THE UNIVERSITY OF

ARIZONA

MT. GRAHAM RED SQUIRREL MONITORING PROGRAM

Annual Report
for
1998

Submitted: 26 February 1998

Prepared by:

Paul J. Young, Supervisor
Vicki L. Greer, Biologist - Senior
Erin L. Bibles, Biologist
Nancy Ferguson, Biologist
J. Elaine Lowry, Biologist
Eric A. Point, 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 1998. The MGIO is located along a ridge extending westward from Hawk Peak in the Graham (Pinaleño) Mountains of southeastern Arizona. In 1998, 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 1998. The major construction activity on the LBT was the enclosure of the foundation building and the continued formation of the steel structure above the foundation.

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 areas is 278.5 ha.

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: April, May, July, August, and October. 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. Food resources were measured at 28 sites distributed among the monitored areas (Figure 1). Conifer seeds, and mushrooms (epigeous or above-ground fungi) were collected at all 28 sites.

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 eight sites throughout the monitored areas.

The Monitoring Program has developed and is maintaining a database using Global Positioning System (GPS) and Geographic Information System (GIS) applications. By the end of 1998, all but a few of the middens on the monitored areas were mapped using GPS, in addition to 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. No part of this report may be used or reproduced in any form without the written permission of the Monitoring Program Supervisor.

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 monitored areas are surveyed during census months to locate newly established middens. In addition, new middens are also discovered during other monitoring activities. All known midden sites are marked with numbered metal tags, and black and orange striped flagging.

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 1997, 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 1997 crop were collected from the seed traps in early June 1998. 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 June through October. 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).

Energetics of Selected Food Resources

The total number of viable seeds or weight of mushrooms does not provide an equitable comparison within or among areas because different species vary greatly in size, weight, and energy content. The energy content of each food type was calculated and the proportional contribution of each of the food resources was determined. The calculations were made using seed weights measured from Mt. Graham seeds and energy values from Smith (1981) (Table 2). Energy content was also used to estimate the total energy available (MJ/ha) on each area. An index of total energy available to squirrels was made by combining the total energy of conifer seeds and mushrooms from the same year. Conifer seeds and mushrooms were used to estimate total energy available because they are the primary food sources of red squirrels, they become available at about the same time of year (late summer and autumn), and they provide the majority of the stored food reserves of red squirrels. Standard statistical tests were used in all comparisons.

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 and energy data. Consequently, the previous year's seed, mushroom, and energy 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 1998, 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: April, May, July, August, and October. 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 questionably 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 questionably occupied when red squirrel sign was found but the sign was insufficient to clearly indicate occupancy. Questionably 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 1997, the number of occupied middens and the sexes of resident squirrels were determined. The December occupancy was then compared to occupancy for June 1998. 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 or squirrel 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 1998, 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

There was no trapping and marking during the 1998 field season.

Midden 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 (Federal Building, Tucson, 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, and rainfall. In addition, the station at the Biology Camp records relative humidity and barometric pressure. Data were collected at 30 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

1997 Conifer Seed Production

Corkbark fir seeds, on average, were the most abundant food resource in numbers of seeds/ha on all of the monitored areas, except the SFN area where Engelmann spruce was the most abundant. This is in contrast to 1996, when Engelmann spruce was the most abundant food resource on most of the monitored areas. In the SF habitat, corkbark fir seeds and Engelmann spruce seeds were nearly equally abundant, accounting for 51% and 48% respectively. Douglas-fir seeds accounted for only 1% of the seed fall in the SF habitat. Filled Douglas-fir seeds were not found in any of the samples from the SFC area. In the TR habitat, corkbark fir was the most abundant, accounting for 65% of the seed fall. Douglas-fir and Engelmann spruce accounted for 25% and 10% respectively in the TR habitat. White pine and ponderosa pine were not represented in the samples collected from any of the plots (Table 3, Appendix A).

The 1997 conifer seed crop was the third highest seen since data collection began in 1993. Only the overall 1993 and 1995 seed crops were higher. Compared to the 1996 seed crop, the 1997 crop for all species was nearly an order of magnitude higher. The seed production, on average, in the TR habitat was an order of magnitude higher than in the SF habitat (Figure 2a-c, Appendix A).

1998 Mushroom Production

Annual mean mushroom production in 1998 was lower than in 1997. All of the monitored areas showed a decrease (TRC-51%, TRN-57%, SFC-5%, SFN-21%) in mean annual production from 1997 to 1998 (Figure 3).

There were no significant differences in annual production ($\bar{x}$ wet weight) between the TR and SF habitats. As in past years, the SF habitat had the greatest (though not significantly) annual mushroom production. There was, however, a significant difference between the TR and SF habitats when comparing $\bar{x}$ dry weight and $\bar{x}$ energy content (Table 4).

On the TRC area, three genera, *Russula, Ramaria, and Auricularia* accounted for 82% of production, with *Russula* alone accounting for 67%. On the TRN area, *Russula, Cortinarius,* and *Clitocybe* accounted for 89% of total production. Again, *Russula* accounted for most of the production, 78%. *Russula, Boletus,* and *Hydnum* accounted for 62% of the production on the SFC area, with *Russula* accounting for 33%. On the SFN area, *Russula, Lycoperdon,* and *Boletus* accounted for 68% of the total production, with Russula accounting for 45% (Table 5).

Energetics of Selected Food Resources in 1997

In the TR habitat, there was significantly more mean energy (MJ/ha) available from corkbark fir and Douglas-fir seeds on the TRC area than the TRN area. Energy available from Engelmann spruce was not significantly different within the TR habitat. Overall, corkbark fir in the TR habitat accounted for the largest proportion of energy available from seeds. Within the SF habitat there were no significant differences in the energy available from the three types of seeds between the SFC and SFN areas. As in the TR habitat, corkbark fir accounted for the largest proportion of energy available from seeds in the SF habitat. For 1997 mushrooms, the amount of energy available was not significantly different between the four areas (Table 6). In 1997, seeds accounted for 66% of the total energy available and mushrooms accounted for 34%. For comparison, in 1996, mushrooms accounted for 94 % of the total energy on all of the areas, and in 1995, seeds accounted for 95% of the total energy (Figure 4).

To compare the 1997 food resources found within the monitored areas, the areas were divided into polygons enclosing each food resource plot. Boundaries between polygons were drawn along the midpoints between adjacent plots so that each area contained all the area that was closer to the sample plot than any other. In all polygons in the TR habitat (9), the total energy available in 1997 was greater than 200 MJ/ha. One plot, TRC-10, had the highest total energy available (1414.4 MJ/ha) of all the monitored areas. On the SFC area, only three of the six polygons had greater than 200 MJ/ha. On the SFN area, only two of the twelve plots had greater than 200 MJ/ha total available energy (Figure 5, Appendix A-1).

Population Biology

Midden Occupancy

Four quarterly censuses (Mar, Jun, Sep, and Dec) of all middens on or near the monitored areas were made in 1998 (Appendix B-1). In addition, the 37 middens within 100 m of the access road or construction were censused during months of construction activity (Appendix C).

From December 1997 to December 1998, the number of red squirrels on the monitored areas increased from 101 to 134, a 25% increase. On the TRC area, the highest number of squirrels (26) was seen in December 1998, and the lowest number was 11 squirrels seen in June. December was also the month with the highest number of squirrels (30) on the TRN area. The lowest squirrel numbers (12) on the TRN area were seen in March. The highest numbers of squirrels (46) on the SFC area were also seen in December and the lowest numbers (19) were seen in June. December again had the highest number of squirrels (32) for the SFN area, and June was also the lowest month with 15 squirrels (Figure 6, Appendix B-1,C,D,E).

Due to an increase in squirrel numbers, 35 new middens were added to the December census (Table 7). Each of these new middens was identified as a new activity area during the September census. These areas had the potential to become new middens based on the presence of squirrel sign and a squirrel was seen at each midden. These middens were reassessed during the December census for improvement in sign and the continued presence of a squirrel. Activity areas that met the criteria were "upgraded" to new middens and added to the regular quarterly census in December (Appendix B-2). More new middens were established in the TR habitat, and the proportion of middens in the TR habitat increased slightly from June 1998 to December 1998. Even with the addition of new middens, the proportion of squirrels on each of the monitored areas did not markedly change from June to December 1998 (Table 8).

In June 1998, 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. This same pattern was also seen in December 1998. Overall, on all of the monitored areas in 1998, the proportion of occupied middens increased from 23% in June to 48% in December. The largest increases were seen in the TR habitat (Table 9).

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 1998. On the TRC area in June, occupied middens were slightly farther (approx. 7 m) from construction than unoccupied middens. By December, however, unoccupied middens were slightly farther from construction (approx. 16 m). In June 1998, on the SFC area, unoccupied middens were closer to construction than occupied middens by an average of 8 m. In December, unoccupied middens were, on average, 3 m closer to construction than occupied middens (Table 10).

Overwinter Survival

There were no significant differences in the number of squirrels that survived the winter of 1997-1998 within or between the TR and SF habitats. Overwinter survival for the TR habitat in 1996-1997 was 46% and overwinter survival in the SF habitat was 38% (Table 11). For comparison, the average proportion of survival from seven previous years of data collection was 61% in the TR habitat and 59% 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.

Spatial Distribution

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 7). The overall crude density of *middens* increased on all areas between December 1997 and December 1998. This increase was due to the addition of 35 new middens in December 1998 (Figure 7, Appendix F-1a).

The crude density of *squirrels* remained fairly stable on all areas from December 1997 to September 1998. By December 1998, however, there were increases in the crude density of squirrels on all of the monitored areas. This is a reflection of the overall pattern in the numbers of squirrels on the monitored areas in 1998. The TRN area had the largest increase because more new middens were established on this area than any other (Figure 7, Appendix F1-b, Table 7).

Local Density

The December 1998 mean local density ($\bar{x}$ LD) of *middens* was greater on all areas (4.9), than in December 1997 (4.6), although several new middens were established on the monitored areas in 1998. There were significant differences in the local density of middens among the four areas. The SFN area had the lowest $\bar{x}$ LD (3.5), and the $\bar{x}$ LD on the remaining three areas (5.1 - 5.9) were similar (Table 12, Figure 8, Appendix F-2).

The $\bar{x}$ LD of *squirrels* (occupied middens) on all areas in December 1998 was 2.9, which is an increase from 1.8 in December 1997. The SFN area had a significantly lower $\bar{x}$ LD of squirrels (1.1) than the 2.5 $\bar{x}$ LD seen on the SFC area. The $\bar{x}$ LD on the TRC (3.9) and the TRN (4.4) were not significantly different from each other (Table 12, Figure 8, Appendix F-2).

Nearest Neighbor Distance

The $\bar{x}$ NND of *middens* on all areas decreased slightly from December 1997 to December 1998. There were no significant differences in $\bar{x}$ NND among the 4 areas in December 1998 (Table 13, Figure 9, Appendix F-2).

The $\bar{x}$ NND of *squirrels* (occupied middens) in the TR habitat decreased from December 1997 to December 1998. In the SF habitat, the $\bar{x}$ NND increased between December 1997 and June 1998. This increase was a reflection in the drop in squirrel numbers in the SF habitat. When squirrel numbers in the SF habitat began to increase through the autumn to their highest level in December, the $\bar{x}$ NND began to decrease. In 1998, the SFN had a significantly longer $\bar{x}$ NND than the other three areas which were similar to each other (Table 13, Figure 9, Appendix F-2).

Reproductive Activity and Success

Four breeding chases were observed in 1998, all in the SF habitat. All of the breeding chases were observed during the June census (Appendix G-1). The earliest date a scrotal male was seen was 3 March in the TRC area, and 13 out of 17 males identified during the March census were scrotal. The latest date a scrotal male was seen was 11 September on the SFC area. However, only two of the males seen during the September census were scrotal. No scrotal males were observed during the December census (Appendix G-3b).

The earliest a lactating female was observed was 4 June on the TRC area and the latest was on 10 September, also on the TRC area. During the March census, 16 females were identified and none were lactating. By June, 16 of the 30 females identified were classified as lactating or reproductive. In September, out of 30 females seen, only one was lactating and 17 were post-lactating. Finally, in December, there was only one post-lactating female out of the 28 identified (Appendix G-3a).

Direct evidence of 4 litters (7 juveniles) was seen during censuses or other monitoring activities. The earliest evidence of a litter was seen on 16 July on the SFC area. The latest evidence of a litter was seen on 27 September on the TRC area (Appendix G-2). In September, 37 squirrels were identified as young of the year. Thirty-six squirrels were classified as young of the year in December (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

There was no trapping and marking on the monitored areas in 1998.

Marked Squirrels

There was only one marked squirrel seen on the monitored areas throughout 1998 (Appendix B-1). In addition to the ear tagged squirrel, there were 15 squirrels on or near the monitored areas in 1998 with natural identifying marks such as an ear notch or a short tail (Appendix H-1). Eight of these squirrels were seen during the December 1998 census.

The marked male was observed outside his midden on one occasion. The marked male from midden 3365 was seen on the same day at two neighboring middens, 74 m and 115 m from his home midden (Appendix H-3). The marked male was observed chattering from one of the neighboring middens (Appendix H-5).

Midden Mapping

At the end of 1998, all but a few of the middens on the monitored areas were mapped using GPS, in addition to food resource plots, MGIO boundaries, and most roads and trails. The GIS database continued to be developed during 1998.

Weather Data

Weather data were collected nearly continuously in 1998 from two weather stations located at the biology camp (TR habitat) and near Emerald Peak (SF habitat). Due to several mechanical and software difficulties, there was no data collected at the biology camp station for February and no data was recorded at the Emerald Peak station for March and April. The maximum temperature recorded was 36.9°C in June at the biology camp and the minimum temperature recorded was -19.8°C in December on Emerald Peak. The maximum average monthly temperature was 17.7°C in June at the biology camp and the minimum average monthly temperature was -5.9°C in February on Emerald Peak. (Figure 10, Appendix I-1). The maximum rainfall at both stations was recorded in July, with 127.0 mm at the biology camp and 130.0 mm at Emerald Peak. June was the driest month with 0 mm recorded at both stations (Figure 11, 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 1997 through May 1998 ranged from 9.0 cm to 183.4 cm (Figure 12, Appendix I-2). For comparison, average accumulated snow depths for the same period in 1996-1997 ranged from 7.0 cm to 150.4 cm, and in 1995-1996 depths ranged from 6 cm to 40 cm. Data on wind chill temperatures, wind direction and speed, humidity, and barometric pressure were also collected (Appendix I-1).

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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. Energy content of some red squirrel food resources. (Note: energy content was calculated using seed weights measured from Mt. Graham seeds and energy values from C. Smith 1981.)

Food Resource	Unit	($\bar{x}$ mg/seed)	Energy Content (kJ/unit)
Engelmann spruce	seed	3.7	0.091
Corkbark fir	seed	18.6	0.444
Douglas-fir	seed	8.7	0.192
Mushroom	mg dry weight		0.018

Table 3. Mean filled conifer seed production, 1997.

Area/Habitat	# of sample plots	Corkbark fir $\bar{x}$ 1000 seeds/ha	Corkbark fir %	Douglas-fir $\bar{x}$ 1000 seeds/ha	Douglas-fir %	Engelmann spruce $\bar{x}$ 1000 seeds/ha	Engelmann spruce %
TRC	5	994.7	64.2	360.0	23.2	194.7	12.6
TRN	4	610.0	68.3	256.7	28.7	26.8	3.0
SFC	7	142.9	79.8	0.0	0.0	36.1	20.2
SFN	12	1.1	1.8	1.1	1.8	59.4	96.4
TR Habitat	9	823.7	65.5	314.1	25.0	120.1	9.5
SF Habitat	19	53.3	50.9	0.7	0.7	50.8	48.5

Table 4. Mean annual mushroom production, 1998.

Area/Habitat	# of sample plots	$\bar{x}$ Wet weight (Kg/ha)	$\bar{x}$ Dry weight (Kg/ha)	$\bar{x}$ Energy content (MJ/ha)
TRC	5	19.760 ± 7.4494	2.071 ± 0.7751	37.274 ± 13.9518
TRN	4	27.003 ± 10.6849	2.909 ± 1.0662	52.358 ±19.1923
SFC	7	65.256 ± 18.9863	6.551 ± 1.7986	117.915 ± 32.3755
SFN	12	62.814 ± 15.1347	6.640 ± 1.5689	119.519 ± 28.2410
TR Habitat	9	22.979 ± 6.0051	2.443 ± 0.6148	43.978 ± 11.0672
SF Habitat	19	63.7137 ± 11.5219	6.607 ± 1.1608	118.928 ± 20.8946

Wilcoxon Test between SF and TR:

Wet Weight	Z= -1.86929	*P*= 0.0616
Dry Weight	Z= -2.06606	***P*= 0.0388**
Energy	Z= -2.06606	***P*= 0.0388**

Table 5. Mean annual mushroom production (wet weight Kg/ha) of selected mushroom genera known to be food resources for red squirrels, 1998. 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	0.062	2.8	0.105	3.5	0.046	0.6	0.476	6.8
Auricularia	0.144	**6.6**	0.000	0.0	0.001	0.0	0.004	0.1
Boletus	0.000	0.0	0.000	0.0	1.201	**16.6**	0.765	**11.0**
Clavaria	0.000	0.0	0.000	0.0	0.005	0.1	0.019	0.3
Clitocybe	0.035	1.6	0.167	**5.6**	0.304	4.2	0.077	1.1
Cortinarius	0.127	5.8	0.167	**5.6**	0.587	8.1	0.494	7.1
Gastroid sp.	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0
Hydnum	0.000	0.0	0.000	0.0	0.933	**12.9**	0.000	0.0
Lactarius	0.023	1.0	0.032	1.1	0.035	0.5	0.427	6.1
Leccinum	0.000	0.0	0.000	0.0	0.543	7.5	0.222	3.2
Lycoperdon	0.102	4.6	0.067	2.2	0.687	9.5	0.844	**12.1**
Pholiota	0.000	0.0	0.000	0.0	0.000	0.0	0.000	0.0
Ramaria	0.204	**9.3**	0.000	0.0	0.210	2.9	0.527	7.5
Russula	1.461	**66.5**	2.339	**77.9**	2.370	**32.7**	3.122	**44.7**
Suillus	0.038	1.7	0.124	4.1	0.328	4.5	0.005	0.1
Total	2.195		3.001		7.250		6.982	

Table 6. Estimated mean energy (MJ/ha) from four primary food resources, 1997.

Area/ Habitat	# of plots	Corkbark fir	Douglas-fir	Engelmann spruce	Total Seeds	Total Mushrooms	Total Energy
		$\bar{x}$ MJ/ha ± se					
TRC	5	441.66 ± 235.394[a]	69.12 ± 33.221[a]	17.72 ± 14.713[a]	528.50 ± 217.085[a]	84.85 ± 28.785[a]	613.34 ± 212.394[a]
TRN	4	270.84 ± 73.059[a,b]	49.29 ±26.996[a,b]	2.44 ± 0.000[a]	322.57 ± 100.014[a,b]	119.68 ± 14.549[a]	442.24 ± 103.478[a,b]
SFC	7	63.43 ± 30.451[b]	0.00 ± 0.000[b]	3.29 ± 0.907[a]	66.72 ± 30.701[b,c]	123.99 ± 25.378[a]	190.70 ± 38.818[b]
SFN	12	0.49 ± 0.488[b]	0.21 ± 0.211[b]	5.41 ± 1.643[a]	6.11 ± 1.683[c]	140.38 ± 25.593[a]	146.48 ± 26.274[b]
TR Hab	9	365.74 ± 131.080	60.31 ± 20.980	10.93 ± 8.206	436.97 ± 126.754	100.33 ± 17.403	537.30 ± 123.366
SF Hab	19	23.68 ± 12.852	0.13 ± .0133	4.63 ± 1.096	28.44 ± 12.819	134.34 ± 18.313	162.78 ± 21.835

a,b,c Means with a different letter are significantly different.

Table 7. Number and discovery status of red squirrel middens on each of the monitored areas, 1997-1998.

		Midden Status			
Year	Area	Old[1]	Newly Found	Newly Established	Total[2]
1997	TRC	27	0	0	27
	TRN	28	0	1	29
	SFC	104	0	0	104
	SFN	100	0	0	100
	Total	259	0	1	260
1998[3]	TRC	25	0	10	35
	TRN	24	0	13	37
	SFC	101	0	4	105
	SFN	97	0	5	102
	Total	247	0	32	279

1 The number of middens during the March censuses.

2 The number of midden during the December censuses.

3 The lower number of middens from the end of 1997 (December census) and the beginning of 1998 (March census) is due to removal of middens from the census database because of low occupancy. These middens had not been occupied for 3 or more years.

Table 8. Proportion of the total area, total number of middens, and total number of squirrels[1] found on each of the monitored areas, 1997-1998.

			Jun 1997				Dec 1997			
	Area		Middens		Squirrels[1]		Middens		Squirrels	
	ha	%[2]	n	%	n	%	n	%	n	%
TRC	49.1	18	27	10	9	10	27	10	15[3]	15
TRN	24.4	9	28	11	10	11	29	11	14	14
SFC	76.1	27	104	40	33	37	104	40	35	35
SFN	128.9	46	100	39	38	42	100	38	37	37
Total	278.5		259		90		260		101	

			Jun 1998				Dec 1998			
	Area		Middens		Squirrels		Middens		Squirrels	
	ha	%	n	%	n	%	n	%	n	%
TRC	49.1	18	26	10	11	19	35	13	26	19
TRN	24.4	9	24	10	13	22	37	13	30	22
SFC	76.1	27	101	41	19	33	105	38	46	34
SFN	128.9	46	97	39	15	26	102	37	32	24
Total	278.5		248[4]		58		279		134	

1 Juveniles living with their mothers are not counted in the number of squirrels.

2 All percentages are rounded to the nearest whole number.

3 This number includes the two red squirrels observed at 1160.

4 The lower number of middens from the end of 1997 (December census) and the beginning of 1998 (March census) is due to removal of middens from the census database because of low occupancy. These middens had not been occupied for 3 or more years.

Table 9. Number and percent of available middens *occupied*, 1998.

	June			December		
Area/Habitat	# mid	# occ	% occ	# mid	# occ	%
TRC	26	11	42	35	26	74
TRN	24	13	54	37	30	81
SFC	101	19	19	105	46	44
SFN	97	15	15	102	32	31
TR Habitat	50	24	48	72	56	78
SF Habitat	198	34	17	207	78	38
TR + SF	248	58	23	279	134	48

Chi Square:

JUNE

within TR	X^2=0.703	df=1	*P*=0.402
within SF	X^2=0.390	df=1	*P=0.532*
between Habitats	X^2=21.174	df=1	***P*=0.001**

DECEMBER

within TR	X^2=0.481	df=1	*P*=0.488
within SF	X^2=3.408	df=1	*P*=0.065
between Habitats	X^2=34.407	df=1	***P*=0.001**

Table 10. Mean distance from construction to occupied and unoccupied middens on the TRC and SFC areas, June and December 1998.

		June		December	
Area	Midden Status	n	$\bar{x}$ ± se (m)	n	$\bar{x}$ ± se (m)
TRC	Occupied	11	220.5 ± 17.68	26	215.4 ± 11.78
	Unoccupied	15	213.8 ± 16.73	9	231.2 ± 14.98
SFC	Occupied	19	162.4 ± 18.07	46	154.9 ± 10.73
	Unoccupied	82	154.1 ± 8.70	59	151.7 ± 10.91

ANOVA:

JUNE

TRC	F=0.07	df=1	P=0.7887
SFC	F=0.17	df=1	P=0.6802

DECEMBER

TRC	F=0.51	df=1	P=0.4871
SFC	F=0.04	df=1	P=0.8396

Table 11. Overwinter survival of red squirrels on the monitored areas, 1997-1998.

Area/Habitat	Number of Squirrels Dec 1997	Number of Squirrels Surviving Jun 1998	% survival
TRC	14	8	57
TRN	14	5	36
SFC	35	14	40
SFN	37	13	35
TR Habitat	28	13	46
SF Habitat	72	27	38

Chi-square tests:

within TR	$X^2 = 0.574$	df = 1	$P = 0.449$
within SF	$X^2 = 0.0334$	df = 1	$P = 0.885$
between habitats	$X^2 = 0.155$	df = 1	$P = 0.694$

Table 12. Mean Local Density of middens and red squirrels (occupied middens) on the monitored areas, 1997 and 1998.

	December 1997				December 1998			
	Middens		Squirrels		Middens		Squirrels	
Area/Habitat	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se
TRC	27	3.6 ± 0.34[c]	14[1]	1.9 ± 0.29[a]	35	5.1 ± 0.40[a]	26	3.9 ± 0.41[a]
TRN	29	4.7 ± 0.28[b]	14	2.6 ± 0.29[a]	37	5.5 ± 0.31[a]	30	4.4 ± 0.29[a]
SFC	104	6.0 ± 0.25[a]	35	2.5 ± 0.22[a]	105	5.9 ± 0.24[a]	46	2.5 ± 0.21[b]
SFN	100	3.4 ± 0.17[c]	37	0.8 ± 0.11[b]	102	3.5 ± 0.17[b]	32	1.1 ± 0.19[c]
TR Habitat	56	4.2 ± 0.23	28[1]	2.3 ± 0.21	72	5.3 ± 0.25	56	4.1 ± 0.24
SF Habitat	204	4.8 ± 1.30	72	1.6 ± 0.16	207	4.7 ± 0.17	78	1.9 ± 0.17
TOTAL	260	4.6 ± 0.15	100[1]	1.8 ± 0.13	279	4.9 ± 0.14	134	2.9 ± 0.17

ANOVA:	**1997**			**1998**		
LD of Middens						
among all areas	F=29.33	df=3	***P=0.0001***	F=23.62	df=3	***P=0.0001***
LD of Squirrels						
among all areas	F=21.54	df=3	***P=0.0001***	F=29.05	df=3	***P=0.0001***

[a,b,c] Means with the same letter(s) are not significantly different.

[1] This is the number of *occupied middens* only, the actual number of *squirrels* may be higher (in December 1997, two squirrels considered to be living at midden 1160).

Table 13. Mean Nearest Neighbor Distance of middens and red squirrels (occupied middens) on the monitored areas, 1997 and 1998.

	December 1997				December 1998			
	Middens		Squirrels		Middens		Squirrels	
Area/Habitat	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se	n	$\bar{x}$ ± se
TRC	27	57.7 ± 7.98[a]	14[1]	76.6 ± 8.80[a,b]	35	41.4 ± 3.08[a]	26	47.1 ± 4.45[b]
TRN	29	45.5 ± 2.87[b]	14	61.0 ± 5.69[a,b]	37	43.0 ± 2.47[a]	30	48.4 ± 3.13[b]
SFC	104	42.3 ± 1.42[b]	35	54.9 ± 5.56[b]	105	42.5 ± 1.39[a]	46	64.3 ± 5.04[b]
SFN	100	50.0 ± 2.14[a,b]	37	90.4 ± 9.43[a]	102	47.7 ± 1.92[a]	32	94.9 ± 8.94[a]
TR Habitat	56	51.4 ± 4.16	28[1]	68.8 ± 5.36	72	42.2 ± 1.95	56	47.8 ± 2.64
SF Habitat	204	46.1 ± 1.30	72	73.2 ± 5.90	207	45.1 ± 1.19	78	76.9 ± 4.99
TOTAL	260	47.2 ± 1.36	100[1]	71.9 ± 4.49	279	44.3 ± 1.02	134	64.7 ± 3.34

ANOVA:	**1997**			**1998**		
NND of Middens						
among all areas	F=4.58	df=3	***P=0.0038***	F=2.15	df=3	*P=0.0944*
NND of Squirrels						
among all areas	F=4.52	df=3	***P=0.0052***	F=12.75	df=3	***P=0.0001***

[a,b] Means with the same letter(s) are not significantly different.

[1] This is the number of *occupied middens* only, the actual number of *squirrels* may be higher (in December 1997, two squirrels considered to be living at midden 1160).

Figure 1. Map of the areas monitored by the University of Arizona Red Squirrel Monitoring Program, December 1998.

Figure 2a. Engelmann spruce seed fall, 1993-1997. Note: scales are different for figures 2a-c.

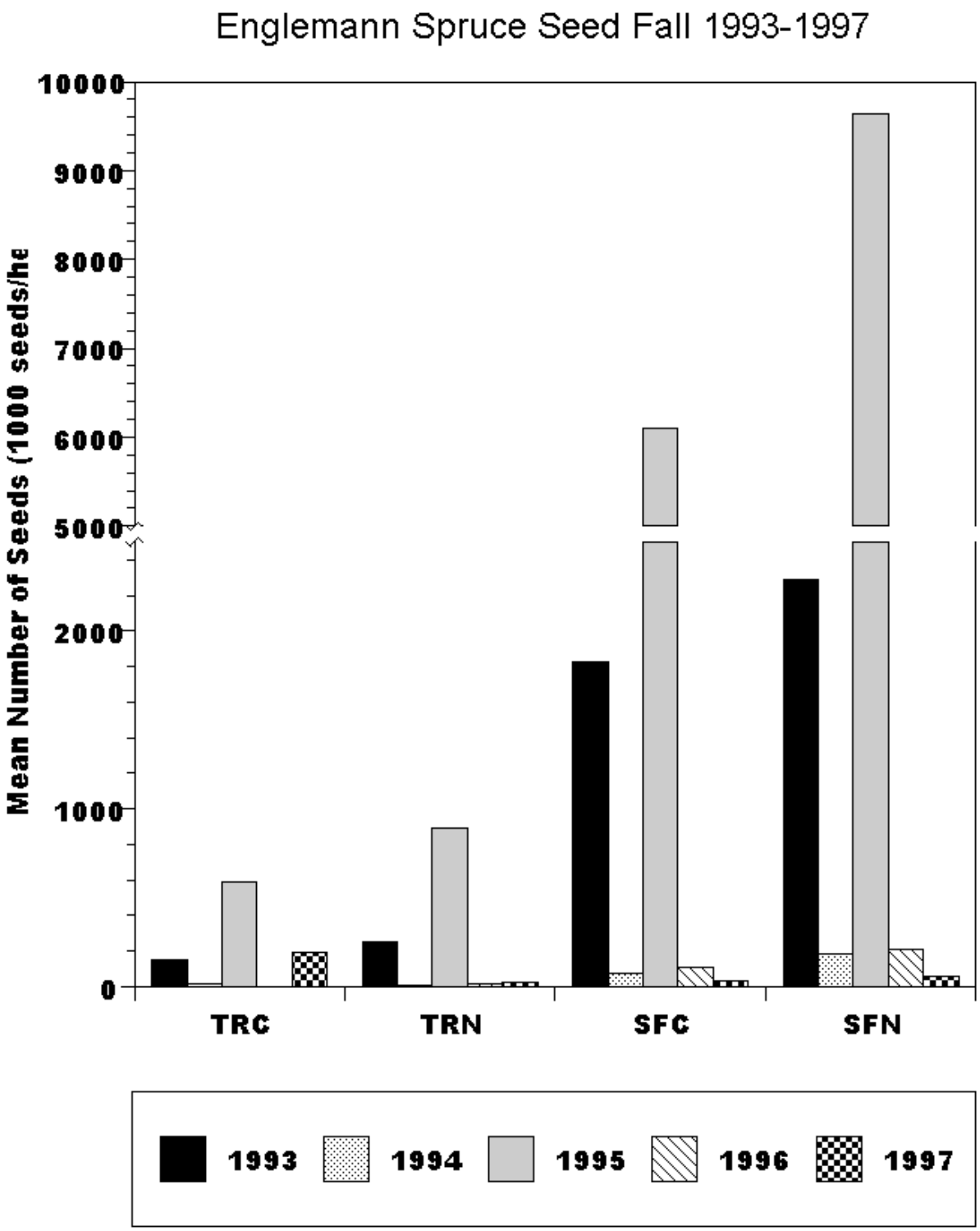


Figure 2b. Corkbark fir seed fall, 1993-1997. Note: scales are different for figures 2a-c.

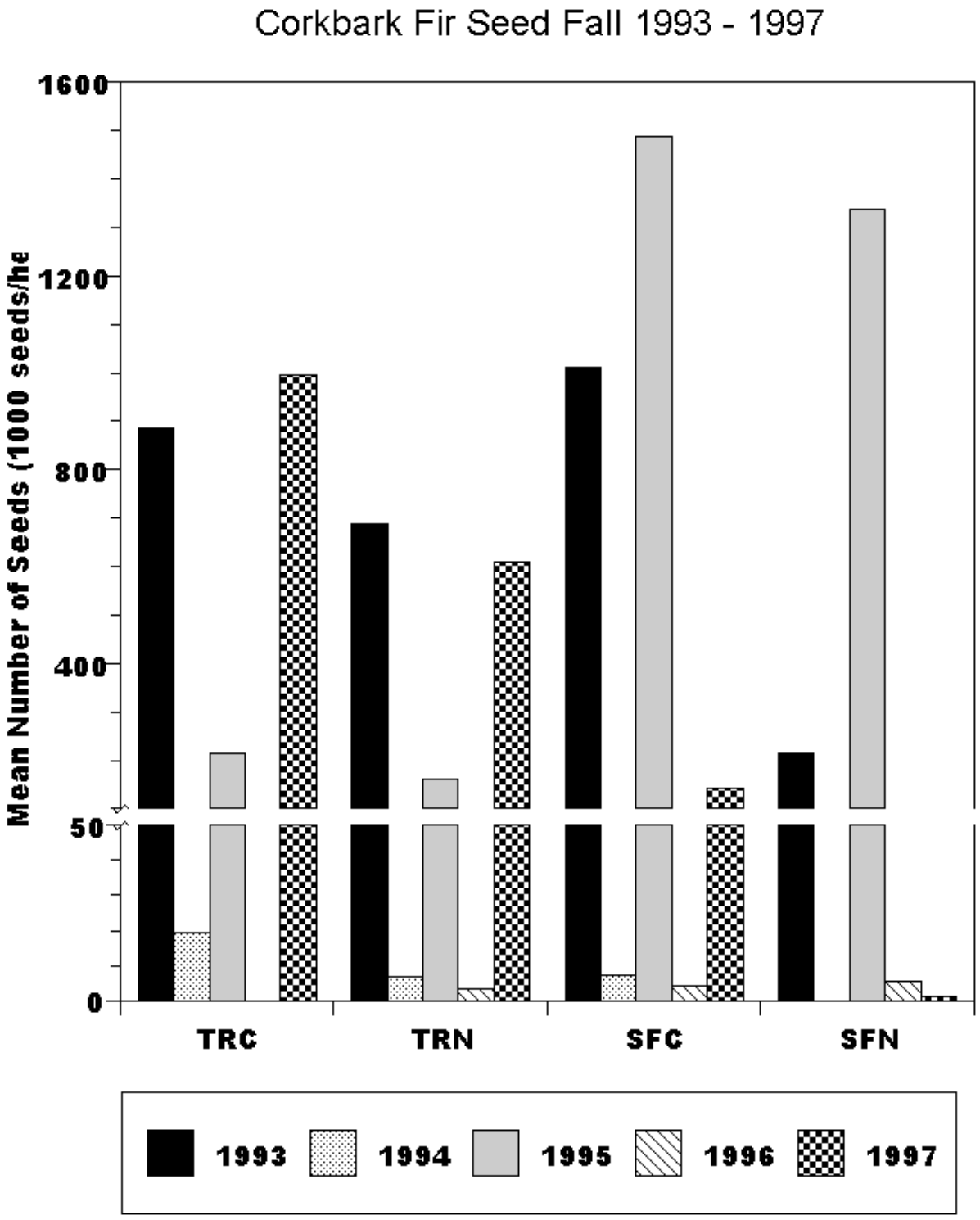


Figure 2c. Douglas-fir seed fall, 1993-1997. Note: scales are different for figures 2a-c.

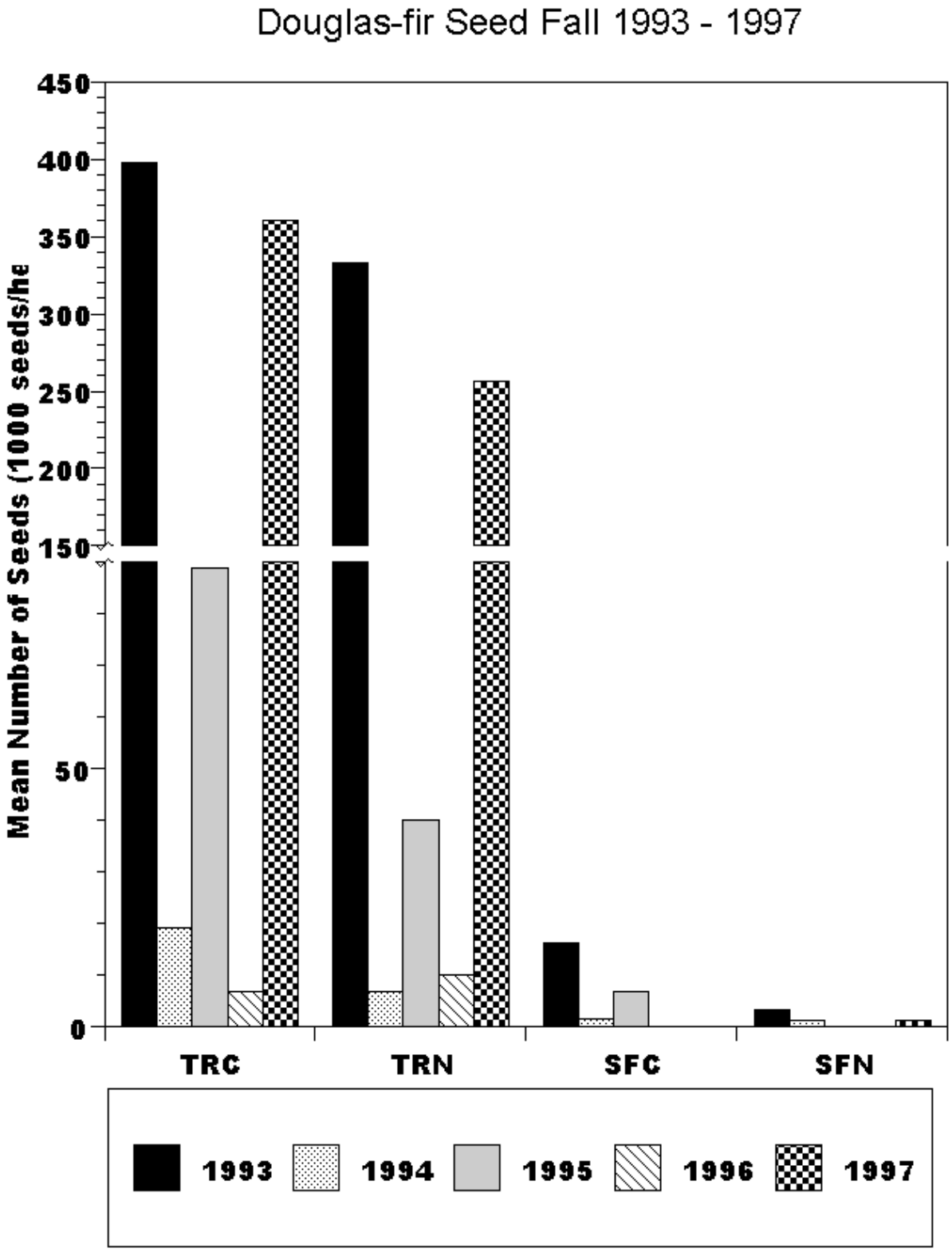


Figure 3. Mushroom crops, 1994-1998.

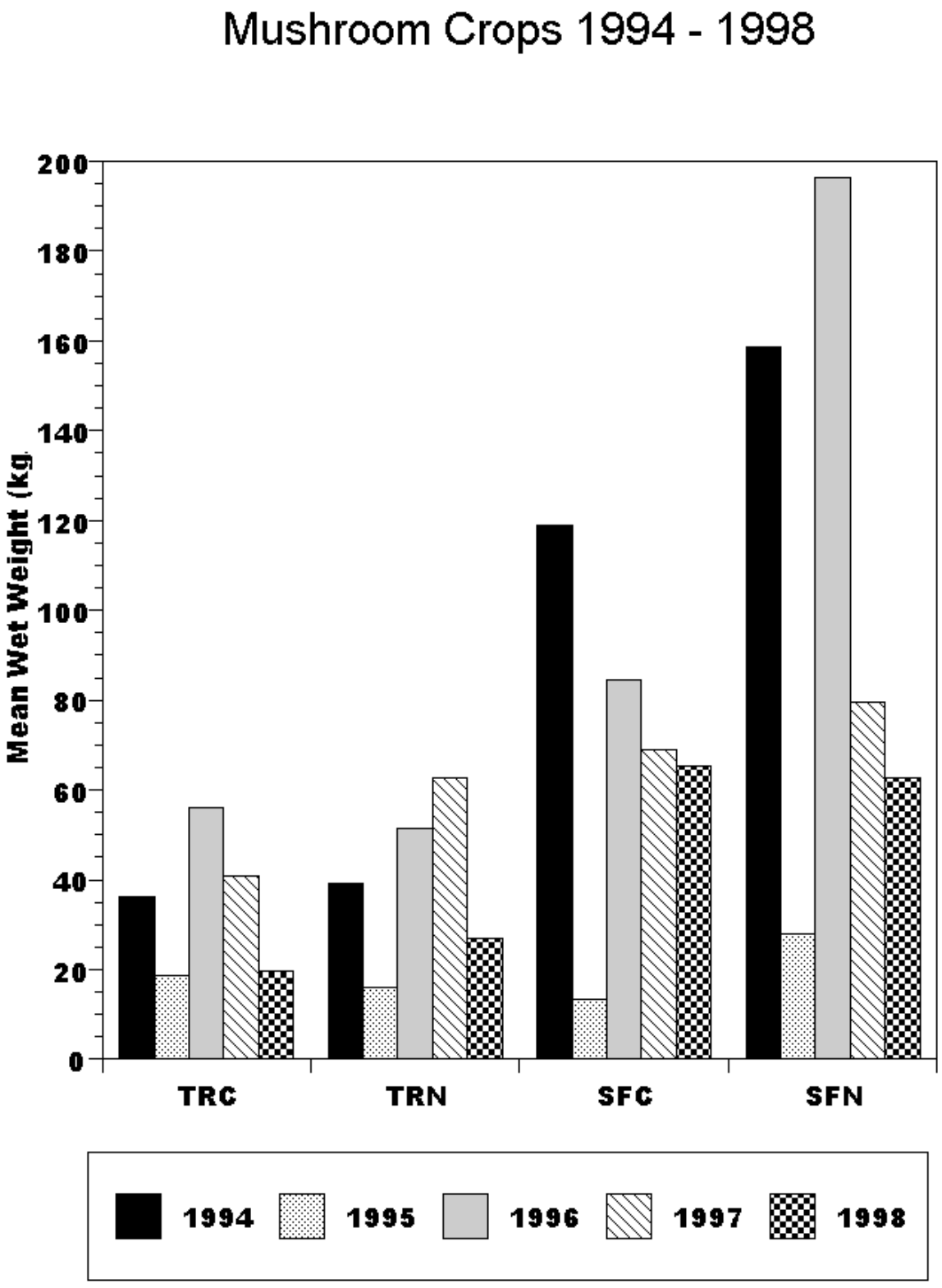


Figure 4. Energy availability on the monitored areas, 1994-1997.

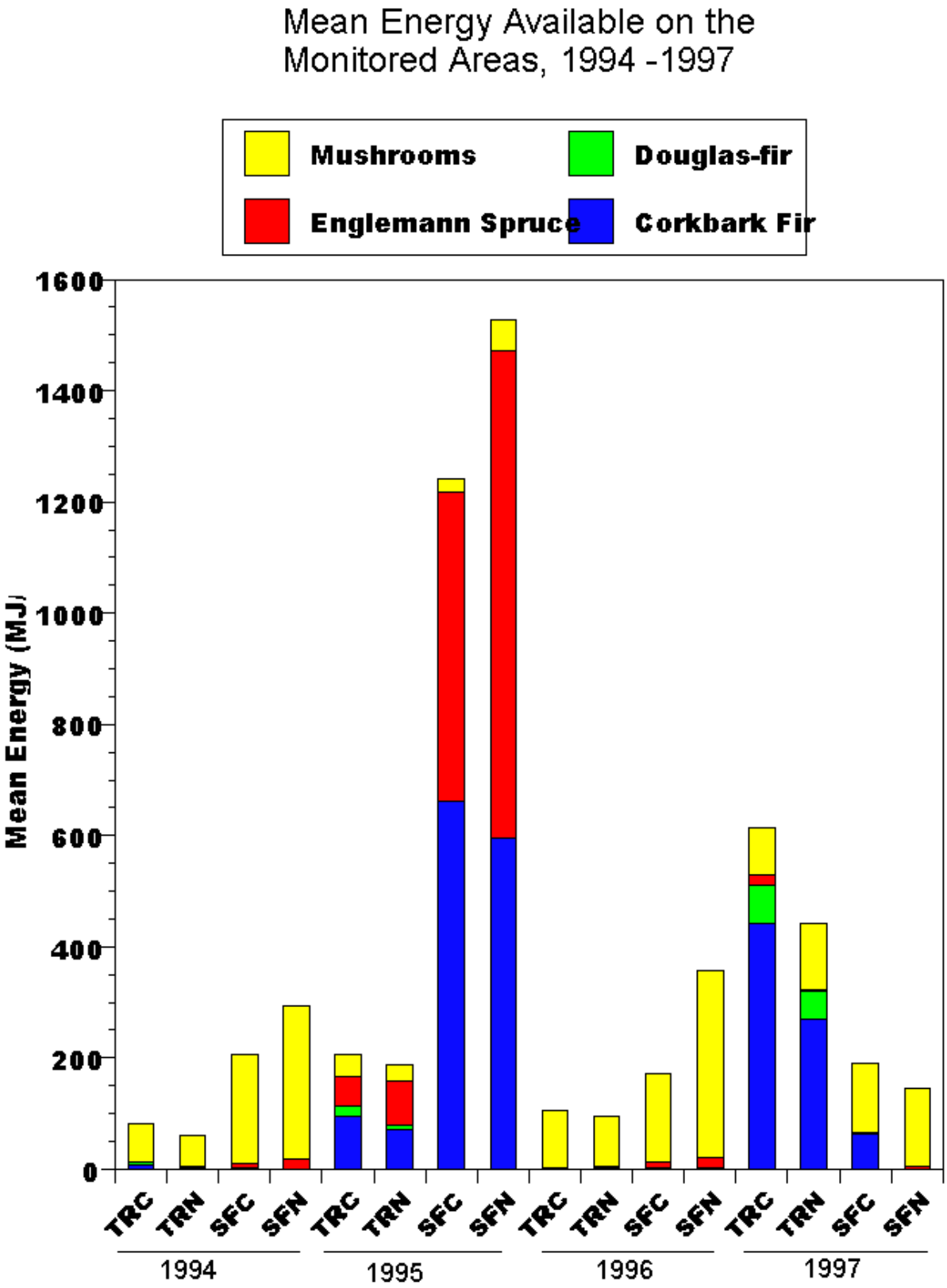


Figure 5. Distribution of total available energy from selected red squirrel food resources, 1997.

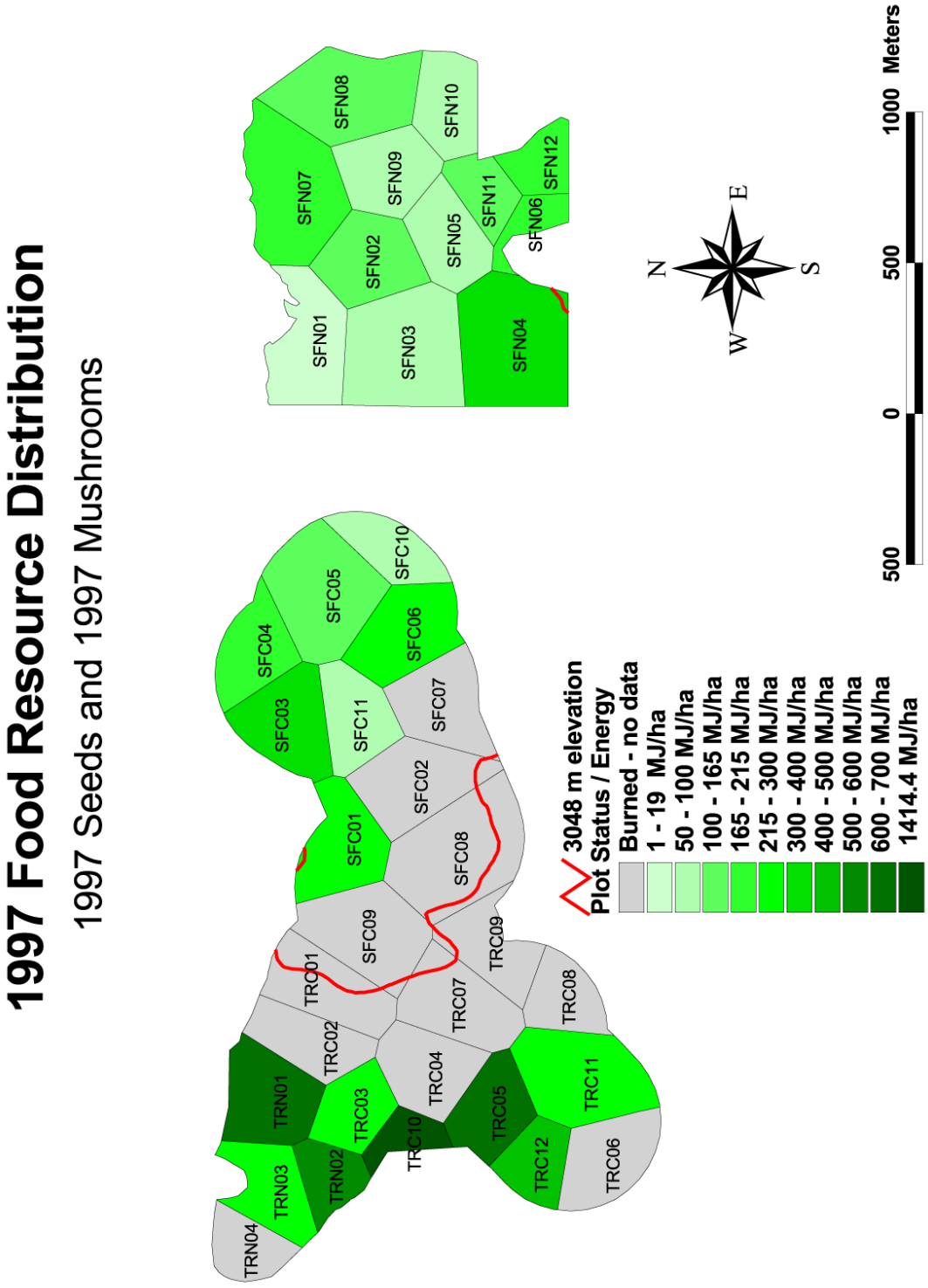


Figure 6. Red squirrel populations (including juveniles) on the monitored areas, December 1997 - December 1998.

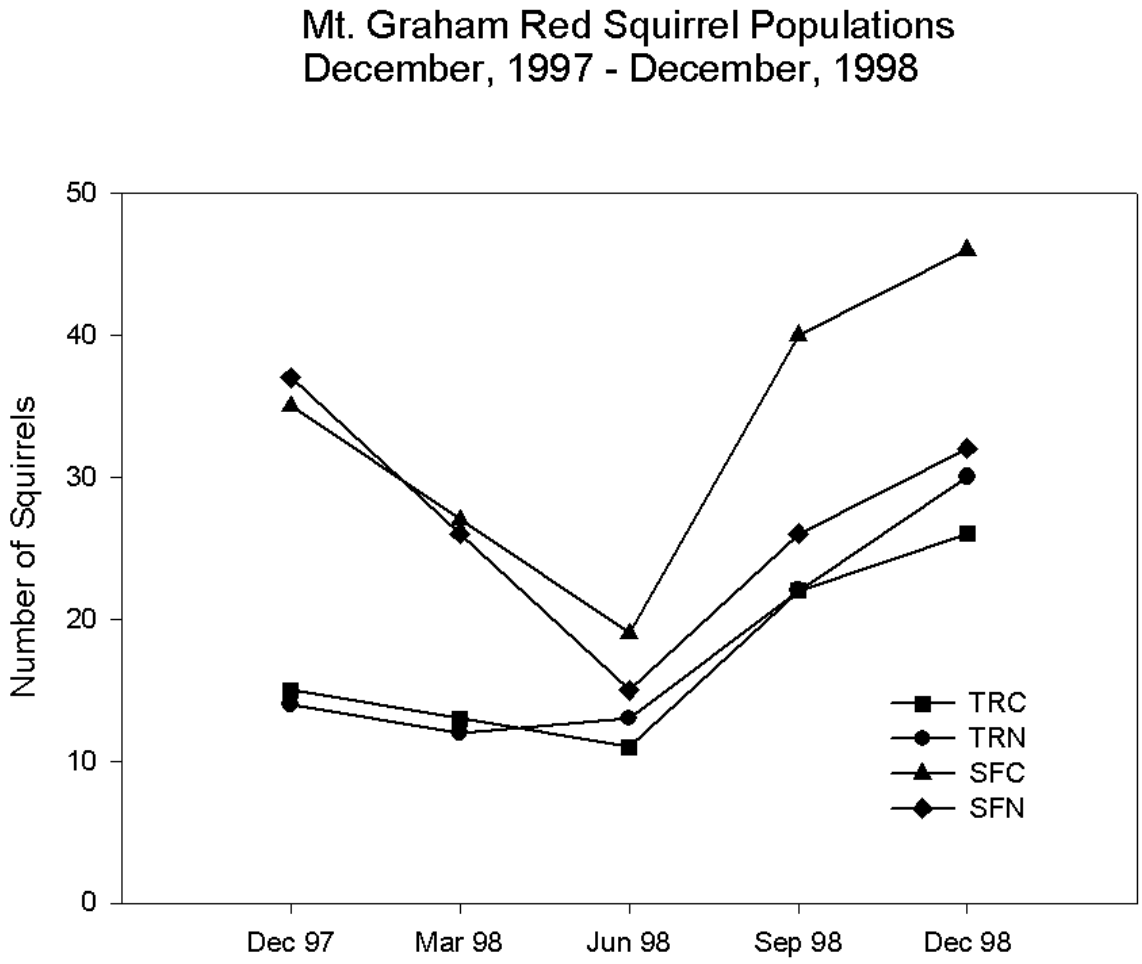


Figure 7. Crude density of middens and squirrels, 1997-1998.

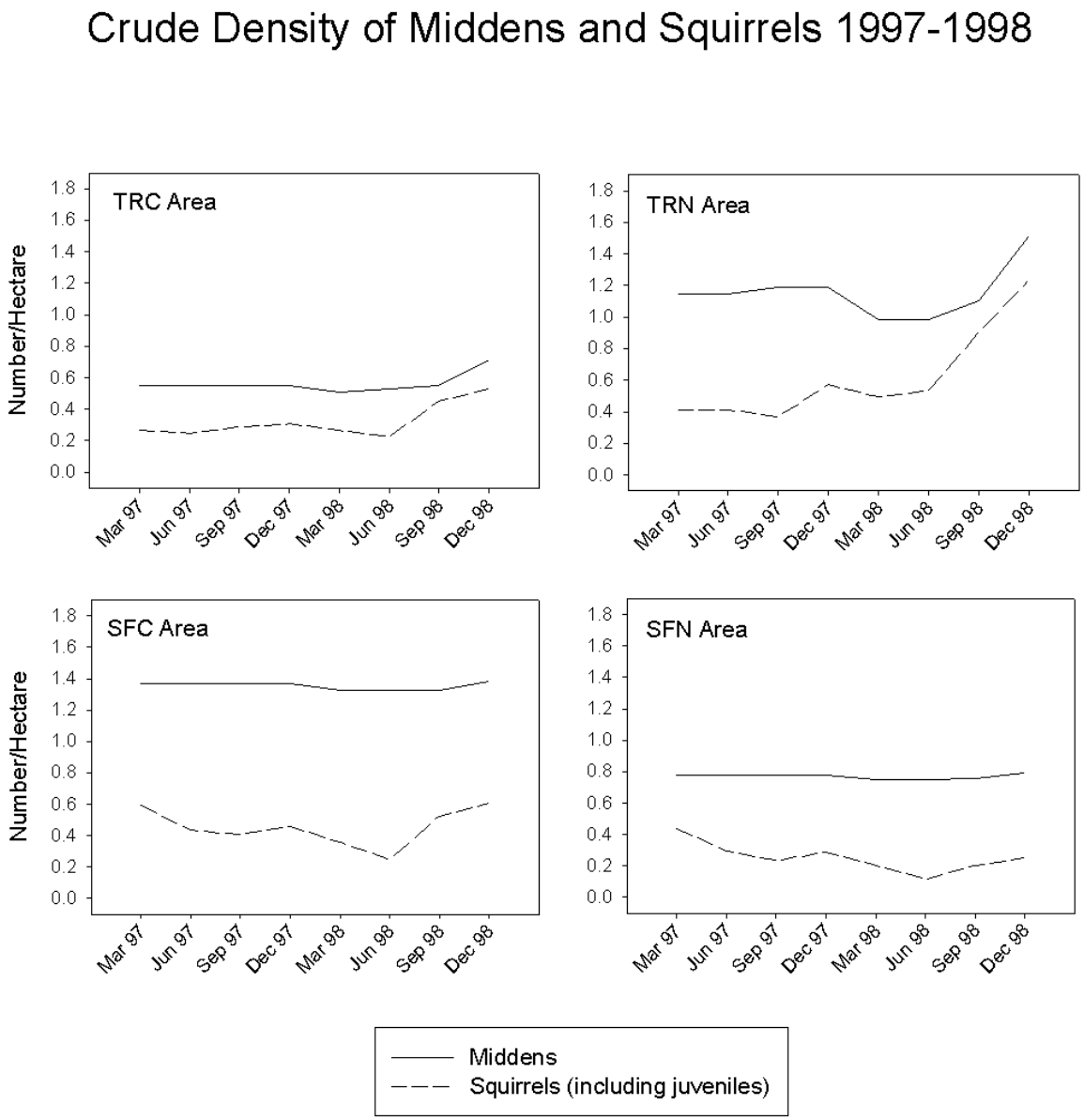


Figure 8. Local density of middens and squirrels, 1997-1998.

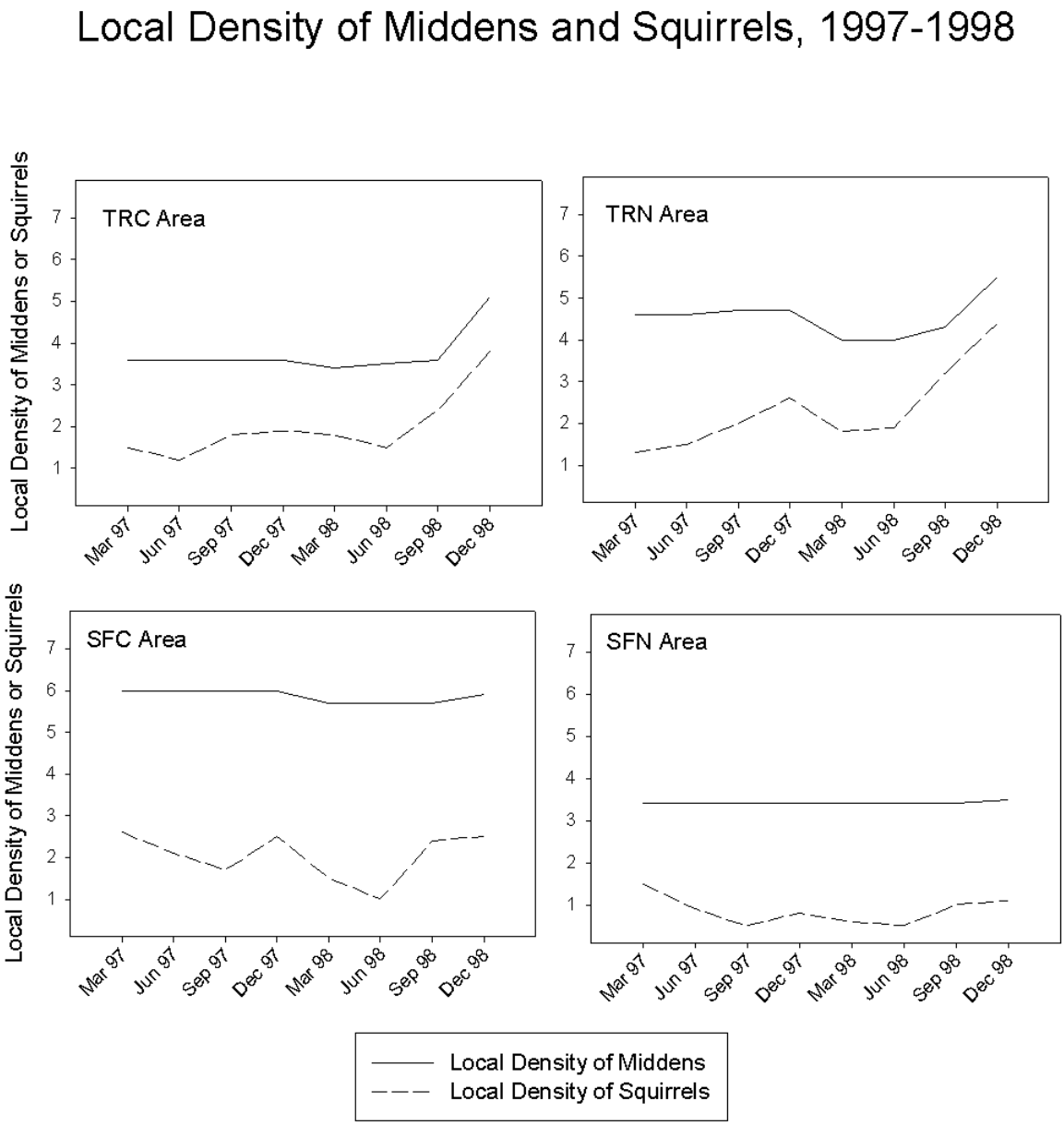


Figure 9. Nearest neighbor distance of middens and squirrels, 1997-1998.

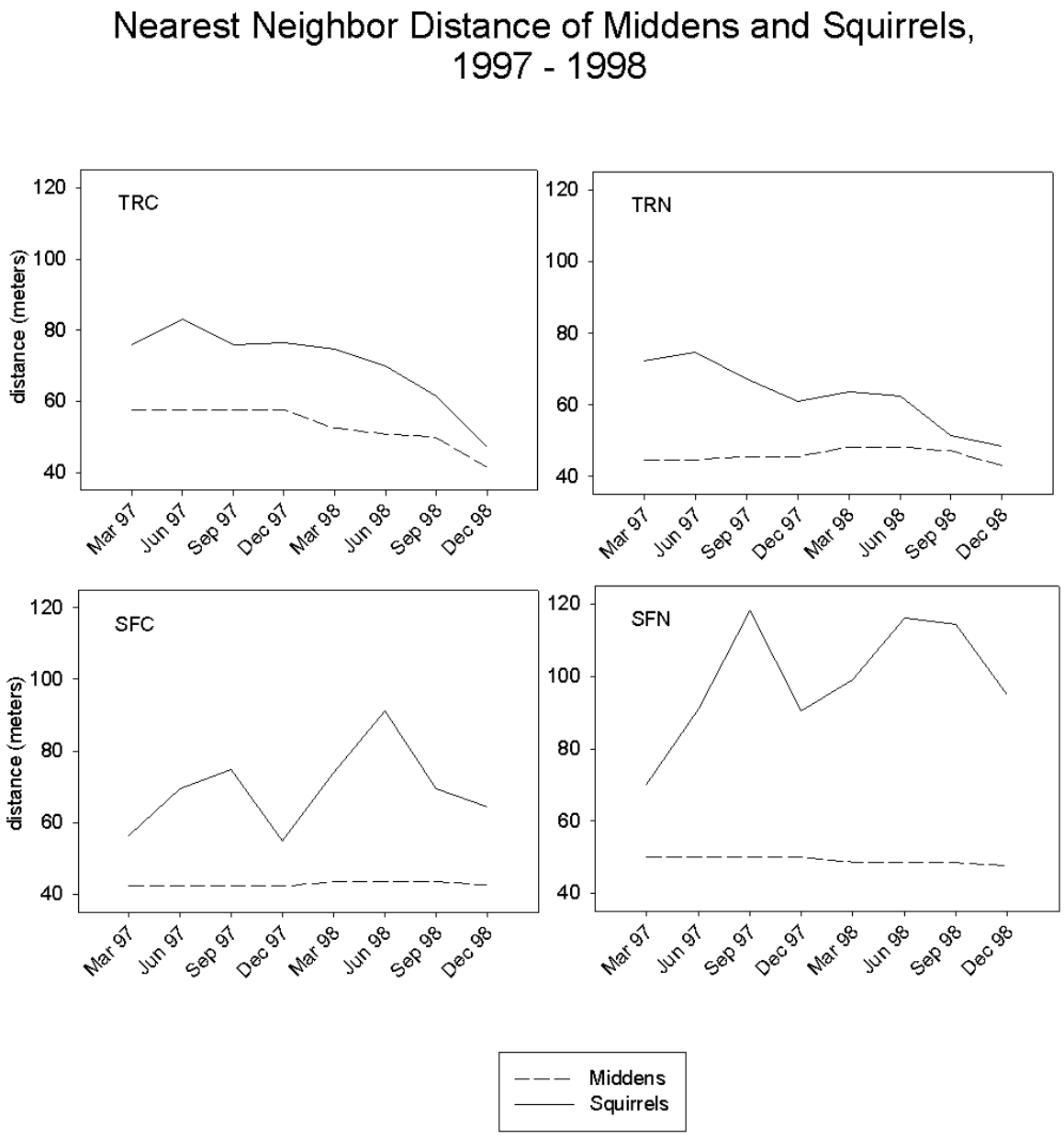


Figure 10. Monthly temperatures on the monitored areas, 1998.

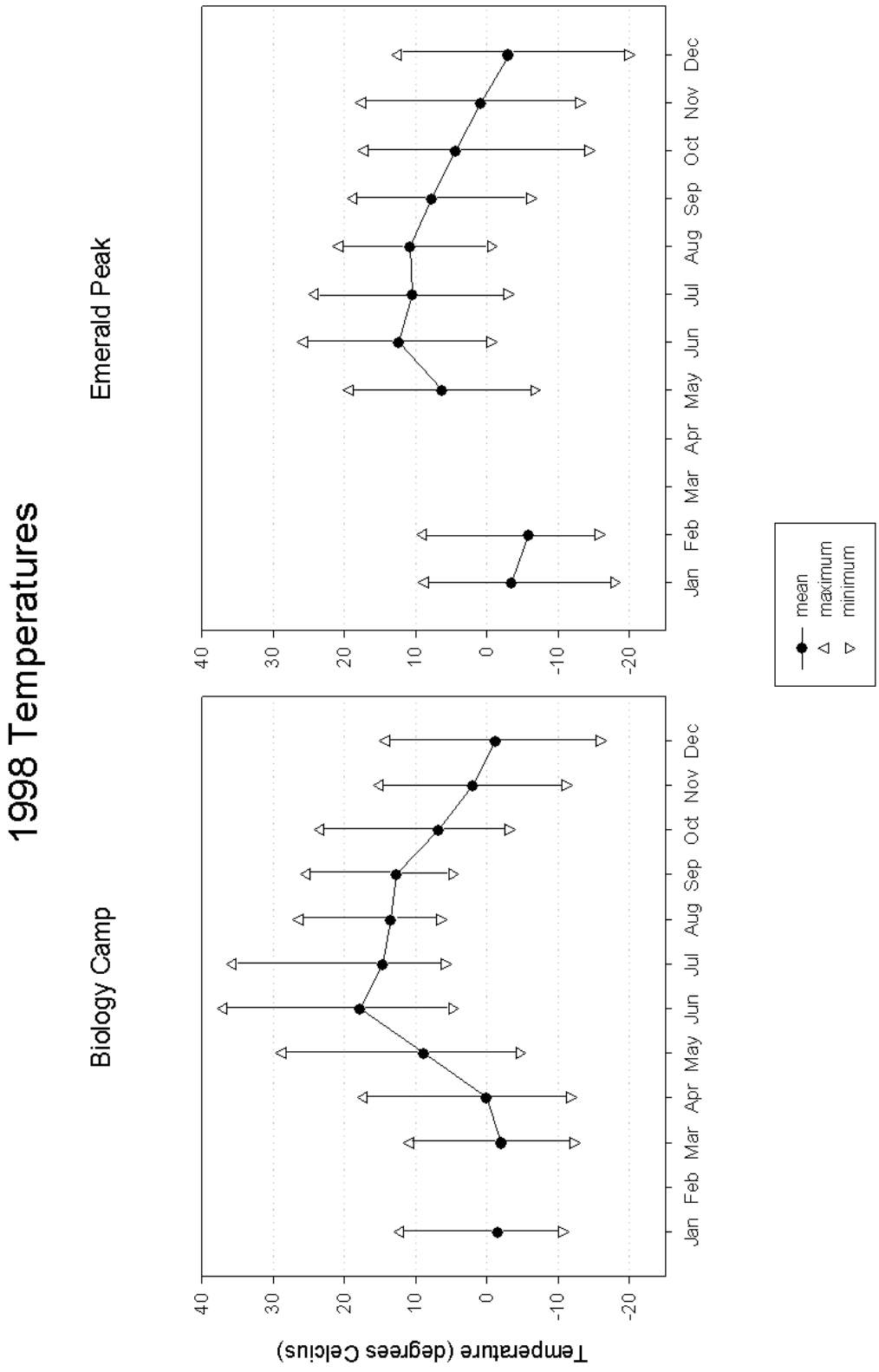


Figure 11. Total monthly precipitation as rain, 1998.

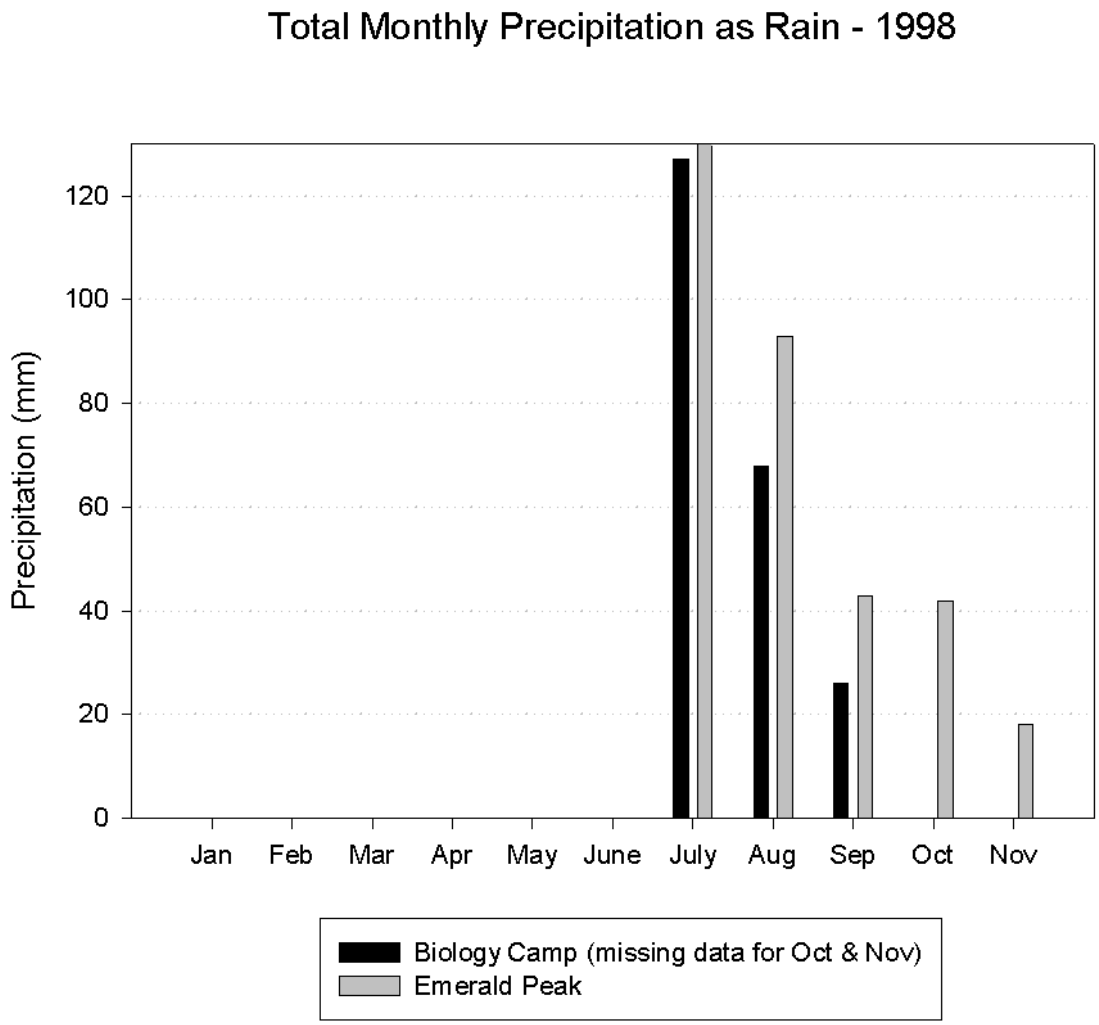
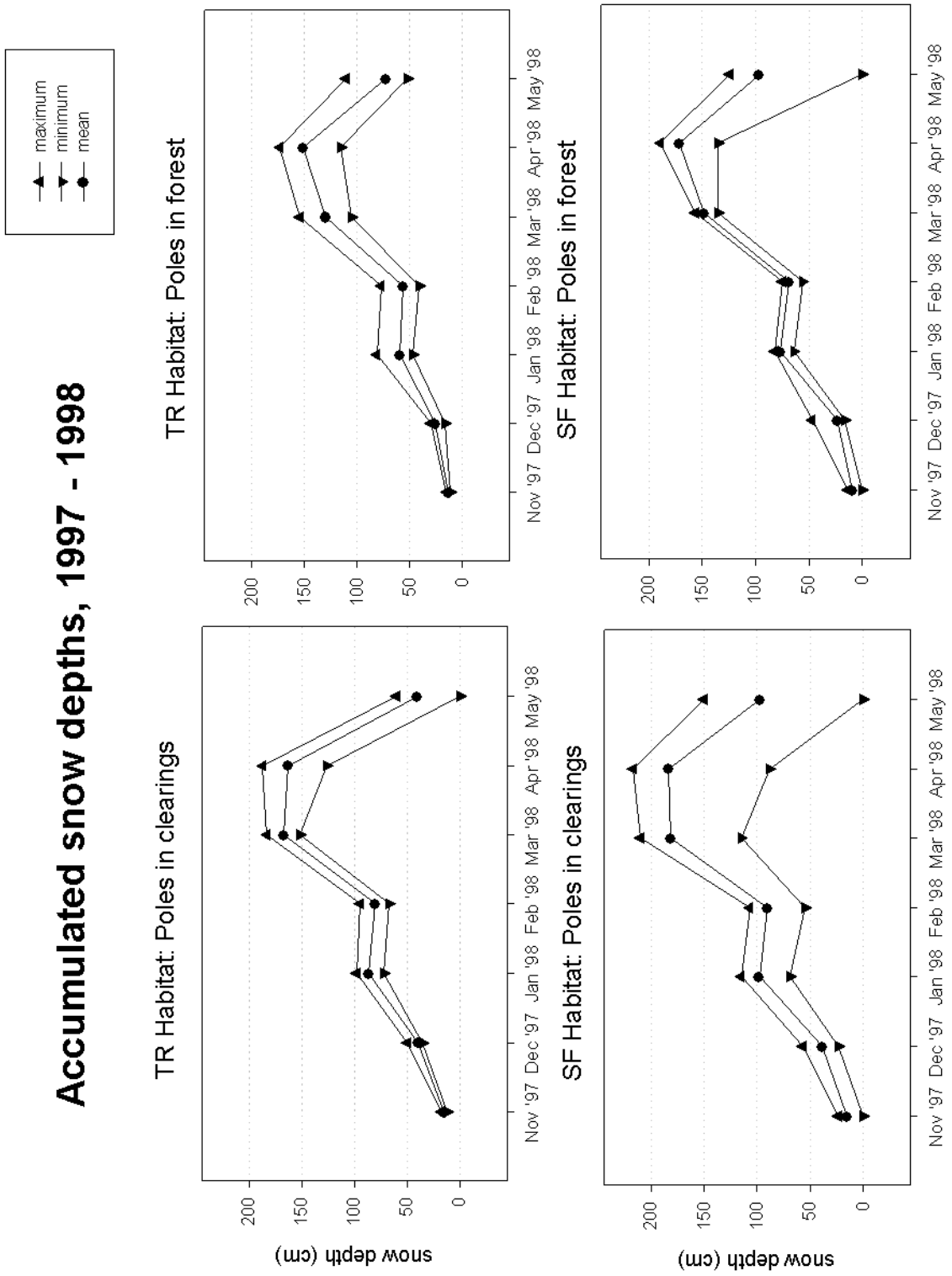


Figure 12. Accumulated snow depths, 1997-1998.



Appendix A. Numbers, weights, and energy values for 1997 seeds and 1997 mushrooms.

A-1. Means

A-2. Medians

Appendix A-1: Mean numbers, weights, and energy values for 1997 seeds and 1997 mushrooms.

		Corkbark Fir		Douglas-fir		Englemann Spruce		Total Seeds		Total Mushrooms			Total Energy
AREA	TRAN	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	ww Kg/ha	dw Kg/ha	MJ/ha	MJ/ha
TRC	1	burned											
	2	burned											
	3	280.0	124.3	80.0	15.4	0.0	0.0	360.0	139.7	75.50	8.90	160.1	299.8
	4	burned											
	5	1106.8	491.4	66.8	12.8	26.8	2.4	1200.4	506.7	72.60	8.10	146.1	652.8
	6	burned											
	7	burned											
	8	burned											
	9	burned											
	10	2986.8	1326.1	106.8	20.5	66.8	6.1	3160.4	1352.7	26.4	3.4	61.7	1414.4
	11	13.2	5.9	653.2	125.4	840.0	76.4	1506.4	207.7	20.4	2.1	37.6	245.3
	12	586.8	260.5	893.2	171.5	40.0	3.6	1520.0	435.7	8.8	1.0	18.7	454.4
TRN	1	920.0	408.5	506.8	97.3	26.8	2.4	1453.6	508.2	72.2	8.7	156.7	665.0
	2	866.8	384.9	493.2	94.7	26.8	2.4	1386.8	482.0	40.50	5.00	89.8	571.8
	3	293.2	130.2	0.0	0.0	26.8	2.4	320.0	132.6	70.40	7.10	127.2	259.9
	4	360.0	159.8	26.8	5.1	26.8	2.4	413.6	167.4	60.50	5.80	105.0	272.4
SFC	1	333.2	147.9	0.0	0.0	13.2	1.2	346.4	149.1	58.90	6.90	124.2	273.4

		Corkbark Fir		Douglas-fir		Englemann Spruce		Total Seeds		Total Mushrooms			Total Energy
AREA	TRAN	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	ww Kg/ha	dw Kg/ha	MJ/ha	MJ/ha
	2						burned						
	3	440.0	195.4	0.0	0.0	53.2	4.8	493.2	200.2	64.10	7.00	125.1	325.3
	4	186.8	82.9	0.0	0.0	80.0	7.3	266.8	90.2	66.50	5.80	104.9	195.1
	5	13.2	5.9	0.0	0.0	13.2	1.2	26.4	7.1	97.8	8.60	155.20	162.2
	6	0.0	0.0	0.0	0.0	53.2	4.8	53.2	4.8	135.7	13.9	250.20	255.10
	7						burned						
	8						burned						
	9						burned						
	10	0.0	0.0	0.0	0.0	13.2	1.2	13.2	1.2	31.2	2.9	51.7	52.9
	11	26.8	11.9	0.0	0.0	26.8	2.4	53.6	14.3	27.90	3.10	56.5	70.9

		Corkbark Fir		Douglas-fir		Englemann Spruce		Total Seeds		Total Mushrooms			Total Energy
AREA	TRAN	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	ww Kg/ha	dw Kg/ha	MJ/ha	MJ/ha
SFN	1	0.0	0.0	0.0	0.0	13.2	1.2	13.2	1.2	8.60	1.00	17.4	18.6
	2	13.2	5.9	0.0	0.0	40.0	3.6	53.2	9.5	73.10	7.00	125.5	135.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.30	4.30	77.9	77.9
	4	0.0	0.0	0.0	0.0	146.8	13.4	146.8	13.4	215.50	20.40	367.3	380.7
	5	0.0	0.0	13.2	2.5	66.8	6.1	80.0	8.6	48.5	5.00	90.60	99.3
	6	0.0	0.0	0.0	0.0	180.0	16.4	180.0	16.4	85.70	8.70	156.8	173.2
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108.1	10.90	196.70	196.7
	8	0.0	0.0	0.0	0.0	66.8	6.1	66.8	6.1	79.60	7.40	132.9	139.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.00	5.50	99.0	99.0
	10	0.0	0.0	0.0	0.0	53.2	4.8	53.2	4.8	48.80	4.90	87.9	92.7
	11	0.0	0.0	0.0	0.0	133.2	12.1	133.2	12.1	66.90	6.80	121.7	133.8
	12	0.0	0.0	0.0	0.0	13.2	1.2	13.2	1.2	125.00	11.70	210.7	211.9
TRC $\bar{x}$	5	994.7	441.7	360.0	69.1	194.7	17.7	1549.4	528.5	40.70	4.70	84.8	613.3
TRN $\bar{x}$	4	610.0	270.8	256.7	49.3	26.8	2.4	893.5	322.6	60.90	6.60	119.7	442.2
SFC $\bar{x}$	7	142.9	63.4	0.0	0.0	36.1	3.3	179.0	66.7	68.80	6.90	124.0	190.7
SFN $\bar{x}$	12	1.1	0.5	1.1	0.2	59.4	5.4	61.6	6.1	79.70	7.80	140.4	146.5
TR $\bar{x}$	9	823.7	365.7	314.1	60.3	120.1	10.9	1257.9	437.0	49.70	5.60	100.3	537.3
SF $\bar{x}$	19	53.3	23.7	0.7	0.1	50.8	4.6	104.9	28.4	75.70	7.50	134.3	162.8

Appendix A-2: Median numbers, weights, and energy values for 1997 seeds and 1997 mushrooms.

		Corkbark Fir		Douglas-fir		Englemann Spruce		Total Seeds		Total Mushrooms			Total Energy
AREA	TRAN	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	ww Kg/ha	dw Kg/ha	MJ/ha	MJ/ha
TRC	1						burned						
	2						burned						
	3	280.0	124.3	80.0	15.4	0.0	0.0	360.0	139.7	75.50	8.90	160.1	299.8
	4						burned						
	5	1106.8	491.4	66.8	12.8	26.8	2.4	1200.4	506.7	72.57	8.12	146.1	652.8
	6						burned						
	7						burned						
	8						burned						
	9						burned						
	10	2986.8	1326.1	106.8	20.5	66.8	6.1	3160.4	1352.7	26.4	3.4	61.7	1414.4
	11	13.2	5.9	653.2	125.4	840.0	76.4	1506.4	207.7	20.4	2.1	37.6	245.3
	12	586.8	260.5	893.2	171.5	40.0	3.6	1520.0	435.7	8.8	1.0	18.7	454.4
TRN	1	920.0	408.5	506.8	97.3	26.8	2.4	1453.6	508.2	72.2	8.7	156.7	665.0
	2	866.8	384.9	493.2	94.7	26.8	2.4	1386.8	482.0	40.46	4.99	89.8	571.8
	3	293.2	130.2	0.0	0.0	26.8	2.4	320.0	132.6	70.37	7.07	127.2	259.9
	4	360.0	159.8	26.8	5.1	26.8	2.4	413.6	167.4	60.48	5.83	105.0	272.4

		Corkbark Fir		Douglas-fir		Englemann Spruce		Total Seeds		Total Mushrooms			Total Energy
AREA	TRAN	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	ww Kg/ha	dw Kg/ha	MJ/ha	MJ/ha
SFC	1	333.2	147.9	0.0	0.0	13.2	1.2	346.4	149.1	58.92	6.90	124.2	273.4
	2	burned											
	3	440.0	195.4	0.0	0.0	53.2	4.8	493.2	200.2	64.05	6.95	125.1	325.3
	4	186.8	82.9	0.0	0.0	80.0	7.3	266.8	90.2	66.46	5.83	104.9	195.1
	5	13.2	5.9	0.0	0.0	13.2	1.2	26.4	7.1	97.76	8.62	155.2	162.2
	6	0.0	0.0	0.0	0.0	53.2	4.8	53.2	4.8	135.67	13.90	250.2	255.1
	7	burned											
	8	burned											
	9	burned											
	10	0.0	0.0	0.0	0.0	13.2	1.2	13.2	1.2	31.16	2.87	51.7	52.9
	11	26.8	11.9	0.0	0.0	26.8	2.4	53.6	14.3	27.89	3.14	56.5	70.9

		Corkbark Fir		Douglas-fir		Englemann Spruce		Total Seeds		Total Mushrooms			Total Energy
AREA	TRAN	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	# 1000 seeds/ha	MJ/ha	ww Kg/ha	dw Kg/ha	MJ/ha	MJ/ha
SFN	1	0.0	0.0	0.0	0.0	13.2	1.2	13.2	1.2	8.59	0.97	17.4	18.6
	2	13.2	5.9	0.0	0.0	40.0	3.6	53.2	9.5	73.07	6.97	125.53	135.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.33	4.33	77.9	77.9
	4	0.0	0.0	0.0	0.0	146.8	13.4	146.8	13.4	215.54	20.41	367.3	380.7
	5	0.0	0.0	13.2	2.5	66.8	6.1	80.0	8.6	48.5	5.04	90.65	99.3
	6	0.0	0.0	0.0	0.0	180.0	16.4	180.0	16.4	85.68	8.71	156.8	173.2
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108.1	10.93	196.69	196.7
	8	0.0	0.0	0.0	0.0	66.8	6.1	66.8	6.1	79.57	7.38	132.9	139.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.0	5.5	99.02	99.02
	10	0.0	0.0	0.0	0.0	53.2	4.8	53.2	4.8	48.84	4.88	87.9	92.7
	11	0.0	0.0	0.0	0.0	133.2	12.1	133.2	12.1	66.85	6.76	121.7	133.8
	12	0.0	0.0	0.0	0.0	13.2	1.2	13.2	1.2	125.0	11.70	210.67	211.9
TRC $\bar{x}$	5	586.8	260.5	106.8	20.5	40.0	3.6	1506.4	435.7	26.44	3.43	61.7	454.4
TRN $\bar{x}$	4	613.4	272.4	260.0	49.9	26.8	2.4	900.2	324.7	65.43	6.45	116.1	422.1
SFC $\bar{x}$	7	26.8	11.9	0.0	0.0	26.8	2.4	53.6	14.3	64.05	6.90	124.2	195.1
SFN $\bar{x}$	12	0.0	0.0	0.0	0.0	46.6	4.2	53.2	5.5	69.96	6.87	123.6	134.4
TR $\bar{x}$	9	600.1	266.4	183.4	35.2	33.4	3.0	1203.3	380.2	45.93	4.94	88.9	438.2
SF $\bar{x}$	19	13.4	6.0	0.0	0.0	36.7	3.3	53.4	9.9	67.01	6.89	123.9	164.8

Appendix B. Midden occupancy records for the monitored areas, 1998.

B-1. Quarterly occupancy records

B-2. Activity area information

Appendix B-1. Midden occupancy records for the monitored areas, 1998.

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), 1998				
Midden	Mar	Jun	Sep	Dec
1101[89]	located off-area, new number - 5101			
1102[89]	S	♂	♀	S
1103[89]	S	♀	♂	S
1104[89]	N	N	♂	♂[NAT3]
1105[89]	burned in Clark Peak fire			
1106[89]	Y	N	♀	♀
1107[89]	burned in Clark Peak fire			
1108[89]	N	N	N	N
1109[89]	burned in Clark Peak fire			
1110[89*]	burned in Clark Peak fire			
1111[89]	N	N	N	N
1112[89*]	N	N	♂	♂
1113[89]	♂	♂	♂	♂
1114[89]	located off-area, new number - 5114			
1115[89]	N	N	N	N
1116[89*]	S	♂	♂	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*]	Y	♀	♂	♂[NAT4]
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*]	N	N	N	N
1130[90]	burned in Clark Peak fire			
1131[90*]	N	N	♀	♀
1132[90*]	N	N	N	N
1134[91*]	removed from census - low occupancy			
1135[91*]	burned in Clark Peak fire			
1136[91*]	burned in Clark Peak fire			
1137[91*]	burned in Clark Peak fire			
1138[91*]	removed from census - low occupancy			
1139[91*]	burned in Clark Peak fire			
1140[91*]	burned in Clark Peak fire			

Transition Construction Area (TRC), 1998				
Midden	Mar	Jun	Sep	Dec
1141[91*]	burned in Clark Peak fire			
1142[91*]	burned in Clark Peak fire			
1143[91*]	burned in Clark Peak fire			
1144[91*]	S	♂	♀	S
1145[91*]	located off-area, new number - 5145			
1146[91*]	N	N	N	N
1147[91*]	♂	♂	♂	♂
1148[91*]	burned in Clark Peak fire			
1149[91*]	Y	N	♂	♂
1150[91*]	located off-area, new number - 5150			
1151[91*]	removed from census		♀[1]	♀
1152[91*]	burned in Clark Peak fire			
1153[92*]	♀	N	3J[2]	N
1154[92*]	N	♀	♀	♀
1155[93*]	located off-area, new number - 5155			
1156[93*]	♀	♂	♀	♂
1157[93*]	located off-area, new number - 5157			
1159[93*]	burned in Clark Peak fire			
1160[96*]	♀	P	♀	♀
1161[96*]	N	N	N	N
1162[96*]	N	N	N	N
1163[98*]	new	♀	♀ + ♂J	♀
1164[98*]	new			♀
1165[98*]	new			♀
1166[98*]	new			♀
1167[98*]	new			♀
1168[98*]	new			♂
1169[98*]	new			♂
1170[98*]	new			S
1171[98*]	new			♂
# Mid	25	26	27	35
# Occ	13	11	19	26
% Occ	52	42	70	74
# Sq	13	11	21[2] + 1J	26

TRC Area (cont.)

1 This midden was previously removed from regular censusing due to low occupancy. This midden has become re-occupied and has been added back in to the quarterly census.

2 This number includes the three young of the year squirrels seen in 1153. No adult female was observed.

3 Male at 1104 with a natural mark - notch in Right ear and a short thin tail.

4 Male at 1121 with a natural mark - short tail.

Transition Non-Construction Area (TRN), 1998				
Midden	Mar	Jun	Sep	Dec
2201[89]	Y	♀	♂	S
2202[89]	N	N	♂	N
2203[89]	♂	S	♂	S
2204[89]	Y	♀	♀	♀
2205[89]	♂	♂	♂	N
2206[89]	Y	♂	S	♂
2207[89*]	removed from census		♀[1]	♂
2208[89*]	S	♂	♂	♂[NAT2]
2209[89]	N	N	N	N
2210[90]	N	N	♂	♂
2211[90*]	♀	♂	♀	♂
2212[90]	♂	N	♀	♀
2213[90]	removed from census - low occupancy			
2214[90*]	N	S	S	S
2215[90*]	Y	♀	♂	S
2216[90*]	removed from census			S[1]
2217[90*]	N	N	♂	S
2218[91*]	N	N	♀	S
2219[91*]	removed from census		♀[1]	S
2220[91*]	♂	♂	S	N
2221[91*]	located off-area, new number - 5221			
2222[91*]	removed from census - low occupancy			
2223[91*]	N	♀	♀	♀
2224[93*]	removed from census - low occupancy			
2225[94*]	removed from census		S[1]	S
2226[95*]	N	N	N	N
2227[95*]	N	P	♂	S
2228[95*]	N	N	N	S
2229[96*]	S	♀	♀	♀
2230[96*]	N	N	N	N
2231[96*]	located off-area, new number - 5231			

Transition Non-Construction Area (TRN), 1998				
Midden	Mar	Jun	Sep	Dec
2232[96*]	located off-area, new number - 5232			
2233[96*]	N	N	N	N
2234[97*]	S	♂	S	S
2235[98*]	new			♀
2236[98*]	new			♀
2237[98*]	new			♀
2238[98*]	new			S
2239[98*]	new			S
2240[98*]	new			♂
2241[98*]	new			S
2242[98*]	new			♂
2243[98*]	new			♀
# Mid	24	24	27	37
# Occ	12	13	22	30
% Occ	50	54	81	81
# Sq	12	13	22	30

1 This midden was previously removed from regular censusing due to low occupancy. This midden has become re-occupied and has been added back in to the quarterly census.

2 Male at 2208 with a natural mark - short tail, possibly broken (bends to the right).

Spruce-Fir Construction Area (SFC), 1998				
Midden	Mar	Jun	Sep	Dec
3000[95*]	N	N	N	N
3001[95*]	Y	N	♀	S
3002[95*]	N	N	N	N
3003[95*]	N	N	N	N
3004[95*]	burned in Clark Peak fire			
3005[95*]	N	N	Y	N
3006[95*]	N	N	♀	N
3007[95*]	removed from census - too far off area			
3008[95*]	N	N	N	N
3009[95*]	N	N	S	S
3010[95*]	N	N	N	N
3011[95*]	located off-area, new number - 5311			
3012[95*]	burned in Clark Peak fire			
3013[95*]	N	N	N	N
3014[95*]	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*]	N	N	N	N
3020[96*]	P	Y	♀	♀
3021[96*]	burned in Clark Peak fire			
3022[96*]	N	N	♀	♂
3023[98*]	new			♀
3024[98*]	new			♂
3025[98*]	new			S
3026[98*]	new			♀
3300[86]	Y	♀	N	♂
3301[94*]	N	N	N	N
3302[94*]	located off-area, new number - 5302			
3303[94*]	Y	N	♂	♂
3304[94*]	N	N	N	N
3305[94*]	N	N	N	N
3306[94*]	Y	♀	♂	♂
3307[94*]	N	N	N	N
3308[95*]	N	N	N	N

Spruce-Fir Construction Area (SFC), 1998				
Midden	Mar	Jun	Sep	Dec
3309[95*]	N	N	N	N
3310[95*]	N	N	N	N
3311[95*]	N	N	N	N
3312[95*]	Y	N	♀	Y
3313[95*]	located off-area, new number - 5313			
3314[95*]	N	N	N	N
3315[95*]	N	N	N	N
3316[95*]	N	N	N	N
3317[95*]	S	N	♂	S
3318[95*]	N	N	♀	♀
3319[95*]	N	N	P	♀
3320[95*]	N	N	N	N
3321[95*]	N	N	N	N
3322[95*]	N	N	S	♀
3323[95*]	♀	♀	♂	♂
3324[95*]	N	N	N	N
3325[95*]	N	N	P	N
3326[95*]	N	N	N	N
3327[95*]	N	N	N	N
3328[95*]	N	N	N	♀
3329[95*]	N	N	N	N
3330[95*]	N	S	♀	♀
3331[95*]	Y	N	♀	♀
3332[95*]	N	N	N	N
3333[95*]	N	N	N	N
3334[95*]	N	N	N	N
3335[95*]	N	N	N	N
3336[95*]	N	N	N	N
3337[95*]	N	N	N	N
3338[95*]	N	N	N	N
3339[95*]	N	N	N	N
3340[95*]	N	N	N	N
3341[95*]	Y	♂	N	N
3342[95*]	N	N	N	♀

Spruce-Fir Construction Area (SFC), 1998				
Midden	Mar	Jun	Sep	Dec
3343[95*]	N	N	♀	S
3344[95*]	N	N	N	N
3345[95*]	N	N	N	N
3346[95*]	N	N	N	N
3347[95*]	N	N	N	N
3348[95*]	N	N	N	N
3349[95*]	N	N	N	N
3350[87]	N	N	♀	N
3351[87]	♀	♀	S	♂
3352[86]	removed from census - low occupancy			
3353[87]	♀	N	♀	S
3354[86]	N	N	N	N
3355[95*]	N	N	♂	♀
3356[86]	S	♂	♂	♂
3357[86]	removed from census - low occupancy			
3358[87]	burned in Clark Peak fire			
3359[87]	burned in Clark Peak fire			
3360[86]	Y	♂[NAT2]	♂[NAT2]	♂[NAT2]
3361[86]	N	N	N	N
3362[86]	N	N	♀	S
3363[86]	N	N	P	P
3364[86]	N	N	N	N
3365[86]	♂[*1]	♂[*1]	♂[*1]	♂[*1]
3366[86]	Y	N	♂	S
3367[87]	Y	N	N	N
3368[86]	S	S	S	♀
3369[86]	S	♀	♂	♂
3370[86]	Y	N	S	♂
3371[87]	N	N	S	♀

Spruce-Fir Construction Area (SFC), 1998				
Midden	Mar	Jun	Sep	Dec
3372[89]	Y	S	S	S
3373[87]	N	N	N	N
3374[89]	♂	S	S	♀
3375[86]	N	N	♀	♀
3376[86]	located off-area, new number - 5376			
3377[87]	located off-area, new number - 5377			
3378[90*]	Y	P	S	S
3379[90*]	N	N	N	N
3380[90*]	removed from census - low occupancy			
3381[90*]	N	N	N	N
3382[91*]	Y	♀	♀	S
3383[91*]	N	N	♂	♂
3384[91*]	burned in Clark Peak fire			
3385[91*]	removed from census - low occupancy			
3386[91*]	N	N	P	P
3387[91*]	S	S	♂	♂
3388[92*]	located off-area, new number - 5388			
3389[93*]	N	N	N	N
3390[93*]	♀	♀	♂	♂
3391[93*]	N	N	N	N
3392[93*]	N	N	♀	S
3393[93*]	N	♀	S	S
3394[93*]	Y	P	♀	♀

Spruce-Fir Construction Area (SFC), 1998				
Midden	Mar	Jun	Sep	Dec
3395[94*]	removed from census - low occupancy			
3396[94*]	N	N	N	N
3397[86]	N	N	N	N
3398[86]	N	N	N	N
3399[94*]	Y	♂	N	N
# Mid	101	101	101	105
# Occ	27	19	40	46
% Occ	27	19	40	44
# Sq	27	19	40	46

1 Marked male at midden 3365 - W/- (W/R)

2 Male at 3360 with natural mark. Middle toe on left front foot sticks up.

Spruce-Fir Non Construction Area (SFN), 1998				
Midden	Mar	Jun	Sep	Dec
4000[95*]	Y	♀	♀	♀
4001[95*]	N	N	N	N
4002[95*]	Y	♀	♀	♀
4003[95*]	Y	N	N	N
4004[95*]	N	N	N	N
4005[95*]	N	N	N	N
4006[95*]	N	N	N	N
4007[95*]	N	N	N	N
4008[95*]	N	N	N	N
4009[95*]	N	N	N	N
4010[95*]	N	N	N	Y
4011[95*]	N	N	N	N
4012[95*]	N	N	N	N
4013[96*]	N	N	N	N
4014[96*]	N	N	N	N
4015[96*]	N	N	N	N
4016[96*]	N	N	Y	Y
4017[96*]	N	N	N	N
4018[96*]	N	N	N	N
4019[96*]	N	N	N	S
4020[96*]	N	N	S	N
4021[96*1]	N	N	N	N
4022[98*]	new			S
4023[98*]	new			♂
4024[98*]	new			S
4400[89]	removed from census - low occupancy			
4401[94*]	N	N	N	N
4402[94*]	N	N	N	N
4403[94*]	N	N	N	N
4404[95*]	N	N	N	N
4405[95*]	N	N	N	N
4406[95*]	N	N	N	N
4407[95*]	N	N	N	N
4408[95*]	N	N	N	N
4409[95*]	N	N	P	N
4410[95*]	located off-area, new number - 5410			

Spruce-Fir Non Construction Area (SFN), 1998				
Midden	Mar	Jun	Sep	Dec
4411[95*]	N	N	N	N
4412[95*]	N	N	N	N
4413[95*]	located off-area, new number - 5413			
4414[95*]	N	N	N	N
4415[95*]	Y	N	N	N
4416[95*]	Y	N	P	N
4417[95*]	♂	♂	♂	S
4418[95*]	N	N	N	N
4419[95*]	N	N	N	N
4420[90]	♂	N	♀	Y
4421[86]	N	N	N	N
4422[86]	Y	N	N	N
4423[86]	♂	Y	S	S
4424[86]	N	N	N	N
4425[87]	removed from census - low occupancy			
4426[86]	N	N	N	N
4427[86]	Y	♀	♂	S
4428[86]	Y	N	P	S
4429[86]	S	S	S	S
4430[86]	N	N	N	N
4431[86]	N	N	N	N
4432[86]	Y	N	N	N
4433[87]	N	N	N	N
4434[86]	removed from census - low occupancy			
4435[86]	♂[NAT 1]	S	S	Y
4436[86]	N	N	N	N
4437[95*]	N	N	N	N
4438[90*]	N	N	N	N
4439[90*]	N	N	N	N
4440[91]	removed from census - low occupancy			
4441[86]	N	N	N	N
4442[95*]	N	N	N	N
4443[86]	♀	N	♀	Y
4444[86]	Y	N	♀	S
4445[86]	N	N	P	N

Spruce-Fir Non Construction Area (SFN), 1998				
Midden	Mar	Jun	Sep	Dec
4446[86]	removed from census - low occupancy			
4447[86]	N	N	P	N
4448[86]	removed from census - low occupancy			
4449[86]	N	N	♀	S
4450[86]	N	N	N	S
4451[88]	removed from census - low occupancy			
4452[86]	N	N	N	P
4453[86]	removed from census - low occupancy			
4454[86]	N	N	N	N
4455[86]	removed from census - low occupancy			
4456[86]	removed from census - low occupancy			
4457[86]	N	N	N	N
4458[86]	removed from census - low occupancy			
4459[86]	removed from census - low occupancy			
4460[87]	N	N	♀	S
4461[91*]	S	S	S	S
4462[90]	N	N	N	N
4463[90]	N	N	N	N
4464[90]	N	N	♂	♂
4465[90*]	N	N	N	N
4466[87]	N	N	N	N
4467[87]	Y	P	♂	♂
4468[87]	removed from census - low occupancy			
4469[87]	S	P	S	N
4470[87]	Y	N	♀	♂
4471[87]	N	N	N	N
4472[87]	Y	♀	♀	♀
4473[87]	Y	S	♂	♂

Spruce-Fir Non Construction Area (SFN), 1998				
Midden	Mar	Jun	Sep	Dec
4474[86]	Y	♂	♂	♂
4475[87]	located off-area, new number - 5405			
4476[95*]	N	N	N	N
4477[87]	Y	♂	♂[NAT2]	♂[NAT2]
4478[90*]	N	N	N	N
4479[90*]	removed from census - low occupancy			
4480[90*]	removed from census - low occupancy			
4481[86]	N	N	N	N
4482[86]	N	Y	N	N
4483[86]	removed from census - low occupancy			
4484[86]	♂	♂	♂	♂
4485[86]	removed from census - low occupancy			
4486[86]	removed from census - low occupancy			
4487[86]	located off-area, new number - 5487			
4488[91*]	N	N	N	N
4489[91*]	removed from census			♂[3]
4490[91*]	Y	♀	P	N
4491[91*]	N	N	N	N
4492[91*]	removed from census		♂[3]	Y
4493[91*]	removed from census - low occupancy			
4494[91*]	N	N	N	N

Spruce-Fir Non Construction Area (SFN), 1998				
Midden	Mar	Jun	Sep	Dec
4495[95*]	N	N	N	N
4496[93*]	N	N	S	♂
4497[93*]	N	N	N	N
4498[93*]	N	N	N	N
4499[93*]	N	N	N	N
# Mid	97	97	98	102
# Occ	26	15	26	32
% Occ	27	15	27	31
# Sq	26	15	26	32

1 The male at midden 4435 has had a natural mark - 2 rips in R ear. In December 1997 and March 1998, one rip was clearly seen in the male's right ear, a second rip was possible, but not clearly seen.

2 Male at 4477 with natural mark - triangle notch in the back of right ear.

3 This midden was previously removed from regular censusing due to low occupancy. This midden has become re-occupied and has been added back in to the quarterly census.

Off-Area Midden Occupancy, 1998				
Midden	Mar	Jun	Sep	Dec
TRC Area				
5101[89]	S	♂	♂	♂
5102[98*]	new			S
5114[89]	removed from census - low occupancy			
5118[94*]	♀	♀	♀	♀
5119[89*]	♀	N	♀	♀
5120[89*]	removed from census - too far off area			
5121[89*]	♀	♀	♀	♀
5122[89]	removed from census		♀[1]	♀
5123[89]	removed from census - too far off area			
5124[90*]	removed from census - too far off area			
5125[89*]	♂	♀	♀	♂
5126[91]	N	N	N	S
5127[95*]	N	N	N	N
5145[91*]	N	N	Y	♂
5150[91*]	N	N	♂	♂
5155[93*]	♀	♀	♀	♀
5157[93*]	♂	P	♀	♀
TRN Area				
5200[93*]	S	♂	♂	S
5221[91*]	removed from census		♀[1]	♂
5231[96*]	N	♀	♀ + 2J	♀
5232[96*]	♀	♀	♀[NAT2]	S[NAT2]
SFC Area				
5302[94*]	N	N	N	N
5311[95*]	♂	♂	♂	S
5313[95*]	Y	S	♀	S
5350[86]	♀	♀	♀	S
5351[94*]	N	N	N	N

Off-Area Midden Occupancy, 1998				
Midden	Mar	Jun	Sep	Dec
SFC Area				
5352[94*]	N	N	N	N
5353[94*]	removed from census - too far off area			
5354[94*]	N	N	N	N
5355[94*]	N	N	N	N
5356[94*]	N	N	N	N
5357[95*]	N	N	N	N
5358[95*]	removed from census - too far off area			
5359[95*]	Y	♂	♂	S
5360[96*]	N	N	N	N
5361[96*]	N	N	N	N
5362[96*]	N	N	N	N
5376[86]	removed from census - low occupancy			
5377[87]	S	Y	S	S
5388[92*]	removed from census - low occupancy			
SFN Area				
5405[87]	N	N	♀	S
5410[95*]	N	N	N	N
5413[95*]	♀	♀	♂[NAT3]	♂[NAT3]
5475[86]	located on area - new number 4021			
5487[86]	removed from census - low occupancy			

1 This midden was previously removed from regular censusing due to low occupancy. This midden has become re-occupied and has been added back in to the quarterly census.

2 Female at 5232 with natural mark - large bump on nose and forehead. In December 98, swelling on nose was not as pronounced. In addition, the squirrel had a small triangle notch high on the back of the Right ear.

3 Male at 5413 with natural mark - half-moon shaped notch in the back of right ear.

Appendix B-2. New activity areas on the monitored areas that have the potential to become new middens. Feeding sign, caching and squirrels were seen at most of these areas. These areas have been assigned a temporary number and will be assessed for improved sign and the presence of a squirrel during the next quarterly census. If conditions warrant, an activity area will then be upgraded to a midden and added to the regular quarterly censuses. See maps for location of activity areas. **Note: Shaded entries** have been upgraded to new middens in December 1998. They are presented in this table for a cross-reference of midden identification numbers.

Midden	Jun	Aug	Sep	Oct	Dec	Notes
8101		S	♂	♂	♂	upgraded to new midden # 3024
8102			♀	-	♀	upgraded to new midden # 1165
8103			♂	-	♂	upgraded to new midden # 1168
8104			P	-	S	upgraded to new midden # 1170
8105			♀	-	S	upgraded to new midden # 5102
8106			♂	-	♂	upgraded to new midden # 1169
8107			Y	-	N	
8108			S	-	N	
8109			♀	-	N	
8114			N	-	N	
8115			S	-	S	upgraded to new midden # 2241
8117			S	N	N	
8118			♂	-	S	upgraded to new midden # 4022
8119			S	-	♀	upgraded to new midden # 1167
8201			♀	-	♀	upgraded to new midden # 1166
8202			♂	-	♂	upgraded to new midden # 4023
8301			♀	-	S	upgraded to new midden # 4024
8302			P	N	N	
8303			P	N	P	
8304			♀	♀	♂	upgraded to new midden # 1171
8305			S	-	P	

Midden	Jun	Aug	Sep	Oct	Dec	Notes
8307			S	-	♂	upgraded to new midden # 2242
8308			♂	-	S	upgraded to new midden # 2239
8309			S	♀	S	upgraded to new midden # 3025
8310			P	-	N	
8311			P	-	N	
8312			S	Y	♀	upgraded to new midden # 3026
8313			P	-	♂	upgraded to new midden # 2240
8314			S	-	♀	upgraded to new midden # 2243
8316					S	new activity area - Dec 1998
8317					♂	new activity area - Dec 1998
8318					S	new activity area - Dec 1998
8402	♀	-	N	-	-	activity area dropped - Sep 1998
8403			♂	-	N	
8405			P	-	N	
8406			N	-	N	
8407			♀	-	N	
8408			S	-	♀	upgraded to new midden # 1164
8409			P	-	N	
8410			♀	-	♀	upgraded to new midden # 3023
8411					♂	new activity area - Dec 1998
8412					♂	new activity area - Dec 1998
8413					♀	new activity area - Dec 1998
8414					♂	new activity area - Dec 1998
8501					♀	new activity area - Dec 1998
8502					♀	new activity area - Dec 1998
8503					♀	new activity area - Dec 1998
8504					♂	new activity area - Dec 1998
8505					S	new activity area - Dec 1998

Midden	Jun	Aug	Sep	Oct	Dec	Notes
8506					♀	new activity area - Dec 1998
8603			♀	-	♀	upgraded to new midden # 2235
8604			S	-	S	upgraded to new midden # 2238
8605			♀	-	♀	upgraded to new midden # 2236
8606			♀	-	♀	upgraded to new midden # 2237
8607					♀	new activity area - Dec 1998
# Mid	-	-	41	-	28	
# Occ	-	-	30		13	
% Occ	-	-	73		46	
# Sq	-	-	30		13	

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 Appendix B-1 for key to symbols.

Middens within 100m of construction										
Midden	Mar[1]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov[4]	Dec
1160	♀	♀	♀	P	♀	♀	♀	♀	-	♀
3003	N	N	N	N	N	N	N	N	-	N
3013	N	N	N	N	N	N	N	N	-	N
3014	N	N	N	N	N	N	N	N	-	♀
3019	N	N	N	N	N	N	N	N	-	N
3020	P	N	N	Y	N	♀	♀	♀	-	♀
3309	N	N	N	N	N	N	N	N	-	N
3314	N	N	N	N	N	♀	N	N	-	N
3315	N	N	N	N	N	N	N	N	-	N
3319	N	N	N	N	N	N	P	P	-	♀
3320	N	N	N	N	N	N	N	N	-	N
3322	N	N	N	N	N	N	S	S	-	♀
3323	♀	S	P	♀L	♀ + 1J	♂	♂	♂	-	♂
3324	N	N	N	N	N	N	N	N	-	N
3325	N	N	N	N	N	N	P	P	-	N
3327	N	N	N	N	N	N	N	N	-	N
3330	N	N	N	S	N	N	♀	♀	-	♀
3334	N	N	N	N	N	N	N	N	-	N
3336	N	N	N	N	N	N	N	N	-	N
3337	N	N	N	N	N	N	N	N	-	N
3339	N	N	N	N	N	N	N	N	-	N
3340	N	N	N	N	N	N	N	N	-	N
3345	N	N	N	N	N	N	N	N	-	N
3346	N	N	N	N	N	N	N	N	-	N
3347	N	N	N	N	N	N	N	N	-	N
3350	N	N	N	N	N	N	♀	♀	-	N
3354	N	N	N	N	N	N	N	N	-	N

Middens within 100m of construction										
Midden	Mar[1]	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov[4]	Dec
3357	removed from census - low occupancy									
3362	N	N	N	N	N	N	♀	♀	-	S
3363	N	N	N	N	N	N	P	P	-	P
3364	N	N	N	N	N	N	N	N	-	N
3365	♂[*2]	♂[*2]	♂[*2]	♂[*2]	♂[*2]	♂[*2]	♂[*2]	♂[*2]	-	♂[*2]
3368	S	S	♂/♀	S	S	♂	S	S	-	♀
3379	N	N	Y	N	N	N	N	N	-	N
3382	Y	S	S	♀	♀	S	♀	♀	-	S
3383	N	N	N	N	N	N	♂	♂	-	♂
3385	removed from census - low occupancy									
3389	N	N	N	N	N	P	N	N	-	N
3391	N	N	N	N	N	N	N	N	-	N
# Mid[3]	35	37	37	37	37	37	37	37	-	37
# Occ	5	5	5	6	5	7	11	11	-	12
% Occ	14	14	14	16	14	19	30	30	-	32
# Sq	5	5	5	6	5 + 1J	7	11	11	-	12

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

2 Marked male at midden 3365 - W/- (W/R).

3 The total number of middens does not include middens 3357 or 3385 (removed from censusing due to low occupancy). All middens are located on the SFC area, except for midden 1160 which is located on the TRC area.

4 No construction census was conducted in November - the only construction activity was winterizing the site and this was completed by the second week in November.

Appendix D. Red squirrel populations (including juveniles) on the areas being monitored by the Red Squirrel Monitoring Program, from December 1997 through December 1998.

Date	TRC	TRN	SFC	SFN	TOTAL
Dec 1997	15[1]	14	35	37	101[1]
Mar 1998	13	12	27	26	78
Jun 1998	11	13	19	15	58
Sep 1998	21[2]+1	22	40	26	109 + 1J
Dec 1998	26	30	46	32	134[3]

1 This number includes two squirrels seen at midden 1160 in December 1997. These two squirrels were seen together in the midden for a brief time. No positive identification as to sex or age was made (one may have been a young of the year). There was sign seen at the midden during later visits, but the squirrels were not observed.

2 This number includes the three juveniles seen at midden 1153 No adult female was observed at this midden.

3 This number includes 25 new middens (upgraded activity areas - see Appendix B-2).

Appendix E: Midden Occupancy Maps, 1998.

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 in each of the monitored areas for December 1997 through December 1998. The size of each area is given in hectares (ha); densities are given in middens per hectare (mid/ha). Post-burn areas are used for the calculations in this table.

DATE (original area)	TRC (83.6 ha)	TRN (24.4 ha)	SFC (101.0 ha)	SFN (128.9 ha)
POST-BURN AREAS[1]	*49.1 ha*	*24.4 ha*	*76.1 ha*	*128.9 ha*
Dec 1997	0.55	1.19	1.37	0.78
Mar 1998	0.51	0.98	1.33	0.75
Jun 1998	0.53	0.98	1.33	0.75
Sep 1998	0.55	1.11	1.33	0.76
Dec 1998	0.71	1.52	1.38	0.79

1 These new area figures are the amount of habitat available for red squirrel use after the Clark Peak Fire. These figures are used in the calculations for crude densities.

Appendix F-1b: Crude Density of red squirrels (including juveniles) in each of the monitored areas for December 1997 through December 1998. The size of each area is given in hectares (ha); densities are given in squirrels per hectare (sq/ha). Post-burn areas are used for the calculations in this table.

DATE (original area)	TRC (83.6 ha)	TRN (24.4 ha)	SFC (101.0 ha)	SFN (128.9 ha)
POST-BURN AREAS[1]	*49.1 ha*	*24.4 ha*	*76.1 ha*	*128.9 ha*
Dec 1997	0.31	0.57	0.46	0.29
Mar 1998	0.26	0.49	0.35	0.20
Jun 1998	0.22	0.53	0.25	0.12
Sep 1998	0.45	0.90	0.53	0.20
Dec 1998	0.53	1.23	0.60	0.25

1 These new area figures are the amount of habitat available for red squirrel use after the Clark Peak Fire. These figures are used in the calculations for crude densities.

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

TRC Area										
		Middens					Squirrels			
Month	# Mid	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean	# RS	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean
Dec 97	27	3.6	0.34	57.7	7.98	14	1.9	0.29	76.6	8.80
Mar 98	25	3.4	0.31	52.5	4.71	13	1.8	0.25	74.8	5.33
Jun 98	26	3.5	0.29	50.8	4.66	11	1.5	0.28	69.8	7.09
Sep 98	27	3.6	0.28	49.9	4.24	19	2.4	0.28	61.6	5.31
Dec 98	35	5.1	0.40	41.4	3.08	26	3.8	0.41	47.1	4.45

TRN Area										
		Middens					Squirrels			
Month	# Mid	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean	# RS	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean
Dec 97	29	4.7	0.28	45.5	2.87	14	2.6	0.29	61.0	5.69
Mar 98	24	4.0	0.32	48.3	3.45	12	1.8	0.28	63.5	4.70
Jun 98	24	4.0	0.32	48.3	3.44	13	1.9	0.26	62.6	4.52
Sep 98	27	4.3	0.31	47.1	3.00	22	3.2	0.24	51.5	2.75
Dec 98	37	5.5	0.31	43.0	2.47	30	4.4	0.29	48.4	3.12

Appendix F-2 (con't.)

SFC Area										
		Middens					Squirrels			
Month	# Mid	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean	# RS	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean
Dec 97	104	6.0	0.25	42.3	1.42	35	2.5	0.22	54.9	5.56
Mar 98	101	5.7	0.24	43.5	1.43	27	1.5	0.20	73.8	7.73
Jun 98	101	5.7	0.24	43.5	1.43	19	1.0	0.17	91.1	8.63
Sep 98	101	5.7	0.24	43.5	1.43	40	2.4	0.21	69.5	6.88
Dec 98	105	5.9	0.24	42.5	1.39	46	2.5	0.21	64.3	5.04

SFN Area										
		Middens					Squirrels			
Month	# Mid	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean	# RS	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean
Dec 97	100	3.4	0.17	50.0	2.14	37	0.8	0.11	90.4	9.43
Mar 98	97	3.4	0.18	48.6	2.07	26	0.6	0.11	99.1	9.31
Jun 98	97	3.4	0.18	48.6	2.07	15	0.5	0.13	116.2	15.42
Sep 98	98	3.4	0.17	48.4	2.05	26	1.0	0.24	114.3	13.39
Dec 98	102	3.5	0.17	47.7	1.92	32	1.1	0.19	94.9	8.94

Appendix F-2 (con't.)

All Areas Combined										
		Middens					Squirrels			
Month	# Mid	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean	# RS	Mean Number w/i 100m	Std. Error of the Mean	Mean Nearest Neighbor Dist (M)	Std. Error of the Mean
Dec 97	296	4.6	0.14	47.2	1.25	100	1.7	0.12	73.7	4.04
Mar 98	279	4.4	0.14	47.0	1.11	93	1.3	0.11	81.7	4.14
Jun 98	280	4.4	0.14	48.9	1.11	72	1.1	0.11	86.6	4.93
Sep 98	287	4.4	0.13	46.6	1.07	128	2.2	0.13	73.5	4.13
Dec 98	314	4.9	0.13	44.5	0.98	157	3.0	0.17	64.0	2.97

Appendix G. Reproductive success on the monitored areas, 1998.

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	
6 Jun 98	3390	Female was first located outside the midden. The naturally marked male from 3360 was located near the female. The female would allow the male to approach within about 1 meter, but if he came any closer she would chase him off. The male continued to follow the female all around the area as she foraged. A second male was seen in the midden sniffing and investigating. He did not interact with the other two squirrels.
6 Jun 98	3399	Male resident was seen in midden feeding on a cone. He soon left the midden to the S. The male chattered and went high in a tree, where a second squirrel squeaked and chattered. ID'd the second squirrel as female (possibly the resident from midden 3300). The male chased and buzz called after the female several times.
9 Jun 98	4427	Followed chase involving 2 squirrels into this midden. Located male digging in midden, and female soon followed. The female squeaked and chattered and then began to feed on a mushroom. The two squirrels were in the midden together for a few minutes. Lost sight of the male. Located female in midden again about an hour later. She is the likely resident.
9 Jun 98	4472	First located a female (non-lactating) 15 meters N of the tag tree. A scrotal male approached the female. She chased him off and ran up a tree where a second male was. The two males then chased and one went out of sight. Male #1 ran back to the tag tree. The female chattered and chased him out of the midden.

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

DATE	MIDDEN	
10 Sep 98	1163	Saw adult female and juvenile male in midden. Female came out of nest tree with a cone and mildly chased the juvenile male to a nearby tree. The female then went up the tree and began feeding.
16 Jul 98	3323	Adult female and juvenile male were seen in the midden feeding on cones.
10 Sep 98	5231	Adult female and two older juveniles were seen in the midden. The two juveniles were seen playing and wrestling in the trees. One of the juveniles gave a buzz call to the female as she entered the midden. The female and the two juveniles were seen again in the midden on 14 Sep 98.
27 Sep 98	1153	Saw 3 older juveniles in this midden and nearby new activity area 8305. No adult female was ever seen in either area. These juveniles likely had already dispersed from their natal midden and were staying together for a while. During the December 1998 census, midden 1153 no longer appeared active and no squirrels were seen there. The nearby activity area was possibly occupied - three squirrels were seen in chases at the midden, but none appeared to clearly be the resident and little sign was found.

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 these tables.

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.
non-lactating	16			11			12			20		
reproductive	0			8			0			0		
lactating	0			8			1			0		
post-lactating	0			0			17			1		
non-reproductive[1]								16	1		13	
unknown				3						7		4

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	13			24			2			0		
non-scrotal	0			0			21			13		2
non-reproductive[1]		0			0			15[2]			16	
unknown	4			2			7		2	10		8

Appendix G-3c. Age information for females and males combined.

March			June			September			December		
Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.	Adult	YOY[1]	Unkn.
51	0	0	66	0	2	80	37[3]	13	77	36	37

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.

2 This number includes 1 squirrel identified as juvenile - still living at the maternal midden.

3 This number includes 3 squirrels identified as juveniles - still living at the maternal midden.

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 natural identifying marks.

Midden	Squirrel ID	Notes
1104	♂ - notched right ear and short, thin tail	seen in Dec
1121	♂ - short tail	seen in Sep & Dec
1169 (old activity area 8106)	♂ - small triangle notch on the back side of left ear	seen in Sep
2208	♂ - short tail	seen in Jun
2208	♂ - short tail, bends to right	seen in Dec
2212	♀ - left ear has rip	seen in Sep
3006	♀ - notch in each ear (right ear notch more noticeable)	seen in Sep
3022	♀ - small notch in right ear	seen in Sep
3360	♂ - middle toe on left front foot sticks straight out	seen in Jun, Sep& Dec He was seen at 3310 in Sep, and seen twice at 3390 in Jun.
4427	S - notch in right ear	seen in Sep
4477	♂ - deep triangle notch, low on back of right ear	seen in Sep & Dec
4484	♂ - round white scar or patch of fur on nose	seen in Jun
5232	S - small triangle notch high on back of right ear	seen in Dec
5413	♂ - shallow notch in back of right ear	seen in Sep & Dec
8504 (activity area)	♂ - short tail	seen in Dec

Appendix H-2. Disappearance of marked squirrels.

No marked squirrels disappeared during 1998.

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

Date	Squirrel ID	Location	Distance from own midden	Notes
11 Sep 98	3365 W/- (W/R)	3019	74 meters	He chattered while at this midden.
11 Sep 98	3365 W/- (W/R)	3367	115 meters	After he chattered at 3019, the observer followed him to 3367.

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

No movements of marked squirrels to new middens were observed in 1998.

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

See Appendix H-3. Marked squirrel from 3365 chattered in midden 3019 on one occasion.

Appendix I. Weather Data

I-1. Monthly Weather Summaries for 1998.

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

Appendix I-1. Monthly Weather Summaries for January through December, 1998.

	Month	Biology Camp	Emerald Peak
Temperature (°C) average (max; min)	January	-1.6 (12.1, -10.5)*	-3.5 (8.7, -17.8)
	February	-*	-5.9 (8.9, -15.6)
	March	-2.0 (10.7, -12.1)*	-*
	April	0.0 (17.2, -11.7)	-*
	May	8.8 (28.7, -4.5)	6.2 (19.2, -6.6)
	June	17.7 (36.9, 4.9)*	12.4 (25.6, -0.4)*
	July	14.6 (35.6, 6.0)	10.4 (24.1, -2.9)
	August	13.4 (26.2, 6.6)	10.8 (20.7, -0.5)
	September	12.7 (25.2, 4.9)	7.7 (18.7, -6.0)
	October	6.7 (23.3, -3.0)	4.3 (17.1, -14.2)
	November	1.9 (15.0, -11.0)	0.8 (17.5, -12.9)
	December	-1.3 (14.1, -15.8)	-3.1 (12.4, -19.8)*
Wind Speed (m/sec), maximum(max. gust)	January	2.2 (9.4)*	2.7 (9.4)
	February	-*	4 (14.8)
	March	2.2 (11.2)*	-*
	April	3.1 (11.2)	-*
	May	2.2 (8.9)	2.2 (10.3)
	June	2.2 (10.3)*	2.2 (12.1)*
	July	2.7 (8.5)	2.7 (7.2)
	August	1.8 (8.9)	4.0 (8.0)
	September	2.2 (9.4)	4.5 (11.6)
	October	0.9 (9.4)	0.9 (13.0)
	November	0.9 (14.3)	0.7 (13.0)

Appendix I-1. Monthly Weather Summaries for January through December, 1998.

	Month	Biology Camp	Emerald Peak
Wind, Most Common Direction	December	3.6 (11.2)	5.4 (13.0)*
	January	n/a	west northwest
	February	n/a	west northwest
	March	n/a	-*
	April	n/a	-*
	May	n/a	east southeast
	June	n/a	west northwest*
	July	n/a	north northwest
	August	n/a	south southeast
	September	n/a	southeast
	October	n/a	southeast
	November	n/a	southeast
	December	n/a	west northwest*

Appendix I-1. Monthly Weather Summaries for January through December, 1998.

	Month	Biology Camp	Emerald Peak
Total Rain (mm) / Maximum Snow Depth (cm)	January (snow)	90	95
	February (snow)	80	93
	March (snow)	167	187
	April (snow)	177	199
	May (snow)	60	124
	June (rain)	0	0
	July(rain)	127	130
	August(rain)	68	93
	September(rain)	26	43
	October(rain)	n/a	42
	November(rain)	n/a	18
	December	27.9 (snow melt)	24 (snow)

Appendix I-1. Monthly Weather Summaries for January through December, 1998.

	Month	Biology Camp	Emerald Peak
Relative Humidity (%) average (max; min)	January	49 (94,14)*	n/a
	February	-*	n/a
	March	33 (100,1)*	n/a
	April	-*	n/a
	May	39 (91,13)	n/a
	June	29 (56,11)	n/a
	July	71 (99,13)	n/a
	August	74 (98,33)	n/a
	September	67 (99,21)	n/a
	October	59 (99, 9)	n/a
	November	51 (96, 13)	n/a
	December	52 (95, 15)	n/a
Dew Point (°C) average (max; min)	January	-12 (-1.3, -24.3)*	n/a
	February	-*	n/a
	March	-18.2 (10.7, -48.7)	n/a
	April	-*	n/a
	May	-5.8 (-4.4, -18.8)	n/a
	June	-1.6 (7.2, -13.2)	n/a
	July	8.7 (15.7, -5.9)	n/a
	August	8.6 (16.5, 2.1)	n/a
	September	6.3 (13.7, -9.2)	n/a
	October	-2.3 (8.2, -28.4)	n/a
	November	-8.2 (3.3, -24.1)	n/a
	December	-11.0 (0.1, -26.9)	n/a

Appendix I-1 (cont.)

*Missing Data (monthly summaries are not included if more than 50% of data is missing):

Biology Camp:

January:	December 31 at midnight to January 13 at 1330
February:	February 3 at 1400 to February 28 at midnight
March:	February 28 at midnight to March 4 at 17:30
April:	March 30 at midnight to April 21 at 1430
June:	May 31 at midnight to June 15 at 13:30
November:	November 18 at 1400 to November 19 at 1300

Emerald Peak:

March:	March 9 at 14:30 to March 31 at midnight
April:	March 31 at midnight to April 21 at 12:30
June:	May 31 at midnight to June 15 at 15:30
December:	November 30 at midnight to December 4 at 9:30

n/a - data not available.

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)(n)	Maximum snow depth (cm)	Minimum snow depth (cm)
Nov. 1997	TR	C	3	14.7	17	12
Nov. 1997	TR	F	3	13.0	15	11
Nov. 1997	SF	C	5	15.0	23	0
Nov. 1997	SF	F	5	9.0	13	0
Dec. 1997	TR	C	4	39.8	50	35
Dec. 1997	TR	F	4	25.5	30	16
Dec. 1997	SF	C	6	38.7	57	23
Dec. 1997	SF	F	6	23.8	47	16
Jan. 1998	TR	C	4	86.5	98	72
Jan. 1998	TR	F	4	59.0	81	47
Jan. 1998	SF	C	5	97.8	115	69
Jan. 1998	SF	F	5	77.0	82	64
Feb. 1998	TR	C	3	80.7	95	67
Feb. 1998	TR	F	3	56.3	77	41
Feb. 1998	SF	C	5	90.4	107	55
Feb. 1998	SF	F	5	68.4	75	56
Mar. 1998	TR	C	3	167.3	183	152
Mar. 1998	TR	F	3	129.7	154	105
Mar. 1998	SF	C	5	181.4	210	115
Mar. 1998	SF	F	5	148.6	156	135
Apr. 1998	TR	C	3	163.3	187	126
Apr. 1998	TR	F	3	151.0	173	115
Apr. 1998	SF	C	5	183.4	217	88
Apr. 1998	SF	F	5	171.0	189	135

Month	Hab	Loc	N[1]	Average snow depth (cm)(n)	Maximum snow depth (cm)	Minimum snow depth (cm)
May 1998	TR	C	3	40.0	60	0
May 1998	TR	F	3	72.3	110	52
May 1998	SF	C	5	97.0	150	0
May 1998	SF	F	5	96.4	124	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. If the number for a given month is higher, this means some poles were read more than once during the month and all readings were included in the average.