

**The Effects of Off-Highway Vehicles on
American Martens (*Martes americana*) in California**

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Introduction

The use of Off Highway Vehicles and Over Snow Vehicles (hereafter OHVs) in California is growing along with the burgeoning population of the state. Managing this growth in a manner that is consistent with multiple land management objectives poses a mounting challenge to land managers and the OHV user community. Basic information on how various aspects of OHV use (e.g., presence, sound, physical effects) affect populations and habitat elements of interest and concern have thus far presented a barrier to informed OHV use management.

Although there are a number of reviews of the effects of recreation and OHV on wildlife (e.g., Boyle and Samson 1985, Gutzwiller 1991, Knight and Gutzwiller 1995) there have been few studies directed at the effects of OHV on top predators (e.g., Creel et al. 2002), and none addressing martens specifically. Martens occur primarily in high-elevation montane forests that, until the last 150 years, were relatively isolated from major human disturbances. For this reason, and because martens occur in habitats where winter and summer recreation in California is increasing, they are an ideal species for which to

evaluate the effects of OHV. Martens are reputed to be sensitive to the presence of humans, yet they also occur in commercial ski areas and have been reported to scavenge on household garbage in isolated resort communities. Their tolerance of both the presence of motorized recreationists and OHV noise, has not been studied nor are we aware of any observations that suggest that they either habituate to, or are especially startled by, noise from OHVs.

Martens detect human activity using visual, olfactory, and acoustic cues from which they assess risk based on perceived approach distance and the magnitude and type of activity. Acoustic stimuli, including vehicle noise, are particularly useful tools that animals use to monitor human activity at long range. Therefore, OHV noise is likely to be an important predictor of effects. One of the most straightforward ways to determine whether the sound of an anthropogenic disturbance affects a species of interest is to compare the distribution of species to the distribution of the sound. Logic dictates that if a given sound is disturbing, an animal will relocate or alter its activity to avoid it. To measure this response requires: 1) sampling the spatial distribution and intensity of sounds generated by OHV use, 2) an interpretation of what constitutes disturbing sound (= noise), and 3) generating a map of the distribution of noise across the study area. Because there may be a relationship between the level and frequency of occurrence of OHV noise and the chances of response, quantitative measurements of noise are desirable as well. The present work focuses primarily on how seasonal and spatio-temporal factors related to OHV use and sound affect the distribution of martens.

Indicators of the response of animals to a potential stressor can be measured at the level of the individual (e.g., behavior, physiology, use of space) and, if individual responses affect survival and reproduction, at the level of the population (e.g., size, distribution, growth rate). This study compares the *spatial relationship* of marten occurrence with the distribution of OHV use, OHV noise, and of suitable habitat under the assumption that if OHV use is perceived as a threat, martens will disproportionately occur in areas where OHV use is low relative to areas where it is high. We did not consider, for this study, a design that required manipulating the OHV stimuli that individual martens received.

This would have required telemetric monitoring of a necessarily small number of individuals whose locations each day would need to be determined prior to applying some experimental noise treatment (e.g., Delaney et al. 1999). This is difficult because mammals, unlike birds during the breeding season, are not restricted for a reasonable amount of time (i.e., nesting) to a location where their behavior can be easily monitored during the application of treatments.

Methods

Study Area

The study will be replicated at 2 areas in the Sierra Nevada. This report summarizes the work that has been conducted in the Lake Tahoe Basin study area; work in the second study area – on the High Sierra Ranger District on the Sierra National Forest – will commence in fall 2004.

The Lake Tahoe study area is located on the west shore of Lake Tahoe and is composed of mostly lands managed by the U. S. Forest Service's Lake Tahoe Basin Management Unit (LTBMU; Fig. 1). The study area is approximately 90 km² and extends from Phipps Peak in northeastern Desolation Wilderness northward to Stanford Rock on the north rim of Blackwood Canyon. Elevations range from about 2100 – 3100 m and the area is composed largely of forested habitats dominated by red fir (*Abies magnifica*), lodgepole pine (*Pinus contorta*), white fir (*Abies concolor*), western white pine (*Pinus monticola*), mountain hemlock (*Tsuga mertensiana*), and Jeffrey pine (*Pinus jeffreyi*).

Sampling Design

The design is based on the need to relate an index of occurrence of martens to 3 potential explanatory variables: (1) OHV use, (2) OHV noise, and (3) suitable habitat. OHV noise is presumed to have either no effect or a negative effect whereas the amount of suitable habitat is assumed to have a positive effect on an index of marten occurrence. Because it is likely that an interaction exists between the effects of OHV noise and the effects of habitat suitability, the effects of OHV use and noise on the spatial distribution of martens cannot be assessed without also accounting for the spatial distribution of suitable habitat.

The study area is divided into two adjacent subunits, the northern area where OHV use was permitted and encouraged (the ‘Use Area’; McKinney/Miller Creek and Blackwood Canyons) and the southern area where OHV use was prohibited (the ‘Non-Use Area’; Desolation Wilderness, Fig. 1). Boundaries of the two subunits were selected to create similar-sized areas (45 km² each) that were also similar in respect to their predicted suitability as marten habitat. This goal was accomplished using the California Wildlife Habitat Relationships (CWHR) system (Mayer and Laudenslayer 1988; California Department of Fish and Game, Ver. 8.0 2002) by identifying, from LTBMU forest inventory maps, areas that were similar in respect to the 3 characteristics that influence CWHR marten suitability: forest type, canopy cover and tree size class. The total percent of each area in the 3 most suitable vegetation types (red fir, Sierran mixed conifer, and lodgepole pine) was ~72% in each area (Fig. 2). Tree size class distributions were also similar between Use and Non-Use Areas and canopy closure differed primarily in the elevated proportion of the Use Area in the ‘moderate’ class (Fig. 2).

Each sub-area was divided into a set of 2-km² hexagonal sample units (Fig. 1). This is about one-half of the average size marten home range in California (Simon 1980, Spencer 1981) and was selected to provide sufficient resolution to capture relative exposure to OHV noise in different marten home ranges. We identified and attempted to sample at least 22 sample units in each subunit of the study area for a total of 44 total sample units for the entire study area.

Sampling of marten occurrence and of OHV use and noise was conducted year round and was divided into 2 seasons of OHV use (Summer: 30 June – 3 September and Winter: 20 January to 27 March) and the 2 intervening seasons when OHV use is reduced (Fall: 10 October to 15 December and Spring: 27 April to 25 June).

Marten Sampling

Primary Response Variable – Occurrence: Marten occurrence in each sample unit was determined by using baited track plates, baited remote cameras, and snow-tracking

(Halfpenny et al. 1995, Kucera et al. 1995, Zielinski 1995). We established 3 stations in the center of each sample unit, each separated by 250 m, and each 636 m from the edge of the unit and 1270 m from the nearest station at an adjacent unit (Fig. 3). During the summer and fall seasons of 2003 we established a single sooted track plate (Zielinski and Kucera 1995) at each of the stations in each sample unit. Each station was baited with chicken and run for 12 consecutive days. A commercial trapping lure (Gusto, Minnesota Trapline Products, Pennock, Minnesota, USA), was placed at each station when it was established as an olfactory attractant. Each station was visited every 3rd day (total of 4 visits) to collect tracks, replace bait, and replace track plates as needed.

During the winter and spring sampling periods we established a single Trailmaster camera system (Kucera et al. 1995) at 2 of the 3 stations in each sample unit. The systems were deployed on single trees with a plastic shield to shed snowfall without triggering photographs (Fig. 4). Each camera station was baited with chicken, received trapping lure, and run for 15 consecutive days. Cameras were visited every 5th day (total of 3 visits) to collect film and replace bait as needed. During the winter season, snowtracking was conducted at each station and on two transects, the first occurred from the sample unit entrance location to the first station, and the second from the first to the second station.

Secondary Response Variables - Activity pattern and Sex ratio: The methods we use to determine the occurrence of martens in each sample unit also produce collateral information that is of value in addressing secondary effects of OHV use on marten behavior and demographics. During seasons when cameras are our primary sampling device we receive information about the time when martens visit bait stations and are photographed. If martens in the Use Area appear at different times of day than in the Non-Use Area, this may mean that martens are adjusting the active phase of their circadian rhythms to avoid the time of day when disturbance by humans is greatest. We are currently organizing and analyzing these data to determine whether activity times differ in the two areas.

The use of track plates also provides us the opportunity to gather incidental information on the effects of OHV on the sex ratio of animals that use each of the areas. Martens are sexually dimorphic and a study in Ontario determined that the tracks of males are significantly larger in specific dimensions compared to females (Routledge 2000). Although we have not conducted a similar analysis for martens in California, we plan to measure the length and width of selected tracks from each sample unit to determine whether track sizes, on average, differ in the Use and Non-Use Areas. If, for example, we find that the average size of tracks is larger in the Use Area, we will conclude that because male tracks are larger than females that more of the visitors to track plates in the Use Area are males. A method for selecting tracks to measure and a simplified method for measurement is being developed.

OHV Sampling

The proposed design requires a measure of OHV use in each sample cell. However, use reflects only the presence of a vehicle and does not measure noise, the stimulus that is likely to affect the behavior of martens. Measures of trail use may be a practical *index* of the sound produced by vehicles but there are a number of reasons why it may not be a sufficient measure of potential disturbance. The detectability of OHVs will vary depending on characteristics of each OHV type (e.g., 4 vs. 2-stroke engine), local topographic features (e.g., ridge vs. drainage, or forest vs. talus scree), and atmospheric conditions. Because these characteristics affect the intensity and pattern of transmission of noise in ways that are not measured by simple counts of travel on prescribed trails, trail use and noise will be measured independently. After the relationship between intensity of OHV use and sound is understood, it may be possible to model -- and thus to predict -- the exposure of different areas without direct measurement with acoustic equipment.

Sampling OHV Use I: Road and Trail Monitoring--We measured use of major roads and trails within sample units during the same period we collected marten occurrence data. Trailmaster 1500 event recorder and sensor units were established on the most highly used road or trail within a sample unit. Each event recorder was established concurrently

with the marten sampling stations and run for the 12 (Summer and Fall) or 15 (Winter and Spring) day period for each season. This method can only be used to record variation in use on existing trails and did not result in estimates of use in cells that have no known OHV trails. A minority of the event recorders also included cameras with which to sample the types of use (motorized versus non-motorized) and types of vehicles (e.g., 4WD truck, ATV, trail bike).

During the winter we also physically mapped (on U.S.G.S. 7.5 minute topographic maps) the snowmobile routes we encountered while traveling within the study area. These mapped routes were then digitized to create a GIS coverage of specific snowmobile use areas and estimates of the frequency of use of each route. This coverage will be used to create an acoustic soundscape by interfacing it with a digital topographic information (see ‘Creating a Predicted Noise Exposure Map’, below).

Sampling OHV Use II: Listening & Walking Surveys--Listening and walking surveys were conducted to detect presence of all forms of human activity within each sample unit, including those without OHV trails. These were executed during each visit after stations had been established, resulting in 4 survey opportunities for each sample unit during the summer and fall of 2003, and 3 surveys per sample unit during the winter and spring of 2004. A walking survey in each sample unit was conducted from the point of access (e.g., edge of sampling unit) to the first station, from the first station to the second (all seasons), and from the third from the second to the third station (summer and fall only). Visual and acoustical detections of use were recorded as well as recent signs of use (e.g., fresh vehicle tracks). Three-minute listening surveys occurred at each station during each check after establishment. During these surveys all sounds of human activities were categorized and their durations were recorded.

Because our research activities also contribute to the stimuli that may affect marten occurrence, we also recorded the amount of time spent, and the type of transportation used when visiting each sample unit in each area. These data will contribute to the data we collect on OHV use in general.

Sampling OHV Noise—Two types of noise data are being collected. First, time-history data are collected over periods of days to measure the incidence of OHV activity and the absolute level of all types of noise that may occur. Second, real-time data are collected to obtain more detailed information about the levels produced by specific types of OHVs.

Time-history data are collected continuously in 2-second intervals using Larson-Davis 720 (LD-720) Type II sound level meters (SLMs). Audiograms have not been developed for martens, but the sounds perceived by weasels (*Mustela frenata*) and mink (*M. vison*) suggest that they are most sensitive to sounds in the 1- 16 kHz range (Heffner and Heffner 1985, Powell and Zielinski 1989). The SLMs record sounds across this range of frequencies. The microphones are mounted 1.4 m above substrate level and covered with 5 cm open-pore foam windscreens. Units are calibrated with a CAL200 calibrator at the beginning and end of each sampling period. The units run for approximately four days with the goal of including at least two weekday and two weekend days.

SLMs were deployed in one of three possible locations within selected sample units. Most commonly, SLMs were paired with a Trailmaster event recorder system monitoring a road or trail. This was the ideal deployment because it allowed us to link the passage of an OHV with the noise produced. Less commonly, SLMs were placed in the center of a sample unit or paired with a marten sampling location. SLMs were established during the set up of marten and/or trail monitoring stations within sample units and were checked on the same schedule as marten stations. During checks, SLM data was downloaded onto a HP pocket PC, recalibrated and SLMs were reset to data collection mode.

Real-time data are recorded using a Sony TCD-Pro II DAT recorder or a Marantz PMD670 compact flash digital recorder. The units are equipped with ACO 7013 microphones calibrated with a Larson-Davis CAL200 calibrator at the beginning and end of each recording. In most cases, data are also collected using a Larson-Davis 824 SLM set to record data in 128-ms intervals. These recordings are used to generate calibrated

1/3-octave band spectral levels and time-varying characteristics of each event, such as onset rate.

Real-time data are collected in two ways, using (1) controlled experiments and (2) opportunistic sampling. In the controlled experiments, real time data are collected during passes by project vehicles at a pre-arranged distance and speed. To date this has been conducted during the winter, using snowmobiles, only. Eleven poles are placed in a row at 5 m intervals to allow vehicle speed to be calculated from an observing station. The stations are placed 15 m from the vehicle track nominally, but distances may vary somewhat due to local conditions. The stations are equipped with a video camera, used to monitor vehicle speed and behavior; a real-time DAT or digital recorder; and an LD-824 SLM. During controlled experiments, the vehicles are driven past the station approximately 5 times at speeds considered typical for the area.

Real time data are also collected opportunistically at sites where recreationists engage in specific types of activities, such as snowmobile/ATV tours and rapid uphill accelerations in remote locations ('high-lining'). During opportunistic sampling periods an observer sets up a monitoring station along a well known road/trail. The monitoring station consists of an LD-824 SLM paired side-by-side with an LD-720 SLM, a TrailMaster event recording unit, a DAT or digital recorder, and a video camera. Observations of passing vehicles are made along a transect of known distance. During observation periods (4-7 hrs) time, vehicle type, and time to cross the transect are recorded.

Creating a Predicted Noise Exposure Map in GIS

Our collection of use *and* noise information will allow us to produce a noise layer in GIS to estimate variation in noise among sample units and between Use and Non-use Areas. For example, in each sample cell that includes an OHV trail or road, we will have an index of the number of vehicle passes on the most prominent road or trail *and* an index of noise exposure for both weekdays and weekends. The index of noise exposure will be based on an estimate of the number of passes by various vehicle types and the acoustic properties of the vehicles taken from the real-time monitoring effort. Estimates of usage

will be derived from Trailmaster data, camera surveys, and indices of use derived from listening and walking surveys (described above). The combination of trail monitoring, observer use monitoring and noise monitoring will be used to illustrate the relationship between level of use and noise levels. Modeling this relationship will allow us to predict noise levels at sample units where SLMs were not deployed. In addition, tracks by machines in the snow provide a unique opportunity during the winter sampling period to map specific trails and paths used by snowmobiles.

The trail and use information will be inputs to a NOISEMAP Simulation Model (NMSIM; Miller et al. 2003) that will be developed to produce a noise surface (comprised of 400 m cells) over each area. NMSIM calculates the level of noise propagating away from a source traveling at a prescribed speed along a route, and accounts for local topography (USGS Digital Line Graph hypsography) and approximate substrate type (forested, snow-covered, etc.). The acoustic characteristics of the source, such as 1/3-octave band spectrum, are entered into the model in advance. When the model has been run for many vehicle passages over a route, and the results have been summed, an estimate of exposure can be calculated for a desired area and time period.

To ensure the best possible characterization of OHV activity, data from a number of sources are being combined to develop an estimate of the type and number of vehicles traveling each route by season. First, TrailMaster units and camera stations are collecting vehicle events as continuously as possible during each sampling block. Second, time-history data from the LD-720 SLMs are being used to determine the distribution of noise characteristics (levels, durations, etc.) of OHV events. Finally, observers collect locations and identities of OHVs in off-trail areas. When combined, the incidence of OHV events, routes or areas traveled, the proportion of events that can be attributed to each vehicle type, and the typical acoustic characteristics of each type will be available. Together, these products will result in predicted relative noise exposure values for each sample unit. The development of the NMSIM model for the Lake Tahoe Basin study area is underway and with the goal of completion by early 2005.

Analyses

We will test alternative hypotheses about marten distribution using logistic regression methods, with the presence or absence of marten detections in each sample unit as a binomial response variable. *A priori* models will be generated, based on the most likely explanations for marten occurrence in each sample unit, and evaluated using a strength of evidence approach (Burnham and Anderson 2002). Alternative models will be constructed using potential predictors that include: habitat values only, OHV use values only, and combinations of OHV and habitat values.

Habitat values will be represented by marten suitability indices predicted by mapped distributions of forest type, size class and canopy cover from CWHR. Although CWHR models are not usually spatial explicit and ignore the juxtaposition of habitat patches in assigning suitability, a 'landscape' model for martens in the Sierra Nevada has been developed within the CWHR framework (Timossi et al. 1995). We will apply this model to the study area to assign to each sample unit an average habitat suitability value.

OHV noise and use values will be represented, most likely in separate analyses, by: (1) the location of the sample unit in either the Use or Non-Use Areas, (2) the use indices (i.e., trailmaster event counts, listening surveys, walking surveys) for the subset of sample units where this will be available, and (3) the predicted noise exposure values generated by NMSIM for each sample unit. Four sets of models will be developed using variables from each set of predictors, one for each of the 4 seasonal sampling periods, and all will be ranked using Akaike's information criteria for small sample sizes (AIC_c). Akaike weights (w) will also be calculated, using ΔAIC_c values, to assist with interpretation. Finally, the relative importance of individual variables will be assessed using the adjusted importance weights (Anderson et al. 2001).

Seasonal Effects- Sampling during the 4 seasons will allow us to evaluate temporal changes in occurrence of martens in each sample unit. In particular, we are interested in whether martens may be absent from sample units during the peaks of OHV use (winter and

summer) yet return there between peak seasons (in the spring and/or fall). Thus, each sample unit will have a 4-season ‘capture history’ sequence where 0 indicates no detection and 1 indicates detection (e.g. 0000, 0011, 0010, 1111). Histories identified as 0101, for example, would represent locations where martens occurred prior to and after each season of OHV disturbance, but not during them. If this case is strongly associated with cells that also have high OHV use or sound values, it represents support for the hypothesis that martens respond negatively to OHV use. The frequency of this case among cells with high sound intensities will be evaluated against its expectation by chance using Chi-square statistics.

Results

[This report includes preliminary summaries of only a few of the analyses we plan to conduct. Final analyses for the Lake Tahoe Basin study area will probably not be available until 2005 and the results may differ from the summaries presented here.]

Marten and OHV Use

During the course of the year, sampling occurred in 52 different sample units, 26 in the Use Area and 26 in the Non-Use Area. Of these, 36 were sampled in each of the 4 seasons, 20 in the use and 16 in the non-use. For the sample units sampled during at least one season, martens were detected at 47 (90%) of them; 24 (92%) in the Use and 23 (88%) in the Non-Use Area. For the 36 units that were sampled during all seasons, martens were detected during at least one season in every case (Table 1).

Summer 2003--Summer sampling occurred from 30 June to 3 September, 2003. Weather during the summer period was warm and dry; however, thunderstorms brought precipitation during each week of August. Using track plate enclosures, animal sampling occurred in 46 sample units, 23 in the Use and 23 in the Non-Use area. Martens were detected at 18 (78%) sample units in the Use and 13 (56%) in the Non-Use Area (Table 1). Road and trail monitoring occurred in 32 total grid cells, 18 in the Use and 14 in the Non-Use area (Table 2). An average of 898 events were recorded per monitoring site in the use and 474 events per station in the non-use. The listening and walking surveys have only been partially summarized and have demonstrated that few sounds are recorded

during the average survey (Table 3). However, in the Use Area the noise from motorized vehicles occupied about 16% of the survey time.

Fall 2003--Fall sampling occurred from 10 October to 15 December 2003. Weather during the fall period was marked with a strong decline in temperatures and abrupt arrival of winter conditions in the middle of the sampling period. About 1 m of snow fell in the study area on the night of October 31st and continuous snow cover remained for the rest of the fall period. A distinct transition in types of vehicle use in the study area occurred as a result; snowmobiles began to appear and use of motorcycles, jeeps and ATVs ended. Animal sampling occurred via track plate enclosures in 46 sample units, 24 in the Use and 22 in the Non-Use area. Martens were detected at 22 (91%) of the sample units in the Use and 13 (59%) in the Non-Use area (Table 1). Road and trail monitoring occurred in 29 sample units, 18 in the Use and 11 in the Non-use area (Table 2). An average of 1146 events were recorded per monitoring site in the Use and 558 events per station in the Non-Use Area.

Winter 2004--Winter sampling occurred from 20 January to 27 March, 2004. Weather during the winter period remained cold, with frequent snowfall, however a long warming trend occurred from the end of February into March. Continuous snow cover remained throughout the study area during the winter. Animal sampling occurred via remote photography in 43 sample units, 23 in the Use and 20 in the Non-Use Area. Martens were detected at 22 (95%) sample units in the Use and 19 (95%) in the Non-Use area (Table 1). Suitable snow conditions were present for snow tracking for the majority of the winter season until the end of the season when a storm-free warming period reduced snow quality. Snow tracking transects yielded detections of at least 8 species, however >90% of all detections were of Douglas squirrels (*Tamiasciurus douglasii*), martens, and snowshoe hares (*Lepus americanus*) (Table 4). Road and trail monitoring occurred in 20 sample units during winter, 16 in the Use and 4 in the Non-Use area (Table 2). Snowmobile use occurred within every sample unit in the use area. An average of 842 events were recorded per monitoring site in the Use and 649 events per station in the Non-Use Area.

Spring 2004--Spring sampling occurred from 27 April to 25 June. Weather during the spring continued to warm with rapid snowmelt. Snowmobile activity ceased shortly after the last storm of the winter, which occurred about 2 weeks before the spring sampling began; no snowmobile use was detected during the spring sampling season. Summer OHV use slowly began to increase during the course of the spring but the Rubicon Trail, in particular, was used intermittently throughout the spring. The gate on the Blackwood Canyon paved road (access to the northern half of the Use area) remained closed until June 1, resulting in little use by OHVs for half the spring season. Marten sampling occurred via remote photography in the spring in 43 sample units, 23 in the Use and 20 in the Non-Use area. Martens were detected at 22 (95.7%) sample units in the Use and 12 (60.0%) in the Non-Use area (Table 1). Black bears began emerging from their dens at the beginning of the spring session and disabled some of the camera stations and damaged SLMs. We have yet to determine exactly how many stations were unable to photograph martens due to this damage, but the number will likely be low. Road and trail monitoring occurred in 24 total grid cells, 17 in the use and 7 in the non-use portions of the study area (Table 2). An average of 1191 events were recorded per monitoring site in the Use and 1140 events per station in the Non-Use Area. Detections of use during listening and walking surveys remained low but reflected the limited use of the study area during the spring (Table 3). Listening surveys detected motorized vehicles during 19 (4%) of the total 441 survey minutes. A single motor noise was recorded for every 1144 m walked and one non-motor noise was recorded for every 958 m walked (Table 3).

Disturbance Caused by the Research Team

Our research activities led to disturbance in sample units that differed depending on the mode of travel (Table 5). Foot travel was roughly equivalent in each season, with the exception of the fall session which may reflect additional effort dedicated to monitoring sound level meters in the Use Area during this season. Our vehicular presence in each of the areas was, of course, much greater in the Use area (Table 5) given that vehicular travel was prohibited in most of the Non-Use area.

OHV Noise

Time-history noise recording -Time-history data will be collected during each of the 4 seasonal sampling periods, but did not begin until Fall 2003. The summer sampling is currently underway. Thus, only the data collected during Fall 2003, Winter 2004, and Spring 2004 are described below. Much of the following is drawn from an earlier report that focused on the noise sampling (Bowles and Yack 2004).

SLMs were tested and calibrated by the manufacturer (Larson-Davis) before deployment. A total of 19 preliminary SLM deployments were made with 12 units from 23 November to 6 December 2003 (Fall 2003). Early snowfall made deployment in the sample units that were distant from roads prohibitively time-consuming. The SLM systems are heavy (~8 kg) and difficult to transport over long distances on skis. In addition, cold temperatures reduced battery life, and infiltration of moisture into the microphone and instrument housings caused instrument malfunctions, resulting in loss of data. Only 8 sample units in the Use Area and 5 units in the Non-Use Area were sampled successfully in the fall (Table 6), as measured by deployments that returned at least some usable data. However, although the number of sites sampled was small, the deployments were relatively successful. Of the hours deployed, instruments functioned well enough to return data 94% of the time, and of that 83% of the hours were usable.

Equipment failure was an unexpected and significant challenge during both the fall and winter periods. Of the initial 12 SLMs provided in fall of 2003, 5 failed and were sent for repair. An additional 6 were calibrated, for a total of 13, but 5 of these failed in the field and were sent for repair before the end of the fall. The major cause of failures was breakage in the microphone cables and connections. Based on this experience, the sampling design was re-evaluated during the winter of 2004. Additional instruments were sent for calibration and all malfunctioning units were sent to Larson-Davis for repair. Only a small number of SLMs were deployed in the centers of sample units. Instead, the sampling effort was focused on collecting data close to OHV routes, especially when it was possible to pair noise monitors with TrailMaster OHV use monitoring units. These sites were expected to yield the data most useful to the NMSIM

modeling effort.

Despite heavy snows and equipment failures, the crew succeeded in collecting data from 31 of the 44 sample units, including 16 in the use area and 11 in the non use area during Winter 2004 (Table 6). Data were collected from 27 January to 26 March, for a total of 72 deployments (18 Use and 13 Non-Use Area). Unfortunately, the cost of the effort was high. Data were obtained during only 39% of the time that instruments were deployed. When instruments functioned, the return rate of usable data was comparable to that found in Fall 2003 (78% of hours).

Noise sampling improved considerably during the spring season. Sampling occurred in 31 grid cells, 21 in the use and 10 in the non-use portions of the study area. The spring yielded 94% usable data hours, the highest value to date. The percent of time the meters collected data also improved considerably (Table 6).

Real time recording -- In Fall 2003, opportunistic real-time sampling was conducted on the Blackwood Trail for three days, and one day on the Rubicon Trail. Snowmobiles, skiers, and foot traffic were monitored (18 hours). Controlled passes were made on the lower part of the Blackwood trail in the Winter of 2004, with data collected from Polaris 500 and 600 snowmobiles. In addition, two days of opportunistic sampling on the Blackwood Trail were conducted (the Winter 2004 effort totaled 14 hours).

Discussion

Preliminary analysis indicates that martens occur in most of the sample units in both the Use and Non-Use Areas. The project is incomplete, however, and a substantial amount of additional data that could alter the interpretation awaits analysis. Some of the analyses that will affect the conclusions are listed below:

1. Variation in OHV use and noise at the Sample Unit level. Noise may vary substantially within Use and Non-Use sampling units. We have not yet investigated how marten occurrence correlates with the use and noise values at

- individual sample units, especially within the Use area. Although the proportion of sample units where martens are detected may be no different between the areas, it is possible that martens are detected less commonly in those sample units that had the greatest use and noise.
2. Habitat Suitability at the Sample Unit Level. Although the areas (Use and Non Use) were selected to equalize the total availability of suitable habitat, predicted habitat suitability varies across each area and we have not yet fully accounted for the effect of variance in habitat suitability among sample units on our results.
 3. Sex differences. We also have not determined whether a sex difference exists in the use of the areas; avoidance of one area by females, for example, would be an indication of its reduced suitability.
 4. Temporal differences. We have yet to assess the temporal distribution of visits to sample units by martens. We will be very interested in determining whether marten use changes with season and whether the circadian pattern of use of bait sites by martens is different in one area versus the other. Nocturnal-biased visits to camera stations in the Use Area only, for example, would suggest that martens have shifted their activity to occur during the time of day with the least disturbance.
 5. Absence of Replication. This study will not be complete until we duplicate it at an additional location. It is possible that the interactions between the marten population, its habitat, and OHV use are unique in the Lake Tahoe Basin. Martens seem to be more common in the Basin than many other places where they have been studied or surveyed. The abundance of martens may affect our ability to discern treatment differences; the spatial distribution of martens relative to OHV use may be different in areas where martens are less common, or habitat is less suitable.

Immediate Future Plans

OHV use and noise monitoring has improved with each season and although the data were poorer in the fall of 2003 than in other seasons, we expect to be able to maintain a high quality of noise monitoring for the balance of the project. Summer OHV noise and

use monitoring at the Lake Tahoe Basin study area will be conducted during August 2004 (we were not yet prepared for noise sampling in June 2003, when marten summer sampling began). In September we will begin work in a second study area, located on the High Sierra Ranger District of the Sierra National Forest. We will begin sampling in October 2004 in the new study area and continue through the fall of 2005.

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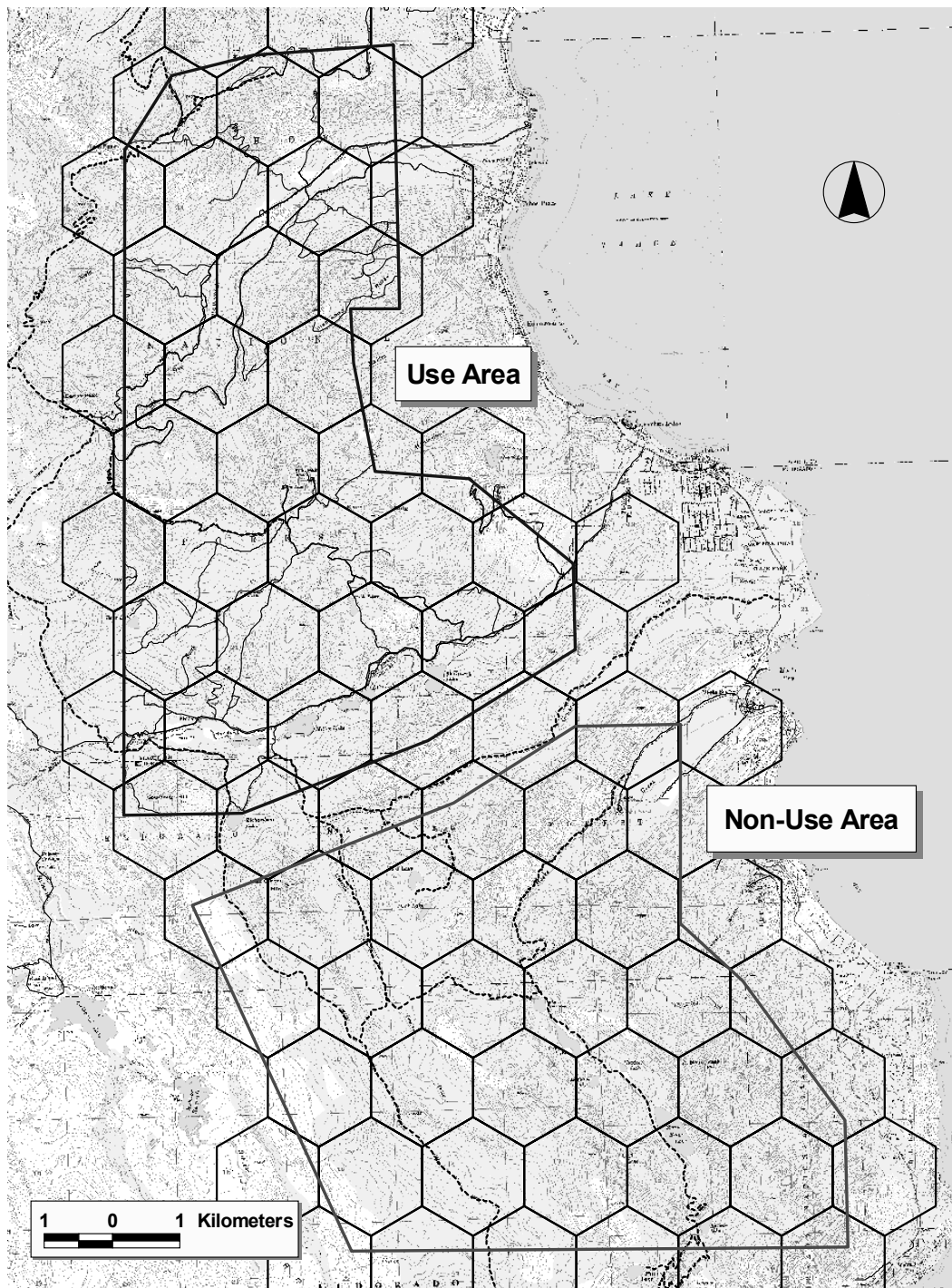


Figure 1. Lake Tahoe Basin study area. 2-km² hexagonal sampling units are indicated in the Use and Non-Use Areas. Dotted lines, primarily in the Non-Use Area, indicate hiking trails and solid lines indicate designated OHV routes.

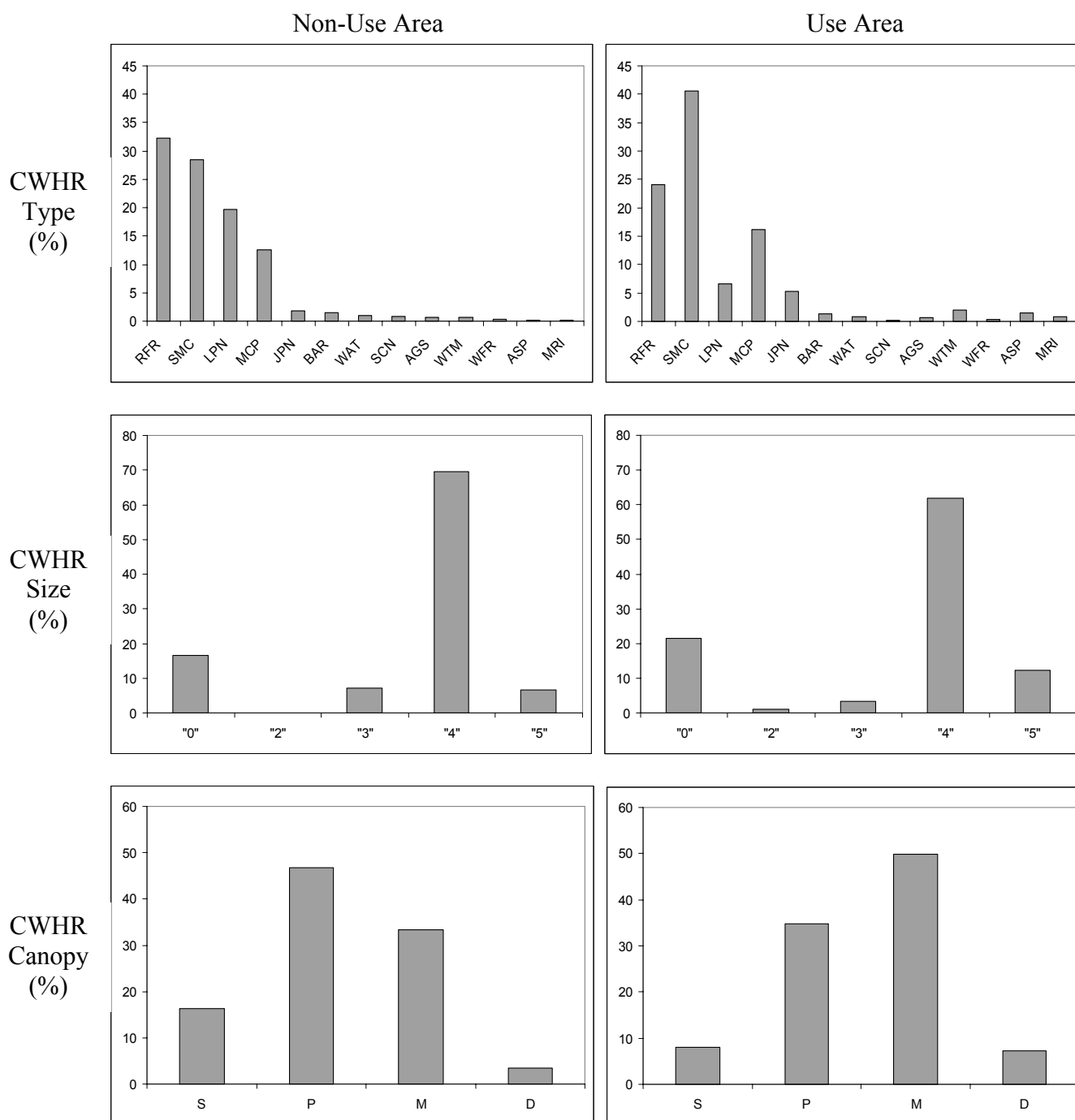


Fig. 2. Comparison of percentages in 3 characteristics of the California Wildlife Habitat Relationships (CWHR) system between the Non-Use and Use Areas on the Lake Tahoe Basin study area. CWHR Type: RFR = Red Fir, SMC = Sierran Mixed Conifer, LPN = Lodgepole Pine, MCP = Montane Chaparral, JPN = Jeffrey Pine, BAR = Barren, WAT = Water, SCN = Subalpine Conifer, AGS = Annual Grassland, WTM = Wet Meadow, WFR = White Fir, ASP = Aspen, MRI = Montane Riparian; CWHR Tree Size: 0 = no data, 2 = Sapling Tree (dbh 1"-6"), 3 = Pole Tree (dbh 6"-11"), 4 = Small Tree (dbh 11"-24"), 5 = Medium/Large Tree (dbh 11"-24"); CWHR Canopy Closure: S = Sparse Cover (10-24%), P = Open Cover (25-39%), M = Moderate Cover (40-59%), D = Dense Cover (60-100%).

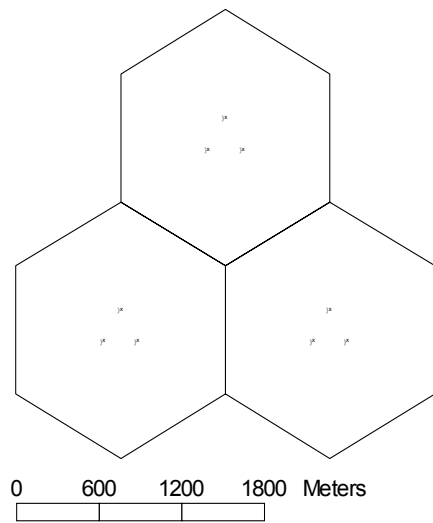


Figure 3. Schematic representation of 3 sampling units and the approximate locations of the sites used to locate either track plate or camera stations.



Figure 4. Photograph of Trailmaster 1500 (above) and 500/550 (below) camera configurations.

Table 1. American marten detection results for Sample Units (SUs) completed during 2003-2004 in the Lake Tahoe Basin Study Area. "Detections" refer to sample units with at least one station detecting a marten. Track plate surveys (Summer-Fall) had 3 stations per sample unit and camera surveys (Winter-Spring) had 2 stations per sample unit.

Area Type	Summer 2003 Track plate		Fall 2003 Track plate		Winter 2004 TM Camera		Spring 2004 TM Camera		Detections for Sus Sampled Each Season*	
	Detections	Sus	Detections	Sus	Detections	Sus	Detections	Sus	Detections	Sus
Use	18 (78.3%)	23	22 (91.7%)	24	22 (95.7%)	23	22 (95.7%)	23	20 (100%)	20
Nonuse	13 (56.5%)	23	13 (59.0%)	22	19 (95.0%)	20	12 (60.0%)	20	16 (100%)	16
Total	31 (67.3%)	46	35 (76.0%)	46	41 (95.3%)	43	34 (79.0%)	43		

*A detection for a sample unit sampled during each of the four seasons indicates a marten detection occurred during at least 1 season at that SU.

Table 2. Results of road and trail monitoring using Trailmaster systems for Summer-Fall 2003 and Winter-Spring 2004 in the Lake Tahoe Basin study area.

Site Type	Summer 2003					Fall 2003					Winter 2004					Spring 2004				
	# Sts	# Events	# Photos			# Sts	# Events	# Photos			# Sts	# Events	# Photos			# Sts	# Events	# Photos		
			T	M	NM			T	M	NM			T	M	NM			T	M	NM
Use																				
ATV Trail	4	1929	54	23	31	4	6776	124	35	76	4	703	213	49	40	3	3139	278	119	7
Unpaved road	9	9231	378	145	191	9	8780	266	18	20	9	8835	339	29	15	6	8781	701	267	200
Paved road	5	5033	44	8	21	5	5073	164	15	15	3	3937	205	8	25	2	8330	732	0	156
Total Use	18	16,174	476	176	243	18	20,629	554	68	111	16	13,475	757	86	80	17	20,250	1711	386	363
Nonuse																				
Foot trail	14	6,648	68	0	68	11	6,146	215	5	8	4	2,597	124	0	27	7	7,980	250	0	324

Sts = Sites, T = Total, M = Motorized, NM = Non-motorized.

Table 3. Results of listening and walking surveys for Use during 2 seasons during 2003-2004 on the Lake Tahoe Basin Study area. Dashes refer to fields where data has been collected, but not yet summarized.

Area Type	Summer 2003*			Fall 2003			Winter 2004			Spring 2004		
	Survey	Detections		Survey	Detections		Survey	Detections		Survey	Detections	
	Time	M	NM	Time	M	NM	Time	M	NM	Time	M	NM
Total Use	114	19	0.3	-	-	-	-	-	-	441	19	1.5
Total Nonuse	75	0	0	-	-	-	-	-	-	354	6	4
Total	189	19	0.3	-	-	-	-	-	-	813	25	5.5

Area Type	Summer 2003*			Fall 2003			Winter 2004			Spring 2004		
	Survey	Detections		Survey	Detections		Survey	Detections		Survey	Detections	
	Distance	M	NM	Distance	M	NM	Distance	M	NM	Distance	M	NM
Total Use	13,550	4	0	-	-	-	-	-	-	56,063	49	7
Total Nonuse	8,740	0	14	-	-	-	-	-	-	47,923	0	50
Total	22,290	4	14	-	-	-	-	-	-	103,986	49	57

M = Motorized; NM = Non-motorized

*Partial Summer 2003 data presented only.

Table 4. Snow tracking results from Winter 2004 in the Lake Tahoe Basin study area. Results represent total detections summed across all sample units within each portion of the study area. Survey distance is total meters surveyed over all survey units and all visits.

Area Type	Survey Distance (m)	Species Detected							
		Marten	Weasel species	Canid or Felid species	Black bear	Snowshoe hare	Squirrel species	Porcupine	Mouse species
Total Use	24540	120	2	20	1	88	323	0	6
Total Nonuse	33801	35	4	19	0	23	282	1	2
Total	58341	155	6	39	1	111	605	1	8

Table 5. Total number of minutes spent in sample units by researchers on foot and in vehicles in the Lake Tahoe Basin study area.

Area Type	Summer 2003		Fall 2003		Winter 2004		Spring 2004	
	Foot	Vehicle	Foot	Vehicle	Foot	Vehicle	Foot	Vehicle
Total Use	10616	3068	7848	367	6100	475	6901	286
Total Nonuse	11828	625	4683	362	5377	0	6113	24
Total	22444	3693	12531	729	11477	475	13014	310

Table 6. Noise monitoring effort in the Lake Tahoe Basin study area, fall, winter, and spring.

Fall 2003*

	Deployments	Usable Deployments	SU's	Usable SU's	Hours	Usable Hours	%Usable	Hours Deployed	% Collected
Total	19	16	18	13	2338	1951	83%	2486	94%
Use	14	11	10	8	1970	1583	80%	2029	97%
Non-Use	5	5	8	5	368	368	100%	457	81%

*Several units were collecting at 64sec intervals this season and thus recorded more hours before memory reached capacity.

Winter 2004

	Deployments	Usable Deployments	SU's	Usable SU's	Hours	Usable Hours	%Usable	Hours Deployed	% Collected
Total	72	55	31	27	3846	2994	78%	9869	39%
Use	44	31	18	16	2455	1717	70%	5504	45%
Non-Use	28	24	13	11	1391	1277	92%	4365	32%

Spring 2004

	Deployments	Usable Deployments	SU's	Usable SU's	Hours	Usable Hours	%Usable	Hours Deployed	% Collected
Total	96	85	31	31	6322	5806	92%	11121	57%
Use	66	58	21	21	4382	3969	91%	7701	57%
Non-Use	30	27	10	10	1940	1837	95%	3420	57%