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Paired Comparisons: A Method For Ranking Mule Deer Preference For Various Browse Species

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ABSTRACT

Ten browse species were ranked according to preference by two tame mule deer. The statistical design was a balanced incomplete block design, using Kendall coefficient of concordance to test significance.

KEYWORDS: palatability ranking, mule deer

Concern has developed in recent years for restoration of big game ranges disturbed by increases in surface mining and other activities (Bay 1976). Knowledge of big game preference for various browse species and subpopulations within species would facilitate long term success in these restoration programs (Plummer and others 1968). Various testing methods have been used to evaluate mule deer (*Odocoileus hemionus*) preference. Often such methods are time consuming and/or show an undesirable amount of error (Smith 1950; Smith 1959; Wallmo and others 1973; Sheehy 1975; Scholl and others 1977; Welch and McArthur 1979; Smith and Shandruk 1979; Welch and others in press). The purpose of this paper is to present a method for rapid evaluation of mule deer preference for various winter browse species.

MATERIALS AND METHODS

In mid-January 1977, two tame deer[2] (a buck and a doe) were used to rank preference of 10 browse species. A population of each browse species to be tested was selected from locations surrounding Provo, Utah (table 1). Test samples consisted of the terminal 4 inches (10.16 cm) of current-year growth from randomly selected shrub plants, except for sweetbriar rose hips, which consisted of a twig and one hip.

The tame deer were fed a daily ration of alfalfa, deer pellets, and barley. Alfalfa and deer pellets were fed *ad libitum* and barley was restricted. One week prior to testing, 10 browse species from the same location where the test samples would be collected were fed daily to the deer *ad libitum*. During this pretesting, all 10 browse species were used but to different degrees. After 5:00 p.m. the day before the actual test, barley was not given out and alfalfa and the pellets were reduced to three-fourths the normal ration to assure the deer would be hungry for the trials. Testing began the following day at 9:00 a.m. During the test the deer were allowed to roam freely around the pen and had access to the alfalfa. All testing of browse species was done in one day.

The feeding trail was conducted as a balanced, incomplete block design with replication. A block consisted of presenting one of the deer with two different browse species at one time, twigs of the two browse species were held in the hands of the observer. There were 10 successive replications within each block and with each replication a new sample was used. Each browse species was compared with the other nine. this totaled 45 blocks or 450 individual comparisons; a layout of this design, as well as the research results, are presented in figure 1. Within each replication the species closest to the nose of the deer was alternated. In

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[2]The tame deer were provided by Utah State Division of Wildlife Resources Wildlife Relations Project, Logan, Utah 84321.

Table 1.—Location of populations of test species used in the paired comparison method of ranking mule deer preference for various browse species

Scientific name	Common name	City and county
Rosa eglanteria	Sweetbrier rose	Provo, Utah County
Cercocarpus ledifolius	Curlleaf mahogany	Provo, Utah County
Cowania mexicana	Cliffrose	Springville, Utah County
Purshia tridentata	Antelope bitterbrush	Springville, Utah County
Prunus virginiana	Black chokecherry	Springville, Utah County
Artemisia tridentata spp. *vaseyana*	Mountain big sagebrush	Springville, Utah County
Atriplex canescens	Fourwing saltbush	Orem, Utah County
Artemisia tridentata spp. *tridentata*	Basin big sagebrush	Indianola, Sanpete County
Chrysothamnus nauseosus	White rubber rabbitbrush	Nephi, Juab County
Cercocarpus montanus	True mountain mahogany	Nephi, Juab County

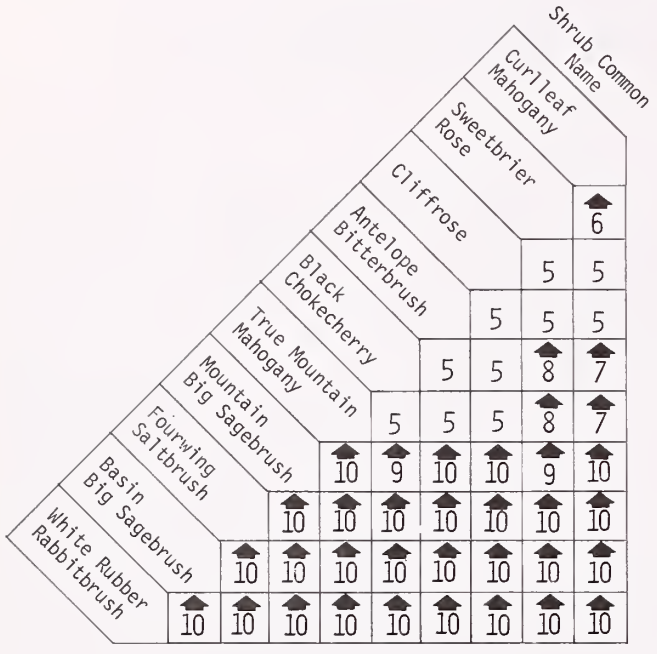

Figure 1.—Experimental design for testing 10 browse species. Each square represents 10 replications. Values in the squares are the number of times out of 10 that one member of the pair was chosen over the other. Arrows point to the pair member favored by the mule deer.

order to evaluate preference, the rank of 1 was assigned to the browse species not selected and a rank of 2 to the species selected.

This design assumes no differential preference between tame mule deer and wild mule deer. Other designs, such as the cafeteria and utilization by the bite-couting methods, make the same assumption.

Smith (1950), studying the preference of two captive wild mule deer for browse species, found that the deer preferred some browse species over others. The ranking of seven species common to ours and Smith's studies was similar (curlleaf mahogany, cliffrose, bitterbrush, chokecherry, mountain mahogany, big sagebrush, and rubber rabbitbrush).

Incomplete blocks in rank experiments make a useful experimental design for determining deer preference for various foods. The advantages of this design to others (Heady 1964): (1) less time and forage samples are needed and it eliminates error due to spilling and scattering of food by the test animals as in cafeteria design (Smith 1950; Smith 1959); (2) it eliminates the need for growing all species of interest in field plots, as in most utilization, rumen, or fecal analysis designs (Heady 1964; Sheehy 1975; Welch and McArthur 1979); (3) less technician time and training are needed compared to rumen or fecal analysis designs (Hansen and Dearden 1975; Smith and Shandruk 1979); (4) it eliminates variation among observers compared to designs based on utilization by percentage of twigs browsed (Pechanec 1936; Cole 1963; Jensen and Scotter 1977); (5) it eliminates differential availability (a weakness of utilization, rumen, or fecal analysis designs) (Heady 1964); and (6) it eliminates estimation errors common to utilization by the bite-counting method designs (Wallmo and others 1973).

Data were analyzed using a nonparametric test, that Durbin (1951) suggested for the analysis ranking of paired comparisons in an incomplete block design (Gibbons 1976); the null hypothesis was that there was no difference in the preference for the 10 species. A nonparametric test was selected because ordinal numerical data were used to rate preference. Requirements for this test: (1) each object should occur an equal number of times, and (2) the number of times two particular objects occur together in the same block should be the same for all possible pairs of objects (Durbin 1951). Following is a test of 10 treatments with Q as the test statistic. The value of W is the Kendall coefficient of concordance; this value lies between 0 and 1. The value of 0 implies no preference or *no* association between objects being tested, and the value of 1 indicates preference or perfect association.

The value of W is computed using the formula:

$$W = \frac{12\left(\sum_{j=1}^{n} R^2 j - 3k^2 m^2 \frac{(m+1)^2}{n}\right)}{\lambda^2 n(n^2-1)}$$

where:

λ = the number of complete sets of paired comparisons
m = the number of ranks
n = the number of objects to be ranked
$R^2 j$ = the sum of the ranks assigned to a particular object
k = the total number of individual comparisons

(In this case the above values were: $\lambda = 45, m = 2, n = 10, R = 188716$, and $k = 450$.)

The test statistic for this test, Q, follows approximately the chi square distribution. The value of Q is used when:

$$Q = \frac{\lambda (n^2-1) W}{m+1}$$

with $n-1$ degrees of freedom. If the null hypothesis is rejected, then a multiple comparison procedure can be used to see which treatments differ significantly from each other using the interval:

$$|Ri - Rj| \leq Z \frac{\sqrt{n \lambda (m+1)}}{6}$$

The value of Z if found from the normal curve, which corresponds to the right-tailed probability of $\alpha / n(n-1)$.

RESULTS AND DISCUSSION

Results of the preference ranking experiment showed that the tame mule deer significantly preferred some of the browse species over others ($W = 0.78$, $Q = 258.6$, $\alpha = 0.000$). Curlleaf mahogany and hips of sweetbriar rose were the most preferred, and white rubber rabbitbrush in our test was never chosen. Table 2 gives the ranking of all 10 browse species. (For comparison of given pairs, see fig. 1). Because genetic variation occurs in palatability with species collected from different locations (Welch and McArthur 1979; Welch and others, in press; White and others, in press), this ranking of the 10 browse species must be considered restricted to the array presented.

Table 2.—The rank position and percent of the times that mule deer chose each of the 10 browse species, in preference to the alternative

Species	Percent of time chosen[1]
Curlleaf mahogany	78
Sweetbrier rose	77
Cliffrose	72
Antelope bitterbrush	72
Black chokecherry	67
True mountain mahogany	66
Mountain big sagebrush	36
Fourwing saltbush	22
Basin big sagebrush	10
White rubber rabbitbrush	0

[1]Deer preference for species connected by the same line does not differ significantly at the 0.05 level.

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