

**THE UNIVERSITY OF
ARIZONA**
MT. GRAHAM RED SQUIRREL MONITORING PROGRAM

2006 Annual Report

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EXECUTIVE SUMMARY

In 2006, 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 Pinaleno Mountains, Graham County, Arizona. A complete census of the study areas was made in March, June, September, and December 2006.

Mushroom production on the monitored areas in 2006 was over three times greater than in 2005, and was the third highest crop since data collection began in 1994. Seed production for 2005 (1 year delay in reporting due to methodology), was nearly three times greater than in 2004, however the 2005 seed crop was the fourth lowest seen since data collection began in 1993.

Overwinter survival, calculated as animals surviving from December 2005 to June 2006, was moderate in TR habitat (50%) and higher in SF habitat (100%). Of the 10 adult females that were known to live on or within 100m of the study areas in 2006, as many as 8 had evidence of producing litters, although only 3 litters were confirmed. From these 3 litters, 9 juveniles were known to emerge from nests and 5 were live-trapped and marked with small metal ear tags for future identification.

Squirrel populations more than doubled on the monitored areas from December 2005 (14 squirrels) to December 2006 (33 squirrels). If the squirrels near the monitored areas (within 100m) are included, a overall increase was still seen from December 2005 (22 squirrels) to December 2003 (44 squirrels).

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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 ($32^{\circ} 42' N$, $109^{\circ} 53' W$). In 2006, 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 2006 were mainly interior building work. Herein, we report on the monitoring efforts from 1 January to 31 December 2006.

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 Supervisor, Dr. John L. Koprowski.

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. These areas are assigned a temporary number and are assessed for improved 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 is compiled. If a midden has been censused for at least three years (12 censuses), including at least one good cone year, and has not been occupied during that time, the midden is removed from the list for regular censusing and are revisited only in December. If any of removed middens become 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 1993 to determine the abundance of major red squirrel food resources: conifer seeds and mushrooms. 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 2005 was estimated from 20 seedfall plots distributed among the monitored areas (Figure 1). Three 0.25 m² seed traps were randomly placed within a 10 m x 10 m plot at each location. Seeds from the 2005 crop were collected from the seed traps in June 2006. Conifer seeds contained in each trap were separated by species and individually tested to determine the proportion of seeds that were likely to be viable. A viable 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 mid-July through early October 2006. In 2006, mushrooms were again collected from north-south oriented plots, instead of east-west as in 2001 and years prior. In 2001, we collected mushrooms from both east-west and north-south plots. We detected no significant differences in weight, number, or diversity of mushrooms between the two orientations; we decided to use north-south plots for 5 years and “rest” the east-west plots. 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 (<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 2006, 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 2006, 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 dependant 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 2005, the number of occupied middens and the identity of resident squirrels were determined. December 2005 occupancy was compared to occupancy for June 2006. 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.

Spatial Distribution

We used three methods to describe spatial distribution of middens and squirrels: crude density, local density, and nearest-neighbor distance. Crude density represents the total number of middens and squirrels per hectare. We made no allowance for differences in habitat quality among monitored areas, and statistical tests are not appropriate.

Local density (LD) is a method of describing local population densities for comparisons among populations in which habitat variables are uncontrolled. For this report, LD is defined as the number of *middens* or *squirrels* within 100 m of a focal *midden* or *squirrel*. Mean LD (\bar{x} LD) of *middens* (all middens, occupied and unoccupied) and *squirrels* (all occupied middens) is compared between areas and habitats. The benefit of using LD is that measurements are not influenced by habitat variables, whereas crude density may include large areas not suitable as squirrel habitat, such as clearings and meadows. The LD method is adapted from distance models of neighborhood modeling used by plant ecologists to describe and compare plant populations (Czárán and Bartha 1992). A circle with a radius of 100 m encloses 3.14 hectares, which is approximately the average home range of Mt. Graham red squirrels (Froehlich 1990) and is also the approximate maximum distance that an observer can recognize and accurately locate a squirrel "chatter" call (P. Young, pers. obs.).

Nearest neighbor distance (NND) is used to describe and compare the spatial distribution of populations and communities of plants and animals (Clark and Evans 1954, Krebs 1989). In this report, NND is the shortest distance (m) from a focal *midden* or *squirrel* to the nearest *midden* or *squirrel*. Mean NND (\bar{x} NND) of middens and squirrels was compared between areas and habitats.

Local density and NND were determined for each midden and squirrel using mapped coordinates and compared among areas and habitats using ANOVA. To determine the LD and NND of some middens and squirrels on the monitored areas, we included off-area middens within 100 m of a focal midden.

Reproductive Activity and Success

In 2006, 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 the reproductive status of a female 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 our Federal Fish and Wildlife Permit, using accepted methods (Koprowski 2002), we trapped red squirrels using Tomahawk wire-mesh box-type live traps, baited with peanuts, peanut butter, apples, mushrooms, or cones. Once captured, we transferred squirrels to a cloth-handling cone for marks and measurements. We tagged squirrels with small numbered metal ear-tags threaded with colored plastic washers and affixed to ears for easy distance identification. We also fitted some adult animals with radio collars. Squirrels were released at the capture site.

Mapping

All middens and other physical features on the monitored areas have been previously mapped using GPS with an accuracy of ± 5 m. Universal Transverse Mercator (UTM) coordinates from GPS files were used to compute local densities and nearest neighbor distances. New GPS data (nests, habitat plots, etc.) were collected using a GeoExplorer II system from Trimble Navigation, Inc. Readings were taken within 5 meters of the location center. Date, time, and location descriptions were noted in the field for later reference. 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 on the SFC; the other was located at the Biology Camp on 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 four 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.

All statistical analyses were conducted using standard tests found in SAS, StatsDirect, or Minitab 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

2005 Conifer Seed Production

The total 2005 seed crop was fourth lowest on the monitored areas since data collection began in 1993. Engelmann spruce was the most abundant seed in 2005. When comparing the 2005 seed crop to all previous years of study for each species, corkbark fir was the fourth lowest reported seed crop, Douglas-fir and Engelmann spruce were the fifth lowest reported seed crop. However, the 2005 overall seed crop was nearly 3 times greater than the seed crop in 2004 (Table 3, Figures 2a-c, Appendix A).

2006 Mushroom Production

Overall annual mean mushroom production in 2006 was over three times greater than in 2005, and was the third highest crop since data collection began in 1994. Production increased in both TR and SF habitats in 2006 as compared to 2005 (Figure 3). In 2006, mushroom production (\bar{x} wet weight) did not differ between TRC and TRN areas, nor between SFC and SFN areas. However, overall production was greater in TR habitat than in SF (Table 4). On TRC, three genera, *Russula*, *Clitocybe*, and *Cortinarius* accounted for 60% of production. On TRN, *Clitocybe*, *Russula*, and *Pholiota* accounted for 79% of total production. *Russula*, *Amanita*, and *Clitocybe* accounted for 73% of the production on SFC. On SFN, *Clitocybe*, *Amanita*, and *Russula* accounted for 90% of the total production (Table 5).

Population Biology

Midden Occupancy

Four quarterly censuses (Mar, Jun, Sep, and Dec) of all middens on or near monitored areas were made in 2006 (Appendix B). From December 2005 to December 2006, the number of red squirrels more than doubled, from 14 to 33. On TRC, the highest number of squirrels (13 Ad) was in December 2006, and the lowest number was 8 Ad in June. The highest numbers (8 Ad) on TRN were also in December and the lowest was 1 Ad in March and June. The highest number of squirrels on SFC was in December (8 Ad) with the lowest (2 Ad) in March and June. On SFN, no squirrels were found to be living on the area during March and June censuses, but 4 squirrels were found in December (Figure 4, Appendix B, C, D). The squirrel populations on the monitored areas in 2006 were low, but by December, a slight upward trend over the past few years was observed (Figure 5).

Three middens, previously removed from regular censusing due to low occupancy, became re-occupied in 2006, one midden each on the TRN, SFC, and SFN areas (Appendix B). In June and December 2006, there was no difference in the proportion of middens occupied in TR and SF habitats (Table 6).

Overwinter Survival

The number of squirrels that survived the winter of 2005-2006 did not differ among all areas (Table 7); survival was 50% in TR habitat and 100% in SF habitat. For comparison, survival from the previous winter (2004-2005) was 80% in TR habitat and 33% in SF habitat.

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.

Crude Density

Between December 2005 and December 2006, crude density of *middens* on the areas increased slightly, as three previously removed middens became reoccupied (Appendix E1-a). Crude density of *squirrels* on all areas also increased from December 2005 to December 2006 (Appendix E1-b).

Local Density

The December 2006 overall mean local density (\bar{x} LD) of *middens* (3.5) was slightly higher than in December 2005 (3.4). Local density of middens differed among the four areas. The SFN had the lowest \bar{x} LD (1.3), and TRN had the highest \bar{x} LD (4.7). The mean \bar{x} LD of *squirrels* (occupied middens) on all areas in December 2006 was 1.7, which is an increase from 0.4 in December 2005. The \bar{x} LD of *squirrels* did not differ among areas (Table 8, Appendix E-2).

Nearest Neighbor Distance

Overall \bar{x} NND of *middens* decreased slightly from December 2005 to December 2006 (59.8m to 57.7m (Table 9, Appendix E-2). Nearest neighbor distance of *middens* differed among the four areas; the longest \bar{x} NND on SFN (78.3m) and the shortest on TRC (44.6m). The \bar{x} NND of *squirrels* (occupied middens) for all areas decreased from 187.5m in December 2005 to 117.5m in December 2006. The \bar{x} NND of *squirrels* did not differ among areas (Table 9, Appendix E-2).

Reproductive Activity and Success

Five breeding chases involving squirrels resident on the monitored areas were observed in 2006, in May and June on/near the TR areas (Appendix F-1). Based on information from census and trapping records, most resident adult males were scrotal from December through August (Appendix F-3b).

The first lactating female was observed 8 August on TRC and the latest was on 3 October, also on TRC. During the June census, of the 6 adult females identified as residents (including nearby off-area middens), 3 were reproductive and 3 were unknown. By September, of 7 resident females, 3 were lactating, and 3 were post-lactation, and 1 was non-reproductive (Appendix F-3a). Direct evidence of 3 litters (9 juveniles) was seen on or near the areas during censuses or other activities. Litters were confirmed from early August through early September, however, some likely emerged slightly earlier as those juveniles were a larger size and roaming further from the nest when first detected (Appendix F-2).

Trapping and Marking

By the end of 2006, nearly all residents on or near monitored areas were fitted with colored ear tags and radio-collared (Appendix B). In addition, 5 juveniles were caught at or near natal middens and fitted with small numbered metal ear tags to aid in the collection of dispersal information.

Mapping

No significant changes in maps of the monitored areas were made in 2006, 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 most of 2006 from two weather stations located at the biology camp (TR habitat) and near Emerald Peak (SF habitat). Data from Emerald Peak were missing between January and February 2006 due to equipment failure and from June and July due to lightning strike. From available data, maximum temperature recorded was 24.3°C in July at the biology camp and the minimum temperature recorded was -20.7°C in November on Emerald Peak. The maximum average monthly temperature was 14.5°C in June at the biology camp and the minimum average monthly temperature was -2.8°C in December on Emerald Peak (Appendix G-1). The maximum total monthly rainfall was recorded in August, at 214.4mm and October was the driest month at 2.4mm (Appendix G-1). Snow depth was recorded from the eight pairs of snow poles. The average accumulated snow depth from February 2006 through April 2005 ranged from 0cm to 47.6cm (Appendix G-2). For comparison, average accumulated snow depths for December -

May in 2004-2005 ranged from 0.2cm to 155.3cm, and in December - April 2003-2004, depths ranged from 10.0cm to 175.4cm. Data on wind chill temperatures, wind direction and speed, humidity, and barometric pressure were also collected (Appendix G-1).

Insect Outbreaks on Monitored Areas

Infestations of bark beetles (*Drycoetes confusus* and *Dendroctonus rufipennis*) continued on parts of the monitored areas in 2006, although to a lesser degree than in previous years. Spruce aphid (*Elatobium abietinum*) were seen, but in much reduced numbers. For a detailed report on forest health and continuing research on the insect infestations, please contact the USFS Southwestern Region Entomology and Pathology Office in Flagstaff, AZ.

<http://www.fs.fed.us/r3/resources/health/>

2006 Publications by Monitoring Program Personnel - Mt. Graham and Sky Islands

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Table 1. Changes in the areas monitored by the University of Arizona's Red Squirrel Monitoring Program as influenced by construction and fire events. TRC = transitional forest in the construction zone, TRN = transitional forest outside of the construction zone, SFC = spruce-fir forest in the construction zone, SFN = spruce-fir forest outside of the construction zone. 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

Table 2. Mushroom genera known to be food resources of red squirrels, and collected from food resource plots on RSMP study areas, Pinaleno Mountains, Arizona.

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

Table 3. Mean filled conifer seed production, on the RSMP study, Pinaleno Mountains, Arizona, 2005. The percent column represents the proportion of each seed species on an individual area.

Area/Habitat	n	<u>Corkbark fir</u>		<u>Douglas-fir</u>		<u>Engelmann spruce</u>	
		\bar{x} 1000 seeds/ha	%	\bar{x} 1000 seeds/ha	%	\bar{x} 1000 seeds/ha	%
TRC	5	15.80	16.1	21.28	21.6	61.20	62.2
TRN	4	6.60	7.6	13.20	15.3	66.60	77.1
SFC	5	0.00	0.0	0.00	0.0	37.20	100.0
SFN	6	0.00	0.0	2.20	2.1	104.27	97.9
TR Habitat	9	11.73	12.6	17.70	19.0	63.60	68.4
SF Habitat	11	0.00	0.0	1.20	1.6	73.78	98.4

Table 4. Mean annual mushroom production on the RSMP study areas, Pinaleno Mountains, Arizona, 2006.

Area/Habitat	n	\bar{x} Wet weight \pm se (Kg/ha)	\bar{x} Dry weight \pm se (Kg/ha)
TRC	5	72.5 \pm 18.7	7.9 \pm 2.1
TRN	4	173.9 \pm 49.9	20.8 \pm 7.2
SFC	5	66.5 \pm 19.6	7.6 \pm 2.3
SFN	6	26.4 \pm 14.5	4.0 \pm 2.3
TR Habitat	9	117.6 \pm 28.8	13.6 \pm 3.9
SF Habitat	11	44.6 \pm 12.9	5.6 \pm 1.6

Wilcoxon Test within TR:

Wet Weight $Z = 1.34$ $P = 0.178$

Dry Weight $Z = 1.34$ $P = 0.178$

Wilcoxon Test within SF:

Wet Weight $Z = 1.4$ $P = 0.170$

Dry Weight $Z = 1.4$ $P = 0.170$

Wilcoxon Test between TR and SF:

Wet Weight $Z = 1.98$ $P = \mathbf{0.048}$

Dry Weight $Z = 1.60$ $P = 0.111$

Table 5. Mean annual mushroom production (wet weight Kg/ha) of selected mushroom genera known to be food resources for red squirrels, 2006. The proportions of the three most available genera on each area are in bold.

Genus	<u>TRC</u>		<u>TRN</u>		<u>SFC</u>		<u>SFN</u>	
	\bar{x} Kg/ha	%	\bar{x} Kg/ha	%	\bar{x} Kg/ha	%	\bar{x} Kg/ha	%
<i>Amanita</i>	1.07	1.5	0.00	0.0	9.50	14.3	2.66	10.1
<i>Auricularia</i>	6.07	8.4	0.35	0.2	7.11	10.7	0.00	0.0
<i>Boletus</i>	6.64	9.2	0.00	0.0	0.00	0.0	0.00	0.0
<i>Clavaria</i>	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
<i>Clitocybe</i>	9.89	13.6	52.78	30.4	8.03	12.1	18.96	71.8
<i>Cortinarius</i>	7.79	10.7	28.99	16.7	2.32	3.5	0.06	0.2
Gastroid sp.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
<i>Hydnum</i>	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
<i>Lactarius</i>	7.55	10.4	0.23	0.1	0.00	0.0	0.00	0.0
<i>Leccinum</i>	1.24	1.7	0.00	0.0	0.00	0.0	0.00	0.0
<i>Lycoperdon</i>	4.86	6.7	4.12	2.3	8.71	13.1	2.56	9.7
<i>Pholiota</i>	0.13	0.2	33.52	19.3	0.00	0.0	0.00	0.0
<i>Ramaria</i>	1.08	1.5	1.31	0.8	0.00	0.0	0.00	0.0
<i>Russula</i>	26.22	36.1	51.55	29.6	30.79	46.3	2.17	8.2
<i>Suillus</i>	0.00	0.0	1.02	0.6	0.00	0.0	0.00	0.0
Total	77.54		173.87		66.46		26.41	

Table 6. Number and percent of available middens occupied by Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) on the RSMP study areas, Pinaleño Mountains, Arizona, 2006.

Area/Habitat	<u>June</u>			<u>December</u>		
	# middens	# occupied	% occ	# middens	# occupied	% occ
TRC	36	8	22	36	13	36
TRN	27	1	4	28	8	29
SFC	21	2	10	22	8	36
SFN	14	0	0	15	4	27
TR Habitat	63	9	14	64	21	31
SF Habitat	35	2	6	37	12	32
TR + SF	98	11	11	101	33	32

Chi Square:

JUNE

within TR* P = 0.066

within SF* P = 0.506

DECEMBER

within TR $X^2 = 0.743$ df = 1 P = 0.389

within SF* P = 0.724

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

Table 7. Overwinter survival of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) on the RSMP study areas, Pinaleño Mountains, Arizona, 2005-2006.

Area/Habitat	Number of Squirrels	Number of Squirrels Surviving	% survival
	Dec 2005 ¹	Jun 2006	
TRC	9	6	67
TRN	3	0	0
SFC	2	2	100
SFN	0	--	--
TR Habitat	12	6	50
SF Habitat	2	2	100

Fisher Exact Test*

within TR	P = 0.091
within SF	not calculated
between habitats	P = 0.308

* Fisher Exact test was used due to the small sample size.

¹ Of the 14 animals resident on the area in Dec 05, 9 were ear-tagged and radio collared thus enabling unique identification and determination of their fate by Jun 06 even if they moved to a different midden or off the area. This large proportion of marked animals in the population increases the accuracy of survival calculations.

Table 8. Mean Local Density of middens and Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) on the monitored areas, Pinaleno Mountains, Arizona, 2005 and 2006.

Area/Habitat	December 2005				December 2006			
	Middens		Squirrels ¹		Middens		Squirrels ¹	
	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$
TRC	36	4.4 ± 0.40 ^a	9	0.4 ± 0.24	36	4.4 ± 0.40 ^a	13	2.2 ± 0.44 ^a
TRN	27	4.4 ± 0.27 ^a	3	0.3 ± 0.33	28	4.7 ± 0.32 ^a	8	1.8 ± 0.37 ^{a,b}
SFC	21	1.7 ± 0.29 ^b	2	0.0 ± 0.00	22	1.8 ± 0.31 ^b	8	1.3 ± 0.49 ^{a,b}
SFN	14	1.1 ± 0.23 ^b	0	--	15	1.3 ± 0.19 ^b	4	0.5 ± 0.29 ^b
TR Habitat	63	4.4 ± 0.25	12	0.4 ± 0.19	64	4.6 ± 0.26	21	2.1 ± 0.30
SF Habitat	35	1.5 ± 0.20	2	0.00 ± 0.00	37	1.6 ± 0.20	12	1.0 ± 0.35
TOTAL ¹	98	3.4 ± 0.23	14	0.4 ± 0.17	101	3.5 ± 0.23	33	1.7 ± 0.24
Kruskal-Wallis LD of Middens among all areas		H = 42.10	df = 3	P < 0.001		H = 42.19	df = 3	P < 0.001
LD of Squirrels among all areas		H = 0.86	df = 2	P = 0.651		H = 5.38	df = 3	P = 0.146

a,b,c,d Means within the same category, with the same letter(s), within the same year, are not significantly different.

¹ Includes only middens on the monitored areas.

Table 9. Mean Nearest Neighbor Distance of middens and Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) on the monitored areas, Pinaleño Mountains, Arizona, 2005 and 2006.

Area/Habitat	December 2005				December 2006			
	Middens		Squirrels		Middens		Squirrels	
	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$
TRC	36	44.6 ± 4.04 ^a	9	115.4 ± 29.62 ^a	36	44.6 ± 4.04 ^a	13	72.9 ± 13.73 ^a
TRN	27	50.1 ± 3.07 ^a	3	92.6 ± 26.0 ^a	28	49.0 ± 3.06 ^a	8	59.0 ± 9.45 ^a
SFC	21	79.0 ± 9.17 ^b	2	654.2 ± 0.00 ^b	22	76.4 ± 9.09 ^b	8	175.1 ± 58.52 ^{a,b}
SFN	14	88.7 ± 18.65 ^b	0	--	15	78.3 ± 17.04 ^b	4	265.8 ± 154.40 ^b
TR Habitat	63	46.9 ± 2.67	12	109.7 ± 8.50	64	46.5 ± 2.64	21	67.6 ± 9.18
SF Habitat	35	82.9 ± 9.14	2	654.2 ± 0.00	37	77.2 ± 8.63	12	205.3 ± 61.53
TOTAL ¹	98	59.8 ± 4.05	14	187.5 ± 53.30	101	57.7 ± 3.84	33	117.7 ± 25.38
2005								
Kruskal-Wallis:								
NND of Middens								
among all areas	H = 22.26	df = 3	P < 0.001	H = 19.13	df = 3	P < 0.001		
NND of Squirrels								
among all areas	H = 5.15	df = 2	P = 0.076	H = 6.62	df = 3	P = 0.085		

a,b,c,d Means within the same category, with the same letter(s), of the same year, are not significantly different.

1 Includes only middens on the monitored areas.

Figure 2a. Corkbark fir (*Abies lasiocarpa* var. *arizonica*) seed fall on RSMP study areas, Pinaleno Mountains, Arizona, 1993-2005. Note: scales are different for figures 2a-c.

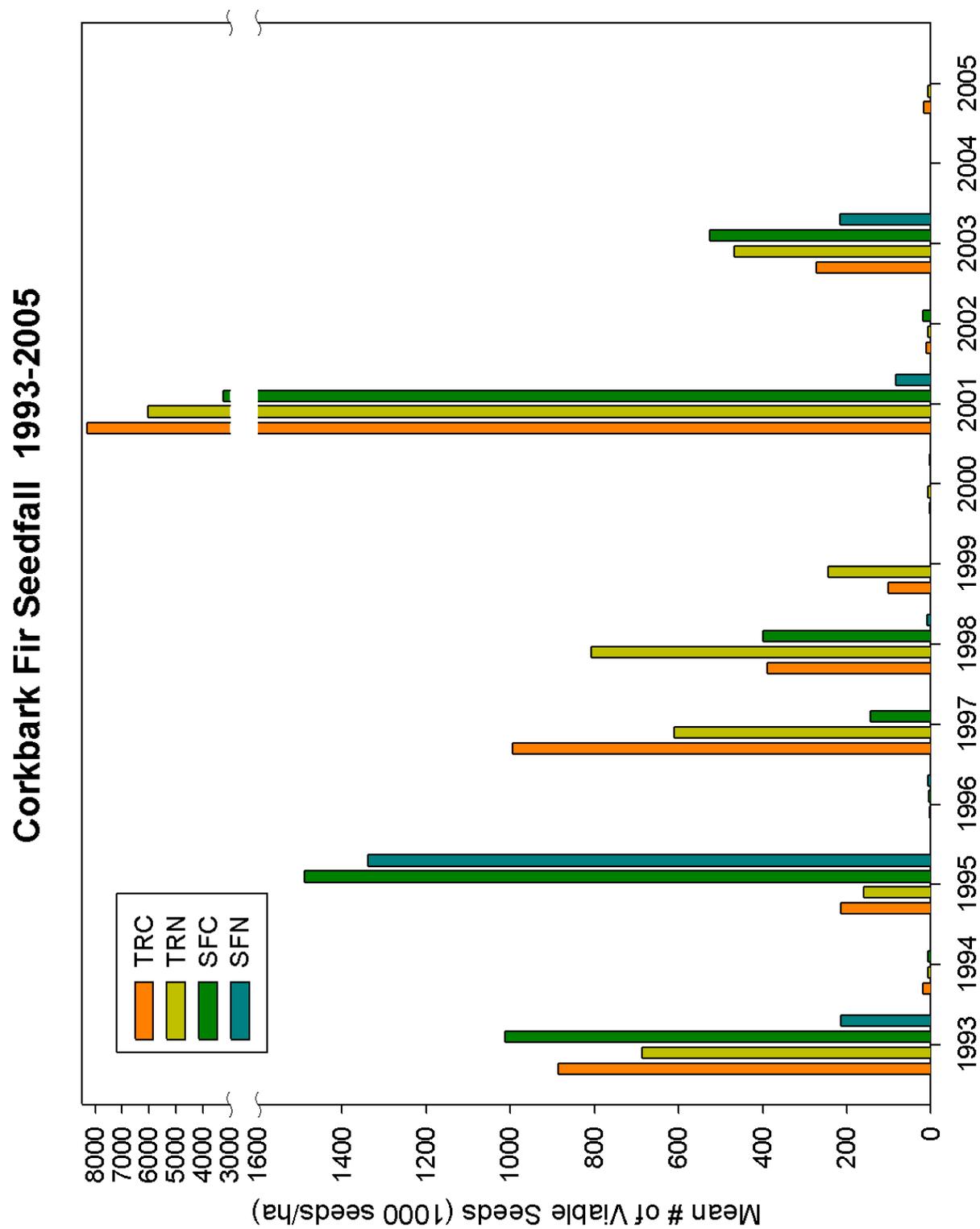


Figure 2b. Douglas-fir (*Pseudotsuga menziesii*) seed fall on RSMP study areas, Pinaleno Mountains, Arizona, 1993-2005. Note: scales are different for figures 2a-c.

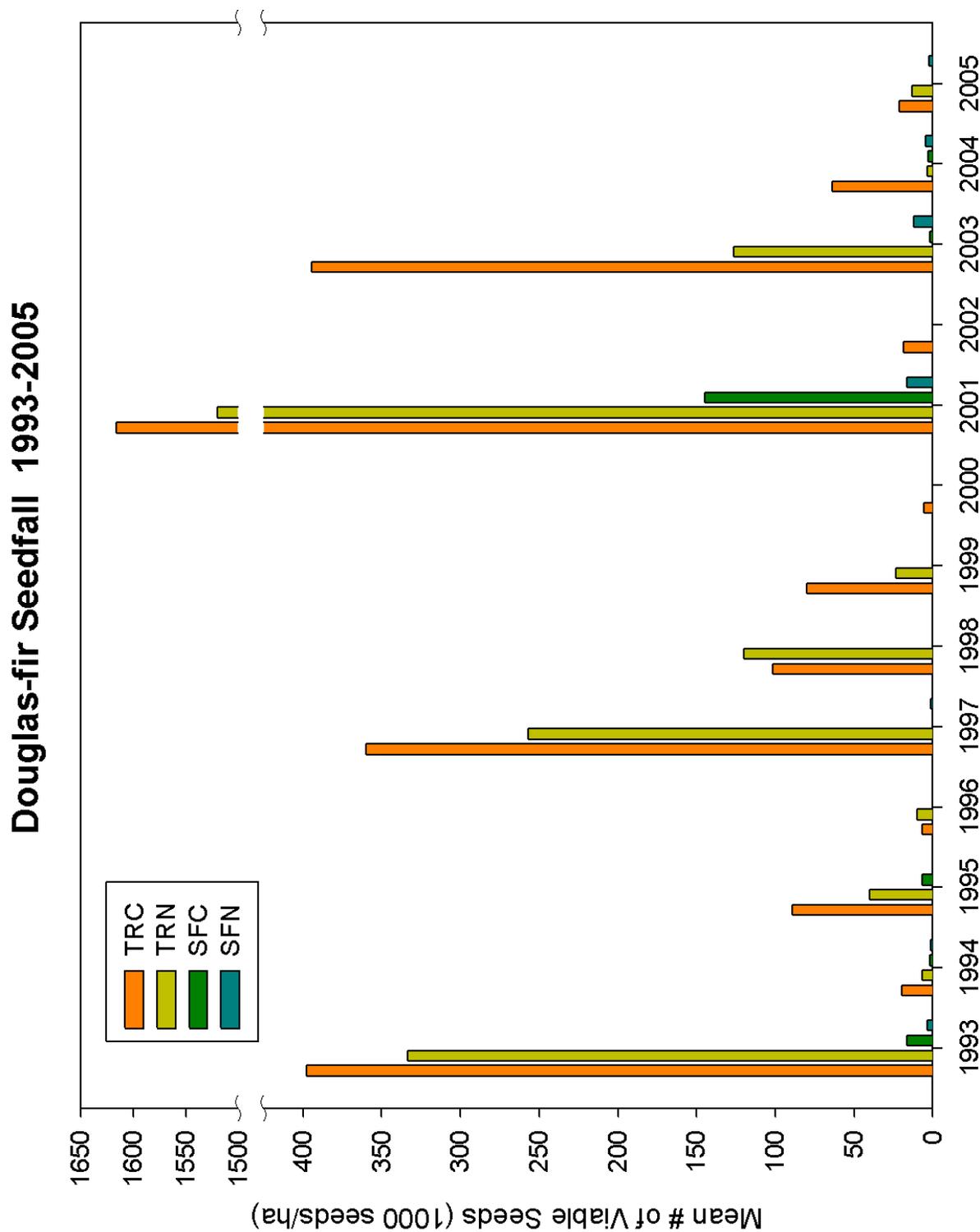


Figure 2c. Engelmann spruce (*Picea engelmannii*) seed fall on RSMP study areas, Pinaleno Mountains, Arizona, 1993-2005. Note: scales are different for figures 2a-c.

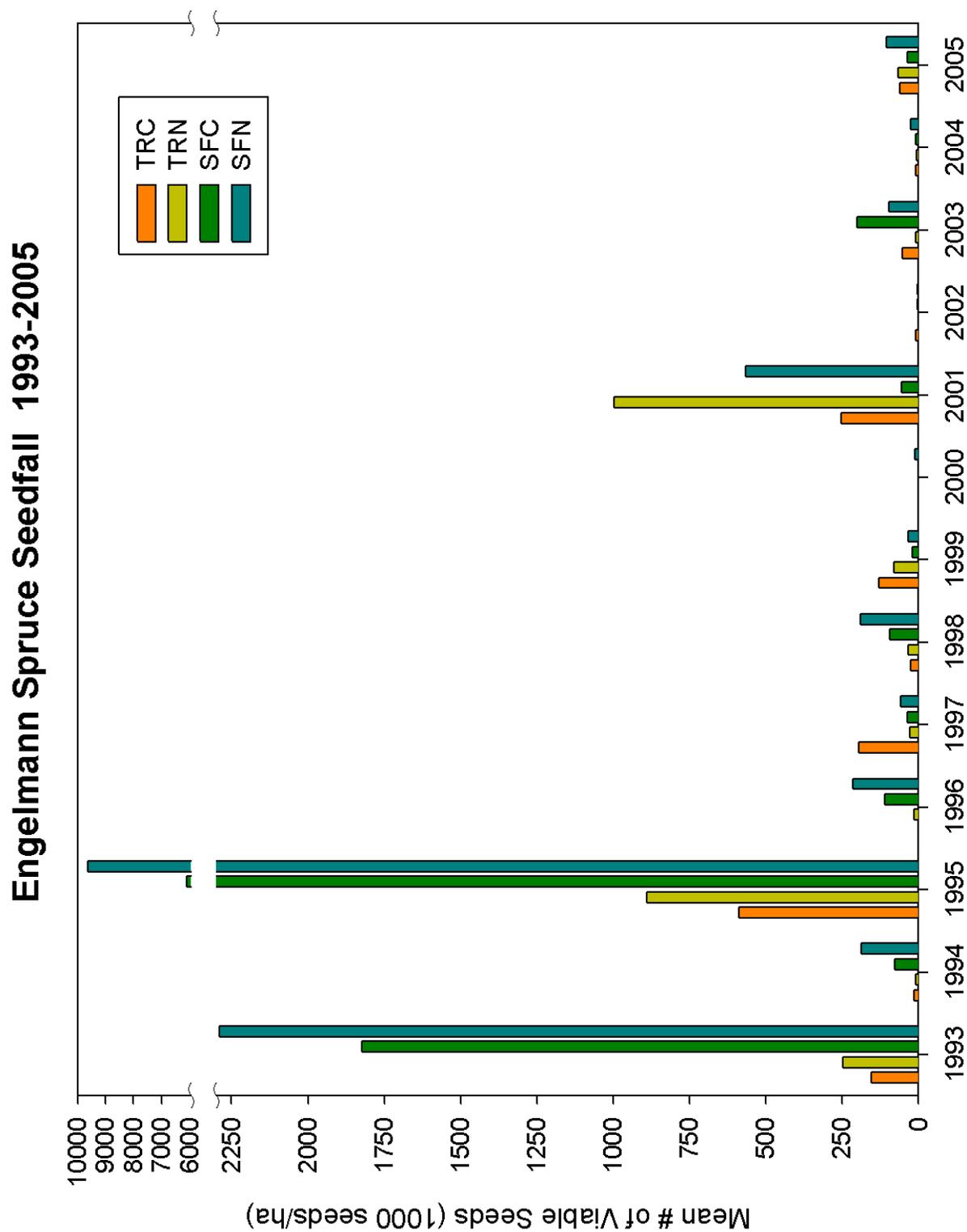


Figure 3. Mushroom crops collected on RSMP study areas, Pinaleno Mountains, Arizona, 1994-2006.

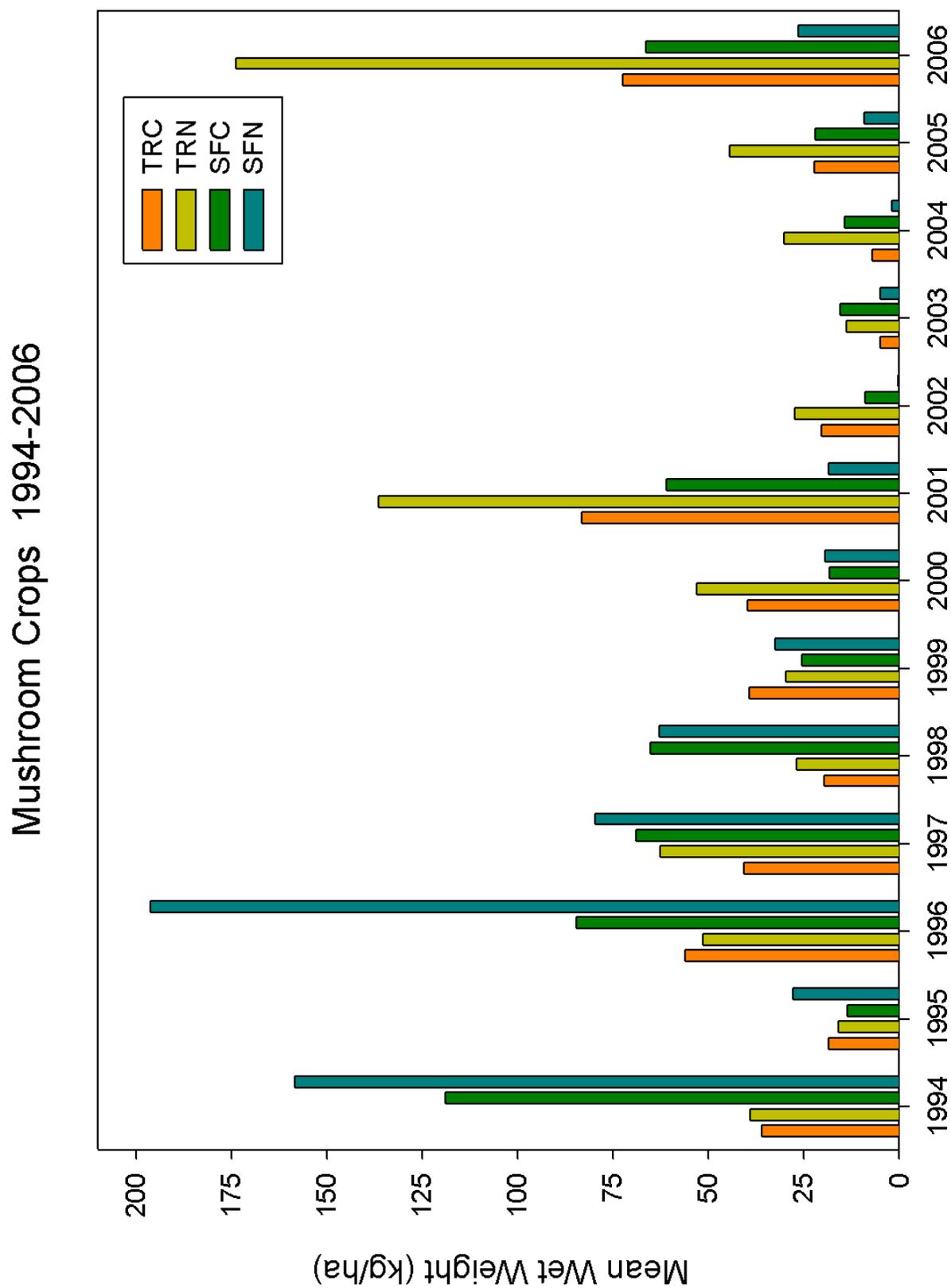


Figure 4. Quarterly Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles) on RSMP study areas, Pinaleno Mountains, Arizona, March 2002 - December 2006.

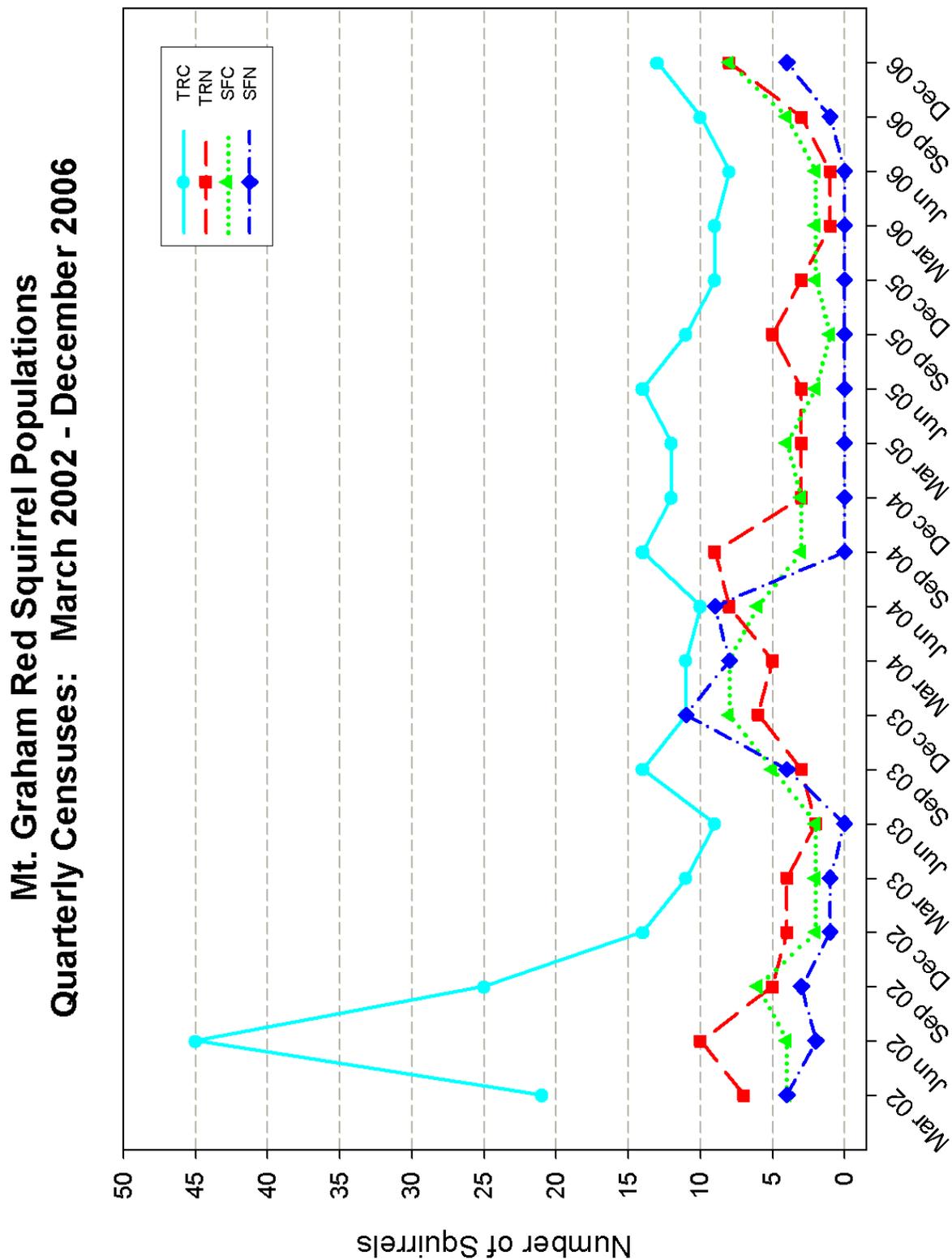
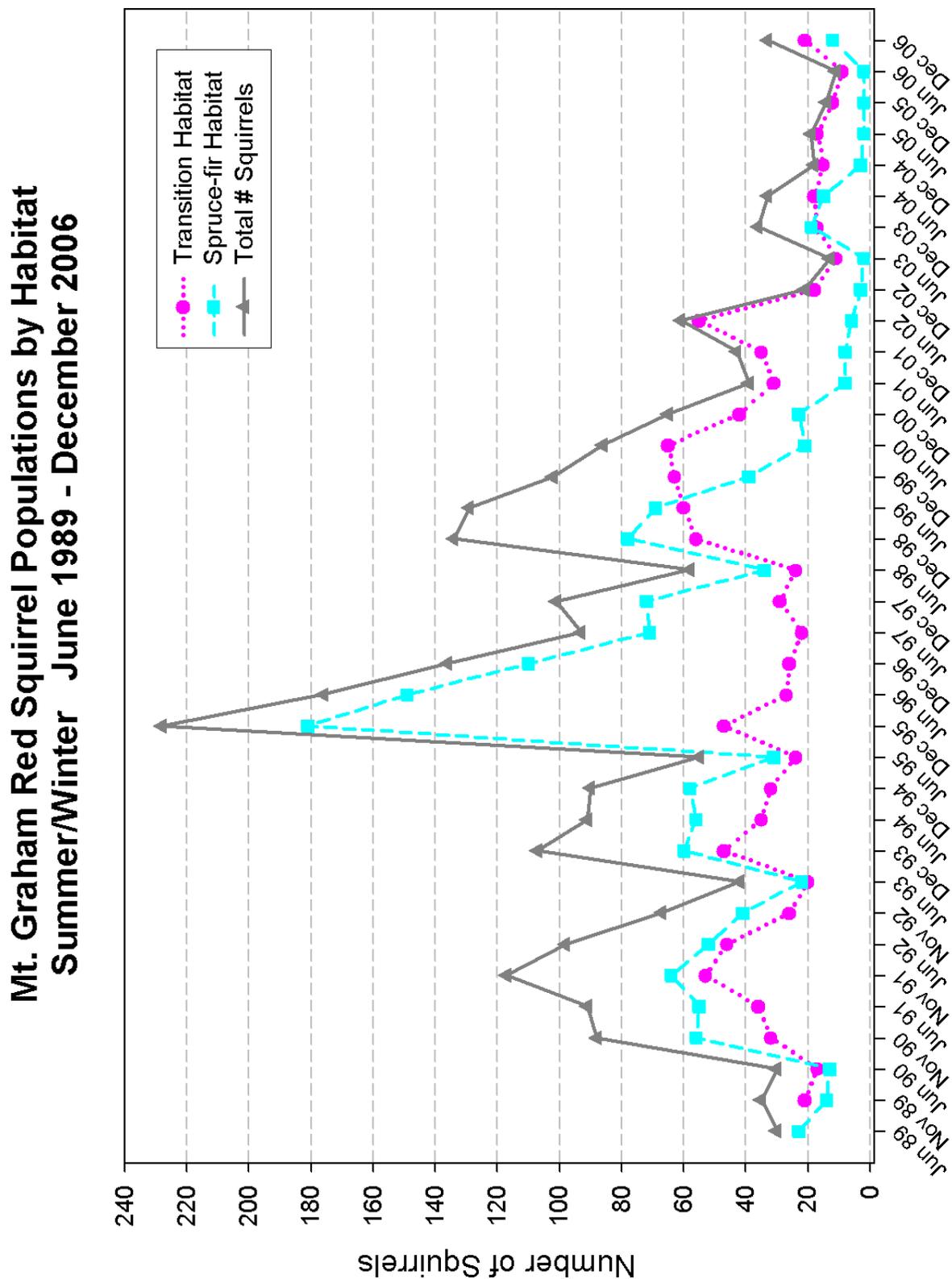


Figure 5. Summer and winter Mt. Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) populations (including juveniles) on RSMP study areas, by habitat, June 1989 through December 2006.



Appendix A. Annual conifer seed and mushroom production on RSMP study areas, Pinaleno Mountains, Arizona, 2005.

A-1: By transect

A-2: By area and habitat

Appendix A-1: Mean number of viable seeds and weights for 2005 seeds and 2005 mushrooms, by transect.

AREA	TRAN #	Corkbark Fir	Douglas-fir	Englemann Spruce	Total Seeds	Total Mushrooms	
		# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	ww Kg/ha	dw Kg/ha
TRC	1	burned - Clark Peak Fire, 1996					
	2	burned - Clark Peak Fire, 1996					
	3	13.2	0.0	0.0	13.2	34.0	3.7
	4	burned - Clark Peak Fire, 1996					
	5	26.4	40.0	66.4	132.8	11.8	1.4
	6	burned - Clark Peak Fire, 1996					
	7	burned - Clark Peak Fire, 1996					
	8	burned - Clark Peak Fire, 1996					
	9	burned - Clark Peak Fire, 1996					
	10	13.2	0.0	66.4	79.6	39.4	3.7
	11	0.0	26.4	133.2	159.6	1.7	0.2
	12	26.4	40.0	40.0	106.4	24.7	2.2
TRN	1	26.4	13.2	13.2	52.8	36.5	3.1
	2	0.0	26.4	120.0	146.4	84.2	7.9
	3	0.0	13.2	93.2	106.4	38.1	3.6
	4	0.0	0.0	40.0	40.0	19.0	1.7

AREA	TRAN #	Corkbark Fir	Douglas-fir	Englemann Spruce	Total Seeds	Total Mushrooms	
		# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	ww Kg/ha	dw Kg/ha
SFC	1	burned - Nuttall fire, 2004					
	2	burned - Clark Peak Fire, 1996					
	3	burned - Nuttall fire, 2004					
	4	burned - Nuttall fire, 2004					
	5	0.0	0.0	0.0	0.0	36.2	4.0
	6	0.0	0.0	26.4	26.4	28.3	3.0
	7	burned - Clark Peak Fire, 1996, Nuttall fire, 2004					
	8	burned - Clark Peak Fire, 1996, Nuttall fire, 2004					
	9	burned - Clark Peak Fire, 1996, Nuttall fire, 2004					
	10	burned - Clark Peak Fire, 1996, Nuttall fire, 2004					
	11	0.0	0.0	13.2	13.2	8.2	1.0
	12	0.0	0.0	40.0	40.0	12.0	1.3
	13	0.0	0.0	106.4	106.4	25.7	3.2
SFN	1	burned - Nuttall fire, 2004					
	2	burned - Nuttall fire, 2004					
	3	burned - Nuttall fire, 2004					
	4	0.0	0.0	13.2	13.2	10.1	1.2
	5	0.0	0.0	106.4	106.4	2.7	0.3
	6	0.0	0.0	13.2	13.2	3.8	0.3
	7	burned - Nuttall fire, 2004					
	8	burned - Nuttall fire, 2004					
	9	burned - Nuttall fire, 2004					
	10	burned - Nuttall fire, 2004					
	11	0.0	0.0	106.4	106.4	6.1	0.6
	12	0.0	0.0	106.4	106.4	18.8	1.7
	13	0.0	13.2	280.0	293.2	14.2	1.6

Appendix A-2: Mean number of seeds and weights for 2005 seeds and 2005 mushrooms, by area and habitat.

		Corkbark Fir	Douglas-fir	Englemann Spruce	Total Seeds	Total Mushrooms	
AREA	N	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	ww Kg/ha	dw Kg/ha
TRC \bar{x}	5	15.8	21.3	61.2	98.3	22.3	2.3
TRN \bar{x}	4	6.6	13.2	66.6	86.4	44.5	4.1
SFC \bar{x}	5	0.0	0.0	37.2	37.2	22.1	2.5
SFN \bar{x}	6	0.0	2.2	104.3	106.5	9.3	1.0
TR \bar{x}	9	11.7	17.7	63.6	93.0	32.1	3.1
SF \bar{x}	11	0.0	1.2	73.8	75.0	15.1	1.6

Appendix B: Midden occupancy records for the monitored areas, 2006.

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, Sub-adult Red Squirrel
A	Abert's Squirrel using area, no Red Squirrel present
XX	Remains of Red Squirrel found
* or ^(R/R)	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] [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
RC	Radio-collared Red Squirrel



Shaded cell indicates a midden that has been renumbered or removed from censusing.

Transition Construction Area (TRC), 2006				
Midden	Mar	Jun	Sep	Dec
1101 ⁸⁹	located off-area, new number - 5101			
1102 ⁸⁹	N	N	N	♂ ^(M/M RC 748)
1103 ⁸⁹	N	N	♂ ^{(M/M RC 316) 7}	♂ ^(M/M RC 316)
1104 ⁸⁹	N	N	N	N
1105 ⁸⁹	burned in Clark Peak fire - April 1996			
1106 ⁸⁹	N	N	N	N
1107 ⁸⁹	burned in Clark Peak fire - April 1996			
1108 ⁸⁹	removed from census - low occupancy ¹			
1109 ⁸⁹	burned in Clark Peak fire - April 1996			
1110 ^{89*}	burned in Clark Peak fire - April 1996			
1111 ⁸⁹	N	N	N	N
1112 ^{89*}	N	N	N	N
1113 ⁸⁹	N	N	N	N
1114 ⁸⁹	located off-area, new number - 5114			
1115 ⁸⁹	N	N	N	Y
1116 ⁸⁹	♀ ^(W/P RC 716)	♀ ^(W/P RC 716)	S ⁸	♂
1117 ⁸⁹	burned in Clark Peak fire - April 1996			
1118 ⁸⁹	♂ ^(M/Ysq RC 666)	♂ ^(M/Ysq RC 666)	♂ ^(M/Ysq RC 666)	♂ ^(M/Ysq RC 666)
1119 ⁸⁸	burned in Clark Peak fire - April 1996			
1120 ⁸⁹	burned in Clark Peak fire - April 1996			
1121 ^{89*}	P	♀ ^{(Y/rip RC 39) 2}	S ²	♀ ^(M/M 728)
1122 ⁸⁹	burned in Clark Peak fire - April 1996			
1123 ^{95*}	burned in Clark Peak fire - April 1996			
1124 ^{95*}	burned in Clark Peak fire - April 1996			
1125 ^{95*}	burned in Clark Peak fire - April 1996			
1126 ^{95*}	removed from census - low occupancy ¹			
1130 ⁹⁰	burned in Clark Peak fire - April 1996			
1131 ^{90*}	N	N	N	S
1132 ^{90*}	removed from census - low occupancy ¹			
1134 ^{91*}	removed from census - low occupancy ¹			
1135 ^{91*}	burned in Clark Peak fire - April 1996			
1136 ^{91*}	burned in Clark Peak fire - April 1996			
1137 ^{91*}	burned in Clark Peak fire - April 1996			
1138 ^{91*}	removed from census - low occupancy ¹			
1139 ^{91*}	burned in Clark Peak fire - April 1996			
1140 ^{91*}	burned in Clark Peak fire - April 1996			

Transition Construction Area (TRC), 2006				
Midden	Mar	Jun	Sep	Dec
1142 ^{91*}	burned in Clark Peak fire - April 1996			
1143 ^{91*}	burned in Clark Peak fire - April 1996			
1144 ^{91*}	N	N	N	N
1145 ^{91*}	located off-area, new number - 5145			
1146 ^{91*}	removed from census - low occupancy ¹			
1147 ^{91*}	N	N	N	N
1148 ^{91*}	burned in Clark Peak fire - April 1996			
1149 ^{91*}	N	N	P	N
1150 ^{91*}	located off-area, new number - 5150			
1151 ^{91*}	N	N	N	N
1152 ^{91*}	burned in Clark Peak fire - April 1996			
1153 ^{92*}	S	♂ (Rsq/Osq RC 724)	S ⁹	♀ (M/M 743)
1154 ^{92*}	♂ (G/Y RC 633)	♂ (G/Y RC 633) ³	N ³	N
1155 ^{93*}	located off-area, new number - 5155			
1156 ^{93*}	♀ (none/R RC 202)	P ⁴	♂	S
1157 ^{93*}	located off-area, new number - 5157			
1159 ^{93*}	burned in Clark Peak fire - April 1996			
1160 ^{96*}	♂ (B/R 720)	♂ (B/R RC 720) ⁵	S	N
1161 ^{96*}	removed from census - low occupancy ¹			
1162 ^{96*}	♂ (M/G RC 316)	♂ (M/G RC 316)	P	P
1163 ^{98*}	N	N	N	N
1164 ^{98*}	removed from census - low occupancy ¹			
1165 ^{98*}	removed from census - low occupancy ¹			
1166 ^{98*}	removed from census - low occupancy ¹			
1167 ^{98*}	N	N	N	♂
1168 ^{98*}	N	N	N	N
1169 ^{98*}	removed from census - low occupancy ¹			
1170 ^{98*}	♂ (W/M RC 14)	♂ (W/M RC 14)	♂ ¹⁰	♂ (Psq/Psq RC 729)
1171 ^{98*}	P	N	N	N
1172 ^{90*}	removed from census - low occupancy ¹			
1173 ^{99*}	N	N	N	N
1174 ^{99*}	removed from census - low occupancy ¹			
1175 ^{99*}	removed from census - low occupancy ¹			
1176 ^{99*}	removed from census - low occupancy ¹			
1177 ^{99*}	♀ (W/R RC 668)	P ⁶	♂	♂
1178 ^{99*}	removed from census - low occupancy ¹			

Transition Construction Area (TRC), 2006				
Midden	Mar	Jun	Sep	Dec
1179 ^{99*}	N	N	N	N
1180 ^{99*}	N	N	N	P
1181 ^{99*}				
1182 ^{02*}	N	N	P	S
1183 ^{04*}	P	N	N	N
1184 ^{04*}	N	N	N	N
1185 ^{05*}	N	N	♀	N
1186 ^{05*}	N	N	N	N
1187 ^{05*}	N	N	N	N
# Mid	36	36	36	36
# Occ	9	8	10	13
% Occ	25%	22%	28%	36%
# Sq	9	8	10	13

Appendix B - TRC (cont.)

- 1 These middens have been removed from regular censusing due to low occupancy. These middens were unoccupied for at least 12 consecutive quarterly censuses (three years) prior to removal. After 2003, all of the removed-low occupancy middens are checked each census. Any middens that become re-occupied are added back to regular censusing.
- 2 Midden 1121 - female (Y/rip RC 39) was resident at midden 5221 in March 06. She was off air for much of the summer, but was seen several times in the area of 1121, and was thought to be resident there for June 06. By September 2006, an unmarked sub-adult (possibly female) was thought to be resident at midden 1121 and female (Y/rip RC 39) appeared to shift back to midden 5221.
- 3 Midden 1154 - male (Gsq/Ysq RC 633) was live-trapped and released at midden 1154 shift in early June. His collar was found a bit N of the midden on 27 Jun 06, but there was no sign of predation. Will consider this male as resident for Jun 06, as he was seen alive in the midden during the census period.
- 4 Midden 1156 - female (rip/R RC 202) appeared to shift her residence from 1156 in Mar 06 to 5106 by Jun 06.
- 5 Midden 1160 - male (B/R RC 720) was seen in a breeding chase, in the northern part of the TR area on 6 Jun 06.
- 6 Midden 1177 - female (W/R RC 668) was not seen since late May 2006. She was not seen during several long census observations in June 06, though the midden looked occupied.
- 7 Midden 1103 - male (M/M RC 316) was previously resident at midden 1162.
- 8 Midden 1116 - unmarked squirrel (sex not confirmed) is now resident. Former resident female (W/P RC 716) was found dead on 22 Sep 06, of an unknown cause, carcass was partially cached inside a low cavity.
- 9 Midden 1153 - unmarked squirrel (sex not confirmed) is now resident. Former resident male (Rsq/Osq RC 724) had an unknown fate after late June when his collar only was found at the base of a nest, with no obvious signs of predation.
- 10 Midden 1170 - unmarked male is now resident. Fate of former resident male (W/M RC 14) is unknown. He apparently left the TRC area and traveled to NE of the SFC area. Radio signal was homed once and then again biangulated in a different area in early Aug 06. However, no signal or sighting was detected after that time.

Transition Non-Construction Area (TRN), 2006				
Midden	Mar	Jun	Sep	Dec
2201 ⁸⁹	removed from census - low occupancy ¹			
2202 ⁸⁹	N	N	N	N
2203 ⁸⁹	N	N	N	N
2204 ⁸⁹	Y	P	P	♂
2205 ⁸⁹	N	N	N	N
2206 ⁸⁹	N	P	♂	♂ (G/P RC 746)
2207 ^{89*}	burned in Nuttall fire - July 2004			
2208 ^{89*}	N	N	N	N
2209 ⁸⁹	removed from census - low occupancy ¹			
2210 ⁹⁰	N	N	N	N
2211 ^{90*}	P	♂	♂	♂
2212 ⁹⁰	removed from census - low occupancy ¹			
2213 ⁹⁰	removed from census - low occupancy ¹			
2214 ^{90*}	located on TRC, new number - 1172			
2215 ^{90*}	N	N	N	N
2216 ^{90*}	N	N	N	S
2217 ^{90*}	N	N	N	N
2218 ^{91*}	N	N	N	N
2219 ^{91*}	removed from census - low occupancy ¹			♂ (M/M 750) 2
2220 ^{91*}	removed from census - low occupancy ¹			
2221 ^{91*}	located off-area, new number - 5221			
2222 ^{91*}	removed from census - low occupancy ¹			
2223 ^{91*}	N	N	N	N
2224 ^{93*}	removed from census - low occupancy ¹			
2225 ⁹⁴	removed from census - low occupancy ¹			
2226 ^{95*}	removed from census - low occupancy ¹			
2227 ^{95*}	N	N	N	N
2228 ^{95*}	removed from census - low occupancy ¹			
2229 ^{96*}	N	N	N	N
2230 ^{96*}	N	P	N	N
2231 ^{96*}	located off-area, new number - 5231			
2232 ^{96*}	located off-area, new number - 5232			
2233 ^{96*}	removed from census - low occupancy ¹			
2234 ^{97*}	N	N	N	N
2235 ^{98*}	N	N	N	N

Transition Non-Construction Area (TRN), 2006				
Midden	Mar	Jun	Sep	Dec
2236 ^{98*}	P	N	N	♀
2237 ^{98*}	N	N	N	N
2238 ⁹⁸	removed from census - low occupancy ¹			
2239 ⁹⁸	removed from census - low occupancy ¹			
2240 ⁹⁸	removed from census - low occupancy ¹			
2241 ^{98*}	N	N	N	N
2242 ^{98*}	N	P	P	♂
2243 ⁹⁸	removed from census - low occupancy ¹			
2244 ^{99*}	N	P	♂	♂
2245 ^{99*}	removed from census - low occupancy ¹			
2246 ^{99*}	N	N	N	N
2247 ^{99*}	burned in Nuttall fire - July 2004			
2248 ^{99*}	N	N	N	P
2249 ^{99*}	N	N	N	N
2250 ^{00*}	N	N	N	N
2251 ^{00*}	removed from census - low occupancy ¹			
# Mid	27	27	27	28
# Occ	1	1	3	8
% Occ	4%	4%	11%	29%
# Sq	1	1	3	8

- 1 These middens have been removed from regular censusing due to low occupancy. These middens were unoccupied for at least 12 consecutive quarterly censuses (three years) prior to removal. After 2003, all of the removed-low occupancy middens are checked each census. Any middens that become reoccupied are added back to regular censusing.
- 2 Midden 2219 - was previously removed from censusing due to low occupancy, but as of Dec 06 was re-occupied by a marked sub-adult male.

Spruce-Fir Construction Area (SFC), 2006				
Midden	Mar	Jun	Sep	Dec
3000 ^{95*}	burned in Nuttall fire - July 2004			
3001 ^{95*}	burned in Nuttall fire - July 2004			
3002 ^{95*}	removed from census - low occupancy ¹			
3003 ^{95*}	removed from census - low occupancy ¹			
3004 ^{95*}	burned in Clark Peak fire - April 1996			
3005 ^{95*}	removed from census - low occupancy ¹			
3006 ^{95*}	destroyed by fire suppression in Nuttall fire - July 2004			
3007 ^{95*}	removed from census - too far off area, new # 5307			
3008 ^{95*}	burned in Nuttall fire - July 2004			
3009 ^{95*}	removed from census - low occupancy ¹			
3010 ^{95*}	removed from census - low occupancy ¹			
3011 ^{95*}	located off-area, new number - 5311			
3012 ^{95*}	burned in Clark Peak fire - April 1996			
3013 ^{95*}	removed from census - low occupancy ¹			
3014 ^{95*}	removed from census - low occupancy ¹			
3015 ^{95*}	burned in Clark Peak fire - April 1996			
3016 ^{95*}	burned in Clark Peak fire - April 1996			
3017 ^{95*}	burned in Clark Peak fire - April 1996			
3018 ^{95*}	burned in Clark Peak fire - April 1996			
3019 ^{96*}	removed from census - low occupancy ¹			
3020 ^{96*}	N	N	N	N
3021 ^{96*}	burned in Clark Peak fire - April 1996			
3022 ^{96*}	removed from census - low occupancy ¹			
3023 ^{96*}	burned in Nuttall fire - July 2004			
3024 ^{98*}	removed from census - low occupancy ¹			
3025 ^{98*}	removed from census - low occupancy ¹			
3026 ^{98*}	removed from census - low occupancy ¹			
3027 ^{99*}	removed from census - low occupancy ¹			
3028 ^{99*}	N	N	N	N
3029 ^{99*}	removed from census - low occupancy ¹			
3030 ^{99*}	removed from census - low occupancy ¹			
3031 ^{99*}	removed from census - low occupancy ¹			
3032 ^{99*}	removed from census - low occupancy ¹			
3300 ⁸⁶	burned in Nuttall fire - July 2004			
3301 ^{94*}	burned in Nuttall fire - July 2004			
3302 ^{94*}	located off-area, new number - 5302			

Spruce-Fir Construction Area (SFC), 2006				
Midden	Mar	Jun	Sep	Dec
3303 ^{94*}	N	N	N	N
3304 ^{94*}	removed from census - low occupancy ¹			
3305 ^{94*}	removed from census - low occupancy ¹			
3306 ^{94*}	burned in Nuttall fire - July 2004			
3307 ^{94*}	removed from census - low occupancy ¹			
3308 ^{95*}	burned in Nuttall fire - July 2004			
3309 ^{95*}	removed from census - low occupancy ¹			
3310 ^{95*}	removed from census - low occupancy ¹		♀ ²	♀
3311 ^{95*}	N	N	N	♂
3312 ^{95*}	N	N	N	N
3313 ^{95*}	located off-area, new number - 5313			
3314 ^{95*}	N	N	N	N
3315 ^{95*}	removed from census - low occupancy ¹			
3316 ^{95*}	burned in Nuttall fire - July 2004			
3317 ^{95*}	removed from census - low occupancy ¹			
3318 ^{95*}	removed from census - low occupancy ¹			
3319 ^{95*}	removed from census - low occupancy ¹			
3320 ^{95*}	removed from census - low occupancy ¹			
3321 ^{95*}	burned in Nuttall fire - July 2004			
3322 ^{95*}	removed from census - low occupancy ¹			
3323 ^{95*}	N	N	N	N
3324 ^{95*}	removed from census - low occupancy ¹			
3325 ^{95*}	removed from census - low occupancy ¹			
3326 ^{95*}	removed from census - low occupancy ¹			
3327 ^{95*}	removed from census - low occupancy ¹			
3328 ^{95*}	removed from census - low occupancy ¹			
3329 ^{95*}	removed from census - low occupancy ¹			
3330 ^{95*}	N	N	N	N
3331 ^{95*}	burned in Nuttall fire - July 2004 ³			
3332 ^{95*}	removed from census - low occupancy ¹			
3333 ^{95*}	removed from census - low occupancy ¹			
3334 ^{95*}	burned in Nuttall fire - July 2004			
3335 ^{95*}	removed from census - low occupancy ¹			
3336 ^{95*}	removed from census - low occupancy ¹			
3337 ^{95*}	removed from census - low occupancy ¹			
3338 ^{95*}	burned in Nuttall fire - July 2004			

Spruce-Fir Construction Area (SFC), 2006				
Midden	Mar	Jun	Sep	Dec
3339 ^{95*}	removed from census - low occupancy ¹			
3340 ^{95*}	removed from census - low occupancy ¹			
3341 ^{95*}	N	N	N	N
3342 ^{95*}	removed from census - low occupancy ¹			
3343 ^{95*}	removed from census - low occupancy ¹			
3344 ^{95*}	removed from census - low occupancy ¹			
3345 ^{95*}	removed from census - low occupancy ¹			
3346 ^{95*}	removed from census - low occupancy ¹			
3347 ^{95*}	removed from census - low occupancy ¹			
3348 ^{95*}	N	N	N	N
3349 ^{95*}	burned in Nuttall fire - July 2004			
3350 ⁸⁷	removed from census - low occupancy ¹			
3351 ⁸⁷	burned in Nuttall fire - July 2004			
3352 ⁸⁶	removed from census - low occupancy ¹			
3353 ⁸⁷	removed from census - low occupancy ¹			
3354 ⁸⁶	removed from census - low occupancy ¹			
3355 ^{95*}	burned in Nuttall fire - July 2004			
3356 ⁸⁶	burned in Nuttall fire - July 2004			
3357 ⁸⁶	removed from census - low occupancy ¹			
3358 ⁸⁷	burned in Clark Peak fire - April 1996			
3359 ⁸⁷	burned in Clark Peak fire - April 1996			
3360 ⁸⁶	♂ (O/O RC 159)	♂ (O/O RC 159)	♂ ³	♂ (P/sq/Ysq RC 745)
3361 ⁸⁶	removed from census - low occupancy ¹			
3362 ⁸⁶	N	N	N	♀
3363 ⁸⁶	removed from census - low occupancy ¹			
3364 ⁸⁶	removed from census - low occupancy ¹			
3365 ⁸⁶	P	N	♂	♂
3366 ⁸⁶	N	N	N	♀
3367 ⁸⁷	removed from census - low occupancy ¹			
3368 ⁸⁶	removed from census - low occupancy ¹			
3369 ⁸⁶	removed from census - low occupancy ¹			
3370 ⁸⁶	N	N	N	N
3371 ⁸⁷	N	N	N	N
3372 ⁸⁹	N	N	N	N
3373 ⁸⁷	removed from census - low occupancy ¹			
3374 ⁸⁹	♀ (Gsq/Bsq RC 653)	♀ (Gsq/Bsq RC 653)	♀ (Gsq/Bsq RC 653)	♂ ⁴

Spruce-Fir Construction Area (SFC), 2006				
Midden	Mar	Jun	Sep	Dec
3375 ⁸⁶	removed from census - low occupancy ¹			
3376 ⁸⁶	located off-area, new number - 5376			
3377 ⁸⁷	located off-area, new number - 5377			
3378 ^{90*}	N	N	N	♀
3379 ^{90*}	removed from census - low occupancy ¹			
3380 ^{90*}	removed from census - low occupancy ¹			
3381 ⁹⁰	burned in Nuttall fire - July 2004			
3382 ^{91*}	N	N	N	N
3383 ^{91*}	removed from census - low occupancy ¹			
3384 ^{91*}	burned in Clark Peak fire - April 1996			
3385 ^{91*}	removed from census - low occupancy ¹			
3386 ^{91*}	removed from census - low occupancy ¹			
3387 ^{91*}	burned in Nuttall fire - July 2004			
3388 ^{92*}	located off-area, new number - 5388			
3389 ^{93*}	removed from census - low occupancy ¹			
3390 ^{93*}	removed from census - low occupancy ¹			
3390 ^{93*}	removed from census - low occupancy ¹			
3391 ^{93*}	removed from census - low occupancy ¹			
3392 ^{93*}	removed from census - low occupancy ¹			
3393 ^{93*}	destroyed by fire suppression in Nuttall fire - July 2004			
3394 ^{93*}	N	N	P	P
3395 ^{94*}	removed from census - low occupancy ¹			
3396 ^{94*}	removed from census - low occupancy ¹			
3397 ⁸⁶	burned in Nuttall fire - July 2004			
3398 ⁸⁶	burned in Nuttall fire - July 2004			
3399 ^{94*}	burned in Nuttall fire - July 2004			
# Mid	21	21	22	22
# Occ	2	2	4	8
% Occ	10%	10%	18%	36%
# Sq	2	2	4	8

Appendix B - SFC (cont.)

- 1 These middens have been removed from regular censusing due to low occupancy. These middens were unoccupied for at least 12 consecutive quarterly censuses (three years) prior to removal. After 2003, all of the removed-low occupancy middens are checked each census. Any middens that become reoccupied are added back to regular censusing.
- 2 Midden 3310 - was previously removed from censusing due to low occupancy, but as of Sep 06 was re-occupied by an unmarked adult female.
- 3 Midden 3360 - an unmarked male (appeared to be a sub-adult) is now resident. The fate of former resident male (O/O RC 159) is unknown. This male was not seen nor signal heard anywhere in or around the area after Jul 06.
- 4 Midden 3374 - The collar and remains (possible avian predation) of previous resident female (Gsq/Bsq RC 653) were found near the midden on 11 Dec 06. A sub-adult male now appears to be resident.

Spruce-Fir Non Construction Area (SFN), 2006				
Midden	Mar	Jun	Sep	Dec
4000 ^{95*}	N	N	N	N
4001 ^{95*}	burned in Nuttall fire - July 2004			
4002 ^{95*}	removed from census - low occupancy ¹			
4003 ^{95*}	burned in Nuttall fire - July 2004			
4004 ^{95*}	burned in Nuttall fire - July 2004			
4005 ^{95*}	burned in Nuttall fire - July 2004			
4006 ^{95*}	burned in Nuttall fire - July 2004			
4007 ^{95*}	burned in Nuttall fire - July 2004			
4008 ^{95*}	burned in Nuttall fire - July 2004 ⁴			
4009 ^{95*}	burned in Nuttall fire - July 2004			
4010 ^{95*}	N	N	N	N
4011 ^{95*}	removed from census - low occupancy ¹			
4012 ^{95*}	burned in Nuttall fire - July 2004			
4013 ^{96*}	removed from census - low occupancy ¹			
4014 ^{96*}	removed from census - low occupancy ¹			
4015 ^{96*}	burned in Nuttall fire - July 2004			
4016 ^{96*}	N	N	N	N
4017 ^{96*}	burned in Nuttall fire - July 2004			
4018 ^{96*}	burned in Nuttall fire - July 2004			
4019 ^{96*}	burned in Nuttall fire - July 2004			
4020 ^{96*}	removed from census - low occupancy ¹			
4021 ^{96*}	burned in Nuttall fire - July 2004			
4022 ^{98*}	removed from census - low occupancy ¹			
4023 ^{98*}	removed from census - low occupancy ¹			
4024 ^{98*}	removed from census - low occupancy ¹			
4025 ^{99*}	removed from census - low occupancy ¹			
4400 ⁸⁹	N	N	N	♀
4401 ^{94*}	burned in Nuttall fire - July 2004			
4402 ^{94*}	burned in Nuttall fire - July 2004			
4403 ^{94*}	removed from census - low occupancy ¹			
4404 ^{95*}	burned in Nuttall fire - July 2004			
4405 ^{95*}	burned in Nuttall fire - July 2004			
4406 ^{95*}	burned in Nuttall fire - July 2004			
4407 ^{95*}	burned in Nuttall fire - July 2004			
4408 ^{95*}	removed from census - low occupancy ¹			
4409 ^{95*}	burned in Nuttall fire - July 2004			

Spruce-Fir Non Construction Area (SFN), 2006				
Midden	Mar	Jun	Sep	Dec
4410 ^{95*}	located off-area, new number - 5410			
4411 ^{95*}	burned in Nuttall fire - July 2004			
4412 ^{95*}	burned in Nuttall fire - July 2004			
4413 ^{95*}	located off-area, new number - 5413			
4414 ^{95*}	burned in Nuttall fire - July 2004			
4415 ^{95*}	burned in Nuttall fire - July 2004			
4416 ^{95*}	burned in Nuttall fire - July 2004			
4417 ^{95*}	N	N	N	N
4418 ^{95*}	burned in Nuttall fire - July 2004			
4419 ^{95*}	burned in Nuttall fire - July 2004			
4420 ⁹⁰	burned in Nuttall fire - July 2004			
4421 ⁸⁶	burned in Nuttall fire - July 2004			
4422 ⁸⁶	burned in Nuttall fire - July 2004			
4423 ⁸⁶	burned in Nuttall fire - July 2004			
4424 ⁸⁶	burned in Nuttall fire - July 2004			
4425 ⁸⁷	burned in Nuttall fire - July 2004			
4426 ⁸⁶	burned in Nuttall fire - July 2004			
4427 ⁸⁶	burned in Nuttall fire - July 2004			
4428 ⁸⁶	burned in Nuttall fire - July 2004			
4429 ⁸⁶	burned in Nuttall fire - July 2004			
4430 ⁸⁶	burned in Nuttall fire - July 2004			
4431 ⁸⁶	burned in Nuttall fire - July 2004			
4432 ⁸⁶	burned in Nuttall fire - July 2004			
4433 ⁸⁷	burned in Nuttall fire - July 2004			
4434 ⁸⁶	burned in Nuttall fire - July 2004			
4435 ⁸⁶	burned in Nuttall fire - July 2004			
4436 ⁸⁶	burned in Nuttall fire - July 2004			
4437 ^{95*}	burned in Nuttall fire - July 2004			
4438 ^{90*}	burned in Nuttall fire - July 2004			
4439 ^{90*}	burned in Nuttall fire - July 2004			
4440 ⁹¹	burned in Nuttall fire - July 2004			
4441 ⁸⁶	burned in Nuttall fire - July 2004			
4442 ^{95*}	burned in Nuttall fire - July 2004			
4443 ⁸⁶	burned in Nuttall fire - July 2004			
4444 ⁸⁶	burned in Nuttall fire - July 2004			

Spruce-Fir Non Construction Area (SFN), 2006				
Midden	Mar	Jun	Sep	Dec
4445 ⁸⁶	burned in Nuttall fire - July 2004			
4446 ⁸⁶	burned in Nuttall fire - July 2004			
4447 ⁸⁶	burned in Nuttall fire - July 2004			
4448 ⁸⁶	burned in Nuttall fire - July 2004			
4449 ⁸⁶	burned in Nuttall fire - July 2004			
4450 ⁸⁶	burned in Nuttall fire - July 2004			
4451 ⁸⁸	burned in Nuttall fire - July 2004			
4452 ⁸⁶	burned in Nuttall fire - July 2004			
4453 ⁸⁶	burned in Nuttall fire - July 2004			
4454 ⁸⁶	removed from census - low occupancy ¹			
4455 ⁸⁶	burned in Nuttall fire - July 2004			
4456 ⁸⁶	burned in Nuttall fire - July 2004			
4457 ⁸⁶	burned in Nuttall fire - July 2004			
4458 ⁸⁶	removed from census - low occupancy ¹			
4459 ⁸⁶	burned in Nuttall fire - July 2004			
4460 ⁸⁷	burned in Nuttall fire - July 2004			
4461 ^{91*}	burned in Nuttall fire - July 2004			
4462 ⁹⁰	burned in Nuttall fire - July 2004			
4463 ⁹⁰	burned in Nuttall fire - July 2004			
4464 ⁹⁰	removed from census - low occupancy ¹			
4465 ^{90*}	removed from census - low occupancy ¹			S ²
4466 ⁸⁷	removed from census - low occupancy ¹			
4467 ⁸⁷	N	N	♂	Y
4468 ⁸⁷	removed from census - low occupancy ¹			
4469 ⁸⁷	N	N	N	S
4470 ⁸⁷	N	N	N	N
4471 ⁸⁷	removed from census - low occupancy ¹			
4472 ⁸⁷	N	N	N	N
4473 ⁸⁷	N	N	N	N
4474 ⁸⁶	N	N	N	N
4475 ⁸⁷	located off-area, new number - 5405			
4476 ^{95*}	removed from census - low occupancy ¹			
4477 ⁸⁷	N	N	N	N
4478 ^{90*}	removed from census - low occupancy ¹			
4479 ^{90*}	removed from census - low occupancy ¹			

Spruce-Fir Non Construction Area (SFN), 2006				
Midden	Mar	Jun	Sep	Dec
4480 ^{90*}	burned in Nuttall fire - July 2004			
4481 ⁸⁶	removed from census - low occupancy ¹			
4482 ⁸⁶	removed from census - low occupancy ¹			
4483 ⁸⁶	removed from census - low occupancy ¹			
4484 ⁸⁶	N	N	N	P
4485 ⁸⁶	removed from census - low occupancy ¹			
4486 ⁸⁶	removed from census - low occupancy ¹			
4487 ⁸⁶	located off-area, new number - 5487			
4488 ^{91*}	removed from census - low occupancy ¹			
4489 ^{91*}	removed from census - low occupancy ¹			
4490 ^{91*}	burned in Nuttall fire - July 2004			
4491 ^{91*}	N	N	N	P
4492 ^{91*}	removed from census - low occupancy ¹			
4493 ^{91*}	burned in Nuttall fire - July 2004			
4494 ^{91*}	burned in Nuttall fire - July 2004			
4495 ^{95*}	burned in Nuttall fire - July 2004			
4496 ^{93*}	removed from census - low occupancy ¹			
4497 ^{93*}	burned in Nuttall fire - July 2004			
4498 ^{93*}	burned in Nuttall fire - July 2004			
4499 ^{93*}	burned in Nuttall fire - July 2004			
# Mid	14	14	14	15
# Occ	0	0	1	4
% Occ	0%	0%	7%	27%
# Sq	0	0	1	4

- 1 These middens have been removed from regular censusing due to low occupancy. These middens were unoccupied for at least 12 consecutive quarterly censuses (three years) prior to removal. After 2003, all of the removed-low occupancy middens are checked each census. Any middens that become reoccupied are added back to regular censusing.
- 2 Midden 4465 - was previously removed from censusing due to low occupancy, but as of Dec 06 was re-occupied by an unmarked squirrel of unknown sex.

Off-Area Midden Occupancy, 2006				
Midden	Mar	Jun	Sep	Dec
TRC Area				
5101 ⁸⁹	♂ (M/rip RC 40)	♂ (M/rip RC 40)	♂ (M/rip RC 40)	♂ (M/rip RC 40)
5102 ^{98*}	P	N	N	♀
5103 ^{99*}	N	N	N	N
5104 ^{99*}	N	P ⁴	P	N
5105 ^{02*}	N	N	N	N
5106 ⁰²	N	♀ (rip/R RC 202) ⁵	N ⁵	N
5107 ⁰²	♂ (Gsq/Psq RC 714)	P ⁶	N	♂
5114 ⁸⁹	removed from census - low occupancy ¹			
5118 ^{94*}	N	N	N	S
5119 ^{89*}	N ²	♂ (Y/R RC 301)	♂ (Bsq/Rsq RC 720) ⁸	♂ (Wsq/Psq RC 742) ⁸
5120 ^{89*}	removed from census - too far off area			
5121 ^{89*}	N	N	♀ (rip/R RC 202)	♀ (P/Y 730)
5122 ⁸⁹	removed from census - low occupancy ¹			
5123 ⁸⁹	<i>Mid ROA - ♀ (B/W RC</i>	<i>♀ (B/W RC 23)³</i>	<i>♂ (M/W RC 456)^{3,9}</i>	<i>♀ (Ysq/Psq 731)⁹</i>
5124 ^{90*}	<i>removed from census - too far off area (ROA)</i>		<i>♀ (B/W RC 23)^{3, 12}</i>	<i>♀ (Y/O RC 740)³</i>
5125 ^{89*}	N	N	N	N
5126 ⁹¹	N	P	N	N
5127 ^{95*}	removed from census - low occupancy ¹			
5145 ^{91*}	N	N	N	N
5150 ^{91*}	♂ (Y/M RC 309)	N	N	P
5155 ^{93*}	N	N	N	♂
5157 ^{93*}	removed from census - low occupancy ¹			
TRN Area				
5200 ^{93*}	S	♀	♀ ¹⁰	S
5201 ^{99*}	♀ (Y/none RC 39)	♀ (Gsq/Rsq RC 725) ⁷	♀ (Gsq/Rsq RC 725) + 5J ⁷	N
5202 ^{99*}	burned in Nuttall fire - July 2004			
5203 ^{00*}	N	N	N	N
5221 ^{91*}	N	P	♀ (Y/rip RC 39) ¹¹	♀ (Y/rip RC 39)
5231 ^{96*}	N	N	N	♀ (M/M 749)
5232 ^{96*}	♂ (Bsq/Osq RC 718)	P ⁸	N	N

Off-Area Midden Occupancy, 2006				
Midden	Mar	Jun	Sep	Dec
SFC Area				
5302 ^{94*}	burned in Nuttall fire - July 2004			
5307 ^{95*}	removed from census - too far off area			
5311 ^{95*}	N	N	N	N
5313 ^{95*}	N	N	N	N
5350 ⁸⁶	N	N	N	♀
5351 ^{94*}	burned in Nuttall fire - July 2004			
5352 ^{94*}	burned in Nuttall fire - July 2004			
5353 ^{94*}	removed from census - too far off area			
5354 ^{94*}	burned in Nuttall fire - July 2004			
5355 ^{94*}	burned in Nuttall fire - July 2004			
5356 ^{94*}	burned in Nuttall fire - July 2004			
5357 ^{95*}	removed from census - low occupancy ¹			
5358 ^{95*}	burned in Nuttall fire - July 2004			
5359 ^{95*}	burned in Nuttall fire - July 2004			
5360 ^{96*}	burned in Nuttall fire - July 2004			
5361 ^{96*}	N	N	N	N
5362 ^{96*}	removed from census - low occupancy ¹			
5376 ⁸⁶	removed from census - low occupancy ¹			
5377 ⁸⁷	removed from census - low occupancy ¹			
5388 ^{92*}	removed from census - low occupancy ¹			
SFN Area				
5405 ⁸⁷	N	N	N	N
5410 ^{95*}	removed from census - low occupancy ¹			
5413 ^{95*}	N	N	N	N
5475 ⁸⁶	located on area - new number 4021			
5487 ⁸⁶	removed from census - low occupancy ¹			

Appendix B - Off Area (cont.)

- 1 These middens have been removed from regular censusing due to low occupancy. These middens were unoccupied for at least 12 consecutive quarterly censuses (three years) prior to removal. After 2003, all of the removed-low occupancy middens are checked each census. Any middens that become reoccupied are added back to regular censusing.
- 2 The signal for ♀(M/Gsq RC 153) was coming from a log near midden 5119. The female was last seen in Jan 06, no sign of residency at midden 5119 in March 06.
- 3 Midden 5123 - female (B/W RC 23) was residing here by March 06 and continued to reside there in June 06. This midden is technically too far off the study area, but the information is included as she resided on the study areas for many months previous. By Sep 05, this female was living at midden 5124, also too far off the study area, so she was not counted in population totals. The collar only for female (B/W RC 23) was found on 7 Oct 06 near midden 5124. There was no clear evidence of predation, so her fate remains unknown.
- 4 Midden 5104 - 6 squirrels: 2 radio-collared females, 3 radio-collared males, and 1 unkn, were seen in a breeding chase at this midden on 6 Jun 06. However, it was unclear if any of them were actually resident in the midden.
- 5 Midden 5106 - female (rip/Red RC 202) was previously resident at midden 1156, but by Jun 06, she appeared to shift her residency to midden 5106.
- 6 Midden 5107 - male(Gsq/Psq RC 714) was previously resident at this midden, but by Jun 06, he had moved to a midden off to the west of the monitored areas and was residing there.
- 7 Midden 5232 - male(Bsq/Osq RC 718) was previously resident at this midden, but by Jun 06, he had moved to a midden to the north of the monitored areas, near the Columbine cabins.
- 8 Midden 5119 - male (Bsq/Rsq RC 720) was previously resident at midden 1160. The fate of former resident male (Y/R RC 309) is unknown; his collar was found at the base of a nest tree on 26 Aug 06 and he was not seen thereafter.
- 9 Midden 5123 - new resident male (M/W RC 456) was last seen/signal heard in summer 2005 as resident of midden 1144. His radio collar was replaced and ID was confirmed on 21 Sep 06. Collar and remains of male (M/W RC 456) were found at the base of a nest tree near the midden, likely an avian predation by evidence found.
- 10 Midden 5200 - resident female has a natural mark - rip in Right ear.
- 11 Midden 5221 - female (Y/rip RC 39) appears to have moved back to one of her old middens, she was last confirmed here in Jun 05, but has lived nearby at midden 5201, 1121, and appears to regularly move around the whole area. She was seen caching cones here at 5221 in Sep 06, so was called resident.
- 12 Middens 5123 and 5124 are technically too far off the monitored areas to be counted in population totals. Information is included here as residents were marked animals that were previously resident on the monitored areas, but these animals are not included in any analyses or counts in this report.

Appendix C. Red squirrel populations (including juveniles still living at maternal middens) on the areas being monitored by the Red Squirrel Monitoring Program, from March 2002 through December 2006.

Date	TRC	TRN	SFC	SFN	TOTAL
Mar 2002	21	7	4	4	36
Jun 2002	22 + 23J	6 + 4J	4	2	34 + 27J
Sep 2002	22 + 3J/SA	5	4 + 2J/SA	3	34 + 5J/SA
Dec 2002	14	4	2	1	21
Mar 2003	11	4	2	1	18
June 2003	9	2	2	0	13
Sep 2003	7 + 7J	3	1 + 4J	4	26
Dec 2003	11	6	8	11	36
Mar 2004	11	5	8	8	32
Jun 2004	8 + 2J	5 + 3J	6	9	28 + 5J
Sep 2004	12 + 2J	4 + 5J	3	0	19 + 7J
Dec 2004	12	3	3	0	18
Mar 2005	12	3	4	0	19
Jun 2005	14	3	2	0	19
Sep 2005	9 + 2J	4 + 1J	1	0	14 + 3J
Dec 2005	9	3	2	0	14
Mar 2006	9	1	2	0	12
Jun 2006	8	1	2	0	11
Sep 2006	10	3	4	1	18
Dec 2006	13	8	8	4	33

Appendix D: Quarterly occupancy maps for Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) on RSMP study areas, Pinaleño Mountains, Arizona, March 2006 - December 2006.

Appendix E: Measures of spatial distribution on the monitored areas, 2006

E-1. Crude Density

a) middens

b) squirrels

E-2. Local density and nearest neighbor distances of middens and squirrels.

Appendix E-1a: Crude Density (middens/ha) of *middens*, in quarterly censuses, for each of the monitored areas for December 2005 through December 2006.

DATE	TRC	TRN	SFC	SFN
Area ¹ (after Jul 04)	51.1 ha	19.8 ha	58.5	34.1
Dec 2005	0.70	1.36	0.36	0.41
Mar 2006	0.70	1.36	0.36	0.41
Jun 2006	0.70	1.36	0.36	0.41
Sep 2006	0.70	1.36	0.38	0.41
Dec 2006	0.70	1.41	0.38	0.44

Appendix E-1b: Crude Density (squirrels/ha) of *red squirrels* (including juveniles at natal middens) in each of the monitored areas for December 2005 through December 2006.

DATE	TRC	TRN	SFC	SFN
Area ¹ (after Jul 04)	51.1 ha	19.8 ha	58.5	34.1
Dec 2005	0.18	0.15	0.03	0.00
Mar 2006	0.18	0.05	0.03	0.00
Jun 2006	0.16	0.05	0.03	0.00
Sep 2006	0.20	0.15	0.07	0.03
Dec 2006	0.25	0.40	0.14	0.12

¹ The reduction in the size of the monitored areas after July 2004 was due to the Nuttall Fire. The areas removed were severely burned and are no longer suitable habitat.

Appendix E-2. Local Density (number within 100m radius) and Nearest Neighbor Distances of *middens* and *squirrels* (number of occupied middens), December 2005 through December 2006.

TRC Area										
Middens						Squirrels				
Month	# Mid	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean	# RS	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean
Dec 05	36	4.4	0.40	44.6	4.04	9	0.4	0.24	115.4	9.87
Mar 06	36	4.4	0.40	44.6	4.04	9	0.6	0.24	97.3	10.81
Jun 06	36	4.4	0.40	44.6	4.04	8	0.5	0.19	88.6	9.10
Sep 06	36	4.4	0.40	44.6	4.04	10	0.9	0.31	97.4	13.50
Dec 06	36	4.4	0.40	44.6	4.04	13	2.2	0.44	72.9	13.70

TRN Area										
Middens						Squirrels				
Month	# Mid	Mean local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean	# RS	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean
Dec 05	27	4.3	0.24	50.2	3.07	3	0.3	0.33	92.6	15.00
Mar 06	27	4.4	0.27	50.1	3.07	1	1.0	--	90.2	--
Jun 06	27	4.4	0.27	50.1	3.07	1	1.0	--	216.1	--
Sep 06	27	4.4	0.27	50.1	3.07	3	1.0	0.58	115.8	50.3
Dec 06	28	4.7	0.32	49.0	3.06	8	1.8	0.37	59.0	9.45

Appendix E-2 (con't.)

SFC Area										
Middens						Squirrels				
Month	# Mid	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean	# RS	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean
Dec 05	21	1.7	0.29	79.0	9.17	2	0.0	0.00	654.2	0.00
Mar 06	21	1.7	0.29	79.0	9.17	2	0.0	0.00	654.2	0.00
Jun 06	21	1.7	0.29	79.0	9.17	2	0.0	0.00	654.2	0.00
Sep 06	22	1.8	0.31	76.4	9.09	4	0.5	0.29	203.3	101.11
Dec 06	22	1.8	0.31	76.4	9.09	8	1.3	0.49	175.1	58.52

SFN Area										
Middens						Squirrels				
Month	# Mid	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean	# RS	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (m)	Std. Error of the Mean
Dec 05	14	1.1	0.23	88.7	18.65	0	--	--	--	--
Mar 06	14	1.1	0.23	88.7	18.65	0	--	--	--	--
Jun 06	14	1.1	0.23	88.7	18.65	0	--	--	--	--
Sep 06	14	1.1	0.23	88.7	18.65	1	0.0	--	1443.0	--
Dec 06	15	1.3	0.19	78.3	17.04	4	0.5	0.29	265.8	154.4

Appendix E-2 (con't.)

All Areas Combined (including only middens on the monitored areas)										
Middens						Squirrels				
Month	# Mid	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean	# RS	Mean Local Dens.	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean
Dec 05	98	3.3	0.22	59.8	4.05	14	0.4	0.17	187.5	53.34
Mar 06	98	3.4	0.23	59.8	4.05	12	0.5	0.19	189.5	63.16
Jun 06	98	3.4	0.23	59.8	4.05	11	0.4	0.15	203.0	68.53
Sep 06	99	3.4	0.23	59.4	4.03	18	0.8	0.21	198.7	77.25
Dec 06	101	3.5	0.23	57.7	3.84	33	1.7	0.24	117.7	25.38

Appendix F: Reproductive success on the monitored areas, 2006.

F-1: Breeding chases seen on or near the monitored areas.

F-2: Litters seen on or near the monitored areas.

F-3: Reproductive status and age statistics by census quarter.

Appendix F-1: Breeding Chases Observed - 2006

Descriptions of mating chases observed on or near the monitored areas in 2006.

<u>Date</u>	<u>Midden</u>	<u>Notes</u>
7 May 06	1121	Female (ID 39) resident was being chased by male (ID 40) and male (ID 316). The males were heard making buzz calls.
20 May 06	8034	A large breeding chase was observed in an area across Swift Trail, approximately 450 m West from the TRC area. The resident female (ID 228) was pursued by 13 males, 6 of whom were resident on the TRC and adjacent areas (Male IDs: 14, 40, 309, 316, 718, 723).
31 May 06	BC-41	A breeding chase was observed at a midden NE of the monitored areas, near the Columbine cabins. The resident female (ID 678) was chased by 4 males, one of whom was resident adjacent to the TRN area (Male ID: 718).
6 Jun 06	5201 area	Two breeding chases were seen in this area over the course of the day. First a chase with 3 unmarked squirrels was seen (1 scrotal male and 1 unkn. chasing another unkn. squirrel) and buzz calls were heard. [Note: an adult female with physical signs of recent breeding, was live-trapped and tagged near this midden on 8 Jun 06]. The second breeding chase was observed later in the day to the South of the midden. Female (ID 39) was being chased by 3 marked males (IDs: 14, 719, 720).

Appendix F-2: Litters observed on or near the monitored areas.

<u>Date</u>	<u>Midden</u>	<u>Notes</u>
9 Aug 06	1153	2 Juveniles confirmed for resident female (ID 202) at maternity nest 11019. The juveniles were agile and ranging far from the nest, they likely emerged 1-2 weeks prior.
31 Aug 06	5201	5 Juveniles confirmed for resident female (ID 725) at maternity nest 15214. The juveniles appeared to have very recently emerged from the nest, as they were tentative and did not stray too far from cavity entrance.
4 Sep 06	5121	2 Juveniles confirmed for resident female (ID 23) at maternity nest 15138. The juveniles were older, possibly near weaning, as the mother would allow them near her in the tree, but not close enough to touch her.

Appendix F-2: (cont.)

<u>Date</u>	<u>Midden</u>	<u>Notes</u>
Females that did not have litters confirmed or did not reproduce.		
May 06	1177	Female (ID 668) resident was not seen on the monitored areas after May 06. Her reproductive condition prior to disappearance was unknown.
Jun 06	1116	Female (ID 716) resident was thought to be pregnant on 8 Jun 06 live-trapping and release, but no longer appeared to be so on 30 Jun 06 live-trapping and release. She appeared to have lost her litter.
Sep 06	5221	Female (ID 39) was seen feeding and foraging in close proximity to two older juveniles/weanlings on two occasions in early Sep 06. This adult female was thought to have recently lactated, determined from live-trapping and release, on 19 Sep 06. She likely had a successful litter, but this was never confirmed.
Sep 06	3374	Female (ID 653) was lactating upon live-trapping and release on 19 Sep 06. On 22 Sep 06, vocalizations from more than one squirrel were heard from the night nest. However, no juveniles were ever detected on several subsequent observations.
Sep 06	1185	Unmarked female was thought to have recently lactated based on visual assessment only. However, no further evidence of her reproduction was known.
Sep 06	3310	Unmarked female was thought to have recently lactated based on visual assessment only. However, no further evidence of her reproduction was known.
Sep 06	5200	Unmarked female had no signs of recent reproduction based on visual assessment only.

Appendix F-3:

Reproductive status and age information for squirrels on or near the monitored areas, for quarterly census months, 2006. Only information on the final resident each month is given. Middens that were determined to be active based on sign alone (Y) are not included. Information gathered on non-resident squirrels is also excluded. Therefore the total number of active middens for a given month may be higher than the totals of the numbers seen here. **Information for off-area middens (5000s) is included in Appx F3a-c.** Information on reproductive condition is taken from trapping records or visual assessment if no trapping data is available.

Appendix F-3a: Female reproductive information

Reproductive Status	March			June			September			December		
	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.
reproductive ²				3								
lactating ²							3					
recent lactation ²							3					
past lactation ²												
non-reproductive ¹	2						1			2	0/8	2
unknown	3			3						1		1

1 J/SA - Juveniles are still living at the maternal midden. Subadult squirrels have dispersed and are living independently. Subadults may be identified by examination during trapping or visual cues: generally smaller size, whiter fur on underside, thinner tail, head may appear slightly large (out of proportion).

2 Reproductive may indicate estrus or pregnancy. Lactating indicates current lactation, milk expressed or other visual cues. Recent lactation includes females that have lactated in the current breeding season. Past lactation indicates lactation in a previous breeding season (at least 1 year prior).

Appendix F-3b: Male reproductive information.

Reproductive Status	March			June			September			December		
	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.
scrotal	7			7			1			3	0/2	
partially scrotal										1		
non-reproductive ¹							6	0/3	1	5	0/8	
unknown	3			2		1	1	1		1	1	

Appendix F-3c: Age information for final monthly resident females, males, and squirrels of unknown sex combined

March			June			September			December		
Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.	Adult	J/SA ¹	Unkn.
15	0/0	2	15	0/0	1	15	5/8	1	16	0/21	5

1 J/SA - Juveniles are still living at the maternal midden. Subadult squirrels have dispersed and are living independently. Subadults may be identified by examination during trapping or visual cues: generally smaller size, whiter fur on underside, thinner tail, head may appear slightly large (out of proportion).

Appendix G. Weather information for RSMP study areas, Pinaleño Mountains, Arizona, January - December, 2006.

G-1: Monthly weather summaries

G-2: Accumulated snow depths

Appendix G-1. Monthly weather summaries - January through December, 200.

Note: Averages are calculated based on the total number of records collected per month. As of 25 September 2000, weather stations are recording data at 1 hour intervals: between approximately 600 and 700 records per month. Data from Emerald Peak are missing from January and February 2006 due to equipment failure, and from June and July 2006 due to lightning strike.

	Month	Biology Camp	Emerald Peak
Temperature (°C) average (max; min)	January	0.15 (13.4; -12.1)	– ¹
	February	-1.2 (11.0; -8.1)	– ¹
	March	-0.9 (11.0; -14.0)	-2.4 (8.1; -15.1)
	April	5.4 (15.7; -8.2)	3.7 (12.5; -10.8)
	May	10.3 (20.4; -0.5)	8.8 (17.3; -1.5)
	June	14.5 (24.3; 6.9)	– ¹
	July	14.3 (23.7; 6.4)	– ¹
	August	11.7 (19.2; 7.3)	10.4 (16.7; 6.4)
	September	8.9 (16.7; 2.1)	7.7 (14.2; 1.0)
	October	5.7 (17.5; -4.6)	4.5 (14.6; -4.8)
	November	3.5 (13.9; -18.7)	2.3 (12.1; -20.7)
	December	-1.2 (10.8; -13.7)	-2.8 (6.9; -14.7)

	Month	Biology Camp	Emerald Peak
Wind Speed (m/sec), maximum(max. gust)	January	2.7(9.8)	– ¹
	February	2.7 (13.0)	– ¹
	March	2.2 (11.2)	3.1 (11.6)
	April	2.2 (10.7)	3.6 (11.6)
	May	2.2 (10.7)	4.5 (13.0)
	June	1.8 (9.8)	– ¹
	July	1.8 (7.6)	– ¹
	August	1.3 (5.8)	4.0 (7.6)
	September	1.8 (11.2)	4.5 (11.2)
	October	1.8 (8.9)	5.8 (20.9)
	November	2.7 (15.2)	4.5 (16.1)
	December	2.7 (9.6)	4.9 (17.7)
Wind, Most Common Direction	January	W	– ¹
	February	W	– ¹
	March	W	N
	April	W	N
	May	W	SE
	June	E	– ¹
	July	E-SE	– ¹
	August	E-SE	N
	September	W-NW	N
	October	W	N
	November	E	SE
	December	E	N

	Month	Biology Camp	Emerald Peak
Maximum Snow Depth (cm) Forest/Clearing	January		
	February	10,9	7,10
	March	39,43	44,69
	April	0,5	32,25
	May		
	June		
	July		
	August		
	September		
	October		
	November		
	December		
Rain Fall (mm) Total	January	_ 2	_ 2
	February	_ 2	_ 2
	March	_ 2	_ 2
	April	_ 2	_ 2
	May	8.4	9.8
	June	16.8	- 1,- 2
	July	175.0	- 1,- 2
	August	164.8	214.4
	September	50.6	59.6
	October	3.8	2.4
	November	_ 3	_ 3
	December	_ 3	_ 3

	Month	Biology Camp	Emerald Peak
Relative Humidity (%) average (max; min)	January	37.4 (100.0; 9.0)	– ¹
	February	36.4 (98.0; 6.0)	– ¹
	March	59.9 (100.0; 13.0)	52.6 (95.0; 5.0)
	April	39.8 (100.0; 13.0)	35.2 (96.0; 6.0)
	May	38.9 (94.0; 14.0)	33.0(94.0; 8.0)
	June	45.8 (98.0; 15.0)	– ¹
	July	73.5 (100.0; 30.0)	– ¹
	August	91.6 (100.0; 46.0)	84.9 (99.0; 34.0)
	September	80.3 (100.0; 29.0)	71.4 (99.0; 19.0)
	October	68.3 (100.0; 13.0)	60.1 (98.0; 6.0)
	November	47.8 (99.0; 14.0)	39.0 (95.0; 6.0)
	December	52.9 (100.0; 6.0)	46.4 (95.0; 4.0)
Dew Point (°C) average (max; min)	January	-14.3 (1.1; -30.6)	– ¹
	February	-14.4 (-0.7; -33.6)	– ¹
	March	-9.1 (0.9; -25.1)	-12.9 (-1.0; -34.4)
	April	-8.6 (3.1; -22.9)	-12.3 (0.8; -32.7)
	May	-3.9 (8.4; -18.2)	-7.8 (5.8; -25.6)
	June	1.9 (12.1; -10.5)	– ¹
	July	9.0 (16.7; 2.4)	– ¹
	August	10.2 (15.3; 2.3)	7.8 (13.1; -1.7)
	September	5.2 (13.9; -7.0)	2.0 (10.2; -15.9)
	October	-0.8 (10.2; -21.6)	-4.7 (8.9; -30.9)
	November	-7.5 (2.3; -24.2)	-12.1 (0.4; -32.2)
	December	-12.0 (0.1; -31.7)	-16.0 (-1.4; -39.0)

- 1 For Emerald Peak: from January and February 2006 due to equipment failure, and from June and July 2006 due to lightning strike.
- 2 The rain gauges were disconnected in Dec 05. All moisture during the winter and spring was in the form of snow. The rain gauges were reconnected in May 06.
- 3 The rain gauges were disconnected in Nov 06 and will be reconnected in the spring after the snow melt. Any precipitation in November was snow, so not included here.

Appendix G-2. Monthly maxima, minima and averages for accumulated snow depth. Data are from snow poles in Spruce-Fir (SF) and Mixed Conifer (TR) habitats from locations in the forest (F) and in clearings (C).

Month	Hab	Loc	N ¹	Average snow depth (cm)	Maximum snow depth (cm)	Minimum snow depth (cm)
Feb 2006	TR	C	1	9	9	9
Feb 2006	TR	F	1	10	10	10
Feb 2006	SF	C	1	10	10	10
Feb 2006	SF	F	1	7	7	7
Mar 2006	TR	C	3	34.8	43	28
Mar 2006	TR	F	3	29.3	39	20.5
Mar 2006	SF	C	3	47.6	69	35
Mar 2006	SF	F	3	40.7	44	36
Apr 2006	TR	C	1	5	5	5
Apr 2006	TR	F	1	0	0	0
Apr 2006	SF	C	1	25	25	25
Apr 2006	SF	F	1	32	32	32

- 1 N represents the number of snow pole readings in each area per month. There are 8 sets of snow poles (a set = 1 forest and 1 clearing) on the monitored areas: 3 in the TR habitat and 5 in the SF habitat. Not all sets of poles may be read every month.