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HOME RANGE CHARACTERISTICS OF MEXICAN SPOTTED OWLS IN THE CANYONLANDS OF UTAH

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Running Head: Spotted Owl Home Range

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Abstract.-We studied home range characteristics of adult Mexican Spotted Owls (*Strix occidentalis lucida*) in southern Utah. Twenty-eight adult owls were radio-tracked using a ground-based telemetry system during 1991-95. The mean bearing error derived from test triangulations was 6.5° (±5.3° SD). Five males and eight females molted tail feathers and dropped transmitters within four weeks. We estimated cumulative home ranges for 15 Spotted Owls (12 males, 3 females). The mean estimate of cumulative home range size was not statistically different between the minimum convex polygon and adaptive kernel (AK) 95% isopleth. Both estimators yielded relatively high SD, and male and female range sizes varied widely. For owls tracked during both the breeding and non-breeding seasons, the mean size of the AK 95% non-breeding home range was 49% larger than the breeding range size. The median AK 75% home range isopleth (272 ha) we observed was similar in size to Protected Activity Centers (PACs) recommended by a recovery team. Our results lend support to the PAC concept and we support continued use of PACs to conserve Spotted Owl habitat in Utah.

KEY WORDS: *canyonlands, habitat, home range, Mexican Spotted Owl,* Strix occidentalis lucida, *telemetry, Utah*.

The Mexican Spotted Owl (*Strix occidentalis lucida*) is distributed among rocky canyonlands and forested highlands in the southwestern United States and northern Mexico (Gutiérrez et al.

1995, Willey 1995). The Mexican Spotted Owl was listed as "threatened" in 1993 due to perceived threats from timber harvest and catastrophic fire (USDI 1995). Although Mexican Spotted Owls are strongly associated with mature mixed-conifer forests, the owl shows considerable variation in habitat affinity across its range (USDI 1995, Ganey et al. 1999, Ganey et al. 2005). While home range characteristics have been described for Mexican Spotted Owls in Arizona and New Mexico (Ganey and Balda 1994, Ganey et al. 2005, Zwank et al. 1994), little information is available from the arid and topographically diverse canyonlands of the Colorado Plateau in Utah (Rinkevich and Gutiérrez 1996, Willey 1998).

In southern Utah, the Mexican Spotted Owl inhabits steep sandstone canyons where field observations are difficult, thus our knowledge of the owl's movements and home range in this region is limited (USDI 1995). We investigated home range characteristics of adult Mexican Spotted Owls within the canyonlands province of southern Utah during 1991-95. Our objectives were to: (1) estimate the average cumulative home range size used by Spotted Owls; (2) estimate and compare the size of non-breeding and breeding season home ranges; (3) estimate the size of adaptive kernel (AK) 75% home range isopleth to represent "protected activity centers" (USDI 1995) within the home range; and (4) describe vegetation cover types present in home ranges.

METHODS

Study Areas. Our research was conducted in four study areas on the Colorado Plateau (Hintze 1988) in southern Utah: Zion, Capitol Reef, and Canyonlands National Parks, and the Manti-LaSal National Forest (Fig. 1). These areas are included in the High Plateau and Canyonlands subsections of the Colorado Plateau Physiographic region (Thornbury 1965, Hintze 1988). The rocky Canyonlands are distinguished by entrenched meandering drainages with steep cliffs interrupted by up-warped plateaus, isolated mesas, and laccolithic mountains. The principal floral types found within our study areas included Petran Montane Conifer Forest, Great Basin Desert Scrub, and Great Basin Desert Woodland (Brown 1982, Willey 1998, Willey and Van Riper 2000).

The Zion National Park (ZION) study area, located in southwest Utah, was characterized by a deep sandstone gorge bisected by side canyons rimmed with large vertical cliffs. Elevation ranged from 1,345-2,141 m. Vegetation along canyon bottoms and north facing slopes was mixed-conifer forest dominated by Douglas-fir (*Psuedotsuga menziesii*), white fir (*Abies concolor*), and ponderosa pine (*Pinus ponderosa*). Riparian vegetation included box elder (*Acer negundo*), and bigtooth maple (*A. grandidentatum*). South-facing aspects supported scattered stands of ponderosa pine *(Pinus ponderosa),* pinyon pine (*P. edulis*), and Utah juniper (*Juniperus utahensis*). Capitol Reef National Park (CARE), located in south-central Utah (Fig. 1), ranged in elevation from 1,835-2,294 m. Vegetation included pinyon-juniper woodland (PJ) on south facing slopes, patches of

mixed-conifer forest on north facing sites, and isolated stands of Fremont cottonwood (*Populus fremontii*) and willow (*Salix* spps.) along riparian corridors. Canyonlands National Park (CANY), located in southeastern Utah (Fig. 1), is a maze-like region of steep canyons eroded deeply into the northern edge of the Monument monocline, where elevation ranged from 1,590-1,989 m. Vegetation was dominated by PJ woodlands, with small pockets of mixed-conifer forest in canyon gottos. Mesas and tablelands bordering the canyons supported a mixture of PJ forest on rocky soils interspersed by blackbrush (*Coleogyne ramosissima*), curl-leaf mahogany (*Cercocarpus ledifolius*) and indian ricegrass (*Stipa hymenoides*) on deeper loam soils. The MANTI study area was located 35-km south of CANY on a prominent north-south tending plateau bisected by deeply eroded canyons. Elevation ranged from 1,529-2,445-m, with intermittent riparian vegetation along canyon bottoms, numerous dry washes, rare mixed-conifer forest as stringers on north facing slopes, and PJ woodland on south facing aspects (Fig. 2). Mesa tops showed a mixture of Ponderosa pine and PJ forests interspersed by Great Basin sagebrush (*Artemesia tridentata*), and mountain mahogany (*Cercocarpus montanus*). Throughout the canyonlands region, annual precipitation averaged 17 cm per year, and temperatures ranged from < 0^{0}C to > 40^{0}C (Willey 1998).

Capture and Radio-Marking. Spotted Owls in the study areas exhibit strong site fidelity (Kertell 1977, Rinkevich and Gutiérrez 1996, Willey 1998). Accordingly, we defined an owl

"territory" as an area used, though not necessarily defended, by a single pair of Spotted Owls. In 1991, our research on owl home ranges began at territories located within each of the study areas (Willey 1998). Sites occupied by Spotted Owls were visited during early morning and evening to locate and trap territorial adults near nest and roost sites. A variety of Spotted Owl calls were used to elicit a response to pinpoint an owl's location (Forsman 1983). Owls were captured with bal-chatri traps containing live bait rodents, and a 3.5-m noose pole. Radio transmitters (Holohil Inc., Ontario, Canada) weighing 5.5-6.0 gm with an average signal life of 12$\pm$6 mos, were attached to the two central tail feathers using quick-set epoxy and dental floss.

Sampling Scheme and Radio Triangulation. We used TR-1 and TR-2 receivers and handheld H-antennae (Telonics Inc., Mesa, AZ) to estimate Spotted Owl locations. Nocturnal tracking was done on foot from cliff rims above the canyons using headlamps. Nocturnal locations were estimated by simultaneous intersection of compass bearings from $\geq$3 tracking positions. The standard deviation of bearing error (Nams 1990) was estimated within each study area by taking a series of 20 triangulations from tracking stations using three bearings to estimate the location of test transmitters placed throughout owl home ranges (White and Garrott 1990).

Owl locations were estimated using the Maximum Likelihood Lenth Estimator (MLE) developed by Lenth (1981), as modified by Lee et al. (1985), and available within Program LOCATE (Nams 1990). Only owl locations with error ellipses $\leq$15.0 ha were used

for home range estimates to reduce spatial error. We present the mean and standard deviation of bearing errors and area of confidence ellipses (Saltz 1994).

During nocturnal tracking periods, our goal was to track each owl once per wk, using 4-6 hour sessions rotated between early (sunset to midnight) and late (midnight to sunrise) periods. During each tracking session, we attempted to gain 3 nocturnal locations per owl tracked. Further, we conducted diurnal tracking twice per wk for each owl to attempt to locate roost sites. Although we attempted to keep sampling levels equal among owls and follow our sampling schedule, for various reasons, including weather and transmitter failures, the sampling effort was not even among owls and locations were not obtained for all owls during each tracking week. We attempted to capture owls whose transmitters molted and install new transmitters; however, we were not always successful recapturing owls, thus tracking duration varied among owls during the study.

Home-range Estimation. We estimated cumulative and seasonal home ranges with the minimum convex polygon (MCP) and AK methods (White and Garrott 1990, Worton 1989). For estimates of MCP ranges, we used 100% MCP polygons to represent cumulative home range. For AK estimates, we used AK 95% isopleth to represent the cumulative home range achieved by individuals. We used the AK 75% isopleth to represent areas of concentrated use, or activity centers, where owls spent most of their time (Forsman et al. 2005).

Our sampling schedule was designed to minimize autocorrelation (Swihart and Slade 1985) yet Otis and White (19999) suggested autocorrelation is typically not relevant when individual animals are used as the sample unit. Thus, we used all locations for MCP and AK home range estimates (Forsman et al. 2005). Estimates of cumulative home range were limited to owls with $\geq$50 relocations, and estimates of seasonal home range was limited to owls with $\geq$10 relocations per season. We generated all estimates using program TELEM (K.S. McKelvey, 1993, Program Telem. USDA Forest Service, Pacific Southwest Research Station, Albany, CA). We stratified locations for each owl between breeding (MAR-SEP) and non-breeding (OCT-FEB) periods to contrast seasonal home range size. The cut off dates for home range seasons were based on previous observations of breeding activities in the Canyonlands region (Willey 1998). Owl pairs typically began courtship activity during early March, and by the end of September, the majority of juveniles had dispersed from natal areas (Willey and Van riper 2000). Thus we believed the breeding season in Utah spanned March through September, and the nonbreeding season was identified as October through February each year of the study. The difference in mean home range size between seasons was evaluated using a paired t-test.

Vegetation Cover types in Home-ranges

We described the presence of different vegetation cover types within each owl's cumulative AK95% home range. We assumed the relative abundance of vegetation present within the home

range represented some level of habitat selection, but we did not quantify the availability, or relative use, of vegetation cover types by the owls. We described cover types present in home ranges by estimating percent cover of desert scrub (scrub), dwarf PJ woodland (PJ), mountain shrub, ponderosa pine, mixed-conifer forest, and riparian using habitat plots. Within each home range, we located 30 random habitat plots selected from a 100^2-m Universal Trans Mercator projection grid overlaid across each home range delineated by the AK 95% isopleth. At random points, we established a 50-m radius fixed plot and visually estimated the dominant vegetation cover type using methods of Brown (1982).

RESULTS

Home Range Characteristics. We captured and radio-marked 28 adults (11 females, 17 males), but 13 owls (8 females, 5 males) molted rectrices within 4 wks of transmitter installation, thus the sample we used to estimate cumulative ranges included 15 owls (12 males, 3 females). One owl (OldTex, Table 1) died after 18 mos of tracking and, although the cause of death was uncertain, a substantial feather pile (with the carcass absent) suggested avian predation. Both Red-tailed Hawks (*Buteo jamaicensis*) and Great-Horned Owls (*Bubo virginianus*) were observed within the OldTex home range during the tracking period.

The mean bearing error derived from error triangulations was 6.5^0 ($\pm 5.3^0$ SD, N = 80 triangulations). The mean area of confidence ellipses used for estimating owl locations was 5.26 ha ($\pm$3.98 SD, N = 2,123 locations). Mean estimates of cumulative

home range size were not statistically different between MCP and AK 95% models (Table 1; t = 1.36, df = 14, P = 0.195). However, MCP estimates tended to be larger than AK 95% estimates. Both types of estimates yielded rather high standard deviations (SD); and SD values for both MCP and AK models were over twice their mean and median estimates. In addition, both male and female owls varied widely in the cumulative size of home ranges used over the course of our study, but no clear distinctions between males and females were observed. Although a male owl used the largest home range we observed (2102 ha), the second largest home range (1924 ha) was observed for a female (Table 1).

For 12 owls tracked sufficiently during both breeding and non-breeding seasons (i.e., $\geq$10 locations/season), the overall mean cumulative AK 95% home range was 928 ha (Table 2). The mean size of the AK 95% non-breeding home range (1032 ha) was 49% larger than breeding range size (545 ha)($P \leq 0.05$, 12 df, t = -4.009; Table 2). In addition, both seasons showed high variation in home range size, with the non-breeding season exhibiting higher SD (Table 2). Furthermore, winter ranges typically included part of the breeding season range plus peripheral areas, and one female moved 35 km during winter to a distant use area, then returned the following February to the nest area (Table 2). The median size of breeding season home ranges used by all owls in the sample was 374 ha (Table 2) in contrast to 545 ha mean range size.

The patterns of spatial use we observed indicated the owls

routinely used focal areas within their home range that equated to "protected activity centers" (USDI 1995). During the breeding season, the majority of relocations were centered around nest trees or, for non-nesting owls, within a frequently used roost area. In contrast, winter ranges showed increased use of peripheral areas outside the AK %75 isopleths. We found that 88 percent of all owl locations we observed were located in the canyons below the rims where terrain was dominated by vertical-walled cliffs. Only 12% of owl locations were identified outside of canyons on rolling mesas and relatively flat topography (Fig. 3).

Vegetation Communities Present in Home Ranges. When averaged across all habitat plots, the PJ woodland was the most common vegetation cover type identified in owl home ranges. PJ was present at 42% of 780 plots visited across all home ranges and represented the dominant cover type. Mixed conifer forest was present at only 31% of random points. Desert scrub vegetation was present at 17% of plots, and deciduous riparian vegetation was present at 10% of plots. Thus nearly 60% of habitat plots located in home ranges supported arid scrub or PJ habitats. Individual owls showed distinct seasonal changes in use of cover types. For example, one female migrated elevationally during winter from a nest area in mixed-conifer forest to a relatively high elevation (2900 m) area dominated by stands of Engelmann spruce (*Picea engelmannii*). A male moved from a nest area dominated by riparian vegetation to winter in desert scrub

habitat. Both owls returned to their previous breeding areas the following February.

DISCUSSION

Our study presents the first description of adult Mexican Spotted Owl home ranges from southern Utah's Canyonlands. The cumulative home ranges we observed were among the largest described for Spotted Owls but comparisons among regions are confounded by differences in methods and tracking periods. Home range size estimated in our study (mean cumulative = 928 ha) was similar in size to home ranges in Arizona reported by Ganey et al. (1999; mean = 895 ha), but larger than reported for spotted owls in New Mexico (365 ha, Zwank et al. 1994). Northern Spotted Owl (*S. o. caurina*) home ranges in Washington (mean = 4972 ha, Forsman et al. 2005) were much larger than those we estimated in southern Utah, thus Spotted Owl home range size varies widely among regions (Forsman et al. 2005, Ganey et al. 2005).

Home range size for Spotted Owls appears to be associated with various factors, including elevation and region (Ganey et al. 2005), habitat complexity (Willey 1998), distribution of mature forest (Carey et al. 1992), and distribution and abundance of prey (Carey et al. 1992).

In southern Utah, our contrast of seasonal home range size indicated that non-breeding season movements, particularly during the fall, accounted, in part, for variation observed in home range size among individuals; however, further research is needed to explore the influence of movements between ranges on home

range size. While many of the owls we tracked remained close to their breeding sites year round, others moved up to 35 km from the nest area during the non-breeding season (Willey 1998). Although long-distance movements are rare for Spotted Owls (*but see* Gutiérrez et al. 1995), movements to peripheral areas in the nonbreeding season have been documented in other studies (Forsman et al. 2005) and were typical of Spotted Owls in Utah (Willey 1998).

We found that Spotted Owls were frequently observed within cliff terrain below canyon rims, where landscapes were dominated by steep cliffs that contrasted sharply with the flat and rolling topography found on rims and plateaus. Rinkevich and Gutiérrez (1996) reported similar use of rugged canyons for Spotted Owls observed in Zion National Park.

Our results for home range characteristics may help focus management efforts in Utah on arid rocky canyon environments that contrast sharply with more classical mature forests. Furthermore, the Mexican Spotted Owl recovery plan (USDI 1995) recommended protecting 243-ha "protected activity centers" (PACs) around occupied nest and roost areas. Those guidelines were based on analysis of median sizes of AK 75% isopleths from Spotted Owls in Arizona (USDI 1995). Our estimated median AK 75% isopleths (272 ha, Table 1) were quite similar to results presented in the Mexican Spotted Owl Recovery Plan (i.e., 243 ha PACs). Given that PACs were intended to focus protection on the areas most important to owls, we think our results lend further support to

the Recovery Plan's recommendation and we support continued use of PACs to conserve Spotted Owl habitat in Utah.

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Table 1. Estimates of cumulative home range size (ha) for individual Mexican Spotted Owls, Utah, 1991-95. Shown are the 100% minimum convex polygon (MCP), and the 75% and 95% isopleths of the adaptive kernel (AK) home range models (*N* = no. relocations).

Owl (Sex)	Tracking Period	*N*	MCP	AK 95%	AK 75%
Twin male	6/03/94 – 11/16/94	306	1655	354	155
Spring male	5/27/91 – 10/15/91	184	733	1012	165
Hidden male	6/16/91 – 07/19/92	116	2102	1151	358
Echo male	5/21/91 – 11/17/92	99	271	120	39
Sams male	9/19/93 - 10/05/94	52	487	505	246
First male	2/05/91 – 10/08/91	87	670	618	78
Elephant male	3/10/93 - 07/20/94	102	1656	2478	317
Burro male	3/01/94 - 07/24/94	75	273	864	212
Peavine male	9/01/92 - 10/15/93	55	1165	1169	343
Oldtexas male	7/07/91 – 03/15/92	130	382	174	69
Newtexas male	5/17/94 - 08/21/95	474	1579	341	180
Dark male	9/19/92 – 08/23/93	151	1638	852	297
Burro female	5/20/94 - 10/03/95	93	1025	1910	576
Hamm female	6/25/91 – 09/06/91	50	1528	819	819
Dark female	9/18/94 - 06/23/95	152	1924	879	334
Mean Size			**1102**	**921**	**288**
Median Size			**1095**	**858**	**272**
Standard Deviation			**638**	**641**	**208**

Table 2. Seasonal adaptive kernel 95% isopleth home range size estimates (ha) for 12 Mexican spotted owls tracked in Utah during 1991-95. The breeding season was March through September, and nonbreeding season from October through February. N represents the number of relocations per owl.

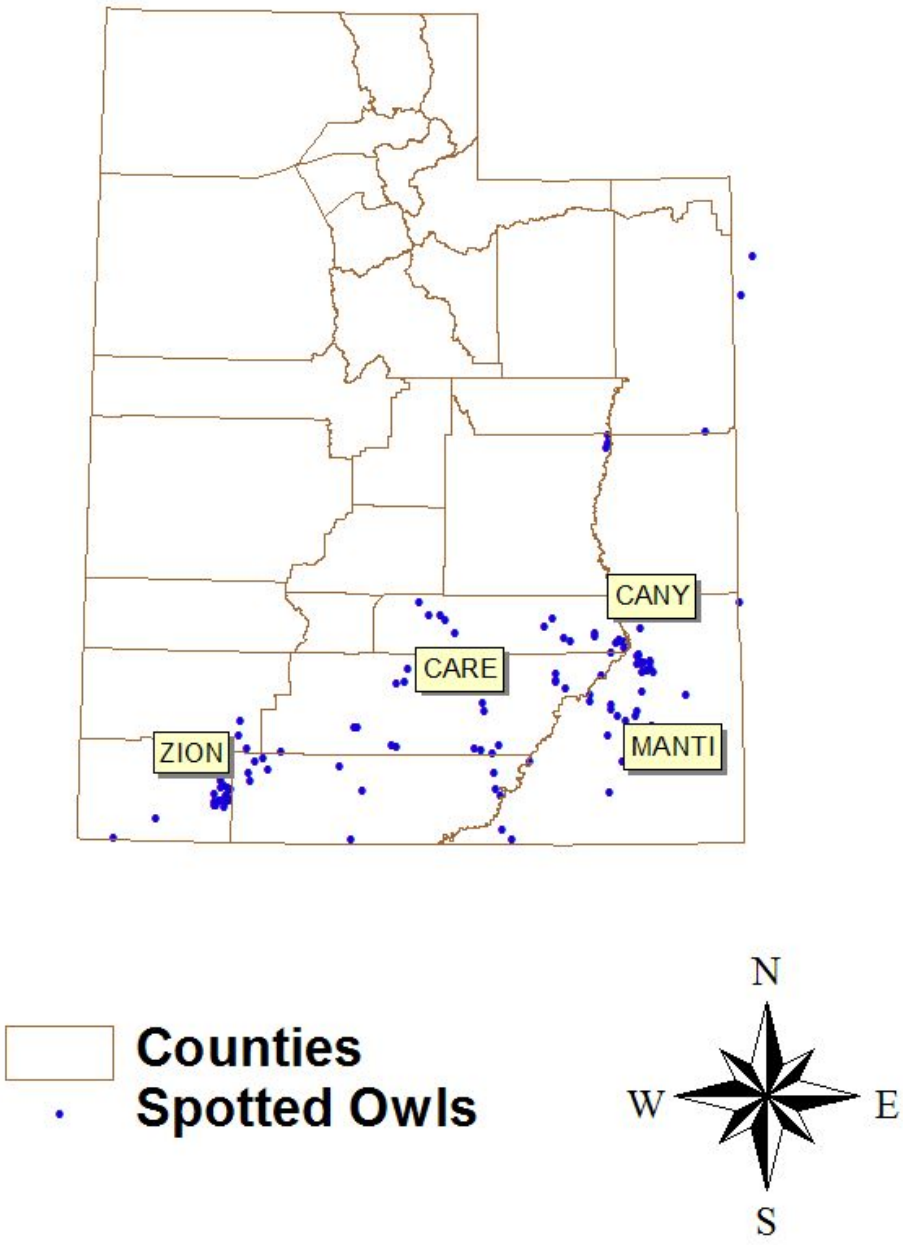
Owl Site/Sex	Breeding	N	Nonbreed	N
Twin male	116	268	809	38
Spring male	294	162	462	22
Sams male	166	146	763	20
Peavine male	383	28	1012	27
Elephant male	366	72	1594	30
New Texas male	873	437	1294	37
Hidden male	735	92	520	24
First male	253	61	771	26
Echo male	75	89	135	10
Dark male	423	136	1690	15
Dark female	945	131	788	21
Burro female	1918	82	2549	11
Means	**545**[a]		**1032**[a]	
Medians	**374**		**798**	
Standard Deviation	**518**		**657**	

[a]significantly different $P \leq 0.05$, df = 12, paired *t*-test.

Figure 1. Location of four study areas where we studied Mexican spotted owls using radio-telemetry, 1991-95. Points indicate the distribution of spotted owl detection sites in Utah (Willey 1995).

Figure 2. Example of rocky canyon habitat within a nesting core area of Mexican Spotted Owls in the Manti La Sal National Forest, Elk Ridge (photo D. Willey).

Figure 3. Distribution of Spotted Owl relocations with the Texas Canyon home range, Manti La Sal National Forest, Utah.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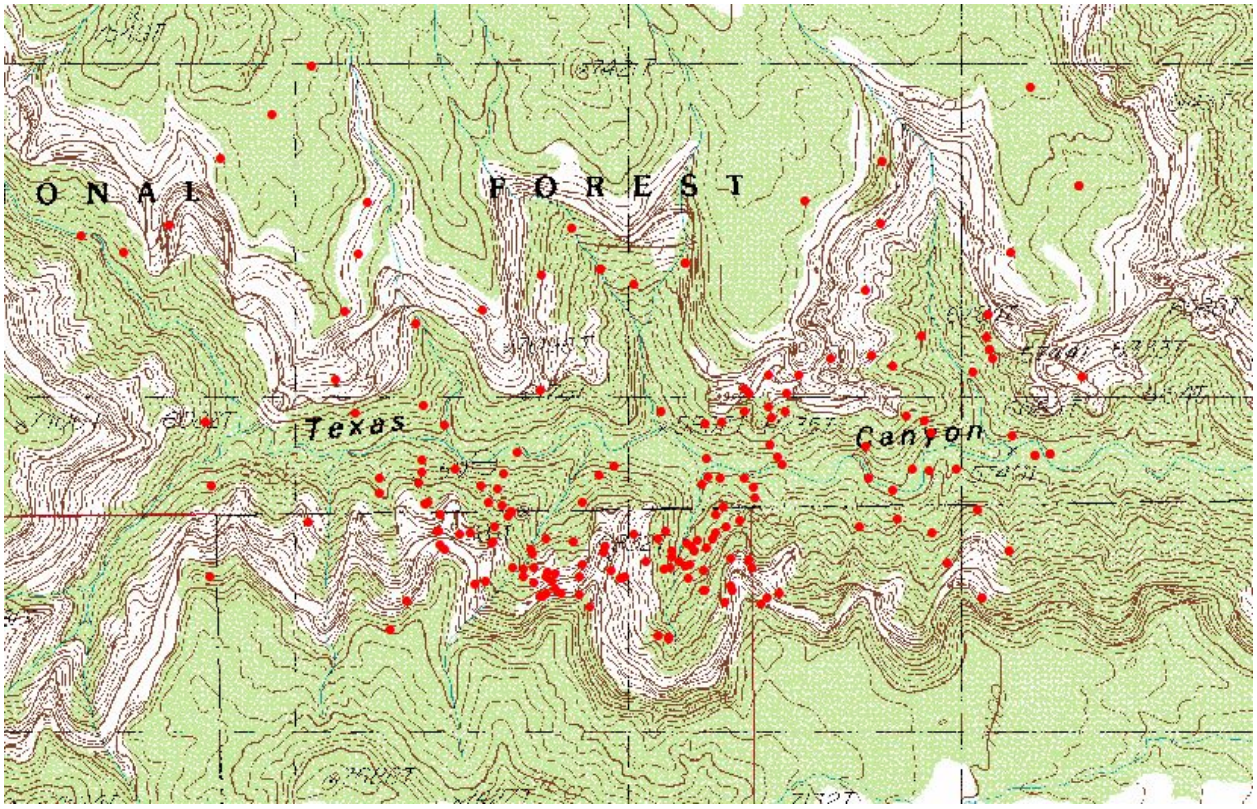
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