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REPTILE OCCURRENCE AND HABITAT ASSOCIATIONS ON HOLLOMAN AIR FORCE BASE

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***Abstract.*—Habitat heterogeneity is necessary to support reptile species diversity and abundance. In the North American Desert Southwest, there is little information regarding habitat preferences that influence reptile community occupancy. In south central New Mexico, we sampled reptiles on Holloman Air Force Base (HAFB) in relatively undisturbed habitat within gypsum sand dunes and clay/loamy soil to determine species richness and relative abundance using Occupancy Modeling. Species were intensively surveyed using pitfall traps, funnels traps, road cruising and active searching. We found six species of lizards, five species of snakes, and one turtle; lizards being more abundant, particularly the Common Side-blotched (*Uta stansburiana*) and Little Striped Whiptail (*Aspidoscelis inornata*) lizards. We also related reptile species assemblages to habitat gradients (cover and soil type) using Canonical Correspondence Analysis (CCA). *Uta stansburiana*, *A. inornata*, and Eastern Collared Lizards (*Crotaphytus collaris*) were the only reptiles observed at a high enough frequency to analyze their habitat associations using CCA. *Uta stansburiana* had a close association with bare ground, *A. inornata* was associated with clay/loamy soil, and *C. collaris* was most closely associated with greater densities of grasses and forbs. There may be confounding influences on the lack of reptile species detected, most notably precipitation, given persistent drought conditions in the Desert Southwest. After rain events resume, it may be necessary to re-examine reptile composition and their habitat associations to investigate the re-establishment and recruitment abilities of these arid-adapted species.**

Key Words.—Community structure; habitat associations; occupancy; reptiles

INTRODUCTION

Reptiles have adapted to a large array of climates and habitat types including arid regions, where diversity is known to be high (Pianka 1967, 1973; Cosentino et al. 2013). The diversity of most species groups are positively influenced by habitat heterogeneity (Tews et al. 2004). Heterogeneous habitats often provide key structures for refuge and food resources, unless heterogeneity is a result of fragmentation (Tews et al. 2004). Reptile diversity and abundance is also known to be positively influenced by habitat heterogeneity (Pianka 1967; Tews et al. 2004; Steen et al. 2012). Pianka (1967) suggested climate variability and length of growth season in the Desert Southwest may lend to the variety of plant life and spatial heterogeneity, which support a wide diversity of lizard species. Grasslands in the Desert Southwest often involve more habitat heterogeneity; including species of yucca, cacti, and forbs, compared to shrub-dominated landscapes (Menke 2003). In fact, shrub-dominated areas resemble fragmented landscapes in that there is more inter-dunal bare ground after shrub encroachment occurs (Báez and Collins 2008).

Vegetation trends in arid and semiarid grasslands worldwide have been shifting from a grassland dominant landscape to shrubland (Wigley et al. 2009; Cosentino et al. 2013). The prevalence of drought, over-grazing, and fire suppression in the southwest contribute to this vegetation regime shift and likely interfere with trophic-level processes that influence reptile diversity and abundance (Schlesinger et al. 1990). We were interested in the current habitat distribution of reptiles and their composition. We defined habitat according to functional groups (shrubs, grasses/forbs, bare ground, and soil type) where reptiles are found, assuming the habitat served some function to reptiles (e.g., refuge from predators, thermoregulation, or access to food). We predicted that larger reptiles would require more densely vegetated habitat (e.g., grasses) and sparsely vegetated habitat would be suitable for smaller reptiles. We predicted that reptile composition among habitats would differ between habitat specialists and generalists depending on dietary and thermo-regulatory requirements. Species distribution may reveal which species are more adaptable or competitive and which ecological functions are most important for each species (Jones et al. 1985).

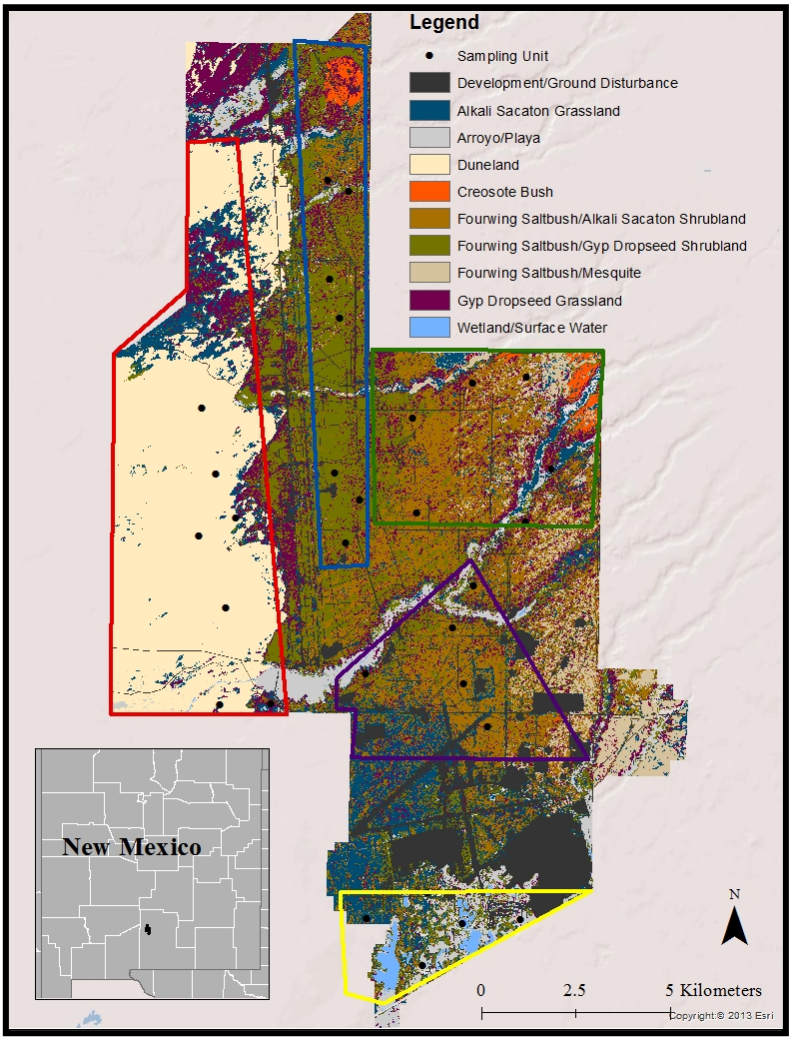

FIGURE 1. Holloman Air Force Base Boundary with 30 randomly selected sampling units selected within generalized habitat types (see following polygons: red = Duneland, blue = Fourwing Saltbush/Gypsum Dropseed Shrubland, green = Fourwing Saltbush/Alkali Sacaton Shrubland/Gypsum Dropseed Shrubland, purple = Fourwing Saltbush/Alkali Sacaton Grassland, and yellow = Wetland/Alkali Sacaton Grassland). Map by Nicole Harings (2013).

The purpose of this study was to obtain a current assessment of the overall reptile diversity and their habitat associations on Holloman Air Force Base (HAFB). The design and survey approach implemented for this study are also intended to be repeated to generate long-term monitoring points to observe the reptile community dynamics within HAFB in light of persistent drought conditions in the Desert Southwest.

MATERIALS AND METHODS

Study site.—Holloman Air Force Base is approximately 21,300 ha (elevation 1,224–1,320 m) within the Tularosa Basin in Otero County, New Mexico. While there are developed areas including military housing and facilities, a large proportion of the base includes relatively undisturbed Chihuahuan Desert habitat. Holloman Air Force Base is mostly surrounded by mountains; with the Sacramento Mountains to the east and the San Andres and Oscura Mountains to the west. In addition, White Sands National Monument is southwest of the base, where gypsum sand dune habitat takes up approximately one tenth of the area within HAFB.

Generalized habitat types within HAFB include: (1) Duneland; (2) Fourwing Saltbush/Gypsum Dropseed Shrubland; (3) Fourwing Saltbush/Alkali Sacaton Shrubland; (4) Fourwing Saltbush/Alkali

Sacaton/Gypsum Dropseed Shrubland/Alkali Sacaton Grassland; and (5) wetland/Alkali Sacaton Grassland, all divided by bisecting roadways (Rachel Guy et al., unpubl. report). These habitat types were used to randomly stratify sites in order to obtain unbiased species estimates throughout the base (Fig. 1).

We sampled reptiles intensively using multiple survey methods (active searching, road cruising, and trapping) to determine the representative reptiles on HAFB. We used the Shannon Diversity Index and Pielou's Index of Evenness to determine species richness and evenness, respectfully (Pielou 1969). We also used Occupancy Modeling to determined unbiased estimates of site occupancy for the most abundant species (MacKenzie et al. 2002). Specifically, we used a stratified random sampling design, with 30 pitfall trapping arrays and nine repeated site visits. We compared models using *a priori* selected habitat covariates (shrubs, grasses/forbs, bare ground, and soil type). The design and survey approach implemented for this study are intended to be repeated to generate long-term monitoring points.

Sampling design.—To determine sampling units, we overlaid a grid onto a land cover map of HAFB areas of interest (Fig. 1). The land cover layer was modified from Muldavin et al. (1997) and resampled to a 1 m resolution, and then vegetation cover types were classified into ecological systems. Restricted areas were determined by HAFB personnel based on where we were permitted to dig and proximity to restricted civilian access areas (test track and shooting ranges). Restricted areas were eliminated as options for random sampling, including a 50 m buffer on either side of roads. Thirty transects (45 × 45 m) were selected using stratified random sampling according to the general, dominant vegetation within different sections of the base (Fig. 1). Within each transect, two drift fences (15.24 m each) were installed, one running east to west and one 10 m south of the east-west fence, running north to south (split-T design modified from Burkett and Black 2004). Silt fences with wooden stakes (DDD Erosion Control, Inc., Ashburn, Georgia, USA) were used for all drift fence arrays. Four pitfall traps (2-gallon buckets) were buried flush with the ground surface under the ends of each fence and one funnel trap was placed along each fence (6 traps/sampling unit; (Fig. 2). To account for species unlikely to be captured in pitfall or funnel traps, such as larger Phrynosomatids and many snakes, active pedestrian and dashboard surveys (i.e., road cruising) were conducted while traveling between sampling units. Road cruising continued for approximately two hours after dark (two nights during each of nine sampling weeks) driving up to 32.2 kph along each roadway. Reptiles were surveyed on HAFB in 2012 from mid-May to early September. Funnel traps were assembled and covered for shade the evening before a survey and pitfall trap cover boards were placed to permit entrance of reptiles while still providing full-shade. Traps were checked the following morning, species were processed and released, funnel traps were disassembled, and pitfall traps were closed and buried to eliminate entrance of reptiles and other organisms (e.g., invertebrates).

FIGURE 2. Sampling unit arrays with 2-gallon buckets buried on either end of each drift fence. (Photographed by Doug Burkett).

Species data from all survey methods were combined to determine species richness, diversity, and evenness. To estimate site occupancy as a function of site-specific habitat covariates, only the species and habitat data from the 30 sampling units (i.e., pitfall traps) with repeated site visit surveys were calculated. We used the same data for the Canonical Correspondence Analysis (CCA; ter Braak and Smilauer 2002), in addition to pedestrian and road cruising data if those species found were in close proximity (~ 50 m) to sampling units. Only species detected on at least 10 occasions were included in the CCA to account for habitat variability.

Sampling effort.—Extensive sampling effort was of utmost importance given the inherent difficulty in sampling reptiles due to their cryptic appearance and behavior. Each sampling unit and roadway was visited nine times (i.e., once during each of nine non-continuous sampling weeks) to allow for sampling throughout the season. Three days were required to visit every site. The order in which sites were visited was randomized to eliminate time of day confounding effects. We included pitfall traps, funnel traps, and road cruising to improve the probability of species detection to estimate richness. No species were captured in funnel traps. After five weeks of sampling, we discontinued using funnel traps.

Vegetation sampling.—Vegetation cover type frequencies were recorded at 30 sites (sampling units). Point intercepts were used to quantify cover type frequencies along three, 25 m line-transects at each site (Woodall and Monleon 2008; Rachel Guy et al. unpubl. report). We used a three-spoke transect design by randomly selecting an initial azimuth from the central location of each site with the next two transects set at ± 120°. Vegetation was recorded every 20 cm along one side of a measuring tape using a pin (50 cm vertical height), where all vegetation in contact with the pin was recorded as a "hit" and identified to functional group (i.e., shrub and/or grass/forb). If no vegetation was in contact with the pin at a given point, we designated the cover type bare ground (i.e., non-vegetated area). Soil type was also distinguished as gypsum sand or clay/loamy soil.

Species diversity.—To determine species diversity, we first used species richness to calculate the Shannon Diversity Index (*H'*; Brower et al. 1989).where,

$$(1)\quad H' = -\sum_{i=1}^{S} pi \log pi$$

where, S = total number of species, and p is the relative abundance of each given species i. Next, we used Pielou's Index of Evenness (J') to determine how equally species were represented out of the species detected (Pielou 1969) where,

$$(2)\quad J' = H'/H_{max}'$$

$$(3)\quad H_{max}' = \ln S$$

Occupancy modeling.—To determine site occupancy, we ran single-species, single-season occupancy models for the species most detected using program PRESENCE 4.4 (MacKenzie et al. 2006). We surveyed 30 sites with 9 non-continuous weekly visits during one summer season (mid-May to early September, 2012). Occupancy modeling is a widely accepted tool used to make inferences on species occurrence (i.e., proportion of landscape occupied), abundance, and distribution (MacKenzie and Royle 2005). Occupancy modeling is unique in that it requires multiple surveys per site to account for imperfect detection (e.g., a species is present, but not detected; Bailey et al. 2007; MacKenzie et al. 2009). Essentially, the program runs simultaneous logistic regression analyses and multinomial maximum likelihood procedures to estimate occupancy (ψ) and detection (p).

The assumptions held when performing occupancy include: (1) the survey area is closed to changes in occupancy for the duration of the sampling period; (2) species detected are independent of those from other sampling units; (3) species are correctly identified; and (4) occupancy is consistent across sites or differences can be explained by the use of covariates (Donovan, T.M., and J. Hines. 2007. Exercises in Occupancy Estimation and Modeling. Available from http://www.uvm.edu/rsenr/vtcfwru/spreedsheets/?Page=occupancy/occupancy11.htm [Accessed 30 September 2012]).

Variability in occupancy was accounted for by using site-specific and survey-specific covariates for occupancy and detection probabilities, respectively. In this study, we tested candidate models (i.e., hypotheses) using habitat variables: shrubs, grasses/forbs, and bare ground coverage. We also tested candidate models where detection was either constant or varied over time (weeks). In addition, we ran multi-method models to determine the detection probability estimates of *Uta stansburiana* between trap survey data and visual encounters over the nine week sampling period. While three to five sampling occasions are typically sufficient to determine unbiased occupancy estimates (MacKenzie and Royle 2005; Nguyen 2013), we were interested in species seasonality and intended to compare species detection results before and after monsoon rain events (usually occurring in late July; Havstad and Schlesinger 2006). When expected rains did not occur, we continued sampling to increase our species detection potential.

Canonical Correspondence Analysis.—Species assemblages were related to habitat using Canonical Correspondence Analysis (CCA; ter Braak and Smilauer 2002). Canonical correspondence analysis is a direct gradient, multivariate analysis which utilizes species and environmental data to create synthetic gradients to interpret associations or niche separation simultaneously (ter Braak 1986; ter Braak and Smilauer 2002). Canonical correspondence analysis was used to describe the uni-modal relationship between reptiles and environmental variables and illustrate their niche separation with an ordination bi-plot (ter Braak and Verdonschot 1995). The ordination bi-plot presents environmental variables as vector gradients (i.e., arrows) with species that are scored (i.e., weighted by their frequencies) and distributed among the gradients. The orientation of the vectors and arrangement of species represent their variability and co-linearity allowing for direct interpretation. Longer vector gradients have more variability. Vectors in close proximity are co-linear, while those in opposition are negatively related. Vectors 90° apart have no association. Species near the center of the bi-plot can be interpreted as having a general affinity to environmental variables, while those further from the center and aligned with a vector are positively associated

TABLE 2. Reptiles captured or observed at Holloman Air Force Base in 2012.

Species	Common Name	Total
Lizards		
Uta stansburiana	Common Side-blotched Lizard	209
Aspidoscelis inornata	Little Striped Whiptail	40
Crotaphytus collaris	Eastern Collared Lizard	11
Holbrookia m. ruthveni	Bleached Earless Lizard	2
Sceloporus cowlesi	Southwestern Fence Lizard	2
Phrynosoma herandesi	Greater Short-horned Lizard	1
Snakes		
Pituophis catenifer	Gophersnake	3
Hypsiglena jani	Chihuahuan Nightsnake	2
Coluber flagellum	Coachwhip	2
Crotalus atrox	Western Diamond-backed Rattlesnake	2
Crotalus viridis	Prairie Rattlesnake	1
Turtle		
Terrapene ornata (shell only)	Box Turtle	1
		$N = 276$

with that environmental gradient (ter Braak and Verdonschot 1995). We selected the down-weighting option for rare species due to the low frequency of detections. We did not include species with fewer than 10 detections in the CCA due to the inability to account for habitat variability.

TABLE 1. Cover type estimates at Holloman Air Force Base of 10% shrubs, 17% grasses/forbs, and 74% bare ground. Sites dominated by gypsum soils are shown in bold.

Site	Shrubs	Grasses/Forbs	Bare ground
0	0.05	0.03	0.92
1	0.09	0.14	0.82
2	0.21	0.04	0.75
3	0.08	0.20	0.74
4	0.01	0.32	0.68
5	0.07	0.00	0.93
6	0.09	0.37	0.58
7	0.06	0.30	0.64
8	0.08	0.19	0.75
9	0.10	0.00	0.90
10	0.08	0.25	0.67
11	0.08	0.09	0.85
12	0.03	0.14	0.83
13	0.04	0.14	0.83
14	0.13	0.16	0.72
15	0.03	0.21	0.76
16	0.07	0.06	0.87
17	0.21	0.30	0.53
18	0.05	0.36	0.59
19	0.07	0.19	0.76
20	0.12	0.04	0.85
21	0.36	0.00	0.64
22	0.14	0.26	0.60
23	0.29	0.09	0.63
24	0.09	0.09	0.83
25	0.01	0.17	0.83
26	0.07	0.13	0.80
27	0.05	0.05	0.90
28	0.14	0.24	0.63
29	0.11	0.51	0.43

RESULTS

Vegetation.—The undeveloped landscape of HAFB is made up of 10% shrubs, 17% grasses and forbs, and 74% bare ground (Table 1). Evidence of shrub encroachment was only apparent in the northeast section of the base, where large mesquite trees dominated the landscape with vast inter-dunal spaces. However, bare ground was the primary cover type throughout HAFB, regardless of the vegetation types present.

Species diversity.—We observed 276 individual reptiles among 12 species and six families from mid-May to early September 2012. The Common Side-blotched Lizard (*Uta stansburiana*), Little Striped Whiptail (*Aspidoscelis inornata*), and Eastern Collared Lizard (*Crotaphytus collaris*) were the most common lizards observed, respectively. Other lizards observed include the Bleached Earless Lizard (*Holbrookia maculata ruthveni*), Southwestern Fence Lizard (*Sceloporus cowlesi*), and Greater Short-horned Lizard (*Phrynosoma herandesi*). Snakes observed include the Chihuahuan Nightsnake (*Hypsiglena jani*), Prairie Rattlesnake (*Crotalus viridis*), Gophersnake (*Pituophis catenifer*), Western Diamond-backed Rattlesnake (*Crotalus atrox*), and there was evidence of the Coachwhip (*Coluber flagellum*) by the presence of sheds, easily identified by their uniform scale patterns. We also observed a single, deceased Ornate Box Turtle (*Terrapene ornata*; Table 2). Overall, the H' index was 0.394, $H_{max'}$ was 2.485, and evenness was low (J' = 0.159).

TABLE 3. Site occupancy models for *Uta stansburiana* detected in pitfall traps. Parameter codes include: ψ = the probability of site occupancy and p = the probability of detection, given the site is occupied. Covariate codes include: Shb = shrubs, Grs = grasses/forbs, Br = bare ground, (.) = occupancy held constant and wk = week. The top six models provide evidence of empirical support (ΔAIC < 2); therefore model averaging (top six models) was used to obtain an occupancy estimate of 0.75 ± 0.02 for *U. stansburiana.*

Model	AIC	ΔAIC	AIC wt	Likelihood	#Par	2*LogLike
ψ(Shb)p(wk)	318.49	0.00	0.253	1.000	11	296.49
ψ(ShbBr)p(wk)	319.67	1.18	0.140	0.554	12	295.67
ψ(GrsBr)p(wk)	319.69	1.20	0.139	0.549	12	295.69
ψ(ShbGrs)p(wk)	319.71	1.22	0.137	0.543	12	295.71
ψ(.)p(wk)	319.96	1.47	0.121	0.480	10	299.96
ψ(Br)p(wk)	320.22	1.73	0.106	0.421	11	298.22
ψ(ShbGrsBr)p(wk)	321.62	3.13	0.053	0.209	13	295.62
ψ(Grs)p(wk)	321.70	3.21	0.051	0.201	11	299.70

Uta stansburiana were captured more than any other species; with more juveniles captured than adults (54.4% juvenile/unknown sex, 25.1% adult female, and 20.5% adult male) between 30 May and 7 September. Juvenile *U. stansburiana* did not appear until 23 July, but were abundant during the remainder of the sampling period. *Aspidoscelis inornata* were only captured from 6 June–27 June. *Crotaphytus collaris* were also observed in pitfall traps and rapidly escaped upon each encounter.

Occupancy modeling.—We ran eight candidate models (i.e., hypotheses) for both *Uta stansburiana* and *Aspidoscelis inornata*. We included a global model with all covariates and a null model, where occupancy was held constant. Detections were insufficient to determine suitable models for *A. inornata*. For *U. stansburiana*, models with detection probabilities allowed to vary over time (i.e., weeks) were more parsimonious than models where detection was held constant over time, thus only models with detection allowed to vary over time are presented (Table 3). Shrub cover was shown to positively influence *U. stansburiana* occupancy as demonstrated by the most parsimonious model (Table 3). Detection probabilities for *U. stansburiana* generally increased over time, with a detection probability of 0.11 ± 0.06 SE on week one, to 0.65 ± 0.09 SE on week nine. Given that the ΔAIC values are less than 2 for six competing models, the covariates associated with those models (e.g., bare ground and grasses/forbs) also contain significant empirical support and are responsible for some of the variability associated with occupancy. We used model averaging with the top six models to obtain an occupancy estimate of 0.75 ± 0.02 for *U. stansburiana*. However, the global model and the model hypothesis that grasses alone influence *U. stansburiana* occurrence have little support (Table 3).

The multi-method models presented show the detection probabilities for both trap and visual encounters collected during mid-May to early September for *U. stansburiana* during nine different weeks (Table 4; Nichols et al. 2008). However, it is important to note the visits for visual encounters do not correspond exactly with the nine trapping weeks. We found that visual surveys were approximately half as successful as the detections from pitfall traps (Table 4).

Canonical correspondence analysis.—Canonical correspondence analysis indicates that the occurrence of *Uta stansburiana* is closely associated with bare ground and *Aspidoscelis inornata* occurrence is associated with soil type; particularly with loamy clay soil (Fig. 3). *Crotaphytus collaris* appears to have a strong association with grasses and forbs. Finally, due to only being detected three times or less during the sampling period, the remaining species were not included in the CCA (Table 2). As a result, the CCA results presented only account for a small proportion of the habitat preferences within the reptile community (Fig. 3).

DISCUSSION

Like its name implies, the Common Side-blotched Lizard (*Uta stansburiana*) is a common species on HAFB and has previously been observed in sparsely vegetated areas (Degenhardt et al. 1996b). However, our data suggest a positive association of *U. stansburiana* with shrubs, the rarest cover type, using occupancy modeling. These results support previous findings (Cosentino et al. 2013) and may represent a common species adapted to or uninfluenced by shrub encroached areas that generate large inter-dunal spaces (Havstad and Schlesinger 2006). The natural Chihuahuan Desert habitat (e.g., shrubs, grasses and scrub habitat) within HAFB appears to have experienced little shrub encroachment, mostly occurring in the northeast (J. Herrick, personal comm.; Fig. 1).

We found *Uta stansburiana*, *Aspidoscelis inornata*, and reptiles that occur sympatrically with these species in New Mexico (e.g., *Crotaphytus collaris*, *Phrynosoma cornutum*, *Coluber flagellum*, *Pituophis catenifer*, and

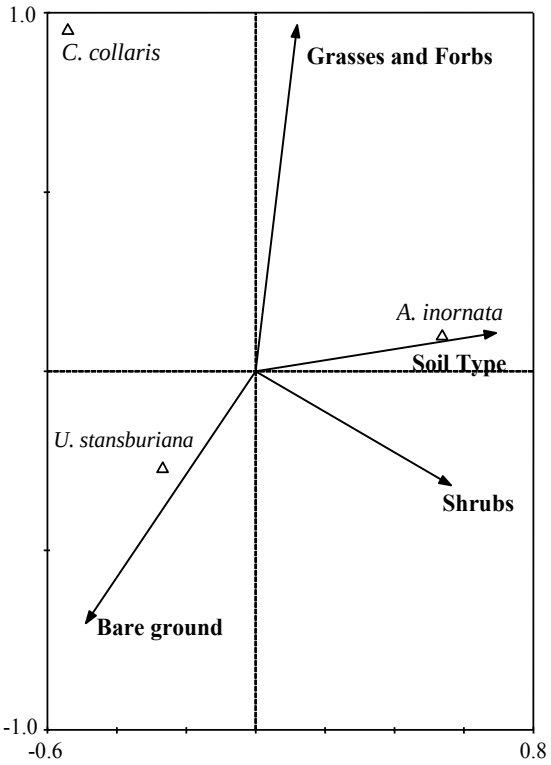

FIGURE 3. Community distribution of the three most observed reptiles on Holloman Air Force Base. Species are represented with open triangles. Habitat gradients are represented by solid vectors (i.e., arrows).

Crotalus atrox; Degenhardt et al. 1996b). Examples of species we expected to find, but did not, included *Gambelia wislizenii* (occur sympatrically with *C. collaris*) and *A. tigris* (prey on *U. stansburiana*; Degenhardt et al. 1996b). Less common species were expected to be associated with key elements within more heterogeneous habitat such as grasses and forbs, but few examples were actually detected beyond *C. collaris*.

The direction of the data was consistent with Menke (2003) and Steen et al. (2012) where many of the lesser common species were found in areas dominated by grasses and forbs. In contrast, some species that were rarely detected in this study that are generally common were found associated with roads (considered bare ground; e.g., *Pituophis catenifer*). We recognize the limitations of our CCA and only a narrow scope of habitat variability and niche separation was accounted for among species; however given the effort put forth, the results are representative of what we observed during an extended drought period.

We found a different complex of species in and near the periphery of the gypsum sand dunes (*Holbrookia m. ruthveni*, *Sceloporus cowlesi*, and *Coluber flagellum*) compared to the clay/loamy soil, but we did not find enough of each species to draw statistically significant conclusions about habitat stratification. The gypsum dunes present a transition zone between habitats, increasing habitat heterogeneity, which can influence species diversity, rates of gene flow, and the metapopulation dynamics of reptiles (Rosenblum 2006). Reptiles in the gypsum dunes have undergone convergent evolution and tend to be cryptic with bleached or pale morphs, while reptiles found in the clay/loamy soil would have visible contrast in gypsum dunes, especially to avian predators (Rosenblum et al. 2010). Mountain ranges and sand dunes contribute to a potentially disjunct herpetofauna community within HAFB that may be poor habitat for several species with the exception of *U. stansburiana* and *A. inornata*. *Aspidoscelis inornata* is thought to be associated with grasses and low-lying shrubs (Degenhardt et al. 1996a). This species was abundant early in the season and tapered off quickly. We suspect *A. inornata* retreated to burrows after breeding (usually breed until late July, but were not observed after 27 June) and were not seen throughout the remainder of the season because of increasing heat and persistent drought conditions (Degenhardt et al. 1996a). *Uta stansburiana*, however, was resilient and detectable all season (Tinkle 1967).

Despite our sampling effort, we had low species richness, preventing estimation of occurrence for most species observed. We intended to sample and compare species detections before and after monsoon events,

TABLE 4. Multi-method (trap vs. visual) models of *Uta stansburiana* detection probability estimates, varying over time. Where, p [1-1] = survey one, trap method, p [1-2] = survey one, visual method. Both survey methods occurred during the same period (May–September, 2012); however visits (1–9) vary among weeks between survey methods. Detection estimates were higher for trap methods.

Model	Estimate	SE	95% C.I.
p[1-1]	0.2000	0.1789	0.0272–0.6911
p[1-2]	0.3333	0.2722	0.0434–0.8465
p[2-1]	0.1424	0.0660	0.0545–0.3237
p[2-2]	0.1068	0.0583	0.0348–0.2837
p[3-1]	1.0000	0.0000	1.0000–1.0000
p[3-2]	0.1250	0.1169	0.0173–0.5373
p[4-1]	0.3204	0.0881	0.1758–0.5103
p[4-2]	0.1068	0.0583	0.0348–0.2837
p[5-1]	0.3204	0.0881	0.1758–0.5103
p[5-2]	0.2136	0.0774	0.0992–0.4012
p[6-1]	1.0000	0.0000	1.0000–1.0000
p[6-2]	0.1250	0.1169	0.0173–0.5373
p[7-1]	0.5340	0.0943	0.3529–0.7066
p[7-2]	0.1424	0.0660	0.0545–0.3237
p[8-1]	0.4272	0.0934	0.2608–0.6119
p[8-2]	0.2136	0.0774	0.0992–0.4012
p[9-1]	0.6052	0.0925	0.4180–0.7660
p[9-2]	0.5340	0.0943	0.3529–0.7066

however monsoonal rains did not occur in 2012. We continued to sample due to our low capture success in order to maintain site covariates and avoid producing occupancy models that were over-parameterized relative to obtained sample size (MacKenzie and Royle 2005). Low species richness may be a result of drought conditions; which persisted from 2010–2012 (Garfin et al. 2013). Additionally, there was an extreme cold event during the winter of 2011 that may have impacted the reptile community (Hardiman, M. 2011. Intense Cold Wave of February 2011. Available from http://www.srh.noaa.gov/images/epz/Storm_Reports/Cold11/Feb2011ColdWx.pdf [Accessed on 3 December 2013]), as evidenced by vegetation canopy damage, which has a trophic-level effect on reptile prey items and predators. Although there is grazing on the northern portion of the base, the pressure is low and unlikely to influence reptile diversity.

Kamienski (2007) suggested that HAFB had low proportion of suitable habitat (e.g., leaf litter, grasses, cacti, shrubs, bare ground, and small trees) for Texas Horned Lizards (*Phrynosoma cornutum*). They detected 11 individuals by road-cruising ~32.2 kph along each roadway 10 times from May through September 2006. We had comparable sampling effort, and no *P. cornutum* were detected. A subsequent study during a normal monsoon season (i.e., ~12.5 cm of precipitation from late July through August; Havstad and Schlesinger 2006) would help determine whether reptile diversity is extremely low on HAFB or whether reptile detections are a function of precipitation, in addition to offering an opportunity to observe habitat preferences of additional reptiles occupying HAFB. Previous studies have demonstrated correlations between lizard abundance and precipitation, likely attributed to food availability (Whitford and Creusere 1977).

The existing natural habitat may be enough to maintain current reptile diversity, but given the predicted increase of extended drought in the southwestern USA (National Assessment Synthesis Team 2000), this should be tested. We designed this survey approach with the intention of repeating the study every 3–5 y to generate long-term monitoring points to understand the community dynamics of reptiles within the Chihuahuan Desert habitat and the unique transition to gypsum sand dune habitat. A long-term study, as opposed to a single-season snap-shot could be valuable in determining species status and their potential requirements for management (Gould et al. 2012). Nonetheless, our study demonstrates the value of pitfall trapping methods, where *U. stansburiana* detection estimates were twice as successful as opportunistic visual searching methods.

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