

Application of the Document Entitled *A Process for Identifying and Managing Risk of Contact between Sierra Nevada Bighorn Sheep and Domestic Sheep*

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INTRODUCTION

On February 12, 2009, representatives of the U.S. Forest Service (Inyo and Humboldt-Toiyabe National Forests), Bureau of Land Management (Bishop Field Office), U.S. Fish and Wildlife Service (Ventura and Nevada Fish and Wildlife Offices), and the California Department of Fish and Game (Bishop Field Office) held a meeting in Bishop, California, to discuss implementation of *A Process for Identifying and Managing Risk of Contact between Sierra Nevada Bighorn Sheep and Domestic Sheep* (Baumer *et al.* 2009; Risk Assessment). During this meeting, the land managers requested further assistance interpreting and applying the information provided in the Risk Assessment. They also expressed a need for guidance that would facilitate consistency in application of the Risk Assessment among the various agencies and jurisdictions. This guidance was requested within the context of recommendations 1, 2, and 8 provided in Section E of the *Recovery Plan for the Sierra Nevada Bighorn Sheep* (U.S. Fish and Wildlife Service 2007), which outlined a Recommended Strategy for Preventing Contact between Domestic Sheep or Goats and Sierra Nevada Bighorn Sheep.

Individuals representing the above-mentioned agencies met on February 19, 2009, to further discuss the information provided in the Risk Assessment and to develop recommendations for land managers to use when applying this information in their analyses of management options to prevent contact between domestic sheep and Sierra Nevada bighorn sheep. This document (Application Document) was developed as a result of this interagency coordination and provides recommendations specific to implementation of the Risk Assessment.

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After completion of the 2009 domestic sheep grazing season and a meeting between the U.S. Forest Service's Regional Forester (Region 4) and the U.S. Fish and Wildlife Service's Regional Director (Region 8) on November 23, 2009, further management coordination was recommended among the federal and state agencies to address domestic sheep grazing in proximity to Sierra Nevada bighorn sheep. As a result, the original Application Document has been revised herein to further clarify how to apply the Risk Assessment.

All participants understand that the Risk Assessment is dynamic and that future updates, based on additional Sierra Nevada bighorn sheep movement data and other pertinent information, will likely change the results. This understanding is essential in the context of recovery for Sierra Nevada bighorn sheep. For recovery to occur, Sierra Nevada bighorn sheep populations must increase in numbers, and populations must be distributed among the 12 herd units identified as essential for conservation of the species in the final recovery plan. These herd units were identified in the Sierra Nevada bighorn sheep recovery plan based on historic bighorn sheep locations and the availability of summer and winter range (U.S. Fish and Wildlife Service 2007). Therefore, the likelihood of contact between Sierra Nevada bighorn sheep and domestic sheep is predicted to increase over time as recovery goals are met. The analyses used in the Risk Assessment and this Application Document focus on the potential for contact between Sierra Nevada bighorn sheep and domestic sheep in the eastern Sierra Nevada.

Section E of the recovery plan recommended a strategy for preventing contact between domestic sheep (and goats) and Sierra Nevada bighorn sheep. It also addressed the possibility that development and use of the Risk Assessment could alter our understanding of the risk of contact between domestic sheep and Sierra Nevada bighorn sheep. It recommended that land managers incorporate use of the Risk Assessment into allotment specific analyses of management options to prevent contact. The Risk Assessment and this revised Application Document provide land managers additional tools for analyzing the risk of contact on domestic sheep allotments. Application of these tools may change our understanding of the risk of contact on certain allotments from that described in Section E of the recovery plan. The Risk Assessment, this Application Document, and the recovery plan are guidance documents that land managers should use along with any additional information from the published literature or Sierra Nevada bighorn sheep monitoring efforts in their decision-making processes to prevent contact between domestic sheep and the federally-listed, endangered Sierra Nevada bighorn sheep.

APPLICATION OF THE RISK ASSESSMENT

A Process for Identifying and Managing Risk of Contact between Sierra Nevada Bighorn Sheep and Domestic Sheep (Baumer *et al.* 2009; Risk Assessment) identified the following five-step process for Risk Assessment implementation:

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

2. Assess whether grazing domestic sheep in a specific allotment could result in contact with Sierra Nevada bighorn sheep;
3. Determine whether changes in the temporal (e.g., seasonal closures) or spatial use of allotments would prevent contact between Sierra Nevada bighorn sheep and domestic sheep;
4. Determine whether implementing the grazing practices detailed in Section III of the Risk Assessment would prevent contact between Sierra Nevada bighorn sheep and domestic sheep; and
5. Monitor and verify whether grazing practices are being implemented and assess their effectiveness in reducing straying of domestic sheep.

Below, we describe a method for applying this five-step process on lands managed by the Inyo and Humboldt-Toiyabe National Forests and the Bureau of Land Management (Bishop Field Office). For more information on the five-step process, please refer to Section IV of the Risk Assessment.

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

Please refer to the Risk Assessment (Section II pages 3-6; Attachment 6; Figure 2; Table 1) for a more complete description including the outcome of this previously completed step. Briefly, a geographic information system (GIS) based model was developed that incorporated Sierra Nevada bighorn sheep habitat suitability and proximity to herd use areas to determine the relative likelihood of Sierra Nevada bighorn sheep use of any particular location within the modeled area.

First, a GIS layer of *habitat suitability* was developed to indicate habitat preferences based on elevation, slope, aspect, hillshade, distance to escape terrain, terrain ruggedness, and vegetation (forest-nonforest). The final habitat suitability layer combines the habitat variables and incorporates each based on its importance. This GIS layer, with thousands of pixels (*i.e.*, geographic parcels) each representing the habitat suitability of 30 meter x 30 meter cells, was applied across the eastern Sierra landscape. In order to determine the relative resistance to bighorn sheep movement for a particular portion of the landscape, the habitat suitability layer was inverted to create a *resistance to movement* layer. In this layer, each pixel now represents the lack of habitat suitability for bighorn sheep at each location.

Second, to determine the relative likelihood of contact between bighorn sheep and domestic sheep at any location, a measure of the actual or potential presence of bighorn sheep was needed for each location. To do that, all known locations of radio-collared bighorn sheep, including GPS, ground, and aerial telemetry locations, were used to create home ranges for each herd unit. Core areas of these home ranges were then delineated using 50 percent kernels to create a *core home range* layer. Only those locations within each core home range were then used as source points for indentifying potential movement paths for bighorn sheep.

Finally, a cost-weighted distance function was applied to the core home range layer, utilizing the resistance to movement layer, to create a *cost distance layer* specific to Sierra Nevada bighorn sheep. This calculates the cost of travel from one cell to the next, initiated at the core home range locations. In the resulting composite cost distance layer, the value of each pixel represents the cumulative cost associated with travel to that point from a core home range location by a Sierra Nevada bighorn sheep.

Because bighorn sheep will not travel indefinitely, the model used a maximum dispersal limit of 60 kilometers from core home range locations (based on travel distances of GPS collared Sierra Nevada bighorn sheep rams) (Sierra Nevada Bighorn Sheep Recovery Program 2004). The cost-weighted distance was calculated from the core home range locations to the maximum dispersal limit.

There are a few recognized limitations to the GIS-based model, including: 1) not all Sierra Nevada bighorn sheep rams are collared, therefore, distance and location data points collected over the modeled time period are limited in number, 2) the vegetation layer used to map habitat suitability was limited in resolution, and 3) while the model was based on the best available data, it cannot predict every outcome.

In addition to the process described above, which is carried over and utilized in this Application Document, the Risk Assessment provided an additional step that averaged all of the pixel values within the boundary of a given allotment. This averaged value was meant to represent the relative likelihood that a Sierra Nevada bighorn sheep would utilize a given allotment. In the Risk Assessment, this value is referred to as the Mean Inverse Weighted Distance (MIWD). Table 1 of the Risk Assessment lists all the allotments analyzed with their MIWD values. Values closer to 1 indicate a high likelihood of use by a Sierra Nevada bighorn sheep. Values closer to 0 indicate a low likelihood of use by a Sierra Nevada bighorn sheep.

The use of MIWD, as discussed above, estimates the mean relative likelihood of Sierra Nevada bighorn sheep use of a given allotment. However, averaging pixel values to obtain a single value for an allotment ignores the variability of pixel values across the allotment. Therefore, an allotment could have portions that are highly conducive to bighorn sheep use, but the allotment's MIWD value would not reflect this because it is an average of all pixels values within the allotment.

In addition, the Risk Assessment does not provide a threshold above which a Sierra Nevada bighorn sheep's use of an allotment would be considered too high a risk for contact. Such a threshold has been requested by land managers to assist in making grazing management decisions. The Application Document does not use the mean relative likelihood of Sierra Nevada bighorn sheep use of a given allotment (*i.e.*, MIWD) in determining risk of contact, but provides an alternative method in Step 2.

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

The Risk Assessment provided an equation for determining a relative risk of contact between Sierra Nevada bighorn sheep and domestic sheep for each allotment based on the allotment's mean relative likelihood that a bighorn sheep would occur there and the dates and length of time the allotment would be grazed (*i.e.*, Relative Risk = MIWD X (number of grazing days + Julian Date; Section II, page 5). The resulting value provides a relative value, but not a threshold value for the risk of contact for each allotment.

After further evaluation of this equation, a few issues also became evident about whether this is an appropriate way to represent risk. These issues include: 1) uncertainty about how the variables relate to one another and whether some are more important than others, 2) equation variables are expressed using different scales, 3) the likelihood that a Sierra Nevada bighorn sheep would occur in an allotment is based on the mean likelihood which ignores the variability of risk across an allotment, and 4) the timing of use of an allotment is more influential in the equation than the bighorn sheep location information.

The equation is, therefore, inappropriate to use in determining whether use of an allotment crosses a threshold of acceptable risk of contact between domestic sheep and Sierra Nevada bighorn sheep. It may be appropriate to use the equation to make modifications to grazing seasons to reduce risk of contact for allotments located further away from Sierra Nevada bighorn sheep core population areas that have a low likelihood of Sierra Nevada bighorn sheep use (see Step 4). For allotments with a high likelihood of Sierra Nevada bighorn sheep use, employing the equation to make modifications to grazing seasons to reduce risk of contact is not appropriate. As a result of these concerns, it is recommended that this equation's role in the determination of the risk of contact between domestic sheep and Sierra Nevada bighorn sheep be diminished.

A more direct approach to assessing the level of risk of contact between domestic sheep and Sierra Nevada bighorn sheep by allotment is to determine whether an allotment or portion of an allotment crosses a threshold of acceptable risk. There are two parts to this analysis. One part is to determine a threshold of acceptable risk and the other is to determine whether this threshold is crossed in an allotment or portion of an allotment.

To determine a threshold of acceptable risk, the final GIS layer (as described in Step 1) was overlain with locations where Sierra Nevada bighorn sheep are known to have occurred. To reduce error and ensure spatial accuracy, only those locations collected using GPS were used, resulting in 6,719 Sierra Nevada bighorn sheep ram locations (2002-2007). Data from these years was utilized because this was the most up to date data available at the time the model and the Risk Assessment were completed. It is important to use a multi-year data set to capture the full range of potential bighorn sheep movement patterns under various conditions. Use of a smaller range of years would reduce the amount of interannual variability that is captured and would provide a narrower view of potential Sierra Nevada bighorn sheep use than is likely to occur.

After the GIS layer was overlain with the Sierra Nevada bighorn sheep location data, the pixel value for each individual ram location in the data set was recorded to determine the full range of pixel values that correspond to Sierra Nevada bighorn sheep locations. All pixels in the GIS layer that have values within this range have a high likelihood of Sierra Nevada bighorn sheep use. By mapping the location of all pixels with values within this range, it is possible to highlight all locations in the eastern Sierra that have a high likelihood of bighorn sheep use instead of examining the relative likelihood as an average over an entire allotment. California Department of Fish and Game's 2002 to 2007 Sierra Nevada bighorn sheep monitoring efforts provided sufficient data for this analysis.

Through the analysis described above, it was determined that the values for all the known locations of collared rams within this dataset ranged from 0.833 to 1.0. The lowest value (0.833) for a known bighorn sheep location may, therefore, be used as a threshold value, above which bighorn sheep use is highly likely. If domestic sheep are grazed in locations (*i.e.*, pixels) that have a high likelihood of Sierra Nevada bighorn sheep use, the potential for contact between domestic sheep and Sierra Nevada bighorn sheep exists and is predicted. Because the goal of the Risk Assessment is to prevent contact between the two species, values currently between 0.833 and 1.0 fall into a category of unacceptable risk. The locations of those areas that have a value between 0.833 and 1.0 and their relationship to domestic sheep grazing allotments are mapped in Figures 1 and 2. These predicted areas of potential contact (*i.e.*, areas with high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833) allow for identification of portions of allotments that are above the 0.833 threshold. This is critical to making sure that land managers do not underestimate risk on some portions of a given allotment. At this time, if the relative likelihood of a Sierra Nevada bighorn sheep being in an allotment or portion of an allotment is 0.833 or greater, a high/unacceptable risk of contact between the two species exists for that allotment or portion of an allotment. If the value is less than 0.833, a low risk of contact between the two species exists for that allotment or portion of an allotment. Areas adjacent to these high contact risk areas should employ best management grazing practices to ensure that domestic sheep do not move into areas of high contact risk (see Step 4).

Since most Sierra Nevada bighorn sheep are not collared, the identified range of the relative likelihood of a Sierra Nevada bighorn sheep being in a location provides a scientific approach to management given the uncertainty associated with observing and tracking the movements of a subset of the population. The 0.833 threshold is based on known locations of GPS collared Sierra Nevada bighorn sheep. Sierra Nevada bighorn sheep location data based on VHF and observational data (some with locations that would expand range of values) were not included. It is also possible that uncollared Sierra Nevada bighorn sheep have moved farther, and into a wider range of habitats, than is demonstrated by the mapped areas of potential contact (*i.e.*, areas with high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833). Due to these restrictions and uncertainty, the value 0.833 is considered a conservative threshold for evaluating the relative risk of contact on an allotment.

The current threshold of 0.833 is based on the best available data at this time. Based on a preliminary review, additional Sierra Nevada bighorn sheep GPS location data collected from 2007 to 2009 (but not yet included in the model) remain within the 0.833 and above values of habitat modeled. Over time, new Sierra Nevada bighorn sheep location data could change the threshold. The value will be at least 0.833 (unless a dramatic loss of a herd occurred), but it will likely become lower as Sierra Nevada bighorn sheep increase in number and expand geographically as is necessary for recovery.

Distances between domestic sheep grazing areas and bighorn sheep locations have been considered by others when evaluating the risk of contact and disease transmission, and distance buffers to separate the two species have been previously recommended. Guidance developed by the Bureau of Land Management (1998) recommended buffer distances up to 9 miles around native wild sheep habitat unless topographic features or other barriers minimized the risk of contact. Singer *et al.* (2001) recommended bighorn sheep be restored to areas that are greater than 14.3 miles from domestic sheep grazing areas. A number of other documents address the concerns associated with domestic sheep grazing near Sierra Nevada or other bighorn sheep habitats. These documents discuss the need for buffers but do not recommend specific distances, or they suggest effective separation through spatial or temporal measures to reduce the risk of contact between the two species (Onderka *et al.* 1988, Sweeney *et al.* 1994, Ward *et al.* 1997, Schommer and Woolever 2001, Western Association of Fish and Wildlife Agencies 2007, George *et al.* 2008, Miller *et al.* 2008, Clifford *et al.* 2009). While a specific distance is not recommended in this Application Document to prevent contact, it is recognized that the proximity between these two species relates to the risk of contact.

The likelihood of contact plays an important role in the risk of disease transmission between domestic sheep and Sierra Nevada bighorn sheep in the Sierra Nevada. Contact may result in the possible introduction of new pathogens from domestic sheep 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.

Clifford *et al.* (2009) developed a spatially explicit disease transmission model to quantitatively assess the risk of respiratory disease transmission from domestic sheep to Sierra Nevada bighorn sheep. This model was used to predict the impacts of a respiratory disease outbreak within and among populations in the Northern, Central, and Southern Recovery Units. We acknowledge several of the study's limitations. These include: 1) disease transmission data was from enclosures or experimental situations, 2) all available Sierra Nevada bighorn sheep location data was not included which could have increased home range size, 3) future Sierra Nevada bighorn sheep movements based on growth or exploration were not modeled, and 4) quantifying husbandry practices that may have increased contact risk, such as grazing estrous domestic sheep females, was not possible. Clifford *et al.* (2009) reported that the most frequently predicted levels of population mortality due to disease (33 to 76 percent in the North; 45 to 77 percent in the Central) were consistent with other estimates of mortality ranging from 28 percent to 80 percent reported in respiratory disease outbreaks of free-ranging bighorn sheep populations located elsewhere (with or without suspected contact with domestic sheep)

(Festa-Bianchet 1988, Ryder *et al.* 1992, Cassirer *et al.* 1996, Enk *et al.* 2001, George *et al.* 2008).

Because the current range wide population of this species is less than 400 individuals, the loss of an entire or almost entire Sierra Nevada bighorn sheep herd(s) due to disease transmission would significantly impact recovery efforts for this species.

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

Land managers should also consider the following criteria when evaluating whether an allotment or portion of an allotment identified as having a high/unacceptable risk of contact using Step 2 (*i.e.*, within the areas of potential contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833) may remain open and still ensure the prevention of contact between Sierra Nevada bighorn sheep and domestic sheep (*i.e.*, allotment specific criteria – see below).

If none of the criteria listed below applies to a given allotment, the allotment or portions of the allotment equal to or greater than the 0.833 threshold should not be grazed by domestic sheep to prevent contact between domestic sheep and Sierra Nevada bighorn sheep. If one or more of the criteria listed below apply to a given allotment, an allotment specific evaluation should be completed to determine whether the site-specific criteria provide sufficient barriers to Sierra Nevada bighorn sheep movement to prevent contact.

Criteria

- 1) Allotments or portions of allotments within the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833; Figures 1 and 2) that are separated from occupied Sierra Nevada bighorn sheep habitat by towns, highly developed recreation areas, or other human developments that inhibit bighorn sheep movement.
- 2) Allotments or portions of allotments within the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833; Figures 1 and 2) that are separated from occupied Sierra Nevada bighorn sheep habitat by large contiguous forested areas that inhibit bighorn sheep movement.
- 3) Allotments or portions of allotments within the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833; Figures 1 and 2) that are east of the U.S. Highway 395 management boundary recommended in Section II-E of the final *Recovery Plan for Sierra Nevada Bighorn Sheep* (U.S. Fish and Wildlife Service 2007).
- 4) Allotments or portions of allotments within the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn

sheep use equal to or greater than 0.833; Figures 1 and 2) that are separated from occupied Sierra Nevada bighorn sheep habitat by major bodies of water (*e.g.*, Mono Lake, Crowley Lake) that inhibit bighorn sheep movement.

For allotments or portions of allotments that meet one or more of the four criteria listed above, land managers may determine that full closure is not required to prevent contact between domestic sheep and Sierra Nevada bighorn sheep. After allotment specific analysis, the responsible land management agency may determine that a given allotment that meets one or more of the above criteria does not require seasonal or spatial restrictions to prevent contact. Conversely, allotment specific analysis may reveal that an allotment that meets one or more of the above criteria does require seasonal and/or spatial restrictions to prevent contact. In such a case, seasonal closure or closure of a portion of the allotment would be a suitable alternative to full closure if the agency determines that grazing under these restrictions would prevent contact between domestic sheep and Sierra Nevada bighorn sheep. Allotment specific seasonal closure periods should be determined by the responsible land management agency in cooperation with the affected permittee and in coordination and consultation, if appropriate, with the U.S. Fish and Wildlife Service.

In addition to the four criteria listed above, land managers may use the equation (Relative Risk = MIWD X (number of grazing days + Julian Date) provided in Section II of the Risk Assessment to quantify the predicted change in the relative risk that would occur as a result of temporal and/or spatial restrictions for a given allotment or allotment subunit. Use of the equation may provide a useful decision-making tool if the land manager determines that seasonal and/or spatial restrictions are needed, but decision makers must keep in mind the equation limitations discussed in Step 2.

If land managers determine, through the allotment specific analysis process described above, that contact between domestic sheep and Sierra Nevada bighorn sheep cannot be prevented on a given allotment, the allotment or portions of the allotment should not be grazed by domestic sheep.

Step 4 - Determine whether implementing the grazing practices detailed in Section III of the Risk Assessment would prevent contact between Sierra Nevada bighorn sheep and domestic sheep (*i.e.*, prevent domestic sheep from straying into areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact with Sierra Nevada bighorn sheep)).

The Risk Assessment indicates that land managers can alleviate some risk of contact between domestic sheep and Sierra Nevada bighorn sheep through implementation of best management grazing practices. However, when evaluating the risk of contact, both domestic sheep movements and Sierra Nevada bighorn sheep movements must be considered. Land managers should not regard the implementation of best management grazing practices as an appropriate means of preventing contact between domestic sheep and Sierra Nevada bighorn sheep on an allotment or portion of an allotment where the analysis described above has determined that there is a high/unacceptable risk of contact

(*i.e.*, modeled areas of likely bighorn sheep use are equal to or greater than 0.833). These best management grazing practices, as detailed in Section III of the Risk Assessment, are designed primarily to keep domestic sheep from straying from the herd and/or allotment, to detect domestic sheep that have strayed from the herd and/or allotment, and to reduce predation on domestic sheep within an allotment. They are not designed to prevent Sierra Nevada bighorn sheep from entering an allotment and coming into contact with domestic sheep.

Herding and guard dogs have traditionally benefitted herders by keeping domestic sheep together and reducing predation. While they may have some potential to keep Sierra Nevada bighorn sheep from coming into contact with domestic sheep on an allotment, there is currently no scientific literature or other information that indicates or supports the assertion that herding or guard dogs can effectively prevent bighorn sheep from coming into contact with domestic sheep. These grazing practices are, therefore, never appropriate as stand-alone mitigation for use on allotments or portions of allotments within the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833) (Figures 1 and 2).

The appropriate use of best management grazing practices is to keep domestic sheep from straying out of open allotments where there is a low risk of contact and into areas where there is a high risk of contact with Sierra Nevada bighorn sheep. As described in the Risk Assessment, the only method to ensure the prevention of contact between domestic sheep and Sierra Nevada bighorn sheep is to avoid the use of overlapping ranges through temporal and/or spatial separation.

The allotment specific application of the best management grazing practices recommended in Section III of the Risk Assessment should be determined by the responsible land management agency in cooperation with the affected permittee and in coordination and consultation, if appropriate, with the U.S. Fish and Wildlife Service.

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

Land managers should monitor and verify that livestock producers are appropriately implementing best management grazing practices as discussed in Section III of the Risk Assessment on those allotments where they are applied (Step 4). For those allotments where the best management grazing practices are required, land managers should compile all monitoring and reporting information from both permittees and agency personnel on an annual basis and evaluate whether these practices are being fully and effectively implemented.

RESULTS OF RISK ASSESSMENT APPLICATION

The predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833)

between Sierra Nevada bighorn sheep and domestic sheep (Figures 1 and 2), determined through application of Step 2, overlap 27 domestic sheep allotments or allotment subunits (Table 1, Figure 2). Of those, eight are vacant to prevent contact between domestic sheep and Sierra Nevada bighorn sheep. Five currently permitted allotments or allotment subunits are entirely within the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833) (Tamarack, Cameron Canyon, Dunderberg, Rock Creek – Hilton Unit, and Sherwin Deadman 1). Only a portion of the predicted areas of potential contact overlaps the remaining 13 allotments (Table 1, Figure 2). Table 1 identifies the allotments that overlap the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833). Table 1, column 6, indicates the mean relative likelihood that a Sierra Nevada bighorn sheep would use a given allotment. Table 1, column 7, indicates the maximum relative likelihood that a Sierra Nevada bighorn sheep would use any point within a given allotment.

RECOMMENDATIONS

We recommend that the Humboldt-Toiyabe and Inyo National Forests and the Bureau of Land Management (Bishop Field Office) analyze all of their respective allotments that overlap the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833) between domestic sheep and Sierra Nevada bighorn sheep (Table 1, Figures 1 and 2) as outlined in Steps 2 and 3.

If the responsible land management agency determines that a given allotment, or portion of an allotment, does not meet one or more of the criteria identified in Step 3, we recommend that the allotment, or portion of the allotment, identified as having a high/unacceptable risk of contact not be grazed by domestic sheep to prevent contact between domestic sheep and Sierra Nevada bighorn sheep. There is uncertainty associated with determining when contact may occur and the likely adverse effects to Sierra Nevada bighorn sheep populations that could result from a contact related disease outbreak. Therefore, it is recommended that any currently permitted allotment, or portion of an allotment, identified as having a high risk/unacceptable risk of contact as a result of the above analysis, be closed on either a temporary non-use or emergency basis until the responsible land management agency determines whether permanent closure to domestic sheep grazing is warranted.

If the responsible agency determines that a given allotment meets one or more of the criteria identified in Step 3, we recommend that the agency determine whether temporal and/or spatial restrictions are necessary to prevent contact through the appropriate agency analysis and decision making process. In instances where domestic sheep could stray from an open allotment into an areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833), we recommend the implementation of best management grazing practices from Section III of the Risk Assessment as outlined in Steps 4 and 5.

The Risk Assessment, this revised Application Document, and the recovery plan are guidance documents that land managers should use along with any additional information from the published literature or Sierra Nevada bighorn sheep monitoring efforts in their decision-making process to prevent contact between domestic sheep and the federally-listed, endangered Sierra Nevada bighorn sheep. The decision tree provided below may be helpful when evaluating the allotments.

As stated in the Risk Assessment, 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. 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. At a minimum, we recommend that Sierra Nevada bighorn sheep location data be reviewed biennially and compared to the 0.833 threshold. If this new location data indicates a substantial shift of bighorn sheep habitat use and therefore changes the risk of contact, the model should be updated to incorporate this new data and new model run outputs made available to agencies. Model updates will be contingent on funding by state and federal agencies or other sources.

Decision Tree

A. Assess whether domestic sheep in an allotment could contact bighorn sheep

1. Does the allotment or portion of the allotment overlap modeled areas of likely bighorn sheep use equal to or greater than 0.833 as indicated in Table 1?

Yes. The allotment or portion of the allotment equal to or greater than 0.833 should not be grazed by domestic sheep and closure of the allotment should be considered, unless it meets one or more of the four criteria in Step 3.

No. Domestic sheep grazing may be permitted. Best management grazing practices should be implemented in areas where domestic sheep might stray off of a low risk allotment into a high risk allotment. Go to C.

B. Determine if the allotment meets one of the Step 3 criteria and whether changes in temporal or spatial use of the allotment would prevent contact

1. Does the allotment meet one or more of the criteria in Step 3?

Yes. The responsible land management agency may determine that full closure is not required to prevent contact. The equation in Step 2 may be used to determine what changes in temporal and/or spatial restrictions would reduce the risk of contact to a low level. Go to B 2. Also go to C.

No. The allotment or portion of the allotment that overlaps modeled areas of likely bighorn sheep use is equal to or greater than 0.833. The allotment or portion of the allotment should not be grazed by domestic sheep and closure of the allotment should be considered.

2. Will changes in temporal or spatial use of the allotment prevent contact?

Yes. Domestic sheep grazing may be permitted under temporal and/or spatial restrictions.

No. The allotment should not be grazed by domestic sheep.

C. Determine whether best management grazing practices would prevent contact

1. Will the use of best management grazing practices prevent contact?

Yes. The allotment or portion of an allotment is less than 0.833 and/or meets one or more of the Step 3 criteria. The allotment may be grazed by domestic sheep with implementation of best management grazing practices. Also go to D.

No. The allotment or portion of the allotment is equal to or greater than 0.833 and none of the Step 3 criteria apply. The allotment or portion of the allotment should not be grazed by domestic sheep and closure of the allotment should be considered.

D. Monitor and verify whether grazing practices are being implemented effectively

If domestic sheep grazing is permitted and grazing practices are implemented to keep domestic sheep from straying off of a low risk allotment into a high risk allotment, monitoring and reporting information should be compiled annually and evaluated.

TABLES AND FIGURES

Table 1. Allotments that overlap the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact; modeled areas of likely bighorn sheep use equal to or greater than 0.833) between Sierra Nevada bighorn sheep and domestic sheep described in Step 2. The Allotment Mean Likelihood of Use values are taken from the Risk Assessment. The values represent the mean likelihood that a Sierra Nevada bighorn sheep will use an allotment. The Allotment Maximum Likelihood of Use values represent the maximum likelihood that a Sierra Nevada bighorn sheep will use a location within an allotment.

Allotment Name	Jurisdiction ^a	Status	Total Permitted Days	Permitted Julian Day	Allotment Mean Likelihood of Use	Allotment Maximum Likelihood of Use
Alger's Lake	INF	Vacant	NA ^b	NA	0.929	0.966
Bloody Canyon	INF	Vacant	NA	NA	0.936	0.974
Cameron Canyon	HTNF	Permitted	95	289	0.911	0.949
Dog Creek	BLM	Permitted	153	305	0.881	0.949
Dunderberg	HTNF	Permitted ^c	95	274	0.970	0.997
Green Creek	BLM	Permitted	153	305	0.852	0.911
Green Creek	HTNF	Vacant	NA	NA	0.929	0.960
Horse Meadow	INF	Vacant	NA	NA	0.937	0.963
Jordan Basin	HTNF	Vacant	NA	NA	0.971	0.999
June Lake (East)	INF	Permitted	62	244	0.800	0.864
June Lake (West)	INF	Vacant	NA	NA	0.836	0.907
Little Mormon	BLM	Permitted	153	305	0.805	0.864
Little Round Valley 1	BLM	Permitted	14	292	0.850	0.873
Little Round Valley 3	BLM	Permitted	14	292	0.831	0.840
McGee	INF	Permitted ^d	92	251	0.903	0.952
Rancheria Gulch	BLM	Permitted	153	305	0.784	0.932
Rickey (South)	HTNF	Permitted	NA	NA	0.827	0.848
Rock Creek 1 (West)	INF	Vacant	NA	NA	0.864	0.906
Rock Creek 2 (Highway)	INF	Vacant	NA	NA	0.865	0.885
Rock Creek 3 (East)	INF	Permitted	92	243	0.819	0.868
Rock Creek 4 (Hilton)	INF	Permitted	66	227	0.860	0.876
Sherwin/Deadman 1 (Mammoth)	INF	Permitted	87	274	0.915	0.931
Sherwin/Deadman 2 (Sawmill)	INF	Permitted	87	274	0.844	0.917
Sherwin/Deadman 4 (Smokey Bear)	INF	Permitted	87	274	0.794	0.882
Summers Meadow S&G	HTNF	Permitted	30	305	0.855	0.885
Tamarack	HTNF	Permitted	95	289	0.912	0.958
Volcanic Tablelands	BLM	Permitted	46	167	0.716	0.871

^a Bureau of Land Management (BLM), Humboldt-Toiyabe National Forest (HTNF), Inyo National Forest (INF).

^b Not applicable (NA).

^c Not grazed in 2007-2009.

^d Closed since finalization of original Application Document

Figure 1 – Red areas are the mapped locations that have Likelihood of Use values between 0.833 and 1 and are considered the predicted areas of potential contact (*i.e.*, areas with a high/unacceptable risk of contact). Green allotments are U.S. Forest Service domestic sheep allotments. Beige allotments are Bureau of Land Management domestic sheep allotments. Allotments are mapped over the Risk Assessment's Sierra Nevada bighorn sheep Likelihood of Use layer (*i.e.*, brown and yellow layer) and the Risk Assessment's Sierra Nevada bighorn sheep ram habitat suitability layer (*i.e.*, black and white layer).

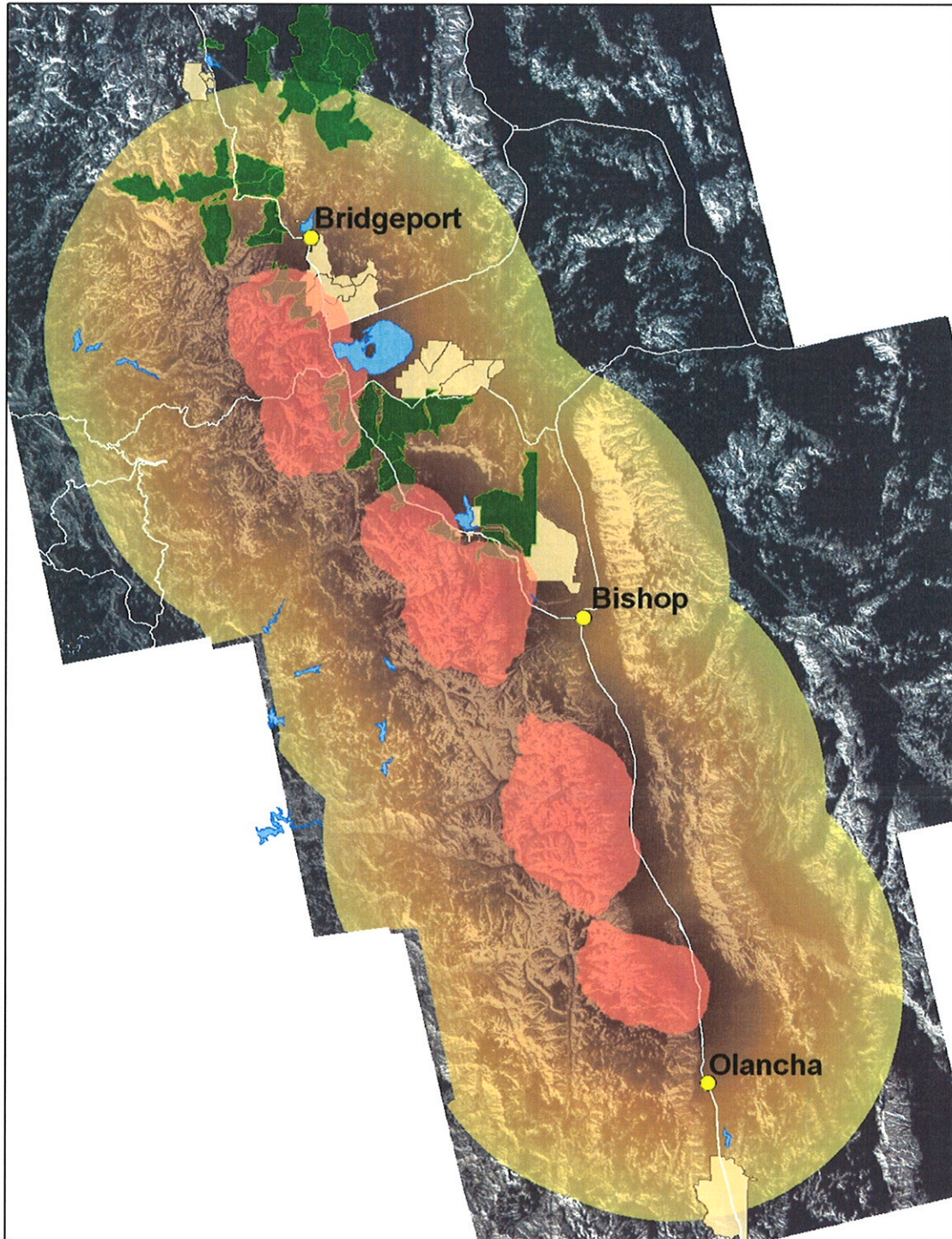
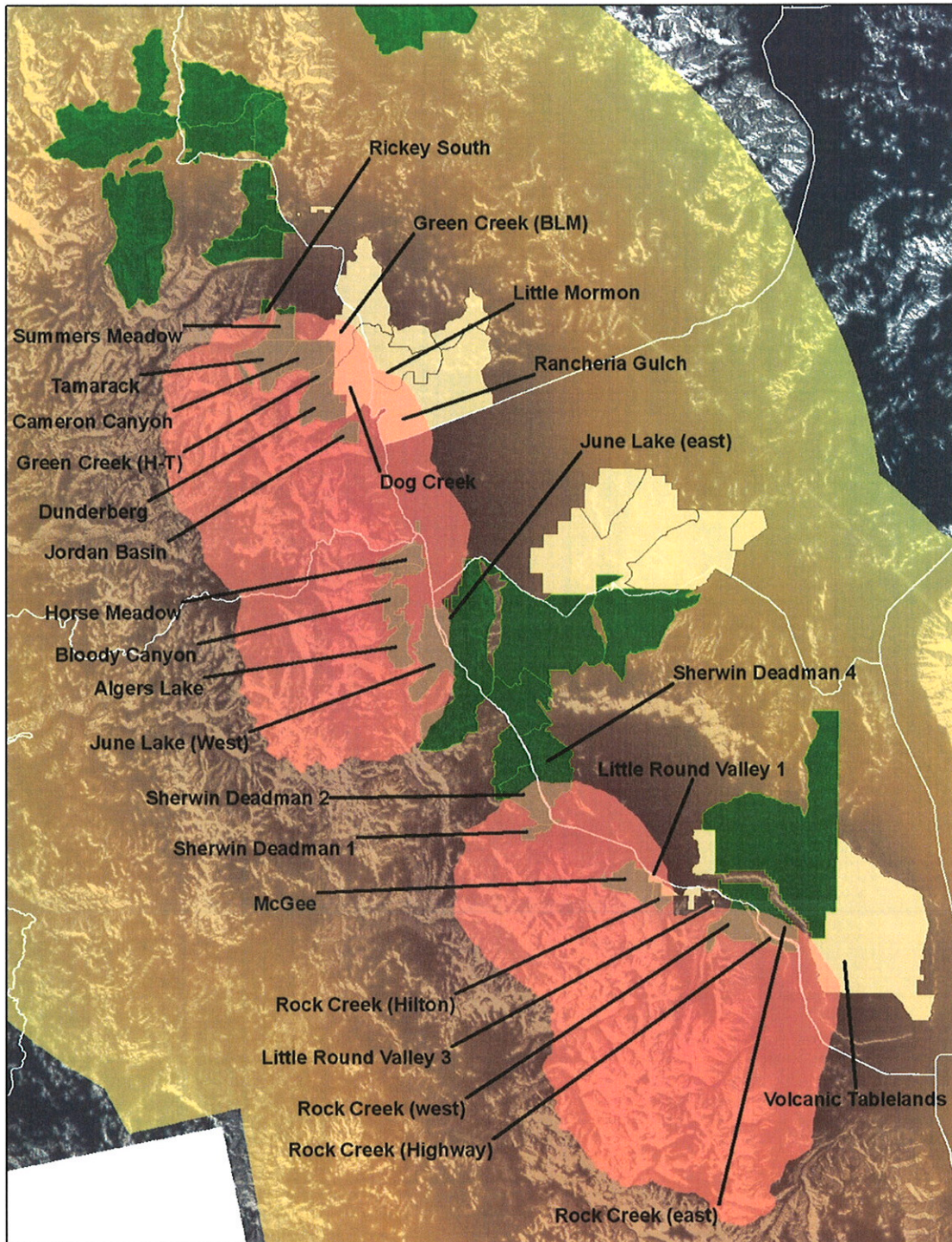


Figure 2 – Labeled allotments overlap the predicted areas of potential contact in red (*i.e.*, areas with a high/unacceptable risk of contact) between Sierra Nevada bighorn sheep and domestic sheep.



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