

**Rosemont Copper Project: Potential Effects of the Rosemont Project
to Jaguar and Proposed Jaguar Critical Habitat**

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INTRODUCTION

WestLand Resources, Inc. (WestLand) was retained by Rosemont Copper Company (Rosemont) to prepare a series of technical memorandums to supplement the Biological Assessment for the Rosemont Copper Project (the Project). This memorandum analyzes the potential effects of the Project to the jaguar (*Panthera onca*) and proposed critical habitat for the jaguar (the Proposed Rule; FR 77, No. 161: 50214-50242; USFWS 2012). We begin with a discussion of potential effects to the jaguar and the consequences of these effects to jaguar populations, and then consider the potential effects to proposed jaguar critical habitat.

1. POTENTIAL EFFECTS OF THE PROJECT TO THE JAGUAR SPECIES

The Project could potentially affect the jaguar species by influencing the movement of jaguars, the biotic communities that are used by jaguars, the risk of collision with vehicles, and the prey base on which jaguars depend. We discuss each of these below.

1.1. EFFECTS ON JAGUAR MOVEMENT

One of the major potential effects of the Project to jaguars that might be using the northern Santa Rita Mountains is the disruption of movement, both within the Santa Rita Mountains and between Sky Island mountain ranges, in particular between the Whetstone and Santa Rita Mountains. We discuss the potential influence of the Project on movement both within and between mountain ranges below.

1.1.1. Movement within Santa Rita Mountains

The Project will entail a perimeter fence encompassing approximately 6,990 acres that will likely exclude jaguars from the mine site. The Project also entails a primary access road from State Route (SR) 83 and a secondary access route and utility corridor to the mine site originating west of the Santa Rita Mountains. The perimeter fence of the Project will exclude jaguars, but will not preclude individuals from moving around the Project. Thus, the perimeter fence will not preclude the movement of jaguars within the northern Santa Rita Mountains.

The secondary access road and associated utility corridor will extend west of the mine site to the Santa Rita Experimental Range. The secondary access road is expected to be used sparingly and be associated with minimal traffic volumes. Male jaguars, the only sex known to be present in the U.S., readily cross roads with low traffic volumes in other portions of their range (Cochero et al. 2010). There are also numerous Forest Service roads that already exist in the vicinity of the Project and are heavily used by off-highway vehicles (OHV) (USDA 2011). These roads include Box Canyon Road, which traverses the northern Santa Rita Mountains, and would have to be crossed by any jaguar moving between the southern and northern Santa Rita Mountains. Moreover, one of the identified critical habitat units (Unit 3) of the proposed jaguar critical habitat designation is bisected by a section of State Route (SR) 82 (USFWS 2012) with daily traffic volumes of 2,100 vehicles (<http://www.azdot.gov/mpd/data/aadt.asp>), far more than traffic levels anticipated for the secondary access road. USFWS also identified proposed critical

habitat Subunit 4b specifically to benefit the movement of jaguars (USFWS 2012). Yet, the entire width of this subunit is crossed by a section of SR 83 associated with daily traffic volumes of 2,300 vehicles (<http://www.azdot.gov/mpd/data/aadt.asp>). As such, the implicit conclusion by USFWS is that roads with these traffic volumes do not preclude, and may not negatively affect, the movement of jaguars. Thus, it is unlikely the secondary access road will affect jaguar movement more than the roads that already exist within and surrounding the northern Santa Rita Mountains.

The utility corridor will consist of a buried waterline and an overhead powerline. Temporary surface disturbances will be associated with the buried waterline, but these disturbances are unlikely to have a negative effect on jaguar movement after construction. Overhead powerlines that traverse the northern Santa Rita Mountains currently exist, such that any jaguars moving between the southern and northern Santa Rita Mountains would have to cross underneath powerlines under current conditions. In addition, in the proposed critical habitat designation for jaguars, USFWS included a subunit (Subunit 4b) specifically to benefit jaguar movement. The entire width of this subunit is crossed by large overhead powerlines. Thus, using the implicit conclusion by USFWS, these types of overhead powerlines do not preclude, and may not negatively affect, the movement of jaguars.

A portion of the primary access road between SR 83 and the mine facilities is outside of the perimeter fence. Traffic predictions estimate that, under the no carpool-scenario, a maximum of approximately 800 trips per day would occur on the primary access road. This estimate is less than one-half of the existing daily traffic volumes on any stretch of SR 83 between Interstate 10 (I-10) and Sonoita, Arizona (2,300-3,200 vehicles <http://www.azdot.gov/mpd/data/aadt.asp>). Daily traffic volume is of particular interest, as USFWS has implicitly concluded in the proposed jaguar critical habitat designation that traffic volumes of this magnitude do not preclude jaguar movement (see above). Thus, while the short stretch of primary access road from SR 83 to the mine facilities may affect jaguar movement, it is unlikely to preclude movement of jaguars within the northern Santa Rita Mountains.

1.1.2. Movement between the Whetstone and Santa Rita Mountains

The Project could impact the movement of jaguars between Sky Island mountain ranges. For this discussion we focus mainly on movement between the Santa Rita and Whetstone Mountains, as these ranges are where jaguars have been recently documented. Below we analyze the potential direct and indirect effects of the Project on movement between these two mountain ranges.

1.1.2.1. Indirect Impacts

Possible indirect influence on movement between the Santa Rita and Whetstone Mountains as a consequence of the Project include increased traffic along SR 83 and increased light from mining operations. Jaguars, particularly males, appear to have a tolerance for a broad array of land cover types (e.g., Boydston and Lopez-Gonzalez 2005), and much of the Santa Rita Mountains and the surrounding areas have been modeled as suitable habitat for jaguar movement (Beier et al. 2006). As such, impacts to vegetation outside of the perimeter fenceline as a result of the Project are not expected to influence jaguar

movement appreciably. The indirect impact from increased lighting on jaguar movement is discussed under separate cover, and the impacts of increased traffic are discussed in Sec. 1.3.

1.1.2.2. Direct Impacts

The major direct impact that the Project could have on jaguar movement between the Santa Rita and Whetstone Mountains is by physically interrupting potential movement corridors between the two mountain ranges. To our knowledge there are no empirical data that can be used to inform where and how jaguars might move between the Santa Rita and Whetstone Mountains. However, there are models informed by jaguar biology that are available to determine the optimal location of a movement corridor between these mountain ranges.

Using expert opinion and information on jaguar movement, Beier et al. (2006) used a GIS modeling approach to identify a “biologically-best” corridor for jaguars between the Whetstones and the Santa Rita Mountains. This model combines expert opinion and available scientific literature on jaguars to produce a habitat suitability landscape specifically for jaguar movement. This landscape is based on scoring by these experts in reference to how jaguar movement is influenced by land cover, distance to roads, elevation and topography. Using this habitat suitability landscape, the GIS model calculates the least cost, or “biologically-best,” movement corridor for jaguars between the Santa Rita and Whetstone Mountains (see Figure 33 in Beier et al. 2006).

We replicated the approach of Beier et al. (2006) to simulate the effect of the Project on a jaguar movement corridor. We first modeled a least cost movement corridor between the Santa Rita and Whetstone Mountains using the corridor design model developed at Northern Arizona University (see corridordesign.org), without simulating the Project. The model uses ESRI ArcGIS software to delineate corridors between wildlife habitats based on preferred habitat conditions. Habitat conditions used to determine the jaguar corridor were first ranked by expert opinion then weighted as follows; land cover 60 percent, elevation 5 percent, topography 15 percent, and distance from roads 20 percent. The variables were then combined to create a habitat suitability map. The model then identifies the least cost corridor for movement between habitat blocks. Following the approach taken by Beier et al. (2006), we used the boundaries of the Coronado National Forest in each mountain range as habitat blocks between which a movement corridor was modeled. The resulting jaguar movement corridor (using the 1% of the landscape with the lowest travel cost) is similar to the corridor identified by Beier et al. (2006) (*Figure 1*)¹.

We then simulated the lands within the perimeter fence line of Project as “recently mined or quarried,” a land cover type avoided by jaguars (see Beier et al. 2006). The results of this simulation demonstrates that the modeled movement corridor is not sensitive to the potential disturbance caused by the proposed mine; the modeled corridor is unchanged and still provides a connection between the Whetstone and Santa Rita Mountains (*Figure 2*). Thus, this simulation provides evidence that the Project will not have a demonstrative effect on jaguar movement between the Whetstone and Santa Rita Mountains, using the

¹ Note that in contrast to Beier et al. (2006), we did not perform any post-hoc adjustments to the resulting corridors, as these adjustments entail substantial subjectivity.

boundaries of the Coronado National Forest as habitat blocks. In Sec. 3.2.5., we model movement between proposed critical habitat units to inform the effects of the Project on jaguar movement using different boundaries for habitat blocks.

1.2. EFFECTS TO BIOTIC COMMUNITIES USED BY JAGUARS

Based on jaguar records, USFWS identifies semi-desert grassland and Madrean evergreen woodland as the main biotic communities that support jaguars in the U.S. (USFWS 2012). The perimeter fence line of the Project will exclude approximately 6,990 acres of semi-desert grassland and Madrean woodland from use by jaguars that might occur in the area. This effect will be temporary, however, as reclamation of disturbed areas other than the pit and the removal of the perimeter fence line following mine closure will result in the availability of approximately 6,200 acres of the 6,990 acres over the long-term. The amount of habitat that will be lost temporarily is small relative to the amount potentially available for use by jaguars. For example, this temporal loss represents less than 0.05 percent of the 15-21 million acres of Arizona that is purported to be suitable for jaguars (Hatten et al. 2005).

The Project could also affect the biotic communities in the vicinity of the mine by increasing fugitive dust levels. Fugitive dust could impact the health of upland vegetation, but these impacts are expected to attenuate as distance from dust sources increases. Thus, dust is expected to have minimal impact on vegetation far from dust sources, and little impact on vegetation outside of the perimeter fence line. Semi-desert and Madrean woodland biotic communities in the vicinity of the Project are also not associated with dense stand of vegetation with high canopy cover, such that incremental increases in fugitive dust may have minimal effects on the vegetation characteristics of the community as a whole. In particular, it is unlikely that fugitive dust will impact vegetation to such a degree that canopy cover diminishes below the three percent threshold established as important for jaguar critical habitat (USFWS 2012). Moreover, because of OHV and other recreational uses in the vicinity of the Project (USDA 2011), the baseline levels of fugitive dust have likely already had an effect on vegetation in the vicinity.

Two main sources of dust are associated with the Project: the plant site and the tailings impoundments. While the dust sources associated with the plant site could negatively impact vegetation in the proximity of the mine facilities, it is unlikely that dust levels from these sources will be so high over baseline levels as to cause substantial impacts on vegetation outside of the perimeter fence line. The drystack tailings technique has certain advantages over conventional tailings impoundments that will minimize the amount of dust from tailings. These include the minimization of the separation of fine sediments and the ability to immediately access deposited tailings to compact and treat tailings to reduce fugitive dust levels. Thus, the design of the tailings impoundments would reduce the risk of high levels of fugitive dust affecting vegetation in the areas surrounding the Project to such an extent as to prevent jaguars from using these areas.

Groundwater withdrawal as a result of the Project could also potentially impact vegetation in the vicinity of the Project. However, the biotic communities associated with jaguar records, semi-desert grasslands and Madrean evergreen woodland, contain plant species that are largely dependent on precipitation events

as a source of water rather than consistent shallow groundwater levels. Thus, groundwater drawdown resulting from Project activities will likely not negatively impact vegetation to an extent that the area could no longer be used by jaguars.

Groundwater drawdown and surface water impoundments as a result of the Project could impact the amount and persistence of surface water resources, (i.e., stock tanks and springs) that currently exist in the vicinity of the Project. These impacts in relation to jaguars and proposed jaguar critical habitat are discussed in Sec. 3.2.2.

1.3. EFFECTS OF INCREASED TRAFFIC VOLUMES

The increase in traffic volume along SR 83 associated with the Project could increase the risk of direct mortality of jaguars as a result of collisions with vehicles. Traffic as a result of the Project is predicted to increase by approximately 804 daily trips by commuters and truck shipments. The increase of 804 trips is 35 percent of the current 2,300 daily traffic volume along the stretch of SR 83 and 27 percent of the predicted traffic volume in 2030 (<http://www.azdot.gov/mpd/data/aadt.asp>). This increase assumes no carpooling by commuting workers, and thus represents the maximum potential increase in traffic from the Project. While an increase in traffic volumes might increase the risk of mortality for both jaguars and their prey species attempting to move across SR 83, it is important to note that the relationship between traffic volume and road kills is nonlinear (see Huijser et al. 2007), and not simply dependent on an increase in traffic. High traffic volumes could result in a lower risk of mortality because higher traffic volume can act as a repellent, pushing animals away from roads. This phenomenon is seen in deer (Bissonette and Kassar 2008), a common prey species for jaguar. Thus, it remains unclear how relevant an increase in 804 trips per day along SR 83, most of which will occur within a two-hour window associated with shift changes (USDA 2011), is to the biology of jaguars that might occur in the northern Santa Rita Mountains.

1.4. EFFECT OF INCREASED NOISE

There will be increased noise associated with the Project due to construction noise, intermittent machinery noise, and increased traffic on SR 83. We do not consider the effect of blasting noise on jaguars because it will be infrequent (no more than once per day).

Much of the maximal intermittent equipment noise associated with the Project will be within the perimeter fence line, with the exception of low noise contours (30-40 dBA) that extend to the south across Box Canyon Road (Tetra Tech 2009). Thus, a considerable portion of the increased sound is predicted to occur within the fence line, an area we already consider as temporarily unavailable to jaguars. Noise levels associated with increased traffic volumes on SR 83 are predicted to increase, but may be indiscernible from background levels (i.e. a less than 3 dBA difference) (Tetra Tech 2009). For humans, an increase of 3 dBA is thought to be the threshold at which a change will be noticed for a sound with the same frequency content or timbre (FHWA 1980). How a jaguar that might occur in the northern Santa Rita Mountains will perceive the incremental increases in noise, however, remains unclear.

1.5. EFFECTS ON JAGUAR PREY BASE

There will be a reduction of approximately 6,990 acres in habitat available for prey species of the jaguar as a result of the perimeter fenceline associated with the Project. In addition, groundwater drawdown could impact a number of water resources in the vicinity of the Project. The density of prey species of jaguar that rely on these water features could be reduced as a result, in turn negatively affecting jaguars. However, many surface water features that are not dependent on regional groundwater (e.g., stock tanks) will not be affected by the Project (see Sec 3.2.2.) and will continue to support prey species of jaguars in the northern Santa Rita Mountains. In addition, Rosemont has proposed conservation measures to replace lost water features resulting from the Project with man-made water features that will benefit both jaguars and their prey base by providing access to water sources throughout the northern Santa Rita Mountains (USDA 2012).

2. CONSEQUENCES OF POTENTIAL EFFECTS TO JAGUARS AT THE POPULATION LEVEL

In the preceding section, we discussed the potential effect of the Project on jaguars that might occur in the vicinity of the Project. While there are potential impacts to individual jaguars as a result of the Project, the impacts to individual jaguars have little influence at the population level. In this section we discuss the low probability of female jaguars reaching the U.S. in the near future and model the importance of male jaguars to the persistence and growth of jaguar populations. We also provide a discussion of the likelihood that jaguars in the U.S. constitute an important and unique source of genetic material. Our results clearly indicate that effects to male jaguars that might occur in the northern Santa Rita Mountains have little impact on jaguar populations, and thus the continued existence of the species.

2.1. FEMALE DISPERSAL

In this section we focus on the discussion of the probability of dispersal of females to the U.S. from the Sonora breeding population. There are several questions that must be examined to properly inform the likelihood of female dispersal from Sonora to the U.S. First, is the Sonora population acting as a source population for dispersing females? Second, will female jaguars disperse to the U.S.? Third, does southern Arizona supply suitable habitat for females?

2.1.1. Is the Sonora Population Acting as a Source Population for Dispersing Females?

The first question we address is the ability of the Sonora population to act as a source population to generate dispersing females. There is little evidence of jaguars dispersing to the U.S. from populations within Mexico other than Sonora (Jaguar Recovery Team 2012). Therefore, the only likely corridors and dispersers are those from the Sonoran population to the United States. Studies of jaguars in Mexico indicate that the current population in Sonora is likely not larger than 150 individuals (Carrillo et al. 2007 and Rosas-Rosas et al. 2008). Despite a conservatively large assumption of 150 jaguars, Carrillo et al. (2007) and our modeling efforts (see Sec. 2.2.2.) indicate that the stochastic growth rate for the Sonora

population is negative, and that any loss of females from the population through either mortality or dispersal would further reduce population growth. These results are particularly revealing because “the strength with which a source population can supply individuals for neighboring regions is critically dependent on its intrinsic capability for growth ...” (Jaguar Recovery Team 2012, pg. 41). Thus, the findings of both modeling efforts indicate that the Sonora population is not acting as a robust source population to generate dispersing females from Sonora to the U.S.

2.1.2. Will Female Jaguars Disperse to the U.S.?

The second question we address is the likelihood of female dispersal to the U.S. Jaguar movement patterns are sex biased, with males moving farther and more often than females (Colchero et al. 2010). Movement behavior of males is also considerably less likely to be influenced by roads and anthropogenic features (Colchero et al. 2010), as is evident by the fact that all recent jaguar sightings in the U.S. (i.e. within the last 60 years) have been males. Roads and other sources of human influence, however, are a significant barrier to the movement of female jaguars (Colchero et al. 2010). Based on the movement behavior of female jaguars, it is unlikely that female jaguars would cross road barriers (including large highways with presumably high traffic volumes) or other areas of human disturbance in the over 130 miles between the Sonoran population and the northern Santa Rita Mountains.

Suitable habitat for jaguars between the Sonora population and the U.S. is fragmented and of marginal quality (Johnson et al. 2011, Recovery Team 2012), further reducing the probability of dispersal of females from Sonora to the U.S. In addition, dispersal entails a survival cost as animals move through unfamiliar territory that often contains unsuitable habitat and significant sources of direct mortality (e.g. Bowler and Benton 2005, Burgess et al. 2012). Thus, many female jaguars that do attempt to disperse from Sonora to the U.S. may not survive the journey. The fact that a general increase in human impacts across the landscape through time is correlated with a lack of female records in the U.S. lends credence to the possibility that conditions in northern Mexico may act as a barrier to female dispersal to the U.S.

2.1.3. Does Southern Arizona Supply Habitat Suitable for Females?

If female jaguars do arrive in the U.S., the habitat available must be suitable for females if they are to reside in U.S. and establish breeding territories. Some authors argue that suitable habitat for females does exist in southern Arizona and New Mexico, but note that habitat preferences differ considerably between male and female jaguars (Boydston and Lopez-Gonzalez 2005). Males tend to utilize a greater proportion of the land cover types available, especially open habitats, and can tolerate increased levels of human disturbance (Colchero et al. 2010). The lack of female detections in the U.S. may be indicative of conditions over the past 60 years that have resulted in an altered landscape whereby habitats preferred by females (e.g. forested areas, especially broad-leaf forests (Boydston and Lopez-Gonzalez 2005)) no longer occur in the U.S. in sufficient quantities to support female occupancy and breeding.

2.2. MALE JAGUARS ARE NOT ESSENTIAL TO THE SONORA POPULATION

Because only male jaguars have been detected in the U.S. over the last 60 years, and the probability of female jaguar dispersal to and successful breeding in the U.S. is low (see above), this section analyzes the importance of male jaguars to jaguar populations. First, male jaguars that might be residents in the U.S. must travel back to the closest breeding population in Sonora in order to contribute to population growth and persistence. Even if male jaguars in the U.S. are able to breed in the Sonora population, they have little influence on jaguar population dynamics, while females are the limiting factor to population growth and persistence.

2.2.1. Opportunities for Male Jaguars in the U.S. to Contribute to Breeding in Sonora

Male jaguars that are detected in the U.S. may not have the opportunity to contribute to breeding populations in Mexico, and thus to the conservation of the species. The distance between the U.S.-Mexico border and the Sonora breeding population is not trivial (130 miles; USFWS 2012), and a male jaguar traveling between these points has to traverse a considerable band of unsuitable habitat (Johnson et al 2011, Jaguar Recovery Team 2012). Moreover, jaguar experts estimate that only 45 percent of adult males are part of the breeding population for a given year due to lack of access to females or competition with established males (Carillo et al. 2007 and references therein).

2.2.2. Male Jaguars have Little Influence on Population Growth and Persistence

Similar to most species with polygynous mating systems, even if male jaguars that occur in the U.S. were able to breed in Sonora, they are expected to have little effect on growth rate or persistence of a population under normal conditions where males are not limiting. Below we use demographic data collected for the species, and discuss sensitivity analyses of demographic models that can be used to inform how the potential effects of the Project on male jaguars that might occur in the northern Santa Rita Mountains could influence the population dynamics of jaguars.

Desbiez et al. (2012) modeled a population viability analysis of jaguar populations in Brazil and concluded that, as expected, male survival was not a primary limiting factor of population growth rate. In sensitivity analyses of their base model, a valuable technique in determining which demographic or reproductive factors limit populations (Caswell 2001), the authors varied survival of juvenile, sub-adult and adult males, and females by both increasing and decreasing survival by 25 percent in each group, and varied the average litter size, percent females breeding, and the age at first reproduction of both males and females (Desbiez et al. 2012). Perturbations of male survival and age at first reproduction had no impact on the growth rate, and by extension persistence, of the population. Female survival and reproduction, however, had substantial influence on growth rate, and by extension persistence, of the population (see SOM Figure 2 in Desbiez et al. 2012). Because male survival did not significantly influence jaguar populations, the authors only analyzed the effect of hunting on females. Results of this analysis support the sensitivity analyses, indicating that increased harvest of females increased the probability of extinction of the modeled jaguar population (see Figure 1 in Desbiez et al. 2012).

A separate effort by jaguar biologists modeled the viability of jaguar populations in Mexico, including the Sonora population (Carillo et al. 2007), the probable source of the jaguars that have been documented in the U.S. (Johnson et al. 2011). In a sensitivity analysis of their base population viability model, changes to female reproductive or survival parameters greatly influenced population growth rate (Carillo et al. 2007), and by extension, persistence. In contrast, neither the number of males contributing to the gene pool nor male mortality (increasing or decreasing adult male mortality by 3.25 percent) had any influence on population growth rate (see Figures 3 and 4 in Carillo et al. 2007). In a separate analysis, population growth rate and persistence diminished only after hunting mortalities in male jaguars reached 5 percent a year (Carillo et al. 2007).

WestLand used the available data provided by Carillo et al. (2007) and Desbiez et al. (2012) to perform additional analyses on the viability and persistence of the Sonora jaguar population. We used population parameters and the frequency and effects of catastrophic events provided by Carillo et al. (2007) to model the viability of the Sonora jaguar population using the program Vortex 9.99 (Lacy et al. 2009) (see **Table I** below for parameters used in the base analysis). Environmental variation of parameters were not identified in Carillo et al. (2007); therefore we used data from Desbiez et al. (2012) to incorporate environmental variation within the model (see **Table I**). Changes in the environmental variation of parameters do not qualitatively change our results. Our models also assumed, as do models presented in Carillo et al. (2007), that the Sonoran population is effectively isolated from other jaguar populations in Mexico.

Table 1. A list of base parameter values used in the initial Population Viability Analyses (PVA). Initial values were obtained from Carillo et al. (2007). EV = environmental variation, and is expressed as a standard deviation.

Model Parameter	Base Parameter Value
Reproductive system	Polygynous
Age of first reproduction (m/f)	4/3
Maximum reproductive age	10
Maximum number of broods per year	1
Maximum number of progeny per brood	3
Sex ratio at birth	1:1
Percentage of breeding females (EV)	20%-50% (5) density dependent
Percentage of Progeny in Brood	1(45%), 2(40%), 3(15%)
Mortality in males from age 0-1 (EV)	25 (7)
Mortality in males from age 1-2 (EV)	20 (3.5)
Mortality in males from age 2-3 (EV)	35 (5)
Mortality in males from age 3-4 (EV)	25 (6)
Mortality in males from age 4+ (EV)	=10 + ((A> 8) * (6.5)/2 * (A-8))) (2)
Mortality in females from age 0-1 (EV)	25 (7)
Mortality in females from age 1-2 (EV)	20 (3.5)
Mortality in females from age 2-3 (EV)	10 (5)
Mortality in females from age 3+ (EV)	=10 + ((A> 8) *5 * (A-8))) (1.5)
Percentage of males in the breeding pool	45%
Inbreeding depression	3.14 (lethal equivalents)
Number of catastrophes	1 (drought) 20% frequency 25% reduction in reproduction 10% reduction in survival
Initial population size	150
Carrying capacity (EV)	172 (5)

Our base PVA model, without including anthropogenic effects, produced results very similar to Carillo et al. (2007). Both stochastic growth rate (-0.014 vs. -0.013) and the probability of extinction (0.136 vs. 0.112) were only slightly different in our model than in Carillo et al. (2007)². Because these models are stochastic, one would not expect to obtain exactly the same results for each model run. Based on these results, we interpret our base model to be equivalent to the base model described in Carillo et al. (2007). Using our base model, we then performed a univariate sensitivity analysis including the survival of sex and age classes by increasing or decreasing survival by five percent in each age and sex class (e.g. juvenile females, subadult males).

The results of this sensitivity analysis clearly indicate that male survival in the Sonora population has little to no influence on the growth rate (*Figure 3*), probability of extinction (*Figure 4*), and genetic

² WestLand's PVA focused on three specific results; stochastic growth rate, probability of extinction, and heterozygosity. Stochastic growth rate is modeled as the change in population size between years including stochastic environmental variation. The result is presented as a percentage, i.e. -0.014 is a decrease of 1.4 percent from one year to the next. Probability of extinction is the proportion of iterations that went extinct. WestLand ran 1000 iterations for 100 years in each model. Therefore, a probability of extinction of 0.136 indicates that 136 of 1000 iterations reached the extinction criteria (only one sex remaining) during the model run. Genetic heterozygosity in the PVA is the proportion of the original gene diversity remaining in the population following the model run. Therefore, a heterozygosity of 0.7807 indicates that on average the population lost 22 percent of its genetic diversity in 100 years.

heterozygosity (*Figure 5*) of the population. In stark contrast, population growth rate, probability of extinction and genetic heterozygosity are highly sensitive to changes in female survival of all age classes.

WestLand also used this base PVA model to perform a separate analysis of the effect of harvest on the Sonora population. We added a harvest of 3.3 percent of the entire population (males and females of all age classes) to simulate the effect of hunting on population growth, probability of extinction, and genetic heterozygosity. This initial harvest model mirrors the conditions used by Carillo et al. (2007) in their analysis of hunting on the Sonora population. Our results from the initial harvest model approximate closely the findings of Carillo et al. (2007); both stochastic growth rate (-0.038 vs. -0.039) and probability of extinction (0.638 vs. 0.684) were only slightly lower in our model. When we simulated a harvest of 3.3 percent of the female population only, results were similar to the initial harvest model (*Table 2*). However, a harvest of 3.3 percent of males had little effect on population growth rate, probability of extinction, or genetic heterozygosity (see *Table 2*). The results of our two sensitivity analyses provide further evidence that the survival of male jaguars has little influence as a limiting factor on population growth and persistence. Our findings augment results from viability analyses in Brazil and Mexico, and extend the general finding that male jaguars have little influence on population persistence and growth rate to the Sonora breeding population specifically.

Table 2. Results of the Population Viability Analysis from modeling hunting on the Sonora population. (Variables: Stoc. r=stochastic growth rate, PE =probability of extinction, H = heterozygosity).

Model	Stoc. r	PE	H
Base Sonora population (no hunting)	-0.014	0.136	0.7807
Sonora harvest (3.3%) both sexes	-0.038	0.638	0.5967
Sonora harvest (3.3%) females only	-0.038	0.645	0.6039
Sonora harvest (3.3%) males	-0.014	0.124	0.7648

2.3. MALE JAGUARS IN THE U.S. ARE NOT LIKELY TO PROVIDE UNIQUE GENETIC RESOURCES

The Proposed Rule discussion of peripheral populations of jaguars creates the impression that male jaguars in the U.S. are imperative to genetic diversity of the species by supplying unique genetic resources as a result of local adaptation to arid conditions (USFWS 2012). Below we discuss why this conclusion is unlikely.

There is no record of a current or recent (i.e. within the last 60 years) breeding population of jaguars in the U.S. Therefore, by definition, there is no population at the northernmost edge of the jaguar’s range other than the Sonora breeding population that can evolve to adapt to local environmental conditions. The males detected in the U.S. have likely originated from the Sonora population and their genetic resources are thus a consequence of the population genetics and environmental conditions acting upon the Sonora population, not the arid environmental conditions of southern Arizona and New Mexico, as no breeding is occurring in the U.S. As such, males in the U.S. cannot by themselves provide the genetic resources that would benefit the species, as they are a product of the Sonora population itself. Thus, while the

conservation of the Sonora population may be important to the conservation of the species, the transfer of this importance to individual males detected in the U.S. is not justified.

Even if a breeding population, so small that it has remained undetected, was to currently exist in the U.S., the genetic resources of this population would likely not be reflective of genetic changes associated with adaptations to the environment. If this hypothetical population was isolated from other jaguar populations, genetic drift would overwhelm natural selection in influencing changes in gene frequency. As a consequence, the population would be characterized by inbreeding depression and deleterious allele combinations rather than adaptation to environmental conditions (Allendorf and Luikart 2007). If this hypothetical population was linked to other larger jaguar populations, gene frequencies will be largely driven by the population genetic conditions of the larger population rather than adaptation to local environmental conditions (Allendorf and Luikart 2007).

3. POTENTIAL EFFECTS TO PROPOSED JAGUAR CRITICAL HABITAT

The Proposed Rule specifically identified the Project as a project that the USFWS will evaluate to determine if “adverse modification to jaguar critical habitat will likely result from this action” (USFWS 2012, Pg. 50233). Below we address the potential effects of the Project on the proposed jaguar critical habitat. We analyze: 1) the acreage of proposed critical habitat that will be affected by the mine footprint, and 2) the potential effects of the Project on the Principle Constituent Elements (PCEs) for jaguar critical habitat described by the Proposed Rule.

3.1. THE FOOTPRINT OF THE ROSEMONT PROJECT INCLUDES A SMALL PORTION OF THE PATAGONIA UNIT AND THE ENTIRE PROPOSED DESIGNATION AS A WHOLE

The portion of proposed critical habitat encompassed by the proposed perimeter fence for the Project constitutes a small percentage of both the total acreage of proposed critical habitat and the acreage of the Patagonia Unit. The perimeter fence of the Project will encompass approximately 5,043 acres of critical habitat in the Patagonia Unit, less than 1.5 percent of the approximately 343,033 acres included in the Patagonia Unit and approximately 0.6 percent of the approximately 838,232 acres included in the entire proposed critical habitat designation. Thus, the amount of proposed critical habitat that will be impacted by the Project is small (less than 25 percent of the minimum habitat polygon size of 84km² as defined by the Proposed Rule [USFWS 2012, pg. 50228]), and should not appreciably diminish the value of critical habitat for the survival or recovery of the species.

3.2. THE POTENTIAL EFFECTS OF THE PROPOSED ROSEMONT PROJECT ARE NOT EXPECTED TO SIGNIFICANTLY ALTER THE PCEs OF THE SURROUNDING PROPOSED CRITICAL HABITAT

The Project could have potential effects on: 1) vegetation in surrounding areas, 2) the persistence of water sources in the area, 3) human activity in the area, 4) levels of native prey species for jaguars in the area and 5) environmental conditions that support connectivity to Mexico. We discuss each of these below.

3.2.1. Impacts on Vegetation

It is possible that a drawdown of groundwater levels from mining operations associated with the Project could potentially impact riparian vegetation that is outside of the perimeter fence line but dependent on regional groundwater. However, the proposed critical habitat does not include riparian vegetation as a necessary habitat component. As described in the Proposed Rule, the PCEs that relate to vegetation identify biotic communities (Madrean evergreen woodland and semi-desert grassland; USFWS 2012, pg. 50224) that contain plant species that are not highly dependent on regional groundwater levels, and thus are not likely to be affected by groundwater drawdown from mining activities. In particular, it is unlikely that regional groundwater drawdown due to the Project will lower canopy cover below the three percent threshold identified by USFWS (2012) in PCE #4 of the Proposed Rule.

Fugitive dust could impact the health of upland vegetation, but these impacts are expected to attenuate as distance from the dust source increases. Thus, dust is expected to have minimal impact on vegetation far from dust sources, and this little impact on vegetation outside of the perimeter fence line. Because of high OHV and other recreational uses in the vicinity of the Project (USDA 2011), fugitive dust has likely already had an effect on vegetation in the vicinity. Yet, the implicit conclusion of the Proposed Rule is that these human activities do not currently influence the PCEs related to vegetation and canopy cover to such an extent that the area cannot be proposed as critical habitat. For fugitive dust from the Project to negatively impact PCEs for critical habitat, its effect would necessitate lowering the percent canopy cover of the area below three percent (canopy cover between three and 40 percent is described as PCE #4). It is unlikely that dust levels outside of the perimeter fenceline will be so elevated from baseline conditions that they will reduce canopy cover to less than three percent.

3.2.2. Persistence of Water Features

Potential reductions in the persistence of seeps and springs are predicted to occur as a result of regional groundwater drawdown from the mine pit and direct impacts from tailings and waste rock storage. However, not all of the identified seeps and springs are expected to be impacted by drawdown of the regional aquifer. Seeps and springs not expected to be impacted by groundwater drawdown are those not connected to regional groundwater and/or those far from the Project mine pit (see USDA 2011). In addition stock tanks outside of the mine footprint will not be affected by groundwater drawdown, as they are dependent on the capture of ephemeral flows from precipitation events. There are a number of stock tanks located within proposed critical habitat that will not be affected by the Project, and are: 1) within 20 km (12.4 mi) of each other and 2) provide water resources within 10 km (6.2 mi) of all proposed critical habitat within the Patagonia Unit surrounding the Project. Thus, while we currently do not have access to the database used by the Proposed Rule to identify surface water sources, the information available indicates that the Project will not impact proposed critical habitat such that this area does not contain PCE #3 as described by the Proposed Rule. In addition, Rosemont will implement conservation measures to replace lost water features resulting from the Project with man-made water features that will benefit jaguars, their prey base, and proposed jaguar critical habitat by providing access to water sources throughout the northern Santa Rita Mountains (USDA 2012).

3.2.3. Levels of Human Activity

The Proposed Rule identifies low human influence as the most important PCE for jaguar critical habitat, and took significant steps to ensure that “only areas in which the [Human Influence Index] HII was 20 or less ... were included in the proposed designation,” (USFWS 2012, pg. 50228). USFWS used a GIS layer from the Socioeconomic Data and Applications Center (SEDAC) that integrates population density and a variety of human disturbance metrics into a relative index (USFWS 2012, pg. 50223). We have requested the specific GIS layer used by USFWS, but have yet to receive this information. A GIS layer that contains a relative index of human influence using the eight input layers described by the Proposed Rule (human population density per square km, railroads, major roads, navigable rivers, coastlines, stable nighttime lighting, urban polygons, and land cover; USFWS 2012, pg. 50223), however, is available from SEDAC. This layer is called the “Human Footprint” and provides a normalized index of human influence to fit a scale from zero to 100 (see SEDAC 2012), as is described for the layer used by USFWS in the Proposed Rule (USFWS 2012, pg. 50228). A GIS layer entitled “Human Influence” is available from SEDAC, but it does not fit the description provided by the Proposed Rule as it is not a relative index normalized by biome and scores range from zero to 64. Thus, our assumption is that the Proposed Rule used the “Human Footprint” data set for its analyses.

The Human Footprint dataset is available in a global coverage with a 1 km cell size. The Human Footprint dataset, downloaded nominally, uses the Interrupted Goode Homolosine Projection (IGHP) on the WGS84 reference ellipsoid. However, when the dataset is brought into GIS software and assigned this projection, we observed that the data was shifted approximately 13 km east and 4 km south of the correct geographic locations. To correct for this, the grid was manually georeferenced to match the geography. The same data are also available from SEDAC in continental subsets available in 30 arc second cell size, which equates to an approximately 860m cell size when projected into NAD83 in the vicinity of the Rosemont Project. We resampled the 30 arc second data to convert it to 1 km pixels using two methods. First, we converted the 860m pixels into point data using the pixel centers as reference locations and the grid value as an attribute. The points were then resampled into a 1 km grid using two different interpolation methods; nearest neighbor and bilinear interpolation. Nearest neighbor is an interpolation algorithm which determines the new value by inserting the value of the geographically closest known data point. Bilinear interpolation uses a weighted average of the 4x4 pixel neighborhood of known points to generate the value for the unknown point. The weighted average is generated using the geographic distances between the known and unknown points. The manually aligned dataset produced highly similar results to the resampled 30 arc second dataset. For the purposes of this discussion, we used the manually aligned 1 km grid cell dataset to generate our results³. However, using the 30 arc second data produces similar results.

The manually aligned Human Footprint GIS layer indicates that all of the Santa Rita Mountains, north of Greaterville, AZ, contain a score over the threshold of 20 identified in the Proposed Rule (see *Figure 6*).

³ Note that WestLand did not perform the extensive refinements on the GIS models that was performed in Beier et al. (2006) after the initial GIS models were obtained. We believe that considerable subjectivity is injected into the modeling process when these types of refinements are made, and we prefer to report unmanipulated results from these models.

In fact, over 30 percent of the proposed designation of critical habit, over 38 percent of the area within the proposed Patagonia Unit, and 100 percent of the proposed critical habitat within the perimeter fence of the Rosemont Project possess Human Footprint scores over 20. These results do not change appreciably when using the original misaligned layer (*see Figure 7*). Although we do not know the exact GIS data layers used by USFWS in the Proposed Rule, this analysis, using a GIS layer that fits the description provided in the Proposed Rule, clearly demonstrates that human influence is high across a large area proposed as critical habitat, including all of the northern Santa Rita Mountains and the entirety of the Project located within the proposed designation, as well as Subunit 4b. Consequently, using these data, the Rosemont Project cannot adversely affect proposed critical habitat in relation to PCE #6, as according to the threshold described in the Proposed Rule, PCE #6 is not currently present in the proposed Patagonia Unit in the vicinity of the Project.

In addition, the level of current and historic human activity within the northern Santa Rita Mountains is high. As a result of mining operations in the Greaterville, Rosemont, and Helvetia areas, the areas surrounding the Project have been subject to relatively high levels of human activity since the mid-1800s (Schaefer 1979). Currently, the area in the vicinity of the Project is heavily used for recreational activities. For example, the Draft Environmental Impact Statement (DEIS) for the Project describes off-highway vehicle (OHV) use as high in the northern Santa Rita Mountains (USDA 2011, pg. 526). In fact, according to the DEIS, the Forest Service specifically manages for increased motorized recreation in the Rosemont vicinity (USDA 2011, pg. 524). As a result, the baseline level of human use over some of the areas surrounding the Project is high, and may be higher than is considered suitable for proposed critical habitat.

3.2.4. Levels of Native Prey

The Project will encompass a portion of proposed critical habitat that is currently available for use by potential prey species of the jaguar. However, the amount of proposed critical habitat that will be affected is small relative to the total amount of proposed habitat in both the Patagonia Unit and the overall proposed designation (see Sec 3.1.).

Activities associated with the Project may also affect water features dependent on regional groundwater due to groundwater drawdown, and select water features dependent on ephemeral flows that will either be directly impacted from mining, or indirectly impacted from stormwater diversion. However, as described in Sec. 3.2.2., some surface water sources will be unaffected by project activities and provide water sources for prey and jaguars throughout the northern Santa Rita Mountains. Moreover, the Proposed Rule does not directly analyze the distribution and abundance of native prey when mapping areas that contain PCE #2, adequate levels of native prey species. Instead, USFWS relies on the “history of effective game management strategies resulting in prey species’ persistence” (USFWS 2012, pg. 50228). Using this metric established by the Proposed Rule, we see no reason why the knowledge of Arizona Game & Fish Department managers and the effectiveness of their game management strategies throughout proposed critical habitat will be affected by the Project.

3.2.5. Connectivity to Mexico

The Proposed Rule places paramount importance on connectivity to Mexico, and specifically identifies the Project as one in which USFWS will analyze in the “context of connectivity to Mexico” (USFWS 2012, pg. 50233). Here we discuss the potential impacts of the proposed Rosemont Project on connectivity through: 1) modeling connectivity corridors between the Whetstone and Santa Rita Mountains, and 2) the use of habitat by jaguars for movement.

3.2.5.1. Movement Corridor Modeling

The Proposed Rule identifies Subunit 4b as necessary to support jaguar movement between the Patagonia and Whetstone Units and connect the Whetstone Unit to Mexico. To inform the analysis of potential effects of the Project on proposed jaguar critical habitat in the context of connectivity, we modeled a least cost movement corridor with the Patagonia and Whetstone Units as habitat blocks using the corridor design model developed at Northern Arizona University (see Sec. 1.1.2. for methodological details). Our modeled corridor also connects the Whetstone Unit to areas in the Patagonia Unit both north and south of the Project (*Figure 8*).

We then simulated the lands within the perimeter fence line of the Project as “recently mined or quarried,” a land cover type avoided by jaguars (see Beier et al. 2006). The results of this simulation demonstrates that the modeled movement corridor is not sensitive to the potential disturbance caused by the proposed mine; the modeled corridor is largely unchanged and still provides a connection between the Whetstone and Santa Rita Mountains (*Figure 9*). Thus, this simulation provides evidence suggesting that the Project will not sever movement of jaguars between the proposed Whetstone and Patagonia Units and will not preclude connectivity to Mexico.

The Proposed Rule also discusses potential impacts of roads on movement of jaguars (USFWS 2012). The Project will entail a secondary access road and a utility corridor through a portion of proposed critical habitat west of the perimeter fence line. While these activities could impact the movement of jaguars, their effect will be far less than the linear disturbances, such as roadways, that are already present in the proposed designation. For example, the Proposed Rule identifies the Santa Rita and Patagonia Mountains as a continuous unit, despite the fact that they are bisected by SR 82. Similarly the Proposed Rule designates a Subunit 4b in order to provide connectivity between the Whetstone and Santa Rita Mountains. The entire length of Subunit 4b is crossed by SR 83. Thus, the implicit conclusion by the Proposed Rule is that neither SR 82 nor SR 83 precludes connectivity of the Santa Rita Mountains to Mexico. Daily traffic volumes on these highways (1,600 to 3,000 vehicles) are considerably higher than traffic expected as a result of the secondary access road and utility corridor. Therefore, to avoid intransitive logic in the analysis of effects to jaguar critical habitat, according to the Proposed Rule these disturbances will have no effect on movement of jaguars, and thus connectivity to Mexico.

Biologically, the available scientific literature indicates that while jaguars avoid human disturbance, male jaguars readily cross roadways and areas of human activity (Colchero et al. 2010). Given that: 1) all of the jaguar detection in the Southwest over the last 60 years have been males, 2) the Proposed Rule determines

occupancy or critical habitat units solely from male records and 3) jaguars detected recently in the U.S. and those that may arrive in the future will already be required to cross busy roadways, utility lines and areas of human influence before arrival to the northern Santa Rita Mountains, it is reasonable to conclude that the secondary access road and associated utility lines will not sever connectivity to Mexico. Thus, proposed critical habitat in the vicinity of the Project will continue to support PCE #1.

3.2.5.2. Use of Areas that Do Not Contain PCEs for Jaguar Movement

The Proposed Rule implies that subunits identified as critical habitat in order to support jaguar movement and connectivity with Mexico and between habitat units do not contain all of the PCEs considered as essential for the conservation of the species. These subunits were chosen to provide connectivity and to contain low human influence and some combination of canopy cover and rugged terrain (USFWS 2012, pg. 50228). The approach by the Proposed Rule implicitly concludes that jaguars have adequate behavioral flexibility such that they can use areas that do not contain all of the identified PCEs. This conclusion is in general agreement with findings from studies of the movement of male jaguars (e.g. Colchero et al. 2010), although female jaguars do not appear to as tolerable to human settlement or roads (Boydston and Lopez-Gonzalez 2005, Colchero et al. 2010). Therefore, even if the Project might preclude the movement of jaguars within a portion of the Patagonia Unit, the surrounding areas not proposed as critical habitat may also contain some PCEs and will continue to support jaguar movement, providing connectivity to Mexico and between other critical habitat units.

4. CONCLUSIONS

In this document, we discuss the potential effects of the Rosemont Copper Project on the jaguar species. We discuss how the Project could affect jaguar movement, the biotic communities used by jaguars, and jaguar prey base, as well as the consequences of the potential increase in traffic volume and noise associated with the Project. While these effects could negatively affect jaguars, we also show that male jaguars that could be using the northern Santa Rita Mountains have little influence on jaguar population dynamics. Thus, potential effects on these individuals do not impact jaguar population growth or persistence, and have no influence on the continued existence of the species.

We also discuss potential effects of the Project to proposed jaguar critical habitat. The Project footprint includes only a small amount of proposed critical habitat, less than 1.5 percent of the approximately 343,033 acres included in the Patagonia Unit and approximately 0.6 percent of the approximately 838,232 acres included in the entire proposed critical habitat designation. The effects of the Project are not expected to significantly alter the PCE of proposed critical habitat. In particular, impacts to the vegetation important for proposed critical habitat are not anticipated to extend far beyond the Project footprint, water features will still persist on the landscape and will be augmented by Rosemont's proposed conservation measures, human activity in the area appears to be already too high to be considered critical habitat, and the Project will not preclude the movement of jaguars to such an extent that connectivity to Mexico will be severed.

In short, these analyses demonstrate that while there could be impacts to jaguars and proposed jaguar critical habitat as a result of the Rosemont Copper Project, these effects are not likely to either influence the continued existence of the species or appreciably diminish the value of critical habitat for the survival or recovery of the species.

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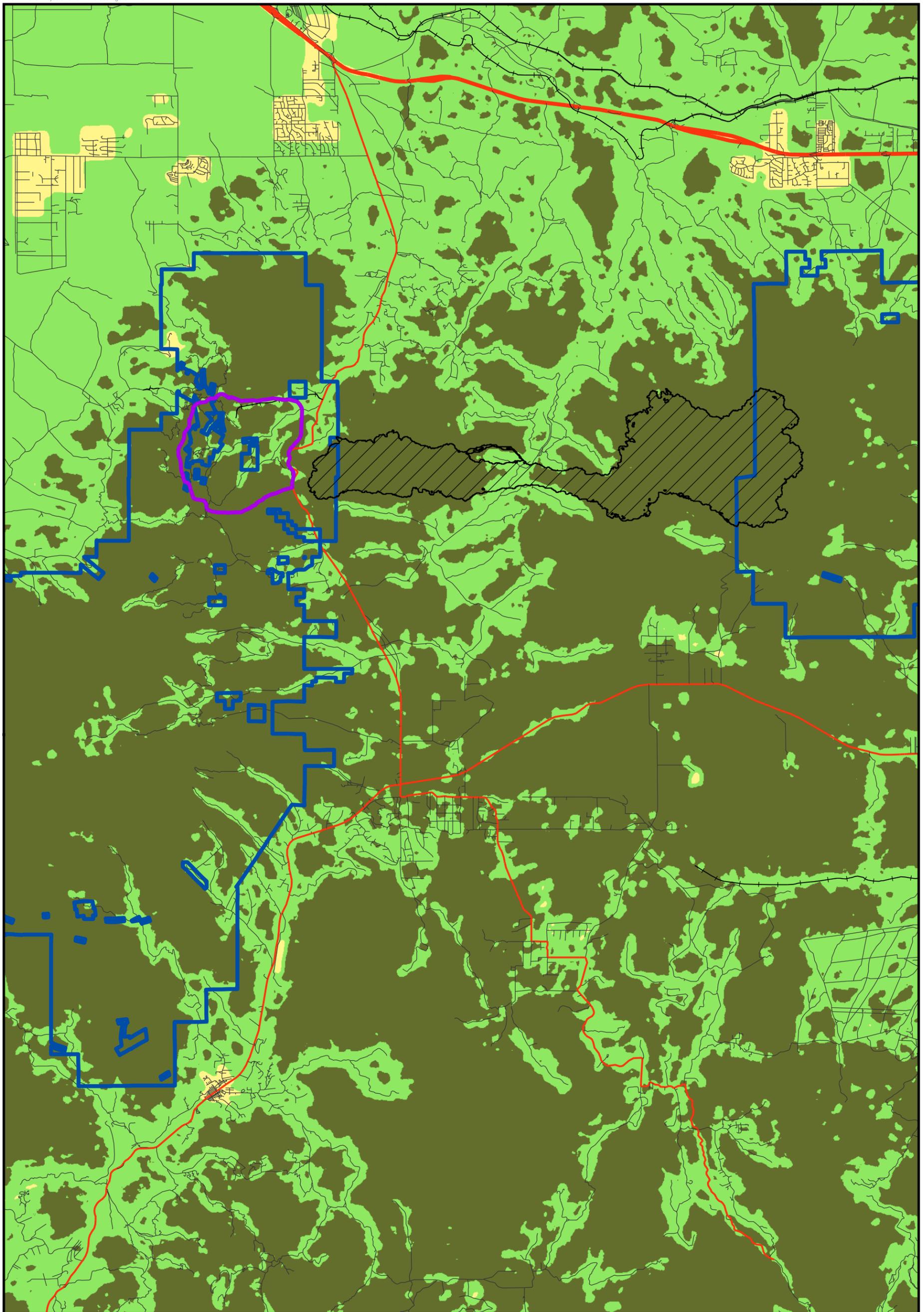
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FIGURES



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N
0 15,000 30,000 Feet

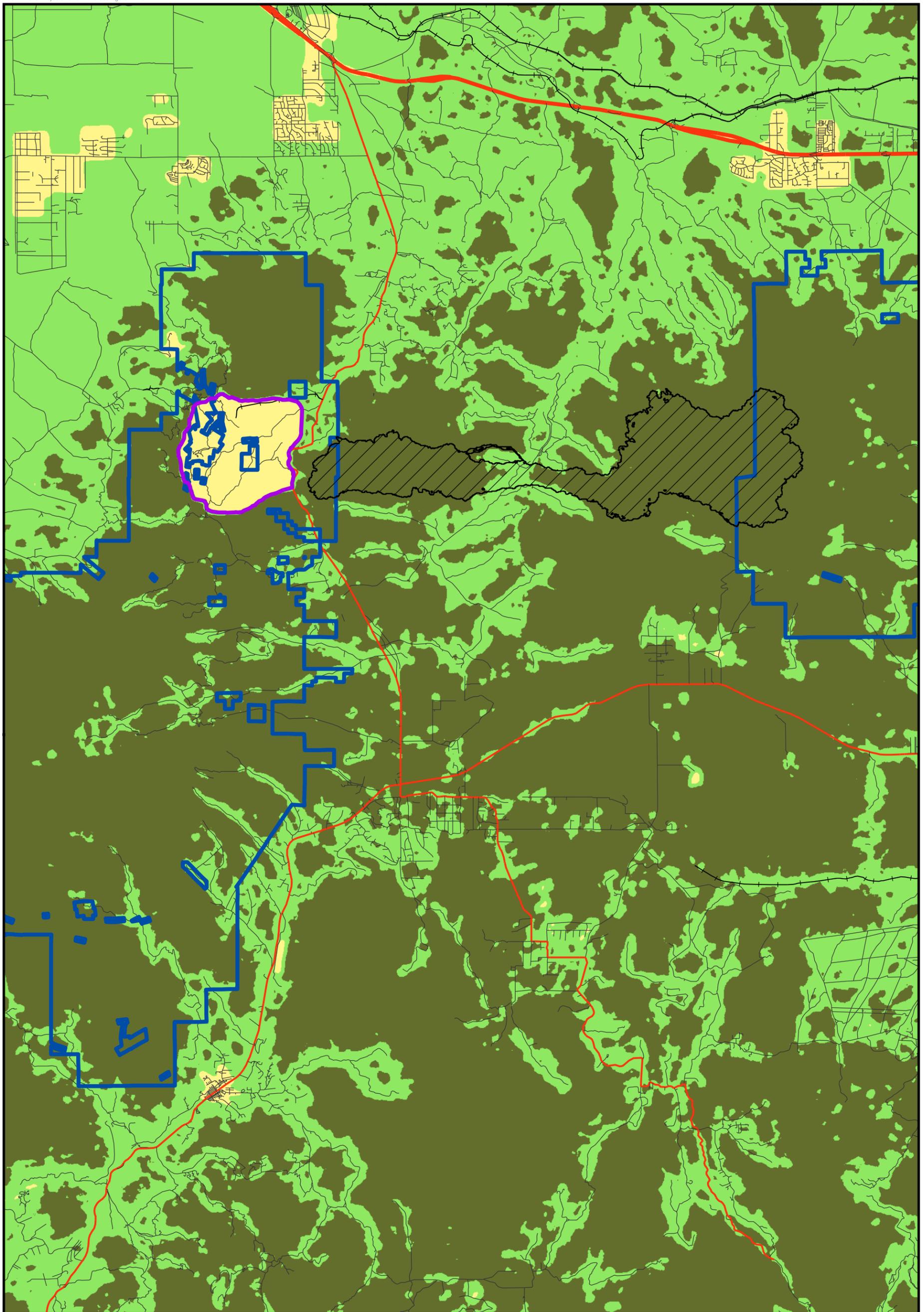
Legend

Jaguar 1% Corridor	Low Suitability
Rosemont Perimeter Fence	Medium Suitability
Forest Service Habitat Block	High Suitability
Roads	
Railroads	
US, State, County Hwys	
Interstates	

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Rosemont Copper Project: Potential Effects of the
Rosemont Project to Jaguar and Jaguar Critical Habitat

JAGUAR MOVEMENT CORRIDOR BETWEEN
FOREST SERVICE HABITAT BLOCKS-BASE MODEL

Figure 1



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Legend

Jaguar 1% Corridor	Low Suitability
Rosemont Perimeter Fence	Medium Suitability
Forest Service Habitat Block	High Suitability
Roads	
Railroads	
US, State, County Hwys	
Interstates	

ROSEMONT COPPER COMPANY
Rosemont Copper Project: Potential Effects of the
Rosemont Project to Jaguar and Jaguar Critical Habitat

JAGUAR MOVEMENT CORRIDOR BETWEEN
FOREST SERVICE HABITAT BLOCKS-SIMULATED PROJECT MODEL

Figure 2

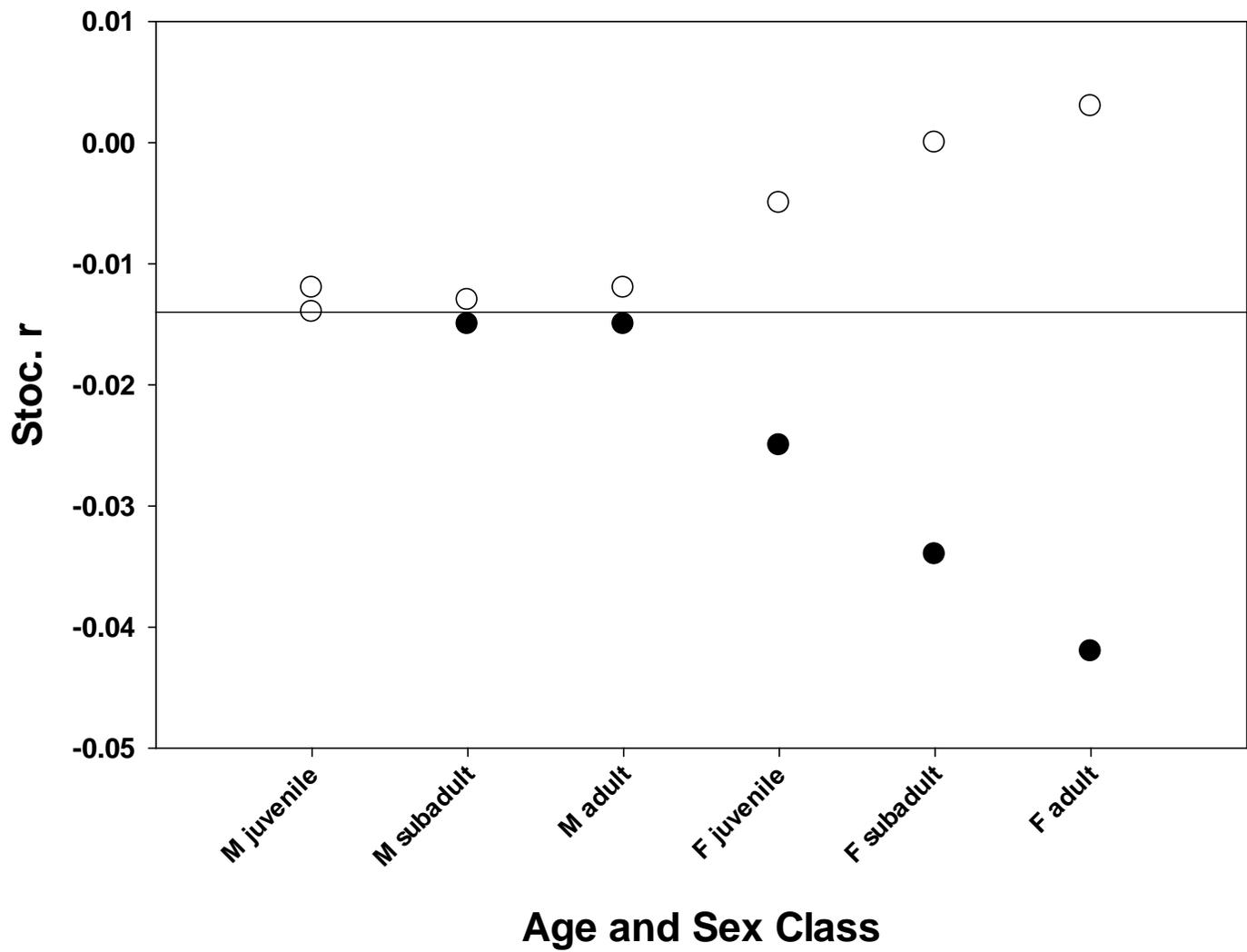


Figure 3. Results from the sensitivity analyses for stochastic growth rates (Stoc. r) run on the base Sonoran Population Viability Analysis model. Open circles represent a 5 percent increase in survival and closed circles represent a 5 percent decrease in survival. The line represents stochastic growth rate of the base model.

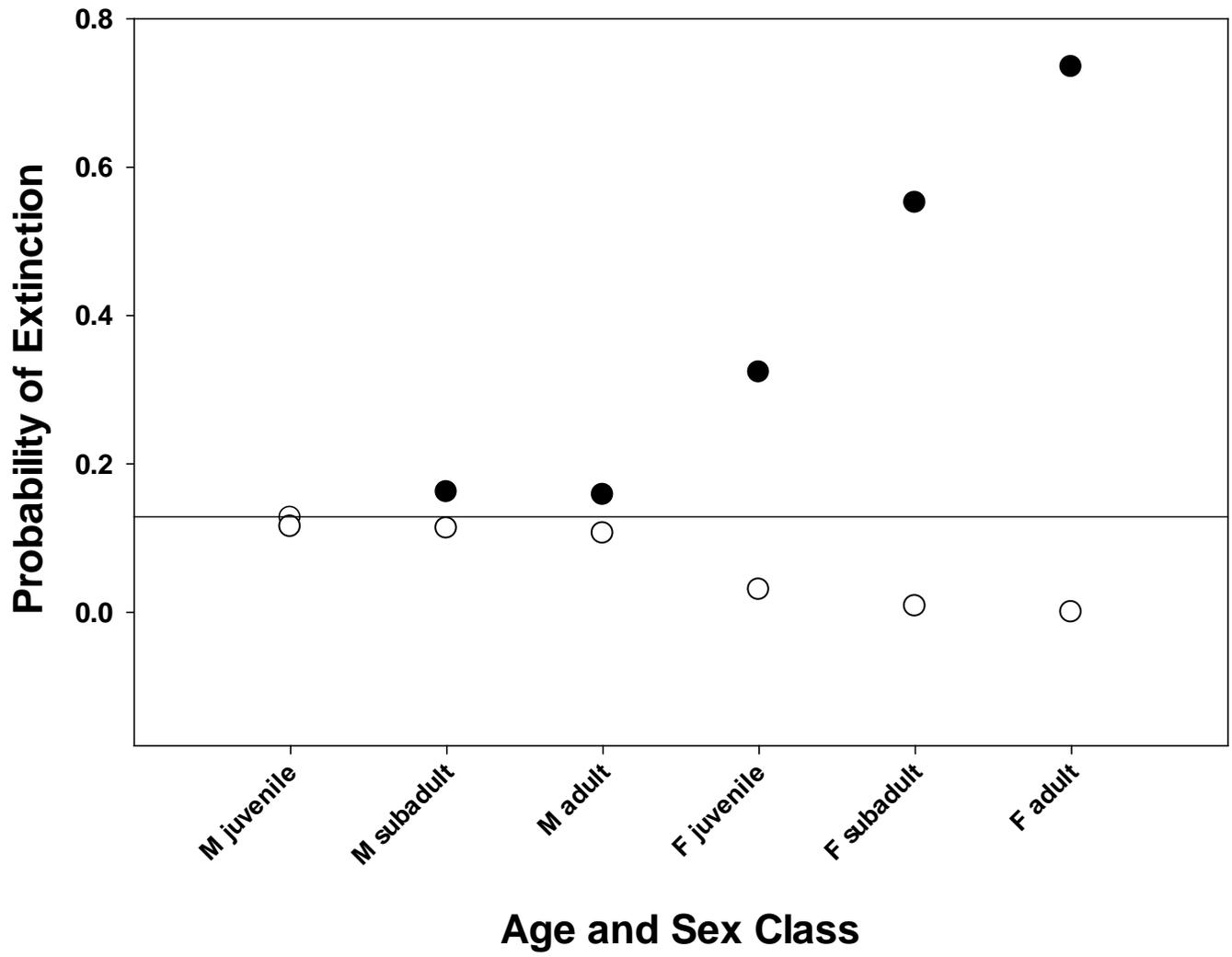


Figure 4. Results from the sensitivity analyses for the probability for the population to reach extinction (PE) in the base Sonoran Population Viability Analysis. Open circles represent a 5 percent increase in survival and closed circles represent a 5 percent decrease in survival. The line represents the probability of extinction of the base model.

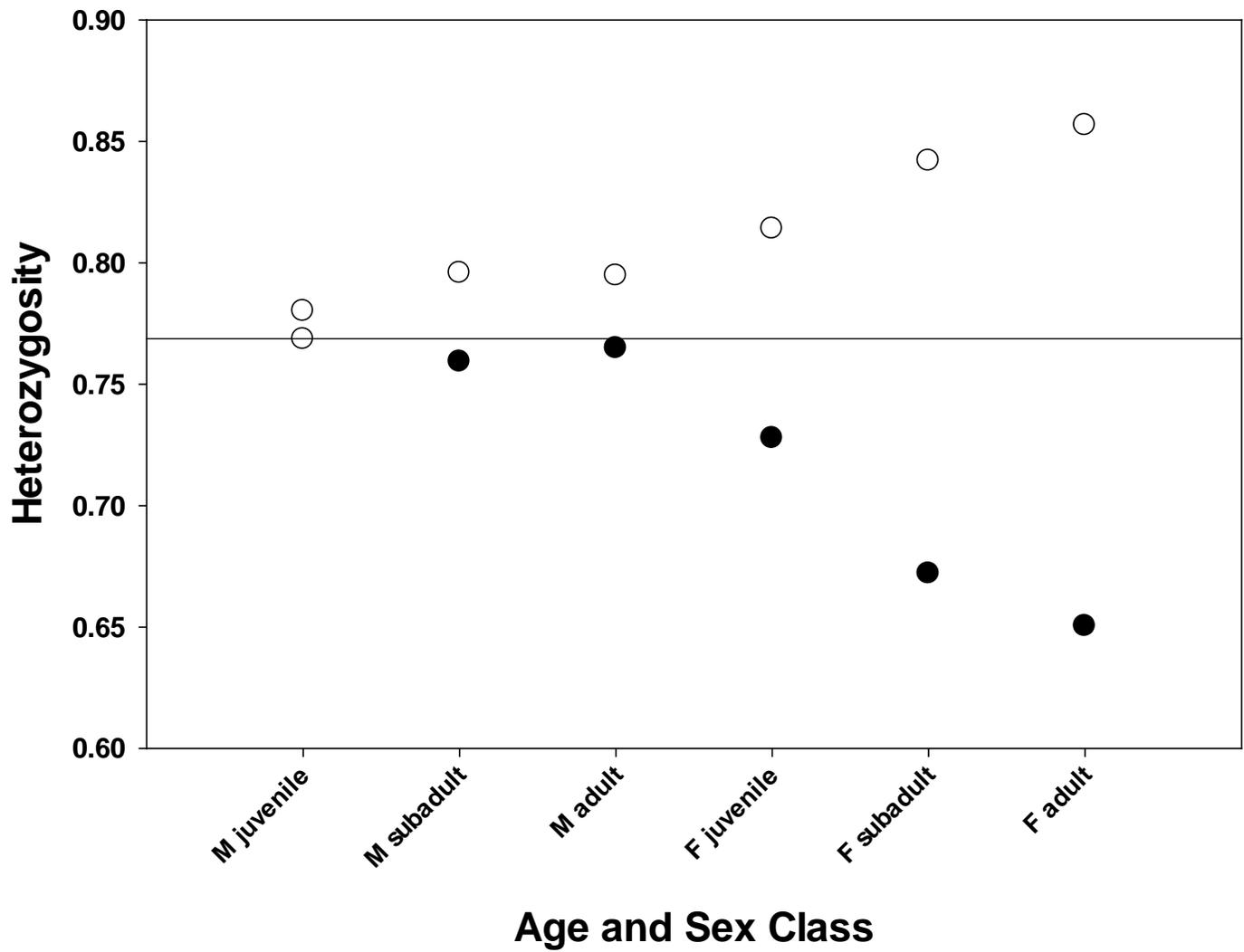
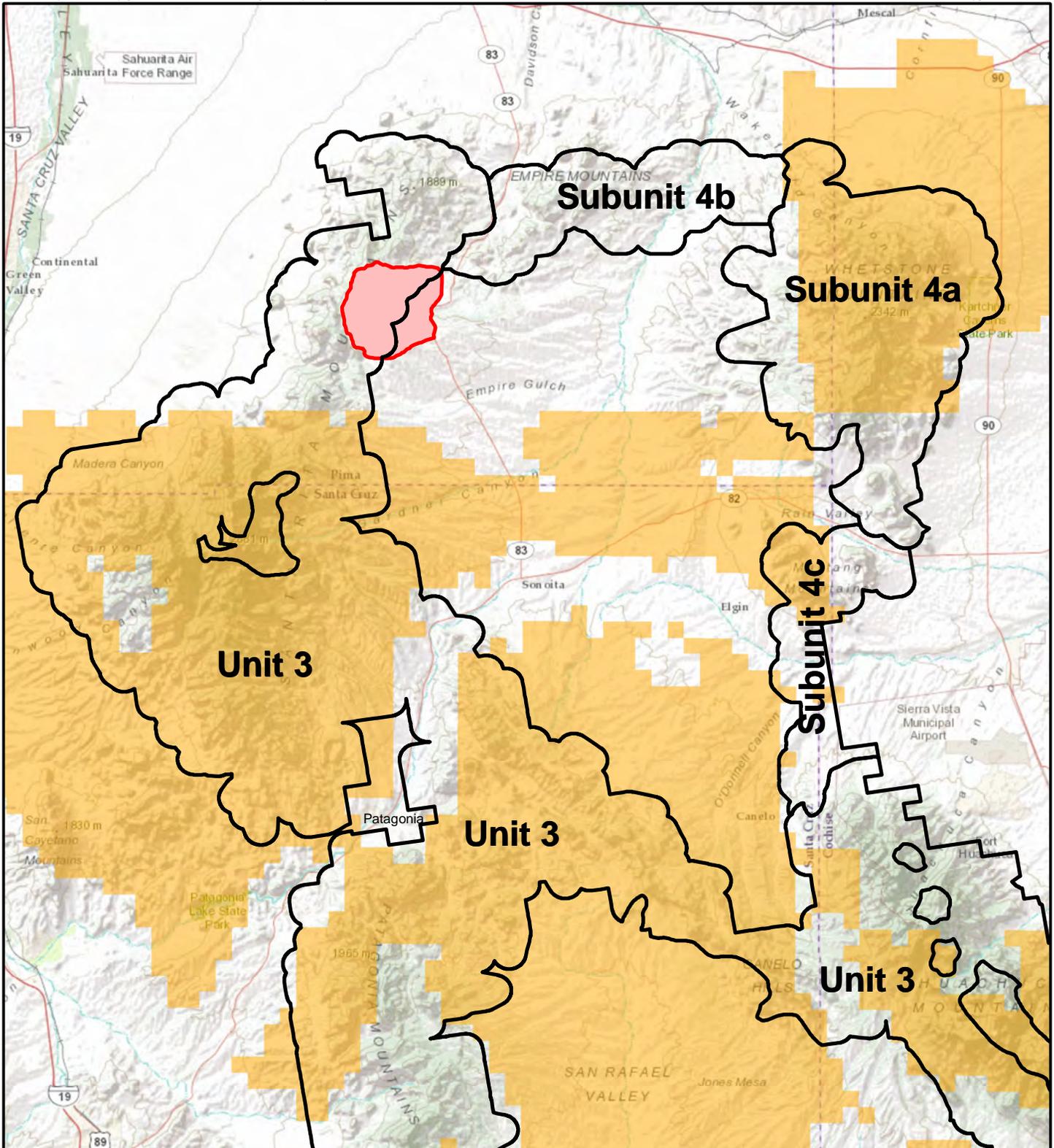


Figure 5. Results from the sensitivity analyses for genetic heterozygosity (H) in the base Sonoran Population Viability Analysis. Open circles represent a 5 percent increase in survival and closed circles represent a 5 percent decrease in survival. The line represents heterozygosity of the base model.



Cochise, Pima and Santa Cruz Counties, Arizona
Data Source: SEDAC, USFWS and ESRI Online

Legend

-  Proposed Jaguar Critical Habitat
-  Rosemont Project Perimeter Fence
- Human Footprint Score**
-  0 - 20
-  20 - 100 (No Color)

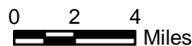
**Rosemont Copper Company
Rosemont Copper Project:
Potential Effects of the
Rosemont Project to Jaguar
and Jaguar Critical Habitat**

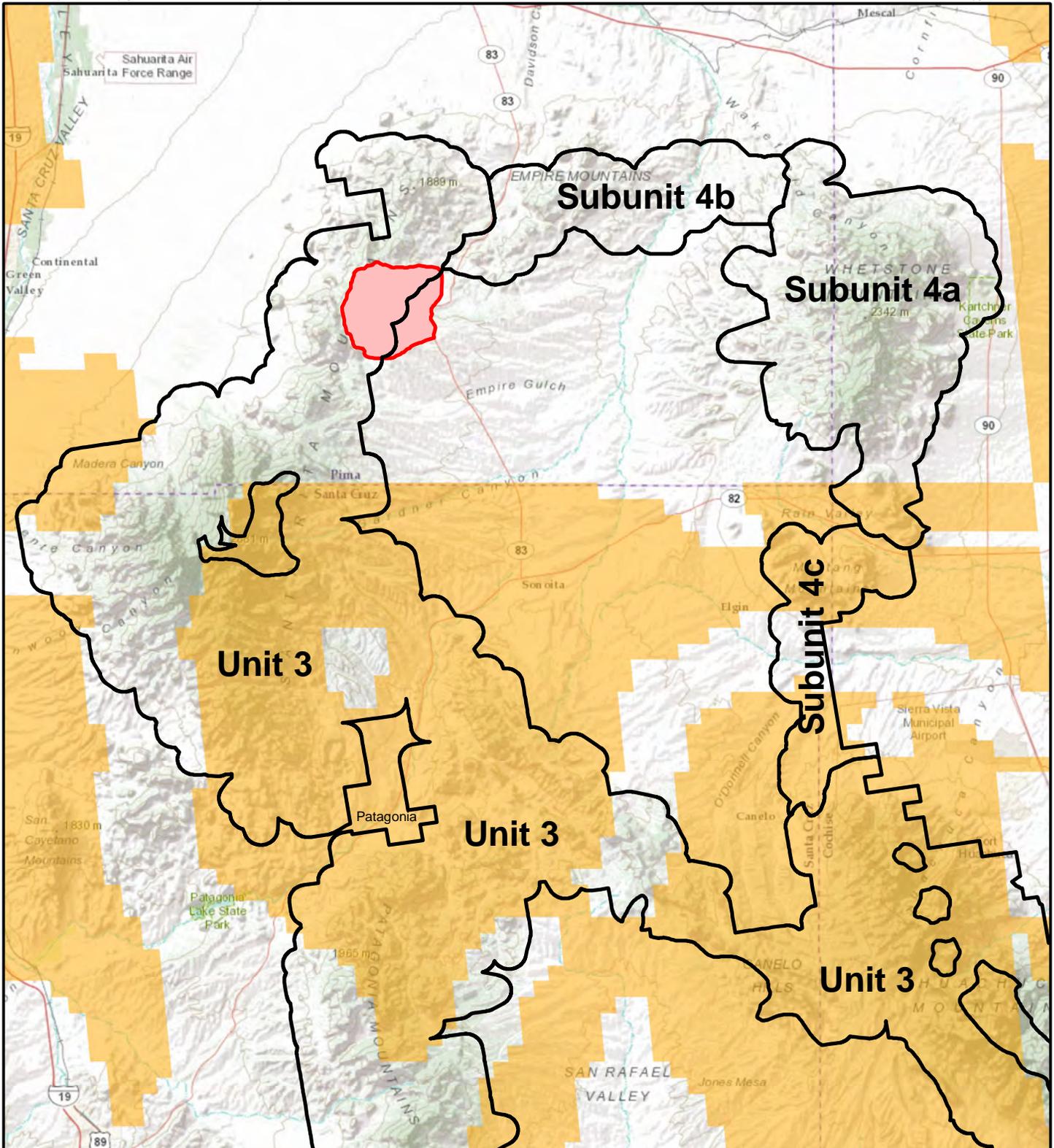
Human Footprint Score
Manually Aligned

Figure 6



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Cochise, Pima and Santa Cruz Counties, Arizona
Data Source: SEDAC, USFWS and ESRI Online

Legend

-  Proposed Jaguar Critical Habitat
-  Rosemont Project Perimeter Fence

Human Footprint Score

-  0 - 20
-  21 - 100 (No Color)

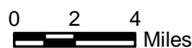
**Rosemont Copper Company
Rosemont Copper Project:
Potential Effects of the
Rosemont Project to Jaguar
and Jaguar Critical Habitat**

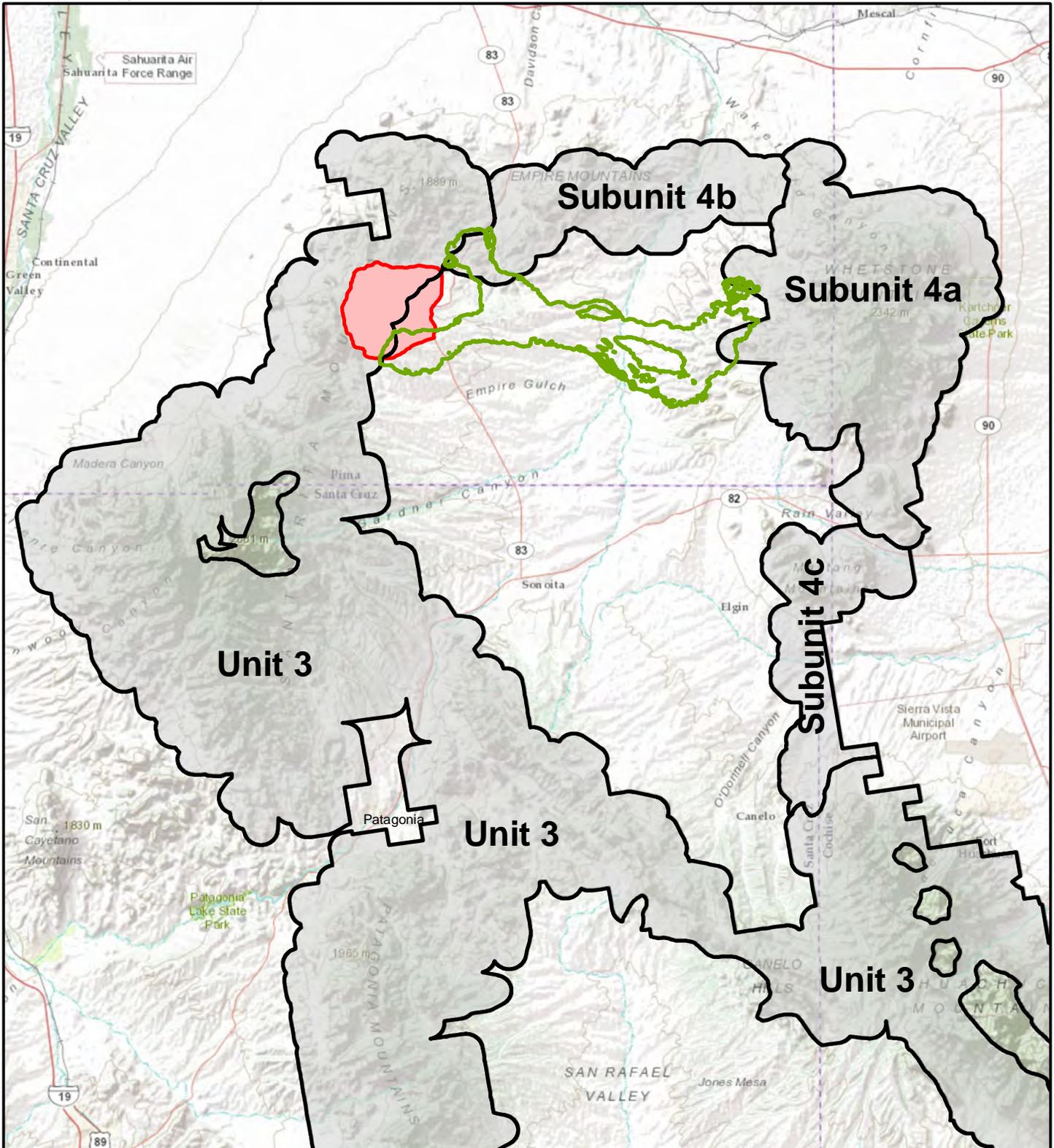
Human Footprint Score
Original Data
Figure 7



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Cochise, Pima and Santa Cruz Counties, Arizona
 Data Source: USFWS and ESRI Online

Rosemont Copper Company
 Rosemont Copper Project:
 Potential Effects of the
 Rosemont Project to Jaguar
 and Jaguar Critical Habitat

Jaguar Movement Corridor
 Between Proposed Critical
 Habitat Units-Base Model

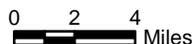
Figure 8

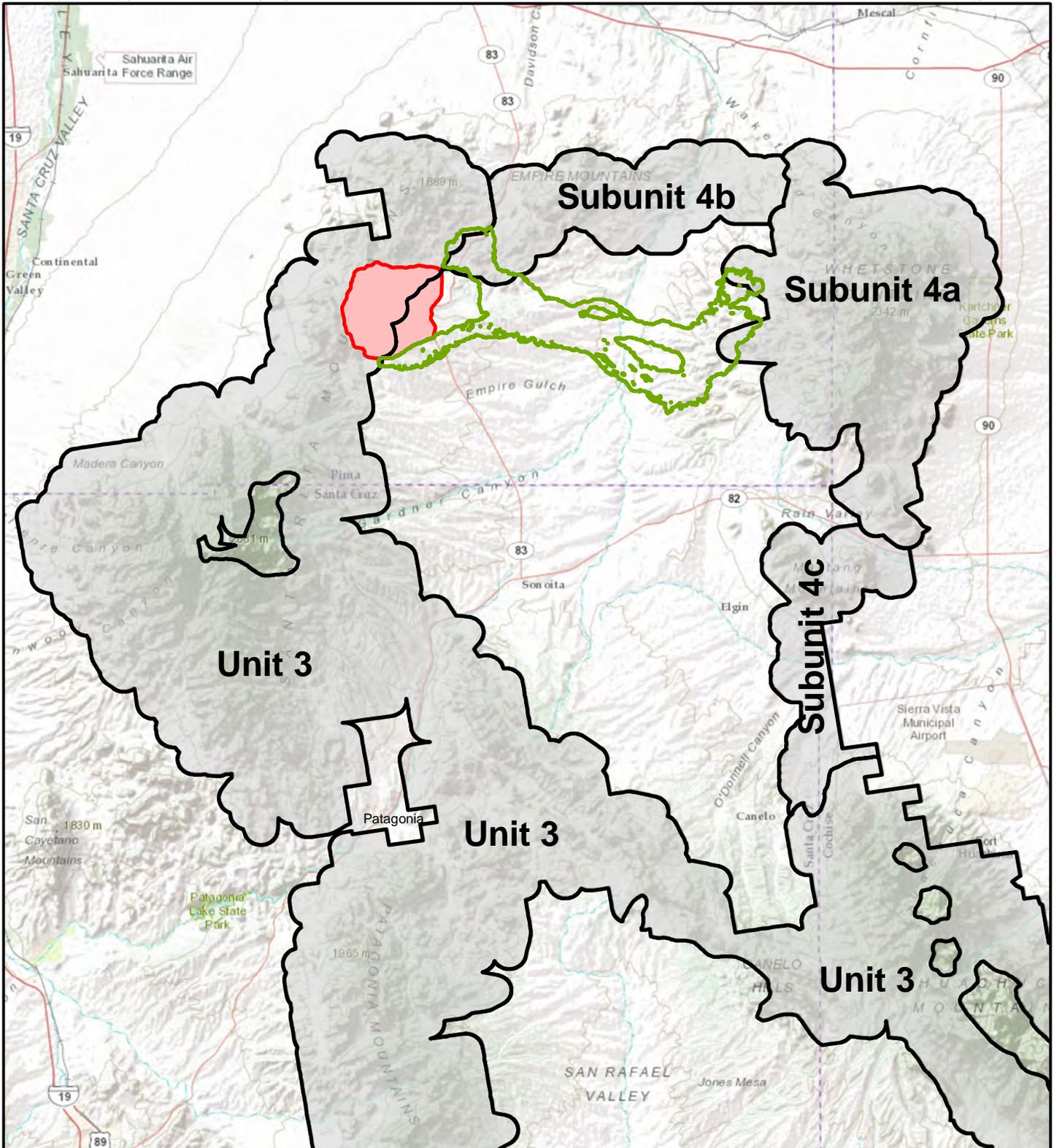


Legend

-  Jaguar 1% Habitat Corridor
-  Rosemont Project Perimeter Fence
-  Proposed Jaguar Critical Habitat

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Rosemont Copper Company
Rosemont Copper Project:
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Rosemont Project to Jaguar
and Jaguar Critical Habitat

Jaguar Movement Corridor
Between Proposed Critical Habitat
Units-Simulated Project Model

Figure 9



Legend

-  GIS-Modeled Jaguar Movement Corridor
-  Rosemont Project Perimeter Fence
-  Proposed Jaguar Critical Habitat

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