BED-SITE CHARACTERISTICS OF PRONGHORN FAWNS

S. KEMBLE CANON,[1] Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409, USA
FRED C. BRYANT,[2] Department of Range and Wildlife Management, Texas Tech University, Lubbock, TX 79409, USA

Abstract: We examined microhabitat factors associated with bedding sites of pronghorn fawns in the Trans-Pecos Region of Texas. We marked 101 fawns during 3 consecutive fawning seasons, April–June 1990–92. We measured and compared 11 microhabitat characteristics of 127 and 489 bed sites from surviving (n = 11) and non-surviving (n = 89) fawns and compared these characteristics to 225 sites we selected randomly. Differences occurred between fawn-selected bed sites and random sites for shrub cover (P = 0.04), shrub density (P = 0.01), grass cover (P = 0.03), nearest concealing cover (NCC; P = 0.0001), rock cover (P = 0.008), and bed slope (P = 0.0001). Shrub cover, shrub density, and grass cover at bed sites of surviving fawns were more similar to that found at random sites than to bed sites of non-surviving fawns. Bed sites of survivors and non-survivors differed in rock cover (P = 0.03), slope (P = 0.008), and bed slope (P = 0.001) characteristics. Fawn age class appeared to influence preference for particular microhabitat characteristics; shrub density was greater (P = 0.027) and grass cover less (P = 0.0001) in young-age fawn bed sites. Environmental features that provided adequate concealment, but that also provided increased long-range visibility of the area surrounding the bed site, appeared to be favored for bedding. Overall, important microhabitat variables were shrub cover, shrub density, grass cover, NCC, and bed slope, and to a lesser extent rock cover, terrain slope, overstory height, and understory height. Management that encourages increased grass and forb production will provide necessary hiding cover for fawns.

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Habitat use by pronghorn during fawning is believed to be important to fawn survival. However, the literature is mixed regarding what comprises good fawning habitat. Pronghorn fawning in less dense vegetation types and in areas with open terrain characteristics often have low fawn mortality (Beale and Smith 1973, Bodie 1978). Presumably, better visibility of fawns and dams in detecting approaching predators resulted in decreased predation. Alternatively, greater survival of fawns in areas with increased cover density has been found (Pyrah 1974, Autenreith 1978, Neff and Woolsey 1980). Other reports also have shown cover to be important in reducing the ability of predators to locate fawns (Autenreith 1980, 1982; McNay 1980).

Although the Trans-Pecos Region of Texas represents important habitat for pronghorn, little specific information is available on fawning habitat. Only 1 study, conducted by Tucker and Garner (1983) examined bedding sites of fawns. We define further the characteristics important for fawning habitat of pronghorn in the Trans-Pecos Region of Texas. Specifically, our objectives were to quantify relations among vegetation and topography of fawn bed sites; we tested the hypothesis that fawn survival was affected by bed-site selection.

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STUDY AREA

We studied pronghorn in the 6,500-ha Buckhorn Pasture on the Double U Ranch in north Hudspeth County, Texas, which is part of the University of Texas Lands System (UTLS). Topography of this semi-desert region (about 30-cm annual rainfall) of the Trans-Pecos mountains was characterized as steep to gentle hills

[1] Present address: Division of Range Animal Science, Sul Ross State University, Alpine, TX 79832, USA.

[2] Present address: Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Campus Box 218, Kingsville, TX 78363, USA.

on the west side bordering the Hueco Mountains, to open flats on the east side. Typical rangeland sites were stony hills, clay flats, gypsum flats, and deep uplands (Correll and Johnston 1970).

Important vegetation types are yucca (*Yucca elata*) savannahs, grama (*Bouteloua* spp.) grasslands, and creosote bush (*Larrea tridentata*)—tarbush (*Flourensia cernua*) desert shrub areas (Correll and Johnston 1970). Dominant grasses include gramas, three-awns (*Aristida* spp.), and muhlenbergias (*Muhlenbergia* spp.). Common forb genera include *Aster, Astragalus, Croton, Dyssodia, Gilia,* and *Sphaeralcea.*

Cattle grazing rights were leased to the Double U Ranch by the UTLS. Cattle were rotated between 2 pastures on a 3-month rotation at an annual rate of about 35 ha/animal unit. Cattle were on our study site from June to August each year.

METHODS

We captured fawns within 5 days of parturition during April–June (primary fawning month was May) and fitted each fawn with a mortality-sensing, eartag transmitter (32 g) during 1990–92. Surgical gloves were used in handling fawns; transmitters were placed in plastic bags containing creosote leaves to mask our scent before attachment. We did not take body measurements to avoid injuring fragile fawns and minimize disturbance. Handling time of fawns was about 1–2 minutes. These efforts were to minimize the potential of fawn abandonment by the dams.

We classified fawns as "young-age" (fawns ≤5 days old), "middle-age" (6–14 days), and "old-age" (>14 days). These categories were chosen based on observations of fawns during capture and tracking operations. Fawns were highly vulnerable to predation and relatively immobile up to 5 days of age. Thereafter, fawns became more active but remained apart from their mothers and were bedded most of the time. About 2–3 weeks of age, fawns began running with their mothers more often and were more active than younger fawns. We used bed sites from initial fawn captures only if those sites were selected by undisturbed fawns. We radio tracked fawns daily (1 location/day) and observed them from a distance of 20–40 m to minimize disturbance. Bed sites were marked with flags and identified on maps for subsequent habitat evaluations.

We began microhabitat evaluations during the latter part of the fawning season. We evaluated each bed site following procedures in Canon (1993). These procedures included visibility estimates in 4 cardinal directions at the bed site from 3 heights (0.1, 0.5, and 1.0 m) to represent fawn bedded, fawn standing, and adult standing positions. We recorded the proportion of the measuring pole visible at 25 and 50 m from the bed site at each location. We placed long-range visibility (~150 m) evaluations into 2 categories: clear to partially obstructed sight-line and totally obstructed sight-line. We measured vegetation understory and overstory height by taking measurements at 15 random points surrounding the bed site for a total of 15 understory and 15 overstory measurements at each site. Shrub canopy cover and density were measured inside 4 30- × 2-m rectangular quadrats extending from the bed site in each cardinal direction. We recorded number of each shrub species present and measured the cover of each shrub with a measuring rod marked in 10-cm increments. Basal cover of grasses and foliar cover of forbs was measured by tossing 24 0.1-m^2 rectangular quadrats in the area surrounding the bed site within a 30 m radius. Percent cover of each species, bare ground, and rock were estimated for each quadrat. We measured terrain slope, slope of the bed site (bed slope), and nearest concealing cover (NCC). Measurements for NCC were taken during the last 2 years of the study after we noticed in 1990 that fawns tended to bed near vertical structure (e.g., tall grass, cacti, yucca, etc.).

To determine if fawns "selected" particular microhabitat features over features found randomly in the area, we randomly selected 225 locations (i.e., artificial bed sites) and measured the pertinent variables as for fawn-selected bed sites. Comparisons were then made between fawn-selected bed sites and random sites.

Statistical Analyses

We used analysis of variance (ANOVA; SAS Inst. Inc. 1988) for a completely randomized design using bed sites as the experimental unit to test for differences in microhabitat characteristics between bed sites and randomly selected sites and between bed sites of surviving and non-surviving fawns; we also compared these 2 categories of fawns to randomly selected sites. In addition, we compared bed site char-

Table 1. Number of pronghorn fawns captured, survivors, non-survivors, bed sites measured, and random sites measured on the Double U Ranch study site in Hudspeth County, Texas, 1990–92.

Description	1990	1991	1992	Total
Fawns captured	20	34	47	101
Survivors	2	7	3	12
Non-survivors	18	27	44	89
Bed sites measured	102	219	295	616
Survivors	21	58	48	127
Non-survivors	81	161	247	489
Random sites measured	75	75	75	225

acteristics among the 3 fawn age classes. For significant ANOVAs, we separated means using the least significant difference (LSD) test.

We used stepwise discriminant analysis (SDA; SAS Institute Inc. 1988) to determine the optimal set of discriminating habitat variables selected by fawns. Although SDA can be used to determine an optimal combination of variables, it may not be the best (maximal) combination (Klecka 1980). However, results from both SDA and ANOVA provided the foundation from which the influence of variables in bed-site selection could be evaluated.

RESULTS

We captured and marked 101 fawns during the 3-year study (Table 1). Of this total, 12 (12%) survived (from capture through mid-late Aug each fawning season). Of the 89 fawns that did not survive, 83 were determined to be predation losses, 5 subsequently were not found, and 1 died of other causes. The "missing" fawns were presumed dead because they were <5 days old and, consequently, incapable of moving out of receiver range. Because of our familiarity with the animals on the study area, these fawns would have been seen if the transmitters had malfunctioned or became detached.

We measured microhabitat characteristics of 616 bed sites, of which 127 and 489 sites were from survivors and non-survivors (Table 1). Sixty-one percent of bed sites were found on slopes, 29% on bottoms, and 10% on ridges.

Bed Sites versus Random Sites

Less shrub cover ($P = 0.04$) and shrub density ($P = 0.01$) occurred at fawn-selected bed sites than at random sites (Table 2), particularly in bottoms and on ridges (Table 3). Differences in shrub cover between fawn-selected and random sites were <1% overall, but shrub cover was 20% greater at random sites than at bed sites (Table 2). Again, this was particularly evident in bottoms (38% more cover) and ridges (30% greater; Table 3). Trends in shrub density at random versus bed sites were similar to that found for shrub cover.

No differences ($P = 0.25$) were found in forb cover between bed sites and random sites (Table 2). Percent basal cover of grass was greater ($P = 0.03$) at bed sites than random sites, particularly on ridge sites (Table 3).

Both overstory ($P = 0.54$) and understory heights ($P = 0.16$) were similar at bed and random sites (Table 2); however, on slopes, overstory height was greater ($P = 0.025$) at bed sites than random sites (Table 3). Bed sites were closer ($P = 0.0001$) to a plant or object providing cover (NCC) than randomly chosen sites

Table 2. Microhabitat features of pronghorn fawn bed sites on the Double U Ranch study site in Hudspeth County, Texas, 1990–92.

	Bed sites (n = 616)		Random sites (n = 225)	
Microhabitat feature	$\bar{x}$[a]	SE	$\bar{x}$	SE
Shrub cover (%)	2.8A	<0.01	3.5B	<0.01
Shrub density (#/ha)*	1,299A	63.5	1,631B	123.0
Forb cover (%)	3.2A	<0.01	3.0A	<0.01
Grass cover (%)	16.1A	<0.01	15.0B	<0.01
Overstory ht (cm)	56.3A	0.87	55.3A	1.51
Understory ht (cm)	13.4A	0.22	13.9A	0.36
Nearest concealing cover[b] (cm)*	20.3A	1.75	36.8B	2.26
Rock cover (%)	11.8A	<0.01	15.4B	0.01
Slope (%)*	5.1A	0.19	4.8A	0.30
Bed slope (%)*	0.6A	0.04	1.2B	0.10

[a] Means not followed by a common letter are different ($P < 0.05$) between bed and random sites.
[b] Nearest concealing cover measured in 1991 and 1992 only (n = 473 bed sites, n = 141 random sites).
* Microhabitat feature selected ($P < 0.05$) by stepwise discriminant analysis.

Table 3. Microhabitat features of pronghorn fawn bed sites (B) and random sites (R) located in bottoms, ridges, and slopes on the Double U Ranch study area in Hudspeth County, Texas, 1990–92.

Microhabitat feature	Bottom		Ridge		Slope	
	B	R	B	R	B	R
Shrub cover (%)	2.3A[a]	3.7B	2.6A	3.7B	3.1A	3.1A
Shrub density (#/ha)	1,025A	1,576B	1,199A	1,761B	1,448A	1,596A
Forb cover (%)	2.4A	2.0A	3.9A	3.6A	3.5A	3.4A
Grass cover (%)	18.4A	17.9A	15.7A	13.3B	15.1A	13.6A
Overstory ht (cm)	57.2A	62.9A	48.4A	50.7A	57.1A	52.2B
Understory ht (cm)	12.8A	13.6A	15.2A	14.6A	13.4A	13.7A
Nearest concealing cover[b] (cm)	24.0A	42.2B	20.6A	31.2A	20.4A	36.8B
Rock cover (%)	4.7A	5.7A	17.7A	19.4A	14.2A	21.1B
Slope (%)	1.6A	1.8A	3.9A	3.4A	4.3A	6.1B
Bed slope (%)	0.1A	0.5B	0.3A	0.7B	0.8A	2.3B

[a] Means not followed by a common letter are different ($P < 0.05$) between bed and random sites for bottom, ridge, and slope topographic sites.
[b] Nearest concealing cover was measured in 1991 and 1992 only.

(Table 2), particularly on bottoms and slopes but not on ridges (Table 3). Ninety-nine percent of NCCs were plants such as grasses (45%), shrubs and forbs (34%), and cacti and yucca (20%). Rock cover was less ($P = 0.008$) at bed sites than at random sites. Slope was similar ($P = 0.36$) between bed sites and random sites (Table 2), but bed slope was less ($P = 0.0001$) at bed sites on slopes than at random sites (Table 3). Visibility estimates from bed sites of fawns (Table 4) were greater than found at random sites in all positions except adult-standing, 25 m (AS25), fawn-standing, 25 m (FS25), and fawn-bedded long range (FBLR).

Microhabitat and visibility characteristics selected ($P < 0.05$) by stepwise discriminant analysis (Tables 2 and 4) were: shrub density, NCC, slope, bed slope, fawn-standing 50 m (FS50), fawn-standing long range (FSLR), fawn-bedded 25 m (FB25), and fawn-bedded 50 m (FB50). All of these variables differed ($P < 0.05$) between bed and random sites except slope.

Surviving versus Non-surviving Fawns

Microhabitat differences were found between bed-site characteristics of surviving and non-surviving fawns (Table 5). Shrub cover, shrub density, and grass cover of survivor bed sites were more similar to that found at random sites than to non-survivor bed sites. Bed sites of surviving fawns had less slope ($P = 0.008$), rock cover ($P = 0.03$), and bed slope ($P = 0.001$) than bed sites of non-surviving fawns (Table 5). No differences were found in visibility characteristics between bed sites of surviving and non-surviving fawns (Table 6). Variables determined by stepwise discriminant analysis ($P < 0.05$) were shrub density, rock cover, and slope (Table 5).

Table 4. Visibility estimates between pronghorn bed sites and random sites from adult standing (1 m), fawn standing (0.5 m), and fawn bedded (0.1 m) heights, at 3 distances (25, 50, and ~150 m) on the Double U Ranch study area in Hudspeth County, Texas, 1990–92.

Height, distance[a]	Bed sites (n = 616)		Random sites (n = 225)	
	$\bar{x}$[b]	SE	$\bar{x}$	SE
Adult standing, 25	220.2A	0.72	218.5A	0.98
Adult standing, 50	203.2A	1.04	197.7B	1.70
Fawn standing, 25	202.9A	1.08	201.5A	1.50
Fawn standing, 50*	175.1A	1.50	164.4B	2.52
Fawn bedded, 25*	97.4A	2.30	124.7B	3.55
Fawn bedded, 50*	49.3A	2.09	62.5B	3.60
Adult standing, LR[c]	61.6A	0.02	49.3B	0.02
Fawn standing, LR*	50.1A	0.01	35.1B	0.02
Fawn bedded, LR	8.9A	0.01	8.4A	0.01

[a] Means for 25- and 50-m distances represent average number of cm visible on a 240-cm pole. Greater values = greater visibility.
[b] Means not followed by a common letter are different ($P < 0.05$) between bed and random sites.
[c] LR = long range visibility, ~150 m distant from site. Means for LR represent mean % of partial to clear sight lines (north, south, east, west) from the site. Greater values = greater visibility.
* Characteristics selected ($P < 0.05$) by stepwise discriminant analysis.

Table 5. Microhabitat characteristics of bed sites of non-surviving and surviving pronghorn fawns, and random sites on the Double U Ranch study area in Hudspeth County, Texas, 1990–92.

Microhabitat feature	Non-surviving (n = 489) $\bar{x}$[a]	SE	Surviving (n = 127) $\bar{x}$	SE	Random (n = 225) $\bar{x}$	SE
Shrub cover (%)	2.7A	<0.01	3.1AB	<0.01	3.5B	<0.01
Shrub density (#/ha)*	1,244A	72.0	1,510AB	133.2	1,631B	123.0
Forb cover (%)	3.3A	<0.01	2.9A	<0.01	3.0A	<0.01
Grass cover (%)	16.2A	<0.01	15.6AB	<0.01	15.0B	<0.01
Overstory ht (cm)	55.6A	0.91	58.8A	1.92	55.3A	1.51
Understory ht (cm)	13.4A	0.24	13.5A	0.47	13.9A	0.36
Nearest concealing cover[b] (cm)	21.5A	2.17	15.7A	1.58	36.8B	2.26
Rock cover (%)*	12.6A	<0.01	8.8B	<0.01	15.4C	0.01
Slope (%)*	5.3A	0.22	4.3B	0.33	4.8AB	0.30
Bed slope (%)	0.6A	0.05	0.4B	0.06	1.2C	0.10

[a] Means not followed by a common letter are different ($P < 0.05$) among bed site categories.
[b] Nearest concealing cover was measured in 1991 and 1992 only (non-surviving n = 373, survivor n = 100, and random n = 141).
* Microhabitat feature selected ($P < 0.05$) by stepwise discriminant analysis.

Bed Sites of Fawn Age-groups

Shrub density was greater ($P = 0.027$) and grass cover less ($P = 0.0001$) at bed sites of young-age fawns than found at bed sites of old-age fawns (Table 7). Differences in plant phenology should not have seriously affected results in fawn age class comparisons because we measured percent basal cover of grasses rather than foliar cover. Also, greater overstory ($P = 0.03$) and understory ($P = 0.007$) heights were found at bed sites of middle-age fawns than at sites of young-age fawns, whereas heights at bed sites of old-age fawns were intermediate (Table 7). No differences ($P = 0.56$) were found in distance to NCC, although this distance increased with age. Bed sites of old-age fawns had less rock cover ($P = 0.04$) and bed slope ($P = 0.007$) than that found at bed sites of young-age fawns (Table 7).

Differences were found in visibility estimates of FB25, FB50, and FBLR (Table 8). Visibility was less ($P = 0.0001$) at bed sites of middle-age fawns than that found for young-age or old-age fawns at FB25. Bed sites of middle-age fawns had less visibility at FB50 ($P = 0.001$) and FBLR ($P = 0.01$) than bed sites selected by old-age fawns. No differences were found in the other visibility categories (Table 8). Variables selected by stepwise discriminant analysis ($P <$ 0.05) were grass cover, overstory height, bed slope, and FB25 (Tables 7 and 8).

DISCUSSION

During the first 2–3 weeks of life, pronghorn fawns spend most of their time lying in seclusion (Fichter 1974, Byers and Byers 1983). Fawns depend on their mothers to initiate activity periods, but act independently in selection of bedding sites (Fichter 1974, Autenreith and Fichter 1975). Bed-site selection for pronghorn fawns may be largely a behavioral response to predation (Bromley 1977). Effective protection of pronghorn fawns from predation is a function of their cryptic coloration, lack of motion, and the ability to select proper concealment features of bed sites (Alldredge et al. 1991).

As part of the Chihuahuan Desert, the Trans-Pecos does not provide the relatively heavy, low cover found in most pronghorn habitats in the western United States and Canada. Because of differences in vegetation composition and structure found in the Trans-Pecos, direct comparisons between studies conducted in other regions are difficult. For example, Barrett (1981) found that in the mixed-grass prairie of Alberta, 75% of the fawns bedded on grassland ranges that had little or no shrub cover. A set of characteristics necessary for optimum pronghorn populations in shrub-steppe habitats was presented by Kindschy et al. (1982). Few habitat characteristics in the Texas Trans-Pecos Region meet their criteria for desirable pronghorn habitat (Canon 1993), yet population levels have remained relatively high and stable since the late 1950s (Hailey 1986). Even bed sites used between macrohabitats within the same desert system can vary considerably (Tucker and Garner 1983, Canon 1993). Tucker and Garner (1983) found that shrubs were not a major component of pronghorn bed sites in the broad open areas that typify the eastern Chihuahuan Desert near Alpine, Texas. Such extreme vari-

Table 6. Bed site visibility estimates for non-surviving and surviving pronghorn fawns and randomly selected sites from adult standing (1 m), fawn standing (0.5 m), and fawn bedded (0.1 m) heights, at 3 distances (25, 50, and ~150 m) on the Double U Ranch study area in Hudspeth County, Texas, 1990–92.

	Non-surviving (n = 489)		Surviving (n = 127)		Random (n = 225)	
Height, distance[a]	$\bar{x}$[b]	SE	$\bar{x}$	SE	$\bar{x}$	SE
Adult standing, 25	220.7A	0.69	218.4A	1.96	218.5A	0.98
Adult standing, 50	203.0A	1.15	203.7A	2.43	197.7B	1.70
Fawn standing, 25	203.4A	1.17	201.2A	2.35	205.9A	1.50
Fawn standing, 50	174.5A	1.71	177.5A	3.11	164.4B	2.52
Fawn bedded, 25	97.9A	2.52	95.3A	5.49	124.7B	3.55
Fawn bedded, 50	48.8A	2.29	51.1A	4.97	62.5B	3.60
Adult standing, LR[c]	61.6A	0.01	61.6A	0.02	49.3B	0.02
Fawn standing, LR	50.8A	0.01	47.4A	0.02	35.1B	0.02
Fawn bedded, LR	9.0A	0.01	8.5A	0.01	8.4A	0.01

[a] Means for 25- and 50-m distances represent average number of cm visible on a 240-cm pole. Greater values = greater visibility.
[b] Means not followed by a common letter are different ($P < 0.05$) among bed site categories.
[c] LR = long range visibility, ~150 m distant from site. Means for LR represent mean % of partial to clear sight lines (north, south, east, west) from the site. Greater values = greater visibility.

ation in bed site selection across geographic regions suggests that fawns select or at least initially imprint upon the optimal combination of local microhabitat features that are necessary to ensure predator avoidance.

We found that the important microhabitat variables for pronghorn fawn bed sites were shrub cover, shrub density, grass cover, NCC, and bed slope, and to a lesser extent rock cover, terrain slope, overstory, and understory. Overall, bed-site selection by fawns was for less shrub density and cover than random sites. In Wyoming, Alldredge et al. (1991) found shrub cover was greater at bed sites than random sites but areas of heaviest shrub cover were not used. Although not significantly different, surviving fawns tended (P = 0.0567) to use bed sites in areas with greater shrub density than non-surviving fawns, thereby potentially decreasing the chances of being detected by predators. However, NCC tended to be greater (P = 0.06) at non-surviving fawn bed sites than found at bed sites of surviving fawns. Both non-surviving and surviving fawns tended to use sites with less shrub cover and density than found at random sites. This finding suggests that elements of both concealment and visual awareness were important factors in bed site selection as suggested by Alldredge et al. (1991).

Characteristics of the immediate bed site help conceal fawns. These characteristics can range from small, barely noticeable depressions in topography to obvious clumped or vertical vegetation. Young gazelles (*Gazella* spp.) often

Table 7. Microhabitat characteristics of bed sites for the 3 age groups of pronghorn fawns on the Double U Ranch study area in Hudspeth County, Texas, 1990–92.

	Young[a] (n = 215)		Middle (n = 267)		Old (n = 134)	
Microhabitat feature	$\bar{x}$[b]	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub cover (%)	3.0A	<0.01	2.9A	<0.01	2.5A	<0.01
Shrub density (#/ha)	1,483A	133.7	1,292AB	92.0	1,020B	69.5
Forb cover (%)	3.2A	<0.01	3.3A	<0.01	3.1A	<0.01
Grass cover (%)*	15.4A	<0.01	15.4A	<0.01	18.7B	<0.01
Overstory ht (cm)*	54.2A	1.33	57.8B	1.21	56.3AB	1.98
Understory ht (cm)	12.8A	0.34	13.8B	0.33	13.6AB	0.47
Nearest concealing cover[c] (cm)	19.0A	3.42	19.6A	2.26	23.1A	4.01
Rock cover (%)	13.1A	<0.01	11.9A	<0.01	9.2B	<0.01
Slope (%)	5.6A	0.39	4.9A	0.24	4.7A	0.36
Bed slope (%)*	0.7A	0.09	0.5B	0.05	0.4B	0.07

[a] Age groups: young (≤5 days), middle (6–14 days), old (>14 days).
[b] Means not followed by common letter are different ($P < 0.05$) among age categories.
[c] Nearest concealing cover was measured in 1991 and 1992 only (young n = 160, middle n = 219, old n = 94).
* Microhabitat feature selected ($P < 0.05$) by stepwise discriminant analysis.

Table 8. Visibility estimates among pronghorn bed sites for the 3 age groups of fawns from adult standing (1 m), fawn standing (0.5 m), and fawn bedded (0.1 m) heights, at 3 distances (25, 50, and ~150 m) on the Double U Ranch study area in Hudspeth County, Texas, 1990–92.

Height, distance[b]	Young[a] (n = 215)		Middle (n = 267)		Old (n = 134)	
	$\bar{x}$[c]	SE	$\bar{x}$	SE	$\bar{x}$	SE
Adult standing, 25	221.1A	1.01	219.6A	1.15	220.1A	1.40
Adult standing, 50	203.0A	1.20	202.6A	1.58	204.7A	1.86
Fawn standing, 25	205.5A	1.62	201.1A	1.67	202.4A	2.25
Fawn standing, 50	175.7A	2.66	173.5A	2.33	177.5A	2.77
Fawn bedded, 25*	101.6A	3.76	89.2B	3.47	106.9A	5.11
Fawn bedded, 50	50.9AB	3.41	43.5B	3.17	58.2A	4.63
Adult standing, LR[d]	62.1A	0.02	60.3A	0.08	63.2A	0.02
Fawn standing, LR	52.4A	0.02	48.8A	0.02	48.9A	0.02
Fawn bedded, LR	9.3AB	0.01	7.5A	0.01	11.2B	0.02

[a] Age groups: young (≤5 days), middle (6–14 days), old (>14 days).
[b] Means for 25- and 50-m distances represent average number of cm visible on a 240-m pole. Greater values = greater visibility.
[c] Values not followed by a common letter are different ($P < 0.05$).
[d] LR = long range visibility, ~150 m distant from site. Means for LR represent mean % of partial to clear sight lines (north, south, east, west) from the site. Greater values = greater visibility.
* Characteristic selected ($P < 0.05$) by stepwise discriminant analysis.

react to 2 sign stimuli in selecting a bed (Walther 1974). Gazelles prefer vertical structure (i.e., high grass, shrub, etc.) and small, shallow depressions. Other studies (Bromley 1977, Barrett 1981) have found similar use of vertical and horizontal structure in pronghorn. Where shrub cover is limited, the tendency to select bedding sites with other features to satisfy both vertical and horizontal structure may be more apparent (Barrett 1981). In the Texas Trans-Pecos, selection of bed sites close to plants or objects providing vertical cover was an important characteristic of bed sites. Fawns tended to bed with their back to an object (NCC), where detection from at least 1 side by a predator would be difficult.

Generally, fawns selected bedding areas where visibility was greater at long distances (50 m, ~150 m) than that found at random sites. This finding suggested that greater sighting distances were preferred, presumably facilitating earlier detection of predators. However, sighting distances were essentially the same at bed sites of non-surviving and surviving fawns, suggesting that this preference did not translate directly into increased survival.

Fawn age was an important factor in changes associated with microhabitat variables of bed sites. Shrub density at bed sites decreased with the age of fawns, whereas grass cover increased. Also, differences in preference for rock cover and bed slope occurred as fawns grew older. Flatter sites (bed slope) may have provided comfort, although flat beds near NCC, may have provided a small depression in local topography similar to those selected for by gazelles (Walther 1974). Visibility from fawn-bedded positions was lowest from bed sites of middle-aged fawns in all 3 distance categories, which may indicate a learning process by fawns. At <6 days of age, fawns may not have learned to select sites with optimal concealment, depending more on maternal preferences. However, in the middle-age group when fawns are still vulnerable to predation but more active, fawns actively may seek beds that have better concealment features. Older fawns tended to select less concealing features. These results suggest that young fawns require concealing cover when their lack of motor ability prevents escape from predation by fleeing. As fawns develop the motor skills necessary to flee from predators, concealing cover becomes less important and observation of approaching predators from a distance becomes more important.

In conclusion, our study found that fawns selected particular microhabitat features that were mostly different from features randomly found in the area. Fawns appeared to select bed sites that provided suitable concealment while in the bedded position and increased visibility before and after bedding. These preferences were related to predator avoidance strategies, which changed as fawns developed the motor skills necessary to avoid predation by fleeing.

MANAGEMENT IMPLICATIONS

We suggest the following characteristics for pronghorn fawning areas in the Texas Trans-Pecos Region: shrub and cacti cover of 3%, shrub and cacti density of 1,500 individuals/ha, forb foliar cover of 3%, grass basal cover of 16%, overstory height of 60 cm, understory height of 14 cm, clumped, taller, understory vegetation to provide fawns with NCC, and slope of 4–5%. Proper management of rangeland in the Trans-Pecos can enhance pronghorn fawning habitat. Livestock stocking rates that encourage increased grass and forb production also can provide cover for fawns and forage for dams while not hampering long-range visibility.

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