

**Jarbidge Cooperative Elk Herd Carrying Capacity Study
Nevada Division of Wildlife, Hunt Unit 072, Elko County, Nevada**

1999 ANNUAL REPORT:

Preliminary Estimates of 1999 Elk Summer Range Carrying Capacity

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EXECUTIVE SUMMARY

This Annual Report provides data summaries and calculations relative to preliminary estimates of carrying capacity for elk (*Cervus elaphus*) on 1999 summer range within Nevada Division of Wildlife (NDOW) Hunt Unit 072. Unit 072 comprises 166,533.8 ha (411,499.2 ac) in Elko County. The Jarbidge Mountains form the core summer range area in the Unit, with most of the area being administered by the U.S. Forest Service and Bureau of Land Management.

Results from preliminary analyses indicate two key communities, aspen (*Populus tremuloides*) and curlleaf mountain mahogany (*Cercocarpus ledifolius*), could have supported about 1,700 (key available forage) to 2,300 (total available forage) elk in summer 1999. The purpose behind estimating carrying capacity on these key communities was to provide managers with potential results from future models incorporating forage availabilities from key foraging areas. These results are at use levels that elk in the study area do not now exhibit. Additional information on snowbrush communities, a third key community type, is needed prior to modeling carrying capacity for this type. It must also be added that 1999 was a near normal precipitation year and elk grazing capacities in drier summers would be expected to be lower than these value ranges. In addition, the key forage estimate probably reflects better the nature of elk selection for preferred forages. Fine-tuning these estimates as well as including results from the 2000 field season will likely result in significant changes. Therefore, a conservative approach to these data should be applied. Final estimates may be higher or lower than these preliminary ones.

Results from two field seasons (1998 and 1999) have demonstrated elk summer habitat selection in the Jarbidge Mountains is associated closely with woody communities. Aspen and curlleaf mountain mahogany are the primary communities used by elk with some selection also being shown for snowbrush ceanothus (*Ceanothus velutinus*) communities. Aspen and mahogany comprise about 9 and 7 percent respectively, of the vegetation cover in the area.

Dietary analyses indicate the major portion of the elk diet in summer has consisted of forbs (1998 = 62.2; 1999 = 49.5) and shrubs (1998 = 20.1; 1999 = 31.7). Livestock summer diets, on the other hand, have been predominated by a high proportion of graminoids (grasses and grass-like plants [cattle, 1998 = 82.6 and 1999 = 91.5; domestic sheep, 1998 = 70.5 and 1999 = 71.5]). Graminoids have been highest in elk spring diets (1998 = 54.3%; 1999 = 34.5%).

A subset of 11 forage species were selected as key forage species in an effort to (1) investigate elk nutritional relationships, (2) examine dietary overlap between elk, livestock, and mule deer, and (3) direct forage availability investigations. Dietary analyses reveal that requirements for crude protein (CP) and digestible energy (DE) by a representative 236 kg (520.3 lb) lactating cow elk are more attainable through consumption of forbs and shrubs; grasses typically provided lower levels. Dietary overlap based on key forage species between elk and other ungulates in summer has been highest ([% \pm 1 SE] 1998 = 48.4 \pm 10.4; 1999 = 43.6 \pm 13.2). between elk and mule deer. Lupines (*Lupinus* spp.) and snowbrush are the two species that occur in highest concentrations in elk and deer summer diets. Both of these plants are abundant in the Jarbidge

Mountains, and in all but one case, contain levels of protein and energy exceeding cow elk requirements throughout the summer.

Dry matter (DM) standing crop (kg/ha) of herbs and shrubs in aspen and mahogany communities was measured at transects for three time periods in three allotments during summer 1999. Elk carrying capacity was calculated for the amount of forage remaining (residual forage) in aspen and mahogany communities after seasonal livestock grazing was essentially completed. United States Forest Service allowable use levels (60% for herbs and 50% for current annual growth (CAG) of shrubs in deferred rotation allotments) were then applied to the remaining forage. However, it appears that a large portion of the standing crop is lost through the summer due to factors other than direct grazing such as trampling, fouling, and forage senescence.

Carrying capacity was calculated based on an estimated daily dry matter intake (DMI) of 2.5% for a 236 kg lactating cow elk. This type of carrying capacity, a form of grazing capacity, was based on elk use of residual herbaceous (graminoids and forbs) and shrubby (CAG) forage following the grazing season. This was considered to be the amount that could be used by elk after all other uses (livestock, mule deer, and current elk numbers) were considered.

Elk use of vegetation at feeding sites in summer 1999 was light (herbs, 3.8 ± 0.8 ; shrubs, 1.3 ± 0.7 [$x\% \pm 1$ SE]). Results from summer 1998 demonstrated similar use levels by elk. Although use by elk should increase in important foraging areas with increased elk densities, it is also assumed that elk use will expand into areas that are not currently frequented.

Carrying capacity estimates were based on key communities as these areas form the major overlap areas between elk, livestock, and mule deer. Sagebrush-grass cover types encompass 70.5% of Unit 072. These areas provide the bulk of grassy forage to livestock. Elk and mule deer certainly forage in these areas, especially directly adjacent to woody communities. However, the long-term ability of the Jarbidge Mountains summer range to support viable elk and mule deer populations depends on healthy stands of trees and shrubs including aspen, mahogany, and snowbrush. These communities provide high yields of nutritious forbs, graminoids, and shrubs to browsing and grazing ungulates throughout the summer.

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INTRODUCTION

The Nevada Elk Species Management Plan calls for development of elk management subplans for the various elk populations throughout Nevada (Nevada Division of Wildlife 1997). The Six Party Agreement for Elk Reintroduction into the Jarbidge Mountains, Nevada was signed in 1989 and was the document wherein management of elk in the Jarbidge Mountains was based until December 31, 1999. Nevada Division of Wildlife personnel are currently in the process of creating a subplan for the Jarbidge elk population.

This report was drafted to reflect issues and needs that may be useful towards creating this subplan. Therefore, this report documents a specific analysis of results from the second of three field seasons (1998-2000) of elk carrying capacity research in the Jarbidge Mountains of northeastern Nevada. Analyses of data sets not pertinent at this time will be included in the final study report. These data sets include 1) productivity and use of wet meadow communities by wildlife and livestock, 2) elk, cattle, and domestic sheep habitat selection, 3) feeding site use by cattle and domestic sheep, and 4) canopy cover in feeding sites and vegetation communities.

STUDY AREA

The Jarbidge Mountains elk study area (Fig. 1) encompasses 166,533.8 ha (411,499.2 ac) in Elko County, northeastern Nevada. The 97,203 ha (240,194 ac) Jarbidge Ranger District composes most of the summer range area of the Jarbidge Mountains. Lands administered by the Bureau of Land Management, Jarbidge and Wells Resource Areas and interspersed private lands comprise the remainder of the area. Elevations range from about 1,525 m (5,000 ft) to 3,304 m (10,839 ft). The 45,851 ha (113,300 ac) Jarbidge Wilderness Area extends across the western half of the Jarbidge Ranger District. The amount of area covered by vegetation types appears in Table 1. Shrub and tree communities cover 27.0% of the total 166,533.8 ha (411,499.2 ac). Sagebrush comprises the largest cover type of 70.5% of the total area.

Most precipitation falls in the form of late fall, winter, and early spring snow. Snow water equivalent is defined as the depth (inches) of melted water in snowpacks (U.S. Soil Conservation Service 1993). April 1 is a commonly used reference date to measure yearly snowpack (Ostler et al. 1982). The 30 year (1961-1990) average snowpack water content at the 2,539 m (8,330 ft) Pole Creek Administrative Site Snowtel site is 51.8 cm (20.4 in). The snowpack water content on April 1, 1999 was 47.0 cm (18.5 in), or 90.7% of average (Idaho Natural Resources Conservation Service, Internet home page 1999 [<http://www.wcc.nrcs.usda.gov/water/snow>]).

METHODS

Vegetation Transects

The Spring Creek and Pole Creek, Black Spring/Caudle Creek, and Wilson Creek Allotments were selected for transect placement to measure herbaceous and shrubby plant productivity and use in key communities. One transect for aspen, curlleaf mountain mahogany, and snowbrush were thus placed within each of these allotments for a total of three transects per key community. This procedure was followed to counter pseudo replication which would likely occur by selecting non-independent transects in dispersed habitat patches (i.e., close patches are really subsamples rather than replicates) (Hurlbert 1984). An effort was made to place transects in those allotments where wet meadow exclosures had been built in fall 1998. Each transect was placed in different patches under similar topographic conditions. Transects were placed to gain information on big game and livestock utilization of key woody communities as well as the annual productivity of these key communities.

Aspen and mahogany transects consisted of 10 perpendicular lines spaced 1.5 m apart along a 15.24 m (50 ft) center baseline. Ten locations for sampling plots were spaced equidistant in 1.5 m intervals along each of these lines for a total of 100 possible sampling plot locations. Repeated sampling occurred at each of these transects during three time periods (late June, early August, and late September-early October (autumn)). Snowbrush communities were sampled along two parallel, 75 m lines in August and autumn. Canopy cover, estimated standing crop (g) and percentage use for each individual species occurring within 15 randomly-selected, nested sampling plots were ocularly estimated at each transect during each sampling period. Shrub CAG was evaluated to a height of 0-1.83 m (0-6 ft) from the ground to account for foraging reach of elk. Nested plots consisted of a 0.1 m² herbaceous plot nested along the bottom center of a 1.0 m² shrub plot. Restriction of randomization excluded plots clipped at earlier sampling periods.

An ocular estimate of cover by individual species in nested plots was acquired by referring to cover classes provided by Anderson (1986). These cover estimates are later converted to cover interval categories suggested by Daubenmire (1959). Daubenmire described six cover classes; these categories have been modified to include nine cover classes to account for zeroes.

Double sampling (Bonham 1989) was implemented to reduce the number of plots clipped. Vegetative standing crop (CAG only in shrubs) in three plots was clipped and all 15 plots were estimated (Interagency Technical Reference 1996). Wet weights were recorded to the nearest 0.5 g. Samples weighing less than 0.5 g were discarded. Linear regressions between the original estimated weight wet (independent variables) and the actual clipped weight (dependent variables) were conducted with SAS (SAS Institute Software, Cary, NC) to produce regression equations to adjust estimates of wet standing crop in plots that were not clipped. Clipped samples were placed in paper bags and then air-dried. Air-dried samples were later oven dried in a forced-air oven at 60°C for 24

hrs and then weighed to the nearest 1/100 gram. Dry matter was calculated by subtracting these dry bag weights from tare weights (empty dry paper bag weight).

All calculations of standing crop and use of standing crop were based on a DM basis. Standing crop, percentage use of standing crop, and residual standing crop for herbs (graminoids and forbs) and shrubs from all three transects per key foraging community were averaged for each sampling period and accompanying standard errors (SE) were calculated.

Elk Feeding Sites

Regular aerial flights to relocate collared cow elk were conducted during the 1999 summer field season by Joe Williams, NDOW Wildlife Biologist. Flights were conducted on May 20, June 9, June 16, June 30, July 7, July 14, August 11, and September 1. The general and specific locations (i.e., GPS coordinates) and general community types where elk were located were provided to field investigators to locate elk on the ground. Radio-telemetry and general observations of groups of elk were included in habitat and dietary sampling procedures. Habitat and dietary data were analyzed according to two sampling periods (early summer [spring] = June 7 - July 19; late summer [summer] = July 10 - September 17) to mirror changes in plant phenology and to compare deer and elk resource selection to livestock. Livestock were considered to be stocked by July 10. The late summer sampling period ended prior to the opening of the cow elk hunt (September 18).

Individual elk were randomly selected from groups of elk and observed with focal animal sampling (Altmann 1974) to determine locations for feeding site placement. Feeding sites were considered to be areas where elk were observed foraging undisturbed for periods of at least 15 minutes. A crude map was drawn to guide researchers back to the exact elk location to conduct feeding site sampling. Feeding sites were examined for use by other ungulates to eliminate dual use biases. This procedure allowed consideration of elk-only use in feeding sites. Feeding sites were examined within one week from observation of elk to reduce forage regrowth biases.

A 100 m² macroplot delineated by an assembly of cords was placed on the center of each feeding site. Ten nested plots (one 0.1 m² herbaceous, and one 1 m² shrub plot at each location) were placed within the macroplot at previously determined positions. Canopy cover, percentage of estimated use, and estimated standing crop were ocularly estimated. Shrub CAG was evaluated to a height of 0-1.83 m (0-6 ft) from the ground to account for foraging reach of elk. Double sampling (Bonham 1989) was employed in each feeding site to reduce sampling effort. Two of the ten plots were randomly selected and all of the standing crop was clipped. Procedures for sampling mirror that described in the Vegetation Transects section above.

Dietary Analyses

Collection, preservation, and lab analyses of 1999 dietary fecal samples generally follows that described in Beck and Peek (1999). Kulczynski's similarity indices were computed (Oosting 1956) from forage species found in at least one of each pair (e.g., elk summer and sheep summer) of ungulate diets. Means and standard errors were calculated from each list of similarity indices to represent average dietary overlap. Spearman's rank correlations (Ludwig and Reynolds 1988) were computed with SAS between the entire list of possible forages between each pair of ungulates in each sampling period. A multivariate analysis of variance (MANOVA) (Johnson 1998) following three years (1998, 1999, and 2000) of data collection should detect differences between the proportions of forage classes (i.e., forbs, grasses, grass-likes, and browse) in summer diets of four species (elk, mule deer, cattle, and domestic sheep).

Nutritional Analyses

Arrowleaf balsamroot (*Balsamorhiza sagittata*), bluebunch wheatgrass (*Pseudoroegneria spicata*), curlleaf mountain mahogany, Idaho fescue (*Festuca idahoensis*), Kentucky bluegrass (*Poa pratensis*), mountain brome (*Bromus carinatus*), mountain snowberry (*Symphoricarpos oreophilus*), needlegrass (*Stipa* spp.), Sandberg's bluegrass (*Poa secunda*), snowbrush ceanothus, and tailcup lupine (*Lupinus caudatus*) were selected as key species through inspection of 1998 dietary results. Samples ($n = 99$) of each of these 11 key species were collected from the three allotment groupings described in the Vegetation Transects section during the three time periods in which vegetation transect sampling was conducted. An effort was made to clip portions of plants and plant parts that were observed to be eaten by elk in feeding sites. In most cases this consisted of clipping only about 5 percent of plant standing crop. An effort was made to mix samples from several plants in each allotment. Typically this was the inflorescence and succulent basal leaves in forbs and grasses and CAG in shrubs.

Air dried samples were dried in a forced-air oven at 60°C and ground to 2 mm particle size. The University of Idaho, Analytical Sciences Lab, was contracted to conduct %C and %N analyses and to conduct a macro element screen for Ca, K, Mg, Na, P, and S. Percent CP was calculated from %N by the standard equation of $6.25 \times [N]$ (Church and Pond 1988).

In vitro dry matter digestibility (IVDMD) analyses of key forage samples were conducted by the principal field investigator at the Range Lab, University of Idaho, Department of Rangeland Ecology and Management, according to modified techniques of Tilley and Terry (1963). Rumen inoculum was collected from a fistulated Hereford cow maintained on a representative diet of 1/3 alfalfa (*Medicago sativa*) and 2/3 grass hays. Triplicates of each forage sample were conducted to obtain mean %IVDMD with coefficients of variation (CV) that were $\leq 5.0\%$. Additional replications were conducted until at least two replicates could be averaged with an accompanying CV $\leq 5.0\%$. Grand means were calculated for each species across each time period from mean results obtained through replicated digestions of each forage sample in each allotment. IVDMD from June and August were increased by 11 and 6 percent, respectively, to correct for underestimation related to air-drying forages that occurs at these time periods (Cook 1990). IVDMD was converted to DE according to Schommer's (1978) regression equation:

(DE (Kcal/g) = -0.705 + 0.051 (%IVDMD)).

Carrying Capacity Estimates

We assume that elk numbers in the Jarbidge Mountains ecosystem will ultimately be regulated by forage use and availability that is compatible with the needs of domestic livestock and other wildlife. As such, calculations were based on use of residual biomass following the livestock grazing period. Forage remaining after the end of this grazing period should also reflect forage remaining after use by big game. Forest Service maximum use levels (from Amendment 2 of the Humboldt National Forest Land and Resource Management Plan; July, 1990) allowed in deferred rotation allotments (60% for herbs and 50% for shrub CAG) were used as the standard protocol in calculating use values.

Grazing capacity calculations for 1999 summer range in aspen and mahogany communities appear in Tables 2 and 3. Preliminary calculations using 1999 data incorporated the daily percentage intake of dry matter by a 236 kg (520.3 lb) cow elk during the summer growth period. A 236 kg cow elk was selected as a model of elk requirements as elk nutritional calculations and requirements have typically considered this weight as an average size for elk cows (Nelson and Leege 1982, Cook In Press).

Holechek (1988) suggested daily DMI by ungulates of 2.5% of body weight during active growth periods when forage is high in quality. Vallentine (1990) noted that range cattle intake rates increase by an average of about 35% when cows are lactating. Intake rates and digestibility decrease as plant maturity increases (Cordova et al. 1978). Holechek (1988) reported a mean daily intake rate of 2.0% of ruminant body weight per day when data are averaged across periods of forage dormancy and active growth. To account for the reduction in quality of plants consumed by a cow elk and to account for greater intake required for lactation during the summer period, DMI rates were maintained at a constant rate of 2.5% of body weight.

The number of days that elk use the summer range was set at seven months, or 210 days. This period was set to reflect results from radio-telemetry work that indicate elk are using aspen and mahogany communities from May through November. The final equation to calculate 1999 summer elk carrying capacity in the Jarbidge Mountains was:

Number of elk (K) = Available Forage (kg)/(0.025 DMI x 236kg x 210 days)

RESULTS AND DISCUSSION

Vegetation Transects

Overall use of total herbaceous standing crop in aspen and mahogany communities were within Forest Service allowable use levels (Figs. 2 and 3, respectively). Separation of herbaceous plants into key categories resulted in similar use levels for aspen and mahogany communities; well within Forest Service maximum use levels (Figs. 4 and 5, respectively). By autumn, the herbaceous understory in aspen communities had received nearly four times the average percent use [$x\% \pm 1$ SE] observed in mahogany communities (26.7 ± 8.5 in aspen [Fig. 2] and 6.8 ± 2.9 in mahogany [Fig. 3]). Mean herbaceous standing crop (kg/ha) in aspen transects was about twice that observed in mahogany transects in autumn (Figs. 6 and 7, respectively).

Snowbrush provided nearly the same amount of residual standing crop ($1,644.6 \pm 294.1$ kg/ha DM [$x \pm 1$ SE]) (Fig. 8) in autumn as the herbaceous residual standing crop in aspen communities in June ($1,878.7 \pm 335.8$ kg/ha DM [$x \pm 1$ SE]) (Fig. 6). By autumn, use of snowbrush was very light (0.22 ± 0.16 [$x\% \pm 1$ SE]). Examination of elk feeding locations in snowbrush communities revealed very light use. This has been confusing as snowbrush constitutes one of the main forages in elk and deer diets (Table 4). Possible explanations for this low use may be 1) a portion of the use on snowbrush is on fallen leaves, and 2) snowbrush is so abundant that use by elk and deer is largely undetectable. However, overbrowsing brought on by large increases in elk and mule deer in the Blue Mountains of Oregon and Washington were attributed to large declines in snowbrush (Irwin et al. 1994). This species will be examined in final carrying capacity evaluations as it is certainly a key forage species forming a monoculture key community.

Elk Feeding Sites

Elk forage use was documented at 12 feeding sites during spring and 17 feeding sites during summer 1999. Twenty-one cattle and 10 domestic sheep feeding sites were examined in summer 1999. Utilization by cattle and domestic sheep in summer and elk in spring 1999 will be reported in the final research report. Elk percent use of total herbs was 3.8 ± 0.8 ($x \pm 1$ SE) and for shrub CAG was 1.3 ± 0.7 . Use of key forages was somewhat lighter with percent use by elk of key herbaceous forages being 2.2 ± 0.9 and $0.4 \pm 0.2\%$ for shrub CAG (Fig 9).

Dietary Analyses

Five composite diets were analyzed for food habits analyses. These diets were: spring elk ($n = 11$) from June 10-July 9; summer elk ($n = 28$) from July 10-September 17; summer mule deer ($n = 27$) from July 10-September 17; and two summer (July 10-September 17) livestock diets (cattle [$n = 29$] and domestic sheep [$n = 64$]).

In 1999, composition of elk spring diets was 30.2% forbs, 34.5% graminoids, and 35.3% browse. The summer 1999 elk diet was dominated by forbs (49.5%) and browse (31.7%); graminoids made up 18.8.% of the diet (Fig. 10). In 1998, composition of elk spring diets was 30.0% forbs,

59.7% graminoids, and 10.3% browse. The summer 1998 elk diet switched to dominance by forbs (62.2%) and browse (20.1%); graminoids contributed to 17.7% of the diet.

Dietary species richness in 1999 ranked as follows: elk spring (38) > elk summer (35) > deer summer (32) = sheep summer (32) > cattle summer (31). By comparison, in 1998, dietary species richness ranked as follows: elk summer (38) > elk spring (35) > deer summer (28) > sheep summer (28) > cattle summer (25).

Key forage species were 46.6 to 71.6 percent of ungulate diets during 1999 (Table 4). Holechek et al. (1989) suggested from one-to-three plants could be selected for key forage species per a given rangeland area. Selecting the top three key forage species by rank (Table 4) results in the following list of forages and composition by diet: (1) elk in spring; snowbrush, bluebunch wheatgrass, and Sandberg's bluegrass (36.4%), (2) elk in summer; lupines, snowbrush, and curlleaf mountain mahogany (58.3%), (3) deer in summer (key species only accounted for two of the top three ranks); lupines, and snowbrush (43.5%), (4) domestic sheep in summer; Sandberg's bluegrass, lupines, and bluebunch wheatgrass (41.4%), and (5) cattle in summer; bluebunch wheatgrass, needlegrasses, and Sandberg's bluegrass (43.9%).

Dietary overlap between all four ungulates for 1998 and 1999 based on key forage species in diets (Tables 5 and 6, respectively) and for dietary overlap based on total forage species in 1998 and 1999 diets (Tables 7 and 8, respectively) provide interesting foraging relationships between these ungulates. Average percentage ($x \pm 1$ SE) dietary overlap between elk and other ungulates was highest with mule deer when only key forage species were considered (1998, 48.4 ± 10.4 ; 1999, 43.6 ± 13.2) (Tables 5 and 6). These results suggest moderate dietary overlap for the 11 key species occurs between elk and mule deer in the summer. Overlap would be much higher between elk and mule deer if these data were analyzed as Holechek et al. (1989) suggests in selecting one-to-three forage species as key species. Elk summer dietary overlap with livestock has been at low levels. Spring elk diets are more similar to summer livestock diets due to the greater total proportion of grasses in elk spring diets.

Nutritional Analyses

Nutrient levels of forage classes decrease as plants mature. Compared to shrubs, protein and energy levels in forbs and grasses are initially higher, decrease more rapidly, and then typically reach levels below shrubs at the end of the growing season (Vallentine 1990). Forage CP, IVDMD, and DE from key forage plants averaged by forage class in the Jarbidge Mountains demonstrated these same relationships (Tables 9, 10, and 11; Figs 11 and 12). However, forbs maintained levels capable of meeting CP requirements for a 236 kg lactating cow elk throughout the summer (Table 9 and Fig. 11). In addition, average levels of DE in forbs satisfied requirements for a 236 kg lactating cow elk from June through August (Table 11 and Fig. 12). Lupines provided CP in levels exceeding requirements by cow elk for all sampling periods (Table 9). Shrubs maintained more constant levels of CP and DE and grasses only satisfied CP requirements in June (Tables 9 and 11, Figs. 11 and 12). These results provide insight into reasons elk and mule deer in the Jarbidge Mountains rely heavily on forbs and shrubs during summer. In most instances grasses appeared to be inadequate in providing essential nutrients.

Carrying Capacity Estimates

Deterministic elk carrying capacity estimates based on residual forage in aspen and mahogany communities indicate 1,691 lactating cow elk weighing 236 kg could subsist for a summer range period of 210 days in Hunt Unit 072 (Table 3). The deterministic estimate for this elk carrying capacity scenario with use of total available forage revealed 2,269 elk could be supported in these key community types without exceeding Forest Service Allowable use levels (Table 2). A detailed discussion of these results is found in the EXECUTIVE SUMMARY.

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Table 1. Community type coverages, Nevada Division of Wildlife, Hunt Unit 072. Data obtained from GAP vegetation cover.

| Community Type | Hectares | Acres | % Of Total |
|------------------------|-----------|-----------|------------|
| Agriculture | 2,374.7 | 5867.9 | 1.43 |
| Alpine | 508.7 | 1,256.9 | 0.31 |
| Aspen | 14,951.1 | 36,943.6 | 8.98 |
| Barren | 303.8 | 750.6 | 0.18 |
| Dry Meadow | 239.1 | 590.9 | 0.14 |
| Grassland | 293.3 | 724.8 | 0.18 |
| Juniper | 341.8 | 844.6 | 0.21 |
| Mahogany ^a | 11,333.9 | 28,005.6 | 6.81 |
| Pine | 2,756.9 | 6,812.2 | 1.66 |
| Sagebrush | 117,389.7 | 290,066.0 | 70.49 |
| Snowbrush ^a | 8,296.7 | 20,500.7 | 4.98 |
| Snow | 263.8 | 651.8 | 0.16 |
| Subalpine Fir | 7,290.5 | 18,014.5 | 4.38 |
| Water | 23.2 | 57.4 | 0.01 |
| Wet Meadow | 144.3 | 356.5 | 0.09 |
| Urban | 22.3 | 55.2 | 0.01 |
| Total | 166533.8 | 411499.2 | 100.0 |

^a Snowbrush and a portion of the mahogany community types were derived by dividing the total area of the mountain shrub community type in half. This was done as it was apparent that the mountain shrub coverage included curleaf mountain mahogany and snowbrush types.

Table 2. Preliminary elk carrying capacity estimates for 1999 summer range based on total allowable forage. Nevada Division of Wildlife, Hunt Unit 072, Elko County, Nevada.

| Key | Forage Class | Total Area (ha) | Available Forage DM (kg/ha) | Total Forage (kg) | Elk Wt (kg) | % DM Daily Intake | Days | Total |
|------------------|--------------|-----------------|-----------------------------|-------------------|-------------|-------------------|------|-------|
| | | | | | | | | |
| Aspen | Herbs | 14,952 | 50.01 | 747,750 | 236 | 0.025 | 210 | 604 |
| Aspen | Shrubs | 14,952 | 16.97 | 253,736 | 236 | 0.025 | 210 | 205 |
| Mahogany | Herbs | 11,334 | 87.67 | 993,652 | 236 | 0.025 | 210 | 802 |
| Mahogany | Shrubs | 11,334 | 37.02 | 419,585 | 236 | 0.025 | 210 | 339 |
| 1999 Population | -- | -- | -- | -- | -- | -- | -- | 319 |
| Grazing Capacity | -- | -- | -- | -- | -- | -- | -- | 2,269 |

| Total Forage Availability Worksheet | | Autumn | | % | | Mean | | Available | |
|-------------------------------------|--------------|-----------------|------------|----------------|---------------------|------------|------------|-----------|------------|
| Key | Forage Class | % Allowable Use | Mean % Use | Useable Forage | Residual DM (kg/ha) | DM (kg/ha) | DM (kg/ha) | Forage | DM (kg/ha) |
| Aspen | Herbs | 60 | 26.45 | 0.3355 | 149.07 | 149.07 | 149.07 | 50.01 | 50.01 |
| Aspen | Shrubs | 50 | 7.28 | 0.4272 | 39.73 | 39.73 | 39.73 | 16.97 | 16.97 |
| Mahogany | Herbs | 60 | 6.75 | 0.5325 | 164.64 | 164.64 | 164.64 | 87.67 | 87.67 |
| Mahogany | Shrubs | 50 | 0.80 | 0.492 | 75.24 | 75.24 | 75.24 | 37.02 | 37.02 |

Table 3. Preliminary elk carrying capacity estimates for 1999 summer range based on key available forage. Nevada Division of Wildlife, Hunt Unit 072, Elko County, Nevada.

| Key | Forage Class | Total Area (ha) | Available Forage | | Total Forage (kg) | Elk Wt (kg) | % DM | Days | Total |
|------------------|--------------|-----------------|------------------|------------|-------------------|-------------|---------|-------|-------|
| | | | Forage | DM (kg/ha) | | | | | |
| Aspen | Herbs | 14,952 | x | 51.72 | = 773,318 | ÷ 236 | x 0.025 | = 210 | = 625 |
| Aspen | Shrubs | 14,952 | x | 9.18 | = 137,260 | ÷ 236 | x 0.025 | = 210 | = 111 |
| Mahogany | Herbs | 11,334 | x | 33.42 | = 378,783 | ÷ 236 | x 0.025 | = 210 | = 306 |
| Mahogany | Shrubs | 11,334 | x | 36.03 | = 408,364 | ÷ 236 | x 0.025 | = 210 | = 330 |
| 1999 Population | -- | -- | - | -- | - | - | -- | -- | 319 |
| Grazing Capacity | -- | -- | - | -- | - | - | -- | -- | 1,691 |

| Key Forage Availability Worksheet | | | | Autumn | | % | | Mean | | Available | |
|-----------------------------------|--------------|-----------------|-----|--------|----------|----------|---------|------------|------------|-----------|--|
| Key | Forage Class | % Allowable Use | Use | Mean % | | Useable | | Residual | | Forage | |
| | | | | Use | Use | Forage | Forage | DM (kg/ha) | DM (kg/ha) | | |
| Aspen | Herbs | 60 | - | 25.99 | = 0.3401 | x 152.07 | = 51.72 | | | | |
| Aspen | Shrubs | 50 | - | 3.24 | = 0.4676 | x 19.63 | = 9.18 | | | | |
| Mahogany | Herbs | 60 | - | 5.28 | = 0.5472 | x 61.08 | = 33.42 | | | | |
| Mahogany | Shrubs | 50 | - | 0.96 | = 0.4904 | x 73.48 | = 36.03 | | | | |

Table 4. Rank and % composition of key forage species in ungulate diets, Jarbidge Mountain, Nevada, 1999.

| Key Species | Elk | | Elk | | Deer | | Sheep | | Cattle | |
|---------------------------|--------|------|--------|------|--------|------|--------|------|--------|------|
| | Spring | | Summer | | Summer | | Summer | | Summer | |
| | Rank | % | Rank | % | Rank | % | Rank | % | Rank | % |
| Arrowleaf balsamroot | 36 | 0.3 | 19 | 0.8 | 18 | 1.3 | 0 | 0.0 | 0 | 0.0 |
| Bluebunch wheatgrass | 2 | 7.6 | 5 | 3.5 | 0 | 0.0 | 3 | 11.8 | 1 | 20.3 |
| Curleaf mountain mahogany | 4 | 7.2 | 3 | 10.0 | 28 | 0.4 | 0 | 0.0 | 0 | 0.0 |
| Idaho fescue | 17 | 1.5 | 0 | 0.0 | 0 | 0.0 | 6 | 4.3 | 8 | 4.0 |
| Kentucky bluegrass | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 5 | 8.3 | 4 | 9.4 |
| Lupine spp. | 5 | 5.5 | 1 | 32.0 | 1 | 31.9 | 2 | 13.6 | 14 | 2.2 |
| Mountain brome | 9 | 3.4 | 12 | 1.8 | 31 | 0.3 | 12 | 2.5 | 15 | 2.1 |
| Mountain snowberry | 20 | 1.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Needlegrass spp. | 18 | 1.5 | 6 | 3.5 | 23 | 0.6 | 4 | 11.7 | 2 | 12.7 |
| Sandberg's bluegrass | 3 | 7.2 | 4 | 3.7 | 26 | 0.5 | 1 | 16.0 | 3 | 10.9 |
| Snowbrush ceanothus | 1 | 21.6 | 2 | 16.3 | 2 | 11.6 | 21 | 0.8 | 0 | 0.0 |
| % Total Diet | | 57.0 | | 71.6 | | 46.6 | | 69.0 | | 61.6 |

Table 5. Mean % dietary overlap of ungulates based on key forage species, Jarbidge Mountains, Nevada, 1998.

| | Elk | | | Elk | | | Deer | | | Cattle | | |
|----------------------|-----------|------|--------------------|-----------|------|-------|-----------|-----|-------|-----------|------|--------------------|
| | Spring | | | Summer | | | Summer | | | Summer | | |
| | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s |
| Elk Spring | | | | | | | | | | | | |
| Elk Summer | 55.4 | 8.7 | +0.14 | | | | | | | | | |
| Deer Summer | 32.7 | 11.1 | +0.02 | 48.4 | 10.4 | +0.54 | | | | | | |
| Cattle Summer | 35.2 | 11.2 | +0.63 ^a | 19.8 | 8.3 | -0.26 | 8.2 | 4.0 | -0.40 | | | |
| Sheep Summer | 37.2 | 10.8 | +0.50 | 23.2 | 6.6 | +0.01 | 11.8 | 4.1 | -0.18 | 64.3 | 13.9 | +0.90 ^a |

^a $P < 0.05$

Table 6. Mean % dietary overlap of ungulates based on key forage species, Jarbidge Mountains, Nevada, 1999.

| | Elk | | | Elk | | | Deer | | | Cattle | | |
|----------------------|-----------|------|--------------------|-----------|------|--------------------|-----------|-----|-------|-----------|------|--------------------|
| | Spring | | | Summer | | | Summer | | | Summer | | |
| | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s |
| Elk Spring | | | | | | | | | | | | |
| Elk Summer | 51.4 | 9.9 | +0.77 ^a | | | | | | | | | |
| Deer Summer | 23.4 | 7.8 | +0.27 | 43.6 | 13.2 | +0.75 ^a | | | | | | |
| Cattle Summer | 31.2 | 10.0 | +0.02 | 22.8 | 9.9 | -0.04 | 5.6 | 2.7 | -0.27 | | | |
| Sheep Summer | 33.1 | 10.3 | +0.22 | 28.2 | 9.6 | +0.31 | 11.0 | 5.9 | +0.09 | 70.0 | 11.5 | +0.85 ^a |

^a $P < 0.05$

Table 7. Mean % dietary overlap of ungulates based on total diets, Jarbidge Mountains, Nevada, 1998.

| | Elk | | | Elk | | | Deer | | | Cattle | | |
|----------------------|-----------|-----|--------------------|-----------|-----|--------------------|-----------|-----|-------|-----------|-----|--------------------|
| | Spring | | | Summer | | | Summer | | | Summer | | |
| | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s |
| Elk Spring | | | | | | | | | | | | |
| Elk Summer | 28.0 | 4.6 | +0.37 ^a | | | | | | | | | |
| Deer Summer | 21.2 | 4.8 | +0.42 ^a | 27.3 | 4.9 | +0.34 ^a | | | | | | |
| Cattle Summer | 22.0 | 4.9 | +0.34 ^a | 14.1 | 3.8 | -0.02 | 7.4 | 2.5 | -0.02 | | | |
| Sheep Summer | 21.5 | 4.7 | +0.32 ^a | 22.4 | 4.5 | +0.14 | 14.4 | 3.5 | +0.14 | 39.3 | 6.7 | +0.69 ^a |

^a $P < 0.05$

Table 8. Mean % dietary overlap of ungulates based on total diets, Jarbidge Mountains, Nevada, 1999.

| | Elk | | | Elk | | | Deer | | | Cattle | | |
|----------------------|-----------|-----|-------|-----------|-----|--------------------|-----------|-----|-------|-----------|-----|-------|
| | Spring | | | Summer | | | Summer | | | Summer | | |
| | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s | \bar{x} | SE | r_s |
| Elk Spring | | | | | | | | | | | | |
| Elk Summer | 39.1 | 5.4 | +0.23 | | | | | | | | | |
| Deer Summer | 28.3 | 4.8 | -0.25 | 27.2 | 5.1 | +0.51 ^a | | | | | | |
| Cattle Summer | 30.2 | 4.9 | -0.06 | 23.7 | 4.5 | +0.21 | 9.2 | 2.8 | +0.24 | | | |
| Sheep Summer | 28.6 | 4.9 | +0.56 | 23.8 | 4.6 | +0.46 ^a | 15.4 | 4.1 | +0.16 | 39.1 | 6.4 | -0.18 |

^a $P < 0.05$

Table 9. Mean seasonal crude protein (%) of key forage species, Jarbidge Mountains, Nevada, 1999. Daily requirements for an adult cow elk, gravid in spring and lactating through mid-autumn, with average consumption rates, daily activities, and metabolic demands (from Cook; In Press).

| Species | June | | August | | Autumn | |
|---------------------------|-----------|-----|-----------|-----|-----------|-----|
| | \bar{x} | SE | \bar{x} | SE | \bar{x} | SE |
| Forbs | 20.7 | 2.0 | 13.2 | 2.1 | 8.4 | 1.2 |
| Arrowleaf balsamroot | 16.5 | 1.4 | 8.8 | 0.6 | 6.0 | 1.1 |
| Lupine spp. | 25.0 | 0.7 | 17.7 | 1.3 | 10.8 | 0.6 |
| Grasses | 15.1 | 1.2 | 8.9 | 0.6 | 6.0 | 0.4 |
| Bluebunch wheatgrass | 15.2 | 1.3 | 7.5 | 0.7 | 4.6 | 0.3 |
| Kentucky bluegrass | 15.8 | 0.6 | 10.2 | 0.6 | 7.9 | 0.2 |
| Idaho fescue | 11.3 | 0.4 | 6.0 | 0.4 | 5.5 | 0.4 |
| Mountain brome | 23.3 | 1.9 | 10.4 | 0.2 | 7.0 | 0.9 |
| Needlegrass spp. | 16.0 | 2.1 | 11.9 | 1.0 | 4.4 | 0.4 |
| Sandberg's bluegrass | 8.8 | 0.4 | 7.3 | 1.5 | 6.9 | 0.4 |
| Woody Plants | 16.6 | 1.0 | 11.0 | 0.5 | 9.0 | 0.4 |
| Curleaf mountain mahogany | 13.8 | 1.3 | 10.0 | 0.4 | 9.6 | 0.6 |
| Mountain snowberry | 17.5 | 0.6 | 10.2 | 1.0 | 7.7 | 0.8 |
| Snowbrush ceanothus | 18.5 | 1.7 | 12.7 | 0.2 | 9.8 | 0.2 |
| Requirements | | 15 | | 12 | | 7.5 |

Table 10. Mean seasonal in vitro dry matter digestibility (%) of key forage species, Jarbidge Mountains, Nevada, 1999.

| Species | June | | August | | Autumn | |
|---------------------------|-----------|-----|-----------|-----|-----------|-----|
| | \bar{x} | SE | \bar{x} | SE | \bar{x} | SE |
| Forbs | 78.1 | 2.1 | 68.3 | 1.2 | 57.0 | 0.9 |
| Arrowleaf balsamroot | 77.5 | 0.9 | 68.8 | 2.3 | 57.0 | 1.9 |
| Lupine spp. | 78.7 | 4.6 | 67.7 | 1.3 | 57.0 | 0.7 |
| Grasses | 67.5 | 1.3 | 57.8 | 1.6 | 54.6 | 1.4 |
| Bluebunch wheatgrass | 65.0 | 4.1 | 58.5 | 2.4 | 49.1 | 3.7 |
| Kentucky bluegrass | 67.1 | 1.0 | 55.3 | 4.3 | 53.4 | 1.7 |
| Idaho fescue | 66.2 | 2.9 | 61.2 | 4.2 | 53.1 | 3.7 |
| Mountain brome | 76.4 | 0.7 | 66.7 | 1.9 | 50.1 | 2.0 |
| Needlegrass spp. | 66.9 | 1.8 | 52.5 | 0.8 | 42.0 | 2.2 |
| Sandberg's bluegrass | 63.5 | 1.5 | 52.9 | 4.1 | 47.2 | 3.7 |
| Woody Plants | 67.5 | 3.7 | 63.0 | 2.1 | 61.7 | 1.3 |
| Curleaf mountain mahogany | 57.6 | 4.4 | 55.7 | 2.2 | 58.0 | 0.7 |
| Mountain snowberry | 79.8 | 2.5 | 68.6 | 1.5 | 62.0 | 1.8 |
| Snowbrush ceanothus | 65.1 | 3.2 | 64.7 | 1.7 | 65.3 | 1.9 |

Table 11. Digestible energy (Kcal/kg) of key forages and by key forage class across 3 time periods. Jarbidge Mountains, Nevada, 1999. Daily requirements for an adult cow elk, gravid in spring and lactating through mid-autumn, with average consumption rates, daily activities, and metabolic demands (from Cook; In Press).

| Species | June | | August | | Autumn | |
|----------------------------|-----------|-------|-----------|-------|-----------|-------|
| | \bar{x} | SE | \bar{x} | SE | \bar{x} | SE |
| Forbs | 3,230.4 | 108.5 | 2,729.9 | 61.0 | 2,157.6 | 45.0 |
| Arrowleaf balsamroot | 3,200.6 | 45.6 | 2,756.0 | 115.5 | 2,158.3 | 94.5 |
| Lupine spp. | 3,260.2 | 236.4 | 2,703.8 | 67.6 | 2,156.8 | 34.3 |
| Grasses | 2,692.4 | 65.7 | 2,198.9 | 83.9 | 2,034.9 | 71.0 |
| Bluebunch wheatgrass | 2,564.2 | 209.5 | 2,230.6 | 120.0 | 1,754.5 | 189.9 |
| Kentucky bluegrass | 2,672.0 | 51.1 | 2,069.4 | 220.1 | 1,972.1 | 85.8 |
| Idaho fescue | 2,624.5 | 146.4 | 2,369.0 | 215.8 | 1,959.1 | 190.7 |
| Mountain brome | 3,147.5 | 35.9 | 2,651.0 | 94.7 | 1,806.2 | 101.7 |
| Needlegrass spp. | 2,660.6 | 93.3 | 1,924.4 | 39.5 | 1,388.7 | 112.0 |
| Sandberg's bluegrass | 2,485.4 | 76.4 | 1,948.8 | 210.9 | 1,656.1 | 191.1 |
| Woody Plants | 2,692.0 | 188.3 | 2,462.3 | 107.8 | 2,397.7 | 66.7 |
| Curlleaf mountain mahogany | 2,184.8 | 223.1 | 2,090.5 | 113.0 | 2,205.2 | 37.6 |
| Mountain snowberry | 3,320.3 | 127.7 | 2,746.5 | 78.2 | 2,410.9 | 90.0 |
| Snowbrush ceanothus | 2,570.9 | 160.9 | 2,550.0 | 85.5 | 2,577.1 | 95.6 |
| Requirements | 3,000 | | 2,700 | | 2,400 | |

Fig. 1. Jarbidge elk study area "Nevada Hunt Unit 072."

Jarbidge Elk Study Area "Nevada Hunt Unit 072"

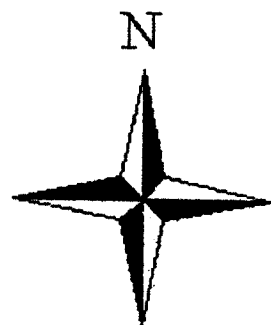
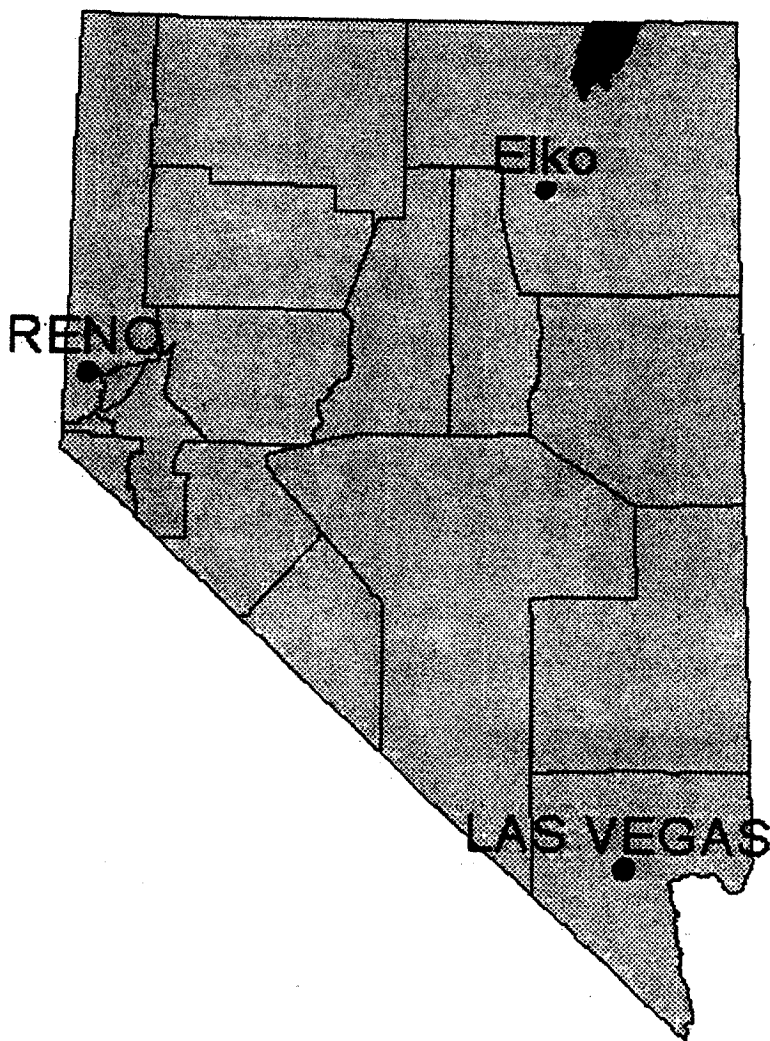


Fig. 2. Mean % use total aspen herbaceous crop, Jarbidge Mountains, Nevada, 1999.

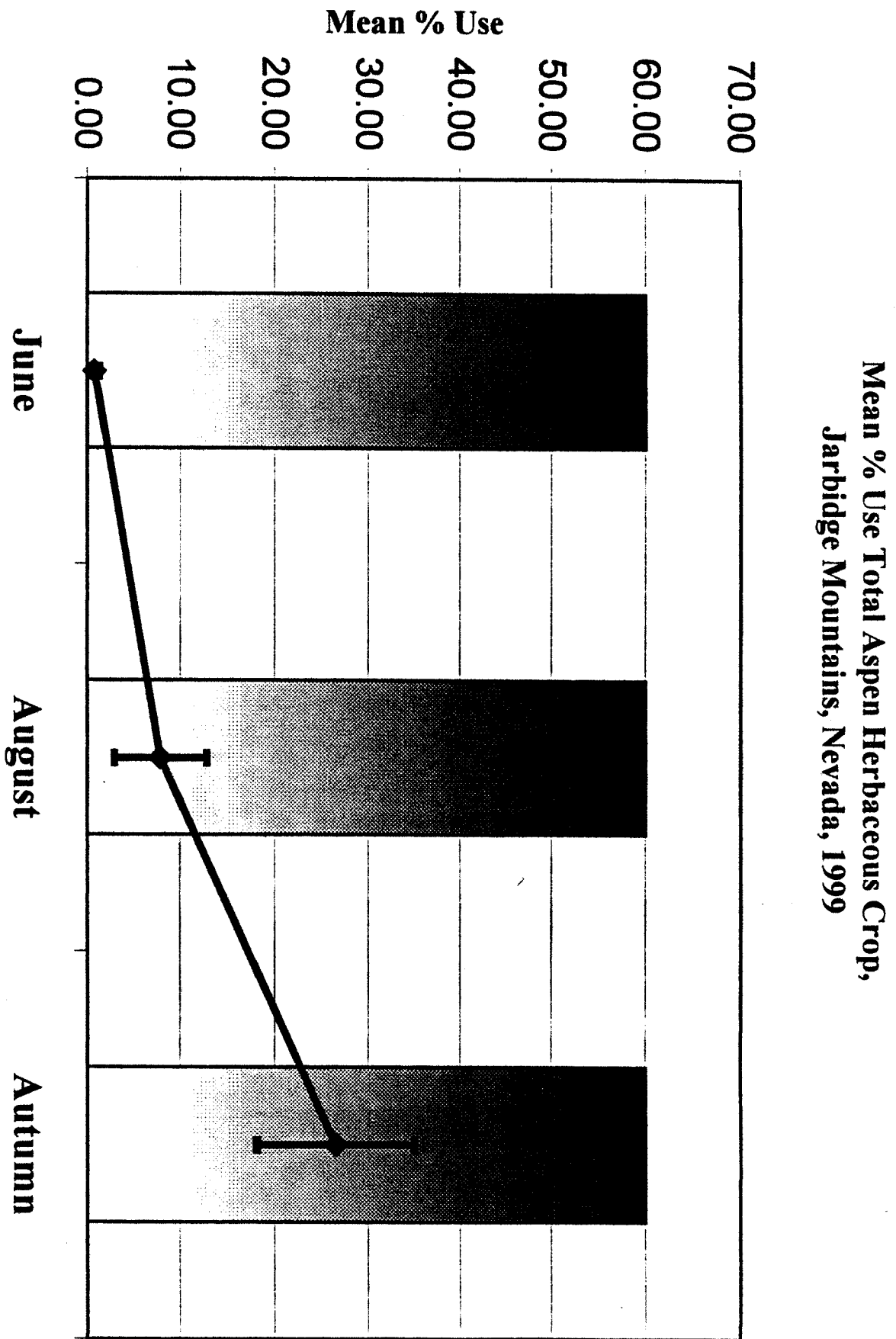


Fig. 3. Mean % use total mahogany herbaceous crop, Jarbidge Mountains, Nevada, 1999.

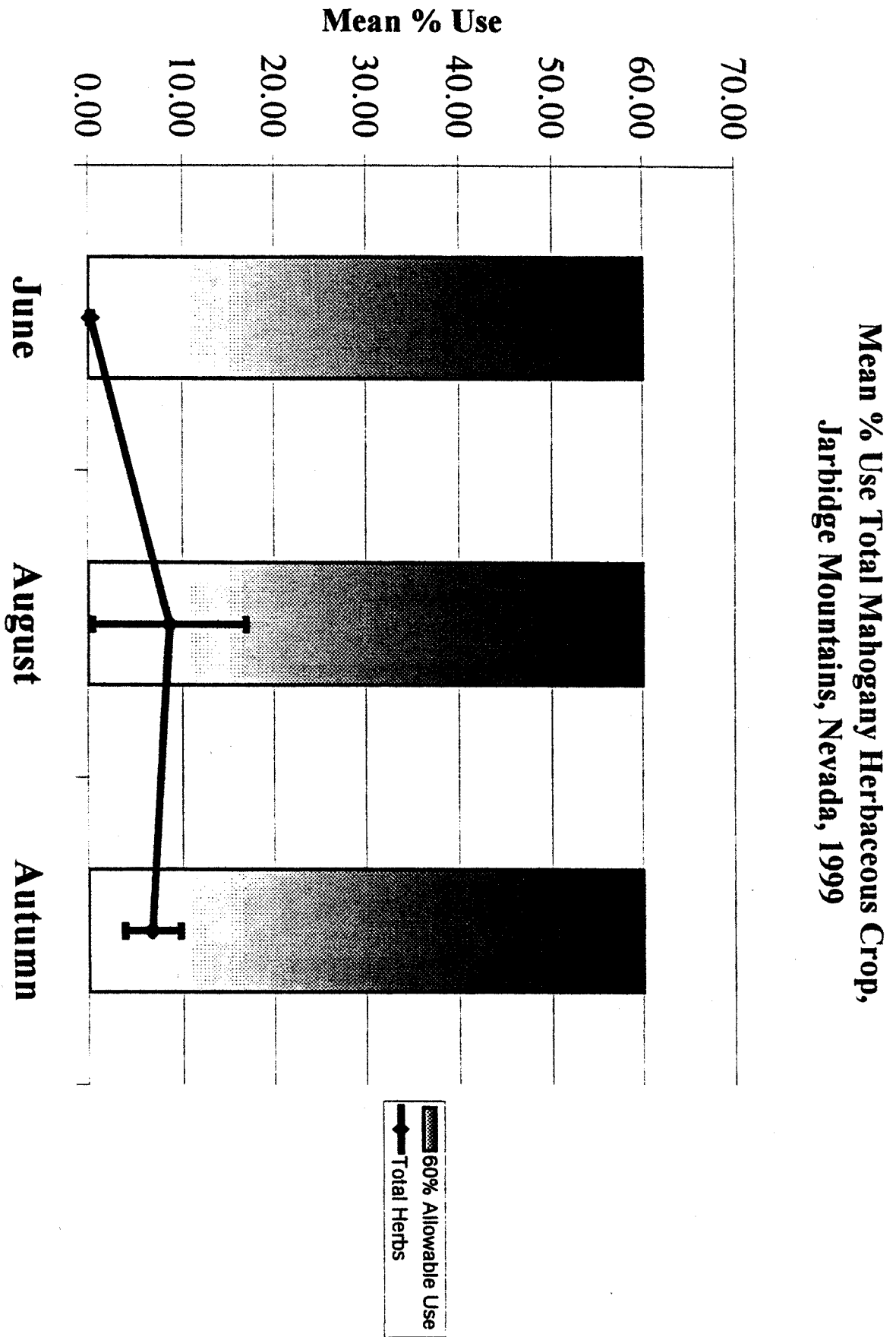


Fig. 4. Mean % use key aspen herbaceous crop, Jarbidge Mountains, Nevada, 1999.

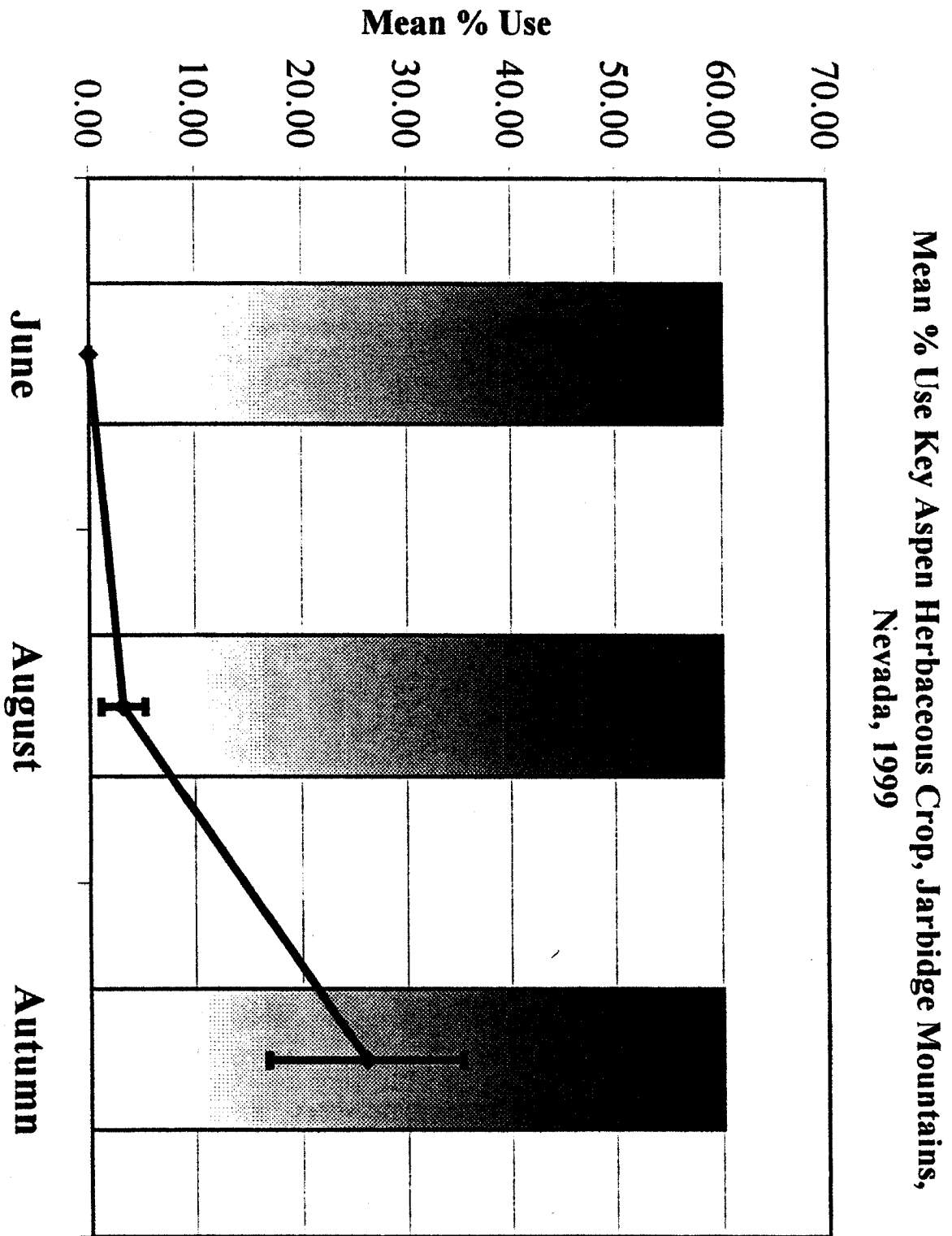
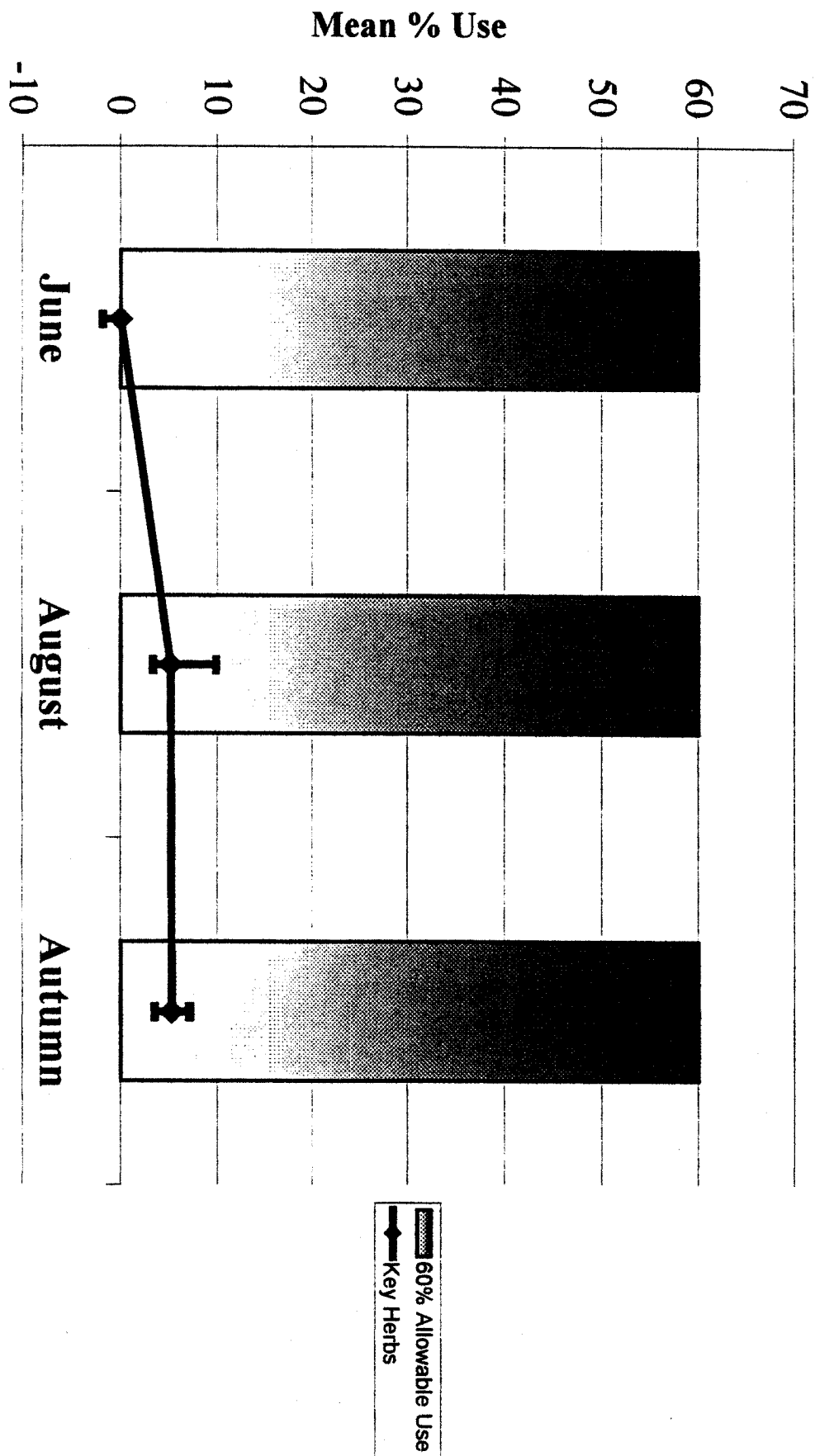


Fig. 5. Mean % use key mahogany herbaceous crop, Jarbidge Mountains, Nevada, 1999.



**Mean % Use Key Mahogany Herbaceous Crop,
Jarbidge Mountains, Nevada, 1999**

Fig. 6. Mean DM (kg/ha) herbaceous aspen standing crop, Jarbidge Mountains, Nevada, 1999.

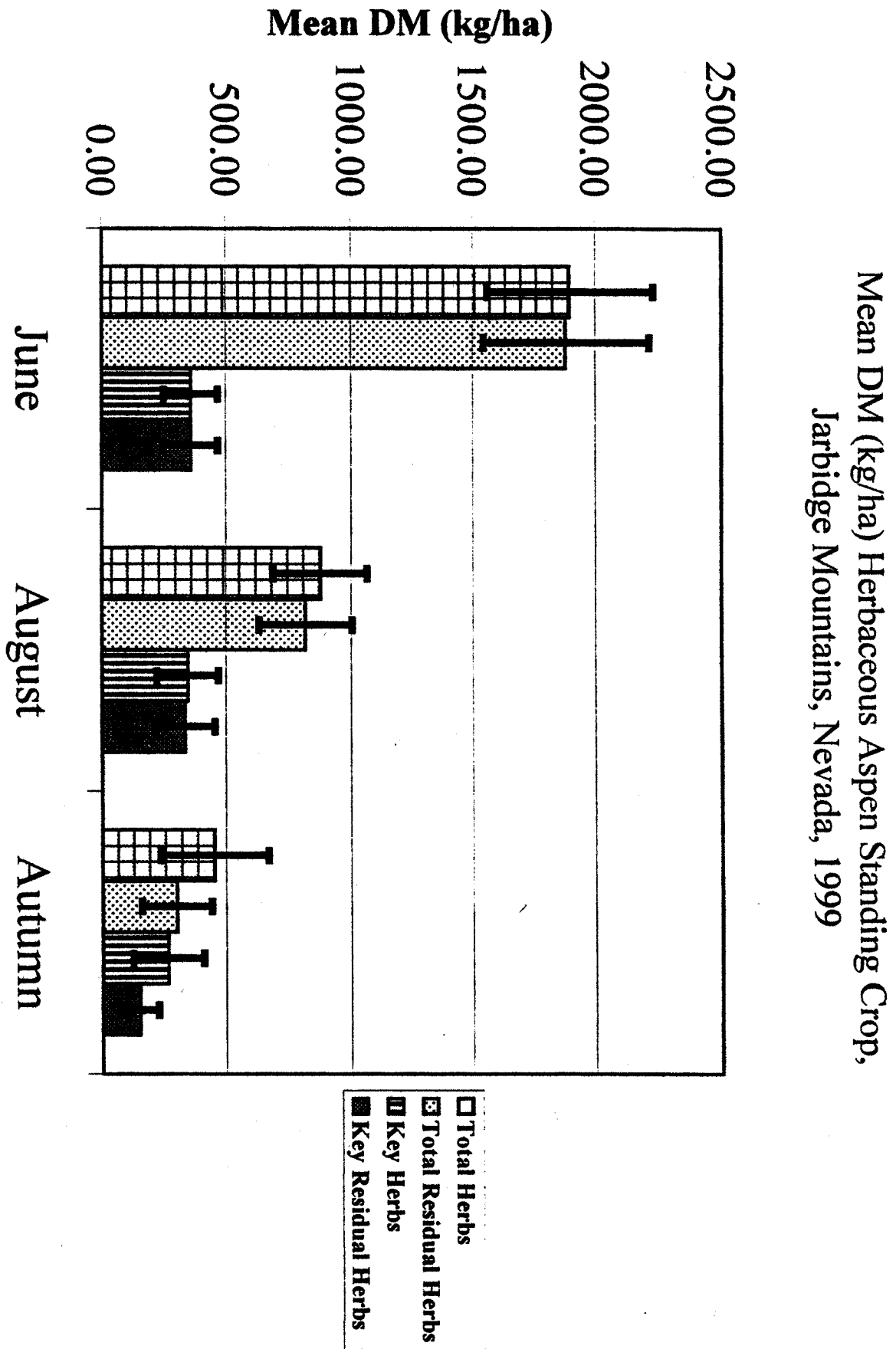


Fig. 7. Mean DM (kg/ha) herbaceous mahogany standing crop, Jarbidge Mountains, Nevada, 1999.

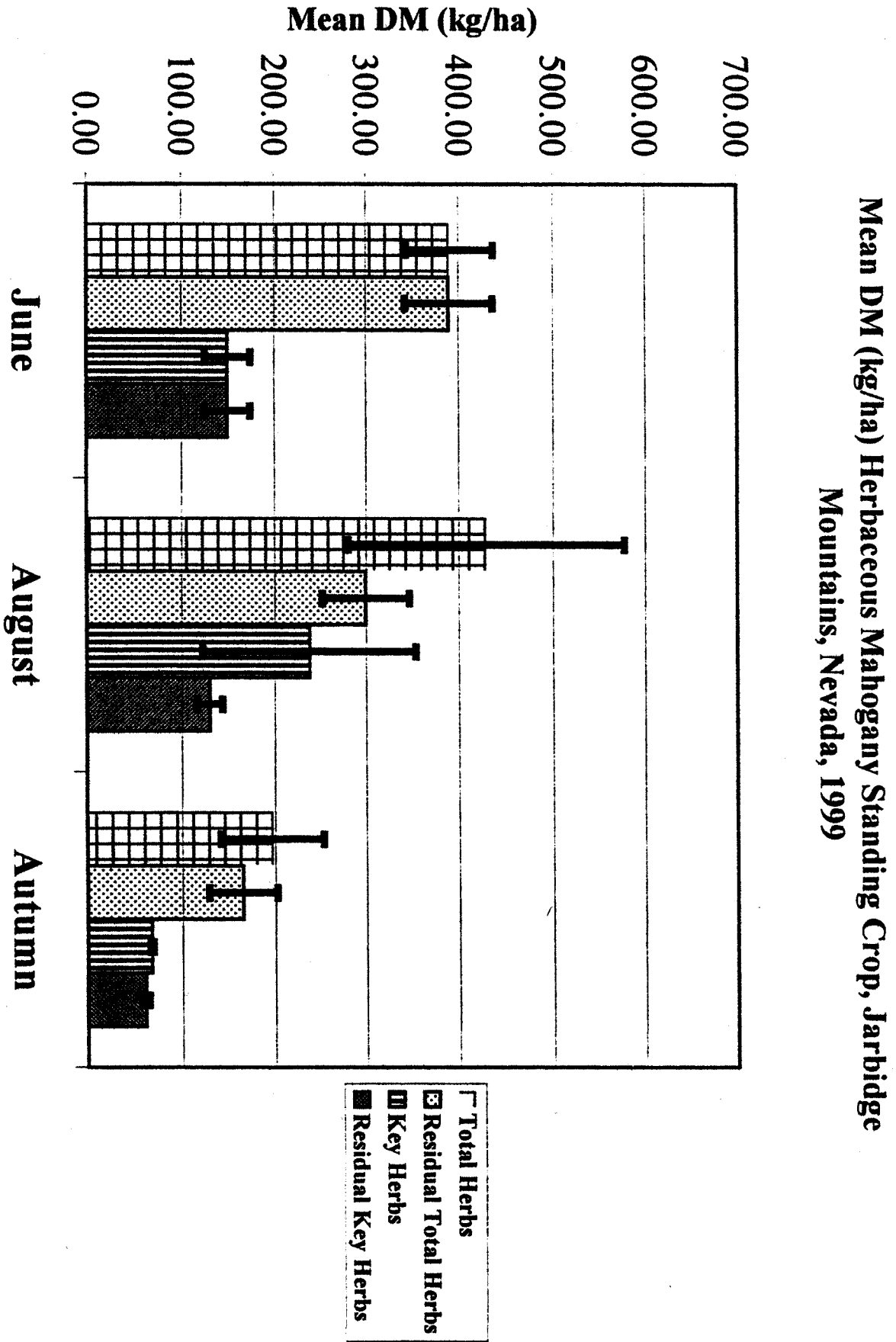


Fig. 8. Mean DM (kg/ha) snowbrush standing crop, Jarbidge Mountains, Nevada, 1999.

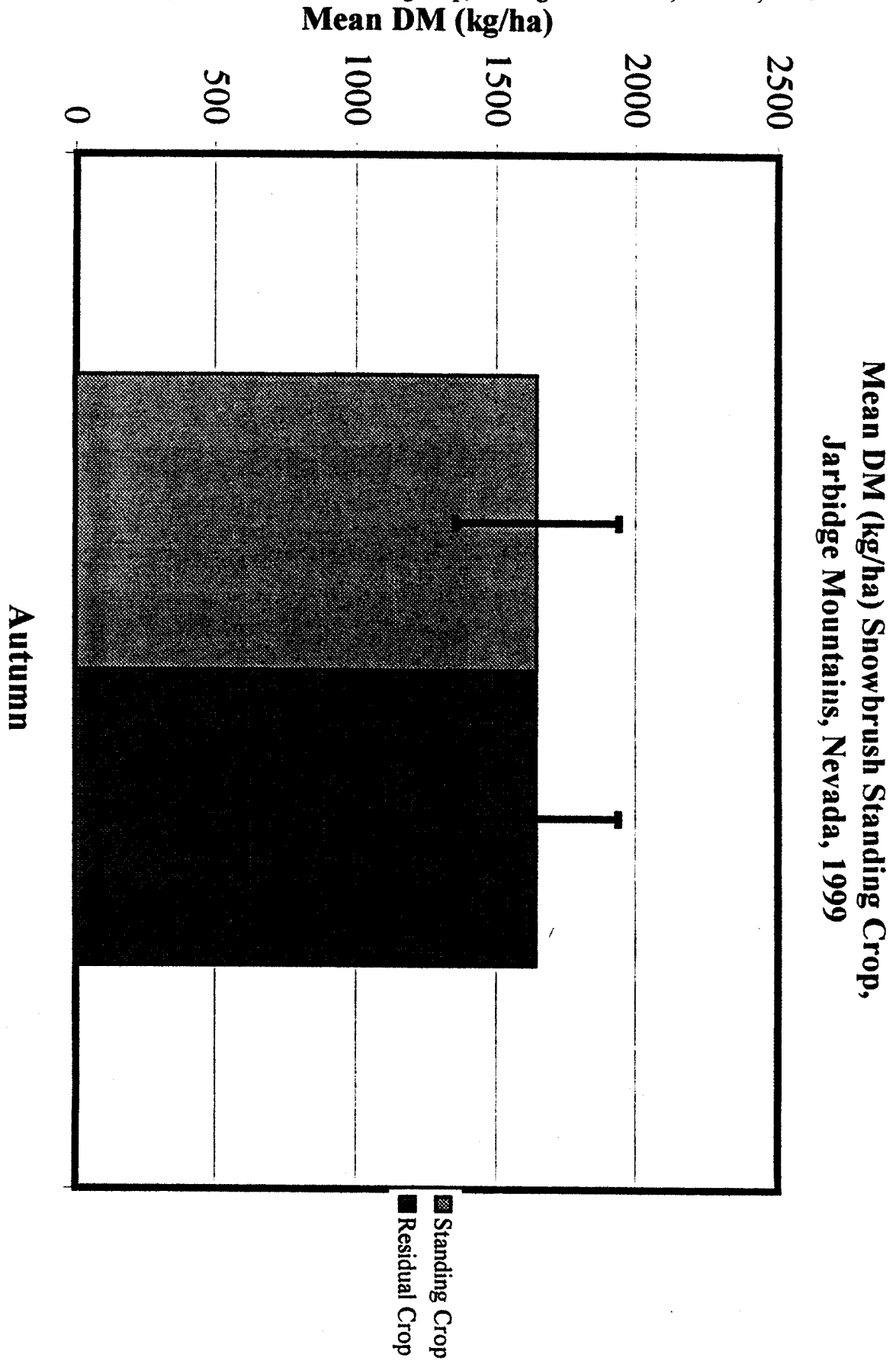


Fig. 9. Mean % use by elk at summer feeding sites, Jarbidge Mountains, Nevada, 1999.

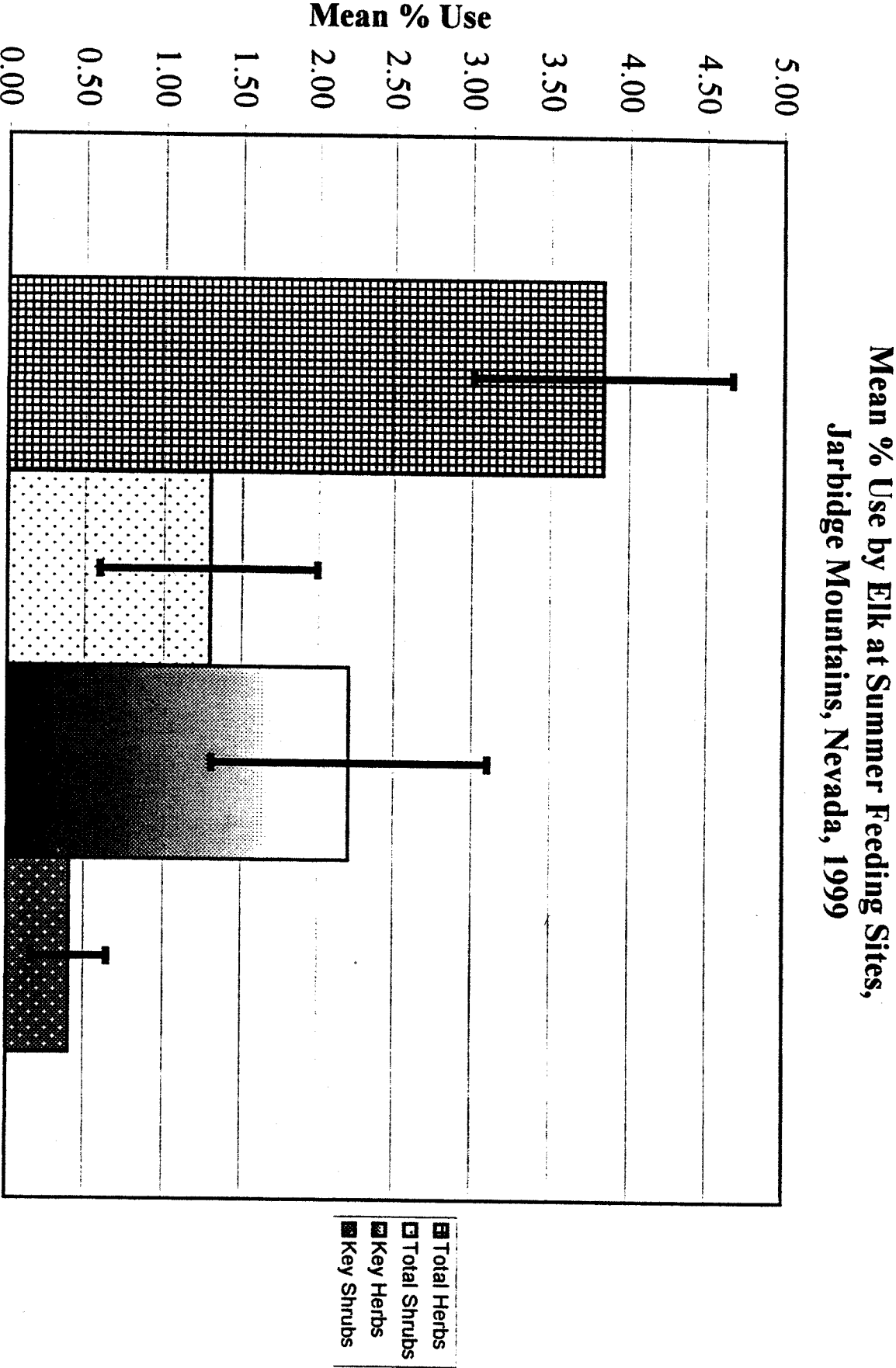


Fig. 10. Dietary proportions by forage class, Jarbidge Mountains, Nevada, 1999.

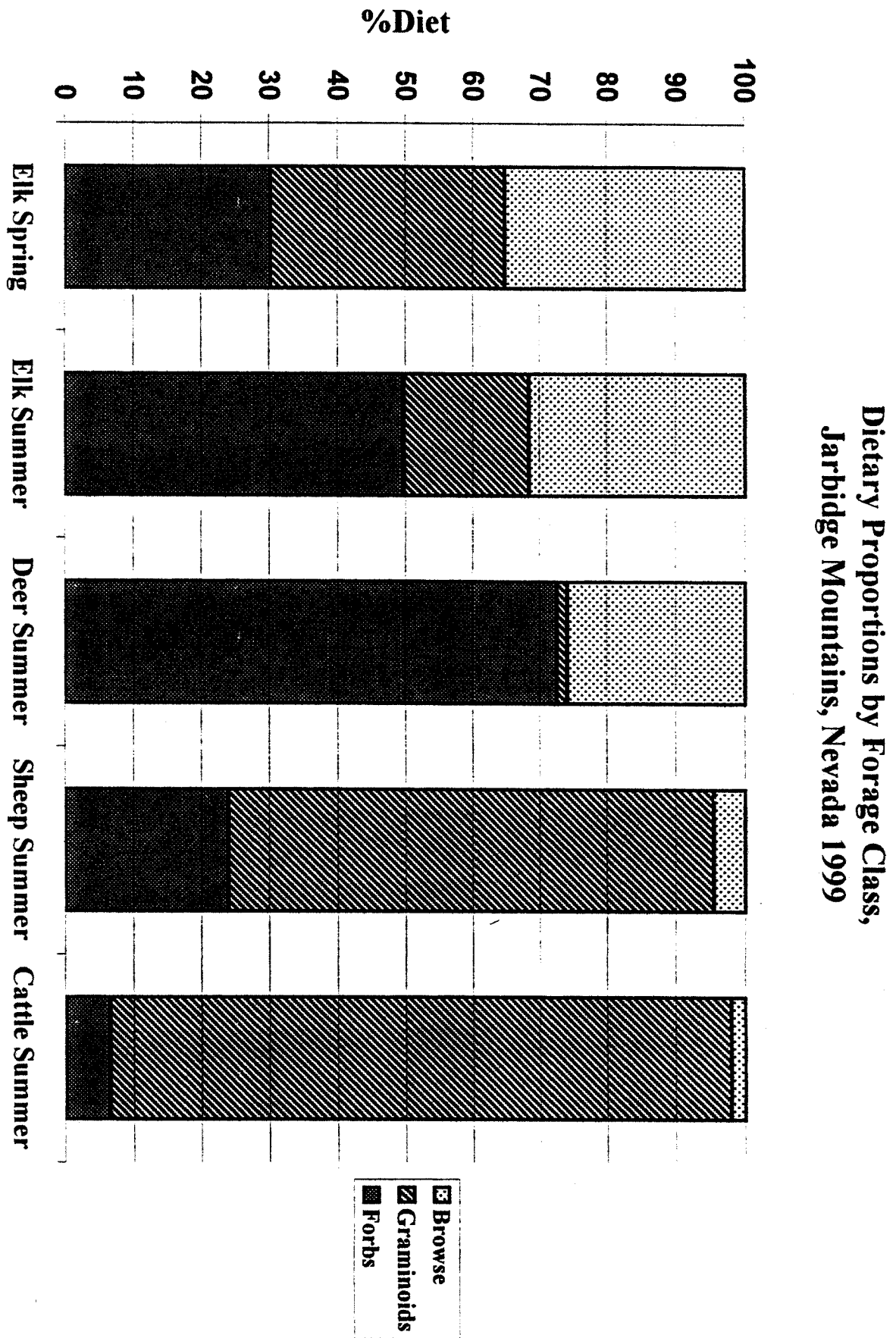


Fig. 11. Mean (%) crude protein of key species by forage class, Jarbidge Mountains, Nevada, 1999.

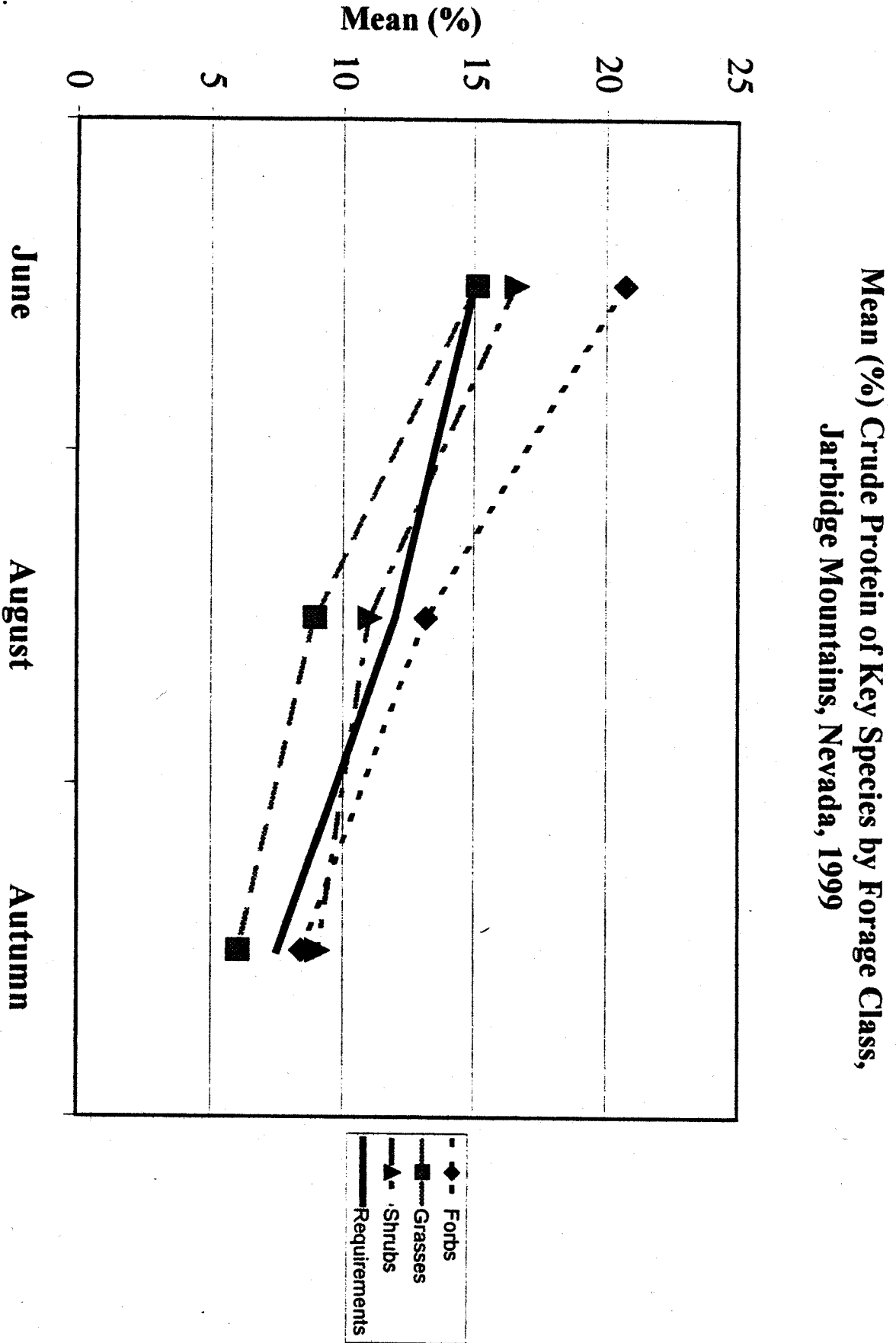


Fig. 12. Mean digestible energy (Kcal/kg) of key species by forage class, Jarbidge Mountains, Nevada, 1999.

