

**YUMA PROVING GROUND WILDLIFE STUDIES: FINAL REPORT  
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This report covers activities under Tasks A-D, conducted from September 2011 through April 2012. A copy of this report has also been provided to the Yuma Proving Ground (YPG) Environmental Sciences Division. Results presented herein are preliminary, have not yet been subject to peer-review or publication, and should not be distributed without the authors' permission. Questions concerning these activities should be directed to the AGFD project technical lead (listed on cover page).

## **TASK A: WILDLIFE USE OF MESQUITE BOSQUES**

### **Overview**

Mesquite (*Prosopis* spp.) bosques are unique woodlands that occur in the Sonoran Desert and other parts of the arid Southwest, that typically occur on terraces above perennial riparian zones or along ephemeral washes dominated by xeroriparian plant communities (Stromberg 1993). These woodlands provide habitat for a diverse array of wildlife and have been adversely impacted by human activities including groundwater pumping, surface water diversion, livestock grazing, and fuelwood cutting (Brown et al. 1977, Stromberg 1993).

In addition to those associated with riparian systems, bosque-like woodlands also occur in upland settings (Sharifi et al 1982). In Southwestern Arizona, these isolated patches are nested within Sonoran desertscrub vegetation, typically broad valleys dominated by creosote bush (*Larrea tridentata*). These unique formations are included on existing statewide vegetation maps and only recently were described in vegetation classifications for Arizona (J. Malusa, University of Arizona, personal communication). The largest known assemblage of these isolated bosques is located on the La Posa Plain, west of Highway 95. Most are located within the YPG Cibola Range, where extensive areas including bosque, were cleared during construction of drop zones used for testing and training activities. Inventories of bosques on YPG were conducted by Jason Associates Corporation (2008, 2009).

In 2009, the Department's Research Branch initiated a camera-trapping study of 16 mesquite bosques on the YPG Cibola Range. Over the course of that 2-year effort we documented 28,518 events (defined as a photo containing one or more identified animals) that included 24 species of birds, mammals, and herpetofauna. Preliminary analyses (see 2011 final report) suggested that bosque size was an important predictor of wildlife use, with larger bosques used more frequently and by more species. Studies in riparian bosques have shown vegetation structure to strongly influence use by birds and small mammals (Ellison and VanRiper 1998, Brand et al. 2008).

In the Sonoran Desert, bosque-like vegetation also occurs in disturbed areas associated with water impoundments, particularly livestock tanks (Dawson and Mannan 1991). Jason Associates Corporation (2009) identified a number of bosques on the YPG Kofa range, which appear to have established following hydrologic modifications associated with road construction or excavation of fill material. Wildlife use of these anthropogenic bosques has not been previously studied.

## Objectives

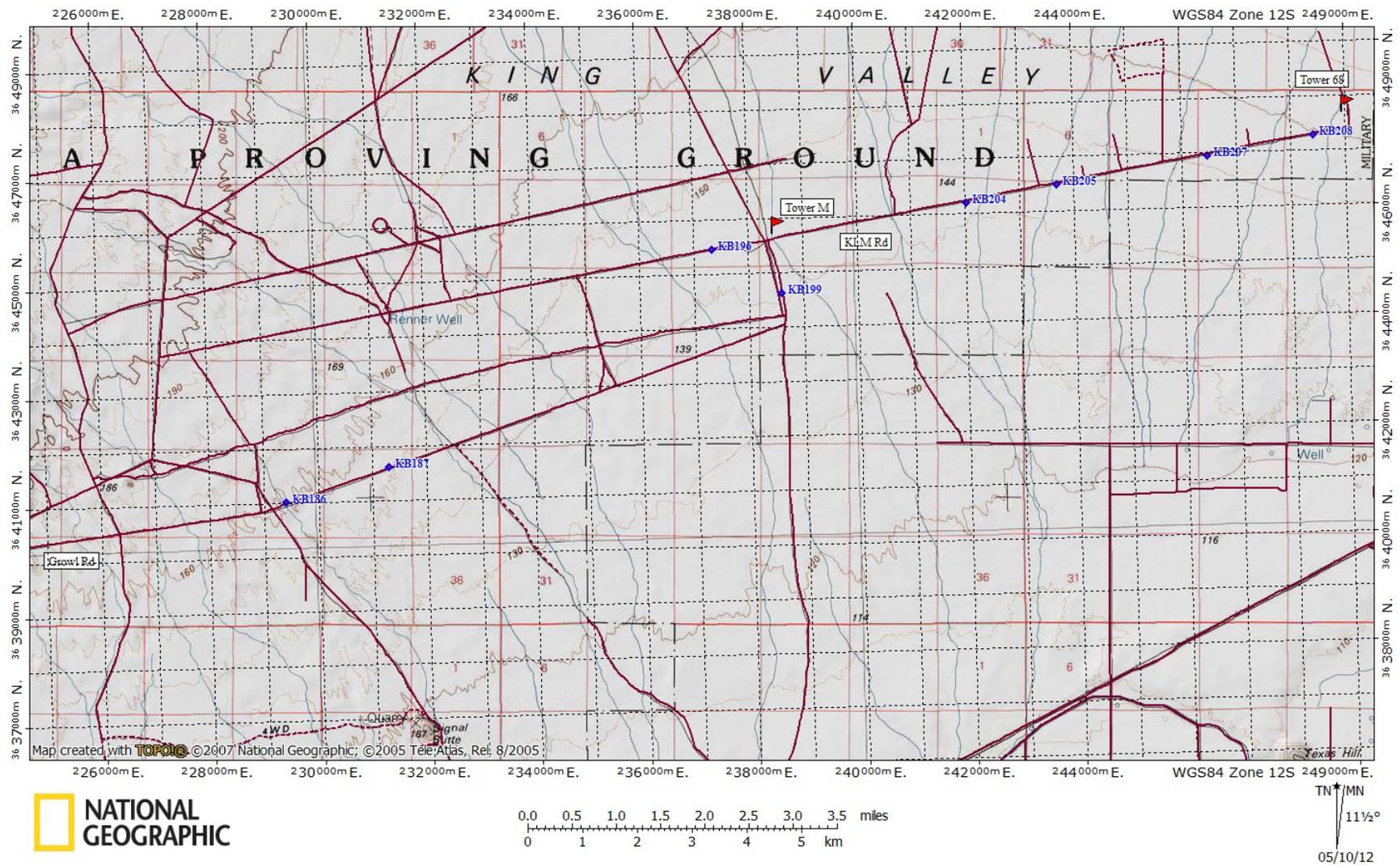
1. Quantify wildlife use of anthropogenic bosques, including species present and seasonal patterns of use
2. Assess influence of vegetation composition and structure on wildlife use of natural bosques
3. Identify biophysical factors associated with occurrence of natural and anthropogenic bosques

## Methods

Using the inventory of Kofa Range bosques conducted by Jason Associates (2009), we selected a subset of 8 sites for camera trapping (Fig. 1). These bosques were 0.2-1.7 ac in size, had a well-developed mesquite component, good vehicular access, and lacked safety hazards, i.e., unexploded ordnance. We placed 1-3 4-megapixel digital trail cameras (Model #I40, Moultrie Feeders, Alabaster, AL) at each site, mounting them on metal t-posts (Fig. 2). Cameras were located proximate to animal trails or openings, under overhanging vegetation where possible, and facing north to reduce temperature and glare from the sun. Cameras were triggered by a motion sensor and equipped with an infrared flash for nighttime operation. The field of view was 52 degrees with an approximate detection range of 12 m (+/- 1.5 m). We programmed each camera to take a single still photo at high resolution (1648 x 1236 pixels) on a 1-minute delay. Each image was stamped with the current temperature, date, time, and camera identification number. Digital images were downloaded monthly, then processed to identify wildlife occurrence. We recorded the following data from each photograph: camera ID, date, time, species, and number of individuals.

Our previous camera trapping study on YPG Cibola Range bosques and anecdotal observations during field visits suggested that these sites are heavily used by passerine birds, particularly during the spring migration period. To assess that use, we conducted ground surveys of 8 sites used previously for camera trapping (Table 1). Each site was surveyed three times at approximately 2-week intervals during March-April 2012. Surveys were done by a single observer, who traversed the full area of each bosque, recording all avian species detected visually or by song/call. Surveys were conducted during a 4-hr block beginning 30-min before sunrise and limited to periods of calm weather and light wind.

A preliminary assessment of variables associated with wildlife use of natural bosques on the Cibola Range suggested that bosque size was the most important predictor of use by mule deer, mammalian predators, small mammals, and all species combined (see 2011 Final Report for details). We expanded this analysis to include within-bosque vegetation attributes (as measured by Jason Associates Corporation 2009, Appendix B), specifically: tree canopy cover and tree height. For this analysis, use was defined as the number of observations by species' group, adjusted by the number of cameras in each bosque (i.e., number of observations per camera). We also conducted regression analysis using the same predictor variables to assess relationships with avian community parameters derived from ground surveys conducted in Spring 2012 (species richness, number of detections for all species).



**Figure 1. Locations of anthropogenic mesquite bosques included in camera trapping study of wildlife use, Kofa Range, Yuma Proving Ground. Three-digit bosque numbers are those assigned during prior survey (Jason Associates Corporation 2009).**



**Figure 2.** Trail camera placed under mature mesquite tree in Bosque #207, YPG Kofa Range.

**Table 1.** Mesquite bosques on YPG Cibola Range surveyed for migrant passerines, March-April 2012. Three-digit bosque numbers are those assigned during prior survey (Jason Associates Corporation 2008).

<b>Bosque ID</b>	<b>NAD 83 UTM</b>		<b>Size (ha)</b>
B046	11S	753246.6 3702325	1.58
B058	11S	752266.7 3702708	0.23
B059	11S	752198.1 3702705	0.3
B081	11S	754712 3696988	0.24
B087	11S	752703.9 3700991	4.05
B096	11S	752279.1 3699519	8.9
B097	11S	751897 3699252	2.58
B098	11S	751677.7 3698895	1.63
B108	11S	751637.9 3698013	2
B111	11S	751255 3697848	0.53
B118	11S	750765.2 3697289	0.23
B119	11S	754156 3695063	0.67

## Results and Discussion

*Camera Trapping* – the smaller, anthropogenic bosques on the Kofa Range received significant wildlife use, though by fewer species and in lesser numbers than found in larger, natural bosques on the Cibola Range (see 2011 Final Report). Two species not documented in Cibola Range bosques (mountain lion and ringtail) were observed at one or more sites on the Kofa Range. We documented 2,356 events that included 14 species (Table 2). Like the Cibola bosques, the most common species were mule deer ( $n = 920$  events), black-tailed jackrabbit ( $n = 683$  events), and coyote ( $n = 156$  events). Mule deer were present in all months of sampling (January to August), with peak observations in June and July. This pattern differs from Cibola Range bosques, where use by deer was greatest in April and October.

**Table 2. Wildlife species observed by trail cameras in 8 mesquite bosques of anthropogenic origin on the YPG Kofa Range, January–August 2012.**

Common Name	Scientific name
Mule Deer	<i>Odocoileus hemionus</i>
<u>Mammalian Predators</u>	
Coyote	<i>Canis latrans</i>
Kit fox	<i>Vulpes macrotis</i>
Bobcat	<i>Felis rufus</i>
Mountain lion	<i>Felis concolor</i>
Badger	<i>Taxidea taxus</i>
Ringtail	<i>Bassariscus astutus</i>
<u>Small Mammals</u>	
Desert cottontail	<i>Sylvilagus audubonii</i>
Black-tailed jackrabbit	<i>Lepus californicus</i>
Round-tailed ground squirrel	<i>Xerospermophilus tereticaudus</i>
<u>Birds</u>	
Greater roadrunner	<i>Geococcyx californianus</i>
Gambel's quail	<i>Callipepla gambelii</i>
Mourning dove	<i>Zenaida macroura</i>
White-winged dove	<i>Zenaida asiatica</i>
Common poorwill	<i>Phalaenoptilus nuttallii</i>

*Passerine Birds* – we found a total of 32 avian species during Spring surveys of bosques on the Cibola Range (Table 3). Four species (black-tailed gnatcatcher, black-throated sparrow, Wilson's warbler, cactus wren) were found at half or more of the sites. The remaining species had patchier occurrence. The number of species per bosque ranged from 1-19, with a mean of 8.

**Table 3. Passerine bird species detected during Spring 2012 ground surveys of 12 naturally-occurring mesquite bosques, YPG Cibola Range.**

<b>Species</b>	<b>Scientific Name</b>	<b>No. Sites</b>
Black-tailed gnatcatcher	<i>Polioptila melanura</i>	8
Black-throated sparrow	<i>Amphispiza bilineata</i>	6
Cactus wren	<i>Campylorhynchus brunneicapillus</i>	5
Wilson's warbler	<i>Wilsonia pusilla</i>	5
Crissal thrasher	<i>Toxostoma crissale</i>	4
Gambel's quail	<i>Callipepla gambelii</i>	4
Horned lark	<i>Eremophila alpestris</i>	4
Orange-crowned warbler	<i>Vermivora celata</i>	4
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	4
Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	3
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	3
Pacific Slope flycatcher	<i>Empidonax difficilis</i>	3
Yellow-rumped warbler	<i>Dendroica coronata</i>	3
Bendire's thrasher	<i>Toxostoma bendirei</i>	2
Gray flycatcher	<i>Empidonax wrightii</i>	2
House finch	<i>Carpodacus mexicanus</i>	2
Mourning dove	<i>Zenaida macroura</i>	2
Northern mockingbird	<i>Mimus polyglottos</i>	2
Ruby-crowned kinglet	<i>Regulus calendula</i>	2
Verdin	<i>Auriparus flaviceps</i>	2
White-winged dove	<i>Zenaida asiatica</i>	2
American kestrel	<i>Falco sparverius</i>	1
Black-chinned hummingbird	<i>Archilochus alexandri</i>	1
Brewer's Sparrow	<i>Spizella breweri</i>	1
Cordillieran flycatcher	<i>Empidonax occidentalis</i>	1
Greater roadrunner	<i>Geococcyx californianus</i>	1
Green-tailed towhee	<i>Pipilo chlorurus</i>	1
Lesser goldfinch	<i>Carduelis psaltria</i>	1
Nashville warbler	<i>Oreothlypis ruficapilla</i>	1
Phainopepla	<i>Phainopepla nitens</i>	1
Violet-green swallow	<i>Tachycineta thalassina</i>	1
Western tanager	<i>Piranga ludoviciana</i>	1

*Factors Associated with Wildlife Use* – all regressions were statistically significant ( $p \leq 0.05$ ,  $R^2 = 0.37-0.66$ ), size was a consistent positive predictor of wildlife use in naturally-occurring bosques (Table 4). However, neither tree canopy cover nor tree height were significant predictors. This result was somewhat unexpected, particularly for passerine birds that commonly respond positively to these vegetation characteristics in riparian bosques (Ellison and VanRiper 1998, Brand et al. 2008).

**Table 4. Multiple linear regression results (standardized coefficients and adjusted  $R^2$ ) for factors potentially influencing wildlife use of naturally-occurring mesquite bosques on the YPG Cibola Range. Values in bold are statistically significant at  $p \leq 0.05$ .**

Taxa	Bosque Size	Tree Canopy Cover	Tree Height	$R^2$
Deer	<b>.64</b>	-.03	.14	<b>.42</b>
Mammalian predators	<b>.78</b>	-.16	.06	<b>.66</b>
All birds (camera trapping)	<b>.68</b>	.33	.14	<b>.57</b>
Passerine species richness <sup>1</sup>	<b>.83</b>	.06	.11	<b>.56</b>
Passerine detections <sup>1</sup>	<b>.87</b>	.15	.04	<b>.47</b>
Small mammals	<b>.58</b>	.26	-.01	<b>.37</b>
All species	<b>.81</b>	.12	.06	<b>.66</b>

<sup>1</sup> derived from ground surveys

Like their natural counterparts on the Cibola Range, bosques of anthropogenic origin on the Kofa Range received heavy use by a diverse array of wildlife and merit careful consideration when considering potential alterations that may occur from test and training activities. We suspect the considerably smaller size and simpler plant communities of these bosques may explain the lower diversity of associated wildlife compared to naturally-occurring ones.

Occurrence of bosque vegetation is tied to available groundwater within the rooting zone (Stromberg et al. 1992, 1993) and soil characteristics (Sharifi et al. 1982). Understanding how these biophysical factors affect establishment of natural and anthropogenic upland bosques on YPG could help identify candidate sites for habitat mitigation or enhancement.

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## **TASK B: HABITAT USE BY DESERT BIGHORN SHEEP**

### **Overview**

The seasonal proximity of desert bighorn sheep (*Ovis canadensis*) to developed water sources has been evaluated in other studies (Blong and Pollard 1968; Cunningham and Ohmart 1986; Simmons 1969, 1990; Krausman and Etchberger 1995). However, these studies were often of short duration and relied on direct observation or infrequent telemetry locations to discern patterns of habitat use. Global Positioning System (GPS) collars can collect large numbers of locations over long periods and under different acquisition schedule, allowing more precise delineation of habitat use.

### **Objectives**

1. Quantify seasonal home ranges and movements of bighorn
2. Determine influence of developed waters and other environmental factors on bighorn habitat use
3. Identify travel corridors used by sheep on YPG during inter-montane movements
4. Assess responses by bighorn to activities on the YPG JERC III course

### **Methods**

We fitted 31 sheep (19M,12F) with GPS collars during separate deployments on the YPG Cibola Range, in 2007, 2008, and 2009. The last of these collars were recovered during the current contract period, so we compiled an operational history for all collars and updated location maps for collared animals. We mapped consecutive locations of individual sheep and visually inspected those data to delineate apparent movement corridors. Finally, we conducted a separate analysis of sheep proximate to the JERC III road course, to assess responses to testing/training activities. For that analysis, we mapped all sheep locations that occurred within a 250-m buffer around the course. We tallied total monthly locations by those animals and compared those data to the level of activity, as determined from vehicle counters deployed on portions of the course in or adjacent to steep escape terrain favored by sheep.

### **Results and Discussion**

*Home Ranges and Movements* – a summary of collar deployments and operation are presented in Table 5. A number of Northstar units (8/21 = 36%) failed during deployment or could not be recovered due to malfunction of automated release, satellite uplink, or VHF systems. These failures reduced our sample size considerably, but did not fully compromise attainment of primary study objectives.

Collared bighorn made extensive use of all major mountain ranges on the northern portion of the Cibola Range (Fig. 3). The lack of locations on southern portions of the range was not indicative of sheep distribution or habitat quality, but rather the fact that sheep exhibit high fidelity to their home ranges and were not captured on that area. Bighorn in the northernmost portion of YPG made extensive use of contiguous montane areas located off the installation (Fig. 3).

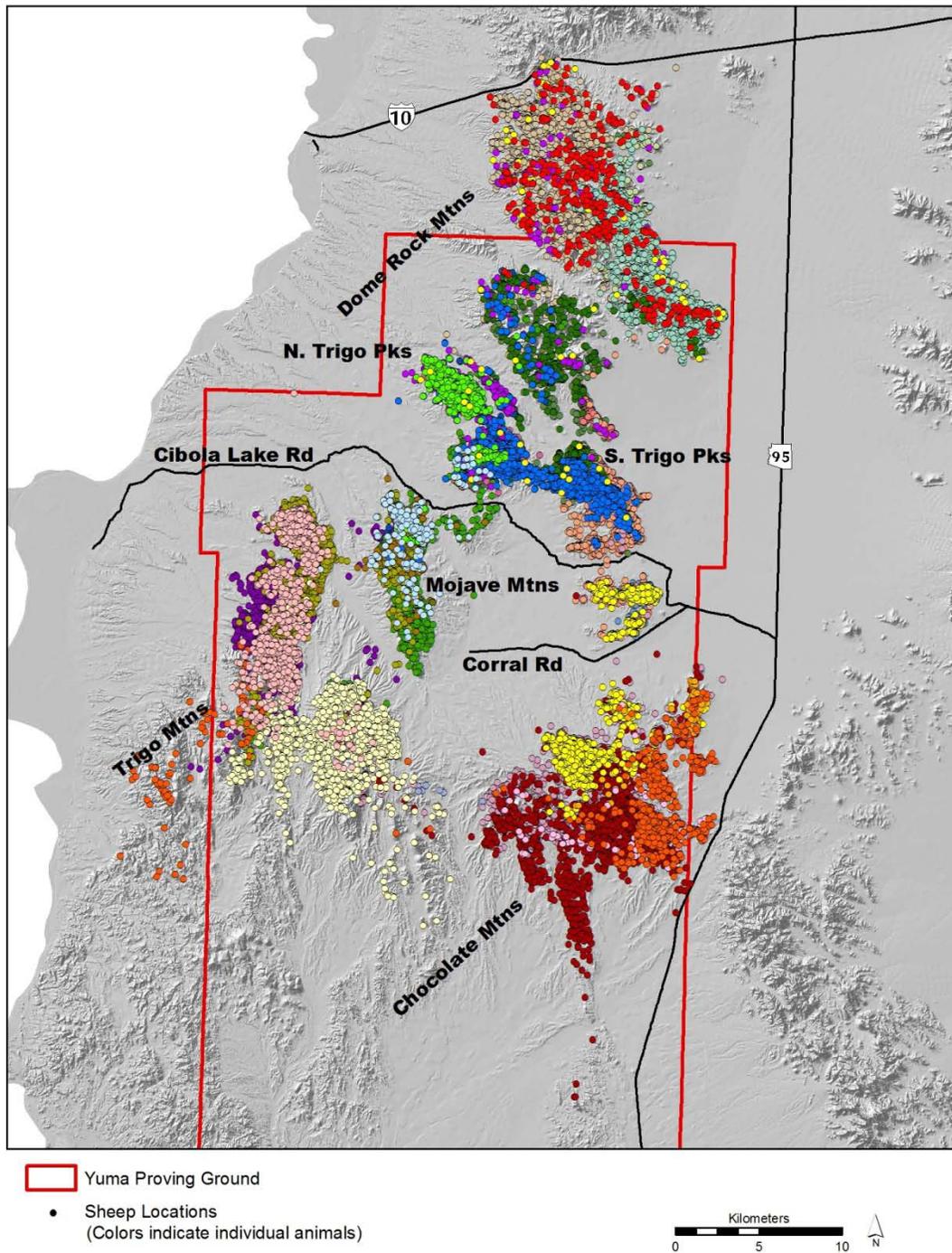
**Table 5. Operational history of GPS collars deployed on desert bighorn sheep on YPG Cibola Range, 2007-2011.**

Capture Date	Sex	Estimated Age	Collar ID#	Mfgr	Op. Days	Collar Recovered	Data <sup>1</sup>	Total Locations
11/15/2007	F	Adult	530295	Telonics	718	yes	sob	2,907
11/15/2007	F	Adult	530292	Telonics	710	yes	sob	710
11/15/2007	F	Adult	512936	Telonics	718	yes	sob	2,808
11/15/2007	F	Adult	512935	Telonics	718	yes	sob	2,763
11/15/2007	F	Adult	530293	Telonics	718	yes	sob	2,877
11/15/2007	F	≤2	530290	Telonics	718	yes	sob	2,821
11/15/2007	M	Yearling	530287	Telonics	718	yes	sob	2,954
11/16/2007	F	≥5	530291	Telonics	230	yes	sob	291
11/16/2007	M	3	530296	Telonics	717	yes	sob	2,924
11/17/2008	M	8-16 (Class IV)	333082	North Star	-	no	no	-
11/17/2008	F	2	330970	North Star	715	yes	sob	2,758
11/17/2008	F	Adult	330964	North Star	677	yes	sob	1,882
11/17/2008	F	3	333007	North Star	719	yes	sob	2,099
11/17/2008	M	6-8 (Class III)	346270	North Star	408	yes	sob	1,338
11/17/2008	M	6-8 (Class III)	345573	North Star	715	yes	sob	2,649
11/17/2008	M	7 (Class III)	345552a	North Star	243	yes	sob	535
11/19/2008	M	8 (Class III)	333267	North Star	724	yes	sob	2,473
11/19/2008	M	6-8 (Class III)	350463	North Star	713	yes	sob	2,672
11/19/2008	M	6-8 (Class III)	351409a	North Star	60	yes	sob	48
11/19/2008	M	6-8 (Class III)	351405	North Star	1,037	no	uplink	1,063
11/19/2008	M	6-8 (Class III)	333072	North Star	632	no	uplink	2,038
11/19/2008	M	6-8 (Class III)	345564	North Star	431	no	uplink	936
11/21/2008	F	Adult	350460	North Star	711	yes	sob	2,361
11/21/2008	F	Adult	330464	North Star	714	yes	sob	2,747

**Table 5. Operational history of GPS collars deployed on desert bighorn sheep on YPG Cibola Range, 2007-2011.**

<b>Capture Date</b>	<b>Sex</b>	<b>Estimated Age</b>	<b>Collar ID#</b>	<b>Mfgr</b>	<b>Op. Days</b>	<b>Collar Recovered</b>	<b>Data <sup>1</sup></b>	<b>Total Locations</b>
11/13/2009	M	4	356815	North Star	114	yes	sob	132
11/13/2009	M	2.5	356807	North Star	719	yes	sob	2,918
11/13/2009	M	5	356805	North Star	359	yes	sob	1,566
11/13/2009	M	3	345552b	North Star	632	no	uplink	456
11/13/2009	M	7	351409b	North Star	69	no	uplink	120
11/13/2009	M	3	356806	North Star	261	no	uplink	435
11/13/2009	M	2	356800	North Star	200	no	uplink	109

<sup>1</sup> sob = downloaded from collar after recovery, uplink = reported at time of acquisition via manufacturer's web site

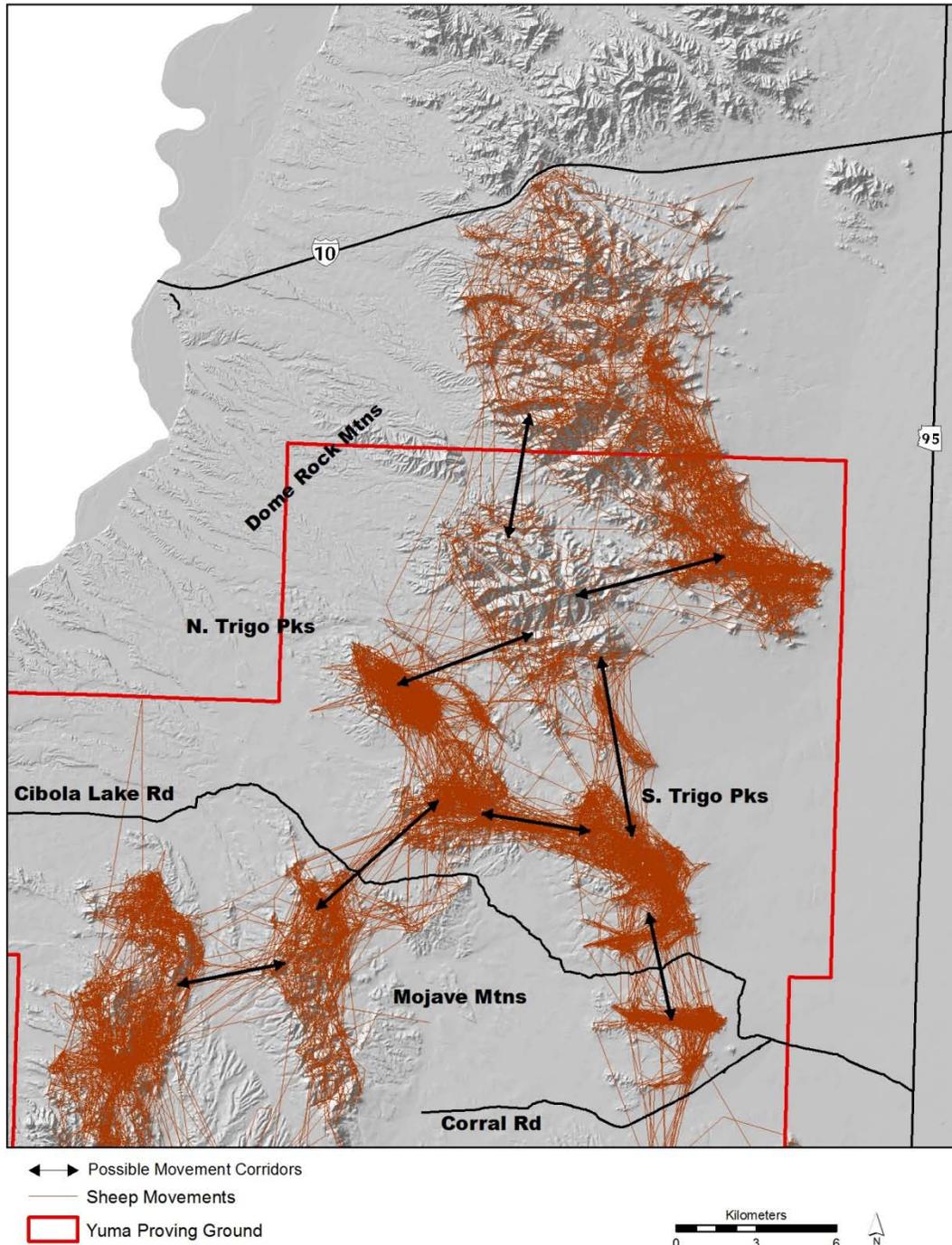


**Figure 3. Locations (2007-2011) of GPS-collared desert bighorn sheep collared on YPG Cibola Range.**

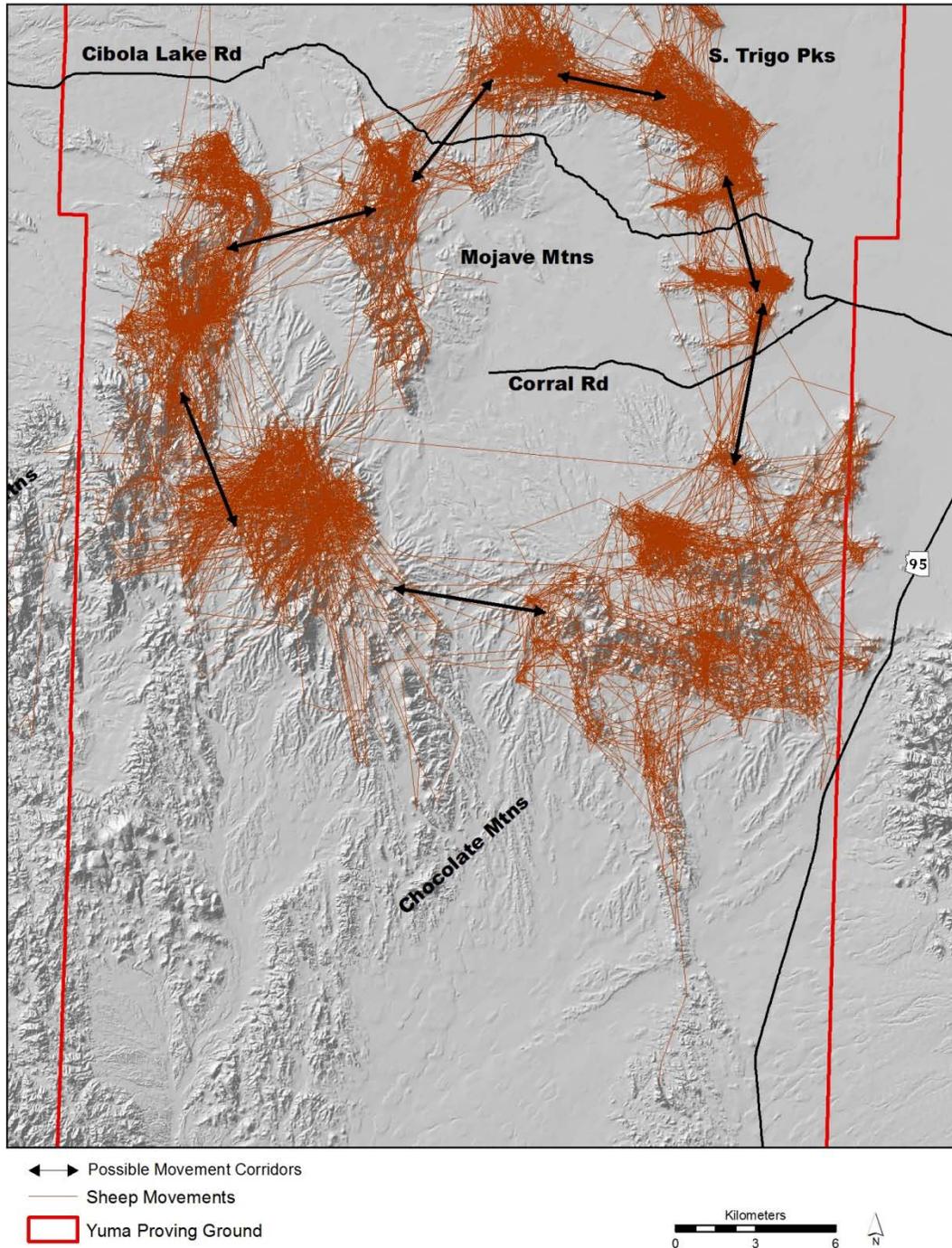
*Influence of Developed Waters and Other Factors* – these objectives were addressed by the NAU graduate student in her MS thesis (Hoglander 2012). A copy of the thesis accompanies this report.

*Travel Corridors* – compiled movement data indicated extensive movements by sheep among mountain ranges on the Cibola Range (Figs. 4-5). These likely track shifting availability of forage and other resources

affected by patchy and irregular precipitation, as well as movements associated with rut and lambing periods. Sheep regularly crossed roads receiving heavy traffic associated with test and training activities (Cibola Lake Rd., Corral Rd.). Maintaining connectivity of these non-contiguous areas of sheep habitat is an important consideration for current and future management of this population.



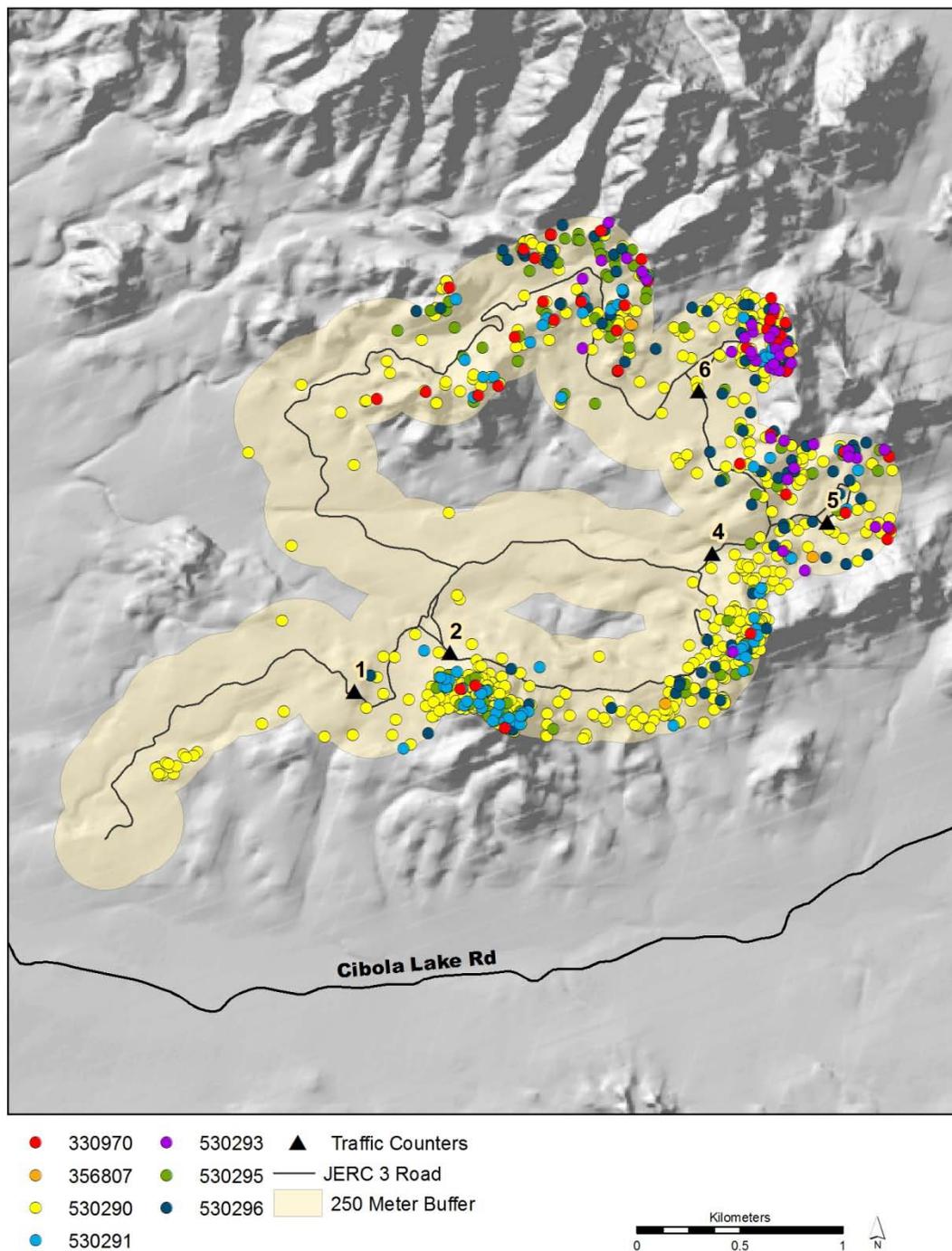
**Figure 4. Movements of GPS-collared desert bighorn sheep on YPG Cibola Range, 2007-2011. Arrows indicate apparent corridors between mountain ranges and across major roads.**



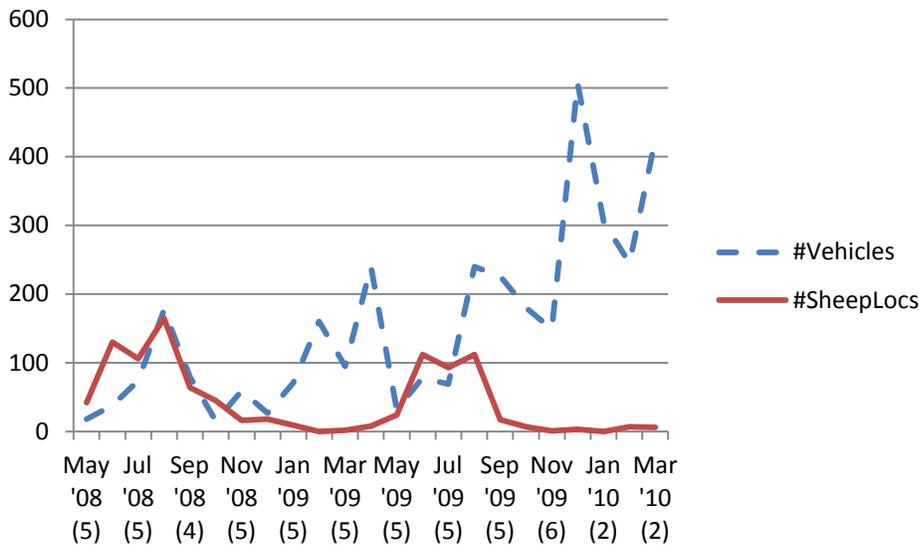
**Figure 5. Movements of GPS-collared desert bighorn sheep on YPG Cibola Range, 2007-2011. Arrows indicate apparent corridors between mountain ranges and across major roads.**

*Responses to Activities on JERC III Course* – seven collared bighorn had locations on or immediately adjacent to the JERCIII course between May 2008 and March 2010 (Fig. 6). Use of this area was greatest from May through September (Fig. 7). Comparison with levels of vehicle traffic did not suggest a clear response by

sheep (Fig. 7). However, this assessment was compromised by the small number of active collars (2) remaining once site development was completed and testing/training activities began.



**Figure 6. Locations of GPS-collared desert bighorn sheep within 250 m buffer of JERCIII road course, YPG Cibola Range, May 2008 through March 2010.**



**Figure 7. Monthly total locations of GPS-collared desert bighorn sheep and vehicle activity along JERCIII road course, YPG Cibola Range, May 2008 through March 2010. Number of GPS collars active during each month is shown in parentheses.**

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## TASK C: WILDLIFE HABITAT CONNECTIVITY ALONG HIGHWAY 95

### Overview

Roads and other transportation corridors are prominent landscape alterations that directly and indirectly impact wildlife, presenting physical barriers to animal movements and causing direct mortality from collisions with vehicles (Trombulak and Frissell 2000, Forman et al. 2003). Species that occur as semi-isolated metapopulations, like desert bighorn sheep, can be particularly susceptible to barriers affecting landscape connectivity and gene flow (Epps et al. 2005). Road design has a strong influence on permeability for wildlife, important factors include width, fencing, and the number and type of undercrossings and drainage structures (Dodd et al. 2007). The latter can be of particular importance to smaller animals (Grandmaison 2011). In Arizona, the Department of Transportation has undertaken extensive efforts to maintain wildlife connectivity and minimize collisions along major highways (Arizona Department of Transportation nd).

Expansion of existing roads can affect wildlife populations, but also presents opportunities for modifications to enhance permeability. U.S. Highway 95 is a 2-lane undivided route connecting Quartzsite and Yuma, Arizona and a major arterial for travelers accessing Interstate Highways I-8 and I-10. Recent growth in both cities and numbers of winter visitors have dramatically increased traffic volumes on Highway 95. An engineering and environmental study is currently underway to determine improvements needed for future operation of US 95 along an approximately 20-mile segment between MP 42 and MP 66. Future improvements along other segments are likely. The stretch of Highway 95 between Quartzsite and Yuma traverses largely undeveloped lands managed by the U.S. Army (Yuma Proving Ground), U.S. Fish and Wildlife Service (Kofa National Wildlife Refuge), and Bureau of Land Management. These areas provide important habitat for a variety of wildlife species, including desert bighorn sheep and mule deer.

### Objectives

1. Quantify frequency and location of large mammal mortalities occurring from vehicle collisions along Highway 95
2. Quantify connectivity provided by existing crossing structures
3. Model connectivity across Highway 95 for desert bighorn sheep and mule deer

### Methods

*Wildlife Mortalities* – in January 2012 we initiated monthly vehicle surveys for road kills along the study segment of Highway 95 between mileposts 40 and 97. Focal species were meso-carnivores and ungulates; smaller vertebrates are quickly removed by scavengers and not effectively surveyed using this approach. Surveys were conducted at consistent speed of 55 mph. Observers inspected each kill found, recording species, sex, estimated age, and GPS location. We also obtained supplemental road kill information through regular contact with personnel from the Bureau of Land Management, Arizona Department of Public Safety, and Arizona Department of Transportation.

*Existing Crossing Structures* – we initiated a complete inventory of undercrossing drainage structures (culverts) currently in place along the study segment of Highway 95. Each structure was classified by type (pipe or concrete box), number of units (individual pipes or box cells), and measured (length; diameter or height/width of each unit). For each structure, we calculated an "openness" index as: opening height x opening width/undercrossing length (Ascensão and Mira 2007). Index values ranged from 0-1, with values

of 1 representing highest permeability. Following Grandmaison (2011) we calculated separate individual index values for each unit of multi-unit undercrossing structures. For each 1-mile segment of Highway 95, we calculated net undercrossing permeability by summing openness values for all units within the segment, then dividing by the maximum possible permeability value (= total number of units).

## Results and Discussion

*Wildlife Mortalities* – we documented 20 mortality events involving large mammals along Highway 95. These consisted of 1 mule deer and 19 feral ass (*Equus asinus*, Table 6). Because our surveys occurred at monthly intervals, they were unsuitable for estimating mortalities of smaller animals quickly removed by scavengers. Collisions with feral asses present a significant public safety concern and underline the importance of managing the herd within designated boundaries and target management levels. Collision-related mortalities of wild ungulates appear to be uncommon along this segment of Highway 95.

**Table 6. Dates and locations of road-killed large mammals along Highway 95, January - August 2012.**

Date	Species	Mile Marker
1/3/2012	feral ass	65
1/5/2012	feral ass	63
1/9/2012	feral ass	67
1/9/2012	feral ass	71
1/10/2012	feral ass	66
1/18/2012	feral ass	73
2/7/2012	feral ass	58
2/7/2012	feral ass	58
2/7/2012	feral ass	64
2/10/2012	feral ass	60
2/10/2012	feral ass	51
2/11/2012	feral ass	54
2/28/2012	feral ass	47
3/1/2012	feral ass	61
3/5/2012	feral ass	54
3/8/2012	feral ass	60
4/16/2012	feral ass	41
4/24/2012	feral ass	41
4/24/2012	feral ass	41
7/2/2012	mule deer	44

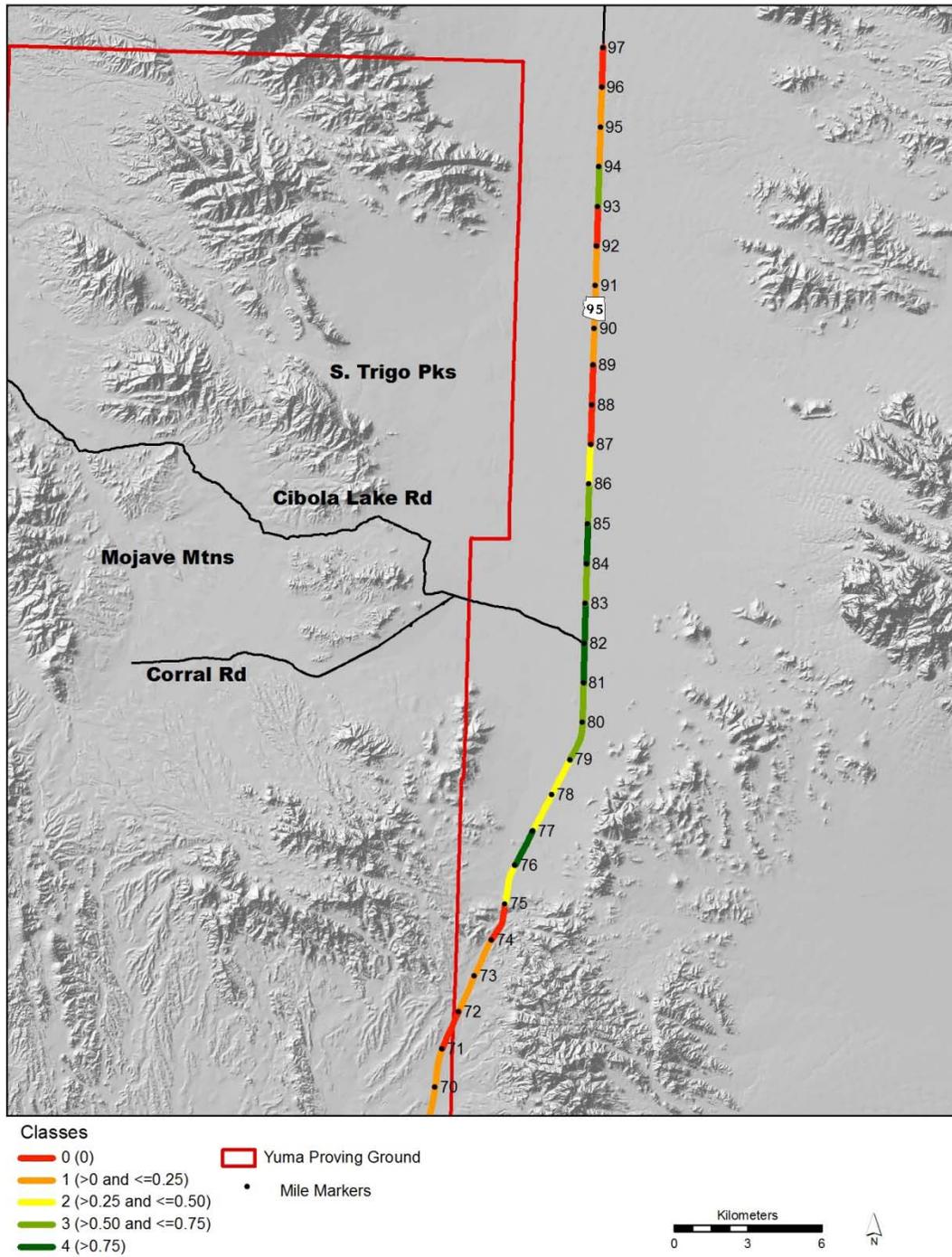
*Existing Crossing Structures* – we identified, classified, measured, and recorded GPS locations of all drainage structures under the highway between mileposts 40 and 97. The surveyed stretch contained a total of 173 structures, 131 metal or plastic tubular culverts and 42 concrete box culverts. There was considerable variability in design and dimensions of these structures. Representative examples are shown in Fig 8.

All but one structure was clear of debris and passable by animals. Anecdotal observations of sign (tracks, scat) indicated that most were used by a variety of wildlife species.

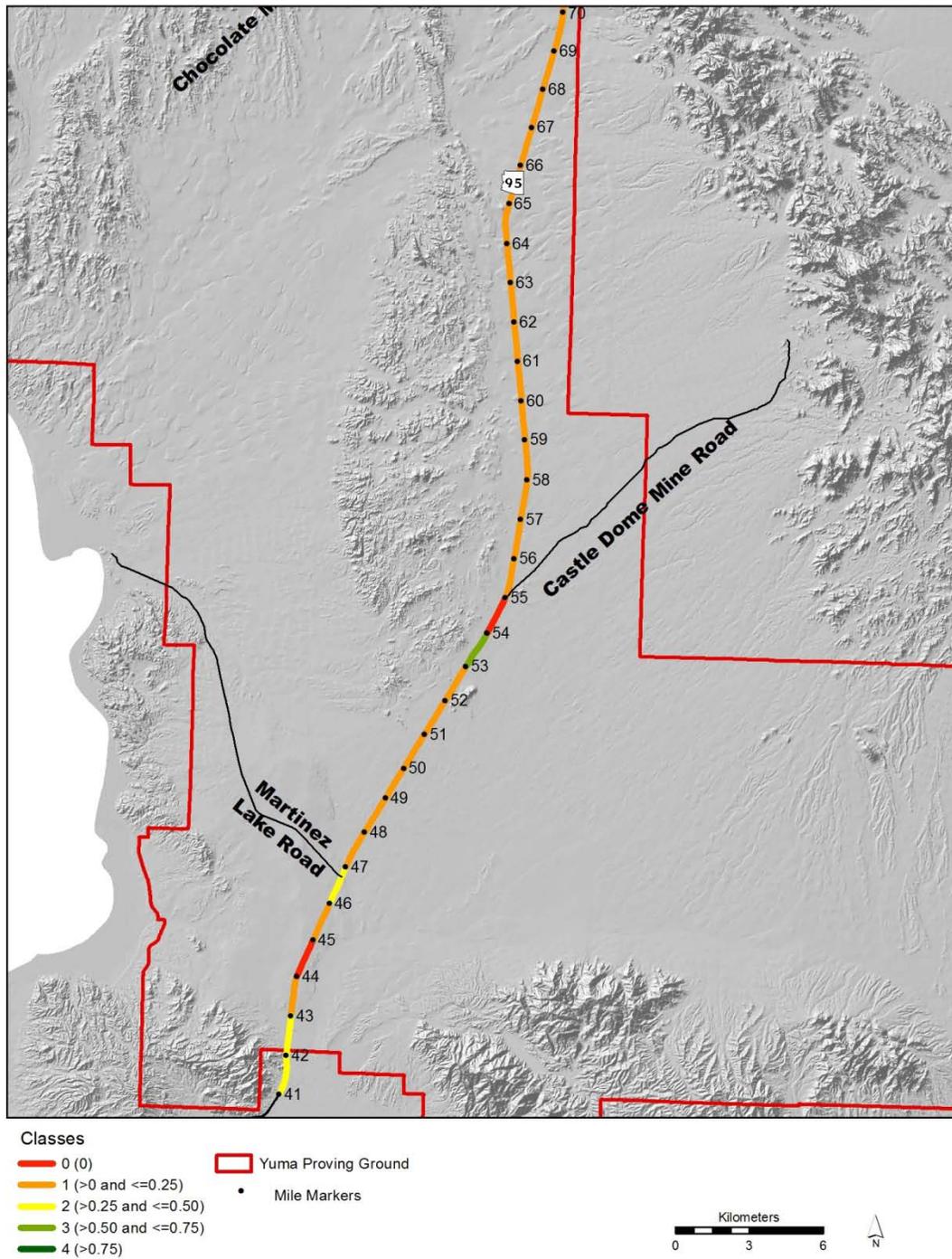


**Figure 8. Examples of drainage structures currently present along Highway 95 between Yuma and Quartzsite, Arizona. Clockwise from upper left: single cell concrete box, multi-cell concrete box, double tube metal culvert and single tube metal culvert.**

These structures are regularly distributed and currently provide opportunities for passage for small animals under all of the Highway 95 corridor (Figs. 9-10). Only 8 (1-mile) segments currently lack undercrossing structures. These baseline data may be useful when planning future modifications of the highway that may occur. Additional information on wildlife use of similar structures elsewhere in the Sonoran Desert and design recommendations to enhance their permeability can be found in Grandmaison (2011).



**Figure 9. Potential permeability for animal movement under Highway 95, as provided by existing drainage structures between mile markers 70 and 97. Each 1-mile segment was placed into 1 of 5 classes derived from continuous permeability estimates that ranged from 0-1, where 0 = no structures and 1 = maximum potential for movement (see text for details).**



**Figure 10. Potential permeability for animal movement under Highway 95, as provided by existing drainage structures between mile markers 41 and 70. Each 1-mile segment was placed into 1 of 5 classes derived from continuous permeability estimates that ranged from 0-1, where 0 = no structures and 1 = maximum potential for movement (see text for details).**

*Connectivity* – our Northern Arizona University collaborators completed a stand-alone modeling effort assessing connectivity for large mammals (mule deer and desert bighorn) across Highway 95 and the surrounding region. Results of that work are presented in a separate report accompanying this report. They merit careful consideration with respect to existing connectivity across the Highway 95 corridor and future modifications that may occur.

Desert bighorn movement data presented above (Task A) also provide insight into the effects of Highway 95 on movements of these animals. None of our GPS-collared animals appeared to cross the highway, however there were a number of locations in areas immediately adjacent where transits might occur (Fig. 5). Given the importance of metapopulation dynamics to desert bighorn, the barrier effects of Highway 95 merit further consideration. While not a focal area for this study, we also documented an apparent pinch point north of YPG along Interstate 10, where northward movement appears to be interrupted (Fig. 3).

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## **TASK D: CAMERA TRAPPING AT WILDLIFE WATER DEVELOPMENTS**

### **Overview**

Previous monitoring of wildlife water developments with video camera systems documented high levels of use by a variety of wildlife species (O'Brien et al. 2005, Waddell et al. 2007). Video observation yields large amounts of data, however these systems are expensive to install and maintain, are complex and prone to component failure, and require tremendous amounts of time for image processing. Still-image trail cameras are an emerging and widely-used technique for wildlife surveys (O'Connell et al. 2011) and have also been used to estimate population parameters for white-tailed deer (*Odocoileus virginianus*; Jacobson et al. 1997). We have successfully used these systems for completed and ongoing studies of mesquite bosques on the installation (see 2011 final report, Task A section of this report).

This project component focused on obtaining additional information on wildlife use of YPG water developments, particularly those not included in the original video monitoring effort. We also sought information that could supplement other deer survey data and help guide management.

### **Objectives**

1. Identify current methodologies for wildlife surveys and analysis of data derived from trail cameras
2. Quantify wildlife use of selected water developments on YPG and adjacent areas

### **Methods**

We completed a thorough review of current published literature on the use of trail cameras in wildlife studies. Results of that review were presented in our May 2012 Interim Report.

We conducted this study at 14 Arizona Game and Fish Department wildlife water developments located on YPG and immediately adjacent lands managed by the Bureau of Land Management (Fig. 11). At each site, we installed a 4-megapixel digital trail camera (Model #I40, Moultrie Feeders, Alabaster, AL) mounted on a metal t-post (Fig. 12). Cameras were placed within 3-4 m of the catchment trough, facing north to reduce temperature and glare from the sun. Cameras were triggered by a motion sensor and equipped with infrared flash for nighttime operation. The field of view was 52 degrees with an approximate detection range of 12 m (+/- 1.5 m). We programmed each camera to take a single still photo at high resolution (1648 x 1236 pixels) on a 1-minute delay. Each image was stamped with the current temperature, date, time, and camera identification number.

Digital images were downloaded monthly, then processed to identify wildlife observations. We tallied occurrence of species at each water development. For mule deer, we collected additional information. Because mule deer commonly visit waters in groups of several-many animals that move in and out of the camera field of view (O'Brien et al. 2006), we selected 2-3 images from each visit sequence that allowed classification of the maximum number of different animals. For this subset of images, we recorded: location, date, time, sex of mature animals, and apparent age (adult, yearling, or fawn).

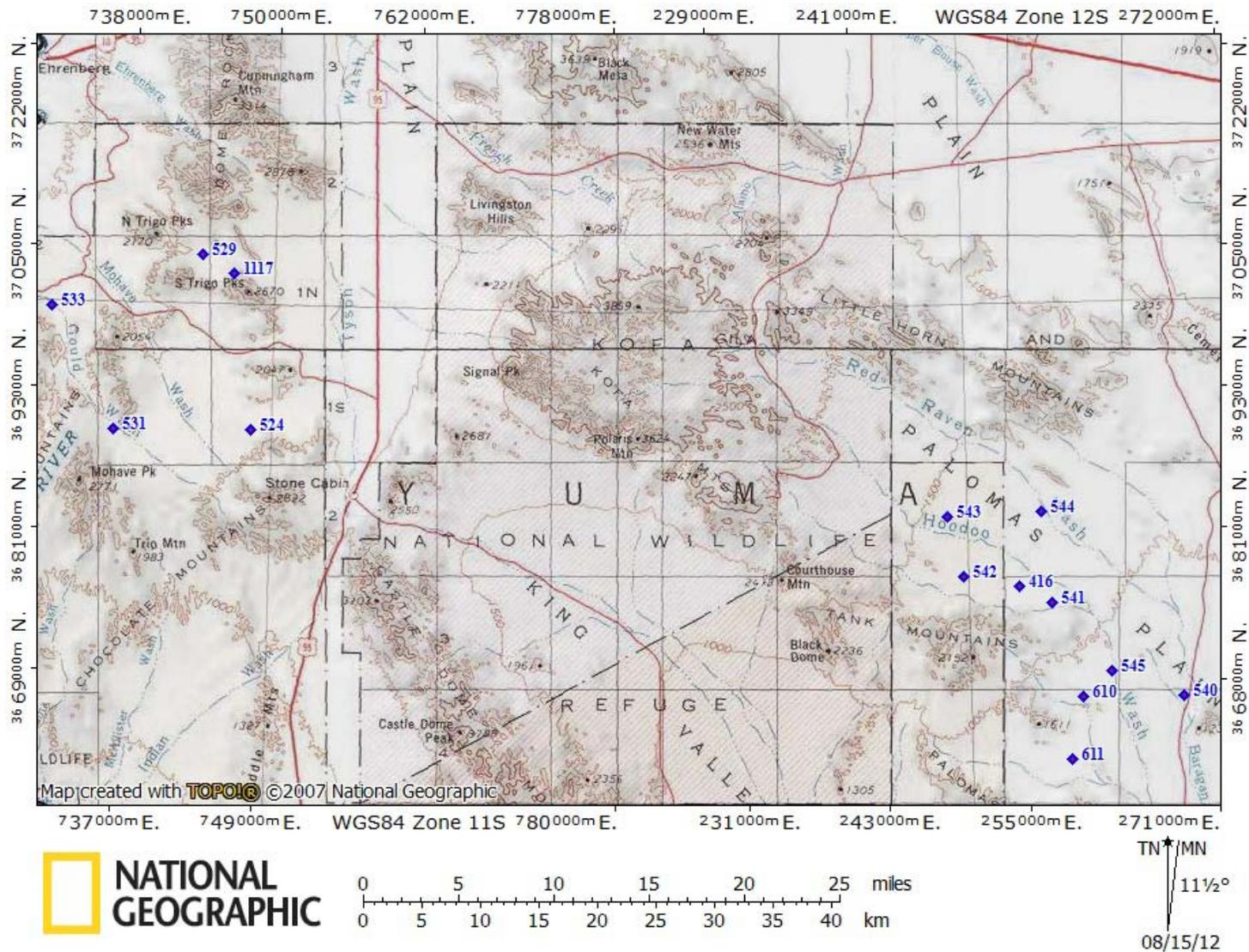


Figure 11. Locations of wildlife water developments included in camera trapping study of wildlife use on YPG and adjacent Bureau of Land Management lands.



**Figure 12. Trail camera installed at AGFD wildlife water development #542, YPG Kofa Range.**

## **Results and Discussion**

Wildlife use of these waters was high, especially during July and August. Cameras typically recorded 1,000- >6,000 images in a 4-week period, occasionally exceeding capacity of the 4 GB memory card. We documented 26 species using these water developments (Table 7). Eight species were ubiquitous: mule deer, coyote, red-tailed hawk, turkey vulture, Gambel's quail, mourning dove, white-winged-dove, and great-horned owl. Six others (bobcat, gray fox, kit fox, black-tailed jackrabbit, common raven, greater roadrunner, and common raven) occurred at least 50% of the waters. Other avian and mammalian species occurred less frequently (Table 7). Notable among these were mountain lions (at #541, 542 and 543) and a golden eagle (#531). Desert bighorn occurred at 2 waters (#531, 1117), a consequence of selecting sites in habitats favored by mule deer and distant from rugged upland escape terrain used by bighorn. We also identified a number of passerine birds (Table 7). Actual diversity was likely higher, because passerines were too far from the camera to be identified in many images.

We classified deer in 1,671 images taken from June 17 - July 26, 2012. They contained 3,003 deer: 749 bucks, 1441 does, and 810 (27%) that could not be classified because of poor image quality, partial views of the animal, or shadowing of nighttime images (Table 8). Only 3 yearlings were identified, however, difficulty of discerning age classes in nighttime images likely resulted in a number of these animals being classified as does or "unknown." No fawns were observed.

Physical characteristics (e.g., antlers, missing pelage or body scarring) allowed some individuals to be identified, though not consistently enough to conduct formal analyses of these data (e.g., in a mark-recapture framework). Because deer commonly visited waters multiple times during the night and over the sampling period, repeat observations of the same individuals were common. Consequently, these data do not provide actual population estimates, but can be used to infer area-specific patterns of deer use and coarse measures of relative abundance. Similarly, we caution that sex-specific differences in patterns of water visitation could bias buck:doe ratios derived from these camera trapping data.

**Table 7. Wildlife species observed in trail camera images taken May - August 2012 at wildlife water developments on YPG and adjacent BLM lands.**

Species	Water#														% Sites
	416	524	529	531	533	540	541	542	543	544	545	610	611	1117	
Great horned owl	x	x	x	x	x	x	x	x	x	x	x	x	x	x	100
Mourning dove	x	x	x	x	x	x	x	x	x	x	x	x	x	x	100
White-winged dove	x	x	x	x	x	x	x	x	x	x	x	x	x	x	100
Coyote	x	x	x	x	x	x	x	x	x	x	x	x	x	x	100
Mule deer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	100
Gambel's quail	x	x	x	x	x	x	x	x		x	x	x	x	x	93
Red-tailed hawk	x	x	x	x	x	x	x	x	x	x	x	x	x		93
Turkey vulture	x	x	x	x	x	x	x	x	x		x	x	x	x	93
Kit fox	x	x		x	x		x	x	x	x		x	x	x	79
Bobcat	x	x	x			x	x	x		x	x		x	x	71
Common raven		x	x				x	x	x		x	x	x	x	64
Grey fox	x	x		x	x			x	x		x	x		x	64
Black-tailed jackrabbit	x		x	x				x			x	x	x	x	57
Greater roadrunner					x	x	x	x	x	x	x				50
America kestrel					x		x	x		x		x		x	43
Gila woodpecker	x				x	x									21
Golden eagle			x	x											14
Prairie falcon			x		x										14
Badger		x			x										14
Mountain lion								x	x						14
Desert cottontail	x		x												14
Desert bighorn				x										x	14
Abert's towhee						x									7
Ash-throated flycatcher											x				7
Boat-tailed grackle										x					7
Striped skunk												x			7

**Table 8. Mule deer observed in trail camera images taken June 17 - July 26, 2012 at 14 wildlife water developments on YPG and adjacent BLM lands. Data are summarized by AGFD Game Management Unit.**

Water	Bucks	Does	Yearlings	Unknown	Total	B:100D Ratio	Unknown (%)
<u>Unit 41</u>							
416	75	166		112	353	45	32
540	6	153		14	173	4	8
541	31	98		71	200	32	36
542	102	113		47	262	90	18
543	42	44		18	104	95	17
544	37	118		51	206	31	25
545	4	16		6	26	25	23
610	11	30		25	66	37	38
611	34	133	2	73	242	26	30
<b>Total</b>	<b>342</b>	<b>871</b>	<b>2</b>	<b>417</b>	<b>1632</b>	<b>39</b>	<b>26</b>
<u>Unit 43A</u>							
529	17	13		10	40	131	25
1117	9	51		29	89	18	33
<b>Total</b>	<b>26</b>	<b>64</b>	<b>-</b>	<b>39</b>	<b>129</b>	<b>41</b>	<b>30</b>
<u>Unit 43B</u>							
524	107	178	1	97	383	60	25
531	173	127		107	407	136	26
533	101	201		150	452	50	33
<b>Total</b>	<b>381</b>	<b>506</b>	<b>1</b>	<b>354</b>	<b>1242</b>	<b>75</b>	<b>29</b>

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