The effect of bait on vertebrate surveys using camera traps



Black bear (*Ursus americanus*), caught by a Trailmaster® camera trap:10 July 2002, Lassen Volcanic National Park

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Examination number:	39731
Supervisor Name:	Dr. Piran White
Submission date:	May 2003

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This Dissertation is submitted in part fulfilment of the B.Sc. in Environment, Economics and Ecology, Environment Department, University of York. The submitted material is my own work, and where there are parts that are not my own work, they are clearly described.

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ABSTRACT

Remote sensing systems such as camera traps can aid in the conservation and protection of wild vertebrates. The Trailmaster® 500 system is one of the most effective and versatile of these systems. The remote locations that these camera traps are often applied in, typically support low densities of medium to large mammals, and hence the incorporation of attractants into these systems has gone largely unquestioned. This study aimed to test the effect of bait and commercial lures on 4 key functions of the Trailmaster® 500 system, including frequency of detections, number of species detected, time till detection and efficiency of the system. Data were collected over a 2-month period, from 8 pairs of camera stations in Lassen Volcanic National Park, California. Each pair consisted of 1 baited and 1 un-baited station located within the same habitat type. The bait applied was a combination of chicken and commercial lures. Through the application of non-parametric statistical tools, it was established that attractants can alter several indicators of camera success. Significantly higher capture rates, at baited stations, were documented for American marten (*Martes americana*) and the vertebrate subgroup carnivores. Attractants also enhanced the efficiency of traps by increasing the capture rates per active night and lessening the time until first detection. However, the potential for deterrence of various species and the possibility of drawing in individuals from adjacent areas has also been highlighted. These findings have shown that the application of attractants can both positively and negatively impact the use of camera traps in wild vertebrate research, and thus their incorporation into remote sensing systems requires careful consideration.

INTRODUCTION

Immense losses of terrestrial vertebrates are occurring across the globe (Wilson 2002; http://www.redlist.org/), demonstrating the need for greater knowledge and understanding of these animals (Wilson et al. 1996). It has widely been accepted that for this to be truly achieved, wild vertebrates must be studied in their natural environments (Dasmann 1975). The problems associated with wildlife research have long been recognized (Elton 1993, Leopold 1933). Far-ranging, nocturnal or cryptic species in remote settings present inherently inaccessible and complex problems (Mace et al. 1994). Traditional methods employed to study vertebrates in remote environments include faecal counts, drive counts and snow tracking techniques (Bookhout 1994, Wilson et al. 1996), to mention but a few. However, these methods provide limited data on species activity, health and general behaviour, and may lead to inaccurate identification of species as they are subject to ground-surface, climatic and observer variability. They are also highly labour intensive and often require calibration before yielding absolute numbers (Seydack 1984, Zielinski and Kucera 1995).

Live trapping is a less subjective method and yields reliable information on types and abundance of species, but does not provide details on activity levels (Hicks et al. 1998). This can be circumvented, to some degree, by attaching timing devices to trap doors. However the problem still remains that by removing individuals, the population size that may be caught later on is reduced and hence activity invariably decreases (Sequin 2000). This method is also confined to accessible areas and may cause some degree of distress and harm to trapped individuals, which has resulted in restriction of its use when dealing with endangered or rare species. Live trapping is often combined with radio-telemetry, which allows for activity to be measured. However, this method is still constrained by small numbers of animals that can be tagged simultaneously, uncertainty about untagged animals, the invasiveness of the method and the high cost and effort involved (White and Garrott 1990).

In summary, none of the aforementioned systems can meet the following 5 requirements simultaneously: 1) Portability and durability, thereby allowing systems to be applied in a broad variety of conditions; 2) Ability to work continuously for lengthy periods of time, independent of observers; 3) Low cost and simple to use; 4) Minimal impact on the target species or the surrounding environment; and 5) Provides

physical results that can be cross-examined thereby minimizing bias. Without these capabilities, remote sensing methods are unable to account for 3 essential characteristics of many terrestrial vertebrate species: secretiveness, rarity and remoteness, thus greatly limiting our knowledge to accessible areas and insensitive, common species.

It was these shortcomings that prompted the development of automated camera trapping systems. These systems operate independently of observers as the animals themselves cause the closure of an electric circuit, which allows for a photograph to be taken. Camera traps have been used for over 4 decades (Kucera and Barrett 1993), with the early systems often incorporating electronic eyes, trip lines and pressure plates as the shutter-activating mechanism. However, many of these systems had heavy power requirements due to flash gun capacitors. They often required A.C. power sources or expensive bulky battery packs and were therefore not truly portable (Dodge and Snyder 1960). They were also relatively complex and did not incorporate film advance mechanisms and so could only take a single photograph. Hence it was not till the invention of lightweight, low power demanding systems, which could detect animals continuously over large areas for lengthy periods of time that the true benefits of automated photography were seen.

Two of the most versatile of these systems are the Trailmaster® (TM) 1500 and TM 500 camera systems (http://www.trailmaster.com). These units have, to date, been used in a variety of wildlife research, ranging from characterizing the activity patterns of kangaroo rats (*Dipodomys sp.*) in Sierra Nevada deserts (Sequin 2000) to estimating tiger (*Panthera tigris*) densities in deciduous Indian forests (Karanth et al. 1998). These camera systems are weatherproof, compact and highly portable. They have low energy requirements and can operate independently in the field for over 30 days, which allows an array of them to detect species continuously over a large area. They are non-invasive, allow for detailed temporal questions to be addressed and provide more permanent and less disputable proof (high-quality photographs) than many other remote sensing techniques.

The aforementioned attributes of TMs allow for them to be established in remote settings, which are often hash and can sustain only low densities of terrestrial vertebrate life. Hence it is intuitive that one should incorporate some form of attractant (bait or scent) when TM cameras are applied in such areas. However, if the same form of un-baited trap is not established in conjunction with the baited trap then

this variable (attractant) has not been controlled for. This is particularly problematic when using these systems to inventory habitats. Bait may draw in individuals from adjacent areas, thereby providing unrepresentative data. In the words of Cutler and Swann (1999): "A disadvantage (of camera traps) was the use of bait to attract animals, because individuals react differentially to bait." Hence by providing attractants alter the behaviour of animals can be alltered, which in turn may bias the researcher's raw data.

When un-baited stations have been employed, they have often been placed along known lines of migration, such as paths and game trails (Karanth et al. 1998). Again, this may bias data, as traps will not be randomly placed (Wilson et al. 1996). Hence any study that seeks to estimate abundance or activity of vertebrates, using this method, may yield inflated results that are unrepresentative. To date, these possibilities have not been thoroughly researched and it was for this reason that this study was carried out.

Goals and objectives

Specifically, this study addressed the question of "how does bait affect the detectability of terrestrial vertebrates by camera trapping systems?" This question was tested by comparing between 8 pairs of baited and un-baited camera stations in Lassen Volcanic National Park, where a mammal surveying program was already in place. The park made use of 8 un-baited cameras to detect species that cannot be detected by pitfall and Sherman traps, i.e. medium to large mammals such as lagomorphs, coyotes, black bear etc. Through the incorporation of theses cameras, the park also hopped to obtaining information on Sierra Nevada red fox (SNRF), a state threatened species[1], and marten, a species of special concern,.

[1] This is a classified subspecies of red fox: *Vulpes vulpes necator*

The overall aims of the project were:

1. To determine if bait significantly alters the frequency of detections for TM 500 camera traps.
2. To determine if the total number of species detected at baited and un-baited stations differed.
3. To determine if bait affects the efficiency of TM 500 camera traps.
4. To determine if bait alters the time to detection (latency) of TM 500 camera traps.
5. To establish if the use of a standard index provides a reliable means of comparison.

Study area

Lassen Volcanic National Park (LVNP) is situated in northern California near the southern terminus of the Cascade Range (40°30'N, 121°30'W)[2]. The park is 430Km^2 in area and forms a junction between the ecosystems of the Great Basin, Sierra Nevada and Cascades, resulting in large overlap in flora and faunal species (http://www.nps.gov/lavo/home.htm). As the name suggests, the park has a long history of volcanic events, the most recent of which was the eruption of Mount Lasssen (1915) where 18.13km^2 of forestland were destroyed by pyroclastic and lava flows. As a result of this activity, park soils are generally acidic and range from over a metres in depth at lower elevations to extremely thin or non-existent at higher altitudes.

The park's range of elevation stretches from 1 524m to 3 048m, comprising 4 of Merriam's life zones: Transition, Canadian, Hudsonian and the treeless Alpine zone. However, due to its unique make-up of soils and location, many plants occurring in Lassen form anomalies to many of these life zones e.g. *Abies concolor* has a higher elevation optimum than *Pinus jeffreyi* in LVNP, whereas it has a lower elevation optimum than *Pinus jeffreyi* on the western slope of the Sierra Nevada.

[2] See Fig.1 for parks location.

The climate of LVNP is of an upland subtropical dry (Mediterranean) summer type, characterized by cool snowy winters and warm dry summers. Precipitation varies across the park with mean annual rainfall at Manzanita Lake of 104.9cm and 135.8cm in Mineral[3]. Monthly temperatures vary park-wide from –1.1°C in January to 16.9°C in July but have been known to be as high as 38 °C and as low as –26 °C. As a result of this great geological and climatological variety the park boasts a rich biological diversity, with over 700 species of flowering plants providing habitat to some 250 vertebrates.

Prior to the mid-1800s, the area currently covered by LVNP was controlled and utilized under low-density hunter/gatherer systems of three separate Indian tribes. However, after the arrival of the first Europeans, communication networks were set up and commercial logging, hunting and ranching operations dominated the area until the establishment of the park in 1914, which included 79 000 acres of designated wilderness (under the 1964 wilderness act).

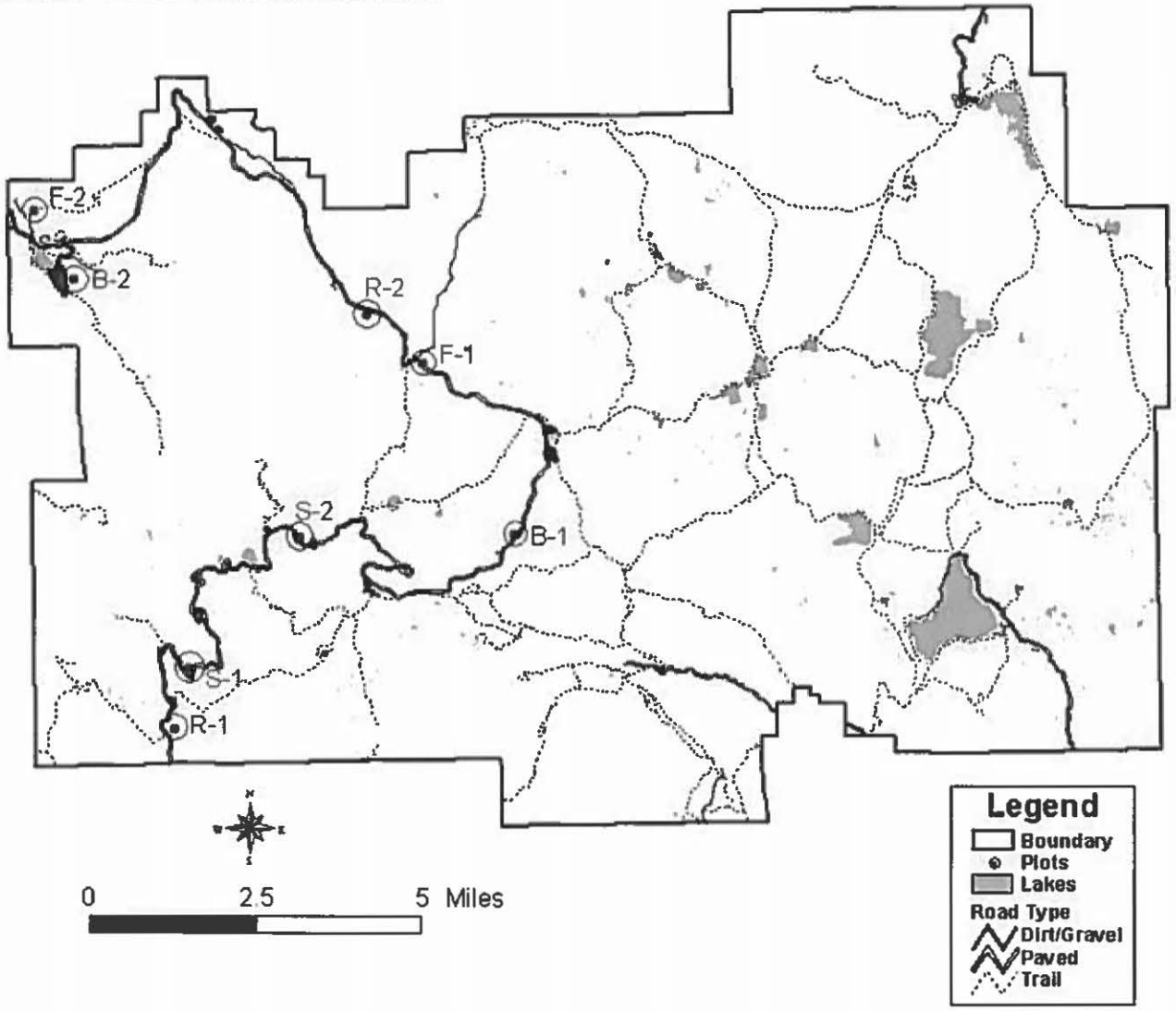
[3] Manzanita Lake is situated in the north west portion of the park and Mineral is approximately 6 miles south of the parks southern boundary.

Fig.1: Location of Lassen Volcanic National Park



Fig. 2.

Location of Camera stations within the four habitat types
Lassen Volcanic National Park



METHODS

Equipment

Each camera station employed a 35-mm camera, modified to be triggered by a TM 500 dual sensor[4], which emits a field of both microwave and passive infrared (PIR) pulses. Working simultaneously, these detect motion and changes in ambient temperatures respectively, (a detection is termed an event). The TM 500 is fully adjustable and can be tailored to suit the researcher's specific needs. The emitted field ranges up to 11m from the sensor and can be restricted to a desired distance and area by obstructing the sensor's PIR window. The length of time the field must be broken before an event is recorded, is adjustable from 0.05 to 1.5 seconds (pulses and pt). The length of time between successive photographs (camera delay) can be adjusted from 0.2 to 98 minutes[5]. Finally, the system can be set such that the sensor only triggers the camera during 2 separate time periods. The sensor includes an event recorder that stores the date, time, event number, and frame number (if a picture is taken) each time an animal is detected. The system is powered by 4 alkaline C-cells, which last approximately 30 days of continuous operation.

The cameras used with the TM 500 sensor are equipped with a clock that can imprint the date and time on each photograph. The flash on each camera can be set to off, automatic (as required by available light), or to continuously on with every picture, (fill-in mode). The flash can illuminate up to 4.5m with 100-ASA film and 9m with 400-ASA film. The camera is powered by 2, 3-v lithium batteries that will suffice for approximately 10 rolls of 36-exposure film. The units are supplied with an 8-m electrical cable to connect the sensor and camera, a metal bracket that shields the top and back of the camera as well as a 10-cm, collapsible tripod.

Field Methods

The location of the park's small mammal monitoring program formed the basis of camera trap placement in this study. There are 4 broad habitat types in the park (Mayer and Laudenslayer 1988). Using the park road as a transect, 4 pairs of camera stations were established in high and low elevation equivalents of the 4 habitat

[4] See appendix 9 for photographs of the TM 500 system.
[5] In this study the following settings were applied: Pulses: 2, Pt: 2, Camera delay: 3.0.

types, yielding 16 stations in total (Fig. 2). Each pair consisted of a baited and un-baited station[6]. Cameras were placed on an open, flat area at least 50m from the road and 200m from one another. The camera and sensor were mounted on a suitable tree, at a height of approximately 1.5m. They were positioned such that they faced northward and so that the sensor's area of sensitivity was no more that 4m from the base of the tree and central to the camera's field of view. Each station was marked with flagging and UTM co-ordinates were established using a Trimble GeoExplorer GPS. These co-ordinates were later differentially corrected using the program "Pathfinder Office 2.9".

The bait used at 8 of the stations, consisted of 2 legs of rancid chicken wired to a medium-sized rock placed in the sensitive area. Also, 2 splashes of fox urine and 2 pea-sized blobs of the commercial stink 'Canine Call' were placed on or near the rock. Canine Call was also added to 2 elevated positions (branches, snags etc.) no more that 4m from the sensitive area. To avoid wildlife interfering with the camera system, baiting and camera checking were done by different individuals, thereby minimizing any chance of bait or lure odours being left on the camera equipment.

The cameras were checked every 3 days. At each check the date, time, events and number of exposures were recorded, the sensitive area cleared of any plant debris, and any damage to the equipment repaired. Also, film, batteries or stolen systems were replaced as needed. At the baited stations the site was always re-baited even if the bait had not been removed. During each check the sensor was assessed for any sun-splash problems, (false triggering of the system through direct exposure, or reflection of solar radiation onto the sensor's PIR window). This was done by scrolling through all the events since the last check and observing any obvious patterns occurring over the past days. If a problem period was identified, then the sensor was turned off for this period of the day.

The frames from each roll of film were scored by recording the date and time for each photo. The frames were then scanned, using a magnifying glass, for 30 seconds. If no animal could be seen it was recorded as a 'miss'. If an animal could be identified, then it was entered as a 'hit' and the species recorded. If it was obvious that some animal had triggered the photo, but it could not be positively identified, the photo was recorded as a 'drop'. Since drops demonstrate the efficient functioning of

[6] For further details on habitat definition and choice of camera placement see reference: LAVO 2001. A summary of monitoring activities for 2001.

the camera and sensor, these data were pooled with hits. The term 'capture' defines the frames where identifiable animals were photographed.

At each of the stations, over-story density (canopy coverage) was estimated. This was done using a spherical densiometer. One reading was taken at the base of the tree and then 4 readings were taken in each of the 4 cardinal directions; the average of these samples gave an estimate of over-story density to the nearest 10 percent.

Statistical methods

Comparisons between baited an un-baited stations were carried out on 2 different data sets, a 21-night scenario and a 100-night scenario. Since the Trailmaster® camera traps employed in this study yield a catch-per-unit-effort index, any analysis that compares across different effort levels could be biased. To avoid this bias, data were compared across 21 active trap nights (ATN), which was the largest number of ATNs recorded by all stations. However, this 21-night baseline greatly reduced the size of the available data set, (6 stations ran for more than double this duration). Hence, to avoid this restriction a standardized, 100-night index was employed. This index was calculated by simply dividing either the number of frames or the number of species per station by the number of ATNs at that station and then multiplying by 100.

All data analysis was carried out using EXCEL and SPSS10. Throughout this study the standard alpha (significance level) of 0.05 (95%) was employed. Before in-depth analysis began, the distribution of the data within each data set was tested for normality using the Kolmogorov-Smirnov test.. This showed both data sets to be non-normally distributed (Appendix 5).

The first method of analysis was a Wilcoxon matched-pairs signed-ranks test (WMPSRT). Executed in SPSS10, this test was used to evaluate if any significant differences between baited versus un-baited stations existed for the number of captures, efficiency or number of species detected. This test is the non-parametric equivalent of the paired t-test. It therefore does not assume the data to be normally distributed. However it requires a minimum sample size of 6 pairs, assumes pairs are related, and that the data are ordinal and on a continuous scale. The main advantage of this test is that, because it assumes data to be 'matched' (through habitat in this

case), the confounding effect caused by extraneous variables is minimized. The test is a powerful test that utilizes information on both the direction and magnitude of a difference. Hence, it is more likely to detect differences where the size of the difference is larger, thus preventing the researcher from making Type I errors. However, since this study was constrained by small sample size, this test could only be applied to 9 pairs in the 100-night scenario and 8 pairs in the 21-night scenario.

The Mann-Whitney U test is the non-parametric equivalent of the independent samples t-test. It is a less powerful test than the WMPSRT, but it does not require a minimum sample size and hence was attractive for use in this study. Again, this test does not assume the data to be normally distributed, nor does it assume that the 2 groups in question are related. However, it does assume the data are at least ordinal. This test was executed in SPSS10 to detect any significant differences between baited versus un-baited stations for the number of captures, efficiency or number of species detected.

All pairs that are significantly different have been displayed as box plot figures (Figures 3-9). Whereas the p-value simply shows if a test is significant, the box plots (created in SPSS10) allow for the degree of variation between pairs to be displayed. Box plots illustrate the inter-quartile range, the effect of skew on the median and the existence of outliers.

The final non-parametric test employed in this study was the Spearman rank correlation coefficient. This test demonstrates the level of association between two variables through its statistical 'r' value. As the name suggests, the test requires the data to be measured on at least an ordinal scale. This test was used to measure the level of association between the 3 measures of efficiency and canopy coverage.

The 3 measures of efficiency were calculated in EXCEL for all 16 stations. The first measure (e1) is the ratio between the number of captures and the total number of frames. The second measure (e2) is the ratio between the number of ATN and the total number of nights that the cameras were in operation for. The final measure of efficiency (e3) is the ratio of captures per ATN.

Cumulative frequency graphs were used to examine the relationship between the length of time all stations were in operation and the proportion of stations that recorded a given species or subgroup. These graphs were created for each species and subgroup. However, limiting sample size allowed for representative comparisons of latency to be carried out only on the 3 main subgroups (small and large mammals and

birds). It was also carried out on American marten and SNRF, as these were species the park was particularly interested in. However, the graph for SNRF was not included as this species was only detected at 1 station.

RESULTS

Summaries of the trapping effort and the overall results are provided in Tables 1 and 2. Additional details are provided in appendices. Golden-mantled ground squirrels were the most commonly detected species (Table 2). They belong to the subgroup (small mammals) that registered the highest number of frames of any subgroup (Table 2). It can also be seen that for all mammal species, with the exception of mule deer, an equal or higher proportion of frames was recorded at baited stations than at un-baited stations (Table 2). A similar pattern was apparent for the bird species detected, with 53 percent of bird species registering higher frame numbers at baited stations than at un-baited stations (Table 2). Although a larger proportion of captures and species were observed at baited stations[7], this increase rarely resulted in a significant difference in the number of captures recorded between the 2 treatments (Tables 5-7).

Note that the sample size in this survey restricted the use of the WMPSRT to just 7 categories under the 21-night scenario, and 8 categories under the 100-night scenario (Table 5). This resulted in a test of relatively low power. The results of the WMPSRT suggested that when comparing across a constant level of effort (21 nights) the only significant difference between baited and un-baited stations occurred when all species were pooled and for the carnivore subgroup. However, when the standardized index based on 100 nights of effort is employed (incorporating the entire data set), the same differences remain (or become more significant), plus an additional 5 more differences are judged significant. Of these 5 the only 1 that comes close to displaying a difference in both scenarios, is the large mammal subgroup, where a significant difference at the 10% level is given under the 21-night scenario (Tables 5; Figures 3-9).

When a comparison of baited and un-baited stations was made using a constant number of trap nights, it was evident that over two thirds of all the animals detected in this study were recorded at baited stations (Table 6). However, the Mann-Whitney U Test detected no significant difference between the total number of frames recorded at baited versus un-baited stations under the 21 nights scenario (Table 6). This pattern holds true for all species with the exception of marten and the subgroups

[7] Baited stations totalled 25% more captures and 30% more species.

carnivores and large mammals. In the case of marten it can be stated that this species occurred significantly more frequently at baited stations than it did at un-baited stations. The same can be said for large mammals and carnivores where 71 and 99 percent more captures were recorded at baited stations, respectively (Tables 6-7).

Of all the subgroups, small mammals were the most common, making up 44 percent of the total number of captures recorded over the 21-night period (Table 6). Here, 39 percent more frames were registered by baited stations, but again no significant difference was found.

Of the 7 species of larger mammals detected in this study, mule deer was the only ungulate. However it was the most commonly detected large animal in the park (over the 21-night period), found at the greatest number of stations (14), and made up 18 percent of the total number of frames recorded over the 21-night period. Although 1.5 times more mule deer were detected at un-baited stations than at baited, the WMPSRT showed no significant differences. This is likely to represent a Type II error resulting from the small sample size and consequent low power of the test (Table 5).

The only other species that came close to exhibiting a significant difference between the 2 treatments was the Douglas squirrel. This species showed a significant difference in the number of frames recorded between the two treatments at the 10% level (Table 6; Figs. 3a,3b).

Table 7 shows the results of the Mann-Whitney U test conducted over 100 active trap night index, that incorporated the entire data set. Here the general trend still remains: for most species except for marten and the subgroups carnivores and large mammals, no significant differences are seen between baited and un-baited stations. However, a major change is that now the total number of frames between the 2 treatments moves from being significant at the 10 percent level to the 5 percent level, despite the fact that the relative proportion of individuals at baited and un-baited stations has remained virtually the same (difference of 0.2 percent).

Apart from this development the only other major changes that can be seen is that the difference between the number of frames detected for black bear at baited and un-baited stations is now significant at the 10 percent level. Also, for the subgroup birds, their level of significance increases by 19 percent but still remains insignificant at both the 5 and 10 percent levels. Overall, the proportion of frames recorded per

species did not change significantly with a slight decrease in the proportion of birds, an increase of 7.1 percent in small mammals and a drop of 6.2 in the percentage of large mammals.

When comparing efficiency between the two treatments, it is evident that baited stations recorded significantly more captures per night, when active, than un-baited stations, however they were not significantly more active than baited stations (per field night), nor did they record greater capture rates per photo taken (Table 3).

The results of the WMPSRT shows that baited stations detected significantly more species that un-baited stations. In both treatments, 50 percent of the total species recorded were detected in the first 6 to 8 days (Figs 10a, 10b). There was a rapid increase in the number of new species detected in the first 5 days and then a slow down until approximately day 15, after which another increase occurred. A slight levelling off in number of new species detected was seen after 20 days in both treatments but no true asymptote was reached (Figures 10a, 10b). The proportion of new species detected per day did not remain constant over time. A general decrease can be seen, in both treatments, in the average number of new species detected per night; e.g. the un-baited stations detected on average 1.2 new species per day by day 5 and an average of 0.85 per day by day 20.

As the number of days increased, there was a more than proportionate increase in the number of frames recorded at both baited and un-baited stations, e.g. by day 10 baited cameras were recording on average 16.6 frames per day and by day 20 they were recording 21.9 frames per day (Figs 11a, 11b). Hence the number of frames recorded is not constantly increasing as the number of days increase. This finding is reinforced by the fact that days and frames are highly positively correlated (Tables 9a, 9b).

It took 3 days before 50 percent of all stations had detected a large mammal. Ninety percent of stations had detected a large mammal by day 17, with no more detections occurring for another 9 days (Fig 12a). Over 50 percent of baited stations had detected a large mammal within 24 hours, whereas it took over 24 hours for half of the un-baited stations to have detected a large mammal (Figures 12b, 12c). Also, baited stations received just under 90 percent of their detections 7 days earlier than un-baited stations (Figures 12b, 12c).

From the initial date of set-up until day 6, camera stations were registering their first detections of small mammals on a daily basis. Over 50 percent of stations had detected a small mammal by day 5, and just under 90 percent of stations had detected a small mammal by day 17, with an additional detection occurring 11 days later (Figure 13a). Half of the baited stations had registered small mammals by day 3, whereas it took the same proportion of un-baited stations 10 days longer (Figures 13b, 13c).

As seen from figure 14a, over one third of all the camera stations had detected a bird species within 24 hours of their establishment; however, only 2 more stations detected a bird species within the next fortnight. After day 15, an initial jump in detections was followed by a slow increase until day 31, when over 90 percent of the stations had recorded at least one bird species. It took a further 10 days for the final station to detect a bird.

From Figure 14b it can be seen that un-baited stations detected birds across three clear intervals: in the first 24 hours, then between days 15 and 16 and again between days 26 and 27. The baited stations (shown in 14c) followed a similar pattern to Figure 14a, with a sharp initial increase and then a staggering of detections till day 19, when 80 percent of stations had detected a bird species.

Figure 15 was typical of most mammal species recorded in this study. It clearly shows a sharp increase in new detection of American marten from the initial day of set up to day 6, following which the 2 final detections occured 12 and 16 days later. The graph for SNRF was not included as its shape was not conducive to establishing optimum effort levels (it was a straight line). SNRF were detected at only 1 baited station, within 24 hours of trap establishment.

Tables and Figures

Table 1: Summary of total active trap nights, captures and species at baited and un-baited stations

Site	Active Trap Nights	Total Captures	Total Species
Un-baited stations			
B1-02	46	18	7
B2-02	45	60	6
F1-02	47	11	5
F2-02	46	27	5
R1-02	47	15	4
R2-02	49	17	4
S1-02	30	31	6
S3-02	21	38	9
Total un-baited	**331**	**217**	**19**
Baited stations			
B1-X	25	26	9
B2-X	25	70	10
F1-X	33	54	6
F2-X	23	72	8
R1-X	24	13	5
R2-X	24	14	3
S1-X	24	36	7
S2-X	30	78	14
Total baited	**208**	**363**	**28**
Total	**539**	**580**	**30**

Table 2: Total number of frames for each species detected over the entire sample period

Common name	Scientific name	Captures Un-baited	Captures Baited	Total Captures
Sharp Shinned Hawk	*Accipiter stiatus*	1	1	2
Blue Grouse	*Dendragapus obscurus*	2	2	4
California Quail	*Callipepla californica*	0	1	1
Mountain Quail	*Oreortyx picta*	1	0	1
Northern Flicker	*Colaptes auratus*	3	0	3
Stellers Jay	*Cyanocitta stelleri*	4	1	5
Grey Jay	*Perisoreus canadensis*	0	3	3
Clark's Nutcracker	*Nucifraga columbiana*	6	5	11
Common Raven	*Corvus ossifragus*	0	13	13
White breasted Nuthatch	*Sitta carolinensis*	0	2	2
Hermit Thrush	Catharus guttatus	0	3	3
American Robin	*Turdus migratorius*	11	6	17
Yellow-rumped Warbler	*Dendroica coronata*	0	1	1
Dark-eyed Junco	*Junco hyemalis*	1	3	4
Fox Sparrow	*Passerella iliaca*	0	1	1
Snowshoe Hare	*Lepus americanus*	1	2	3
Chipmunk	*Tamias spp.*	34	55	89
California ground squirrel	*Citellus tridecemlineatus*	3	3	6
Golden-Mantled Ground Squirrel	*Spermophilus lateralis*	44	71	115
Western Gray Squirrel	*Sciurus griseus*	1	1	2
Douglas Squirrel (Chickaree)	*Tamiasciurus douglasii*	24	36	60
Deer Mouse	*Peromyscus maniculatus*	2	8	10
Common Porcupine	*Erethizon dorsatum*	1	2	3
Coyote	*Canis Latrans*	0	1	1
Red Fox	*Vulpes vulpes*	0	19	19
Grey Fox	*Urocyon cinereoargenteus*	0	9	9
Black Bear	*Ursus americanus*	5	21	26
American Marten	*Martes americana*	2	61	63
Bobcat	*Lynx rufus*	0	1	1
Mule Deer (Black-tailed Deer)	*Odocoileus hemionus*	71	31	102
Total		**217**	**363**	**580**
Birds		29	42	71
Small Mammals		109	176	285
Carnivores		2	90	92
Large Mammals		79	145	224

Table 3: Comparison of efficiency between baited and un-baited stations. Significant differences are shown in bold

	Un-baited	**Baited**
Average efficiency (e1)	0.388	0.468
	Wilcoxon	
	Z Statistic	P-value (2 tailed)
Baited vs. Un-baited (e1)	-0.98	0.326
Average efficiency (e2)	0.797	0.735
	Wilcoxon	
	Z Statistic	P-value (2 tailed)
Baited vs. Un-baited (e2)	-1.12	0.263
Average efficiency (e2)	0.759	1.749
	Wilcoxon	
	Z Statistic	P-value (2 tailed)
Baited vs. Un-baited (e2)	-2.521	**0.012**

Table 4: Comparison between number of species detected at baited and un-baited stations both for 21 and 100 trap nights. Significant differences are shown in bold

	Wilcoxon 21 nights		**Wilcoxon 100 nights**	
	Z Statistic	P-value (2 Tailed)	Z Statistic	P-value (2 Tailed)
Species	-2.132	**0.033**	-2.521	**0.012**

Table 5: Table showing the level of difference in the number of captures at baited und un-baited stations given by the Wilcoxon match-pairs signed-ranks test for both 21 and 100 active trap nights. Significant differences are shown in bold.

	Wilcoxon 21 nights		**Wilcoxon 100 nights**	
Group	Z Statistic	P-value (2 Tailed)	Z Statistic	P-value (2 Tailed)
Birds	-0.108	0.914	-0.980	0.327
Chipmunk	-0.105	0.916	-0.338	0.735
Douglas Squirrel	-1.179	0.238	-2.366	**0.018**
Small Mammals	-1.187	0.235	-2.240	**0.025**
Black Bear*	N/A	N/A	-1.992	**0.046**
Mule Deer	-1.020	0.308	-1.120	0.263
Large Mammals	-1.612	0.107	-2.100	**0.036**
Carnivores	-2.366	**0.018**	-2.366	**0.018**
Total	-2.375	**0.018**	-2.521	**0.012**

* The Wilcoxon matched-pairs signed-ranks test could not be applied to black bear under the 21 nights scenario as there were less than 6 recorded pairs.

Table 6: Table showing the level of difference in the number of captures at baited und un-baited stations given by the Mann-Whitney U test for 21 active trap nights. Significant differences are shown in bold

	Mann-Whitney		Percentages		
Species	U Statistic	P-value (2 tailed)	% Un-baited	% Baited	% Total
Sharp Shinned Hawk	28.000	0.317	100.0	0.0	0.3
Blue Grouse	32.000	1.000	50.0	50.0	0.5
California Quail	28.000	0.317	0.0	100.0	0.3
Mountain Quail	28.000	0.317	100.0	0.0	0.3
Northern Flicker	24.000	0.144	100.0	0.0	0.8
Stellers Jay	31.500	0.927	66.7	33.3	0.8
Grey Jay	28.000	0.317	0.0	100.0	0.3
Clark's Nutcracker	29.000	0.644	54.5	45.5	2.8
Common Raven	24.000	0.144	0.0	100.0	3.4
White breasted Nuthatch	28.000	0.317	0.0	100.0	0.5
Hermit Thrush	28.000	0.317	0.0	100.0	0.8
American Robin	28.500	0.654	50.0	50.0	2.6
Yellow-rumped Warbler	28.000	0.317	0.0	100.0	0.3
Dark-eyed Junco	32.000	1.000	50.0	50.0	0.5
Fox Sparrow	28.000	0.317	0.0	100.0	0.3
Birds	22.500	0.301	36.4	63.6	14.2
Chipmunk	30.000	0.826	29.0	71.0	16.1
California ground squirrel	31.500	0.927	25.0	75.0	1.0
GM Ground Squirrel	23.500	0.340	22.8	77.2	14.8
Western Grey Squirrel	32.000	1.000	50.0	50.0	0.5
Douglas Squirrel	16.500	0.092	43.2	56.8	9.6
Deer Mouse	31.500	0.927	28.6	71.4	1.8
Small Mammals	24.000	0.397	30.2	69.8	43.8
Common Porcupine	28.000	0.317	100.0	0.0	0.3
Coyote	28.000	0.317	0.0	100.0	0.3
Red Fox	28.000	0.317	0.0	100.0	4.1
Grey Fox	28.000	0.317	0.0	100.0	0.8
Black Bear	21.000	0.184	19.0	81.0	5.4
American Marten	14.000	**0.030**	2.0	98.0	13.2
Mule Deer	23.500	0.364	59.4	40.6	17.9
Carnivores	5	**0.0029**	1.41	98.6	3.57
Large Mammals	10.500	**0.023**	29.0	71.0	42.0
Total	16.000	0.092	30.6	69.4	100.0

Table 7: Table showing the level of difference in the number of captures at baited und un-baited stations given by the Mann-Whitney U test for 100 active trap nights. Significant differences are shown in bold

	Mann-Whitney		Percentages		
Species	U Statistic	P-value (2 tailed)	% Un-baited	% Baited	% Total
Sharp Shinned Hawk	31.500	0.927	44.4	55.6	0.4
Blue Grouse	29.000	0.644	45.0	55.0	0.6
California Quail	28.000	0.317	0.0	100.0	0.2
Mountain Quail	28.000	0.317	100.0	0.0	0.1
Northern Flicker	24.000	0.144	100.0	0.0	0.6
Stellers Jay	28.000	0.538	75.3	24.7	0.8
Grey Jay	28.000	0.317	0.0	100.0	0.5
Clark's Nutcracker	29.000	0.644	62.2	37.8	2.3
Common Raven	24.000	0.144	0.0	100.0	2.6
White breasted Nuthatch	28.000	0.317	0.0	100.0	0.3
Hermit Thrush	28.000	0.317	0.0	100.0	0.5
American Robin	29.500	0.763	64.2	35.8	3.1
Yellow-rumped Warbler	28.000	0.317	0.0	100.0	0.2
Dark-eyed Junco	28.000	0.538	30.2	69.8	0.8
Fox Sparrow	28.000	0.317	0.0	100.0	0.2
Birds	17.000	0.114	41.1	58.9	13.2
Snowshoe Hare	31.500	0.927	21.7	78.3	0.5
Chipmunk	30.500	0.874	31.9	68.1	16.5
California ground squirrel	31.500	0.927	35.7	64.3	0.9
GM Ground Squirrel	28.000	0.661	25.9	74.1	20.3
Western Grey Squirrel	31.500	0.927	33.3	66.7	0.3
Douglas Squirrel	16.500	0.102	38.1	61.9	10.6
Deer Mouse	28.000	0.538	26.8	73.2	1.8
Small Mammals	23.000	0.345	30.6	69.4	50.9
Common Porcupine	31.500	0.927	21.0	79.0	0.5
Coyote	28.000	0.317	0.0	100.0	0.2
Red Fox	28.000	0.317	0.0	100.0	3.2
Grey Fox	28.000	0.317	0.0	100.0	1.9
Black Bear	16.500	0.082	11.5	88.5	4.8
American Marten	14.500	**0.035**	2.0	98.0	10.8
Bobcat	28.000	0.317	0.0	100.0	0.2
Mule Deer	22.500	0.318	60.0	40.0	14.2
Carnivores	5	**0.0029**	1.36	98.6	16.1
Large Mammals	5.000	**0.005**	26.3	73.7	35.8
Total	12.000	**0.036**	30.4	69.6	100.0

Fig 3a: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for douglas squirrels across 21 active trap nights (U: 16.5 P-value: 0.092; Z: -1.179 P-value: 0.238)

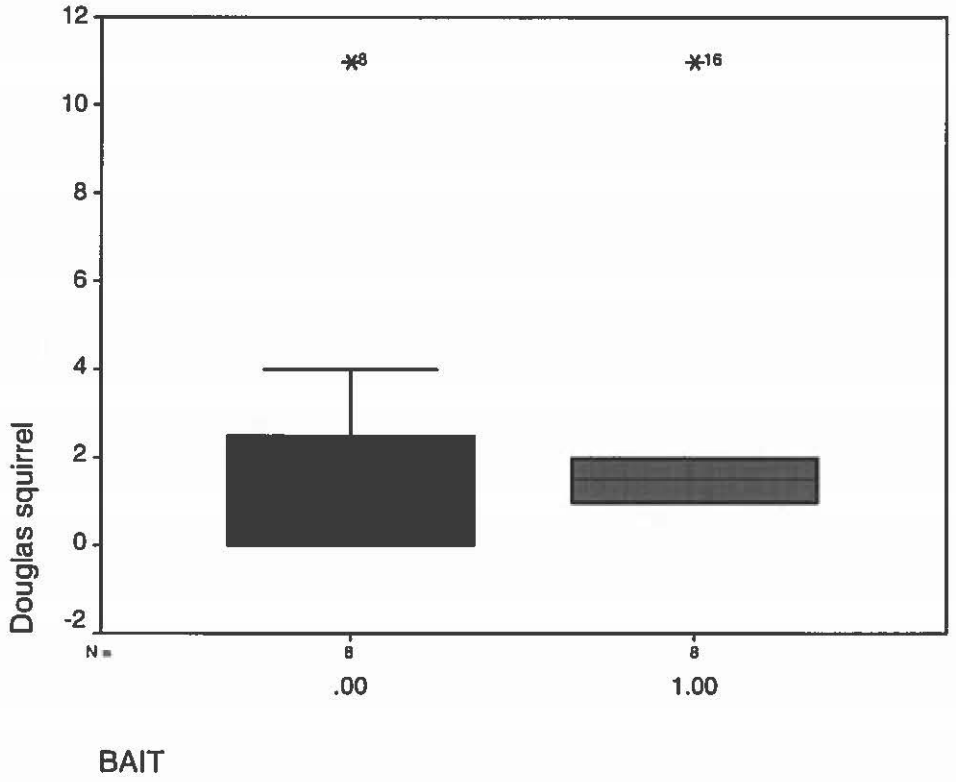


Fig 3b: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for douglas squirrel across 100 active trap nights (U: 16.5 P-value: 0.102; Z: -2.366 P-value: 0.018)

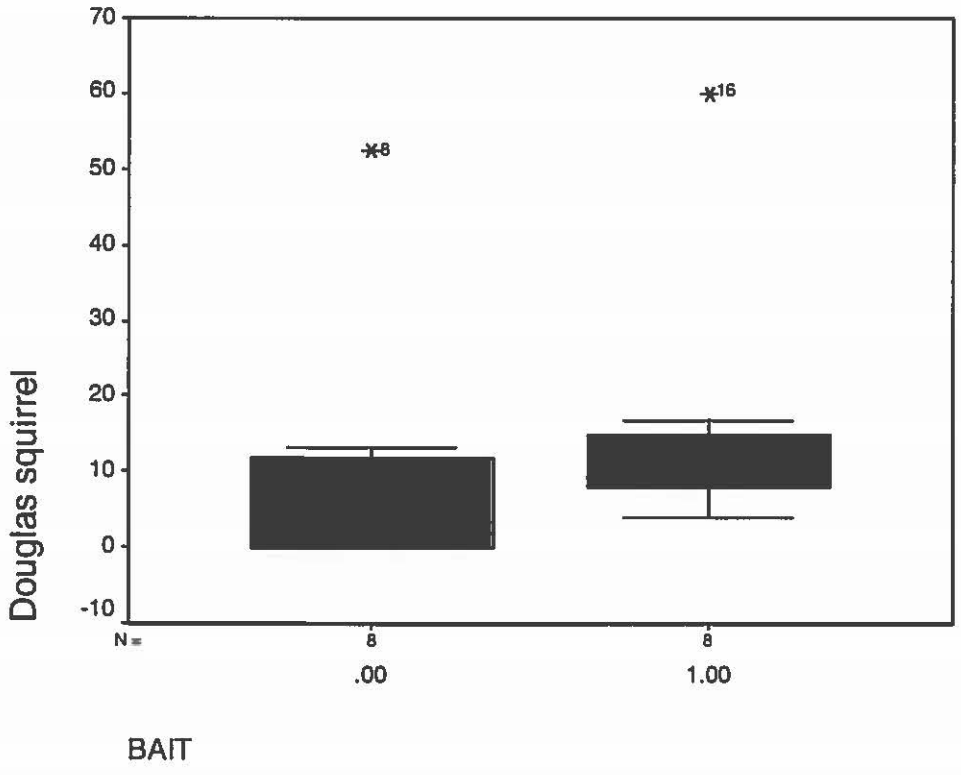


Fig 4a: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for small mammals across 21 active trap nights (U: 24 P-value: 0.397; Z: -1.187 P-value: 0.235)

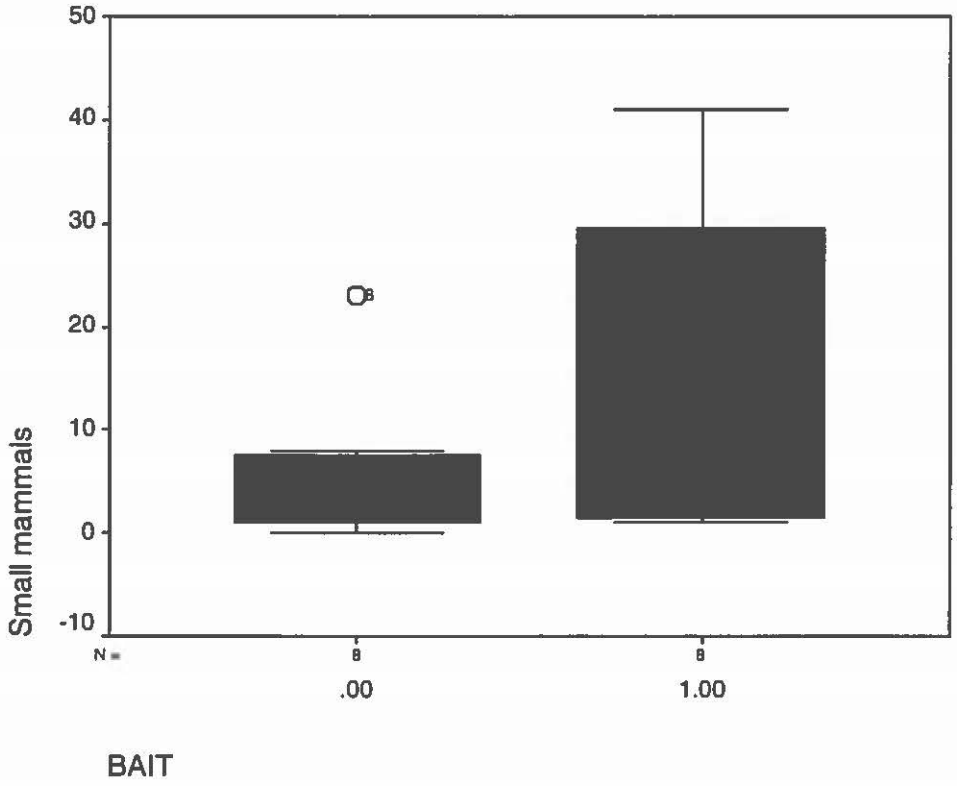


Fig 4b: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for small mammals across 100 active trap nights (U: 23 P-value: 0.345; Z: -2.24 P-value: 0.025)

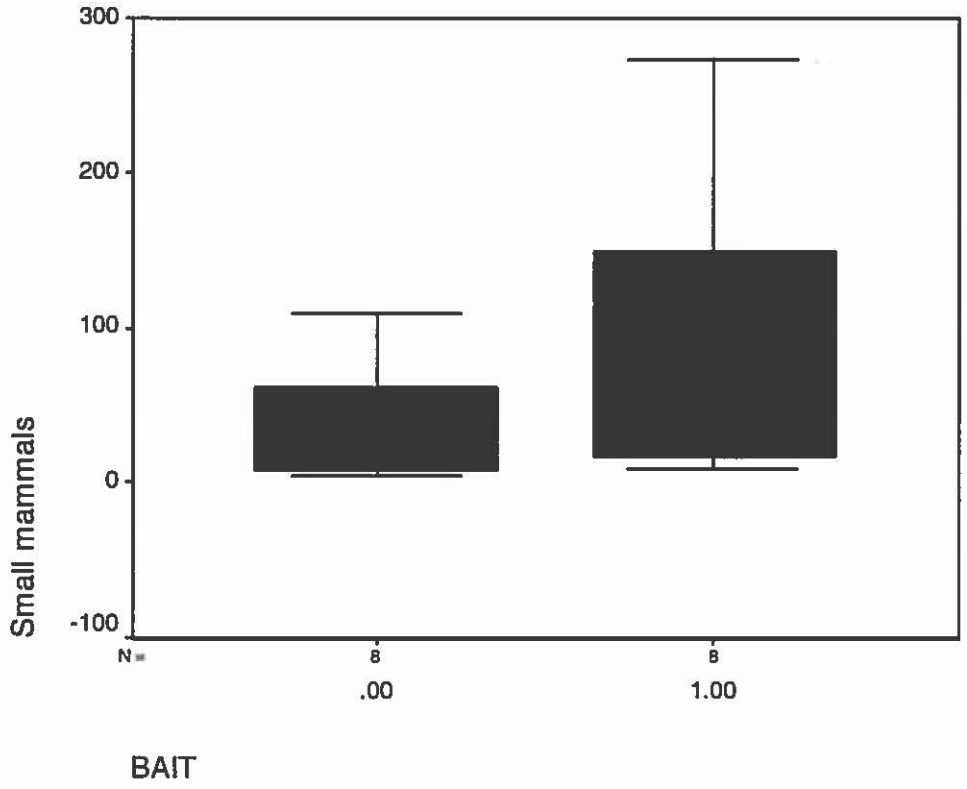


Fig 5a: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for black bear across 21 active trap nights (U: 21 P-value: 0.189; Z: N/A P-value: N/A)

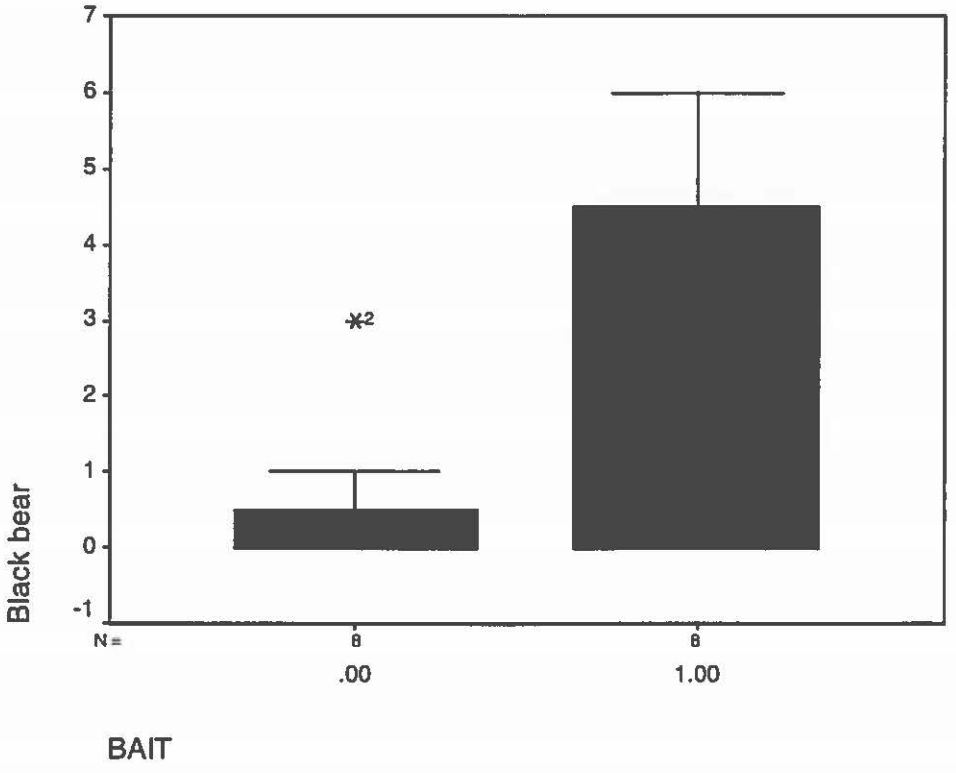


Fig 5b: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for black bear across 100 active trap nights (U: 16.5 P-value: 0.082; Z: -1.992 P-value: 0.046)

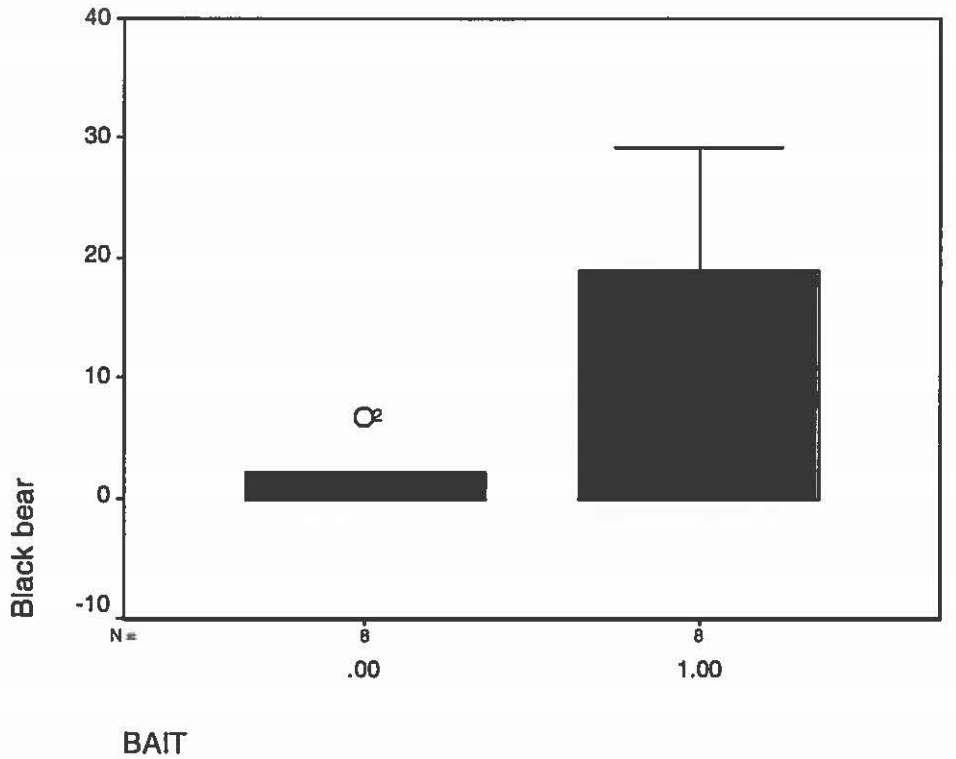


Fig 6a: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for American marten across 21 active trap nights (U: 14 P-value: 0.03; Z: N/A P-value: N/A)

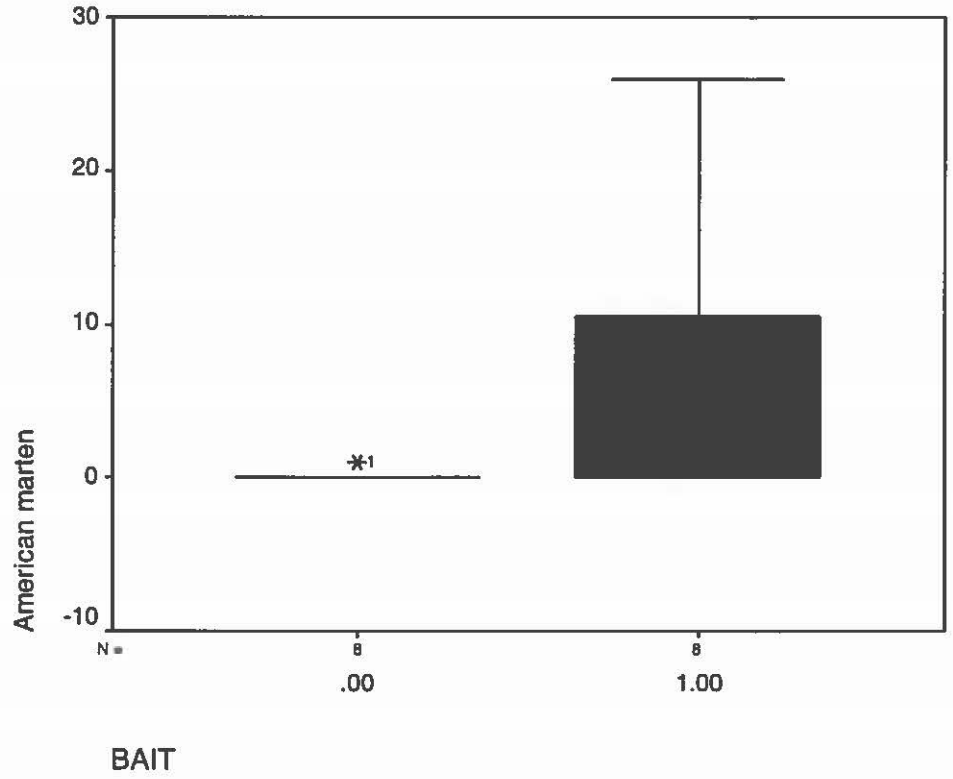


Fig 6b: Chart comparing differences in number of frames at baited (1) and un-baited (0) stations for American marten across 100 active trap nights (U: 14.5 P-value: 0.035; Z: N/A P-value: N/A)

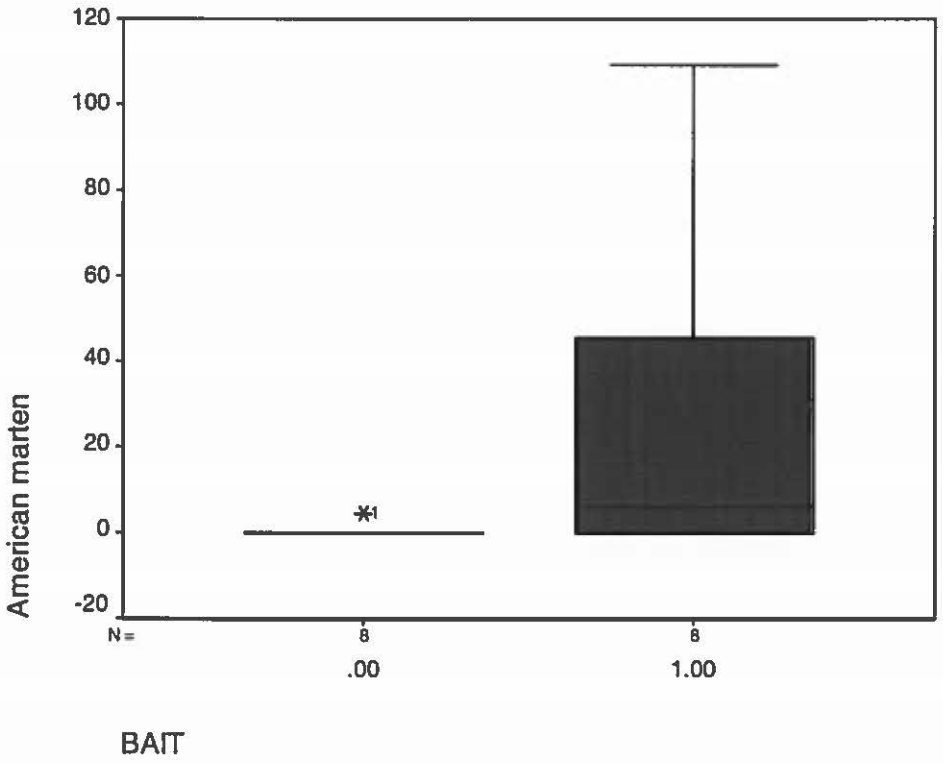


Fig 7a: Chart comparing differences in number of capures at baited (1) and un-baited (0) stations for large mammals across 21active trap nights (U: 10.5 P-value: 0.023; Z: -1.612 P-value: 0.107)

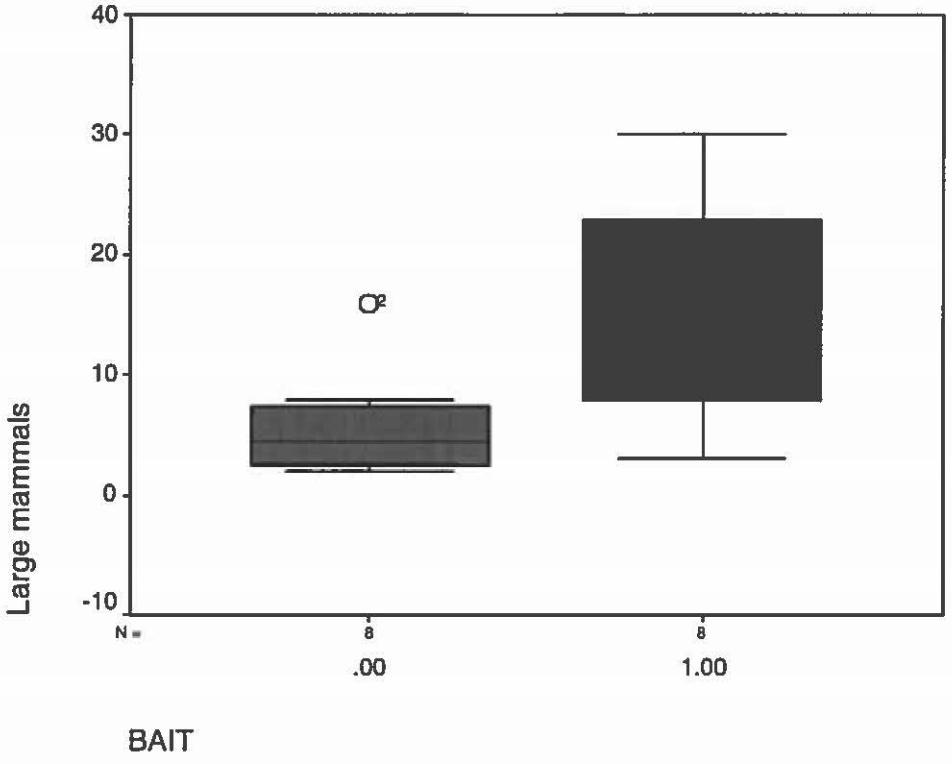


Fig 7b: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for large mammals across 100 active trap nights (U: 5 P-value: 0.005; Z: -2.1 P-value: 0. 036)

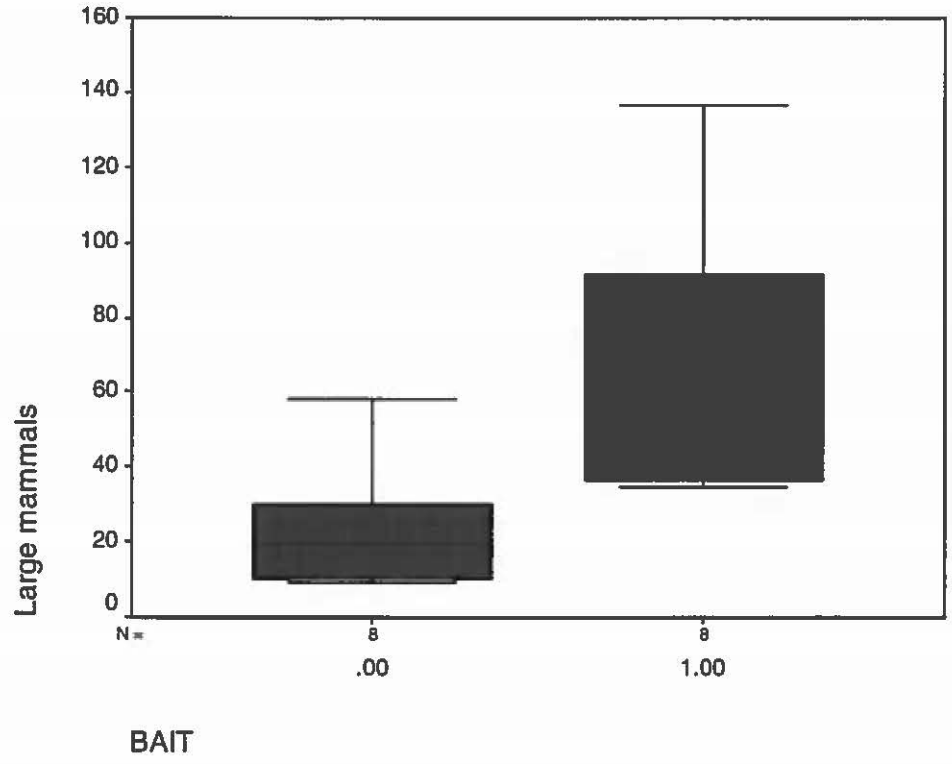


Fig 8a: Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for carnivores across 21 active trap nights (U: 5 P-value: 0.0029; Z: -2.366 P-value: 0.018)

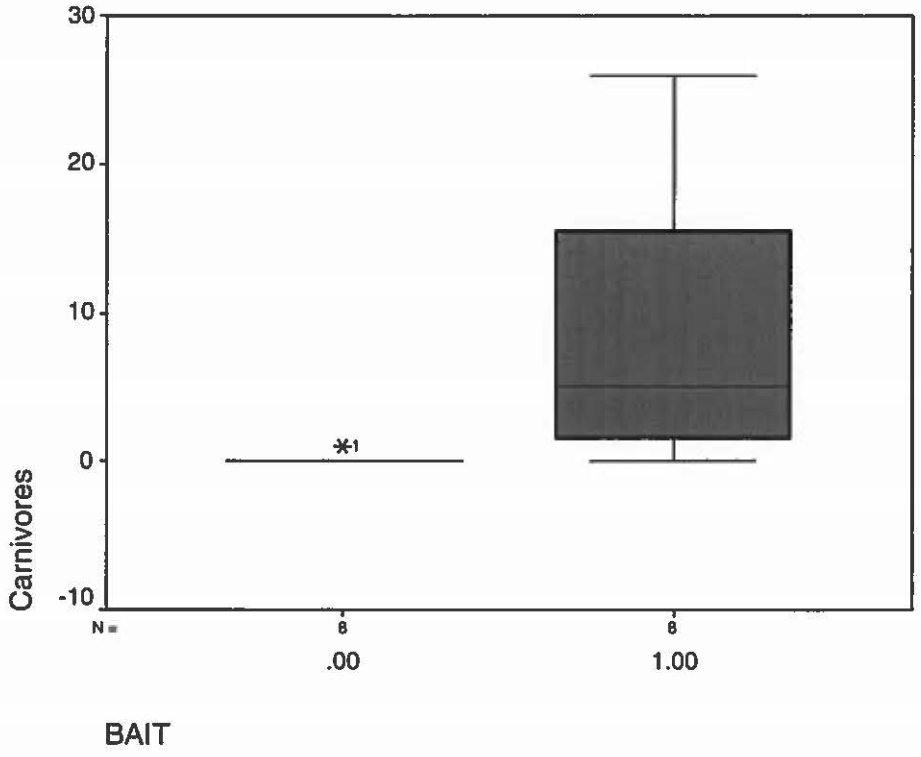


Fig 8b : Chart comparing differences in number of captures at baited (1) and un-baited (0) stations for carnivores across 100 active trap nights (U: 5 P-value: 0.0029; Z: -2.366 P-value: 0.018)

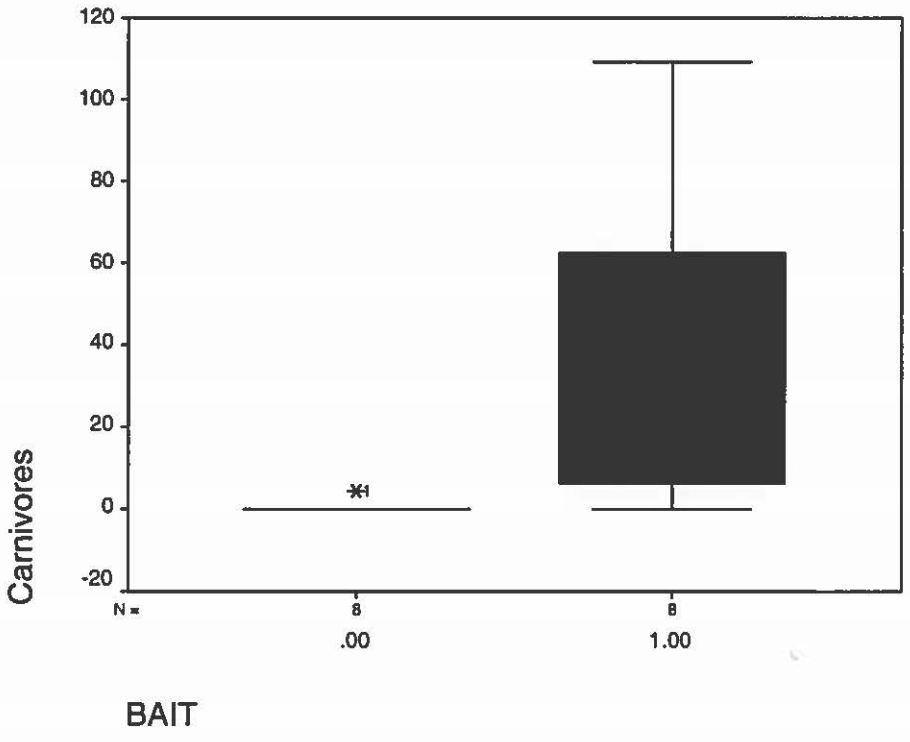


Fig 9a: Chart comparing differences in total number of captures at baited (1) and un-baited (0) stations for 21 active trap nights (U: 16 P-value: 0.092; Z: -2.375 P-value: 0. 018)

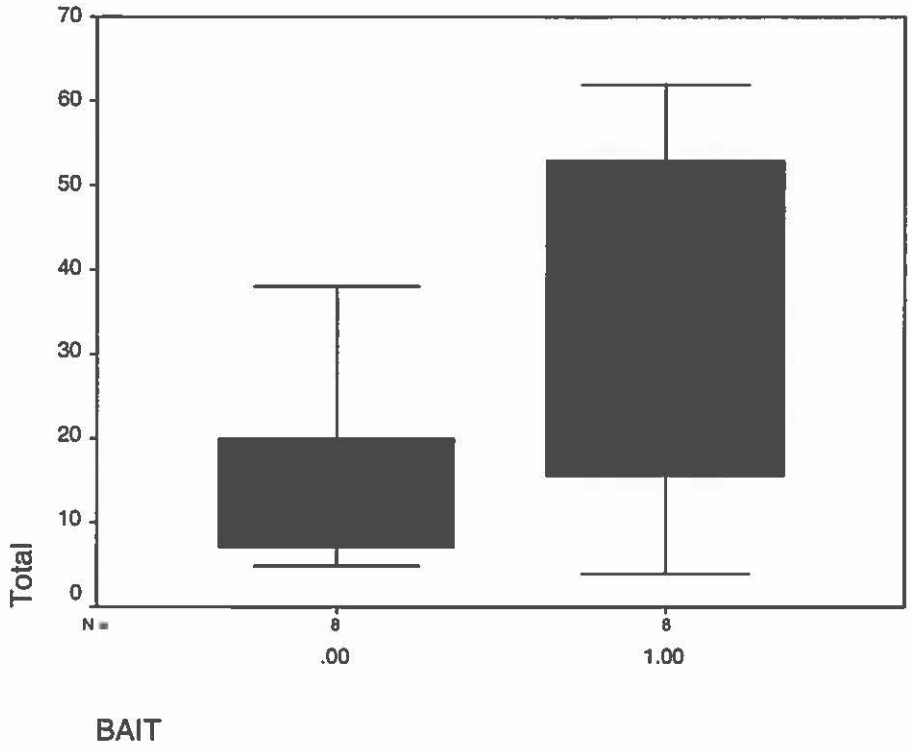


Fig 9b: Chart comparing differences in total number of captures at baited (1) and un-baited (0) stations for 21 active trap nights (U: 12 P-value: 0.036; Z: -2.1 P-value: 0. 036)

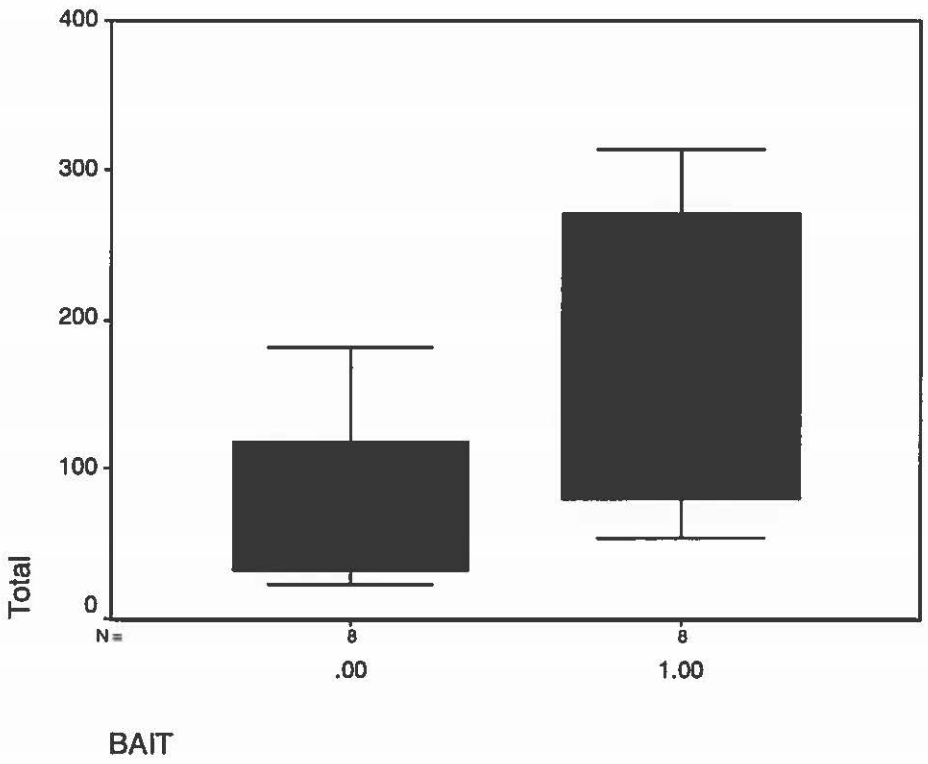


Fig 10a: Cumulative number of species recorded at un-baited stations across 21 active trap nights

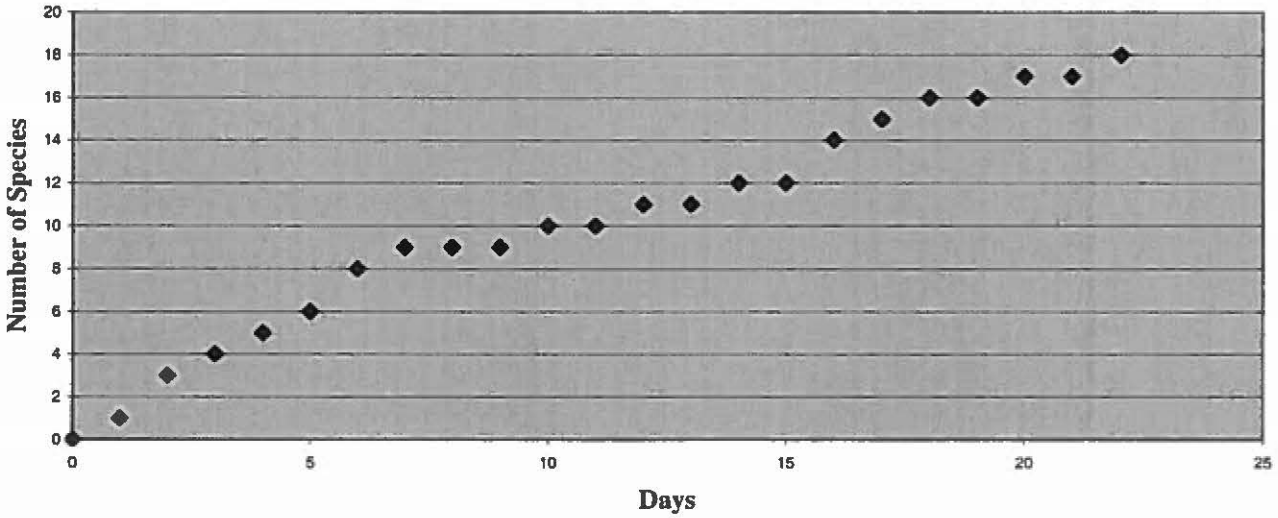


Table 8a: Table showing Spearman rank correlation between days and number of new species detected at un-baited stations

UN-BAITED			SPECIES
	DAYS	Correlation Coefficient	0.998
		P-value (2 tailed)	< 0.001
		N	23

Fig 10b: Cumulative number of species recorded at baited stations across 21 active trap nights

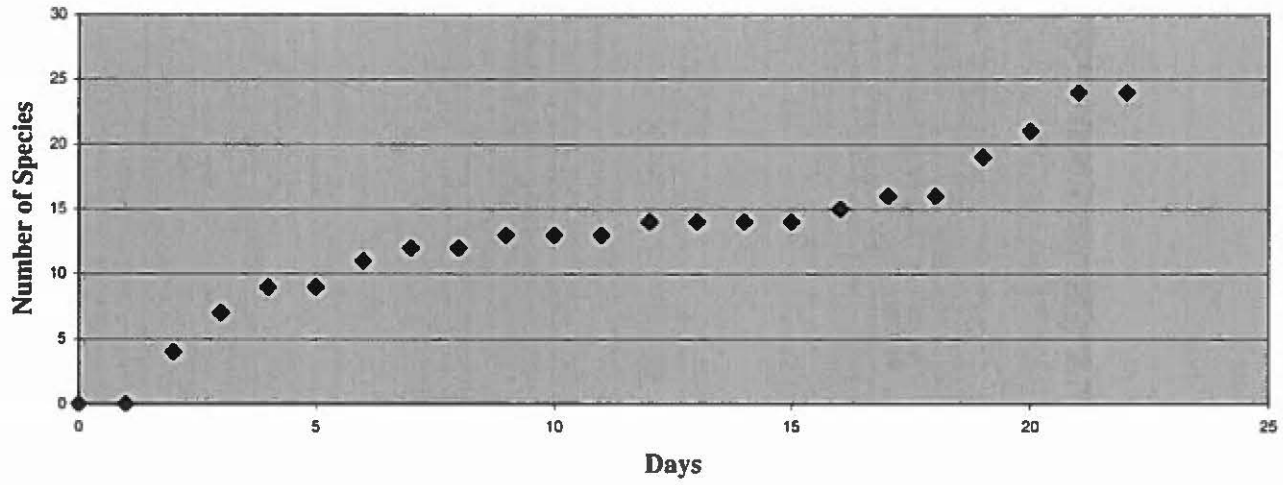


Table 8b: Table showing Spearman rank correlation between days and number of new species detected at baited stations

BAITED			SPECIES
	DAYS	Correlation Coefficient	0.995
		P-value (2-tailed)	< 0.001
		N	23

Fig 11a: Cumulative number of frames recorded at un-baited stations across 21 active trap nights

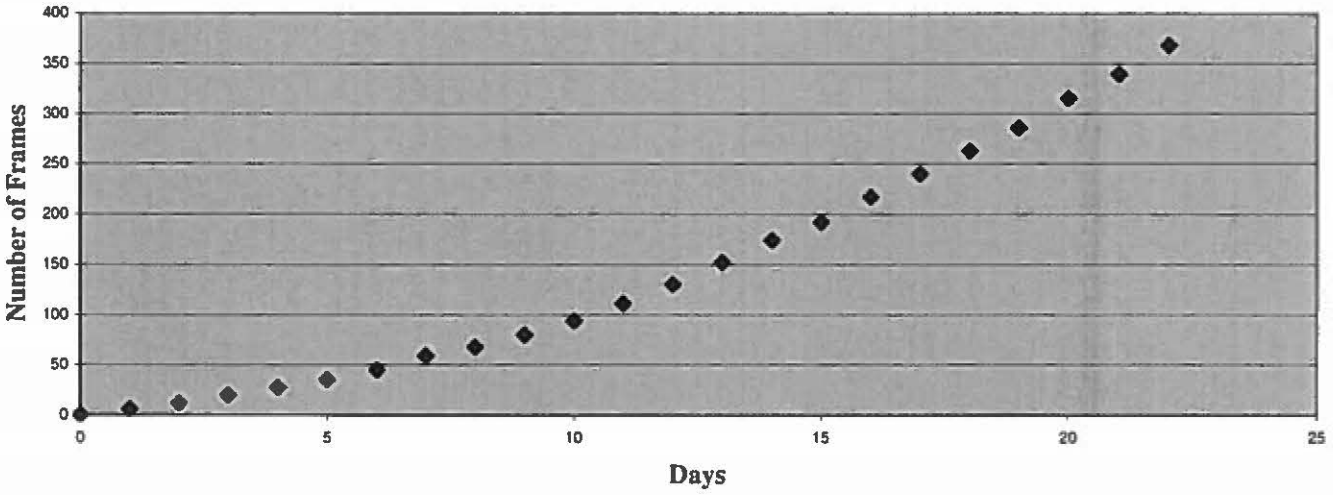


Table 9a: Table showing Spearman rank correlation between days and frames at un-baited stations

UN-BAITED			FRAMES
	DAYS	Correlation Coefficient	1
		P-value (2-tailed)	< 0.001
		N	23

Fig 11b: Cumulative number of frames recorded at baited stations across 21 active trap nights

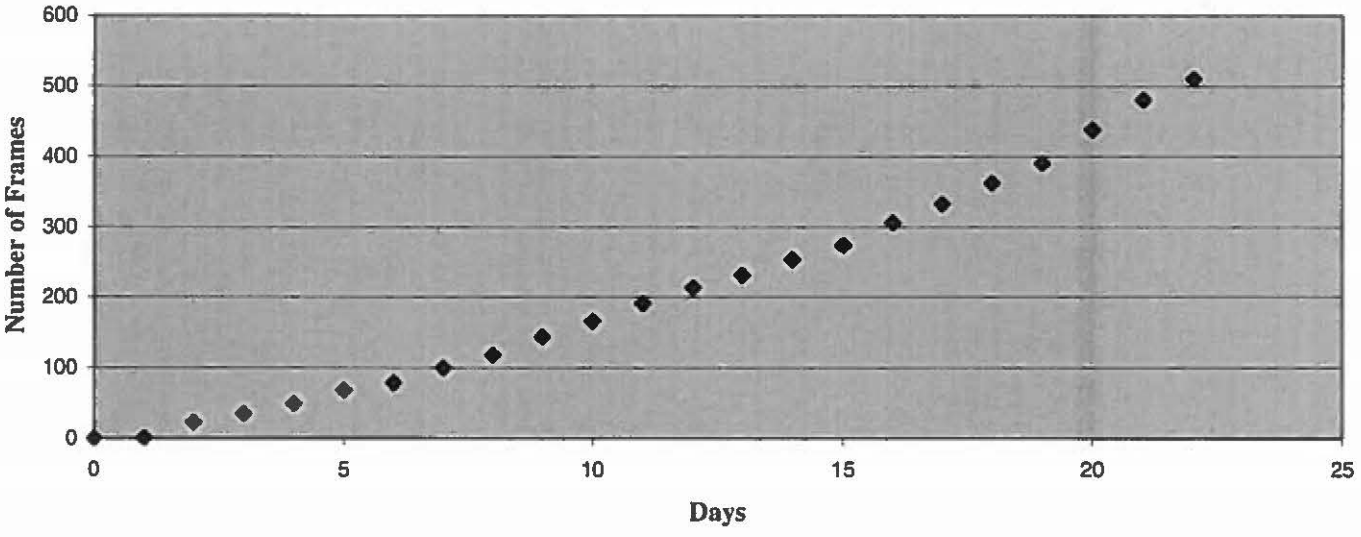


Table 9b: Table showing Spearman rank correlation between days and frames at baited stations

BAITED			FRAMES
	DAYS	Correlation Coefficient	1
		P-value (2-tailed)	< 0.001
		N	23

Fig 12: Graphs showing cumulative proportion of stations at which large mammals were detected

Fig 12a: Latency to first detection for large mammals across all stations

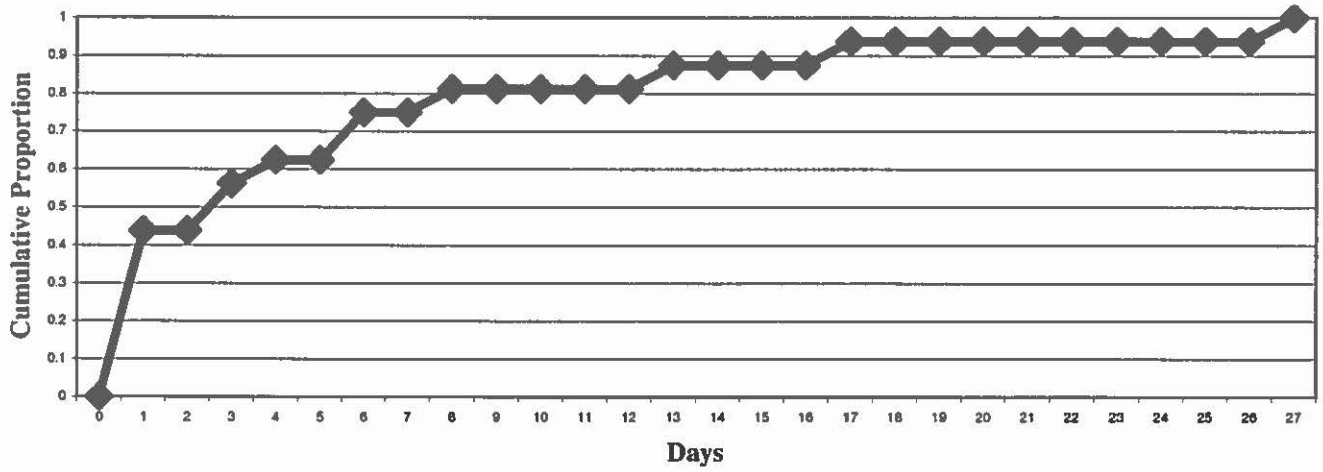


Fig 12b: Latency to first detection for large mamals across 8 un-baited stations

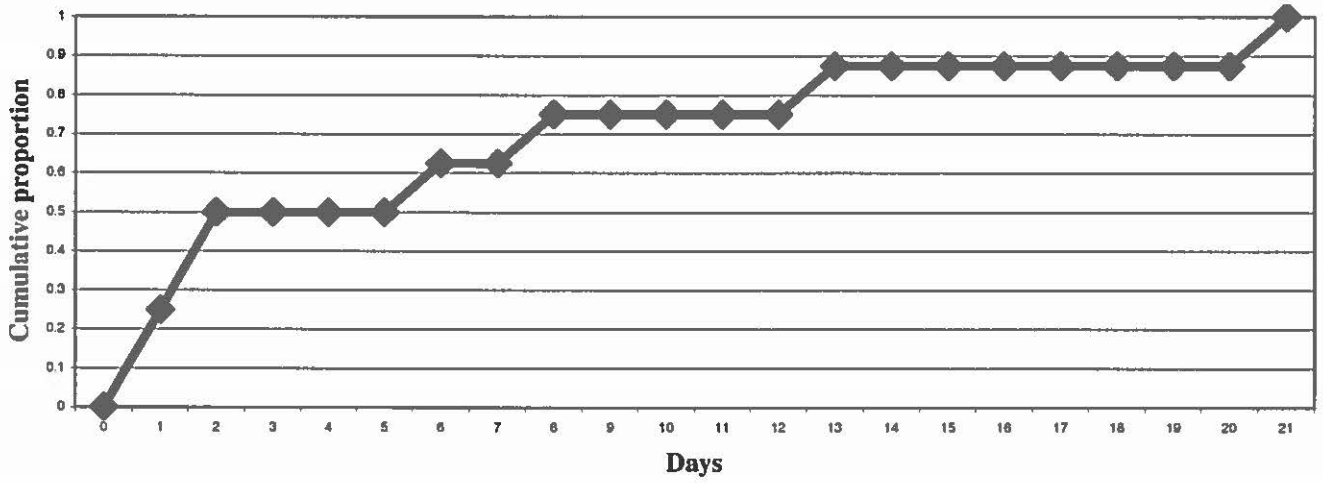


Fig 12c: Latency to first detection for large mamals across 8 baited stations

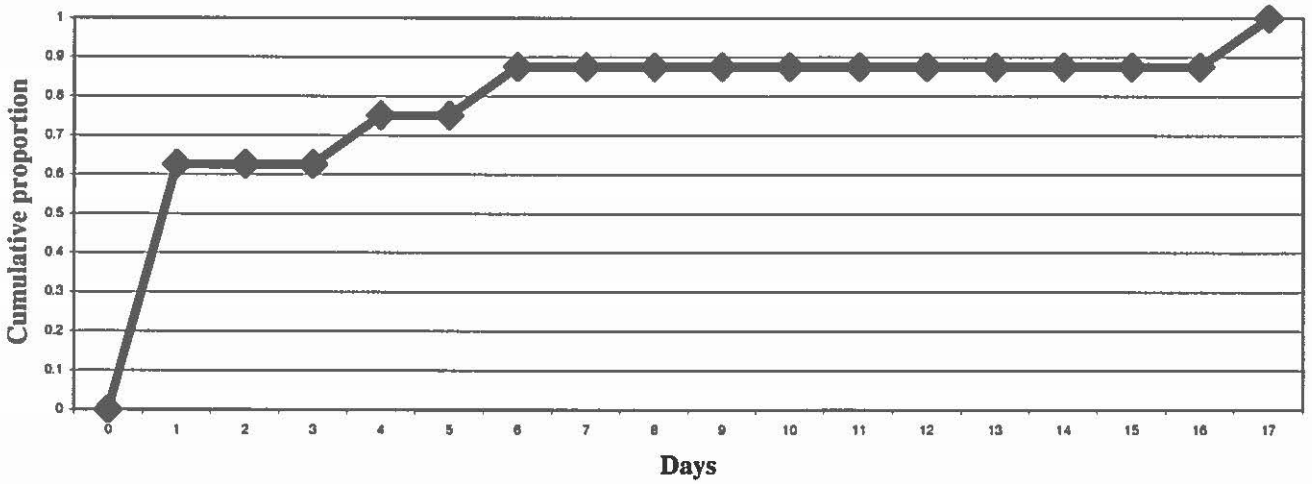


Fig 13: Graphs showing cumulative proportion of stations at which small mammals were detected

Fig13a: Latency to first detection for small mammals across all stations

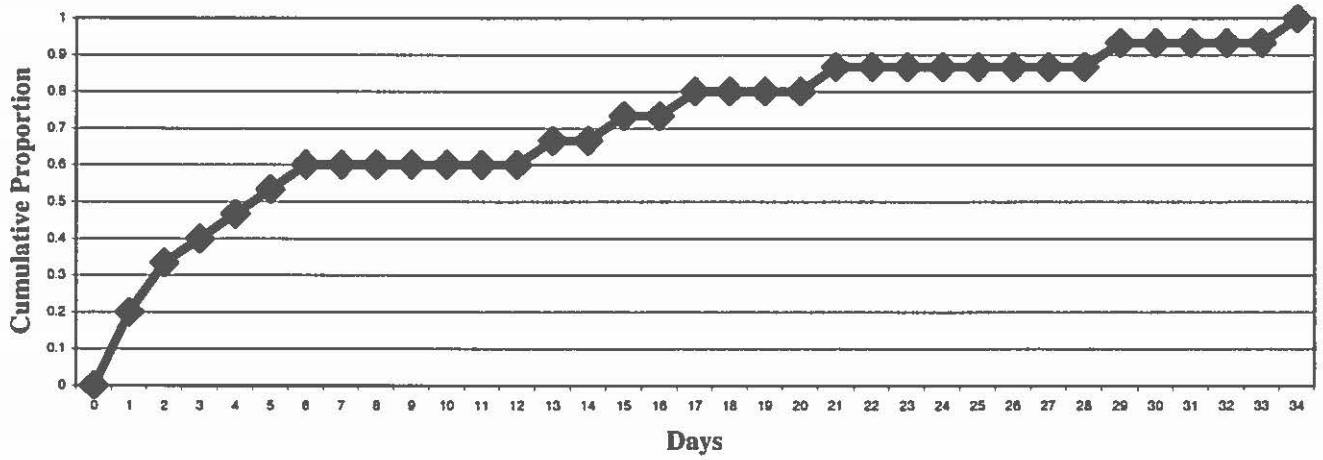


Fig13b: Latency to first detection for small mammals across 8 unbaited stations

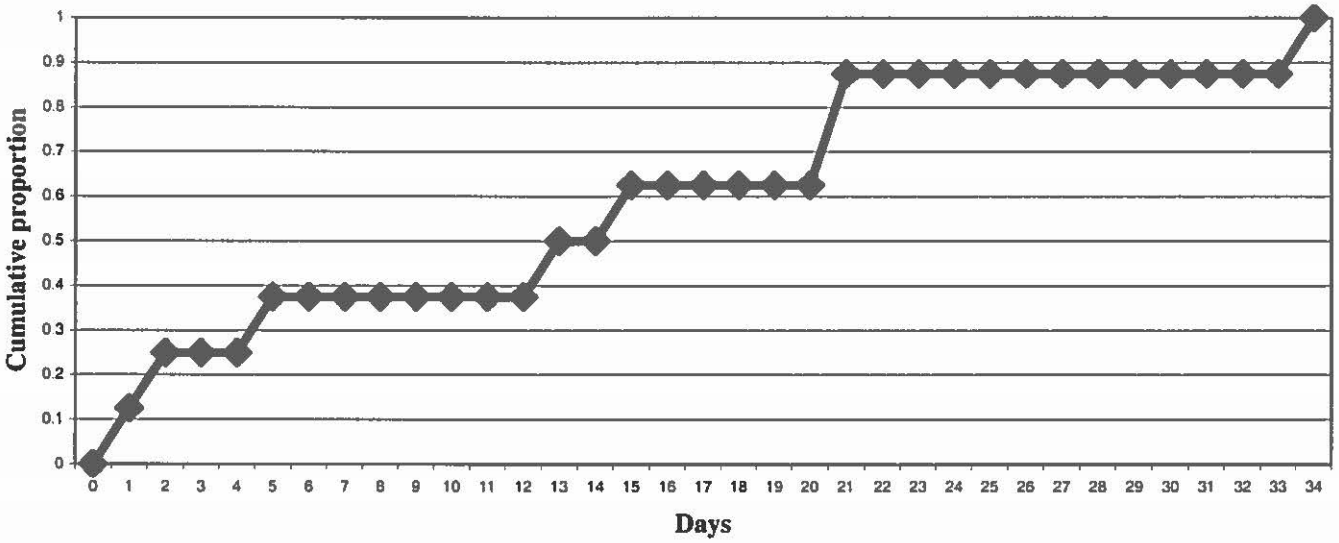


Fig13c: Latency to first detection for small mamals across 8 baited stations

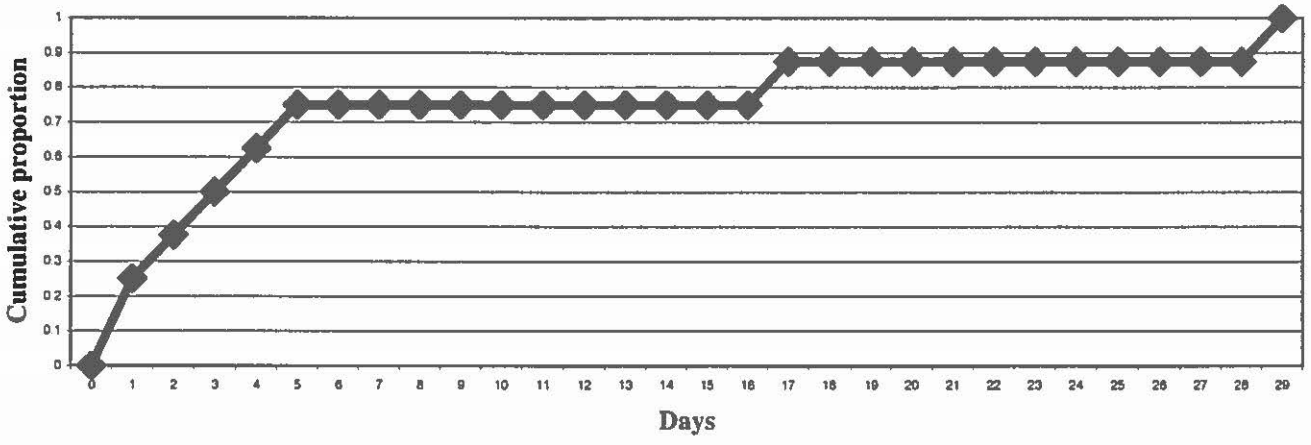


Fig 14: Graphs showing cumulative proportion of stations at which birds were detected

Fig14a: Latency to first detection for birds across all stations

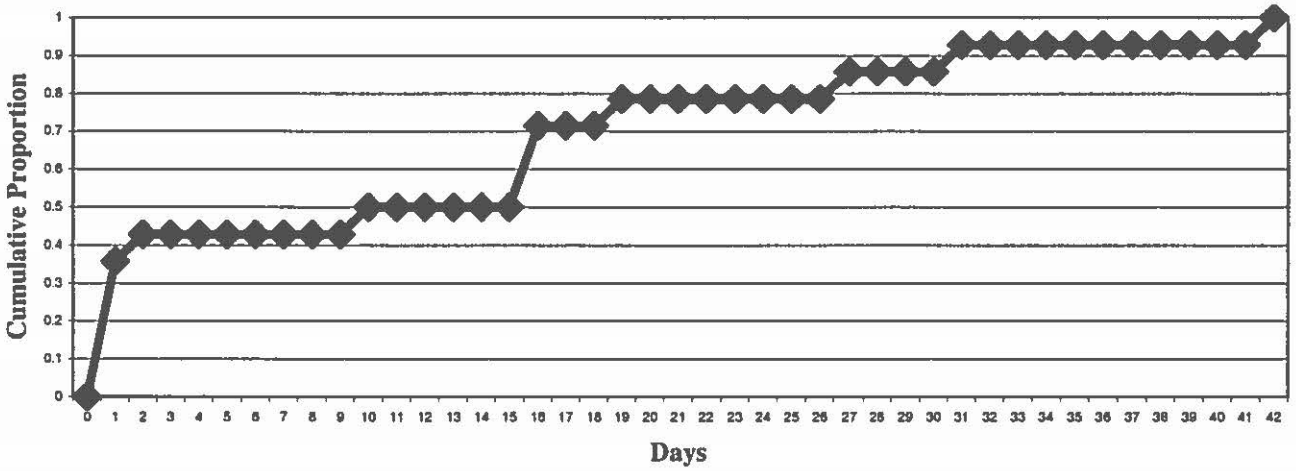


Fig14b: Latency to first detection for birds at 6 unbaited

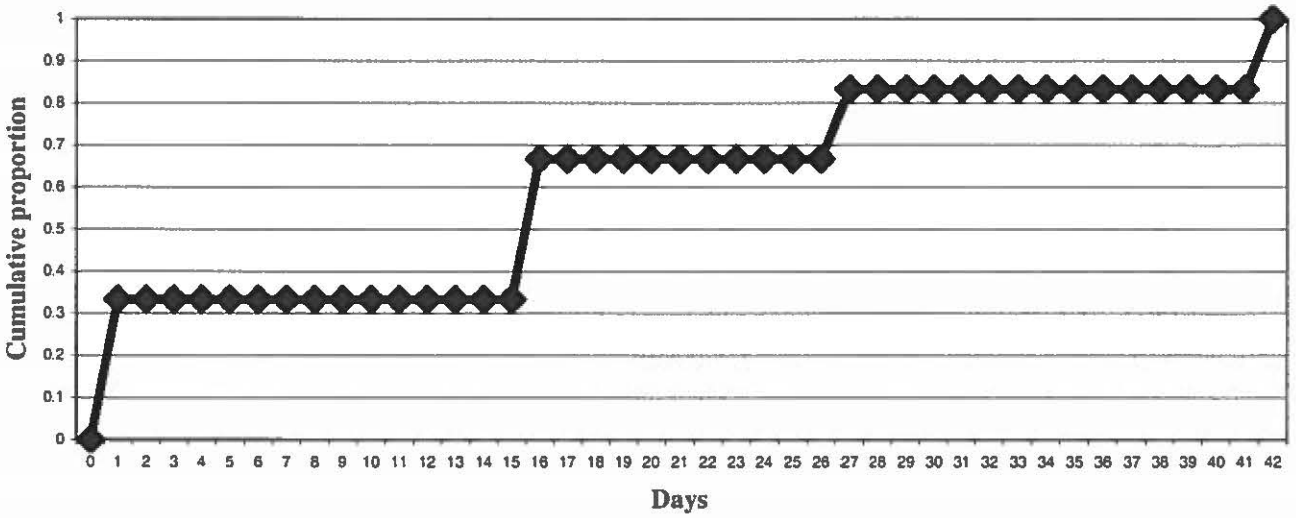


Fig 14c: Latency to first detection for birds at 8 baited stations

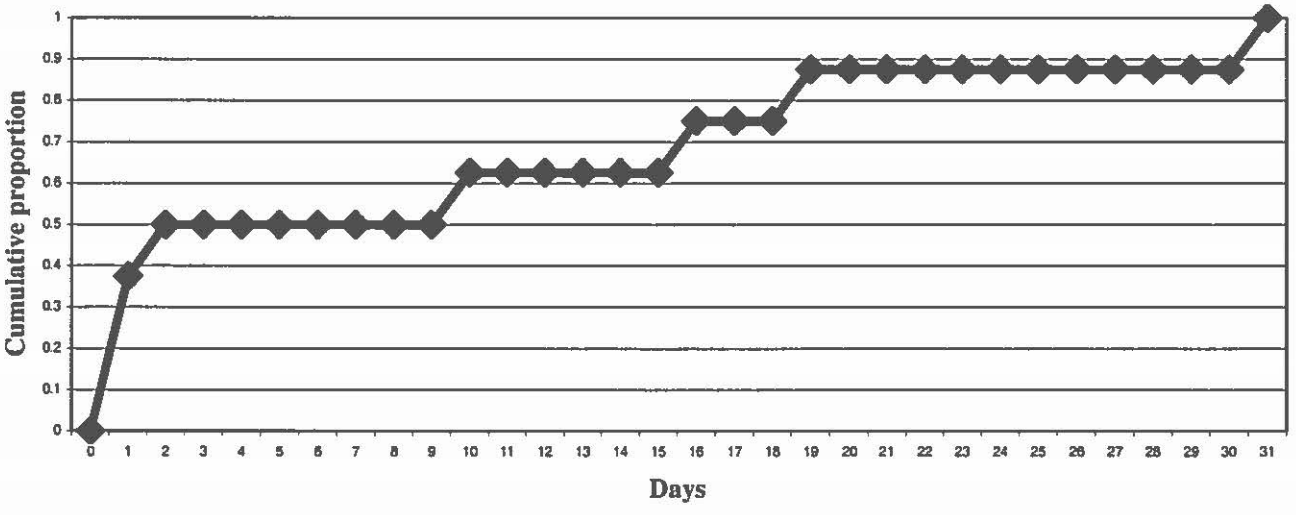
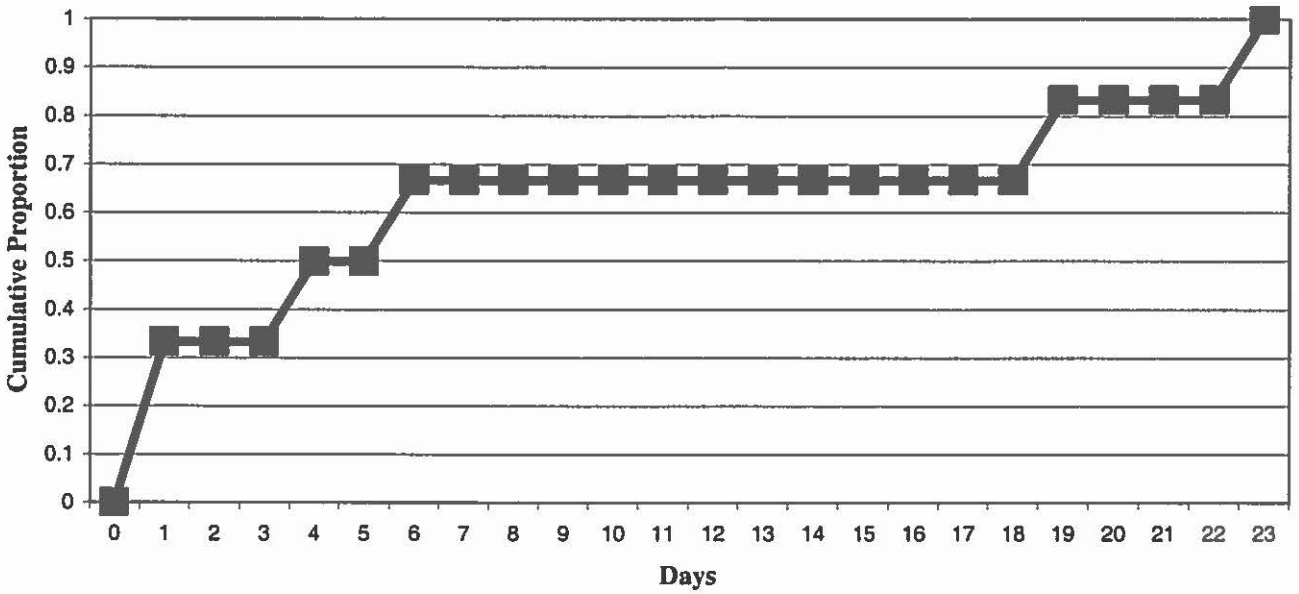


Fig15: Latency graph for American marten showing the cumulative proportion of stations at which they were detected. (recorded at 1 un-baited and 6 baited stations)



DISCUSSION

Eight pairs of TM 500 camera traps were established throughout LVNP to detect medium to large mammals in conjunction with the park's mammal survey programme. Only half of these traps were baited, in an attempt to test the effect of adding bait and lures on several variable functions of the Trailmaster® system, including frequency of detections, number of species detected, efficiency of the system and latency to first detection.

Frequency of detections and presence-absence applications

The addition of bait and lures clearly enhanced the frequency of detections by the TM 500 system. It may seem self-evident that incorporating attractants into such a trapping method will lead to increased capture rates. However, the ramifications of this finding are significant. In general, it can no longer be assumed that the act of baiting does not affect the data a camera station produces. For example, if the system is used to assess activity of a certain species, by incorporating bait the researcher may alter activity patterns or increase sample size. Sequin (2000) showed both these effects to occur when describing activity patterns of kangaroo rats (*Dipodomys sp.*).

Marten and the carnivore subgroup responded positively to bait and lures. The fact that all the other species recorded did not register significantly higher capture rates at baited stations, suggests that bait does not greatly affect the frequency of detection for these species. However, this must be interpreted with caution, as all mammal species with the exception of mule deer registered a higher proportion of captures at baited stations. Thus it may simply be small sample size that prevented any significant differences from becoming apparent due to the low power of the test.

The bait applied was largely a carnivore attractant, which may have deterred certain species. Fox urine and commercial stink may have indicated to herbivorous species that predators were nearby, thereby lowering the level of their detection at baited stations[1]. A total of 6 vertebrate species registered higher detections at un-baited stations, of these mule deer was the only mammal. However, since none of

[1] This problem could only have been overcome if different baits had been applied at separate stations; needless to say this would have greatly increased cost.

these differences were significant, not much can be concluded, but further study in this area may yield interesting results.

Since individuals were not identified, the differences seen in the frequency of detections between the 2 treatments may not reflect differences in abundance. This could only have been achieved if 1) individuals could have been differentiated by pelage e.g. bobcat spots, and thereby applied a Mark-Recapture model (e.g. Bowden's estimator), or 2) some form of index had been created that could be shown to correlate with an increase in abundance. For this reason the above argument has focused purely on the frequency of detections registered in the 2 treatments.

More useful information may be gained from the presence-absence data that this study yielded. A fundamental element in this study's design was to pair the stations. This would allow for a detection at a particular station to be causally linked to the type of treatment present. Coyote, bobcat, SNRF and grey fox were the only mammals detected exclusively at baited stations. All these species are carnivores and have home ranges that greatly exceed the distance between the paired camera traps, implying that these species were 'present' at both treatments but chose to visit only the baited stations. This finding has significant ramifications for one of the most popular uses of camera traps, that is inventorying specific habitats (Cutler et al. 1999). It suggests that when camera traps are applied as part of an inventory protocol, they may miss certain species, particularly carnivores, if bait is not applied.

A finding of equal importance is that baited stations detected significantly more species that un-baited stations. So here again, to effectively use camera traps for inventories, they should incorporate bait or else certain species may not be accounted for. This is reinforced by the fact that baited stations not only recorded 93 percent of species that un-baited stations did, but also detected 11 species exclusively whereas un-baited only detected 2 exclusively. This last finding suggests that if a study is constrained by cost it would be better to apply a baited treatment as it is likely to miss fewer species, particularly carnivores[2].

Two bird species, mountain quail and northern flicker, occurred exclusively at un-baited stations. Following through with the same argument, it could be said that these species actively chose the un-baited stations. However, I would argue that it is more reasonable to assume that they were deterred from the baited station. This

[2] Appendix 7 shows that for most stations, baited traps detected the same species as un-baited traps but aditionaly detected carnivores.

implies that if an inventory system incorporates bait as a single treatment it too may miss detecting certain species, particularly birds. Hence it can be concluded that if Trailmaster® systems are to be applied to any inventory protocol, for all species within an area to be adequately accounted for, it is likely that both treatments should be applied, with several different types of bait incorporated at separate stations. An alternative would be to start with no bait, then switch to bait for herbivores (alfalfa, apples etc), then to bait for carnivores.

However, it may be argued that it is erroneous to assume that an absence at one station and detection at another resulted from choice by the animal as a result of the type of treatment present. If an animal is extremely rare or at low density it may just be chance that it occurred at one station and not at the other, i.e. the assumption that the species is 'present' at both treatments is wrong. This may hold true particularly for bird species which occurred only at un-baited stations, as there is no biological reason for them to have occurred at the un-baited stations. One way in which causality could be shown is if the treatments had been switched back and forth after a certain time (Morrison et al. 2001). If a certain species was still only recorded at one treatment it would imply that the species was making a choice.

Understanding the above, the question may then arise: why have numerous studies incorporating TM camera traps not apply bait (Karanth, 1998; and Seydack 1984) including the established monitoring program at LVNP? At LVNP it was thought that bait may actively draw-in animals from adjacent habitats. Hence, it was reasoned that un-baited cameras would be more representative[3]. Although this was not directly proven by this study, the potential danger of bait drawing in individuals from adjacent areas may be a significant concern limiting its application in studies of habitat preference.

Efficiency and latency

The increase in the frequency of detections and number of species recorded at baited stations did not significantly increase the ratio of captures to total frames taken by the cameras, nor did it increase the number of nights active per field night, i.e. it did not increase this measure of efficiency. Intuitively, bait attracts individuals to the

[3] Personal Communication, John F. Arnold. Senior Park Biologist (Jonathan_arnold@nps.gov)

centre of the camera's field of view, thereby increasing the likelihood of accurate identification and lowering the probability of drop photographs. However, this did not occur, suggesting that, given this definition of efficiency, the incorporation of bait into a monitoring protocol to increase the return on the level of effort applied is a redundant activity. However, baited stations did record significantly more captures per active trap night than un-baited stations. These findings are fairly predictable in that since baited cameras recorded significantly more captures, they were more likely to have shot through the entire roll of film before they were checked. It is also more likely that a more active trap will drain the camera or sensors batteries faster than a less active camera[4]. This implies that baited stations will have to be checked more regularly than un-baited stations.

An additional area of interest was to see if bait and lures affected the time to detection of any species (i.e. shortened the latency to detection). As this study was constrained by small sample size, this analysis could only be carried out on 2 subgroups of vertebrates: large and small mammals and birds. All 8 baited stations detected large mammals 4 days earlier than un-baited stations. Similarly, for small mammals, baited stations all recorded detections at least 5 days before un-baited stations had. Thus, bait lessens the length of time required to sample small or large mammals. Given this definition of efficiency, baiting can enhance the efficiency of camera traps. In effect it will cut down on costs by reducing the length of time a camera must be left in the field.

Another interesting finding that these curves demonstrate is that just under 90 percent of all the stations that are going to detect large mammals have detected them by day 17. In other words, for each additional day the traps are left in the field after day 17, the return[5] per day is significantly lower than that before day 17. Although a similar trend can be seen for the small mammals it was not as definitive, with the 90 percent level only being attained by day 29, after which it increased by the final 10 percent just 3 days later. Hence, when monitoring large mammals and applying the methods used in this study, 17 days will generally suffice. For the smaller mammals a similar decline in new detections will be noted after about 2 weeks. However, since

[4] Here it may not be evident that an inactive camera (resulting from film depletion) can still drain sensor and camera batteries, as animal activity will still close the electric circuit, causing the receiver, flash and shutter to be activated.

[5] Here return can be defined as the number of stations receiving their first detection of a certain species.

no true asymptote is reached, it may be the case that additional days even after day 34 may lead to relatively good returns per additional field day.

The same form of analysis can be applied to the 2 species the park hoped to gain information on through this study, American marten and SNRF.
American marten is a California state species of special concern and is often heralded as a flagship of forest health and biodiversity. Studies done by Foresman et al. (1998) showed that camera traps should be left out in the field for at least 28 days for a survey to 'adequately' account for marten. However, in this study 65 percent of the stations that were going to detect marten over the survey period, had detected them by day 6, suggesting a low return after this date. This is assuming that exactly the same methodology is applied. However, the fact that only 1 marten was ever detected at an un-baited station, and that the level of detection at baited stations was significantly higher, suggests that it may be better to apply bait as a single treatment if the aim is purely to detect marten. The reason why the park has not applied bait to their stations in the past is because of the aforementioned danger seen with drawing in individuals from adjacent habitat.

SNRF was the other species the park wanted to gain information on. The latency curve for this species is very different from that of marten; it never reached an asymptote, suggesting that a longer time period may yield good returns. However only 1 camera (a baited station) detected SNRF and this occurred within 24 hours of the camera's establishment. Hence it may be that the species is simply extremely rare, which would imply that that greater trap field time may not result in increased new detections at other stations.

The Trailmaster® system

Many of the known advantages of TM systems have been demonstrated by this study. It operated successfully for several consecutive days in remote locations under a variety of field conditions and in several different habitat types, independent of observer supervision. Over the 2-month study period, the camera traps successfully detected 30 different species, and yielded 78 high quality photographs. These photographs could be cross checked by professionals and stored as long-term records. The establishment and maintenace of the traps required minimal staff

training, and at no time required more than 2 individuals to ensure the smooth running of all 16-camera stations across the entire park.

The TM system was also one of the least invasive of the vertebrate monitoring methods that the park had at its disposal, which included live trapping, radio telemetry, and mist-netting. These require capture and handling of animals, which can cause stress and damage to individuals. Such stress can lead to reactivation of latent viruses through immunosuppression (Burrows et al. 1994), a problem not faced with TM systems.

This study also illustrated several drawbacks of these systems. From the previous discussion it was noted that baited stations had to be checked more regularly than un-baited stations which could limit their application to more accessible areas. This is particularly true when applying heavy baits, like those used to census large carnivores (Mace et al. 1994), where transport over long distances is impractical. Hence if TM camera traps are to operate successfully and yield representative data (on certain species), their application may be limited to accessible locations.

Another problem associated with the portability of these systems is that of theft, which, in this case, lead to financial losses and loss of important data[6]. This can be minimized by relying on GPS units to locate stations rather than flagging. Also the equipment can be attached several meters from the ground. However, this may again limit the remote placement of these systems as checks and repairs will require the transportation of ladders or other climbing aids into the field.

In terms of the efficiency, 2 problem areas were encountered. The first was the 'false' triggering of the system through direct exposure, or reflection of solar radiation onto the sensor window. Thus photographs were taken when no animal activity occurred. This was a particular problem when cameras were facing directly over snow[7], or when physical conditions, such as slope and tree position, prevented cameras from facing due north. This can be circumvented to some degree by switching the system off during hours of the day when this problem occurred. However, this may lead to biases. The second efficiency problem was the delay in information feed back due to the development time required for camera films. Hence,

[6] S2-02 was stolen between the 24th June and 1st of July; approximated replacement cost was $600.
[7] This problem is particular to TM 500s, the problems of reflection are significantly less when using TM 1500 systems.

a problem (e.g. flash flare or missing time date stamp) would only be corrected at a station several days after it had occurred.

Although the TM 500 system is heralded as one of the most versatile systems, capable of surveying for a broad range of species, it can be seen from Appendix 6 that many vertebrates known to occur in LVNP were not detected using this technique. Some of these species might be accounted for by applying specific baits e.g. deer quarters for mountain lion. However, there are still certain species which have specific feeding and behavioural patterns that would prevent their detection by camera traps, e.g. bats[8].

Although significantly less invasive than other monitoring methods, it is evident that they are not utterly non-invasive. The flash, sound of the shutter and the presence of human scent may all contribute to eliciting a trap response in vertebrates, i.e. that their behaviour is altered by the presence of the systems, possibly leading to unrepresentative findings. Some species were visibly startled e.g. coyotes (Appendix 8) and others were overly curious e.g. black bear (see front cover). This last finding lead to a further problem: damage to the equipment by animals. Over 10 connection cables were gnawed through by rodents and 2 cameras where knocked out of place and damaged by bears.

The application of standard indices and statistics

This study employed two statistical tools to analyse raw data produced by TM 500 camera traps. The WMPSRT is the more powerful and reliable of these two tests, since it is more likely to detect a true difference between a pair than the Mann-Whitney U test (MWU). This fact limits the possibility of Type I errors and hence the results that this test yields was preferred over MWU test results in this discussion. However, this project, like many ecological studies, was constrained by small sample size, which resulted in a restricted proportion of the available samples being analysed using this technique. Hence, when sample size was too small, the results of the MWU test have been employed.

Of the 30 vertebrate species recorded in this study, only 1 was detected significantly more at baited than at un-baited stations. This species was the American

[8] These species could only be detected if traps were established at rousting sites which would likely restrict the sample to these species alone.

marten (*Martes americana)*. Furthermore, since over 20 tests were run, it is possible that significant difference occurred simply by chance[9]. However, I do not feel that it should be concluded that bait has no significant effect on any other species, rather that the sample size was not large enough for differences to emerge significant as discussed above.

To try and minimize this problem of small sample size, the data were converted to a per trap night basis and then projected to a standard 100 trap night index, which allowed the entire data set to be utilized. Such methods have traditionally been employed when sample sizes varied (Carbone et al. 2001). However, TM 500 systems yield a "catch-per-unit-effort" index and any such index may be biased to the extent effort is not consistent (Morrison et al. 2001). This bias is not realized if the rate of detections per day is constant over the duration of the sample period or if the difference in the level of effort between stations is small.

It can be seen from Figures 11a and 11b that the number of detections per day was not constant over time, but increasing, i.e. the capture rate per day increased the longer traps were left in operation.It can also be seen from Appendix 2, that the effort level varied widely from station to station. Hence, it can be concluded that the use of an index for comparisons of number of captures between baited and un-baited stations is likely to yield unrepresentative results.

However, this is not the case when comparing the number of species recorded between the two treatments. Here the trend is opposite to that of total captures, i.e. the longer traps were left out in the field, the lower the number of new species per day they detected. However, as can be seen from Figures 10a and 10b this change is far less pronounced than the change seen in the number of captures, suggesting that the use of a standard index is more reliable when comparing differences in species numbers between treatments, than it is for comparing differences in captures.

Also evident from a comparison of Figures 11a and 11b is that although the 2 curves have a broadly similar shape, they do not display the same rate of change; the increase in the number of captures per night is greater at baited stations than for un-baited stations. This was because baited stations detected more carnivores than un-baited stations. Carnivores, by constraint of their trophic position, occur at lower densities than herbivores; hence it takes un-baited camera traps longer to detect this

[9] One way in which future research could avoid this danger is by applying the Bonferroni procedure where the alpha level would be divided by the number of tests to yield a smaller significance threshold.

group of animals. This same increase is observed for the number of new species detected by baited stations. Here, baited stations from day 2 detected more new species per day than un-baited stations.

CONCLUSION

This study has shown that the use of attractants can significantly alter several functions of the Trailmaster® camera trapping system. The detection of American marten (*Martes americana*) and the subgroup carnivores, can be significantly increased when the stated bait and lures are incorporated. Also, a greater number of species will be detected by applying these attractants. Moreover, it is clear that attractants allowed for the detection of most species that un-baited treatments registered, but additionally detected carnivorous species that this treatment missed.

Attractants enhanced certain efficiency measures of camera traps, in that they significantly increased the number of captures per active night and decreased the time to first detection of certain species. These attributes generally argue in favour of the use of attractants, particularly carnivore attractants. However, this study has also highlighted the fact that bait may introduce significant biases through its possible draw-in or deterring effects.

This study could be expanded to gain more conclusive results. A larger array of paired cameras over a significantly longer time period may have allowed for trends and differences to become apparent that are currently equivocal due to small sample size. It would also allow for the use of more powerful statistical tools leading to more representative conclusions.

Two major changes in study design that would allow for the effect of bait to be more definitively assessed include: 1) Use of mark recapture techniques as this would allow (through the use of models) an increase in detections to be related to abundance at a specific treatment. 2) Switching the 2 treatments over after a certain time period, as this would allow for possible confounding variables to be minimized and thus causality to be more accurately determined. The use of several different baits at different stations would have shown if certain baits deter specific species and if a combination of baits would allow for the most thorough accounting of individuals present in an area.

Finally, it would be interesting to carry out the research in winter when food sources may be significantly more scares and hence the application of bait have a more pronounced effect.

In conclusion, it can be stated that attractants should not simply be viewed as necessary components of trapping systems, but rather as important and possibly confounding variables that require careful consideration before their application. Additional research is warranted to clarify the effects of a variety of baits on a wider range of species.

LITERATURE CITED

AIROLA, D.A. 1998. Guide to the California Wildlife Habitat Relationships System. California Department of Fish and Game, Rancho Cordova, CA.

BOOKHOUT, T.A. 1994. Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, MD.

BULL, E.L., R.S. HOLTHAUSEN AND L.R. BRIGHT. 1992. Comparison of 3 techniques to monitor marten. Wildlife Society Bulletin 20:406-410

BURROWS R.B., H. HOFER AND M.L. EAST. 1994. Demography, extinction and intervention in a small population: the case of the Serengeti wild dogs. Proc. R. Soc. London 256:281-292.

CARBONE, C., S. CHRISTIE, K. CONFORTI, T. COULSON, N. FRANKLIN, J.R. GINSBERG, M. GRIFFITHS, J.HOLDEN, K. KAWANISHI, M. KINNAIRD, R. LAIDLAW, A. LYNAM, D.W. MACDONALD, D. MARTYR, C. McDOUGAL, L. NATH, T. O'BRIEN, J. SEIDENSTICKER, D.J.L. SMITH, M. SUNQUIST, R. TILSON, W.N.W. SHAHRUDDIN. 2001. The use of photographic rates to estimate densities of tigers and other cryptic mammals. Animal Conservation 4: 75-79

COHEN, J. 1998. Statistical power analysis for the behavioural sciences. 2nd ed. Lawrence Erlbaum Associates, Publishers, Hillsdale, NJ.

CUTLER, T.L., AND D.E. SWANN. 1999. Using remote photography in wildlife ecology: a review. Wildlife Society Bulletin. 27(3):571-581

DASMANN, R.F. 1975. The conservation alternative. John Wiley & Sons, New York, NY.

DODGE, W.E., AND D.P., SNYDER. 1960. An automatic camera device for recording wildlife activity. Journal of Wildlife Management 24(3):3451-342.

DYTHAM, C. 1999. Choosing and Using Statistics. A Biologists Guide. Blackwell Science.

ELTON, C. 1993. The ecology of animals. Oxford.

FORESMAN, K.R., AND D.E. PEARSON. 1998. Comparison of proposed survey procedures for detection of forest carnivores. Journal of wildlife Management. 62(4):1217-1226

JACOBSON, H.A., J.C. KROLL, R.W. BROWNING, B.H. KOERTH AND, M.H. CONWAY.1997. Infrared-triggered cameras for censusing white-tailed deer. Wildlife Society Bulletin, 25(2):547-556

KUCERA, T.E., R.H., BARRET. 1993. The Trailmaster® camera system for detecting wildlife. Wildlife Society Bulletin. 21:505-508

KUCERA, T. E. 1995. The Trailmaster® camera system: response. Wildlife Society Bulletin 23:111-113.

KARANTH, K.U. 1995. Estimating tiger (*Panthera tigris*) populations from camera-trap data using capture-recapture models. Biological Conservation 71:333-338.

KARANTH, K.U., AND J.D. NICHOLS. 1998. Estimation of tiger densities in India using photographic captures and recaptures. Ecology 79(8): 2852-2862

KINNEAR, P.R. AND C.D. GRAY. 1999. SPSS for Windows Made Simple, 3rd Edition. Psychology Press Ltd.

LAVO. 2001. General Management Plan and Final Environmental Impact Statement for Lassen Volcanic National Park. Unpublished report, Lassen Volcanic National Park. Mineral, CA

LAVO. 2001. A summary of monitoring activities for 2001. Lassen Volcanic National Park. Unpublished report, Lassen Volcanic National Park, Mineral, CA.

LEOPOLD, A. 1933. Game management. Charles Scribner's Sons, New York, NY.

MACE, R.D., S.C., MINITA, T.L., MANLEY AND K.E., AUNE. 1994. Estimating grizzly bear population size using camera sightings. Wildlife Society Bulletin. 22:74-83

MAYER, K.E., AND W.F. LAUDENSLAYER (eds.). 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection, Sacramento, CA.

MOGENS, T. 2003. Mammal survey in the southeastern Pantanal, Brazil. Biodiversity and Conservation 12:823-836.

MORRISON, M. L., W. M. BLOCK, M. D. STRICKLAND, and W. L. KENDALL. 2001. Wildlife study design. Springer Series on Environmental Management, New York, NY.

PARKER, J.P. 1991. Forest/environment relationships in Lassen Volcanic National Park, California, U.S.A. Journal of Biogeography 18:543-552

PETERSON, L.M., AND J.A., THOMAS. 1998. Performace of Trailmaster® infrared sensors in monitoring captive coyotes. Wildlife Society Bulletin 26(3):592-596

PINDER, J.E., G.C. KROH, J.D. WHITE AND A.M. BASHAM MAY. 1997. The relationships between vegetation type and topography in Lassen Volcanic National Park. Plant Ecology 131:17-29

RICE, C.G. 1995. Trailmaster® camera system: the dark side. Wildlife Society Bulletin 23:110-111

SEYDACK, A.H.W. 1984. Application of a photo-recording device in the census of larger rain-forest mammals. South African Journal of Wildlife Research 14: 10-14

SERRA, G., R.H. BARRET, M.M. JAEGER, M.M. CONNER AND, T.E. KUCERA. 2000. Photographic mark-resighting to census bobcat populations. Wildlife Society Bulletin

SEQUIN, E. 2000. Temporal Activity Patterns of Kangaroo Rats (*Dipodomys sp.*) using Infrared-triggered Camera Systems, University of Nevada, Reno, unpublished manuscript.

SIEGEL, S. 1956. Nonparametric Statistics for the behavioural sciences. McGraw-Hill Book Company, Inc.

SOUKKALA, A.M., AND W.J. ZELINSKI. 1995. Photographic bait stations. Pages 25-65 in W.J. Zielinski and T.E. Kucera, editors. American marten, fisher, lynx, and wolverine: survey methods for their detection. U.S. Forest Service General Technical Report PSW-GTR 157

SUNQUIST, M.E. 1981. The social organization of tigers *Panthera tigris* in Royal Chitwan National Park, Nepal. Smithsonian Contributions in zoology 336:1-98

WAITE, S. 2000. Statistical Ecology in Practice: A Guide to Analysing Environmental and Ecological Field Data. Pearson Education Limmited.

WHITE, G. C., AND R. A. GARROTT. 1990. Analysis of wildife radio-tracking data. Academic Press, Inc., New York, NY.

WILSON, D. E., F. R. COLE, J. D. NICHOLS, R. RUDRAN, and M.S. FOSTER. 1996. Measuring and monitoring biological diversity. Standard methods for Mammals. Smithsonian Institution Press, Washington, DC.

WILSON, G.J., AND R.J. DELAHAY. 2001. A review of methods to estimate the abundance of terrestrial carnivores using field signs and observation. Wildlife Research 28:151-164

WILSON, E. O. 2002. The future of life. Alfred A. Knopf, New York, NY.

ZEINER, D. C., W. F. LAUDENSLAYER, K. E. MAYER, and M. WHITE (eds.). 1990. California's wildlife, Volume III Mammals. California Department of Fish and Game, Sacramento, CA.

ZIELINSKI, W.J. AND H.B. STAUFFER. 1996. Monitoring *Martes* populations in California: survey design and power analysis. Ecological Applications 6(4):1254-1267.

Summary of all useful photo-captures

Site	Roll	Frame	Date	Time	Species 1	Number	Frames
B1-02	1	5	15-Jun	15:53	Mule Deer	1	1
B1-02	1	8	16-Jun	23:06	Black Bear	1	1
B1-02	1	10	17-Jun	09:05	Golden-Mantled Ground Squirrel	1	1
B1-02	1	12	17-Jun	13:49	Chipmunk	1	1
B1-02	2	4	18-Jun	07:41	Golden-Mantled Ground Squirrel	1	1
B1-02	2	8	18-Jun	12:27	Golden-Mantled Ground Squirrel	1	1
B1-02	2	20	21-Jun	15:10	Golden-Mantled Ground Squirrel	1	1
B1-02	2	22	23-Jun	11:36	Chipmunk	1	1
B1-02	3	2	26-Jun	13:58	Mule Deer	1	1
B1-02	3	13	30-Jun	08:14	Golden-Mantled Ground Squirrel	1	1
B1-02	3	16	30-Jun	19:12	American Marten	1	1
B1-02	3	17	01-Jul	10:27	Golden-Mantled Ground Squirrel	1	1
B1-02	4	16	09-Jul	11:14	Steller's Jay	1	1
B1-02	5	4	11-Jul	10:30	Mule Deer	1	1
B1-02	5	5	13-Jul	03:02	American Marten	1	1
B1-02	5	10	14-Jul	11:22	Golden-Mantled Ground Squirrel	1	1
B1-02	6	6	23-Jul	07:49	American Robin	1	1
B1-02	6	10	24-Jul	06:54	American Robin	1	1
B1-X	1	2	26-Jun	04:05	American Marten	1	1
B1-X	1	4	27-Jun	10:13	Clark's Nutcracker	1	1
B1-X	2	3	02-Jul	16:48	Black Bear	1	1
B1-X	2	17	04-Jul	19:43	American Marten	1	1
B1-X	2	18	05-Jul	06:51	American Marten	1	1
B1-X	2	20	06-Jul	01:09	American Marten	1	1
B1-X	3	2	09-Jul	21:07	American Marten	1	1
B1-X	3	4	10-Jul	19:29	Black Bear	3	1
B1-X	3	5	10-Jul	19:33	Black Bear	1	1
B1-X	3	6	10-Jul	19:36	Black Bear	3	1
B1-X	3	7	11-Jul	23:04	American Marten	1	1
B1-X	3	8	12-Jul	00:39	American Marten	1	1
B1-X	4	5	21-Jul	13:58	Common Raven	1	1
B1-X	4	6	21-Jul	14:02	Common Raven	1	1
B1-X	4	7	21-Jul	15:13	Common Raven	1	1
B1-X	4	8	21-Jul	16:46	Douglas' Squirrel	1	1
B1-X	4	9	22-Jul	13:37	Golden-Mantled Ground Squirrel	1	1
B1-X	4	10	22-Jul	15:44	Golden-Mantled Ground Squirrel	1	1
B1-X	4	11	23-Jul	08:20	American Robin	1	1
B1-X	5	2	26-Jul	13:25	Chipmunk	1	1
B1-X	5	3	26-Jul	14:11	Chipmunk	1	1
B1-X	5	4	27-Jul	02:56	Porcupine	1	1
B1-X	5	5	27-Jul	03:54	Porcupine	1	1
B1-X	5	6	27-Jul	14:03	Golden-Mantled Ground Squirrel	1	1
B1-X	5	8	28-Jul	13:08	Chipmunk	1	1
B1-X	5	9	29-Jul	19:21	American Marten	1	1
B2-02	1	3	03-Jun	14:38	Mule Deer	1	1
B2-02	1	4	03-Jun	19:43	Mule Deer	1	1
B2-02	1	5	03-Jun	19:48	Mule Deer	1	1
B2-02	2	4	11-Jun	09:09	Mule Deer	1	1
B2-02	2	21	13-Jun	22:33	Black Bear	1	1
B2-02	3	4	18-Jun	02:45	Mule Deer	1	1
B2-02	3	5	18-Jun	08:31	Golden-Mantled Ground Squirrel	1	1
B2-02	3	10	19-Jun	23:51	Black Bear	1	1

B2-02	3	11	20-Jun	03:08	Black Bear	1	1
B2-02	3	12	20-Jun	08:15	Golden-Mantled Ground Squirrel	1	1
B2-02	3	17	23-Jun	07:32	Golden-Mantled Ground Squirrel	1	1
B2-02	3	18	23-Jun	12:34	Mule Deer	1	1
B2-02	3	22	24-Jun	12:32	Mule Deer	1	1
B2-02	4	3	25-Jun	16:01	Mule Deer	1	1
B2-02	4	5	25-Jun	20:35	Mule Deer	2	1
B2-02	4	6	26-Jun	12:53	Mule Deer	1	1
B2-02	4	8	26-Jun	16:30	California Ground Squirrel	1	1
B2-02	4	10	27-Jun	10:49	Golden-Mantled Ground Squirrel	1	1
B2-02	4	11	27-Jun	20:14	Mule Deer	1	1
B2-02	4	12	28-Jun	07:26	Mule Deer	1	1
B2-02	4	13	28-Jun	08:05	Mule Deer	1	1
B2-02	5	13	03-Jul	17:00	California Ground Squirrel	1	1
B2-02	5	16	04-Jul	15:57	Mule Deer	1	1
B2-02	5	20	05-Jul	06:14	Chipmunk	1	1
B2-02	5	21	05-Jul	11:31	Golden-Mantled Ground Squirrel	1	1
B2-02	5	22	05-Jul	12:56	Golden-Mantled Ground Squirrel	1	1
B2-02	6	4	10-Jul	09:37	Golden-Mantled Ground Squirrel	1	1
B2-02	6	6	11-Jul	07:42	Golden-Mantled Ground Squirrel	1	1
B2-02	6	7	12-Jul	06:53	Mule Deer	1	1
B2-02	6	9	14-Jul	08:02	Golden-Mantled Ground Squirrel	1	1
B2-02	6	10	14-Jul	08:07	Mule Deer	1	1
B2-02	6	11	14-Jul	08:37	Chipmunk	1	1
B2-02	6	12	15-Jul	06:20	Mule Deer	1	1
B2-02	6	13	15-Jul	07:37	Golden-Mantled Ground Squirrel	1	1
B2-02	6	14	15-Jul	08:49	Golden-Mantled Ground Squirrel	2	1
B2-02	6	15	15-Jul	09:44	Golden-Mantled Ground Squirrel	1	1
B2-02	7	6	18-Jul	17:57	Golden-Mantled Ground Squirrel	1	1
B2-02	7	7	19-Jul	05:49	Mule Deer	1	1
B2-02	7	8	19-Jul	08:14	Chipmunk	1	1
B2-02	7	10	22-Jul	08:29	Golden-Mantled Ground Squirrel	1	1
B2-02	7	11	23-Jul	07:56	Golden-Mantled Ground Squirrel	1	1
B2-02	7	13	23-Jul	09:52	Golden-Mantled Ground Squirrel	1	1
B2-02	7	14	23-Jul	10:31	Golden-Mantled Ground Squirrel	1	1
B2-02	7	15	23-Jul	11:14	Golden-Mantled Ground Squirrel	1	1
B2-02	7	16	23-Jul	11:23	California Ground Squirrel	1	1
B2-02	8	2	23-Jul	11:29	Mule Deer	1	1
B2-02	8	4	25-Jul	07:00	Mule Deer	1	1
B2-02	8	5	25-Jul	07:05	Mule Deer	2	1
B2-02	8	6	25-Jul	07:53	Mule Deer	1	1
B2-02	8	7	25-Jul	16:15	Golden-Mantled Ground Squirrel	1	1
B2-02	8	8	25-Jul	17:31	Mule Deer	1	1
B2-02	8	10	26-Jul	11:27	Golden-Mantled Ground Squirrel	1	1
B2-02	8	11	26-Jul	16:35	Golden-Mantled Ground Squirrel	1	1
B2-02	8	12	27-Jul	01:13	Snowshoe Hare	1	1
B2-02	8	14	27-Jul	17:34	Chipmunk	1	1
B2-02	8	15	27-Jul	19:17	Golden-Mantled Ground Squirrel	1	1
B2-02	8	17	28-Jul	11:30	Golden-Mantled Ground Squirrel	1	1
B2-02	8	18	28-Jul	19:35	Golden-Mantled Ground Squirrel	1	1
B2-02	8	21	29-Jul	17:08	Golden-Mantled Ground Squirrel	1	1
B2-02	8	22	29-Jul	19:22	Golden-Mantled Ground Squirrel	1	1
B2-X	1	3	26-Jun	07:29	Mule Deer	1	1
B2-X	1	4	26-Jun	07:49	Mule Deer	1	1
B2-X	1	7	27-Jun	07:06	Mule Deer	1	1
B2-X	1	12	28-Jun	08:05	Human	1	1

APPENDIX 1

B2-X	1	13	28-Jun	10:43	California Ground Squirrel	1	1
B2-X	1	16	29-Jun	11:47	California Ground Squirrel	1	1
B2-X	1	17	29-Jun	13:32	Golden-Mantled Ground Squirrel	1	1
B2-X	1	18	29-Jun	16:45	California Ground Squirrel	1	1
B2-X	1	21	01-Jul	07:45	Chipmunk	1	1
B2-X	1	22	01-Jul	08:38	Golden-Mantled Ground Squirrel	1	1
B2-X	1	23	01-Jul	12:33	Chipmunk	1	1
B2-X	1	25	02-Jul	07:51	Chipmunk	1	1
B2-X	1	26	02-Jul	08:48	Golden-Mantled Ground Squirrel	1	1
B2-X	2	2	02-Jul	17:59	Chipmunk	1	1
B2-X	2	4	03-Jul	07:50	Chipmunk	1	1
B2-X	2	6	03-Jul	08:12	Chipmunk	1	1
B2-X	2	7	03-Jul	10:58	Chipmunk	1	1
B2-X	2	8	03-Jul	11:11	Golden-Mantled Ground Squirrel	1	1
B2-X	2	10	03-Jul	19:34	Chipmunk	1	1
B2-X	2	12	04-Jul	08:07	Chipmunk	1	1
B2-X	2	14	05-Jul	07:47	Chipmunk	1	1
B2-X	2	15	05-Jul	07:58	Steller's Jay	1	1
B2-X	2	16	05-Jul	11:08	Chipmunk	1	1
B2-X	2	17	05-Jul	16:16	Chipmunk	1	1
B2-X	2	19	06-Jul	07:42	Mule Deer	1	1
B2-X	2	20	06-Jul	07:47	Mule Deer	1	1
B2-X	2	21	06-Jul	12:44	Mule Deer	1	1
B2-X	2	22	06-Jul	17:18	Chipmunk	1	1
B2-X	3	2	09-Jul	19:27	Chipmunk	1	1
B2-X	3	5	10-Jul	10:35	Golden-Mantled Ground Squirrel	1	1
B2-X	3	6	10-Jul	15:23	Golden-Mantled Ground Squirrel	1	1
B2-X	3	7	10-Jul	16:36	Chipmunk	1	1
B2-X	3	8	10-Jul	18:09	Golden-Mantled Ground Squirrel	1	1
B2-X	3	9	10-Jul	19:13	Human	1	1
B2-X	3	11	11-Jul	10:28	Chipmunk	1	1
B2-X	3	20	14-Jul	14:39	Mule Deer	1	1
B2-X	3	21	14-Jul	15:31	Chipmunk	1	1
B2-X	3	23	14-Jul	19:56	Dog	1	1
B2-X	4	5	18-Jul	02:27	Mule Deer	1	1
B2-X	4	6	18-Jul	07:48	Chipmunk	1	1
B2-X	4	7	18-Jul	08:12	Chipmunk	2	1
B2-X	4	9	18-Jul	10:57	Golden-Mantled Ground Squirrel	1	1
B2-X	4	13	19-Jul	08:27	Douglas' Squirrel	1	1
B2-X	4	14	19-Jul	14:52	Common Raven	1	1
B2-X	4	15	19-Jul	14:56	Common Raven	1	1
B2-X	4	16	19-Jul	15:01	Common Raven	1	1
B2-X	4	17	19-Jul	15:05	Common Raven	1	1
B2-X	4	18	19-Jul	15:08	Common Raven	1	1
B2-X	4	19	19-Jul	15:14	Common Raven	1	1
B2-X	4	20	19-Jul	15:20	Common Raven	1	1
B2-X	4	21	19-Jul	15:24	Common Raven	1	1
B2-X	4	22	19-Jul	15:28	Common Raven	1	1
B2-X	4	23	19-Jul	19:41	Common Raven	1	1
B2-X	4	25	20-Jul	07:01	Chipmunk	1	1
B2-X	5	2	23-Jul	15:58	Chipmunk	1	1
B2-X	5	3	24-Jul	07:31	Chipmunk	1	1
B2-X	5	4	24-Jul	08:48	Chipmunk	1	1
B2-X	5	5	24-Jul	10:52	Golden-Mantled Ground Squirrel	1	1
B2-X	5	6	24-Jul	10:55	Golden-Mantled Ground Squirrel	1	1
B2-X	5	7	24-Jul	15:34	Golden-Mantled Ground Squirrel	1	1

APPENDIX 1

B2-X	5	9	25-Jul	05:09	Bobcat	1	1
B2-X	5	11	25-Jul	08:14	Chipmunk	1	1
B2-X	5	12	25-Jul	08:25	Chipmunk	1	1
B2-X	5	13	25-Jul	08:37	Chipmunk	1	1
B2-X	5	15	25-Jul	12:22	Chipmunk	1	1
B2-X	5	16	25-Jul	13:26	Golden-Mantled Ground Squirrel	1	1
B2-X	5	17	25-Jul	13:54	Golden-Mantled Ground Squirrel	1	1
B2-X	5	18	25-Jul	17:45	California Quail	1	1
B2-X	5	19	25-Jul	20:03	Chipmunk	1	1
B2-X	5	21	25-Jul	20:44	Snowshoe Hare	1	1
B2-X	5	23	26-Jul	07:50	Chipmunk	1	1
B2-X	5	25	26-Jul	23:51	Snowshoe Hare	1	1
B2-X	5	26	27-Jul	06:27	Douglas' Squirrel	1	1
F1-02	1	2	03-Jun	19:10	Northern Flicker	1	1
F1-02	1	3	04-Jun	20:31	Mule Deer	1	1
F1-02	1	4	04-Jun	23:54	Porkupine	1	1
F1-02	2	14	17-Jun	07:29	Mule Deer	1	1
F1-02	3	10	24-Jun	08:25	Douglas' Squirrel	1	1
F1-02	4	4	01-Jul	15:11	Mule Deer	1	1
F1-02	4	18	16-Jul	06:32	Black Bear	1	1
F1-02	6	3	27-Jul	08:26	Douglas' Squirrel	1	1
F1-02	6	4	27-Jul	09:05	Douglas' Squirrel	1	1
F1-02	6	6	28-Jul	05:50	Douglas' Squirrel	1	1
F1-02	6	7	28-Jul	09:05	Douglas' Squirrel	1	1
F1-X	1	2	26-Jun	10:53	American Marten	1	1
F1-X	1	3	26-Jun	10:56	American Marten	1	1
F1-X	1	4	26-Jun	11:00	American Marten	1	1
F1-X	1	5	26-Jun	14:24	American Marten	1	1
F1-X	1	7	26-Jun	14:47	American Marten	1	1
F1-X	1	8	26-Jun	14:51	American Marten	1	1
F1-X	1	9	26-Jun	14:59	American Marten	1	1
F1-X	1	10	26-Jun	20:02	American Marten	1	1
F1-X	2	2	27-Jun	22:42	American Marten	1	1
F1-X	2	3	27-Jun	22:45	American Marten	1	1
F1-X	2	4	27-Jun	22:48	American Marten	1	1
F1-X	2	5	27-Jun	22:51	American Marten	1	1
F1-X	2	6	27-Jun	22:55	American Marten	1	1
F1-X	2	7	27-Jun	23:00	American Marten	1	1
F1-X	2	8	28-Jun	05:46	American Marten	1	1
F1-X	2	9	28-Jun	05:55	American Marten	1	1
F1-X	2	10	28-Jun	06:09	American Marten	1	1
F1-X	2	12	28-Jun	10:33	American Marten	1	1
F1-X	2	15	29-Jun	03:07	Mule Deer	1	1
F1-X	2	19	01-Jul	07:43	Douglas' Squirrel	1	1
F1-X	3	5	03-Jul	17:43	American Marten	1	1
F1-X	3	6	03-Jul	17:47	American Marten	1	1
F1-X	3	9	04-Jul	16:59	American Marten	1	1
F1-X	3	11	06-Jul	22:25	Mule Deer	1	1
F1-X	3	12	07-Jul	01:15	American Marten	1	1
F1-X	4	4	10-Jul	19:08	American Marten	1	1
F1-X	4	5	10-Jul	19:13	American Marten	1	1
F1-X	4	6	10-Jul	19:24	American Marten	1	1
F1-X	4	7	11-Jul	05:26	American Marten	1	1
F1-X	4	8	11-Jul	06:40	Grey Jay	2	1
F1-X	4	12	14-Jul	23:50	Mule Deer	1	1
F1-X	4	17	15-Jul	21:39	Mule Deer	1	1

APPENDIX 1

F1-X	4	23	17-Jul	03:24	Deer Mouse	1	1
F1-X	4	24	17-Jul	07:04	Douglas' Squirrel	1	1
F1-X	5	2	17-Jul	19:00	American Marten	1	1
F1-X	5	3	18-Jul	05:09	American Marten	1	1
F1-X	5	4	18-Jul	07:04	Grey Jay	1	1
F1-X	5	5	18-Jul	07:21	Mule Deer	1	1
F1-X	5	6	18-Jul	07:37	Grey Jay	1	1
F1-X	5	7	18-Jul	08:28	Mule Deer	1	1
F1-X	5	8	18-Jul	17:01	American Marten	1	1
F1-X	5	9	18-Jul	23:01	Black Bear	1	1
F1-X	5	10	18-Jul	23:04	Black Bear	1	1
F1-X	5	11	19-Jul	10:07	American Marten	1	1
F1-X	5	15	20-Jul	00:07	Deer Mouse	1	1
F1-X	5	16	20-Jul	05:53	Black Bear	2	1
F1-X	5	23	20-Jul	20:22	American Marten	1	1
F1-X	6	2	23-Jul	17:52	American Marten	1	1
F1-X	6	3	23-Jul	18:05	American Marten	1	1
F1-X	6	4	23-Jul	18:50	American Marten	1	1
F1-X	6	5	24-Jul	05:21	American Marten	1	1
F1-X	6	9	24-Jul	12:23	American Marten	1	1
F1-X	6	12	26-Jul	08:15	Douglas' Squirrel	1	1
F1-X	6	13	26-Jul	20:10	Douglas' Squirrel	1	1
F2-02	1	3	05-Jun	11:43	Chipmunk	1	1
F2-02	1	4	05-Jun	13:23	Douglas' Squirrel	1	1
F2-02	1	5	06-Jun	07:07	Douglas' Squirrel	1	1
F2-02	1	9	13-Jun	06:15	Chipmunk	1	1
F2-02	1	10	16-Jun	12:54	Douglas' Squirrel	1	1
F2-02	1	11	16-Jun	18:51	Mule Deer	1	1
F2-02	2	2	20-Jun	09:06	Douglas' Squirrel	1	1
F2-02	2	6	24-Jun	08:16	Mule Deer	1	1
F2-02	2	7	24-Jun	09:08	Western Grey Squirrel	1	1
F2-02	2	10	30-Jun	11:58	Chipmunk	1	1
F2-02	2	13	01-Jul	16:46	Golden-Mantled Ground Squirrel	1	1
F2-02	2	14	02-Jul	10:54	Douglas' Squirrel	1	1
F2-02	2	15	04-Jul	13:00	Chipmunk	1	1
F2-02	2	17	05-Jul	16:29	Chipmunk	1	1
F2-02	2	18	06-Jul	05:49	Mule Deer	1	1
F2-02	2	20	07-Jul	12:07	Chipmunk	1	1
F2-02	2	21	08-Jul	11:52	Mule Deer	1	1
F2-02	3	2	09-Jul	17:39	Golden-Mantled Ground Squirrel	1	1
F2-02	3	4	12-Jul	10:58	Golden-Mantled Ground Squirrel	1	1
F2-02	3	5	13-Jul	15:15	Douglas' Squirrel	1	1
F2-02	3	9	23-Jul	11:21	Golden-Mantled Ground Squirrel	1	1
F2-02	3	12	24-Jul	13:28	Chipmunk	1	1
F2-02	3	13	24-Jul	17:31	Golden-Mantled Ground Squirrel	1	1
F2-02	3	15	25-Jul	13:02	Golden-Mantled Ground Squirrel	1	1
F2-02	3	16	25-Jul	13:32	Golden-Mantled Ground Squirrel	1	1
F2-02	3	18	27-Jul	06:32	Mule Deer	1	1
F2-02	3	19	27-Jul	18:12	Golden-Mantled Ground Squirrel	1	1
F2-X	1	11	29-Jun	12:46	Chipmunk	1	1
F2-X	1	19	30-Jun	09:06	Chipmunk	1	1
F2-X	2	8	05-Jul	08:38	Chipmunk	1	1
F2-X	2	9	05-Jul	10:21	Golden-Mantled Ground Squirrel	1	1
F2-X	2	10	05-Jul	11:29	Golden-Mantled Ground Squirrel	1	1
F2-X	2	11	05-Jul	11:40	Golden-Mantled Ground Squirrel	1	1
F2-X	2	12	05-Jul	11:53	Golden-Mantled Ground Squirrel	1	1

APPENDIX 1

F2-X	2	13	05-Jul	12:18	Chipmunk	1	1
F2-X	2	14	05-Jul	12:24	Chipmunk	1	1
F2-X	2	16	06-Jul	11:48	Golden-Mantled Ground Squirrel	1	1
F2-X	2	17	06-Jul	13:18	Golden-Mantled Ground Squirrel	1	1
F2-X	2	21	07-Jul	19:10	Douglas' Squirrel	1	1
F2-X	2	23	08-Jul	09:35	Golden-Mantled Ground Squirrel	1	1
F2-X	2	24	08-Jul	10:20	Golden-Mantled Ground Squirrel	1	1
F2-X	3	2	09-Jul	13:51	Golden-Mantled Ground Squirrel	1	1
F2-X	3	3	10-Jul	09:17	Chipmunk	1	1
F2-X	3	6	11-Jul	09:14	Golden-Mantled Ground Squirrel	1	1
F2-X	3	7	11-Jul	09:56	Golden-Mantled Ground Squirrel	1	1
F2-X	3	8	11-Jul	10:56	Chipmunk	1	1
F2-X	3	10	12-Jul	11:52	Golden-Mantled Ground Squirrel	1	1
F2-X	3	11	13-Jul	11:14	Golden-Mantled Ground Squirrel	1	1
F2-X	3	12	13-Jul	11:56	Golden-Mantled Ground Squirrel	1	1
F2-X	3	13	14-Jul	06:53	Chipmunk	1	1
F2-X	3	14	14-Jul	08:35	Douglas' Squirrel	1	1
F2-X	3	16	15-Jul	05:02	Mule Deer	1	1
F2-X	3	17	15-Jul	05:11	Mule Deer	1	1
F2-X	3	18	15-Jul	12:58	Golden-Mantled Ground Squirrel	1	1
F2-X	3	19	15-Jul	13:02	Golden-Mantled Ground Squirrel	1	1
F2-X	3	20	16-Jul	08:02	Western Grey Squirrel	1	1
F2-X	4	2	16-Jul	12:34	Chipmunk	1	1
F2-X	4	4	17-Jul	10:27	Golden-Mantled Ground Squirrel	1	1
F2-X	4	5	17-Jul	10:42	Golden-Mantled Ground Squirrel	1	1
F2-X	4	6	17-Jul	11:34	Chipmunk	1	1
F2-X	4	7	17-Jul	11:47	Golden-Mantled Ground Squirrel	1	1
F2-X	4	8	17-Jul	11:54	Junco	1	1
F2-X	4	11	17-Jul	14:16	Chipmunk	1	1
F2-X	4	12	17-Jul	14:20	Chipmunk	1	1
F2-X	4	13	18-Jul	06:16	Coyote	1	1
F2-X	4	14	18-Jul	10:26	Golden-Mantled Ground Squirrel	1	1
F2-X	4	15	18-Jul	10:36	Golden-Mantled Ground Squirrel	1	1
F2-X	4	16	18-Jul	11:52	Golden-Mantled Ground Squirrel	1	1
F2-X	4	18	19-Jul	06:38	Black Bear	1	1
F2-X	4	19	19-Jul	06:43	Black Bear	1	1
F2-X	4	20	19-Jul	06:47	Black Bear	1	1
F2-X	4	21	19-Jul	06:50	Black Bear	1	1
F2-X	4	22	19-Jul	06:53	Black Bear	1	1
F2-X	4	23	20-Jul	09:30	Chipmunk	1	1
F2-X	4	24	20-Jul	09:49	Golden-Mantled Ground Squirrel	1	1
F2-X	4	25	20-Jul	10:01	Golden-Mantled Ground Squirrel	1	1
F2-X	5	2	23-Jul	17:39	Golden-Mantled Ground Squirrel	1	1
F2-X	5	3	24-Jul	14:10	Douglas' Squirrel	1	1
F2-X	5	4	24-Jul	15:59	Golden-Mantled Ground Squirrel	1	1
F2-X	5	7	25-Jul	11:46	Chipmunk	1	1
F2-X	5	7	25-Jul	11:46	Golden-Mantled Ground Squirrel	1	1
F2-X	5	8	25-Jul	12:03	Golden-Mantled Ground Squirrel	1	1
F2-X	5	9	25-Jul	12:16	Golden-Mantled Ground Squirrel	1	1
F2-X	5	11	25-Jul	12:52	Golden-Mantled Ground Squirrel	1	1
F2-X	5	12	25-Jul	12:57	Golden-Mantled Ground Squirrel	2	1
F2-X	5	13	25-Jul	13:08	Golden-Mantled Ground Squirrel	1	1
F2-X	5	14	25-Jul	13:27	Golden-Mantled Ground Squirrel	1	1
F2-X	5	15	25-Jul	13:54	Golden-Mantled Ground Squirrel	2	1
F2-X	5	16	25-Jul	14:12	Golden-Mantled Ground Squirrel	1	1
F2-X	5	17	25-Jul	15:52	Golden-Mantled Ground Squirrel	1	1

APPENDIX 1

F2-X	5	18	25-Jul	16:02	Golden-Mantled Ground Squirrel	1	1
F2-X	5	19	25-Jul	17:40	Golden-Mantled Ground Squirrel	1	1
F2-X	5	20	25-Jul	18:16	Golden-Mantled Ground Squirrel	1	1
F2-X	5	21	26-Jul	09:39	Golden-Mantled Ground Squirrel	1	1
F2-X	5	22	26-Jul	09:49	Golden-Mantled Ground Squirrel	3	1
F2-X	5	23	26-Jul	10:09	Golden-Mantled Ground Squirrel	2	1
F2-X	5	24	26-Jul	10:26	Golden-Mantled Ground Squirrel	1	1
F2-X	5	25	26-Jul	10:56	Golden-Mantled Ground Squirrel	2	1
F2-X	5	26	26-Jul	10:59	Golden-Mantled Ground Squirrel	1	1
R1-02	2	7	20-Jun	07:39	Mule Deer	1	1
R1-02	2	14	22-Jun	20:04	Mule Deer	1	1
R1-02	2	18	25-Jun	06:18	Mule Deer	1	1
R1-02	3	3	28-Jun	09:17	Mule Deer	1	1
R1-02	3	7	28-Jun	20:57	Mule Deer	1	1
R1-02	4	12	07-Jul	15:00	Mule Deer	1	1
R1-02	4	14	07-Jul	20:24	Mule Deer	1	1
R1-02	5	11	16-Jul	16:06	Chipmunk	1	1
R1-02	6	13	22-Jul	20:14	Mule Deer	1	1
R1-02	6	15	24-Jul	07:45	Blue Grouse	2	1
R1-02	7	2	25-Jul	21:14	Mule Deer	1	1
R1-02	7	4	27-Jul	06:58	Mule Deer	1	1
R1-02	7	6	27-Jul	20:50	Mule Deer	1	1
R1-02	7	9	29-Jul	08:28	Douglas' Squirrel	1	1
R1-02	7	12	30-Jul	05:04	Mule Deer	1	1
R1-X	1	3	27-Jun	12:44	Yellow Rumpt Warbler	1	1
R1-X	1	5	28-Jun	06:44	Douglas' Squirrel	1	1
R1-X	1	8	02-Jul	01:39	American Marten	1	1
R1-X	1	9	02-Jul	04:04	American Marten	1	1
R1-X	1	11	02-Jul	07:52	Mule Deer	1	1
R1-X	1	12	02-Jul	14:52	Douglas' Squirrel	1	1
R1-X	2	2	02-Jul	19:22	Black Bear	1	1
R1-X	2	3	03-Jul	03:01	Black Bear	1	1
R1-X	2	4	05-Jul	11:24	Black Bear	1	1
R1-X	2	6	10-Jul	06:12	Black Bear	1	1
R1-X	2	7	10-Jul	10:43	Black Bear	1	1
R1-X	3	3	13-Jul	17:09	Black Bear	1	1
R1-X	3	8	21-Jul	07:50	Black Bear	1	1
R2-02	1	3	06-Jun	20:17	Mule Deer	1	1
R2-02	1	4	09-Jun	09:03	Mule Deer	1	1
R2-02	1	5	09-Jun	17:37	Human	1	1
R2-02	1	9	11-Jun	04:04	Mule Deer	1	1
R2-02	1	11	15-Jun	14:43	Mule Deer	1	1
R2-02	2	3	19-Jun	13:16	Mountain Quail	1	1
R2-02	2	4	19-Jun	23:05	Mule Deer	1	1
R2-02	2	5	20-Jun	03:25	Mule Deer	1	1
R2-02	2	6	22-Jun	07:13	Mule Deer	1	1
R2-02	2	7	24-Jun	10:55	Chipmunk	1	1
R2-02	2	8	25-Jun	11:54	Douglas' Squirrel	1	1
R2-02	2	11	28-Jun	07:52	Mule Deer	1	1
R2-02	3	2	01-Jul	18:36	Mule Deer	1	1
R2-02	3	3	02-Jul	21:05	Mule Deer	2	1
R2-02	3	4	04-Jul	15:51	Mule Deer	1	1
R2-02	3	11	19-Jul	03:52	Mule Deer	1	1
R2-02	3	14	24-Jul	23:11	Mule Deer	1	1
R2-02	3	16	30-Jul	13:21	Chipmunk	1	1
R2-X	1	12	26-Jun	12:41	Butterfly	1	1

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R2-X	1	16	26-Jun	22:56	Gray Fox	1	1
R2-X	1	17	26-Jun	23:00	Gray Fox	1	1
R2-X	2	23	29-Jun	23:06	Gray Fox	1	1
R2-X	6	7	24-Jul	10:07	Douglas' Squirrel	1	1
R2-X	6	8	26-Jul	14:36	Sharp Shinned Hawk	1	1
R2-X	6	9	27-Jul	02:10	Gray Fox	1	1
R2-X	6	10	27-Jul	02:14	Gray Fox	1	1
R2-X	6	13	28-Jul	00:08	Gray Fox	1	1
R2-X	6	15	28-Jul	08:52	Douglas' Squirrel	1	1
R2-X	6	16	28-Jul	09:11	Douglas' Squirrel	1	1
R2-X	6	17	28-Jul	18:51	Douglas' Squirrel	1	1
R2-X	6	18	29-Jul	03:29	Gray Fox	1	1
R2-X	6	19	29-Jul	03:34	Gray Fox	1	1
R2-X	6	20	29-Jul	03:37	Gray Fox	1	1
S1-02	1	2	13-Jun	04:55	Blue Grouse	1	1
S1-02	2	2	18-Jun	19:24	Mule Deer	2	1
S1-02	2	3	18-Jun	19:28	Mule Deer	2	1
S1-02	2	4	18-Jun	19:31	Mule Deer	1	1
S1-02	2	9	22-Jun	05:46	Mule Deer	1	1
S1-02	2	10	22-Jun	06:55	Steller's Jay	1	1
S1-02	2	11	25-Jun	07:25	Chipmunk	1	1
S1-02	2	13	26-Jun	06:29	American Robin	1	1
S1-02	3	2	27-Jun	07:02	Chipmunk	1	1
S1-02	3	4	27-Jun	13:29	Chipmunk	1	1
S1-02	3	5	28-Jun	06:32	Mule Deer	1	1
S1-02	3	6	28-Jun	07:38	Chipmunk	1	1
S1-02	3	7	28-Jun	13:02	Steller's Jay	1	1
S1-02	3	11	30-Jun	06:10	Mule Deer	1	1
S1-02	4	4	04-Jul	16:57	Mule Deer	1	1
S1-02	4	5	05-Jul	04:22	Mule Deer	1	1
S1-02	4	6	05-Jul	18:25	Sharp Shinned Hawk	1	1
S1-02	4	7	06-Jul	07:15	Chipmunk	1	1
S1-02	4	9	06-Jul	19:01	Chipmunk	1	1
S1-02	4	10	10-Jul	05:29	American Robin	1	1
S1-02	6	3	26-Jul	00:17	Mule Deer	1	1
S1-02	6	5	26-Jul	07:43	Chipmunk	1	1
S1-02	6	6	26-Jul	15:35	American Robin	1	1
S1-02	6	9	26-Jul	18:30	Chipmunk	1	1
S1-02	6	10	26-Jul	18:36	Steller's Jay	1	1
S1-02	6	11	26-Jul	23:05	Mule Deer	1	1
S1-02	6	12	27-Jul	06:12	American Robin	1	1
S1-02	6	13	27-Jul	06:32	American Robin	1	1
S1-02	6	14	27-Jul	16:10	Chipmunk	1	1
S1-02	6	15	28-Jul	17:54	Chipmunk	1	1
S1-02	6	16	29-Jul	08:12	Chipmunk	2	1
S1-X	1	2	27-Jun	06:53	Mule Deer	1	1
S1-X	2	4	30-Jun	02:28	American Marten	1	1
S1-X	2	5	30-Jun	02:32	American Marten	1	1
S1-X	2	6	30-Jun	06:57	Douglas' Squirrel	1	1
S1-X	2	15	02-Jul	03:29	American Marten	1	1
S1-X	2	18	02-Jul	14:04	Chipmunk	1	1
S1-X	3	13	04-Jul	04:42	Mule Deer	1	1
S1-X	3	20	05-Jul	08:37	Douglas' Squirrel	1	1
S1-X	3	25	05-Jul	10:52	Golden-Mantled Ground Squirrel	1	1
S1-X	4	2	12-Jul	15:36	American Robin	1	1
S1-X	4	4	13-Jul	21:43	Black Bear	1	1

APPENDIX 1

S1-X	4	8	14-Jul	20:32	Mule Deer	1	1
S1-X	4	17	16-Jul	09:58	Mule Deer	2	1
S1-X	4	18	17-Jul	09:12	Golden-Mantled Ground Squirrel	1	1
S1-X	5	3	18-Jul	09:10	Chipmunk	1	1
S1-X	5	4	18-Jul	09:39	Chipmunk	1	1
S1-X	5	5	18-Jul	09:53	Golden-Mantled Ground Squirrel	1	1
S1-X	5	6	19-Jul	08:22	Golden-Mantled Ground Squirrel	1	1
S1-X	5	8	19-Jul	09:30	Chipmunk	1	1
S1-X	5	9	19-Jul	17:15	Golden-Mantled Ground Squirrel	1	1
S1-X	6	2	25-Jul	22:36	American Marten	1	1
S1-X	6	3	25-Jul	22:40	American Marten	1	1
S1-X	6	4	26-Jul	03:36	American Marten	1	1
S1-X	6	5	26-Jul	03:41	Black Bear	1	1
S1-X	6	6	26-Jul	03:50	American Marten	1	1
S1-X	6	7	26-Jul	03:54	American Marten	1	1
S1-X	6	8	26-Jul	14:17	American Robin	1	1
S1-X	6	9	26-Jul	21:35	American Marten	1	1
S1-X	6	10	26-Jul	21:39	American Marten	1	1
S1-X	6	11	26-Jul	21:47	American Marten	1	1
S1-X	6	12	26-Jul	21:56	American Marten	1	1
S1-X	6	13	26-Jul	22:03	American Marten	1	1
S1-X	6	14	27-Jul	01:03	American Marten	1	1
S1-X	6	18	30-Jul	09:18	Golden-Mantled Ground Squirrel	1	1
S1-X	6	19	30-Jul	09:26	Chipmunk	1	1
S1-X	6	20	01-Aug	08:05	Golden-Mantled Ground Squirrel	1	1
S2-X	1	3	27-Jun	01:23	Red Fox	1	1
S2-X	1	4	27-Jun	01:29	Red Fox	1	1
S2-X	1	5	27-Jun	10:03	Golden-Mantled Ground Squirrel	1	1
S2-X	1	7	27-Jun	14:10	Fox Sparrow	1	1
S2-X	1	8	27-Jun	20:30	Mule Deer	1	1
S2-X	1	9	27-Jun	22:59	Red Fox	1	1
S2-X	2	2	28-Jun	21:33	Red Fox	1	1
S2-X	2	8	29-Jun	21:51	Red Fox	1	1
S2-X	2	9	30-Jun	08:08	American Robin	1	1
S2-X	2	10	30-Jun	09:37	Hermit Thrush	1	1
S2-X	2	11	30-Jun	10:31	Hermit Thrush	1	1
S2-X	2	12	30-Jun	13:47	Hermit Thrush	1	1
S2-X	2	14	30-Jun	15:23	White Breasted Nutchatch	1	1
S2-X	2	15	30-Jun	16:16	Chipmunk	1	1
S2-X	2	16	30-Jun	19:35	Mule Deer	1	1
S2-X	2	17	30-Jun	19:48	Junco	1	1
S2-X	2	18	02-Jul	10:35	Mule Deer	1	1
S2-X	3	4	02-Jul	16:03	White Breasted Nutchatch	1	1
S2-X	3	5	03-Jul	03:51	Red Fox	1	1
S2-X	3	6	03-Jul	03:55	Red Fox	1	1
S2-X	3	7	03-Jul	04:09	Red Fox	1	1
S2-X	3	8	03-Jul	09:18	Douglas' Squirrel	1	1
S2-X	3	14	04-Jul	02:48	Red Fox	1	1
S2-X	3	18	04-Jul	22:32	Deer Mouse	1	1
S2-X	3	19	05-Jul	02:19	Deer Mouse	1	1
S2-X	3	22	06-Jul	09:48	Douglas' Squirrel	1	1
S2-X	4	3	11-Jul	03:19	Red Fox	1	1
S2-X	4	4	11-Jul	03:24	Red Fox	1	1
S2-X	4	8	11-Jul	19:14	Chipmunk	1	1
S2-X	4	9	11-Jul	21:38	Red Fox	1	1
S2-X	4	10	12-Jul	05:40	Douglas' Squirrel	1	1

APPENDIX 1

S2-X	4	11	12-Jul	08:00	Douglas' Squirrel	1	1
S2-X	4	12	12-Jul	10:38	Clark's Nutcracker	1	1
S2-X	4	14	12-Jul	21:16	Red Fox	1	1
S2-X	4	18	14-Jul	08:02	Golden-Mantled Ground Squirrel	1	1
S2-X	4	19	14-Jul	10:06	Douglas' Squirrel	1	1
S2-X	4	24	14-Jul	20:52	Mule Deer	1	1
S2-X	4	25	15-Jul	00:25	Deer Mouse	1	1
S2-X	5	2	17-Jul	22:38	Red Fox	1	1
S2-X	5	3	18-Jul	07:19	Blue Grouse	1	1
S2-X	5	4	19-Jul	05:24	American Marten	1	1
S2-X	5	5	19-Jul	07:13	Douglas' Squirrel	1	1
S2-X	5	6	19-Jul	07:22	Chipmunk	1	1
S2-X	5	7	19-Jul	08:00	Douglas' Squirrel	1	1
S2-X	5	8	19-Jul	08:16	Douglas' Squirrel	1	1
S2-X	5	9	19-Jul	09:45	Chipmunk	1	1
S2-X	5	10	19-Jul	10:50	Douglas' Squirrel	1	1
S2-X	5	11	19-Jul	19:06	Clark's Nutcracker	1	1
S2-X	5	12	19-Jul	20:21	Mule Deer	1	1
S2-X	5	13	19-Jul	22:37	Deer Mouse	1	1
S2-X	5	14	20-Jul	01:46	Red Fox	1	1
S2-X	5	15	20-Jul	07:44	Mule Deer	1	1
S2-X	5	16	21-Jul	09:10	Douglas' Squirrel	1	1
S2-X	5	17	21-Jul	20:48	American Robin	1	1
S2-X	5	18	23-Jul	06:22	Clark's Nutcracker	1	1
S2-X	5	20	23-Jul	10:39	Clark's Nutcracker	1	1
S2-X	5	21	23-Jul	19:01	Mule Deer	1	1
S2-X	5	22	23-Jul	22:33	Red Fox	1	1
S2-X	5	23	24-Jul	05:24	Mule Deer	1	1
S2-X	5	24	24-Jul	05:28	Mule Deer	1	1
S2-X	5	25	24-Jul	23:25	Deer Mouse	1	1
S2-X	5	26	25-Jul	09:35	Douglas' Squirrel	1	1
S2-X	6	2	26-Jul	08:10	Douglas' Squirrel	1	1
S2-X	6	3	26-Jul	09:24	Douglas' Squirrel	1	1
S2-X	6	5	27-Jul	09:02	Douglas' Squirrel	1	1
S2-X	6	6	27-Jul	20:56	Red Fox	1	1
S2-X	6	7	27-Jul	21:01	Red Fox	1	1
S2-X	6	8	27-Jul	21:06	Red Fox	1	1
S2-X	6	9	27-Jul	22:15	Deer Mouse	1	1
S2-X	6	10	28-Jul	07:08	Mule Deer	1	1
S2-X	6	11	28-Jul	07:29	Douglas' Squirrel	1	1
S2-X	6	12	28-Jul	17:17	American Robin	1	1
S2-X	6	13	28-Jul	19:59	Douglas' Squirrel	1	1
S2-X	6	14	29-Jul	09:57	Junco	1	1
S2-X	6	16	30-Jul	08:59	Blue Grouse	1	1
S2-X	6	17	30-Jul	10:38	Golden-Mantled Ground Squirrel	1	1
S2-X	6	18	30-Jul	14:23	Douglas' Squirrel	1	1
S2-X	6	19	31-Jul	09:23	Douglas' Squirrel	1	1
S3-02	1	20	13-Jun	12:32	Chipmunk	1	1
S3-02	2	22	02-Jul	23:16	Deer Mouse	1	1
S3-02	3	4	13-Jul	03:52	Deer Mouse	1	1
S3-02	3	5	13-Jul	11:58	Chipmunk	1	1
S3-02	3	13	18-Jul	08:21	Clark's Nutcracker	1	1
S3-02	3	14	18-Jul	10:44	American Robin	1	1
S3-02	3	15	19-Jul	07:58	Douglas' Squirrel	1	1
S3-02	3	16	19-Jul	09:28	Douglas' Squirrel	1	1
S3-02	3	17	19-Jul	18:03	Chipmunk	1	1

S3-02	3	18	19-Jul	19:47	Clark's Nutcracker	1	1
S3-02	3	19	20-Jul	05:27	American Robin	1	1
S3-02	3	21	20-Jul	11:10	Chipmunk	1	1
S3-02	3	22	20-Jul	13:25	Clark's Nutcracker	5	1
S3-02	3	23	21-Jul	09:31	Douglas' Squirrel	1	1
S3-02	3	24	21-Jul	09:40	Clark's Nutcracker	1	1
S3-02	3	25	21-Jul	11:07	Clark's Nutcracker	4	1
S3-02	4	2	26-Jul	07:55	Douglas' Squirrel	1	1
S3-02	4	3	26-Jul	09:00	Golden-Mantled Ground Squirrel	1	1
S3-02	4	4	26-Jul	09:34	Junco	1	1
S3-02	4	5	26-Jul	11:23	Northern flicker	1	1
S3-02	4	6	26-Jul	17:11	Chipmunk	1	1
S3-02	4	7	26-Jul	18:07	Golden-Mantled Ground Squirrel	1	1
S3-02	4	8	26-Jul	18:24	Clark's Nutcracker	1	1
S3-02	4	9	27-Jul	08:05	Douglas' Squirrel	1	1
S3-02	4	10	27-Jul	09:02	Douglas' Squirrel	1	1
S3-02	4	11	28-Jul	19:29	American Robin	1	1
S3-02	4	12	29-Jul	09:02	Mule Deer	1	1
S3-02	4	13	29-Jul	09:49	American Robin	1	1
S3-02	4	14	30-Jul	06:26	Chipmunk	1	1
S3-02	4	15	30-Jul	06:37	Douglas' Squirrel	1	1
S3-02	4	16	30-Jul	09:09	Mule Deer	1	1
S3-02	4	17	30-Jul	09:35	Chipmunk	1	1
S3-02	4	18	30-Jul	09:47	Golden-Mantled Ground Squirrel	1	1
S3-02	4	19	30-Jul	19:28	Northern flicker	1	1
S3-02	4	20	31-Jul	06:56	Douglas' Squirrel	1	1
S3-02	4	21	31-Jul	10:56	Douglas' Squirrel	1	1
S3-02	4	22	01-Aug	06:04	Douglas' Squirrel	1	1
S3-02	4	23	01-Aug	11:44	Douglas' Squirrel	1	1
					Total	614	585

Note:
Each station is separated with a solid line, the dotted line is the 21 nights boundary

APPENDIX 2

Table showing all information recorded per station

Site	UTM-E	UTM-N	Start date	End date	M.A.N.	T.N.	Rolls	Frames	Hits	Misses	Test	Drops	Elevation (m)	Veg. Type	CC	Cam H (m)
B1-02	632903.7	4481616.6	12-Jun	30-Jul	46	48	7	119	18	85	16	0	2164	RFR2S	51	1.6
B1-X	632869.6	4481831.0	25-Jun	30-Jul	25	35	5	91	26	56	9	0	2177	RFR2S	82	1.35
B2-02	622100.6	4487469.3	03-Jun	30-Jul	45	57	8	173	61	99	13	1	1813	SMC2S	73	1.3
B2-X	621984.1	4487256.6	25-Jun	30-Jul	25	35	5	126	74	45	7	1	1791	SMC2S	52	1.5
F1-02	630620.6	4485244.2	03-Jun	30-Jul	47	57	6	98	12	69	17	1	1959	SMC5D	95	1.35
F1-X	630658.0	4485460.3	25-Jun	30-Jul	33	35	6	125	55	60	10	1	1951	SMC5D	78	1.15
F2-02	621199.7	4488971.8	03-Jun	30-Jul	46	57	3	54	28	10	16	1	1777	PPN5D	97	1.45
F2-X	621038.2	4488930.5	25-Jun	30-Jul	23	35	5	123	72	42	10	0	2170	PPN5D	74	1.3
R1-02	624395.7	4476492.8	12-Jun	01-Aug	47	50	7	121	15	92	14	0	2602	MRI4P	85	1.2
R1-X	624551.0	4476377.9	26-Jun	01-Aug	24	36	3	29	13	8	8	0	2628	MRI4P	88	1.3
R2-02	629092.0	4486452.0	03-Jun	30-Jul	49	57	3	41	18	7	16	0	1929	MRI4P	88	1.2
R2-X	629243.7	4486304.0	25-Jun	30-Jul	24	35	6	126	15	104	7	0	1951	MRI4P	77	1.4
S1-02	624876.2	4478033.8	12-Jun	01-Aug	30	50	6	87	31	41	15	0	2273	SCN4S	58	1.2
S1-X	625178.5	4478243.9	26-Jun	01-Aug	24	36	6	124	36	79	9	0	2628	SCN4S	58	1.55
S2-X	627376.2	4481358.2	26-Jun	01-Aug	30	36	6	129	79	41	9	1	2434	SCN3S	69	1.5
S3-02*	627652.7	4481409.4	12-Jun	01-Aug	21	35	4	98	38	53	7	0	2610	SCN3S	62	1.4

Note:

*S2-02 was stolen between the 26/6/02 and 1/7/02, S3-02 was setup on the 2/7/02

All stations with suffix 02 are un-baited, all sites with suffix X are baited

* Veg. Type was described using "A guide to wildlife habitats of California" Mayer et al. (1988)

Key:

MAN: Minimum Active Nights (same as ATN)

TN: Total Nights

CC: Canopy Coverage

Hits: All photographs where an animal or object has triggered the camera

Drops: Photographs where an unidentifiable subject has triggered the camera

Miss: Photographs where no visable subject trigged the TM500 sensor.

Test: Test photograph

Cam H: Height, from ground level, of camera attached to a tree

Dist: Distance from centre of TM 500 sensitive area to base of tree

S.Area: TM500 area of sensitivity

APPENDIX 2

Sensor Height (m)	Dist (m)	Bearing	S. Area (m^2)	Camera Type
1.3	2.8	20	1.33	Canon
1.1	3.3	22	0.525	Olympus
1.2	3.5	34	1.375	Yashica
1.25	2.3	30	1.4	Olympus
1	3.1	14	1.47	Canon
1.15	2.95	18	1.05	Canon
1.2	3.5	18	2.34	Canon
1.2	3.7	8	0.99	Canon
1.1	3.5	44	1.3775	Yashica
1.1	3.4	4	0.85	Cannon
1.1	3.9	20	1.44	Yashica
1.15	2.4	28	0.6	Canon
1.1	3.1	4	1.5	Olympus
1.35	3.9	2	0.77	Olympus
1.25	3.3	360	0.75	Olympus
1.2	3.1	13	1.103	Olympus

APPENDIX 3

Camera Station Monitoring Record - Lassen Fox Project

rev 2 July 2002

Monitoring Date:_____ Station ID: _____

erson(s):_____ Arrival Time: _____

M Data: Type of station (circle): TM 500 TM 1500 Other:_____ Entry Test Photo: _____

Events:_____ (see below for times of photo events) Camera batteries OK? _____

Camera on Exp #: _____ Replaced (circle): film (label old roll w/date and code) batteries neither

Confirm time / date correct: Sensor:_____ Camera:_____ (comment below if necessary)

Describe any damage: _____

ait: Status of old bait: _____

New bait? (describe): _____ New scent / urine? (describe): _____

M Settings: Pulses:_____ Pt: _____ Cam Delay: _____ Activity: 24 hr On: _____ Off: _____

Before leaving, confirm station operational: sensor and event recorder work, camera takes photo (flash).

Exit Test photo(s):_____ Camera on Exp #: _____ Sensor on Event #: _____ Departure Time: _____

omments:_____

_____

rom the TM sensor record, note the times of the first 30 events at which photos were taken. (Do NOT record events for which no photo was taken. This is a check in case the photo does not show the time clearly.)

vent #	Date	Time	Event #	Date	Time	Event #	Date	Time

APPENDIX 3

Camera Station Results - Lassen Fox Project

rev 3 July 2002

Station ID: _____ Code: _____ Roll #: _____

Film in: Date: _____ Time: _____ Person(s): _____

Bait / lures used: _____ Activity: On: _____ Off: _____

Film out: Date: _____ Time: _____ Person(s): _____

Comment: _____

Photo Results

Frame	Date	Time	Contents
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			

Summary # Exposures: _____ Hits: _____ Misses: _____ Tests: _____ Drops: _____ Entered: _____

APPENDIX 4

Spearman rank correlation between canopy coverage and efficiency

			e1
Spearman's rho	Canopy coverage	Correlation Coefficient	0.162
		P-value (2-tailed)	0.549
		N	16.000
Correlations			
			e2
Spearman's rho	Canopy coverage	Correlation Coefficient	0.231
		Sig. (2-tailed)	0.389
		N	16.000
Correlations			
			e3
Spearman's rho	Canopy coverage	Correlation Coefficient	-0.541
		Sig. (2-tailed)	**0.031**
		N	16.000

APPENDIX 5

21 nights

Tests of Normality

	Kolmogorov-Smirnov		
Species	Statistic	df	Sig.
SSH	0.520776	17	5.87E-14
BG	0.485721	17	4.91E-12
CQ	0.520776	17	5.87E-14
MQ	0.520776	17	5.87E-14
NF	0.482463	17	7.28E-12
SJ	0.482463	17	7.28E-12
GJ	0.520776	17	5.87E-14
CN	0.430781	17	2.55E-09
CR	0.477607	17	1.3E-11
WBN	0.520776	17	5.87E-14
HT	0.520776	17	5.87E-14
AR	0.32605	17	3.76E-05
YRW	0.520776	17	5.87E-14
DEJ	0.485721	17	4.91E-12
FS	0.520776	17	5.87E-14
BIRDS	0.314807	17	8.79E-05
CHIP	0.33118	17	2.52E-05
CGS	0.478653	17	1.15E-11
GMGS	0.34312	17	9.68E-06
WGS	0.485721	17	4.91E-12
DS	0.366836	17	1.28E-06
DM	0.480438	17	9.29E-12
SMAM	0.311647	17	0.000111
PORC	0.520776	17	5.87E-14
COY	0.520776	17	5.87E-14
RF	0.520776	17	5.87E-14
GF	0.520776	17	5.87E-14
BLB	0.316485	17	7.76E-05
AM	0.381204	17	3.5E-07
MD	0.360496	17	2.24E-06
LMAM	0.325932	17	3.79E-05
TOTAL	0.367799	17	1.18E-06

a Lilliefors Significance Correction

100 nights

Tests of Normality

	Kolmogorov-Smirnov		
Species	Statistic	df	Sig.
SSH	0.51685	16	5.42E-13
BG	0.472153	16	1.02E-10
CQ	0.536206	16	4.75E-14
MQ	0.536206	16	4.75E-14
NF	0.493986	16	8.45E-12
SJ	0.461719	16	3.23E-10
GJ	0.536206	16	4.75E-14
CN	0.458639	16	4.5E-10
CR	0.499442	16	4.44E-12
WBN	0.536206	16	4.75E-14
HT	0.536206	16	4.75E-14
AR	0.355977	16	7.21E-06
YRW	0.536206	16	4.75E-14
DEJ	0.487918	16	1.71E-11
FS	0.536206	16	4.75E-14
BIRDS	0.322257	16	9.46E-05
SH	0.497944	16	5.3E-12
CHIP	0.255871	16	0.006259
CGS	0.511831	16	1E-12
GMGS	0.313485	16	0.000176
WGS	0.509851	16	1.27E-12
DS	0.315372	16	0.000154
SMAM	0.218724	16	0.03939
DM	0.470431	16	1.24E-10
PORC	0.497119	16	5.85E-12
COY	0.536206	16	4.75E-14
RF	0.536206	16	4.75E-14
GF	0.536206	16	4.75E-14
BLB	0.287693	16	0.00097
AM	0.380344	16	9.31E-07
BOB	0.536206	16	4.75E-14
MD	0.179248	16	0.179698
LMAM	0.219973	16	0.037248
TOTAL	0.195129	16	0.105031

a Lilliefors Significance Correction

APPENDIX 6

Lassen Volcanic National Park species list - BIRDS

Order	Family	Latin Name	TSN
Anseriformes	Anatidae	Aix sponsa	175122
Anseriformes	Anatidae	Anas acuta	175074
Anseriformes	Anatidae	Anas americana	175094
Anseriformes	Anatidae	Anas clypeata	175096
Anseriformes	Anatidae	Anas crecca	175081
Anseriformes	Anatidae	Anas cyanoptera	175089
Anseriformes	Anatidae	Anas discors	175086
Anseriformes	Anatidae	Anas platyrhynchos	175063
Anseriformes	Anatidae	Aythya affinis	175134
Anseriformes	Anatidae	Aythya collaris	175128
Anseriformes	Anatidae	Aythya valisineria	175129
Anseriformes	Anatidae	Branta canadensis	174999
Anseriformes	Anatidae	Branta canadensis canadensis	175000
Anseriformes	Anatidae	Bucephala albeola	175145
Anseriformes	Anatidae	Bucephala clangula	175141
Anseriformes	Anatidae	Bucephala islandica	175144
Anseriformes	Anatidae	Chen caerulescens	175038
Anseriformes	Anatidae	Cygnus columbianus	174987
Anseriformes	Anatidae	Histrionicus histrionicus	175149
Anseriformes	Anatidae	Mergus merganser	175185
Anseriformes	Anatidae	Oxyura jamaicensis	175175
Apodiformes	Apodidae	Aeronautes saxatalis saxatalis	178015
Apodiformes	Apodidae	Chaetura vauxi	178002
Ciconiiformes	Accipitridae	Accipiter cooperii	175309
Ciconiiformes	Accipitridae	Accipiter gentilis atricapillus	175301
Ciconiiformes	Accipitridae	Accipiter striatus	175304
Ciconiiformes	Accipitridae	Aquila chrysaetos	175407
Ciconiiformes	Accipitridae	Buteo jamaicensis	175350
Ciconiiformes	Accipitridae	Buteo lagopus	175373
Ciconiiformes	Accipitridae	Buteo regalis	175377
Ciconiiformes	Accipitridae	Buteo swainsoni	175367
Ciconiiformes	Accipitridae	Circus cyaneus	175430
Ciconiiformes	Accipitridae	Haliaeetus leucocephalus	175420
Ciconiiformes	Accipitridae	Haliaeetus leucocephalus leucocephalus	175421
Ciconiiformes	Accipitridae	Pandion haliaetus	175590
Ciconiiformes	Accipitridae	Pandion haliaetus carolinensis	175591
Ciconiiformes	Ardeidae	Ardea herodias	174773
Ciconiiformes	Ardeidae	Botaurus lentiginosus	174856
Ciconiiformes	Ardeidae	Butorides striatus	174798
Ciconiiformes	Ardeidae	Casmerodius albus	174810
Ciconiiformes	Ardeidae	Egretta thula	174813
Ciconiiformes	Ardeidae	Nycticorax nycticorax	174832
Ciconiiformes	Charadriidae	Charadrius semipalmatus	176506
Ciconiiformes	Charadriidae	Charadrius vociferus	176520
Ciconiiformes	Ciconiidae	Cathartes aura	175265
Ciconiiformes	Ciconiidae	Cathartes aura septentrionalis	175267
Ciconiiformes	Falconidae	Falco columbarius	175613
Ciconiiformes	Falconidae	Falco mexicanus	175603
Ciconiiformes	Falconidae	Falco peregrinus	175604

APPENDIX 6

Ciconiiformes	Falconidae	Falco peregrinus anatum	175605
Ciconiiformes	Falconidae	Falco sparverius	175622
Ciconiiformes	Falconidae	Falco sparverius phalaena	-501498
Ciconiiformes	Gaviidae	Gavia immer	174469
Ciconiiformes	Laridae	Larus californicus	176829
Ciconiiformes	Laridae	Larus delawarensis	176830
Ciconiiformes	Laridae	Sterna caspia	176924
Ciconiiformes	Laridae	Xema sabini	176866
Ciconiiformes	Pelecanidae	Pelecanus erythrorhynchos	174684
Ciconiiformes	Phalacrocoracidae	Phalacrocorax auritus	174717
Ciconiiformes	Podicipedidae	Aechmophorus occidentalis	174503
Ciconiiformes	Podicipedidae	Podiceps nigricollis	174485
Ciconiiformes	Podicipedidae	Podilymbus podiceps	174505
Ciconiiformes	Scolopacidae	Actitis macularia	176612
Ciconiiformes	Scolopacidae	Calidris mauri	176668
Ciconiiformes	Scolopacidae	Calidris minutilla	176656
Ciconiiformes	Scolopacidae	Catoptrophorus semipalmatus	176638
Ciconiiformes	Scolopacidae	Gallinago gallinago	176700
Ciconiiformes	Scolopacidae	Phalaropus tricolor	176736
Ciconiiformes	Scolopacidae	Tringa melanoleuca	176619
Columbiformes	Columbidae	Columba fasciata	177065
Columbiformes	Columbidae	Columba livia	177071
Columbiformes	Columbidae	Zenaida macroura	177125
Columbiformes	Columbidae	Zenaidura macroura marginella	-501584
Coraciiformes	Cerylidae	Ceryle alcyon	178119
Coraciiformes	Cerylidae	Megaceryle alcyon	178106
Galliformes	Odontophoridae	Callipepla californica	175876
Galliformes	Odontophoridae	Oreortyx pictus	175893
Galliformes	Odontophoridae	Oreortyx pictus pictus	175895
Galliformes	Phasianidae	Bonasa umbellus	175790
Galliformes	Phasianidae	Dendragapus obscurus	175860
Galliformes	Phasianidae	Dendragapus obscurus sierrae	175778
Galliformes	Phasianidae	Meleagris gallopavo	176136
Gruiformes	Gruidae	Grus canadensis	176177
Gruiformes	Rallidae	Fulica americana	176292
Gruiformes	Rallidae	Porzana carolina	176242
Gruiformes	Rallidae	Rallus limicola	176221
Passeriformes	Aegithalidae	Psaltriparus minimus	178764
Passeriformes	Aegithalidae	Psaltriparus minimus californicus	178766
Passeriformes	Alaudidae	Eremophila alpestris	554256
Passeriformes	Bombycillidae	Bombycilla cedrorum	178532
Passeriformes	Certhiidae	Catherpes mexicanus	178610
Passeriformes	Certhiidae	Certhia americana	178803
Passeriformes	Certhiidae	Certhia familiaris zelotes	178799
Passeriformes	Certhiidae	Salpinctes obsoletus	178614
Passeriformes	Certhiidae	Salpinctes obsoletus obsoletus	178615
Passeriformes	Certhiidae	Thryomanes bewickii	178562
Passeriformes	Certhiidae	Troglodytes aedon	178541
Passeriformes	Certhiidae	Troglodytes aedon parkmanii	571695
Passeriformes	Certhiidae	Troglodytes troglodytes	178547
Passeriformes	Cinclidae	Cinclus mexicanus	178536

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Passeriformes	Cinclidae	Cinclus mexicanus unicolor	178537
Passeriformes	Corvidae	Aphelocoma coerulescens	179693
Passeriformes	Corvidae	Corvus brachyrhynchos	179731
Passeriformes	Corvidae	Corvus corax	179725
Passeriformes	Corvidae	Cyanocitta stelleri	179685
Passeriformes	Corvidae	Cyanocitta stelleri frontalis	179689
Passeriformes	Corvidae	Nucifraga columbiana	179750
Passeriformes	Corvidae	Perisoreus canadensis	179667
Passeriformes	Fringillidae	Agelaius phoeniceus nevadensis	179053
Passeriformes	Fringillidae	Carduelis lawrencei	179232
Passeriformes	Fringillidae	Carduelis pinus	179233
Passeriformes	Fringillidae	Carduelis pinus pinus	202299
Passeriformes	Fringillidae	Carduelis psaltria	179234
Passeriformes	Fringillidae	Carduelis tristis	179236
Passeriformes	Fringillidae	Carpodacus cassinii	179190
Passeriformes	Fringillidae	Carpodacus mexicanus	179191
Passeriformes	Fringillidae	Carpodacus purpureus	179186
Passeriformes	Fringillidae	Carpodacus purpureus californicus	179189
Passeriformes	Fringillidae	Chondestes grammacus	179371
Passeriformes	Fringillidae	Coccothraustes vespertinus	179173
Passeriformes	Fringillidae	Coccothraustes vespertinus brooksi	-501477
Passeriformes	Fringillidae	Dendroica auduboni auduboni	-501488
Passeriformes	Fringillidae	Dendroica coronata	178891
Passeriformes	Fringillidae	Dendroica coronata auduboni	178894
Passeriformes	Fringillidae	Dendroica nigrescens	178896
Passeriformes	Fringillidae	Dendroica occidentalis	178902
Passeriformes	Fringillidae	Dendroica petechia	178878
Passeriformes	Fringillidae	Dendroica townsendi	178897
Passeriformes	Fringillidae	Euphagus cyanocephalus	179094
Passeriformes	Fringillidae	Geothlypis trichas	178944
Passeriformes	Fringillidae	Hesperiphona vespertina brooksi	179177
Passeriformes	Fringillidae	Icterus galbula	179083
Passeriformes	Fringillidae	Junco hyemalis	179410
Passeriformes	Fringillidae	Junco hyemalis thurberi	179419
Passeriformes	Fringillidae	Junco oreganus thurberi	-501528
Passeriformes	Fringillidae	Leucosticte arctoa	179224
Passeriformes	Fringillidae	Loxia curvirostra	179259
Passeriformes	Fringillidae	Loxia curvirostra bendirei	179263
Passeriformes	Fringillidae	Melospiza lincolnii	179484
Passeriformes	Fringillidae	Melospiza lincolnii alticola	179486
Passeriformes	Fringillidae	Melospiza lincolnii lincolnii	179485
Passeriformes	Fringillidae	Melospiza melodia	179492
Passeriformes	Fringillidae	Molothrus ater	179112
Passeriformes	Fringillidae	Oporornis tolmiei	178940
Passeriformes	Fringillidae	Oporornis tolmiei tolmiei	178942
Passeriformes	Fringillidae	Passerculus sandwichensis	179314
Passeriformes	Fringillidae	Passerella iliaca	179464
Passeriformes	Fringillidae	Passerella iliaca fulva	179478
Passeriformes	Fringillidae	Passerella iliaca megarhyncha	179479
Passeriformes	Fringillidae	Passerella iliaca schistacea	179474
Passeriformes	Fringillidae	Passerella iliaca sinuosa	179470

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Passeriformes	Fringillidae	Passerina amoena	179151
Passeriformes	Fringillidae	Pheucticus melanocephalus	179140
Passeriformes	Fringillidae	Pinicola enucleator	179205
Passeriformes	Fringillidae	Pipilo chlorurus	179310
Passeriformes	Fringillidae	Pipilo erythrophthalmus	179276
Passeriformes	Fringillidae	Pipilo fuscus	179293
Passeriformes	Fringillidae	Piranga ludoviciana	179882
Passeriformes	Fringillidae	Pooecetes gramineus	179366
Passeriformes	Fringillidae	Spizella breweri	179440
Passeriformes	Fringillidae	Spizella breweri breweri	179442
Passeriformes	Fringillidae	Spizella passerina	179435
Passeriformes	Fringillidae	Spizella passerina arizonae	179437
Passeriformes	Fringillidae	Sturnella neglecta	179039
Passeriformes	Fringillidae	Vermivora celata	178856
Passeriformes	Fringillidae	Vermivora celata lutescens	178859
Passeriformes	Fringillidae	Vermivora ruficapilla	178861
Passeriformes	Fringillidae	Vermivora ruficapilla ridgwayi	178863
Passeriformes	Fringillidae	Wilsonia pusilla	178973
Passeriformes	Fringillidae	Wilsonia pusilla chryseola	178976
Passeriformes	Fringillidae	Xanthocephalus xanthocephalus	179043
Passeriformes	Fringillidae	Zonotrichia atricapilla	179461
Passeriformes	Fringillidae	Zonotrichia leucophrys	179455
Passeriformes	Fringillidae	Zonotrichia leucophrys gambelii	179457
Passeriformes	Fringillidae	Zonotrichia leucophrys leucophrys	179456
Passeriformes	Fringillidae	Zonotrichia leucophrys oriantha	179458
Passeriformes	Hirundinidae	Hirundo pyrrhonota	178453
Passeriformes	Hirundinidae	Hirundo rustica	178448
Passeriformes	Hirundinidae	Iridoprocne bicolor	178434
Passeriformes	Hirundinidae	Progne subis	178464
Passeriformes	Hirundinidae	Stelgidopteryx serripennis	178443
Passeriformes	Hirundinidae	Tachycineta bicolor	178431
Passeriformes	Hirundinidae	Tachycineta thalassina	178427
Passeriformes	Muscicapidae	Catharus guttatus	179779
Passeriformes	Muscicapidae	Catharus guttatus sequoiensis	179783
Passeriformes	Muscicapidae	Catharus ustulatus	179788
Passeriformes	Muscicapidae	Catharus ustulatus ustulatus	179789
Passeriformes	Muscicapidae	Myadestes townsendi	179824
Passeriformes	Muscicapidae	Myadestes townsendi townsendi	179825
Passeriformes	Muscicapidae	Sialia currucoides	179811
Passeriformes	Muscicapidae	Sialia mexicana	179806
Passeriformes	Muscicapidae	Turdus migratorius	179759
Passeriformes	Muscicapidae	Turdus migratorius propinquus	179764
Passeriformes	Paridae	Parus gambeli	178718
Passeriformes	Paridae	Parus gambeli abbreviatus	178720
Passeriformes	Paridae	Parus inornatus	178744
Passeriformes	Paridae	Poecile gambeli	554385
Passeriformes	Passeridae	Anthus rubescens	554127
Passeriformes	Regulidae	Regulus calendula	179870
Passeriformes	Regulidae	Regulus calendula cineraceus	179872
Passeriformes	Regulidae	Regulus satrapa	179865
Passeriformes	Regulidae	Regulus satrapa olivaceus	179867

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Passeriformes	Sittidae	Sitta canadensis	178784
Passeriformes	Sittidae	Sitta carolinensis	178775
Passeriformes	Sittidae	Sitta carolinensis nelsoni	178778
Passeriformes	Sittidae	Sitta carolinensis tenuissima	178780
Passeriformes	Sittidae	Sitta pygmaea	178788
Passeriformes	Sittidae	Sitta pygmaea pygmaea	178789
Passeriformes	Sturnidae	Sturnus vulgaris	179637
Passeriformes	Sylviidae	Chamaea fasciata	178826
Passeriformes	Turdidae	Ixoreus naevius	179773
Passeriformes	Tyrannidae	Contopus borealis	178365
Passeriformes	Tyrannidae	Contopus cooperi	554221
Passeriformes	Tyrannidae	Contopus sordidulus	178360
Passeriformes	Tyrannidae	Contopus sordidulus veliei	178361
Passeriformes	Tyrannidae	Empidonax difficilis	178348
Passeriformes	Tyrannidae	Empidonax hammondii	554254
Passeriformes	Tyrannidae	Empidonax oberholseri	178346
Passeriformes	Tyrannidae	Empidonax traillii	178341
Passeriformes	Tyrannidae	Empidonax traillii brewsteri	178342
Passeriformes	Tyrannidae	Empidonax wrightii	178347
Passeriformes	Tyrannidae	Myiarchus cinerascens	178316
Passeriformes	Tyrannidae	Sayornis nigricans	178330
Passeriformes	Tyrannidae	Tyrannus verticalis	178287
Passeriformes	Vireonidae	Vireo gilvus	179023
Passeriformes	Vireonidae	Vireo gilvus swainsoni	179025
Passeriformes	Vireonidae	Vireo huttoni	178997
Passeriformes	Vireonidae	Vireo solitarius	179010
Passeriformes	Vireonidae	Vireo solitarius cassinii	179014
Piciformes	Picidae	Asyndesmus lewis	178200
Piciformes	Picidae	Colaptes auratus	178154
Piciformes	Picidae	Colaptes auratus collaris	178159
Piciformes	Picidae	Dryocopus pileatus	178166
Piciformes	Picidae	Dryocopus pileatus abieticola	178168
Piciformes	Picidae	Dryocopus pileatus picinus	178167
Piciformes	Picidae	Melanerpes formicivorus	178189
Piciformes	Picidae	Melanerpes lewis	178196
Piciformes	Picidae	Picoides albolarvatus	178256
Piciformes	Picidae	Picoides arcticus	178250
Piciformes	Picidae	Picoides pubescens	178259
Piciformes	Picidae	Picoides villosus	178262
Piciformes	Picidae	Sphyrapicus nuchalis	178211
Piciformes	Picidae	Sphyrapicus ruber	178212
Piciformes	Picidae	Sphyrapicus thyroideus	178208
Piciformes	Picidae	Sphyrapicus thyroideus thyroideus	178209
Piciformes	Picidae	Sphyrapicus varius	178202
Piciformes	Picidae	Sphyrapicus varius daggetti	178207
Strigiformes	Caprimulgidae	Chordeiles minor	177979
Strigiformes	Caprimulgidae	Chordeiles minor hesperis	177981
Strigiformes	Caprimulgidae	Phalaenoptilus nuttallii	555544
Strigiformes	Caprimulgidae	Phalaenoptilus nuttallii californicus	177970
Strigiformes	Strigidae	Aegolius acadicus	177942
Strigiformes	Strigidae	Asio flammeus	177935

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Strigiformes	Strigidae	Asio otus	177932
Strigiformes	Strigidae	Bubo virginianus	177884
Strigiformes	Strigidae	Bubo virginianus pacificus	177892
Strigiformes	Strigidae	Glaucidium gnoma	177902
Strigiformes	Strigidae	Otus flammeolus	177878
Strigiformes	Strigidae	Otus kennicottii	555388
Strigiformes	Strigidae	Strix nebulosa	177929
Strigiformes	Strigidae	Strix occidentalis	177925
Strigiformes	Strigidae	Strix occidentalis occidentalis	177927
Strigiformes	Strigidae	Strix varia	177921
Trochiliformes	Trochilidae	Calypte anna	178036
Trochiliformes	Trochilidae	Selasphorus rufus	178040
Trochiliformes	Trochilidae	Stellula calliope	178048
Unassigned Animal	Unassigned Animal	Certhia americana zelotes	-9725048
Unassigned Animal	Unassigned Animal	Contopus cooperi mariorinus	-9725028
Unassigned Animal	Unassigned Animal	Dendroica aestiva brewsteri	-9725024
Unassigned Animal	Unassigned Animal	Euphagus cyanocephalus minusculus	-9725023
Unassigned Animal	Unassigned Animal	Picoides villosus orius	-9725049
Unassigned Animal	Unassigned Animal	Poecile gambeli abbreviatus	-9725039
Unassigned Animal	Unassigned Animal	Poecile gambeli baileyae	-9725029
Unassigned Animal	Unassigned Animal	Sphyrapicus ruber daggetti	-9725034
Unassigned Animal	Unassigned Animal	Spizella passerina stridula	-9725050

APPENDIX 6

Lassen Volcanic National Park species list - MAMMALS

Order	Family	StandardScientificName	TSN
Artiodactyla	Antilocapridae	Antilocapra americana	180717
Artiodactyla	Bovidae	Bos taurus	183838
Artiodactyla	Cervidae	Cervus elaphus	180695
Artiodactyla	Cervidae	Odocoileus hemionus	180698
Artiodactyla	Cervidae	Odocoileus hemionus columbianus	-501743
Artiodactyla	Cervidae	Odocoileus hemionus hemionus	-501744
Carnivora	Canidae	Canis latrans	180599
Carnivora	Canidae	Canis latrans lestes	-501596
Carnivora	Canidae	Canis lupus	180596
Carnivora	Canidae	Urocyon cinereoargenteus	180609
Carnivora	Canidae	Vulpes vulpes	180604
Carnivora	Felidae	Felis concolor	180587
Carnivora	Felidae	Felis rufus	203547
Carnivora	Felidae	Lynx rufus	180582
Carnivora	Mephitidae	Mephitis mephitis	180562
Carnivora	Mephitidae	Spilogale putorius	180570
Carnivora	Mustelidae	Lutra canadensis	180572
Carnivora	Mustelidae	Martes americana	180559
Carnivora	Mustelidae	Martes pennanti	180560
Carnivora	Mustelidae	Mustela erminea	180555
Carnivora	Mustelidae	Mustela frenata	180556
Carnivora	Mustelidae	Mustela vison	180553
Carnivora	Mustelidae	Taxidea taxus	180565
Carnivora	Procyonidae	Bassariscus astutus	180577
Carnivora	Procyonidae	Procyon lotor	180575
Carnivora	Ursidae	Ursus americanus	180544
Chiroptera	Vespertilionidae	Eptesicus fuscus	180008
Chiroptera	Vespertilionidae	Eptesicus fuscus bernardinus	-501640
Chiroptera	Vespertilionidae	Lasionycteris noctivagans	180014
Chiroptera	Vespertilionidae	Lasiurus cinereus	180017
Chiroptera	Vespertilionidae	Myotis californicus californicus	-501719
Chiroptera	Vespertilionidae	Myotis evotis	179995
Chiroptera	Vespertilionidae	Myotis lucifugus	179988
Chiroptera	Vespertilionidae	Myotis lucifugus carissima	-501722
Chiroptera	Vespertilionidae	Myotis volans	179990
Chiroptera	Vespertilionidae	Myotis volans interior	-501728
Chiroptera	Vespertilionidae	Myotis yumanensis	180004
Didelphimorphia	Didelphidae	Didelphis virginiana	179921
Insectivora	Soricidae	Sorex monticolus	179950
Insectivora	Soricidae	Sorex palustris	179933
Insectivora	Soricidae	Sorex palustris navigator	-501808
Insectivora	Soricidae	Sorex trowbridgii	179956
Insectivora	Soricidae	Sorex vagrans	179932
Insectivora	Talpidae	Neurotrichus gibbsii	179975
Insectivora	Talpidae	Scapanus latimanus	179981
Lagomorpha	Leporidae	Lepus americanus	180112
Lagomorpha	Leporidae	Lepus californicus	180115
Lagomorpha	Leporidae	Sylvilagus nuttallii	180126
Lagomorpha	Ochotonidae	Ochotona princeps	180109
Rodentia	Aplodontiidae	Aplodontia rufa	180133
Rodentia	Castoridae	Castor canadensis	180212
Rodentia	Dipodidae	Zapus princeps	180387
Rodentia	Erethizontidae	Erethizon dorsatum	180393

APPENDIX 6

Rodentia	Erethizontidae	Erethizon dorsatum epixanthum	-501643
Rodentia	Erethizontidae	Erethizon epixanthum epixanthum	-501644
Rodentia	Geomyidae	Thomomys monticola	180227
Rodentia	Heteromyidae	Dipodomys heermanni	180239
Rodentia	Heteromyidae	Perognathus californicus	180258
Rodentia	Muridae	Clethrionomys californicus	180295
Rodentia	Muridae	Clethrionomys gapperi	180294
Rodentia	Muridae	Microtus longicaudus	180299
Rodentia	Muridae	Microtus montanus	180310
Rodentia	Muridae	Neotoma cinerea	180371
Rodentia	Muridae	Neotoma cinerea occidentalis	-501732
Rodentia	Muridae	Ondatra zibethicus	180318
Rodentia	Muridae	Peromyscus boylii	180282
Rodentia	Muridae	Peromyscus maniculatus	180276
Rodentia	Muridae	Phenacomys intermedius	180359
Rodentia	Muridae	Reithrodontomys megalotis	180343
Rodentia	Sciuridae	Glaucomys sabrinus	180169
Rodentia	Sciuridae	Marmota flaviventris	180140
Rodentia	Sciuridae	Sciurus griseus	180176
Rodentia	Sciuridae	Spermophilus beecheyi	180148
Rodentia	Sciuridae	Spermophilus beldingi	180149
Rodentia	Sciuridae	Spermophilus lateralis	180154
Rodentia	Sciuridae	Tamias amoenus	180190
Rodentia	Sciuridae	Tamias merriami	180194
Rodentia	Sciuridae	Tamias minimus	180195
Rodentia	Sciuridae	Tamias quadrimaculatus	180200
Rodentia	Sciuridae	Tamias senex	180203
Rodentia	Sciuridae	Tamias speciosus	180206
Rodentia	Sciuridae	Tamiasciurus douglasii	180167
Unassigned Animal	Unassigned Animal	Citellus oregonus	-9725025
Unassigned Animal	Unassigned Animal	Clethrionomys gapperi mazama	-9725047
Unassigned Animal	Unassigned Animal	Glaucomys sabrinus lascivus	-9725046
Unassigned Animal	Unassigned Animal	Martes americana sierrae	-9725045
Unassigned Animal	Unassigned Animal	Microtus longicaudus sierrae	-9725044
Unassigned Animal	Unassigned Animal	Mustela erminea muricus	-9725043
Unassigned Animal	Unassigned Animal	Neotoma cinerea alticola	-9725042
Unassigned Animal	Unassigned Animal	Ochotona princeps schisticeps	-9725041
Unassigned Animal	Unassigned Animal	Peromyscus maniculatus gambelii	-9725040
Unassigned Animal	Unassigned Animal	Scapanus latimanus dilatus	-9725038
Unassigned Animal	Unassigned Animal	Sorex trowbridgii mariposae	-9725022
Unassigned Animal	Unassigned Animal	Sorex vagrans amoenus	-9725037
Unassigned Animal	Unassigned Animal	Spermophilus beldingi oregonus	-9725036
Unassigned Animal	Unassigned Animal	Spermophilus lateralis chrysodeirus	-9725035
Unassigned Animal	Unassigned Animal	Tamias speciosus frater	-9725033
Unassigned Animal	Unassigned Animal	Tamiasciurus douglasii albolimbatus	-9725032
Unassigned Animal	Unassigned Animal	Taxidea taxus neglecta	-9725031
Unassigned Animal	Unassigned Animal	Zapus princeps pacificus	-9725030

APPENDIX 7

High Elevation Brush RFR2S



Photographer: T. Balzer Date: 30 July 02 Time: 15:40

B1-02	45 nights	100 nights
GM Ground Squirrel	7	15
Mule Deer	3	7
American Marten	2	4
American Robin	2	4
Chipmunk	2	4
Stellers Jay	1	2
Black Bear	1	2
Total	18	39

B1-X	25 nights	100 nights
American Marten	8	32
Black Bear	4	16
Chipmunk	3	12
GM Ground Squirrel	3	12
Common Raven	3	12
Common Porcupine	2	8
Clarks Nutcracker	1	4
American Robin	1	4
Douglas Squirrel	1	4
Total	26	104

APPENDIX 7

Low Elevation Brush SMC2S



Photographer: T. Balzer Date: 30 July 02 Time: 11:48

B2-02	45 nights	100 nights
GM Ground Squirrel	26	58
Mule Deer	23	51
Chipmunk	4	7
Cal. Ground Squirrel	3	9
Snowshoe Hare	1	2
Black Bear	3	7
Total	60	134

B2-X	25 nights	100 nights
Chipmunk	29	116
GM Ground Squirrel	13	52
Common Raven	10	40
Mule Deer	8	32
Cal. Ground Squirrel	3	12
Douglas Squirrel	2	8
Snowshoe Hare	2	8
Stellers Jay	1	4
California Quail	1	4
Bobcat	1	4
Total	70	280

APPENDIX 7

High Elevation Mixed Conifer Forest SMC5D



Photographer: T. Balzer Date: 30 July 02 Time: 14:23

F1-02	47 nights	100 nights
Douglas Squirrel	5	11
Mule Deer	3	6
Common Porcupine	1	2
Black Bear	1	2
Northern Flicker	1	2
Total	11	23

F1-X	33 nights	100 nights
American Marten	36	109
Mule Deer	6	18
Douglas Squirrel	4	12
Grey Jay	3	9
Black bear	3	9
Deer Mouse	2	6
Total	54	164

APPENDIX 7

Low Elevation Mixed Conifer Forest PPN5D



Photographer: T. Balzer Date: 30 July 02 Time: 10:19

F2-02	46 nights	100 nights
GM Ground Squirrel	8	17
Chipmunk	7	15
Douglas Squirrel	6	13
Mule Deer	5	11
Western Grey Squirrel	1	2
Total	27	59

F2-X	23 nights	100 nights
GM Ground Squirrel	45	196
Chipmunk	14	61
Black Bear	5	22
Douglas Squirrel	3	13
Mule Deer	2	9
Western Grey Squirrel	1	4
Dark eyed Junco	1	4
Coyote	1	4
Total	72	313

APPENDIX 7

High Elevation Riparian MRI4P



Photographer: T. Balzer Date:1 August 02 Time: 09:29

R1-02	47 nights	100 nights
Mule deer	12	26
Blue Grouse	1	2
Chipmunk	1	2
Douglas Squirrel	1	2
Total	15	32

R1-X	24 nights	100 nights
Black Bear	7	29
American Marten	2	8
Douglas Squirrel	2	8
Mule Deer	1	4
YR Warbler	1	4
Total	13	54

APPENDIX 7

Low Elevation Riparian MRI4P



Photographer: T. Balzer Date: 1 August 02 Time: 09:29

R2-02	49 nights	100 nights	R2-X	24 nights	100 nights
Mule deer	13	27	Grey Fox	9	38
Chipmunk	2	4	Douglas Squirrel	4	17
Douglas Squirrel	1	2	Sharp Shinned Hawk	1	4
Mountain Quail	1	2			
Total	17	35	Total	14	58

Low Elevation Sub-alpine SCN4S



Photographer: T. Balzer Date: 26 July 02 Time: 13:32

S1-02	30 nights	100 nights
Chipmunk	11	37
Mule Deer	10	33
American Robin	5	17
Stellers Jay	3	10
Sharp Shinned Hawk	1	3
Blue Grouse	1	3
Total	31	103

S1-X	24 nights	100 nights
American Marten	14	58
GM Ground Squirrel	7	29
Chipmunk	5	21
Mule Deer	4	17
American Robin	2	8
Douglas Squirrel	2	8
Black Bear	2	8
Total	36	150

APPENDIX 7

High Elevation Sub-alpine SCN3S



Photographer: T. Balzer Date: 25 July 02 Time: 14:53

S3-02	21 nights	100 nights
Douglas Squirrel	11	52
Chipmunk	7	33
Clark's Nutcracker	6	29
American Robin	4	19
GM Ground Squirrel	3	14
Northern Flicker	2	10
Deer Mouse	2	10
Mule Deer	2	10
Dark-eyed Junco	1	5
Total	38	181

S2-X	30 nights	100 nights
Red Fox	19	63
Douglas Squirrel	18	60
Mule Deer	10	33
Deer Mouse	6	20
Chipmunk	4	13
Clark's Nutcracker	4	13
Hermit Thrush	3	10
American Robin	3	10
GM Ground Squirrel	3	10
Blue Grouse	2	7
WB Nuthatch	2	7
Dark-eyed Junco	2	7
Fox Sparrow	1	3
American Marten	1	3
	78	259

Photographs of all mammal species recorded throughout the study (with the exception of western grey squirrel)

SNOWSHOE HARE (*Lepus americanus*)



Date: 25 July 2002 Time: 20:44 Site: B2-X

APPENDIX 8

CHIPMUNK (*Tamias spp.*)



Date: 18 July 2002 Time:08:12 Site: B2-X

CALIFORNIA GROUND SQUIREL (*Citellus tridecemlineatus*)



Date:29 July 2002 Time: 11:47 Site: B2-X

APPENDIX 8

GOLDEN-MANTLED GROUND SQUIRREL (*Spermophilus lateralis*)



Date: 27 July 2002 Time: 14:03 Site: B1-X

DOUGLAS SQUIRREL (*Tamiasciurus douglasii*)



Date: 30 July 2002 Time: 06:37 Site: S3-02

APPENDIX 8
DEER MOUSE (*Peromyscus maniculatus*)



Date: 2 July 2002 Time: 23:16 SiteS3-02

APPENDIX 8

COMMON PORCUPINE (*Erethizon dorsatum*)



Date: 4 June 2002 Time: 23:54 Site: F1-02

COYOTE (*Canis Latrans*)



Date: 18 July 2002 Time: 06:16 Site: F2-X

APPENDIX 8

RED FOX (*Vulpes vulpes*)



Date: 11 July 2002 Time: 03:19 Site: S2-X

GREY FOX (*Urocyon cinereoargenteus*)



Date: 27 July 2002 Time: 02:14 Site: R2-X

APPENDIX 8

BLACK BEAR (*Ursus americanus*)



Date:10 July 2002 Time: 19:36 Site: B1-X

AMERICAN MARTEN (Martes americana)



Date: 23 July 2002 Time: 17:52 Site: F1-X

APPENDIX 8

BOBCAT (Lynx rufus)



Date: 25 July 2002 Time: 05:09 Site: B2-X

MULE DEER (*Odocoileus hemionus*)



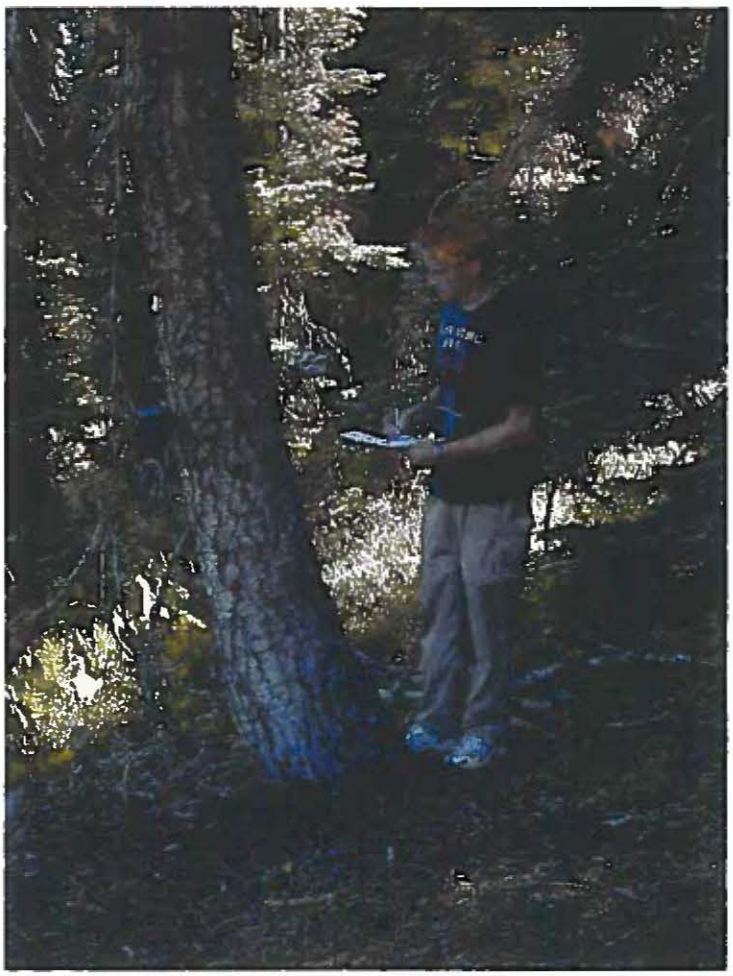
Date: 18 June 2002 Time: 19:28 Site: S1-02

APPENDIX 9

Fig 1a: Establishing sensors 'sensitive' area for site S2-02



Fig 1B: Height photo and camera set up for site S2-02



APPENDIX 9

Fig 2A: Alternate Camera set up, F2-02



Fig 2B: Side view for F2-02

