

**Distribution and Habitat Selection/Space Use of Migratory and Resident Golden Eagles
(*Aquila chrysaetos*) in Areas with High Potential for Wind Energy Development
in New Mexico**

Project Status Report: July 2015



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EXECUTIVE SUMMARY

This report summarizes efforts conducted for a Bureau of Land Management (BLM)-funded project examining the occurrence and movements of golden eagles (*Aquila chrysaetos*) in southern New Mexico from 20 October 2013 through 25 July 2015. Our objectives for the study were to:

- 1) Assess habitat and space use of migratory and resident golden eagles in areas managed by the BLM with a focus on areas with a high potential for wind energy development in southern New Mexico.
- 2) Determine phylogeographic patterns of relatedness for resident and wintering golden eagles in southern New Mexico.
- 3) Identify the origin and migration patterns for golden eagles over-wintering in southern New Mexico.
- 4) Identify nest sites and estimate productivity and survival of golden eagles on BLM managed lands in areas with a high potential for wind energy development in southern New Mexico.

Findings:

- Ten territories were active in 2014. Of these, only five had nests that were attended. However, only two territories were observed with pairs and none of these were successful. Eleven territories were active in 2015. Seven territories were observed with pairs and at least three nests were successful, producing at least five fledglings.
- One-hour surveys at 41 fixed points were repeatedly surveyed on a monthly basis from 20 October 2013 to 25 July 2015; a total of up to 21 visits per point were accomplished (some points were sampled less frequently owing to changes in accessibility).
- Raptor and prey survey transects were surveyed between 7 December 2013 and 25 July 2015; transects were identical, with raptors being observed during the day and prey observed at night to increase the detection rates of lagomorphs. Eighteen raptor and prey transects were surveyed up to 19 times (due to changes in accessibility) each for a distance of 4,700 km surveyed for raptor transects and 4,794 km for prey transects. A total of 9,494 km were surveyed.
- Eighty-one golden eagles were observed at 20 survey points (17 from the Southwest Region), 12 were observed during seven raptor transects, and 14 incidental observations were made of 16 golden eagles (12 were observed in the Southwest Region).

2013-2015 Surveys – Data that can be used to estimate golden eagle and raptor occupancy and prey density were collected near 12 potential wind energy development projects (Table 1) using a set of fixed-point surveys and transect surveys initiated in October 2013 and focused near active breeding territories of golden eagles. The surveys were in three general regions in southeastern and south-central New Mexico. The northern most project region (hereafter referred to as Central) is located within Corona and Capitan, Lincoln and Torrance Counties (Figure 1). New Mexico Highways 246 and 247, US Hwy 54, and Lincoln County Road B014 essentially encompass the Central study region. The southeast project region (hereafter referred to as Southeast) is located within Carlsbad, Eddy and Chavez Counties, including the northern Guadalupe Mountain Rim (Figure 2). Chaves County Rd 24 (Pinon-Dunken Rd), Eddy County Rd 429 (McKittrick Rd), Chaves County Rd C4-035 (Cauhape Ranch Rd), and Chaves County Rd 408 (Dark Canyon Rd) encompass the Southeast region. The southwest project region (hereafter referred to as Southwest) is located near the cities of Las Cruces and Hatch, Dona Ana County; Deming, Luna County; and Lake Valley Townsite, Sierra County (Fig. 3). Dona Ana County Rd D012, Interstate Highway - 10, Luna County Rd A024, and Sierra County Rd B116 bound the Southwest study region.

Seventeen historic golden eagle territories and two new nesting territories were monitored in 2014 and 2015 (Table 2). The new territory (Southern Cooke's Range) added in 2014 was located in the Southwest, east of Luna County Rd A018. A pair was observed copulating in that area. However, a nest was never located and may have been situated on an adjacent formation. In 2015, the Hilltop territory was added in the Southwest. This nest was observed on the southwestern side of a formation located to the east of Starvation Draw. It is approximately 2,400 m southeast of the Hilltop survey point. A golden eagle was observed multiple times on the nest, however, no chicks nor fledglings were observed at the nest or within the territory.

Ten territories had at least one golden eagle observed during the 2014 breeding season. Five territories exhibited nest maintenance (fresh material added), however, pairs were only observed at two territories: Southern Cooke's Range and Town Mountain. Successful nesting attempts were not observed at any territory. The lack of nesting attempts and success in 2014 may be due to the low numbers of prey items, primarily lagomorphs (Fig. 4), present at the beginning of the breeding season. The number of lagomorphs did increase dramatically as the year progressed, but this increase in prey was likely too late to influence nest success for the 2014 breeding season (Fig. 4).

Eleven territories had at least one golden eagle observed during the 2015 breeding season. Seven of these had pairs within the territory (Table 3). Five of these territories were observed to have active nests, producing at least 5 known fledglings from three of these nests. The pair in Crooked Canyon observed on 20-Feb may have had a nest in an adjacent canyon that was inaccessible. The pair at Magdalena Peak may have a nest or nests on the southern or southwestern side, which was inaccessible for monitoring. From discussions with climbers, the pair nesting in the Dona Ana Mountains territory may have nested on the opposite side of the mountain during this breeding season. The pair at the Good sight South territory constructed a new nest in 2015. This produced 1-2 fledglings. Two older chicks were observed in the nest on 16 May and one

fledgling was observed flying above and near the nest site on 28 June and 25 July. Two hatch year golden eagles were observed on 25 July, six kilometers to the north of the nest near the Butterfield Windmill. The Hilltop nest had an eagle sitting in the nest on 16 May, presumably a late incubating female or an older chick. The distance of the observation point from the nest made the age of the bird difficult to determine. However, only adult eagles were observed following that visit so we assumed that this nest was unsuccessful. On 16 May, the nest on the south side of Nutt Mountain was observed to have an older chick at the nest being attended to by both adults. One adult was observed near the top of the peak on the following visit (27 June). The chick is assumed to have fledged. The nest on the north side of Round Mountain produced two chicks (observed 17 May), which both fledged. On 27 June, they were observed flying and perching on the sides of the mountain. One adult was present during that visit as well.

Forty-one fixed survey points were visited eight times each from October 2013 to July 2015 (Table 4). Survey periods consist of 60 min survey blocks, in which the observer performs a 360° sweep of the area with binoculars and a spotting scope and records all golden eagles and other raptors observed. Throughout the duration of the survey period, the observer continually scans the area recording all birds of interest as well as other pertinent observations. Site conditions including temperature, average and maximum wind speed within a 20 s period, wind direction and cloud cover were also recorded at the beginning of each survey period.

Eighty-one golden eagles were observed at 20 survey points (Table 5). Many of these are likely repeated observations of the same individuals. Three of the observations were groups of three. One of these was at the Good sight South territory following the 2014 breeding season (19 Aug 2014) and may have been the result of a successful breeding attempt in the area. Likewise, an observation of a group of three golden eagles on 21 July 2014 at Nutt Mountain may have resulted from a successful breeding attempt in that area. There were 16 observations of pairs at 13 survey points. Most of these observations ($n = 13$) occurred in the Southwest region, and three occurred at Jack's Peak in the Central region. It is likely that the same pair was observed three times around Jack's Peak in the Central region. Jack's Peak is a historic nesting territory. A nest was found in the historic location, but was never active, and other potential nesting sites in the area are located on private land and were inaccessible. The rest of the observations ($n = 40$) were of individuals at 17 survey points. One adult was observed being chased by a nesting red-tailed hawk (*Buteo jamaicensis*) in the Southeast above Four-mile Canyon. A juvenile was also observed at a later date being harassed by a pair of red-tailed hawks in the same area, but from a raptor transect. One pair was observed at a great distance from the survey point Hilltop in 2014 and 2015. These observations led to discovering the Southern Cooke's Range territory in 2014 and the Hilltop territory in 2015.

Fourteen different raptor species were observed during the point count surveys (Table 6). All 14 species were observed in the Southwest study region while 10 species were observed in the Southeast region, and nine in the Central region. The Southwest had the greatest number of birds of prey observed; $n = 700$ versus 419 in the Southeast and 405 in the Central regions. Overall, turkey vultures (*Cathartes aura*) were the most common species observed ($n = 867$), but their foraging mode may also have contributed to a high detection probability. Swainson's hawks

(*Buteo swainsonii*; $n = 196$) and red-tailed hawks ($n = 141$) were the next two most frequently observed species. Swainson's hawks are common breeders in the Chihuahuan Desert and frequently use low shrubs as nesting sites, which could have increased their detection relative to red-tailed hawks. Three species of falcons were observed, including the American kestrel (*F. sparverius*; $n = 40$), prairie falcon (*F. mexicanus*; $n = 11$), and peregrine falcon (*Falco peregrinus*; $n = 4$). Accipiters were not commonly observed, with only five Cooper's hawks (*Accipiter cooperii*) and a single sharp-shinned hawk (*A. striatus*) observed. Three species of owl were observed during the point counts: burrowing owl (*Athene cunicularia*; $n = 22$), great horned owl (*Bubo virginianus*; $n = 20$), and long-eared owl (*Asio otus*; $n = 7$). Short-eared owls (*Asio flammeus*) were observed foraging incidentally during prey surveys east of the Good sight Mountains ($n = 2$) in the Southwest region on 15 Feb 2014 and north side of Jack's Peak ($n = 1$) in the Central region on 22 Feb 2014. Ferruginous hawks (*Buteo regalis*) were the least encountered *Buteo* hawk on the survey with only three occurrences in the Southwest region.

Raptor Transect Surveys - Distance sampling (Buckland et al. 2001) was conducted for golden eagles and other birds of prey in an attempt to increase the probability of detection within the survey regions. These surveys began in December 2013, and consisted of 19 transects ranging from six to 37 km in length (Table 7). There are six transects in the Central totaling 120 km, five in the Southeast totaling 67 km, and eight in the Southwest totaling 100 km. These transects run between survey points. When a bird of prey was detected the angle and radial distance of the animal relative to the observer and transect were recorded. The program DISTANCE (Laake et al. 1994, Thomas et al. 2010) will be used to analyze the distance sampling surveys, however, we may have to truncate observations to only those ≤ 1000 m, the maximum distance estimable with a range finder, or not use this approach owing to the difficulty in accurately measuring the distance to a flying bird > 1000 m. Within each transect, the distance travelled through each habitat type will be calculated using ArcGIS (ESRI Inc. 2010).

From 7 December 2013 to 25 July 2015, most transects were visited 16 - 19 times for a total distance of 4,700 km. BP_extension was established on 8 February 2014 to augment the BP transect and PH_a was shortened on 18 April 2014 due to private property issues and renamed Ph_b. NNM was shortened following the 17 Nov 2014 survey due to private property issues. Most observations occurred in the Central ($n = 455$), followed by the Southeast ($n = 254$) and Southwest ($n = 205$). Similar to the fixed point surveys, turkey vultures were observed the most ($n = 386$), followed by Swainson's hawks ($n = 236$), American kestrels ($n = 108$), red-tailed hawks ($n = 90$), and northern harriers (*Circus cyaneus*; $n = 43$) (Table 8). Twelve golden eagles were observed from seven raptor transects (Table 9). There were two hatch-year golden eagles along the Good sight Mountains transect near the Butterfield Windmill on 25 July 2015 (see above). All of the other observations were of single golden eagles. Additional raptors that were observed during transect sampling included ferruginous hawk ($n = 8$), Cooper's hawk ($n = 4$), short-eared owl ($n = 2$), great horned owl ($n = 1$), and long-eared owl ($n = 1$). Species observed during the raptor transects that were not detected during fixed point surveys included white-tailed kite (*Elanus leucurus*; $n = 1$) and Mississippi kite (*Ictinia mississippiensis*; $n = 1$) in the Central region.

Incidental Sightings – There were sixteen incidental sightings of golden eagles from 21 October 2013 to 26 May 2015 (Table 10). Twelve of these observations occurred in the Southwest, and two sightings each occurred in both the Central and Southeast study regions. One individual observed in the Central region was roosting in the interior of a one-seed juniper (*Juniperus monosperma*) on 23 October 2013. One individual observed in the southeast was near a nest in the Crooked Canyon territory on 26 May 2015. One eagle observed north of Deming on US Hwy180 on 14 February 2014 had a telemetry backpack (antenna observed).

Prey Density Surveys - Starting in December 2013 distance sampling (Buckland et al. 2001) was conducted for known golden eagle prey species (Stahlecker et al. 2010). Surveys consisted of sampling the 19 raptor transects at night using two observers with spotlights. When a prey species was detected the angle and radial distance of the animal relative to the observer and transect were recorded. The program DISTANCE (Laake et al. 1994, Thomas et al. 2010) will be used to analyze the distance sampling surveys. Within each transect, the distance travelled through each habitat type will be calculated using ArcGIS (ESRI Inc. 2010).

From December 2013 to July 2015, most transects were visited 16 - 19 times for a total of 4,794 km. A total of 2,620 individuals were observed from the prey transects (Table 11). Black-tailed jackrabbits (*Lepus californicus*) were observed most often ($n = 1,513$) followed by desert cottontails (*Sylvilagus audubonii*) ($n = 464$). The greatest number of prey observations occurred in the Central region ($n = 1,097$), followed by the Southwest ($n = 960$), and Southeast ($n = 563$), respectively. However, this order also reflects differences in total prey transect length. The number of lagomorph individuals encountered per kilometer driven generally increased from 7 December 2013 to 25 July 2015 for all three regions (Fig. 4). The Central region had the highest encounter rate (0.47 ind/km; SD = 0.16), followed by the Southwest (0.46 ind/km; SD = 0.19), and Southeast (0.26 ind/km; SD = 0.19). Mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) fawns are potential prey items for golden eagles so we recorded any encounters during prey transects. Mule deer were most abundant ($n = 188$) in the broken canyon habitat found in the Southeast whereas pronghorn were more numerous in the open habitat common in the Southwest ($n = 94$) and Central regions ($n = 64$). Kit fox (*Vulpes macrotis*) were most abundant in the Southwest ($n = 64$) followed by the Central ($n = 19$). Surprisingly, one kit fox was observed on a ridge along the RG_a FM prey transect on 13 August 2014. Coyote (*Canis latrans*; $n = 34$), gray fox (*Urocyon cinereoargenteus*; $n = 13$), and American badger (*Taxidea taxus*; $n = 11$) were not commonly encountered. Eight additional potential prey species had less than 10 occurrences each.

Progress on Assessing the Landscape Genetic Structure of Golden Eagles – We initiated a collaboration with USFWS biologists to develop a tissue and feather database for this project and this effort resulted in the first-ever relationship with the National Eagle Repository and the collection of tissue and feather samples from golden eagle carcasses of known provenance that arrive there. This beginning led to a grant from the USFWS and the USGS to expand the collaborative network and which enabled a workshop held December 17-18, 2014 at NMSU. A consortium of scientists, post-docs, and students from federal resource agencies and universities participated. The workshop was specifically held to determine the best approach to describe the

phylogeographic structure of the western continental population of golden eagles. It was decided that: 1) tissue and feather samples would be shared among all labs (a new federal permit authorizing the sharing of samples was later issued to all pertinent participants – Permit # MB58285B-0); 2) that two labs would pursue a SNP (single nucleotide polymorphism) analysis and another lab would pursue the use of a new sequencing platform (MinION) for the landscape genetic analysis; and 3) that a fourth lab would conduct a stable isotope analysis of golden eagle feathers.

Samples from golden eagles are being stored in the Department of Fish, Wildlife, and Conservation Ecology, New Mexico State University. This database now has 774 entries of individual eagles that have either been trapped under permit or submitted to the National Eagle Repository. One hundred and sixty tissue samples of nestling golden eagles were genotyped in the laboratory of Dr. Andrew DeWoody (Purdue University, West Lafayette, IN) using a panel of SNP loci; these data revealed that there are at least three phylogeographic clusters of golden eagles in the western U.S. and has resulted in a manuscript submitted to *Conservation Genetics*. An additional set of approximately 80 tissue samples has been sent to Dr. DeWoody's lab for another SNP analysis. Three tissue samples have been transferred to the lab of Dr. Brook Milligan (NMSU) who is currently using the MinION sequencer to sequence and subsequently align the genome of the golden eagle to a greater level of genomic coverage than has been done to date (Doyle et al. 2014). Seventy-eight nestling feather samples also were sent to the lab of Dr. David Nelson (University of Maryland, Frostburg, MD) where stable isotope signatures of carbon, nitrogen, and hydrogen were generated to begin the development of a stable isotope base map for golden eagles. Once preliminary analyses are completed, we will send an additional set of nestling feather samples to refine the isotope map. One of the main issues we have with either the genetic or stable isotope analyses is to obtain greater sample coverage, both in density and extent, to characterize the western U.S. region. We hope to use the genetic and stable isotope data to illuminate the phylogeographic structure of golden eagles in the western continental U.S. and then use this information to assign recovered carcasses to specific regions to understand both the movements of golden eagles and the mortality factors that maybe impacting the western continental population.

Summary of Movements by Satellite-telemetered Golden Eagles – Between October 2014 and October 2015 two adult males (117401 and 113625) continued to be monitored via satellite telemetry. Both males displayed migration routes and breeding area use patterns that were essentially identical to those observed in 2014. Male 117401 left New Mexico in March 2015, it spent approximately 6-8 weeks 90 miles west of Whitehorse, Yukon Territory before moving north to the Brooks Range on the Beaufort Sea in Alaska for the remainder of the breeding season. This animal then began his southward migration in late October.

Male 113625 began northward migration in April 2015 spent the breeding season southwest of Jasper National Park in British Columbia, Canada where it remained for the entire 2015 breeding season. In late October, 113625 began southward migration back to New Mexico. Both birds are currently wintering in southern New Mexico. This is the third round-trip migration documented for both of these birds.

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Table 1. The location, size and status of the wind energy projects proposed for development in southern New Mexico. Locations are representative project points, and are listed in UTM NAD 83, zone 13.

Project Name	Easting	Northing	Acres	County	Project Status
Bandana Point	541962	3582241	9,922	Eddy	cancelled
Texas Hill	514749	3588634	7,108	Eddy	cancelled
Otero Wolf	502757	3602160	3	Chaves	pending
Four Mile	494873	3616473	22,360	Chaves	pending
Guadalupe Mountains	491628	3622902	46,547	Chaves	pending
Jacks Peak	450622	3756417	25,358	Lincoln	pending
Bald Hills	452225	3759649	36,556	Lincoln	authorized
Pelon Hills	450667	3764502	9,290	Lincoln	authorized
Tecolote Peak	441038	3766104	22,304	Lincoln	pending
Karbon Zero	465539	3799953	1	Torrance	pending
Nutt Valley	266108	3603760	2,000	Luna	functional
Sleeping Lady Hills	--	--	--	Dona Ana	unknown

Table 2. Golden eagle territories that were monitored in southern New Mexico between 8 February, 2014 and 25 July, 2015. There were no nesting attempts in 2014 and only five nesting attempts in 2015. Three of these attempts were successful in 2015.

Reg- ion	Territory	N	E	2014			2015		
				Occu- pied	Nest Active	Success- ful	Occu- pied	Nest Active	Success- ful
C	Jacks Peak	3754275	442014	Y	N	N	Y	N	N
SE	Crooked Canyon	3598813	500344	N	N	N	Y	N	N
SE	Seco Canyon	3590285	516346	N	N	N	N	N	N
SE	South Well Canyon	3601561	486960	N	N	N	N	N	N
SW	Fosters Hole	3620736	274356	N	N	N	Unk	Unk	Unk
SW	Gila Forest	3629105	249252	N	N	N	Unk	Unk	Unk
SW	Goodsight north	3590559	269252	Y	N	N	Y	N	N
SW	Goodsight Peak	3596348	268646	Y	N	N	Y	N	N
SW	Goodsight South	3585442	271283	N	N	N	Y	Y	Y
SW	Greg Spring	3609299	257059	N	N	N	N	N	N
SW	Hilltop	3583803	248367	-	-	-	Y	Y	Unk
SW	Magdalena Peak	3597515	297507	Y	N	N	Y	Unk	Unk
SW	North Nutt Mountain	3616159	271771	Y	N	N	Unk	Unk	Unk
SW	Nutt Junction	3603435	268350	Y	N	N	N	N	N
SW	Nutt Mountain	3611060	270817	Y	N	N	Y	Y	Y
SW	Round Mountain	3613355	263117	Y	N	N	Y	Y	Y
SW	Sleeping Lady Hills	3575421	308101	N	N	N	N	N	N
SW	Southern Cooke's Range	3585792	251977	Y	N	N	Unk	Unk	Unk
SW	Town Mountain	3623214	257456	Y	N	N	Y	Y	N

Table 3. Nest fates for Golden eagle nests monitored in southern New Mexico between 1 January, 2015, and 25 July, 2015. Three nests in the Southwest Region produced 5 fledglings.

Region	Territory	Active	Nesting	Adults Present	Eggs	Chicks	Fledglings	Notes
C	Jack's Peak	Y	N	1	-	-	-	1 GOEA sighted @ 8:58 on transect between JP2 and LUNA
SE	Crooked Canyon	Y	N	2	-	-	-	Pair only observed in area. Subadult observed later
SE	Seco Canyon	N	N	-	-	-	-	
SE	South Well Canyon	N	N	-	-	-	-	
SW	Dona Ana Mountains	Y	N	1	-	-	-	Had report that active nest was on the other side of the mountain
SW	Fosters Hole	Unk	Unk	-	-	-	-	No access
SW	Gila Forest	Unk	Unk	-	-	-	-	No time to access
SW	Goodsight North	Y	N	1	-	-	-	
SW	Goodsight Peak	Y	N	1	-	-	-	
SW	Goodsight South	Y	Y	2	Unk	2	2	Only one of two nestlings observed post-fledge at nest. Two observed to the north, close to Goodsight North
SW	Greg Spring	N	N	-	-	-	-	Occupied by Red-tailed Hawks
SW	Hilltop	Y	Y	2	Unk	1?	-	One observation could have been either an adult or older chick. No fledglings were observed
SW	Magdalena Peak	Y	Unk	2	-	-	-	Likely nesting on the south side - inaccessible
SW	North Nutt Mountain	Unk	Unk	-	-	-	-	No access
SW	Nutt Junction	N	N	0	-	-	-	
SW	Nutt Mountain	Y	Y	2	Unk	1	1	One chick near fledging and assumed to have fledged
SW	Round Mountain	Y	Y	2	Unk	2	2	Both fledglings observed
SW	Sleeping Lady Hills	N	N	0	-	-	-	
SW	Soledad Canyon	Unk	Unk	-	-	-	-	Territory was not visited
SW	Southern Cooke's Range	Unk	Unk	-	-	-	-	Territory was not visited
SW	Town Mountain	Y	Y	2	Unk	0	0	Adult was on nest and possibly incubating but was never seen on nest afterwards.

Table 4. The fixed survey points visited between 20 October 2013 and 27 July 2015 in southern New Mexico. Most survey points were visited once per month unless access to the points was not possible due to road conditions or land owners.

Region	Point	Location	Northing	Easting	Visits
Central	BH_a	Grasslands east of Jack's Peak	3761289	476430	20
	JP_1	Jack's Peak	3754404	444109	20
	JP_2	Jack's Peak	3753898	439110	20
	JP_VAL	Grasslands east of Jack's Peak	3743820	451322	20
	KZ_a	Camaleon Hill	3795158	462487	20
	Luna	Jack's Peak	3758792	438698	20
	PH_a	Bonita Canyon	3769450	456137	4
	PH_b	Bonita Canyon	3774278	449197	16
	TP_a	Tecolote Peak	3766784	439675	20
	TP_b	Tecolote Peak	3766508	443611	20
	TP_c	Tecolote Peak	3772884	468491	18
Points	11				
Southeast	BP_a	Bandana Peak	3579955	538291	21
	BP_b	Bandana Peak	3582624	542524	21
	FM_a	Fourmile Draw	3615085	495033	21
	FM_b	Fourmile Draw	3617365	494638	21
	LMD_a	Carnero Peak	3580366	556195	21
	RG_a	Russell Gap	3609146	490458	21
	TH_a	Texas Hill	3590337	519495	21
	TH_b	Texas Hill	3589787	516273	21
	TH_c	Texas Hill	3587726	514938	21
	TH_d	Texas Hill	3589334	513146	20
Points	10				
Southwest	FH	Foster's Hole	3618244	270497	10
	GS	Goodsight Mountains	3586183	271387	18
	GS_1	Goodsight Mountains	3591191	268703	21
	GS_2	Goodsight Mountains	3593725	275451	21
	GSP	Goodsight Mountains	3594627	267763	21
	Hilltop	Hill Top Mountains	3585142	246421	20
	NJ	Nutt Junction	3604370	267521	20
	NM	Nutt Mountain	3611218	271012	17
	NNM	Northern Nutt Mountain	3616411	272904	10
	NV_1	Nutt Valley	3610263	266492	20
	NV_2	Nutt Valley	3612047	259192	20
	NV_3	Nutt Valley	3615066	264842	19

Region	Point	Location	Northing	Easting	Visits
	NV_4	Nutt Valley	3619168	265877	16
	NV_5	Nutt Valley	3621824	260538	18
	NV_a	Nutt Valley	3598777	261060	20
	NV_b	Nutt Valley	3604040	255446	20
	NV_c	Nutt Valley	3609149	252822	20
	SLH_1	Sleeping Lady Hills	3573638	312724	20
	SLH_2	Sleeping Lady Hills	3581893	311847	20
	SLH_3	Sleeping Lady Hills	3587222	305850	20
	TM_1	Town Mountain	3624021	258739	19
Points	21				

Table 5. The number of Golden eagles observed at the fixed survey points and the estimated distance from the survey location within three study regions (Central, Southeast and Southwest) established in southern New Mexico. A total 59 observations were made of 81 Golden eagles. It is likely that many of these are repeated observations. The majority of these observations were made in the Southwest region.

Regions	Survey Point	Date	No. Observed	Distance (m)
C	JP_1	22-Feb-14	2	2000
C	JP_1	22-Mar-14	2	2100
C	JP_2	22-Mar-14	2	3000
SE	FM_a	24-Oct-13	1	1500
SW	FH	13-Apr-14	1	1600
SW	GS	19-Aug-14	3	900
SW	GS	29-Oct-14	1	530
SW	GS	28-Feb-15	1	1500
SW	GS	28-Jun-15	1	1000
SW	GS	25-Jul-15	1	1500
SW	GS_1	16-Feb-14	1	900
SW	GS_1	12-Apr-14	1	1000
SW	GS_1	19-Aug-14	2	900
SW	GS_1	28-Feb-15	1	880
SW	GSP	9-Mar-14	1	3800
SW	GSP	12-Apr-14	1	1600
SW	GSP	29-Oct-14	1	530
SW	GSP	12-Dec-14	2	1340
SW	Hilltop	16-Feb-14	2	5500
SW	Hilltop	9-Mar-14	1	4900
SW	Hilltop	20-Jan-15	1	2370
SW	Hilltop	28-Feb-15	2	2500
SW	Hilltop	16-Mar-15	1	2440
SW	Hilltop	24-Jul-15	1	2400
SW	NM	21-Jul-14	3	1000
SW	NM	17-Nov-14	2	950
SW	NM	10-Dec-14	1	900
SW	NM	19-Jan-15	1	1030
SW	NM	26-Feb-15	1	1010
SW	NM	16-May-15	3	800
SW	NM	27-Jun-15	1	1000
SW	NNM	13-Apr-14	1	1100
SW	NV_1	27-Jun-15	1	2500
SW	NV_2	19-Feb-14	1	2000

Regions	Survey Point	Date	No. Observed	Distance (m)
SW	NV_2	8-Mar-14	1	450
SW	NV_2	18-Nov-14	2	2200
SW	NV_2	18-Nov-14	1	4000
SW	NV_2	19-Jan-15	1	1200
SW	NV_3	13-Apr-14	1	2000
SW	NV_3	18-Nov-14	1	2440
SW	NV_4	4-Oct-14	2	1400
SW	NV_4	18-Nov-14	2	2500
SW	NV_4	11-Dec-14	1	1500
SW	NV_4	11-Dec-14	2	2400
SW	NV_5	15-Feb-14	1	2300
SW	NV_5	18-Aug-14	1	1850
SW	NV_5	28-Oct-14	1	2400
SW	NV_5	28-Oct-14	1	2400
SW	NV_5	10-Dec-14	2	2500
SW	NV_5	17-Mar-15	1	2500
SW	NV_5	27-Jun-15	1	2000
SW	NV_a	21-Oct-13	2	186
SW	SLH_1	16-Nov-14	1	2500
SW	SLH_3	19-Nov-14	1	2750
SW	TM_1	15-Feb-14	2	1500
SW	TM_1	28-Oct-14	1	1500
SW	TM_1	19-Jan-15	1	1530
SW	TM_1	27-Feb-15	2	2030
SW	TM_2	15-Feb-14	1	1510

Table 6. The number of raptors observed within three study regions (Central, Southeast and Southwest) established in southern New Mexico. Surveys were conducted at various fixed survey points within each region between October 2013 and July 2015. Turkey Vultures were observed most frequently followed by Swainson’s Hawks, and Red-tailed Hawks. *Three Short-eared Owls, one Long-eared Owl, and eighteen Great Horned Owls were observed during nocturnal prey transects. The two Great Horned Owl observations in the Central were diurnal observations.

Species	C	SE	SW	Total
Turkey Vulture (<i>Cathartes aura</i>)	268	345	254	867
Swainson's Hawk (<i>Buteo swainsoni</i>)	73	3	120	196
Red-tailed Hawk (<i>Buteo jamaicensis</i>)	33	40	68	141
Northern Harrier (<i>Circus cyaneus</i>)	1	1	88	90
Golden eagle (<i>Aquila chrysaetos</i>)	6	1	74	81
American Kestrel (<i>Falco sparverius</i>)	20	6	37	63
Burrowing Owl (<i>Athene canicularia</i>)	0	9	13	22
Great Horned Owl (<i>Bubo virginianus</i>)*	2	9	9	20
Prairie Falcon (<i>Falco mexicanus</i>)	1	0	10	11
<i>Buteo sp.</i>	0	2	6	8
Long-eared Owl (<i>Asio otus</i>)*	1	0	6	7
Cooper's Hawk (<i>Accipiter cooperii</i>)	0	3	2	5
Peregrine Falcon (<i>Falco peregrinus</i>)	0	0	4	4
Ferruginous Hawk (<i>Buteo regalis</i>)	0	0	3	3
<i>Falco sp.</i>	0	0	3	3
Short-eared Owl (<i>Asio flammeus</i>)*	0	1	2	3
Sharp-shinned Hawk (<i>Accipiter striatus</i>)	0	0	1	1
Total	405	420	700	1525

Table 7. Raptor and prey transect routes, the regions where transects are located in and their approximate location, length and the number of times they were visited between December 2013 and July 2015. All transects are located in southern New Mexico. Most survey transects were visited once per month unless access was not possible due to road conditions or land owners.

Region	Transect	Location	Length (km)	Raptor Visits	Prey Visits
Central	BHa JP_VAL	Grasslands east of Jack's Peak	37	18	19
	KZ_a	Camaleon Hill	7	18	19
	Luna JP	Jack's Peak	15	19	19
	PHa	Bonita Canyon	28	3	3
	PHb	Bonita Canyon	19	16	16
	TP	Tecolote Peak	13	19	19
Total Length (km)			120		
Southeast	BP	Bandana Peak	8	18	18
	BP extension	Dark Canyon	12	15	17
	LMD_a	Carnero Peak	13	18	18
	RG_a FM	Russell Gap	19	19	19
	TH	Texas Hill	14	18	19
Total Length (km)			67		
Southwest	GS	Goodsight Mountains	21	19	19
	Hilltop	Hilltop	7	19	19
	NM	Nutt Mountain	6	16	16
	NNM	Northern Nutt Mountain	12	16	17
	NV 1-2	Nutt Valley	8	18	18
	NV a-c	Nutt Valley	16	18	18
	SLH	Sleeping Lady Hills	19	19	19
TM1 NV3	Town Mountain	12	17	17	
Total Length (km)			100		

Table 8. Golden eagles observed while surveying the raptor transects within three study regions (Central, Southeast and Southwest) established in southern New Mexico. The abundance of eagles, the location of the observers, and the estimated distance and direction from the observers are reported. A total 11 observations were made of 12 Golden eagles. It is likely that there are repeated observations. The majority of these observations were made in the Southwest region.

Region	Transect Name	Date	N	E	Abundance	Distance (m)	Direction (°)
C	Luna JP	16-May-14	37549301	441877	1	148	235
C	Luna JP	26-Apr-15	3754429	439179	1	175	336
SE	RG_a FM	23-Jun-14	3617471	494961	1	115	213
SE	RG_a FM	24-May-15	3614530	493066	1	200	15
SW	GS	12-Dec-14	3593803	267011	1	200	82
SW	GS	12-Dec-14	3594352	267508	1	1400	36
SW	GS	25-Jul-15	3592935	271508	2	325	10
SW	Hilltop	18-Nov-14	3579182	247260	1	250	330
SW	NM	26-Feb-15	3610813	270268	1	1300	350
SW	SLH	16-Nov-14	3575388	312124	1	299	284
SW	TM1 NV3	19-Jan-15	3624021	258739	1	1530	240

Table 9. The number of raptor species observed on raptor transects established within three study regions (Central, Southeast and Southwest) in southern New Mexico from December 2013 to July 2015. All observations occurred during the day. Turkey Vultures were observed most frequently followed by Swainson’s Hawks, and American Kestrels.

Species	C	SE	SW	Total
Turkey Vulture (<i>Cathartes aura</i>)	159	206	21	386
Swainson's Hawk (<i>Buteo swainsoni</i>)	171	2	63	236
American Kestrel (<i>Falco sparverius</i>)	69	6	33	108
Red-tailed Hawk (<i>Buteo jamaicensis</i>)	34	29	27	90
Northern Harrier (<i>Circus cyaneus</i>)	2	2	39	43
Prairie Falcon (<i>Falco mexicanus</i>)	9	0	6	15
Golden Eagle (<i>Aquila chrysaetos</i>)	2	2	8	12
Ferruginous Hawk (<i>Buteo regalis</i>)	3	0	5	8
Cooper's Hawk (<i>Accipiter cooperii</i>)	0	4	0	4
Short-eared Owl (<i>Asio flammeus</i>)	0	0	2	2
White-tailed Kite (<i>Elanus leucurus</i>)	1	0	0	1
Mississippi Kite (<i>Ictinia mississippiensis</i>)	1	0	0	1
Great Horned Owl (<i>Bubo virginianus</i>)	0	1	0	1
Long-eared Owl (<i>Asio otus</i>)	1	0	0	1
<i>Buteo sp.</i>	1	1	0	2
<i>Falco sp.</i>	2	1	1	4
Total	454	254	205	913

Table 10. Incidental sightings of Golden eagles within three study regions (Central, Southeast and Southwest) in southern New Mexico from December 2013 to July 2015. A total 14 incidental observations were made of 16 Golden eagles. The majority of these observations were made in the Southwest region.

Region	Date	Abundance	N	E	Distance (m)	Direction (°)
C	23-Oct-13	1	3793617	461481	45	134
C	21-Feb-14	1	3731182	591458	100	0
SE	9-Aug-14	1	3531242	514222	2000	110
SE	26-May-15	1	3599810	503347	400	251
SW	21-Oct-13	1	3597148	262641	0	0
SW	14-Feb-14	1	3590875	772734	100	270
SW	8-Aug-14	2	3529670	362055	200	320
SW	4-Oct-14	1	3601569	265911	200	264
SW	29-Oct-14	2	3595075	261432	192	282
SW	15-Nov-14	1	3612234	380035	175	66
SW	12-Dec-14	1	3600015	371718	100	200
SW	4-Feb-15	1	3571816	315076	200	45
SW	4-Feb-15	1	3575093	312225	300	250
SW	17-Mar-15	1	3586381	255469	230	230

Table 11. The number of potential prey species observed on transects established within three study regions (Central, Southeast and Southwest) in southern New Mexico from December 2013 to July 2015. Lagomorphs, *Lepus californicus* and *Sylvilagus audubonii*, were observed most frequently. All observations occurred at night.

Species	C	SE	SW	Total
Black-tailed jackrabbit (<i>Lepus californicus</i>)	643	207	663	1513
Desert cottontail (<i>Sylvilagus audubonii</i>)	225	157	82	464
Mule deer (<i>Odocoileus hemionus</i>)	92	188	23	303
Pronghorn (<i>Antilocapra americana</i>)	64	0	94	158
Kit fox (<i>Vulpes macrotis</i>)	19	1	64	84
Coyote (<i>Canis latrans</i>)	22	6	6	34
Gray fox (<i>Urocyon cinereoargenteus</i>)	7	0	6	13
American badger (<i>Taxidea taxus</i>)	5	0	6	11
Unknown canid species	3	0	6	9
Unknown owl species	4	0	2	6
Striped skunk (<i>Mephitis mephitis</i>)	2	0	3	5
Great Horned Owl (<i>Bubo virginianus</i>)	3	1	0	4
Unknown lagomorph species	2	0	2	4
Collared peccary (<i>Pecari tajacu</i>)	0	3	0	3
Bobcat (<i>Lynx rufus</i>)	1	0	1	2
Short-eared owl (<i>Asio flammeus</i>)	1	0	1	2
Domestic cat (<i>Felis catus</i>)	2	0	0	2
Elk (<i>Cervus canadensis</i>)	1	0	0	1
Unknown fox species	0	0	1	1
Porcupine (<i>Erethizon dorsatum</i>)	1	0	0	1
Total	1097	563	960	2620

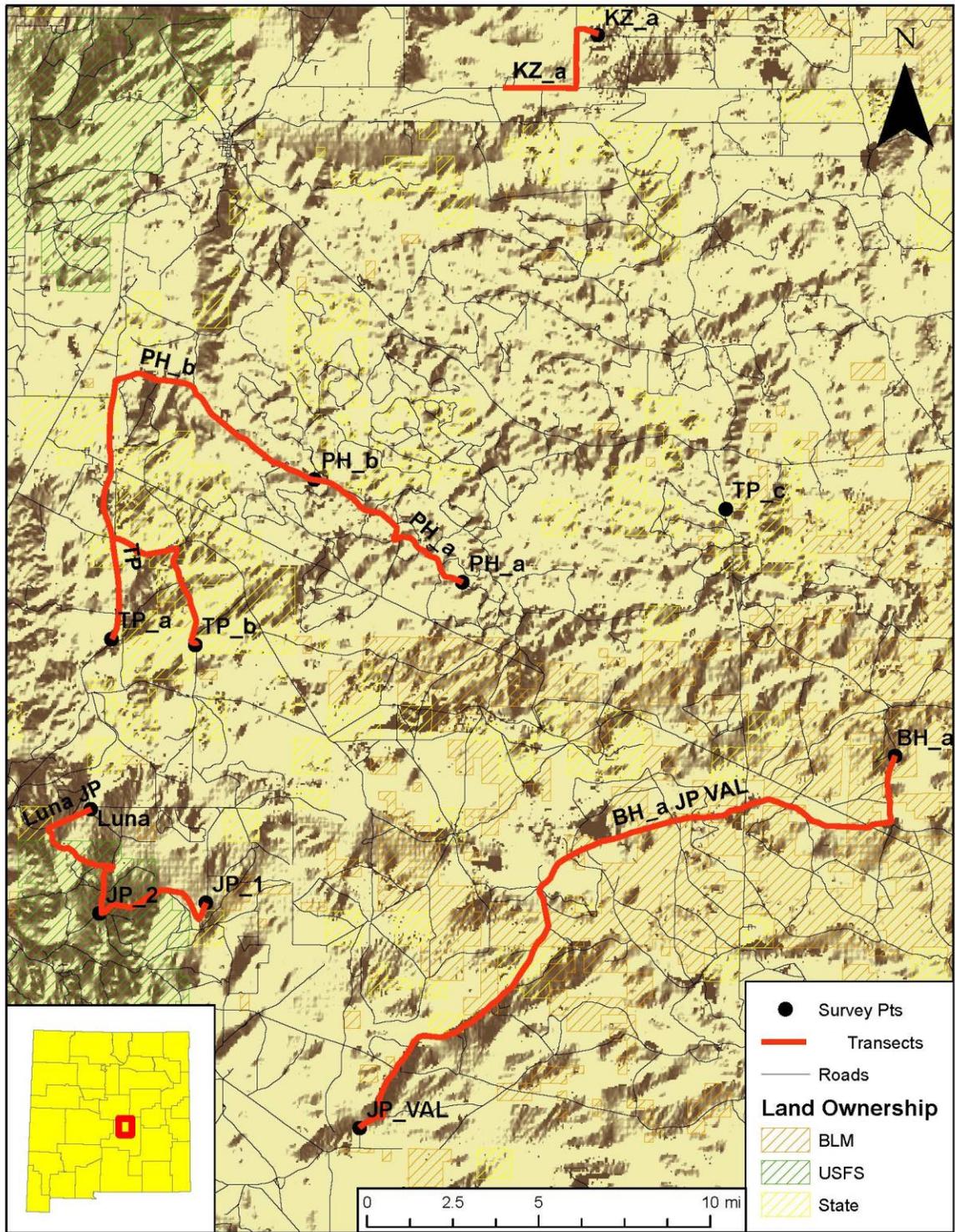


Figure 1. The Central survey region used to assess the occupancy of Golden eagles in southern New Mexico. Fixed survey points are noted as black dots, transects are depicted as red lines.

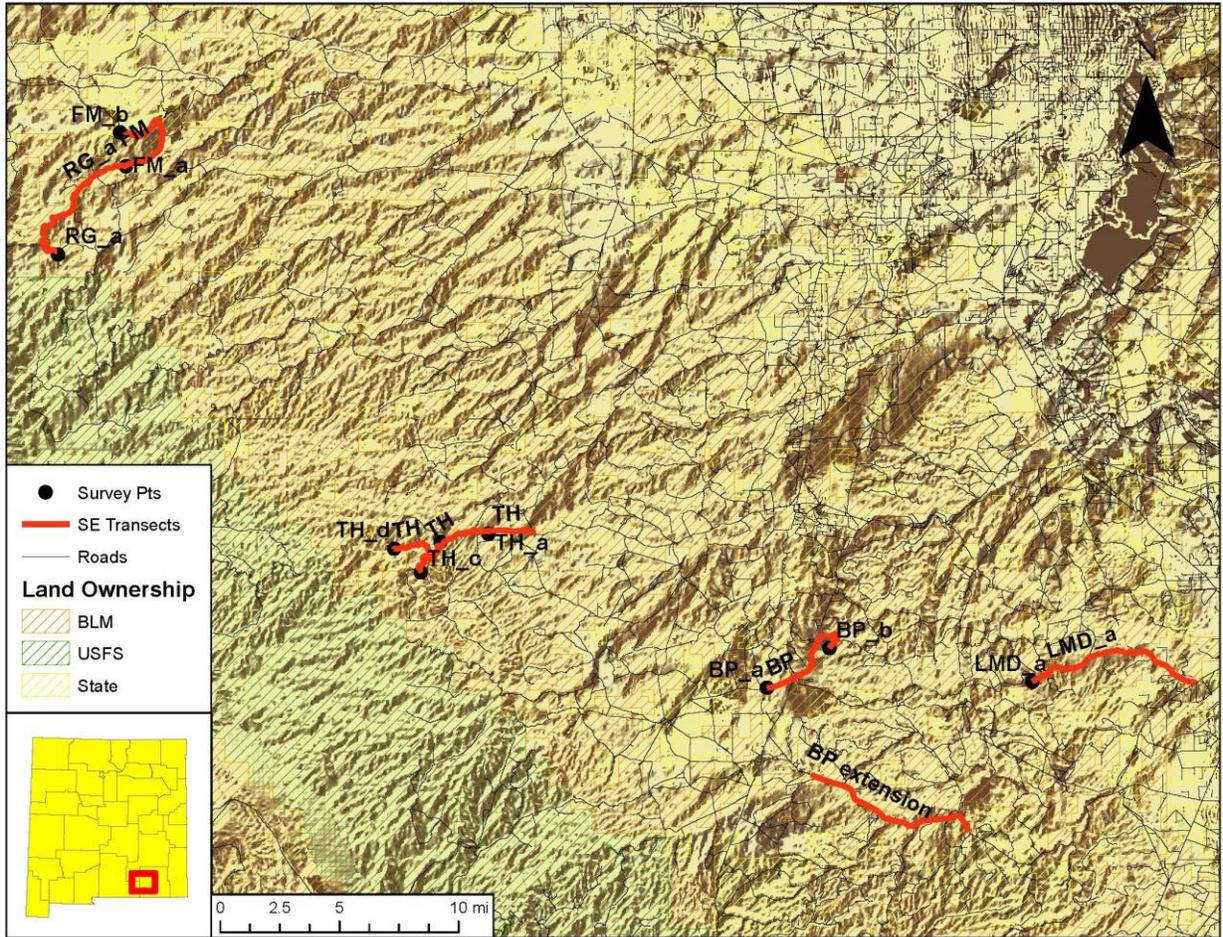


Figure 2. The Southeast survey region used to assess the occupancy of Golden eagles in southern New Mexico. Fixed survey points are noted as black dots, transects are depicted as red lines.

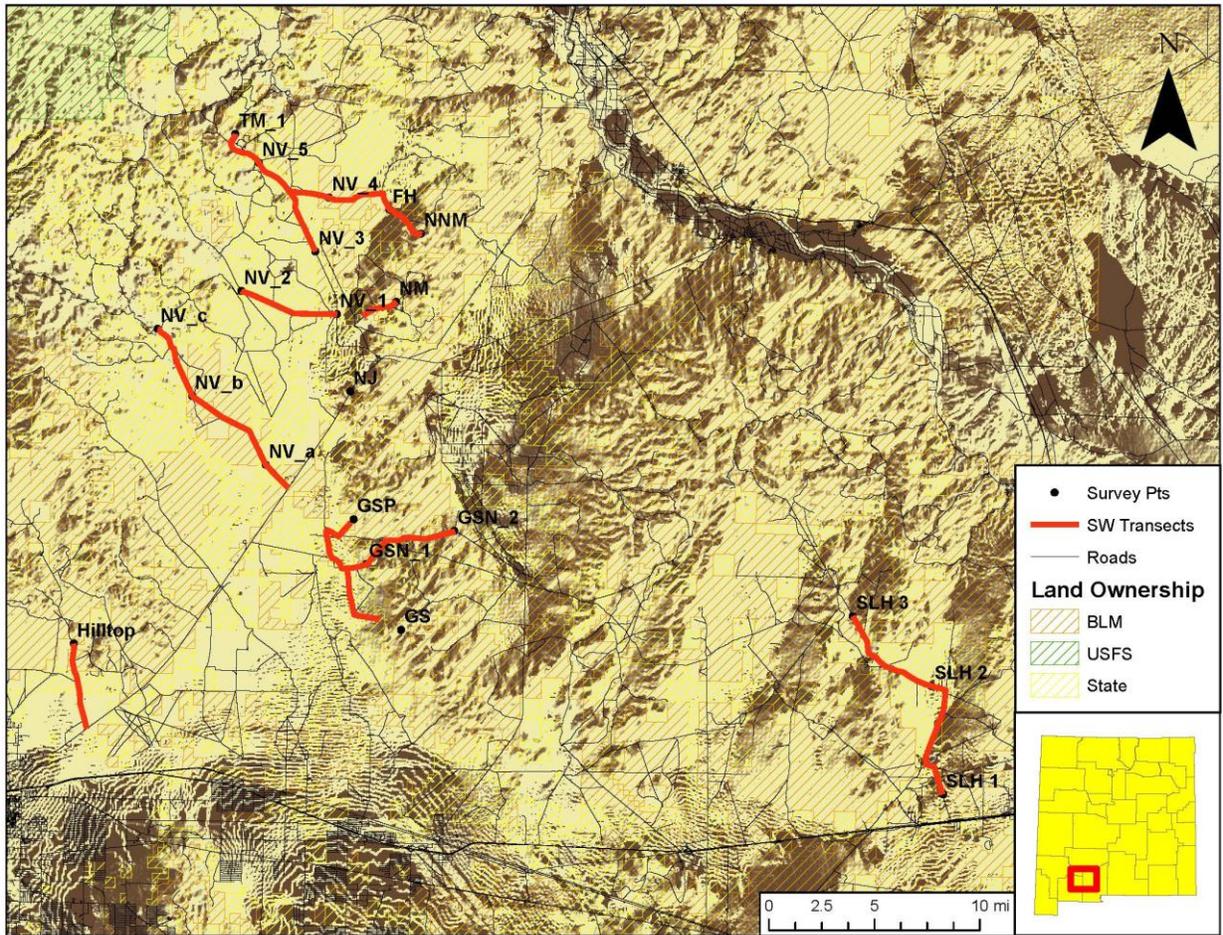


Figure 3. The Southwest survey region used to assess the occupancy of Golden eagles in southern New Mexico. Fixed survey points are noted as black dots, transects are depicted as red lines.

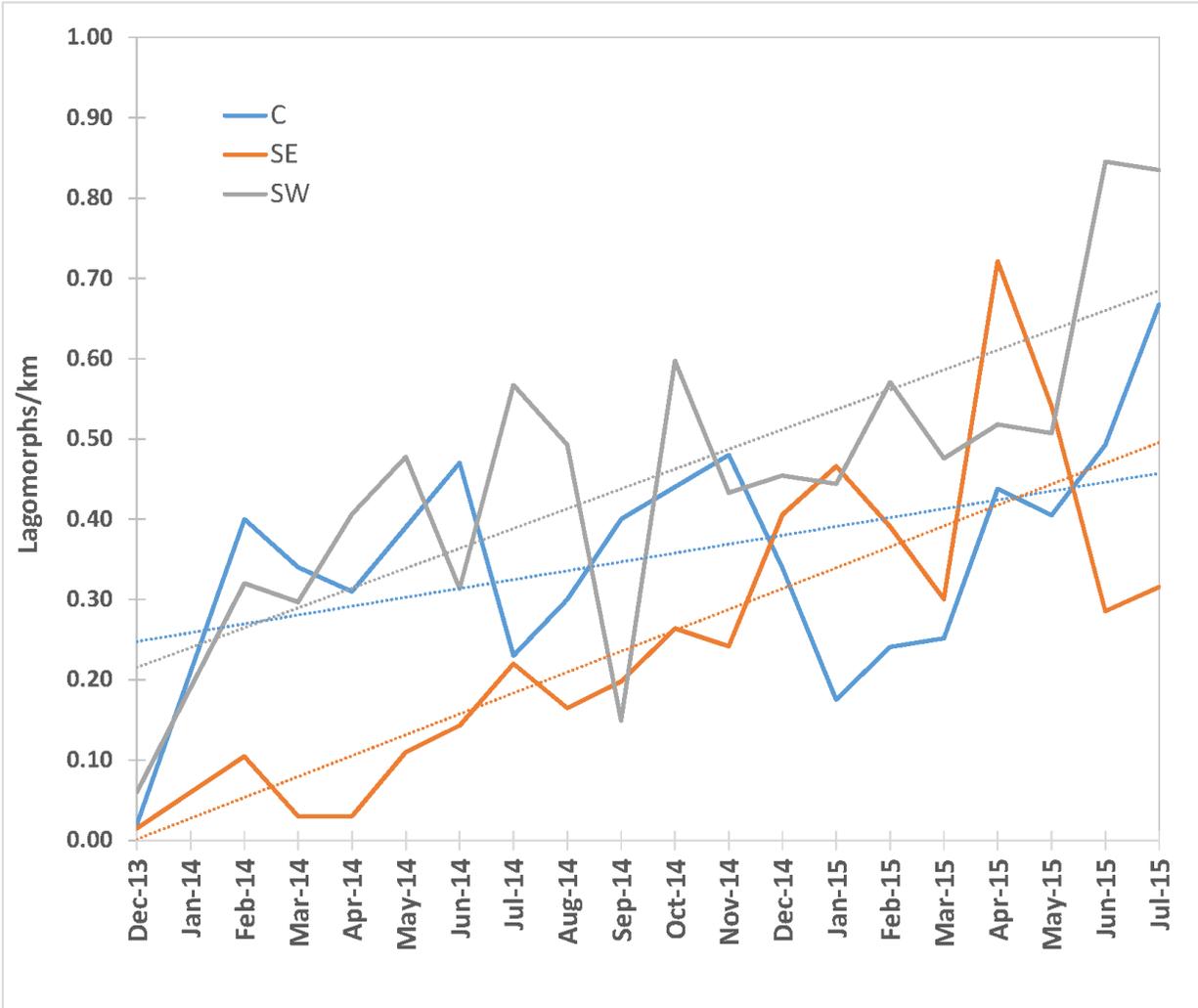


Figure 4. The number of individual lagomorphs observed per kilometer driven in each survey region from 7 December 2013 to 25 July 2015. There was a general increase in the number of individuals encountered over time.