# THE EFFICACY OF MEASURES TO MINIMIZE CONTACT BETWEEN DOMESTIC SHEEP AND SIERRA NEVADA BIGHORN SHEEP ON THE HUMBOLDT-TOIYABE NATIONAL FOREST, MONO COUNTY, CALIFORNIA

A Report by the California Department of Fish and Game on the results of Challenge Cost Share Agreement (FS #05-CS-11041730-070, FWS #1448-84320-5-J323) with the Humboldt-Toiyabe National Forest and the U. S. Fish and Wildlife Service.

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Abstract: We evaluated bighorn movement, husbandry of domestic sheep, and intensive monitoring of both species in an effort to reduce the likelihood of contact, and possible subsequent disease transmission to Sierra Nevada bighorn sheep (*Ovis canadensis seirrae*). During July – October 2005 radio-collared bighorn (9) in the Northern Recovery Unit did not wander into adjacent domestic sheep allotments, however, husbandry methods likely would have been inadequate to sufficiently minimize the likelihood of contact or to enable rapid response to contact. Factors such as the elevation grazed, the density of vegetation used by domestic sheep, the level of predation, and domestic sheep oversight by herders and guard dogs were such that risk of contact was minimized insufficiently given proximity to occupied bighorn sheep habitat.

## Introduction

Sierra Nevada bighorn sheep received permanent listing as federally endangered in 2000 (U. S. Fish and Wildlife Service 2000, 2003). Bighorn sheep in the Sierra Nevada are currently distributed among 5 broad geographic areas and number about 350 animals (Wehausen and Stephenson 2005). The Northern Recovery Unit (the only unit that lies partially within the Humboldt-Toiyabe National Forest) currently supports the fewest (30 – 40) bighorn.

Domestic sheep are grazed on hundreds of thousands of acres of public and private land in the eastern Sierra Nevada during June - November. During 15 June – 15 October 2005, domestic sheep were permitted to use 3 allotments on the Bridgeport Ranger District that lie within 5 – 15 km (3 – 9 miles) of currently occupied bighorn habitat. Domestic sheep operations that used the Bridgeport Ranger District during 2005 were required to use 1 herder, 3 guard dogs, and 2 herd dogs on each allotment (U. S. Fish and Wildlife Service 2005); they typically had 1 donkey as well. Grazing permits allowed up to 550 ewes and their lambs on the Dunderberg allotment, 600 ewes and their lambs on the Cameron Canyon allotment, and 1650 ewes on the Tamarack allotment. The current permittee is a spring-lambing operation and, hence, grazed ewes and lambs on the Forest during the summer and estrus ewes and rams during the fall.

Domestic sheep can carry various diseases and those diseases have the potential to trigger outbreaks in bighorn (Martin et al. 1996). Recovery of bighorn sheep in the Sierra Nevada is incumbent upon preventing contact between bighorn and domestic sheep and, hence, eliminating the potential for disease transmission. Past recommendations for minimizing contact have focused largely on distance as a barrier to contact. Movements by bighorn rams are unpredictable, and the current scale of domestic sheep grazing in the

eastern Sierra makes closure of grazing allotments in proximity to bighorn range problematic. Based on these considerations, intensive monitoring to minimize contact was proposed and funded through a Challenge-Cost Share Agreement among the California Department of Fish and Game, the Humboldt-Toiyabe National Forest, and the U. S. Fish and Wildlife Service as a means of mitigating risk to bighorn recovery (U. S. Fish and Wildlife Service 2005). We evaluated active measures to minimize contact through frequent monitoring of bighorn and domestic sheep as a means to prevent possible disease transmission.

Our primary goal was the prevention of, or response to, nose-to-nose contact between bighorn and domestic sheep. We monitored bighorn movements and proximity to allotments in the Northern Recovery Unit. In addition, we implemented an intensive monitoring program aimed at describing and assessing domestic sheep husbandry and grazing practices in allotments located near the Northern Recovery Unit. Our specific objectives were to (1) determine the proximity of bighorn sheep to domestic sheep allotments; (2) determine the effectiveness of husbandry methods at containing domestic sheep and movement patterns of domestic bands adjacent to bighorn ranges; (3) ensure a rapid response in the event of contact between the 2 species; (4) evaluate movements of both species relative to assessing potential for contact; and, (5) evaluate the feasibility of alternative approaches to preventing contact, such as intensive monitoring of both species.

**Methods**

## Collaring of Domestic Sheep

We deployed VHF and store-on-board GPS collars on domestic sheep with the assistance of herders to restrain them. We deployed 3 GPS collars and 1 VHF collar on domestic sheep on the Dunderberg allotment (3 GPS collars were worn by 6 different sheep because collars were removed and redeployed midway through the Dunderberg grazing period). We deployed 4 GPS collars and 1 VHF collar on sheep on the Cameron allotment and 3 GPS and 1 VHF collar on the Tamarack allotment. A VHF collar was deployed with the Tamarack band on the day they went on the allotment, however, VHF collars were not deployed on Dunderberg and Cameron sheep until they had been on the allotments for about 2 weeks. Location data were downloaded from GPS collars upon retrieval of collars. GPS collars were programmed to acquire locations at 0200, 0600, 1000, 1400, 1800, and 2200 hours.

## Field Observations of Domestic Sheep

We attempted to observe domestic sheep on each allotment on a daily basis during the period for which grazing was permitted. Prior to the use of VHF collars on domestic sheep, considerable time was spent attempting to locate the band. Following deployment of VHF collars on domestic sheep, bands were located using a radio-telemetry receiver and a directional "H" antenna. We hiked to bands, regardless of the distance from roads, to assess husbandry and the need to react to possible bighorn proximity. After the band was located, we recorded the UTM coordinates of the band (at its perimeter) and the herder using a hand-held GPS (Appendix A). Band composition was noted as ewes and lambs or ewes and rams. We attempted to count marker sheep

(e.g., black sheep, color-branded sheep, and sheep wearing bells) when conditions permitted. We also recorded the presence and proximity of the herder, 3 guard dogs, 2 herd dogs, and 1 donkey to the herd. Because vegetation could obscure the herd, we estimated the proportion of the herd visible to the herder and the observer.`

Habitat and Husbandry

We recorded vegetation and husbandry variables within each distinctive type used during a period of direct observation. Furthermore, when a band was visible, the number of distinct groups was recorded, and individual stragglers were noted. A 'main group' was defined as the group with the largest number of individuals, or the group under the direct observation of the sheepherder. Subgroups were defined as groups of two or more individuals that were physically separate from the main band. Stragglers were defined as single sheep physically separate from the band by a distance of at least several hundred meters. While band movements are dynamic, after a given period of time stragglers that did not rejoin the group were noted as such. The activity of the main band, subgroup, and stragglers also were noted. Activity categories were defined as: bedded, grazing, moving, or other. Habitat characteristics for each location were recorded based on the following categories: shrub, meadow, aspen, conifer, pinyon-juniper, krumholz, and other. These categories reflected the vegetation present in all allotments observed. The density of the vegetation also was estimated.

## Counts of Domestic Sheep

We participated in total counts that were conducted by the permittee as domestic sheep went on and came off of allotments. Two types of total counts were used: those where a corral was used to facilitate counting, and those where no corral was used. We also attempted marker counts while observing bands if conditions were appropriate.

## Monitoring of Sierra Nevada Bighorn Sheep

During the 2005 grazing season, there were 9 radio-collared bighorn sheep in the Northern Recovery Unit. Upon initially arriving on an allotment, we monitored radio-frequencies of bighorn sheep in adjacent herd units, and noted presence and strength of signals. In addition, we attempted telemetry flights using a fixed-wing aircraft on a weekly basis as weather permitted to determine locations of radio-collared bighorn. Ground surveys of bighorn were conducted periodically to assess population size, composition, and location of marked and unmarked bighorn. Locations of bighorn were noted, and these locations were provided on a weekly basis to USFS, CDFG, USFWS and FIM Corporation personnel. We also remotely acquired location data from bighorn wearing GPS collars.

## Analysis

We analyzed spatial data using a geographic information system. For GPS collar location data (UTM easting and northing), elevation and vegetation type were derived from a digital elevation layer and a vegetation layer, respectively.

**Results**

During the 2005 grazing season on the Bridgeport Ranger District, we observed allotments on 138 occasions for the 83 days that domestic sheep were on allotments. We made observations as early as 0630 and as late as 2000 hours; no direct observations were made during non-daylight hours, although GPS collar locations were obtained during day and night. Observation periods on allotments varied between < 1 hour to > 8 hours. VHF collars facilitated observing bands and husbandry activity because less time was expended attempting to simply locate a band.

We acquired 109 locations of domestic sheep by aerial or ground observation and an additional 445 locations using GPS collars on individual domestic sheep (Figure 1). Although sheep on all 3 allotments wore GPS collars, locations were successfully acquired and downloaded only for the Dunderberg and Tamarack allotments; on those allotments only 7 collars functioned properly. Overall collar failure rate was 46% (6 of 13 failed catastrophically). All locations for the Cameron allotment came from direct observations.

Bands of domestic sheep, under the watch of a herder, typically exhibited 2 bedding and 2 grazing periods every 24 hours. The morning grazing period ran from dawn to mid-morning (0800-1000), and bedding occurred until mid-afternoon (1500-1700), followed by grazing until dusk. The night-time bedding period occurred from dusk to dawn.

We attempted marker counts, but generally were unsuccessful because we did not have the ability to manipulate the band, as did the herder, while conducting counts.

Furthermore, it often was not feasible given the density of vegetation that the band used. We did not attempt marker counts if a portion of the band was obscured by vegetation; this occurred often.

We accompanied the permittee during total counts as sheep went on and came off of allotments (Table 1). The initial count on the Dunderberg allotment occurred without the use of a corral but all counts off allotments and the counts going on Cameron and Tamarack were conducted using a corral. We observed losses of sheep to predation on the Dunderberg and Cameron allotments (Table 2). No sheep were lost due to predation or any other cause on the Tamarack allotment.

We observed a low incidence of straying, but 2 instances were notable. On 5 August 2005, a black bear was observed harassing the band in an aspen stand on the Cameron allotment and a subgroup was 400 m away. On 3 September 2005 on the Cameron allotment, a group of 10 sheep split away from the band after watering and eventually split into 4 subgroups with 1 subgroup moving away at an estimated distance of 900 m.

As required to restrict domestic sheep use of alpine and subalpine habitat on the Dunderberg allotment, domestic sheep were kept east of the temporary adjustment of the west boundary. While on Dunderberg, the band did use BLM land just east of the allotment (Figure 2). While on the Cameron allotment, the band remained within its boundaries and moved below the 1 September elevation boundary as required (Figure 3). The band used adjacent areas outside of the Tamarack allotment including the Cameron allotment, the Summer's Meadow allotment, and private land (Figure 4).

Domestic sheep used elevations ranging from 8,252 to 9,634 feet while on the Dunderberg Allotment, with a maximum elevation being recorded on 27 July (Figure 5). The highest elevation use recorded on the Bridgeport Ranger District was 10,815 feet on the Cameron allotment (Figure 6). Use on the Tamarack allotment was largely in the vicinity of lower elevation meadows and mean elevation was 7,479 feet (SD = 470; Figure 7).

Domestic sheep were documented using dense vegetation (defined as aspen and conifer) during 31-36% of observations on Dunderberg and Cameron allotments (Figure 8), far exceeding the implication that dense vegetation would be avoided. Eighteen percent of observations on the Tamarack allotment occurred in aspen. Aspen stands often were used as bedding areas for bands during the day but feeding occurred in them as well. Estimated density of aspen stands typically was >80%. In addition, GPS vegetation types associated with GPS collar locations indicated that 61% of locations were in non-forested types and 39% were in forest.

Herders were documented >1 km from the band on 3 occasions and were > 0.5 km on another 5 occasions (Figure9). Unless we traveled past the herder's camp while locating the band, we generally did not attempt to record the location of the camp; hence, the location of many camps was not recorded. Herders were confirmed with the herd 42-72% of the time depending on the length of time that the herd was observed; of the remainder of the time, 17-38% of the time the herder was confirmed to be in a location not with the herd (Table 3). For the remainder of observations, the location of the herder was recorded as unknown if we were unable to determine his exact location. The proportion of observations where the herder was clearly with the herd was greatest in the

early morning and late afternoon (Figure 10) because herders often returned to their camp during the mid-day period when sheep bedded. Consequently, the band was visible to the herder during only 40, 51, and 78 % of our observations on the Cameron, Dunderberg, and Tamarack allotments, respectively.

No guard dogs were observed with the band during 29-62% of the observations when all 3 dogs could be accounted for, depending on the length of those observations (Table 4). Of the observations with 0 guard dogs, in most cases the location of all guard dogs was unknown (Table 5). Three guard dogs were observed with the band < 14% of the time. Herd dogs typically remained with the herder whether he was with the band or not.

Domestic sheep on the Humboldt-Toiyabe National Forest grazed within 5 km (3 miles; Lundy Canyon to the Dunderberg allotment) of known bighorn sheep locations during July (Figure 1). By October, domestic sheep on the Toiyabe National Forest moved to a distance of 15 km (9 miles) from radio-collared bighorn (Figure 1). Despite repeated attempts, bighorn sheep were observed from the ground on only 12 occasions during July – October 2005 in the Northern Recovery Unit. Locations of telemetered bighorn were acquired much more frequently from aircraft and GPS collars (Figure 1).

**Discussion**

While domestic sheep were on the allotments, we observed no movement of radio-collared bighorn into allotments during July – October 2005. Prior to the grazing season, we had observed only 1 uncollared bighorn ram in the Mt. Warren herd unit;

however, program personnel conducting field surveys during September observed 4 uncollared rams on the north side of Lundy Canyon. Because the rams were unmarked, we cannot be certain of their origin, and they could be rams from Mt. Gibbs or elsewhere. The presence of those unmarked rams illustrates the difficulty of identifying all animals in even a small population of wild sheep, and emphasized the risk of assuming that the movements of radio-collared animals are representative of all bighorn in a particular area.

In 2004, a radio-collared bighorn ram was present on the north end of Kavanaugh Ridge, indicating their ability to move beyond areas that radio-collared bighorn used during the 2005 monitoring effort. A radio-collared yearling ram (S65; Figure 1) whose GPS collar was downloaded during late October 2005 and provided locations during July – October 2005, indicates extensive use of the north side of Lundy Canyon. Much of the time he used extremely rugged terrain in Lundy Canyon and has been difficult to observe even with telemetry. Location data indicate considerable movement between Lundy Canyon and Mt. Warren (3 miles).

Although the grazing operations on the 3 allotments on the Bridgeport Ranger District that we monitored used donkeys to enable mobility of the herder, the herder typically established a base camp for 4 – 7 days and returned to the camp at midday and at night. On 3 documented instances the band was bedded > 1 km from the herder's camp and in numerous other cases the band was out of sight and earshot of the herder. The lack of a 24 hour presence with the band raised concerns about the potential for domestic sheep to stray, particularly given repeated harassment by predators, or the inability to respond to bighorn sheep that might have entered the allotments.

Herder attentiveness reduces losses. Tignel and Larson (1977) reported that a combination of inexperience and poor supervision lead to increased scattering, predation and missing sheep. Nass et al. (1984) suggested that a combination of factors increased predation losses. Minimizing predation events may contribute to fewer strays.

Although the permittee was expected to keep 3 guard dogs with the sheep, we frequently observed no guard dogs with the band. It had been suggested that guard dogs would never leave the band and would be an effective deterrent to intruding bighorn sheep. Particularly during the heat of midday, guard dogs that did remain with the herd often were unresponsive to human intruders.

Guard dogs are widely considered an effective means of reducing predation on domestic sheep in open and closed herding conditions (Tigner and Larson 1977). When large numbers of sheep were present, the importance of having >1 working guard dog has been emphasized (Coppinger et al. 1983). The character of individual guard dogs is also important; socialized guard dogs generally are more effective than untrained dogs, and tend to run away less (Hansen and Smith 1999). Individuals that are older, or more mature, are more attentive to herds, and it has been suggested that intensive training is required to ensure the success of younger animals (Hansen and Smith 1999, Coppinger et al. 1983). Attentiveness to the guard dogs may decrease problems. Hansen and Smith (1977) reported that loose guard dogs without the command of a dog handler were uncontrollable, and dogs were documented chasing wildlife, running to nearby settlements, and missing more often.

The western boundary of the Dunderberg allotment was modified this grazing season to exclude domestic sheep from alpine environments in that allotment. Yet on the

Cameron allotment and within the guidelines of the permit, domestic sheep grazed alpine and subalpine environments during August. Grazing domestic sheep in high elevation environments during any portion of the grazing season increases the potential for contact given that alpine is the primary summer habitat for bighorn sheep. The proximity of these allotments are within average travel distances to known current bighorn locations (< 6 miles).

The frequent use of aspen stands may contribute to predation on domestic sheep and decrease the effectiveness of guard dogs. Such practices also make the band less visible to the herder. Predation losses were associated with grazing in or adjacent to aspen stands.

The composition of the band and the landscape may contribute to predation loss, regardless of management efforts. Herders whose bands included lambs and who grazed dense vegetation exhibited higher predation losses (Nass et al. 1984). High-loss producers grazed animals in rough, bottomland or brush areas, or were adjacent to those types in more instances than did low loss producers (Nass et al. 1984). Environmental characteristics also may contribute to the efficacy of guard dogs (Nass et al. 1984). This may be due to the fact that arid climates, widely scattered herds, and grazing areas with dense vegetation may reduce the effectiveness of livestock guard dogs (Green and Woodruff 1983). Penning at night has been associated with low loss percentages (Nass et al. 1984). Optimal herd management practices and prevention of predation result in less risk of strays.

**Conservation/Management Implications**

Because the consequences of contact between domestic and bighorn sheep can be disastrous, it is necessary to alleviate the potential for contact at multiple levels. Contact may result from bighorn moving onto domestic sheep range or domestic sheep straying into bighorn habitat. Preventing contact resulting from bighorn movements may occur through intensive tracking of bighorn movements through the use of telemetry and GPS collaring, or through preventing, or responding to, contact with the domestic sheep operation. Domestic sheep, especially when grazed in or adjacent to bighorn habitat (e.g., especially alpine and subalpine vegetation), may increase the likelihood of contact through straying or simply using risky habitats.

We proposed to use intensive monitoring to minimize the risk of contact. Given the need to minimize the potential for contact and observe the bands of sheep, we were interested in maximizing our time on allotments (Figure 11). Our efforts were constrained by driving distance (180 miles round trip) from our Bishop office, distance of the band from roads, difficulty in finding bands obscured by dense vegetation particularly prior to using telemetry, and the need to observe multiple allotments during part of the season. Although we monitored allotments every day of the week, the time spent on any one allotment was not sufficient to ensure that contact between domestic and bighorn sheep could not occur, especially given the routine absence of guard dogs and herders. The cost of our additional monitoring effort including vehicle gas and maintenance, GPS and VHF collars for domestic sheep, fixed-wing and ground monitoring of bighorn sheep, and personnel salary was in excess of $30,000.

Separation of domestic sheep from bighorn ranges by minimum distances ranging from 14.5 to 23 km (9 – 14.5 miles) has been recommended (Bureau of Land

Management 1992, 1998, Singer et al. 2000). In the absence of such separation, risk of contact, and possible subsequent disease transmission, varies with a number of factors relative to domestic sheep behavior and husbandry including (1) elevation at which they are grazed; (2) constancy of attendance by herder; (3) visibility of the band as a result of density of vegetation; (4) intensity of predator activity; and, (5) efficacy of guard dogs in responding to intruders.

The entire Dunderberg, Cameron, and Tamarack allotments lie within 14.5 km (9 miles) of current bighorn sheep locations and considerably less distance if previous bighorn locations are considered. Although we did not document northerly bighorn movements that resulted in contact this season, we know that bighorn in the Sierra Nevada make long distance movements (e.g., >50 km; Sierra Nevada Bighorn Sheep Recovery Program 2003) that could place them in contact with domestic sheep. If domestic sheep are to continue to graze these allotments, extraordinary measures must be taken to prevent bighorn contact with domestic sheep and possible subsequent disease transmission. Measures followed this summer likely would have been inadequate to reduce contact had bighorn moved into allotments. The high percentage of the time that the herder and guard dogs were not present, domestic sheep use of dense vegetation, and the use of high elevation range greatly diminish the potential to prevent, recognize, or respond to contact with bighorn. Furthermore, the potential for straying and the inability to detect it were of concern. Had straying occurred in numbers small enough to avoid detection by the herder's marker counts, it could not have been confirmed until the total off-count occurred. Because of the concern over even 1 missing animal, marker counts always will be inadequate. Consequently, there is a need to identify the presence of

every sheep in a band on a more frequent basis. Daily counts may become possible with the advent of electronic id tags used to mark every sheep.

Accurate total counts, including lambs, are the only effective means of ensuring that no domestic sheep are missing and may have strayed; as such, they must be conducted routinely. Marker counts conducted by herders indicate whether larger groups of animals are missing, but should not be relied upon to identify small numbers of missing animals. Marker ratios of 1:35, such as used on the Bridgeport Ranger District, only should be used to detect larger groups of missing animals (e.g., >35 on average). One stray domestic sheep potentially is sufficient to transmit disease to bighorn sheep.

Grazing near, adjacent to, or in alpine environments greatly increases the risk of contact during summer. Sierra bighorn primarily use alpine and subalpine habitats during summer. The upper reaches of the Dunderberg, Cameron, and Tamarack allotments are continuous with suitable bighorn summer range habitats.

As grazing currently is managed on the Humboldt-Toiyabe National Forest, husbandry practices are insufficient to significantly reduce contact. Even with the aid of telemetry, given the distances from roads at which grazing occurs, reliance on agency personnel to adequately aid in preventing contact appears to be unrealistic. Furthermore, communication between herders and the permittee is so infrequent (routinely occurred once every 8 days) that responding to contact would have been delayed significantly.

If contact is not prevented, then the necessity of measures to facilitate rapid response to contact is essential. Such ability for immediate contact could be greatly enhanced by requiring permittees to provide satellite or cell phones to herders and requiring daily check-in calls, a proactive measure that is employed by other operators.

Use by domestic sheep of high elevation, alpine and sub-alpine ranges, increases the probability of contact because domestic animals are occupying bighorn summer range. Domestic use of dense vegetation further raises concern because of the inability of a herder to adequately monitor his own herd as well as approaches by wild sheep.

The California Department of Fish and Game has authority under state and federal law to "take" bighorn to prevent disease transmission. Nevertheless, this measure should be viewed as a last resort and only is effective if contact is observed and may be responded to rapidly. The logistics of implementing lethal take are further complicated when domestic sheep grazing occurs at elevations far above and distances far removed from road access. Portions of the allotments on the Bridgeport Ranger District are >3 miles and >3,000 feet from a drivable road. The poor road access combined with the poor communication between herder and permittee likely make response times to potential contact unacceptably slow (e.g., 1-2 days).

If domestic sheep grazing is to continue in proximity to known occupied bighorn sheep habitat, agencies must be effective in ensuring that permittees meet all stipulations in the permits. Further, agencies must ensure that those stipulations be well defined to meet the requirement of minimizing the potential for contact between the species. Ultimately, the majority of the measures will be effective only with full cooperation and compliance by the permittee and his herders because realistically they are the ones that have the opportunity to continuously oversee the domestic sheep.

Acknowledgements

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Table 1. Total counts and grazing dates of domestic sheep on the Bridgeport Ranger District during 2005 as determined by the permittee.

| Allotment | Date On | Date Off | Count On | Count Off | Composition |
|---|---|---|---|---|---|
| Dunderberg | 5 July | 10 August | 1433 | 1425 | Ewes/lambs |
| Cameron | 13 July | 7 September | 1721 | 1720 | Ewes/lambs |
| Tamarack | 2 October | 14 October | 1080 | 1080 | Ewes/rams |

Table 2. Predator activity and predation that we observed on domestic sheep allotments on the Bridgeport Ranger District, during July – October 2005.

| Allotment | Date | Mortality | Harassment | Predator |
|---|---|---|---|---|
| Dunderberg | 21 July | | yes | Coyote |
| Dunderberg | 22 July | 1 | | Coyote |
| Dunderberg | | 2 | | Coyote |
| Cameron | 5 August | | Yes | Black bear |
| Cameron | 1 September | | Yes | Black bear |
| Cameron | 2 September | 1 | | Black bear |
| Cameron | 3 September | 1 | | Black bear |

Table 3. Location of herder by interval of time that band was observed on domestic sheep allotments on the Bridgeport Ranger District during July – October 2005.

| Herder | Observation Time | | | | |
|---|---|---|---|---|---|
| Location | Unknown* | < 30 min | 30 - 60 min | 60 - 120 min | > 120 min |
| with Herd | 44% | 42% | 50% | 72% | 45% |
| not with Herd | 28% | 21% | 38% | 17% | 27% |
| Unknown | 28% | 38% | 13% | 11% | 27% |

*Unknown time durations resulted from failure of observers to record the time upon which allotment was departed.

Table 4. Location of guard dogs by interval of time that band was observed on domestic sheep allotments on the Bridgeport Ranger District during July – October 2005.

| | Observation Time | | | | |
|---|---|---|---|---|---|
| | Unknown | < 30 min | 30 - 60 min | 60 - 120 min | > 120 min |
| Dog Location | | | | | |
| 0 with Band | 41% | 62% | 50% | 29% | 50% |
| 1 with Band | 24% | 29% | 12% | 43% | 0% |
| 2 with Band | 35% | 0% | 23% | 29% | 25% |
| 3 with Band | 0% | 10% | 15% | 0% | 25% |

Table 5. Details of dog locations when 0 were recorded with the band on domestic sheep allotments on the Bridgeport Ranger District during July – October 2005 (in Table 4). Indicated as number of observations.

| Observation Time | 3 dogs w/Herder | 2 dogs w/Herder | 1 dogs w/Herder | 0 dogs w/Herder |
|---|---|---|---|---|
| Unknown | 2 | 0 | 0 | 5 |
| < 30 min | 6 | 1 | 1 | 5 |
| 30 - 60 m | 2 | 3 | 2 | 6 |
| 60 - 120 m | 0 | 0 | 0 | 2 |
| > 120 m | 0 | 0 | 0 | 2 |

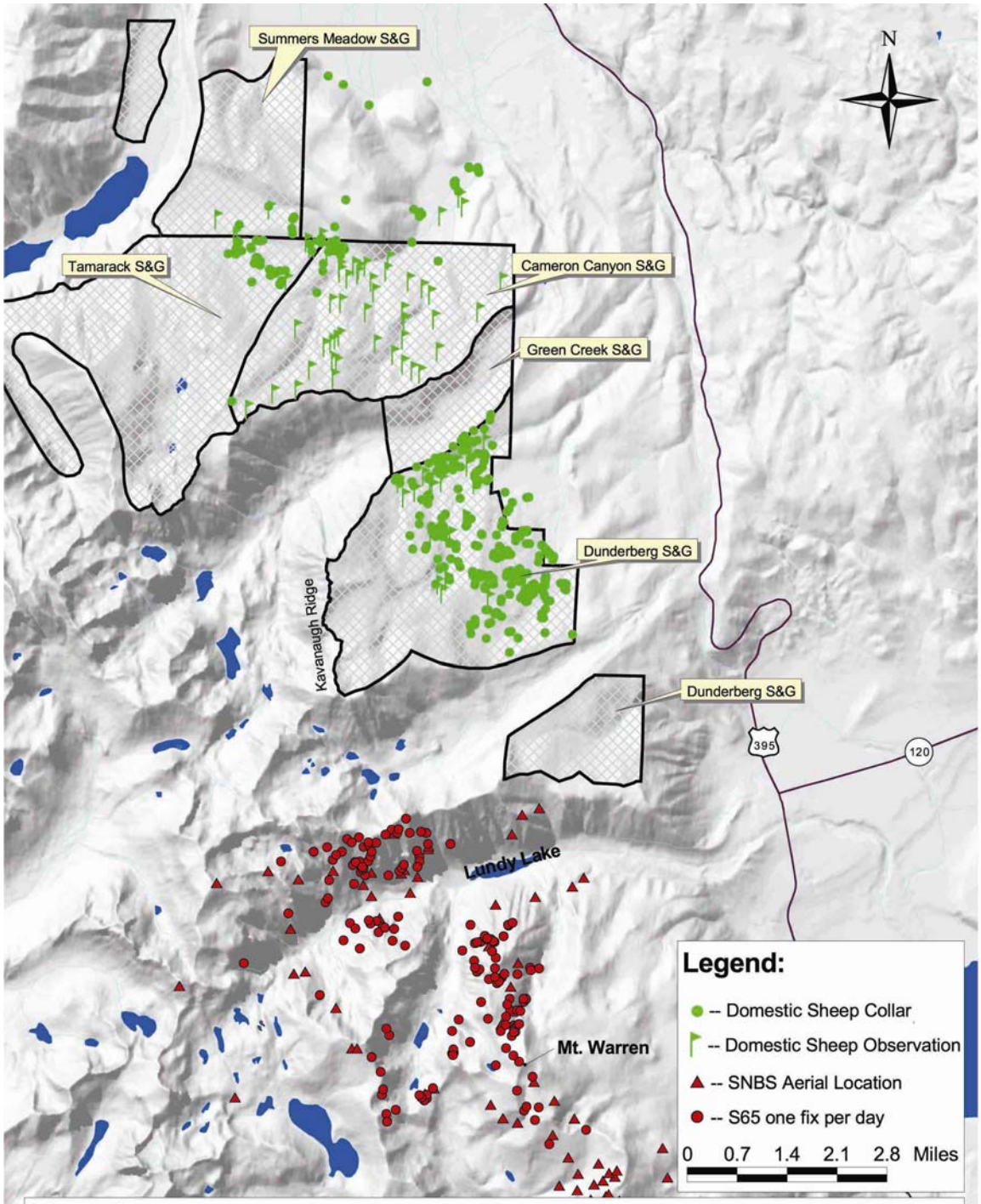


**Figure 1.** Bighorn sheep (Mt. Warren Herd Unit) and domestic sheep (Bridgeport Ranger District) locations in and adjacent to the Northern Recovery Unit during June-October 2005. One location per day is provided for the GPS collar.

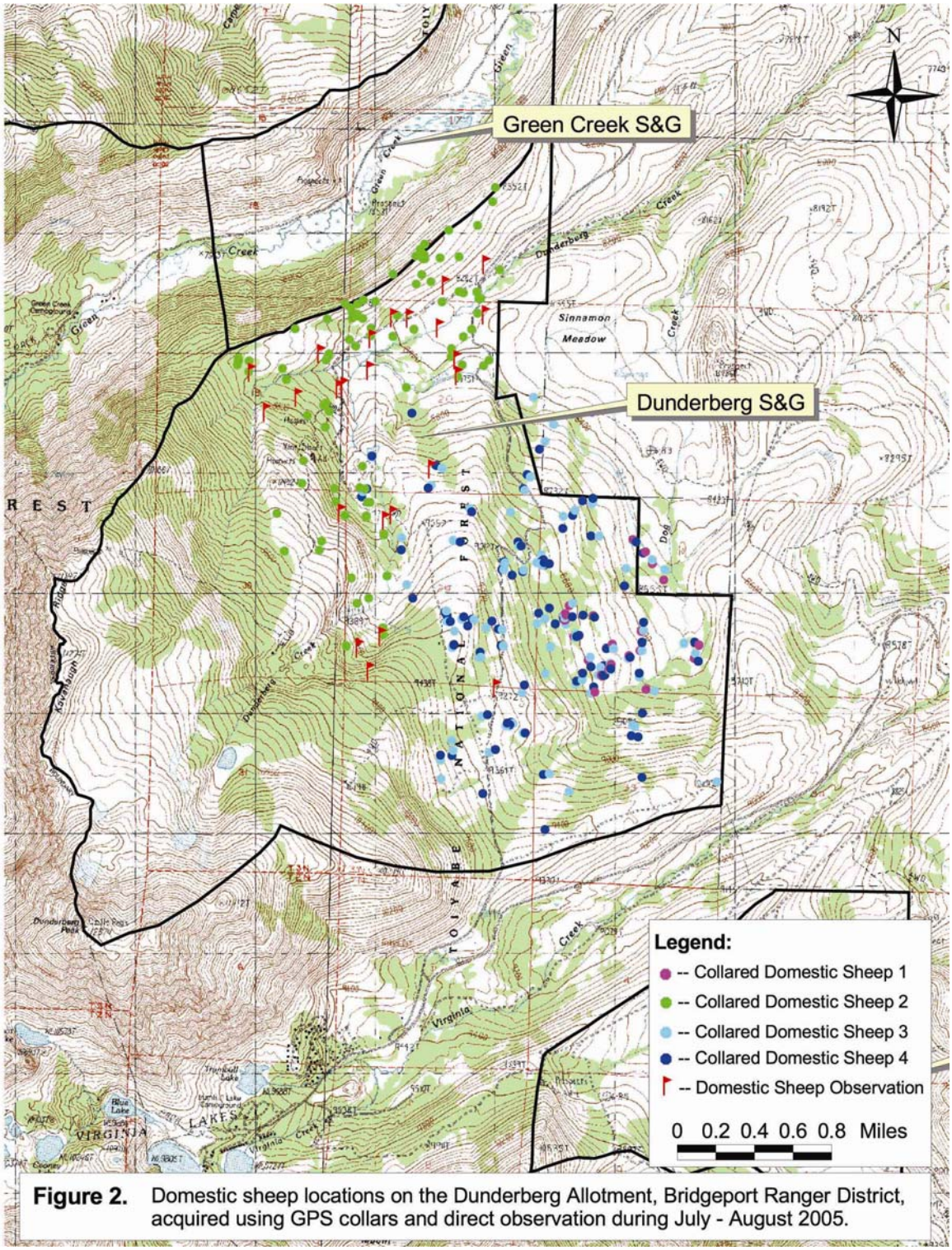


**Figure 2.** Domestic sheep locations on the Dunderberg Allotment, Bridgeport Ranger District, acquired using GPS collars and direct observation during July - August 2005.

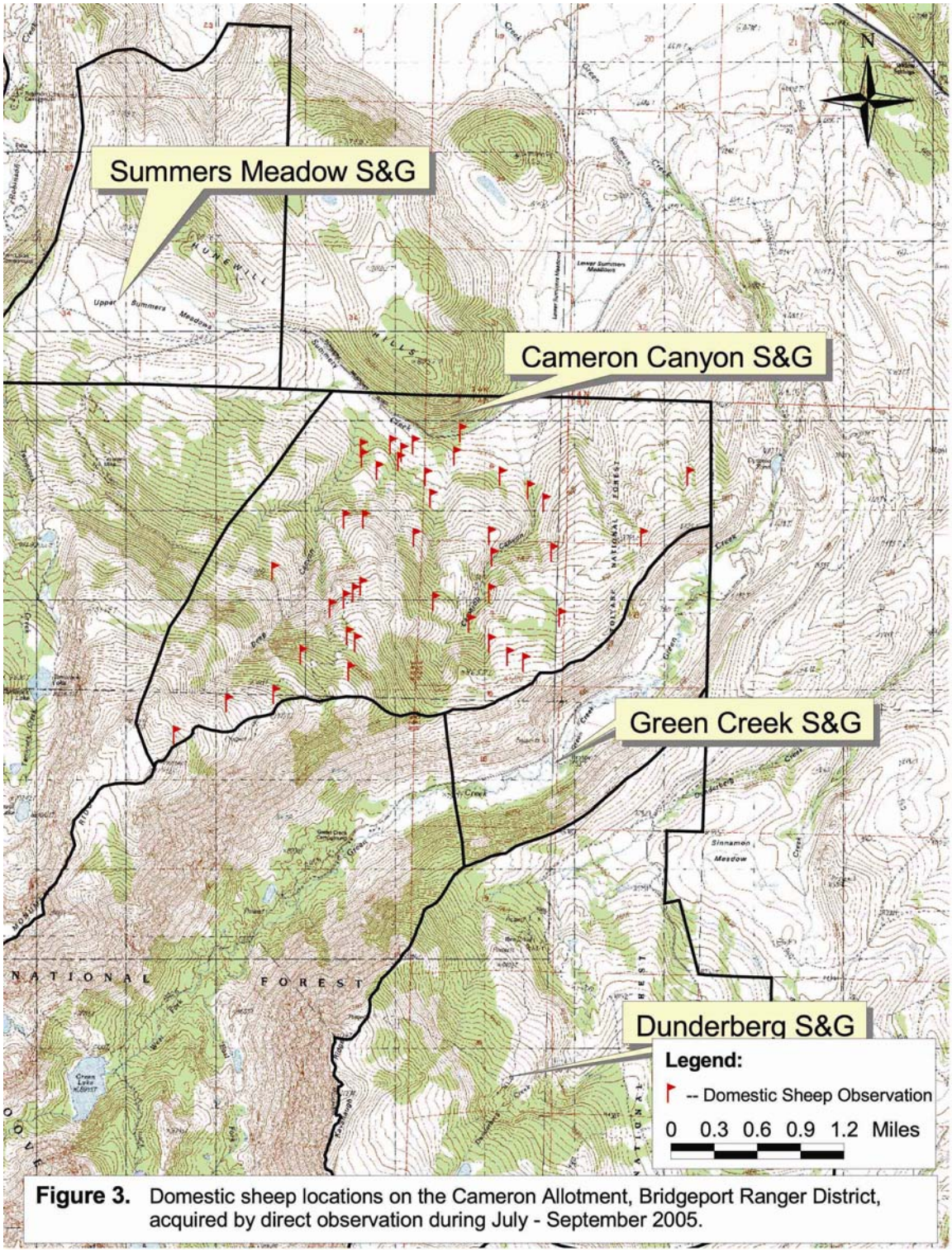


**Figure 3.** Domestic sheep locations on the Cameron Allotment, Bridgeport Ranger District, acquired by direct observation during July - September 2005.

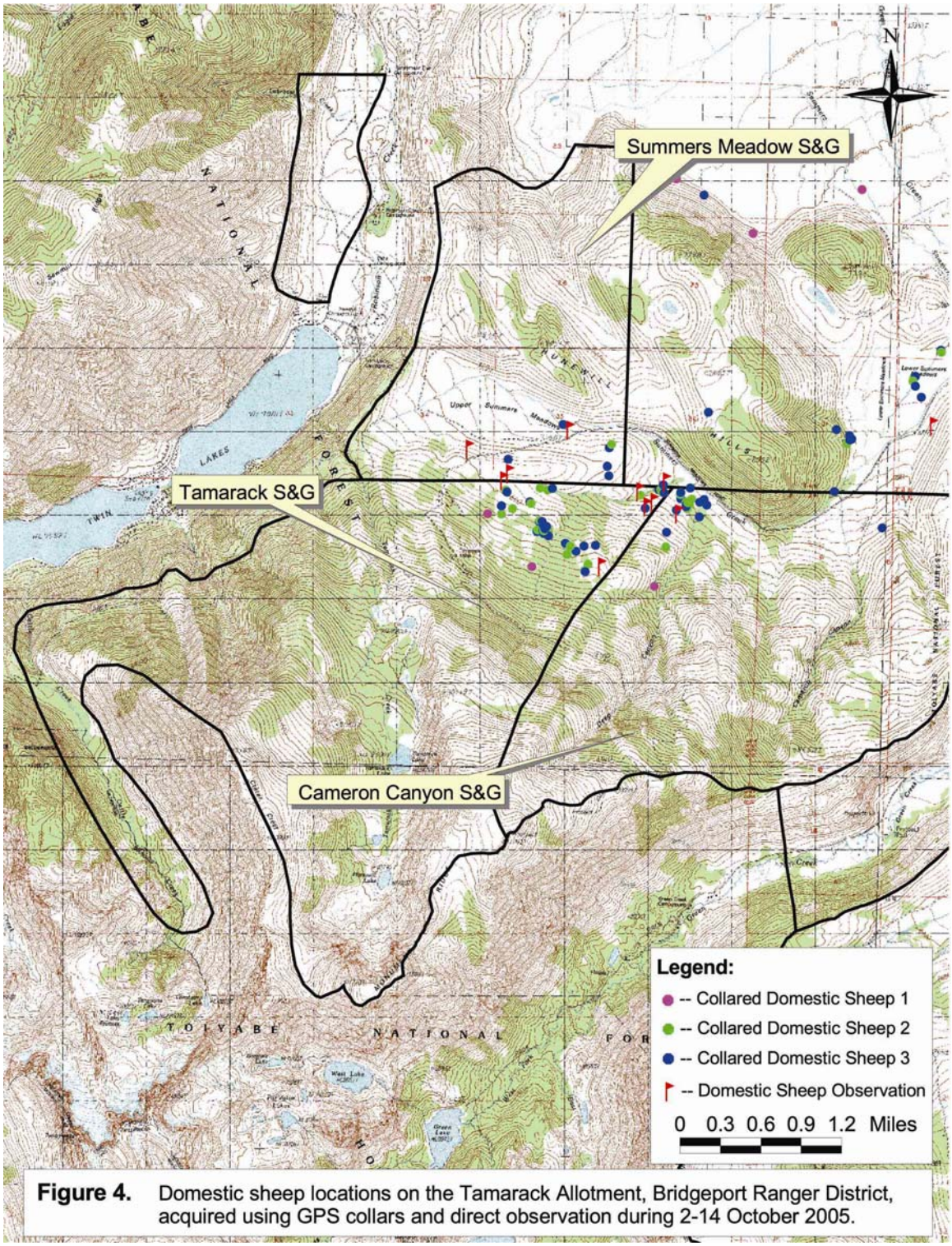


**Figure 4.** Domestic sheep locations on the Tamarack Allotment, Bridgeport Ranger District, acquired using GPS collars and direct observation during 2-14 October 2005.

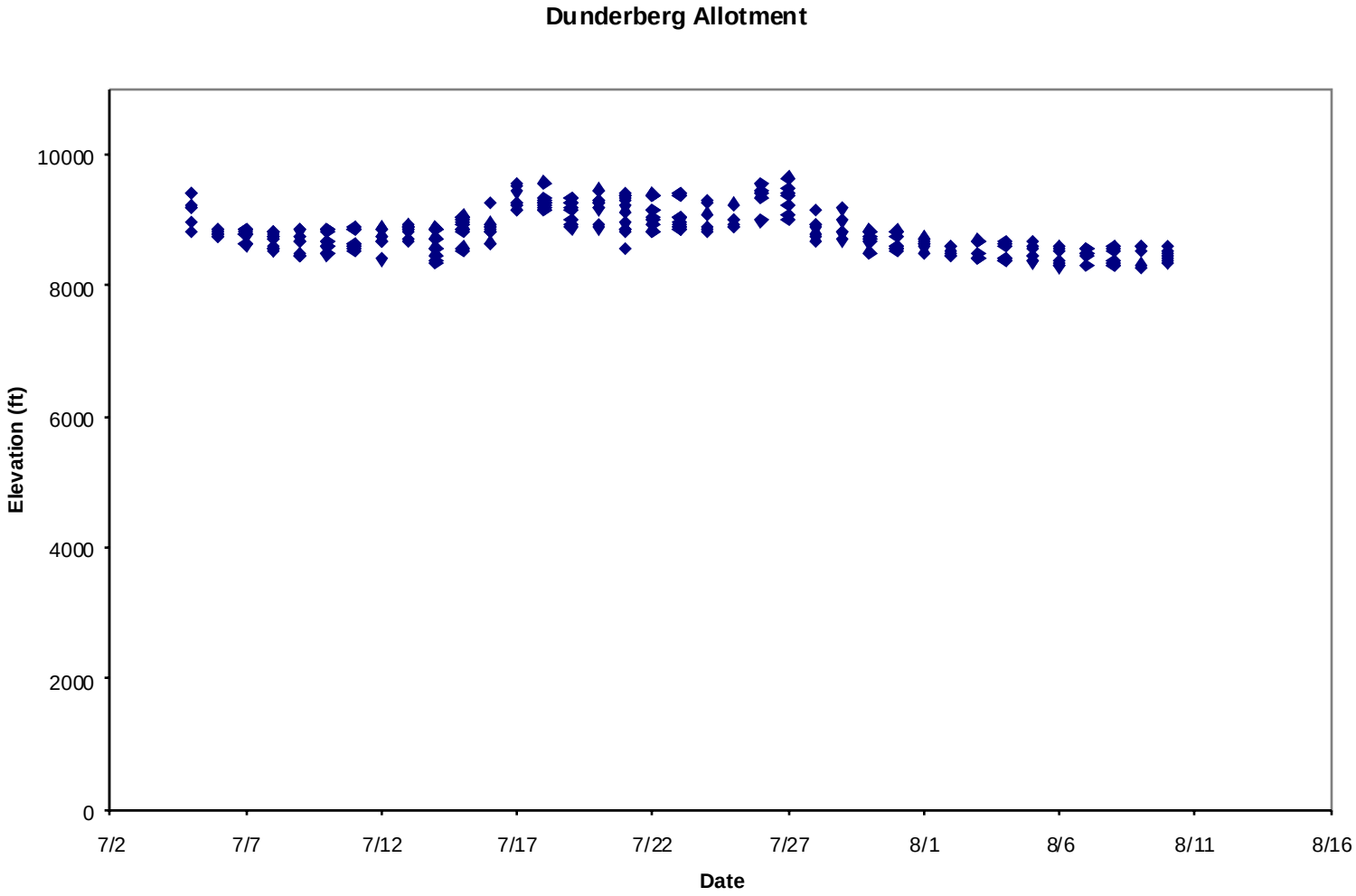


Figure 5. Elevation of use by date for domestic sheep on the Dunderberg Allotment, Bridgeport Ranger District, during July – August 2005.

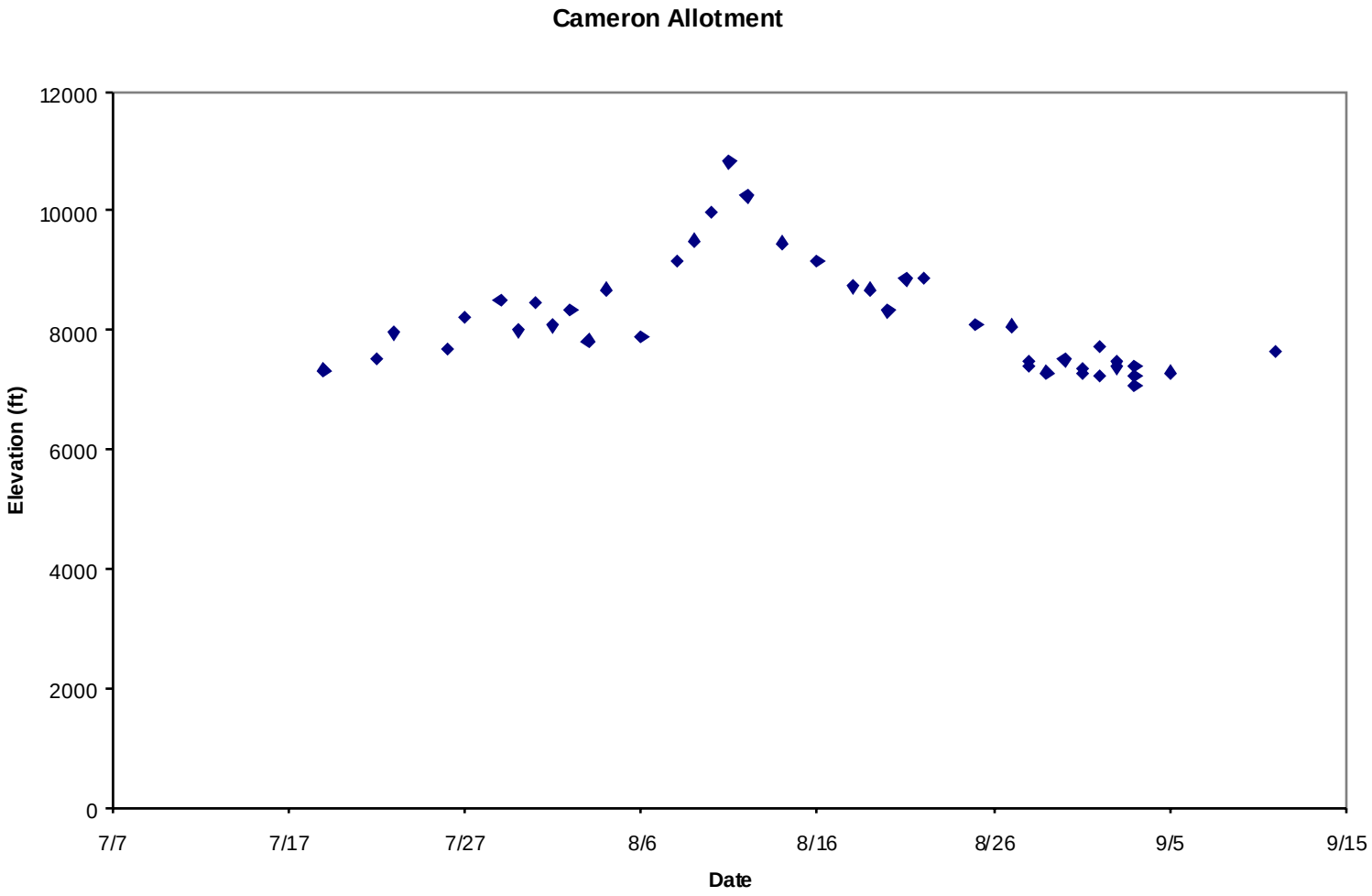


Figure 6. Elevation of use by date for domestic sheep on the Cameron Allotment, Bridgeport Ranger District, during July – August 2005.

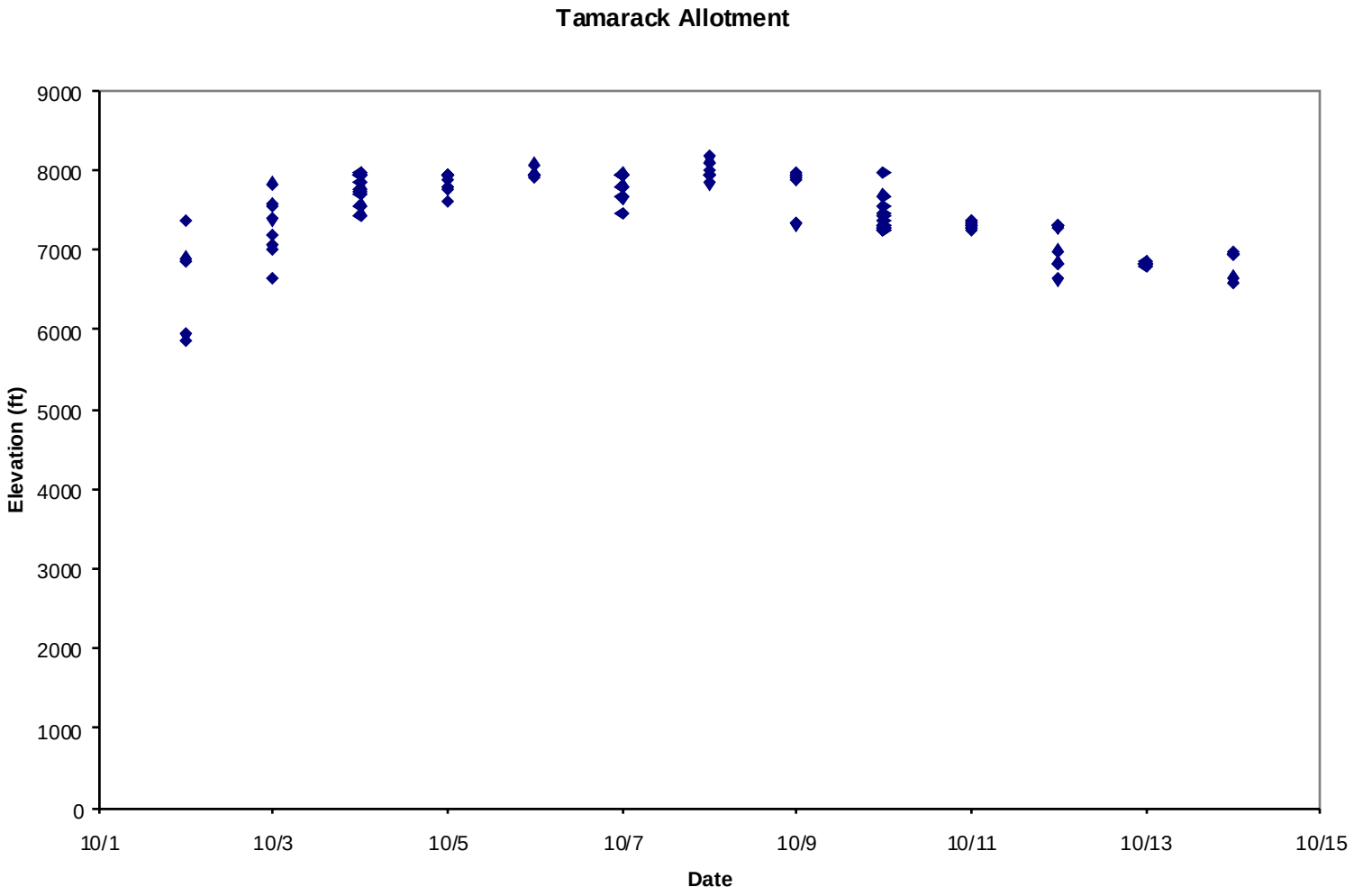


Figure 7. Elevation of use by date for domestic sheep on the Tamarack Allotment, Bridgeport Ranger District, during July – August 2005.

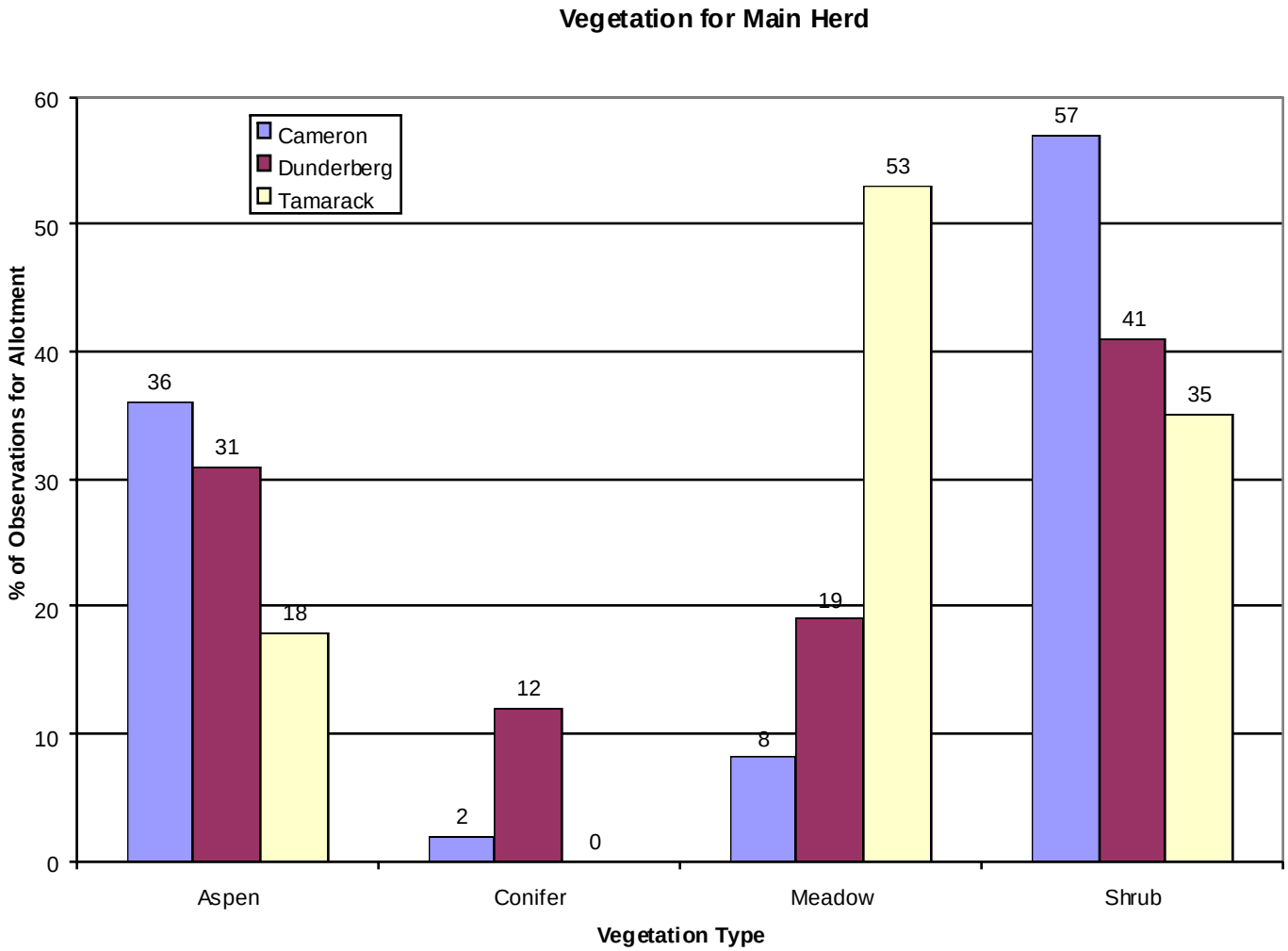


Figure 8. Use of vegetation types by domestic sheep as recorded during direct observation on the Bridgeport Ranger District, during July – October 2005.

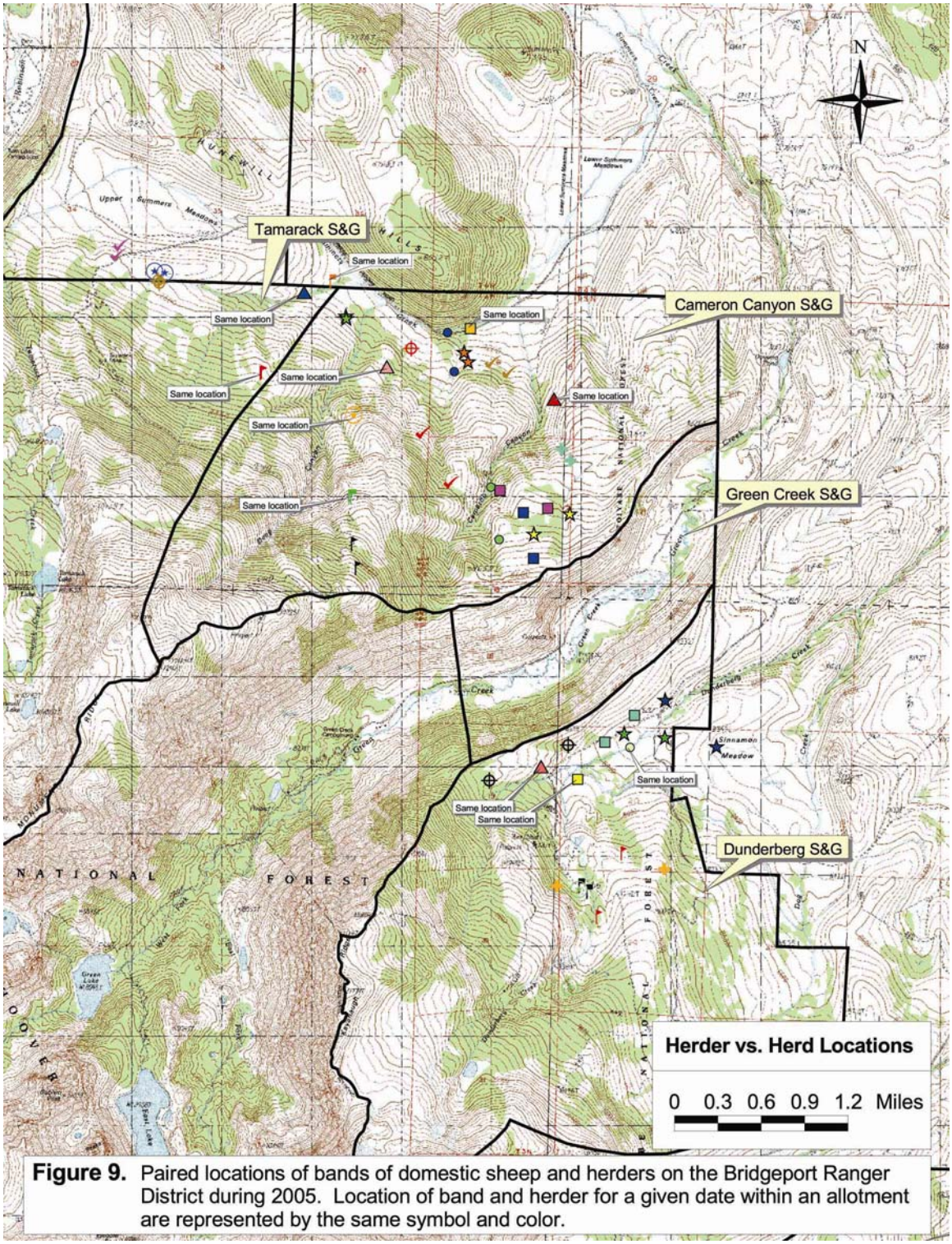


**Figure 9.** Paired locations of bands of domestic sheep and herders on the Bridgeport Ranger District during 2005. Location of band and herder for a given date within an allotment are represented by the same symbol and color.

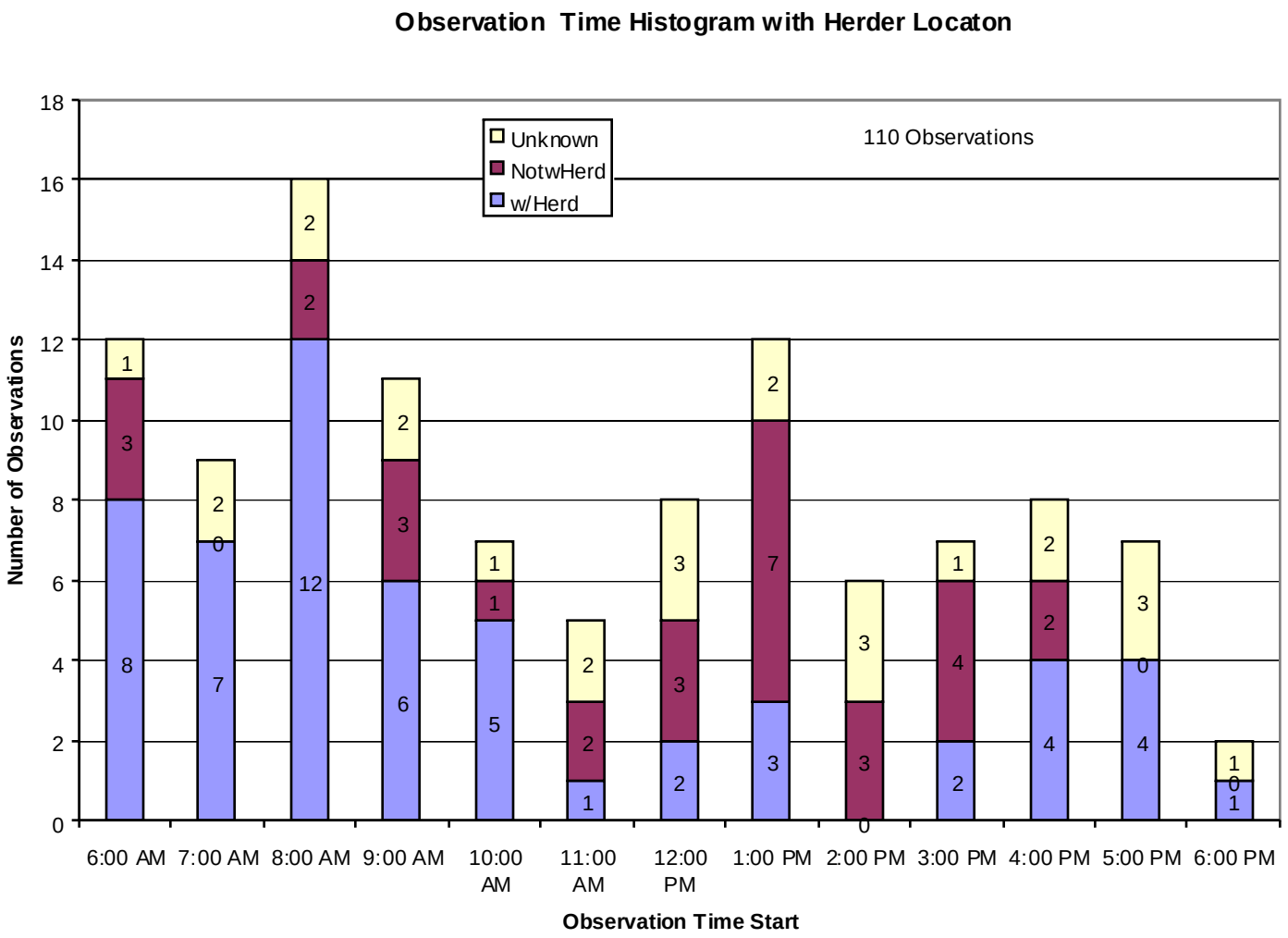


Figure 10. Herder locations and associated time for beginning of observation period on the Bridgeport Ranger District during 2005.

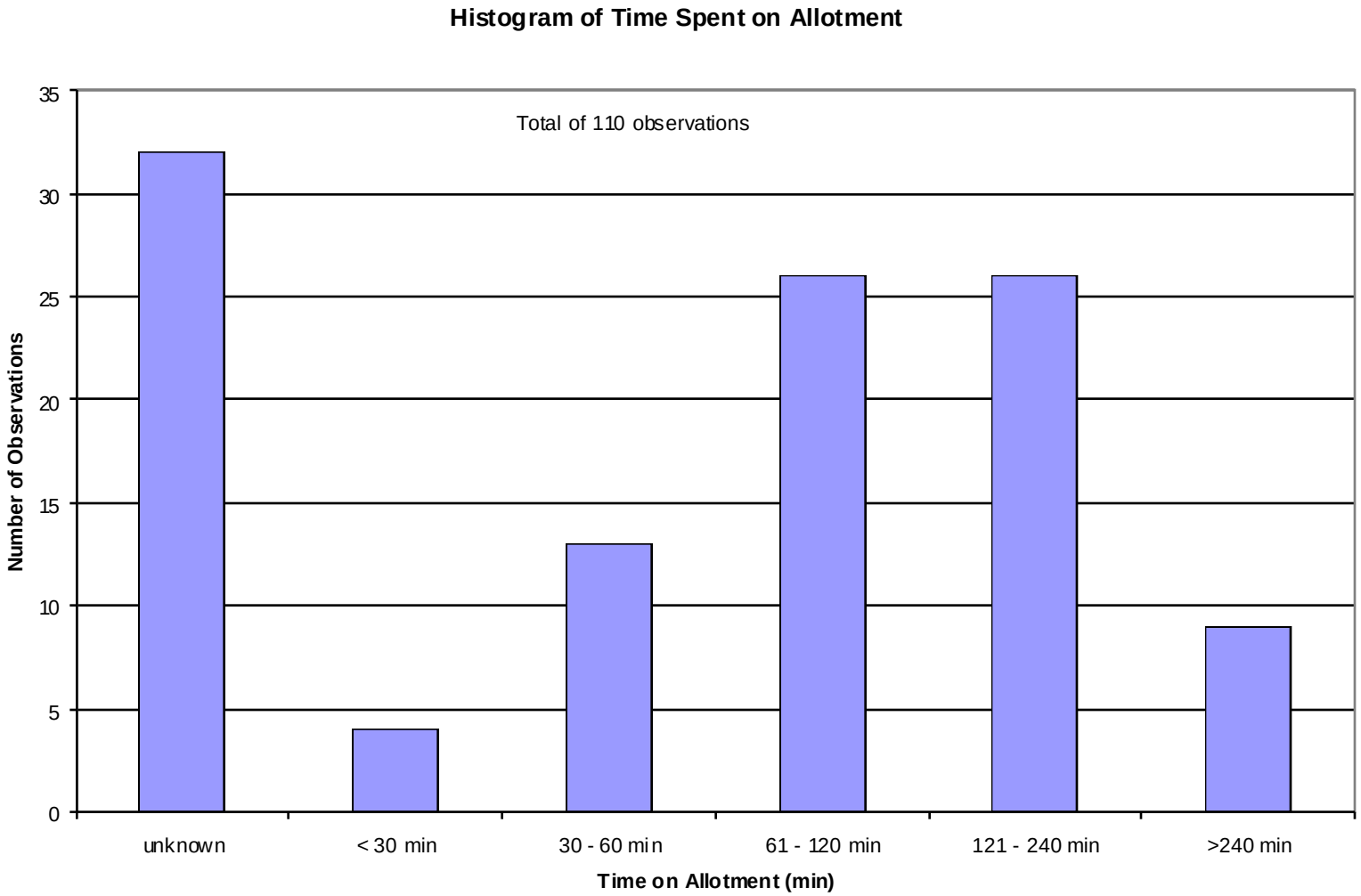


Figure 11. Time spent on domestic sheep allotments during observations on the Bridgeport Ranger District during July – October 2005. Unknown time durations resulted from failure of observers to record the time upon which allotment was departed.

# Appendix A

**Domestic Sheep Monitoring Program:**
**DATA COLLECTION FORM**

Date:_____
Observer(s): _____
Time (begin): _____
Allotment: _____

**WEATHER**
Wind: calm, breezy, windy, gale
Sky: clear, partly cloudy, cloudy
Est. Ambient Temp. _____ (degrees F)

**GENERAL**
Herd location (describe): _____
Herd location: UTME _____ UTMN_____ Elev. _____
Herder location (describe): _____
Herder location: UTME _____ UTMN_____ Elev. _____

Herd Composition (circle): Ewes Lambs Rams
Types of sheep visible/audible (circle): Red Marker Bell Sheep Black Sheep Other (describe):_____
Is it possible to get a reliable marker count? Red Marker _____ Bell Sheep _____ Black Sheep _____ Other (describe):_____
Guard Dog 1 with herd with herder lost other general description or UTM _____
Guard Dog 2 with herd with herder lost other general description or UTM _____
Guard Dog 3 with herd with herder lost other general description or UTM _____
Herd Dog 1 with herd with herder lost other general description or UTM _____
Herd Dog 2 with herd with herder lost other general description or UTM _____
Donkey location: lost/other _____ w/ main herd _____ with herder (check both if together)

Approx. Distance from Herder to main herd group: _____ m
Percent herd visible to herder: _____ (percent)

**HERD INFORMATION**
Percent of herd visible (to observer): _____ Percent Certainty: _____
Number of Distinct Grps: _____ Number of stragglers _____
**Activity of main herd** bedded grazing moving other _____
Vegetation of majority of group shrub meadow aspen conifer piny on-juniper krumholz other _____
Density of vegetation _____ %
Vegetation of remainder of group shrub meadow aspen conifer piny on-juniper krumholz other _____
Density of vegetation _____ %
**Activity of sub-group**s bedded grazing moving other _____
Vegetation of majority of group shrub meadow aspen conifer piny on-juniper krumholz other _____
Density of vegetation _____ %
Vegetation of remainder of group shrub meadow aspen conifer piny on-juniper krumholz other _____
Density of vegetation _____ %
**Activity of stragglers** bedded grazing moving other _____
Vegetation of majority of group shrub meadow aspen conifer piny on-juniper krumholz other _____
Density of vegetation _____ %
Vegetation of remainder of group shrub meadow aspen conifer piny on-juniper krumholz other _____
Density of vegetation _____ %

Please comment on any relevant activities, observations, anomalies, etc.
_____
_____
_____
_____

DOCUMENTATION
Please describe any photos or video takens _____
_____
_____

Time End: _____

Time On Allotment: _____ Time Off Allotment: _____