Appendix K

Bighorn/Domestic Sheep Risk of Association Modeling

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ACRONYMS AND ABBREVIATIONS

	Full Phrase
BLM	United States Department of the Interior, Bureau of Land Management
CHHR	core herd home range
CPW	Colorado Parks and Wildlife
Forest Service	United States Department of Agriculture, Forest Service
GIS	Geographic Information Systems
NEPA	National Environmental Policy Act of 1969
PA	probability assessment
planning area	Uncompahgre Field Office boundary, including all lands, regardless of land ownership, except the Gunnison Gorge NCA Planning Area and the Dominguez-Escalante NCA
PoI	probability of interaction (model)
RoC	risk of contact (model)
UFO	Uncompahgre Field Office
WAFWA	Western Association of Fish and Wildlife Agencies

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APPENDIX K
BIGHORN /DOMESTIC SHEEP RISK OF ASSOCIATION MODELING

K.1 DISEASE SUMMARY

The potential effect that association (intermingling) with domestic sheep has on bighorn sheep is the probability of die-off and population viability; this is well documented and recognized. Current science indicates that the bacteria that cause pneumonia in bighorn sheep, *Mycoplasma ovipneumoniae* and *Mannheimia haemolytica*, appear to be transmitted only between domestic sheep and bighorn sheep when they come in direct contact (less than 30 feet; Besser et al. 2012a; Lawrence et al. 2010; Schommer and Woolever 2008). Besser et al. (2012b) identified that epizootic pneumonia[1] of bighorn sheep is a devastating disease and that the etiology[2] regarding the bacterial respiratory pathogens is unclear. This is also the case in Colorado (Miller and Wolf 2011). Transmission of *M. haemolytica* from domestic sheep to bighorn sheep was irrefutable, as demonstrated by Lawrence et al. (2010); this provides justification sufficient for preventing range overlap and potential association of domestic sheep and goats with bighorn sheep (Western Association of Fish and Wildlife Agencies [WAFWA] 2012).

No one form of evidence can conclusively demonstrate that bighorn sheep in the wild coming in contact with domestic sheep frequently leads to die-offs; however, taken together, the experiments and observations from the laboratory and the field do indicate that wild bighorn sheep coming in contact with domestic sheep does pose a risk of disease transmission and die-offs in free-ranging bighorn populations. Laboratory experiments demonstrate the particular sensitivity of bighorn sheep to some pneumonia-causing bacteria. The controlled conditions of inoculation and pen experiments show that healthy domestic sheep often carry bacteria that are fatal to bighorn sheep and that they can transmit those bacteria through close contact. Finally, nearly a century of observations in the field supports the view that proximity to domestic sheep is a risk factor for bighorn sheep, due to disease transmission.

[1]Temporary and widespread
[2]Cause

Garde et al. (2005) offers the following summary of the risk to wild bighorn sheep from *Pasteurella* spp. and *Mannheimia* spp.:

- These bacteria can cause pneumonia in bighorn sheep, but there are benign commensal strains in the upper respiratory tract that have no harmful effects.
- Pathogens that are benign in domestic sheep can be lethal in bighorn sheep.
- The transference of pathogens from domestic to bighorn sheep has been documented in laboratory settings, with resulting mortality in bighorn sheep.
- Domestic sheep, goats, and llamas have been reported with these bacteria species.
- Wild sheep and mountain goats have been reported with these bacteria species.
- Transmission is by direct contact and aerosolization.[3]
- These bacteria species do not persist in the environment.
- Acute-to-chronic die-offs in bighorn sheep populations can result in low to 100 percent mortality, although these bacteria can be present in healthy sheep.
- These bacteria are considered opportunistic and can result in pneumonia outbreaks.
- These bacteria can cause clinical disease in domestic sheep and goats but are rarely primary pathogens.

In summary, field observations suggest that bighorn sheep have a high probability of contracting fatal pneumonia following contact with domestic sheep, which has led to numerous independent experiments. These experiments provide strong corroboration that bighorn sheep have a high probability of contracting fatal pneumonia following contact with domestic sheep.

The impact of disease on bighorn sheep conservation is likely to increase as habitat loss and fragmentation restrict their movement and concentrate them into smaller areas, increasing contact rates and the spread of disease (Cahn et al. 2011; Scott 1988; Levins et al. 1994). Given the substantial concern raised in the published literature over the past 30 years, management guidance has focused on the separation of domestic sheep and bighorn sheep to prevent disease transmission (The Wildlife Society 2014; WAFWA 2012; Cahn et al. 2011; Foreyt 1989; O'Brien et al. 2014; US Department of Agriculture Forest Service [Forest Service] 2009).

The WAFWA Wild Sheep Working Group recommends that land management agencies and state wildlife agencies cooperate to complete comprehensive risk assessments of domestic sheep grazing allotments to inform the land use planning process (WAFWA 2012). WAFWA provides recommendations for land management agencies, state wildlife agencies, and domestic sheep permittees to consider implementing its recommendations to minimize the risk of bighorn sheep associating with domestic sheep, commensurate with the level of risk.

The United States (US) Department of the Interior, Bureau of Land Management (BLM), Uncompahgre Field Office (BLM-UFO) used geographical information system (GIS) modeling to quantify the relative risk of association. In 2011, two models were developed: Probability of

[3]Fine mist from breathing

Interaction (PoI) model, developed by the BLM-UFO in 2011, and the Risk of Contact (RoC) model, developed by the US Department of Agriculture Forest Service (Forest Service) and the BLM in Idaho (see additional discussion below).

The BLM UFO used the results from the models described below to inform the management actions in each alternative in Chapter 2 of the Draft RMP/EIS, to minimize the risk of association between domestic and wild sheep. The parameters used in this model were based on existing science, where information could be obtained (see references), but they were also based on professional judgment.

K.2 PROBABILITY OF INTERACTION (POI) MODEL

K.2.1 Assumptions for PoI Model

The BLM-UFO assumed that the Colorado Parks and Wildlife's (CPW's) mapping of bighorn sheep range was equivalent to suitable occupied habitat and used that data as the basis for the highest priority habitat for bighorn sheep. Additionally, the PoI model is concerned with bighorn sheep herds or populations and not with individual wandering bighorns (most often sub-adult rams; WAFWA 2012). The PoI model attempts to quantify the probability of intermingling between domestic and bighorn sheep populations given that either is free to move across the land naturally (i.e., without herders, for domestic sheep).

Explanation of PoI Model Assumptions

In order to use the model at a landscape level and to maintain parsimony,[4] the BLM-UFO made the following assumptions:

1. CPW bighorn sheep overall range maps (CPW 2013a) are equivalent to occupied bighorn sheep habitat. Suitable habitat maps for desert bighorn sheep (*Ovis canadensis nelson*) were not available.
2. When bighorn and domestic sheep occur in the same area, the risk of interaction is high; as distance increases from bighorn sheep mapped range (occupied habitat), the risk of interaction decreases. Risk is also affected by a great number of other variables, such as the sex of the animal, the proximity of escape terrain, source habitats, and unsuitable habitat; because of the limited available data, the BLM-UFO was unable to factor the variables into the model.
3. Allotments have particular natural barriers to movement for both bighorn and domestic sheep that may prove to naturally mitigate some risk, as follows:
    a. Domestic sheep barriers to movement (Holecheck et al. 1989; McDaniel and Tiedeman 1981) are as follows:
        i. Continuous cliffs (>70% slope) = barrier to movement.
        ii. Major rivers = barrier to movement.
        iii. Continuous steep slopes (40-70%) = partial (50%) barrier to movement.

[4]The ability of a model to keep the number of variables small and still retain enough predictive power to be useful.

b. Bighorn sheep barriers to movement are determined as follows:

i. As distance from occupied habitat increases, the barrier to movement outward increases.

ii. At greater than 9 miles from mapped bighorn sheep range, the probability of the presence of a bighorn sheep is extremely low, and interaction is unlikely (WAFWA 2012).

iii. At greater than 2 miles from bighorn sheep range, extensive flat terrain (0-10% slope; interconnected areas >0.5 mile in diameter) would increase the barriers to movement outward from the bighorn sheep range.

4. Seasonal overlap of domestic sheep during breeding seasons would increase the likelihood of interaction between domestic and bighorn sheep because of the following:

a. Attraction between bighorn sheep and domestic sheep would increase during the two species' breeding seasons.

b. Risk of interaction is higher when both bighorn and domestic sheep are present during either breeding season.

5. Additional assumptions used in the assessment of seasonal overlap are the following:

a. Female domestic sheep are not turned out on BLM-administered lands until after breeding.

b. Male domestic sheep are not permitted on BLM-administered lands.

c. Desert bighorn sheep breeding season for the Middle Dolores (S-63) and Uncompahgre (S-62) bighorn sheep populations is August 1 to September 30.[5]

d. Rocky Mountain bighorn sheep (*Ovis canadensis*) breeding season for the Black Canyon (S-80), Cow Creek/Wetterhorn (S-21), Dillon Mesa (S-80) and Snowmass West (S-25) bighorn sheep population is November 1 to December 31.[6]

e. Domestic sheep grazing season is defined by the dates of permitted use on an allotment.

f. Seasonal overlap = number of days of domestic sheep grazing season that overlap with the bighorn sheep breeding season.

K.2.2 PoI Model Methods

The following is a description of the meth used to quantify the probability of mingling between domestic sheep and bighorn sheep to determine the risk posed by domestic sheep grazing in

[5]B. Banulis, Biologist, Colorado Parks and Wildlife, personal communication with Missy Siders, Wildlife Biologist of BLM-UFO, comment on breeding dates and locations of desert versus Rocky Mountain bighorn sheep populations. Bighorn/domestic sheep model meeting, October 7, 2011.
[6]Ibid.

BLM-UFO allotments (**Figure K-1** [Criteria for the Domestic/Bighorn Sheep Probability of Interaction Assessment] and **Figure K-2** [Allotment Probability Classification]).

1. In an initial risk assessment, the allotment risk was characterized by the percentage of the allotment that fell within the bighorn sheep occupied habitat, as follows:
    a. >75% = automatic rating of high risk
    b. <75% = determined through the of the process, below
2. The rest of the process consisted of evaluating the undetermined areas for physiographic barriers to movement and the compounding temporal effects that allotment use incurs for increasing the risk, as follows (see also **Figure K-1**):
    a. Phase 1: Proximity to Bighorn Sheep Range
    b. Phase 2: Natural Barriers to Movement
    c. Phase 3: Season of Use
3. Using ArcGIS, natural breaks in the data were determined using the Natural Breaks (Jenks) option for displaying graduated color groups (Jenks 1967; Esri 2012); four categories for those allotments fell within 9 miles of bighorn sheep habitat in the UFO and in all of the Dominguez-Escalante National Conservation Area RMP planning area only. Using the results of the statistical analysis, combined with the analysis of proximity to bighorn sheep range, the classifications in **Table K-1** (Bighorn Sheep Probability of Interaction Allotment Risk Category Ranges) were developed.

These risk categories were applied to all of the allotments in both the UFO and Dominguez-Escalante National Conservation Area on the basis of their respective PA2 values.[7]

Table K-1
Bighorn Sheep Probability of Interaction Allotment Risk Category Ranges

Allotment Risk Category	PA2 Low	PA2 High
Low (>9 miles from bighorn sheep range)	0.00	0.00
Some	0.000001	1.5
Moderate	1.500001	3.22
High	3.22001	5+

K.2.3 PoI model Results

The PoI model analyzed 231 allotments or allotment pieces (**Table K-5** [Summary of POIM Results for the UFO RMP Area]). Most of the assessed areas are allotted to cattle or horses (87.4 percent). A smaller portion of the UFO RMP area is allotted to sheep (11.7 percent) or cattle or sheep (0.9 percent). Most assessed areas were considered to be "low" (33.3 percent) or "some" (32.9 percent) in the Allotment Risk Category. Only 12.6 percent of assessed areas were considered "high" and 21.2 percent were considered "moderate." Domestic sheep would be managed according to the probability of risk (**Figure K-3** [Management of Risk]).

[7]PA2 is the final probability assessment score from the process. See **Figure K-1**.

Figure K-1. Criteria for the Domestic/Bighorn Sheep Probability of Interaction Assessment

Criteria for the Domestic/Bighorn Sheep Probability of Interaction Assessment

PHASE 1 (PF)
Proximity to Bighorn Sheep Range

Bighorn sheep range areas (CPW data) are buffered at 2-, 5-, and 9-mile zones (see zone map, **Figure K-2**) from the edge of the range. Probability of intermingling between bighorn sheep and domestic sheep is anticipated to decrease with increasing distance from the range boundary.

Grazing allotments are divided into the different distance zones, and a proximity factor (PF) is assigned to each portion of the allotment with the following values:

- Within bighorn sheep range PF =5 (highest PF)
- 0-2 miles from bighorn sheep range PF =4
- 2-5 miles from bighorn sheep range PF =3
- 5-9 miles from bighorn sheep range PF =1
- >9 miles from bighorn sheep range PF =0 (lowest risk)

The area of each zone is calculated to determine the percentage of the allotment for weighting purposes.

PF is Probability Factor

PHASE 2 (PA1)
Natural Barriers to Movement

For every allotment within 9 miles of the bighorn sheep range, each buffer zone is characterized for its natural barriers to domestic sheep and bighorn sheep movement. The following barriers are suggested to inhibit movement of both domestic and bighorn sheep:

Barriers to domestic sheep:

- Cliffs >70% slope (absolute)
- Steep slopes 40-70% (partial)
- Major rivers (absolute)

Barriers to bighorn sheep:

- Flat terrain 0-10% slope (>2 miles from occupied bighorn sheep range)

The barriers are assigned a numeric value based on their continuity, extent, and orientation relative to bighorn sheep range:

- 0 = No barrier
- 4 = Total barrier

The percent barrier score for each allotment zone is calculated by summing the numeric assessment and dividing by the maximum potential score.

Integrating Probability:
An allotment's integrated probability score is the area weighted average of the proximity factor combined with each zones' percent barrier to motion. The following formula was employed to generate a probability assessment (PA) score.

- e.g., PA_1=proximity factor (0-5) zone area*1-% barrier for each allotment zone.
- $\sum PA_1$=allotment 'score'

PA is Probability Assessment

PHASE 3 (PA2)
Season of Use

Incorporates allotment dates used by domestic sheep weighed against bighorn sheep breeding season, which varies by population:

- Rocky Mountain bighorn sheep (November 1 – December 31)
- Desert bighorn sheep (August 1 – September 30)

A straight percentage is determined by counting the number of overlap days an allotment is in use and dividing by the total number of breeding season days.

- e.g., an allotment is used for domestic sheep from October 15 to November15. Use overlaps the Rocky Mountain bighorn sheep breeding season by 15 days, or approximately 25% of the season (15/61=0.246)

The ratio of use days to breeding season days is added to the summed PA_1 score determined in Phase 2 for every allotment in the UFO to produce a PA_2 value.

- e.g., in the aforementioned case, 0.246 is added to the PA_1 value to determine PA_2.

PA is Probability Assessment

Statistical Analysis: The PA_2 values are calculated for each allotment within the 9-mile buffer zone. The values are then statistically analyzed to determine the natural breaks in the data set using the Jenks Natural Breaks method. The final probability assessment (PA) map for the UFO, Dominguez-Escalante National Conservation Area and Gunnison Gorge sheep includes the weighted average PA_1 risk combined with the breeding season analysis.

Figure K-2. Allotment Probability Classification

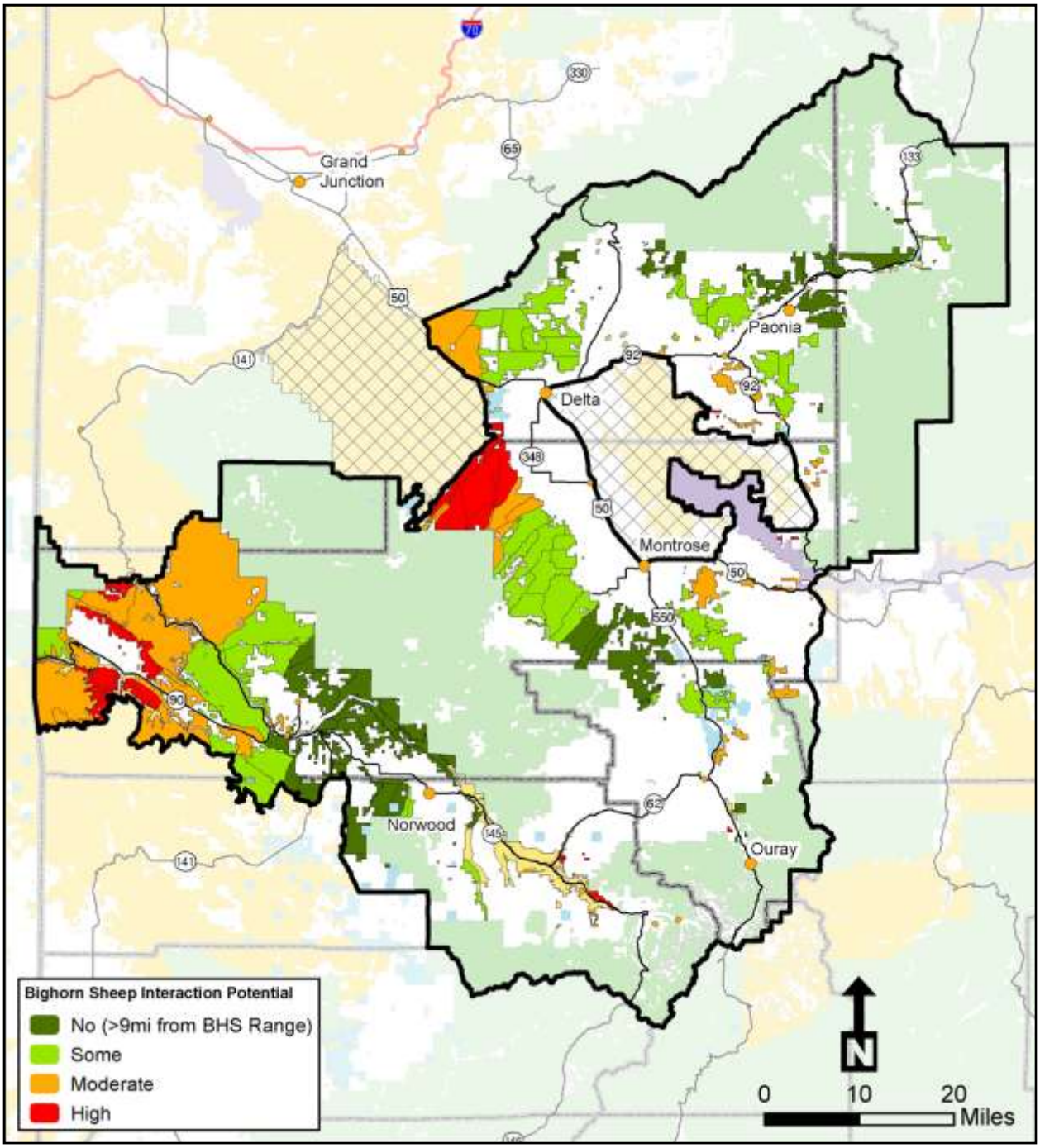
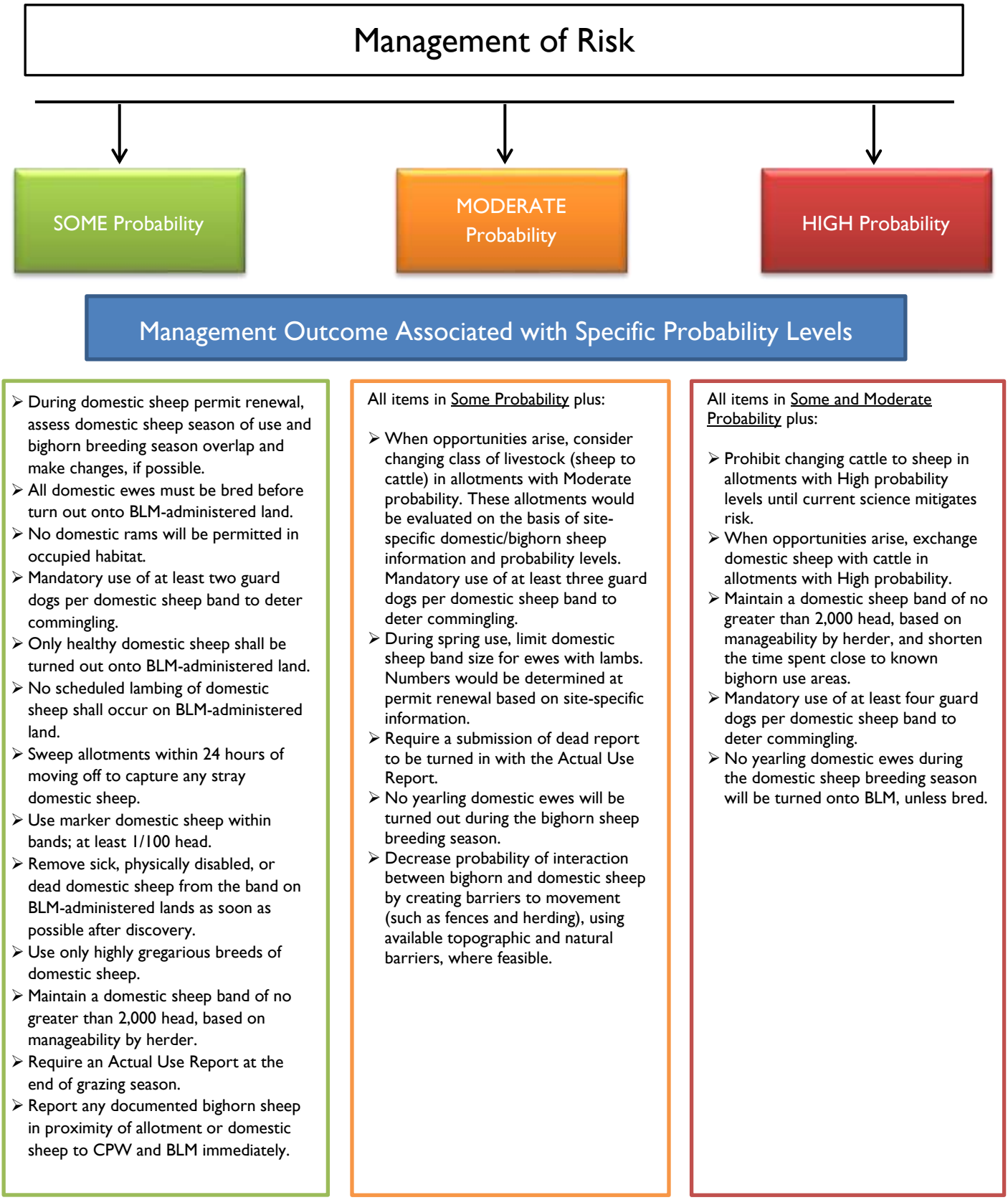


Figure K-3. Management of Risk



K.3 RISK OF CONTACT (ROC) MODEL

In response to bighorn sheep population viability concerns, the Payette National Forest developed a method for calculating the probability and rates of contact between bighorn sheep and active domestic sheep allotments. Subsequently, in 2011, the Forest Service initiated a process to develop a geospatial platform, based on the concepts used in the Payette analyses, for application on other national forests. This was subsequently expanded to include the BLM (January 2013) and became an ArcGIS extension available to the BLM in early 2014. Information for this model can be found in the extension tool user's guide (Forest Service 2013a).

The RoC model was developed in an area that was rich in bighorn sheep movement and habitat data. For analysis of the risk of contact for this area, the BLM-UFO modified the use of the RoC model, based on the best available data for our local bighorn populations. In order to use the best available data for model inputs, the BLM-UFO and Colorado Parks and Wildlife Biologists conducted a series of webinars to agree on data use and assumptions.[8]

The RoC model estimates the probability that foraying bighorn sheep will reach a domestic sheep allotment. However, within an allotment it is not possible to determine where and when domestic sheep would consistently occur or for how long. Use of some areas within an allotment may present less chance of contact with bighorn sheep than others, while some areas may have higher probability of contact (e.g., source habitats as defined by the RoC User Guide). Consequently, because of this uncertainty, the RoC Model predicts potential interspecies contact by using the assumption that contact with an allotment results in interspecies contact. Of key importance to the model, the core herd home range (CHHR) defines the most important portion of a herd's use area, characterized by most (95 percent) of the use. By definition, where a CHHR overlaps an allotment, there is contact with the allotment and the assumption is that one or more contacts per year may occur. Stray domestic sheep could have implications for bighorn sheep herds and in many rangeland settings may pose a risk of disease transmission as large as or greater than that from foraying bighorn sheep. However, the bighorn sheep risk of contact tool (Forest Service 2013a) does not model the risk of stray domestic sheep and the subsequent potential for contact with bighorn sheep.

The following is a description of the method used to quantify the probability of bighorn sheep to have contact with a grazing allotment, and ultimately contact with domestic sheep to determine the risk posed by domestic sheep grazing in BLM-UFO allotments. Bighorn sheep populations within approximately 35 kilometers (21.7 miles) of the UFO RMP planning area boundary were selected for the RoC analysis because the RoC model calculates foray probabilities for bighorn sheep to approximately that distance.[9] The model was developed according to procedures outlined in the RoC ArcGIS extension tool user's guide (Forest Service 2013a).

1. Inputs to the model include the following:
    a. Bighorn suitable habitat

[8]December 12, 2014, January 15, 2015, and February 20, 2015.
[9]E.T. Rinkes, Wildlife Biologist, BLM, personal communication with Missy Siders, Wildlife Biologist of BLM-UFO, at the Bighorn Sheep Modeling Workshop, January 15, 2015.

b. Bighorn core herd home range

c. Relative preference for habitat

d. Bighorn ram distance/ewe distance files

e. Bighorn adult herd size and sex ratios

f. Foray probability values (ram and ewe)[10]

K.3.1 Suitable Habitat Model

Bighorn sheep occupy rugged canyons, foothills, and mountainous terrain at elevations ranging from 1,450 to 10,500 feet. Key habitat features are steep, rugged escape terrain, grasses and forbs for forage, and a limited amount of tall vegetation. Bighorn sheep have habitat preferences and select habitat based on such factors as proximity of steep-sloped escape terrain, forage availability, and horizontal visibility (Forest Service 2013b; O'Brien et al. 2014).

The CPW developed a Rocky Mountain bighorn sheep suitable habitat model for the state of Colorado in 2012 (CPW 2012; **Figure K-4** [CPW Rocky Mountain Bighorn Sheep Suitable Habitat Model for RoC Analysis Area]), but a desert bighorn sheep model was not available until late in 2014 (**Figure K-5** [CPW Desert Bighorn Sheep Suitable Habitat Model for RoC Analysis Area]).

The CPW made available the desert bighorn sheep habitat model during the webinars. This model is similar to the Rocky Mountain suitable habitat model but uses a less rugged terrain feature and shows habitat only to within 35 kilometers (21.7 miles) of the Dolores and Dominguez desert bighorn herds. As prescribed in the User's Guide (Forest Service 2013a), based on the source habitat model, all areas in the Rocky Mountain and desert suitable habitat models were assigned to one of three habitat classes—source habitat, connectivity area, and nonhabitat. Source habitat for bighorn sheep occurs in BLM-UFO domestic sheep allotments and adjacent landscape.

K.3.2 Telemetry Data/Core Herd Home Range Modeling

Usually, CHHR analysis uses bighorn sheep telemetry location points to identify and enclose an area that contains 95 percent of all telemetry points from radio-collared bighorn sheep. The CPW did not feel that it had enough telemetry locations to conduct this portion of the model. As stated in the User's Guide (Forest Service 2013a), "If point location data are not available, a polygon layer containing the CHHR boundaries must be supplied." CPW biologists reviewed their existing spatial data for bighorn sheep home range polygons for overall, summer, and winter ranges and provided their best professional judgment for boundaries for the populations

[10]Foray distance distributions files provide the probabilities that individual ram or ewe forays will reach each of the 1-kilometer-wide (0.62-mile-wide) concentric rings emanating from the core herd home range boundary. "Sample data" are provided with the model and were derived from 12 years of Hells Canyon (Idaho) area telemetry data, used as part of the Payette National Forest analysis. "The foray distance distributions exhibited by the Hells Canyon area bighorn sheep were consistent with published observations of bighorn sheep movements from several other areas of western North America. These default data should be used unless other well-supported, scientifically derived estimates of foray distance distributions are available for the area under consideration." (Forest Service 2013, pp. 4-12)

involved (**Figure K-6** [Analysis Area and Bighorn Sheep Populations Used in the RoC Model]). The biologists acknowledged that these areas were overestimates of the CHHR concept and will overestimate foray distances.

Because of the focus on the UFO RMP area results, the RoC model was run for each of the 12 bighorn sheep populations that are within approximately 35 kilometers (21.7 miles) of the UFO RMP area (**Figure K-6**). Results across bighorn sheep populations were added to create the final results. If an area intersected with at least one bighorn sheep CHHR, the results were given as "This allotment intersects the home range polygon and is therefore not included in the RoC analysis." The RoC model assumes contact due to direct overlap and can be viewed similar to high probability of interaction under the PoI model.

K.3.3 Foray Analysis

Bighorn sheep, particularly rams, occasionally travel long distances beyond their CHHR. Singer et al. (2001) defined these forays as any short-term movement of an animal away from and back to its CHHR. This life-history trait can put bighorn sheep at risk of contact with domestic sheep, particularly when suitable habitats are well connected and overlap with domestic sheep use areas (Singer et al. 2000; Gross et al. 2000), or even when domestic sheep use is outside of CHHR areas.

The risk of contact between dispersing bighorn sheep and domestic sheep is related to the number of bighorn sheep in a herd, the proximity of domestic sheep use areas (allotments) to a bighorn sheep CHHR, the distribution of bighorn sheep source habitats across the landscape, and the frequency and distance of bighorn sheep forays outside of the CHHR. The risk of contact can be increased by straying domestic sheep in the following ways:

- The stocking rates and numbers of straying sheep
- The frequency and distance of straying
- The distance that grazing occurs from bighorn sheep source habitat
- Straying sheep persistence on the range

(However, these risk factors were not analyzed.)

The foray model analyzes how often bighorn sheep leave the CHHR, whether they travel far enough to reach an allotment, and whether they then actually intersect an allotment (i.e., rather than intersecting a different area at the same distance from the CHHR). For this analysis, information on habitat preference and foray distance (ram/ewe) is used to generate a foray probability raster. Again, local bighorn herd information was limited; during the webinar discussion, the BLM-UFO and CPW biologists agreed to use the default Idaho (summer) values as the best available information, in the absence of more local information (**Table K-2** [Default Idaho (Summer) Relative Preference Values by Habitat Class]).

Table K-2
Default Idaho (Summer) Relative Preference Values by Habitat Class

Habitat Class	Habitat Name	Relative Preference
1	Suitable	1
2	Corridor	0.177
10	Nonhabitat	0.029

K.3.4 Probability That a Bighorn Sheep Will Intersect an Allotment Analysis

Many animals (particularly bighorn sheep ewes) may not travel far, even if they are observed outside of the CHHR. The probability that a bighorn sheep on a foray will reach an allotment decreases as the travelling distance increases. Bighorn sheep rams are more mobile and leave CHHRs significantly more often than ewes, and they have a higher probability of interspecies contact.

For this portion of the analysis, information on herd size, sex ratios, and foray rates are needed. CPW population and sex ratio information typically includes juvenile bighorns. This model assumes that herd size and sex ratios are for adult animals only. CPW biologists provided their professional adjustment of adult survey numbers for model use (**Table K-3** [CPW Rocky Mountain Bighorn Sheep Herd Population Estimates* for RoC Model]; **Table K-4** [Summary of POIM Results for the UFO RMP Area]). For some areas, CPW population areas were combined into one CHHR unit because they did not have enough information to be able to divide the existing polygons. Again, local information was limited on foray rates, and during the webinar discussion, the BLM-UFO and CPW biologists agreed to use the default Idaho (Summer) values as the best available information in the absence of more local information (ram 0.141; ewe 0.015).

Within the RoC model, given that an animal has reached a ring, the probability that it will be in an allotment is proportional to the size of the allotment and to the quality of the habitat in the allotment, relative to the size and quality of habitat in the ring as a whole. (Results from the analysis across all bighorn sheep populations are found in **Table K-6** [RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]]; an example interpretation of the results is given in a footnote at the bottom of the table.)

K.3.5 Probability of Disease Outbreak Analysis

The RoC model assumes that allotments that intersect with the CHHR have contact with domestic sheep and therefore could transmit the disease. The sequence of events by which a disease outbreak could result from contact between a bighorn sheep and a domestic sheep or goat in an active allotment outside of a bighorn sheep CHHR can be broken down into a number of steps.

To reach an occupied allotment, a bighorn sheep must go through the following steps:

(1) Leave the CHHR

(2) travel far enough to reach the allotment

(3) Intersect with the allotment, rather than some other area at the same distance from the CHHR

Once this occurs, in order for disease transmission to occur, the bighorn sheep must go through more steps, as follows:

(1) Come in contact with domestic sheep in the allotment

(2) Contract the disease from the domestic sheep

(3) For an outbreak to affect the animal's home herd, the infected bighorn sheep must make its way back to the CHHR

(4) It must transmit the disease to other members of the herd

The literature (Forest Service 2013b; Carpenter et al. 2014; O'Brien et al. 2014) identifies uncertainty as to what frequency of interspecies contacts in a rangeland situation result in disease transmission and disease outbreaks within a bighorn sheep population. Because of this uncertainty and lack of appropriate data, the BLM-UFO did not conduct herd-specific modeling for disease transmission and herd persistence.

There is no scientific evidence to support a specific assumption for acceptable risk of contact and disease outbreak. The results should be viewed as a means of comparing the relative risks of disease outbreaks, not as definitive values. Results of the model support the current knowledge and characteristics of the bighorn sheep herds and the science, based on the understanding of potential disease outbreaks potentially occurring from contact of a bighorn sheep with a domestic sheep within an allotment.

A high degree of uncertainty exists regarding the probability that contact of a bighorn sheep with a domestic sheep in an allotment will lead to disease outbreak within a bighorn sheep herd (Forest Service 2013b; Carpenter et al. 2014; O'Brien et al. 2014). Quantification of disease transmission and outbreaks in bighorn sheep populations following contact with domestic sheep or goats, and the subsequent ability of a population to recover, are key to interpreting the results from the above models; however, the mechanisms of disease transmission and resulting disease outbreaks in bighorn sheep is not fully understood. Empirical data are lacking recommend the frequency of outbreaks and the effects on population persistence. Therefore, the BLM-UFO relied on the following to assist with the interpretation of RoC model results:

- The effects of respiratory disease outbreaks on bighorn sheep populations are often severe (Besser et al. 2012a; Besser et al. 2012b). Controlled pen experiments identified in Besser et al. 2012b resulted in complete or nearly complete die-offs of bighorn sheep following contact with domestic sheep. It has also been documented that disease perturbations can affect lamb recruitment for several years following a severe population decline resulting from a disease outbreak that rapidly affects many animals in a specific area at the same time (Besser et al. 2012a; Coggins and Matthews 1992; Foreyt 1990). Consequently, when bighorn sheep disease die-offs occur, there is a substantial immediate population decline and a delayed recovery due to poor lamb recruitment for many years (Besser et al. 2013). Population

recovery is unlikely where interspecies come in contact within a few decades of each other, potentially resulting in disease transmission and subsequent outbreak (BLM/CPW 2015). There is no specific guidance on the number of decades required to recover from a disease outbreak; observations of herds that have experienced pneumonia indicate it likely requires several decades.

- Another important trend of wild/domestic sheep disease transmission is that an illness's effect on individual bighorn populations can be long lasting. Cahn et al. (2011) explained the trend of suppressed lamb recruitment: "Whether mild or severe, most respiratory disease outbreaks in bighorn populations are followed by several years of pneumonia caused mortality of lambs resulting in low recruitment rates and juvenile survival. Continuing lamb infection apparently results from females that remain infective following an outbreak, although mortality or morbidity among the females may not be detectable. Such recurring lamb infections can substantially delay the recovery of depleted populations to pre-outbreak levels."

The BLM-UFO recognizes the uncertainty of the relationship between the number of bighorn sheep contacts with a domestic sheep allotment and predictions for disease transmission and outbreaks. Because of this uncertainty, modelers ran the disease model assuming a range of values from 0.05 (1 in 20 contacts would result in a disease outbreak) to 1.00 (every contact would result in a disease outbreak). The range of values modeled were 0.05, 0.10, 0.25, 0.50, 0.75, 0.90, and 1.00. Results for this calculation are found in **Table K-7** (Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results).

It is important to disclose that accurate modeling of the impacts of disease based on individual animals is difficult because the dynamics of respiratory disease in the wild are only partly known. An individual-based model would require understanding many factors, such as the incubation period and active infection durations, the probability and rate of recovery from disease, the rate of effective contact between individuals within the herd, and the possible role of persistently infected individuals in harboring and spreading the disease. Variations in the resistance to disease of individual bighorn sheep and in the virulence of the disease-causing organisms themselves can also affect population dynamics.

Furthermore, modeling population dynamics of large herbivores at the individual level requires estimating numerous parameters, from adult and juvenile survival rates to age at sexual maturity, fecundity, and lamb survival (Gaillard et al. 2000). In addition, the average values for each of those life-history parameters may be modified by interacting impacts of density dependence, weather, forage availability, and predation. Properly estimating these parameters would require extensive age- and class-specific population data, ideally from the populations being modeled. Such data are not currently available.

In a review of other RoC modeling, general trends appear to develop. The Payette National Forest Analysis (Forest Service 2010) stated that total foray contact rates >0.04 annually (less than a 25-year interval) were deemed unacceptable due to estimated disease return intervals and subsequent impacts on long-term viability of bighorn herds. Additionally, they assumed that 1 in 4 contacts (0.25) would result in disease transmission, based on local information. The Rio

Grande National Forest (Forest Service 2013b) stated that a disease occurring in a bighorn herd every 25 years or less would result in a high risk to bighorn long-term viability and a low probability of population persistence. This would result in a bighorn sheep population that is constantly being exposed to ongoing disease transmission and resultant outbreaks.

K.3.6 RoC Analysis Results

Given the assumption of 1 in 4 contacts results in a disease, the relative risk rates were generated using the following scheme:

0-25 years	High
26-50 years	Moderate
51-75 years	Some
76-100 years	Low
>100 years	Very low

The RoC analyzed 259 allotments or allotment pieces (**Table K-8** [Summary of RoC Model Results for the UFO RMP Area]). Most of the assessed areas are allotted to cattle or horses (84.2 percent). A smaller portion of the UFO RMP area is allotted to sheep (15.1 percent) or cattle or sheep (0.8 percent). Most assessed areas were considered to be Very Low (48.3 percent), with a smaller portion considered Low (6.2 percent), Some (3.5 percent), or Moderate (8.1 percent). Slightly more than one-quarter (25.5 percent) of assessed areas were considered High, including 15.8 percent of the areas that had direct overlap with CCHR. However, only 3.8 percent of areas assessed were considered High and were within domestic sheep areas; 1.5 percent were domestic sheep areas directly overlapping CHHR, and 2.3 percent were domestic sheep areas outside CHHR.

K.4 ADDITIONAL DISCUSSION

K.4.1 Probability of Interaction Model

At the time that planning for this RMP began, there were no standardized approaches to modeling potential disease transfer between wild and domestic sheep. In the spring of 2012, the BLM-UFO completed PoI model and used it for planning purposes. The BLM-UFO worked in conjunction with CPW to develop the weighting factors described in **Figure K-1**.[11]

In the initial stages of spatial mapping of risk for bighorn sheep, scores for risk of exposure to domestic sheep were highest for the allotment zones within the bighorn sheep range. Those allotments with greater than 75 percent of their area in bighorn sheep-occupied habitat automatically puts them in a high-risk allotment (see PoI model methods, above). In addition, zones greater than 9 miles from bighorn sheep range automatically receive a low-risk despite the resulting risk-layer results. Zones between 0 and 9 miles from bighorn sheep range had increasing point values in the zones closest to the bighorn sheep range and lowest point values in the zones farthest from the bighorn sheep range. In this way, proximity to bighorn sheep range within and outside of 9 miles had a weighted effect on all other inputs to the model. In order to reduce the risk of a biased model result, no other weighting was used in the model.

[11]Fall 2011 to Winter 2012. Series of meetings, phone calls, and letters between CPW biologists and the BLM.

Additional parameters for natural barriers to movement (domestic sheep or bighorn) and season of use were used to refine the model.

This risk assessment (probability of interaction model) is the first cut at the *landscape level* for RMP analysis. It was meant to be a generalized model to assess risk levels for the RMP analysis of effects. Once the UFO RMP is finalized, the BLM-UFO would assess each allotment in more detail during implementation to evaluate site-specific risk factors and how to mitigate those factors. This is germane to the process of renewing grazing permits and will be discussed with the permittees before they turn out their sheep. The BLM-UFO intends to develop the implementation process in cooperation with CPW and the permittees.

The PoI model was based on peer-reviewed research to the extent possible. However, Johnson (1995) is the origin of the assumptions that bighorn sheep and domestic sheep habitat overlap within 16 kilometers (9.94 miles) is a high-risk situation and that habitat overlap beyond 33 kilometers (20.50 miles) is a no-risk situation. Although Johnson 1995 is a Master's thesis and not a peer-reviewed document, this assumption was later refined by Johnson and Swift (2000) in a peer-reviewed published paper.

Distance information was based on the WAFWA bighorn sheep recommendations (WAFWA 2012), which state that buffer zones to minimize associations between wild sheep and domestic sheep or goats are frequently said to be a minimum of 9 straight miles when applied to bighorn herds or populations rather than to individual wandering bighorn. The Desert Bighorn Council (1990) recommends a 13.5-kilometer (8.5-mile) buffer. Smaller buffer increments (0 to 2, 2 to 5, and 5 to 9 miles) were based on discussions with the CPW and BLM-UFO biologists and on council members' professional judgment.

Natural barrier factors were assessed separately for bighorn sheep and domestic sheep. WAFWA's Wild Sheep Working Group (2012) recommends the use of geographic/topographic barriers that enhance species separation and seasonal or spatial separation through domestic sheep and goat management.

Each natural barrier was assessed individually, and barrier scores were cumulatively assessed for each combination of allotment and distance buffer zone (0 to 2, 2 to 5, and 5 to 9 miles). The barriers to movement between a particular buffer zone and bighorn sheep range are additive with distance from the range. Thus, if a continuous cliff band exists in the 0- to 2-mile buffer zone, this cliff also poses a barrier to movement in the 2- to 5- and 5- to 9-mile buffer zones, along with barriers assessed within those particular zones.

Domestic sheep are permitted to graze only during a specific season. The permittee is permitted only a certain number of days during the period on the permit. The seasonal overlap was assessed on the basis of the entire season of use that a permit could be on the allotments rather than on the actual number of days domestic sheep are permitted on the allotment. This is because the season when domestic and wild sheep may be attracted to each other during breeding season was of greater concern than the duration. The BLM-UFO assumed that there is a base level of attraction between wild and domestic sheep but that during bighorn breeding season, attraction between wild and domestic sheep would increase.

K.4.2 Risk of Contact

In response to internal comments on the PoI model, the BLM-UFO conducted additional analyses using the currently available RoC model and following the risk of contact tool User's Guide (Forest Service 2013a). With assistance from CPW biologists, the BLM rand the RoC model using the best available local bighorn population information to provide the parameters for the model. However, much of the needed data was not available for individual Colorado bighorn sheep populations.

The BLM-UFO made the following assumptions:

Data Assumptions/Issues

1. CPW (2013a) bighorn sheep overall range maps approximate bighorn sheep CHHR for the purposes of the RoC model.
    a. CHHR is the area occupied by bighorn sheep 95 percent of the time, based on telemetry or other location data.
    b. Telemetry data to generate CHHR within the model was unavailable for this population.
    c. These areas overestimate the CHHR concept and therefor overestimate foray distances.
2. Suitable habitat is mapped for the domestic sheep grazing period and is mapped as suitable, corridor, and nonhabitat.
    a. Domestic sheep grazing is predominantly during the winter.
    b. The CPW mapped the year-round desert bighorn suitable habitat and provided it for this modeling.[12]
3. The CPW mapped summer Rocky Mountain bighorn suitable habitat and provided it for this modeling.

    Default values from Idaho bighorn sheep (summer) approximate local desert and Rocky Mountain populations for the domestic sheep grazing season for
    a. Bighorn sheep habitat preference
    b. Bighorn sheep ram and ewe foray distances
    c. Bighorn sheep foray probabilities

K.4.3 Comparison of Model Results

Given the requirements of the different models, the number of units analyzed was different between PoI model (231) and RoC (259; **Table K-9** [Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Domestic Sheep Allotments] and **Table K-10** [Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments]). Model results were similar in some areas and different in others

[12]K. Eichhoff, Biologist, Colorado Parks and Wildlife, personal communication with Missy Siders, Wildlife Biologist of BLM-UFO, January 26, 2015.

(**Figure K-7** [Comparison of PoI Model and RoC Model Results for UFO RMP Area]). Both models predict that Canal, Lee Lands, and Leopard Creek domestic sheep allotments are of high concern for disease transmission to bighorn sheep populations (**Table K-9**). Additionally, both models place 22 cattle areas as high concern for disease transmission to bighorn sheep if they were converted to domestic sheep (**Table K-10**).

Five areas were placed in Moderate by both models (Alkali Flats [**Table K-9**], Big Bear Creek, Cimarron 40, Roatcap, Slagle Pass [**Table K-10**]). For some areas, results between the two models are very different (Cushman, Delta Pipeline, Petrie Mesa, Point Creek, and Sandy Wash [**Table K-9**]; Buckeye, Burro Ridge, Dry Creek Basin, Houser, Lion Creek Basin, Naturita Ridge, Piney, Pipeline, Sawtooth, Tabeguache Creek, Transfer Road, and Ward Creek/Doughspoon [**Table K-10**]). The difference between the models is the result of different modeling methods, issues with assumptions or data quality, or different modeling data sets.

Both the PoI model and the draft Preferred Alternative were developed using the best available science, professional judgment, and knowledge of the local bighorn herd in 2011, when the model was developed. Additionally, the RoC model provides additional information for the relationship between bighorn and domestic sheep in the area for the proposed plan. The models and the RMP are the first big-scale look at the management situation. When grazing permits for these areas are renewed, the BLM-UFO will conduct NEPA analyses using more site-specific information and any new data to determine the bighorn herd's current condition and possible subsequent changes in management. At that time, the BLM-UFO will also use the currently accepted method and model to conduct the analysis.

Table K-3
CPW Desert Bighorn Sheep Herd Population Estimates* for RoC Model

CPW Population Names	Uncompahgre/ Dominguez	Black Ridge	Middle Dolores	Upper Dolores
Game Management Unit	S62	S56	S63	S64
	DAU 60#		**DAU 61#**	
Adult Herd Size	120	150	42	92
	270		**134**	
Herd Sex Ratio/Numbers of (Rams:Ewes)	36:84	56:94	13:29	31:61
	93:177		**44:90**	
Ram Ratio (for reference)	43.7:100	60:100	44.8:100	50:100
	52.8:100		48.4:100	

*CPW 3-year average; # populations were merged into one unit for analysis purposes; **bold** text are numbers used for analysis.

Table K-4
CPW Rocky Mountain Bighorn Sheep Herd Population Estimates* for RoC Model

CPW Population Names	Black Canyon	Cow Creek/ Wetterhorn	Lake Fork/ Pole Mountain	Dillon Mesa/W. Elk	Snowmass West	Snowmass East	Taylor River	Fossil Ridge	Lower Lake Fork	Main Canyon	Battlement Mesa
Game Management Unit	**S80**	S21	S33	**S54**	**S25**	**S13**	S26	S71	**S81**	**S75**	**S24**
		DAU=21					**DAU=23**				
Adult Herd Size	**30**	204	100	**90**	**51**	**60**	30	25	**10**	**45**	**55**
		304					**50**				
Herd Sex Ratio/Numbers of (Rams:Ewes)	**8:22**	82:122	44:56	**28:62**	**16:35**	**20:40**	13	5	**4:6**	**10:35**	**16:39**
		126:178					**20**				
Ram Ratio (for reference)	35:100	67.9:100	67.9:100	45:100	47.4:100	50:100	76:100	25:100	40:100	30:100	40:100
		67.9:100					67:100				

*CPW 3-year average; # populations were merged into one unit for analysis purposes; **bold** text are numbers used for analysis.

Table K-5
Summary of POIM Results for the UFO RMP Area

Type of Livestock	Number of Areas Assessed (%) per Risk Category				
	High	Moderate	Some	Low	Total
Cattle	26 (11.3%)	43 (18.6%)	62 (29.0%)	67 (26.8%)	198 (85.7%)
Cattle or Horse			1 (0.4%)	1 (0.4%)	2 (0.9%)
Cattle or Sheep			2 (0.9%)		2 (0.9%)
Horse				2 (0.9%)	2 (0.9%)
Sheep	3 (1.3%)	6 (2.6%)	11 (4.8%)	7 (3.0%)	27 (11.7%)
Total	**29 (12.6%)**	**49 (21.2%)**	**76 (32.9%)**	**77 (33.3%)**	**231**

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
Adobe	05027	Cattle	0.005786	0.001632	0.009545	0.000699	0.010244
Alder Creek-A	17253	Cattle	0.000611	0.000329	0.010857	0.000877	0.011734
Alder Creek-B	17253	Cattle	0.000611	0.001144	0.010781	0.003054	0.013835
Alkali Flats	14017	Sheep	0.009295	0.002794	0.116135	0.006637	0.122772
Allen Reservoir	05050	Cattle	0.019497	0.006029	0.035328	0.002859	0.038187
Anthracite Creek	14525	Cattle	0.017408	0.005453	0.056528	0.004059	0.060587
Aspen Ditch-A	14551	Sheep	0.001227	0.000267	0.001406	0.000094	0.001499
Aspen Ditch-B	14551	Sheep	0.001241	0.000288	0.001451	0.000105	0.001556
Bald Hills	05510	Cattle	0.007959	0.002039	0.102362	0.005035	0.107397
Baldy	05568	Cattle			*		
Barkelew Draw Com	07303	Cattle	0.004518	0.001574	0.028067	0.002199	0.030266
Beaver Canyon	17060	Cattle	0.004952	0.001135	0.087972	0.003031	0.091003
Beaver Hill	05522	Sheep	0.007369	0.002546	0.084104	0.005864	0.089969
Beaver Rim	07204	Horse	0.003112	0.000307	0.055292	0.000821	0.056113
Ben Lowe	14013	Cattle			*		
Big Bear Creek-A	07207	Cattle	0.005396	0.000537	0.095006	0.001345	0.096351
Big Bear Creek-B	07207	Cattle	0.002751	0.003495	0.041613	0.008570	0.050183
Big Bucktail	17061	Cattle	0.002254	0.001260	0.021435	0.002346	0.023782
Big Gulch-40	05036	Sheep	0.002280	0.002284	0.002882	0.000824	0.003706
Big Gulch-A	03630		0.000741	0.000355	0.000867	0.000123	0.000990
Big Gulch-B	03630		0.000178	0.000103	0.000212	0.000037	0.000249
Big Pasture	05044	Cattle	0.023384	0.006496	0.043031	0.003296	0.046327
Black Bullet	05045	Cattle	0.019316	0.012926	0.021937	0.004292	0.026229

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
Blue Cimarron	16036	Cattle or Sheep	0.027424	0.020987	0.037759	0.007392	0.045151
Bolinger Ditch	07219	Cattle	0.000385	0.000038	0.006815	0.000101	0.006915
Bramier Draw	07235	Cattle	0.000786	0.000213	0.004874	0.000287	0.005161
Broad Canyon	17199	Cattle	0.002080	0.000524	0.012903	0.000708	0.013611
Buck	07232	Cattle or Horse	0.000027	0.000011	0.000241	0.000019	0.000260
Buckeye	17033	Cattle			*		
Burn Canyon	17022	Cattle	0.000493	0.000615	0.003122	0.001160	0.004282
Burro Creek	05556	Cattle			^		
Burro Ridge	05532	Cattle	0.011198	0.001363	0.174460	0.002599	0.177058
Busted Boiler	03648	Cattle			^		
Canal	14012	Sheep			*		
Carpenter Ridge Com	17100	Cattle			*		
Carpenter Ridge Com/Horse Bench	17100	Cattle			*		
Cedar	05570	Cattle	0.007198	0.002186	0.016240	0.001034	0.017274
Cedar Creek-A	05535	Cattle	0.036759	0.010278	0.041586	0.003473	0.045059
Cedar Creek-B	05535	Cattle	0.001290	0.000495	0.001461	0.000164	0.001625
Cedar Point	05012	Cattle	0.015913	0.003484	0.020203	0.001226	0.021429
Chaffee	00019	Cattle	0.004756	0.001827	0.045020	0.003202	0.048221
Chaffee Gulch	05528	Cattle	0.003681	0.001534	0.018223	0.002648	0.020871
Cimarron 40	03658	Cattle	0.004898	0.000119	0.082878	0.000048	0.082927
Cimarron Stock Driveway	03650	Cattle			*		
Coal Canyon	17107	Cattle	0.002032	0.000712	0.012714	0.000983	0.013697
Coal Creek	05509	Cattle	0.000488	0.000153	0.002749	0.000162	0.002911
Coal Gulch-A	14517	Sheep	0.008236	0.002008	0.025047	0.001441	0.026488
Coal Gulch-B	14517	Sheep	0.001537	0.001560	0.003810	0.000903	0.004713
Coke Ovens	17027	Cattle	0.013751	0.002810	0.085313	0.003793	0.089106
Collins	05043	Cattle	0.001771	0.000388	0.002474	0.000146	0.002620
Cone	03635	Cattle			^		
Cookie Tree	05560	Cattle			^		
Coventry	07222	Cattle	0.003194	0.000480	0.050329	0.000860	0.051189
Cow Creek	05566	Cattle			*		
Crawford Reservoir	05018	Cattle	0.008256	0.001787	0.010066	0.000683	0.010749
Creek Bottom	03632	Cattle			^		
Cushman	05506	Sheep	0.048246	0.009514	0.541295	0.021561	0.562856
Cut Off	05052	Cattle	0.000409	0.000084	0.000461	0.000028	0.000488
Dave Wood Road	05518	Sheep	0.003991	0.000960	0.050038	0.002250	0.052288
Davis Mesa	17037	Cattle			*		
Deep Creek	14524	Cattle	0.007625	0.002362	0.023364	0.001597	0.024961
Deer Basin/Midway-A	14019	Sheep	0.008094	0.001779	0.096718	0.004190	0.100908

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
Deer Basin/Midway-B	14019	Sheep	0.011010	0.002621	0.135599	0.005790	0.141389
Deer Basin/Midway-C	14019	Sheep	0.000086	0.000024	0.000622	0.000029	0.000651
Delta Pipeline	03277	Sheep	0.033100	0.007320	0.274724	0.012728	0.287452
Dexter Creek	05551	Cattle			*		
Dirty George	14023	Cattle	0.001878	0.000812	0.005095	0.000572	0.005667
Doby Canyon	17042	Cattle	0.002468	0.000698	0.016656	0.001237	0.017893
Dolores Canyon	17004	Cattle			*		
Doug Creek	05028	Cattle	0.014318	0.004593	0.025417	0.002009	0.027426
Downing	05541	Cattle	0.000212	0.000072	0.000511	0.000043	0.000555
Dry Cedar-A	05537	Sheep	0.016474	0.005417	0.045904	0.002496	0.048400
Dry Cedar-B	05537	Sheep	0.000253	0.000041	0.002774	0.000031	0.002805
Dry Cedar-C	05537	Sheep	0.000283	0.000013	0.004466	0.000009	0.004475
Dry Creek	14549	Cattle	0.010641	0.003496	0.012042	0.001155	0.013197
Dry Creek Basin	05513	Cattle or Sheep	0.025462	0.005323	0.305510	0.012727	0.318237
Dry Creek Place	05525	Cattle or Horse	0.001081	0.000253	0.008871	0.000373	0.009244
Dry Gulch	05540	Cattle	0.014868	0.005812	0.019056	0.004177	0.023233
Dry Park	07300	Cattle	0.000954	0.000668	0.011884	0.001567	0.013451
Duroy	03637	Cattle			^		
E Fork Dry Creek	05514	Cattle	0.003329	0.000686	0.043084	0.001714	0.044798
E Gould Reservoir	05041	Cattle	0.017926	0.004185	0.028847	0.001968	0.030814
E Paradox Com-A	17101	Cattle			*		
E Paradox Com-B	17101	Cattle	0.020310	0.004307	0.126002	0.005814	0.131816
E Roatcap Ind	14512	Cattle	0.000056	0.000013	0.000063	0.000004	0.000067
Far Away	17213	Cattle	0.000539	0.000157	0.009248	0.000419	0.009667
Feedlot	17078	Cattle			*		
Fire Mountain Canal	14508	Cattle	0.000737	0.000283	0.000831	0.000093	0.000924
Flatiron	05501	Cattle	0.022379	0.011204	0.265040	0.028357	0.293396
Franklin Mesa	05512	Cattle or Sheep	0.012334	0.002724	0.135192	0.006110	0.141301
Gravel Pit	07063	Cattle	0.000713	0.000366	0.005371	0.000626	0.005997
Green	05503	Cattle	0.005921	0.003108	0.076050	0.008160	0.084209
Hairpin	05569	Cattle	0.022462	0.010830	0.026337	0.003904	0.030241
Hamilton Mesa	07209	Cattle	0.002749	0.000822	0.017101	0.001141	0.018242
High Park	05549	Cattle	0.006109	0.003119	0.011948	0.003359	0.015306
Highway 90	05521	Sheep	0.009925	0.003306	0.113440	0.007618	0.121058
Hillside	05562	Cattle			*		
Home Ranch	07201	Cattle	0.002185	0.000788	0.014222	0.001255	0.015477
Horsefly	05523	Cattle	0.000835	0.000289	0.013765	0.000627	0.014391
Horsefly Com	07301	Cattle	0.001082	0.000192	0.018614	0.000511	0.019125
Houser	07076	Cattle	0.029500	0.013270	0.183016	0.017915	0.200931
Hubbard Creek	14516	Sheep	0.001942	0.002108	0.004215	0.001134	0.005349

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
Jumbo Mountain	14527	Cattle	0.008211	0.002841	0.014354	0.001637	0.015991
Juniper Knob	14505	Cattle	0.002160	0.000441	0.002436	0.000146	0.002582
Kinnikin	03643	Cattle			^		
La Sal Creek	17011	Cattle			*		
Lavender	07075	Cattle	0.039684	0.022901	0.246197	0.030916	0.277113
Lee Bench	14011	Cattle	0.005296	0.002520	0.069209	0.006682	0.075891
Lee Lands-A	17003	Sheep			*		
Lee Lands-B	17003	Sheep	0.008701	0.000469	0.154046	0.001216	0.155262
Leopard Creek	07205	Sheep			*		
Leroux	14550	Cattle	0.009498	0.002287	0.010714	0.000755	0.011468
Leroux Creek	14504	Cattle	0.001343	0.000380	0.001515	0.000125	0.001640
Lillylands/West	17024	Cattle	0.006749	0.001764	0.041870	0.002381	0.044251
Lion Canyon	17012	Cattle			*		
Lion Creek Basin	17044	Cattle			*		
Little Baldy	07223	Cattle	0.001763	0.001207	0.031326	0.003222	0.034548
Little Maverick Draw	07210	Cattle	0.000441	0.000167	0.002919	0.000243	0.003161
Log Hill	05529	Cattle or Sheep	0.001672	0.001142	0.016056	0.002083	0.018139
Lower Beaver Canyon	07211	Cattle	0.000048	0.000977	0.000855	0.002608	0.003462
Lower Hamilton	07234	Cattle	0.001671	0.000421	0.010369	0.000569	0.010938
Lower Horsefly-A	05520	Sheep	0.000560	0.000070	0.007245	0.000107	0.007352
Lower Horsefly-B	05520	Sheep	0.002540	0.000467	0.040917	0.000943	0.041860
Lower Horsefly-C	05520	Sheep	0.000738	0.000200	0.006355	0.000253	0.006608
Lower Pinion	07213	Cattle	0.000616	0.000389	0.005219	0.000720	0.005939
Lower Roc Creek	07216	Cattle	0.007578	0.002911	0.047016	0.003930	0.050947
Lower Roubideau Canyon	05000	Cattle			*		
Mailbox Park-A	17001	Cattle	0.000014	0.000003	0.000210	0.000004	0.000215
Mailbox Park-B	17001	Cattle	0.001413	0.000629	0.015355	0.001168	0.016523
Maverick Draw	17018	Cattle	0.000787	0.000339	0.005437	0.000560	0.005997
McDonald Creek	14532	Sheep	0.017173	0.003884	0.019673	0.001345	0.021018
McKee Draw	07206	Cattle	0.000768	0.000708	0.007690	0.001248	0.008938
Mesa Creek-A	17014	Cattle			*		
Mesa Creek-B/First Park	17014	Cattle	0.009200	0.002404	0.057077	0.003245	0.060323
Mesa Creek-C	17014	Cattle			*		
Middle Hamilton Lse	07233	Cattle	0.001173	0.000296	0.007278	0.000399	0.007678
Milk Creek	14544	Cattle	0.000037	0.000013	0.000047	0.000006	0.000052
Moonshine Park	05563	Cattle			*		
Morrow Point	03631	Cattle			*		
Mud Springs	07230	Cattle	0.001129	0.000553	0.011678	0.001045	0.012724
Muddy Creek	14519	Sheep	0.006602	0.002567	0.016419	0.001562	0.017981
N Saddle Peak	14540	Cattle	0.001577	0.000508	0.002703	0.000217	0.002920

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
N Wickson Draw	17023	Cattle	0.001006	0.000338	0.006243	0.000457	0.006700
Naturita Canyon-A	07203	Cattle	0.001055	0.000230	0.006547	0.000311	0.006857
Naturita Canyon-B	07203	Cattle	0.000059	0.000015	0.000368	0.000020	0.000388
Naturita Canyon-C	07203	Cattle	0.000049	0.000015	0.000302	0.000020	0.000322
Naturita Canyon-D	07203	Cattle	0.000061	0.000019	0.000381	0.000025	0.000406
Naturita Canyon-E	07203	Cattle	0.000609	0.000184	0.003778	0.000248	0.004026
Naturita Canyon-F	07203	Cattle	0.000269	0.000081	0.001668	0.000110	0.001778
Naturita Ridge	17035	Cattle	0.062360	0.013224	0.386878	0.017852	0.404730
Needle Rock	14542	Horse	0.000569	0.000178	0.000972	0.000077	0.001049
Norwood Hill	07218	Cattle	0.001836	0.000100	0.032617	0.000266	0.032883
Nyswanger	17082	Cattle			*		
Oak Hill	07225	Cattle	0.001005	0.000311	0.017862	0.000830	0.018692
Oak Hill 40	03644	Cattle			^		
Oak Mesa	14506	Cattle	0.007195	0.001880	0.008115	0.000620	0.008736
Oak Ridge Com	14528	Cattle	0.005351	0.001375	0.014046	0.000967	0.015013
Onion Lakes	05533	Cattle or Sheep	0.011575	0.001282	0.154453	0.001158	0.155611
Overland	14511	Cattle	0.000210	0.000049	0.000237	0.000016	0.000253
Park	17030	Cattle	0.004831	0.001070	0.029973	0.001445	0.031417
Parkway	17062	Cattle	0.000853	0.000211	0.005545	0.000309	0.005854
Petrie Mesa	14022	Sheep	0.036802	0.009590	0.339704	0.017094	0.356798
Piney	05516	Cattle	0.020442	0.009790	0.266032	0.025710	0.291741
Pinion	03641	Cattle			^		
Pipeline	05507	Cattle or Sheep	0.025079	0.006472	0.288450	0.014289	0.302739
Pocket Ind	17085	Cattle			*		
Point Creek	14021	Sheep	0.027646	0.006135	0.327320	0.014210	0.341530
Popp Ranch	14531	Cattle	0.001263	0.000436	0.001588	0.000184	0.001773
Radio Tower	02660	Cattle	0.003787	0.001273	0.023495	0.001718	0.025213
Ragsdale	03708	Cattle			^		
Rawhide/Coffee Pot-A	05034	Sheep	0.009168	0.004268	0.016004	0.001509	0.017513
Rawhide/Coffee Pot-B	05034	Sheep	0.018411	0.014541	0.022776	0.005171	0.027947
Rawhide/Coffee Pot-C	05034	Sheep			*		
Rawlings Ind	17021	Cattle			*		
Ray (Wray) Mesa	03298	Cattle			*		
Redvale	07227	Cattle	0.002511	0.000934	0.016378	0.001304	0.017681
Reynolds/McDonald-A	14530	Cattle	0.000422	0.000136	0.000604	0.000061	0.000664
Reynolds/McDonald-B	14530	Cattle	0.033291	0.008301	0.038364	0.002952	0.041316
Ridgway Reservoir	00001	Cattle			^		
Rim Rock	05051	Cattle			*		
Smith Fork Rim	03526	Cattle			*		
River	17079	Cattle			*		

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
River Allotment	07200	Cattle	0.002920	0.001252	0.042982	0.003131	0.046113
Roatcap	05504	Cattle	0.009721	0.006274	0.120063	0.016222	0.136285
Roatcap/Jay Creek	14507	Cattle	0.018193	0.005564	0.020521	0.001836	0.022357
Roc Creek	17020	Cattle	0.033260	0.019194	0.206345	0.025911	0.232256
Rock Ditch	05538	Cattle	0.000126	0.000037	0.000629	0.000023	0.000652
Round Top	00002	Cattle			^		
Rowher Canyon	17080	Cattle			*		
S Dry Creek	14548	Cattle	0.010282	0.003144	0.011608	0.001038	0.012646
S Piney-A (Olathe Reservoir East)	05515	Cattle or Sheep	0.003132	0.000722	0.040075	0.001687	0.041762
S Piney-B	05515	Cattle or Sheep	0.018089	0.007097	0.231140	0.017475	0.248616
San Miguel Rim	03639	Cattle			^		
San Miguel River	03640	Cattle			^		
Sandy Wash	05502	Sheep	0.020198	0.009368	0.246753	0.023812	0.270566
Saw Pit	03636	Cattle			^		
Sawtooth	17032	Cattle			*		
Second Park	17105	Cattle	0.012555	0.003023	0.077894	0.004082	0.081975
Section 35	14547	Cattle	0.000855	0.000256	0.002395	0.000158	0.002553
Sewemup	03646	Cattle			^		
Shavano Mesa	05511	Sheep	0.005201	0.001197	0.063177	0.002857	0.066035
Shinn Park	05534	Sheep	0.073631	0.015434	0.083669	0.006023	0.089692
Simms Mesa-A	05519	Sheep	0.000480	0.000130	0.001457	0.000128	0.001585
Simms Mesa-B	05519	Sheep	0.001221	0.000920	0.011483	0.001776	0.013259
Slagle Pass	05547	Cattle	0.005813	0.000558	0.086024	0.000686	0.086710
Slaugher Grade	03651	Cattle			^		
Smith Fork Ind	05049	Cattle	0.025896	0.012459	0.029619	0.004218	0.033838
South Branch	14004	Cattle	0.002206	0.000899	0.013448	0.001005	0.014453
South of Town	14534	Sheep	0.010049	0.004487	0.011368	0.001489	0.012856
Spring Creek	05517	Cattle			^		
Spring Creek Canyon	03659	Cattle			^		
Spring Creek and Highway 90	03638	Cattle			*		
Spring Gulch	05029	Cattle			*		
Stevens Gulch Com	14513	Cattle	0.005086	0.001108	0.006439	0.000411	0.006849
Stingley Gulch	14503	Cattle	0.006308	0.001929	0.007115	0.000637	0.007752
Stock Driveway	14521	Cattle	0.002184	0.000692	0.005123	0.000397	0.005520
Sundown	03633	Cattle			*		
Sunrise Gulch Com	17102	Cattle			*		
Sunshine Mesa	14541	Cattle	0.006437	0.001426	0.007260	0.000470	0.007731
Swain Bench	17081	Cattle			*		
Tabeguache Creek	17031	Cattle	0.025582	0.006866	0.164013	0.010500	0.174513
Tappan Creek-A	05575	Sheep	0.000244	0.000026	0.003489	0.000040	0.003529

Table K-6
RoC Model Results for Desert Bighorn Risk of Contact with Allotments (Probability that a Bighorn Sheep Will Intersect an Allotment)[1]

Allotment Name	Allotment Number	Type of Livestock	Probability of Contact		Rate of Contact/10 Years		
			Ram	Ewe	Ram	Ewe	Herd
Tappan Creek-B	05575	Sheep	0.000044	0.000007	0.000636	0.000012	0.000648
Taylor Draw	05555	Cattle	0.005691	0.001685	0.090401	0.003627	0.094028
Third Park Com	17103	Cattle	0.010779	0.002286	0.066870	0.003086	0.069956
Tinkler Ind	05530	Cattle	0.001981	0.001309	0.007034	0.002543	0.009577
Transfer Road	05505	Cattle	0.021507	0.008115	0.260493	0.020283	0.280776
Tuttle Draw	17106	Cattle	0.020981	0.004287	0.130167	0.005787	0.135954
Twenty Five Mesa N	14008	Cattle			*		
Twenty Five Mesa N Proposed	14008	Cattle			^		
Twenty Five Mesa S-A	07008	Cattle	0.001188	0.000506	0.008257	0.000878	0.009135
Twenty Five Mesa S-B	07008	Cattle	0.000663	0.000370	0.005360	0.000616	0.005977
Uncompahgre Bench	07007	Cattle	0.009129	0.003201	0.057178	0.004422	0.061599
Uncompahgre Com-A	07302	Cattle	0.000982	0.000102	0.017442	0.000272	0.017714
Uncompahgre Com-B	07302	Cattle	0.001052	0.000308	0.018696	0.000823	0.019518
Uncompahgre Com-C	07302	Cattle	0.004680	0.000098	0.083149	0.000262	0.083411
Uncompahgre Com-D	07302	Cattle	0.004344	0.000029	0.077177	0.000078	0.077254
Uncompahgre Com-E	07302	Cattle	0.002434	0.000002	0.043246	0.000005	0.043251
Upper Mail Box	07208	Cattle	0.000216	0.000081	0.003479	0.000191	0.003670
Upper Maverick Draw	07202	Cattle	0.000855	0.000529	0.005889	0.000821	0.006710
Upper Terror Creek	14514	Cattle	0.000463	0.000343	0.000823	0.000152	0.000975
W Roatcap	14510	Cattle	0.000144	0.000049	0.000163	0.000016	0.000179
W Stevens Gulch	14515	Cattle	0.008353	0.001959	0.009422	0.000647	0.010069
W Youngs Peak	14536	Cattle	0.016611	0.003329	0.019074	0.001166	0.020240
Wakefield	03628	Cattle			^		
Ward Creek/Doughspoon	14025	Cattle	0.051155	0.014199	0.257059	0.015760	0.272819
Washboard Rock-A	05548	Cattle	0.015798	0.004511	0.076412	0.003146	0.079557
Waterdog Basin	05546	Cattle	0.001399	0.000222	0.009594	0.000111	0.009705
Weimer Hill Place	03660	Cattle			^		
Wells Gulch	14016	Sheep	0.014522	0.007551	0.179680	0.017748	0.197427
White Ranch	14015	Cattle	0.011673	0.004484	0.153065	0.011906	0.164971
Wickson Draw	17010	Cattle	0.006772	0.001916	0.042010	0.002586	0.044597
Wilbanks-A	14502	Cattle	0.010570	0.003542	0.012681	0.001254	0.013936
Washboard Rock-B	14502	Cattle	0.000130	0.000044	0.000150	0.000015	0.000165
Williams Creek	14523	Cattle	0.003363	0.001105	0.009386	0.000693	0.010080
Willims Ditch	07220	Cattle	0.000219	0.000064	0.001358	0.000086	0.001443
Winter/Monitor Mesa	14010	Cattle			*		
Youngs Peak	14537	Cattle	0.015303[a]	0.003260	0.018164[b]	0.001195	0.019359[c]

*This allotment intersects the home range polygon and is therefore not included in the RoC analysis.
^This is a proposed allotment in the RMP that was not included in the RoC model run.
Sample Interpretation for Youngs Peak:
[a]Given that a ram is on foray, there is a 1.5% probability that it will come in contact with this allotment.
[b]Given the probability of ram on foray, predicts a rate of 0.2 ram contacts with allotment in 10 years.
[c]Given the probability of foray of bighorn in the population, a rate of 0.2 contact with allotment in 10 years is predicted.

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Adobe	05027	Cattle	0.010244	98	98	108	130	195	390	976	1952
Alder Creek-A	17253	Cattle	0.011734	85	85	95	114	170	341	852	1704
Alder Creek-B	17253	Cattle	0.013835	82	72	80	96	145	289	723	1446
Alkali Flats	14017	Sheep	0.122772	8	8	9	11	16	33	81	163
Allen Reservoir	05050	Cattle	0.038187	26	26	29	35	52	105	262	524
Anthracite Creek	14525	Cattle	0.060587	17	17	18	22	33	66	165	330
Aspen Ditch-A	14551	Sheep	0.001499	667	667	741	889	1334	2668	6671	13342
Aspen Ditch-B	14551	Sheep	0.001556	643	643	714	857	1285	2570	6426	12851
Bald Hills	05510	Cattle	0.107397	9	9	10	12	19	37	93	186
Barkelew Draw Com	07303	Cattle	0.030266	33	33	37	44	66	132	330	661
Beaver Canyon	17060	Cattle	0.091003	11	11	12	15	22	44	110	220
Beaver Hill	05522	Sheep	0.089969	11	11	12	15	22	44	111	222
Beaver Rim	07204	Horse	0.056113	18	18	20	24	36	71	178	356
Big Bear Creek-A	07207	Cattle	0.096351	10	10	12	14	21	42	104	208
Big Bear Creek-B	07207	Cattle	0.050183	20	20	22	27	40	80	199	399
Big Bucktail	17061	Cattle	0.023782	42	42	47	56	84	168	420	841
Big Gulch-40	05036	Sheep	0.003706	270	270	300	360	540	1079	2698	5397
Big Gulch-A	03630		0.000990	1010	1010	1122	1346	2020	4039	10098	20196
Big Gulch-B	03630		0.000249	4013	4013	4459	5351	8026	16052	40130	80259
Big Pasture	05044	Cattle	0.046327	22	22	24	29	43	86	216	432
Black Bullet	05045	Cattle	0.026229	38	38	42	51	76	153	381	763
Blue Cimarron	16036	Cattle or Sheep	0.045151	22	22	25	30	44	89	221	443
Bolinger Ditch	07219	Cattle	0.006915	145	145	161	193	289	578	1446	2892
Bramier Draw	07235	Cattle	0.005161	194	194	215	258	388	775	1938	3875
Broad Canyon	17199	Cattle	0.013611	73	73	82	98	147	294	735	1469
Buck	07232	Cattle or Horse	0.000260	3844	3844	4271	5125	7688	15376	38440	76879

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Burn Canyon	17022	Cattle	0.004282	234	234	259	311	467	934	2335	4671
Burro Creek	05556	Cattle						^			
Burro Ridge	05532	Cattle	0.177058	6	6	6	8	11	23	56	113
Busted Boiler	03648	Cattle						^			
Cedar	05570	Cattle	0.017274	58	58	64	77	116	232	579	1158
Cedar Creek-A	05535	Cattle	0.045059	22	22	25	30	44	89	222	444
Cedar Creek-B	05535	Cattle	0.001625	616	616	684	821	1231	2462	6155	12311
Chaffee	00019	Cattle	0.048221	21	21	23	28	41	83	207	415
Chaffee Gulch	05528	Cattle	0.020871	48	48	53	64	96	192	479	958
Cimarron 40	03658	Cattle	0.082927	0	12	13	16	24	48	121	241
Coal Canyon	17107	Cattle	0.013697	73	73	81	97	146	292	730	1460
Coal Creek	05509	Cattle	0.002911	344	344	382	458	687	1374	3435	6870
Coal Gulch-A	14517	Sheep	0.026488	38	38	42	50	76	151	378	755
Coal Gulch-B	14517	Sheep	0.004713	212	212	236	283	424	849	2122	4243
Coke Ovens	17027	Cattle	0.089106	11	11	12	15	22	45	112	224
Collins	05043	Cattle	0.002620	382	382	424	509	763	1526	3816	7632
Cone	03635	Cattle						^			
Cookie Tree	05560	Cattle						^			
Coventry	07222	Cattle	0.051189	20	20	22	26	39	78	195	391
Crawford Reservoir	05018	Cattle	0.010749	93	93	103	124	186	372	930	1861
Creek Bottom	03632	Cattle						^			
Cushman	05506	Sheep	0.562856	2	2	2	2	4	7	18	36
Cut Off	05052	Cattle	0.000488	2048	2048	2275	2730	4095	8191	20477	40954
Dave Wood Road	05518	Sheep	0.052288	19	19	21	25	38	76	191	382
Deep Creek	14524	Cattle	0.024961	40	40	45	53	80	160	401	801
Deer Basin/Midway-A	14019	Sheep	0.100908	10	10	11	13	20	40	99	198
Deer Basin/Midway-B	14019	Sheep	0.141392	7	7	8	9	14	28	71	141

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Deer Basin/Midway-C	14019	Sheep	0.000651	1536	1536	1707	2048	3073	6145	15363	30726
Delta Pipeline	03277	Sheep	0.287454	3	3	4	5	7	14	35	70
Dirty George	14023	Cattle	0.006951	144	176	196	235	353	706	1765	3529
Doby Canyon	17042	Cattle	0.017893	56	56	62	75	112	224	559	1118
Doug Creek	05028	Cattle	0.027426	36	36	41	49	73	146	365	729
Downing	05541	Cattle	0.000555	1803	1803	2003	2404	3606	7212	18031	36062
Dry Cedar-A	05537	Sheep	0.048400	21	21	23	28	41	83	207	413
Dry Cedar-B	05537	Sheep	0.002805	357	357	396	475	713	1426	3565	7130
Dry Cedar-C	05537	Sheep	0.004475	223	223	248	298	447	894	2235	4469
Dry Creek	14549	Cattle	0.013278	75	76	84	101	152	303	758	1516
Dry Creek Basin	05513	Cattle or Sheep	0.318237	3	3	3	4	6	13	31	63
Dry Creek Place	05525	Cattle or Horse	0.009244	108	108	120	144	216	433	1082	2164
Dry Gulch	05540	Cattle	0.023233	43	43	48	57	86	172	430	861
Dry Park	07300	Cattle	0.013451	74	74	83	99	149	297	743	1487
Duroy	03637	Cattle						^			
E Fork Dry Creek	05514	Cattle	0.044798	22	22	25	30	45	89	223	446
E Gould Reservoir	05041	Cattle	0.030814	32	32	36	43	65	130	325	649
E Paradox Com-B	17101	Cattle	0.131816	8	8	8	10	15	30	76	152
E Roatcap Ind	14512	Cattle	0.000067	14903	14903	16559	19871	29806	59613	149031	298063
Far Away	17213	Cattle	0.009667	103	103	115	138	207	414	1034	2069
Fire Mountain Canal	14508	Cattle	0.000924	1082	1082	1202	1442	2164	4327	10818	21636
Flatiron	05501	Cattle	0.293396	3	3	4	5	7	14	34	68
Franklin Mesa	05512	Cattle or Sheep	0.141301	7	7	8	9	14	28	71	142
Gravel Pit	07063	Cattle	0.005997	167	167	185	222	333	667	1667	3335
Green	05503	Cattle	0.084209	12	12	13	16	24	48	119	238

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Hairpin	05569	Cattle	0.030241	33	33	37	44	66	132	331	661
Hamilton Mesa	07209	Cattle	0.018242	55	55	61	73	110	219	548	1096
High Park	05549	Cattle	0.015306	65	65	73	87	131	261	653	1307
Highway 90	05521	Sheep	0.121058	8	8	9	11	17	33	83	165
Home Ranch	07201	Cattle	0.015477	65	65	72	86	129	258	646	1292
Horsefly	05523	Cattle	0.014391	69	69	77	93	139	278	695	1390
Horsefly Com	07301	Cattle	0.019125	52	52	58	70	105	209	523	1046
Houser	07076	Cattle	0.200931	5	5	6	7	10	20	50	100
Hubbard Creek	14516	Sheep	0.005349	187	187	208	249	374	748	1869	3739
Jumbo Mountain	14527	Cattle	0.015991	63	63	69	83	125	250	625	1251
Juniper Knob	14505	Cattle	0.002582	387	387	430	516	775	1549	3873	7746
Kinnikin	03643	Cattle						^			
Lavender	07075	Cattle	0.277113	4	4	4	5	7	14	36	72
Lee Bench	14011	Cattle	0.075891	13	13	15	18	26	53	132	264
Lee Lands-B	17003	Sheep	0.155262	6	6	7	9	13	26	64	129
Leroux	14550	Cattle	0.011468	87	87	97	116	174	349	872	1744
Leroux Creek	14504	Cattle	0.001640	610	610	678	813	1220	2439	6098	12196
Lillylands/West	17024	Cattle	0.044251	23	23	25	30	45	90	226	452
Little Baldy	07223	Cattle	0.034548	29	29	32	39	58	116	289	579
Little Maverick Draw	07210	Cattle	0.003161	316	316	351	422	633	1265	3163	6326
Log Hill	05529	Cattle or Sheep	0.018139	55	55	61	74	110	221	551	1103
Lower Beaver Canyon	07211	Cattle	0.003462	289	289	321	385	578	1155	2888	5776
Lower Hamilton	07234	Cattle	0.010938	91	91	102	122	183	366	914	1829
Lower Horsefly-A	05520	Sheep	0.007352	136	136	151	181	272	544	1360	2720
Lower Horsefly-B	05520	Sheep	0.041860	24	24	27	32	48	96	239	478
Lower Horsefly-C	05520	Sheep	0.006608	151	151	168	202	306	605	1513	3026

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Simms Mesa-A	05519	Sheep	0.001585	631	631	701	841	1262	2524	6311	12622
Simms Mesa-B	05519	Sheep	0.013259	75	75	84	101	151	302	754	1508
Lower Pinion	07213	Cattle	0.005939	168	168	187	225	337	674	1684	3368
Lower Roc Creek	07216	Cattle	0.050947	20	20	22	26	39	79	196	393
Mailbox Park-A	17001	Cattle	0.000215	4659	4659	5176	6211	9317	18634	46586	93172
Mailbox Park-B	17001	Cattle	0.016523	61	61	67	81	121	242	605	1210
Maverick Draw	17018	Cattle	0.005997	167	167	185	222	334	667	1668	3335
McDonald Creek	14532	Sheep	0.021018	48	48	53	63	95	190	476	952
McKee Draw	07206	Cattle	0.008938	112	112	124	149	224	448	1119	2238
McKee Draw	07206	Cattle	0.008938	112	112	124	149	224	448	1119	2238
Mesa Creek-B	17014	Cattle	0.060323	17	17	18	22	33	66	166	332
Middle Hamilton Lse	07233	Cattle	0.007678	130	130	145	174	260	521	1302	2605
Milk Creek	14544	Cattle	0.000065	15477	19173	21304	25564	38347	76693	191733	383467
Mud Springs	07230	Cattle	0.012724	79	79	87	105	157	314	786	1572
Muddy Creek	14519	Sheep	0.017981	56	56	62	74	111	222	556	1112
N Saddle Peak	14540	Cattle	0.002920	342	342	381	457	685	1370	3425	6849
N Wickson Draw	17023	Cattle	0.006700	149	149	166	199	299	597	1493	2985
Naturita Canyon-A	07203	Cattle	0.006857	146	146	162	194	292	583	1458	2917
Naturita Canyon-B	07203	Cattle	0.000388	2574	2574	2860	3432	5148	10296	25741	51482
Naturita Canyon-C	07203	Cattle	0.000322	3104	3104	3449	4139	6209	12417	31043	62087
Naturita Canyon-D	07203	Cattle	0.000406	2466	2466	2740	3288	4931	9863	24656	49313
Naturita Canyon-E	07203	Cattle	0.004026	248	248	276	331	497	994	2484	4968
Naturita Canyon-F	07203	Cattle	0.001778	563	563	625	750	1125	2250	5626	11252
Naturita Ridge	17035	Cattle	0.404730	2	2	3	3	5	10	25	49
Needle Rock	14542	Horse	0.001049	954	954	1060	1272	1907	3815	9537	19074
Norwood Hill	07218	Cattle	0.032883	30	30	34	41	61	122	304	608
Oak Hill	07225	Cattle	0.018692	53	53	59	71	107	214	535	1070

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Oak Hill 40	03644	Cattle						^			
Oak Mesa	14506	Cattle	0.008736	114	114	127	153	229	458	1145	2289
Oak Ridge Com	14528	Cattle	0.015013	67	67	74	89	133	266	666	1332
Onion Lakes	05533	Cattle or Sheep	0.155611	6	6	7	9	13	26	64	129
Overland	14511	Cattle	0.000253	3947	3947	4386	5263	7895	15790	39474	78949
Park	17030	Cattle	0.031417	32	32	35	42	64	127	318	637
Parkway	17062	Cattle	0.005854	171	171	190	228	342	683	1708	3416
Petrie Mesa	14022	Sheep	0.356798	3	3	3	4	6	11	28	56
Piney	05516	Cattle	0.291741	3	3	4	5	7	14	34	69
Pinion	03641	Cattle						^			
Pipeline	05507	Cattle or Sheep	0.302739	3	3	4	4	7	13	33	66
Point Creek	14021	Sheep	0.341530	3	3	3	4	6	12	29	59
Popp Ranch	14531	Cattle	0.001773	564	564	627	752	1128	2257	5641	11283
Radio Tower	02660	Cattle	0.025213	40	40	44	53	79	159	397	793
Ragsdale	03708	Cattle						^			
Rawhide/Coffee Pot-A	05034	Sheep	0.017513	57	57	63	76	114	228	571	1142
Rawhide/Coffee Pot-B	05034	Sheep	0.027947	36	36	40	48	72	143	358	716
Redvale	07227	Cattle	0.017681	57	57	63	75	113	226	566	1131
Reynolds/McDonald-A	14530	Cattle	0.000664	1506	1506	1673	2007	3011	6022	15055	30110
Reynolds/McDonald-B	14530	Cattle	0.041316	24	24	27	32	48	97	242	484
Ridgway Reservoir	00001	Cattle						^			
River Allotment	07200	Cattle	0.046113	22	22	24	29	43	87	217	434
Roatcap	05504	Cattle	0.136285	7	7	8	10	15	29	73	147
Roatcap/Jay Creek	14507	Cattle	0.022357	45	45	50	60	89	179	447	895

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Roc Creek	17020	Cattle	0.232256	4	4	5	6	9	17	43	86
Rock Ditch	05538	Cattle	0.000652	1534	1534	1705	2046	3069	6137	15344	30687
Round Top	00002	Cattle						^			
S Dry Creek	14548	Cattle	0.012646	79	79	88	105	158	316	791	1582
S Piney-A	05515	Cattle or Sheep	0.041762	24	24	27	32	48	96	239	479
S Piney-B	05515	Cattle or Sheep	0.248616	4	4	4	5	8	16	40	80
San Miguel Rim	03639	Cattle						^			
San Miguel River	03640	Cattle						^			
Sandy Wash	05502	Sheep	0.270566	4	4	4	5	7	15	37	74
Saw Pit	03636	Cattle						^			
Second Park	17105	Cattle	0.081975	12	12	14	16	24	49	122	244
Section 35	14547	Cattle	0.002553	392	392	435	522	783	1567	3917	7833
Sewemup	03646	Cattle						^			
Shavano Mesa	05511	Sheep	0.066035	15	15	17	20	30	61	151	303
Shin Park/South Canal	05534	Cattle	0.066035	15	15	17	20	30	61	151	303
Shinn Park	05534	Sheep	0.089692	11	11	12	15	22	45	111	223
Slagle Pass	05547	Cattle	0.086710	12	12	13	15	23	46	115	231
Slaugher Grade	03651	Cattle						^			
Smith Fork Ind	05049	Cattle	0.033838	30	30	33	39	59	118	296	591
South Branch	14004	Cattle	0.015474	65	69	77	92	138	277	692	1384
South of Town	14534	Sheep	0.012856	78	78	86	104	156	311	778	1556
Spring Creek	05517	Cattle						^			
Spring Creek Canyon	03659	Cattle						^			
Stevens Gulch Com	14513	Cattle	0.006849	146	146	162	195	292	584	1460	2920
Stingley Gulch	14503	Cattle	0.007752	129	129	143	172	258	516	1290	2580
Stock Driveway	14521	Cattle	0.005520	181	181	201	242	362	725	1812	3623

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Sunshine Mesa	14541	Cattle	0.007731	129	129	144	172	259	517	1294	2587
Tabeguache Creek	17031	Cattle	0.174513	6	6	6	8	11	23	57	115
Tappan Creek-A	05575	Sheep	0.003529	283	283	315	378	567	1134	2834	5668
Tappan Creek-B	05575	Sheep	0.000648	1543	1543	1715	2057	3086	6172	15431	30862
Taylor Draw	05555	Cattle	0.094028	11	11	12	14	21	43	106	213
Third Park Com	17103	Cattle	0.069956	14	14	16	19	29	57	143	286
Tinkler Ind	05530	Cattle	0.009577	104	104	116	139	209	418	1044	2088
Transfer Road	05505	Cattle	0.280776	4	4	4	5	7	14	36	71
Tuttle Draw	17106	Cattle	0.135954	7	7	8	10	15	29	74	147
Twenty Five Mesa S-A	07008	Cattle	0.009135	109	109	122	146	219	438	1095	2189
Twenty Five Mesa S-B	07008	Cattle	0.005977	167	167	186	223	335	669	1673	3346
Uncompahgre Bench	07007	Cattle	0.061599	16	16	18	22	32	65	162	325
Uncompahgre Com-A	07302	Cattle	0.017714	56	56	63	75	113	226	565	1129
Uncompahgre Com-B	07302	Cattle	0.019518	51	56	63	75	113	226	565	1129
Uncompahgre Com-C	07302	Cattle	0.083411	12	51	57	68	102	205	512	1025
Uncompahgre Com-D	07302	Cattle	0.077254	13	12	13	16	24	48	120	240
Uncompahgre Com-E	07302	Cattle	0.043251	23	13	14	17	26	52	129	259
Upper Mail Box	07208	Cattle	0.003670	273	23	26	31	46	92	231	462
Upper Maverick Draw	07202	Cattle	0.006710	149	149	166	199	298	596	1490	2981
Upper Terror Creek	14514	Cattle	0.000975	1025	1025	1139	1367	2051	4102	10255	20510
W Roatcap	14510	Cattle	0.000179	5599	5599	6221	7465	11197	22394	55986	111972
W Stevens Gulch	14515	Cattle	0.010069	99	99	110	132	199	397	993	1986
W Youngs Peak	14536	Cattle	0.020240	49	49	55	66	99	198	494	988
Wakefield	03628	Cattle						^			
Ward Creek/Doughspoon	14025	Cattle	0.274489	4	4	4	5	7	15	37	73
Ward Creek/Doughspoon	14025	Cattle	0.274489	4	4	4	5	7	15	37	73

Table K-7
Predicted Years Between Potential Disease Events for Allotments That Did Not Intersect with CHHR, Based on RoC Model Results

Allotment Name	Allotment Number	Type of Livestock	Herd Rate of Contact[a]	Years Between Contact[b]	Years Between Potential Disease Events[c]						
					1:1 (1.0)	1:1.1111 (0.9)	1:1.3333 (0.75)	1:2 (0.50)	1:4 (0.25)	1:10 (0.10)	1:20 (0.05)
Washboard Rock-A	05548	Cattle	0.079557	13	13	14	17	25	50	126	251
Waterdog Basin	05546	Cattle	0.009705	103	103	114	137	206	412	1030	2061
Weimer Hill Place	03660	Cattle						^			
Wells Gulch	14016	Sheep	0.197428	5	5	6	7	10	20	51	101
White Ranch	14015	Cattle	0.164971	6	6	7	8	12	24	61	121
White Ranch	14015	Cattle	0.164971	6	6	7	8	12	24	61	121
Wickson Draw	17010	Cattle	0.044597	22	22	25	30	45	90	224	448
Wilbanks-A	14502	Cattle	0.014274	70	72	80	96	144	287	718	1435
Wilbanks-B	14502	Cattle	0.000173	5787	6069	6743	8091	12137	24274	60686	121372
Williams Creek	14523	Cattle	0.010080	99	99	110	132	198	397	992	1984
Willims Ditch	07220	Cattle	0.001443	693	693	770	924	1386	2771	6928	13856
Youngs Peak	14537	Cattle	0.019359	52	52	57	69	103	207	517	1033

[a]From last column.
[b]1/Herd rate of contact
[c]Gray-shaded cells for allotments show potential disease event rates more frequently than 25 years.
^This is a proposed allotment in the RMP that was not included in the RoC model run.

Table K-8
Summary of RoC Model Results for the UFO RMP Area

Type of Livestock	Number (Percent) of Areas Assessed							
	High*	**High**	**Moderate**	**Some**	**Low**	**Very Low**	**^**	**Grand Total**
Cattle	37 (14.3%)	19 (7.3%)	14 (5.4%)	7 (2.7%)	13 (5.0%)	102 (39.4%)	22 (8.5%)	214 (82.6%)
Cattle or Horse						2 (0.8%)		2 (0.8%)
Cattle or Sheep			1 (0.4%)			1 (0.4%)		2 (0.8%)
Horse				1 (0.4%)		1 (0.4%)		2 (0.8%)
Sheep	4 (1.5%)	6 (2.3%)	6 (2.3%)	1 (0.4%)	3 (1.2%)	19 (7.3%)		39 (15.1%)
Grand Total	**41 (15.8%)**	**25 (9.7%)**	**21 (8.1%)**	**9 (3.5%)**	**16 (6.2%)**	**125 (48.3%)**	**22 (8.5%)**	**259**

Table K-9
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	POIM Results#	Allotment Number	RoC Allotment Name	RoC Results@
Alkali Flats	14017	Sheep	Moderate	14017	Alkali Flats	Moderate
Aspen Ditch	14551	Sheep	Some	14551	Aspen Ditch-A	Very Low
					Aspen Ditch-B	Very Low
Beaver Hill	05522	Sheep	Low	05522	Beaver Hill	Moderate
Big Gulch-40	05036	Sheep	Moderate	05036	Big Gulch-40	Very Low
Canal	14012	Sheep	High	14012	Canal	High*
Coal Gulch	14517	Sheep	Low	14517	Coal Gulch-A	Very Low
					Coal Gulch-B	Very Low
Cushman	05506	Sheep	Some	05506	Cushman	High
Dave Wood Road	05518	Sheep	Low	05518	Dave Wood Road	Low
Deer Basin/Midway	14019	Sheep	Some	14019	Deer Basin/Midway-A	Moderate
					Deer Basin/Midway-B	Moderate
					Deer Basin/Midway-C	Very Low
Delta Pipeline	03277	Sheep	Some	03277	Delta Pipeline	High
Dry Cedar	05537	Sheep	Some	05537	Dry Cedar-A	Low
					Dry Cedar-B	Very Low
					Dry Cedar-C	Very Low
Highway 90	05521	Sheep	Some	05521	Highway 90	Moderate
Hubbard Creek	14516	Sheep	Low	14516	Hubbard Creek	Very Low
Lee Lands	17003	Sheep	High	17003	Lee Lands-A	High*
					Lee Lands-B	Moderate
Leopard Creek	07205	Sheep	High	07205	Leopard Creek	High*

Table K-9
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	POIM Results#	Allotment Number	RoC Allotment Name	RoC Results@
Log Hill	05529	Cattle or Sheep	Some	05529	Log Hill	Very Low
Lower Horsefly Combined	05520	Sheep	Low	05520	Lower Horsefly-A	Very Low
					Lower Horsefly-B	Low
					Lower Horsefly-C	Very Low
				05519	Simms Mesa-A	Very Low
					Simms Mesa-B	Very Low
McDonald Creek	14532	Sheep	Some	14532	McDonald Creek	Very Low
Muddy Creek	14519	Sheep	Low	14519	Muddy Creek	Very Low
Onion Lakes	05533	Cattle or Sheep	Some	05533	Onion Lakes	Moderate
Petrie Mesa	14022	Sheep	Some	14022	Petrie Mesa	High
Point Creek	14021	Sheep	Some	14021	Point Creek	High
Rawhide/Coffee Pot	05034	Sheep	Moderate	05034	Rawhide/Coffee Pot-A	Very Low
					Rawhide/Coffee Pot-B	Very Low
					Rawhide/Coffee Pot-C	High*
Sandy Wash	05502	Sheep	Some	05502	Sandy Wash	High
Shavano Mesa	05511	Sheep	Some	05511	Shavano Mesa	Some
Shinn Park/South Canal	05534	Cattle	Some	05534	Shin Park	Moderate
Shinn Park	05534	Sheep	Moderate			
South of Town	14534	Sheep	Moderate	14534	South of Town	Very Low
Tappan Creek	05575	Sheep	Low	05575	Tappan Creek-A	Very Low
					Tappan Creek-B	Very Low
Wells Gulch	14016	Sheep	Moderate	14016	Wells Gulch	High

#Using ArcGIS , natural breaks in the data were determined using the Natural Breaks option for displaying graduated color groups (Jenks 1967; Esri 2012), with four categories for those allotments falling within 9 miles of bighorn sheep habitat in the UFO**:** High, Moderate, Some, and Low.
@High—Intersects with bighorn sheep range or disease contact less than 25 years (assume 1:4 contacts results in disease event); Moderate—disease contact 25-50 years; Some—disease contact 50-75 years; Low—disease contact 75-100 years; Very Low—disease contact greater than 100 years.
*Allotments intersect the CHHR for RoC model.
^This is a proposed allotment in the RMP that was not included in the RoC model effort.

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
Adobe	05027	Cattle	Moderate	05027	Adobe	Very Low
Alder Creek	17253	Cattle	High	17253	Alder Creek-A	Very Low
					Alder Creek-B	Very Low
Allen Reservoir	05050	Cattle	Moderate	05050	Allen Reservoir	Very Low
Anthracite Creek	14525	Cattle	Some	14525	Anthracite Creek	Some
Bald Hills	05510	Cattle	Some	05510	Bald Hills	Moderate
Baldy	05568	Cattle	High	05568	Baldy	High*
Barkelew Draw Com	07303	Cattle	Low	07303	Barkelew Draw Com	Very Low
Beaver Canyon	17060	Cattle	Some	17060	Beaver Canyon	Moderate
Beaver Rim	07204	Horse	Low	07204	Beaver Rim	Some
Ben Lowe	14013	Cattle	Moderate	14013	Ben Lowe	High*
Big Bear Creek	07207	Cattle	Moderate	07207	Big Bear Creek-A	Moderate
					Big Bear Creek-B	Low
Big Bucktail	17061	Cattle	Low	17061	Big Bucktail	Very Low
Big Gulch	03630	Cattle	Some	03630	Big Gulch-A	Very Low
					Big Gulch-B	Very Low
Big Pasture	05044	Cattle	Moderate	05044	Big Pasture	Low
Black Bullet	05045	Cattle	Moderate	05045	Black Bullet	Very Low
Blue Cimarron	03642	Cattle	Moderate	03642	Blue Cimarron	Low
Bolinger Ditch	07219	Cattle	Low	07219	Bolinger Ditch	Very Low
Bramier Draw	07235	Cattle	Low	07235	Bramier Draw	Very Low
Broad Canyon	17199	Cattle	Low	17199	Broad Canyon	Very Low
Buck	07232	Cattle or Horse	Low	07232	Buck	Very Low
Buckeye	17033	Cattle	Some	17033	Buckeye	High*
Burn Canyon	17022	Cattle	Low	17022	Burn Canyon	Very Low
Burro Creek	05556	Cattle	Some		Burro Creek	^
Burro Ridge	05532	Cattle	Some	05532	Burro Ridge	High
Busted Boiler	03648	Cattle	Low		Busted Boiler	^
Carpenter Ridge Com	17100	Cattle	Moderate	17100	Carpenter Ridge Com	High*
Horse Bench	03634	Cattle	Moderate	03634	Carpenter Ridge Com/Horse Bench	High*
Cedar	05570	Cattle	Some	05570	Cedar	Very Low
Cedar Creek	05535	Cattle	Moderate	05535	Cedar Creek-A	Low
					Cedar Creek-B	Very Low
Chaffee	00019	Cattle	Some	00019	Chaffee	Low
Chaffee Gulch	05528	Cattle	Some	05528	Chaffee Gulch	Very Low
Cimarron 40	03658	Cattle	Moderate	03658	Cimarron 40	Moderate
Cimarron Stock Driveway	03650	Cattle	High	03650	Cimarron Stock Driveway	High*
Coal Canyon	17107	Cattle	Low	17107	Coal Canyon	Very Low

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
Coal Creek	05509	Cattle	Some	05509	Coal Creek	Very Low
Coke Ovens	17027	Cattle	Some	17027	Coke Ovens	Moderate
Collins	05043	Cattle	Moderate	05043	Collins	Very Low
Cone	03635	Cattle	Some		Cone	^
Cookie Tree	05560	Cattle	Moderate		Cookie Tree	^
Coventry	07222	Cattle	Low	07222	Coventry	Low
Cow Creek	05566	Cattle	High	05566	Cow Cr	High*
Crawford Reservoir	05018	Cattle	Some	05018	Crawford Reservoir	Very Low
Creek Bottom	03632	Cattle	Low		Creek Bottom	^
Cut Off	05052	Cattle	Some	05052	Cut Off	Very Low
Davis Mesa	17037	Cattle	Moderate	17037	Davis Mesa	High*
Deep Creek	14524	Cattle	Low	14524	Deep Creek	Very Low
Dexter Creek	05551	Cattle	High	05551	Dexter Creek	High*
Dirty George	14023	Cattle	Low	14023	Dirty George	Very Low
Doby Canyon	17042	Cattle	Low	17042	Doby Canyon	Very Low
Dolores Canyon	17004	Cattle	High	17004	Dolores Canyon	High*
Doug Creek	05028	Cattle	Some	05028	Doug Creek	Very Low
Downing	05541	Cattle	Some	05541	Downing	Very Low
Dry Creek	14549	Cattle	Low	14549	Dry Creek	Very Low
Dry Creek Basin	05513	Cattle	Some	05513	Dry Creek Basin	High
Dry Creek Place	05525	Cattle or Horse	Some	05525	Dry Creek Place	Very Low
Dry Gulch	05540	Cattle	Some	05540	Dry Gulch	Very Low
Dry Park	07300	Cattle	Low	07300	Dry Park	Very Low
Duroy	03637	Cattle	Moderate		Duroy	^
E Fork Dry Creek	05514	Cattle	Some	05514	E Fork Dry Creek	Low
E Gould Reservoir	05041	Cattle	Moderate	05041	E Gould Reservoir	Very Low
E Paradox Com	17101	Cattle	Moderate	17101	E Paradox Com-A	High*
				17101	E Paradox Com-B	Moderate
E Roatcap Ind	14512	Cattle	Low	14512	E Roatcap Ind	Very Low
Far Away	17213	Cattle	Low	17213	Far Away	Very Low
Feedlot	17078	Cattle	Moderate	17078	Feedlot	High*
Fire Mountain Canal	14508	Cattle	Moderate	14508	Fire Mountain Canal	Very Low
Flatiron	05501	Cattle	Moderate	05501	Flatiron	High
Franklin Mesa	05512	Cattle	Some	05512	Franklin Mesa	Moderate
Gravel Pit	07063	Cattle	Low	07063	Gravel Pit	Very Low
Green	05503	Cattle	Some	05503	Green	Moderate
Hairpin	05569	Cattle	Moderate	05569	Hairpin	Very Low
Hamilton Mesa	07209	Cattle	Low	07209	Hamilton Mesa	Very Low
High Park	05549	Cattle	Moderate	05549	High Park	Very Low
Hillside	05562	Cattle	High	05562	Hillside	Very Low*

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
Home Ranch	07201	Cattle	Low	07201	Home Ranch	Very Low
Horsefly	05523	Cattle	Some	05523	Horsefly%	Very Low
Horsefly (W)	05523	Cattle	Some			
Horsefly Com	07301	Cattle	Low	07301	Horsefly Com	Very Low
Houser	07076	Cattle	Some	07076	Houser	High
Jumbo Mountain	14527	Cattle	Low	14527	Jumbo Mountain	Very Low
Juniper Knob	14505	Cattle	Some	14505	Juniper Knob	Very Low
Kinnikin	03643	Cattle	Some		Kinnikin	^
La Sal Creek	17011	Cattle	High	17011	La Sal Creek	High*
Lavender	07075	Cattle	Moderate	07075	Lavender	High
Lee Bench	14011	Cattle	Moderate	14011	Lee Bench	Some
Leroux	14550	Cattle	Some	14550	Leroux	Very Low
Leroux Creek	14504	Cattle	Some	14504	Leroux Creek	Very Low
Lillylands/West	17024	Cattle	Low	17024	Lillylands/West	Low
Lion Canyon	17012	Cattle	Moderate	17012	Lion Canyon	High*
Lion Creek Basin	17044	Cattle	Some	17044	Lion Creek Basin	High*
Little Baldy	07223	Cattle	Some	07223	Little Baldy	Very Low
Little Maverick Draw	07210	Cattle	Low	07210	Little Maverick Draw	Very Low
Log Hill	05529	Cattle or Sheep	Some	05529	Log Hill	Very Low
Lower Beaver Canyon	07211	Cattle	Low	07211	Lower Beaver Canyon	Very Low
Lower Hamilton	07234	Cattle	Low	07234	Lower Hamilton	Very Low
Lower Pinion	07213	Cattle	Low	07213	Lower Pinion	Very Low
Lower Roc Creek	07216	Cattle	High	07216	Lower Roc Creek	Low
Lower Roubideau Canyon	05000	Cattle	High	05000	Lower Roubideau Canyon	High*
Mailbox Park	17001	Cattle	Low	17001	Mailbox Park-A	Very Low
					Mailbox Park-B	Very Low
Maverick Draw	17018	Cattle	Low	17018	Maverick Draw	Very Low
McKee Draw	07206	Cattle	Some	07206	McKee Draw	Very Low
McKee Draw (E)	07206	Cattle	Some	07206	McKee Draw	Very Low
Mesa Creek	17014	Cattle	Moderate	17014	Mesa Creek-A	High*
					Mesa Creek-C	High*
Mesa Cr/First Park	03645	Cattle	Low		Mesa Creek-B	Some
Middle Hamilton Lse	07233	Cattle	Low	07233	Middle Hamilton Lse	Very Low
Milk Creek	14544	Cattle	Low	14544	Milk Creek	Very Low
Moonshine Park	05563	Cattle	High	05563	Moonshine Park	High*
Moonshine Park (N)	05563	Cattle	High	05563	Moonshine Park	High*
Morrow Point	03631	Cattle	High		Morrow Point	High*
Mud Springs	07230	Cattle	Low	07230	Mud Springs	Very Low

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
North Saddle Peak	14540	Cattle	Low	14540	N Saddle Peak	Very Low
North Wickson Draw	17023	Cattle	Low	17023	N Wickson Draw	Very Low
Naturita Canyon	07203	Cattle	Low	07203	Naturita Canyon-A	Very Low
					Naturita Canyon-B	Very Low
					Naturita Canyon-C	Very Low
					Naturita Canyon-D	Very Low
					Naturita Canyon-E	Very Low
					Naturita Canyon-F	Very Low
Naturita Ridge	17035	Cattle	Some	17035	Naturita Ridge	High
Needle Rock Allotment-not ACEC	14542	Horse	Low	14542	Needle Rock	Very Low
Norwood Hill	07218	Cattle	Low	07218	Norwood Hill	Very Low
Nyswanger	17082	Cattle	High	17082	Nyswanger	High*
Oak Hill	07225	Cattle	Low	07225	Oak Hill	Very Low
Oak Hill 40	03644	Cattle	Some		Oak Hill 40	^
Oak Mesa	14506	Cattle	Some	14506	Oak Mesa	Very Low
Oak Ridge Com	14528	Cattle	Low	14528	Oak Ridge Com	Very Low
Onion Lakes	05533	Cattle or Sheep	Some	05533	Onion Lakes	Moderate
Overland	14511	Cattle	Low	14511	Overland	Very Low
Park	17030	Cattle	Some	17030	Park	Very Low
Parkway	17062	Cattle	Low	17062	Parkway	Very Low
Piney	05516	Cattle	Some	05516	Piney	High
Pinion	03641	Cattle	Low		Pinion	^
Pipeline	05507	Cattle	Some	05507	Pipeline	High
Pocket Ind	17085	Cattle	Moderate	17085	Pocket Ind	High*
Popp Ranch	14531	Cattle	Some	14531	Popp Ranch	Very Low
Radio Tower	02660	Cattle	Low	02660	Radio Tower	Very Low
Ragsdale	03708	Cattle	Low		Ragsdale	^
Rawlings Ind	17021	Cattle	Moderate	17021	Rawlings Ind	High*
Ray (Wray) Mesa	03298	Cattle	Moderate	03298	Ray (Wray) Mesa	High*
Redvale	07227	Cattle	Low	07227	Redvale	Very Low
Reynolds/McDonald	14530	Cattle	Some	14530	Reynolds/ McDonald-A	Very Low
					Reynolds/ McDonald-B	Low
Ridgway Reservoir	00001	Cattle	Moderate		Ridgway Reservoir	^
Rim Rock	05051	Cattle	High	05051	Rim Rock	High*
Smith Fork Rim	03526	Cattle	High	03526	Smith Fork Rim	High*
River	17079	Cattle	High	17079	River	High*
River Allotment	07200	Cattle	Low	07200	River Allotment	Low

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
Roatcap	05504	Cattle	Moderate	05504	Roatcap	Moderate
Roatcap/Jay Creek	14507	Cattle	Some	14507	Roatcap/Jay Creek	Very Low
Roc Creek	17020	Cattle	High	17020	Roc Creek	High
Rock Ditch	05538	Cattle	Low	05538	Rock Ditch	Very Low
Round Top	00002	Cattle	Moderate		Round Top	^
Rowher Canyon	17080	Cattle	Moderate	17080	Rowher Canyon	High*
S Dry Creek	14548	Cattle	Some	14548	S Dry Creek	Very Low
South Piney	05515	Cattle	Some	05515	S Piney-A	
					S Piney-B	High
San Miguel Rim	03639	Cattle	Low		San Miguel Rim	^
San Miguel River	03640	Cattle	Low		San Miguel River	^
Saw Pit	03636	Cattle	Moderate		Saw Pit	^
Sawtooth	17032	Cattle	Some	17032	Sawtooth	High*
Second Park	17105	Cattle	Some	17105	Second Park	
Section 35	14547	Cattle	Some	14547	Section 35	Very Low
Sewemup	03646	Cattle	High		Sewemup	^
Shinn Park/South Canal	05534	Cattle	Some	05534	Shin Park	Moderate
Shinn Park	05534	Sheep	Moderate			
Slagle Pass	05547	Cattle	Moderate	05547	Slagle Pass	Moderate
Slaugher Grade	03651	Cattle	Low		Slaugher Grade	^
Smith Fork Ind	05049	Cattle	Moderate	05049	Smith Fork Ind	Very Low
South Branch	14004	Cattle	Low	14004	South Branch	Very Low
Spring Creek	05517	Cattle	Low		Spring Creek	^
Spring Creek Canyon	03659	Cattle	Low		Spring Creek Canyon	^
Spring Creek and Highway 90	03638	Cattle	Moderate	03638	Spring Creek and Highway 90	High*
Spring Gulch	05029	Cattle	High	05029	Spring Gulch	High
Stevens Gulch Com	14513	Cattle	Low	14513	Stevens Gulch Com	Very Low
Stingley Gulch	14503	Cattle	Some	14503	Stingley Gulch	Very Low
Stock Driveway	14521	Cattle	Some	14521	Stock Driveway	Very Low
Sundown	03633	Cattle	High	03633	Sundown	High*
Sunrise Gulch Com	17102	Cattle	High	17102	Sunrise Gulch Com	High*
Sunshine Mesa	14541	Cattle	Some	14541	Sunshine Mesa	Very Low
Swain Bench	17081	Cattle	Moderate	17081	Swain Bench	High*
Tabeguache Creek	17031	Cattle	Some	17031	Tabeguache Creek	High
Taylor Draw	05555	Cattle	Moderate	05555	Taylor Draw	Moderate
Third Park Com	17103	Cattle	Some	17103	Third Park Com	Some
Tinkler Ind	05530	Cattle	Low	05530	Tinkler Ind	Very Low
Transfer Road	05505	Cattle	Some	05505	Transfer Road	High
Tuttle Draw	17106	Cattle	Some	17106	Tuttle Draw	Moderate
Twenty Five Mesa N	14008	Cattle	High	14008	Twenty Five Mesa N	High*

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
Twenty Five Mesa N (proposed)	14008	Cattle	Moderate	14008	Twenty Five Mesa N	^
Twenty Five Mesa S	07008	Cattle	Low	07008	Twenty Five Mesa S-A	Very Low
					Twenty Five Mesa S-B	Very Low
Uncompahgre Bench	07007	Cattle	Some	07007	Uncompahgre Bench	Some
Uncompahgre Com	07302	Cattle	Some	07302	Uncompahgre Com-A	Very Low
					Uncompahgre Com-B	Very Low
					Uncompahgre Com-C	Very Low
					Uncompahgre Com-D	Moderate
					Uncompahgre Com-E	Some
Upper Mail Box	07208	Cattle	Low	07208	Upper Mail Box	Low
Upper Maverick Draw	07202	Cattle	Low	07202	Upper Maverick Draw	Very Low
Upper Terror Creek	14514	Cattle	Low	14514	Upper Terror Creek	Very Low
W Roatcap	14510	Cattle	Low	14510	W Roatcap	Very Low
W Stevens Gulch	14515	Cattle	Low	14515	W Stevens Gulch	Very Low
W Youngs Peak	14536	Cattle	Some	14536	W Youngs Peak	Very Low
Wakefield	03628	Cattle	Low		Wakefield	^
Ward Creek-Doughspoon	14025	Cattle	Some	14025	Ward Cr/Doughspoon	High
Ward Creek-Doughspoon (south)	14025	Cattle	Some	14025	Ward Creek/Doughspoon	High
Washboard Rock	05548	Cattle	Moderate	05548	Washboard Rock-A	Some
Waterdog Basin	05546	Cattle	Some	05546	Waterdog Basin	Very Low
Weimer Hill Place	03660	Cattle	Low		Weimer Hill Place	^
White Ranch	14015	Cattle	Moderate	14015	White Ranch	High
White Ranch (proposed)	14015	Cattle	Moderate	14015	White Ranch	High
Wickson Draw	17010	Cattle	Low	17010	Wickson Draw	Low
Wilbanks	14502	Cattle	Low	14502	Wilbanks-A	Very Low
					Wilbanks-B	Very Low
Williams Creek	14523	Cattle	Low	14523	Williams Creek	Very Low
Williams Ditch	07220	Cattle	Low	07220	Willims Ditch	Very Low
Camel Back Pasture	14010	Cattle	High	14010	Winter/Monitor Mesa	High

Table K-10
Comparison of PoI Model and RoC Model Results for Bighorn Risk of Contact with Non-Domestic Sheep Allotments

PoI Model Allotment Name	Allotment Number	Type of Livestock	PoI Model Results#	Allotment Number	RoC Model Allotment Name	RoC Model Results@
Winter-Monitor Mesa	14010	Cattle	High	14010	Winter/Monitor Mesa	High*
Winter-Monitor Mesa (proposed)	14010	Cattle	High	14010	Winter/Monitor Mesa	High
Youngs Peak	14537	Cattle	Some	14537	Youngs Peak	Very Low

#Using ArcGIS , natural breaks in the data were determined using the Natural Breaks option for displaying graduated color groups (Jenks 1967; Esri 2012) with four categories for those allotments falling within 9 miles of bighorn sheep habitat in the UFO**:** High, Moderate, Some, and Low.
@High—Intersects with bighorn sheep range or disease contact less than 25 years (assume 1:4 contacts results in disease event); Moderate—disease contact 25-50 years; Some—disease contact 50-75 years; Low—disease contact 75-100 years; Very Low—disease contact greater than 100 years.
*Allotments intersect the CHHR for RoC model.
^This is a proposed allotment in the RMP that was not included in the RoC model run.
%Same as Horsefly and Horsefly (W) combined

Figure K-4. CPW Rocky Mountain Bighorn Sheep Suitable Habitat Model for RoC Analysis Area

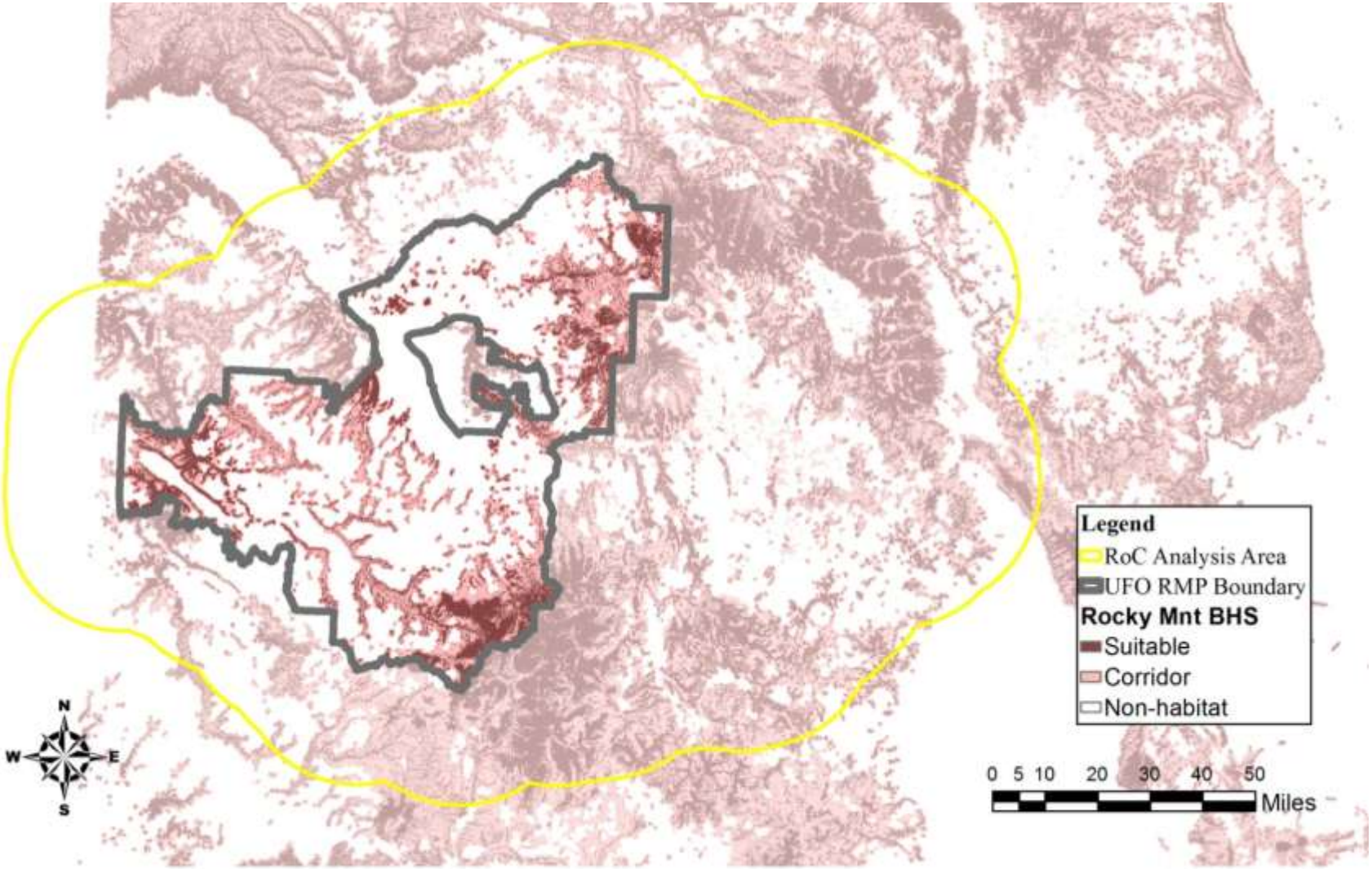


Figure K-5. CPW Desert Bighorn Sheep Suitable Habitat Model for RoC Analysis Area

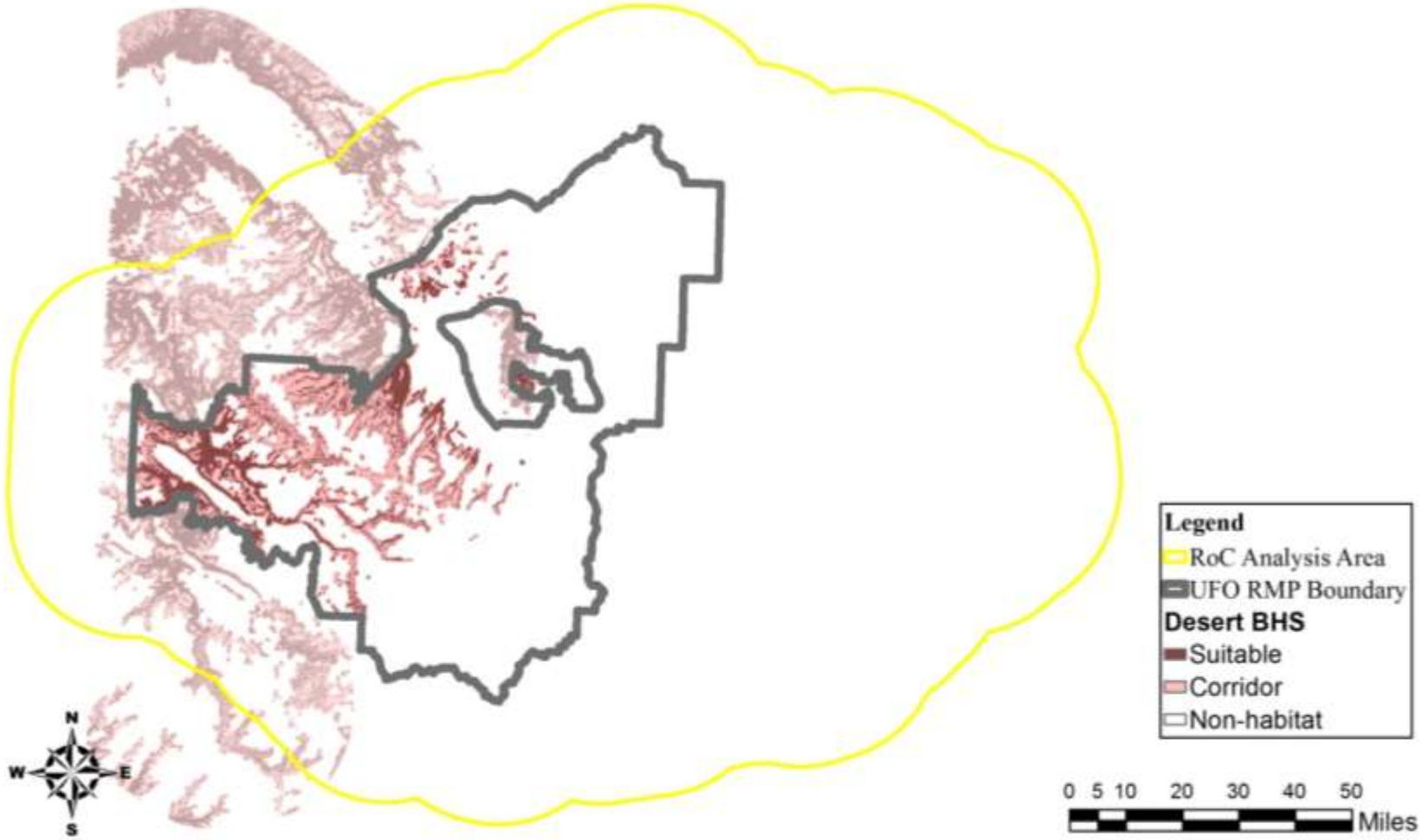


Figure K-6. Analysis Area and Bighorn Sheep Populations Used in the RoC Model

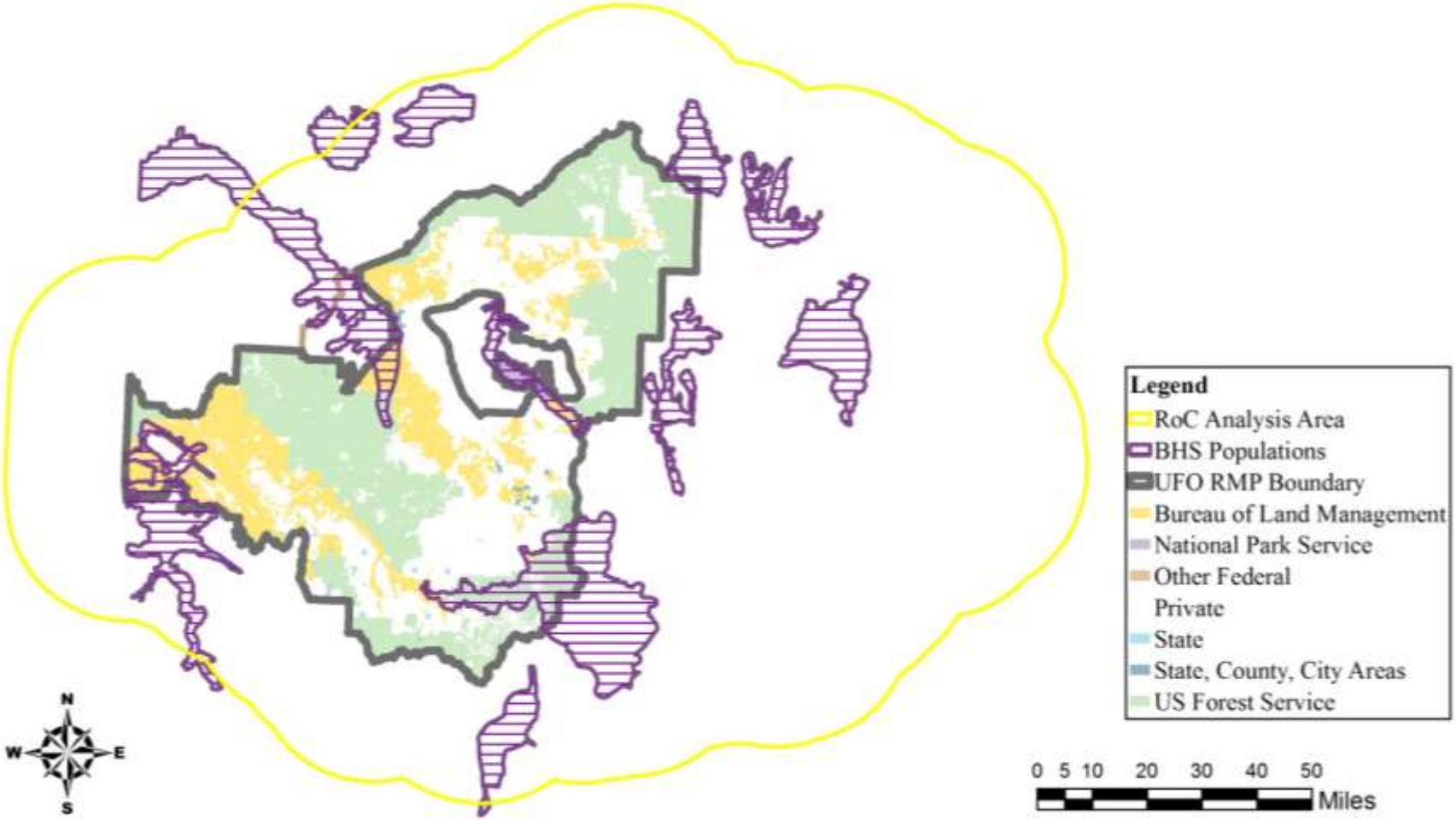
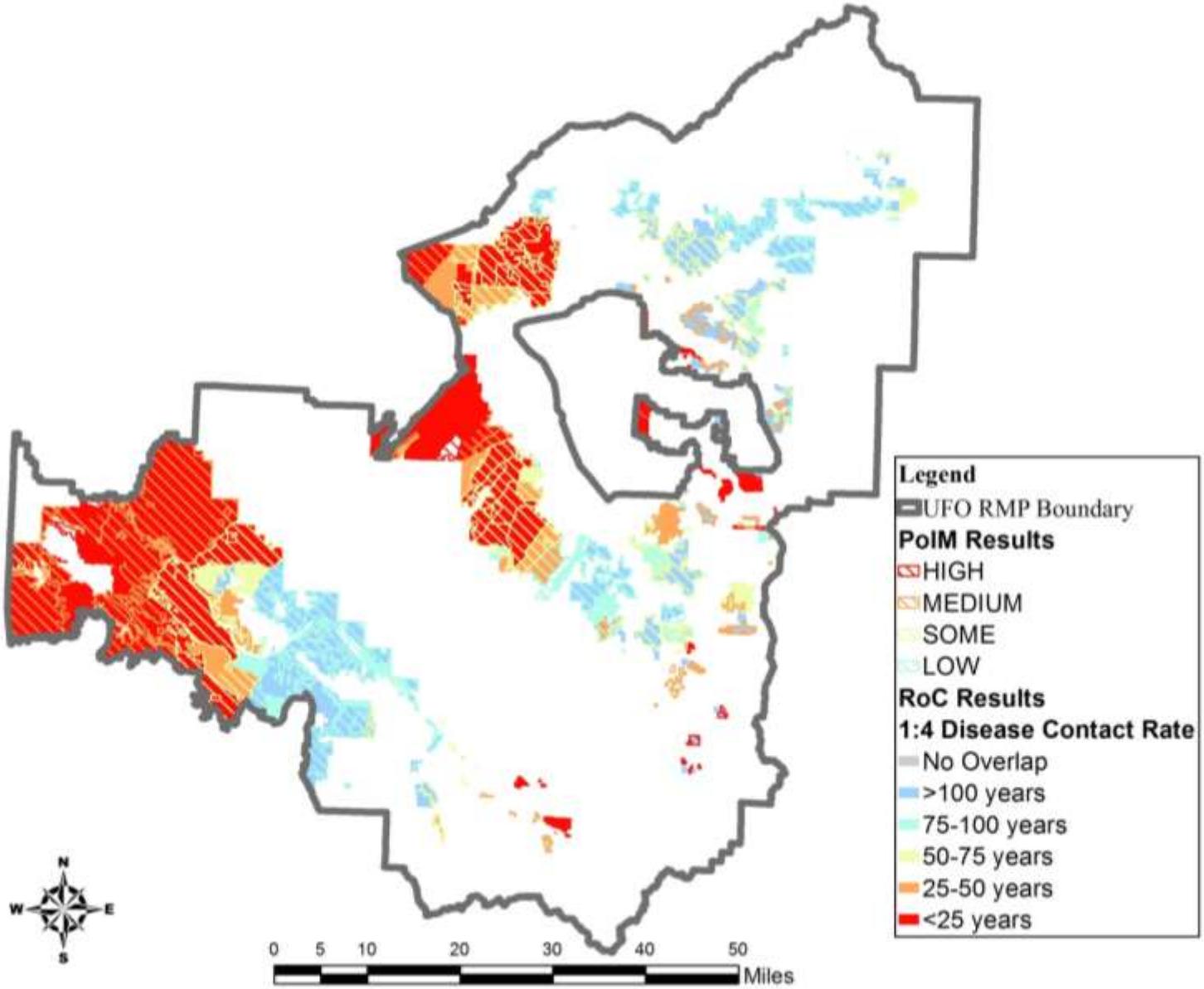


Figure K-7. Comparison of PoI Model and RoC Model Results for UFO RMP Area



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