Soda Mountain Solar, LLC
5275 Westview Drive
Frederick, MD 21703

July 24, 2012

California Energy Commission
Dockets Office, MS-4
Docket No. 09-RENEW EO-01
1516 Ninth Street
Sacramento, CA 95814-5512
docket@energy.ca.gov

RE: Comments on DRECP Baseline Biology Report

Dear Sir/Madam:

Soda Mountain Solar, LLC (SMS) is the developer of the Soda Mountain Solar Project (the Project). The Project is a proposed 350 megawatt photovoltaic solar electric power generating facility located approximately six miles southwest of Baker, California, along Interstate 15, in San Bernardino County. The Project would be located within a 4,400 acre right-of-way on federal land administered by the U.S. Bureau of Land Management. The Soda Mountain Project area is shown in Figure 1 at the end of this letter.

SMS has reviewed the *Draft Desert Renewable Energy Conservation Plan (DRECP) Baseline Biology Report* (CEC 2012) and compared its habitat suitability results for desert tortoise and bighorn sheep with results of field studies conducted within the Soda Mountain Solar project area.[1] Our review also identified weaknesses in the methods used in the *Draft DRECP Baseline Biology Report*. The full analysis, including evaluation of the underlying models applied in the *Draft DRECP Baseline Biology Report*, is provided in the enclosed document, "Analysis of Habitat Suitability and Connectivity in the Soda Mountain Area, San Bernardino County, California" (Heim and Hietter 2012). The findings and recommendations of this analysis as they specifically apply to the *Draft DRECP Baseline Biology Report* and the Soda Mountain Solar Project site are

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[1] As part of the right-of-way application process, SMS has completed detailed environmental studies within the proposed Project area, including: desert tortoise survey; golden eagle and bighorn sheep survey; special-status plant survey; Mojave fringe-toed lizard survey; avian surveys; habitat assessment; water resource investigation and delineation; hydrologic and groundwater evaluation; geologic characterization; and a percolation and scour analysis. The results of each of these surveys are on file with the BLM.

provided below. Our letter concludes with several recommendations for the revision of the *Draft DRECP Baseline Biology Report* as it applies to the Soda Mountain Solar Project site.

Recommendations

The *Draft DRECP Baseline Biology Report* should be revised as described below.

1) **Section 3: Figure 3-4.** The Soda Mountain Solar Project area should not be designated as a connectivity corridor in the Baseline Biology Report because the species-specific analysis conducted by the California Desert Connectivity Project did not identify any linkages within the Soda Mountain Solar area.

The polygons of essential connectivity areas from the California Essential Connectivity Project should be removed and replaced with the more detailed linkage network developed by the California Desert Connectivity Project, where the two efforts overlap. This replacement is recommended in *California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California* (Spencer et al. 2010):

> *"Essential Connectivity Areas are placeholder polygons that can inform land-planning efforts, but that should eventually be replaced by more detailed Linkage Designs, developed at finer resolution based on the needs of particular species and ecological processes. It is important to recognize that even areas outside of Natural Landscape Blocks and Essential Connectivity Areas support important ecological values that should not be "written off" as lacking conservation value. Furthermore, because the Essential Habitat Connectivity Map was created at the statewide scale, based on available statewide data layers, and ignored Natural Landscape Blocks smaller than 2,000 acres, it has errors of omission that should be addressed at regional and local scales".*

The inclusion of Essential Connectivity Areas where detailed regional scale analyses are available is inconsistent with the methods and recommendations of the California Essential Connectivity Project. Figure 3-4 of the Baseline Biology Report should be revised by removing the Essential Connectivity Areas from the map where finer resolution linkages, such as the California Desert Connectivity Project, are available. The Soda Mountain Solar proposed project area should not be designated as a connectivity corridor in the Baseline Biology Report. The species-specific analysis conducted by the California Desert Connectivity Project did not identify any linkages within the Soda Mountain Solar area.

2) **Appendix B - PRELIMINARY DRAFT March 2012, DRECP Species Statistical Model: Desert Bighorn Sheep.** The Preliminary Draft statistical model for desert bighorn sheep should be revised to include additional data. The model was constructed using 32 presence data points, none of which are located within the Soda Mountains. There is a population of bighorn sheep that was surveyed in the south Soda Mountains by California Department of Fish and Game (CDFG 2012). These data should be incorporated into the model to assist in model refinement. There are seven locations where bighorn sheep were identified in the CDFG surveys. In addition, the model should be refined through ground-truthing. Low-lying areas and areas next

to highways, such as those in the southern portion of the Soda Mountain Solar Project area, should not be included in the model because they do not meet known conditions for suitable habitat, as confirmed by bighorn sheep survey work performed for the Soda Mountain Solar Project. Further documentation of methods should also be provided. The method should state which specific data sources listed in Appendix C were used in the final model, and the resolution of the model.

3) **Appendix B – PRELIMINARY DRAFT March 2012, DRECP Species Model: Desert Tortoise.** The Preliminary Draft species model for desert tortoise identifies suitable habitat throughout the entire valley between the Soda Mountains. This identification of suitable habitat is inconsistent with the method used for the species model (e.g., OHV areas and areas of disturbance were to be removed from suitable habitat areas) and it is inconsistent with field studies of habitat suitability. The OHV area to the south and east of the Project area is identified as suitable habitat for desert tortoise. Similarly, the I-15 highway and corridor, which are highly disturbed, are identified as suitable habitat. The enclosed study provides an evaluation of habitat suitability for desert tortoise within the Project area. The habitat is not likely to sustain a population of desert tortoise due to the limited area between the mountains, high level of human disturbance (I-15 highway and OHV area), low elevation, abundance of rocks and cobbles, and sparse vegetation cover with low vegetative diversity. The model should be updated to reflect a lower quality of habitat within the Project area.

4) The DRECP should be revised to include the Soda Mountain Study Area as a solar development area in draft integrated alternatives 2, 3, and 5. Alternative 2, "Geographically Balanced/Transmission Aligned Alternative," state that development should be aligned with the existing and planned transmission network. The C is located in a BLM utility corridor that currently includes two transmission lines and a distribution line.

Alternative 3, "West Mojave and Tribal Sensitivity Emphasis," is designed to emphasize development in the West Mojave and to exclude projects in areas considered by multiple tribes to have high sensitivity. The Soda Mountain Study Area is located in the West Mojave area and no tribal conflicts have been identified after initial consultation by BLM.

Alternative 5, "Increase Geographic and Technology Flexibility," seems to be the alternative with the highest allowed resource conflicts and the greatest flexibility. The Soda Mountain Study Area has limited resource conflicts and is consistent with Alternative 5.

Conclusion

Based on the enclosed "Analysis of Habitat Suitability and Connectivity in the Soda Mountain Area, San Bernardino County, California", we recommend revising the *DRECP Baseline Biology Report* as it applies to the Soda Mountain Solar Project site as follows:

- Remove the connectivity corridor designation from Figure 3-4 at the Soda Mountain project area;

- Remove the suitable habitat designation in the Soda Mountain project area from the DRECP Statistical Model for Desert Bighorn Sheep; and
- Remove the suitable habitat designation in the Soda Mountain Solar Project area from the DRECP Species Model for Desert Tortoise.

A process should also be designed for updating the Baseline Biology Report to incorporate detailed species-specific survey data as it becomes available. The *Baseline Biology Report* relies heavily on the use of models to develop information. Models are representations of reality based upon assumptions. Models are limited in their ability to characterize real world conditions and should be updated by field data like those generated for the Soda Mountain Solar Project. The enclosed analysis is essentially a case study demonstrating this point.

The Soda Mountain Study Area has been shown to be an area with limited resource conflicts. It should therefore be included in the DRECP as a solar development area in draft integrated alternatives 2, 3, and 5.

Please review the enclosed study upon which we base our recommendations. We believe it will help to improve the accuracy of the DRECP particularly as it applies to the Soda Mountain Solar Project site. We appreciate the opportunity to review and provide comments.

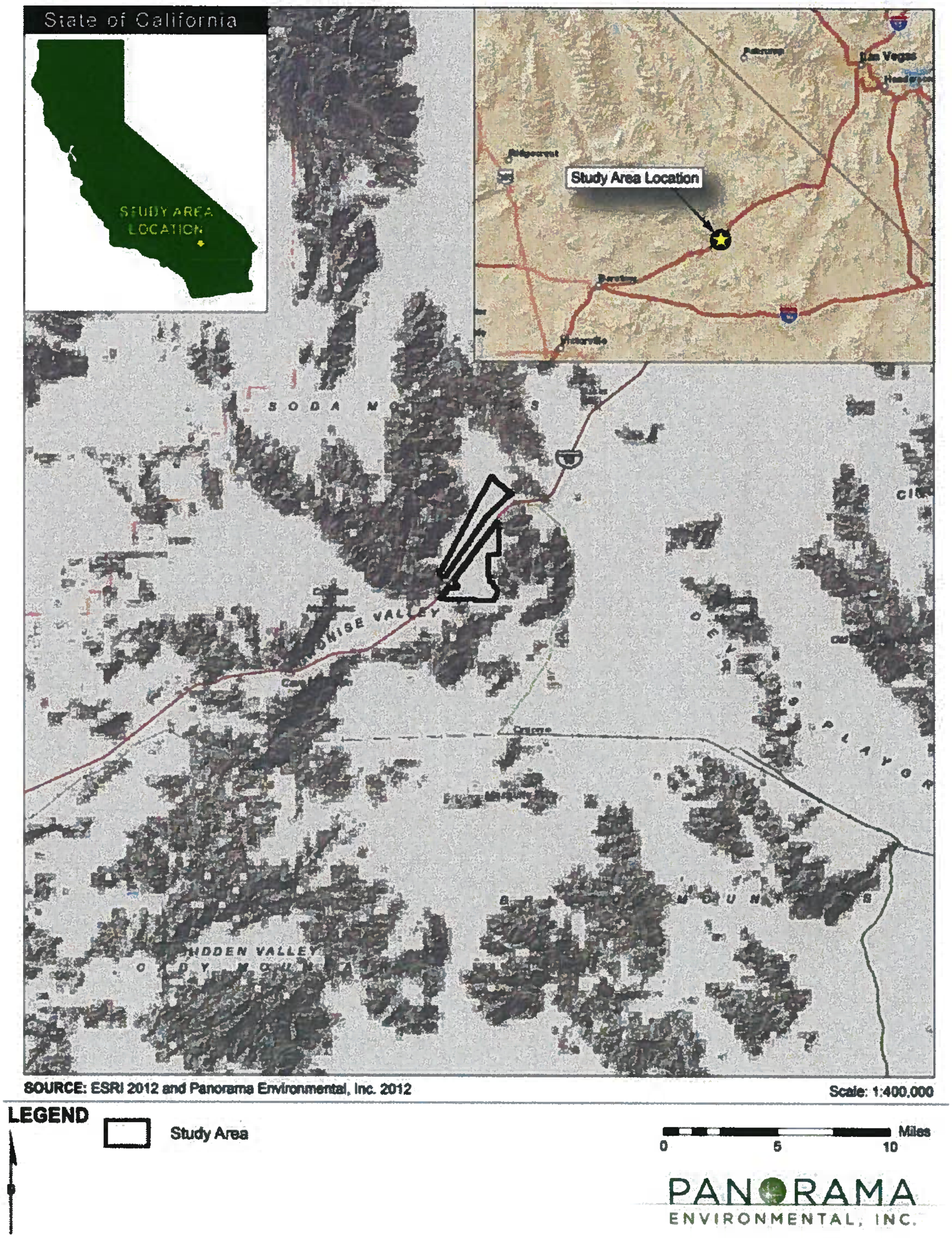
Sincerely,

Adriane E. Wodey

Adriane E. Wodey
Manager
Soda Mountain Solar, LLC

Enclosure: "Analysis of Habitat Suitability and Connectivity in the Soda Mountain Area, San Bernardino County, California"

Figure 1


State of California
STUDY AREA
LOCATION
Study Area Location
Las Vegas
SOURCE: ESRI 2012 and Panorama Environmental, Inc. 2012
Scale: 1:400,000
LEGEND
Study Area
Miles
0
5
10
PANORAMA
ENVIRONMENTAL, INC.

Analysis of Habitat Suitability and Connectivity in the Soda Mountain Area, San Bernardino County, California

Susanne Heim and Laurie Hietter

July 2012

PANORAMA
ENVIRONMENTAL, INC.

One Embarcadero Center, Suite 740 San Francisco, CA 94111 650-373-1200
www.panoramaenv.com

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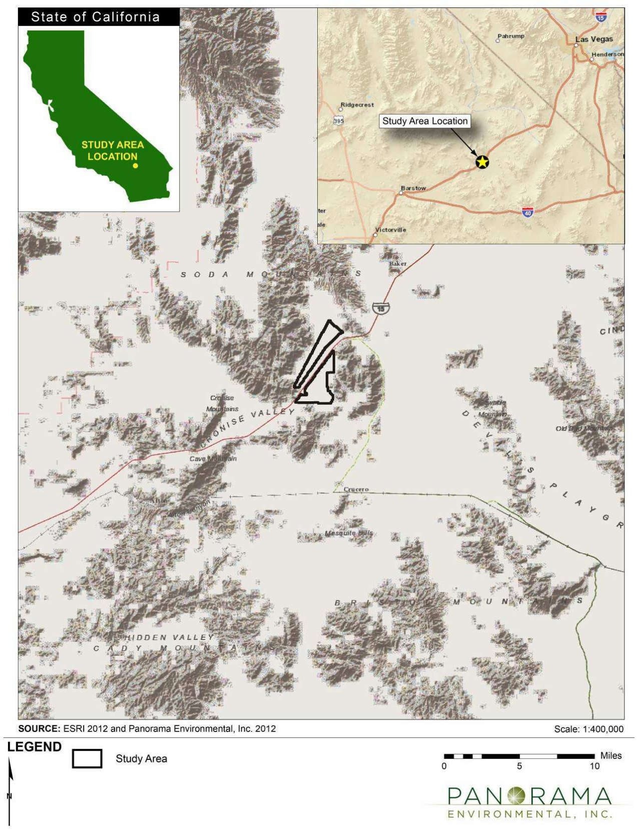
EXECUTIVE SUMMARY

This study was commissioned by Soda Mountain Solar, LLC to assess habitat suitability and connectivity for desert tortoise (*Gopherus agassizii*) and desert bighorn sheep (*Ovis canadensis nelsoni*) in the valley between the north and south Soda Mountains, San Bernardino County, California, which is referred to as the Soda Mountain Study Area. This study provides an analysis of the accuracy of habitat suitability and connectivity model predictions for an approximately 7,000 acre area within the Mojave Desert. Habitat suitability and connectivity models are being used by regulatory agencies to define areas for habitat conservation and development. The accuracy and limitations of model predictions are important considerations for decision-makers when relying on habitat suitability and connectivity models for land use decisions.



Five studies of desert tortoise and bighorn sheep habitat and connectivity were reviewed. The results of these studies were compared with the results of field surveys performed in the Soda Mountain Study area, which is in the valley located between the north and south Soda Mountains. The comparison provides insight into the accuracy of models to correctly predict habitat and species occurrence. The comparison revealed that habitat suitability models have inherent weaknesses and should not substitute for field studies, particularly where detailed field survey data are available.

STUDIES REVIEWED

Habitat and Connectivity Models

Several studies have been conducted that used models to identify suitable habitat for desert tortoise and bighorn sheep, and to identify potential wildlife connectivity corridors. Studies reviewed in this paper include:

1. *Modeling Habitat of the Desert Tortoise (Gopherus agassizii) in the Mojave and Colorado Deserts, California, Nevada, Utah, and Arizona* (Nussear et al. 2009)

2. "Making Molehills Out of Mountains: Landscape Genetics of the Mojave Desert Tortoise" (Hagerty et al. 2010)
3. *California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California* (Spencer et al. 2010)
4. *A Linkage Network for the California Deserts* (Penrod et al. 2012)
5. *Draft Desert Renewable Energy Conservation Plan (DRECP) Baseline Biology Report* (California Energy Commission [CEC] 2012)

Field Studies

Field studies were performed in the Soda Mountain Study Area between 2009 and 2012. Field studies that were compared with the habitat model predictions include:

- Desert tortoise survey, 100% coverage (2009)
- Bighorn sheep surveys, aerial and ground-based (2011 and 2012)
- Special-status plant surveys (2009)
- Avian point count surveys (2009)
- Water resource investigation (2009)
- Geology studies (2010)

DESERT TORTOISE HABITAT

Desert tortoise habitat suitability models predict moderately suitable habitat (0.6 to 0.8 predicted probability) for desert tortoise within the Study Area (Nussear et al 2009) and the area is defined as suitable habitat (CEC 2012). The model results differ from the field survey results, which identified no tortoise, burrows, or sign within the study area during 100% coverage surveys conducted on 10-meter transects throughout the entire Study Area. No desert tortoise or sign were identified in any of the studies conducted in the study area (biology, geology, and cultural resources). The field surveys also indicate that conditions are not likely to support populations of desert tortoise because:

- The elevation of the area (less than 1,600 feet) is low for desert tortoise
- Vegetation is sparse with low diversity
- Soils are very rocky
- Habitat is fragmented by Interstate-15 (I-15)
- Disturbance from off-highway vehicle use and construction of two transmission lines, a distribution line, a fiber optic cable, and two fuel pipelines)

These conditions, combined with the field survey results for desert tortoise, indicate that few, if any, desert tortoise would be expected in the Study Area.

DESERT TORTOISE CONNECTIVITY

The Study Area is not identified within a modeled desert tortoise connectivity corridor (CEC 2012), and the Baker sink, located east of the Study Area, is identified as a barrier to tortoise movement (Hagerty et al 2010). The modeled lack of desert tortoise connectivity within the area is consistent with the presence of 1) mountains surrounding the Study Area, 2) the Baker sink to the east of the Study Area, and 3) highway I-15 bisecting the Study Area. These landscape features individually and cumulatively inhibit tortoise movement through the Study Area.

BIGHORN SHEEP HABITAT

The model of suitable habitat for bighorn sheep identified suitable habitat within the southern portion of the Study Area (CEC 2012). The model results differ from field survey and habitat assessment results, which indicate the area is not suitable habitat for bighorn sheep. The flat and open terrain, absence of a water source, and presence of I-15 all indicate that if bighorn sheep were to use the habitat, the use would be temporary and they would not be expected to stay in the valley for long. The adjacent south Soda Mountains are considered suitable habitat and the herds have been identified as using the east slope of the mountains, which is closer to the water source at Zzyzx Spring,

BIGHORN SHEEP CONNECTIVITY

The model of bighorn sheep connectivity does not identify linkage areas within the Study Area (Penrod et al. 2012). This conclusion is consistent with the field results, which identified a population of bighorn sheep in the south Soda Mountains, but no bighorn sheep to the north. Prior to I-15, the area may have been used for connectivity between the north and south Soda Mountains; however, the presence of I-15 reduces the potential for connectivity in the area. Individual bighorn sheep may cross through the Study Area and attempt to cross I-15, but populations of bighorn sheep would not be expected to use the area as a connectivity corridor.

CONCLUSION

Models of habitat suitability and connectivity have limitations that can result in inaccurate predictions of species habitat and connectivity. The primary limitations of these models include:

1) Errors in the model input that would cause errors in the model predictions,
2) Human disturbance, which has fragmented the habitat or reduced the value of habitat for species, is not considered, and
3) Model errors due to application to a small area.

These limitations should be considered when using the models to make conservation or land use decisions. Where field data are available, the data should be incorporated into the decision-making process.

ABSTRACT

Species habitat and connectivity models are frequently used to support land management decisions. While modeling provides an important tool for decision makers, there are limitations of habitat suitability and connectivity models that land use managers and decision makers should be aware of. Models of desert tortoise (*Gopherus agassizii*) and bighorn sheep (*Ovis canadensis nelsoni*) habitat suitability and connectivity are evaluated in this case study. The model predictions are compared to field study results of desert tortoise and bighorn sheep presence and use within an approximately 2,800-hectare (7,000-acre) area of the Mojave Desert along the Interstate-15 corridor between the North and South Soda Mountains. The comparison of model predictions to field conditions is used to evaluate the strength of each model. This analysis identifies limitations that are common to habitat and species distribution models. Model results can be inaccurate and should only be used in the absence of, rather than as a substitute for, field survey results.

PEER REVIEW

We would like to thank the following experts for their contributions and review of this paper:

Richard Tracy, Ph.D.
University of Nevada, Reno

Peter Woodman
Kiva Biological

Brent Helms, Ph.D.
NOREAS Environmental Science and Engineering

Eric Dugan, Ph.D.
NOREAS Environmental Science and Engineering

Lenny Malo
NOREAS Environmental Science and Engineering

Tim Glenner
NOREAS Environmental Science and Engineering

1 INTRODUCTION

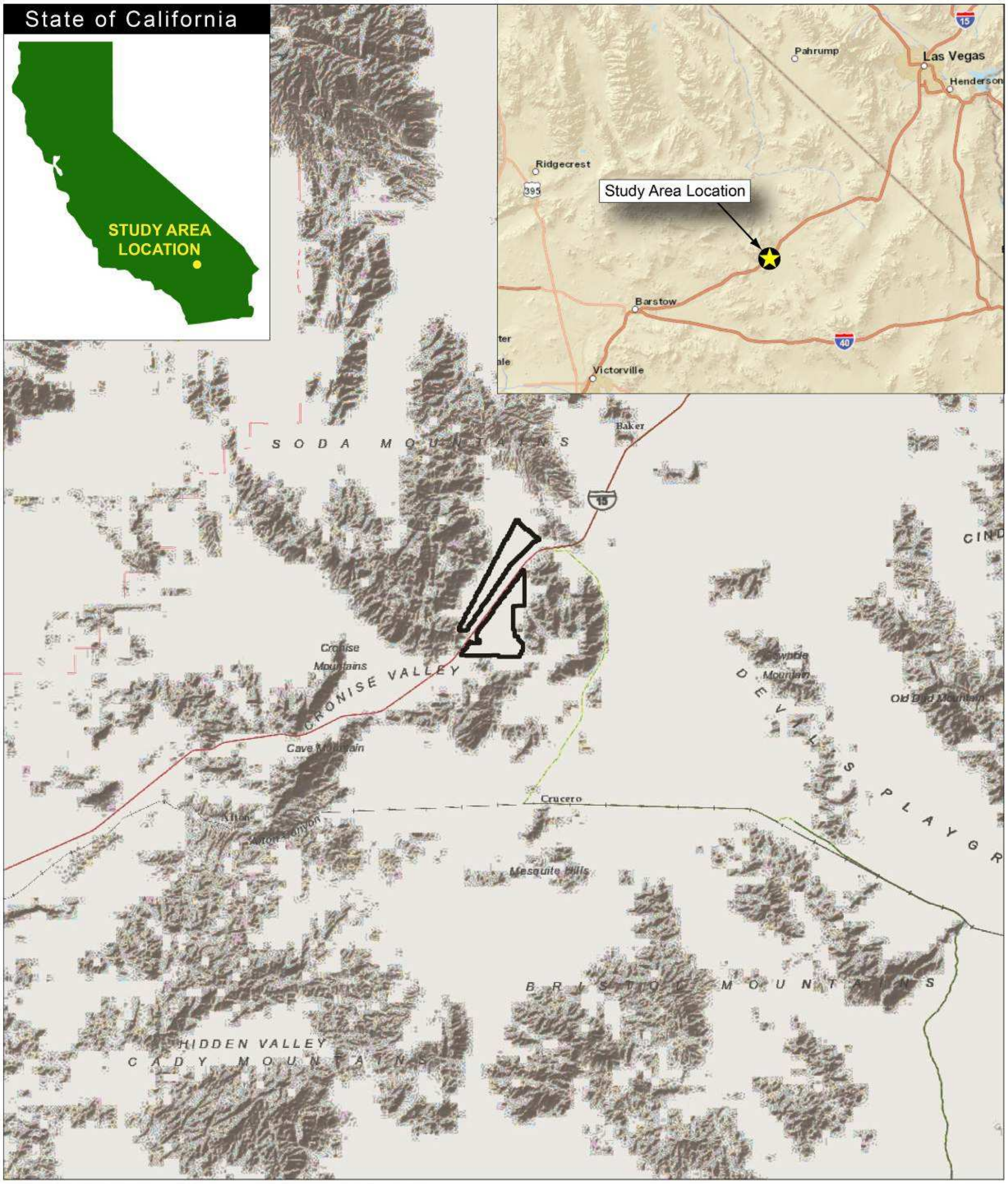
Recent studies of habitat suitability and linkage corridors in the Mojave Desert have used habitat modeling to predict suitability of species habitat and connectivity over multi-state, state, and regional geographic areas. The model results are being used to guide land use decisions related to development and conservation. This case study presents an analysis of the effectiveness of habitat models developed to predict habitat suitability at large geographic scales for use in estimating suitable habitat at a much smaller scale (4,000 hectares or less).

The primary method for determining habitat suitability and connectivity over large geographic areas is through the use of stochastic models. A stochastic modeling approach applies computer processing power to large data sets to estimate a probability distribution. This probability distribution is used to determine habitat suitability for areas within the model. Models of habitat for the desert tortoise (*Gopherus agassizii)*, bighorn sheep (*Ovis canadensis nelsoni*), and wildlife connectivity are reviewed in this case study. Field studies are reviewed to analyze model accuracy for a 2,800-hectare (7,000 acre) area.

1.1 STUDY AREA

The focus area for this study is an approximately 2,800-hectare (7,000-acre) area located along the Interstate 15 (I-15) corridor between the north and south Soda Mountains, referred to here as the Soda Mountain Study Area, San Bernardino, California (Figure 1).The Soda Mountain Study Area lies south and west of the town of Baker, California within an intermontane desert valley composed of alluvial fan deposits and surrounded by the Soda Mountains. Most of the Soda Mountains are northwest of the Study Area and reach an elevation of approximately 1,100 meters. Lower mountains to the south and east of the Study Area form a discontinuous border reaching elevations of approximately 730 meters. Elevations in the Study Area range from approximately 470 meters in the north to 380 meters in the southeast. The Baker sink, a relic of one of the drainages feeding the Pleistocene Lake Manley in Death Valley, is located east of the Study Area and the south Soda Mountains. Average annual precipitation in the Study Area is approximately 4.1 inches (Prism Climate Group 2012).

Figure 1: Soda Mountain Study Area



SOURCE: ESRI 2012 and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

Study Area

0 5 10 Miles

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PANORAMA ENVIRONMENTAL, INC.

2 BACKGROUND

2.1 HABITAT

2.1.1 Desert Tortoise

Mojave desert tortoises are known to occur from below sea level to an elevation of 2,225 meters (U.S. Fish and Wildlife Service [USFWS] 2011). Desert tortoises occur most commonly on gently sloping terrain (bajadas) consisting of sand- and gravel-rich soils where there is sparse cover of low-growing shrubs. Soils normally must be friable enough for digging burrows, yet firm enough so that burrows do not collapse (USFWS 2011). Tortoises generally cannot construct burrows in rocky soils or shallow bedrock (USFWS 2011). Typical habitat for the desert tortoise in the Mojave Desert has been characterized as creosote bush scrub between 600 meters and 1,800 meters, where precipitation ranges from 2 to 8 inches, and vegetation diversity and production is high (Nussear et al. 2009). Desert tortoises are known to occupy large home ranges.

Threats to desert tortoise populations identified in the Desert Tortoise Recovery Plan (USFWS 1994) are numerous and include:

6. Human contact and mortality, including vehicle collisions and collection of tortoises
7. Predation, primarily from raven, but also from feral dogs, coyotes, mountain lions and kit fox
8. Disease
9. Habitat destruction, degradation, and fragmentation resulting from grazing, land development, off-highway vehicles (OHVs), wildfire, and road construction

2.1.2 Bighorn Sheep

Bighorn sheep populations are found in steep, rocky, mountainous areas, commonly on slopes of 10 percent or greater (URS 2009a). Sixty-nine discrete population groups have been documented within the Mojave Desert (Bare et al. 2009). Steep, rugged terrain is the primary habitat used by bighorn sheep, particularly females and lambs, because it affords good protection from predators. Alluvial fans and washes on gently sloping terrains are also used to obtain forage and water. The availability of water is an important habitat element for bighorn sheep, particularly between May and October, when reproduction occurs (California Energy Commission [CEC] 2012).

2.1.3 Habitat Connectivity

The pace of development in the western deserts has increased with the institution of renewable portfolio standards in California, Nevada, and Arizona and federal goals for renewable energy development (CDFG et al. 2010). Wildlife corridors are increasingly impacted by land development and linear transportation features, such as highways, which can bisect and abate migration routes resulting in segregation and isolation of wildlife populations. Engineered features, such as under-highway culverts, can provide the means to cross roads safely and allow populations to connect across highways. Habitat connectivity studies are needed to identify and preserve key habitat corridors that support movement of wildlife populations and gene flow. Maintaining key corridors for wildlife dispersal is also important under changing climate conditions where wildlife populations may need to move to new habitat areas as optimal habitat is sought.

2.2 MODELS OF HABITAT SUITABILITY AND CONNECTIVITY

Several recent studies of habitat suitability and wildlife connectivity involving the California deserts have been performed to support protection of rare or threatened species, identify key areas of the desert that include the highest value habitat, and identify areas that are used by species for movement and migration. The studies analyzed in this paper are:

1. *Modeling Habitat of the Desert Tortoise (Gopherus agassizii) in the Mojave and Colorado Deserts, California, Nevada, Utah, and Arizona* (Nussear et al. 2009)
2. "Making Molehills Out of Mountains: Landscape Genetics of the Mojave Desert Tortoise" (Hagerty et al. 2010)
3. *California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California* (Spencer et al. 2010)
4. *A Linkage Network for the California Deserts* (Penrod et al. 2012)
5. *Draft Desert Renewable Energy Conservation Plan (DRECP) Baseline Biology Report* (CEC 2012)

The regional, state, and multi-state geographic scale of these studies required the use of stochastic models with large data sets to determine the potential for suitable habitat and wildlife connectivity. The purpose, methods, limitations, and results of each study are summarized.

2.2.1 Model Methods and Limitations

1. *Modeling Habitat of the Desert Tortoise (Gopherus agassizii) in the Mojave and Colorado Deserts, California, Nevada, Utah, and Arizona* (Nussear et al. 2009)

Purpose

The US Geological Survey (USGS) modeled desert tortoise habitat to evaluate the effectiveness of management efforts for the desert tortoise outlined in the 1994 USFWS Recovery Plan (Nussear et al. 2009). The USGS model was intended for use in conservation program design and to evaluate changes in species distributions. The USGS model was developed to support preparation of the Revised Recovery Plan published by USFWS in 2011.

Approach and Methods

Desert tortoise habitat suitability was modeled using the Maximum Entropy Model (Maxent) (Phillips et al. 2006). The area modeled included the desert region of California, Nevada, Utah and Arizona. Maxent allows for modeling of species distribution using presence-only data. The Maxent model is appropriate for species where there is limited absence data, or where absence is difficult to verify due to the habits of the species. The model uses presence data to define an expected probability of suitable habitat on the basis of past observances of presence of the species.

Habitat suitability was modeled using 16 data layers in a geographic information system (GIS). The model used continuous independent variables. The GIS data were obtained from various data sources and included:

1. Mean dry season precipitation for 30-year normal period
2. Dry season precipitation, spatially distributed coefficient of variation (CV)
3. Mean wet season precipitation for 30-year normal period
4. Wet season precipitation, spatially distributed coefficient of variation (CV)
5. Elevation
10. Slope
11. Northness (aspect)
12. Eastness (aspect)
13. Average surface roughness
14. Percent smooth
15. Percent rough
16. Average soil bulk density
17. Depth to bedrock
18. Average percentage of rocks >254 millimeters B-axis diameter
19. Perennial plant cover
20. Annual plant cover

A total of 15,311 presence data points representing desert tortoise presence or occurrence were aggregated from desert tortoise surveys performed from 1970 through 2008. Presence was determined from evidence of live tortoises, carcasses, burrows, scat, or other sign. Absence data were randomly selected from model grid cells where there were no desert tortoise observances during desert tortoise surveys.

The model was developed at a resolution of 1 square kilometer (km^2) (i.e., grid size). The model was tested using area under the curve (AUC)[1] to estimate model sensitivity and specificity. Due

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[1] Area under the curve (AUC) is used to test model performance by plotting sensitivity (true positive rate) on the y-axis, and specificity (false positive rate) on the x-axis (Nussear et al. 2009). The AUC characterizes the performance of the model, and is summarized by a single number ranging from 0 to 1, where 1 indicates perfect model performance, 0.5 indicates the equivalent of a random guess, and less than 0.5 indicates performance worse than random (Nussear et al. 2009). In general, AUC scores between 0.7 and 0.8 are considered fair to good, and scores above 0.9 are considered excellent (Swets 1988).

to the lack of absence data, AUC tested the model performance against pseudo-absence data rather than true absence data (Phillips et al. 2006). Pearson's correlation coefficient was calculated as the correlation between the predicted model values and 1) test presence data points where tortoises were observed, and 2) the random background points where no tortoises were observed. Pearson's correlation coefficient was used as a more direct measure of how the model predictions vary from observations. Several variables were not predictive of suitable habitat including eastness, northness, wet season precipitation CV, dry season precipitation CV, percent roughness, and slope. These variables were eliminated from the final model.

The model output of habitat potential was binned into categories ranging from 0 to 1 at increments of 0.1, where 0 represents areas where the habitat potential approaches 0 percent habitable, and 1 represents areas where the habitat potential approaches 100 percent habitable. The categories were mapped for each 1-km^2 grid cell to represent percent potential habitat.

Limitations

Limitations of the method used to predict habitat suitability include:

1. Presence-only-based modeling is commonly subject to sampling bias and spatial autocorrelation (Phillips et al. 2006).
2. Errors may be present in the data used for the model. No data were collected for this study, so it is dependent on the accuracy of the various data sources (Nussear et al. 2009).
3. There may be variables that are important to tortoise habitat suitability that were not accounted for in the model (e.g., soil type, vegetation diversity) (Phillips et al. 2006).
4. The model output was not corrected to remove areas where desert tortoises have historically not been found to inhabit, areas that are not inhabited due to biotic interactions, or areas of anthropogenic effects such as habitat destruction, fragmentation, or natural disturbances (Nussear et al. 2009; Phillips et al. 2006).
5. The approach predicts suitability statistically rather than mechanistically as in Kearney and Porter (2009). Species presence and absence in sampling data are assumed to reveal habitat suitability, but may actually reflect stochastic population dispersion (Tracy 2012).

2. "Making Molehills Out of Mountains: Landscape Genetics of the Mojave Desert Tortoise" (Hagerty et al. 2010)

Purpose

Hagerty et al. (2010) evaluated the impacts of habitat fragmentation on desert tortoise genetic diversity. Genetic testing was used to identify landscape features that could facilitate or impede tortoise movement. This study identifies barriers and limitations to tortoise movement to provide a better understanding of how landscape features can impact desert tortoise genetic diversity. Maintaining genetic diversity is particularly important for rare species whose continued existence can be threatened by disease. An improved understanding of landscape genetics is needed to identify methods to maintain or tortoise genetic diversity and support species recovery efforts.

Approach and Methods

Habitat connectivity for desert tortoise was modeled and used in combination with genetic data to determine the factors that influence tortoise gene flow. DNA was extracted from blood collected from 744 desert tortoises in 25 different geographic areas within California, Nevada, Utah and Arizona deserts. Genetic distance measures or the genetic divergence within the desert tortoise population were calculated for the 25 sampling locations. Euclidian distances (geographic distances) were also calculated as a straight-line measure between the center points of the 25 areas using GIS tools.

A habitat suitability model was developed using Maxent. The model was similar to the model developed by Nussear et al. (2009) and used the same tortoise presence data and 12 of the 16 data layers in its construction. Three separate models were constructed using the outputs of a habitat suitability model:

1. Least-cost path
2. Isolation by resistance
3. Isolation by barriers

Two models of landscape friction, least-cost path and isolation by resistance, were developed using a resistance surface[2] where cells of lower potential habitat would reduce the ability for desert tortoise to traverse the landscape. The least-cost path was identified between the center point of each of the 25 geographic areas, where the shortest distance with least cost for movement (determined by the resistance surface) was defined. In the isolation by resistance model, a resistance distance was estimated similar to least-cost pathway, except the resistance distance decreases proportionally with the increase in available pathways between locations. The resistance distance also assumes a random walk between locations where the habitat suitability in each adjacent cell is used to determine friction resisting movement. The third model, an isolation by barriers model, was created by identifying barriers to movement across the landscape. Areas with a predicted probability of potential habitat less than 0.125 were coded as "no data" and defined as complete barriers to movement. Within the isolation by barriers model, tortoise were allowed to move across all non-barrier cells without friction.

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[2] A resistance surface is developed in GIS using a habitat suitability model. The probability of suitable habitat is subtracted from 1 for each cell in the model. The resulting values are the resistance surface representing the "cost" of movement from one habitat cell in the model to an adjacent cell.

Limitations
Due to the long generational time (25 years) of desert tortoise, the results of the study based upon genetic information cannot reflect current habitat connectivity or barriers. It normally would take several tortoise generations before the effects of roads or other human made barriers would be reflected in population genetics (Hagerty et al. 2010).

Landscape friction was not significantly correlated with genetic diversity. The variables used in the landscape friction model describe desert tortoise habitat in the present and may not capture the appropriate temporal scale to explain the genetic population structure. The resistance surfaces developed from the habitat suitability model may only reflect habitat use and not the resistance to dispersal (Hagerty et al. 2010).

3. *California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California* (Spencer et al. 2010)

Purpose
The *California Essential Habitat Connectivity Project* was prepared for the California Department of Transportation (Caltrans) and California Department of Fish and Game (CDFG). The purpose of the study was to increase efficiency and decrease costs of transportation and land use planning, and to reduce wildlife-vehicle collisions. The report was prepared to define a functional and connected network of wildlands. High quality habitat areas and the connections between these areas were defined to maintain wildlife diversity, which is threatened by human development and climate change.

Approach and Methods
The California Essential Habitat Connectivity Project identified habitat connectivity corridors throughout California. The process for defining wildlife connectivity corridors involved:

1. Delineating Natural Landscape Blocks (areas with high habitat value)
2. Identifying which Natural Landscape Blocks to connect
3. Defining Essential Connectivity Areas

Natural Landscape Blocks were delineated based on a rating of the naturalness of the landscape, called an ecological condition index. Within the Mojave Desert, landscape blocks were limited to those areas larger than 4,000 hectares (10,000 acres) with an ecological condition index greater than 95 and with high biological value. High biological value was defined as areas with GAP Conservation Status 1 or 2 and areas with 1) critical habitat for threatened or endangered species, 2) wetlands or vernal pools, 3) CDFG mapped hotspots using a rarity-weighted richness index, or 4) BLM Areas of Critical Environmental Concern. Lines were drawn between the center point of a landscape block and the center point of the closest and second closest landscape blocks.

Least-cost corridor models were used to define essential connectivity areas between Natural Landscape Blocks along each of the lines. The least-cost corridor model used a resistance surface based on the ecological condition index (0 percent to 100 percent) representing the resistance of the landscape to ecological flow. Using the resistance layer, the cost to move from one landscape block to another was calculated by subtracting the resistance value from 1. The cost of movement from one landscape block to the adjacent block was summed along the entire distance. The area with the 5 percent lowest cost of movement from one landscape block to the next was designated as an Essential Connectivity Area.

Limitations

1. Natural Landscape Blocks excluded Department of Defense lands and multiple-use lands administered by BLM because they did not meet the criteria of being highly conserved and being mapped as having high biological value. Department of Defense lands include areas of high ecological value (Spencer et al. 2010).
2. Spencer et al. modeled connectivity areas on the basis of naturalness of habitat. Species-specific modeling was not used to identify connectivity corridors. The lack of species-specific modeling produces a result that is of limited use to understanding how wildlife would use these corridors as different species have different habitat requirements that affect their movement across the landscape (Tracy 2012). To overcome this limitation, , "Essential Connectivity Areas are placeholder polygons that can inform land-planning efforts, but that should eventually be replaced by more detailed Linkage Designs, developed at finer resolution based on the needs of particular species and ecological processes."(Spencer et al. 2010) Results of finer-scale regional analyses for connectivity should replace the Essential Connectivity Map for those areas in the statewide report.

4. *A Linkage Network for the California Deserts* (Penrod et al. 2012)

Purpose

The California Desert Connectivity Project was designed to identify areas of ecological connectivity that are essential for conserving biological diversity within the Mojave and Sonoran Deserts in California. Key areas of connectivity are identified to maintain genetic diversity. The key areas of connectivity collectively form a linkage design within the California Deserts. The linkage designs were developed to inform land management, land acquisition, restoration, and stewardship decisions in ecological connectivity zones.

Approach and Methods

Habitat connectivity was evaluated for 44 species that were identified as important to the Mojave and Sonoran Desert habitat. Landscape blocks were defined in this study as those areas that are highly protected, including wildlife management areas and Department of Defense lands. The landscape blocks were connected through 22 separate corridors where connectivity analysis was conducted.

Habitat suitability was modeled for the focal species using expert-assigned scores from 0 to 10 for habitat suitability for each factor (see list below). Weights were assigned for the factor to express relative influence of each factor, such that the weights for all factors summed to 100 percent. Each 30-square-meter (m^2) grid cell was scored across the modeled area. Data used in the expert-based models included scores for:

- Land cover
- Elevation
- Aspect (i.e., facing direction)
- Slope
- Distance to streams
- Road density

Corridor modeling was performed to evaluate habitat connectivity for both desert tortoise and bighorn sheep. A corridor was then defined using a least-cost corridor model and selecting those areas with the 5 percent least cost of movement[3].

Additional wildlife corridors were also defined using least-cost corridor modeling. Land facets[4] were used to define pathways for wildlife to move from high elevation to low elevation under changing climatic conditions. Field surveys were conducted to:

1. Ground-truth data (i.e., field data were collected to verify model data)
2. Document habitat barriers (e.g., roads, railroads, and canals)
3. Document potential crossing structures along those barriers
4. Identify locations where restoration and management would enhance connectivity

The land facet corridors and species-specific corridors were combined and used as a preliminary linkage design. The preliminary linkage design was refined through field investigation and removal of redundant connections between landscape blocks. The resulting linkage design incorporated the analyses of fieldwork, species-based modeling, and land facet corridors.

Limitations

1. The expert-based models used habitat scores and weights selected by experts. This approach is subject to expert bias and differences in expert opinions (Rochet and Rice 2004; Greenland and O'Rourke 2001).
2. An expert-assigned score of 0 for any criterion would reduce the habitat score to 0 regardless of the relative weight of that criterion (Penrod et al. 2012).

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[3] Least-cost corridor modeling involves calculating the "cost" of movement from one cell in a model to the next cell using a resistance surface. The cost of movement is aggregated over the distance between the start and end point.

[4] Land facets are enduring landscape features or units with uniform topographic and soil attributes that are "areas of biological activity" (Penrod et al. 2012).

5. *Draft DRECP Baseline Biology Report* (CEC 2012)

Purpose

The Desert Renewable Energy Conservation Plan (DRECP) is being developed to protect and conserve California's deserts while allowing for renewable energy development in areas that have a low level of environmental conflict. The DRECP Baseline Biology Report provides a summary of environmental and biological conditions within the DRECP Plan Area[5] (Figure 2). The biological baseline data will serve as the basis for conservation planning under the DRECP.

Approach and Methods

Desert Tortoise. The *Draft Desert Renewable Energy Conservation Plan Baseline Biology Report* (CEC 2012) identifies suitable desert tortoise habitat through a GIS model that is built on the results of the model developed by Nussear et al. (2009). The DRECP Plan Area covers areas within southern California deserts. The output of the desert tortoise habitat model developed by Nussear et al. (2009), was used as a base layer in GIS. Potential suitable habitat was first defined in this model as those areas with a predicted probability of desert tortoise habitat suitability of 0.6 or greater. Suitable habitat was then limited to all areas with a probability of suitable habitat between 0.6 and 1.0 that could be reached from any 1.0-rated area, with no intervening unconnected habitat areas.

The model was adjusted for anthropogenic disturbance using the National Landcover Dataset impervious surfaces layer and The Nature Conservancy's (TNC) "highly converted areas" data (TNC 2009; TNC 2010). Areas with high anthropogenic disturbance were converted to zero habitat potential. Additionally, military bases and OHV areas were manually removed from the suitable habitat model layer because they would not be considered for development or reserve areas.

Bighorn Sheep. Suitable habitat for bighorn sheep was modeled at a 1-km^2 resolution using the Maxent model (Phillips et al. 2006). Twenty-four occurrence data points obtained over the DRECP Plan Area were used to calibrate the model and eight occurrence points were used to test the model. Suitable habitat was defined as areas with a modeled probability of 0.236[6] or higher. The threshold for suitable habitat was determined using Jenks Natural Breaks[7] to classify the model output. AUC was used to determine model predictive capability.

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[5] The DRECP Plan Area covers the Mojave and Colorado Desert Ecoregions within California.

[6] The threshold for suitable habitat is much lower for bighorn sheep than for desert tortoise. This could be attributed to the small number of data points used to construct the model for bighorn sheep.

[7] The Jenks method maximizes between class variability and minimizes within class variability to find the strongest natural breakpoint in the histogram of cell probability values. This approach is used to separate

Habitat Connectivity. Habitat connectivity in the DRECP baseline biology study was defined using the GIS outputs of previous habitat connectivity mapping projects, which included:

- *A Linkage Network for the California Deserts* (Penrod et al. 2012)
- *The California Essential Connectivity Project* (Spencer et al. 2010)
- *The South-Coast Missing Linkages Project* (Beier et al. 2006; South Coast Wildlands 2008)
- *A Linkage Design for the Joshua Tree-Twentynine Palms Connectivity* (Penrod et al. 2008)

Limitations

Desert Tortoise. Because the methods used in this study relied on the results of a previous desert tortoise habitat suitability model (Nussear et al. 2009), several limitations of that study would apply:

1. Presence-only-based modeling is commonly subject to sampling bias and spatial autocorrelation (Phillips et al. 2006).
2. Errors may be present in the data used for the model. No data were collected for this study, so it is dependent on the accuracy of other studies (Nussear et al. 2009).
3. There may be variables that are important to tortoise habitat suitability that were not accounted for in the model (e.g., soil type, vegetation diversity, desert pavement) (Phillips et al. 2006).
4. An Off-Highway Vehicle (OHV) area located directly south and east of the Soda Mountain Study Area was included as suitable habitat, which conflicts with the methods described for this study (i.e., OHV areas are not to be included in the model).

Bighorn Sheep. The following aspects are limitations of the model for bighorn sheep:

1. The model may be subject to sample bias and spatial autocorrelation (Phillips et al. 2006).
2. Model accuracy depends on the accuracy of the data used to construct the model (Phillips et al. 2006).
3. The home range of Desert bighorn sheep can be very large, and observations of presence is generally temporally fleeting, and may not adequately represent habitat that can, or will be used by sheep (Tracy 2012).
4. The model was not corrected for human disturbance or other factors that may preclude species presence (Phillips et al. 2006).

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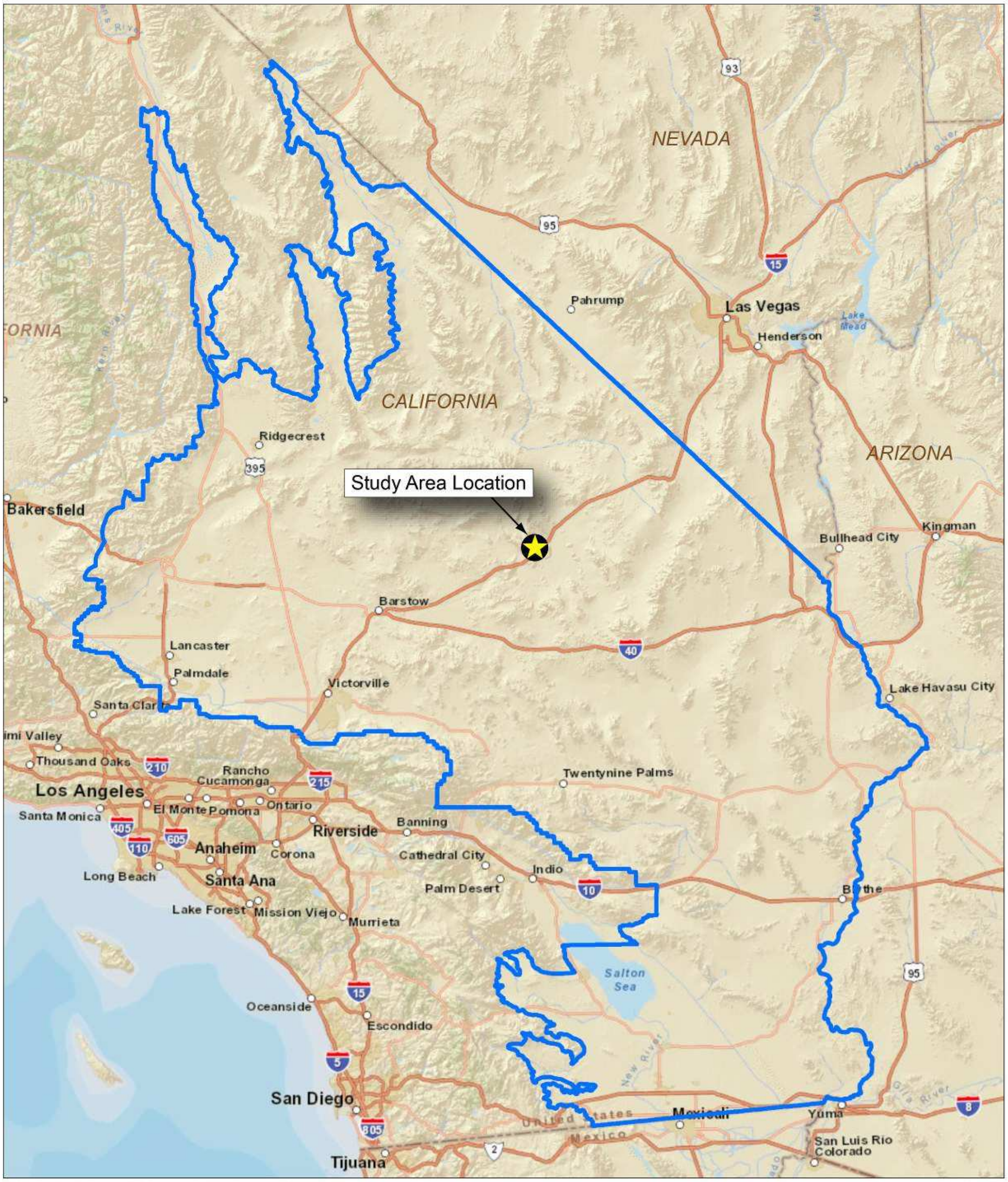
areas of higher probability of occurrence (habitat) from areas of lower probability of occurrence (non-habitat) (CEC 2012).

Figure 2: DRECP Plan Area



SOURCE: ESRI 2012 and Panorama Environmental, Inc. 2012

Scale: 1:3,000,000

LEGEND

Study Area Location

DRECP Boundary

0 25 50 75 100 Miles

N

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Connectivity. The *DRECP Baseline Biology Report* used the base maps from *A Linkage Network for the California Deserts* (Penrod et. al 2012) and *The California Essential Connectivity Project* (Spencer et al. 2010); therefore, the limitations of those efforts, presented previously, apply to the *DRECP Baseline Biology Report* as well. This study did not critically evaluate or prioritize the mapping efforts where there was overlap. The base map for the *California Essential Connectivity Project* includes essential connectivity areas in the Mojave Desert (Figure 3.8, Spencer et al. 2010). Where the linkage map from *A Linkage Network for the California Deserts* (Penrod et al. 2012) overlaps with the base map for the *California Essential Connectivity Project* (Spencer et al. 2010), the finer scale linkage map developed by Penrod et al. (2012) should replace the connectivity base mapping layer developed by Spencer et al. (2010).In the *DRECP Baseline Biology Report*, there was no replacement of mapped connectivity areas with the finer-scale species-specific regional linkage maps where the finer-scale maps overlapped with the generalized connectivity map. The *DRECP Baseline Biology Report* violates and is inconsistent with the method proposed by Spencer et al. 2010, which included replacement of the general connectivity maps with the finer-scale regional maps developed using species specific analysis.

2.2.2 Modelled Results for Soda Mountain Study Area

The general results for habitat suitability and wildlife connectivity modeling are presented in Table 1. Specific results within the Soda Mountain Study Area are also provided in Table 1.

2.3 SODA MOUNTAIN STUDY AREA FIELD STUDIES

Field studies were conducted to evaluate habitat for desert tortoise and bighorn sheep within the Soda Mountain Study Area. These studies include:

- Surveys for desert tortoise
- Aerial and ground surveys for bighorn sheep
- Field surveys of vegetation and wildlife
- Water resources studies
- Geology studies

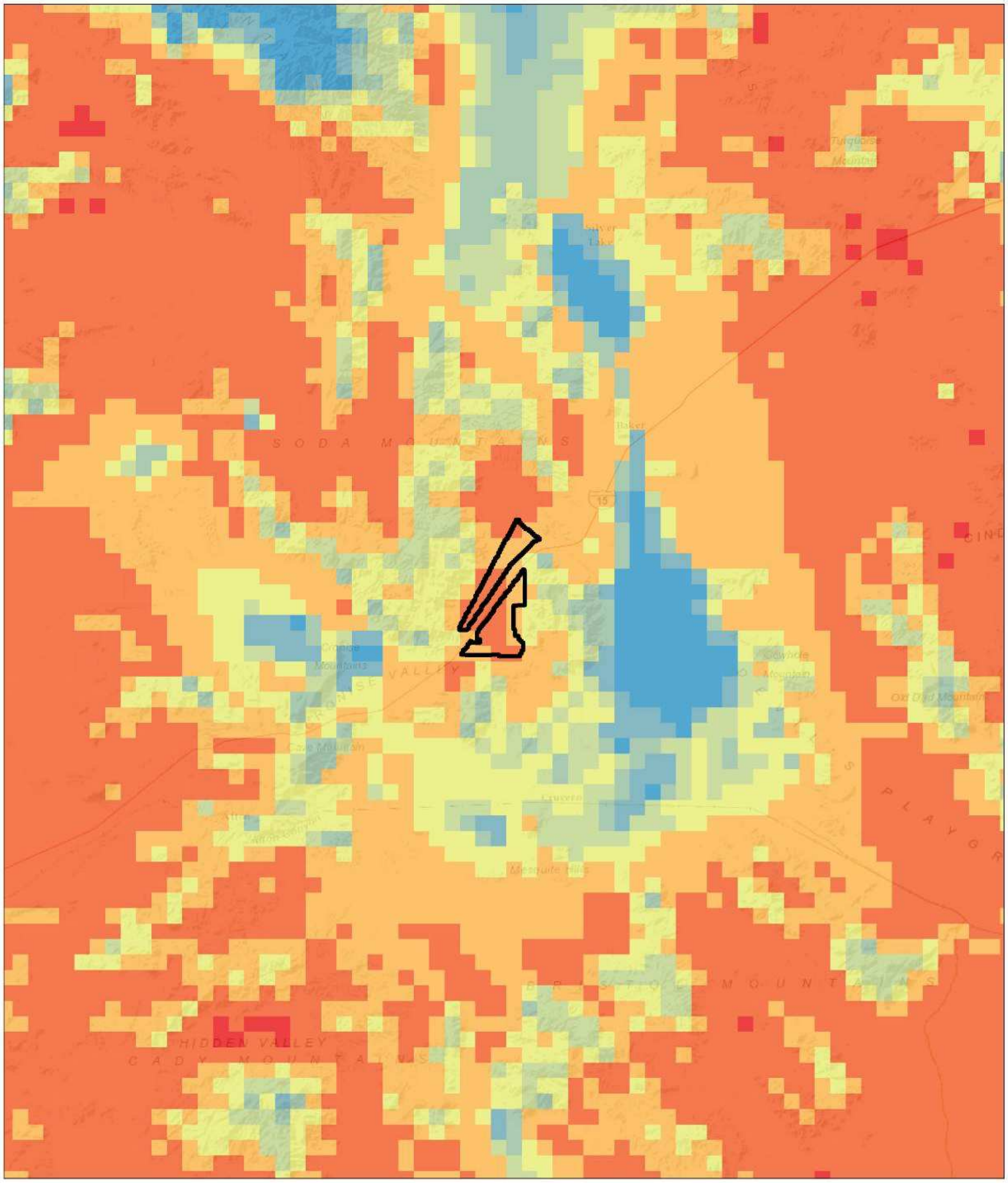
Table 1: Modelled Results for the Study Area

Study	Results/Output	Results for Soda Mountain Study Area
Desert Tortoise		
1 Nussear et al. 2009	The model output was used to produce a map of predicted habitat suitability for the Mojave, Colorado, and Sonoran Deserts. The model result was significant and the AUC test score was	Areas within the Soda Mountain Study Area have a predicted habitat potential between 0.6 and 0.8, indicating the presence of adequate, predicted suitable habitat for desert tortoise, and thus, a

Table 1: Modelled Results for the Study Area		
Study	**Results/Output**	**Results for Soda Mountain Study Area**
	0.93, indicating a good fit between model data and observations. The mean model score for cells where tortoise were observed was 0.84. Ninety-five percent of cells with documented tortoise presence had a model score of 0.70 or higher.	high likelihood of tortoise presence (Figure 3).
5 CEC 2012	The output of this study is a GIS layer depicting suitable habitat for desert tortoise.	The entire Soda Mountain Study Area is identified as suitable habitat for desert tortoise (Figure 4).
Bighorn Sheep		
5 CEC 2012	A map depicting suitable habitat was constructed using the model output. The model had an AUC value of 0.962 for the calibration data and 0.889 for the test data, demonstrating good predictive capability.	The Maxent model identified suitable habitat for bighorn sheep within the southern portion of the Soda Mountain Study Area. Suitable habitat was also identified within the Soda Mountains north and south of the Study Area (Figure 5).
Habitat Connectivity		
2 Hagerty et al. 2010	Geographic distance and dispersal barriers using the isolation by barriers model were identified as dominant factors and were significantly correlated with genetic structure. Landscape friction was not significantly correlated with gene flow. To construct the model and test hypotheses, GIS models of tortoise barriers, resistance, and least-cost corridors were developed. This study supports the conclusion that habitat within the Mojave population of the desert tortoise is well connected.	Barriers to tortoise movement were identified to the south, east and north of the Soda Mountain Study Area. These barriers included the Baker sink to the south and east, and the mountains to the north. No specific barriers to dispersal were identified within the Study Area (Figure 6).
3 Spencer et al. 2010	An Essential Connectivity Map was developed for California. The map includes 850 Natural Landscape Blocks. Areas that connected two or more	The Soda Mountain Study Area is located within an Essential Connectivity Area (Figure 7).

Table 1: Modelled Results for the Study Area		
Study	**Results/Output**	**Results for Soda Mountain Study Area**
	Natural Landscape Blocks were identified as Essential Connectivity Areas. These maps should be replaced with the results of finer scale regional studies (Spencer et al. 2010).	
4 Penrod et al. 2012	This study resulted in maps showing linkage corridors for 44 focal species and for wildlife connectivity in a union of linkages. Linkages were defined for desert tortoise and bighorn sheep.	The Soda Mountain Study Area does not fall within a least-cost corridor delineated for desert tortoise (Figure 8) or bighorn sheep (Figure 9), or a least-cost union.
5 (CEC 2012)	The result of the DRECP effort is a map of habitat connectivity generated using layers from each of the connectivity projects (including Study 3 and 4).	The Soda Mountain Study Area is identified within the Essential Connectivity Area mapped by the California Essential Connectivity Project (Study 3). It is not identified as a connectivity area within any of the other habitat connectivity mapping efforts.

Figure 3: Desert Tortoise Habitat Suitability (Nussear et al. 2009)



SOURCE: ESRI 2012, USGS Western Ecological Research Center 2009, and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

Study Area

Habitat suitability	
0 - 0.1	0.5 - 0.6
0.1 - 0.2	0.6 - 0.7
0.2 - 0.3	0.7 - 0.8
0.3 - 0.4	0.8 - 0.9
0.4 - 0.5	0.9 - 1

0 5 10 Miles

N

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Figure 4: Desert Tortoise Suitable Habitat (CEC 2012)

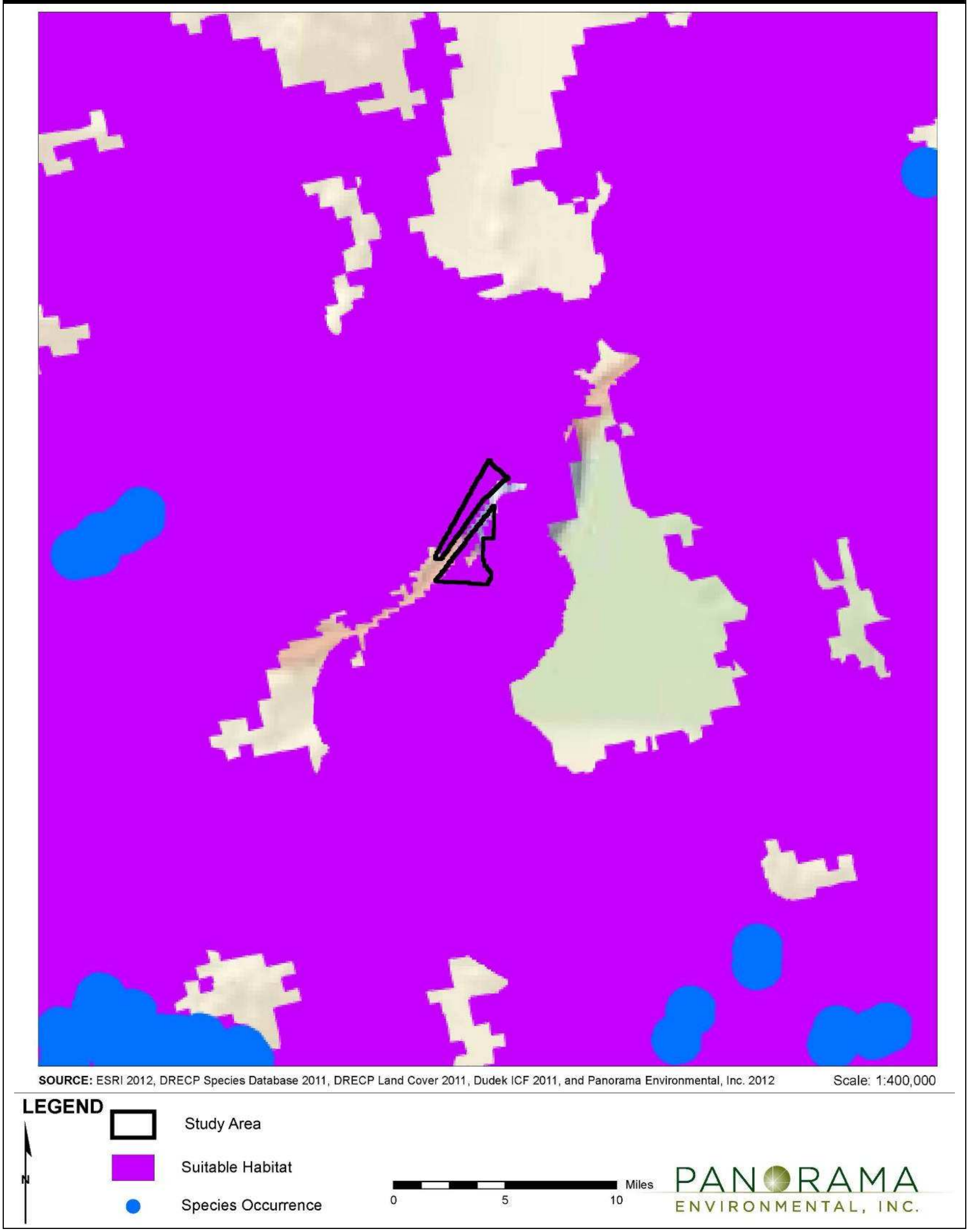


Figure 5: Bighorn Sheep Suitable Habitat (CEC 2012)

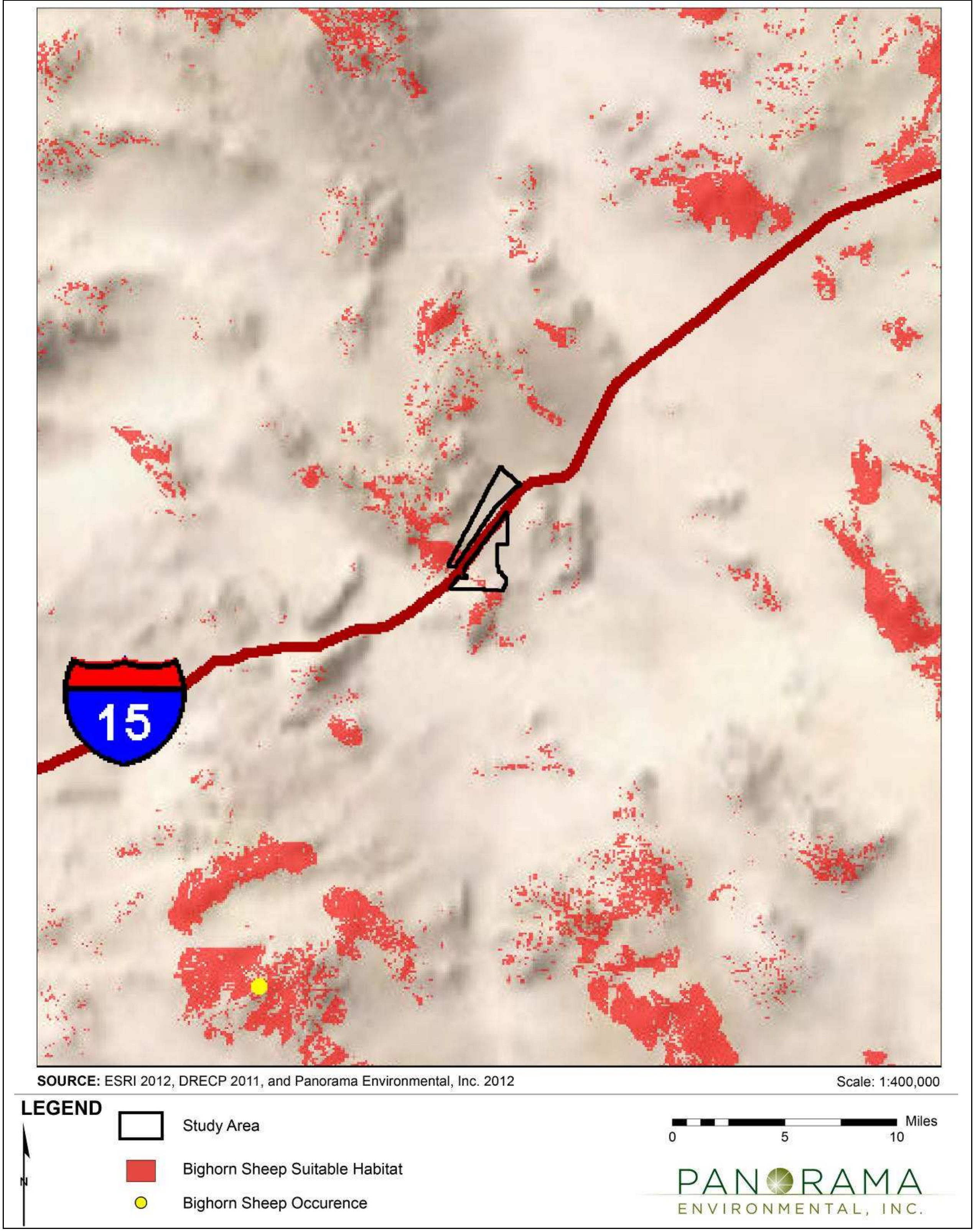
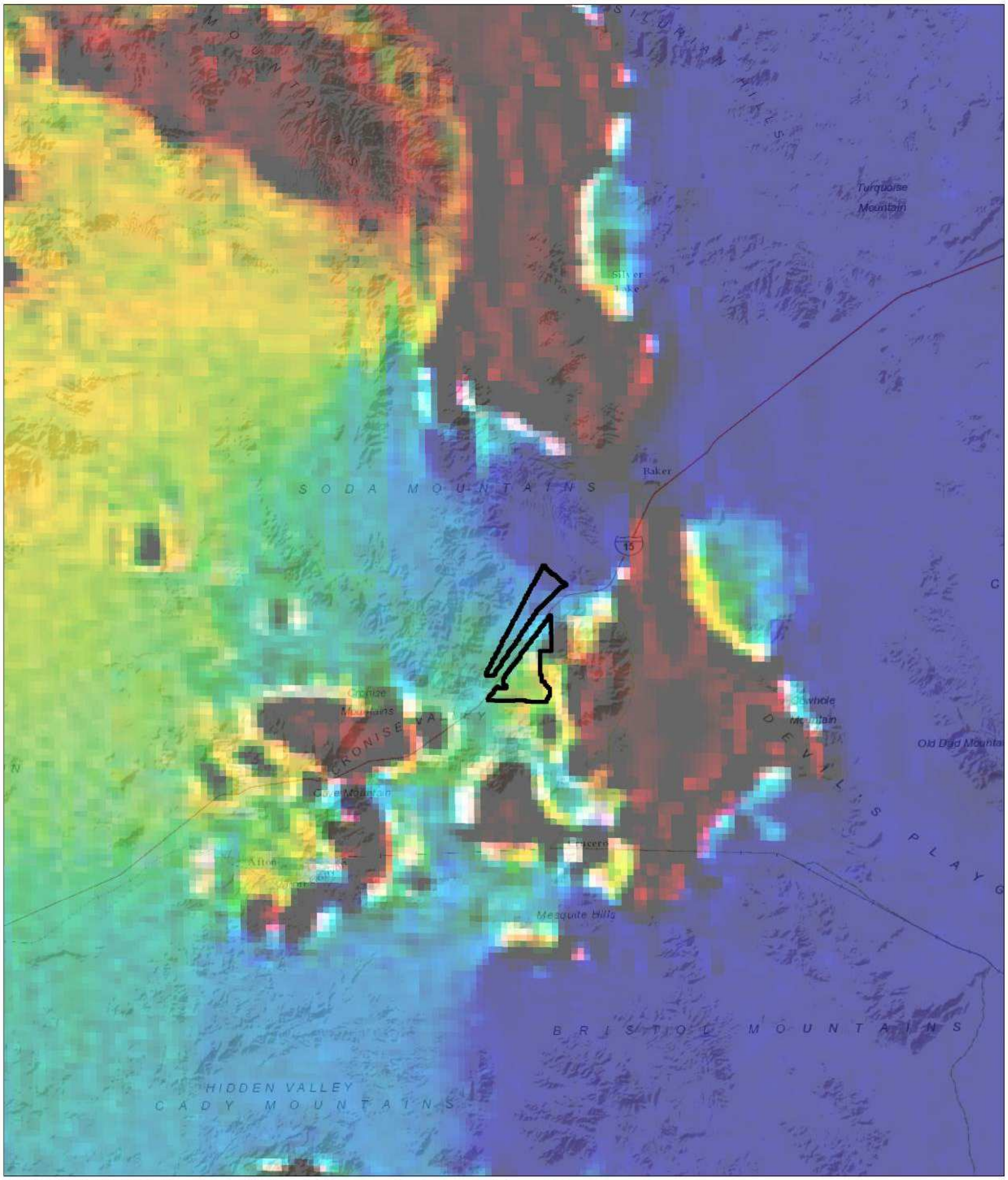


Figure 6: Barriers to Desert Tortoise Movement (Hagerty et al. 2010)



SOURCE: ESRI 2012, Hagerty et al 2010, and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

Study Area

Barrier

0 5 10 Miles

N

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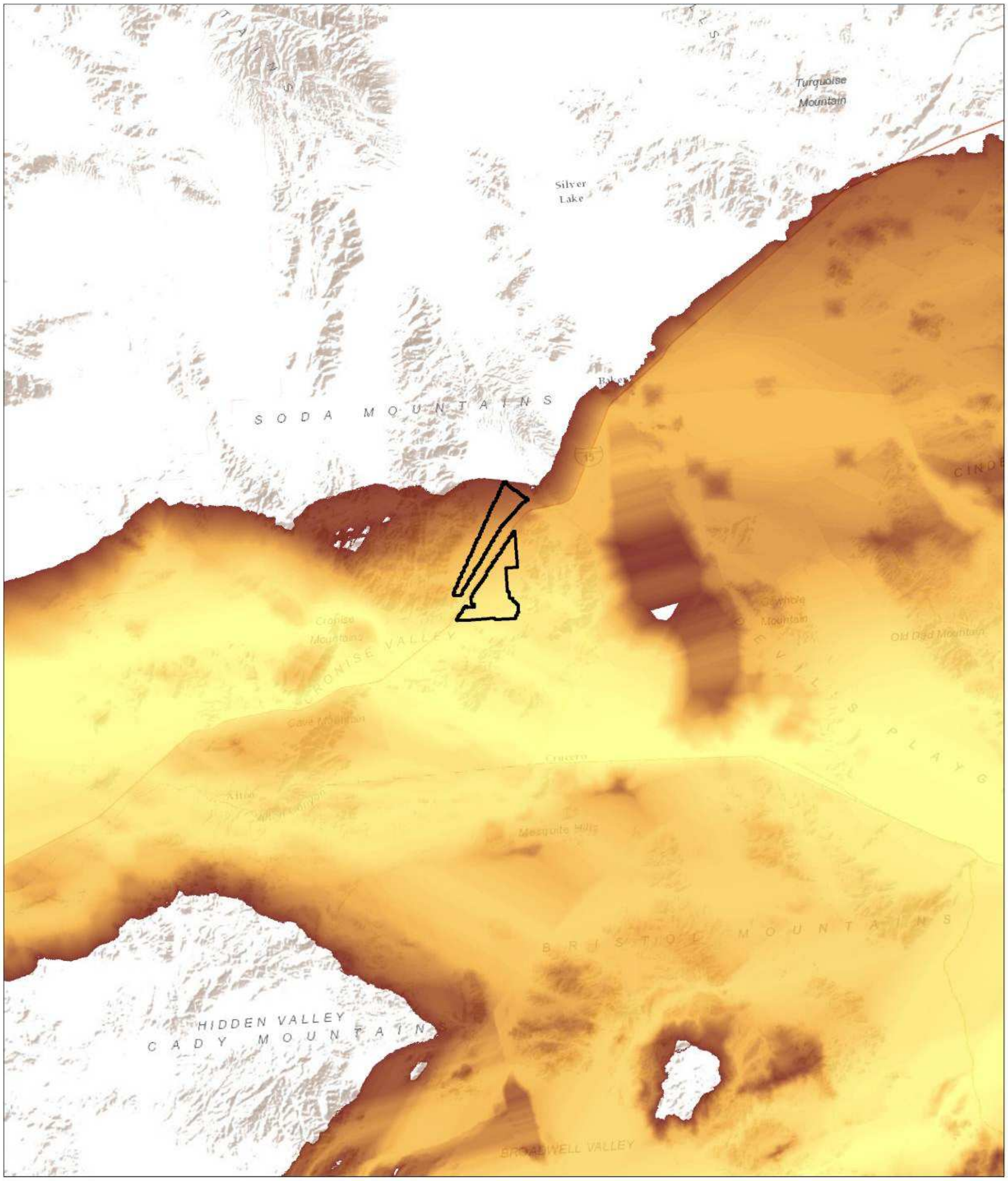
Figure 7: Essential Connectivity Areas (Spencer et al. 2010)



SOURCE: ESRI 2012, CalTrans 2010, and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

Study Area

Essential Connectivity Area

More Cost — Less Cost

0 5 10 Miles

N

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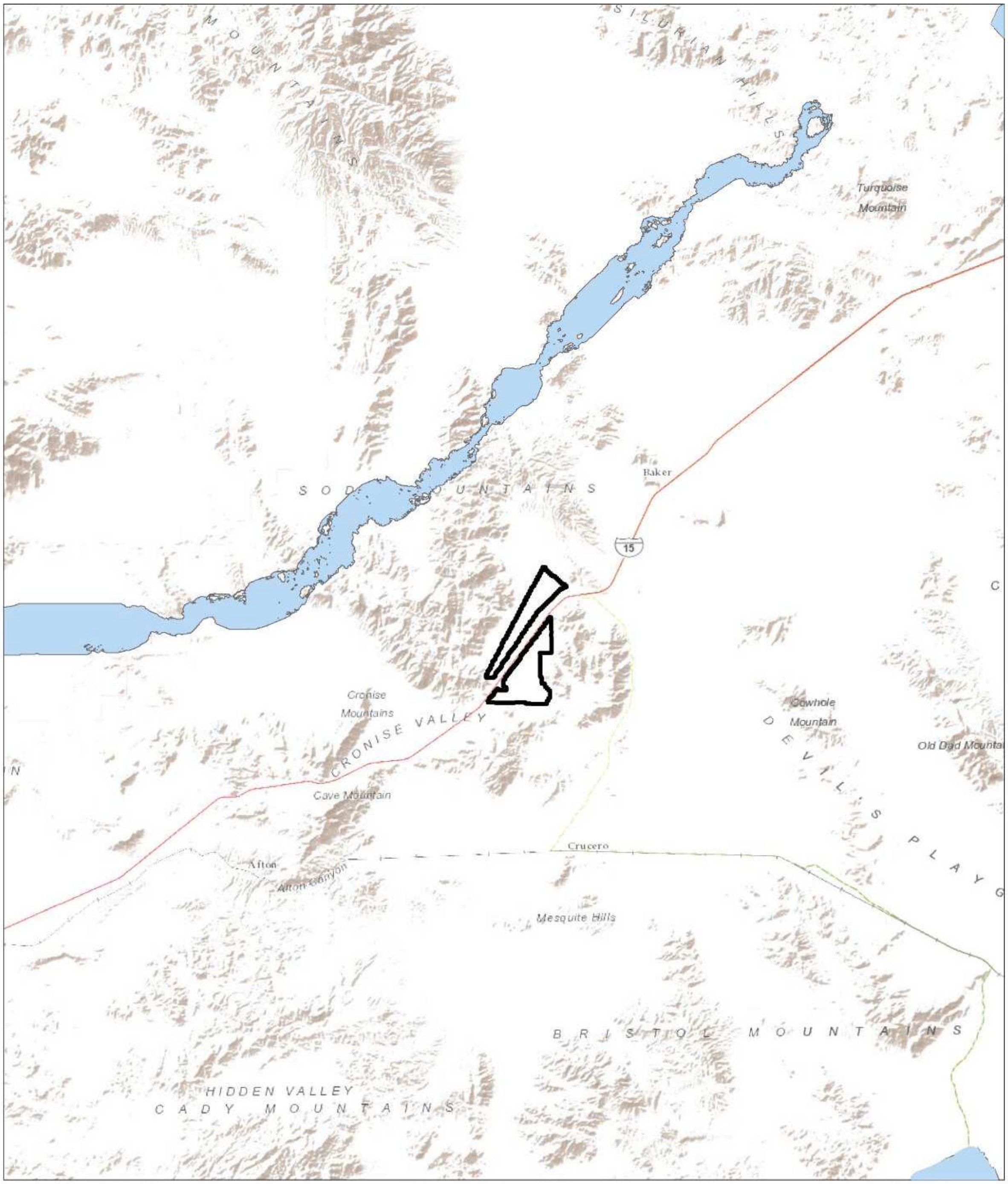
Figure 8: Desert Tortoise Linkages



SOURCE: ESRI 2012, Nussear et al 2009, and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

Study Area

Desert Tortoise Linkage

0 5 10 Miles

N

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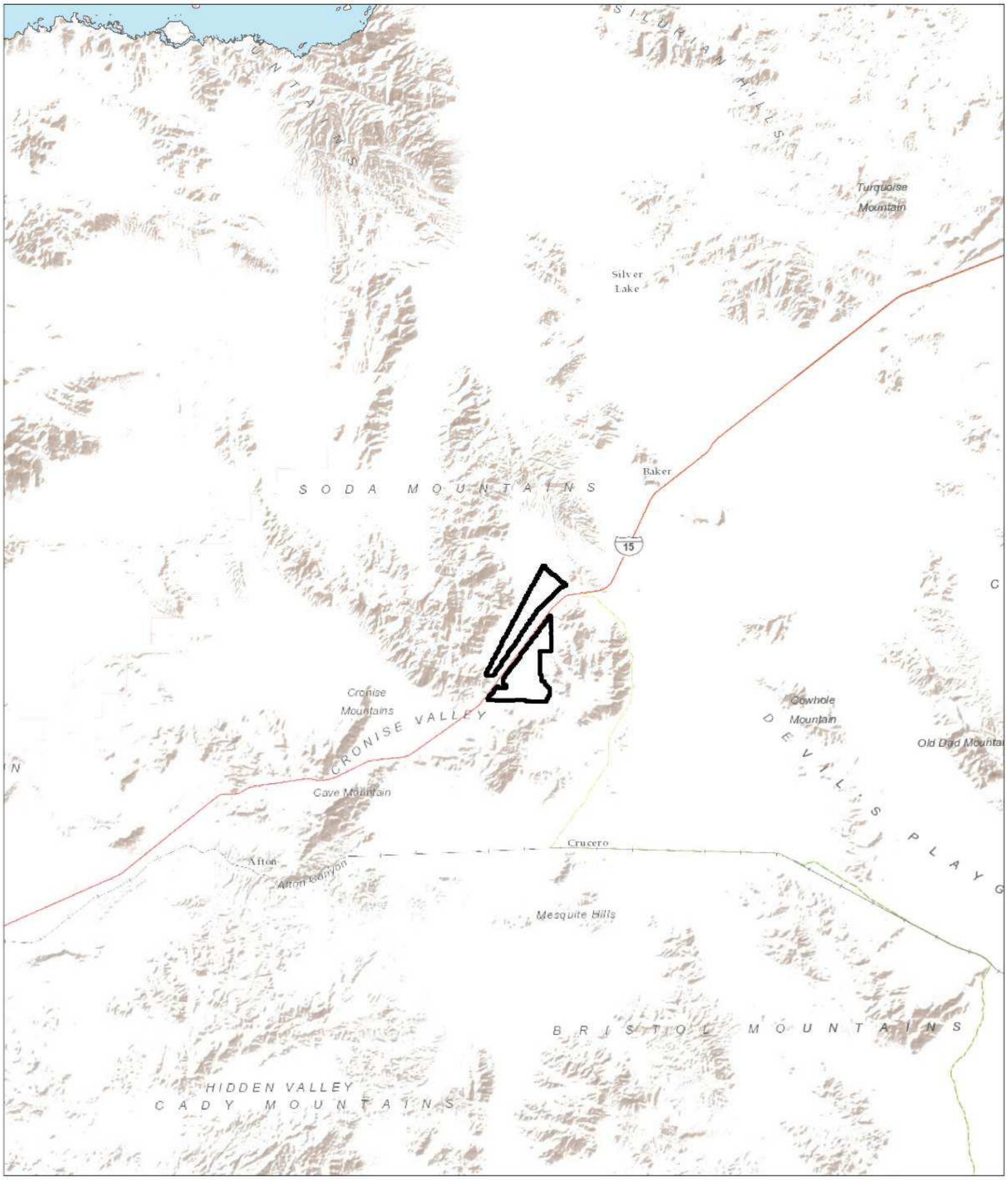
Figure 9: Bighorn Sheep Linkages



SOURCE: ESRI 2012, Mojave Desert Ecosystem Program 2012, and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

Study Area

Bighorn Sheep Linkage

0 5 10 Miles

N

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2.3.1 Methods

Desert Tortoise

Field surveys for desert tortoise were performed in 2001 and 2009 within the Soda Mountain Study Area and vicinity. The 2001 survey was performed in the Opah Ditch Mine area located in the foothills of the Soda Mountains north of I-15 and west of Los Angeles Department of Water and Power (LADWP) and Southern California Edison (SCE) transmission lines (Figure 10). The survey was performed on March 30 and April 4, 2001, in accordance with USFWS-recommended *Field Survey Protocol for Any Non Federal Action That May Occur Within the Range of the Desert Tortoise* (1992). Belt transects spaced approximately 10 meters (30 feet) apart were walked over approximately 80 percent of the site and the dirt-haul road that provides site access (AMEC 2001). A 30-meter-wide buffer zone survey was performed in accessible areas adjacent to the site. Desert tortoise sign were marked and mapped.

The 2009 survey was conducted for the Soda Mountain Study Area north and south of the I-15 corridor (Figure 10) between May 4 and May 29, 2009. Survey techniques followed both the 1992 USFWS protocol for desert tortoises (USFWS 1992), and the survey protocol described in *Preparing for Any Action that May Occur within the Range of the Mojave Desert Tortoise (Gopherus agassizii)* (USFWS 2009). The field survey consisted of 100 percent coverage belt transects spaced at 10 meters (33 feet) within the entire Study Area. In addition to 100 percent coverage of the study area, Zone of Influence (ZOI) transects[8] were also performed (URS 2009a). ZOI transect locations were located in areas containing potentially suitable tortoise habitat based on aerial image analysis, elevation, and field observations of potentially suitable habitat within the Study Area. ZOI transects were surveyed with transects spaced at 30, 90, 180, 370, and 730 meter intervals, where applicable (URS 2009a). Areas along the mountains where the topography was very steep were not included in the ZOI surveys.

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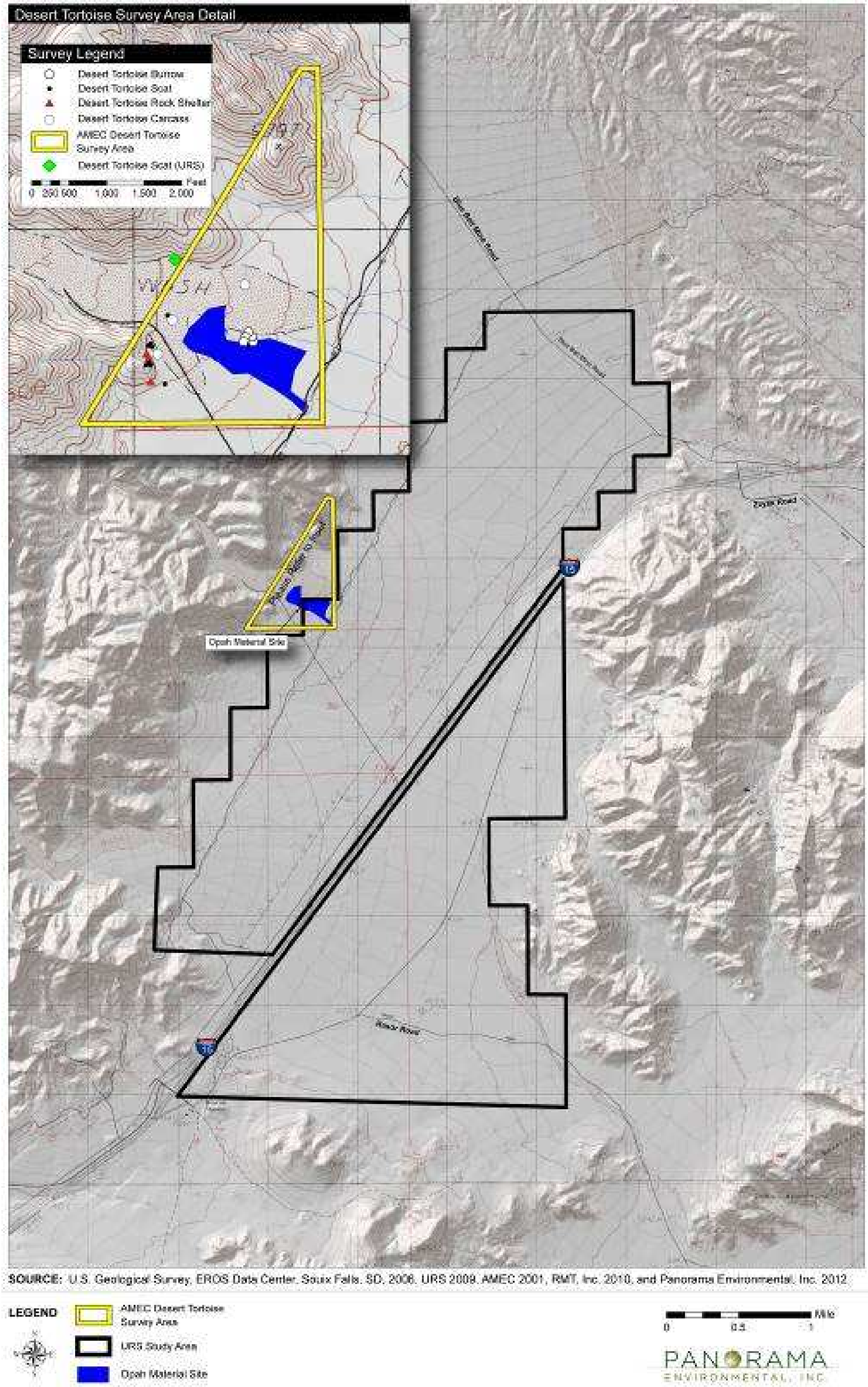
[8] The zone of influence is an area outside of the Study Area that may be affected by a land use action. Zone of influence transects were established outside of the Study Area running parallel to the Study Area boundary.

Figure 10: Desert Tortoise Survey Locations



To validate the accuracy of the protocol surveys, biologists performed an additional intensive quality assurance/quality control (QA/QC) survey on 5 percent of the Study Area (USFWS 1992). This intensive survey effort was a 100 percent coverage using belt transects with spacing width reduced to 3 meters (10 feet) and was conducted in randomly chosen, representative habitats within the Study Area. QA/QC transects were conducted perpendicular to the initial transect survey direction to maximize tortoise detection. A comparison was then made between data recorded from transects during the 100 percent survey effort (10-meter belt transects) and data recorded during the intensive QA/QC survey effort (3-meter belt transects).

Bighorn Sheep

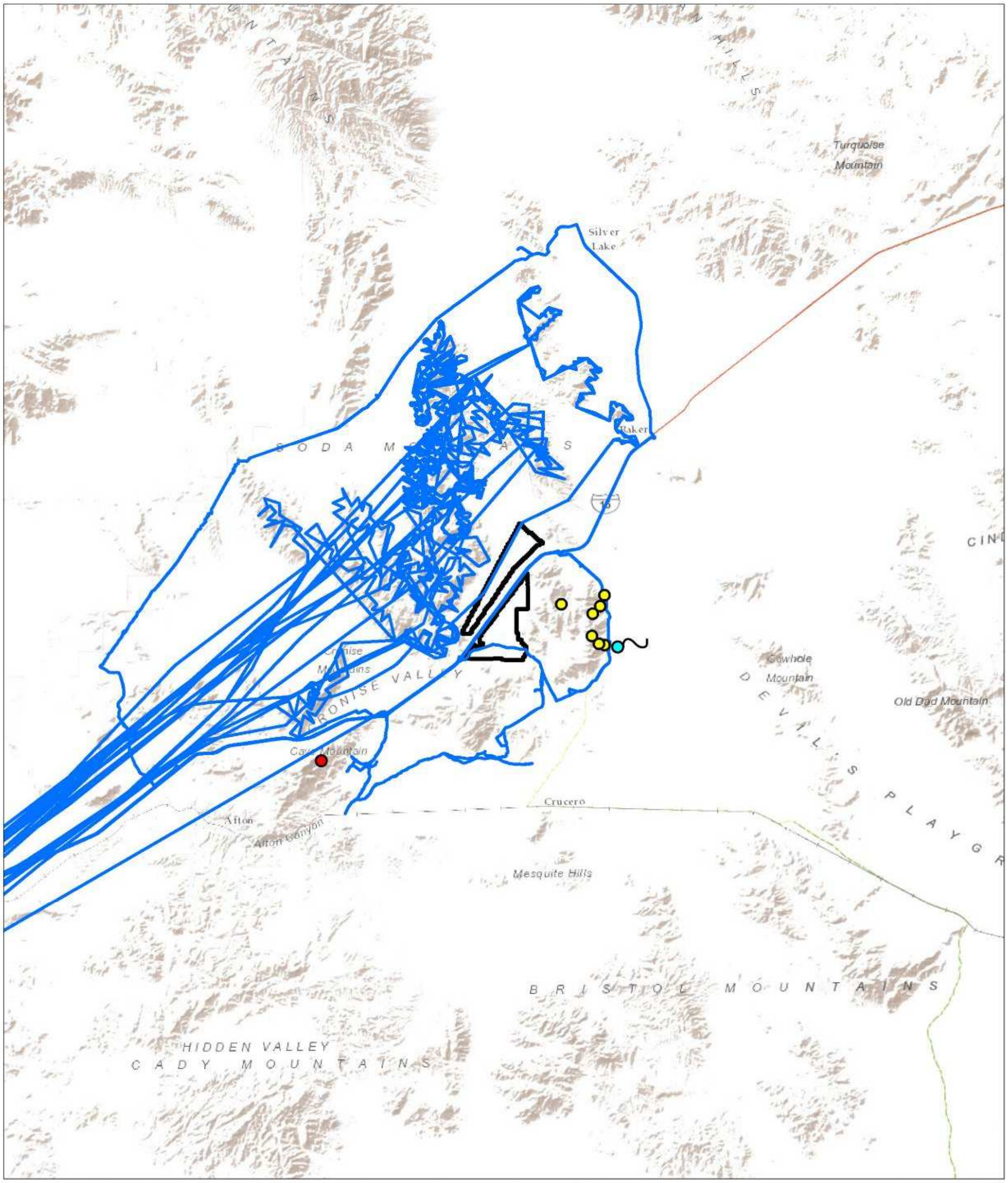
Surveys for bighorn sheep in the Soda Mountains were conducted in 2011 and 2012. Aerial surveys for bighorn sheep were conducted by BioResource Consultants on March 21 and 22, 2011 and May 9, 2011, and ground surveys between March 23 and 25, 2011 (RMT 2011c). The aerial surveys were six two-hour flights. Aerial surveys were conducted north of I-15 within the Soda Mountains. Each canyon was flown up and down. Contouring passes were made at different elevations to cover tall cliffs and long, steep slopes fully. Survey areas for bighorn sheep are identified on Figure 11. Ground surveys were conducted from observation points. During all aerial and ground-based survey work, biologists also scanned for any movement, sign, or habitat settings (e.g., water sources) that might accommodate or predict the presence of desert bighorn sheep. Potential water sources within the search area were identified in advance for surveying and evaluation. Data collected during the surveys included numbers of animals, age of animals and herd composition, general behavior, location, and habitat, where feasible (RMT 2011c).

CDFG conducted a ground survey on April 30 and May 1, 2012 in the south Soda Mountains near Zzyzx Spring. All sheep that could be located on the east side of the range in the vicinity of water were counted. Three groups of biologists explored areas not visible from the road area. One group climbed from the Zzyzx Field Station to the main ridge top above the road and followed the ridge north. Another group ascended a wash to the northwest of the main ridge and climbed into a separate section of the range. The third group searched further south of the field station along the main ridge. The location, number of sheep, class, and gender were logged at each sheep siting (Abella 2012).

Environmental Conditions

Field studies were conducted to document conditions for vegetation, wildlife, soils, water sources, and disturbance within the Soda Mountain Study Area. Biology field studies and a water resource investigation were conducted in 2009 and geology field studies were conducted in 2010 within the Soda Mountain Study Area.

Figure 11: Bighorn Sheep Survey Locations



SOURCE: ESRI 2012, BRC 2011, CDFG 2012, and Panorama Environmental, Inc. 2012

Scale: 1:400,000

LEGEND

- Study Area
- BRC Survey Routes
- BRC Survey Point
- CDFG Survey Point
- Zzyzx Spring

Miles: 0, 5, 10

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Biology Studies
Field surveys of the Soda Mountain Study Area were performed in 2009 to assess general and dominant vegetation types, vegetation community sizes, habitat types, and wildlife and plant species present within communities (URS 2009b). Biologists documented wildlife observations for birds, mammals, amphibians, and reptiles within the Study Area during field surveys. The presence of a wildlife species was based on direct observation, wildlife sign (e.g., tracks, burrows, nests, and scat), or vocalization. Field data compiled for wildlife included the scientific name, common name, habitat, and evidence of sign when no direct observations were made. Field surveys conducted in 2009 include:

- Special status plants survey
- Desert tortoise survey (discussed above)
- Avian point count surveys
- Water resource investigation

Special Status Plants. Special status plant surveys were conducted between May 4 and May 30, 2009 in accordance with standardized guidelines issued by the USFWS, CDFG, and the California Native Plant Society (URS 2009c). Surveys were conducted in parallel belt transects spaced at approximately 10 meters throughout the entire Study Area.

Avian Point Count. Avian point count surveys were conducted in the spring and fall of 2009. Field survey methods were derived and adapted from *BLM Solar Facility Point Count Protocol* (2009) and *Managing and Monitoring Birds Using Point Counts* (Ralph et al. 1995). Point count locations were established within the Study Area using the following parameters:

- One (1) point count transect per square mile;
- Eight (8) point count locations per transect; and
- Point counts must be at least 250 meters apart

The point count locations were then further modified in the field based on placing the points in the most suitable areas for birds (e.g., washes, and high vegetation areas) (URS 2010). A total of 10 transects with 8 point count locations per transect (80 points total) were identified within the Study Area (URS 2010).

Spring surveys were conducted between April 23 and May 14, 2009, and fall surveys were conducted between September 30 and October 29, 2009 (URS 2010). Each point was surveyed for a 10-minute observation period and data were recorded on avian species observed within a 100-meter radius. Presence of avian species was determined using direct observation, vocalization, or avian sign (e.g., nests, pellets, whitewash, etc.) (URS 2010).

Water Resources Investigation. A water resources investigation was performed in May and June 2009. Water resources were delineated using U.S. Army Corps of Engineers and CDFG guidance for delineation of waters of the U.S. and waters of the State (URS 2009d). The ordinary high water mark was used to define the limits of waters within the Study Area.

Geologic Studies

Geologic field studies were conducted in September 2010 throughout the Study Area (Wilson Geosciences 2011). Fifteen geotechnical boreholes were located throughout the Study Area along dirt roads. Boreholes extended from approximately 4 meters to 30 meters (14 feet to 100 feet) feet in depth. Geologic studies defined material types and engineering properties within the construction zone (upper 6+ meters) at all 15 borehole locations; at 12 of these locations data were obtained to depths of 18 to 24 meters using geophysical methods. In addition, electrical resistivity (transient electromagnetic sounding—TEM) surveys at three locations defined general material types, saturated sediments, and estimated depth to buried bedrock.

2.3.2 Results

Desert Tortoise Surveys

The 2001 survey for desert tortoise located west of the Study Area found:

- Five desert tortoise burrows (Class 2-4)
- Nine tortoise scat (Class 2-4)
- Three highly fragmented tortoise carcasses (Class 5)
- Three desert tortoise rock shelters (Class 2)

No live tortoises were observed during the survey. All of the desert tortoise burrows observed were located within the scar of an old borrow (mining) pit, where rocks had been removed and soils were suitable for burrowing.

The 2009 survey for desert tortoise did not find live tortoise, burrows, or sign of tortoise within the Soda Mountain Study Area. One desert tortoise scat was found beyond the western edge of the Study Area during the ZOI surveys along a 370-meter (1,200 foot) interval transect. The scat was identified in the same general location as tortoise sign were previously identified (i.e., during the 2001 Opah Ditch Mine survey performed by AMEC), suggesting that conditions at the Opah Ditch site provide suitable habitat for tortoises. All of the previously identified burrows were located within the borrow pit scar, indicating that the site provides better habitat for tortoises than surrounding areas perhaps because rocks have been removed and the soil is more permeable than the surrounding areas.

Bighorn Sheep Survey

No desert bighorn sheep were observed during the March or May 2011 surveys in the Soda Mountains north and south of I-15. No springs, seeps, or pools of standing water were observed in the mountains above the desert floor. The only water resources observed in this area were the playa lake beds (east of the Soda Mountains and the project area), which still held some water during the March survey. In the plot area south of I-15, two desert bighorn sheep were observed during the March survey fleeing down a ravine approximately 13 kilometers southwest of the Study Area in the Cave Mountains (RMT 2011c). No other individuals or groups of sheep were seen during the remainder of the March survey, nor during the second survey performed in May 2011 (RMT 2011c).

A total of 47 sheep in seven groups were identified within the south Soda Mountains during the CDFG 2012 survey (Figure 11). The sheep viewed during the survey (Abella 2012) included:

- 26 adult females
- 3 yearling females
- 5 lambs
- 7 yearling males
- 6 older males (three class II, two class III, and one class IV)

The upper elevations above where these sheep were seen had very little sign of recent use by bighorn (Abella 2012). It appears that the eastern portion of the south Soda Mountains, where most of the sheep were seen is occupied primarily by females and associated younger sheep this time of year. Given that few adult males were seen, this population can be projected to fall into the 51-100 size category with the additional males not seen (Abella 2012). Conditions within the south Soda Mountains are highly suitable for bighorn sheep because of the presence of a year-round water source at Zzyzx Spring.

Environmental Conditions

Biologic Resources

Vegetation and wildlife communities within the Study Area were identified during several area surveys, including the desert tortoise survey, avian point count surveys, special status plant surveys, and water resource investigation. The Study Area is sparsely vegetated and includes three vegetation communities/land types identified in Table 2 below. Community/land types are based on dominant vegetation composition and density observed during field surveys of the Study Area (URS 2009a).

Table 2: Vegetation Communities

Vegetation Community	Vegetation Species	Description	Hectares in Study Area
Mojave Creosote Bush Scrub	creosote bush (*Larrea tridentate*) burrobush (*Ambrosia dumosa*) desert senna (*Senna armata*) Mormon tea (*Ephedra sp.*) cheesebush (*Hymenoclea salsola*) big galleta (*Pleuraphis rigida*) chollas (*Cylindropuntia sp.*) beaver tail (*Opuntia basilaris*)	Shrubs are typically widely spaced, with an open canopy and bare ground between individual plants. An annual herb layer is usually present between shrubs and may flower in late March and April with sufficient winter rains. This community is usually found on well-drained secondary soils with very low available water-holding capacity on slopes,	2651 (6,552 acres)

Table 2: Vegetation Communities			
Vegetation Community	**Vegetation Species**	**Description**	**Hectares in Study Area**
		alluvial fans, bajadas, and valleys.	
Mojave Wash Scrub	smoke tree (*Psorothamis spinosus*) blue palo verde (*Cercidium floridum*) cheesebush (*Hymenoclea salsola*) sweetbush (*Bebbia juncea*)	Mojave Wash Scrub is a low, open desert shrub community with a scattered overstory of microphyllous trees. This community is most often observed on sandy bottoms of wide canyons, and sandy, braided, shallow washes of lower bajadas.	21 (52 acres)
Disturbed	N/A	Those areas devoid of vegetation, including unpaved roads, abandoned mining areas, OHV trails, and utility lines (e.g., transmission lines, pipelines, and fiber optic lines). Disturbed areas also include nonnative and/or native communities that have been significantly degraded due to anthropogenic activity.	65 (160 acres)

Source: URS 2009a

Wildlife. The prevailing wildlife species observed within the Study Area include a variety of commonly occurring avian species and, less frequently, commonly occurring mammals, reptiles, amphibians, and invertebrates typical of the Mojave Desert. In general, the Study Area contains relatively low species diversity with the majority of observed wildlife consisting of a few dominant species (URS 2009). This diversity is typical for many parts of the Mojave Desert where vegetation communities are generally sparse and uniform.

Avian Surveys. A total of 629 birds (22 species) were recorded within the Study Area during the spring avian point count surveys. The most abundant bird species observed during the spring surveys were horned lark (*Eremophila alpestris*), black-throated sparrow (*Amphispiza bilineta*), and white-crowned sparrow (*Zonotrichia leucophrys*) (URS 2010). Horned lark accounted for more than 65 percent of total bird observations during the spring surveys. A total of 210 birds (23 species) were recorded within the study area during the fall point count surveys. The most abundant bird species observed were horned lark (*Eremophila alpestris*), Say's phoebe (*Sayornis saya*), and common raven (*Corvus corax*) (URS 2010). Avian abundance was higher during the spring surveys, but species diversity was similar for spring and fall surveys.

Water Sources

There are no perennial water sources within the Soda Mountain Study Area or surrounding valley, all water resources are characterized as ephemeral (URS 2009d). During rain events water draining from the Soda Mountains is conveyed through the site in a series of unnamed desert washes. Water is only available on the site during and shortly after rain events, due to the low levels of precipitation in the area (approximately 4 inches annually) and high temperatures. There is a perennial water source at Zzyzx Spring, on the east side of the Soda Mountains, approximately 8 kilometers southwest of the Study Area.

Surface drainage flows predominantly east and southeast from the Soda Mountains; drainage is interrupted at the I-15 highway where it is directed to several culverts under the freeway. To a lesser extent, drainage flows from the lower mountains on the south, east, and north. Active drainage washes exit the Study Area on the northeast from north of I-15 at Zzyzx Road draining toward Silver Lake and on the southeast at Rasor Road, draining toward Soda Lake (RMT 2011a; RMT 2011b).

Geology/Soils

Soils within the Soda Mountain Study Area are predominantly sand and silty sand. Survey locations were characterized by granitic and volcanic, subangular to subrounded clasts. Particle size ranged from silt and clay to boulders, with most material in the coarse sand to cobble size range (Wilson 2011). Abundant cobbles and boulders were identified throughout the Study Area during field surveys. Alluvial fans and channels with vertical slopes up to 3 meters were observed throughout the Study Area.

Disturbance

The Soda Mountain Study Area lies within a valley that includes a designated BLM utility corridor. Highway I-15 bisects the Soda Mountain Study Area northeast to southwest and is a four-lane, divided highway. Other utilities constructed through the valley include:

- Two transmission lines (and associated access roads),
- Power distribution line
- Two fuel pipelines
- Fiber optic line
- Cell tower

The Xpress West (formerly Desert Xpress) rail right-of-way (ROW) was recently approved by BLM in December 2011 and follows the northwest edge of the I-15 ROW in the Study Area.

The Opah Ditch Mine is located just west of the Study Area. Rasor Road at the south end of the Study Area is a main entrance to the Rasor Road Off-Highway Vehicle (OHV) Recreation area. The OHV area is adjacent to and south and east of the Study Area. Evidence of OHV activity can be seen throughout the Study Area.

3 METHODS

3.1 DESERT TORTOISE HABITAT

Habitat predictions for desert tortoise presented in *Modeling Habitat of the Desert Tortoise* (Nussear et al. 2009) and the *DRECP Baseline Biology Report* (CEC 2012) were compared to desert tortoise field survey results. To evaluate model results for the Study Area, a GIS layer depicting the model results and each of the 16 GIS data source layers were obtained from the USGS (2012). Data layers were overlain with the Study Area to determine the specific results and data being used to characterize the Study Area in the model. Data obtained during field studies were compared with the data used in the model. Study Area field data, including vegetation diversity and density, area physiography and level of human disturbance, were reviewed to identify environmental conditions that could affect or fragment desert tortoise habitat.

3.2 DESERT TORTOISE CONNECTIVITY

Models of desert tortoise connectivity presented in "Making Molehills out of Mountains" (Hagerty et al. 2010) and *A Linkage Network for California Deserts* (Penrod et al. 2012) were evaluated for the Study Area. Because connectivity requires a larger scale analysis, the model results both within the study area and for the surrounding areas were evaluated to determine their accuracy in assessing field conditions and barriers to tortoise movement. Model results were compared with the results of field surveys of desert tortoise and conditions within the Study Area that could be barriers to tortoise movement. This comparison was used to assess the accuracy of connectivity predictions within the Study Area.

3.3 BIGHORN SHEEP HABITAT

Habitat predictions for bighorn sheep presented in the *DRECP Baseline Biology Report* (CEC 2012) were compared with field survey results for bighorn sheep and field-documented conditions within the Study Area.

3.4 BIGHORN SHEEP CONNECTIVITY

The following bighorn sheep experts were contacted to discuss bighorn sheep behavior and potential use of the Soda Mountain Study Area:

- Mr. Andrew Pauli, CDFG, Inland Deserts and Eastern Sierra Region, Apple Valley, California
- Dr. Jack Tuner, Sam Houston State University, Huntsville, Texas
- Mr. George Kerr, Society for the Conservation of Bighorn Sheep, Pasadena, California
- Mr. Chris Otahal, BLM, Barstow, California

The experts were provided information pertaining to the Study Area, including a map showing the study area in relation to the surrounding mountains and human-made features (e.g., I-15), and a description of the Study Area location. The experts were asked to provide information on expected bighorn sheep presence, use of the area, movement, and migration.

3.5 GENERAL WILDLIFE CONNECTIVITY

The methods for assessing wildlife connectivity presented in *California Essential Connectivity Project* (Spencer et al. 2010) and in *A Linkage Network for the California Deserts* (Penrod et al. 2012), were reviewed. Spencer et al. (2010) recommend that the generalized Essential Connectivity Areas developed by the California Essential Connectivity project be replaced by the species specific linkage designs like those prepared by the California Desert Connectivity Project (Penrod et al. 2012):

> "*Essential Connectivity Areas are placeholder polygons that can inform land-planning efforts, but that should eventually be replaced by more detailed Linkage Designs, developed at finer resolution based on the needs of particular species and ecological processes. It is important to recognize that even areas outside of Natural Landscape Blocks and Essential Connectivity Areas support important ecological values that should not be "written off" as lacking conservation value. Furthermore, because the Essential Habitat Connectivity Map was created at the statewide scale, based on available statewide data layers, and ignored Natural Landscape Blocks smaller than 2,000 acres, it has errors of omission that should be addressed at regional and local scales*".

In other words, the method of defining wildlife connectivity in the absence of species specific analysis is inherently flawed because connectivity is dependent on individual species habitat characteristics and how each species moves across the landscape (Tracy 2012). An aspect of the landscape that is a barrier for a reptile would likely not be a barrier to birds or large mammals, for example. General wildlife connectivity is not analyzed further in this case study, and connectivity is analyzed by species. Therefore, further consideration of Essential Connectivity Areas (Spencer et al. 2010) is rejected in favor of the species specific linkages presented in *A Linkage Network for the California Deserts* (Penrod et. al 2012).

4 ANALYSIS

The model results were compared with the field study results for desert tortoise habitat, desert tortoise connectivity, bighorn sheep habitat, and bighorn sheep connectivity. Results are presented in Table 3. The results presented in Table 3 are summarized from the model and field study results presented in Section 2.2.2 and 2.3.2, respectively.

Table 3: Comparison of Model Results to Field Study Results		
Topic	**Model Results**	**Field Study Results**
Desert Tortoise		
Desert Tortoise Habitat	The Study Area has a predicted habitat suitability rating of 0.6 to 0.8 (Nussear et al. 2009) indicating moderately suitable habitat. The Study Area is defined as suitable habitat for desert tortoise (CEC 2012).	No live tortoise, burrows, or other sign were identified within the Study Area during desert tortoise surveys. The Study Area would not be expected to support large populations of desert tortoise because: 1) The Study Area elevation (380 meters to 470 meters amsl) is below the optimum range for desert tortoise. 2) The Study Area is sparsely vegetated. 3) Soils within the Study Area consist of sand and gravel. 4) Numerous rocks, boulders, and cobbles are present in the Study Area. 5) I-15 bisects and fragments potential habitat in the area 6) An OHV area is located south and east of the Study Area and there is evidence of OHV use throughout the Study Area.
Desert Tortoise Connectivity	The Baker Sink is a barrier to desert tortoise movement (Hagerty et al. 2010). Desert tortoise linkage corridors are not identified within the Study Area (Penrod et al.	No live tortoise, burrows, or other sign were identified within the Study Area during desert tortoise or other field surveys. Large numbers of tortoise would not be

Table 3: Comparison of Model Results to Field Study Results

Topic	Model Results	Field Study Results
	2012).	expected to move through the area because: 1) I-15 bisects the Study Area and restricts tortoise movement through the area 2) The Study Area is surrounded by mountains 3) Baker sink due east of the study area would inhibit tortoise movement 4) There are steeply sloping channels within the study area
Bighorn Sheep		
Bighorn Sheep Habitat	Suitable habitat for bighorn sheep was predicted in the southern portion of the Study Area and within the Soda Mountains north and south of the Study Area (CEC 2012).	Bighorn sheep were not identified within the Study Area or the north Soda Mountains during field surveys. A population of bighorn sheep exists within the south Soda Mountains and sheep were viewed 13 kilometers south in the Cave Mountains. There are no water sources within the Study Area. The Study Area is flat (<5% slope). There is over 450 meters of flat terrain between the Study Area and the Soda Mountains.
Bighorn Sheep Connectivity	Bighorn sheep linkage corridors were not identified within the Study Area (Penrod et al. 2012)	I-15 bisects the Study Area and is considered an impediment to bighorn sheep movement through the area, although bighorn sheep may

Table 3: Comparison of Model Results to Field Study Results		
Topic	**Model Results**	**Field Study Results**
		use the culverts under the highway.

5 DISCUSSION

5.1 DESERT TORTOISE

5.1.1 Suitable Habitat

The model predictions of desert tortoise suitable habitat (Nussear et al. 2009; CEC 2012) indicate a high probability of desert tortoise presence within the Study Area. Desert tortoise field surveys covering 100 percent of the Study Area along 10-meter transects found no tortoise, burrows or sign within the Study Area. In addition, no desert tortoises were observed during avian point counts, special-status plant surveys, or water resource studies. The divergence between model predictions and field survey results could be attributed to: 1) the model scale, 2) human disturbance throughout the area, which is not accounted for in either model, and 3) there are limitations of stochastic models of habitat suitability.

The models of desert tortoise suitable habitat were constructed using 1-km^2 grid cells. The model construction requires averaging environmental data over a 1-km^2 area. For variables such as slope and rocks, the data used in the model do not accurately characterize field conditions or variability due to the scale of the model. The multi-state geographic scale of the model required the use of large data sets that could be inaccurate. The data used to generate the model identified the Study Area as containing 0% rocks. Site-specific field geology studies indicate that there are numerous rocks, boulders, cobbles, and gravel throughout the Study Area. Soil conditions would not be ideal for tortoise burrowing.

The method used by Nussear et al. (2009) to predict tortoise habitat did not involve removing areas of anthropogenic impact that would no longer be suitable habitat. The Maxent modeling method developed by Phillips et al. (2006) did provide for removal of highly disturbed areas from the model output to increase model accuracy. The adjustments to the suitable habitat model for the *DRECP Baseline Biology Report* removed highly disturbed areas from the model output (CEC 2012). However, within and adjacent to the Study Area, heavily disturbed areas are predicted as suitable habitat in the adjusted model. Both the I-15 corridor and the OHV recreation area south and east of the Study Area are identified as suitable habitat after adjustments were made to the model. The I-15 highway and OHV land uses have likely resulted in fragmentation and degradation of desert tortoise habitat in the area. While historically the area may have supported higher quality suitable habitat for desert tortoise, the quality of habitat is reduced by current land use and installation of the utilities in the corridor.

There are limitations of stochastic models of habitat suitability. The models do not account for physiological processes that are important to species habitat use. The Study Area lies within a small valley wedged between the north and south Soda Mountains. The presence of Highway I-15 through the center of the valley, and high desert tortoise mortality rates along highways render the area too small to support a population of desert tortoise (Tracy 2012). Studies of tortoise presence along highways reveal that tortoise densities increase further from the highway and high-volume highways can result in decreases in tortoise sign up to 4,000 meters from highways(Hoff and Marlow 2002). Because the Study Area is bounded by mountains, tortoises have very limited usable habitat area that is not near the highway. Analysis of population dynamics, which cannot be provided by modeling alone, is required to evaluate whether desert tortoise would use the area.

The predicted habitat suitability for the Soda Mountain Study Area does not match the documented absence of desert tortoise in the area and the low likelihood of desert tortoise presence due to the site conditions. The presence of surrounding mountains, abundant rocks and cobbles, sparse vegetation, low vegetation diversity, low elevation (below 470 meters), sand and gravel soils, and level of human disturbance indicate that the habitat is fragmented and not highly suitable for desert tortoise. If desert tortoise were to occur in the area, they would be expected in low numbers.

5.1.2 Habitat Connectivity

Habitat connectivity for desert tortoise was evaluated using genetic diversity data (Hagerty et al. 2010). That analysis indicated that genetic distance is closely tied to physiographic barriers to tortoise movement and geographic distance between populations. The Study Area is located adjacent to the Baker sink, which was identified as a physiographic barrier to tortoise movement. The Soda Mountain Study Area therefore is unlikely to lie within a major corridor for tortoise movement; however, some tortoises may move through the area as evidenced by the presence of tortoise burrows and sign west of and adjacent to the Study Area.

Habitat linkages for desert tortoise were modeled in A Linkage Network for California Deserts (Penrod et al. 2012). Desert tortoise linkage areas were not identified within the Soda Mountain Study Area. Linkages for desert tortoise were identified to the south connecting the southern end of Mojave National Preserve to Twentynine Palms and to the north connecting the Kingston Mesquite Mountains to the China Lake South Range approximately 10 miles north of the Study Area. This linkage design would be consistent with documented field conditions including the presence of the I-15 highway, incised channels, and mountainous surroundings that could restrict tortoise movement.

5.2 BIGHORN SHEEP

5.2.1 Suitable Habitat

Predicted suitable habitat for bighorn sheep was identified within the southern portion of the Study Area and the Soda Mountains north and south of the Study Area (CEC 2012). The 2012 survey identified seven groups of bighorn sheep within the south Soda Mountains east of the Study Area (Abella 2012). Areas that bighorn sheep are known to occur within the south Soda Mountains were not identified as suitable habitat by the model. Suitable habitat for bighorn sheep habitat was not identified within the Study Area during field studies (URS 2009a). While suitable habitat may exist within the north Soda Mountains, field surveys did not identify a population within that area. Bighorn sheep are unlikely to occupy the Study Area (Kerr 2010; Pauli 2010; Turner 2010). Sheep likely would have used the margins of the Study Area as a movement corridor between the mountains north and south of the Study Area prior to the I-15 highway. Sheep have, however, been sighted foraging near Zzyzx Road, adjacent to the mountains (Weasma 2012). They may be able to cross through the Study Area using the culverts under the I-15 highway.

The north side of the Study Area is potentially a "transition zone" for bighorn sheep (Kerr 2010). Bighorn would likely cross I-15 at the highway culvert north of the Study Area or the overpass at Zzyzx Road. The bighorn sheep would not stay in the area for long because it does not provide any water. The Study Area is not prime habitat and there is unlikely to be a large population in the area (Kerr 2010). Bighorn sheep rely on the flat lands for food and water, and do not remain in flat areas, except for potential food sources following heavy rains or as potential migration routes (Kerr 2010). Bighorn sheep prefer to stay in the mountainous area, their natural habitat, which provides them with views of the surrounding area and vantage points (Turner 2010). These views allow the bighorn sheep to identify any potential threats in the area.

5.2.2 Habitat Connectivity

The Study Area was not identified within a linkage corridor for bighorn sheep by Penrod et al. (2012). Although there are populations of bighorn sheep in the Soda Mountains to the south, it is unlikely that populations of bighorn sheep would cross through the Study Area due largely to presence of I-15. Individual sheep have previously been seen attempting to cross I-15 or killed along I-15 near the Study Area. Each of the bighorn sheep experts contacted stated that construction of I-15 created a migration barrier for the bighorn sheep. Major interstates are typical barriers to bighorn sheep migration (Turner 2010). Heavy traffic on I-15 discourages bighorn sheep from crossing from one side to the other. If the bighorn sheep were to cross I-15, it would most likely be in the area north of the Study Area where I-15 passes through the mountain range (Turner 2010).

6 CONCLUSION

This report presents an evaluation of five studies used to predict 1) desert tortoise habitat, 2) bighorn sheep habitat, and 3) linkages for desert tortoise and bighorn sheep connectivity. The results of these studies were compared with the results of field surveys performed within an approximately 2,800-hectare (7,000-acre) area located in a valley surrounded by the Soda Mountains.

The model of suitable habitat for desert tortoise (Nussear et al. 2009) identified the Study Area as containing moderately suitable habitat (0.6 to 0.8). Protocol surveys for the Study Area did not identify any sign of desert tortoise within the Study Area. This difference in results can occur for two major reasons: 1) errors in the model input, 2) historic changes in the presence of tortoise habitat (e.g., land use changes), or 3) limitations of the model. Errors in model input could be due to improper data used in the model (i.e., the data did not identify and account for the numerous boulders or cobbles in the Study Area) and the model resolution. Field-documented conditions including low vegetation diversity and density, presence of abundant gravel and cobbles, and the low elevation of the area (below 470 meters are not conducive to supporting a tortoise population; the area would be expected to have low numbers of desert tortoise, if any (Woodman 2012). These conditions were not correctly documented in the model input due to the scale of the model (1-km^2) and the use of data that were not field verified. Historic changes in the presence of tortoises suggest that the habitat may indeed be suitable but that tortoises are not present in the Study Area for other reasons such as population processes centered on excess mortality due to I-15. These processes are not considered in niche habitat modeling. However, population processes play a large role in species presence and can affect tortoise presence, as demonstrated by decreased tortoise sign thousands of meters from high-traffic highways. There are other limitations of stochastic habitat distribution modeling including sample bias (e.g., more samples near highways/roadways) and expected error within models. Models are representations of reality, and cannot account for all conditions that affect habitat and species use of habitat.

Similarly, the model for bighorn sheep predicted suitable habitat in flatland areas of the Study Area that do not possess characteristics of bighorn sheep suitable habitat, although the areas immediately adjacent to the mountains outside the Study Area may be used periodically for foraging. The model also underestimated suitable habitat areas within the south Soda Mountains where bighorn sheep are known to occur. The flatland areas within the southern portion of the Study Area are located adjacent to I-15 and in highly disturbed areas near a gas station. While bighorn sheep could use this area temporarily, they would not be expected to stay in the area for long. The difference in results between the models and the surveys can be attributed to the same factors that impact the accuracy of desert tortoise model results, as well as the use of a lower threshold (0.236) to classify bighorn sheep habitat and the limited number of data points (32) used in the model.

The model for connectivity used by Penrod et al. in *A Linkage Network for the California Deserts*, did not identify the Study Area as part of a linkage area for desert tortoise or bighorn sheep. This model is consistent with the results of field studies and knowledge of area physiography.

7 RECOMMENDATIONS

The Essential Connectivity Area map for the Mojave Desert provided in the *California Essential Connectivity Project* (2010), which identified the Study Area within an Essential Connectivity Area, should be replaced with the maps of habitat linkages in the *Linkage Network for the California Deserts* (2012).

Due to the large geographic area that was modeled in many of the studies reviewed, fine-scale field ground-truthing was not feasible. The *Linkage Network for the California Deserts* used a regional-scale analysis and did use field ground-truthing. Ground-truthing of the data sources used to construct the model could increase the accuracy of the models applied. It would also allow for spot verification of modeled results to increase model reliability.

Field studies are usually conducted at a much finer scale than species habitat models and provide information that are not easily gained through modeling alone. Where available, field information should be used to supplement the information provided in species habitat models to provide a greater understanding of area resources and habitat use. Land use managers should collect field data from private parties so that these data can be used for future land use planning and management. Information provided in models should also be supplemented by more detailed analysis when land use changes are being considered.

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