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HABITAT CHARACTERISTICS OF WINTER ROOST SITES OF WILD TURKEYS IN TRANS-PECOS, TEXAS

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ABSTRACT—Wild turkeys (*Meleagris gallopavo*) occur intermittently throughout Trans-Pecos, Texas. In the lower desert of the Trans-Pecos, turkeys are associated strongly with the limited riparian habitat where roosting habitat is found. We initiated a study to document microhabitat characteristics of roost sites in the Trans-Pecos region of Texas. We measured microhabitat characteristics (canopy cover, density of stand, visual obstruction, understory herbaceous cover, height of tree, diameter at breast height (dbh), height-to-lowest live branch, slope, and aspect) at 15 winter roosts and 15 random sites in three habitats in the Trans-Pecos region: ponderosa pine (*Pinus ponderosa*), live oak (*Quercus virginiana*), and sugar hackberry *(Celtis laevigata*). All roost sites were <1 km from riparian corridors and located in riparian regions. Among the three habitats, large diameters and height of trees were a prerequisite for roost trees in live oak and sugar hackberry habitat, where live oaks used as roost trees were larger (mean dbh = 57.78 cm) than non-roosting trees (mean dbh = 39.13 cm). Roost trees in live oak habitat had a greater height than trees in random sites (13.58 and 11.28 m, respectively). Sugar hackberries used as roost trees had larger dbh, height, height-to-lowest live branch, and canopy cover than nonroost trees in random sites. Due to the sparse density of trees, we recommend that riparian corridors with potential roosting habitat be protected throughout the Trans-Pecos. In addition, exotic species (e.g., *Tamarisk*) should be controlled and native riparian habitats should be preserved.

RESUMEN—Los pavos silvestres (*Meleagris gallopavo*) se encuentran en forma intermitente a lo largo de la región Trans-Pecos, Texas. En el desierto inferior del Trans-Pecos, los pavos están fuertemente asociados con el limitado hábitat ripario en donde se encuentran sus dormideros. Se llevó a cabo un estudio para documentar las características de microhábitat de los dormideros en la región del Trans-Pecos de Texas. Se cuantificaron las características de microhábitat (cobertura del dosel, densidad vegetal, obstrucción visual, cobertura herbácea del sotobosque, altura de los árboles, diámetro a la altura del pecho (dbh), altura hasta la rama viva más baja, pendiente y aspecto) en 15 dormideros invernales y 15 sitios elegidos al azar en tres tipos de hábitat en la región de Trans-Pecos: pino ponderosa (*Pinus ponderosa*), encino (*Quercus virginiana)* y *Celtis laevigata*. Todos los dormideros estaban a <1 km de los corredores riparios y ubicados en las regiones riparias. Entre los tres hábitats, diámetros y alturas mayores de los árboles fueron un requisito para dormideros en el hábitat de encino y de *Celtis*, donde los árboles de encino utilizados como dormideros fueron más grandes (dbh media = 57.78 cm) que los árboles no utilizados como dormideros (dbh media = 39.13 cm). Los árboles dormideros en el hábitat de encino tuvieron una mayor altura que los de sitios elegidos al azar (13.58 y 11.28 m, respectivamente). Los árboles dormideros *Celtis* tuvieron mayor dbh, altura, altura a la rama viva más baja, y cobertura del dosel que los árboles no dormideros en los sitios elegidos al azar. Debido a la baja densidad arbórea, recomendamos que se protejan los corredores riparios con hábitats de dormideros potenciales a lo largo de la región Trans-Pecos. Además, las especies exóticas (por ej., *Tamarisk*) deben controlarse y los hábitats riparios nativos deben preservarse.

Restoration of wild turkeys (*Meleagris gallopavo*) has been touted as one of the greatest wildlife success stories in North America. Populations of wild turkeys have been restocked to many habitats throughout their historic range and many populations have successfully recolonized former habitats. Three subspecies of turkeys occur in Texas including eastern (*M. g.*

silvestris), Rio Grande (*M. g. intermedia*), and Merriam's (*M. g. merriami*), and turkey hunting represents a substantial portion of the hunting economy in Texas (Harmel-Garza et al., 1999).

Certain habitat requirements must be met for an area to sustain a viable population of wild turkeys. According to Porter (1992), there are two key components for suitable winter habitat; food and roosting cover. During winter, food is critical for increasing fat deposits in young and adults for survival. Mast is the primary food source of wild turkeys during winter. The value of habitat increases with the proportion of mast-producing species (Porter, 1992). Trees and forested areas provide food, protection from adverse weather, and roosting sites. During autumn and winter, turkeys increase use of these areas and decrease use of open areas (Speake et al., 1975; Kennamer et al., 1980; Campo et al., 1989).

In Texas, little research has been conducted on expanding populations of wild turkeys in the Trans-Pecos ecoregion. King (2003) conducted an ecological study on turkeys in the Davis Mountains of Texas and Latch et al. (2006) evaluated genetic identity of turkeys in western Texas. However, no information exists on habitats of wild turkeys. Therefore, we initiated a study in the Trans-Pecos ecoregion of Texas in August 2002 to evaluate habitat characteristics of winter roost sites used by wild turkey among three distinct habitats.

Study Area—We chose four study sites in the Trans-Pecos region of Texas to quantify roosting habitat of turkeys. Data were collected from three habitats within these locations, which include ponderosa pine (*Pinus ponderosa*) forest, live oak (*Quercus virginiana*) woodland, and sugar hackberry (*Celtis laevigata*) woodland.

Ponderosa Pine Forest—The study site at Davis Mountain Preserve was in Jeff Davis County, 41.8 km N Fort Davis on FM 118. Average annual precipitation was 45.7–63.5 cm and mean annual temperature was 17°C. Elevations were 1,814–2,554 m. At higher elevations, soils generally were shallow to moderately deep and non-calcareous. Gravelly soils and sandy loams were in lower valleys (J. Karges, unpublished data). The Davis Mountain Preserve encompasses 73.8 km^2, which included eight distinct habitats from Chihuahuan Desert grasslands at lower elevations to montane forests at higher elevations (J. Karges, unpublished data). Some dominant grasses included blue grama (*Bouteloua gracilis*), black grama (*B. eriopoda*), tobosa grass (*Hilaria mutica*), and purple threeawn (*Aristida purpurea*). Dominant shrubs included honey mesquite (*Prosopis glandulosa*), lotebush (*Ziziphus obtusifolia*), and catclaw acacia (*Acacia greggii*). Primary woody species included ponderosa pine, gray oak (*Q. grisea*), alligator juniper (*Juniperus deppeana*), and pinyon pine (*Pinus edulis*).

Live Oak Woodland—The study site at Oasis Ranch Preserve was in Terrell County, 57.9 km N Dryden on FM 349. Average annual precipitation was 35.6–45.7 cm and mean annual temperature was 18°C. Soils generally were of limestone origin. The Oasis Ranch Preserve comprises 79.9 km^2 with elevations of 661–1,128 m. The terrain was deep valleys with rugged canyons and plateaus. Independence Creek ran through the ranch and hosted a variety of wildlife and plant communities (J. Wrinkle, unpublished data). Vegetation at higher elevations was composed of green sprangletop (*Leptochloa dubia*), grassland croton (*Croton dioicus*), cane bluestem (*Bothriochloa barbinodis*), netleaf hackberry (*Celtis reticulata*), redberry juniper (*Juniperus pinchotii*), and catclaw acacia. Buffalograss (*Buchloe dactyloides*), common horehound (*Marrubium vulgare*), live oak, Texas persimmon (*Diospyros texana*), ashe juniper (*Juniperus ashei*), honey mesquite, western soapberry (*Sapindus saponaria*), and salt cedar (*Tamarix*) were at lower elevations and along creekbeds.

Sugar Hackberry Woodland—Study sites at El Capitan and X ranches (X Ranch is adjacent to El Capitan Ranch) were near Sanderson on Highway 90 in Brewster and Pecos counties; both ranches had similar habitat characteristics. These areas received 35.6–50.8 cm of annual precipitation and had a mean annual temperature of 18°C. Elevations were 671–915 m. Topography was limestone hillsides and mesas with canyons forming both wide and narrow valleys. Soils generally were shallow, stony loams with some sandy, clayey subsoils (B. Warnock, unpublished data). Combined, El Capitan and X ranches encompasses 165.8 km^2 (74.7 and 91.9 km^2, respectively). Vegetation was sparse grasses, desert shrubs, and woody species. Representative species includes sideoats grama (*Bouteloua curtipendula*), sprangletop, tanglehead (*Heteropogon contortus*), ocotillo (*Fouquieria splendens*), sotol (*Dasylirion leiophyllum*), blackbrush acacia (*Acacia rigidula*), littleleaf sumac (*Rhus microphylla*), redberry juniper, netleaf hackberry, and sugar hackberry.

Materials and Methods—Data were collected during August 2002–August 2004. Roosting sites used in winter were located during late October–early March each year. Roost sites were located using information from landowners and personal observations. Presence of turkey droppings and feathers indicated active roosting areas (Hoffman, 1968). Data were collected from three habitattypes: ponderosa pine forest, live oak woodland, and sugar hackberry woodland. Within each habitat, data were collected from five known roost sites and five random (unused) sites. Due to limited roosting habitat in western Texas, random sites were selected for sampling from systematically located points over the entire wooded portion of study areas.

A baseline was established through the center of each site parallel to its geographic contour lines. Data were collected from 10 points along the baseline using a random-numbers table. Random numbers represented distances along the baseline at which we collected data. Each point was ≥5 m apart, so that the same trees were not measured repeatedly. At each point, the point-centered-quarter method (Smeins and Slack,

1982) was used to determine density of stand, dominance, and frequency. Distance to nearest tree in each quarter was measured with a 25-m tape. Trees were defined as having a minimum diameter of 6 cm. Diameter at breast height (dbh; Mueller-Dombois and Ellenberg, 1974; Knight, 1978) was measured with a 10-m tape.

A convex-spherical densiometer was used to determine average percentage canopy cover (Lemmon, 1956). Canopy cover was estimated in four cardinal directions at each point and then averaged. Characteristics of roost trees, such as height of tree, height of lowest live branch, dbh, and species of tree were documented along the baseline. Roost trees were randomly chosen and measured at each point. Height of tree and height of lowest live branch were measured with a clinometer.

Visual-obstruction readings were taken at the first, fifth, and tenth point along the baseline using a 1.22-m Robel pole (Robel et al., 1970) to determine screening cover. Visual-obstruction readings were measured in two cardinal directions (upslope and downslope) from the baseline. Two readings (50 and 100% obstruction) were measured in each direction. Composition and cover of herbaceous species was recorded along a 50-m tape using a line intercept (Mueller-Dombois and Ellenberg, 1974; Knight, 1978). Other data collected at each site included elevation, slope, and aspect. A two-sample, two-tailed *t*-test was used to test the null hypothesis that habitat characteristics did not differ between roost sites and random sites.

Results—*Ponderosa Pine Forest*—All roost trees measured at the 10 sites were ponderosa pine. Turkeys selected east-northeast exposures in four sites; the remaining sites had a northwesterly aspect. Elevations of roost sites averaged 1,864 ± 31 m and did not differ ($P = 0.253$) from random sites. Slope of roost sites averaged 19.30 ± 4.81% and differed ($P = 0.009$) from random sites. Litter constituted 46% of herbaceous ground cover and redberry juniper (37%) dominated the understory of roost sites. Grasses made up 53% of herbaceous ground cover with gray oak dominating the understory at random sites at 29%. Random sites had a greater canopy cover of 66.84 ± 2.46% than roost sites (50.81 ± 2.15%). Height of tree at random sites averaged 20.0 ± 0.59 m and differed ($P < 0.001$) from roost sites. Average dbh also was different ($P = 0.034$) from roost sites, averaging 50.8 ± 1.65 cm (Table 1).

Live Oak Woodland—Nine of 10 sites were predominantly live oak mottes; the remaining site was an ashe juniper woodland. Turkeys in the study area tended to favor southerly exposures. In all sites, litter averaged 73% of herbaceous ground cover and plateau oak was the dominant understory species averaging 62%. Height of roost tree averaged 13.58 ± 0.46 m and differed ($P < 0.001$) from trees in random sites. Roost trees had an average dbh of 57.8 ± 2.67 cm and were taller ($P < 0.001$) than the 39.1 ± 1.66-cm trees in random sites. All other characteristics were similar at roost sites and random sites (Table 1).

Sugar Hackberry Woodland—Most sites (8 of 10) in the study area were sugar hackberry woodlands. Netleaf hackberry and Graves oak (*Quercus gravesii*) were the remaining roost sites. Four of five roost sites had a west-northwest aspect; the remaining site had an east-northeast exposure. At roosting sites, grasses (43%) and forbs (37%) constituted >75% of herbaceous ground cover. Whereas, grasses and forbs were 55% of herbaceous ground cover at random sites. Sugar hackberry and redberry juniper dominated the understory at all sites. Density of stand at roost sites averaged 281 ± 25.94 plant/ha and did not differ ($P = 0.339$) from random sites. Percentage slope of 7.80 ± 0.68 at roost sites was greater ($P < 0.001$) than at random sites. Cover of overstory canopy was greater ($P = 0.038$) at roost sites than random sites. Turkeys in the study area selected taller trees (9.64 ± 0.35 m, $P < 0.001$) with a greater height to lowest live branch (2.26 ± 0.14 m, $P < 0.001$) than random sites. Average dbh of trees at roost sites (25.8 ± 1.38 cm) was greater ($P = 0.013$) than at random sites. Density of understory shrub was greater ($P = 0.040$) at random sites. No difference was detected for other habitat characteristics in the study area (Table 1).

Discussion—*Ponderosa Pine Forest*—Latch et al. (2006) identified a mixture of Merriam's and Rio Grande turkeys inhabiting the Davis Mountains. In Arizona, Merriam's turkeys were strongly associated with distribution of ponderosa pine (Shaw and Mollohan, 1992). According to Fowells (1965), ponderosa pine was the most common tree selected for roosting by Merriam's turkeys. In Montana, Jonas (1966) noted that 96% of roost sites of Merriam's turkeys were in ponderosa pine habitat. In our study, all sites (roost and random) were located in ponderosa pine habitat. Roost sites on the Davis Mountain Preserve had similar east-northeasterly exposures as Boeker and Scott (1969) and Jones (1981). In South Dakota, Rumble (1992) reported most roosts had easterly aspects, whereas, Phillips (1980) and C. M. Mollohan and D. R. Patton

TABLE 1—Microhabitat characteristics (mean ± *SE*) of roost and nonroost sites of wild turkeys at three study sites in Trans-Pecos, Texas, August 2002–August 2004.

Study site	Microhabitat characteristic	Roost sites	Nonroost sites	*P*-value
Davis Mountain Preserve, Jeff Davis County	Overstory canopy cover (%)	50.81 ± 2.15	66.84 ± 2.46	<0.001
	Height of tree (m)	16.92 ± 0.42	20.00 ± 0.59	<0.001
	Height of lowest live branch (m)	6.61 ± 0.21	7.07 ± 0.30	0.245
	Diameter at breast height (cm)	45.67 ± 1.26	50.80 ± 1.65	0.030
	Mean area per plant (m^2/plant)	15.60 ± 4.21	19.52 ± 2.14	0.507
	Total density (plants/ha)	788 ± 150	538 ± 59	0.196
	Visual obstruction (m) for 50%	29.07 ± 2.42	31.80 ± 2.82	0.499
	Visual obstruction (m) for 100%	41.03 ± 3.60	41.40 ± 3.05	0.932
	Slope (%)	19.30 ± 4.81	9.20 ± 2.69	0.010
	Elevation (m)	1,864 ± 31	1,901± 21	0.245
Oasis Ranch Preserve, Terrell County	Overstory canopy cover (%)	86.66 ± 2.03	87.12 ± 1.25	0.859
	Height of tree (m)	13.58 ± 0.46	11.28 ± 0.38	<0.001
	Height of lowest live branch (m)	3.74 ± 0.19	3.68 ± 0.16	0.798
	Diameter at breast height (cm)	57.78 ± 2.67	39.13 ± 1.66	<0.001
	Mean area per plant (m2/plant)	21.38 ± 3.80	26.93 ± 9.06	0.651
	Total density (plants/ha)	519 ± 76	644 ± 224	0.658
	Visual obstruction (m) for 50%	28.00 ± 2.23	29.37 ± 3.76	0.794
	Visual obstruction (m) for 100%	33.63 ± 2.96	35.97 ± 3.76	0.698
	Slope (%)	4.20 ± 0.92	5.20 ± 1.04	0.305
	Elevation (m)	591 ± 5	590 ± 4	0.789
El Capitan and X ranches, Brewster and Pecos counties	Overstory canopy cover (%)	43.02 ± 4.88	30.72 ± 3.24	0.038
	Height of tree (m)	9.64 ± 0.35	7.75 ± 0.16	<0.001
	Height of lowest live branch (m)	2.26 ± 0.14	1.51 ± 0.05	<0.001
	Diameter at breast height (cm)	25.80 ± 1.38	21.29 ± 0.78	0.013
	Mean area per plant (m^2/plant)	36.82 ± 3.44	51.39 ± 7.41	0.202
	Total density (plants/ha)	281 ± 25.94	218 ± 42.20	0.339
	Visual obstruction (m) for 50%	17.00 ± 2.67	18.63 ± 1.31	0.556
	Visual obstruction (m) for 100%	24.13 ± 3.02	24.40 ± 1.79	0.928
	Slope (%)	7.80 ± 0.68	5.50 ± 0.64	<0.001
	Elevation (m)	848 ± 197	862 ± 201	0.324

(in litt.) reported no preference in exposure of roost site. Merriam's turkeys usually select roosting areas with moderately steep slopes. In Montana, Jonas (1966) reported roost sites averaging 34% slope and Hoffman (1968) had roosting areas with an average slope of 18% in Colorado. Boeker and Scott (1969) and Shaw and Mollohan (1992) concluded that steepness of slope has little effect on selection of roost sites. In this study, slopes averaged 19% in roosting areas.

Dense canopies of conifers may provide more thermal cover and roosting branches than sparse canopies (Mackey, 1984). According to Robbins (1971) and Moen (1973), denser canopy cover can reduce loss of body heat by lowering wind velocities. Rumble (1992) reported no statistical difference in canopy cover at roost sites and adjacent sites. C. M. Mollohan and D. R. Patton (in litt.) reported 60% average canopy cover on roost sites in Arizona. Roost sites at the Davis Mountain Preserve had mean canopy coverage of 51% and were significantly lower than random sites.

In south-central Washington, Mackey (1984) reported average height of roost tree was 26.6 m and average dbh was 45.2 cm. According to Boeker and Scott (1969), height of roost tree and dbh were larger than unused trees, 24.4 and 64.5 cm, respectively. Rumble (1992) reported no significant difference in height of roost tree or dbh among roosting sites and random sites. Shaw and Mollohan (1992) noted a minimum height of roost tree of 9–11 m, and suggested height and diameter of tree were not primary characteristics when selecting a roosting tree. Furthermore, Shaw and Mollohan (1992) suggest roost trees must be >15 m in height and have well-spaced horizontal branches. In our

study, height of roost tree averaged 16.9 m with an average dbh of 45.7 cm. Characteristics of roosting sites in the Davis Mountain Preserve are within the average reported in other literature. Roosting habitat was in areas with steeper slopes. Wild turkeys in the Davis Mountain Preserve did not choose the tallest and largest trees in the area. We theorize this was due to the high diversity of plant communities at the preserve, more than anywhere else in the Trans-Pecos. Wild turkeys have a wide variety of species of trees to choose from throughout the preserve. Turkeys are habitat generalists that adapt to a variety of environmental conditions (Dickson et al., 1978).

Live Oak Woodland—The Rio Grande turkey is a highly sociable, nomadic bird that often shows strong fidelity to traditional roost sites in winter (Beasom and Wilson, 1992). They choose the tallest trees without regard to species (Beasom and Wilson, 1992) and use a wide variety of species, including live oak, hackberry, pecan (*Carya illinoinensis*), and cottonwood (*Populus nigra*). Roost trees have large canopies with spreading horizontal branches (Haucke, 1975). In southern Texas, Haucke (1975) reported live oaks and hackberries as dominant roosting trees. In our study, four of five roost sites were dominated by live oak woodland; the remaining site was ashe juniper habitat.

Average height of roost trees in Texas is 12–13 m (Crockett, 1973). According to Haucke (1975), wild turkeys selected the tallest and largest trees for roosting, averaging 13.2 m in height and 62.5 cm dbh. Kilpatrick et al. (1988) reported eastern wild turkeys (*Meleagris gallopavo silvestris*) chose the tallest and largest-dbh trees for roosting in Rhode Island. Jones (1981) reported mean height of trees (16 m) at roost sites to be greater than trees at control sites. In New Mexico, Goerndt (1983) determined that roost sites had greater height of tree, dbh, and canopy cover. Roost sites at the Oasis Ranch Preserve had an average height of tree of 13.6 m and 57.8 cm dbh. Wild turkeys at this study area used roost sites with taller trees and larger diameters, which is consistent with published literature.

Sugar Hackberry Woodland—Roosting sites at El Capitan and X ranches primarily are sugar hackberry habitat. Netleaf hackberry and Graves oak also were used as roosting areas. Schemnitz and Zeedyk (1982) and York (1991) noted that Gould's turkeys (*Meleagris gallopavo mexicana*) roosted in the largest and tallest trees in Mexico and New Mexico. Boeker and Scott (1969) and Mackey (1984) reported the average lowest height to lowest live branches were greater at roost sites than control sites. In this study area, Rio Grande turkeys chose taller trees with a greater dbh and height to lowest live branch.

Canopy cover was greater at roost sites than random sites in this study area. In Washington, Mackey (1984) determined that canopy coverage was greater in roost sites than at random sites. Haucke (1975) reported roost trees in winter had significantly larger canopies than potential roost trees, and concluded that large canopies provided more horizontal perches for wild turkeys.

Turkeys usually are reluctant to enter dense vegetation (Bailey and Rinell, 1967; Holbrook and Lewis, 1967; Kennamer et al., 1980). They seem to prefer open and mature woodlands (Lindzey, 1967; Markley, 1967). Bottomland hardwoods often were used by the Florida wild turkey (*Meleagris gallopavo osceola*). These hardwoods had a relatively open understory (Williams, 1992). Turkeys rely on open habitat and keen eyesight to detect predators and increase their chance of survival (Lindzey, 1967). Random sites at El Capitan and X ranches had a greater density of understory shrubs than roost sites.

Percentage slope was greater at roost sites than random sites at this study area. Boeker and Scott (1969) reported an average slope of 5% for roost sites in northern Arizona. Mackey (1984) recorded 8–35% slopes in south-central Washington. Phillips (1980) reported turkeys had no preference for slope when selecting roost sites in central Arizona. Kilpatrick et al. (1988) detected no difference in slope or elevation between roost sites and control sites. Shaw and Mollohan (1992) concluded that steepness of slope for winter roosts was not a critical factor. Compared to other studies, roost sites at El Capitan and X ranches had similar characteristics. Roost sites in our study area had greater canopy cover, height of tree, lowest height to live branch, dbh, and slope. However, there was a possible bias with these data, because one roost site at X Ranch wasGraves oak. This species has large diameters and can reach heights of 13 m.

Conclusions—In dry environments, roost sites in winter may be a factor limiting the distribu-

tion of wild turkeys. Healy (1992) stated that lack of trees, rather than a shortage of water, limits the range of turkeys in the Central Plains and western Texas. Additionally, Boeker and Scott (1969) reported that a lack of suitable roost trees may limit Merriam's turkey in the Southwest. In this semiarid region, trees are more valuable as roost sites than as a source of food (Healy, 1992).

Most studies have shown that wild turkeys select roost sites in winter based on proximity to water, height of tree, and diameter of tree (Hoffman, 1968; Boeker and Scott, 1969; Haucke, 1975; Flake et al., 1995). Habitats vary considerably across the Trans-Pecos from desert scrub to montane forests. With such a diversity of habitat, wild turkeys must select site-specific habitat characteristics.

In our study, all roost sites in winter were in canyons and swales along riparian corridors in the Trans-Pecos region. Riparian areas are critical habitat for wild turkeys, especially for roosting. Roosting habitat has declined throughout Texas because of changing weather patterns, invasion of exotic plants (e.g., *Tamarisk*), and overgrazing in riparian areas. Data provided herein serves as a baseline inventory of roosting habitat of wild turkeys west of the Pecos River. Based on our results, we recommend that wildlife managers, as well as, private landowners preserve, manage, and reestablish riparian corridors through reseeding, fencing, and conservative grazing.

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