SNOWCREEK SKI AREA DEER MIGRATION STUDY
1993 SPRING MIGRATION REPORT

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August 1993

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CHAPTER 1. INTRODUCTION AND METHODS

INTRODUCTION

Dempsey Construction Corporation has proposed the construction and operation of a major destination alpine ski area, the Snowcreek Ski Area, near the town of Mammoth Lakes, California. Much of the land on which the ski area is to be located is managed by the U.S. Forest Service. In 1982, the proponents of the ski area were issued a Special Use Permit to complete a feasibility study for the proposed project. A site-specific wildlife survey (Kucera 1988) was conducted in the project area from 1984-1985 in coordination with the feasibility study. The primary focus of this investigation was to determine the timing, pattern and intensity of mule deer (Odocoileus hemionus) use in the area and to delineate critical areas used by deer (e.g. fawning and migration). Results of the study indicated that nearly half of all deer wintering in Round Valley migrate through the vicinity of the proposed project.

On October 1, 1991, the U.S. Forest Service in conjunction with the proponents, local agencies and the general public completed a Final Environmental Impact Statement (FEIS) for the area. A number of potential impacts to migratory deer were identified in the FEIS. In addition, mitigation measures and management requirements intended to avoid impacts to deer or minimize the magnitude of an adverse consequence were also described. However, specific methods necessary to implement mitigation measures identified in the FEIS were deferred to a Master Development Plan (MDP) which is presently being prepared by the proponent.

In conjunction with the MDP, the proponent is required to develop a comprehensive wildlife monitoring plan that will: (1) determine when to implement the various scheduled mitigation measures, (2) determine the effectiveness of project design mitigation, and (3) monitor the overall condition of the Round Valley population. As a result, the present study was initiated in April 1993 in order to begin the monitoring of baseline conditions and to develop methodologies for gathering the necessary baseline information.

PROJECT AREA

The proposed Snowcreek Ski Area (SSA) is situated within the Town of Mammoth Lakes in sections 2, 3, 9-15, 23, and 24 of T. 4 S., R. 27 E., in the Mammoth Ranger District, Inyo National Forest, California (Figure 1). It comprises approximately 3,100 acres of steep, generally north-facing, mountainous terrain at elevations ranging from 7,960 to 11,730 feet. The site is bordered on the southwest by the Sherwin crest, which includes Pyramid Peak, Red Peak, and Fingers Peak; on the east by the Sherwin Creek drainage; and on the north by the U.S. Forest Service Mammoth Meadows and the Dempsey Construction Corporation's Snowcreek development (U.S. Forest Service 1991, I; pp 2).

Vegetation within the project area is composed of eight major plant communities including: barren or fellfield, whitebark pine, mixed

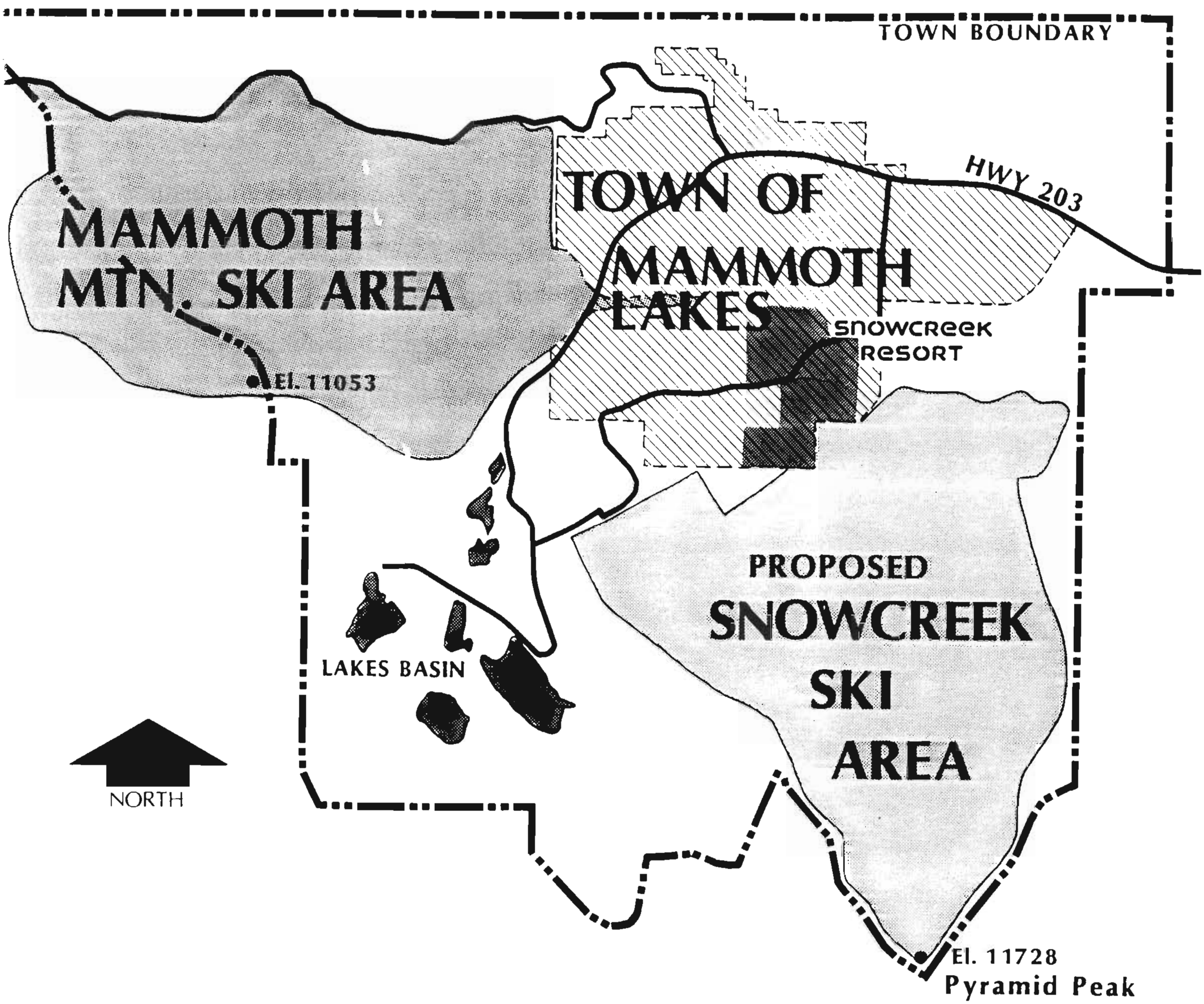


Figure: 1 LOCATION OF THE SNOWCREEK SKI AREA NEAR THE TOWN OF MAMMOTH LAKES, CA

conifer, mixed brush, quaking aspen, riparian, wetland, possible wetland, and late-seral mixed conifer (old growth) (U.S. Forest Service 1991). A complete description of these plant communities and their locations within the project area was provided by U.S. Forest Service (1991, III; pp 17-20).

METHODS

Field surveys of deer migration were conducted from 23 April-5 July 1993. Habitat mapping within the Sherwin holding area (SHA) was conducted during July and August 1993.

Habitat Mapping

Habitats occurring within the SHA were classified according to the Wildlife Habitat Relationships (WHR) System (Mayer and Laudenslayer 1988). Color aerial photographs (1:24,000 scale) provided by the U.S. Forest Service, Mammoth Ranger District, were used to make determinations on appropriate habitat classification. Habitats were then delineated on U.S. Geological Survey 7.5 minute series topographic maps and their boundaries verified in the field.

Migration Studies

Sherwin Holding Area

Deer Count Surveys--During the spring migration of 1993, deer were counted once weekly from a slow moving vehicle along a fixed route located on dirt roads within the SHA (Figure 2). The survey route began near the junction of the Convict Lakes road and State Route 395, immediately north of the Convict Knolls, went west along Southern California Edison Company's power line corridor to Sherwin Road, and then continued south along Sherwin Road to the Y.M.C.A. camp. At the Y.M.C.A. camp, the route turned west to Mammoth Creek and then followed Mammoth Creek north to SR 395. At SR 395, the route then went east to Sherwin Road and then south along Sherwin Road to the TML. All counts were performed beginning about one-half hour before official sunrise. Data collected during deer counts included the number of groups (n) and group size. The locations of each group were plotted on U.S. Geological Survey 7.5 minute topographic maps of the area. In addition, all marked deer observed were recorded and their locations mapped.

Radio-telemetry Studies--During January 1993, 39 deer were captured and fitted with radio collars in Round Valley in conjunction with larger ecological study of the Round Valley population (Vern Bleich, California Dept. of Fish and Game, pers. comm.).

From 7 June-10 July, radio-collared deer in the SHA and the project area were monitored using radio-telemetry. Initial locations were made from a vehicle equipped with a Telonics TR-2 receiver with an attached program-scanner (TS-1) and a base loaded whip antenna. Triangulation bearings (1 observer) were obtained using a hand-held, 2-

element antenna (RA-2A; Telonics Inc., Mesa, Ariz.) and ear phones. A bearing was defined as the bisection of the arc of audible reception (Garrott et al. 1987). Radio locations taken within $\geq$10 minutes of each other were "triangulated" on a map at the intersection of the directional vectors. If the angle of bearing intersection is <60 or >120 degrees, additional bearings were obtained from different recording locations. Due to safety considerations and limited manpower, night monitoring of radio-collared deer was not attempted.

Because of the error in signal location induced by steep, rocky terrain, attempts were made to verify triangulation locations by approaching deer on foot and, whenever possible, observing deer from a distance. Variables recorded once deer were observed include aspect (N, S, E, W), slope (%), elevation, group size, and sex and age classification.

Deer Fecal Pellet Collections--During May and June 1993, deer fecal pellets were collected weekly from the SHA. A total of 5 pellets were sampled from at least 40 fresh or recent defecations and pooled into weekly composite samples. Composited fecal samples were then stored in individual paper bags and air-dried for subsequent laboratory analysis. From each composited sample, 100 pellets were removed at random and sent to the University of Arizona, Tucson, for determination of plant species composition by microhistological identification of plant fragments (Sparks and Malachek 1968). One-hundred additional pellets were sent to Washington State University, Pullman, for analysis of fecal crude protein, measured as nitrogen x 6.25, by the Kjeldahl method.

Ground Surveys--Deer count surveys were conducted on foot within and immediately adjacent to the lower, northeastern portion of the SSA to determine the timing and amount of holdover deer use of the project area and to provide an index of the number of deer using the Mammoth Rock migration corridor. Ground surveys were conducted once weekly between 30 April and 1 July 1993 along a fixed route located in the rolling hills at the base of the Sherwin escarpment, between the road leading to the Moto Cross and the U.S. Forest Service meadow (Figure 3). In order to obtain the greatest possible visibility, the survey route followed major ridgelines through the area.

Snowcreek Ski Area

Infrared Sensor Equipment--Trail Master 1500 units (Goodson and Assoc., Lenexa, KS) were used on an experimental basis during the 1993 spring migration in attempt to determine the amount, timing, and specific locations of deer migration through Solitude Canyon. The Trail Master 1500 operates with an invisible infrared light beam that automatically records an event each time the infrared beam is broken. Each event is stored by date and by time (to-the-minute) and can instantly be recalled. By positioning the Trail Master beam at a certain height and setting the length of time that the beam of light is broken, the Trail Master can be used to monitor the activities of deer, as opposed to most other wildlife species.

Eight Trail Master units were used during the spring 1993 surveys. Each unit was fastened to a tree and the infrared beam aligned to cross a narrow deer trail at about 24 inches above ground. One Trail Master unit (station 1) was established immediately adjacent to the Prospect Road below Solitude Flat (Figure 4). Three units (stations 2-4) were situated on Solitude Flat along major deer trails headed west from Sherwin Lakes. Station 5 was situated in Solitude Canyon on the first bench immediately south of Solitude Flat. Three Trail Master units (stations 6-8) were established along two major deer trails located at Solitude Pass. Because of human activity in the vicinity of the Mammoth Rock migration corridor, sampling with Trail Master units was not conducted in this area.

The accuracy of the Trail Master as a deer counting device was determined in three ways. The first was from direct observations of deer crossing through the infrared beam at Trail Master stations located at Solitude Pass. The second way employed use of a 35 mm camera used in conjunction with the Trail Master at Station 4 to photographically record the number of deer that broke the beam. A third way involved positioning two Trail Master units within close proximity of one another along the same trail so that they provided replicate samples of the same day's events.

Trail Master units operated continuously between 14 May and 5 July; information on the number of deer passing through each station was recorded at 3-5 intervals.

Verification of Deer Migration Trails--The locations of deer migration trials in the project area have been described by Kucera (1988). The locations of deer migration trails mapped in previous work was verified during the course of spring field work using 1:24,000 color aerial photos.

Weather Data

Daily weather data (maximum and minimum temperatures and precipitation) was provided by the U.S. Forest Service, Mammoth Lakes Ranger District.

CHAPTER 2. RESULTS AND DISCUSSION

This chapter describes the results of the spring 1993 studies and compares the results with previous work conducted in the area.

HABITAT TYPES IN THE SHERWIN HOLDING AREA

Seven habitat types were delineated in the Sherwin holding area: Jeffrey pine, montane riparian, sagebrush, montane chaparral, aspen, perennial grassland and wet meadow. Each of these habitats is described briefly.

Jeffrey pine (*Pinus jeffreyi*) is the dominate conifer species in the SHA, occurring in pure stands at elevations ranging from 7,200-7,400 feet (Figure 5). A large, contiguous Jeffrey pine stand comprising approximately 800 acres occurs in the central portion of the holding area, primarily between Sherwin Road and SR 203. This forest is generally open, but the density of *Pinus jeffreyi* varied considerably from place to place. The understory of this habitat is dominated by a scrub layer consisting of big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), rubber rabbitbrush (*Chrysothamnus nauseous*) and snowberry (*Symphoricarpos vaccinioides*). Herbaceous understory species commonly associated with the Jeffrey pine type include squirreltail (*Sitanicn hystrix*), needle-and-thread grass (*Stipa comata*), phlox (*Phlox* spp.), and lupine (*Lupinus* spp.).

Montane riparian habitat is characterized as a narrow, often dense grove of winter deciduous trees with a sparse understory (Grenfell 1988). Within the SHA, montane riparian habitat comprises approximately 270 acres and is present in narrow bands along Mammoth, Sherwin and Laurel Creeks (Figure 5). Characteristic species include aspen (Populus tremuloides), willow (Salix sp.), alder (Alnus spp.) and black cottonwood (Populus triochocarpa). Along the lower reaches of Laurel creek (north of Sherwin Road) and portions of Mammoth Creek, montane riparian habitats occur primarily as willow stringers.

Shrub-dominated habitats occurring within the project area include sagebrush and montane chaparral. Sagebrush is the most extensive habitat in the holding area. It comprises approximately 4,500 acres and generally occurs in large, contiguous stands located primarily on the lava flats in the lower north and eastern portions of the holding area (Figure 5). Throughout most of the sagebrush habitat type, big sagebrush occurs as a codominate with antelope bitterbrush. Other associated shrubs include rubber rabbitbrush, desert peach (Prunus andersonii) and snowberry (Symphoricarpos vaccinoides). Common associates in the understory include Stipa comata, Sitanion hystrix, wildrye (Elymus triticoides), indian ricegrass (Oryzopsis hymenoides), cheatgrass (Bromus tectorium) and Phlox spp.

Montane chaparral habitat occurs at upper elevations (7,500-7,700 feet) of the holding area on gently to steeply sloping mountain uplands above sagebrush dominated habitats. It comprises approximately 700 acres primarily in the extreme western portion of holding area near the

TML and on the steep north facing slope of Laurel Mountain. Greenleaf manzanita (Arctostaphylos patula) is consistently the dominate and associates with tobacco brush (Ceanothus velutinus), Symohoricarpos vaccinoides, gooseberry (Ribes spp.), bitter cherry (Prunus emarginata) and curlleaf mountain mahogany (Cercocarpus ledifolius). On more mesic sites, common associates include Pinus jeffreyi, western juniper (Juniperus occidentalis) and singleleaf pinyon pine (Pinus monophylla). Common associates in the understory include Stipa comata, Sitanion hystrix, Elymus triticoides, Oryzopsis hymenoides, Bromus tectorium and Phlox spp.

Aspen (Populus tremuloides) habitat comprises about 40 acres in the SHA. Two large groves are present in the holding area, one on the north side of Laurel Mountain immediately above Cold Springs campground, the other in Summers Meadow adjacent to Laurel Creek.

Herbaceous dominated habitats in the SHA include wet meadow and perennial grassland. Wet meadow habitat comprises approximately 250 acres and occurs primarily on land administered by LADWP in the lower northern portion of the project area, mainly along Laurel Creek (Figure 5). Wet meadow habitat consists of variety of grasses and forbs and is typically irrigated in the spring and summer for livestock. Species common to this habitat include sedges (Carex spp.), rushes (Juncus spp.) and saltgrass (Distichlis spicata).

Perennial grassland habitat dominates a large burn on the northwest side of Laurel Mountain, immediately south of Sherwin Road. Numerous grasses make up this habitat including blue grass (Poa spp.), Bromus tectorium, Bromus spp., Elymus spp., Sitanion hystrix, Stipa comata, and Oryzopsis hymenoides. Common associates on the burn include mule-ears (Wyethia mollis), Purshia spp., Artemisia tridentata, Chrysothamnus spp., and Mojave horsebrush (Tetradymia stenolapsis). Perennial grassland habitat also dominates openings of poorly developed, drier soils within Jeffrey pine, sagebrush and montane chaparral habitats.

Sagebrush is the dominate habitat in the rolling hills located at the base of the project area (Figure 5). It comprises approximately 340 acres mostly on the more gently, less rocky slopes of the project area. Montane chaparral habitat, dominated primarily by Arctostaphylos patula, comprises about 150 acres and assumes dominance on north and west facing slopes and ridges. Mixed conifer habitat, dominated by Pinus jeffreyi, and white fir (Pinus concolor), is present in several small patches (3-9 acres) that provide important thermal and hiding cover for holdover deer. Mixed Conifer is the dominate habitat immediately above the holding area (7,700-9,600 feet elevation).

MIGRATION STUDIES

Studies to determine the temporal pattern of migration and patterns of deer distribution and habitat use in the holding area were conducted between 23 April and 25 June 1993. Studies to determine the amount, timing, and the specific locations of deer migration through the project area were conducted between 14 May and 5 July 1993.

Sherwin Holding Area

Timing and Intensity of Migration--A total of 10 deer count surveys were conducted in the SHA between 23 April and 25 June 1993. Based on deer count surveys, deer from the Round Valley herd delayed migration on the holding area for approximately 9 weeks, from 30 April-25 June (Figure 6). There were no deer observed in the holding area during the first deer count survey on 23 April. This survey revealed that much of the holding area and the adjacent migration route was still covered with snow and that most deer continued to occupy lower elevation winter ranges. Because snow blocked Sherwin Road, vehicle access during this initial survey was restricted entirely to the lower northern and eastern portions of the holding area.

Deer counts indicate that animals began arriving on the holding area during the last few days in April; 24 deer were observed on lower elevation sagebrush habitat near the base of Laurel Mountain during a survey on 30 April. A sharp increase in deer numbers occurred during the first week of May and peak numbers were counted between 19 and 25 May (Figure 6). After 25 May, deer numbers on the holding area steadily declined as the animals migrated to the summer range. Only 39 deer were observed in the holding area during a survey conducted on 25 June. Deer were first observed on foot in the project area on 7 May and peak numbers were counted in late May and early June (Figure 7).

The temporal pattern of deer migration off the winter range and subsequent arrival on the holding area was approximately 1 month later than previously described for this deer herd (Kucera 1988). In this

Figure 6. Total Number of Deer Counted
on Deer Count Surveys, Spring 1993

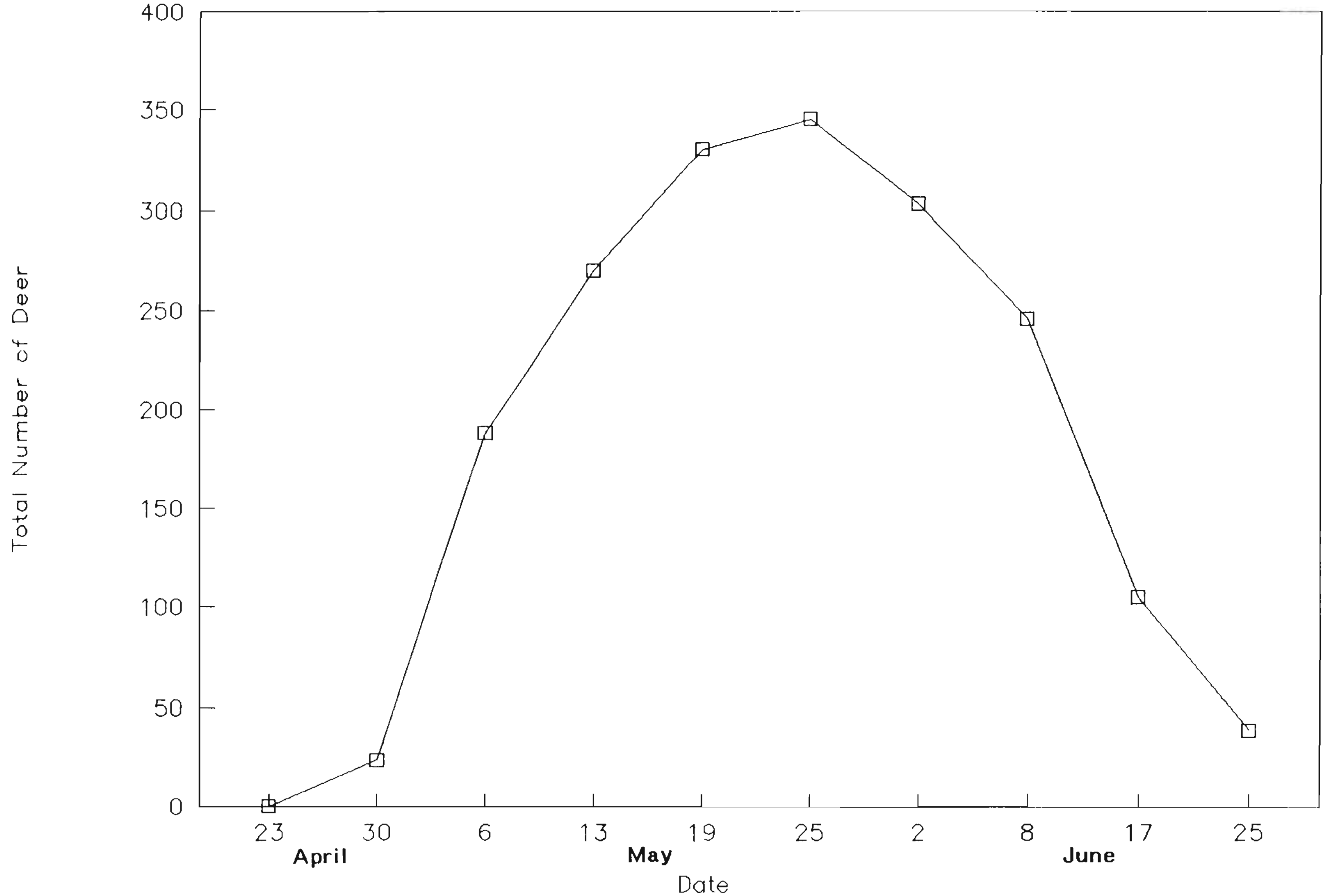
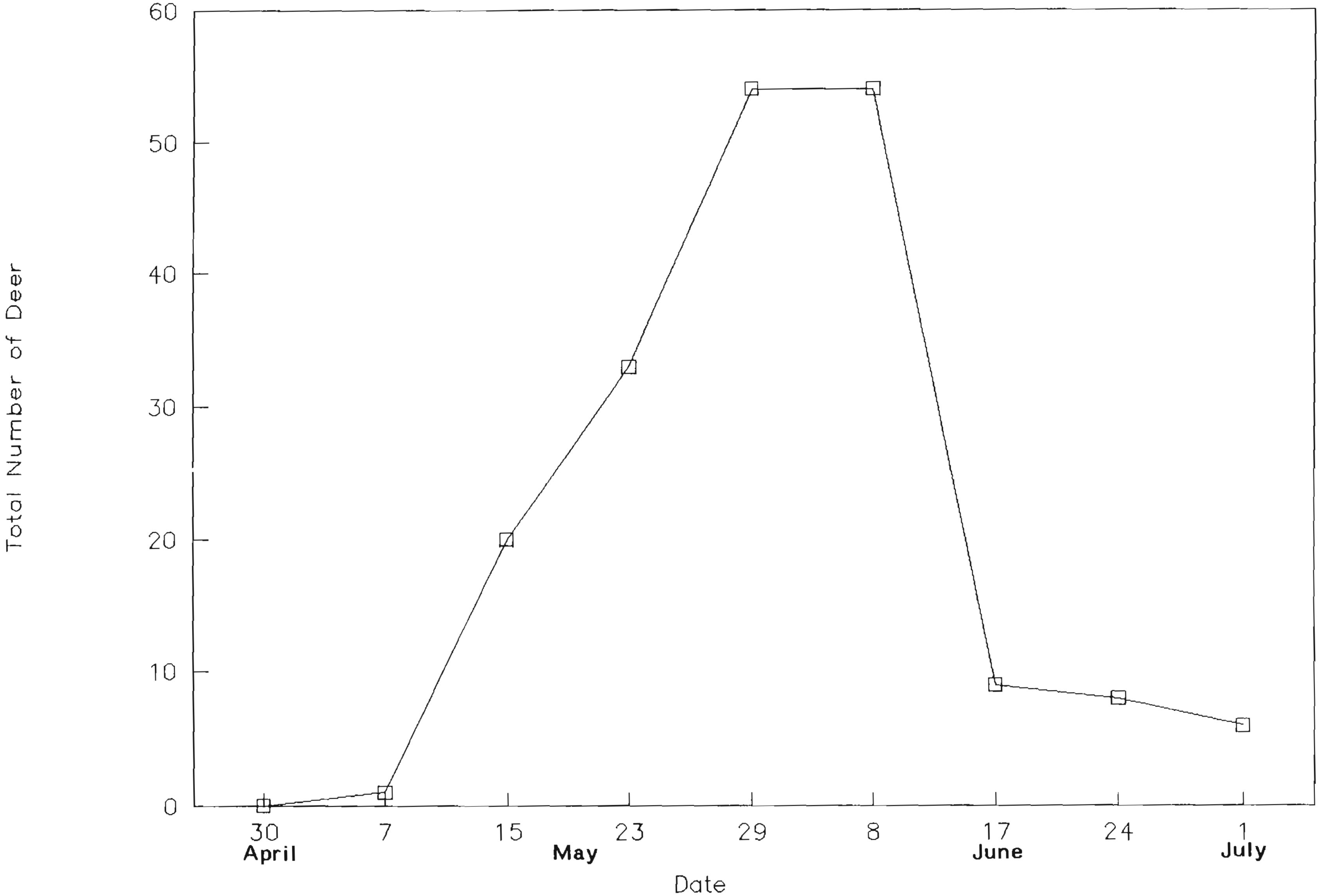


Figure 7. Total Number of Deer Observed

on 9 Ground Surveys, Spring 1993



previous work, which was conducted from 1984-1987, deer left the winter range in early April and were already present "in the hundreds" on the holding area by the time of the first deer count survey in mid April (Kucera 1988). This pattern was consistent among years despite extreme differences in the severity of winter. Maximum numbers of deer on the holding area were counted in late April and early May, with numbers declining to a minimum by mid June, as deer migrated to the summer range. During the spring migration of 1985, deer were first observed in the project area on 17 April (Kucera 1985), approximately 3 weeks earlier than in the present study.

Kucera (1988) hypothesized that similarities among years in the temporal pattern of spring migration may have been related to nutritional factors, assuming that forage on the winter range in early April was of poor quality, or in lesser abundance than on the holding area. Deer may have also been attempting to seek thermal relief because maximum daytime temperatures in Bishop average about 72 degrees Fahrenheit in April and 80 degrees Fahrenheit in May.

Several authors (Russell 1932, Leopold et al. 1951, Bertram and Remple 1977, Loft et al. 1989) have associated the timing of spring migration from the winter range with the receding snow pack and the availability of spring forage. In the present work, spring migration was delayed approximately 1 month because average minimum temperatures of 19 degrees Fahrenheit in March and 21 degrees Fahrenheit in April delayed snow melt and plant phenology along migration routes and within the holding area. Snow remained on lower elevations of the holding area until the second week in May and a heavy snowpack persisted in the project area until early June. Average minimum temperatures in the Mammoth Lakes area were not consistently above freezing until late May when peak numbers of deer were observed in the holding area.

Bertram and Remple (1977) found that deer from the North Kings herd migrated from the winter range approximately two weeks earlier following dry winters than after winters of normal to above normal precipitation. In Colorado, Garrott et al. (1987) reported that the timing of spring migration following a severe winter was approximately 1 month later than after winters that were relatively mild. These authors hypothesized that to initiate migration, which requires additional energy demands, deer must first reverse the negative energy balance experienced during the winter. Hence, after more severe winters, deer migration is delayed on lower elevation winter ranges to extend the intake of high quality forage and improve the deer's overall physiological condition. Garrott et al. (1987) also suggested that by delaying migration after a severe winter, deer can avoid the heavier snowpack at upper elevations, which would impede their movements and reduce forage availability at a time when energy demands of pregnant does are high because of the late stage of pregnancy. Energy reserves are depleted when deer are forced to traverse in snow (Wallmo and Gill 1971), and the energy output required by deer to feed in snow often exceeds that supplied by the food eaten (Kelsall 1969).

Radio-telemetry--Another approach to determining the temporal pattern of deer migration is from radio-telemetry. Limited manpower during the 1993 spring migration period made it difficult to effectively radio-track the movements of all radioed deer in the holding area. However, by determining the presence or absence of radio collared deer on the holding area, it was possible to generally determine the temporal pattern of deer migration.

Of 39 deer radio collared on the Round Valley winter range, 14 died before the onset of spring migration (Vern Bleich, Dept. of Fish and Game, pers. comm.). Of the remaining 25 deer, 20 were known to migrate north from the winter range.

Monitoring of radio collared deer in the holding area was conducted with varying intensity from 8 June-3 July 1993. Telemetry data indicates that movements of radio collared deer were consistent with information obtained from deer count surveys. There were 14 radio-collared deer present in the holding area on the first day of monitoring on 8 June and this was the maximum number of deer detected during the survey period. After 8 June, the number of deer in the holding area steadily declined as animals migrated to the summer range. Seven deer were located in the holding area on 12 June, 6 on 17 June, 5 on 21 and 25 June and 4 on 1 July. No deer were detected in the holding area during a telemetry survey conducted on 13 July.

Of the 14 radioed deer detected in the holding area, 4 were known to stage within the project area. The presence of each deer in the project area was confirmed at least once by approaching the animal on foot and then verifying its location. Doe #340 was observed weekly in the project area between 29 May and 25 June. Doe #210 was present in the project area between 8 June and 21 June. Doe #610 was located in the project between 12 June and 3 July and doe #350 between 8 June and 21 June. Thus, 4 (20%) of the 20 deer known to have migrated north from the winter range delayed migration in the project area during the 1993 spring migration. Because telemetry surveys were not initiated until 7 June and were only conducted 1-2 times weekly, it is likely that some radio-collared deer were not detected when they moved through the project area. Kucera (1988) reported that 52% of deer radioed in Round Valley in 1985 passed through or near the project area.

Patterns Deer Distribution and Habitat Use in the Holding Area-- Knowledge of deer distribution and habitat use patterns in the holding area is necessary for developing census techniques and determining the locations and dispersion of potential habitat manipulation projects. One approach to determining temporal patterns of habitat use in the holding area is from direct observations of deer. There were 152 groups of deer recorded during the 10 deer count surveys conducted in the holding area (Appendix Table 1). Average group size ranged from 4-17 deer/group ($\bar{X}$= 12.1, SE = 1.23) and typically consisted of a mixture of males, females and fawns.

Deer were observed in sagebrush habitat on 53% of observations (Table 1, Figure 8). The majority of these groups occupied the large sagebrush flat located in the lower northwest portion of the

Table 1. Number of deer groups observed by habitat type in the Sherwin holding area on 10 deer count surveys conducted from 23 April-25 June 1993.

Habitat	Groups		Deer	
	n	%	n	%
Sagebrush	80	52.6	1147	62.1
Jeffrey Pine	15	9.9	69	3.7
Wet Meadow	2	1.3	15	0.5
Montane Chaparral	39	25.7	358	19.4
Burn	16	10.5	264	14.3

holding area, between the base of Laurel Mountain and SR 203. Deer were observed in montane chaparral and Jeffrey pine habitats on 19% and 4% of observations, respectively. Fourteen percent of observations were in perennial grassland habitat in the Laurel Mountain burn; only 1% of deer groups were observed in wet meadow habitat (Table 1, Figure 8).

Deer use of sagebrush habitat was greatest in late April and early May and then declined in mid May as the snow pack receded and vegetation matured at upper elevations of the holding area (Figure 9). As deer use of sagebrush habitat decreased, use of other habitats in the holding area, mainly montane chaparral and perennial grassland, increased (Figure 9). Average group size diminished during the course of the holding period as animals gradually dispersed to higher elevations and then migrated to the summer range (Figure 10)

There were 22 deer groups observed within and immediately adjacent to the SSA on 9 ground surveys conducted from 30 April-1 July 1993 (Table 2, Figure 7). Deer were observed in montane chaparral habitat on 73% of observations. Eighteen percent of observations were in sagebrush habitat and 9% were in mixed conifer forest.

The disproportionately high level of deer use of montane chaparral habitat in the SSA portion of the holding area may be related to density of cover provided by this type. Montane chaparral is comprised of a dense mixture of shrubs including Arctostaphylos patula Ceanothus velutinus, Symohoricarops vaccinoides, Ribes spp., Prunus emarginata, Cercocarpus ledifolius, Artemisia tridentata, and Purshia

Figure 9. Number of Deer Observed by

Habitat Type, Sherwin Holding Area

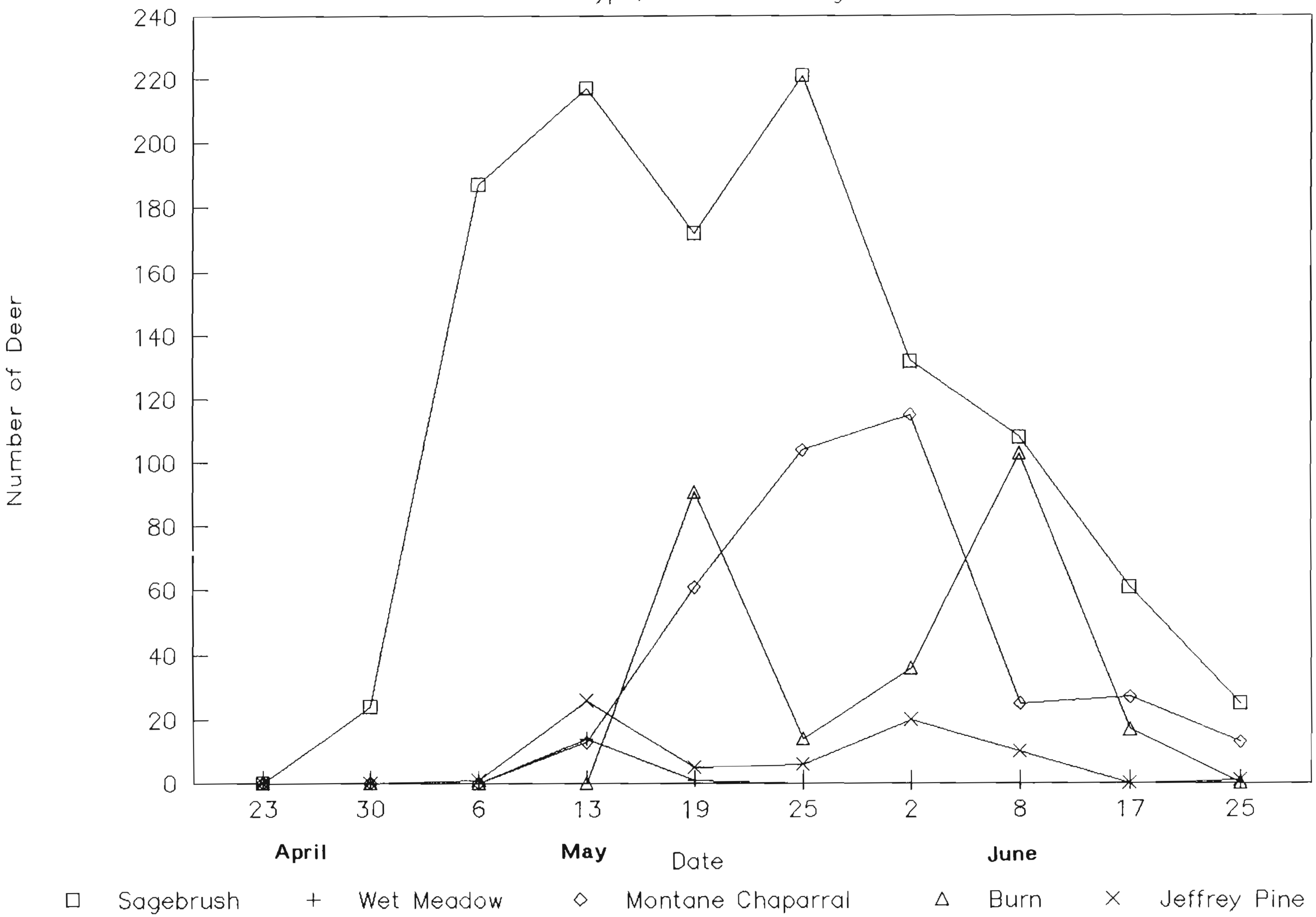


Figure 10. Average Size of Deer Groups

During the Spring Migration

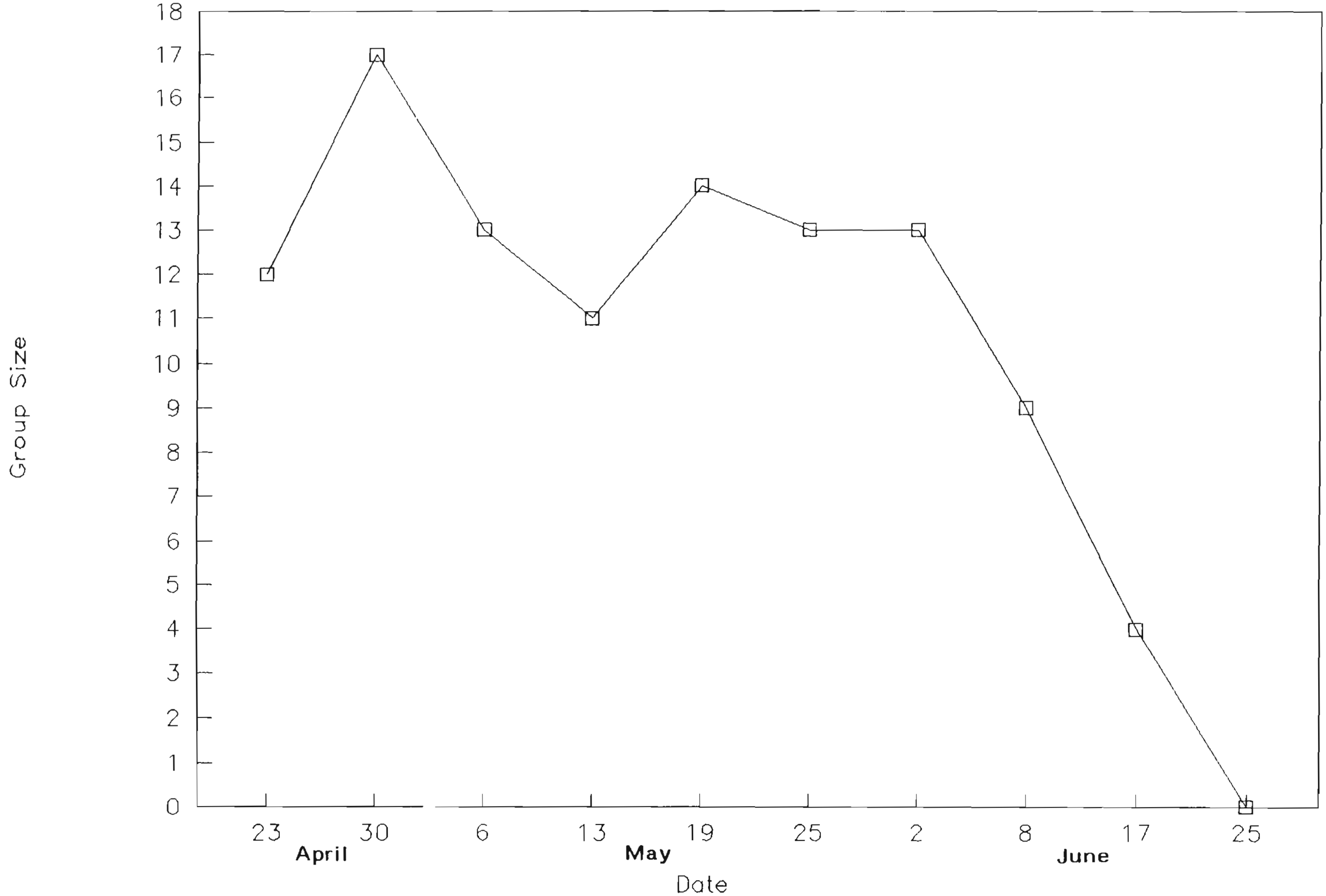


Table 2. Number of deer groups observed by habitat type within and immediately adjacent to the holding area portion of the SSA on 9 deer count surveys conducted from 30 April-1 July 1993.

Habitat	Groups n	Groups %	Deer n	Deer %
Sagebrush	4	18.1	24	13.7
MIxed Conifer	2	9.0	25	14.2
Montane Chaparral	16	72.7	126	72.0

tridentata, which provide adequate security cover for deer. These and other vegetation types common to montane chaparral habitat are also preferred by deer for feeding and resting activities. Kucera (1988) reported that _Ceanothus velutinus_, _Artemisia_, and _Purshia_ comprised >90% of spring diets. Information obtained from analysis of deer fecal pellets collected from the holding area during May and June 1993 will add measurably to understanding patterns of spring deer use of the various habitat types occurring in the holding area.

Snowcreek Ski Area

Timing and Intensity of Migration--Of the 8 Trail Master counting stations established in Solitude Canyon, 4 (stations 5, 6, 7, and 8) provided information on the timing and intensity of deer movements through the project area during the spring migration of 1993. Data collected at stations 1, 2, 3 and 4 was considered to be unreliable because these units often recorded phantom events caused by weather or events caused by other wildlife, mainly black bears (_Ursus americanus_). Additionally, black bears periodically disabled these stations by pulling either the transmitter or the receiver out of alignment.

A total of 193 events were recorded at Station 5 between 25 May and 3 July 1993; no deer sign was observed in Solitude Canyon prior to 25 May. Data collected at this station was considered to be reliable because the Trail Master was activated continuously during the survey period, human and other wildlife activity appeared to be minimal, the station was well protected from weather, and most deer moving through the canyon appeared to pass through this station. Nine percent of the deer counted by the Trail Master moved through Station 5 between 25 May and 7 June. Seventy-three percent moved through between 9 and 19 June and 18% between 20 June and 3 July (Figure 11).

The timing of deer movements over Solitude Pass was estimated from stations 6, 7 and 8. These stations were located within small patches of whitebark pine (_Pinus albicaulis_) on two well defined trails located on the north side of Solitude Pass. Unlike station 5, the stations located on Solitude Pass were highly exposed to weather and were therefore periodically disabled because of high winds and snow storms. Additionally, because of a heavy snow pack which persisted into early July, the trails normally used by deer moving over Solitude Pass were not easily recognizable. As a result, many deer did not go through the stations when attempting to cross over the pass.

A total of 164 events were recorded at stations 6, 7 and 8 between 30 May and 3 July 1993. Seventeen percent of deer moved over Solitude Pass between 30 May and 1 June (Figure 12). There were no events recorded between 4 June and 7 June because the stations were disabled by a late spring snow storm that deposited approximately 2 feet of snow on Solitude Pass. Thirty-nine percent of deer crossed over Solitude Pass on 14 and 15 June and 31% between 16 June and 3 July.

Deer migration through Solitude Canyon during spring 1993 was approximately 10 days later than reported in 1985 following a winter of below normal precipitation (Kucera 1988) (Table 3). Taylor (1989) reported that deer movements through Solitude Canyon lasted from

Figure 11. Number of Deer Counted at

Station 5, Spring Migration 1993

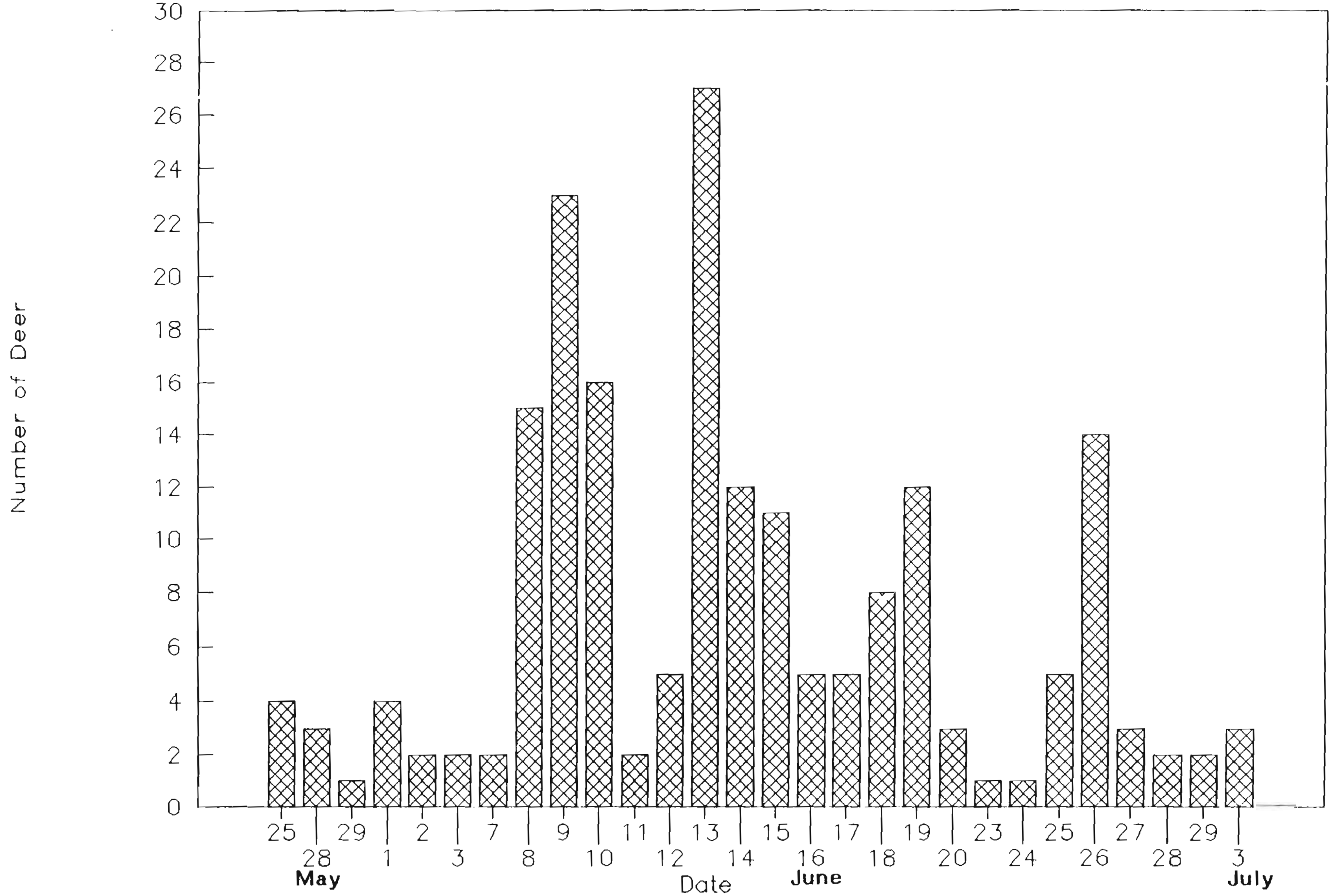


Figure 12. Total Number of Deer Moving
Over Solitude Pass, Spring 1993

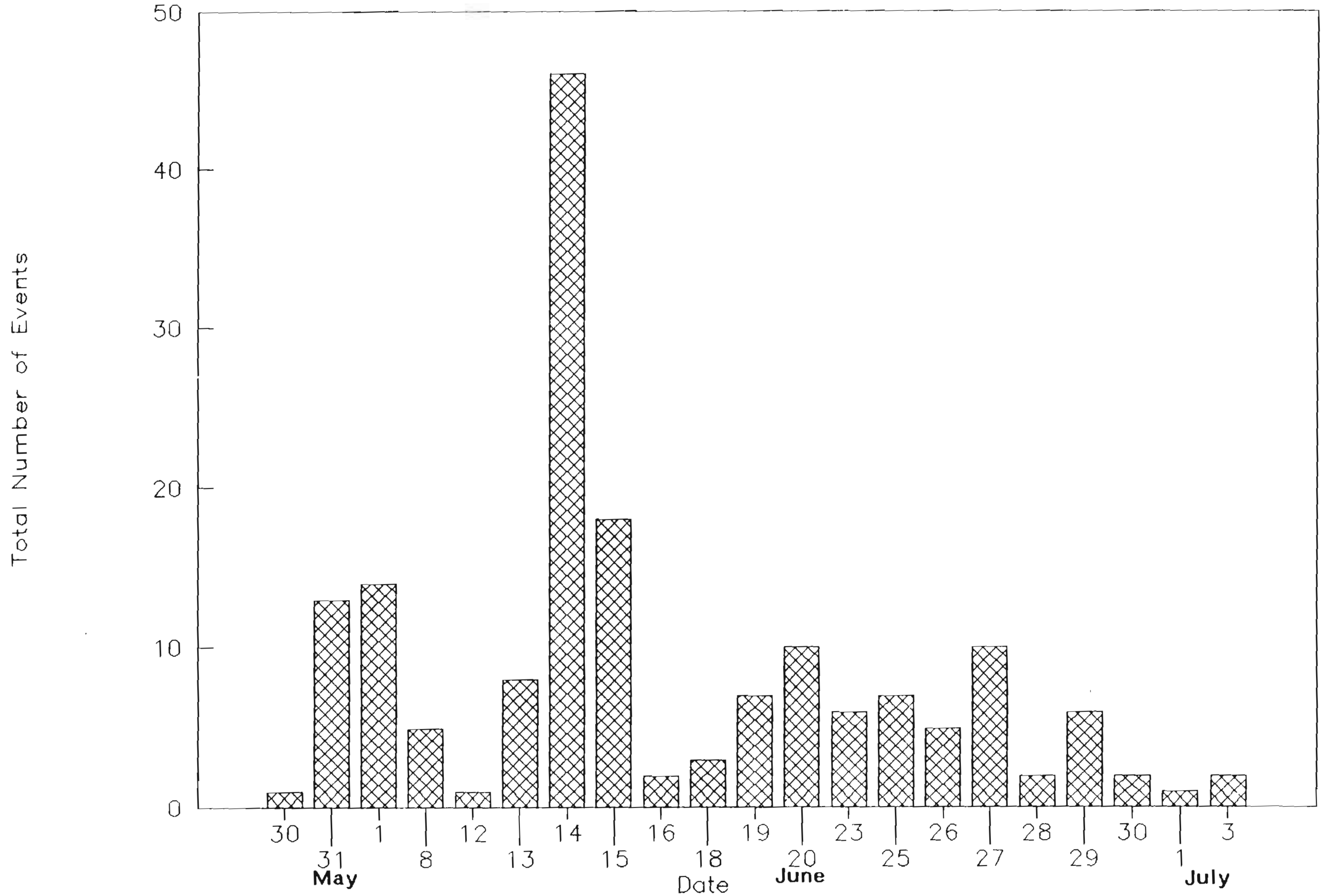


Table 3. Approximate timing of deer movements through Solitude Canyon during the spring migrations of 1985-1989 (Taylor 1989, Kucera 1985).

Year	Total Annual Snowfall (in.)	Start of Migration	End of Migration
1984-85	264.0	16 May	24 June
1985-86	294.3	25 May	24 June
1986-87	100.7	14 May	24 June
1987-88	143.0	16 May	24 June
1988-89	184.5	14 May	29 June

approximately 14 May-24 June following winters of below average snowfall. During the spring migration of 1986, which followed a winter of above average snowfall, deer movements through Solitude Canyon were delayed until approximately 25 May (Taylor 1989).

Daily Timing of Deer Movements--Event data recorded at station 5 and at Stations 6, 7 and 8 were used to determine the daily timing of deer movements through the project area. At station 5, 48% of deer counted by the Trail Master moved through the project area between the hours of 7:00 a.m. and 9:00 a.m. (Figure 13). Fourty-one percent moved through the project area between 10 a.m. and 10 p.m. and 11% between 11 p.m. and 6 a.m.

Event data recorded at Solitude Pass indicated that 46% of the deer counted by Trail Masters moved over Solitude Pass between the hours of 8:00 a.m. and 11:00 a.m. (Figure 14). Twenty-three percent of deer crossed over the pass between the hours of 1:00 p.m. and 6:00 p.m., 7% between the hours of 8:00 p.m. and 11:00 p.m., and 22% between the hours of 12:00 a.m. and 7:00 a.m.

The propensity of deer moving through the project area between the hours of 7:00 a.m. and 11:00 a.m. may be related to the physical characteristics of the snowpack at upper elevations of the project area. The surface hardness and density of snow at these higher elevations was greater in the early morning hours following nights when temperatures were below freezing. This hardened crust provided deer increased mobility as they moved over the snowpack. Verme (1968)

Figure 13. Timing of Deer Movements at

Station 5, Spring 1993

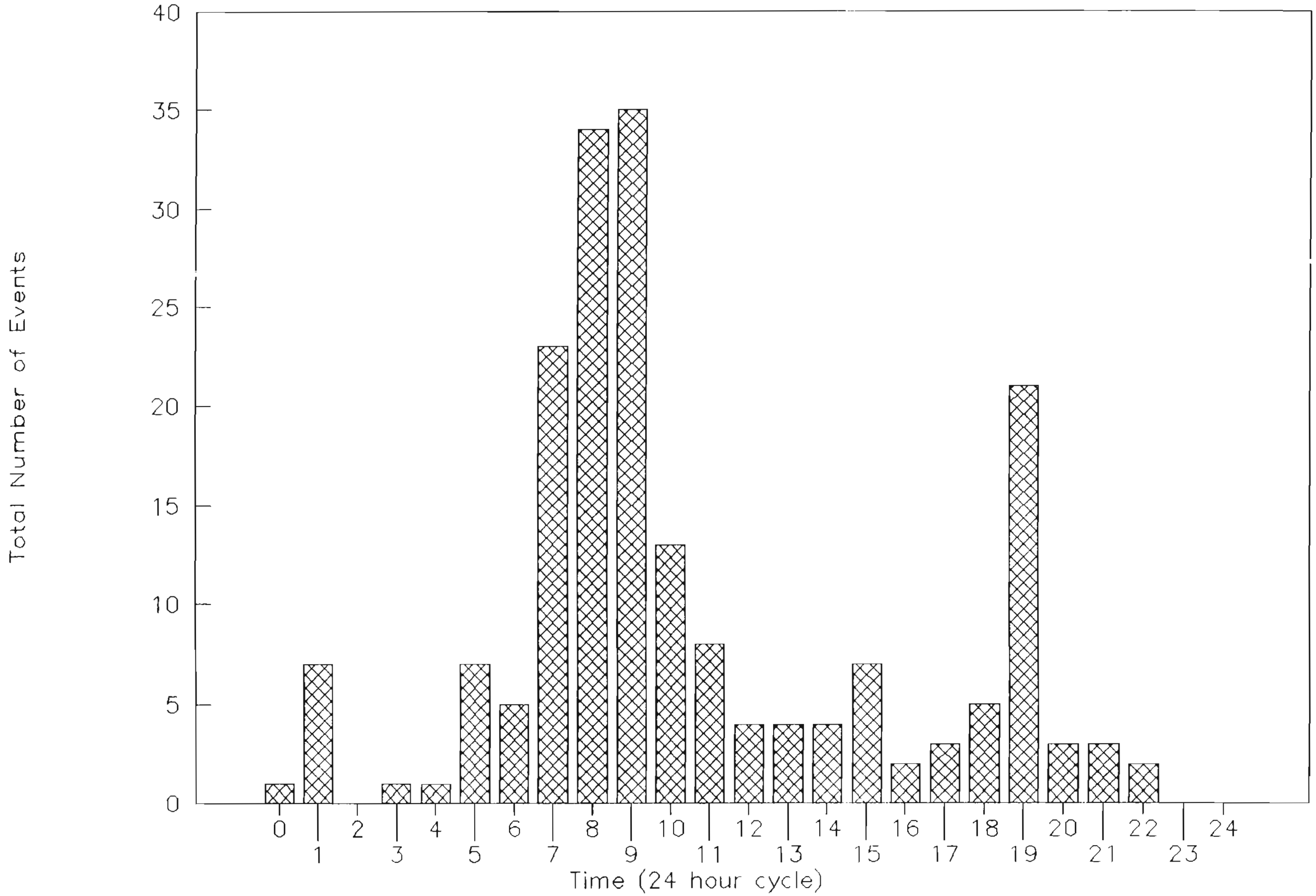
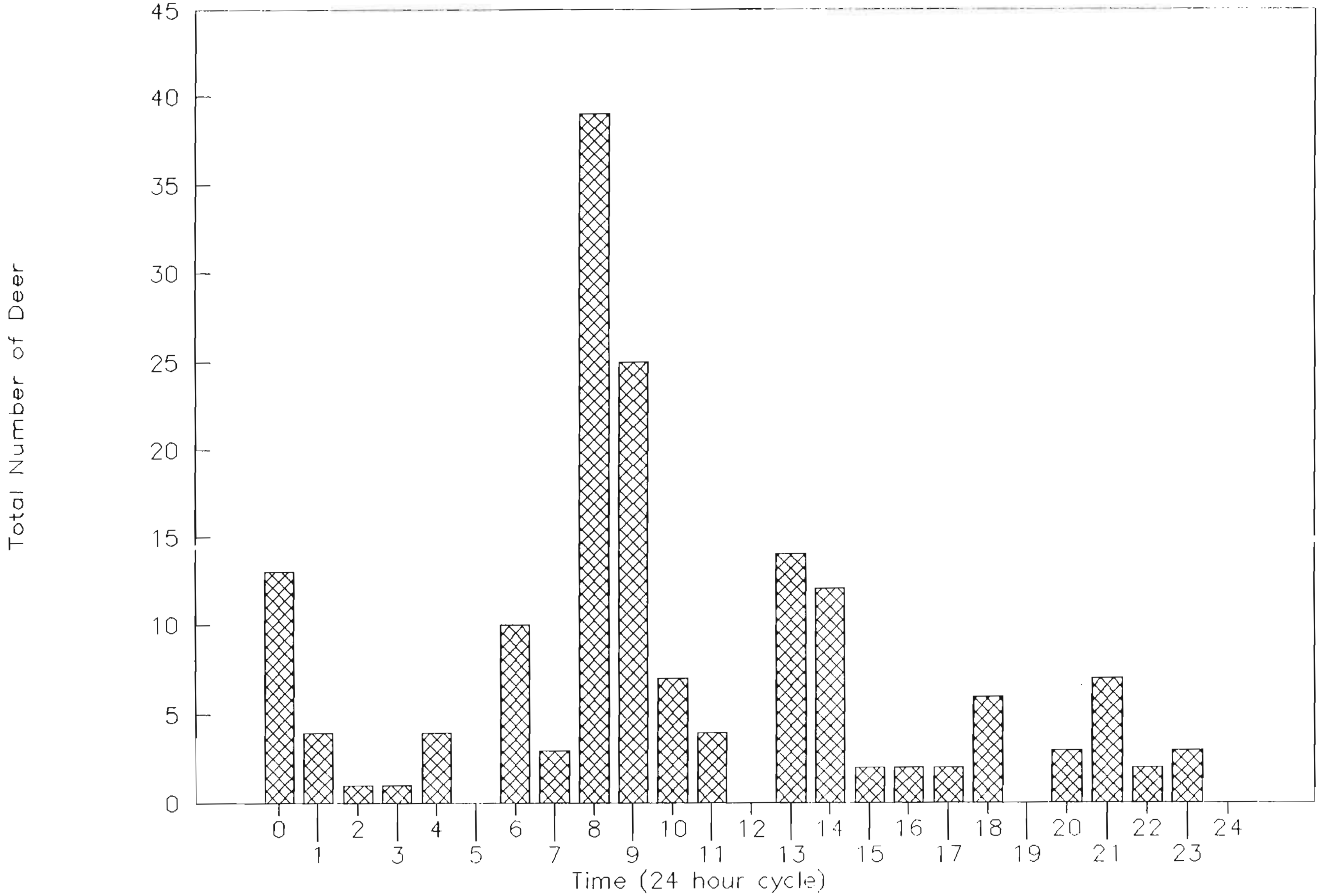


Figure 14. Timing of Daily Deer

Movements at Solitude Pass, Spring 1993



observed that hard crusts allowed deer to roam freely, but weak crusts broke repeatedly, causing injury and excessive tiring.

Verification of Deer Counting Accuracy--The accuracy of the Trial Master as a deer counting device was determined from direct observations of deer crossing through the infrared beam, from a 35 mm camera used in conjunction with the Trail Master, and from replicate samples of the same day's events.

In order to access the accuracy of Trail Master units located on Solitude Pass, direct observations of deer crossing over the pass were made on 15 and 16 June 1993. During these two days of observation, 13 deer were observed crossing over Solitude Pass, 10 on 15 June and 3 on 16 June. On 15 June, 8 deer were observed moving through station 6 between 7:17 a.m. and 14:48 p.m.; 8 events were recorded by the Trail Master. During the same period, 2 deer were observed going over the pass but not through the counting stations. On 16 June, 3 deer were observed crossing Solitude Pass between 12:00 p.m. and 12:17 p.m.; none of these moved through the counting stations. Thus, 38% of deer observed moving over Solitude Pass were not recorded by the Trail Masters.

The accuracy of the Trail Master was also determined by positioning the 2 units located at stations 7 and 8 within approximately 30 feet of one another along the same trail so that they provided replicate samples of the same day's events. Between 12 June and 3 July, 80 and 70 events were recorded at stations 7 and 8, respectively. Of the 80 deer recorded at station 7, 52 (65%) were also recorded at station 8. Of the 70 deer recorded at station 8, 56 (80%) were also recorded at station 7. Thus, 35% of the deer recorded at station 7 did not move through station 8 and 20% of the deer recorded at station 8 did pass through station 7.

A 35 mm camera used in conjunction with the Trail Master at station 4 also provided information regarding the accuracy of the Trail Master as a deer counting device. A total of 15 photographs was taken of 15 individual deer as they crossed through the infrared beam. In each case, the number of deer recorded by the Trail Master was the same as the number of deer in the photograph.

Data obtained from direct observations of deer, the 35 mm camera and replicate samples of the same day's events indicated that the Trail Master accurately counted deer when the animals crossed in single file through the infrared beam. One-hundred percent of the 23 deer known to have crossed through the infrared beam were accurately counted by the Trail Masters. However, Trail Masters appear to underestimate total numbers of deer moving through the project area by as much as 35% because not all deer pass through the infrared beam. Thus, by applying a 35% correction factor to account for deer not counted by the Trail Masters, it can be estimated that approximately 220 deer (164 + 57) crossed over Solitude Pass during the 1993 spring migration. This number, of course, does not account for those deer which moved west through the lower portion of the project area along the Mammoth Rock migration corridor.

Verification of Deer Migration Trails--The locations of major deer migration trails identified in previous work (Kucera 1988) appear to be accurate. Many of the more minor trails delineated by Kucera (1988) occurred in snow and thus, were not found during the course of spring work.

Deer Fecal Pellet Collections

Analyses of deer fecal pellets is currently being conducted at the University of Arizona and will be completed in November 1993. The results of the analysis will be provided as an addendum to the 1993 spring report.

CHAPTER 3. RECOMMENDATIONS

Because telemetry surveys were initiated late in the migration period, information obtained from radio-telemetry provided minimal information on deer migration patterns through the project area. The possibility of using permanent monitoring stations located within the holding area to relocate radio-collared deer should be investigated. It is also recommended that additional personnel be used in fall 1993 to more effectively radio-track deer as they migrate back to the winter range.

The Trail Masters may provide a reasonable estimate of the number of deer moving through Solitude Canyon. Additional studies will be required to determine more precisely the number of deer that bypass the counting stations. It is recommended that two additional Trail Masters counting stations be established at Solitude Pass in attempt to more accurately quantify the number of deer which migrate through Solitude Canyon. The use of Trail Masters was not possible within the Mammoth Rock migration corridor because of problems associated with topography and human activity.

CHAPTER 4. ACKNOWLEDGMENTS

This investigation was conducted under a contract with Dempsey Construction Corporation, Mammoth Lakes, California, with the cooperation of a Special Use Permit from the U.S. Forest Service, Mammoth Ranger District, Inyo National Forest. The design of field work was based on consultations with Dr. Ken Raedeke and much of the graphics was done by Caroline Smith of Dempsey Construction Corporation.

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Appendix Table 1. Summary table of data collected on 10 deer count surveys conducted in the Sherwin holding area from 23 April-25 June 1993. 1 = Sagebrush, 2 = Jeffrey Pine, 3 = Wet Meadow, 4 = Montane Chaparral, 5 = Burn

Deer Group Number	Date Observed	Group Size	Habitat Type
1	43093	2	1
2		22	1
3	50693	18	1
4		2	1
5		6	1
6		29	1
7		16	1
8		19	1
9		28	1
10		3	1
11		45	1
12		21	1
13		2	2
14	51393	7	1
15		13	1
16		6	1
17		9	4
18		14	3
19		80	1
20		2	1
21		39	1
22		4	1
23		17	1
24		4	1
25		22	1
26		9	1
27		4	1
28		7	1
29		3	1
30		9	2
31		7	2
32		5	2
33		5	2
34		3	4
35		1	4
36	51993	11	1
37		4	1
38		6	1
39		1	1

Appendix Table 1. Summary table of data collected on 10 deer count surveys conducted in the Sherwin holding area from 23 April-25 June 1993. 1 = Sagebrush, 2 = Jeffrey Pine, 3 = Wet Meadow, 4 = Montane Chaparral, 5 = Burn

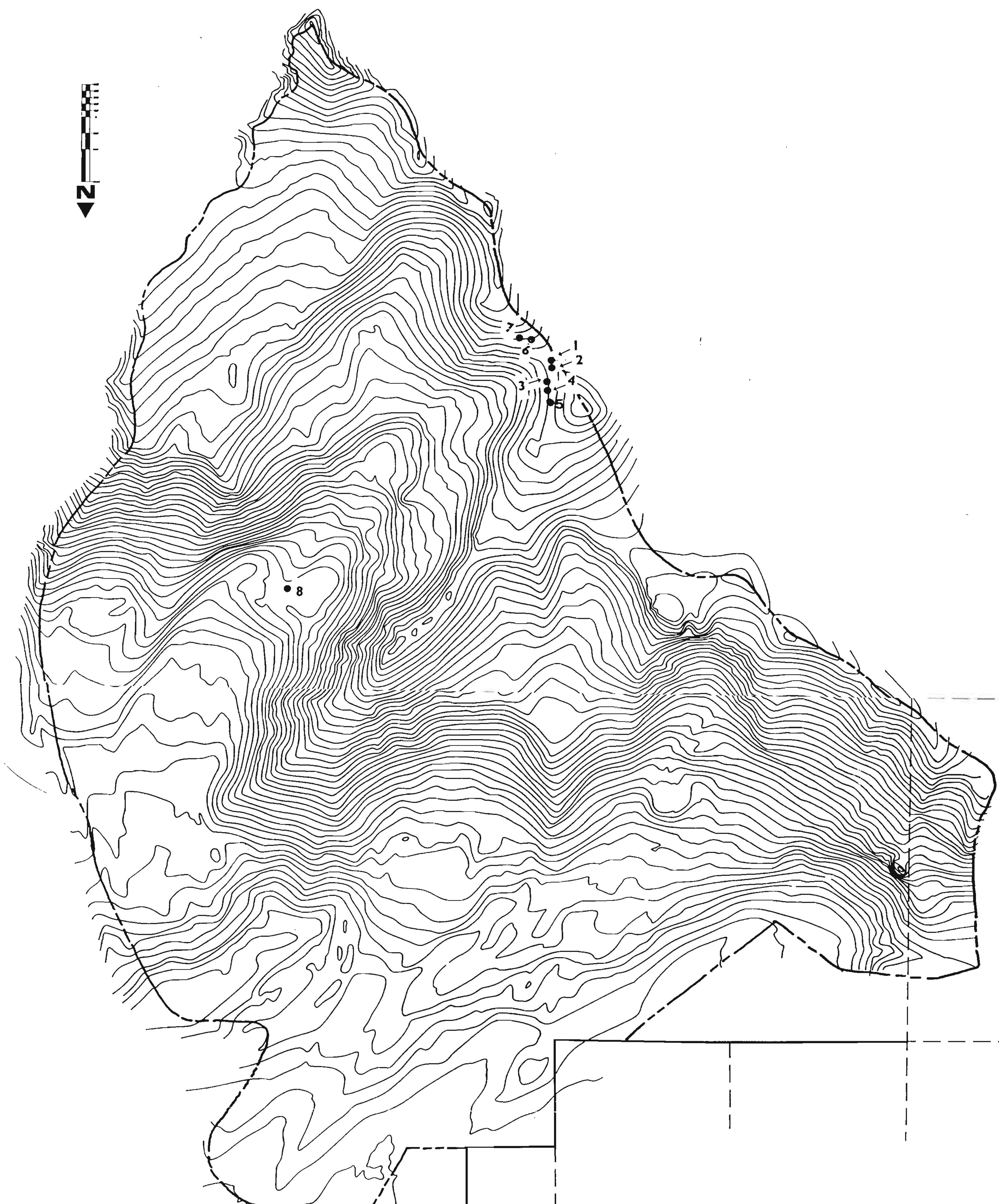
Deer Group Number	Date Observed	Group Size	Habitat Type
40	51993	19	4
41		8	4
42		15	1
43		5	1
44		20	1
45		1	3
46		13	4
47		9	4
48		12	4
49		35	5
50		13	1
51		1	5
52		38	5
53		5	5
54		3	1
55		1	2
56		2	1
57		4	1
58		5	1
59		10	1
60		6	1
61		43	1
62		19	1
63		12	5
64		3	2
65		5	1
66		1	2
67	52593	1	1
68		24	1
69		16	4
70		7	4
71		1	4
72		12	4
73		4	4
74		18	4
75		2	1
76		10	1

Appendix Table 1. Summary table of data collected on 10 deer count surveys conducted in the Sherwin holding area from 23 April-25 June 1993. 1 = Sagebrush, 2 = Jeffrey Pine, 3 = Wet Meadow, 4 = Montane Chaparral, 5 = Burn

Deer Group Number	Date Observed	Group Size	Habitat Type
77	52593	27	1
78		76	1
79		1	1
80		17	1
81		44	4
82		3	1
83		2	1
84		31	1
85		27	1
86		14	5
87		1	2
88		5	2
89		1	4
90		1	4
91	60293	2	1
92		4	1
93		19	1
94		9	1
95		20	4
96		9	4
97		4	4
98		2	4
99		3	4
100		2	4
101		12	1
102		1	1
103		38	4
104		2	1
105		32	4
106		13	1
107		14	5
108		70	1
109		22	5
110		5	4
111		4	2
112		5	2
113		11	2
114	60893	5	1

Appendix Table 1. Summary table of data collected on 10 deer count surveys conducted in the Sherwin holding area from 23 April-25 June 1993. 1 = Sagebrush, 2 = Jeffrey Pine, 3 = Wet Meadow, 4 = Montane Chaparral, 5 = Burn

Deer Group Number	Date Observed	Group Size	Habitat Type
115	60893	1	1
116		3	1
117		10	1
118		70	1
119		4	4
120		12	4
121		2	4
122		1	5
123		42	5
124		56	5
125		15	1
126		4	5
127		1	1
128		10	2
129		3	1
130		6	4
131		1	4
132	61793	4	1
133		4	1
134		44	1
135		4	4
136		20	4
137		5	4
138		5	5
139		1	1
140		5	5
141		8	1
142		6	5
143		1	5
144	62593	19	1
145		5	1
146		2	4
147		6	4
148		2	4
149		2	4
150		1	1
151		1	2
152		1	4



snowcreek SKI AREA
SNOWCREEK RESORT
at Mammoth Lakes, California

LOCATIONS OF TRAIL MASTER DEER COUNTING STATIONS IN THE SNOWCREEK SKI AREA

Timothy Taylor
Consulting
Wildlife Biologist

FIGURE: 1-2