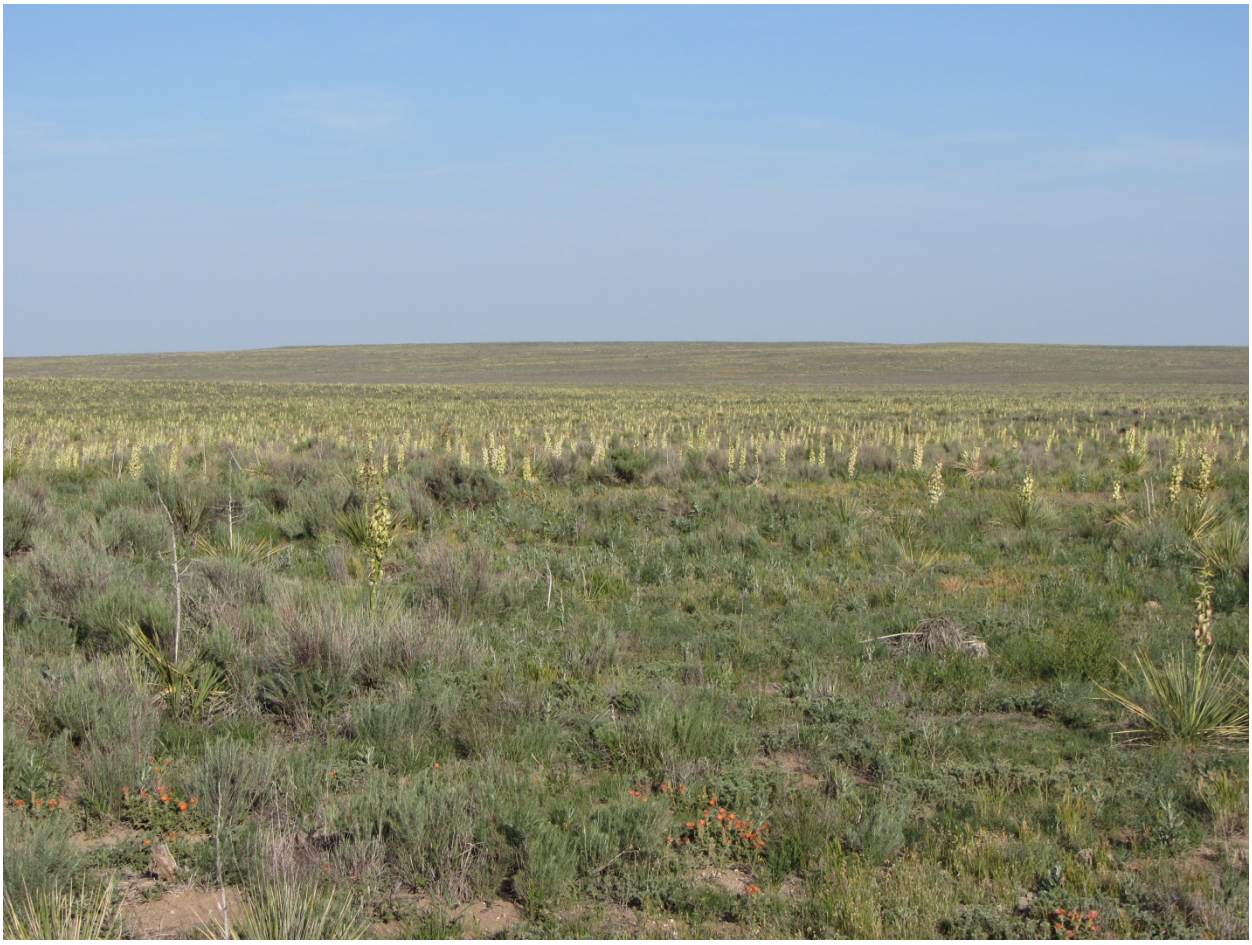
Vegetation Sampling of Lesser Prairie Chicken Habitat Comanche National Grassland



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Executive Summary

Colorado Natural Heritage Program ecologists and USFS personnel conducted vegetation sampling at the Comanche National Grassland in 2012 in order to assess vegetation on potential Lesser Prairie Chicken (LEPC) habitat. The study was intended to contrast differences between the inside and the outside of long-term cattle-grazing exclosures, and to determine the overall suitability of LEPC habitat in the vicinity of these exclosures. LEPC habitat treated by disk-plowing in recent (2009) exclosures was also evaluated for the effects of this treatment on habitat suitability for LEPC.

Results for long-term exclosures indicate:

- Species that are generally considered to increase with grazing showed differences in density or cover between interior and exterior of exclosures. Sandsage density was higher outside exclosures, as was cover of sand dropseed and three-awn.

- Most exclosures differed significantly between inside vs. outside the exclosure for at least one vegetative variable, although we did not detect a consistent fenceline contrast in plant species composition. Differences at Windmill and Big Deweese exclosures were the most notable. Windmill exclosure had higher forb cover within, and higher cover of increaser grass species outside. Both Windmill and Big Deweese had higher abundance of sandsage (either density or cover) outside than inside.

- It is important to note that the long-term exclosures we measured were not originally set up to quantify the impact of cattle grazing. Furthermore, these sites were previously highly altered (old homesteads or blowouts) disturbed areas prior to being fenced, and may still be recovering from the disturbances they experienced prior to grazing exclusion.

- Our results suggest that the exclosures established in 2009 may be more relevant to answering questions related to the effects of grazing on LEPC habitat. However, it is likely that the benefits, if any, to LEPC habitat from grazing exclusion will arise over decades and would not be measurable until additional time, including wet years, has transpired. To determine the effects of grazing on LEPC habitat, it would probably be worthwhile to add more exclosures.

- The LEPC habitat goals/needs were never completely satisfied inside or outside of exclosures. Results from 2012 sampling are similar to those of the habitat characterization reported in Rondeau and Decker (2010), indicating that measured vegetation variables were generally comparable to conditions found during 1986-1990 (Giesen 1994).

Results for the disk-line treatments in 2009 exclosures indicate:

- Disking appears to be effective in increasing the cover of forbs, but species diversity is lower in disked areas when compared to adjacent untreated areas.

Vegetation differences due to grazing are present, but are not by themselves sufficient to account for the presence or absence of LEPC on the Comanche National Grassland.

Introduction

The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) is one of several gallinaceous birds native to Colorado's eastern plains. Although similar to the Greater Prairie-Chicken (*Tympanuchus cupido*), whose distribution slightly overlaps that of the Lesser Prairie Chicken (LEPC) in western Kansas, the *T. pallidicinctus* is smaller, has different courtship displays and vocalizations, and inhabits midgrass and sandsage (*Artemisia filifolia*) rangelands associated with sandy soils rather than native tallgrass prairies interspersed with agricultural habitats that are more typical of loamy soil (Hagan and Giesen 2005). The historic distribution of LEPC covers parts of 5 states in the southern Great Plains. The southeastern corner of Colorado represents a small portion of the historic range of this species, which once inhabited a substantial portion of southwestern Kansas, eastern New Mexico, western Oklahoma, and north-central Texas.

In Colorado, the species has been documented in Baca, Cheyenne, Kiowa, and Prowers counties within the past ten years (CNHP 2012). In recent years, however, the Colorado population numbers have undergone a significant decline. In 2012, 105 LEPC were counted in the entire Colorado range, an approximate 35% decline compared to the 161 birds counted in 2011; the estimated total population size is thought to be in the range of 175-225 birds; (personal communication, Mike Smith, CPW). Population numbers are expected to be negatively affected by drought conditions in the near future, making management decisions for this species even more critical.

Although lands within the range of LEPC generally have low human population density, historic anthropogenic activities appear to have had a significant impact on LEPC populations. Incompatible agricultural practices, such as excessive livestock grazing of rangelands and conversion of native rangelands to cropland, combined with periodic drought, have significantly reduced populations sizes as well as the overall distribution of the Lesser Prairie-Chicken since the early 1900s (Hagan and Giesen 2005). The LEPC is considered Threatened by the state of Colorado, but currently lacks federal protection. The species is a candidate for listing under Federal Endangered Species Act.

Rangewide, LEPC needs for vegetation structure and composition depend on season and life stage (i.e., nesting or brood-rearing, chicks or adults), but can be described generally as native rangeland in different stages of plant succession and consisting of a diversity of native, short- to tall-height grasses and forbs interspersed with low-growing shrubby cover. In Colorado, sand sagebrush communities dominated by a mix of sand dropseed, side oats grama, and little bluestem are the habitats where LEPC are most often found.

Study Area

The Comanche National Grasslands encompass more than 440,000 acres in Otero, Las Animas, and Baca counties in southeastern Colorado. The National Grasslands have their origin in the agricultural difficulties of the 1930's, when cultivation of sub-marginal lands, in combination with severe drought, led to severe erosional damage and eventual abandonment of farms during the period generally referred to as the Dust Bowl. These lands were subsequently brought under federal ownership and management by a variety of mechanisms, but primarily the Bankhead-

Jones Farm Tenant Act of 1937. This legislation permitted the federal government to purchase or otherwise acquire sub-marginal farmlands. In 1954 the Forest Service assumed administration of about 3.85 million acres of these lands from the Soil Conservation Service (now the Natural Resource Conservation Service), and in 1960 the lands were designated as National Grasslands by the Secretary of Agriculture (Olson 1997). Within these lands, LEPC occurrences have been documented from National Grassland parcels in southern Baca County, particularly in sandy areas north of the Cimarron River.

Beginning soon after the designation, a series of small grazing exclosures were constructed at former homestead sites as wildlife habitat improvement areas. These exclosures were intended to protect the homestead sites from livestock damage and to improve habitat for scaled quail. In the 1980s rainwater catchment "guzzlers" were built in the exclosures for use by quail and other animals. There are no records of LEPC using the exclosures.

In 2009 four larger exclosures (200 acres each) were fenced within two different grazing allotments. Exclosures were located within two miles of known lek sites from 2009. These exclosures are intended to benefit LEPC by improving nesting cover and increasing the percentage of mid-tall warm season grass species in areas adjacent to active leks. In Feb 2010, and again in early 2012 the USFS plowed a single ~18 ft. wide line with a disk-plow within each of the 2009 exclosures. These disk lines are intended to increase the diversity of vegetation, especially annual forbs, within the exclosure.

We compared habitat factors inside and outside of eight long-term livestock exclosures on potential LEPC habitat, as well as species composition on and off disked areas within three newer exclosures on the Mt. Carmel grazing allotment. All sites are located on the Comanche National Grasslands in Baca County, Colorado (Figure 1).

Questions addressed in this assessment include:

- Are there habitat differences between the inside and the outside of long-term exclosures?
- What is the overall suitability of habitat for LEPC in the vicinity of each exclosure? Current conditions are compared to characteristics of desired vegetation as described below.
- Are there differences in vegetation between disk-plowed areas and adjacent unplowed areas within the 2009 exclosures?

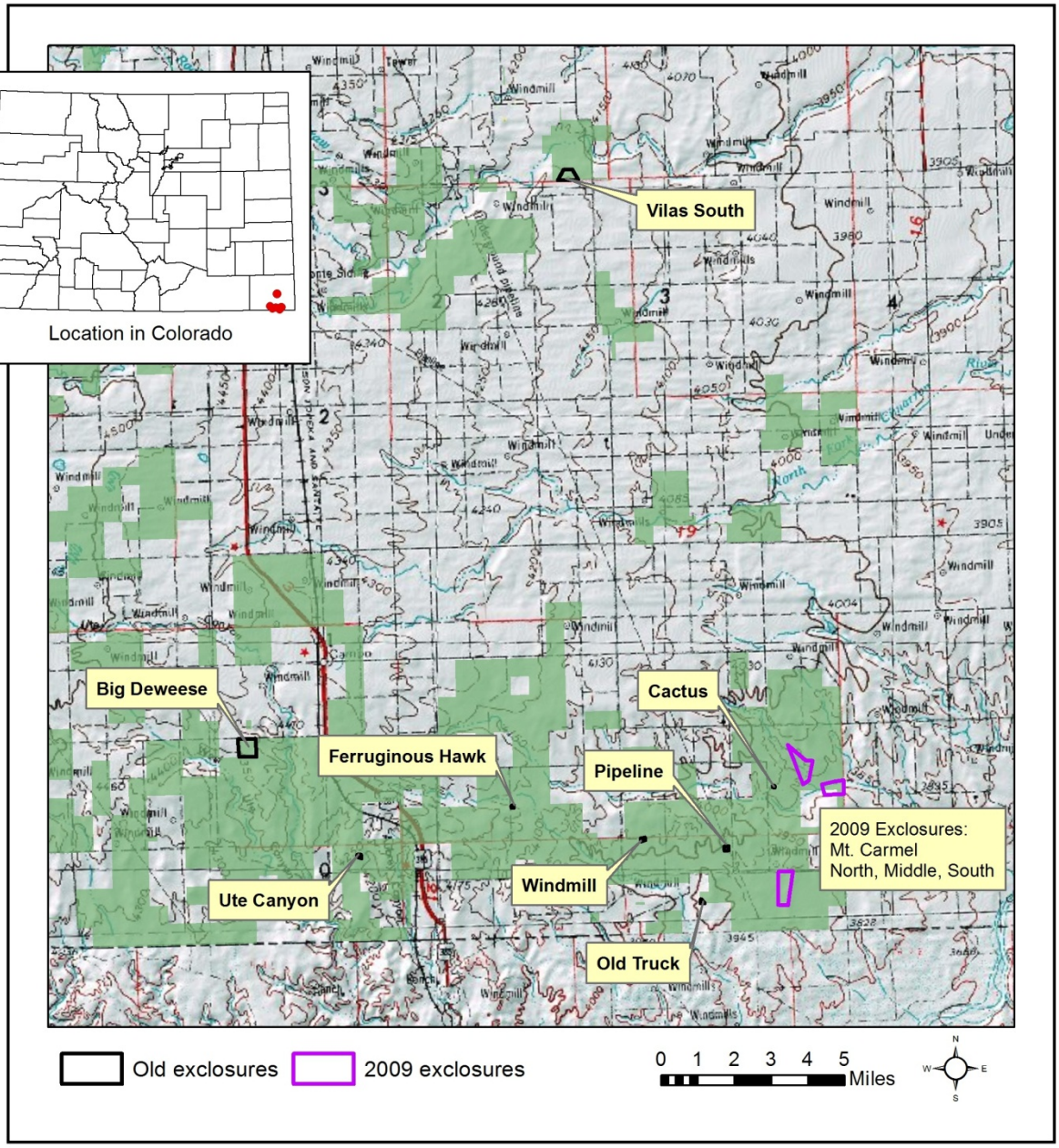


Figure 1. Exclosure locations, Comanche National Grassland.

Methods

Long-term exclosures

Vegetation at eight long-term exclosures (Figure 1) was evaluated with regard to requirements for nesting and brood-rearing LEPC, according to target conditions shown in Table 1. High quality LEPC nesting habitat is characterized by grass condition; ideally the area would be a mosaic of about 65% grassy clumps, interspersed with 20-30% shrubs, and 5-15% forbs. Grasses and shrubs should average at least 20 inches in height (USFWS 1999). In considering the quality

of brood-rearing habitat, the focus is on vegetation structure that provides high abundance of insects. Ideal LEPC brood-rearing cover has an interspersion of 40-45% of shrubs (in Colorado, sand sagebrush, yucca and snakeweed); 40-45% of short- to medium height grasses, and 15-20% forbs (USFWS 1999).

Table 1. Lesser Prairie Chicken vegetation attributes for nesting and brood-rearing habitat.

Habitat factor	Nesting	Source
Shrub cover (%)	>20, (10 better than 0) 5-30+*	Patten et al. (2005) Giesen (1994)
Shrub height (cm)	≥47.6* ≥50	Giesen (1994) USFWS (1999)
Forb cover (%)	≥15 5-15*	Hagen et al. (2005) USFWS (1999)
Forb height (cm)	21	Giesen (1994)
Grass cover (%)	>20* 65% "grassy mottes" (clumps)	Bidwell et al. (no date) USFWS (1999)
Grass height (cm)	≥48-51 >36 ≥20*	Bidwell et al. (no date) Giesen (1994) USFWS (1999)
	Brood-rearing	
Shrub density (plants/ha)	2000-7000 * 3471	Hagen et al. (2005) Giesen (1994)
Shrub cover (%)	40-45	USFWS (1999)
Forb cover (%)	15-20	USFWS (1999)
Grass cover (%)	40-45	USFWS (1999)
Grass height	Short to medium	USFWS (1999)

* Target condition

Vegetation sampling of long-term exclosures was conducted at the Comanche NG on May 14-18, 2012 by Renée Rondeau, Bernadette Kuhn, and Lee Grunau of CNHP, assisted by Steve Olson, Stephanie Shively, and Christina Kemp of the USFS. Eight long-term exclosures were sampled in a series of paired 10 m transects. The sampling layout is shown in Figure 2. At each transect point, a 50 m tape was laid out perpendicular to the fence line (Figure 3a). Both inside and outside the exclosure, a 10m long section on the tape was read as a transect. Transects typically began 25m from the fence and were sampled going toward the fence. In some locations, the transect starting point was adjusted in order to avoid anthropogenic disturbance such as a two-track. After both inside and outside transects had been read, the team moved 30-50 m down the fenceline (Figure 3b) and repeated the sampling procedure (distances between transects were adjusted when the exclosure was small, or to avoid anthropogenic disturbance). At each transect, the following was measured: 1) percent vegetation cover, 2) shrub density (sandsage, yucca, and snakeweed), 3) shrub, grass, and forb cover and height, and 4) overall vegetation height-density (Robel method).

A 10 m x 2 m belt transect (1m on each side of tape, Figure 3c) was used to measure shrub density (Bonham 1989). Individual sandsage, yucca (*Yucca glauca*) and snakeweed (*Gutierrezia sarothrae*) shrubs were counted in a 1m band on both sides of each 10 m transect. A shrub was counted if >50% of its basal stem(s) was within the transect line. Because yucca is rhizomatous and therefore difficult to distinguish as individual plants, individual stems were counted.

To estimate percent cover of shrubs, grasses, and forbs, a point-intercept reading was taken every 0.5 meter along the 10 m transect, beginning at the 0.5 m mark. Bare soil, macrophytic crusts, pebbles, downed litter (including stump remains of grasses), and cowpies were counted under the bare ground/litter category. Only standing plants (may be green or brown) were measured. It was possible to have greater than 100% total cover as grasses may be underneath forbs. Grasses and shrubs were identified to species; forbs were lumped, except for *Opuntia* spp. and *Salsola* spp. Species recorded during field work, and codes used below, are shown in Table 2.

Table 2. Species recorded during field work.

Scientific name	Common name	Code	Scientific name	Common name	Code
Grasses			Forbs		
Andropogon hallii	sand bluestem	ANHA	*Opuntia* spp.	pricklypear	OPSP
Aristida spp.	three-awn	ARSP	*Salsola tragus*	Russian thistle	SALS
Bouteloua curtipendula	sideoats grama	BOCU	Other forbs	n/a	FORB
Bouteloua gracilis	blue grama	BOGR			
Bromus spp.	brome	---	Shrubs		
Bromus tectorum	cheatgrass	BRTE	*Artemisia filifolia*	sand sagebrush	ARFI
Buchloe dactyloides	buffalo grass	BUDA	*Gutierrezia sarothrae*	snakeweed	GUSA
Elymus elymoides	squirreltail	ELEL	*Yucca glauca*	soapweed yucca	YUGL
Hesperostipa comata	needle-and-thread	STCO			
Hordeum jubatum	foxtail barley	HOJU			
Pascopyrum smithii	western wheatgrass	PASM			
Pleuraphis jamesii	galleta	PLJA			
Sorghastrum nutans	Indiangrass	SONU			
Sporobolus cryptandrus	sand dropseed	SPCR			
Vulpia octoflora	sixweeks fescue	VUOC			

Vegetation height-density at each transect was estimated by using a 150 cm round pole with 1-inch increments marked along its length (Robel 1970 visual obstruction method). At four positions along each transect (2, 4, 6, and 8m from start point) the highest point on the pole obscured by vegetation was recorded (Figure 3d). At each of these four positions, the height of the nearest shrub, nearest grass, and nearest forb was also measured, and the height of green material recorded.

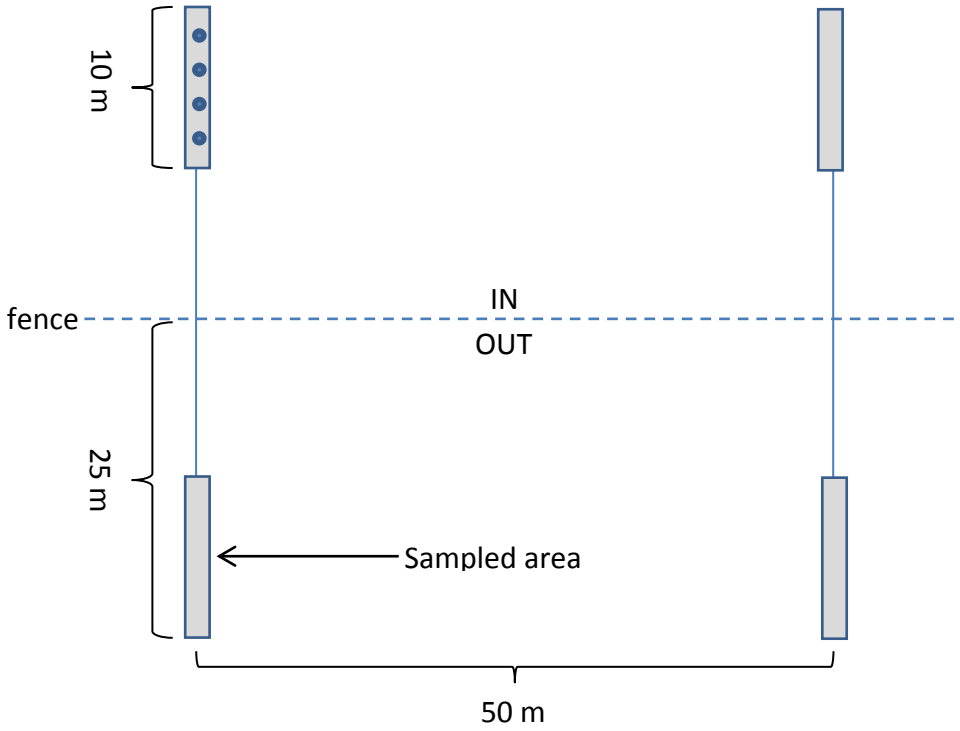
A total of 68 transects were sampled. All data from field forms were entered into Excel spreadsheets, reviewed for accuracy, and summarized for use in statistical analysis software (JMP 9.0.2, SAS Institute Inc. 2010). Means were compared using Welch's t-test for unequal variances.

2009 exclosure disk lines

Vegetation sampling of disk-plowed transects was conducted at the Comanche NG during July 23-25, 2012 by Bernadette Kuhn and Lee Grunau of CNHP. For each of three disk lines, random points were generated within the disked area (Figure 4). Points were at least 25m apart. At each point, plant species cover percent was estimated using a 1 meter x 1 meter quadrat with grid divisions of 10 cm square (Figure 5). The number of squares covered by each species was recorded to the nearest half square. Species covering less than half of a 10 cm x 10 cm square were recorded as "trace." A range finder was then used to locate a companion point 10 m outside the disk line, and another 1 m x 1 m quadrat was sampled. The side for off-line sampling was

randomly selected at the first point, and all subsequent points were taken from the same (right) side of the disk line. A total of 84 points (42 pairs) were sampled.

All data from field forms were entered into Excel spreadsheets, reviewed for accuracy, and summarized for use in statistical analysis software (JMP 9.0.2, SAS Institute Inc. 2010). Means were compared using Welch's t-test for unequal variances.



Shrub density measured by counting plants in a 2 m wide belt transect; >50% of the sandsage trunk must be within the transect; stems of yucca are counted.

Vegetation cover by point- intercept method every ½ meter on 10 m of tape.

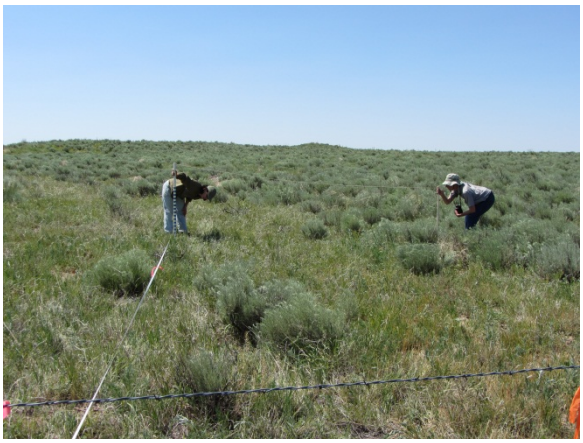
Height of shrubs, forbs, grasses, and height-density measured at 2, 4, 6, 8 m from start (always perpendicular to line on right side of line).

Figure 2. General layout of a transect crossing the fenceline at a long-term exclosure.

(a)

(b)

(c)



(d)

Figure 3. Examples of sampling techniques: (a) setting up the 50m tape across the fence, (b) measuring along fence line to next sample point, (c) counting shrub density in belt transect, (d) reading the Robel pole for vegetation height and visual obstruction measurements.

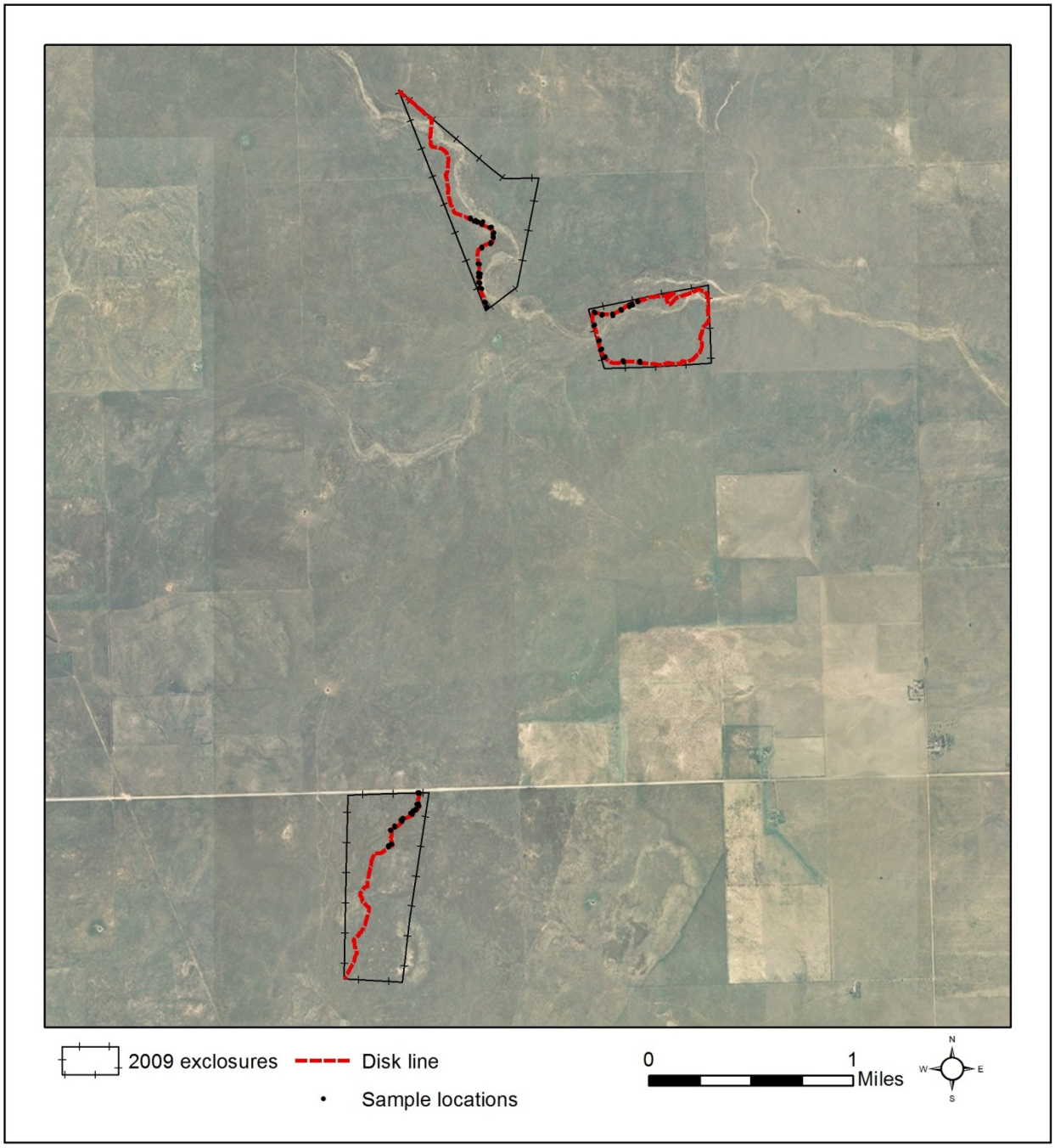


Figure 4. Disk line sample locations.

Figure 5. Disk line sample frame

Results: Long-term exclosures

Frequency - percent cover

Although there are noticeable differences in the vegetation at different exclosure sites (Table 3, Figures 6-8), in general, there were few significant differences between the interior and exterior samples of the long-term exclosures. The Big Deweese exclosure has significantly higher grass cover (primarily from side-oats grama and blue grama) than the surrounding area, while the Old Truck exclosure interior has significantly lower grass cover than the exterior area. The Windmill exclosure is the only one that is significantly different from the surrounding vegetation in all three vegetation categories, with lower grass and shrub frequency and higher forb frequency compared to the outside area. Cover of sand dropseed is higher outside exclosures in seven of eight sites, but the difference is only significant at the Big Deweese site (Figure 6). When data from all exclosures are pooled, the only significant differences between inside and outside are for threeawn (Welch's t=2.1722 , p=0.0322), and sand dropseed (Welch's t=3.3417 , p=0.0011), which both had overall higher cover outside of exclosures.

Table 3. Summary of overall characteristics of each long-term exclosure. Mean proportion cover is shown with standard deviation in parenthesis. Differences significant at the level of p=0.05 are in bold.

Exclosure Name (code)	Position	Top 3 species	Shrub	Grass	Forb	Bare/Litter
Big Deweese (BD)	IN	BOCU, BOGR, YUGL	0.10 (±0.11)	**0.55 (±0.22)**	0.05 (±0.08)	0.31 (±0.15)
N = 10	OUT	ARFI, BOCU, SPCR	0.15 (±0.17)	**0.32 (±0.26)**	0.13 (±0.11)	0.43 (±0.12)
Cactus (CA)	IN	FORB, VUOC, BUDA	0.03 (±0.05)	0.29 (±0.13)	0.33 (±0.15)	0.44 (±0.15)
N = 8	OUT	FORB, BOGR, BUDA	0.06 (±0.07)	0.29 (±0.17)	0.26 (±0.18)	0.43 (±0.1)
Ferruginous Hawk (FH)	IN	BOGR, FORB, BUDA	0.04 (±0.04)	0.49 (±0.17)	0.19 (±0.14)	0.33 (±0.11)
N = 8	OUT	BUDA, BOGR, FORB	0.02 (±0.04)	0.54 (±0.12)	0.11 (±0.10)	0.34 (±0.11)
Old Truck (OT)	IN	FORB, BOGR, YUGL	0.08 (±0.15)	**0.17 (±0.19)**	0.23 (±0.18)	0.53 (±0.19)
N = 8	OUT	BOGR, FORB, BUDA	0.05 (±0.07)	**0.39 (±0.16)**	0.11 (±0.21)	0.45 (±0.15)
Pipeline (PL)	IN	BOCU, ARFI, FORB	0.05 (±0.05)	0.59 (±0.09)	0.06 (±0.11)	0.34 (±0.12)
N = 8	OUT	BOCU, FORB, ARFI	0.08 (±0.08)	0.44 (±0.18)	0.09 (±0.07)	0.46 (±0.15)
Ute Canyon (UC)	IN	FORB, ARFI, BOGR	0.11 (±0.14)	0.23 (±0.23)	0.29 (±0.19)	0.36 (±0.16)
N = 8	OUT	FORB, BOGR, ARFI	0.09 (±0.09)	0.35 (±0.23)	0.29 (±0.13)	0.26 (±0.12)
Vilas South (VS)	IN	ARFI, FORB, BOCU	0.24 (±0.20)	0.18 (±0.13)	0.18 (±0.08)	0.42 (±0.12)
N = 10	OUT	ARFI, FORB, SPCR	0.23 (±0.16)	0.19 (±0.17)	0.19 (±0.16)	0.38 (±0.19)
Windmill (WM)	IN	FORB, SALS, ARFI	0.03 (±0.07)	**0.04 (±0.07)**	**0.46 (±0.31)**	**0.53 (±0.20)**
N = 8	OUT	ARFI, BOCU, SPCR	0.22 (±0.20)	**0.36 (±0.19)**	**0.09 (±0.09)**	**0.38 (±0.14)**

Sandsage is present at all exclosure sites, and has higher mean cover outside exclosures at five of the eight locations (Figure 7). However, the difference is significant only at the Windmill site. Salsola is also present at all sites, and has significantly greater cover within the exclosure at the Old Truck and Windmill sites.

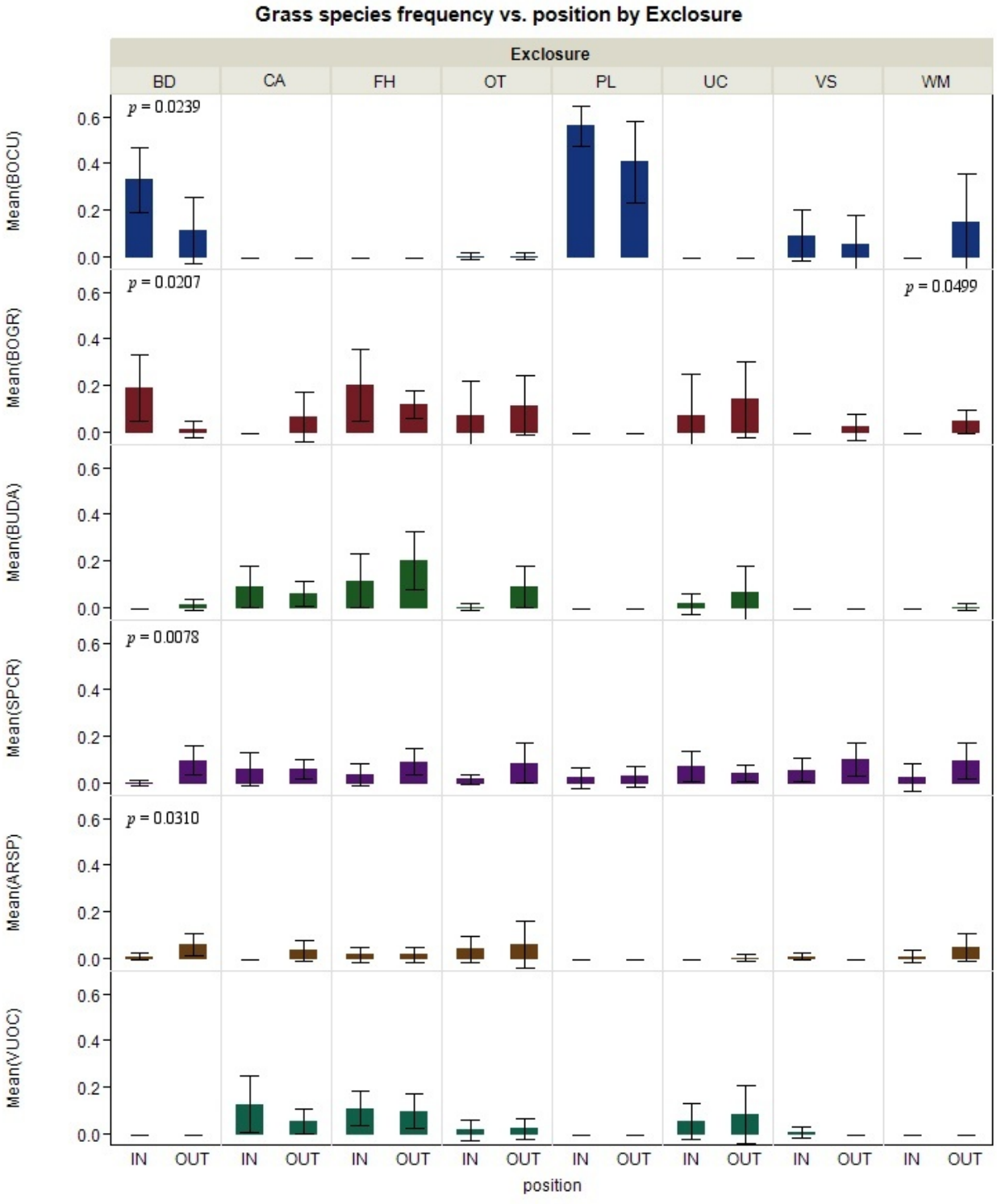


Figure 6. Mean percent cover of most common grass species inside and outside exclosures. Error bars indicate a 95% confidence interval of the mean. P-values are shown for differences significant at $\alpha = 0.05$.

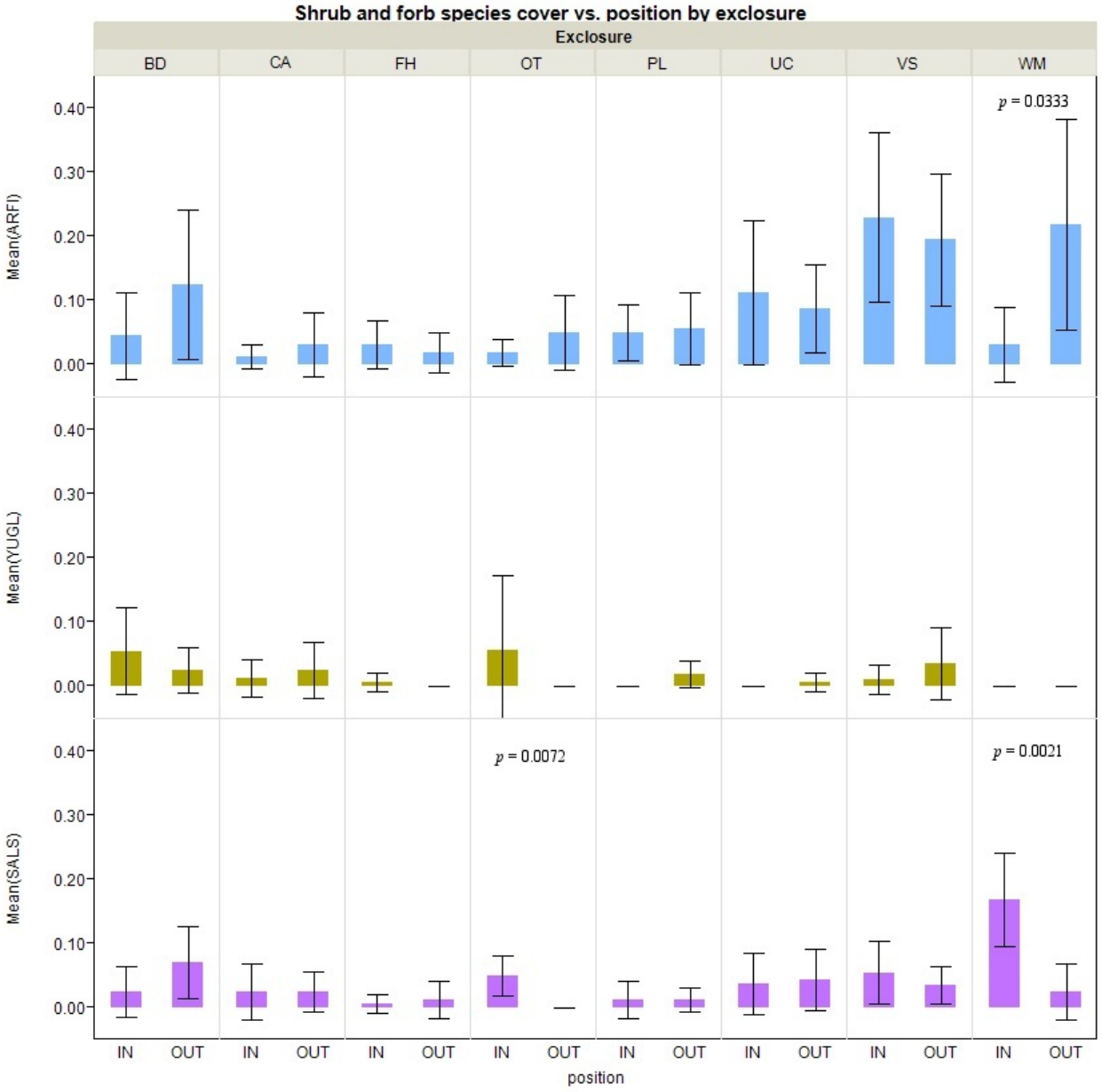


Figure 7. Mean percent cover of most common shrub and forb species inside and outside exclosures. Error bars indicate a 95% confidence interval of the mean. P-values are shown for differences significant at $\alpha = 0.05$.

Percent cover of bare ground / litter is generally greater than that of any single species, with an overall mean of 40% (range 5-95%). Although the differences between exclosures are significant, there was no overall difference between inside vs. outside the exclosures in the amount of bare ground /litter, and no individual exclosures were significantly different between in and out (Figure 8). There are clear differences between the sites in the relative percent cover by shrubs, grasses, or forbs, but no real difference between inside and outside the exclosures.

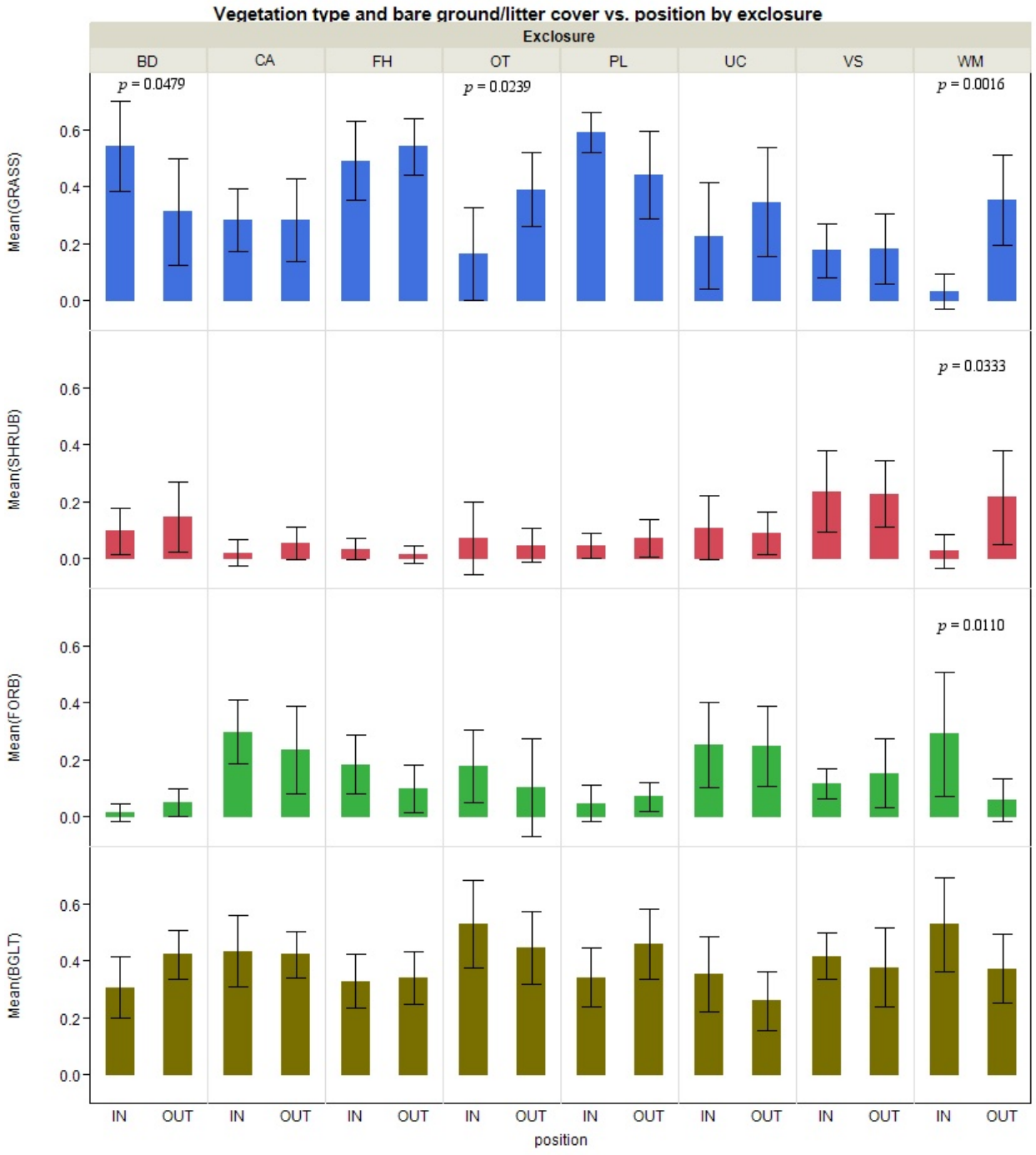


Figure 8. Summary of mean cover types by position at each long-term exclosure. Error bars indicate a 95% confidence interval of the mean. P-values are shown for differences significant at $\alpha = 0.05$.

Shrub density

Yucca was present with lower density than sandsage at all sites, and was a major contributor to overall shrub density only at the BD site. Density of yucca stems showed no pattern of difference between inside and outside of exclosures, and no differences were significant. Snakeweed was not a notable contributor to shrub density except at the FH site. Differences in shrub density were largely due to the prevalence of *Artemisia filifolia*. Sandsage density was lower inside the exclosure at all sites, although the difference was significant only at the BD site (Figure 9). When all exclosures were pooled, sandsage density was significantly higher outside exclosures (Welch's t=2.1157, p=0.0367).

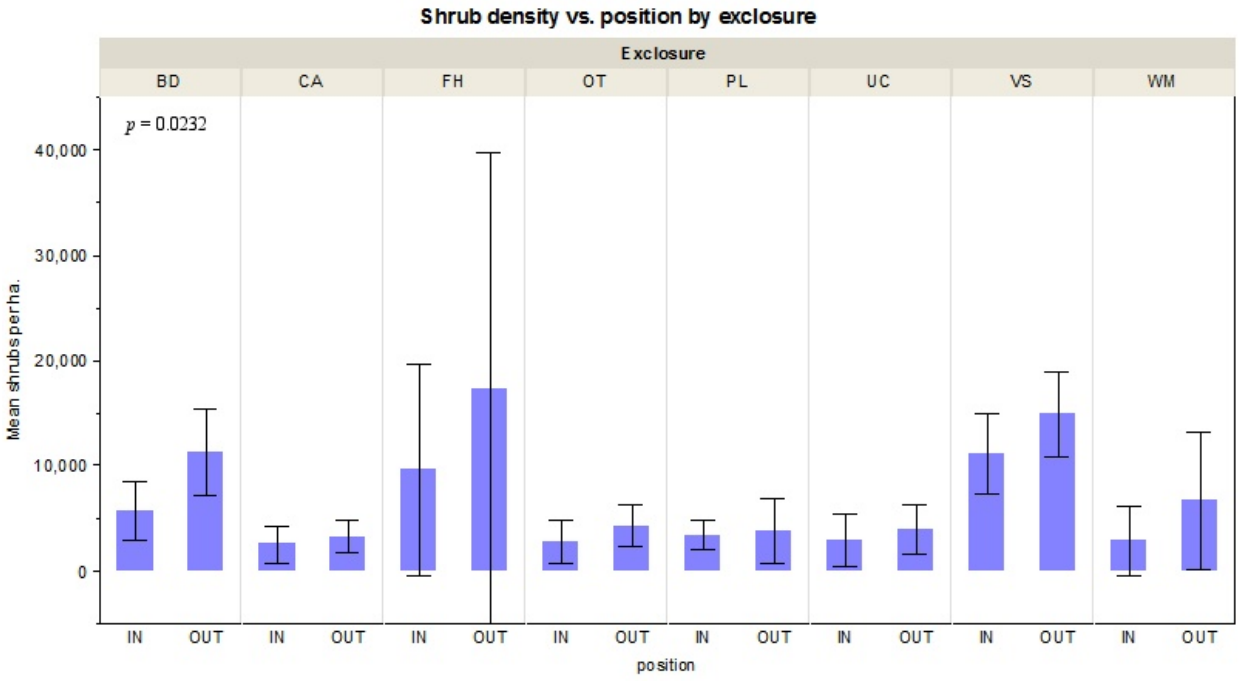


Figure 9. Comparison of shrub density by position at each long-term exclosure. Error bars indicate a 95% confidence interval of the mean. P-values are shown for differences significant at α = 0.05.

Vegetation height

In all sites except Big Deweese, grass height was greater inside the exclosure in comparison with outside the exclosure, however, the difference was significant only at the Ferruginous Hawk site (Figure 10). Although overall shrub height was slightly greater outside exclosures, there were no clear patterns of shrub height difference between inside and outside exclosures, and the overall difference is not significant. Mean forb height within exclosures was slightly higher than outside, but there were no clear patterns of forb height difference between inside and outside exclosures, and the overall difference is not significant.

Overall vegetation height as measured by visual obstruction was slightly higher outside of exclosures, but there were no clear patterns of height difference between inside and outside exclosures, and the overall difference is not significant.

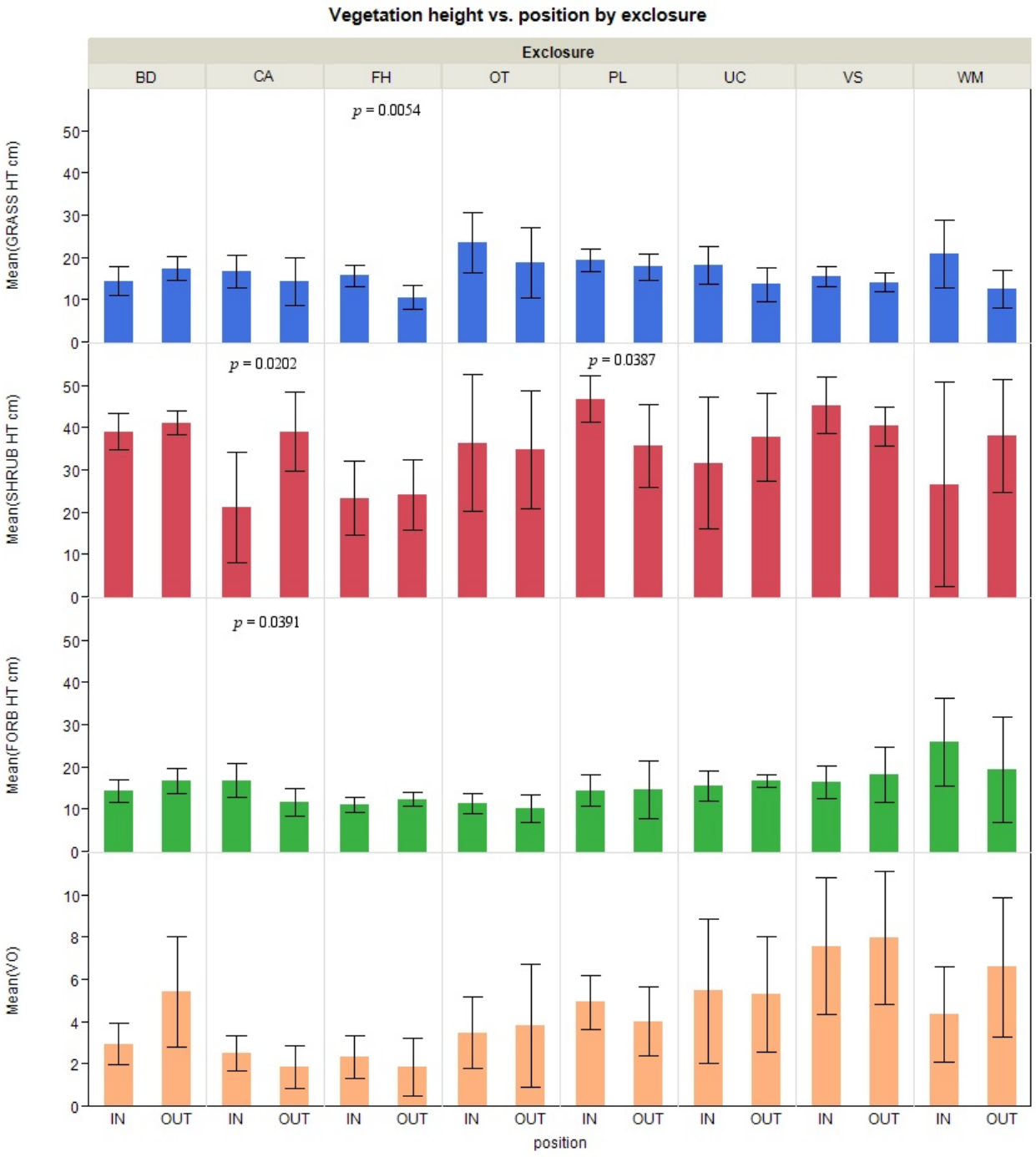


Figure 10. Comparison of vegetation height and height density (visual obstruction) by position at each long-term exclosure. Error bars indicate a 95% confidence interval of the mean. P-values are shown for differences significant at $\alpha = 0.05$.

Habitat characteristics for LEPC

Long-term exclosure means for vegetation attributes considered to be important for LEPC are shown in Table 4. No site, either within or outside of the exclosure meets all of the desired habitat characteristics for shrub density, cover, and height, and grass and forb cover (Table 5). The most common deficiency is lack of tall shrubs. However, all exclosure interiors fall within the range of observed shrub cover and density reported by Giesen (1994) for active lek areas (Figure 11).

Table 4. Habitat characteristics by long-term exclosure site.

Site	Position	Shrub density (plants/ha)	Shrub cover (%)	Shrub height (cm)	Forb cover (%)	Forb Height (cm)	Grass cover (%)	Grass height (cm)	Height density (cm)	Bare ground (%)
BD	In	5,750	10%	39.3	5%	14.5	55%	14.7	7.6	32%
	Out	11,300	15%	41.4	13%	17.0	32%	17.6	13.9	44%
	All	8,525	13%	40.4	9%	15.8	43%	16.1	10.8	38%
CA	In	2,563	3%	21.3	33%	17.1	29%	16.9	6.5	44%
	Out	3,250	6%	39.3	26%	12.0	29%	14.5	4.8	43%
	All	2,906	4%	30.3	29%	14.5	29%	15.7	5.7	43%
FH	In	9,625	4%	23.6	19%	11.3	49%	16.0	6.0	35%
	Out	17,188	2%	24.4	11%	12.5	54%	10.8	4.8	34%
	All	13,406	3%	24.0	15%	11.9	52%	13.4	5.4	35%
VS	In	11,100	24%	45.6	18%	16.6	18%	15.8	19.4	45%
	Out	14,900	23%	40.6	19%	18.4	19%	14.4	20.3	47%
	All	13,000	24%	43.1	18%	17.5	18%	15.1	19.8	46%
PL	In	3,438	5%	47.1	6%	14.7	59%	19.6	12.6	34%
	Out	3,875	8%	35.9	9%	14.8	44%	18.0	10.3	46%
	All	3,656	6%	41.5	8%	14.8	52%	18.8	11.5	40%
WM	In	2,875	3%	26.8	46%	26.2	4%	21.2	11.2	54%
	Out	6,688	22%	38.3	9%	19.6	36%	12.9	16.8	39%
	All	4,781	13%	32.5	28%	22.9	20%	17.0	14.0	46%
OT	In	2,750	8%	36.7	23%	11.7	17%	23.9	9.0	53%
	Out	4,313	5%	35.1	11%	10.3	39%	19.0	9.8	46%
	All	3,531	6%	35.9	17%	11.0	28%	21.4	9.4	49%
UC	In	3,000	11%	31.9	29%	15.8	23%	18.4	14.0	39%
	Out	4,000	9%	37.9	29%	17.0	35%	13.9	13.6	31%
	All	3,500	10%	34.9	29%	16.4	29%	16.2	13.8	35%

Table 5. Sites meeting habitat goals (•) meets, (+) high, (-) low.

Habitat character	BD		CA		FH		VS		PL		WM		OT		UC	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
Shrub density (2000-7000/ha)	●	+	●	●	+	+	+	+	●	●	●	●	●	●	●	●
Shrub cover - nesting (5-30+%)	●	●	-	●	-	-	●	●	●	●	-	●	●	●	●	●
Shrub cover - brooding (>40%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shrub height (>47.5 cm = 18.7in)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forb cover - nesting (5-15%)	●	●	+	+	+	●	+	+	●	●	+	●	+	●	+	+
Forb cover - brooding (15-20%)	-	-	●	●	●	-	●	●	-	-	●	-	●		●	●
Grass cover - nesting (>20%)	●	●	●	●	●	●	-	-	●	●	-	●	-	●	●	●
Grass cover - brooding (>40%)	●	-	-	-	●	●	-	-	●	●	-	-	-	-	-	-

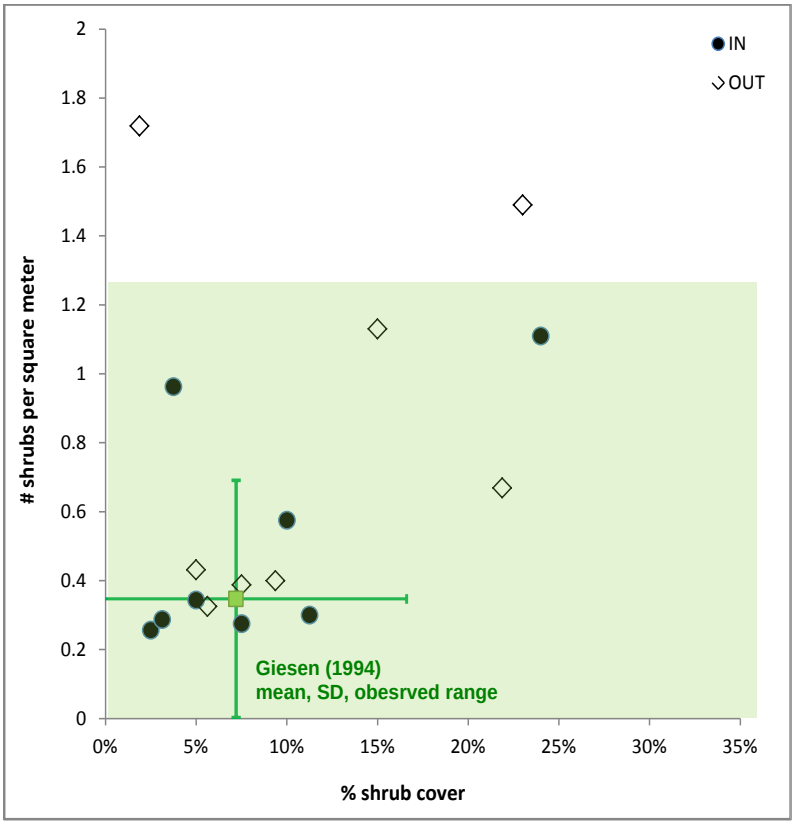


Figure 11. Relationship between the two habitat variables for the long-term exclosures, in comparison with the target criteria from Table 1, and mean observed values from Giesen (1994). Total observed range from Giesen (1994) is shaded.

Results: Disk lines

Species composition

A total of 47 species were recorded in samples on and off disk lines (Table 6). The disked area was dominated by the annual forb species *Amaranthus arenicola, Chenopodium pratericola, Croton texensis, Helianthus annuus, Salsola tragus,* and *Solanum rostratum*. Unplowed areas were dominated by sandsage, grasses including *Bouteloua curtipendula, Sporobolus cryptandrus, Aristida purpurea,* and annual-biennial or perennial forbs.

Table 6. Summary of species recorded during disk line sampling. A = annual, B = biennial, P=perennial.

Scientific name	Duration	Form	Percent cover		# plots present	
			On	Off	On	Off
Amaranthus arenicola	A	Forb	3.11	0.29	20	3
Ambrosia psilostachya	A-P	Forb	0.32	0.13	8	3
Andropogon hallii	P	Grass	0.15	0.10	1	1
Aristida purpurea	A-P	Grass	0.19	1.08	4	6
Artemisia filifolia	P	Shrub	1.42	7.18	10	13
Astragalus sp.	P	Forb	0.00	0.00	1	0
Bouteloua curtipendula	P	Grass	0.48	12.89	11	11
Calylophus serrulatus	P	Subshrub/forb	0.00	0.07	0	1
Chamaesyce glyptosperma	A	Forb	0.04	0.08	1	4
Chenopodium pratericola	A	Forb	5.70	0.42	24	5
Chloris verticillata	P	Grass	0.00	0.07	0	2
Chorispora tenella	A	Forb	0.05	0.00	1	0
Commelina erecta	P	Forb	0.00	0.06	0	1
Croton texensis	A	Forb	7.87	0.93	29	21
Cryptantha minima	A	Forb	0.05	3.44	2	26
Elymus elymoides	P	Grass	0.00	0.01	0	1
Erigeron flagellaris	B	Forb	0.00	0.19	0	6
Eriogonum annuum	A-B	Forb	0.05	7.16	1	32
Euphorbia dentata	A	Forb	0.01	0.04	1	1
Evolvulus nuttallianus	P	Forb	0.00	0.02	0	2
Gaura coccinea	P	Subshrub/forb	0.06	0.06	1	1
Gutierrezia sarothrae	P	Shrub	0.00	0.02	0	1
Helianthus annuus	A	Forb	1.96	0.01	20	1
Hesperostipa comata	P	Grass	0.02	0.25	1	2
Heterotheca horrida	P	Forb	0.00	0.04	0	1
Hordeum jubatum	P	Grass	0.00	0.43	0	1
Hordeum pusillum	A	Grass	0.00	1.07	0	4
Ipomoea leptophylla	P	Forb	0.74	0.38	2	2
Krameria lanceolata	P	Subshrub/forb	0.00	0.17	0	1
Machaeranthera tanacetifolia	A-B	Forb	0.00	0.23	0	1
Mentzelia nuda	P	Forb	0.30	0.07	12	5

Scientific name	Duration	Form	Percent cover		# plots present	
			On	Off	On	Off
Mimosa rupertiana	P	Forb	0.00	0.15	1	2
Munroa squarrosa	A	Grass	0.14	0.00	3	1
Opuntia sp.	P	Shrub	0.02	0.02	1	2
Psoralidium lanceolatum	P	Forb	0.98	0.85	2	3
Psoralidium tenuiflorum	P	Forb	0.14	0.00	2	0
Quincula lobata	P	Forb	0.00	0.07	0	1
Salsola tragus	A	Forb	4.06	1.14	33	15
Solanum rostratum	A	Forb	1.42	0.00	8	0
Sphaeralcea coccinea	P	Subshrub/forb	0.12	0.26	5	8
Sporobolus cryptandrus	P	Grass	0.14	4.01	8	26
Sporobolus giganteus	P	Grass	0.24	0.21	1	2
Stephanomeria pauciflora	P	Subshrub/forb	0.39	0.11	2	2
Thelesperma megapotamicum	P	Forb	0.01	0.00	1	0
Vulpia octoflora	A	Grass	0.02	1.61	1	24
Yucca glauca	P	Shrub	0.07	0.13	1	2
Zinnia grandiflora	P	Subshrub/forb	0.00	0.01	0	1
Litter			7.83	28.38	---	---
Bare Ground			61.54	26.87	---	---

Bare ground was conspicuous in May, while forb growth was apparent in July (Figure 12). Disked areas had significantly higher cover of forbs (Figure 13a, and lower grass and shrub cover in comparison with adjacent unplowed areas (Figure 13b and 13c). Not surprisingly, mean cover of bare ground was significantly higher in disked areas (Figure 13d), while litter cover was significantly lower (Figure 13e).

Figure 12. Views of disk lines in May (left) and July (right) of 2012.

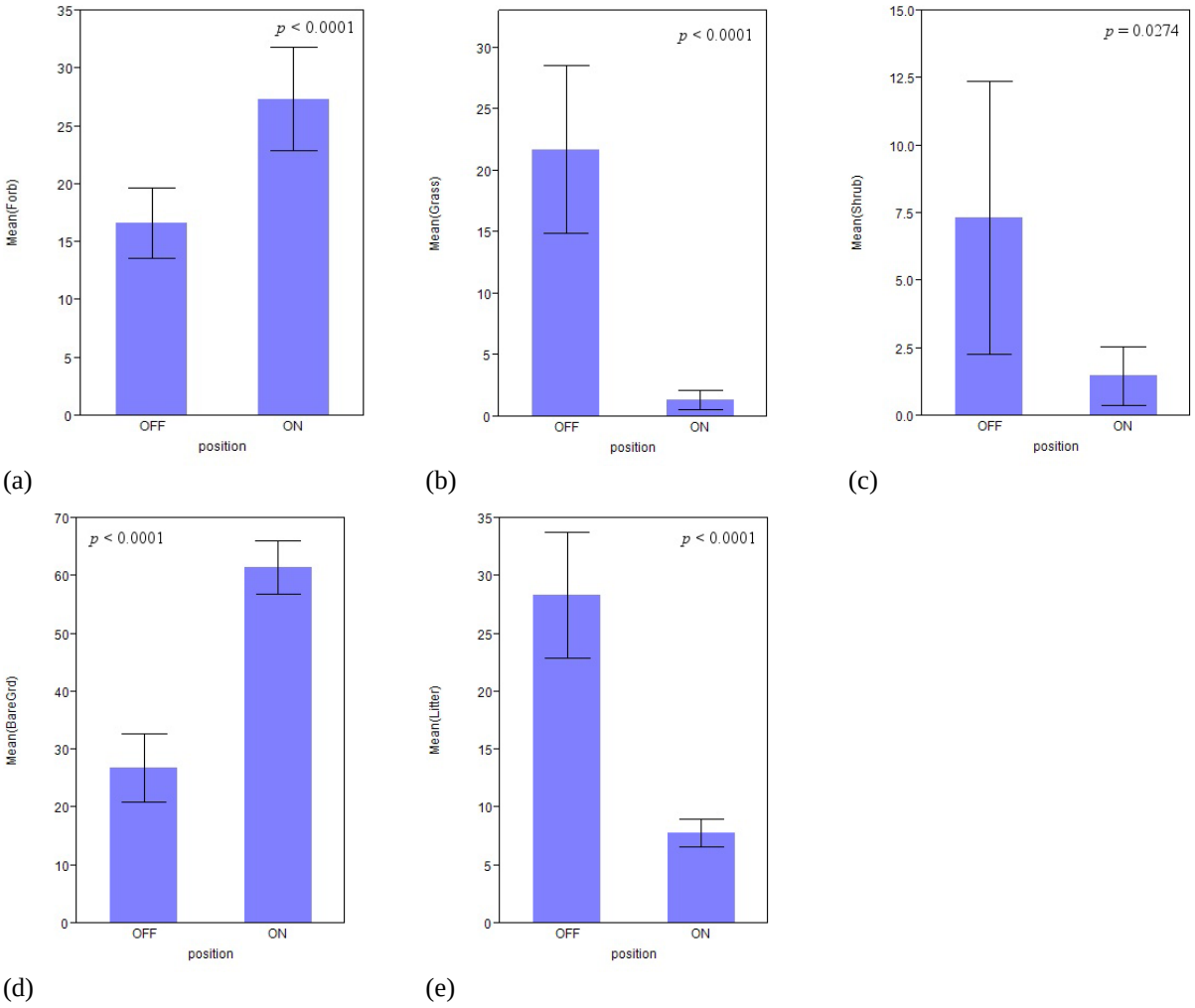


Figure 13. Comparison percent cover for three vegetation groups on plowed area (ON) and adjacent unplowed area (OFF). Error bars indicate a 95% confidence interval of the mean. P-values are shown for differences significant at $\alpha = 0.05$.

Species diversity

A total of 34 species were recorded in plots on the disked area, in contrast to 43 on adjacent plots (Table 6). Disked and undisked areas both had about the same number of short-lived species, but more perennial species were found on undisked areas (Table 7).

Table 7. Summary of lifecycle characteristics of species on and off disk-plowed line.

	Number of Species		
Form	**Plowed**	**Un-plowed**	**Total observed**
Annual forb	10	8	10
Annual grass	2	3	3
Other short-lived forb/grass	3	5	5
Perennial forb	7	8	11
Perennial grass	5	8	8
Perennial subshrub/forb	3	6	6
Perennial shrub	3	4	4
Total:	33	42	47

Discussion

Long-term exclosures

Conditions within and outside long-term exclosures do appear to be generally similar to those observed in 1986-1990 (Giesen 1994); interior conditions more frequently fall within the target range (Figure 11).

The primary differences that we detected were in sandsage density and cover of three-awn and sand dropseed. Density or cover of these species was greater outside the exclosure, indicating that they are increasing in the presence of grazing. Similar trends have been documented elsewhere in Colorado (e.g. Rondeau 2013). It is interesting to note that, although the long-term exclosures are readily identifiable in contrast to the surrounding vegetation on aerial photos (Figure 14), this difference was not always reflected in the vegetation measurements. For instance, vegetation cover appears higher within exclosures, but this was not always detected by our transects.

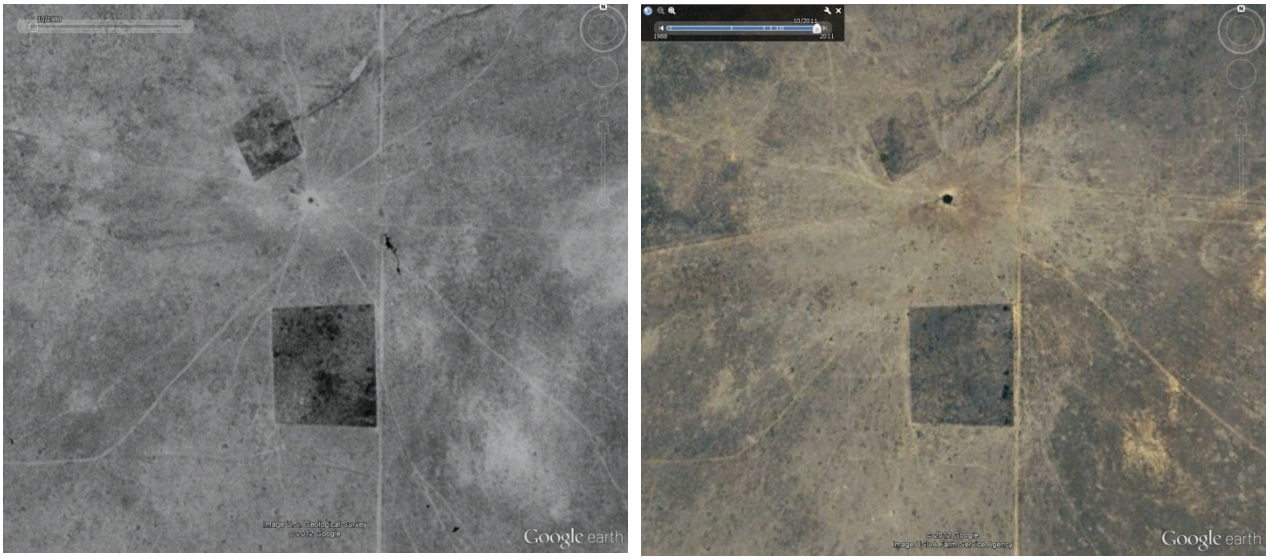


Figure 14. Aerial imagery of the Ferruginous Hawk (FH) long term exclosure (lower exclosure). Image dated 1988 on left, 2011 on right.

Six of the eight exclosures had at least one variable that was significantly different between inside and outside the fence, but differences were not consistent across exclosures. A difference in the abundance of one or two species may be sufficient to produce a noticeable fenceline effect in aerial imagery. One important factor to consider is that these long-term exclosures were not designed to detect differences between grazed and ungrazed land, but were set up to protect homesites and enhance upland bird habitat. Due to the previous land use (homesteading or Dust Bowl era blowouts) in the exclosures, the vegetation and soils were already highly altered prior to the fencing of the area. In order to address the question of positive vs. negative effects of grazing on LEPC habitat, it would be better to establish a number of large (1 ha or more) exclosures in areas that were not homesteads or blowouts, are distant from current fences and water tanks, and where the area inside and outside of the fence represents an essentially uniform sample of soil and vegetation type at the time of exclosure. The exclosures established in 2009

are more likely to provide suitable contrast, but we expect that it will take more time before any differences are apparent.

Recent climate conditions may have suppressed any differences that could be detected by the measurement techniques employed. During the period 1986 to 1990, when Giesen was observing LEPC in the area, average annual precipitation was 18.64 inches. In the period 2007-2011, the annual average was 13.57 inches, about 5 inches less. During Giesen's study, late spring and early summer (April-June) were wetter than normal, while in the past five, it has been drier than period-of-record average (Figure 15). During the study period there were a few significant rainfall events that made the vegetation appear fairly lush. Differences in forb cover between the inside and outside of exclosures may be obscured by such precipitation events, especially if the area has not yet been grazed by the cattle.

USFS records give no indication that these long-term grazing exclosures have benefited LEPC, or other upland birds, for that matter. Although vegetation differences attributable to cattle grazing are present, they are not sufficient to account for the dramatic decline in LEPC populations. Previous vegetation assessment at Comanche National Grassland (Rondeau and Decker 2010) noted that it is likely that additional factors, including processes originating outside the boundaries of the study area (e.g. habitat fragmentation, energy development, and climatic variability) are also contributing to the observed decline in LEPC populations.

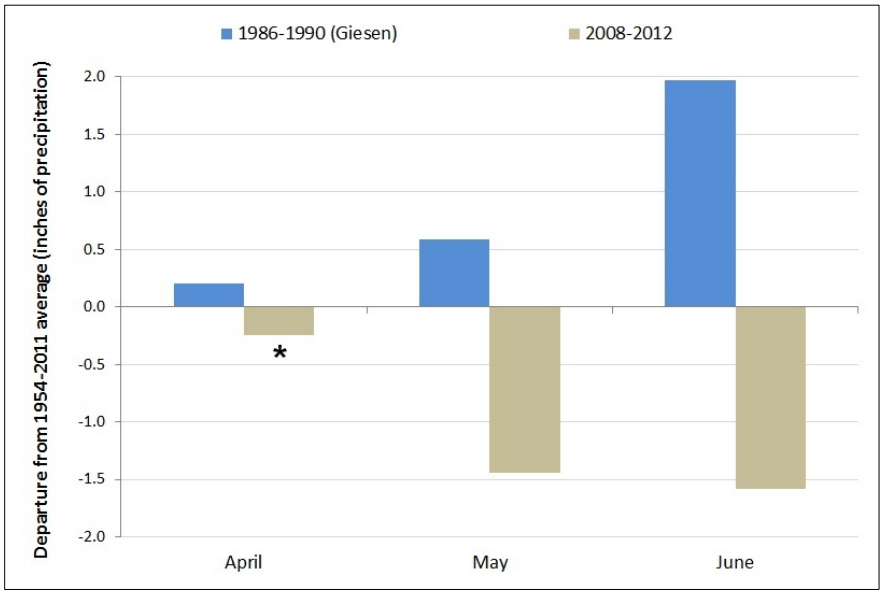


Figure 15. Average April-June precipitation comparison between the period of Giesen's study, and the five-year period immediately preceding this study, as measured at the Campo 7S NWS Cooperative Station (WRCC 2012) *Data from April 2012 are not available, so average departure shown is for period 2008-2011.

Disk line Vegetation Composition

Native forbs are an important component of LEPC habitat, providing food as seeds and foliage, and supporting insects that are also food for these birds (USFWS 1999, Bidwell et al. no date).

Vegetation of occupied habitat for LEPC is generally described as including a proportion of forbs ranging from 5-20% (Giesen 1994, USFWS 1999). Forbs, especially annuals are generally more common in areas where disturbance has created open ground and conditions that favor their establishment. Disk-plowing transects within the 2009 exclosures has had the effect of increasing forb cover in comparison with unplowed areas, although species diversity declined somewhat. It remains to be seen whether this treatment will have a beneficial effect on the population of LEPC in the area.

Davis et al. (2008) note that habitat requirements for LEPC are still not completely understood. Moreover, recent review of (Rotenberry and Wiens 2009) of the effectiveness of habitat models in predicting actual species population numbers suggests that it may be most important to concentrate on preserving large tracts of relatively undisturbed shrubland, in hopes of providing a diverse mosaic of natural habitat types that will allow the birds to survive under a variety of shifting environmental factors, rather than focusing on extensive manipulation of local habitat to achieve a particular “optimal” habitat condition.

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Appendix A. Sample locations

Long-term exclosure fence line transect coordinates (UTM NAD83, Zone 13).

Exclosure	Point ID	Easting (X)	Northing (Y)
Vilas South (VS)	1	Not recorded	
	2	Not recorded	
	3	Not recorded	
	4	Not recorded	
	5	725281.54	4130579.02
	6	725306.86	4130624.13
	7	725328.55	4130665.98
	8	725351.81	4130708.66
	9	725515.08	4130985.27
	10	725563.98	4130989.68
Big Deweese (BD)	11	712006.19	4105265.13
	12	712008.44	4105316.93
	13	712005.97	4105365.58
	14	712003.40	4105454.44
	15	712002.65	4105508.06
	16	711742.95	4105182.25
	17	711795.18	4105183.82
	18	711843.16	4105184.17
	19	711897.79	4105185.31
	20	711947.24	4105190.30
Pipeline (PL)	21	732590.18	4101053.69
	22	732650.36	4101059.46
	23	732563.20	4101093.88
	24	732563.18	4101150.81
	25	732561.64	4101198.34
	26	732562.20	4101227.51
	27	732579.96	4101249.38
	28	732620.62	4101251.03
Windmill (WM)	29	728961.97	4101471.83
	30	729007.43	4101489.21
	31	729094.01	4101573.44
	32	729092.30	4101592.96
	33	729051.98	4101634.79
	34	729004.24	4101628.85
	35	728898.86	4101584.95
	36	728899.44	4101570.67
Cactus (CA)	37	734708.74	4103838.77
	38	734726.90	4103841.67
	39	734771.92	4103869.56
	40	734773.44	4103900.00
	41	734741.95	4103920.80
	42	734709.14	4103921.92
	43	734692.52	4103882.67

Exclosure	Point ID	Easting (X)	Northing (Y)
Cactus (CA)	44	734692.56	4103861.31
Old Truck (OT)	45	Not recorded	
	46	Not recorded	
	47	Not recorded	
	48	Not recorded	
	49	Not recorded	
	50	731669.68	4098748.07
	51	731643.97	4098749.40
	52	731593.80	4098746.90
Ferruginous Hawk (FH)	53	723253.86	4102936.46
	54	723284.35	4102934.72
	55	723222.26	4102965.84
	56	723221.89	4102995.97
	57	723219.26	4103027.54
	58	723248.56	4103056.78
	59	723277.52	4103059.20
	60	723307.87	4103060.60
Ute Canyon (UC)	61	716444.89	4100808.02
	62	716448.90	4100874.36
	63	716492.14	4100883.27
	64	716543.33	4100883.33
	65	716620.65	4100859.12
	66	716625.89	4100804.57
	67	716611.31	4100723.77
	68	716564.67	4100742.51

Disk line plot pair coordinates (UTM NAD83, Zone 13).

Exclosure	Point ID	Position	Easting (X)	Northing (Y)
Mt. Carmel North	15	ON	736041.96	4103990.85
	15	OFF	736046.52	4103995.23
	16	ON	736025.36	4104032.06
	16	OFF	736038.26	4104030.86
	17	ON	735989.10	4104148.59
	17	OFF	736007.66	4104139.62
	18	ON	735978.38	4104189.35
	18	OFF	735991.08	4104186.35
	19	ON	735980.48	4104236.55
	19	OFF	735991.60	4104231.34
	20	ON	735981.65	4104265.86
	20	OFF	735993.47	4104260.08
	21	ON	735976.12	4104337.59
	21	OFF	735986.14	4104336.50
	22	ON	736005.98	4104473.92
	22	OFF	736005.70	4104459.40

Exclosure	Point ID	Position	Easting (X)	Northing (Y)
Mt. Carmel North	23	ON	736073.54	4104505.53
	23	OFF	736075.46	4104494.28
	24	ON	736094.55	4104547.62
	24	OFF	736096.77	4104544.86
	25	ON	736094.44	4104574.54
	25	OFF	736101.98	4104581.47
	26	ON	736065.75	4104624.15
	26	OFF	736084.30	4104630.02
	27	ON	736006.01	4104648.20
	27	OFF	736013.00	4104670.79
	28	ON	735969.58	4104666.06
	28	OFF	735977.22	4104672.01
	29	ON	735946.35	4104674.68
	29	OFF	735955.13	4104681.94
	30	ON	735914.13	4104691.12
	30	OFF	735916.80	4104699.94
Mt. Carmel Middle	31	ON	737236.45	4104040.89
	31	OFF	737242.10	4104036.16
	32	ON	737189.88	4104024.39
	32	OFF	737198.26	4104012.35
	33	ON	737170.31	4103998.61
	33	OFF	737171.15	4104016.71
	34	ON	737104.30	4103975.96
	34	OFF	737111.05	4103969.37
	35	ON	737039.27	4103940.96
	35	OFF	737042.03	4103928.47
	36	ON	736959.05	4103938.59
	36	OFF	736956.46	4103932.45
	37	ON	736894.98	4103959.01
	37	OFF	736900.36	4103949.20
	38	ON	736890.64	4103847.01
	38	OFF	736896.45	4103855.81
	39	ON	736927.37	4103728.26
	39	OFF	736936.57	4103731.81
	40	ON	736943.63	4103657.13
	40	OFF	736956.75	4103662.78
	41	ON	736975.39	4103595.23
	41	OFF	736983.50	4103603.01
	42	ON	737126.67	4103562.42
	42	OFF	737124.40	4103572.91
	43	ON	737254.65	4103556.13
	43	OFF	737255.55	4103567.70
Mt. Carmel South	1	ON	735510.15	4100157.95
	1	OFF	735500.68	4100157.92
	2	ON	735510.39	4100151.53
	2	OFF	735502.04	4100151.48
	3	ON	735502.40	4100073.89

Exclosure	Point ID	Position	Easting (X)	Northing (Y)
Mt. Carmel South	3	OFF	735492.33	4100068.66
	4	ON	735508.94	4100053.70
	4	OFF	735499.13	4100053.68
	6	ON	735485.37	4100022.13
	6	OFF	735480.58	4100026.88
	7	ON	735472.28	4100015.00
	7	OFF	735462.94	4100015.47
	8	ON	735455.23	4099987.31
	8	OFF	735442.23	4099996.75
	9	ON	735387.35	4099953.66
	9	OFF	735382.57	4099959.55
	10	ON	735374.22	4099932.46
	10	OFF	735365.28	4099940.75
	11	ON	735318.41	4099887.24
	11	OFF	735316.19	4099896.81
	12	ON	735286.33	4099858.43
	12	OFF	735282.07	4099864.03
	13	ON	735295.26	4099752.10
	13	OFF	735285.89	4099753.27
	14	ON	735266.43	4099730.29
	14	OFF	735266.36	4099740.51

Appendix B. Data

Percent cover raw data, number of points on 10 m transect, sampled every 0.5 m.

Exclosure	Transect	Position	BOCU	BOGR	ARSP	SPCR	STCO	ARFI	YUGL	FORB	BUDA	ANHA	HOJU	OPSP	SALS	VUOC	BG - Litter	Other	Other spp
VS	1	IN	9														11		
VS	1	OUT	11						1	1							7		
VS	2	IN	2					3		2					2		7	5	SONU
VS	2	OUT		5		2		1		1					1		10		
VS	3	IN	5					8		2							5		
VS	3	OUT				3		5		12							3		
VS	4	IN	3		1			1		1					4		9		
VS	4	OUT								1					2		3	16	BRTE
VS	5	IN				2		6		4							9		
VS	5	OUT				3		8		1					1		9		
VS	6	IN				1		5		4					2		9		
VS	6	OUT						2	1	3							16		
VS	7	IN				4		11		3					1		6		
VS	7	OUT				5		6		3							9		
VS	8	IN						8	2	4							6		
VS	8	OUT						5	5	2					1		8		
VS	9	IN			1	2		4		3							10		
VS	9	OUT				4		6		5					2		5		
VS	10	IN				3	1			1					2	2	12	1	BRTE
VS	10	OUT				4		6		2							6	2	BRTE
BD	11	IN	3	12													7		
BD	11	OUT	4		4	3					2						7		
BD	12	IN	7	6													6		
BD	12	OUT	3		2	3	1										11		
BD	13	IN	4	5													10		
BD	13	OUT	1	3	2	3		1							1		9		
BD	14	IN	6	1	1				2						2		8		
BD	14	OUT			2	4				1	1				4		10		
BD	15	IN	5	8					2	2							4		
BD	15	OUT						2	3						2		13		
BD	16	IN	11	2													7		
BD	16	OUT						10		3							8		
BD	17	IN	13			1		4									2		
BD	17	OUT			1	4		3	1	3					1		7		
BD	18	IN	10		1				1								8		
BD	18	OUT	2					3	1	3					2		9		
BD	19	IN						5		2					3		9	1	ELEL
BD	19	OUT	13		2												5		
BD	20	IN	8	5					6								1		
BD	20	OUT				3		6		1					4		6	3	ELEL
PL	21	IN	13					1									7		

Exclosure	Transect	Position	BOCU	BOGR	ARSP	SPCR	STCO	ARFI	YUGL	FORB	BUDA	ANHA	HOJU	OPSP	SALS	VUOC	BG - Litter	Other	Other spp
PL	21	OUT	6					1	1	1							11		
PL	22	IN	12					1									7		
PL	22	OUT				3				4					1		13		
PL	23	IN	11					3									7		
PL	23	OUT	11			1		2		1							6		
PL	24	IN	11					2		2							7		
PL	24	OUT	12					1		1							6		
PL	25	IN	14							4					2		2		
PL	25	OUT	10			1		1		1					1		8		
PL	26	IN	9														11		
PL	26	OUT	10					4	1	2							10		
PL	27	IN	8			3		1		2							8		
PL	27	OUT	12						1								7		
PL	28	IN	13			1											6		
PL	28	OUT	5							2							13		
WM	29	IN								5					3		11		
WM	29	OUT		2	1	4				1	1						9	2	PASM
WM	30	IN				4				4					6		6		
WM	30	OUT	9														11		
WM	31	IN								7					3		10		
WM	31	OUT			2	2		7		3							8		
WM	32	IN			2					5					3		10	1	brome sp
WM	32	OUT			4			10							1		6		
WM	33	IN						4		4					3		10		
WM	33	OUT	1	2	1			5		1							10		
WM	34	IN						1		3					4		12		
WM	34	OUT	13			2		2									4		
WM	35	IN								1							19		
WM	35	OUT		1		4		9							3		3		
WM	36	IN								18					5		7		
WM	36	OUT	1	3		4		2		5							9		
CA	37	IN				4				5	3						7		
CA	37	OUT		6		2			3		3						9		
CA	38	IN						1	2	6	2					1	8		
CA	38	OUT		5	1	1					3				1	1	10		
CA	39	IN								8						7	7		
CA	39	OUT			3	2			1	4						1	9		
CA	40	IN								6	1				3	2	9		
CA	40	OUT			1	1				9					1	1	7		
CA	41	IN								8	3				1	6	7		
CA	41	OUT			1	1				9						3	6		
CA	42	IN								8						5	8	1	ELEL
CA	42	OUT						3		4	2						11		
CA	43	IN				3		1									16		
CA	43	OUT				3		2		8	1						6		

Exclosure	Transect	Position	BOCU	BOGR	ARSP	SPCR	STCO	ARFI	YUGL	FORB	BUDA	ANHA	HOJU	OPSP	SALS	VUOC	BG - Litter	Other	Other spp
CA	44	IN				3				7	6						8		
CA	44	OUT								4	1				2	3	10		
OT	45	IN		10					1	2					1		6		
OT	45	OUT	1	2							6						11		
OT	46	IN	1		4			1		2					1	3	8		
OT	46	OUT								12	2					1	5		
OT	47	IN			1	1				10					2		6		
OT	47	OUT		3	7												10		
OT	48	IN			1	1				6					1		11		
OT	48	OUT			1	4		1		1							13		
OT	49	IN								3					1		16		
OT	49	OUT				3		4		3						3	6	1	unknown
OT	50	IN						1	8								11		
OT	50	OUT		9		2		1		1	1						6		
OT	51	IN						1		3					2		13		
OT	51	OUT		1	2	5					3						9		
OT	52	IN		2	1	1				3	1						14		
OT	52	OUT		4				2			3						12		
FH	53	IN		3						1	7					3	8		
FH	53	OUT		1		3				4	3					2	9		
FH	54	IN				3				9					1	2	6		
FH	54	OUT				2				2	5					1	9		
FH	55	IN		3	2	2		1		4	1					3	5		
FH	55	OUT		4		1				1	5				2	2	5		
FH	56	IN		1		1				3	2					1	11		
FH	56	OUT		3	1					1	7						8		
FH	57	IN		10				2		5						1	4		
FH	57	OUT		2		1					9					1	7		
FH	58	IN		9						3						1	8		
FH	58	OUT		3		3				6	2					2	4		
FH	59	IN		5				2		3	3					6	6		
FH	59	OUT		3		4		2		1	2					6	4		
FH	60	IN		2	1				1	2	6					1	5	3	PASM
FH	60	OUT		4	2	1		1		1						2	9		
UC	61	IN				2				11			1		1	4	4		
UC	61	OUT				1				6	2				1	9	1	1	PLJA
UC	62	IN		12		2				2							5		
UC	62	OUT		9		2		3		2					3		5		
UC	63	IN				1		6		4							9		
UC	63	OUT		8		1		1		4						1	7		
UC	64	IN				5				6					2		3	5	BRTE
UC	64	OUT		5						6						1	8		
UC	65	IN						2		4						4	10		
UC	65	OUT						3		9						1	7		
UC	66	IN				1		4		10							5		

Exclosure	Transect	Position	BOCU	BOGR	ARSP	SPCR	STCO	ARFI	YUGL	FORB	BUDA	ANHA	HOJU	OPSP	SALS	VUOC	BG - Litter	Other	Other spp
UC	66	OUT						4		10						2	4		
UC	67	IN						6		2							11	1	ELEL
UC	67	OUT		1	1	1		3	1	2	8				1		3		
UC	68	IN				1				2	3				3	1	10		
UC	68	OUT				2				1	1				2		7	7	unknown

Shrub density data – counts per 10 m x 2 m belt transect

Exclosure	Transect	Position	ARFI	YUGL	GUSA
VS	1	IN	1	7	
VS	1	OUT	6	11	
VS	2	IN	17	0	
VS	2	OUT	29	2	
VS	3	IN	24		
VS	3	OUT	22		
VS	4	IN	13	3	
VS	4	OUT	8	0	
VS	5	IN	33		
VS	5	OUT	36		
VS	6	IN	25		
VS	6	OUT	32		
VS	7	IN	26	2	
VS	7	OUT	29		
VS	8	IN	35	1	
VS	8	OUT	44		
VS	9	IN	31		
VS	9	OUT	37		
VS	10	IN	4		
VS	10	OUT	42		
BD	11	IN	0	5	
BD	11	OUT	7	12	
BD	12	IN	0	1	
BD	12	OUT	3	10	
BD	13	IN	0	4	
BD	13	OUT	7	0	
BD	14	IN	0	9	
BD	14	OUT	5	3	
BD	15	IN	0	11	
BD	15	OUT	10	11	
BD	16	IN	5	8	
BD	16	OUT	31	1	

Exclosure	Transect	Position	ARFI	YUGL	GUSA
BD	17	IN	20	8	
BD	17	OUT	23	11	
BD	18	IN	0	16	
BD	18	OUT	17	10	
BD	19	IN	0	11	1
BD	19	OUT	21	1	
BD	20	IN	1	15	
BD	20	OUT	34	9	
PL	21	IN	8	1	
PL	21	OUT	15	3	
PL	22	IN	3	5	
PL	22	OUT	5	0	
PL	23	IN	12		
PL	23	OUT	16		
PL	24	IN	7	1	
PL	24	OUT	2		
PL	25	IN	4	2	
PL	25	OUT	0	1	
PL	26	IN	1		
PL	26	OUT			
PL	27	IN	0	4	
PL	27	OUT	5	0	
PL	28	IN	4	3	
PL	28	OUT	15	0	
WM	29	IN	0	0	
WM	29	OUT	0	2	
WM	30	IN	0	0	
WM	30	OUT	0	0	
WM	31	IN	20	1	
WM	31	OUT	1	0	
WM	32	IN	8		
WM	32	OUT			

Exclosure	Transect	Position	ARFI	YUGL	GUSA
WM	33	IN	13	0	
WM	33	OUT	25	9	
WM	34	IN	4	0	
WM	34	OUT	15	2	
WM	35	IN	0	0	
WM	35	OUT	37	2	
WM	36	IN	0		
WM	36	OUT	14		
CA	37	IN	5	3	
CA	37	OUT	0	5	
CA	38	IN	6	7	
CA	38	OUT	3	7	
CA	39	IN			
CA	39	OUT	3	2	
CA	40	IN	4		
CA	40	OUT	4		
CA	41	IN	0		
CA	41	OUT	2		
CA	42	IN	3	2	
CA	42	OUT	4		
CA	43	IN	6		
CA	43	OUT	11		
CA	44	IN	3	2	
CA	44	OUT	11		
OT	45	IN	7	5	
OT	45	OUT	0	0	3
OT	46	IN	4		
OT	46	OUT	3		
OT	47	IN	3	0	
OT	47	OUT	0	4	
OT	48	IN	1	0	1
OT	48	OUT	4	5	
OT	49	IN	0		
OT	49	OUT	10		
OT	50	IN	6	3	
OT	50	OUT	15		
OT	51	IN	11		1

Exclosure	Transect	Position	ARFI	YUGL	GUSA
OT	51	OUT	12		
OT	52	IN	2		
OT	52	OUT	13		
FH	53	IN	1	0	
FH	53	OUT	14	1	
FH	54	IN			
FH	54	OUT		3	
FH	55	IN	24	2	2
FH	55	OUT	1	0	0
FH	56	IN	2		1
FH	56	OUT	7		5
FH	57	IN	4		0
FH	57	OUT	77		1
FH	58	IN	44		0
FH	58	OUT	3		3
FH	59	IN	65	0	
FH	59	OUT	150	3	
FH	60	IN	9		
FH	60	OUT	7		
UC	61	IN	4		
UC	61	OUT	8		
UC	62	IN	3	3	
UC	62	OUT	11	6	
UC	63	IN	2	0	
UC	63	OUT	8	1	
UC	64	IN	0		
UC	64	OUT	1		
UC	65	IN	10		
UC	65	OUT	13		
UC	66	IN	5	0	
UC	66	OUT	9	1	
UC	67	IN	13	6	
UC	67	OUT	5	0	
UC	68	IN	2		
UC	68	OUT	1		

Vegetation height and height density raw data (inches)

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
VS	1	IN	Shrub	17	9	16	6
			Grass	5	2	4	4
			Forb	3	3	1	8
			Vis. Obst.	2	0	7	1
VS	1	OUT	Shrub	17	9	7	14
			Grass	6	3	4	4
			Forb	16	19	4	3
			Vis. Obst.	4	3	0	2
VS	2	IN	Shrub	15	14	16	15
			Grass	4	2	15	13
			Forb	6	3	10	5
			Vis. Obst.	3	1	10	0
VS	2	OUT	Shrub	8	18	11	16
			Grass	3	6	4	7
			Forb	6	10	4	4
			Vis. Obst.	1	3	0	1
VS	3	IN	Shrub	15	25	24	26
			Grass	9	2	5	8
			Forb	15	7	9	7
			Vis. Obst.	14	16	7	22
VS	3	OUT	Shrub	19	17	16	24
			Grass	4	5	6	7
			Forb	9	24	13	17
			Vis. Obst.	11	12	12	14
VS	4	IN	Shrub	21	23	19	19
			Grass	7	5	6	9
			Forb	2	2	7	7
			Vis. Obst.	6	6	1	1
VS	4	OUT	Shrub	8	17	23	25
			Grass	8	9	9	9
			Forb	8	3	8	10
			Vis. Obst.	4	9	5	22
VS	5	IN	Shrub	16	14	17	17
			Grass	5	9	7	9
			Forb	7	4	6	17
			Vis. Obst.	12	13	11	9
VS	5	OUT	Shrub	18	18	16	19
			Grass	3	6	6	8
			Forb	3	4	3	8
			Vis. Obst.	16	15	10	13
VS	6	IN	Shrub	21	25	26	11
			Grass	6	6	6	6
			Forb	4	13	10	6
			Vis. Obst.	0	0	15	14
VS	6	OUT	Shrub	6	18	25	19
			Grass	8	4	6	5
			Forb	6	6	6	3
			Vis. Obst.	16	13	3	12
VS	7	IN	Shrub	8	19	24	19
			Grass	5	8	8	6
			Forb	3	10	5	4
			Vis. Obst.	21	5	17	10
VS	7	OUT	Shrub	20	15	8	11
			Grass	6	5	7	3
			Forb	5	5	4	4
			Vis. Obst.	14	0	17	9
VS	8	IN	Shrub	26	22	19	26
			Grass	5	6	4	7
			Forb	6	6	15	5
			Vis. Obst.	6	1	5	18
VS	8	OUT	Shrub	16	16	19	24
			Grass	1	6	6	6
			Forb	1	4	4	7
			Vis. Obst.	0	2	11	0
VS	9	IN	Shrub	13	19	18	21
			Grass	5	9	3	4
			Forb	3	8	3	2
			Vis. Obst.	9	14	9	8
VS	9	OUT	Shrub	15	15	13	17
			Grass	8	9	3	6
			Forb	10	9	9	2
			Vis. Obst.	2	13	13	13
VS	10	IN	Shrub	16	16	9	16
			Grass	9	6	6	4
			Forb	7	6	4	13
			Vis. Obst.	3	4	0	4
VS	10	OUT	Shrub	15	16	17	14
			Grass	4	5	7	4
			Forb	6	5	5	12
			Vis. Obst.	11	2	10	2
BD	11	IN	Shrub	12	12	20	18
			Grass	7	5	5	5
			Forb	3	8	9	4
			Vis. Obst.	2	0	4	4
BD	11	OUT	Shrub	12	7	15	20
			Grass	8	6	8	8
			Forb	3	3	3	10
			Vis. Obst.	3	2	0	0
BD	12	IN	Shrub	16	16	12	14
			Grass	12	11	9	7

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
			Forb	6	13	5	4
			Vis. Obst.	2	3	2	2
BD	12	OUT	Shrub	18	18	20	19
			Grass	6	5	4	3
			Forb	11	7	4	12
			Vis. Obst.	2	1	0	2
BD	13	IN	Shrub	16	18	16	13
			Grass	4	7	7	6
			Forb	10	12	5	3
			Vis. Obst.	2	3	2	2
BD	13	OUT	Shrub	8	20	21	16
			Grass	3	2	4	8
			Forb	6	5	3	8
			Vis. Obst.	7	1	1	2
BD	14	IN	Shrub	20	12	15	13
			Grass	5	3	3	2
			Forb	4	3	9	4
			Vis. Obst.	1	1	1	3
BD	14	OUT	Shrub	21	11	14	15
			Grass	6	4	8	10
			Forb	8	2	7	2
			Vis. Obst.	12	3	4	1
BD	15	IN	Shrub	15	16	15	14
			Grass	4	5	3	8
			Forb	4	6	3	9
			Vis. Obst.	2	2	1	7
BD	15	OUT	Shrub	19	20	13	17
			Grass	10	4	5	9
			Forb	6	3	5	7
			Vis. Obst.	2	0	7	9
BD	16	IN	Shrub	11	18	5	13
			Grass	5	4	5	6
			Forb	6	4	3	4
			Vis. Obst.	4	2	4	3
BD	16	OUT	Shrub	16	18	12	13
			Grass	6	10	9	6
			Forb	10	9	7	8
			Vis. Obst.	8	18	7	2
BD	17	IN	Shrub	17	16	19	18
			Grass	9	8	9	6
			Forb	4	3	9	4
			Vis. Obst.	12	2	5	4
BD	17	OUT	Shrub	14	17	11	30
			Grass	8	9	7	8
			Forb	5	12	5	5
			Vis. Obst.	8	11	2	1
BD	18	IN	Shrub	15	24	23	18

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
			Grass	8	6	8	4
			Forb	4	4	3	3
			Vis. Obst.	5	6	3	2
BD	18	OUT	Shrub	12	20	14	20
			Grass	6	9	5	5
			Forb	4	8	10	7
			Vis. Obst.	6	1	3	6
BD	19	IN	Shrub	14	15	15	6
			Grass	4	4	4	5
			Forb	5	5	3	7
			Vis. Obst.	0	1	2	2
BD	19	OUT	Shrub	13	15	19	19
			Grass	14	4	14	3
			Forb	11	3	7	5
			Vis. Obst.	2	3	25	8
BD	20	IN	Shrub	7	20	16	26
			Grass	9	4	2	3
			Forb	15	8	6	5
			Vis. Obst.	3	2	10	2
BD	20	OUT	Shrub	13	14	20	18
			Grass	13	6	10	4
			Forb	7	12	5	13
			Vis. Obst.	10	9	19	11
PL	21	IN	Shrub	15	22	20	26
			Grass	8	9	12	8
			Forb	4	4	7	11
			Vis. Obst.	2	4	4	3
PL	21	OUT	Shrub	14	16	25	12
			Grass	8	7	6	6
			Forb	7	4	4	4
			Vis. Obst.	5	4	3	1
PL	22	IN	Shrub	15	10	18	16
			Grass	7	7	7	10
			Forb	4	4	4	5
			Vis. Obst.	3	2	4	4
PL	22	OUT	Shrub	24	21	15	17
			Grass	8	10	8	8
			Forb	3	11	3	3
			Vis. Obst.	2	1	2	2
PL	23	IN	Shrub	18	15	27	16
			Grass	9	6	9	8
			Forb	11	8	2	8
			Vis. Obst.	15	7	2	4
PL	23	OUT	Shrub	16	19	17	9
			Grass	6	4	7	8
			Forb	3	8	3	3
			Vis. Obst.	4	16	6	2

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
PL	24	IN	Shrub	26	18	22	16
			Grass	7	8	8	8
			Forb	7	6	6	7
			Vis. Obst.	2	2	13	4
PL	24	OUT	Shrub	14	20	0	0
			Grass	3	5	3	7
			Forb	4	7	4	7
			Vis. Obst.	1	1	3	0
PL	25	IN	Shrub	19	27	23	21
			Grass	5	9	4	8
			Forb	2	6	2	7
			Vis. Obst.	14	2	4	5
PL	25	OUT	Shrub	11	11	0	0
			Grass	8	8	11	10
			Forb	12	14	17	12
			Vis. Obst.	4	6	7	6
PL	26	IN	Shrub	19	24	10	16
			Grass	6	5	6	5
			Forb	5	2	5	2
			Vis. Obst.	3	2	3	10
PL	26	OUT	Shrub	28	24	0	11
			Grass	9	8	8	7
			Forb	4	3	6	5
			Vis. Obst.	5	3	5	4
PL	27	IN	Shrub	19	15	17	17
			Grass	7	7	10	9
			Forb	11	10	12	2
			Vis. Obst.	3	4	6	2
PL	27	OUT	Shrub	22	11	17	13
			Grass	5	7	7	10
			Forb	8	2	6	6
			Vis. Obst.	4	10	3	2
PL	28	IN	Shrub	16	19	20	11
			Grass	8	8	9	10
			Forb	4	3	2	12
			Vis. Obst.	19	7	0	0
PL	28	OUT	Shrub	10	17	24	14
			Grass	5	6	7	7
			Forb	3	4	4	3
			Vis. Obst.	1	3	3	11
WM	29	IN	Shrub	0	0	0	0
			Grass	10	10	12	7
			Forb	1	3	8	6
			Vis. Obst.	0	0	0	0
WM	29	OUT	Shrub	0	0	0	19
			Grass	4	2	5	7
			Forb	4	0	7	4

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
			Vis. Obst.	0	0	0	0
WM	30	IN	Shrub	0	0	0	0
			Grass	12	13	14	10
			Forb	14	11	14	20
			Vis. Obst.	15	9	4	0
WM	30	OUT	Shrub	0	22	16	0
			Grass	5	8	2	4
			Forb	0	2	2	2
			Vis. Obst.	4	6	1	2
WM	31	IN	Shrub	24	17	23	18
			Grass	9	15	9	10
			Forb	4	11	7	3
			Vis. Obst.	1	7	9	1
WM	31	OUT	Shrub	26	26	26	21
			Grass	6	5	8	10
			Forb	28	20	12	18
			Vis. Obst.	26	3	8	6
WM	32	IN	Shrub	22	18	16	24
			Grass	5	10	9	7
			Forb	9	13	16	12
			Vis. Obst.	0	12	3	4
WM	32	OUT	Shrub	19	21	20	24
			Grass	7	8	8	6
			Forb	6	8	11	28
			Vis. Obst.	15	4	5	17
WM	33	IN	Shrub	18	32	25	26
			Grass	15	7	11	9
			Forb	10	32	6	15
			Vis. Obst.	22	4	6	1
WM	33	OUT	Shrub	16	18	18	14
			Grass	3	2	5	3
			Forb	4	9	4	5
			Vis. Obst.	17	3	10	13
WM	34	IN	Shrub	17	18	20	20
			Grass	6	9	7	7
			Forb	7	6	5	3
			Vis. Obst.	1	1	2	14
WM	34	OUT	Shrub	14	13	11	16
			Grass	10	6	3	12
			Forb	4	5	4	14
			Vis. Obst.	12	5	4	8
WM	35	IN	Shrub	0	0	0	0
			Grass	0	0	0	0
			Forb	8	9	5	8
			Vis. Obst.	1	0	1	3
WM	35	OUT	Shrub	18	20	9	21
			Grass	5	2	2	2

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
			Forb	5	4	6	2
			Vis. Obst.	5	11	0	9
WM	36	IN	Shrub	0	0	0	0
			Grass	12	8	7	7
			Forb	11	24	14	15
			Vis. Obst.	1	10	6	3
WM	36	OUT	Shrub	16	12	7	19
			Grass	2	3	5	2
			Forb	5	5	5	14
			Vis. Obst.	2	1	10	5
CA	37	IN	Shrub	11	15	12	12
			Grass	7	11	2	3
			Forb	2	7	19	10
			Vis. Obst.	0	3	5	1
CA	37	OUT	Shrub	17	0	0	14
			Grass	2	1	1	4
			Forb	5	1	1	1
			Vis. Obst.	0	0	0	0
CA	38	IN	Shrub	0	16	27	20
			Grass	10	10	9	9
			Forb	13	5	9	7
			Vis. Obst.	2	1	1	1
CA	38	OUT	Shrub	5	15	12	14
			Grass	1	2	2	3
			Forb	7	5	2	1
			Vis. Obst.	0	0	1	4
CA	39	IN	Shrub	0	0	0	0
			Grass	8	13	6	9
			Forb	4	5	4	4
			Vis. Obst.	3	2	0	2
CA	39	OUT	Shrub	17	22	25	22
			Grass	8	9	11	11
			Forb	7	6	2	5
			Vis. Obst.	2	8	0	0
CA	40	IN	Shrub	0	0	8	12
			Grass	8	6	5	7
			Forb	2	10	13	4
			Vis. Obst.	10	1	4	2
CA	40	OUT	Shrub	15	11	12	28
			Grass	7	5	8	6
			Forb	11	9	6	4
			Vis. Obst.	3	4	0	9
CA	41	IN	Shrub	0	0	0	0
			Grass	8	9	6	2
			Forb	10	7	6	7
			Vis. Obst.	6	2	0	2
CA	41	OUT	Shrub	20	20	25	0
			Grass	5	5	6	5
			Forb	3	6	6	4
			Vis. Obst.	3	1	2	3
CA	42	IN	Shrub	21	11	0	0
			Grass	6	8	4	7
			Forb	8	9	5	7
			Vis. Obst.	0	7	4	4
CA	42	OUT	Shrub	24	18	18	20
			Grass	12	9	3	5
			Forb	3	1	7	8
			Vis. Obst.	0	1	1	2
CA	43	IN	Shrub	11	10	13	17
			Grass	9	5	2	8
			Forb	3	4	4	7
			Vis. Obst.	1	5	0	4
CA	43	OUT	Shrub	15	17	15	18
			Grass	8	14	2	6
			Forb	5	8	3	6
			Vis. Obst.	4	4	0	2
CA	44	IN	Shrub	13	7	19	13
			Grass	3	3	3	7
			Forb	3	4	7	6
			Vis. Obst.	1	2	4	2
CA	44	OUT	Shrub	22	13	10	11
			Grass	6	8	6	2
			Forb	6	6	5	1
			Vis. Obst.	3	0	1	3
OT	45	IN	Shrub	15	16	18	26
			Grass	8	6	7	7
			Forb	5	3	9	6
			Vis. Obst.	4	2	3	5
OT	45	OUT	Shrub	4	0	0	0
			Grass	2	3	2	10
			Forb	3	4	3	3
			Vis. Obst.	0	0	0	2
OT	46	IN	Shrub	24	15	27	11
			Grass	16	11	20	9
			Forb	5	4	4	6
			Vis. Obst.	14	3	4	4
OT	46	OUT	Shrub	11	10	20	21
			Grass	8	10	6	14
			Forb	6	6	3	5
			Vis. Obst.	3	4	2	2
OT	47	IN	Shrub	22	21	24	15
			Grass	13	15	5	7
			Forb	4	7	4	6
			Vis. Obst.	6	2	5	5

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
OT	47	OUT	Shrub	14	21	14	0
			Grass	10	13	13	10
			Forb	6	3	1	3
			Vis. Obst.	4	2	2	4
OT	48	IN	Shrub	9	5	6	23
			Grass	17	6	11	10
			Forb	2	3	3	5
			Vis. Obst.	1	2	2	2
OT	48	OUT	Shrub	19	10	20	12
			Grass	17	16	15	8
			Forb	3	5	2	3
			Vis. Obst.	3	7	6	4
OT	49	IN	Shrub	0	0	0	0
			Grass	18	11	14	12
			Forb	3	5	7	2
			Vis. Obst.	0	1	2	1
OT	49	OUT	Shrub	21	13	16	29
			Grass	5	3	9	8
			Forb	4	3	6	11
			Vis. Obst.	3	0	9	13
OT	50	IN	Shrub	24	29	20	22
			Grass	8	5	10	8
			Forb	7	3	5	4
			Vis. Obst.	3	2	2	8
OT	50	OUT	Shrub	13	14	11	15
			Grass	10	2	4	4
			Forb	11	3	2	2
			Vis. Obst.	1	0	0	6
OT	51	IN	Shrub	15	8	6	11
			Grass	4	4	2	9
			Forb	2	3	3	3
			Vis. Obst.	1	0	3	2
OT	51	OUT	Shrub	28	24	17	23
			Grass	6	8	6	8
			Forb	5	6	5	7
			Vis. Obst.	28	13	1	2
OT	52	IN	Shrub	0	15	15	20
			Grass	3	4	10	11
			Forb	6	5	5	8
			Vis. Obst.	12	3	1	8
OT	52	OUT	Shrub	10	6	15	11
			Grass	2	2	2	3
			Forb	2	2	1	1
			Vis. Obst.	1	0	1	1
FH	53	IN	Shrub	13	23	14	21
			Grass	4	6	9	3
			Forb	5	3	3	5
			Vis. Obst.	2	1	2	1
FH	53	OUT	Shrub	14	7	6	15
			Grass	4	5	3	6
			Forb	4	6	9	6
			Vis. Obst.	3	6	3	4
FH	54	IN	Shrub	0	0	25	0
			Grass	7	13	8	7
			Forb	5	4	5	4
			Vis. Obst.	2	2	2	4
FH	54	OUT	Shrub	17	15	20	17
			Grass	7	3	8	5
			Forb	8	6	4	4
			Vis. Obst.	2	0	2	0
FH	55	IN	Shrub	9	10	12	9
			Grass	2	2	10	9
			Forb	3	3	4	6
			Vis. Obst.	7	2	3	7
FH	55	OUT	Shrub	16	16	0	0
			Grass	4	4	6	7
			Forb	3	9	5	4
			Vis. Obst.	0	2	1	1
FH	56	IN	Shrub	0	6	10	5
			Grass	6	6	8	8
			Forb	5	4	4	5
			Vis. Obst.	2	4	5	2
FH	56	OUT	Shrub	7	6	7	4
			Grass	2	2	2	2
			Forb	3	4	3	5
			Vis. Obst.	0	0	1	2
FH	57	IN	Shrub	14	0	8	0
			Grass	4	7	4	5
			Forb	2	2	6	3
			Vis. Obst.	2	3	2	2
FH	57	OUT	Shrub	3	5	7	7
			Grass	2	4	2	5
			Forb	10	1	6	3
			Vis. Obst.	0	1	0	2
FH	58	IN	Shrub	3	3	23	4
			Grass	8	5	7	6
			Forb	4	6	2	5
			Vis. Obst.	2	0	0	2
FH	58	OUT	Shrub	7	13	0	10
			Grass	3	4	3	3
			Forb	5	5	3	3
			Vis. Obst.	0	0	2	0
FH	59	IN	Shrub	14	10	3	21
			Grass	6	6	5	5

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
			Forb	6	4	6	3
			Vis. Obst.	4	2	3	1
FH	59	OUT	Shrub	16	11	5	5
			Grass	4	7	4	5
			Forb	4	9	2	4
			Vis. Obst.	1	7	2	0
FH	60	IN	Shrub	7	5	5	20
			Grass	8	3	3	11
			Forb	5	9	5	6
			Vis. Obst.	1	1	0	3
FH	60	OUT	Shrub	12	16	13	10
			Grass	4	4	3	9
			Forb	4	3	2	11
			Vis. Obst.	4	5	2	8
UC	61	IN	Shrub	0	11	14	22
			Grass	8	2	8	11
			Forb	5	5	6	3
			Vis. Obst.	5	5	6	4
UC	61	OUT	Shrub	21	11	14	0
			Grass	7	10	5	5
			Forb	23	4	3	2
			Vis. Obst.	14	4	1	0
UC	62	IN	Shrub	15	17	20	19
			Grass	5	3	5	5
			Forb	4	5	6	6
			Vis. Obst.	2	2	5	0
UC	62	OUT	Shrub	24	18	19	20
			Grass	5	6	5	3
			Forb	7	3	8	12
			Vis. Obst.	1	2	2	2
UC	63	IN	Shrub	22	22	13	23
			Grass	8	13	10	10
			Forb	8	8	2	3
			Vis. Obst.	0	14	2	4
UC	63	OUT	Shrub	17	19	12	10
			Grass	5	3	4	3
			Forb	8	4	7	7
			Vis. Obst.	0	1	4	0
UC	64	IN	Shrub	0	0	0	0
			Grass	12	6	8	8

Excl	Trans	Pos	Vegetation	2m	4m	6m	8m
			Forb	5	4	8	5
			Vis. Obst.	2	6	6	4
UC	64	OUT	Shrub	17	0	21	15
			Grass	4	5	2	2
			Forb	9	7	5	6
			Vis. Obst.	2	2	13	2
UC	65	IN	Shrub	18	18	20	18
			Grass	7	10	11	10
			Forb	4	11	20	2
			Vis. Obst.	4	16	25	14
UC	65	OUT	Shrub	32	16	21	18
			Grass	6	8	9	11
			Forb	7	5	7	5
			Vis. Obst.	6	5	14	12
UC	66	IN	Shrub	0	8	10	14
			Grass	7	10	4	5
			Forb	5	6	5	5
			Vis. Obst.	4	8	4	6
UC	66	OUT	Shrub	18	12	26	20
			Grass	8	6	5	8
			Forb	6	3	5	10
			Vis. Obst.	2	3	5	18
UC	67	IN	Shrub	16	22	22	15
			Grass	4	7	4	11
			Forb	3	3	6	12
			Vis. Obst.	1	19	3	1
UC	67	OUT	Shrub	12	17	17	0
			Grass	3	6	3	2
			Forb	4	3	10	7
			Vis. Obst.	2	12	0	1
UC	68	IN	Shrub	23	0	0	0
			Grass	9	3	5	3
			Forb	14	7	2	11
			Vis. Obst.	1	0	2	1
UC	68	OUT	Shrub	0	0	10	21
			Grass	8	4	6	8
			Forb	2	6	12	7
			Vis. Obst.	7	1	17	16

Disk line plot data, number of 10 cm^2 squares

Exclosure	Pair	Position	Amaranthus arenicola	Ambrosia psilostachya	Andropogon hallii	Aristida purpurea	Artemisia filifolia	Astragalus sp.	Bouteloua curtipendula	Calylophus serrulatus	Chamaesyce glyptosperma	Chenopodium pratericola	Chloris verticillata	Chorispora tenella	Commelina erecta	Croton texensis	Cryptantha minima	Elymus elymoides	Erigeron flagellaris	Eriogonum annuum	Euphorbia dentata	Evolvulus nuttallianus	Gaura coccinea	Gutierrezia sarothrae	Helianthus annuus	Hesperostipa comata	Heterotheca horrida	Hordeum jubatum	Hordeum pusillum	Ipomoea leptophylla	Krameria lanceolata	Machaeranthera tanacetifolia	Mentzelia nuda	Mimosa rupertina	Munroa squarrosa	Opuntia spp.	Psoralidium lanceolatum	Psoralidium tenuiflorum	Quincula lobata	Salsola tragus	Solanum rostratum	Sphaeralcea coccinea	Sporobolus cryptandrus	Sporobolus giganteus	Stephanomeria pauciflora	Thelesperma megapotamicum	Vulpia octoflora	Yucca glauca	Zinnia grandiflora	Litter	Bare Ground
South	1	ON	5				13									4					0.5				3																2										19	44.5
South	1	OFF					25										1			14												0.5										4				1		8	46.5
South	2	ON	0.5	1		0.5										4									6																2									5	81
South	2	OFF	3	0.5		1.5	25				0.5					3	6				1.5																				0.5									22	36.5
South	3	ON					2		0.5					2																											14	2.5							6.5	65.5
South	3	OFF							88																								0.5												4			4.5	3
South	4	ON		0.5					0.5		1.5	0.5				6									1																		1						11	78
South	4	OFF							66							0.5													11				6															10	6.5
South	6	ON					0.5					12				1.5													8												0.5				8.5			5	64
South	6	OFF							51																																				0.5			8	41
South	7	ON							2							9							2.5										tr				5		8							0.5			14.5	48.5
South	7	OFF							42	3						1.5						tr		1																									19	34
South	8	ON						tr				34				8																								1									3.5	53.5
South	8	OFF							61							0.5																								0.5									15	23
South	9	ON							4			6.5				35																								14									10	30.5
South	9	OFF							59			2				2																																	20	17
South	10	ON							0.5							61													23																					1.5	14
South	10	OFF		11					38				2			5.5													5																					31	8
South	11	ON							tr			29				14									tr							3.5								2			0.5						12	39
South	11	OFF							36			4			2.5	3.5					tr																										3.5		38	12.5
South	12	ON		1					0.5			14				8									tr																3.5									7	66
South	12	OFF							32								10				12																													37	1.5
South	13	ON		1.5								1					tr								4																2			0.5						8	83
South	13	OFF				20											7		0.5		7.5																													16	45
South	14	ON							11							3.5																	tr				1									8			2	75
South	14	OFF							68								0.5				2																													16	14
North	15	ON	4.5									0.5				11																								4.5	5.5									2	72
North	15	OFF														1.5	14				6														0.5									7			4.5		31	35.5
North	16	ON										5.5				0.5																			1						3	12		1						3	74
North	16	OFF															15				5																						2	12			1				18	46.5
North	17	ON				5	2									13																		1.5						6	1								10	61.5
North	17	OFF				1							1				11				21																				1		6			0.5				18	41
North	18	ON														11																		1						9		2							5.5	72
North	18	OFF				1										4	5.5				13	1																		tr		2	2		1		0.5		27	43
North	19	ON							tr			2				28																								4									9	67
North	19	OFF				9										2.5	6				13														0.5													17	43
North	20	ON	0.5									5				10																		1							35									4	45.5
North	20	OFF		4.5												2	11				3																													60.5	10
North	21	ON	2	1.5								2.5				11									13																1									10	59
North	21	OFF					2										9	0.5			14																													18	50.5
North	22	ON	1				0.5					1													5.5																2.5		0.5							8.5	80.5
North	22	OFF					5					0.5				0.5	1				11																				2		0.5							67.5	7
North	23	ON	tr									tr													9																7		1							4.5	78.5
North	23	OFF					81										3		3		3														0.5				3	0.5			tr							6
North	24	ON	2				3									4.5									7																3.5		tr							10	70

Exclosure	Pair	Position	Amaranthus arenicola	Ambrosia psilostachya	Andropogon hallii	Aristida purpurea	Artemisia filifolia	Astragalus sp.	Bouteloua curtipendula	Calylophus serrulatus	Chamaesyce glyptosperma	Chenopodium pratericola	Chloris verticillata	Chorispora tenella	Commelina erecta	Croton texensis	Cryptantha minima	Elymus elymoides	Erigeron flagellaris	Eriogonum annuum	Euphorbia dentata	Evolvulus nuttallianus	Gaura coccinea	Gutierrezia sarothrae	Helianthus annuus	Hesperostipa comata	Heterotheca horrida	Hordeum jubatum	Hordeum pusillum	Ipomoea leptophylla	Krameria lanceolata	Machaeranthera tanacetifolia	Mentzelia nuda	Mimosa rupertina	Munroa squarrosa	Opuntia spp.	Psoralidium lanceolatum	Psoralidium tenuiflorum	Quincula lobata	Salsola tragus	Solanum rostratum	Sphaeralcea coccinea	Sporobolus cryptandrus	Sporobolus giganteus	Stephanomeria pauciflora	Thelesperma megapotamicum	Vulpia octoflora	Yucca glauca	Zinnia grandiflora	Litter	Bare Ground
North	24	OFF					12		2.5		tr								1	9																												51.5	18
North	25	ON	3.5	0.5																					5															2.5										10	78.5
North	25	OFF	1.5		4															17																				1									12	64.5
North	26	ON	3									9													1.5															7									7	72.5
North	26	OFF														2	6			13																0.5								6			1.5		52	19
North	27	ON	4		6.5																				2								tr			26			3									8	50.5
North	27	OFF	7.5								2					3																1.5							7			3					1	48	29
North	28	ON	3	0.5												1.5				5					5							2							3.5									8	76.5
North	28	OFF																		21								9								3			1									14	52
North	29	ON							1			12				1																1							12									10	63
North	29	OFF					2									1	6			8								7				tr															20	30
North	30	ON										40																											6									10	44
North	30	OFF					2									tr	1.5			21																			3		4	2					2.5		12	52
Middle	31	ON	19													1									2									2										1					8	67
Middle	31	OFF															12			3					0.5			25																7.5				45	7
Middle	32	ON	15													12	2			2												1															10		1		9	48
Middle	32	OFF														tr	0.5			8							18																					19			1.5		18	35
Middle	33	ON	16			1.5			0.5							2									1.5															1	2								8.5	67
Middle	33	OFF									1					2.5	1			3															tr										17					9	66.5
Middle	34	ON	9									6				18																		0.5						1.5						tr				9	56
Middle	34	OFF														0.5	0.5			10								4																						15	66
Middle	35	ON	11				7.5									6.5									9								0.5		3				1									8	53.5
Middle	35	OFF					25									1	3		1.5	9						1.5																					12			5		23	19.5
Middle	36	ON										1				8									2															11										5	73.5
Middle	36	OFF		0.5													9			16																						1	3					3.5		54	13
Middle	37	ON	20	7																					5																	1.5	1.5							15	50
Middle	37	OFF					44									2				2																						1								37	14
Middle	38	ON	3.5			1						3				2									1								0.5				15		2									6	66
Middle	38	OFF																		11																32		0.5			1	3							49.5	13
Middle	39	ON	8				10					12																							1					5									6	58
Middle	39	OFF					10										tr		tr	11																			1			5			0.5			67.5	5
Middle	40	ON														36																										1.5							4.5	58
Middle	40	OFF					28													10																						5					3		46	8
Middle	41	ON					13					20																											2.5									7.5	57
Middle	41	OFF					42					4					0.5								2															5			8						33	6
Middle	42	ON										12													1															18			tr					3	14	52
Middle	42	OFF																	2	2		2.5											7	9.5						2			12				4.5		29	29.5
Middle	43	ON					8					11																												6									4	71
Middle	43	OFF				13						7					5.5			2.5					8.5								0.5						23			1.5					1.5	26.5	10.5

Plot photographs delivered electronically