645	
Max	21.000	722.600	100.000	15.600	1.300	2.410	21.000	6.200
Total								25.200
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: South East

Appendix F-1 (cont.):

Biology Camp Weather Summary

Date: Oct 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-1.600	712.400	18.000	-18.700	0.000	0.000	-1.600	0.000
Avg	7.316	716.393	51.511	-2.880	0.267	0.505	7.298	
Max	15.300	720.700	100.000	6.500	1.300	2.410	15.300	2.600
Total								3.400
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: North

Date: Nov 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-13.500	704.600	15.000	-20.800	0.000	0.000	-13.500	0.000
Avg	3.839	716.891	56.199	-5.127	0.165	0.313	3.780	
Max	14.100	721.900	100.000	3.500	1.800	3.220	14.100	2.400
Total								8.600
	C	millibars	%	C	meters/sec	meters/sec	C	millimeters

Predominant Wind Direction: North North East

Date: Dec 2012

Recording Interval: 60min

	Outside Temperature	Barometric Pressure	Relative Humidity	Dew Point	Wind Speed	Max Wind Speed	Wind Chill	Rain
Min	-14.400	701.500	17.000	-24.100	0.000	0.000	-15.800	0.000
Avg	-1.590	711.398	60.139	-9.689	0.519	0.965	-2.106	
Max	13.400	721.200	100.000	0.600	2.700	4.830	13.400	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 2011- 2012.

Snow Depth Summary

Snow Year Year	Month	Habitat	Location	Avg Depth (cm)	Min Depth (cm)	Max Depth (cm)	Avg. % Cover	# of Readings for Avg.
2011-2012								
2011	Nov	Spruce-fir	Clearing	17.5	15	20	100.0	2
2011	Nov	Spruce-fir	Forest	5.0	5	5	100.0	1
2011	Nov	Transition	Clearing	9.7	0	20	83.3	6
2011	Nov	Transition	Forest	12.8	5	26	100.0	4
2011	Dec	Spruce-fir	Clearing	44.8	33	51	100.0	4
2011	Dec	Spruce-fir	Forest	35.0	30	45	100.0	4
2011	Dec	Transition	Clearing	52.7	27.5	84	100.0	6
2011	Dec	Transition	Forest	54.0	30	84	100.0	3
2012	Jan	Spruce-fir	Clearing	43.5	0	87	70.0	2
2012	Jan	Spruce-fir	Forest	45.0	35	55	100.0	2
2012	Jan	Transition	Clearing	54.7	30	73	100.0	3
2012	Jan	Transition	Forest	50.5	28	73	100.0	2
2012	Feb	Spruce-fir	Clearing	71.0	0	127	74.8	4
2012	Feb	Spruce-fir	Forest	60.0	34	83	95.0	4
2012	Feb	Transition	Clearing	68.0	27	100	96.8	9
2012	Feb	Transition	Forest	64.2	32	96	100.0	6
2012	Mar	Spruce-fir	Clearing	76.0	0	109	80.0	6
2012	Mar	Spruce-fir	Forest	53.3	14	72	79.2	6
2012	Mar	Transition	Clearing	48.4	0	100	65.7	9
2012	Mar	Transition	Forest	59.6	0	98	78.6	11
2012	Apr	Spruce-fir	Clearing	12.4	0	55	35.6	5
2012	Apr	Spruce-fir	Forest	15.2	0	49	41.0	5
2012	Apr	Transition	Clearing	14.5	0	42	41.3	6
2012	Apr	Transition	Forest	9.3	0	37	32.5	4
		Averages for Snow Year		40.7	14.4	66.3	82.2	Sum # Readings
			Std Dev	22.63				114
			SE of Mean	2.12				