

REASSESSING LIZARD COMMUNITY ASSEMBLAGES IN BIG BEND NATIONAL PARK

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ABSTRACT--A lizard census established in 1955 by Dr. William G. Degenhardt in Big Bend National Park, Texas was reinvestigated in 2005. Using the original study quadrats and methods established by Degenhardt, a lizard/acre index was determined and compared to previous survey years. Overall, the lizard/acre numbers were lower in 2005 when compared to the last time the quadrats were run in 1969. Within quadrats where *Cophosaurus texanus* had been present up to 1969, there has been a decrease to the point of absence for some quadrats. The *Aspidoscelis gularis septemvittata* per-acre index number increased on both high elevation quadrats (Green Gulch 1, Green Gulch 2). Lizard assemblage similarity is highest in the Tornillo quadrat and lowest in the Green Gulch 1 quadrat, when comparing 2005 to previous surveys. Percent vegetative cover was measured and found to have increased with all quadrats. The data suggests lizard composition and density are both at least partially dependant upon changes in vegetative cover.

INTRODUCTION--Revisiting previously established lizard census plots in Big Bend National Park (Big Bend NP) is fundamental to acknowledging and interpreting successions in community structure over time. In 1955, Dr. William G. Degenhardt began a population survey of lizards and associated vegetation in Big Bend NP (Degenhardt, 1960, 1966, 1970, 1977). The

initial work, conducted from 1955 through 1957, was part of an ecological survey of the Big Bend NP area by the Texas Game and Fish Commission. Among the objectives of this survey was the need to “determine the successional trends of plant and animal communities” (Degenhardt, 1960). This initial survey was continued through 1960, and then later revisited in 1968 and 1969 (Degenhardt, 1970, 1977).

Pianka (1973) describes population patterns found in lizard communities as they relate to available resources. Abiotic and biotic limiting factors affecting diurnal ground lizard populations would include but are not limited to: available prey, vegetative cover, basking sights, soil composition, interspecific competition, and precipitation (Garcia and Whalen, 2003; Pianka, 1970, 1973, 1986; Pianka and Vitt, 2003). Given a time lapse of 36 years since the last visit to the Degenhardt census, it is of interest to note changes within the lizard and vegetative communities. Specifically, have there been any changes in the lizard assemblage diversity or density? Have there been any changes in the floral composition or density? Finally, how have any differences affected the lizard population?

MATERIALS & METHODS--*Study area*--The 6 quadrats established by Degenhardt are located in a southwest-northeast line near the center of Big Bend NP. All quadrats are adjacent to a roadside and most of the original rebar that delineates them is still standing. The Tornillo Flat (TORN) quadrat is 4 acres and the Grapevine Hills (GRAP), Burnham Flat (BURN), Green Gulch 1 (GG 1), Green Gulch 2 (GG 2), and Green Gulch 3 (GG 3) are all one acre.

As alluded to by Degenhardt (1970; pers. comm.), operating the full set of quadrats would be too much work for one person to complete in one summer. Because a lack of resources necessary to complete a full survey, the GG 3 quadrat at 1600 m was not surveyed in 2005. This

vegetatively overgrown quadrat (GG 3) was omitted due to likelihood that the abundant vegetation would have altered lizard visibility, resulting in a biased index number. The remaining 5 (TORN, GRAP, BURN, GG 1, GG 2) of the 6 original quadrats were visited between 13 May and 13 August 2005.

Lizard sampling--The quadrats were walked in a grid pattern following Degenhardt (1970) and all lizard sightings were recorded during the time spent surveying the quadrats (ca. 30 min). The quadrats were surveyed when the morning ground temperature reached 35°C following the guidelines established by Degenhardt (1966, 1970). Ground temperature was measured with a digital waterproof thermometer with an accuracy of $\pm 1^\circ\text{C}$. Degenhardt chose this temperature because *Aspidoscelis* (= *Cnemidophorus*; Reeder et al. 2002) and *Cophosaurus* are believed to be most active at 35°C (Degenhardt, 1960, 1966, 1970, 1977). Each quadrat was surveyed a total of ten times ($n = 10$) in 2005. Lizard/acre index numbers were calculated by dividing the total lizards seen by n , with the exception of the four acre quadrat TORN, where $n = 40$.

Vegetation sampling--Vegetation monitoring was completed from 28 August to 14 September 2005 using similar methods to those previously published (Degenhardt, 1966, 1970, 1977). Metric measurements for the line transects were used rather than English measurements as used by Degenhardt, to follow modern convention. Five 30.5 meter transects replaced the five 100' transects on each quadrat in the same locations as found in Degenhardt (1970). The line intercept method was used to determine a percentage cover for each line. Cover was recorded following Degenhardt (1970), using the categories "shrub" and "grass or forb". The 5 lines were totaled and averaged to determine percentage cover for the individual quadrats.

Analysis--The lizard species assemblage similarity between census years was calculated using the assemblage-similarity index:

$$C_{ij} = 1 - \frac{1}{2} \sum_{k=1}^s (P_{ik} - P_{jk})$$

where C_{ij} represents the proportional similarity between censuses i and j , with P_{ik} and P_{jk} representing the proportions of the fauna in each census that comprise species k (Sale, 1984). The C_{ij} varies from 0.0 (no overlap) to 1.0 (complete overlap). Similarities for each quadrat were calculated comparing the 2005 lizard/acre index numbers for the three most abundant species (*Aspidoscelis tigris marmorata*, *Aspidoscelis gularis septemvittata*, and *Cophosaurus texanus*) as compared to: the lizard/acre index for each species in 1957 (the first year of the census), the lizard/acre index mean of each species on the individual quadrats leading up to 2005, the overall assemblage-similarity index mean for each species on all quadrats in the census.

RESULTS--The quadrats with the most change to index number were GRAP and GG 1 (Table 1). The GRAP quadrat index numbers were 8.7 and 8.2 lizard/acre in 1956 and 1957 respectively, while they were 2.5 lizard/acre in 2005. The GG 1 quadrat lizard/acre index numbers were 12.8 and 9.9 in 1958 and 1959 respectively, and in 2005 the index number was 2.8 lizard/acre. The quadrats with the least change in index number were both TORN and BURN (Table 1). TORN experienced 1.2 and 1.6 lizard/acre in 1957 and 1958 respectively, while 1.3 lizard/acre was recorded in 2005. BURN recorded 4.0 and 7.9 lizard/acre in 1957 and 1958 respectively, and in 2005 recorded 4.7 lizard/acre.

Lizard composition densities on the quadrats have changed over 36 years. *Aspidoscelis tigris marmorata* were in much greater numbers at the 3 lower elevation quadrats in 1969 when compared to 2005 (Figure 1). Likewise, over that same period *A. g. septemvittata* has increased on the higher elevation quadrats. Changes in lizard composition (Figure 1) include the addition of *A. g. septemvittata* in the GG 1 quadrat and an apparent decline in *C. texanus* on the lower elevation quadrats. Index numbers of *C. texanus* decreased in GRAP (0.2 lizard/acre) and GG 1 (0.0 lizard/acre) quadrats in 2005 as compared to previous lizard/acre index numbers (1956 GRAP: 3.4, 1957 GRAP: 3.2; 1957 GG 1: 8.0, 1958 GG 1: 6.1).

The overall species composition of the set of quadrats has remained largely unchanged, with the addition of only *Urosaurus ornatus*, *Phrynosoma modestum*, and *Sceloporus magister*. By comparison, certain individual quadrat assemblages have changed considerably (Table 2). The quadrat bearing the least similarity to the initial survey was GG 1 (0.01 similarity), with TORN remaining the most similar (0.84 similarity). This comparison holds true when compared with all prior quadrat means for both GG 1 (0.01) and TORN (0.99). The general index mean (a species assemblage mean of all censuses) was compared to the 2005 mean (the species assemblage mean for all quadrats in 2005) to demonstrate influences (made by particular quadrats) on the overall mean (Table 2). The GRAP quadrat shows the highest similarity to the calculated means, which illustrates the quadrat with the highest lizard/acre numbers and the most diversity since the beginning of the census.

There was an overall increase in vegetative cover in the quadrats from the beginning of the survey (1957) to 2005 (Table 3). The quadrat with the largest increase in vegetation cover was GG 2 (1417 m), where 21.0% cover was recorded in 1957 and 91.4% cover was recorded in 2005, an increase of 4.35. In 2005, the GG 2 quadrat was covered in grasses and forbs (e.g.,

Eragrostis lehmanniana and *Erigeron modestus*), shrubs (e.g., *Dasyrion leiophyllum*, *Acacia angustissima*, and *Viguiera stenoloba*), and cactus (*Opuntia spp.*). The least vegetative change was found in the BURN quadrat which had a 1.80 fold increase in cover from 1957 to 2005. This quadrat was dominated by *Agave lechuguilla*, *Larrea tridentata*, *Viguiera stenoloba*, and *Bouteloua spp.*, not dissimilar to plants found during the 1969 census.

DISCUSSION--The 2 quadrats with the most change in lizard/acre index number and the lowest assemblage-similarity index numbers compared to previous years were GRAP and GG 1. Both quadrats had high lizard/acre numbers at the start of the census (1957) yet were experiencing a much decreased lizard population in 2005. Both quadrats also had increased in vegetative cover over 3 fold from the start of the census in 1957. The data suggests a correlation between the shift of more shrub dominated habitats and a decrease in lizard/acre numbers.

The quadrat that changed the least was TORN, where the lizard/acre index numbers are similar to previous study years. This quadrat has not seen a very large departure from initial lizard/acre numbers nor has the dominant lizard species (*A. t. marmorata*) changed. However, the vegetative cover had increased nearly 4 fold within this quadrat. It should be noted that the majority of the TORN quadrat is still not covered by vegetation of any kind (84.5%) and remains relatively unchanged.

GG 1 has shown the greatest overall change, with an assemblage-similarity index of 0.01 compared to the mean prior to 2005. The lizard/acre index for GG 1 was 0.0 in 1969 and 2.8 in 2005. In 1957, *A. t. marmorata* were the most common lizards on GG 1 while *C. texanus* was second most common. Degenhardt found only 1 *A. g. septemvittata* after ten independent surveys on this quadrat in the following years: 1957, 1958, and 1968. In 2005, *A. g. septemvittata* was the most dominant lizard at GG 1 ($n = 24$). It is likely that the increase in

vegetative cover, primarily shrubs, has caused the subsequent change in lizard composition and density. In 1958, Degenhardt recorded 26% vegetative cover, categorized as 4% shrub cover, and 22% grasses and forbs. This increased in 1969 with a 5 times upsurge in shrubs and 2 fold increase in grasses and forbs. In 2005, GG 1 showed a similar vegetative composition (42 % shrubs; 21 % grasses and forbs) while indicating a slight increase in total percent cover (Table 3).

The number of *C. texanus* found in 2005 has decreased when compared to the 1969 survey (Figure 1). Based upon field observations, *C. texanus* are found in large numbers throughout Big Bend NP and its surrounding vicinity in proper habitat. However, within the specific quadrats, which no longer contain the proper habitat, the absence of *C. texanus* is obvious. This species is commonly found in dry drainages and open rocky habitats where plentiful basking areas are available (Axtell 1991, Bashey and Dunham 1997, Durtsche et al. 1997, Howland 1992). The decline in *C. texanus* is likely a result of increased vegetation that has grown during the post grazing years in Big Bend NP.

The data may suggest that the increase in *A. g. septemvittata* is due to a vegetative shift toward increased shrubs. Within the Chihuahuan desert, not far from Big Bend NP, Barbault and Maury (1981) found *A. g. septemvittata* to be opportunistic, highly variable, and geographically erratic. Historically, *A. g. septemvittata* in Big Bend NP, were described as selecting both woodland and chino-sotol habitats and would not be found regularly below 1220 m (Degenhardt, 1969). In 2005, *A. g. septemvittata* were found in and around the quadrats BURN (1036 m) and GRAP (935 m), much lower than they had previously been found, in habitat that would not currently fit either habitat description (Plumb, 1992).

Lizard numbers were anticipated to be greatest at 35°C. On two occasions it was found that the thermometer did not reach 35°C until noon, on these days lizard activity was very slow in the quadrats and these data were not used towards the final totals. On days when the clouds interrupted the normal lizard activity cycle, the data may not be controlled enough using previous standards. There is evidence that suggests that both temperature and time of day are factors in the activity patterns of *Aspidoscelis* spp. (Winne and Keck 2004). Therefore, it is proposed that the surveying of the quadrats be done between the hours of 8:00 am and 10:30 am with a temperature of 35°C, in order to further standardize the ground lizard/acre index numbers.

Future surveys should attend to other important limiting factors such as precipitation or insect prey availability, as well as accounting for changes in vegetation. It is likely that, the lizard compositions have changed as a result of numerous factors which have yet to be examined by this survey. It is possible that lizard density has been affected by vegetation as found in other surveys, though as Garcia and Whalen (2003) found variables such as prey availability may hold the answer to questions of diversity change within lizard populations. In addition, a larger reinvestigation of the other censuses that were established under the Texas Game and Fish Commission ecological survey of Big Bend NP might provide a more detailed understanding of what has occurred on this landscape.

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TABLE 1--Ground lizard/acre index results for the five quadrats from 1956 to 2005.

(Reported as Lizard/Acre mean $\pm$ SE)

TORNILLO FLAT (TORN) 853 m

	1957	1958	1960	1968		1969		2005
Adults	44	45	52	68	55	81	106	51
Juveniles	6	18	2	0	2	0	6	9
Total	50	63	54	68	57	81	112	60
Lizards/Acre	1.2 $\pm$.2	1.6 $\pm$.2	1.7 $\pm$.2	1.7 $\pm$.2	2.4 $\pm$.3	2.0 $\pm$.2	2.8 $\pm$.3	1.3 $\pm$.5

GRAPEVINE (GRAP) 945 m

	1956	1957	1968	1969		2005
Adults	155	82	28	70	43	25
Juveniles	2	0	23	0	14	0
Total	157	82	51	70	57	25
Lizards/Acre	8.7 $\pm$.7	8.2 $\pm$.8	4.6 $\pm$.7	7.0 $\pm$ 1.0	5.7 $\pm$.7	2.5 $\pm$.6

BURNHAM FLAT (BURN) 1036 m

	1957	1958	1968		1969		2005
Adults	40	38	43	43	44	18	42
Juveniles	0	41	2	2	0	12	5
Total	40	79	45	35	44	30	47
Lizards/Acre	4.0 $\pm$.6	7.9 $\pm$.9	4.5 $\pm$.8	4.4 $\pm$.7	4.9 $\pm$.4	2.7 $\pm$.4	4.7 $\pm$.6

GREEN GULCH 1 (GG 1) 1280 m

	1957	1958	1968		1969		2005
Adults	119	89	10	4	0	0	26
Juveniles	9	0	0	0	0	0	2
Total	128	89	10	4	0	0	28
Lizards/Acre	12.8 ± .4	9.9 ± .6	1 ± .5	1.3 ± .3	0 ± .0	0 ± .0	2.8 ± .6

GREEN GULCH 2 (GG 2) 1417 m

	1957	1958	1968	1969	2005
Adults	34	11	4	1	13
Juveniles	6	0	0	0	0
Total	40	11	4	1	13
Lizards/Acre	4.0 ± .6	5.5 ± 3.5	0.7 ± .7	0.2 ± .2	1.3 ± .5

TABLE 2--2005 Assemblage similarity index compared to quadrat indexes from 1957, quadrat mean prior to 2005, a general index mean for all quadrats, and the 2005 index mean.

As Compared with:	1957	Quadrat Mean Prior to 2005	General Index Mean	2005 Mean
TORN	0.84	0.99	0.66	0.52
GRAP	0.48	0.69	0.74	0.90
BURN	0.80	0.83	0.63	0.53
GG 1	0.01	0.01	0.12	0.48
GG 2	0.55	0.73	0.12	0.48

TABLE 3--Total percent vegetative cover on the quadrats from 1957 to 2005.

	1957	1958	1968	1969	2005	Percent Increase 1957 to 2005
TORN	4	2	5.7	8.5	15.5	388 %
GRAP	17	N/A	41.2	43	56.9	335 %
BURN	32	28	38.5	40	57.5	180 %
GG 1	23	26	73	74.7	76.7	333 %
GG 2	21	28	69	48.2	91.4	435 %

FIGURE 1--Lizard composition divergence between 1969 and 2005 for all five quadrats.

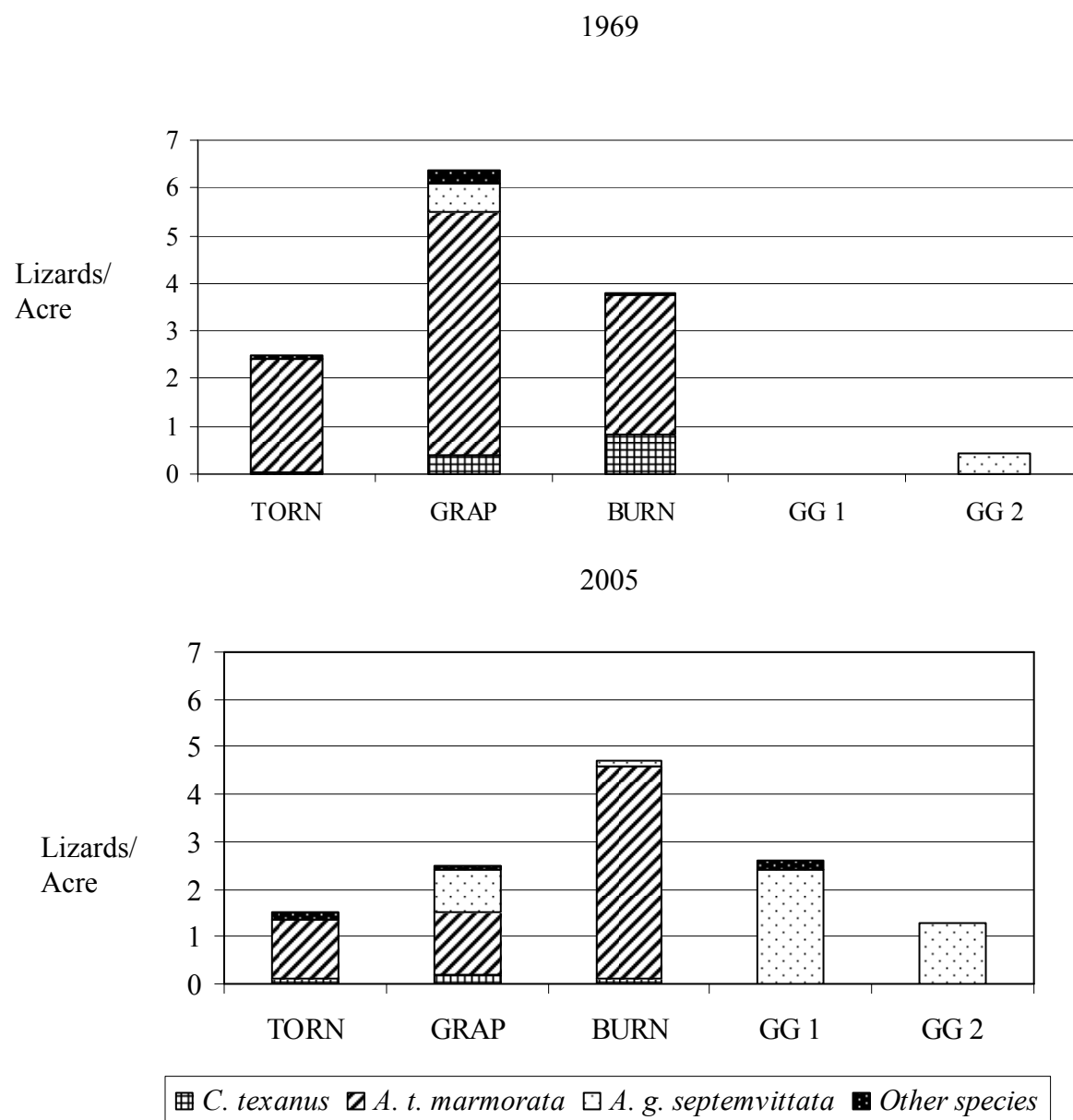


FIGURE 2--Percent total vegetative cover on the quadrats in 1969 and 2005.

