THE UNIVERSITY OF

ARIZONA

MT. GRAHAM RED SQUIRREL MONITORING PROGRAM

Annual Report
for
2001

Submitted: 17 May 2002

Prepared by:

Dr. John L. Koprowski, Principal Investigator
Vicki L. Greer, Biologist - Senior
Marit I. Alanen, Biologist
Kelly A. Hutton, Biologist
Carol A. Schauffert, Biologist

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INTRODUCTION

The University of Arizona's Mount Graham Red Squirrel Monitoring Program continued monitoring the status of Mt. Graham red squirrels (*Tamiasciurus hudsonicus grahamensis*) near the Mount Graham International Observatory (MGIO) in 2001. The MGIO is located along a ridge extending westward from Hawk Peak in the Graham (Pinaleño) Mountains of southeastern Arizona. In 2001, 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 continued on the Large Binocular Telescope (LBT) throughout 2001, with mainly interior building work. In addition, work on the buried commercial power line to MGIO took place during most of 2001, with completion in November.

The Monitoring Program was established in 1989 to meet the requirements of the MGIO Management Plan (USDA Forest Service 1989), with the principal goal of detecting possible effects of construction on the Mt. Graham red squirrel. Four areas encompassing 337.9 ha were defined in the vicinity of the MGIO site to monitor red squirrel populations (Figure 1). These areas include two forest habitat types: transitional (TR) or mixed conifer forest and spruce-fir (SF) forest. The TR habitat, below 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, above 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. For comparison, a *non-construction* area beyond 300 m from the MGIO site or the access road was defined in each habitat. This resulted in four monitored areas: TR habitat construction (TRC) (83.6 ha), TR habitat non-construction (TRN) (24.4 ha), SF habitat construction (SFC) (101.0 ha) and SF habitat non-construction (SFN) (128.9 ha). After the Clark Peak fire in spring 1996, the amount of habitat available for use by red squirrels was reduced to 49.1 ha on the TRC area and 76.1 on the SFC area. The amount of available habitat on the TRN and SFN areas remained unchanged. The total amount of available habitat on all four monitored after 1996 was 278.5 ha. In 2000, the size of the four monitored areas was further refined through GPS mapping: TRC - 51.1ha, TRN - 21.0 ha, SFC - 76.0 ha, and SFN - 104.4, for a total of 252.5ha.

A census of all middens within the monitored areas was conducted in March, June, September, and December. In addition, middens within 100 m of the LBT site or the access road were censused during months of construction: January, February, April, May, July, August, October and November. Census data were analyzed to determine the potential effects of construction on squirrel numbers, distribution, and density.

Efforts were continued to describe and quantify other environmental parameters that may affect squirrel populations on Mt. Graham. Conifer seeds and mushrooms (epigeous or above-ground fungi) were collected at all 28 sites (Figure 1).

Weather data was collected by two computerized weather stations, one each in the TR and SF habitats. During the winter months, snow depths were recorded from up to eight sites throughout the monitored areas.

The Monitoring Program has developed and maintains a database using Global Positioning System (GPS) and Geographic Information System (GIS) applications. By the end of 2001, all of the major features on the monitored areas were mapped using GPS, including middens, food resource plots, roads, trails, and MGIO boundaries.

All use of the terms *construction* or *construction areas* refers to those areas within 300 m of previous MGIO construction activity. All use of the terms *red squirrel* or *squirrel* refers to the Mt. Graham red squirrel unless otherwise noted.

Percentages are rounded to the nearest whole number, therefore totals may be slightly more or less than 100%.

METHODS

Red squirrels cache conifer cones in selected locations known as middens. Middens are easily recognized by the presence of cached cones and piles of discarded cone scales. The Monitoring Program defines a midden site as a circular area with a 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 an activity area shows no improvement in the two quarterly censuses following initial location, it will be removed.

At the end of each calender 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, it is removed from the regular censusing list. These “removed” middens will checked once a year during the winter (December) census. If any of these middens become re-occupied, they are added back to the regular censusing list.

All statistical analyses were conducted using standard tests found in SAS and/or SigmaStat statistical software. The significance level for all tests was $P \leq 0.05$.

Red Squirrel Food Resources

Conifer Seed Production

The Monitoring Program began collecting quantitative data in 1993 to determine the abundance of some red squirrel food resources. Conifer seeds and mushrooms were selected because they provide the majority of the red squirrels' diet and are readily sampled. In 2000, seed production was estimated from 28 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 2000 crop were collected from the seed traps in June 2001. The conifer

seeds contained in each trap were separated by species and individually tested (squashed) 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 the total number of viable seeds because some seeds may have been preyed upon within the trap. Estimates of the seedfall for each conifer species were calculated as the average number of viable seeds from all three traps on each plot. The seeds of white pine and ponderosa pine are not readily dispersed by wind due to their large size. Because of this, the crops of these species are under represented in the seed trap samples. Both of these species may be important local food supplies for red squirrels, but at present there is no reliable method for estimating the size of the crops.

Mushroom Production

As in previous years, mushrooms were collected from plots 1 m by 100 m (0.01 ha) at two week intervals, from July through September. Mushrooms were collected from a total of 28 plots including the four plots added on the TRC and SFC in late 1996 (after the Clark Peak fire). These plots are oriented east to west and centered on seed collection plots. Collections were restricted to genera of mushrooms used by red squirrels on Mt. Graham or in other regions (Table 1). Collected mushrooms were separated by plot and genus, and the wet weights were measured. For most genera, dry weight was calculated by multiplying the wet weight by a wet weight/dry weight ratio determined from previous samples on Mt. Graham. Dry weights were still measured for those genera with small numbers of specimens previously collected (<50).

Because seeds for a given year are not collected and analyzed until the following spring, there is a one year delay in the presentation of seed data. 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 the number and distribution of occupied middens on each monitored area. In March, June, September, and December 2001, all middens were visited at least once to determine occupancy. In addition, middens within 100 m of construction activity or the access road were censused during months of construction activity: January, February, April, May, July, August, October, and November. If a midden appeared to be occupied on the basis of feeding sign (cone scales, dried mushrooms, and conifer clippings) or caching, every attempt was made on subsequent midden visits to observe the squirrel and to determine its sex, age, and reproductive condition. During winter months, visual verification was often not practical, and determination of occupancy, in some cases, was based on the presence and age of feeding sign, tracks, and snow tunnels.

All middens on the monitored areas were classified as either occupied, unoccupied, or possibly occupied, with an occupied midden representing one squirrel. A midden was

considered to be unoccupied when there was no squirrel or squirrel sign present. A midden was considered to be possibly occupied when red squirrel sign was found but the 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 and midden occupancy relative to distance from construction 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 2000, the number of occupied middens and the sexes of resident squirrels were determined. The December occupancy was then compared to occupancy for June 2001. A squirrel was considered to have survived the 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 survival.

Spatial Distribution

Three methods were used to describe the 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. No allowance was made for differences in habitat quality among the 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*. The 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 these measurements of density 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). It is also about 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, expressed in meters, from a focal *midden* or *squirrel* to the nearest *midden* or *squirrel*. The 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 from the mapped coordinates and compared among areas and habitats using ANOVA tests. To determine the LDs and NNDs of some of the middens and squirrels on the monitored areas, it was necessary to include some off-area middens that were within 100 m of a focal midden.

Reproductive Activity and Success

In 2001, the breeding condition of adult male and female squirrels, and litter activity was recorded when observed. By examining the squirrel's condition through binoculars, the reproductive status of a female was determined to be non-lactating, reproductive (vulva visibly swollen or appearance of pregnancy), lactating, or post-lactating. The reproductive status of male squirrels was also determined by visual assessment and was recorded as "testes non-scrotal" (non-reproductive) or "testes scrotal" (sexually active).

Trapping and Marking

In accordance with Federal Fish and Wildlife Permit #TE041875-1, using accepted methods (Koprowski, *in press*) red squirrels are trapped using Tomahawk wire-mesh box-type live traps, baited with peanuts, peanut butter, apples, mushrooms, or cones. Once captured, red squirrels are transfered to a cloth-handling cone for tagging and morphological measurements. Squirrels are tagged with small numbered metal ear-tags threaded with colored plastic washers for easy distance identification. Squirrels are normally released with in 2-3 minutes of transfer to the cloth-handling bag and are observed for several minutes to ensure good condition.

Mapping

Almost all middens and other physical features on the monitored areas have been mapped using GPS with an accuracy of ± 5m. Universal Transverse Mercator (UTM) coordinates from the GPS files were used to compute local densities, nearest neighbor distances, and distance to construction. GPS data were collected using the Pathfinder Pro system from Trimble Navigation, Inc. Readings were taken within 5 meters of the midden center. Date, time, and location descriptions were noted in the field for later reference. Final midden locations were based on an average from a minimum of 200 three-dimensional data points. Locations were

differentially corrected using base station (Prescott National Forest, 344 S. Cortez St., Prescott, AZ) files provided by the Forest Service. Maps were produced using PC-ARC Info and Arc-View (ESRI 1995).

Weather Data

Weather data were collected using two Davis Instruments weather stations. One station is located along the abandoned Forest Service road north of Emerald Peak on the SFC area; the other is located at the Biology Camp on the TRC area. The stations record air temperature (high, low, and average), wind speed, wind direction, rainfall, relative humidity and barometric pressure. Data were collected at 30 minute intervals until September 2000, when the stations were recalibrated to record at 60 minute intervals. Snow depth (cm) was recorded from four snow pole pairs located in the SF habitat, one pair at the 3050 m level on the access road, and three snow pole pairs in the TR habitat. Each pair consists of a pole in a clearing or canopy opening and a second pole nearby in the forest.

RESULTS

Red Squirrel Food Resources

2000 Conifer Seed Production

The total 2000 seed crop on the monitored areas was, on average, 95% lower than the 1999 seed crop, with the largest decreases seen in the SF habitat (Table 2, Figures 2a-c, Appendix A).

For the 2000 corkbark fir seed crop, decreases were seen from the 1999 crop in the TR habitat. In 2000, there was a slight increase in the number of corkbark fir seeds found in the SF habitat, as compared to no seeds in the 1999 samples. Overall, there was a 96% decrease in the corkbark fir crop from 1999 to 2000.

As was seen in 1999, there were no Douglas-fir seeds in any of the samples from the SF habitat in 2000. There was a 95% decrease in Douglas-fir crops in the TR habitat from 1999 to 2000.

Overall, there was a 94% decrease in 2000 Engelmann spruce crops from the previous year. There were no Engelmann seeds in the samples from the TR habitat, which accounts for most of the decrease from 1999 to 2000. In the SF habitat, there was a 74% decrease in Engelmann sprice seen from 1999 to 2000.

The 2000 overall seed crop was approximately 5% of the seed crop seen in 1999. Seed production in 2000 was the lowest since data collection began in 1993. (Table 2, Figures 2a-c, Appendix A).

2001 Mushroom Production

Overall annual mean mushroom production in 2001 was more than double that seen in 2000, and was the third highest since data collection began in 1994. There were increases in both habitats in 2001 as compared to 2000. In the SF habitat, this is a reversal of the year to year decreases seen since 1996 (Figure 3). Most of this increase in annual production ($\bar{x}$ wet weight) for the SF habitat in 2001 was accounted for by the SFC area, which was significantly greater than the SFN area (Table 3). The production between the areas in the TR habitat was not statistically different (Table 3).

On the TRC area, three genera, *Russula, Cortinarius,* and *Lycoperdon* accounted for 69% of production. On the TRN area, *Russula, Cortinarius,*and *Amanita* accounted for 74% of total production. *Russula, Lycoperdon,* and *Clitocybe* accounted for 74% of the production on the SFC area. On the SFN area, *Lycoperdon, Russula,* and *Clitocybe* accounted for 67% of the total production (Table 4).

Population Biology

Midden Occupancy

Four quarterly censuses (Mar, Jun, Sep, and Dec) of all middens on or near the monitored areas were made in 2001 (Appendix B-1). In addition, the 27 middens (by Dec 01) within 100 m of the access road or construction were censused during months of construction activity (Appendix C).

From December 2000 to December 2001, the number of red squirrels on the monitored areas decreased from 65 to 43, a 34% decrease. On the TRC area, the highest number of squirrels (23 Ad + 2SA) was seen in Dec 2001, and the lowest number was 18 squirrels seen in March. June was the month with the highest number of squirrels (12 Ad) on the TRN area. The lowest squirrel numbers (8) on the TRN area were seen in September. The highest number of squirrels on the SFC area was seen in September (3Ad + 4 Juv) with the lowest (3Ad) seen in March. On the SFN area, numbers of squirrels remained fairly constant at three to four adults, with the exception of September when no squirrels were found to be resident on the area (Figure 4, Appendix B-1,C,D,E).

No newly established middens were found in 2001. However two middens, previously removed from regular censusing because of low occupancy, became reoccupied (Table 5). As a result, the proportion of middens in each of the monitored areas remained fairly stable. The proportion of squirrels in each of the two habitats remained fairly stable from June to December 2001, with small changes within the TR habitat (Table 6).

In June 2001, there were no significant differences in the proportion of middens occupied *within* the TR or SF habitats. However, there was a significantly greater proportion of middens occupied in the TR habitat when compared to the SF habitat in June 2001. In December 2001 there was a significantly higher proportion of middens occupied on the TRC area than on the TRN area. There were no differences in December within the SF habitat. (Table 7).

The average distance to construction of occupied middens and unoccupied middens was not significantly different on either the TRC or SFC areas for June and December 2001. On the TRC area in both June and December, occupied middens were slightly closer to construction than unoccupied middens. In June 2001, on the SFC area, occupied middens were closer to construction than unoccupied middens by an average of 56 m. In December, however, unoccupied middens were, on average, 36 m closer to construction than occupied middens (Table 8).

Overwinter Survival

There were a significantly higher number of squirrels that survived the winter of 2000-2001 on the TRC area than on the TRN area. There were no significant differences in overwinter survival between the SFC and SFN areas (Table 9). The average proportion of survival was 57% in the TR habitat and 13% in the SF habitat. For comparison, the average proportion of survival from the previous winter (1999-2000) was 78% in the TR habitat and 41% in the 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.

Crude Density

The crude density of middens and squirrels was plotted to provide a visual representation of the potential (number of middens) versus actual (number of squirrels) midden occupancy (Figure 5). Between December 2000 and December 2001, the crude density of *middens* decreased slightly on all areas due to the removal of low occupancy middens from regular censusing (Figure 5, Appendix F-1a).

The crude density of *squirrels* on all areas decreased from December 2000 to December 2001. The TRC was the exception, with a slight increase seen by December 2001 (Figure 5, Appendix F1-b).

Local Density

The December 2001 overall mean local density ($\bar{x}$ LD) of *middens* was lower (4.2), than in December 2000 (4.6), mainly due to middens removed from regular censusing due to low occupancy. There were significant differences in the local density of middens among the four areas. The SFN area had the lowest $\bar{x}$ LD (1.5), and the TRN area had the highest (6.6) (Table 10, Figure 6, Appendix F-2).

The $\bar{x}$ LD of *squirrels* (occupied middens) on all areas in December 2001 was 2.4, which is a slight increase from 2.2 in December 2000. The TR habitat had a significantly greater $\bar{x}$ LD of squirrels than the SF habitat (Table 10, Figure 6, Appendix F-2).

Nearest Neighbor Distance

The overall $\bar{x}$ NND of *middens* increased slightly from December 2000 to December 2001 (48.6 to 53.3 m). The $\bar{x}$ NND in the SF habitat was significantly longer than in the TR habitat in December 2001 (Table 11, Figure 7, Appendix F-2).

The $\bar{x}$ NND of *squirrels* (occupied middens) for all areas decreased slightly from 85.9 m in December 2000 to 83.3 m in December 2001. The $\bar{x}$ NND of the TRC, TRN, and SFC areas was similar in December 2001, but the $\bar{x}$ NND of squirrels in the SFN area was significantly longer (Table 11, Figure 7, Appendix F-2).

Reproductive Activity and Success

Only one breeding chase was observed in 2001, in June on the TRC area (Appendix G-1). The earliest date a scrotal male was seen was 5 June in the TR habitat, somewhat later than seen in previous years. All nine of the resident males identified during the June census were scrotal. The latest date a scrotal male was seen was 8 December on the the TRC area (Appendix G-3b). Again, this seems later than observations in previous years.

The earliest a lactating female was observed was 5 June on the TRC area and the latest was on 10 September, also on the TRC area. During the June census, of the nine adult females identified as residents, two were reproductive and two were lactating. By September, four of the eight resident females were classified as lactating, and two were classified as post-lactating. In December, out of 18 resident adult females, none were lactating and six were post-lactating. (Appendix G-3a).

Direct evidence of 7 litters (19 offspring) was seen during censuses or other monitoring activities. The earliest litters were seen during early September in both habitats, somewhat later than seen in previous years (Appendix G-3c).

For reproductive status and age information, it must be noted that the numbers do not necessarily represent the residents of the same middens from census to census. Because the squirrels are not marked, information is provided only for a general picture of the reproductive and age status of the squirrels on the monitored areas.

Trapping and Marking

Marked Squirrels

One post-lactating female, weighing 260g, was trapped on 8 September 2001. This female was fitted with ear tags (174Red/174Red) and released in 3.5 minutes. The female was calm in the handling cone and was in good condition upon release (Appendix B-1). In addition to the ear tagged squirrel, there were four resident squirrels on or near the monitored areas in 2001 with natural identifying marks such as an ear notch or a short tail (Appendix H-1).

Mapping

No significant changes in maps of the monitored areas were made in 2001, as all major features (middens, roads, trails, construction areas, etc.) have been mapped in previous years.

Weather Data

Weather data were collected nearly continuously in 2001 from two weather stations located at the biology camp (TR habitat) and near Emerald Peak (SF habitat). The maximum temperature recorded was 32.5°C in June at the biology camp and the minimum temperature recorded was -18.3°C in February on Emerald Peak. The maximum average monthly temperature was 14.8°C in June at the biology camp and the minimum average monthly temperature was -5.5°C in January on Emerald Peak. (Figure 8, Appendix I-1). The maximum total monthly rainfall was recorded in August, with 113.2 mm at the Biology Camp. September was the driest month with 5.6mm recorded at the biology camp and 7.6mm on Emerald Peak (Figure 9, Appendix I-1). Snow depth was recorded from the eight pairs of snow poles on the monitored areas. The average accumulated snow depth from November 2000 through May 2001 ranged from 0 cm to 132.5 cm (Figure 10, Appendix I-2). For comparison, average accumulated snow depths for the same period in 1999-2000 ranged from 0 cm to 43.0 cm, and in 1998-1999

depths ranged from 0.0 cm to 37.7 cm. Data on wind chill temperatures, wind direction and speed, humidity, and barometric pressure were also collected (Appendix I-1).

Insect Outbreaks on the Monitored Areas

Infestations of bark beetles (*Drycoetes confuses* and *Dendroctonus rufipennis*) continued on parts of the monitored areas in 2001, 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 refer to the yearly forest health report prepared by the USFS Southwestern Region Entomology and Pathology Office in Flagstaff, AZ. The 2001 report will soon be available online at http://www.for.nau.edu/usfs/r3_fpm/.

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Table 1. Mushroom genera known to be food resources of red squirrels, and collected from the food resource plots.

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 2. Mean filled conifer seed production, 2000. The percent column represents the proportion of each seed species on an individual area.

		Corkbark fir		Douglas-fir		Engelmann spruce	
Area/Habitat	n	$\bar{x}$ 1000 seeds/ha	%	$\bar{x}$ 1000 seeds/ha	%	$\bar{x}$ 1000 seeds/ha	%
TRC	5	2.6	33.3	5.3	66.7	0.0	0.0
TRN	4	6.6	100.0	0.0	0.0	0.0	0.0
SFC	7	0.0	0.0	0.0	0.0	1.9	100.0
SFN	12	2.2	16.6	0.0	0.0	11.1	83.4
TR Habitat	9	4.4	60.0	2.9	40.0	0.0	0.0
SF Habitat	19	1.4	15.3	0.0	0.0	7.7	84.7

Table 3. Mean annual mushroom production, 2001.

Area/Habitat	n	$\bar{x}$ Wet weight (Kg/ha)	$\bar{x}$ Dry weight (Kg/ha)
TRC	5	83.28 ± 12.717	8.32 ± 1.161
TRN	4	136.37 ± 48.427	12.98 ± 4.667
SFC	7	61.07 ± 13.907	7.16 ± 1.595
SFN	12	18.45 ± 4.752	2.22 ± 0.525
TR Habitat	9	106.88 ± 22.864	10.39 ± 2.162
SF Habitat	19	34.15 ± 7.480	4.04 ± 0.857

Wilcoxon Test within TR:

Wet Weight	*Z = 0.6124*	P = 0.540
Dry Weight	*Z = 0.8573*	P = 0.391

Wilcoxon Test within SF:

Wet Weight	*Z = 2.4932*	**P = 0.013**
Dry Weight	*Z = 2.4932*	**P = 0.013**

Table 4. Mean annual mushroom production (wet weight Kg/ha) of selected mushroom genera known to be food resources for red squirrels, 2001. The proportions of the three most available genera on each area are in bold.

	TRC		TRN		SFC		SFN	
Genus	$\bar{x}$ Kg/ha	%	$\bar{x}$ Kg/ha	%	$\bar{x}$ Kg/ha	%	$\bar{x}$ Kg/ha	%
Amanita	3.96	4.8	**8.59**	6.3	0.32	0.5	3.17	17.1
Auricularia	5.46	6.6	7.04	5.2	1.15	1.9	0.10	0.6
Boletus	1.88	2.3	0.00	0.0	2.86	4.7	0.46	2.5
Clavaria	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Clitocybe	2.67	3.2	2.81	2.1	**10.72**	17.5	**3.86**	20.9
Cortinarius	**16.33**	19.6	**31.88**	23.4	9.70	15.9	2.32	12.6
Gastroid sp.	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Hydnum	0.00	0.0	3.70	2.7	0.00	0.0	0.00	0.0
Lactarius	3.58	4.3	6.47	4.7	0.14	0.2	0.00	0.0
Leccinum	0.00	0.0	5.37	3.9	1.21	2.0	0.00	0.0
Lycoperdon	**8.97**	10.8	2.33	1.7	**12.72**	20.8	**4.45**	24.1
Pholiota	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0
Ramaria	0.07	0.1	0.00	0.0	0.28	0.5	0.00	0.0
Russula	**32.03**	38.5	**60.03**	44.0	**21.97**	36.0	**4.05**	22.0
Suillus	8.34	10.0	8.15	6.0	0.00	0.0	0.03	0.2
Total	83.28		136.37		61.07		18.44	

Table 5. Number and discovery status of red squirrel middens on each of the monitored areas, 2000-2001.

		Midden Status				
Year	Area	Old	Newly Found	Newly Established	Re-Occupied[2]	Total
2000	TRC	40	0	0	1	41
	TRN	43	0	0	0	43
	SFC	83	0	0	1	84
	SFN	75	0	0	0	75
	Total	241	0	0	2	243
2001	TRC	40[1]	0	0	0	40
	TRN	42[1]	0	0	0	42
	SFC	68[1]	0	0	2	70
	SFN	51[1]	0	0	0	51
	Total	201[1]	0	0	2	203

1 The difference in the number of middens from the end of 2000 to the beginning of 2001 reflects middens removed from regular censusing after the December 2000 cenus due to low occupancy.

2 These are middens that were previously removed from regular censusing due to low occupancy, but have become re-occupied.

Table 6. Proportion of the total area, total number of middens, and total number of squirrels[1] found on each of the monitored areas, 2000-2001.

	Area		Jun 2000 Middens		Jun 2000 Squirrels[1]		Dec 2000 Middens		Dec 2000 Squirrels[1]	
	ha	%[2]	N	%[2]	N	%[2]	N	%[2]	N	%[2]
TRC	51.1	20	40	17	31	38	41	17	21	32
TRN	21.0	8	43	18	29	36	43	18	21	32
SFC	76.0	30	83	34	12	15	84	35	12	18
SFN	104.4	41	75	31	9	11	75	31	11	17
Total	252.5		241		81		243		65	

	Area		Jun 2001 Middens		Jun 2001 Squirrels[1]		Dec 2001 Middens		Dec 2001 Squirrels[1]	
	ha	%[2]	N	%[2]	N	%[2]	N	%[2]	N	%[2]
TRC	51.1	20	40	20	19	49	40	20	22	55
TRN	21.0	8	42	21	12	31	42	21	9	23
SFC	76.0	30	69	34	4	10	70	34	4	10
SFN	104.4	41	51	25	4	10	51	25	4	10
Total	252.5		202[3]		39		203		39	

1 Juveniles living with their mothers are not counted in the number of squirrels. Number of squirrels is equal to the number of occupied middens.

2 All percentages are rounded to the nearest whole number.

3 The difference in the number of middens from December 2000 to June 2001 reflects middens removed from regular censusing due to low occupancy after the December 2000 census.

Table 7. Number and percent of available middens occupied, 2001.

	June			December		
Area/Habitat	# middens	# occupied	% occ	# middens	# occupied	% occ
TRC	40	19	48	40	22	55
TRN	42	12	29	42	9	21
SFC	69	4	6	70	4	6
SFN	51	4	8	51	4	8
TR Habitat	82	31	38	82	31	38
SF Habitat	120	8	7	121	8	7
TR + SF	202	39	19	203	39	19

Chi Square:

JUNE

within TR	X^2=3.122	df=1	*P*=0.077
within SF	X^2=0.197	df=1	*P*=0.659
between habitats	X^2=30.317	df=1	***P*<0.0001**

DECEMBER*

within TR	X^2=9.820	df=1	***P*=0.002**
within SF	X^2=0.217	df=1	*P*=0.642

* No between habitat comparisons were made due to within habitat differences.

Table 8. Mean distance from construction to occupied and unoccupied middens on the TRC and SFC areas, June and December 2001.

		June		December	
Area	Midden Status	n	$\bar{x}$ ± se (m)	n	$\bar{x}$ ± se (m)
TRC	Occupied	19	204.0 ± 13.49	22	207.6 ± 12.33
	Unoccupied	21	224.7 ± 12.27	18	223.7 ± 13.64
SFC	Occupied	4	92.8 ± 29.30	4	180.3 ± 13.21
	Unoccupied	65	148.3 ± 9.58	66	143.9 ± 9.66

ANOVA:

JUNE

TRC	F = 1.30	df = 1	P = 0.262
SFC	F = 1.99	df = 1	P = 0.163

DECEMBER

TRC	F = 0.77	df = 1	P = 0.387
SFC	F = 0.84	df = 1	P = 0.363

Table 9. Overwinter survival of red squirrels on the monitored areas, 2000-2001.

Area/Habitat	Number of Squirrels Dec 2000	Number of Squirrels Surviving Jun 2001	% survival
TRC	21	16	76.2
TRN	21	8	38.1
SFC	12	2	16.7
SFN	11	1	9.1
TR Habitat	42	24	57.1
SF Habitat	23	3	13.0

Chi-square Test

within TR $X^2 = 4.76$ df = 1 **P = 0.029**

Fisher Exact Test*

within SF P = 1.000

* The Fisher Exact test was used for this analysis due to the small sample size in these areas.

Table 10. Mean Local Density of middens and red squirrels (occupied middens) on the monitored areas, 2000 and 2001.

	December 2000				December 2001			
	Middens		Squirrels		Middens		Squirrels	
Area/Habitat	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$	n	$\bar{x} \pm se$
TRC	41	5.9 ± 0.37^{b}	21	2.8 ± 0.22^{a}	40	5.8 ± 0.39^{b}	22	3.1 ± 0.34^{a}
TRN	43	6.7 ± 0.27^{a}	21	3.4 ± 0.25^{a}	42	6.6 ± 0.27^{a}	9	$2.2 \pm 0.43^{a,b}$
SFC	84	4.9 ± 0.22^{c}	12	0.7 ± 0.19^{b}	70	3.9 ± 0.21^{c}	4	0.5 ± 0.29^{b}
SFN	75	2.2 ± 0.15^{d}	11	0.2 ± 0.12^{b}	51	1.5 ± 0.17^{d}	4	0.5 ± 0.29^{b}
TR Habitat	84	6.3 ± 0.23	42	3.1 ± 0.17	82	6.2 ± 0.24	31	2.9 ± 0.28
SF Habitat	159	3.6 ± 0.17	23	0.4 ± 0.12	121	2.9 ± 0.18	8	0.5 ± 0.19
TOTAL [1]	243	4.6 ± 0.16	65	2.2 ± 0.20	203	4.2 ± 0.18	39	2.4 ± 0.27

ANOVA:		**2000**			**2001**	
LD of Middens						
among all areas	F=68.48	df=3	***P< 0.0001***	F=72.35	df=3	***P< 0.0001***
LD of Squirrels						
among all areas	F=42.46	df=3	***P< 0.0001***	F=7.03	df=3	***P= 0.0008***

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 11. Mean Nearest Neighbor Distance of middens and red squirrels (occupied middens) on the monitored areas, 2000 and 2001.

	December 2000				December 2001			
	Middens		Squirrels		Middens		Squirrels	
Area/Habitat	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se
TRC	41	41.9 ± 2.32[b]	21	58.1 ± 4.81[c]	40	42.1 ± 2.43[c]	22	51.9 ± 4.04[b]
TRN	43	40.4 ± 1.95[b]	21	57.6 ± 3.11[c]	42	40.8 ± 2.06[c]	9	66.1 ± 7.41[b]
SFC	84	48.9 ± 2.32[a,b]	12	108.7 ± 16.88[b]	70	54.4 ± 2.81[b]	4	115.6 ± 43.30[b]
SFN	75	56.8 ± 2.71[a]	11	168.0 ± 23.15[a]	51	70.7 ± 5.02[a]	4	262.2 ± 108.37[a]
TR Habitat	84	41.1 ± 1.50	42	57.9 ± 2.83	82	41.5 ± 1.58	31	56.0 ± 3.71
SF Habitat	159	52.6 ± 1.79	23	137.1 ± 15.19	121	61.3 ± 2.76	8	188.9 ± 60.71
TOTAL[1]	243	48.6 ± 1.33	65	85.9 ± 7.33	203	53.3 ± 1.89	39	83.3 ± 14.95

ANOVA:	**2000**			2001		
NND of Middens among all areas	F=8.25	df=3	***P< 0.0001***	F=15.05	df=3	***P< 0.0001***
NND of Squirrels among all areas	F=20.89	df=3	***P< 0.0001***	F=10.44	df=3	***P< 0.0001***

a,b,c 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 seed fall, 1993-2000. Note: scales are different for figures 2a-c.

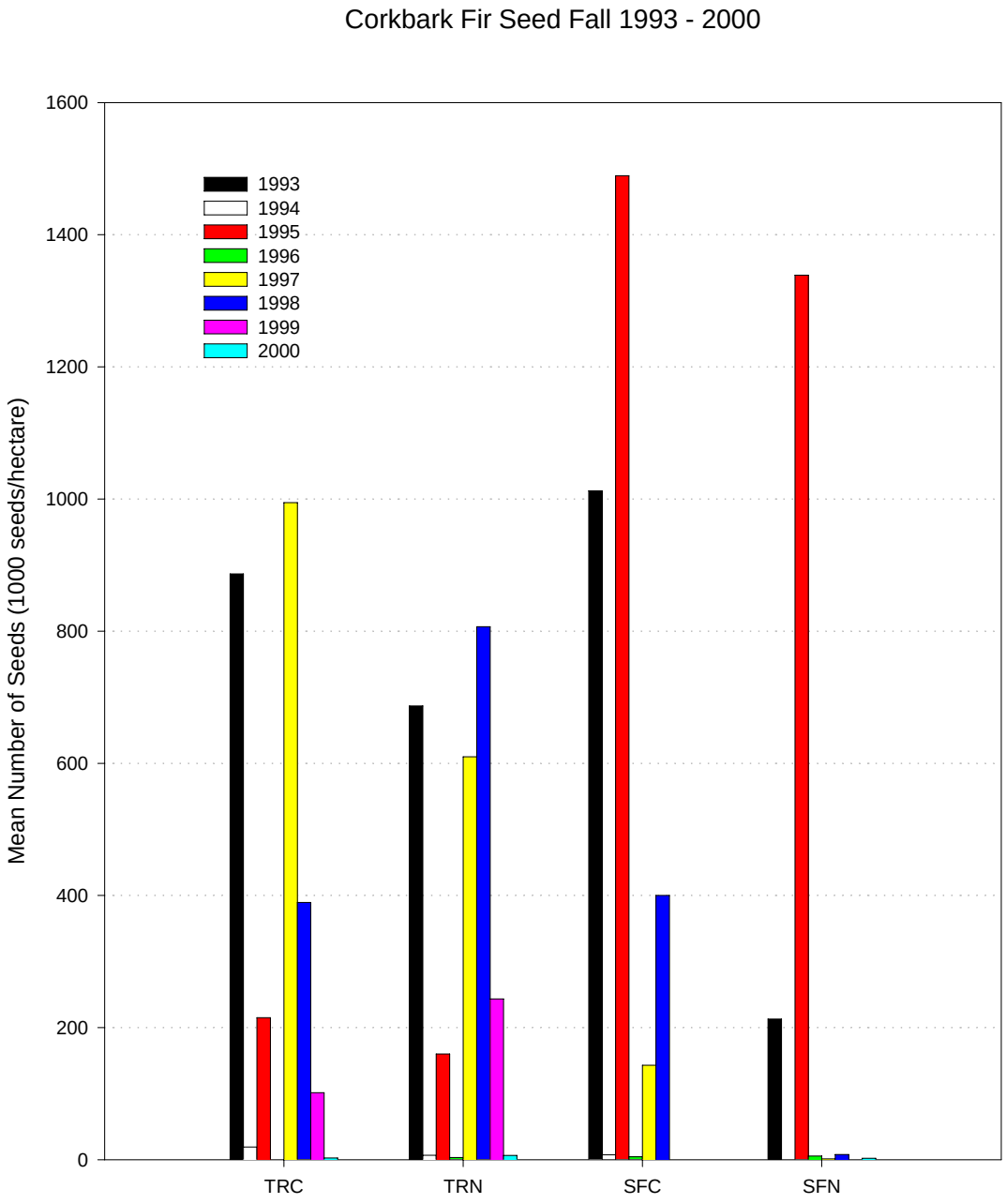


Figure 2b. Douglas-fir seed fall, 1993-2000. Note: scales are different for figures 2a-c.

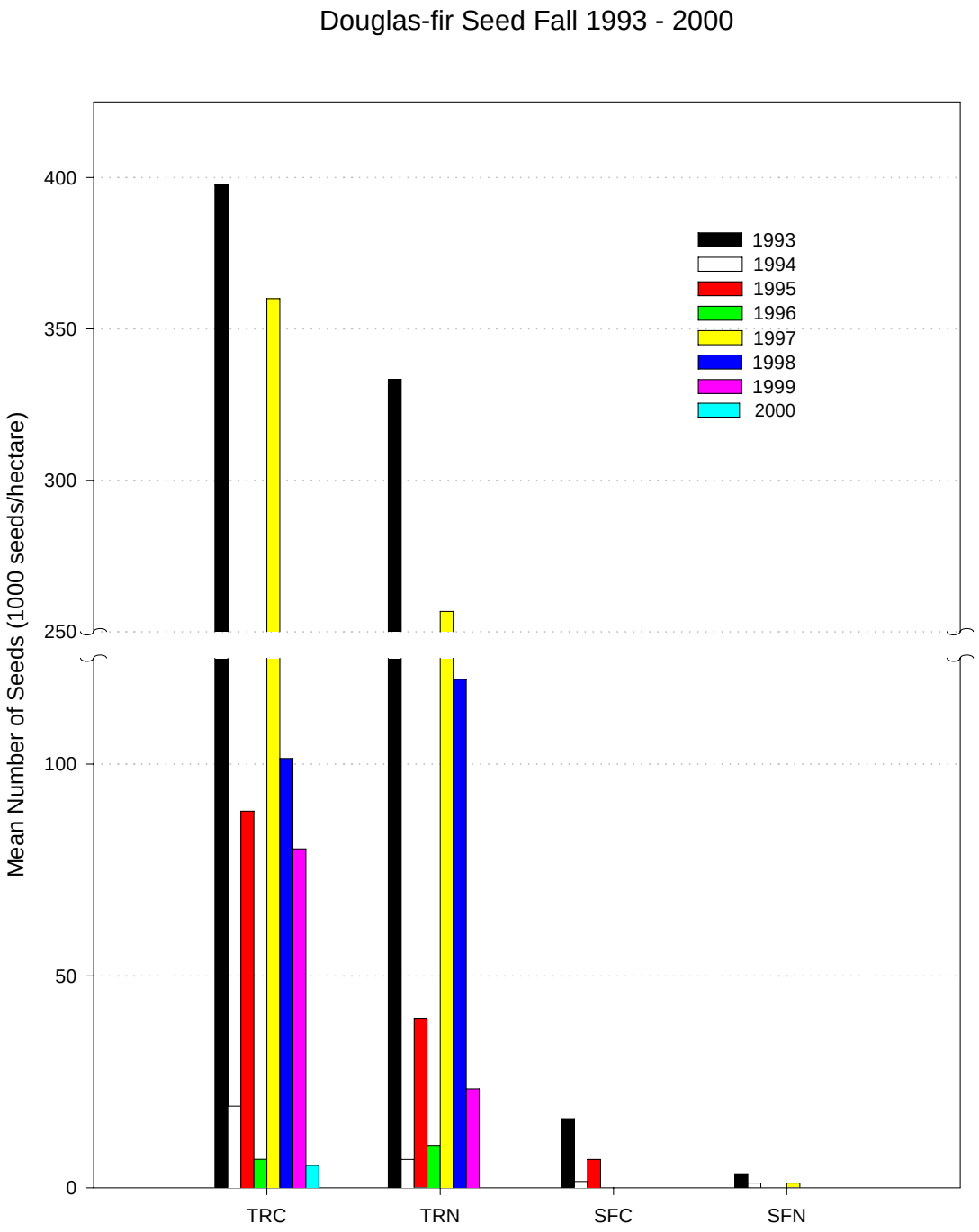


Figure 2c. Engelmann spruce seed fall, 1993-2000. Note: scales are different for figures 2a-c.

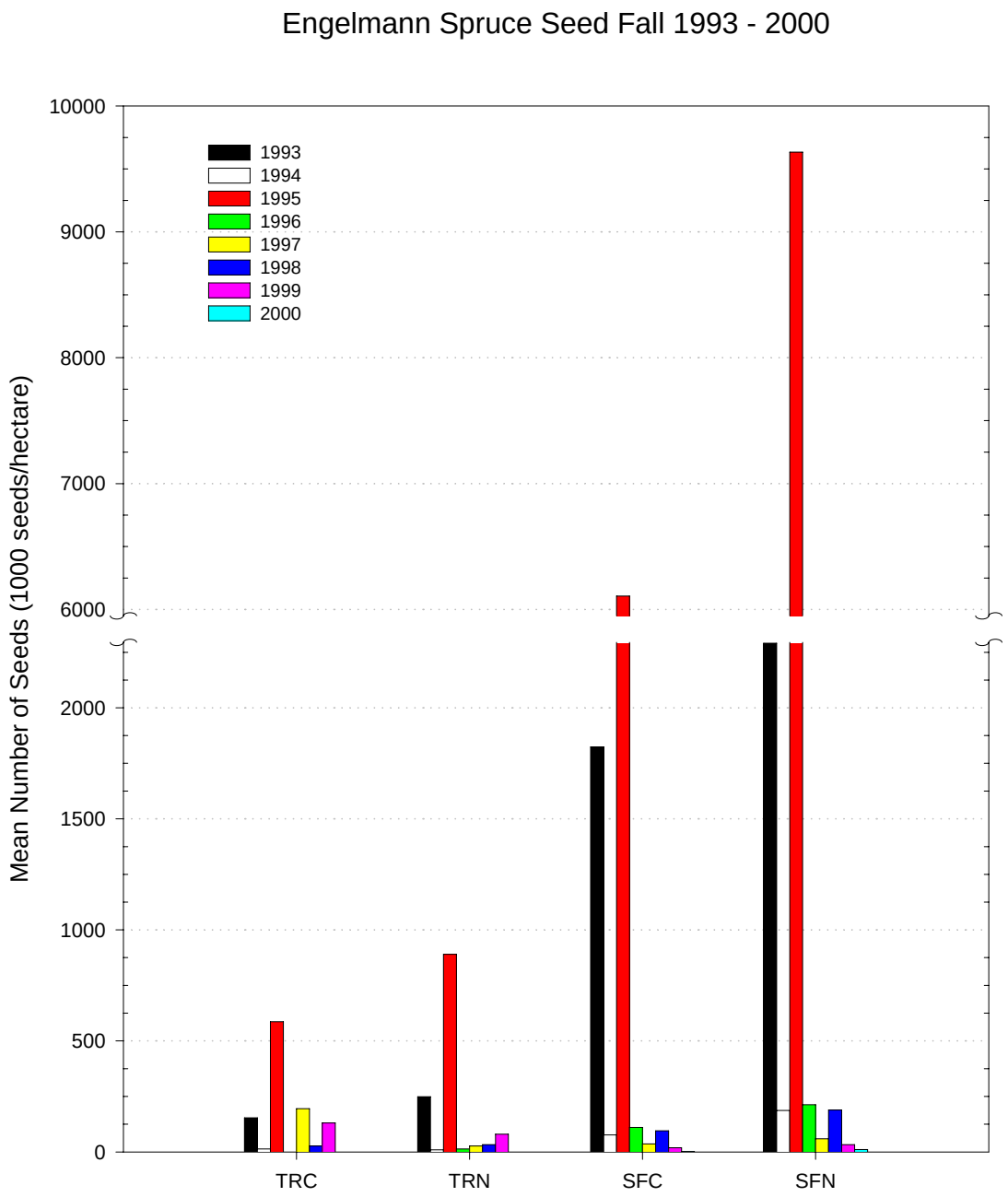


Figure 3. Mushroom crops, 1994-2001.

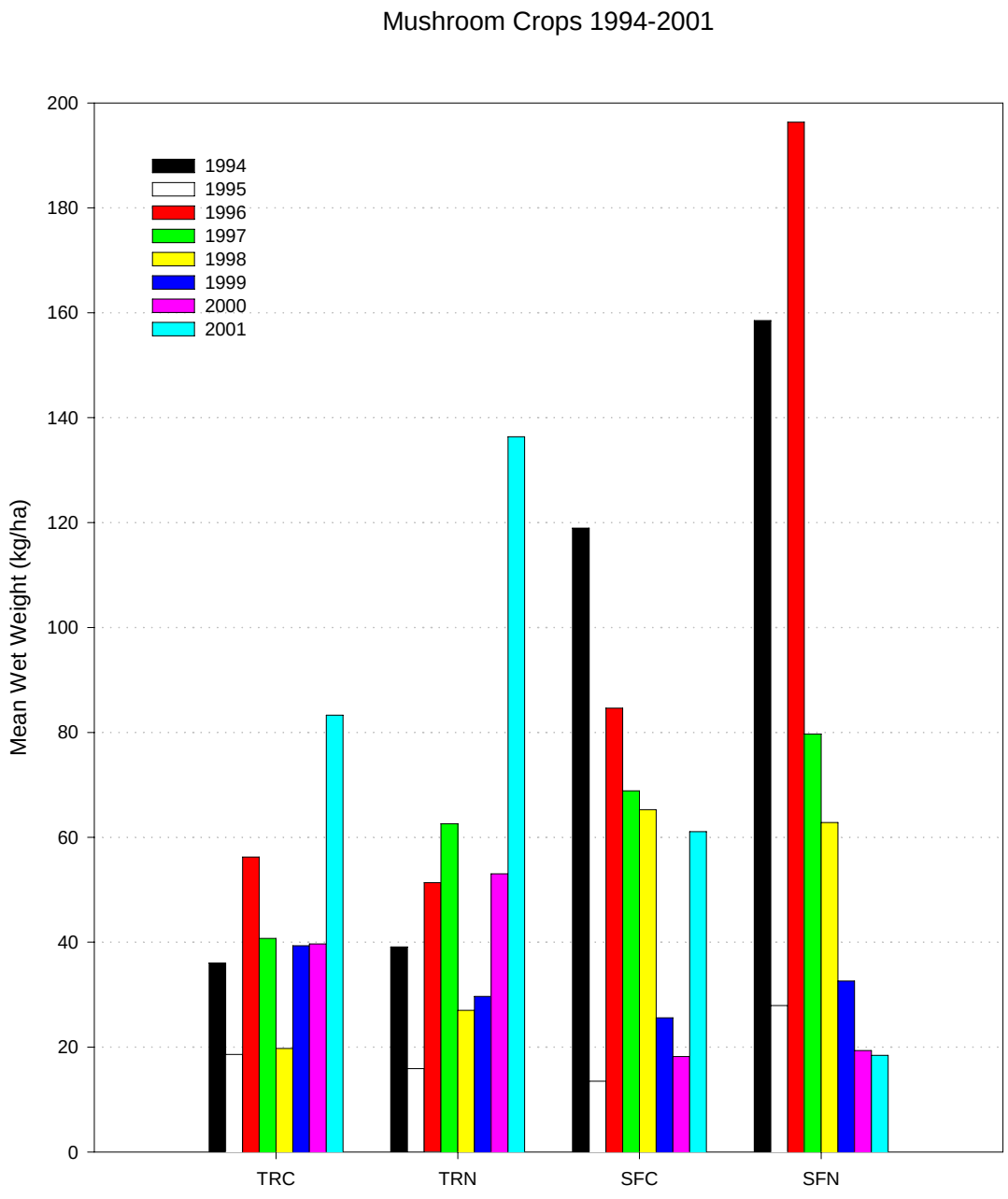


Figure 4. Red squirrel populations (including juveniles) on the monitored areas, December 2000 - December 2001.

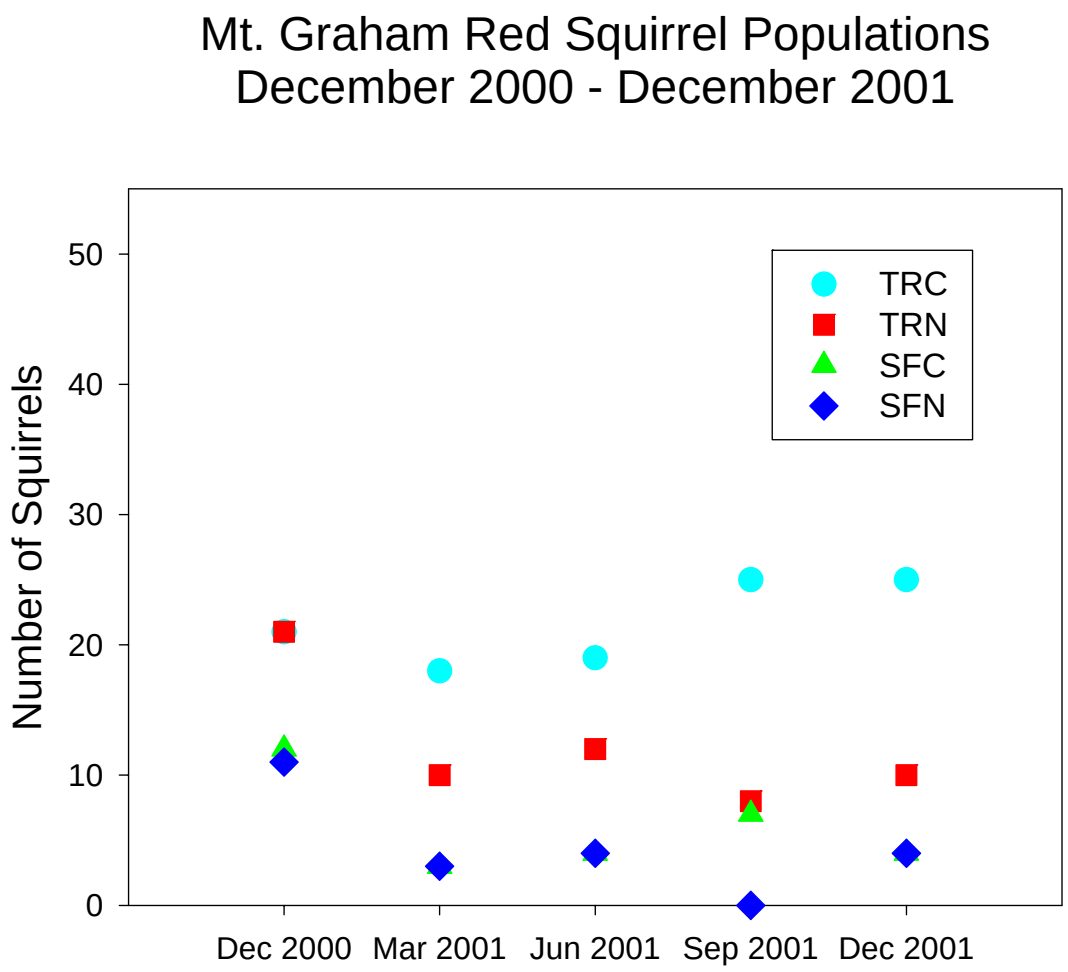


Figure 5. Crude density of middens and squirrels, 2000-2001.

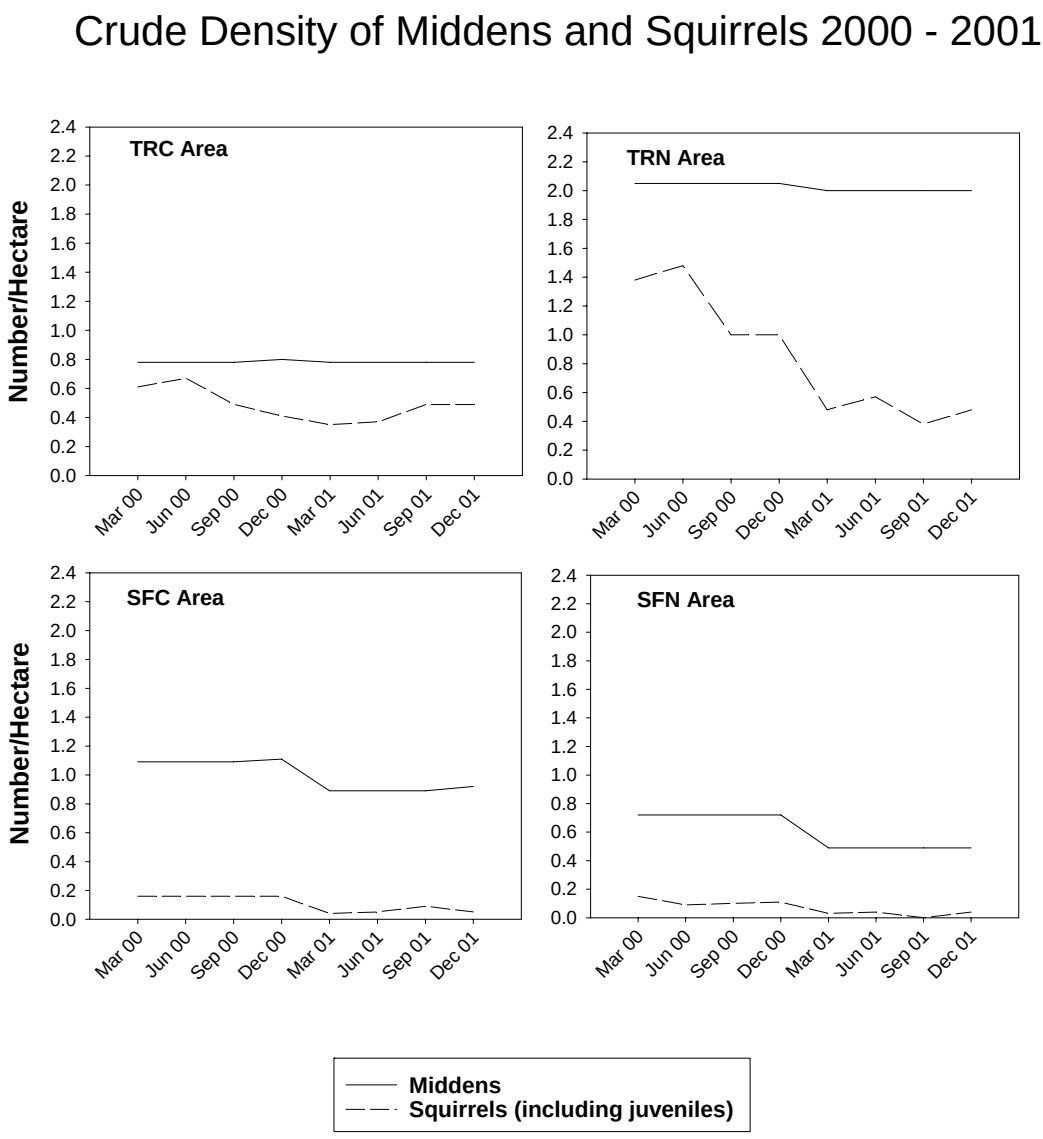


Figure 6. Local density of middens and squirrels, 2000-2001

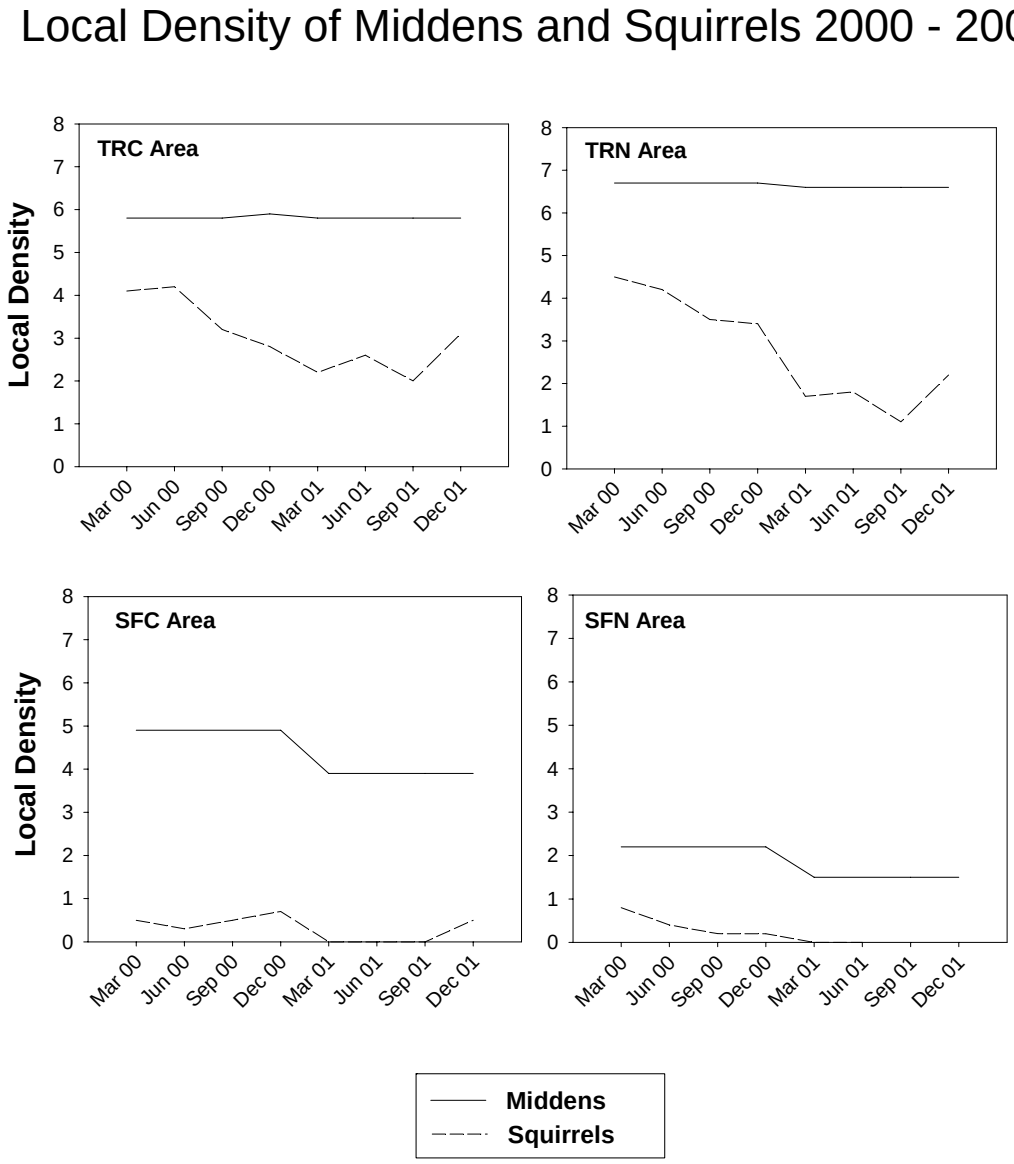


Figure 7. Nearest neighbor distance of middens and squirrels, 2000-2001.

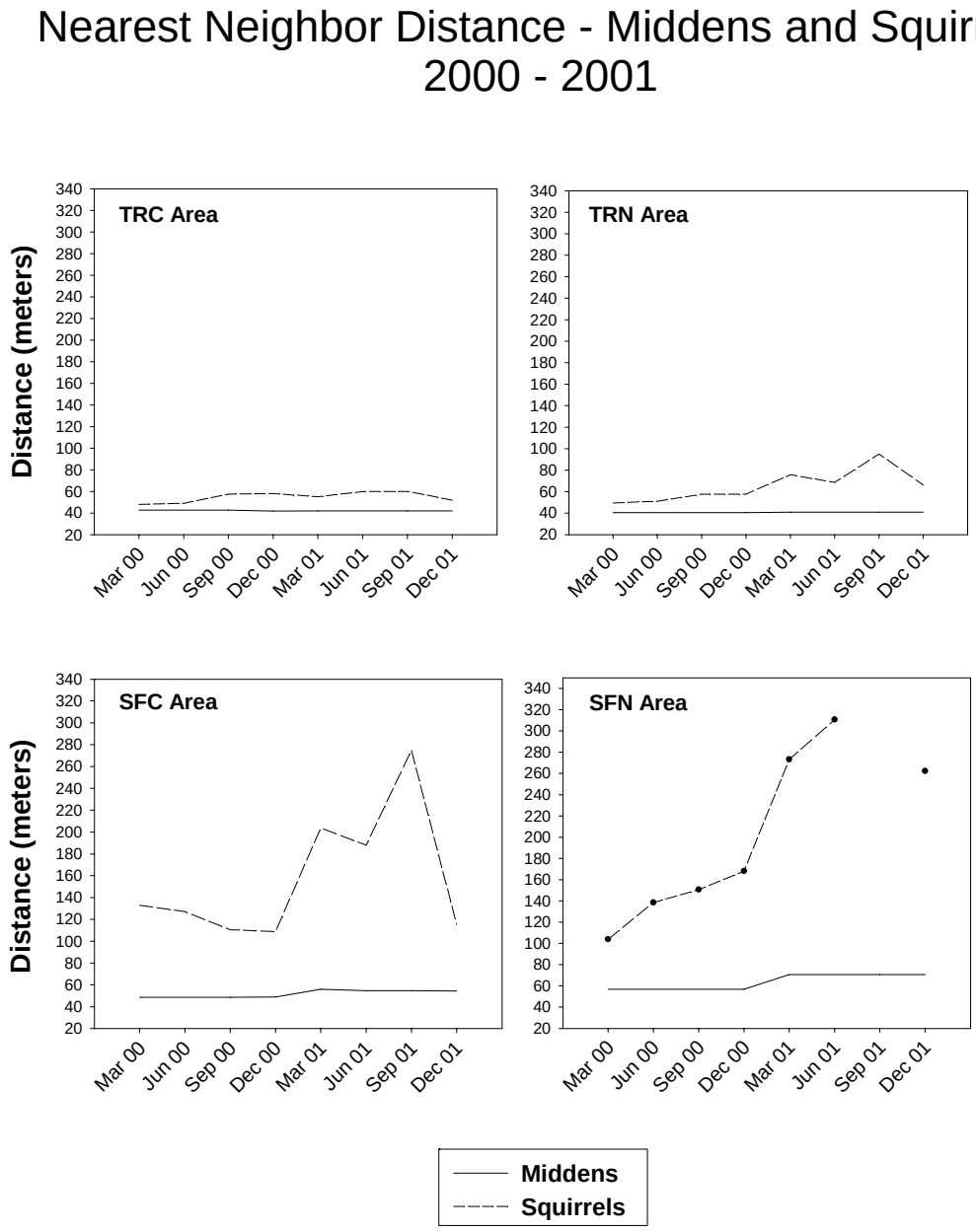


Figure 8. Monthly temperatures on the monitored areas, 2001.

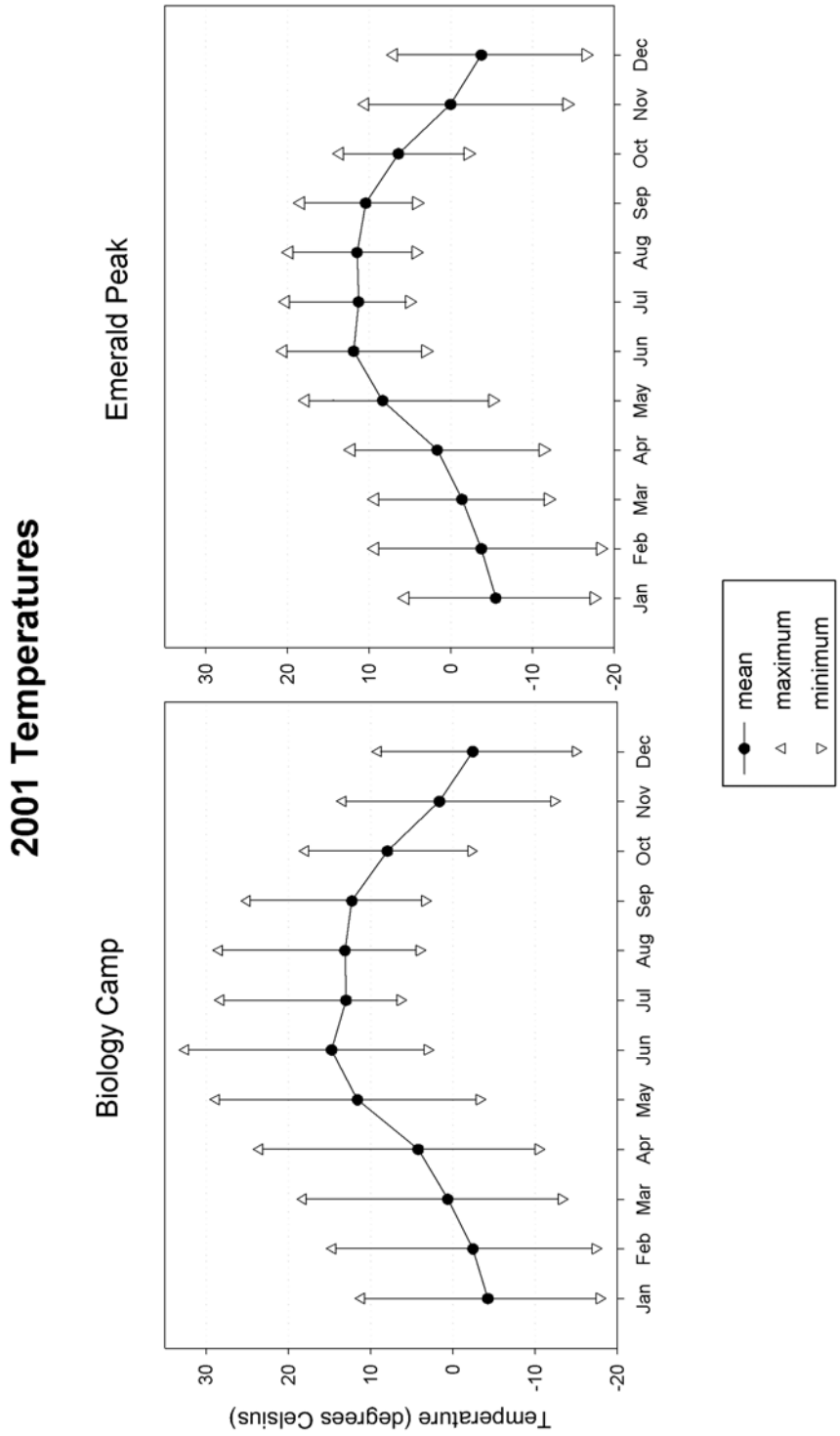


Figure 9. Total monthly precipitation as rain, 2001.

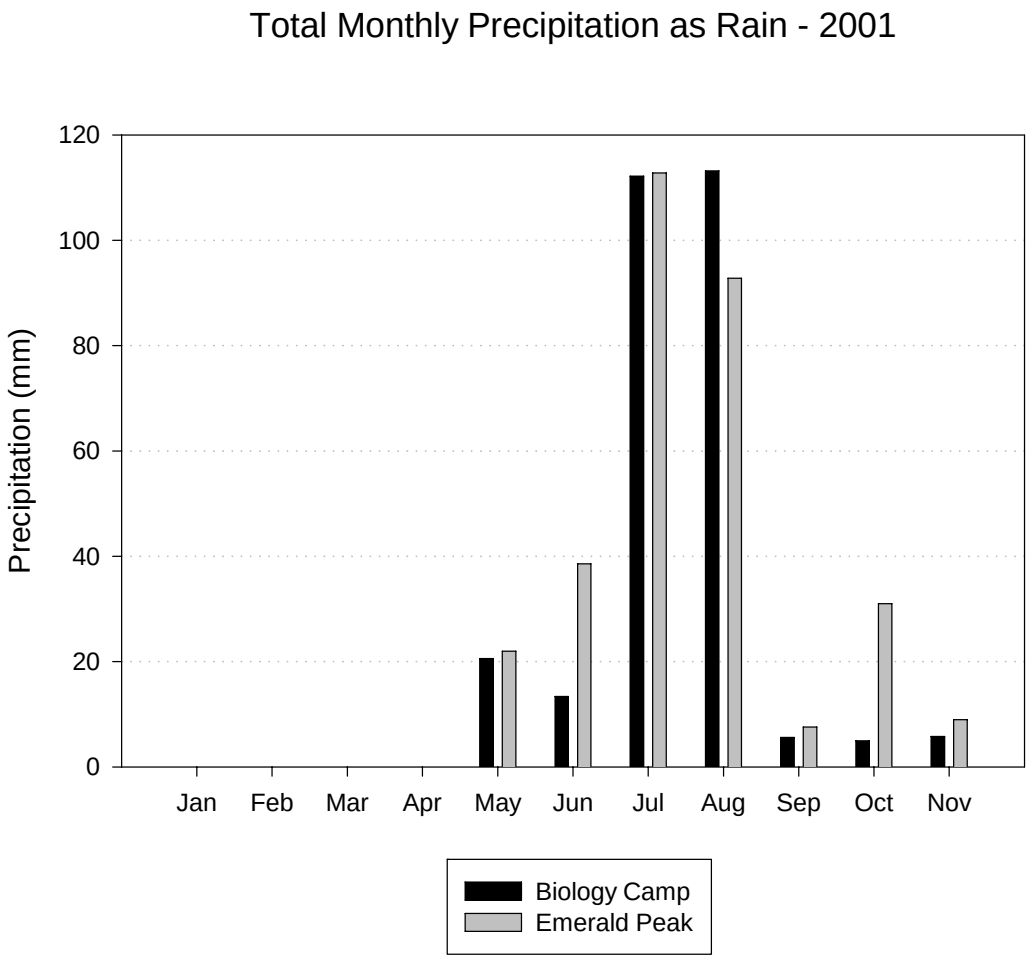
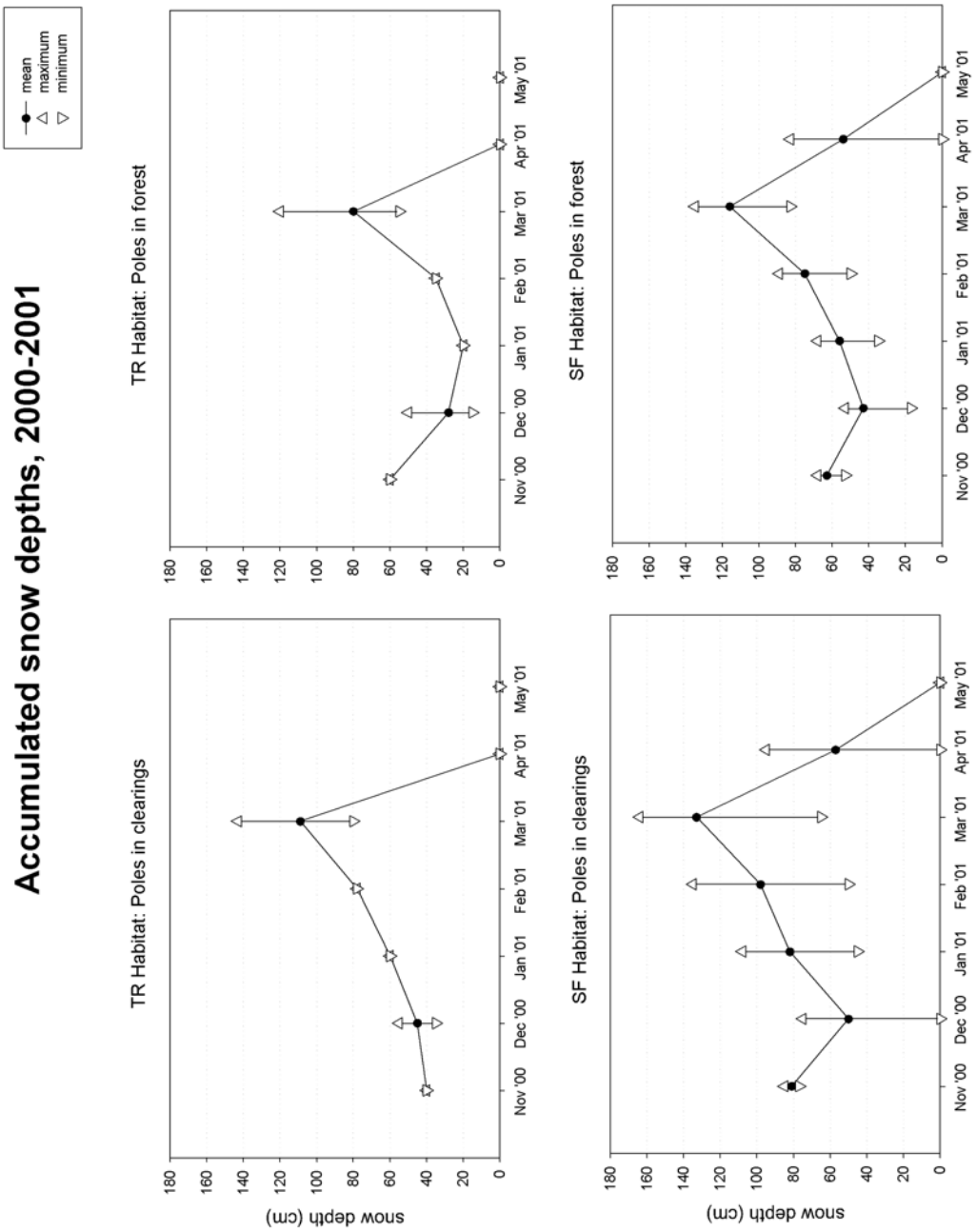


Figure 10. Accumulated snow depths, 2000-2001.



Appendix A. Mean numbers and weights for 2000 seeds and 2000 mushrooms.

A-1: By transect

A-2: By area and habitat

Appendix A-1: Mean number of seeds and weights for 2000 seeds and 2000 mushrooms, by transect.

		Corkbark Fir	Douglas-fir	Englemann Spruce	Total Seeds	Total Mushrooms	
AREA	TRAN #	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	# 1000 seeds/ha	ww Kg/ha	dw Kg/ha
TRC	1	burned					
	2	burned					
	3	0.0	0.0	0.0	0.0	47.5	5.0
	4	burned					
	5	13.2	0.0	0.0	13.2	57.6	5.4
	6	burned					
	7	burned					
	8	burned					
	9	burned					
	10	0.0	0.0	0.0	0.0	31.9	3.1
	11	0.0	0.0	0.0	0.0	24.2	3.0
	12	0.0	26.4	0.0	26.4	37.2	3.8
TRN	1	0.0	0.0	0.0	0.0	76.8	7.6
	2	26.4	0.0	0.0	26.4	97.2	10.1
	3	0.0	0.0	0.0	0.0	27.7	2.9
	4	0.0	0.0	0.0	0.0	10.4	0.9

AREA	TRAN #	Corkbark Fir # 1000 seeds/ha	Douglas-fir # 1000 seeds/ha	Englemann Spruce # 1000 seeds/ha	Total Seeds # 1000 seeds/ha	Total Mushrooms ww Kg/ha	Total Mushrooms dw Kg/ha
SFC	1	0.0	0.0	0.0	0.0	24.6	2.5
	2	burned					
	3	0.0	0.0	0.0	0.0	17.1	1.8
	4	0.0	0.0	0.0	0.0	28.5	3.4
	5	0.0	0.0	0.0	0.0	18.9	2.0
	6	0.0	0.0	13.2	13.2	21.7	2.6
	7	burned					
	8	burned					
	9	burned					
	10	0.0	0.0	0.0	0.0	4.3	0.5
	11	0.0	0.0	0.0	0.0	12.4	1.5
SFN	1	0.0	0.0	0.0	0.0	0.4	0.1
	2	0.0	0.0	0.0	0.0	23.1	2.9
	3	0.0	0.0	13.2	13.2	9.1	1.1
	4	0.0	0.0	13.2	13.2	10.4	1.1
	5	0.0	0.0	0.0	0.0	29.9	3.8
	6	0.0	0.0	0.0	0.0	25.9	3.0
	7	0.0	0.0	0.0	0.0	7.6	1.1
	8	0.0	0.0	0.0	0.0	21.2	2.3
	9	26.4	0.0	0.0	26.4	29.5	3.7
	10	0.0	0.0	0.0	0.0	17.9	2.2
	11	0.0	0.0	106.4	106.4	33.5	3.8
	12	0.0	0.0	0.0	0.0	23.6	2.8

Appendix A-1: Mean number of seeds and weights for 2000 seeds and 2000 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	2.6	5.3	0.0	7.9	39.7	4.0
TRN $\bar{x}$	4	6.6	0.0	0.0	6.6	53.0	5.4
SFC $\bar{x}$	7	0.0	0.0	1.9	1.9	18.2	2.1
SFN $\bar{x}$	12	2.2	0.0	11.1	13.3	19.3	2.3
TR $\bar{x}$	9	4.4	2.9	0.0	7.3	45.6	4.6
SF $\bar{x}$	19	1.4	0.0	7.5	9.1	18.9	2.2

Appendix B. Midden occupancy records for the monitored areas, 2001.

B-1. Quarterly occupancy records

B-2. Activity area information

Appendix B-1. Midden occupancy records for the monitored areas, 2001.

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
A	Abert's Squirrel using area, no Red Squirrel present
XX	Remains of Red Squirrel found
*	Squirrel is tagged
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 (Arizona Game and Fish Study)

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

Transition Construction Area (TRC), 2001				
Midden	Mar	Jun	Sep	Dec
1101[89]	located off-area, new number - 5101			
1102[89]	Y	♀	S	Y
1103[89]	N	N	N	♂
1104[89]	Y	♀	S	P
1105[89]	burned in Clark Peak fire			
1106[89]	S	♀L	♀	S
1107[89]	burned in Clark Peak fire			
1108[89]	removed from census - low occupancy [1]			
1109[89]	burned in Clark Peak fire			
1110[89*]	burned in Clark Peak fire			
1111[89]	Y	♀	♀L+4J	♀
1112[89*]	S	S	♂	♀
1113[89]	Y	S	♀	♀
1114[89]	located off-area, new number - 5114			
1115[89]	N	N	N	♂
1116[89*]	Y	S	♂	♂
1117[89]	burned in Clark Peak fire			
1118[89]	♂	♂	♂	♂
1119[88]	burned in Clark Peak fire			
1120[89]	burned in Clark Peak fire			
1121[89*]	N	N	N	P
1122[89]	burned in Clark Peak fire			
1123[95*]	burned in Clark Peak fire			
1124[95*]	burned in Clark Peak fire			
1125[95*]	burned in Clark Peak fire			
1126[95*]	removed from census - low occupancy [1]			
1130[90]	burned in Clark Peak fire			
1131[90*]	Y	S	♂	♂
1132[90*]	removed from census - low occupancy [1]			
1134[91*]	removed from census - low occupancy [1]			
1135[91*]	burned in Clark Peak fire			
1136[91*]	burned in Clark Peak fire			
1137[91*]	burned in Clark Peak fire			

Transition Construction Area (TRC), 2001				
Midden	Mar	Jun	Sep	Dec
1138[91*]	removed from census - low occupancy [1]			
1139[91*]	burned in Clark Peak fire			
1140[91*]	burned in Clark Peak fire			
1142[91*]	burned in Clark Peak fire			
1143[91*]	burned in Clark Peak fire			
1144[91*]	S	S	♀L	♀
1145[91*]	located off-area, new number - 5145			
1146[91*]	removed from census - low occupancy [1]			
1147[91*]	Y	Y	Y	N
1148[91*]	burned in Clark Peak fire			
1149[91*]	Y	♂	♂	♂
1150[91*]	located off-area, new number - 5150			
1151[91*]	N	N	N	N
1152[91*]	burned in Clark Peak fire			
1153[92*]	S	P	♀L+3J	♂
1154[92*]	Y	♂	♂	Y
1155[93*]	located off-area, new number - 5155			
1156[93*]	N	N	N	♀
1157[93*]	located off-area, new number - 5157			
1159[93*]	burned in Clark Peak fire			
1160[96*]	Y	N	♀* [2]	♀*[2] +2SA
1161[96*]	removed from census - low occupancy [1]			
1162[96*]	P	♀	P	♀
1163[98*]	Y	S	N	N
1164[98*]	N	N	N	N
1165[98*]	N	N	N	N
1166[98*]	N	N	N	N
1167[98*]	P	N	N	♀[NAT 3]
1169[98*]	N	N	N	N
1168[98*]	Y	♂	Y	♂

Transition Construction Area (TRC), 2001				
Midden	Mar	Jun	Sep	Dec
1170[98*]	P	♂	♂	♂
1171[98*]	P	N	N	2 ♀SA
1172[90*]	N	N	N	N
1173[99*]	N	N	N	N
1174[99*]	N	N	N	N
1175[99*]	N	N	N	N
1176[99*]	N	N	N	N
1177[99*]	N	N	N	N
1178[99*]	N	N	N	N
1179[99*]	Y	Y	N	N
1180	P	♀L	Y	♂
1181	N	N	N	N
# Mid	40	40	40	40
# Occ	18	19	18	22
% Occ	45	48	45	55
# Sq	18	19	18 + 7J	23+2SA[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. All middens removed due to low occupancy are checked once per year (usually in December) for activity. Any middens that become reoccupied are added back to regular censusing.

2 The female at midden 1160 was trapped on 8 Sep 01. She is now marked with 174Red/174Red (Left Ear/Right Ear) tags. December 2001 - Two subadults were seen in the area of 1160 on multiple occasions during the December census. The marked female and 2 subadults were seen together in the area two weeks prior to the census.

3 The female at midden 1167 had a natural mark - a red spot on the left side of her nose in the white fur - it appeared to be blood.

4 The number of squirrels (23) includes the 2 ♀ subadults that appeared to be living independently at midden 1171. The 2 subadults at 1160, seemed to still be residing in the area of 1160 where a post-lactating marked female was the resident. They are included in the "+ #" notation where juveniles still living at the natal midden are normally counted.

Transition Non-Construction Area (TRN), 2001				
Midden	Mar	Jun	Sep	Dec
2201[89]	N	N	N	N
2202[89]	Y	P	Y	Y
2203[89]	Y	Y	N	N
2204[89]	N	N	P	N
2205[89]	Y	S	N	Y
2206[89]	Y	Y	P	2 SA [3]
2207[89*]	N	N	N	N
2208[89*]	Y	P	N	N
2209[89]	removed from census - low occupancy [1]			
2210[90]	Y	Y	P	N
2211[90*]	Y	Y	Y	N
2212[90]	N	N	N	N
2213[90]	removed from census - low occupancy [1]			
2214[90*]	located on TRC, new number - 1172			
2215[90*]	P	Y	P	♂
2216[90*]	N	N	N	N
2217[90*]	N	N	N	N
2218[91*]	N	N	N	N
2219[91*]	N	N	N	N
2220[91*]	N	N	N	N
2221[91*]	located off-area, new number - 5221			
2222[91*]	removed from census - low occupancy [1]			
2223[91*]	P	♂[NAT 2]	Y	N
2224[93*]	removed from census - low occupancy [1]			
2225[94*]	N	N	N	N
2226[95*]	N	N	N	N
2227[95*]	P	P	Y	P
2228[95*]	N	N	N	N
2229[96*]	Y	♂	Y	♀
2230[96*]	P	N	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]			

Transition Non-Construction Area (TRN), 2001				
Midden	Mar	Jun	Sep	Dec
2234[97*]	P	Y	Y	♀
2235[98*]	P	P	N	N
2236[98*]	P	N	N	N
2237[98*]	N	N	N	N
2238[98*]	N	N	N	N
2239[98*]	N	N	N	N
2240[98*]	N	N	N	N
2241[98*]	P	P	N	N
2242[98*]	Y	Y	P	♀
2243[98*]	N	N	N	N
2244[99*]	P	N	P	Y
2245[99*]	N	N	N	N
2246[99*]	P	N	N	N
2247[99*]	N	N	N	N
2248[99*]	N	Y	Y	S
2249[99*]	P	P	N	N
2250[00*]	Y	Y	Y	N
2251[00*]	N	N	N	N
# Mid	42	42	42	42
# Occ	10	12	8	9
% Occ	24	29	19	21
# Sq	10	12	8	10

Appendix B-1 TRN (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. All middens removed due to low occupancy are checked once per year (usually in December) for activity. Any middens that become reoccupied are added back to regular censusing.

2 The male at midden 2223 has a natural mark - a rip in the right ear.

3 Two sub-adult squirrels were seen in this midden, playing and foraging. No adult female was observed in the midden and the sub-adults looked old enough to be independently living.

Spruce-Fir Construction Area (SFC), 2001				
Midden	Mar	Jun	Sep	Dec
3000[95*]	removed from census - low occupancy [1]			
3001[95*]	N	N	N	N
3002[95*]	removed from census - low occupancy [1]			
3003[95*]	removed from census - low occupancy [1]			
3004[95*]	burned in Clark Peak fire			
3005[95*]	N	N	N	N
3006[95*]	N	N	N	N
3007[95*]	removed from census - too far off area, new # 5307			
3008[95*]	P	N	N	N
3009[95*]	N	N	N	N
3010[95*]	removed from census - low occupancy [1]			
3011[95*]	located off-area, new number - 5311			
3012[95*]	burned in Clark Peak fire			
3013[95*]	removed from census - low occupancy [1]			
3014[95*]	N	N	N	N
3015[95*]	burned in Clark Peak fire			
3016[95*]	burned in Clark Peak fire			
3017[95*]	burned in Clark Peak fire			
3018[95*]	burned in Clark Peak fire			
3019[96*]	removed from census - low occupancy [1]			
3020[96*]	N	N	N	N
3021[96*]	burned in Clark Peak fire			
3022[96*]	N	N	N	N
3023[98*]	N	N	N	N
3024[98*]	N	N	N	N
3025[98*]	N	N	N	N
3026[98*]	N	N	N	N
3027[99*]	N	N	N	N
3028[99*]	Y	N	N	N
3029[99*]	N	N	N	N
3030[99*]	N	N	N	N
3031[99*]	N	N	N	N
3032[99*]	N	N	N	N

Spruce-Fir Construction Area (SFC), 2001				
Midden	Mar	Jun	Sep	Dec
3300[86]	N	N	N	N
3301[94*]	removed from census - low occupancy [1]			
3302[94*]	located off-area, new number - 5302			
3303[94*]	N	N	N	N
3304[94*]	N	N	N	N
3305[94*]	removed from census - low occupancy [1]			
3306[94*]	N	N	N	N
3307[94*]	removed from census - low occupancy [1]			
3308[95*]	removed from census - low occupancy [1]			
3309[95*]	removed from census - low occupancy [1]			
3310[95*]	removed from census - low occupancy [1]			
3311[95*]	removed from census - low occupancy [1]			
3312[95*]	N	Y	P	N
3313[95*]	located off-area, new number - 5313			
3314[95*]	P	N	N	N
3315[95*]	removed from census - low occupancy [1]			
3316[95*]	removed from census - low occupancy [1]			
3317[95*]	N	N	N	N
3318[95*]	N	N	N	N
3319[95*]	N	N	N	N
3320[95*]	removed from census - low occupancy [1]			
3321[95*]	removed from census - low occupancy [1]			
3322[95*]	N	N	N	N
3323[95*]	N	N	N	N
3324[95*]	removed from census - low occupancy [1]			
3325[95*]	N	N	N	N
3326[95*]	removed from census - low occupancy [1]			
3327[95*]	N	N	N	N
3328[95*]	N	N	N	N
3329[95*]	removed from census - low occupancy [1]			
3330[95*]	N	N	N	N
3331[95*]	N	N	N	N
3332[95*]	removed from census - low occupancy [1]			

Spruce-Fir Construction Area (SFC), 2001				
Midden	Mar	Jun	Sep	Dec
3333[95*]	removed from census - low occupancy [1]			
3334[95*]	removed from census - low occupancy [1]			
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*]	removed from census - low occupancy [1]			
3339[95*]	removed from census - low occupancy [1]			
3340[95*]	removed from census - low occupancy [1]			
3341[95*]	P	N	N	N
3342[95*]	N	N	N	N
3343[95*]	N	N	N	N
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*]	removed from census - low occupancy [1]			
3349[95*]	removed from census - low occupancy [1]			
3350[87]	N	N	N	N
3351[87]	N	N	N	N
3352[86]	removed from census - low occupancy [1]			
3353[87]	N	N	N	N
3354[86]	removed from census - low occupancy [1]			
3355[95*]	N	N	N	N
3356[86]	N	N	N	♀
3357[86]	removed from census - low occupancy [1]			
3358[87]	burned in Clark Peak fire			
3359[87]	burned in Clark Peak fire			
3360[86]	P	Y	N	♂
3361[86]	removed from census - low occupancy [1]			
3362[86]	P	P	Y	N
3363[86]	N	N	N	N
3364[86]	removed from census - low occupancy[1]			
3365[86]	Y	S	Y	N

Spruce-Fir Construction Area (SFC), 2001				
Midden	Mar	Jun	Sep	Dec
3366[86]	P	P	N	N
3367[87]	N	N	N	N
3368[86]	N	N	N	N
3369[86]	N	N	N	N
3370[86]	P	N	N	♀
3371[87]	P	P	♀+4J	N
3372[89]	P	N	N	N
3373[87]	N	N	N	N
3374[89]	P	P	N	N
3375[86]	N	N	N	N
3376[86]	located off-area, new number - 5376			
3377[87]	located off-area, new number - 5377			
3378[90*]	N	N	N	N
3379[90*]	N	N	N	N
3380[90*]	removed from census - low occupancy [1]			
3381[90]	removed from census - low occ			♀
3382[91*]	Y	♂	P	N
3383[91*]	N	N	N	N
3384[91*]	burned in Clark Peak fire			
3385[91*]	removed from census - low occupancy [1]			
3386[91*]	N	N	N	N
3387[91*]	P	P	N	N
3388[92*]	located off-area, new number - 5388			
3389[93*]	N	N	N	N
3390[93*]	N	N	N	N
3391[93*]	removed from census - low occupancy [1]			
3392[93*]	N	N	N	N
3393[93*]	N	N	N	N
3394[93*]	N	N	N	N

Spruce-Fir Construction Area (SFC), 2001				
Midden	Mar	Jun	Sep	Dec
3395[94*]	removed from census - low occupancy [1]			
3396[94*]	removed from census - low occupancy [1]			
3397[86]	RLO [1]	P [2]	N	N
3398[86]	removed from census - low occupancy [1]			
3399[94*]	N	N	N	N
# Mid	68	69	69	70
# Occ	3	4	3	4
% Occ	4	6	4	6
# Sq	3	4	3 + 4J	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. All middens removed due to low occupancy are checked once per year (usually in December) for activity. Any middens that become reoccupied are added back to regular censusing.

2 Midden 3397 had been previously removed due to low occupancy. In June, some signs of occupancy were detected, but by the end of the month it was unclear whether or not this midden was occupied. It was therefore called Possibly occupied, and added back to regular censusing.

Spruce-Fir Non Construction Area (SFN), 2001				
Midden	Mar	Jun	Sep	Dec
4000[95*]	P	N	N	N
4001[95*]	removed from census - low occupancy [1]			
4002[95*]	N	N	N	N
4003[95*]	N	N	N	N
4004[95*]	removed from census - low occupancy [1]			
4005[95*]	removed from census - low occupancy [1]			
4006[95*]	removed from census - low occupancy [1]			
4007[95*]	removed from census - low occupancy [1]			
4008[95*]	removed from census - low occupancy [1]			
4009[95*]	removed from census - low occupancy [1]			
4010[95*]	N	N	N	N
4011[95*]	removed from census - low occupancy [1]			
4012[95*]	removed from census - low occupancy [1]			
4013[96*]	removed from census - low occupancy [1]			
4014[96*]	removed from census - low occupancy [1]			
4015[96*]	removed from census - low occupancy [1]			
4016[96*]	N	P	N	N
4017[96*]	removed from census - low occupancy [1]			
4018[96*]	removed from census - low occupancy [1]			
4019[96*]	N	N	N	N
4020[96*]	N	N	N	N
4021[96*]	removed from census - low occupancy [1]			
4022[98*]	N	N	N	N
4023[98*]	N	N	N	N
4024[98*]	N	N	N	N
4025[99*]	N	N	N	N
4400[89]	removed from census - low occupancy [1]			
4401[94*]	removed from census - low occupancy [1]			
4402[94*]	removed from census - low occupancy [1]			
4403[94*]	removed from census - low occupancy [1]			
4404[95*]	Y	P	N	N
4405[95*]	removed from census - low occupancy [1]			
4406[95*]	removed from census - low occupancy [1]			

Spruce-Fir Non Construction Area (SFN), 2001				
Midden	Mar	Jun	Sep	Dec
4407[95*]	removed from census - low occupancy [1]			
4408[95*]	removed from census - low occupancy [1]			
4409[95*]	N	N	N	N
4410[95*]	located off-area, new number - 5410			
4411[95*]	removed from census - low occupancy [1]			
4412[95*]	removed from census - low occupancy [1]			
4413[95*]	located off-area, new number - 5413			
4414[95*]	removed from census - low occupancy [1]			
4415[95*]	N	N	N	N
4416[95*]	N	N	N	N
4417[95*]	P	Y	N	N
4418[95*]	N	N	N	N
4419[95*]	removed from census - low occupancy [1]			
4420[90]	P	P	N	N
4421[86]	removed from census - low occupancy [1]			
4422[86]	N	N	N	N
4423[86]	N	N	N	N
4424[86]	removed from census - low occupancy [1]			
4425[87]	removed from census - low occupancy [1]			
4426[86]	removed from census - low occupancy [1]			
4427[86]	N	N	N	N
4428[86]	N	N	N	N
4429[86]	P	N	N	N
4430[86]	removed from census - low occupancy [1]			
4431[86]	removed from census - low occupancy [1]			
4432[86]	N	N	N	N
4433[87]	removed from census - low occupancy [1]			
4434[86]	removed from census - low occupancy [1]			
4435[86]	N	N	N	N
4436[86]	removed from census - low occupancy [1]			
4437[95*]	removed from census - low occupancy [1]			
4438[90*]	removed from census - low occupancy [1]			
4439[90*]	removed from census - low occupancy [1]			

Spruce-Fir Non Construction Area (SFN), 2001				
Midden	Mar	Jun	Sep	Dec
4440[91]	removed from census - low occupancy [1]			
4441[86]	removed from census - low occupancy [1]			
4442[95*]	removed from census - low occupancy [1]			
4443[86]	N	N	N	N
4444[86]	N	N	N	N
4445[86]	N	N	N	N
4446[86]	removed from census - low occupancy [1]			
4447[86]	N	N	N	N
4448[86]	removed from census - low occupancy [1]			
4449[86]	P	N	N	S
4450[86]	N	N	N	N
4451[88]	removed from census - low occupancy [1]			
4452[86]	N	N	N	N
4453[86]	removed from census - low occupancy [1]			
4454[86]	removed from census - low occupancy [1]			
4455[86]	removed from census - low occupancy [1]			
4456[86]	removed from census - low occupancy [1]			
4457[86]	removed from census - low occupancy [1]			
4458[86]	removed from census - low occupancy [1]			
4459[86]	removed from census - low occupancy [1]			
4460[87]	Y	♂	P	♂
4461[91*]	N	N	N	N
4462[90]	removed from census - low occupancy [1]			
4463[90]	removed from census - low occupancy [1]			
4464[90]	N	N	N	N
4465[90*]	N	N	N	N
4466[87]	removed from census - low occupancy [1]			
4467[87]	N	N	N	N
4468[87]	removed from census - low occupancy [1]			
4469[87]	N	N	N	N
4470[87]	Y	N	N	N
4471[87]	removed from census - low occupancy [1]			
4472[87]	P	P	N	N
4473[87]	P	P	N	N

Spruce-Fir Non Construction Area (SFN), 2001				
Midden	Mar	Jun	Sep	Dec
4474[86]	P	Y	N	♂
4475[87]	located off-area, new number - 5405			
4476[95*]	removed from census - low occupancy [1]			
4477[87]	N	N	N	Y
4478[90*]	removed from census - low occupancy [1]			
4479[90*]	removed from census - low occupancy [1]			
4480[90*]	removed from census - low occupancy [1]			
4481[86]	removed from census - low occupancy [1]			
4482[86]	N	N	N	N
4483[86]	removed from census - low occupancy [1]			
4484[86]	N	Y	N	N
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*]	N	N	N	N
4490[91*]	N	N	N	N
4491[91*]	removed from census - low occupancy [1]			
4492[91*]	N	N	N	N
4493[91*]	removed from census - low occupancy [1]			
4494[91*]	N	N	N	N
4495[95*]	N	N	N	N
4496[93*]	N	N	N	N
4497[93*]	removed from census - low occupancy [1]			
4498[93*]	removed from census - low occupancy [1]			
4499[93*]	removed from census - low occupancy [1]			
# Mid	51	51	51	51
# Occ	3	4	0	4
% Occ	6	8	0	8
# Sq	3	4	0	4

Appendix B-1 SFN (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. All middens removed due to low occupancy are checked once per year (usually in December) for activity. Any middens that become reoccupied are added back to regular censusing.

Off-Area Midden Occupancy, 2001				
Midden	Mar	Jun	Sep	Dec
TRC Area				
5101[89]	Y	♀	♂	♂
5102[98*]	N	N	N	N
5103[99*]	N	N	N	S
5104[99*]	N	N	N	♂
5114[89]	removed from census - low occupancy [1]			
5118[94*]	P	Y	♂	♂
5119[89*]	Y	S	Y	♀
5120[89*]	removed from census - too far off area			
5121[89*]	Y	Y	Y	♂
5122[89]	N	N	N	N
5123[89]	removed from census - too far off area			
5124[90*]	removed from census - too far off area			
5125[89*]	Y	Y	Y	N
5126[91]	N	N	P	N
5127[95*]	removed from census - low occupancy [1]			
5145[91*]	Y	N	N	N
5150[91*]	Y	Y	♀	♀
5155[93*]	Y	S	♂	♂
5157[93*]	N	N	N	N
TRN Area				
5200[93*]	♂	Y	Y	N
5201[99*]	N	N	N	N
5202[99*]	N	N	N	N
5203[00*]	Y	P	Y	P
5221[91*]	S	Y	♂	♂[NAT 2]
5231[96*]	Y	Y	Y	N
5232[96*]	P	N	N	♀

Off-Area Midden Occupancy, 2001				
Midden	Mar	Jun	Sep	Dec
SFC Area				
5302[94*]	removed from census - low occupancy [1]			
5311[95*]	N	N	N	♂
5313[95*]	N	N	N	♀
5350[86]	Y	♀	P	♀+2SA
5351[94*]	removed from census - low occupancy [1]			
5352[94*]	removed from census - low occupancy [1]			
5353[94*]	removed from census - too far off area			
5354[94*]	removed from census - low occupancy [1]			
5355[94*]	removed from census - low occupancy [1]			
5356[94*]	removed from census - low occupancy [1]			
5357[95*]	removed from census - low occupancy [1]			
5358[95*]	removed from census - too far off area			
5359[95*]	N	N	N	N
5360[96*]	removed from census - low occupancy [1]			
5361[96*]	removed from census - low occupancy [1]			
5362[96*]	removed from census - low occupancy [1]			
5376[86]	removed from census - low occupancy [1]			
5377[87]	N	N	N	N
5388[92*]	removed from census - low occupancy [1]			
SFN Area				
5405[87]	P	N	N	N
5410[95*]	removed from census - low occupancy [1]			
5413[95*]	P	S	Y	N
5475[86]	located on area - new number 4021			
5487[86]	removed from census - low occupancy [1]			

Appendix B-1 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. All middens removed due to low occupancy are checked once per year (usually in December) for activity. Any middens that become reoccupied are added back to regular censusing.

2 The male at midden 5221 had a natural mark - his tail was short with a long, thin end.

Appendix B-2: New activity areas on the monitored areas in 2001.

There were no new activity areas located on any of the monitored areas in 2001.

Appendix C: Occupancy status of middens located within 100 meters of construction (telescopes or access road). These middens are checked during months other than the quarterly full census months (Mar, Jun, Sep, Dec) in which there is construction activity. These middens are checked as an "early warning" indicator of a large population decrease in between the quarterly censuses. See Table 2 for key to symbols.

Middens within 100m of construction												
Mid #	Jan	Feb	Mar[1]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1160	S	S	Y	♀	Y	N	P	♀	♀*4	♀*4	♀*4	♀*4+2SA
1179	Y	Y	Y	S	Y	Y	Y	Y	N	N	N	N
3003	N	N	removed from census - low occupancy [2]									
3013	removed from census - low occupancy [2]											
3014	N	N	N	N	N	N	N	N	N	N	N	N
3019	removed from census - low occupancy [2]											
3020	N	N	N	N	N	N	N	P	N	N	N	N
3024	N	N	N	N	N	N	N	N	N	N	N	N
3026	N	N	N	N	N	N	N	N	N	N	N	N
3027	N	N	N	N	N	N	N	N	N	N	N	N
3028	N	N	Y	Y	P	N	N	N	N	N	N	N
3030	N	N	N	N	N	N	N	N	N	N	N	N
3031	N	N	N	N	N	N	N	N	N	N	N	N
3032	N	N	N	N	N	N	N	N	N	N	N	N
3309	N	N	removed from census - low occupancy [2]									
3314	N	N	P	N	N	N	N	N	N	N	N	N
3315	N	N	removed from census - low occupancy [2]									
3319	N	N	N	N	N	N	N	N	N	N	N	N
3320	N	N	removed from census - low occupancy [2]									
3322	N	N	N	N	N	N	N	N	N	N	N	N
3323	N	N	N	N	N	N	N	N	N	N	N	N
3324	removed from census - low occupancy [2]											
3325	N	N	N	N	N	N	N	N	N	N	N	N
3327	N	N	N	N	N	N	N	N	N	N	N	N
3330	N	N	N	N	N	N	N	N	N	N	N	N
3334	removed from census - low occupancy [2]											
3336	removed from census - low occupancy [2]											

Middens within 100m of construction												
Mid #	Jan	Feb	Mar[1]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3337	removed from census - low occupancy [2]											
3339	removed from census - low occupancy [2]											
3340	removed from census - low occupancy [2]											
3345	removed from census - low occupancy [2]											
3346	removed from census - low occupancy [2]											
3347	removed from census - low occupancy [2]											
3350	N	N	N	N	N	N	N	N	N	N	N	N
3354	removed from census - low occupancy [2]											
3357	removed from census - low occupancy [2]											
3362	S	Y	P	Y	S	P	N	N	Y	♂	Y	N
3363	N	N	N	N	N	N	N	N	N	N	N	N
3364	removed from census - low occupancy [2]											
3365	S	S	Y	Y	Y	S	Y	Y	Y	Y	Y	N
3368	N	N	N	N	N	N	N	N	N	N	N	N
3379	N	N	N	N	N	N	N	N	N	N	N	N
3382	S	Y	Y	Y	S	♂	Y	Y	P	N	N	N
3383	N	N	N	N	N	N	N	N	N	N	N	N
3385	removed from census - low occupancy [2]											
3389	N	N	N	N	N	N	N	N	N	N	N	N
3391	removed from census - low occupancy [2]											
# Mid[3]	31	31	27	27	27	27	27	27	27	27	27	27
# Occ	5	5	5	6	5	3	3	4	3	3	3	1
% Occ	16	16	19	22	19	11	11	15	11	11	11	4
# Sq	5	5	5	6	5	3	3	4	3	3	3	1 + 2SA

Appendix C (cont.)

1 A complete census of all areas is conducted in Mar, Jun, Sep, and Dec (see Table 2).

2 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. All middens removed due to low occupancy are checked once per year (usually in December) for activity. Any middens that become reoccupied are added back to regular censusing.

3 The total number of middens does not include middens removed from censusing due to low occupancy. All middens are located on the SFC area, except for middens 1160 and 1179 which are located on the TRC area.

4 The female at midden 1160 is tagged - left ear 174Red / right ear 174Red.

Appendix D: Red squirrel populations (including juveniles) on the areas being monitored by the Red Squirrel Monitoring Program, from December 2000 through December 2001.

Date	TRC	TRN	SFC	SFN	TOTAL
Dec 2000	21	21	12	11	65
Mar 2001	18	10	3	3	34
June 2001	19	12	4	4	39
Sep 2001	18 + 7J	8	3 + 4J	0	29 + 11J
Dec 2001	23 + 2SA	10	4	4	41[1] + 2SA [2]

1 This number includes the 2 subadult females that appeared to be living independently at midden 1171, and the two sub-adult squirrels of unknown sex that appeared to be living independently at midden 2206.

2 This number includes the 2 subadults that still were in the area of 1160 (presumed natal midden). The marked female at midden 1160 was seen with two subadults near the midden two weeks prior to the December census. By the December census, it did not appear that they had established a separate midden, so they were included with the adult post-lactating marked female at 1160.

Appendix E: Midden Occupancy Maps, 2001.

Appendix F: Measures of Spatial Distribution.

F-1. Crude Density

a) middens

b) squirrels

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

Appendix F-1a: Crude Density of Red Squirrel Middens

Crude Density (middens/ha) of red squirrel middens in each of the monitored areas for December 2000 through December 2001.

DATE	TRC	TRN	SFC	SFN
Dec 2000	0.80	2.05	1.11	0.72
Area [1] (after Jan 2000)	(51.1 ha)	(21.0 ha)	(76.0 ha)	(104.4 ha)
Mar 2001	0.78	2.00	0.89	0.49
Jun 2001	0.78	2.00	0.89	0.49
Sep 2001	0.78	2.00	0.89	0.49
Dec 2001	0.78	2.00	0.92	0.49

Appendix F-1b: Crude Density of Red Squirrels

Crude Density (squirrels/ha) of red squirrels (including juveniles) in each of the monitored areas for December 2000 through December 2001.

DATE	TRC	TRN	SFC	SFN
Dec 2000	0.41	1.00	0.16	0.11
Area [1] (after Jan	(51.1 ha)	(21.0 ha)	(76.0 ha)	(104.4 ha)
Mar 2001	0.35	0.48	0.04	0.03
Jun 2001	0.37	0.57	0.05	0.04
Sep 2001	0.49	0.38	0.09	0.00
Dec 2001	0.49	0.48	0.05	0.04

1 The new area sizes for 2000 and afterwards are the result of more accurate GPS mapping of features on the monitored areas. The greatest change occurred on the SFN area - this was mainly due to more accurate mapping of the northern boundary (a Forest Service hiking trail).

Appendix F-2. Local Density and Nearest Neighbor Distances of *middens* and *squirrels*.

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 00	41	5.9	0.37	41.9	2.32	21	2.8	0.22	58.1	4.81
Mar 01	40	5.8	0.39	42.1	2.43	18	2.2	0.21	55.1	4.86
Jun 01	40	5.8	0.39	42.1	2.43	19	2.6	0.16	59.9	4.77
Sep 01	40	5.8	0.39	42.1	2.43	18	2.0	0.21	60.0	4.55
Dec01	40	5.8	0.39	42.1	2.43	22	3.1	0.34	51.9	4.04

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 00	43	6.7	0.27	40.4	1.95	21	3.4	0.25	57.6	3.11
Mar 01	42	6.6	0.27	40.8	2.06	10	1.7	0.26	75.7	8.00
Jun 01	42	6.6	0.27	40.8	2.06	12	1.8	0.22	68.4	3.95
Sep 01	42	6.6	0.27	40.8	2.06	8	1.1	0.35	95.0	9.55
Dec 01	42	6.6	0.27	40.8	2.06	9	2.2	0.43	66.1	7.41

Appendix F-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 00	84	4.9	0.22	48.9	2.32	12	0.7	0.19	108.7	16.88
Mar 01	68	3.9	0.21	55.9	3.38	3	0.0	0.00	203.7	49.36
Jun 01	69	3.9	0.21	54.8	2.84	4	0.0	0.00	187.9	35.29
Sep 01	69	3.9	0.21	54.8	2.84	3	0.0	0.00	274.9	32.99
Dec 01	70	3.9	0.21	54.4	2.81	4	0.5	0.29	115.6	43.30

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 00	75	2.2	0.15	56.8	2.71	11	0.2	0.12	168.0	23.15
Mar 01	51	1.5	0.17	70.7	5.02	3	0.0	0.00	273.2	5.26
Jun 01	51	1.5	0.17	70.7	5.02	4	0.0	0.00	310.6	79.28
Sep 01	51	1.5	0.17	70.7	5.02	0	---	---	---	---
Dec 01	51	1.5	0.17	70.7	5.02	4	0.5	0.29	262.2	108.37

Appendix F-2 (con't.)

All Areas Combined

(including off-area middens within 100m of 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 00	276	4.5	0.15	49.4	1.25	81	2.2	0.18	82.5	6.32
Mar 01	229	4.3	0.18	53.9	1.84	46	1.7	0.16	92.9	12.47
Jun 01	230	4.2	0.18	53.6	1.75	51	1.8	0.18	97.0	12.16
Sep 01	230	4.2	0.18	53.6	1.75	41	1.7	0.19	122.1	38.09
Dec 01	231	4.3	0.18	53.5	1.75	52	2.4	0.24	85.3	12.93

Appendix G. Reproductive success on the monitored areas, 2001.

G-1. Breeding chases seen on the monitored areas.

G-2. Litters seen on the monitored areas.

G-3. Reproductive status and age statistics by month.

Appendix G-1. Breeding chases on the monitored areas.

DATE	MIDDEN	
7 Jun 01	1160	Four, possibly five, different squirrels were seen in this midden during the observation. Two were positively identified as scrotal males. Several chases were observed. By the end of the month, however, no resident could be confirmed at this midden

Appendix G-2: Litters seen on the monitored areas.

DATE	MIDDEN	
1111	8 Sep 01	An adult female in late stage lactation (young were feeding heavily on solid foods and hair was regrowing around her teats) was observed moving young to a new cavity nest. The nest was newly discovered by the observers, but the scratch marks on the bark suggested previous use of the cavity. The female was not carrying the juveniles, but encouraging them to follow her, sometimes unsuccessfully, to the new nest. The adult female was observed in play with her 4 young (3 male, 1 female) and they repeatedly tried to nurse from her but were rebuffed. At least two of the male juveniles were observed in mock-copulation attempts, also rebuffed. The adult female was observed feeding on moss, mushrooms, CB fir, and white pine. Some of the juveniles were also observed eating these foods.
1153	10 Sep 01	On 5 Sep 01 a late stage lactating female was observed in the midden. On 10 Sep 01, 3 juveniles (2 male, 1 female) were located in an aspen snag about 20m S of 1153 tag tree. Juveniles look fairly independent - moving all over snag and adjacent small corkbark fir trees, but never on to the ground. All three were sample feeding on corkbark fir bark and needles, and aspen bark. They were also observed playing - tail pulling/mock biting/chasing/mock copulations/wrestling.
1160	18 Nov 01	The marked adult female (R/R) was seen with two juveniles about 10m N of the midden. On 5 December, two sub-adults (1 male, 1 unknown) observed moving around in the trees about 50m E-NE of the midden. They eventually entered and remained in a cavity together. The adult female was not seen during the December observation.
1171	8 Dec 01	Two female sub-adult squirrels were seen in this midden: feeding, moving in the trees, and entering a cavity nest nearby. No adult female was seen and the two sub-adult females were assumed to be living independently at this midden.

Appendix G-2 (cont.)

2206	5 Dec 01	Two sub-adult squirrels (unknown sex) were observed in this midden: playing, vocalizing, and moving around in the trees. Based on behavior, the two sub-adults appeared to be siblings and living together at this midden. No adult female was seen in the midden.
3371	8 Sep 01	Four juveniles (2 male, 1 female, 1 unknown) were observed foraging, feeding and playing. They moved between the nest tree to a nearby tree, but they never approached the ground. The adult lactating female was observed in this midden twice and traveling back and forth from nearby midden 3375.
5350	06 Dec 01	Two subadults (1 male, 1 unknown) seen with late-stage / post lactation adult female. She followed them slowly then gave a short chase when they tried to play with her on the edge of the midden.

Appendix G-3. Reproductive status and age statistics by month. For each month, these numbers are based on the final resident of the middens where a squirrel was seen. Middens that were determined to be active based on sign alone and no squirrel was seen are not included. Information gathered on squirrels determined to be non-residents at a midden 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 is included in Appendix G-3(a-c).*** Information for new activity areas is ***NOT*** included in Appendix G-3 (a-c).

Appendix G-3a. Female reproductive information

Reproductive Status	March			June			September			December		
	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.
reproductive				2								
lactating				2			4					
post-lactating							2			6		
non-reproductive[1]				3			1			11	3	
unknown				1			1			1		

1 YOY = Young of year, squirrels that have left the maternal midden. Identified by visual cues: generally smaller size, whiter fur on underside, thinner tail, head may appear slightly large (out of proportion). Young of the year are by definition not reproductively mature.

Appendix G-3b. Male reproductive information

Reproductive Status	March			June			September			December		
	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.
scrotal				9			7			4		
non-reproductive	2						2			7	8	1
unknown									2	2		1

Appendix G-3c. Age information for females, males, and squirrels of unknown sex combined.

March			June			September			December		
Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.
7			24		4	18		3	34	16	2

1 YOY = Young of year, squirrels that have left the maternal midden. Identified by visual cues: generally smaller size, whiter fur on underside, thinner tail, head may appear slightly large (out of proportion). Young of the year are by definition not reproductively mature.

Appendix H. Marked Squirrel Data

H-1. Squirrels with natural identifying marks.

H-2. Disappearance of marked squirrels.

H-3. Sightings of marked squirrels outside their midden.

H-4. Movements of marked squirrels to new middens.

H-5. Evidence of marked squirrels using >1 midden.

Appendix H-1. Squirrels with identifying marks (natural and tagged). Only information for resident squirrels is included.

Midden	Squirrel ID	Notes
1160	**Marked ♀** - Red (left ear)/Red (right ear)	Seen in Sep,Oct, Nov, Dec
1167	♀ - red spot in white fur on left side of nose, (possibly blood)	Seen in Dec
2223	♂ - Rip in right ear	Seen in Jun
3356	S - Tip of tail missing	Seen in Oct
5221	♂ - Tail short with long thin end	Seen in Dec

Appendix H-2. Disappearance of marked squirrels.

No marked squirrels were known to have disappeared from the monitored areas.

Appendix H-3. Sightings of marked squirrels outside their midden.

No marked squirrels were observed outside their midden in 2001.

Appendix H-4. Movements of marked squirrels to new middens.

No marked squirrels were observed moving to new middens in 2001.

Appendix H-5. Evidence of marked squirrels using >1 midden.

No evidence of marked squirrels using more >1 midden in 2001.

Appendix I. Weather Data

I-1. Monthly Weather Summaries for 2001.

I-2. Monthly maxima, minima, and averages from snow poles.

Appendix I-1. Monthly weather summaries for 2001.

	Month	Biology Camp	Emerald Peak
Temperature (°C) average (max; min)	January	-4.2 (11.1; -17.8)	-5.5 (5.6; -17.5)
	February	-2.4 (14.6; -17.3)	-3.7 (9.3; -18.3)
	March	0.6 (18.2; -13.2)	-1.3 (9.3; -11.9)
	April	4.2 (23.5; -10.4)	1.7 (12.2; -11.3)
	May	11.6 (28.8; -3.2)	8.4 (17.8; -5.1)
	June	14.8 (32.5; 3.1)	11.9 (20.5; 3.1)
	July	13.0 (28.2; 6.4)	11.3 (20.2; 5.1)
	August	13.1 (28.4; 4.1)	11.5 (19.8; 4.3)
	September	12.3 (25.0; 3.4)	10.4 (18.4; 4.2)
	October	8.0 (17.9; -2.2)	6.4 (13.6; -2.1)
	November	1.6 (13.4; -12.3)	0.0 (10.5; -14.2)
	December	-2.4 (9.1; -14.9)	-3.7 (7.0; -16.5)

	Month	Biology Camp	Emerald Peak
Wind Speed (m/sec), maximum(max. gust)	January	2.7 (13.0)	3.6 (12.1)
	February	2.7 (13.0)	2.2 (10.3)
	March	2.7 (11.2)	3.1 (11.2)
	April	3.1 (12.5)	2.2 (13.9)
	May	2.2 (10.3)	2.2 (9.8)
	June	2.2 (13.0)	2.2 (9.8)
	July	1.8 (7.6)	1.3 (6.7)
	August	1.3 (7.2)	1.3 (6.7)
	September	1.3 (11.2)	2.2 (12.5)
	October	1.8 (11.2)	2.7 (12.5)
	November	2.2 (14.3)	2.7 (13.0)
	December	2.7 (11.2)	2.7 (15.2)
Wind, Most Common Direction	January	N [1]	SE
	February	S	SE
	March	N	NW
	April	S	SE
	May	N	N
	June	N	N
	July	N	N
	August	N	N
	September	SSW	S
	October	SSW	SSE
	November	S	SSE
	December	N	N

	Month	Biology Camp	Emerald Peak
Maximum Snow Depth (cm) (Forest/Clearing)	January	20/60	65/94
	February	35/78	86/109
	March	55/105	116/139
	April	0/0	78/95
	May	0/0	0/0
	June	0/0	0/0
	July	0/0	0/0
	August	0/0	0/0
	September	0/0	0/0
	October	0/0	0/0
	November	0/0	0/0
	December	29/31[7]	6/8[7]
Rain Fall/Snow Melt (mm) (Average/Total)	January	n/a[2]	n/a[2]
	February	n/a[2]	n/a[2]
	March	n/a[2]	n/a[2]
	April	n/a[2]	n/a[2]
	May	20.6[3]	22.0[3]
	June	13.4	38.6
	July	112.2	112.8
	August	113.2	92.8
	September	5.6	7.6
	October	5.0[4]	31.0[4]
	November	5.8[5]	9.0[5]
	December	n/a[6]	n/a[6]

	Month	Biology Camp	Emerald Peak
Relative Humidity (%) average (max; min)	January	64.6 (96.0; 11.0)	58.2 (95.0; 3.0)
	February	62.4 (96.0; 16.0)	55.3 (93.0; 9.0)
	March	62.9 (95.0; 19.0)	55.9 (93.0; 10.0)
	April	54.7 (95.0; 19.0)	50.1 (92.0; 6.0)
	May	41.1 (99.0; 13.0)	37.6 (95.0; 8.0)
	June	44.4 (99.0; 13.0)	38.1 (95.0; 8.0)
	July	81.8 (100.0; 31.0)	73.8 (96.0; 27.0)
	August	78.0 (100.0; 25.0)	69.0 (96.0; 22.0)
	September	57.8 (96.0; 19.0)	50.8 (95.0; 9.0)
	October	56.5 (99.0; 18.0)	50.7 (96.0; 9.0)
	November	64.8 (98.0; 9.0)	62.6 (95.0; 4.0)
	December	47.4 (95.0; 10.0)	41.3 (93.0; 4.0)
Dew Point (°C) average (max; min)	January	-10.8 (3.2; -25.6)	-14.4 (0.7; -37.1)
	February	-9.4 (1.1; -25.7)	-13.1 (-3.0; -32.2)
	March	-6.4 (2.8; -19.6)	-10.3 (-1.3; -27.9)
	April	-5.2 (7.7; -19.7)	-9.1 (4.0; -34.2)
	May	-2.5 (9.7; -17.7)	-6.7 (4.5; -25.2)
	June	1.0 (14.4; -11.7)	-3.6 (10.8; -20.7)
	July	9.6 (15.7; 4.2)	6.5 (11.7; -2.4)
	August	8.8 (18.2; 1.1)	5.3 (12.8; -3.8)
	September	3.3 (14.2; -13.3)	-0.6 (11.2; -22.8)
	October	-1.2 (9.1; -15.3)	-4.7 (5.3; -25.2)
	November	-5.0 (5.1; -29.8)	-7.4 (3.4; -39.2)
	December	-13.9 (-1.2; -28.5)	-18.4 (-2.5; -38.7)

Appendix I-1 (cont.)

1 A reading of “no wind” was actually the most common recording this month, but of the directions recorded, North was the most common.

2 The rain gauge on Emerald Peak was disconnected on 13 February 2001. Any moisture recorded at Emerald Peak and Biology Peak during January, February, March and April was most likely snow melt and was therefore not included in the data summaries. There was snow on the ground at the end of April.

3 There was rain data beginning on 12 May for the Biology Camp weather station. The monsoons came a bit early this year, the snow melted in early May and there wasn’t any snow left on the ground, so this was assumed to be actual rain. The rain gauge on Emerald Peak was not plugged in until 16 May however so some rain data may have been missed at this weather station for May.

4 On 6 and 7 October 2001 rain was recorded on Emerald Peak. No rain was recorded during this time at the Biology Camp weather station. We were unable to determine if this was an actual lack of rain or if something was wrong with the rain gauge. The gauge appeared to be working at the Biology Camp since there were rain readings throughout the month.

5 Some of the moisture recorded this month was snow/sleet melt.

6 The rain gauge was disconnected on 7 December 2001. All moisture during the month of December was in the form of snow.

7 The Biology Camp snow poles were checked on 6 and 22 December 2001. The data reported for the Biology Camp is from 22 December 2001 (7/8 for 6 December 2001). The Emerald Peak snow poles were only checked on 6 December 2001, so the amount of snow was actually greater by the end of the month.

Appendix I-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)
Nov 2000	TR	C	1	60.0	60.0	60.0
Nov 2000	TR	F	1	40.0	40.0	40.0
Nov 2000	SF	C	3	81.3	85.0	77.0
Nov 2000	SF	F	3	63.0	68.0	53.0
Dec 2000	TR	C	3	44.7	55.0	35.0
Dec 2000	TR	F	3	28.3	50.0	15.0
Dec 2000	SF	C	5	50.0	75.0	0.0
Dec 2000	SF	F	5	43.0	53.0	17.0
Jan 2001	TR	C	1	60.0	60.0	60.0
Jan 2001	TR	F	1	20.0	20.0	20.0
Jan. 2001	SF	C	3	82.3	108.0	45.0
Jan 2001	SF	F	3	56.0	68.0	35.0
Feb 2001	TR	C	1	78.0	78.0	78.0
Feb 2001	TR	F	1	35.0	35.0	35.0
Feb 2001	SF	C	3	98.0	135.0	50.0
Feb 2001	SF	F	3	75.0	89.0	50.0
Mar 2001	TR	C	3	109.3	143.0	80.0
Mar 2001	TR	F	3	80.0	120.0	55.0
Mar 2001	SF	C	4	132.5	164.0	65.0
Mar 2001	SF	F	5	116.0	135.0	83.0

Month	Hab	Loc	N[1]	Average snow depth (cm)	Maximum snow depth (cm)	Minimum snow depth (cm)
Apr 2001	TR	C	1	0.0	0.0	0.0
Apr 2001	TR	F	1	0.0	0.0	0.0
Apr 2001	SF	C	3	56.7	95.0	0.0
Apr 2001	SF	F	3	53.7	83.0	0.0
May 2001	TR	C	5	0.0	0.0	0.0
May 2001	TR	F	4	0.0	0.0	0.0
May 2001	SF	C	5	0.0	0.0	0.0
May 2001	SF	F	5	0.0	0.0	0.0

1 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. During the months when only a mini-census is conducted, we read a subset of the snow poles: 1 set in the TR habitat and 3 sets in the SF habitat.