A Process for Identifying and Managing Risk of Contact between Sierra Nevada Bighorn Sheep and Domestic Sheep

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INTRODUCTION

During a Sierra Nevada Bighorn Sheep Recovery Team (Team) meeting, made up of science and stakeholder teams, held on April 26-27, 2006, a decision was made that the disease risk assessment portion of Appendix B (Sierra Nevada Bighorn Sheep Recovery and Domestic Livestock: Preliminary Risk Assessment of Disease in the Eastern Sierra) provided in the Draft Final Recovery Plan for the Sierra Nevada Bighorn Sheep (*Ovis canadensis californiana*) (U. S. Fish and Wildlife Service 2006) should be redeveloped. To avoid delay in the completion of the final recovery plan for the Sierra Nevada Bighorn Sheep, the Team decided that this portion of Appendix B would be removed from the final plan, and a new disease risk assessment would be developed. This document provides a means to better understand and assess the likelihood of contact between domestic sheep (and goats) and Sierra Nevada bighorn sheep, a federally endangered species. The likelihood of contact plays a role in the risk of transmitting diseases to Sierra Nevada bighorn sheep from domestic sheep in the Sierra Nevada (Tuolumne, Mono, Fresno, Inyo, and Tulare Counties) California. Contact may result in the possible introduction of new pathogens to Sierra Nevada bighorn sheep that may cause pneumonia. There is concern that this could lead to the loss of entire bighorn sheep herds in the Sierra Nevada.

The Team assigned a subgroup representing the Team to revisit the risk assessment and develop a technique for assessing the risk of disease transmission between domestic sheep (and goats) and Sierra Nevada bighorn sheep. Subgroup representatives included land management agencies (Forest Service), wildlife management agencies (California Department of Fish and Game, U. S. Fish and Wildlife Service), sheep producers (F.I.M. Corp., Echenique Livestock), environmental organizations, and the Science Team.

Amongst the subgroup, there are varying opinions on the adequacy of the best available science related to disease transmission from domestic sheep to bighorn sheep in the wild. We did agree that disease transmission may be possible in the wild, and therefore, the goal is to prevent contact between domestic sheep (and goats) and Sierra Nevada bighorn sheep.

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In this document we describe an approach for assessing the risk of contact between Sierra Nevada bighorn sheep and domestic sheep (and goats) and discuss specific grazing practices we consider practicable to manage that risk. This approach assesses the risk by overlaying domestic sheep use areas with predicted Sierra Nevada bighorn sheep locations derived from a model based on habitat preferences and least-cost pathway analysis. This approach will assist in determining areas Sierra Nevada bighorn sheep are likely to travel/occupy in relation to movement of domestic sheep through grazing allotments. This process will be updated as needed or as new information becomes available as resources allow.

We address the factor/concerns related to disease transmission between domestic sheep (and goats) and Sierra Nevada bighorn sheep in four sections: I. Ecology of Sierra Nevada Bighorn Sheep, II. Spatial Assessment of Risk of Contact between Sierra Nevada Bighorn Sheep and Domestic Sheep (and Goats), III. Grazing Practices for Reducing and Detecting Straying of Domestic Sheep, and IV. Risk Assessment Implementation. The purpose of this approach is to provide land, wildlife, and livestock managers a tool for determining risk of contact between livestock and Sierra Nevada bighorn sheep and identifying ways to prevent contact.

The biology and historic distribution of bighorn sheep and the history of domestic sheep grazing in the Sierra Nevada are discussed in the Recovery Plan for the Sierra Nevada Bighorn Sheep (U. S. Fish and Wildlife Service 2007). Readers of this document should review the final recovery plan's Appendix B and other scientific literature which discusses diseases and concerns related to domestic livestock and bighorn sheep management.

While we developed this document for management of domestic sheep (and goats) near Sierra Nevada bighorn sheep, application of this assessment may assist others in recognizing potential conflicts and using specified grazing practices to reduce the likelihood of contact between domestic sheep (and goats) and bighorn sheep in their areas of concern. Likely users of this document include land managers, wildlife managers, and sheep and goat producers to assist in responsibly managing livestock in proximity to bighorn sheep. This document could also be provided to the general public that raises backyard sheep and goats, including 4H members and other interested parties, to increase awareness and thus assist in reducing the likelihood of contact between bighorn sheep and domestic sheep and goats.

SECTION I - ECOLOGY OF SIERRA NEVADA BIGHORN SHEEP

This section provides a brief overview of the ecology of Sierra Nevada bighorn sheep. For a full discussion, refer to the final recovery plan (U. S. Fish and Wildlife Service 2007). Sierra Nevada bighorn sheep are a mountain dwelling ungulate whose life history is associated with the acquisition of food and mates in a rugged, topographically diverse landscape. In their search for optimal foraging habitat, Sierra Nevada bighorn sheep

climb to elevations as high as 4,267 meters (14,000 feet) during the summer following green forage as it progresses up the mountains with increasing temperatures. They tend to remain at high elevations through the autumn breeding season (the rut) if weather permits, but rams exhibit a greater tendency to use a range of elevations throughout the year. Bighorn sheep have a polygynous mating system with males competing for breeding dominance during a rutting period that extends from late September through December. The peak of mating occurs in early November with a 180 day gestation period following conception. As winter snows arrive, most bighorn ewes are pregnant and the rams are in poor condition. In the winter, they seek areas with forage that is not buried by snow. Such areas may be low elevation [1,372 – 2,438 meters (4,500 – 8,000 feet)] ranges or high elevation [above 3,353 meters (11,000 feet)], wind scoured, alpine ridgelines. If they migrate to low elevation ranges, they typically remain there into April and have access to early green-up that results from warmer temperatures associated with lower elevations. Most lambs are born during May but may be born between mid April and early July. As new forages grow in the spring with warming temperatures, bighorn sheep begin migrating to higher elevations and ewes give birth to lambs in extremely steep terrain. Within a matter of days, newborn lambs begin following their mothers and continue migrating to higher elevations. Summer movements allow for maximizing intake of nutritious forage while ensuring access to steep, escape terrain, especially for ewes with lambs.

Bighorn sheep in the Sierra Nevada are elevational migrants with annual home ranges of ewes and rams averaging 53 square kilometers (20.5 square miles) and 100 square kilometers (38.6 square miles), respectively. Long distance movements may be associated with seasonal migration or forays by rams in search of mates. Movements of a Sierra Nevada bighorn sheep ram of more than 50 kilometers (31 miles) (measured in straight line travel distances) has been measured during the rut. Movements beyond core home ranges may occur in less suitable habitat. Winter ranges are characterized by snow-free, wind-scoured, or south-facing slopes that support abundant shrub and herbaceous forage. In contrast, summer ranges tend to be high elevation slopes in proximity to lush, alpine meadows. Forage quantity and quality on ranges is determined by precipitation, plant composition, and competition among conspecifics, with bighorn sheep population limitation occurring at higher densities through the mechanisms of density dependence.

SECTION II - SPATIAL ASSESSMENT OF RISK OF CONTACT BETWEEN SIERRA NEVADA BIGHORN SHEEP AND DOMESTIC SHEEP (AND GOATS)

We have developed an objective technique for determining the relative likelihood that Sierra Nevada bighorn sheep will move into or otherwise use habitat allotted to or otherwise grazed by domestic sheep (and goats). The possibility of contact between Sierra Nevada bighorn sheep and domestic sheep (and goats) can be determined, in part, by quantitatively estimating the relative likelihood of a bighorn sheep moving into a domestic sheep allotment. This approach uses a Geographic Information System (GIS) to approximate the likelihood of a bighorn sheep moving into or through habitat by

incorporating known locations of bighorn sheep, habitat characteristics, and domestic sheep allotments. The techniques used are well established in the literature and include habitat suitability modeling (*e.g*., Zeigenfuss et al. 2000) and least-cost pathway modeling (*e.g*., Beazley et al. 2005).

The methods are summarized briefly here and then described in more detail below:

1. Construct a bighorn sheep *habitat suitability model* and input it into ArcGIS.
2. Convert the habitat model suitability to a *resistance surface (i.e.*, layer*)*.
3. Identify *source points* for bighorn sheep movements.
4. Determine the *cost of movements* through the landscape for bighorn sheep from source point locations by creating a model of inverse weighted distances. This is referred to as the inverted *cost surface*.
5. Overlay the *outcomes* of bighorn sheep predictive modeling with domestic sheep allotment boundaries.
6. Calculate a *risk value* as the product of the spatial and temporal aspects of grazing allotments.

1. Construct Bighorn Sheep Habitat Suitability Model

A habitat suitability model for bighorn sheep was created using locations of bighorn sheep obtained from Global Positioning System (GPS) collars (Johnson et al. 2005). Bighorn sheep use and non-use of particular landscape features were identified using a multivariate logistic regression to predict preference of habitat by bighorn sheep. Landscape features considered include vegetation type (forested or non-forested), slope, aspect, hillshade, elevation, ruggedness, and distance to escape terrain (Johnson et al. 2005). The habitat suitability model was then computed in ArcGIS using a resource selection function wherein each pixel on the landscape was assigned a value that represents its suitability (*i.e*., probability of bighorn preference) as bighorn habitat. This model forms the habitat suitability surface.

2. Create Resistance Surface

In order to determine the relative likelihood that a bighorn will pass through a particular portion of the landscape, the *habitat suitability surface* was inverted to create a *resistance surface*. In this layer, each pixel represents its *lack* of suitability and hence the "cost" associated with moving through the habitat at that location. "Cost" is defined by distance and landscape features that are perceived as less desirable (*e.g*., not adjacent to rugged escape terrain) for travel by bighorn sheep. The costs of movement can be defined in terms of lack of available forage, proximity to escape terrain, etc.

3. Identify Source Points for Bighorn Sheep Movement

The relative likelihood of contact between bighorn sheep and domestic sheep (and goats) can be defined not only by the suitability of habitat for bighorn sheep in or adjacent to allotments but also by the actual or potential presence of bighorn sheep. Therefore, we

next identified “source”, or potential starting points for modeling bighorn sheep movement paths occurring within the core range (the area most consistently used during daily activities) of each radio-collared individual bighorn using GPS, ground, and aerial telemetry locations. Then, locations occurring within the 50 percent core home range were determined and used as the “source points” for identifying potential movement paths for individual bighorn sheep.

4. Determine Cost of Movements for Bighorn Sheep on the Landscape from Source Points (Bighorn Sheep Surface)

Using the source point of each individual bighorn sheep as a starting location, the “cost” associated with bighorn sheep moving out from that point will be calculated in ArcGIS. This approach utilizes the minimum cost distance associated with any individual bighorn sheep location to create a single surface. This composite layer represents the cumulative cost associated with travel to that point on the landscape by any individual. The cost is a function of the straight-line distance of a pixel from a source point and the habitat suitability value associated with that particular pixel and all pixels in the intervening space along the least-cost path. The cost surface is bounded by a maximum distance representing the maximum dispersal distance that a bighorn sheep is likely to travel in the region. The final cost surface is inverted such that values further from the source points represent lower risk (0), while those adjacent to source points represent higher risk (1) (inverted cost surface).

5. Overlay Inverted Cost Surface onto Domestic Sheep Allotment Map

The next step assigns each domestic sheep allotment a value that describes the relative likelihood of a bighorn sheep traveling adjacent to or into that allotment. This is accomplished by overlaying the inverted cost surface with the allotment surface.

6. Calculate Risk Value

The risk of contact is related to the amount of time and the temporal proximity to the fall bighorn sheep rut (as measured from January 1st) that domestic sheep are in allotments. The risk value for each allotment (or section of an allotment) was calculated as the product of the spatial and temporal aspects of grazing. The spatial component is the mean inverse weighted distance (MIWD; inverted cost surface). The temporal component is the sum of the number of days that the allotment is grazed and the latest Julian date that the allotment is grazed. Our use of the Julian date is based on the assumption that Sierra Nevada bighorn sheep are more likely to travel long distances as the rutting dates (September-December) approach.

$$\text{Risk} = \text{MIWD} \times (\text{number of grazing days} + \text{Julian Date})$$

* MIWD is the mean relative likelihood that a bighorn sheep will occupy a given allotment. Julian Date is a serial number equal to the number of days elapsed since January 1 of a year. For example, February 15 is equal to Julian Date 46.

The model described here represents an effort to utilize the most current and detailed information available at the time the model was developed. Nevertheless, the model does have limitations. While the initial goal in developing the model was to predict the probability of contact between bighorn sheep and domestic sheep, the lack of quantitative data on direct contact *(i.e.*, no bighorn sheep wearing GPS collars in this recovery area has made direct contact with domestic sheep) precluded such a level of specificity. Thus the risk values that are output by the model represent a relative likelihood of contact rather than an absolute one. GPS collars have been deployed on 25 - 75 percent of the rams in the Northern and Central Recovery Units. While this represents a high level of monitoring, not all movements have been documented and hence the source points used represent a minimum. Of the GIS layers incorporated into the habitat suitability layer, the vegetation layer used to identify forested-nonforested vegetation was limited in resolution during development. Consequently, the model may be less sensitive in predicting use or avoidance of areas based on vegetation cover. Vegetation GIS layers continue to improve in resolution on an annual basis, it is expected that future versions of the model will more accurately reflect bighorn use based on preferences for types of vegetation. The model focuses on predicting the potential for contact through movement by bighorn sheep into allotments, however, contact may also occur through straying of domestic sheep. Although not specifically addressed, the risks associated with straying may be approximated by assessing the proximity of allotments to occupied bighorn habitat.

SECTION III – GRAZING PRACTICES FOR REDUCING AND DETECTING STRAYING OF DOMESTIC SHEEP

The prevention of straying of domestic sheep and goats is a high priority in the Sierra Nevada because unmanaged sheep or goats could mingle with Sierra Nevada bighorn sheep, particularly when grazing at high elevations. This section references grazing practices for domestic sheep that should reduce the straying of domestic sheep (and goats) and thereby reduce the likelihood of contact with Sierra Nevada bighorn sheep (Lynch et al. 1992).

The analysis in Clifford et al. (2007) showed a significant reduction in the probability of Sierra Nevada bighorn sheep respiratory disease transmission by not grazing domestic sheep during the rut, limiting grazing days by domestic sheep (76 to 81 percent reduction for 2005 and 2006 schedules compared with entire grazing season) and vigilant domestic sheep grazing management (48 to 62 percent reduction with no 1-kilometer spatial buffer). The utilization of the 2006 grazing strategy, allotment boundary adjustment, and vigilant management to prevent strays reduced the annual probability of respiratory disease transmission from 7 percent to 1.2 percent per year in the Northern Recovery Unit. This supports the development of possible mitigation strategies.

There are factors which may cause individuals or small groups of domestic sheep (or goats) to stray from their band. The following is a partial list (as additional factors may

become realized at a later date) of possible/likely reasons domestic sheep stray which results in an increase in risk of contact between domestic and bighorn sheep. These factors include: 1) Sick or lame sheep; 2) Lambs separated from ewes or ewes separated from the band; 3) Inattentive or absent sheepherders; 4) Predator attacks or attempts on sheep; 5) Use of either non-gregarious sheep breeds or goats as leaders; 6) Disturbance of sheep by recreationists, especially hikers with dogs, motorized off-road vehicles, etc.; 7) Herd management activities aside from grazing, including: off-loading of trucks; weaning and shipping lambs; trailing, especially with small lambs; driving (herding) to corrals or other unusual location for counting; or for other activities that disturb domestic sheep; 8) Inadequate preferred forage and/or livestock water; 9) Sheepherder's camp location; 10) Sheep bedding ground location; 11) Grazing through taller vegetation (e.g., forests, tall sagebrush, mountain mahogany); 12) Environmental events including thunder, lightening, high winds, and unseasonal snowstorms, wildfire, moonlit nights; 13) Inattentive or absent guard or herding dogs; 14) Domestic sheep band size too large (*i.e.*, greater than 900 to 2,400 individuals, see item C below); 15) Non gregarious domestic sheep breed; and 16) Poorly confined backyard sheep and goats.

The grazing practices listed below are considered to be measures that exemplify intensively managed domestic sheep grazing operations. When applied in their entirety, they should reduce the risk of straying and assist in reducing the likelihood of contact between domestic sheep (and goats) and Sierra Nevada bighorn sheep. Some practices mitigate more than one factor that may cause straying. Others provide a method for detecting that an individual(s) has strayed from the band. We have grouped these grazing practices into two categories: verifiable and unverifiable. These categories were identified because certain practices are more readily monitored on the ground by agency personnel than others. In addition, though not included in our list of measures to be implemented in their entirety, we mention that the construction and maintenance of electric or boundary fences can be useful in some situations to contain domestic sheep (*e.g.*, around bedding grounds as a temporary measure on public lands; around domestic backyard flocks).

Grazing Practices to Reduce and Detect Straying of Domestic Sheep and Goats

Verifiable Grazing Practices

A. Select only highly gregarious breeds of sheep (*i.e.*, Merino, Rambouillet, "Western white-faced ewes", fine wools and crosses thereof) (American Sheep Industry Association, Inc. 2003). Exceptions are during those brief periods of time when rams of non-gregarious breeds (*e.g.*, Suffolk) are present; ewes of gregarious breeds will continue to stay together as a band and will also cause the non-gregarious rams to stay with the band through the breeding season only.
B. The onset of estrus in domestic sheep is influenced by breed, season (fall) and cessation of lactation. Use ewes that are pregnant (determined by ultrasound preferably) or nursing lambs (twins preferably). These are the most suitable groups to graze nearest to bighorn sheep habitat while open ewes, yearling replacement ewes, and ewes that have lost their lambs are the least suitable.

C. Maintain a band size of less than 1,500 dry ewes or yearlings, 900 ewes with single lambs (1,800 total), or 700-800 ewes with twin lambs (2,100 to 2,400 total). These numbers are less than historically established domestic sheep numbers handled by a herder and dogs.

D. Require instruction/training and supervision to ranch and agency staff members (*i.e.*, camptenders and sheepherders) specific to Sierra Nevada bighorn sheep identification, prevention of contact, and escape procedures. Ranch owners and camptenders provide frequent instructions to the sheepherders concerning locations where there is forage and water available for domestic sheep and monitor that the grazing standards and guidelines are being followed. Document meetings and instructions to sheepherders in the log book (two examples of log book sheets are provided in Attachments 1 and 2; examples of instructional materials are provided in Attachment 3).

E. Remove sick or physically disabled sheep from the band; provide prompt veterinary treatment to injured sheep that are not disabled according to written protocols that should be established by the operator (a protocol example is provided in Attachment 4).

F. Place mature and effective guard dogs and herding dogs with the bands (recommended at least two herding and two guard dogs per band). Female dogs in heat should not be placed on allotments. Please refer to the American Sheep Industry Association, Inc. (2003) publication.

G. Conduct full counts of all individuals (ewes, rams, and lambs) when moving onto and off of each allotment to establish a baseline. Land managers should be present during these counts.

H. Maintain and record a ratio of at least 1 marker sheep to every 20 adult sheep. This ratio needs to be kept during the entire grazing season by replacing marker sheep as needed.

I. Count marker sheep on regular basis (at least twice per day). In the event that domestic sheep scatter, complete a full count as soon as possible.

J. Place bells on a customary number (at least a ratio of 1:100) of mature ewes to serve as warning sound for herder and to serve as identification and location of sheep to other sheep. If using "bell" sheep as markers, place an identifying mark on the bell sheep in case the bell is lost.

K. Require that each sheepherder consistently use a log book or other record keeping aid (Attachments 1 and 2). If grazing federal lands, the log book will be made available to appropriate federal employees upon request; if there is an issue with the log book, land managers will contact the permittee.

L. Select herder's camp, nighttime bedding ground, and midday (siesta) bedding ground locations that maintain communication between guard dogs and herding dogs by smell, sound (barking), and sight, and to take advantage of both guard dog and herding dog reticular activating systems. If grazing federal lands, one must adhere to established "bed ground" standards.

M. Select camp locations and bedding ground locations that will be acceptable to the sheep and thus result in the sheep remaining within the bedding grounds. If grazing federal lands, one must adhere to established "bed ground" standards.

N. Do not trail further than 5 miles in a day or stop trailing when sheep or lambs show signs of fatigue, whichever comes first; consider trucking instead of trailing. Please be aware that the domestic sheep may cross multi-jurisdictional lands during trailing.
O. Truck in water if needed (thirsty sheep are more likely to stray).
P. Develop and follow a plan for locating and reacquiring stray sheep. This plan, developed in conjunction with the land management agency, can be considered an Escape Management/Communication Protocol Plan. It indicates that if at any time during the grazing season, a domestic sheep is determined missing from the band on the allotments, the permittee will immediately initiate a comprehensive search and notify the land manager as defined in the plan. The search would continue until the stray is located and its locations evaluated in relation to Sierra Nevada bighorn sheep locations. The results will be immediately reported to the designated official. An example plan is available from the Humboldt-Toiyabe National Forest, Bridgeport Ranger District, Bridgeport, California.
Q. Require that sheepherder use communication equipment such as cell phones so that they may contact appropriate personnel in case of straying or Sierra Nevada bighorn sheep sightings.
R. Require that sheepherder use GPS receiver and record GPS locations in the sheepherder's log book.

Unverifiable Grazing Practices

S. Place the more experienced, informed, and responsible sheepherders with bands of sheep on allotments located nearer to Sierra Nevada bighorn sheep habitat.
T. Avoid moving domestic sheep through dense vegetation (go around instead of through) where possible.
U. Increase sheepherder vigilance on bright moonlit nights.

SECTION IV – RISK ASSESSMENT IMPLEMENTATION

The following describes the steps to be used by land management and regulatory agencies to: (1) assess the relative likelihood of contact between Sierra Nevada bighorn sheep and domestic sheep (and goats) on allotments, and (2) determine how to prevent such contact from occurring. As recovery goals are met (U. S. Fish and Wildlife Service 2007), the number and distribution of Sierra Nevada bighorn sheep will increase. Therefore, the likelihood of contact between bighorn sheep and domestic sheep will also increase. The assessment will need to be updated as new information becomes available. It is assumed that coordination among agencies and permittees is occurring during this process. Land management agencies should evaluate the need for section 7 consultation under the Endangered Species Act of 1973, as amended, and initiate consultation with the U. S. Fish and Wildlife Service as appropriate.

We envision a five step process that can be used by wildlife and land managers as follows:

Step 1. Determine the relative likelihood that a Sierra Nevada bighorn sheep will utilize habitat where domestic sheep are grazed.

Use the spatial risk model described above to quantitatively measure the relative likelihood that a Sierra Nevada bighorn sheep will utilize habitat where domestic sheep are grazed. Attachment 6 provides a model run output completed in 2008.

The model will be updated by the California Department of Fish and Game in coordination with land management agencies, as new information is collected on bighorn sheep movement and domestic sheep allotment management. Prior to a model update, land management agencies will provide the California Department of Fish and Game of any major management modifications (*i.e.*, boundary line changes, permitted and actual use, allotment status, etc.). California Department of Fish and Game will share model output (including intermediate analyses upon request) with land management and regulatory agencies to inform their determinations regarding grazing domestic sheep allotments. Land management agencies should share these outputs with permittees. Model updates will be contingent on funding by state and federal agencies or other sources.

We stress that current and comprehensive data is essential if the model is expected to provide managers with accurate information that reflect current conditions. The model should be rerun when new information (*e.g.*, changes in bighorn sheep distribution/movement, habitat conditions and/or domestic sheep grazing regimes) is available. Model inputs should be clearly defined with each update (*e.g.*, Attachment 6).

Step 2. Assess whether grazing domestic sheep in a specific allotment could result in contact with bighorn sheep.

The land management agency, in coordination with the U. S. Fish and Wildlife Service, the California Department of Fish and Game, and the permittee if necessary, should review the output of the spatial model and make a determination as to whether grazing domestic sheep in a specific allotment could result in contact with bighorn sheep. It should be recognized that while the model was based on the best available data, any modeling effort inherently does not predict every aspect of reality. Also the broad habitat preferences exhibited by Sierra Nevada bighorn sheep rams result in reduced specificity of the model's predictions. In addition to the model output, other documents and information needs to be considered during this coordination process. These documents include forest plans, resource management plans, the final recovery plan, peer reviewed literature, and any other applicable laws and regulations. Information on the specific allotments in question, such as, Sierra Nevada bighorn sheep habitat, vegetation types, spatial features (*i.e.*, rock outcrops, ridges), grazing rotations, grazing patterns, other land uses (*i.e.*, recreation, residences, resorts), and Sierra Nevada bighorn sheep locations should also be considered. Managers should also consider the risks associated with

straying by domestic sheep outside of the rut period in allotments that are in close proximity to bighorn sheep habitat. In making their evaluations, managers should consider the cumulative impact posed by allotments in the context of both space (*i.e.*, more than one allotment) and time (*i.e.*, more than one year). For example, managers with multiple allotments or those adjacent to an allotment managed by a different entity should not consider each allotment in isolation. As the recovery plan states, "the potential for contact between bighorn sheep and domestic sheep or goats must be eliminated to avoid the possibility of a catastrophic epizootic" (U. S. Fish and Wildlife Service 2007).

If a determination is made that grazing domestic sheep on a specific allotment could result in contact with bighorn sheep then land managers should proceed to step 3. If contact is not predicted, modification of grazing practices to prevent disease transmission is not essential.

Step 3. Determine whether changes in the temporal (*e.g.*, seasonal closures) or spatial use of allotments would prevent contact between bighorn sheep and domestic sheep or goats.

Managers, in coordination, should determine if making changes in the temporal (*e.g.*, seasonal closures) or spatial use of specific allotments would prevent contact between bighorn sheep and domestic sheep. If it is determined that changes in the temporal or spatial use of specific allotments would *not* prevent contact between bighorn sheep and domestic sheep then land managers should proceed to step 4.

Step 4. Determine whether implementing the grazing practices detailed in Section III above would prevent contact between bighorn and domestic sheep.

Managers should determine whether implementing the grazing practices, described in Section III in their entirety, would prevent contact between bighorn sheep and domestic sheep. We believe that some likelihood of contact may be mitigated through the use of grazing practices. However, because the likelihood of contact is higher when domestic sheep are grazed in proximity to habitat occupied by bighorn sheep the only method that ensures that contact can not occur is avoiding the use of overlapping ranges by the two species. Therefore, the use of grazing practices can not be expected to prevent contact in every situation.

If it is determined that implementation of the grazing practices would prevent contact between domestic sheep and bighorn sheep and grazing is subsequently permitted, then managers should proceed to Step 5. If it is determined that contact between bighorn sheep and domestic sheep (or goats) cannot be prevented on an allotment(s), we recommend closure to domestic sheep (and goats) (see Section E of the final recovery plan).

Step 5. Monitor and verify whether grazing practices are being implemented and assess their effectiveness in reducing straying of domestic sheep.

It is the permittee's responsibility to adhere to any standard and guidelines that are a part of their term grazing permit. The responsibility for monitoring and verifying that livestock producers are using the prescribed grazing practices during the grazing season is the responsibility of the land management agencies (Attachment 5).

For allotments where grazing is permitted in Step 4 based on implementation of grazing practices, managers should, on an annual basis, compile monitoring and reporting information from permittees and monitoring and verification reporting from agency personnel. This information should be used to verify that grazing practices are being implemented as prescribed and to assess whether the mitigation measures are effectively preventing straying of domestic sheep (and goats). We consider this an essential component of implementation that will allow the U. S. Fish and Wildlife Service, California Department of Fish and Game, and appropriate land management agencies to assess whether this process is providing needed conservation benefit and will assist in identifying needed changes to it in the future. It will also help to ensure that effective measures are continued and that ineffective measures, which may add cost but no benefit, are discontinued.

FOR MORE INFORMATION:

To obtain information on the risk of contact between domestic sheep (and goats) and Sierra Nevada bighorn sheep on a particular Forest Service or Bureau of Land Management allotment, one should contact the appropriate office located in Bishop or Bridgeport, California. To obtain information on the risk of contact for non allotment areas or private land, one should contact the appropriate office of California Department of Fish and Game in Bishop, California, or the U. S. Fish and Wildlife Service in Ventura, California, or Reno, Nevada.

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Attachment 1

Log Book

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Total Count

_____ _____ _____
Permitte Allotment Grazing Season

Date Fecha	Time of Count Hora de Contar	# of Marker Sheep # de Marcas de Borregas	Total Loss Ewe, Ram, Lamb Muertas Borrega, Toro, Borreguito	Cause of Loss Muertas Porque?	Time of GPS Tiempo de GPS	Elevation Location Elevacion Situacion	Notes Nota

Scatter event O weather * predator place either symbol next to count row above as appropriate

Log Book **Attachment 2**

FECHA:_____ AREA:_____ PAGINA:_____
(Date) (Allotment or Area) (Page)

Toros (rams)				Campanas (bells)				Negras (blacks)				Prietas (black-faced)			
ID Nu. (ID No.)	Tiempo (Time):	Tiempo (Time):	Tiempo (Time):	ID Nu. (ID No.)	Tiempo (Time):	Tiempo (Time):	Tiempo (Time):	ID Nu. (ID No.)	Tiempo (Time):	Tiempo (Time):	Tiempo (Time):	ID Nu. (ID No.)	Tiempo (Time):	Tiempo (Time):	Tiempo (Time):

Attachment 2
(continued)

NOTA (notes) –

Aqui tienes que notar el total de animales perdidos. Es necesario indicar el tipo de animal perdido (carnero, oveja, cordero), y la causa de la perdida (enfermidad, animal cojo, despredador). Recomendamos que el visitante firma o inicie el registro, especialmente si hay cambios en el grupo de ovejas. Si posiciones del GPS son indicadores por el grupo de ovejas, pueden ser incluidos aqui.

This section should account for total losses (reduction in band number), and should indicate the type of loss (ram, ewe, lamb), and the reason for the loss (sick, lame, predator). We recommend any visitor initial or sign the log sheet, especially if changes are made to the band for any reason. If GPS locations are indicated for the band, they can be included in this section:

Indicar perdida total (total losses):_____

Perdida tipo (type of loss):_____

Causa perdido (reason for the loss):_____

Visita (visitor):_____

GPS sitio (GPS locations):_____

Attachment 3

Sierra Nevada Bighorn Sheep Identification Information

Bighorn sheep have a generally stocky build. As adults, Sierra Nevada bighorn sheep stand about three feet tall at the withers (the highest part of the back at the base of the neck of a horse, sheep, etc.) and weigh up to 140 pounds for females and 220 pounds for males. Coat color is variable from almost white to dark brown with a distinctive large white rump patch and a short dark tail. Females carry small narrow horns which rarely exceed 12 inches in length. Mature males carry more massive horns that are notably wide and flaring but relatively narrow at the base for bighorn. Young males (age 1-2) possess horns with shorter lengths than mature males but with broader bases than females. Lamb horns vary in length from 0 to 6 inches.

Carneros salvajes típicamente tienen el un aspecto general bien fuerte. Como adultos, los carneros salvajes del Sierra Nevada miden como 3 pies de altura a los hombros. Las ovejas pesan hasta 140 libras y los carneros hasta 220 libras. El color del pelaje es variable, se encuentran pelajes casi blancos hasta marrón oscuro. Se ve una marca blanca distinta al trasero del animal con una cola corta y oscura. Las ovejas llevan los cuernos estrechos y pequeños que raramente exceden 12 pulgadas en longitud, mientras que los carneros llevan cuernos mas masivos que son notablemente anchos y que son mas separados hacia los puntos. Carneros jóvenes (edades 1-2) tienen cuernos mas pequeños que carneros maduros pero mas anchos que ovejas. Cuernos de los corderos son variable en longitud y miden de 0 a 6 pulgadas.

Contact information:
(informacion de contacto)

California Department of Fish and Game
407 West Line Street, Room 8
Bishop, CA 93514
Telephone: 760-872-1171

Sierra Nevada Bighorn Sheep Pictures

Male Sierra Nevada Bighorn Sheep (SNBS)

Male and female SNBS

Male SNBS

Yearling male and female SNBS

Male and female SNBS

SNBS lamb

Adult female, yearling female, and yearling male

Group of male and female SNBS

SNBS on a ridge top

Female SNBS

Females and juveniles

Male SNBS

Attachment 4

Veterinary Protocol

1. Pre-turnout treatment for internal and external parasites. Products chosen for internal parasites should be effective against stomach worms, lung worms and nose bots. External parasite (post-shearing) treatment must be effective against crawling as well as sucking lice. Usually a pour-on insecticide is needed to treat crawling lice while injectable ivermectins and their derivatives, used for stomach worms, will eliminate sucking lice.

2. No modified live vaccines, i.e. Bluetongue or IBR-BVD-PI3 should be given to sheep within 30 days of turnout.

3. Basic supplies: self stick bandage wrap, duct tape, bandage scissors, 3cc and 12cc syringes, 18G 1-inch needles, and foot trimmers.

4. Drugs and solutions: Hydrogen Peroxide, auto starter fluid with ether, Koportox®, wound insect repellent spray, long acting tetracycline, Penicillin, Baytril®, oxytocin, Banamine®. Administer drugs subcutaneously.

5. Treatment Response Protocol

Code	Condition	Treatment
1.	Mastitis	Oxytocin, penicillin, Banamine®, milk affected udder
2.	Lameness (feet)	LA 200® or Baytril®, Koportox®—Trim affected hoof
3.	Pneumonia	Baytril®, Banamine®
4.	Wounds/bites	Hydrogen Peroxide Flush, insect repellent, LA 200®, Banamine®, Starter Spray to treat maggots
5.	Leg Fracture	Banamine®, splint using stick and bandage material
6.	Eye Infection	LA 200®
7.	Reproductive Infection	Oxytocin, LA 200® or Baytril®, Banamine®
8.	Other	

No response in 48 hours, change antibiotic; send sick sheep home with camptender; sick guard dogs can have penicillin only.

- Banamine®--This drug is very useful in treating pain, inflammation, and toxicity due to infection. An animal that has an infection should be given antibiotics as well.

- Oxytocin®--This drug is used to increase milk letdown , aid in emptying uterus with reproductive infection, and during lambing difficulties.

- Penicillin, LA200®, and Baytril® are examples of antibiotics used to treat various infections. The choice of antibiotic used related to the needs and history of the sheep operation.

Attachment 5

Domestic Sheep Allotment Administration

Allotment Name: _____

Date: _____ Time of Day: _____ Name of _____

Start: _____ Observers:_____

Elevation End: _____ _____

Of Sheep: _____ _____

Sheep Location(s): _____

_____

_____

GPS Location(s): _____

Activity of Sheep (grazing, bedding down, moving, scattered):

_____

_____

_____

_____

Marker Sheep Seen: YES NO Number of Marker Sheep Observed: _____

Sheep Herder Seen: YES NO Location of Herder to Sheep: _____

_____

_____

Location of Sheep Herder Camp and Camp GPS Location: _____

_____

_____

_____

Guard Dogs Observed: YES NO Location of Guard Dogs to Sheep: _____

_____

Number of Guard Dogs Observed: _____ _____

Herding Dogs Observed: YES NO Location of Herding Dogs to Sheep: _____

_____

Number of Herding Dogs Observed: _____ _____

Other Notes and Observations: _____

_____

_____

_____

_____

_____

_____

Weather: _____

Attachment 6

Application of Risk Modeling to Domestic Sheep Allotments in Proximity to Bighorn Sheep Herd Units in the Eastern Sierra Nevada

We developed a habitat suitability model to identify habitat preferences by Sierra Nevada bighorn sheep. The model was developed using data only for rams, as they exhibit the greatest tendency to move beyond their core home ranges. The model incorporates 4,556 locations acquired from 15 GPS collared rams in the Northern (n=8), Central (n=6), and Southern (n=1) Recovery Units during May to December 2001 - 2006. May to December represents the primary period when domestic sheep are on public land allotments and also encompasses the rutting season when bighorn rams are likely to make long distance movements. We applied the model over a broad geographic region in an effort to identify the availability of areas that bighorn sheep might use during forays beyond the recovery area. The suitability model predicts habitat preferences based on elevation, slope, distance to escape terrain, terrain ruggedness, vegetation (forest-nonforest), and aspect. Next, the bighorn sheep source layer identifies the core area used by existing Sierra bighorn populations and incorporates 45,923 GPS, ground observations, and aerial telemetry locations from 28 collared bighorn rams during 2001 - 2006. The cost surface layer then combines the information on bighorn habitat preferences and their current core use areas to model the likelihood of a bighorn sheep using any particular point on the landscape within a 60 kilometer (37 miles) radius of the core area. Bighorn sheep in the Sierra Nevada have been documented to travel 53 kilometer (33 miles) from their core home range; bighorn sheep in other regions of North America have been documented to travel distances well in excess of this so the radius was rounded to 60 kilometers (37 miles) for the purposes of examining risk. This 60 kilometer (37 miles) radius does include habitat known to be populated by desert bighorn sheep.

Use data for allotments in public ownership (Humboldt-Toiyabe National Forest, Inyo National Forest, Bureau of Land Management, Mono County, and the City of Los Angeles) in proximity to the eastern Sierra Nevada was initially collected for consideration in the risk model. Allotments that fell beyond the 60 kilometer (37 miles) radius were not considered in the model. A number of other vacant or closed allotments for which use data were not available at this time were also not considered. Those allotments included Alger Lake, Bloody Canyon, Gray Hills, Green Creek, Horse Meadow, Sarman Ranch, Saroni Canal, Silver Creek, Sugarloaf, Tobacco Flat, Walters Ranch, and Wild Oat. In addition, risk values were calculated for subdivisions of allotments that occurred in closest proximity to bighorn sheep herd units; subdivisions were defined by managers or permittees based on elevation or logistical boundaries. Allotments with subdivisions included Dunderberg, Tamarack and Cameron combined, Rock Creek, and Sherwin-Deadman.

Risk in this model is determined by a combination of spatial and temporal variables associate with allotments. Spatial proximity is quantified by Mean Inverse Weighted Distance (MIWD). The temporal component was considered at two levels: permitted use and actual use. Many allotments are used for a shorter time period than is permitted by

the managing agency; this reduces the risk associated with an allotment because when domestic sheep are not on the range, there is no potential for contact.

An important step in determining the risk of contact between Sierra Nevada bighorn sheep and domestic sheep is to determine where allotments occur relative to bighorn sheep on the landscape. Figure 1 illustrates the allotments and where they lie relative to their distance as it is weighted by the underlying habitat suitability. The darker red areas indicate allotments that have the least "cost" for a bighorn to move into. Figure 2 identifies the mean inverse weighted distance (MIWD) for each allotment. Mean inverse weighted distance captures a more realistic measure of spatial proximity of allotments to bighorn sheep herds in the eastern Sierra Nevada.

We determine a risk value for each allotment by calculating the product of the spatial component (MIWD) and the temporal component (the sum of the number of days grazed and the last date grazed). The risk value adjusts the risk posed by proximity by incorporating the time and date relative to the bighorn sheep rut that domestic sheep are actually using allotments (Table 1). Figures 3 -5 illustrate that many allotments that are grazed for shorter time periods and earlier in the season pose less risk than suggested simply by their proximity (Figure 2).

Clifford et al. (2007) emphasized that even with probabilities of contact between Sierra Nevada bighorn and domestic sheep as low as 2 percent per year, over a 70 year period there remains a greater than 50 percent probability of a significant disease outbreak. In the context of recovery of an endangered species, this represents a high level of risk. Data substantiating the direct transmission of respiratory pathogens between domestic sheep and bighorn sheep in the wild are lacking primarily due to the inherent logistical difficulties in obtaining the data (Martin et al. 1996 as cited in Clifford et al. 2007). The approach used to spatially model the probability of contact in the Clifford et al. (2007) model used kernel probabilities to estimate potential overlap between bighorn movements and domestic sheep allotments. Such a model can only be used to predict the likelihood of contact when a high percentage of bighorn sheep within a population are radio-collared and their movements are identified in detail. This was the case in the Northern Recovery Unit for Sierra Nevada bighorn sheep at the time the Clifford et al. (2007) model was constructed. However, this was not the case in all portions of the recovery area and such an intense level of monitoring will be expensive and difficult to maintain continuously.

Conversely, the spatial model applied in this risk assessment is based on resource selection functions and cost-weighted distances to predict the pattern of bighorn sheep use over the landscape. In contrast to the kernel distributions in the Clifford et al. (2007) model, the output of this model (combined with the temporal component) represents the relative likelihood of contact but not a probability. The benefit of this approach is that all allotments falling within the 60 kilometers (37 miles) boundary may be assessed, thus we are able to estimate larger range of variation in risk among allotments. In the Northern Recovery Unit, the allotments that fell within kernel distributions and represented a risk of contact in the Clifford et al. (2007) model also ranked the highest in this model.

Figures 3 - 5 demonstrate that the process developed by this team provides a relative ranking of risk on allotments based on the available data. Figures 3 - 5 identify allotments of highest risk on the left and allotments of relatively lower risk on the right. Figure 3 is sorted by permitted use, figures 4 and 5 are sorted by permitted use. Figure 4 includes management subdivisions of allotments, whereas figure 5 does not.

Allotment maps may be viewed at appropriate land management agency offices.

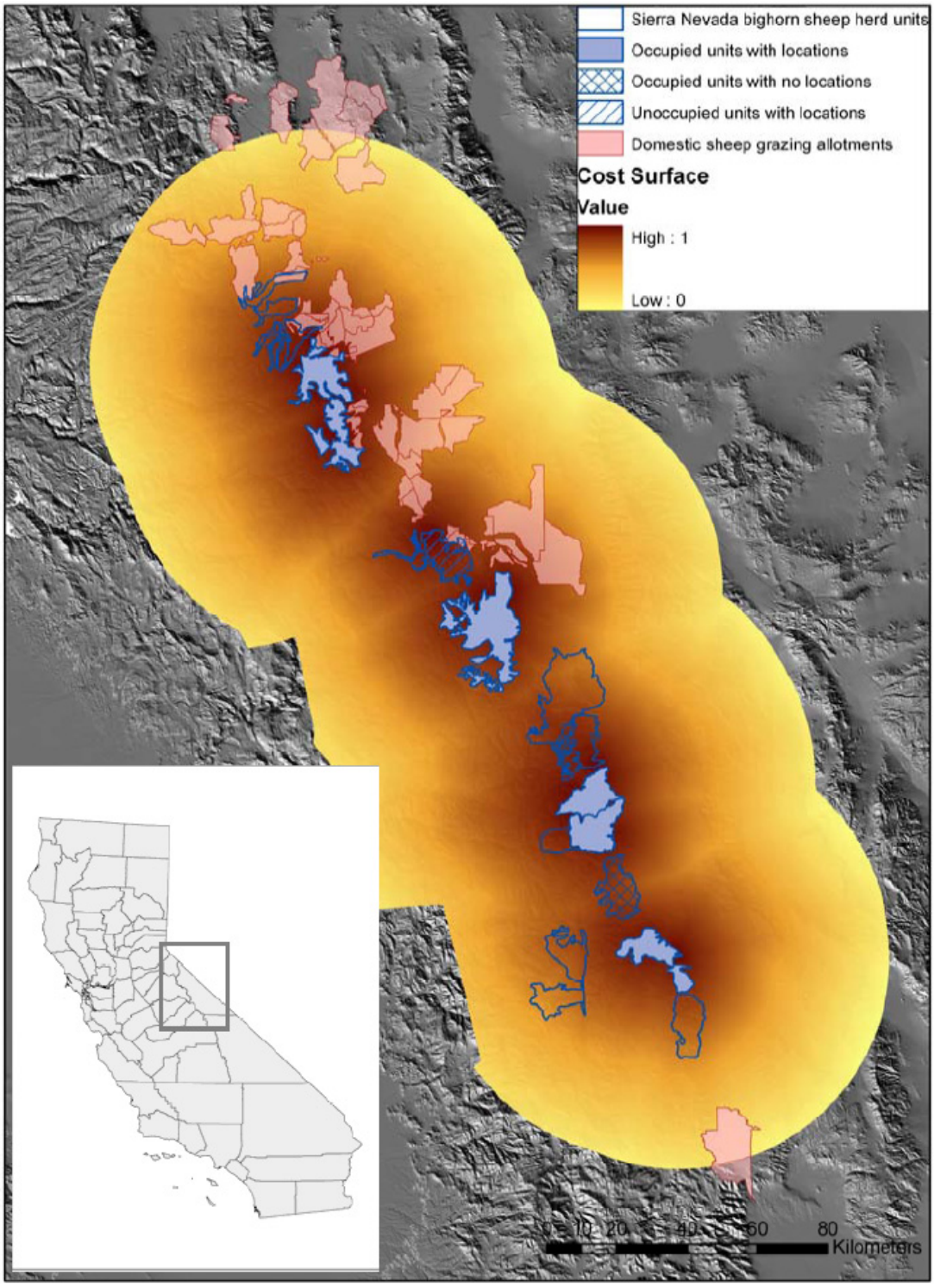

Figure 1. Inverted cost surface overlaid with the domestic sheep allotment polygons and occupied Sierra Nevada bighorn sheep herd units. The extent of the cost surface was defined to predict the maximum travel distance of Sierra Nevada bighorn sheep; the shading of the cost surface represents a decreasing likelihood of a bighorn sheep traveling that distance as the maximum extent is reached (lighter yellow).

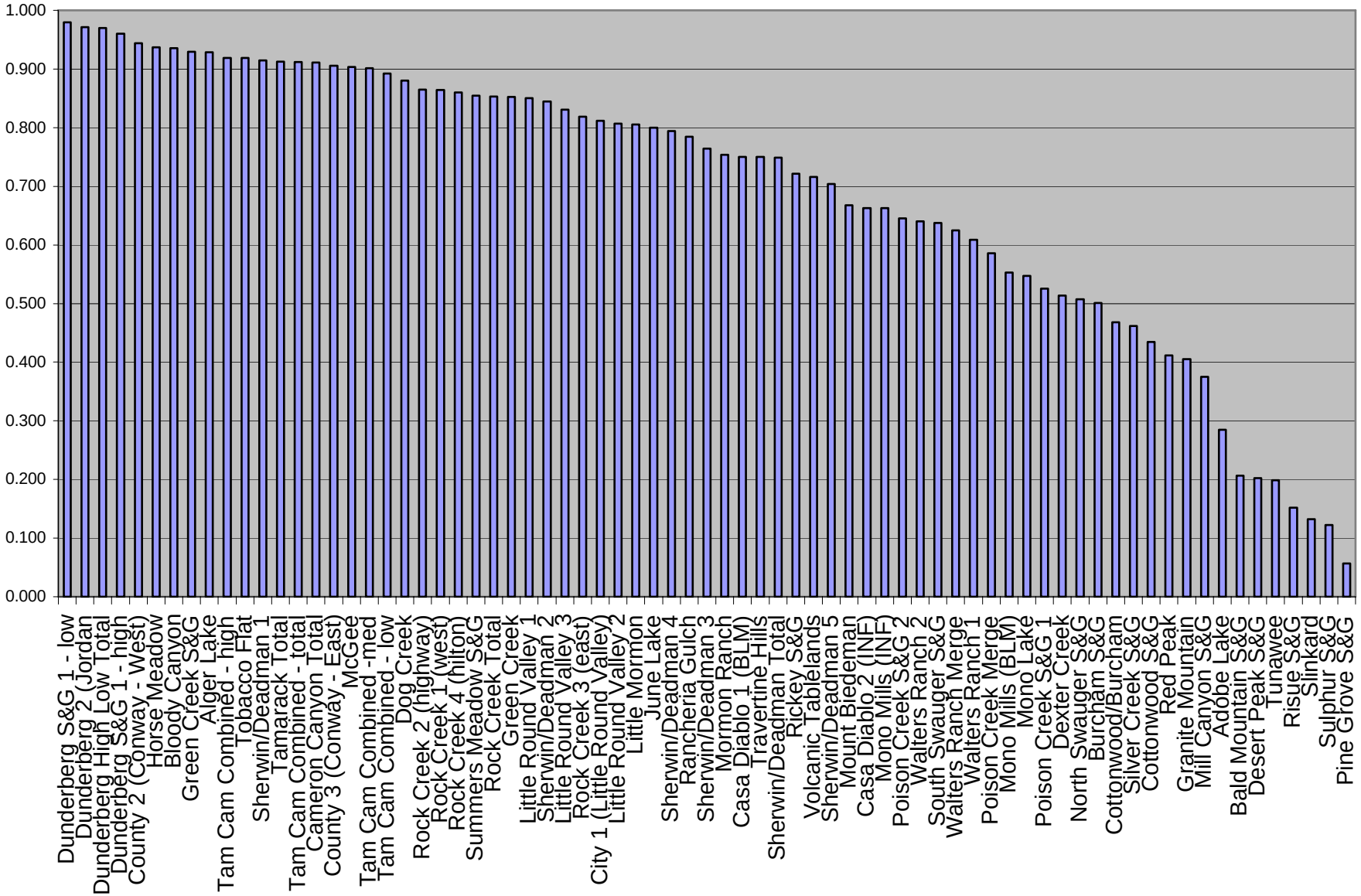

Figure 2. Mean Inverse Weighted Distance (y-axis) for each allotment (x-axis). The value represents the relative spatial proximity of domestic sheep allotments to Sierra Nevada bighorn sheep occupied habitat. Note: Cam = Cameron Canyon and Tam = Tamarack allotment.

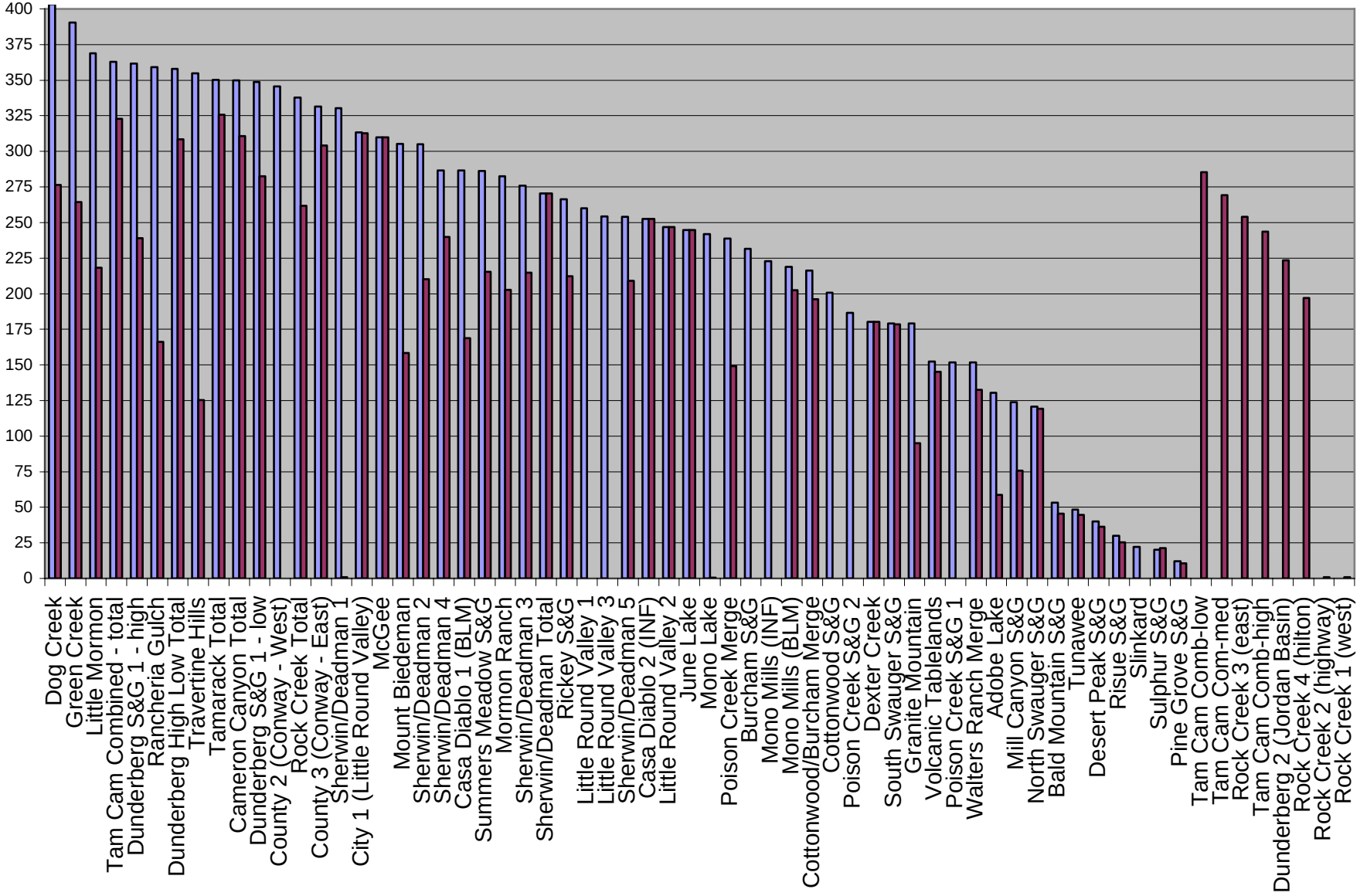

Figure 3. Relative risk values (y-axis) associated with domestic sheep allotments (x-axis) in proximity to Sierra Nevada bighorn sheep occupied habitat; sorted by permitted use. The purple (lighter) bars represent permitted use. The maroon (darker) bars represent actual use. Subunits for allotments with no value for permitted use occur because permitted use occurs for entire allotments, hence see the total allotment for permitted use. Allotments with no value permitted use occur because they have not been permitted for use in recent years.

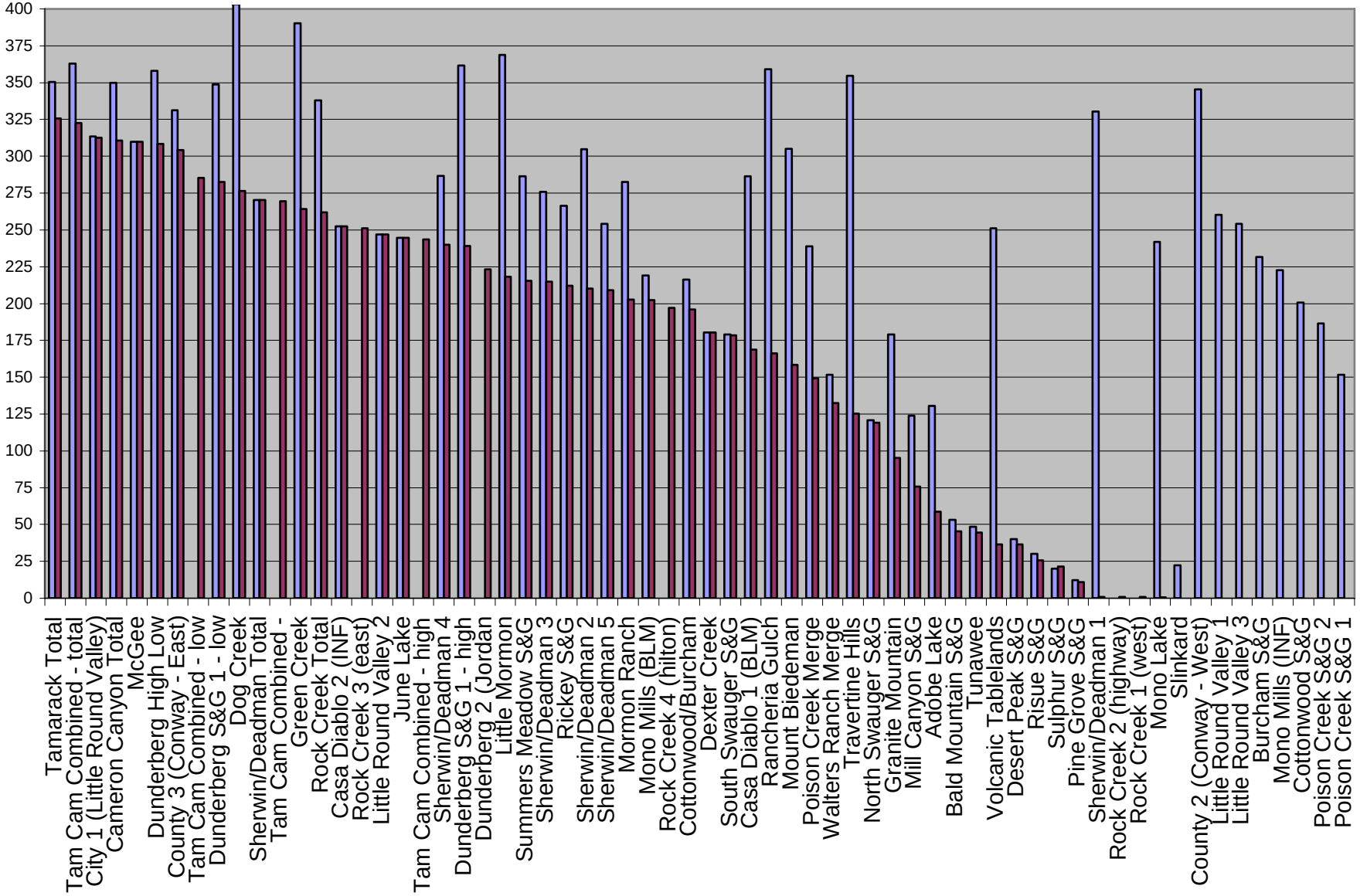

Figure 4. Relative risk values (y-axis) associated with domestic sheep allotments (x-axis) in proximity to Sierra Nevada bighorn sheep occupied habitat; sorted by actual use. The purple (lighter) bars represent permitted use. The maroon (darker) bars represent actual use. Allotments with no actual use risk value occur because no use of the allotment occurred in recent years.

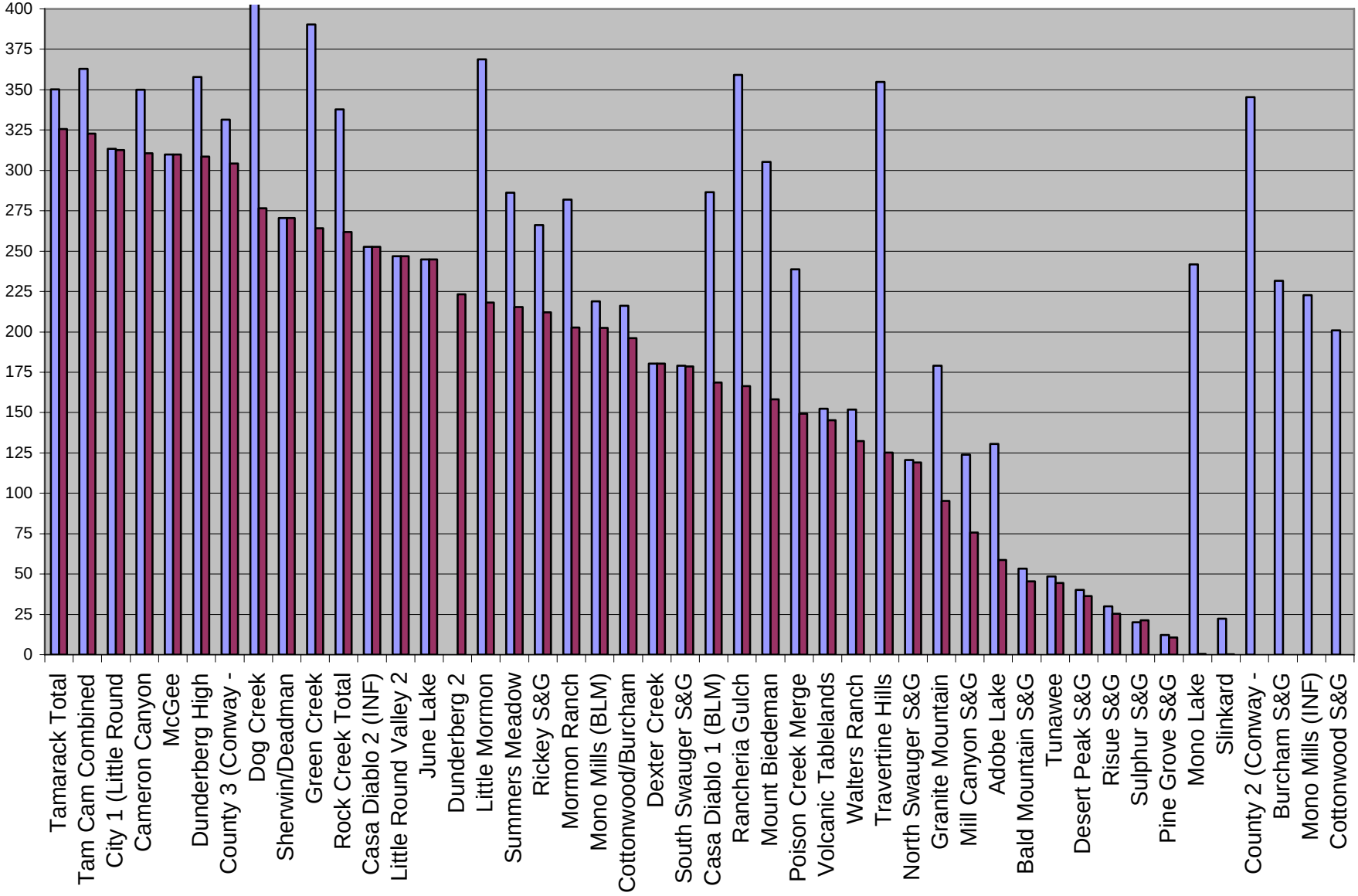

Figure 5. Relative risk values (y-axis) associated with domestic sheep allotments (x-axis) in proximity to Sierra Nevada bighorn sheep occupied habitat; sorted by actual use and excluding management subdivisions of allotments. The purple (lighter) bars represent permitted use. The maroon (darker) bars represent actual use. Allotments with no actual use risk value occur because no use of the allotment occurred in recent years.

Table 1. Domestic sheep allotments in proximity (within 60 km) to Sierra Nevada bighorn sheep habitat and associated attributes. Jurisdictional abbreviations include BLM = Bureau of Land Management, INF = Inyo National Forest, HTNF = Humboldt-Toiyabe National Forest, SNF = Stanislaus National Forest, and DWP = Los Angeles Department of Water and Power. MIWD = mean inverse weighted distance (a measure of distance adjusted by habitat suitability from bighorn locations where 1 is adjacent and 0 is distant).

NAME	AREA M2	JURISDICTION	Permittee	Status	Permitted Sheep	Permitted Dates	Total Permitted Days	Last Date	Julian Date	Max. Actual Dates	Max. Actual Days	Max. Last Date	Max. Julian Date	MEAN IWD
Adobe Lake	14243602	BLM	Indacochea	Active	99	6/1-10/31	153	31-Oct	305	7/1-7/12	12	12-Jul	194	**0.285**
Alger Lake	11881400	INF	n/a	Vacant										**0.929**
Aristo Ranch	3088699	BLM												**0.000**
Bald Mountain S&G	108427000	HTNF	F.I.M. CORP.	Active	900	5-15 to 7-15	61	15-Jul	197	6/25-7/1	37			**0.207**
Bloody Canyon	22265500	INF	n/a	Vacant										**0.936**
Burcham S&G	40592500	HTNF	F.I.M. CORP.	Active		See combined w/ Cottonwood								**0.501**
Cameron Canyon S&G Total	17057200	HTNF	F.I.M. CORP.	Active	900	6/28-9/30, 10/1-10/15	95	15-Oct	289	7/10-9/22	75	22-Sep	266	**0.911**
Casa Diablo 1 (BLM)	203150000	BLM	Ansolabehere	Active	57	6/15 to 9/30	108	30-Sep	274	8/1-8/6	6	6-Aug	219	**0.750**
Casa Diablo 2 (INF)	12784300	INF	Ansolabehere	Active	3500	6/15-9/30	107	30-Sep	274	6/15-9/30	107	30-Sep	274	**0.665**
City 1 (Little Round Valley)	3576810	DWP	Echenique	Active	1000	20-25 May-5 July, 20-sep - 28-oct	84	28-Oct	302	5/20-7/5, 9/20-10/28	83	28-Oct	302	**0.812**
Cottonwood S&G	54833000	HTNF	F.I.M. CORP.	Active		See combined w/ Burcham								**0.435**
Cottonwood/Burcham	95425500	HTNF	F.I.M. CORP.	Active	900	6/15 - 10/25	163	25-Oct	299	6/18-9/19	156	19-Sep	263	**0.468**
County 2 (Conway Ranch - West)	1044910	Mono County	F.I.M. CORP.	Active	1000	approx. 1-sep - 1-nov	60	1-Nov	306					**0.944**
County 3 (Conway Ranch - East)	3592200	Mono County	F.I.M. CORP.	Active		approx. 1-sep - 1-nov	60	1-Nov	306	~10/1-11/1	30	1-Nov	306	**0.905**
Desert Peak S&G	75385700	HTNF	F.I.M. CORP.	Active	1025	5/16-6/15	31	15-Jun	167	5/15-6/6	22	6-Jun	158	**0.202**
Dexter Creek	75959500	INF	I&M Sheep Co.	Active	1500	6/15-9/15	92	15-Sep	259	6/15-9/15	92	15-Sep	259	**0.514**
Dog Creek[1]	31060900	BLM	F.I.M. CORP.	Active	985	6/1-10-31	153	31-Oct	305	6/5-6/17,6/30-8/28	73	29-Aug	242	**0.881**
Dry Canyon	3684088	BLM	Borda	Active	51	3/1-5/31	92	31-May	152	4/1-4/20	20	20-April	111	**0.000**
Dunderberg S&G 1 - high	8262746	HTNF	F.I.M. CORP.	Active	900	6/28-9/30	95	30-Sep	274	7/25-8/12	19	12-Aug	225	**0.960**
Dunderberg S&G 1 - low	13153824	HTNF	F.I.M. CORP.	Active	900	6/28-9/30	95	30-Sep	274	8/13-9/18	37	18-Sep	262	**0.980**
Dunderberg S&G 2 (Jordan Basin)	5720541	HTNF	F.I.M. CORP.	Active						7/1-7/24	24	24-Jul	206	**0.971**

[1] "Max Actual Dates" and "Max Actual Days" value for Dog Creek are based on discussions with the permitte, but are not consistenet with the values provided by the BLM for the 2006 grazing season. BLMs records indicate "Max Actual Dates" of 7/20-8/29 and "Max Actual Days" of 41. Figures 3-5 (above) depict the allotment's actual relative risk based on the values in the table that were provided by the permittee. Descrepency is likely a result of the permittee reporting typical use over a number of years while the BLM reported grazing information for a single grazing season.

Dunderberg S&G High Low Total	21416570	HTNF	F.I.M. CORP.	Active	900	6/28-9/30	95	30-Sep	274	7/25-9/18	56	18-Sep	262	**0.970**
Granite Mountain	85830648	BLM	Indacochea	Active	845	7/1-10/15	153	15-Oct	289	7/12-8/1	21	1-Aug	214	**0.405**
Gray Hills S&G	14961400	HTNF	E.L.W. Ranches Inc.	Active	1650	4/3-4/2 nte 1695 sm	41							**0.000**
Green Creek[2]	17737000	BLM	I&M SHEEP CO.	Active	607	1-Jun to 31 Oct	153	31-Oct	305	7/1-9/15	51	15-Sep	259	**0.852**
Green Creek S&G	5279280	HTNF	n/a	Vacant										**0.929**
Horse Meadow	8717560	INF	n/a	Vacant										**0.937**
June Lake	66876800	INF	I&M Sheep Co.	Active	1500	7/1-8/31	62	31-Aug	244	7/1-8/31	62	31-Aug	244	**0.800**
Little Mormon	40363300	BLM	F.I.M. CORP.	Active	2981	6/1-10/31	153	31-Oct	305	6/1-7/20	50	20-Jul	202	**0.805**
Little Round Valley 1 (North)	3351920	BLM	Echenique	Active	Pt. of LRV	5-Oct - 18 Oct	14	18-Oct	292	7/8 – 7/27	20	NA	209	**0.850**
Little Round Valley 2	3470780	BLM	Echenique	Active	1400	5-Oct - 18 Oct	14	18-Oct	292	10/5-10/18	14	18-Oct	292	**0.807**
Little Round Valley 3 (South)	637036	BLM	Echenique	Active	Pt. of LRV	5-Oct – 18 Oct	14	18-Oct	292					**0.831**
McGee	17295700	INF	Ansolabehere	Active	1600	6/07-9/07	92	7-Sep	251	6/07-9/07	92	7-Sep	251	**0.903**
Mill Canyon S&G	30930000	HTNF	F.I.M. CORP.	Active	1025	6/1-6/25	25	31-Oct	305	6/1-6/25	25	25-Jun	177	**0.375**
Mono Lake	35774900	BLM	Indacochea	Active	763	1-Jul to 15 Oct	153	15-Oct	289	8/1 – 8/15	15	15-Aug	228	**0.547**
Mono Mills (BLM)	118311000	BLM	I&M SHEEP CO.	Active	3045	1-Jul - 15-Oct	107	15-Oct	289	7/1-9/30	92	30-Sep	274	**0.553**
Mono Mills (INF)	138152000	INF	Etchegeray	Active	4000	7/01-9/15	77	15-Sep	259					**0.663**
Mormon Ranch	13432500	BLM	I&M SHEEP CO.	Active	582	22-Jul - 15 Oct	86	15-Oct	289	7/22-8/23	33	23-Aug	236	**0.754**
Mount Biedeman	20044800	BLM	F.I.M. CORP.	Active	507	6/1-10/31	153	31-Oct	305	6/1-6/15, 6/23-7/16	39	16-Jul	198	**0.668**
North Swauger S&G	21670300	HTNF	I&M Sheep Co.	Active	1200	7/27-8/10	15	10-Aug	223	7/22-8/6	16	6-Aug	219	**0.507**
Pine Grove S&G	69288200	HTNF	F.I.M. CORP.	Active	900	5/25-6/27	34	27-Jun	179	6/12-6/24	13	24-Jun	176	**0.057**
Poison Creek Merge	105954630	HTNF	F.I.M. CORP.	Active	1025	6/19-10-15	119	15-Oct	289	6/26-8/3	39	3-Aug	216	**0.585**
Poison Creek S&G 1	4480630	HTNF	F.I.M. CORP.	Active		See merge		15-Oct	289					**0.525**
Poison Creek S&G 2	101474000	HTNF	F.I.M. CORP.	Active		See merge		15-Oct	289					**0.646**
Rancheria Gulch	102571000	BLM	F.I.M. CORP.	Active	1590	1-Jun to 31 Oct	153	31-Oct	305	6/1-6/30	30	30-Jun	182	**0.784**
Red Peak	70200000	SNF		Active										**0.412**
Rickey S&G	28428900	HTNF	F.I.M. CORP.	Active	900	6/28-9/30	95	30-Sep	274	7/25-9/6	44	6-Sep	250	**0.722**
Risue S&G	52462700	HTNF	F.I.M. CORP.	Active	1025	4/16-5/31	46	31-May	152	5/16-5/31	16	31-May	152	**0.152**
Rock Creek 1 (west)	16661300	INF	Echenique	Active	1250	6/1-9/30					0			**0.864**

[2] "Max Actual Dates", "Max Actual Days", "Max Last Date", and "Max Julian Date" values for Green Creek are based on discussions with the permitte, but are not consistenet with the values provided by the BLM for the 2006 grazing season. BLMs records indicate "Max Actual Dates" of 7/1-8/10; "Max Actual Days" of 41; "Max Last Date" of 10-August; and "Max Julian Date" of 223. Figures 3-5 (above) depict the allotment's actual relative risk based on the values in the table that were provided by the permittee. Descrepency is likely a result of the permittee reporting typical use over a number of years while the BLM reported grazing information for a single grazing season.

Rock Creek 2 (highway)	4296790	INF	Echenique	Active		6/1-9/30					0			**0.865**
Rock Creek 3 (east)	24696500	INF	Echenique	Active		6/1-9/30	122	30-Sep	274	5/31-8/6	68	6-Aug	219	**0.819**
Rock Creek 4 (hilton)	5164700	INF	Echenique	Active		6/1-9/30	122	30-Sep	274	7/8-7/27	20	27-Jul	209	**0.860**
Rock Creek Total	50819290	HTNF	Echenique	Active	1250	6/1-9/30	122	30-Sep	274	5/31-8/6	88	6-Aug	219	**0.853**
Saroni Canal S&G	32163100	HTNF	F.I.M. CORP.	Active	1025	4/1-5/18	48	18-May	139	4/28-5/15	18	15-May	136	**0.000**
Sherwin/Deadman 1	3929960	INF	Echenique	Active	2600	7/05-9/30	87	30-Sep	274		0	1-Jan	001	**0.915**
Sherwin/Deadman 2	24422000	INF	Echenique	Active	2600	7/05-9/30	87	30-Sep	274	7/30-8/17	19	17-Aug	230	**0.844**
Sherwin/Deadman 3	20384300	INF	Echenique	Active	2600	7/05-9/30	87	30-Sep	274	8/18-9/12	25	12-Sep	256	**0.764**
Sherwin/Deadman 4	35580000	INF	Echenique	Active	2600	7/05-9/30	87	30-Sep	274	9/17-10/2	26	2-Oct	276	**0.794**
Sherwin/Deadman 5	36063900	INF	Echenique	Active	2600	7/05-9/30	87	30-Sep	274	8/19-9/19	34	19-Sep	263	**0.704**
Sherwin/Deadman Total	120380160	INF	Echenique	Active	2600	7/05-9/30	87	30-Sep	274	7/30-9/30	87	30 Sep	274	**0.749**
Silver Creek S&G	78331500	HTNF	N/A	Vacant										**0.462**
Slinkard	50691800	BLM	F.I.M. CORP.	Active	670	5/15-5/31	17	31-May	152		0			**0.132**
South Swauger S&G	35001900	HTNF	I&M SHEEP CO.	Active	1200	7/6-7/26 & 8/11-8/28	40	28-Aug	241	7/1-7/21, 8/7-8/27	40	27-Aug	240	**0.637**
Sugarloaf S&G	56030100	HTNF	F.I.M. CORP.	Active	1800	16/16-2/28 (not to exceed 35d)	35	28-Feb	059					**0.000**
Sulphur S&G	205543000	HTNF	F.I.M. CORP.	Active	1025	12/16-3/15 (not to exceed 35d), 4/10-5/20,4/10-4/22	89	15-Mar	075	4/17-5/15	39	15-May	136	**0.122**
Summers Meadow S&G	9982230	HTNF	Borda Land & Sheep Co.	Active	2000	6/16-10/31 nte 1172 sm	30	31-Oct	305	7/21-8/14	25	14-Aug	227	**0.855**
Tamarack & Cameron Combined - high	9415872	HTNF	F.I.M. CORP.	Active						6/19-9/21		21-Sep	265	**0.919**
Tamarack & Cameron Combined - low	7672993	HTNF	F.I.M. CORP.	Active						6/19-9/21	55	21-Sep	265	**0.892**
Tamarack & Cameron Combined - med	16600632	HTNF	F.I.M. CORP.	Active						6/19-9/21	34	21-Sep	265	**0.901**
Tamarack & Cameron Combined - total	41229500	HTNF	F.I.M. CORP.	Active	1025	6/28-9/30, 10/1-10/15	109	15-Oct	289	6/19-9/21	89	21-Sep	265	**0.912**
Tamarack Total	24172300	HTNF	F.I.M. CORP.	Active	1650	6/28-9/30, 10/1-10/15	95	15-Oct	289	7/10-9/30	83	30-Sep	274	**0.912**
Travertine Hills	42882400	BLM	F.I.M. CORP.	Active	670	17-May - 31-Oct	168	31-Oct	305	5/17-5/31	15	31-May	152	**0.750**
Tunawee	226600000	BLM	Echinique	Active	3040	3/1 – 5/31	92	31-May	152	3/20-5/31	72	31-May	152	**0.199**
Volcanic Tablelands	190820000	BLM	Ansolabehere	Active	1010	1-May - 15-Jun	46	15-Jun	167	5/20-6/15	27	15-Jun	167	**0.716**
Walters Ranch 1	1941890	BLM												**0.609**
Walters Ranch 2	160755	BLM												**0.640**
Walters Ranch Merge	2102645	BLM	I&M SHEEP CO.	Active	452	5/1-6/30	61	30-Jun	182	6/1-6/30	30	30-Jun	182	**0.625**
Wild Oat S&G 1	101755	HTNF	F.I.M. CORP.	Active										**0.000**
Wild Oat S&G 2	10745000	HTNF	F.I.M. CORP.	Active										**0.000**

Wild Oat S&G Merge	10846755	HTNF	F.I.M. CORP.	Active	1650	4/1-7/15 (not to exceed 24 d)	24			8/12-8/14	3	31-Jul	213	**0.000**

Note: In rare cases, the number of actual days that an allotment was used is the sum of days for 2 separate bands of sheep using different areas of an allotment.