

REPORT ON BIOLOGICAL STUDIES ATTECAPULIN
MOUNTAIN NATIONAL MONUMENT DURING THE LATE
SPRING, SUMMER, AND EARLY FALL OF 1976
1977

by: A.L. Gennaro, J. Patton, and T. Soapes

Report on Biological Studies at
Capulin Mountain National Monument
during the Late Spring, Summer,
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A.L. Gennaro, James Patton, and Thomas Soapes
Natural History Museum
Eastern New Mexico University
Portales, New Mexico 88130

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INTRODUCTION

The Natural History Museum of Eastern New Mexico University began a grassland monitoring program on Capulin Mountain National Monument, New Mexico in May 1974. The purpose and detailed methods involved in that program were described by Gennaro (1974). Briefly, he stated that two local ranchers were each given grazing permits for Areas 1 and 2 (Fig. 1) on the Monument as follows:

- 1) Area 1 -- Under permit by John Morrow since 1972. The annual grazing period is from 1 November to 1 June and the limitation is 36 animal unit months per year. Mr. Morrow had not grazed livestock on the area as of September 1976. The permit expired 1 September 1976.
- 2) Area 2 -- Under permit by Carlos Cornay since 1972. The annual grazing period is from 20 February to 1 June and the limitation is 18 animal unit months per year. The area has been grazed since 1972, the last grazing period being February through early May of 1976. The permit expires 1 March 1978.

During 1974, two 50 x 200 m barbed wire enclosures were constructed in each of Areas 1 and 2. Plant species composition and ground cover percentages of litter, vegetation, and bare ground were determined within each enclosure by using 100-point paced transects. During the summer and fall of 1975, 100-point paced transects were run inside and outside of Enclosures 1 and 2. During 1976 transects were run in the same manner.

Other research projects conducted on the Monument in 1975 and 1976 included surveys to determine the following: 1) annual browse utilization by deer in areas not under grazing permits, 2) index of the deer population, and 3) kinds and distribution of herptiles (amphibians and reptiles) and mammals. In 1976 we also studied the extent of Porcupine damage to conifers.

METHODS

The big game browse analysis techniques for New Mexico was used as a guide to determine vegetative composition and ground cover percentages on the areas under grazing permits, to determine annual browse utilization by deer on areas not under permits, and to interpret form and age class data from the browse utilization transects. References for plant identifications included: Kearney and Peebles (1964), Hitchcock (1950), Harrington (1954), and Correll and Johnston (1970).

To study the effects of grazing on permit Areas 1 and 2, three 100-point paced transects were run inside and two outside each of Exclosures 1 and 2 during May, June, July, August, and September of 1976. On Area 2, where grazing occurred from February - May 1976, Chi-square tests were used to determine whether or not significant differences occurred between the percentages of litter, plant cover, and bare ground inside as compared to outside Exclosure 2.

To study annual browse utilization on areas not under grazing permits, we ran four 100-point paced transects within the same area where they were run in 1975. We assumed that those sites received the heaviest browse use.

Four deer transects, each consisting of ten 1/100 acre plots were established on the Monument to derive an index to evaluate the annual trend in the deer population. One transect was placed within each of four habitat types; namely, Pinyon-Juniper-steep cinder slope, Little Blue Stem-Blue Grama,

Pinyon-Juniper-Oak-Blue Grama, and Oak-Mountain Mahogany. The total of 40 plots was cleared of deer pellet groups, and after 100 days, pellet groups (within the plots) were counted. The deer index was calculated by a formula presented by Dasmann (1964).

Two 1-ha plots were selected to determine the effects of Porcupine damage to conifers. One plot was established within an area dominated by Western Yellow Pine, and another within an area dominated by Pinyon.

Four measurements were taken from each Western Yellow Pine tree within the first plot and four measurements were taken from each Pinyon within the second plot. Those measurements (in.) included: 1) diameter at breast height, 2) height of the tree, 3) percentage of branch damage, and 4) percentage of girdling.

A range finder was used to determine tree height. A measurement was taken from the investigator to both the base of the tree and to the top of the tree. The height of the tree was then determined by solving for the unknown leg of the right triangle.

Percentage branch damage was determined by a randomizing technique, in the following manner. The position of a second hand on the observers watch established the side of a tree to be examined. If the second hand was on 6 o'clock as the observer faced a tree, the number of damaged branches out of 10 from the bottom on the side of the tree facing the observer was counted. If the second hand was on 12 o'clock, damaged branches were counted on the opposite side of the tree, etc.

The percentage of girdling was recorded (complete, 100%; half-girdling, 50%, etc.) by selecting and measuring the most extensive girdle on a tree. Only one girdle per tree was measured. Girdles out of reach were estimated.

Vertebrate distributions were studied in relationship to various habitat

types. The types were delineated with respect to dominant vegetation and physical structure. Herptiles were sighted or collected. Mammals were sighted, detected by signs, or captured with Museum Special snaptraps, commercial rat traps, Havahart live traps, or Sherman live traps from 6,000 trap nights. Bats were surveyed on three areas adjacent to the Monument where metal stock tanks were available. Herptiles were preserved in alcohol; mammals were preserved in alcohol or prepared as round, dried study skins. All specimens were deposited in the Eastern New Mexico University Natural History Museum.

RESULTS AND DISCUSSION

Effects of Grazing. The results of the 100-point paced transects are shown in Tables 1-4. On Area 2, where grazing occurred during 1975, Chi-square tests showed significant differences at the 80% confidence level inside and outside the enclosure for litter, plant cover, and bare ground (Table 5), meaning that 8 or more times out of 10 the differences in percentages of litter, plant cover, and bare ground outside as compared to inside the enclosure were due to factors other than chance. In this particular case, grazing by livestock would appear to be the factor causing the differences.

A significant difference in plant cover inside and outside Enclosure 2 occurred only during May (Table 5) because in subsequent months, the extensive germination of Russian Thistle on bare ground outside the enclosure resulted in an increase in the plant cover percentages outside that enclosure (Tables 3 and 4).

Previously, Gennaro and Trujillo (1975) noted a significant difference in litter percentages inside and outside Enclosure 2. They pointed out the consequences of litter reduction, stating that continued failure to return litter to the soil could result in the reduction of the following:

- 1) humus accumulation
- 2) soil aeration
- 3) nutrient retention of the humus fraction
- 4) recycling of nutrient materials
- 5) seed germination

The 1976 transect data showed that the consequences predicted by Gennaro and Trujillo may be in effect.

Cool season grasses such as Squirrel Tail and Western Wheatgrass were lower in percentage outside than inside Exclosure 2 (Tables 3 and 4). Gennaro and Trujillo (1975) stated that those grasses form the earliest growth of the new season, and that they are very attractive to grazers during mild winters and early spring. Continual grazing pressure on the already scarce grasses may result in their eventual elimination.

Percentages of plant cover on Areas 1 and 2, both inside and outside the exclosures, were higher in 1976 than 1975. Differences in precipitation during those two years may have been responsible. During 1975, precipitation records (in.) from January through August were 0.70, 0.52, 0.93, 0.39, 0.27, 2.66, 2.64, and 2.75, respectively. During 1976, records from January through August were 0.40, 0.46, 0.02, 0.64, 1.84, 1.41, 2.24, and 1.08, respectively. During May 1976, a precipitation of 1.84 in. was approximately seven times the precipitation in May 1975 (0.27 in.). Perhaps that early spring precipitation occurred at the right time to bring about a dense plant cover in 1976.

RECOMMENDATIONS: In 1975, Gennaro and Trujillo noted the low percentage of cool-season grasses and litter outside Exclosure 2 as compared to inside that exclosure. They recommended that grazing be eliminated on Area 2. As an alternative recommendation, they suggested a change in grazing schedule from

20 February-1 June to 20 November-1 March, as well as a reduction in animal unit months from the allotted 18 to 9. The 1976 data also showed a reduction of cool-season grasses and a significant reduction of litter and plant cover outside as compared to inside Exclosure 2. Bare ground was significantly increased outside Exclosure 2. On the basis of the 1976 data, we recommend, with a high priority, the elimination of grazing on Area 2; on a low priority basis, we suggest a shifting of the grazing schedule and reduction of animal unit months as stated by Gennaro and Trujillo in 1975.

Annual Utilization of Browse Species. Annual browse utilization percentages are shown in Table 6. Thirty-nine percent was the highest utilization recorded. James F. Johnson (personal communication, New Mexico Department of Game and Fish) stated that 60% or more utilization for several consecutive years was indicative of heavy browse. Therefore, in areas where transects were run, plants were not browsed enough to cause a reduction of productivity.

The vigor rating for "A" species for the browse utilization transects was determined from Age Classes (Table 7) and Form Classes (Table 8). The vigor rating for "A" species was medium, and the replacement of decadents by young plants among "A" species was greater than 100%. Thus, the overall productivity of "A" species is satisfactory.

RECOMMENDATIONS: As long as deer occupy the Monument, annual utilization checks are necessary. We recommend that the four transect areas surveyed in 1976 be surveyed again in 1977.

Deer index. Data collected from four transects provided baseline data for monitoring trend in the deer population on the Monument. The actual density parameter of deer cannot be established with a great deal of accuracy by the pellet group method because of the many factors which affect

the number of pellet groups counted, such as movements of pellets down slopes by water runoff, redistribution of pellets by flooding in low areas, or other factors which may cause pellets to be dispersed rather than confined to groups. Also, the figure obtained from the pellet-group-count method assumes that all deer are distributed evenly. Such a distribution is unlikely. Deer herds frequent some areas and rarely visit others. It would be very difficult to select survey sites which would sample a hypothetical distribution.

The 1976 trend data from the habitat types (Fig. 1) were as follows:

- 1) Habitat type C: Little Blue Stem-Blue Grama, 0.3 deer/acre.
- 2) Habitat type H: Oak-Mountain Mahogany, 0.3 deer/acre.
- 3) Habitat type J: Pinyon-Juniper-steep cinder slope, 0.3 deer/acre.
- 4) Habitat type K: Pinyon-Juniper-Oak-Blue Grama, 0.1 deer/acre.

The annual utilization check of browse species indicated that percentage browse was less than that which would be detrimental to browse plants. The aforementioned indices from each habitat type thus represent a population size of deer that is not in excess of carrying capacity on the Monument.

RECOMMENDATIONS: The four deer transects should be run about every 100 days. The indices derived, plus information from annual browse utilization checks, should provide comparable data to monitor population size of deer in relationship to browse usage.

Porcupine damage. Sizes of Western Yellow Pine and Pinyon in the 1-ha study plots are shown in Table 9. Porcupine injury noted on those trees was as follows:

- 1) Western Yellow Pine: A total of 74 living trees and 4 dead trees (5% of the total) was examined. No seedlings were observed. All percentages hereafter refer to living trees.

Ninety-two percent of the trees were girdled either partially or completely (Table 9). Fifty-eight percent of the Western Yellow Pines showed "top girdling", i.e., a 100% girdle near the terminal end of the tree. That part of the tree above the girdle was dead. Consequently, the crown of the tree was produced entirely by secondary branches, resulting in a globular growth form.

Ninety-nine percent of the trees showed branch damage (Table 9). Branch damage or girdling or both occurred on the four dead trees.

2) Pinyon: A total of 313 living trees, 15 seedlings, and 14 dead trees (5% of the total) was examined. All percentages hereafter refer to living trees; seedlings are not included.

Seventy percent of the trees showed girdle damage (Table 10). Of those, 17% showed "top girdling" and the same kind of growth form as Western Yellow Pine.

Sixty-one percent of the trees displayed branch damage (Table 10). Branch damage or girdling or both occurred on 50% of the dead trees.

The study of Porcupine damage has revealed the extent of damage. At this date, there is no way to determine how long it took to produce that damage or when it occurred.

Apparently Porcupines are not killing a large percentage of the trees. The death of trees on the plots was low (5% for Western Yellow Pine and 5% for Pinyon), and those deaths could not be attributed to injuries caused by Porcupines. The main problem seems to be deformation of trees and exposure of the trees to disease and fungus infections.

RECOMMENDATIONS: Spencer (1945-47) studied the effects of Porcupine injury to conifers on Mesa Verde National Park, Colorado. He stated that injured conifers died directly from girdling or from diseases and fungi which invaded

the injured tissue.

Although the percentage of dead trees was low on Capulin Mountain National Monument study plots, the high percentage of injured pine trees and the extensive amount of tree deformation present a situation in need of further investigation. To gather data regarding recommendations about control of Porcupines, the study plots on the Monument should be examined each year to record damage on an annual basis. Next, a baseline needs to be initiated to relate degree of tree damage to longevity.

Vertebrate Survey. Nine kinds of herptiles and 23 kinds of mammals were recorded from Capulin Mountain National Monument, New Mexico (Table 11). Records for those species were based on captures, observations, and signs.

Gennaro and Trujillo (1975) surveyed and associated herptiles and mammals to major habitats. The approach in 1976 was more specific. First, 17 habitat types were delineated on the basis of dominant vegetation and physical structure (Fig. 1). Then, each one of those habitat types was surveyed extensively. Habitat types and the herptiles and mammals associated with them are as follows:

A. Blue Grama-Prairie Sage-wart.

Blue Grama abundant; Prairie Sage-wart moderate in amount and dispersed; humus abundant; moderate to gentle slope; base of mountain on south side.

HERPTILES:

Lesser Earless Lizard
Eastern Fence Lizard
Six-lined Racerunner
Racer
Gopher Snake

MAMMALS:

Cottontail
Black-tailed Jack Rabbit
Botta's Pocket Gopher
Hispid Pocket Mouse
Ord's Kangaroo Rat
Deer Mouse

Porcupine
Mule Deer

B. Yucca-Blue Grama

Yucca dispersed throughout a dense mat of Blue Grama; humus abundant; gentle slope; abundant cinder deposits radiating out from the base of the mountain; base of mountain on east side.

HERPTILES:

Lesser Earless Lizard
Eastern Fence Lizard
Short-horned Lizard
Racer
Western Rattlesnake

MAMMALS:

Cottontail
Botta's Pocket Gopher
Hispid Pocket Mouse
Ord's Kangaroo Rat
Western Harvest Mouse
Deer Mouse
Northern Grasshopper Mouse
Porcupine
Mule Deer

C. Little Blue-Stem-Blue Grama

Both grass species abundant; humus abundant; level to gentle slope; base of mountain on west side.

HERPTILES:

Gopher Snake

MAMMALS:

Botta's Pocket Gopher
Hispid Pocket Mouse
Deer Mouse
Mexican Vole
Porcupine
Mule Deer

D. Pinyon-Juniper-lava outcrop

Moderate amounts of Pinyon and One-seeded Juniper; sparsely scattered Western Yellow Pine; substrate with small to large lava rocks forming extrusions frequently over 10 ft high.

HERPTILES:

Eastern Fence Lizard

MAMMALS:

Colorado Chipmunk
 Rock Squirrel
 Botta's Pocket Gopher
 Deer Mouse
 Brush Mouse
 White-throated Woodrat
 Mexican Woodrat
 Porcupine
 Gray Fox
 Bobcat (skull)
 Mule Deer

E. Blue Grama-lava extrusions

Blue Grama moderate; Pinyon and One-seeded Juniper very sparse; humus moderate; habitat traversed by lava ridges usually less than 10 ft high.

HERPTILES:

Eastern Fence Lizard
 Gopher Snake

MAMMALS:

Desert Cottontail
 Colorado Chipmunk
 Rock Squirrel
 Botta's Pocket Gopher
 Deer Mouse
 Mexican Woodrat
 Porcupine
 Mule Deer

F. Pinyon-Juniper-lava extrusions

Sparsely scattered Pinyon and One-seeded Juniper and understory of Oak dispersed over lava extrusions; extrusions usually less than 10 ft high.

HERPTILES:

Eastern Fence Lizard

MAMMALS:

Desert Cottontail
 Colorado Chipmunk

Rock Squirrel
 Botta's Pocket Gopher
 Deer Mouse
 Brush Mouse
 Rock Mouse
 White-throated Woodrat
 Porcupine
 Coyote
 Mule Deer

G. Common Horehound-Four-wing Saltbush

Moderate stands of Common Horehound and Four-wing Saltbush; excessive erosion; sparsely scattered Pinyon and One-seeded Juniper; south-facing steep slope.

HERPTILES:

Lesser Earless Lizard
 Eastern Fence Lizard
 Six-lined Racerunner

MAMMALS:

Botta's Pocket Gopher
 Ord's Kangaroo Rat
 Western Harvest Mouse
 Deer Mouse
 Porcupine
 Coyote
 Mule Deer

H. Oak-Mountain Mahogany

Dense stands of mixed Oak and Mountain Mahogany; homogeneous stands of either of those shrubs; humus abundant; northwest-facing slope.

MAMMALS:

Deer Mouse
 Mexican Vole
 Porcupine
 Mule Deer

I. Pinyon-Juniper-Mountain Mahogany belt

A tree-shrub vegetative belt that virtually surrounds the base of the mountain, the belt being interrupted only on the south-facing slope by Common Horehound-Four-wing Saltbush habitat type.

HERPTILES:

Eastern Fence Lizard
 Six-lined Racerunner

MAMMALS:

Cottontail
 Black-tailed Jack Rabbit
 Botta's Pocket Gopher
 Deer Mouse
 Porcupine
 Gray Fox
 Mule Deer

J. Pinyon-Juniper-steep cinder slope

Dense stands of Pinyon and One-seeded Juniper; no understory; cinder slope containing deep furrows perpendicular to the mountain contours; furrows formed from water runoff from culverts along mountain road; most of the furrows filled with large rocks; east-facing slope.

HERPTILES:

Eastern Fence Lizard
 Six-lined Racerunner

MAMMALS:

Colorado Chipmunk
 Rock Squirrel
 Botta's Pocket Gopher
 Deer Mouse
 Brush Mouse
 White-footed Mouse
 Rock Mouse
 White-throated Woodrat
 Porcupine
 Gray Fox
 Mule Deer

K. Pinyon-Juniper-Oak-Blue Grama

Trees and shrubs evenly dispersed over Blue Grama; cinder more abundant than humus; west-facing steep slope.

HERPTILES:

Eastern Fence Lizard
 Gopher Snake

MAMMALS:

Botta's Pocket Gopher
 Mexican Vole
 Porcupine
 Mule Deer

L. Oak-Squaw Bush-Chokecherry

Dense stands of Oak, Squaw Bush, and Chokecherry in eroded furrows perpendicular to contours and radiating out from the crater rim to the mountain base.

MAMMALS:

Deer Mouse
Mexican Vole
Porcupine
Mule Deer

M. Muhly Grassland-crater rim

Muhly (Muhlenbergia spp.) dense; substrate a humus-cinder mixture; north-facing slope; outside and immediately below crater rim.

MAMMALS:

Botta's Pocket Gopher
Hispid Pocket Mouse
Deer Mouse
Mexican Vole
Porcupine
Mule Deer

N. Lava ridge-crater rim

Sparsely scattered Pinyon and One-seeded Juniper among large lava rocks forming ridge; southeast-facing slope; outside and immediately below crater rim.

HERPTILES:

Eastern Fence Lizard

MAMMALS:

Colorado Chipmunk
Deer Mouse
Piñon Mouse
Mexican Woodrat
Porcupine
Mule Deer

O. Pinyon-Juniper-cinder-humus substrate

Moderate amounts of Pinyon and One-seeded Juniper; understory of Mountain Mahogany; cinder-humus substrate inside crater and immediately below rim; south-facing slope.

HERPTILES:

Eastern Fence Lizard

MAMMALS:

Colorado Chipmunk
 Rock Squirrel
 Deer Mouse
 Porcupine
 Mule Deer

P. Mountain Mahogany-Squaw Bush-Prickly Pear

Moderate amounts of Mountain Mahogany, Squaw Bush, and Prickly Pear (Opuntia spp.) dispersed among small and large lava rocks; moderate erosion; inside crater; south-facing slope.

HERPTILES:

Eastern Fence Lizard

MAMMALS:

Colorado Chipmunk
 Rock Squirrel
 Deer Mouse
 Brush Mouse
 Porcupine
 Mule Deer

Q. Oak-Squaw Bush-Chokecherry-Mountain Mahogany

Dense mixed stands of Oak, Squaw Bush, Chokecherry, and Mountain Mahogany; large lava rocks dispersed throughout the area; north-facing slope inside crater.

HERPTILES:

Eastern Fence Lizard
 Gopher Snake

MAMMALS:

Cottontail
 Colorado Chipmunk
 Rock Squirrel
 Western Harvest Mouse
 Deer Mouse
 Pinon Mouse
 Mexican Vole
 Porcupine
 Mule Deer

Two assumptions must be considered when surveying species in relationship to delineated habitat types--one, that the failure to detect a species

does not mean that it does not occur there; and two, as the survey continues certain species are discovered in more and more habitat types. Our statements result from a one-season survey. Thus, comments about certain species can only be generalizations. More specific comments will follow subsequent surveys.

Amphibians: Only one kind of amphibian, the Western Spadefoot, was captured. Specimens were taken from a temporary pool on the western edge of the Monument and from inside the crater in Oak-Squaw Bush-Chokecherry-Mountain Mahogany. Those animals prefer temporary pools of water for breeding and can be expected to occur within any habitat where pools develop during the rainy season.

Lizards: The Lesser Earless Lizard occupied the lower elevations, being found primarily at the mountain's base in Blue Grama-Prairie Sage-wart and Yucca-Blue Grama. The species also occurred just above the mountain's base in Common Horehound-Four-wing Saltbush.

The Six-lined Racerunner was recorded from all habitats occupied by Lesser Earless Lizards, but it was found at higher elevations up to 7,500 ft in the Pinyon-Juniper-steep cinder slope. That elevation is approximately one-half the distance to Capulin Mountain summit.

The Eastern Fence Lizard was recorded from 13 of 19 habitats. The animal appears to occupy all the habitat types on the Monument.

The Short-horned Lizard was found only in Yucca-Blue Grama. However, the lizards tolerance for low temperatures in New Mexico, where it occurs as high in elevation as pine-spruce (Stebbins 1954), would seemingly not restrict it from any elevation on the Monument.

Snakes: Snakes are nocturnal and secretive; thus, their affinities for specific habitat types is difficult to interpret. The Gopher Snake was

encountered more often than other snakes. It occurred in five habitat types including those on the base of the mountain, on the slopes, and within the crater. Racers were recorded only from the mountain's base in Yucca-Blue Grama and Blue Grama-Prairie Sage-wart. Likewise, the Western Rattlesnake was collected only in the Yucca-Blue Grama habitat type. However, both the Racer and Western Rattlesnake are expected to occupy all elevations within the Monument. Gennaro and Trujillo (1975) collected a Plains Garder Snake in a temporary pool near the western edge of the Monument. Stebbins (1954) stated that Plains Garder Snakes are occasionally found a considerable distance from water. That being the case, the snake can be expected to occur in several habitat types.

Bats: The Fringed Myotis and Small-footed Myotis were collected from one of three areas surveyed outside the Monument boundary. Both species were taken from open grassland 2.25 mi. NE by road from Capulin Mountain National Monument. Bats occurring adjacent to the boundary would probably be associated with most habitats within the Monument.

Lagomorphs: Two kinds of Cottontails (the Desert Cottontail and Eastern Cottontail (Sylvilagus floridanus Gray) and one hare, the Black-tailed Jack Rabbit occupy the Monument. The Black-tailed Jack Rabbit was observed only once within the Pinyon-Juniper-Mountain Mahogany belt, and Blue Grama-Prairie Sage-wart habitats. The hare's greatest densities in New Mexico are in grasslands and deserts although it occasionally occurs as high as 8,700 ft in open Yellow Pine forests (Findley et al. 1975).

Since the two species of cottontails can be distinguished only by body and cranial measurements, their capture is necessary. We have taken two specimens thus far, and both were Desert Cottontails. One was captured in Blue Grama-lava extrusions and the other in Pinyon-Juniper-lava extrusions.

Both habitats are at the base of Capulin Mountain. At the present time, we cannot state that the Desert Cottontail only occurs at the base of the mountain, because Cottontails (either species?) were sighted on the slopes, as well as inside the crater.

Rodents: During this preliminary survey, more effort was put forth to seek out rodent habitat affinities than any other vertebrates. However, our knowledge of habitat preferences in certain species is still meager and should be enhanced by subsequent investigations.

Diurnal rodents, or those that produce distinctive signs, or both, include the Colorado Chipmunk, Rock Squirrel, Botta's Pocket Gopher, and Porcupine. The Colorado Chipmunk occurred everywhere except in grassland at the mountain's base. Rock squirrels were not observed in the grassland, but they were common wherever lava rock occurred. Pocket gophers were collected or their mounds were sighted wherever soils were suitable for excavation. The evidence of Porcupine damage to conifers indicated that those animals were present in all habitats occupied by Pinyon and/or Western Yellow Pine.

Certain species were nocturnal and showed affinities for lava rock habitats. Those included the Brush Mouse, Piñon Mouse, Rock Mouse, White-throated Woodrat, and Mexican Woodrat. Woodrats were easily identified; but, we encountered difficulty in identifying the Brush, Piñon, and Rock mice. We standardized the identification procedure, however, by using taxonomic keys prepared by Findley *et al.* (1975).

The woodrats were each collected from three habitats. One habitat, Pinyon-Juniper-lava outcrop, was common to both species. All those habitats contained large lava rocks. However, woodrat collections were not numerous enough to indicate habitat affinities.

At best, our comments about the Brush, Piñon, and Rock Mouse are general. All three species were taken from habitats with lava rock. They appear not to prefer separate distinct habitats as stated by Findley et al. (1975). He stated that the Rock Mouse preferred rocky areas, the Brush Mouse, stands of evergreen oak, and the Piñon Mouse, Pinyon Juniper woodland. All three of those habitats are within the Monument, but none covers a broad area. Perhaps the small size and mosaic pattern of those habitats causes the three species to overlap into habitats secondary in preference.

The Deer Mouse was captured from 16 of the 17 habitat types. The animal was always abundant and seems to display a broad habitat tolerance.

The White-footed Mouse was only collected from Pinyon-Juniper-steep cinder slope. Gennaro and Trujillo (1975) collected specimens in Yucca-Blue Grama. That species prefers brushy arroyos in grasslands and riparian areas. Such habitats do not occur on the Monument; therefore, the White-footed Mouse is probably not abundant there.

The Mexican Vole and Western Harvest Mouse were collected from habitat types at the base, on the slope, and inside the crater. Level or sloping grassland and grassland beneath shrubs and trees were preferred.

Certain rodents on the Monument are grassland dwellers. They included the Hispid Pocket Mouse, Ord's Kangaroo Rat, and Northern Grasshopper Mouse. All those species occur at the base of the Capulin Mountain in grassland habitats. However, the Hispid Pocket Mouse was also trapped in the Muhly grassland-crater rim habitat which is situated at the highest elevation on Capulin Mountain.

Carnivores: We recorded three kinds of carnivores from only a few habitat types. Coyotes were recorded from scats in Pinyon-Juniper-lava

extrusions, and Common Horehound-Four-wing Saltbush. A Bobcat skull was found in Pinyon-Juniper-lava outcrop. The Gray Fox was sighted in the Pinyon-Juniper-lava outcrop, Pinyon-Juniper-Mountain Mahogany belt, and Pinyon-Juniper-steep cinder slope.

Continuous surveys will probably indicate that carnivores recorded thus far occur in all the habitat types on Capulin Mountain. Also, subsequent surveys are likely to add more species to the carnivore checklist.

Although Mule Deer were observed within all habitat types, certain habitats were preferred over others. Deer were frequently observed during daylight hours on the sides of the mountain and within the crater in any of the habitat types where trees and shrubs provided cover and/or browse. Deer were rarely observed on open grassland at the mountain's base. To date, we have not observed Mule Deer during their nocturnal activities.

RECOMMENDATIONS: The delineation of habitat types presented us with a baseline from which to begin studies of vertebrate distributions. Surveys each year would continue to determine habitat preferences of those species least known.

The 1976 survey provided us with the kind of information necessary to establish future goals as follows:

- 1) More than one kind of amphibian is expected to occupy the Monument. We suggest extensive surveys in mesic areas where those animals are most likely to occur.
- 2) At least four subspecies of the Eastern Fence Lizard may occupy Capulin Mountain and surrounding area. At the present time, we do not have large enough samples from habitat types to make subspecific identifications. We recommend that large samples be obtained in 1977.

- 3) More field time is needed to search for snakes, especially during the night time.
- 4) More than two species of bats are likely to occur on the Monument. We suggest that more metal stock tanks outside the boundary and crevices on the mountain be surveyed.
- 5) The identifications and distributions of Peromyscus such as the Brush Mouse, Piñon Mouse, and Rock Mouse are not clear. Larger samples of those species from their preferred habitat types should be obtained.
- 6) The distribution of the White-throated Woodrat and Mexican Woodrat needs to be clarified. Again, larger series from all lava habitats need to be examined.
- 7) The habitat preferences of Cottontail species should be elucidated. Since only subtle differences separate the Desert Cottontail from The Eastern Cottontail, rabbits should be collected and identified from each habitat.
- 8) Finally, we were not able to devote enough time in 1975 and 1976 searching for carnivores or their signs. More time should be devoted to that kind of search during future surveys.

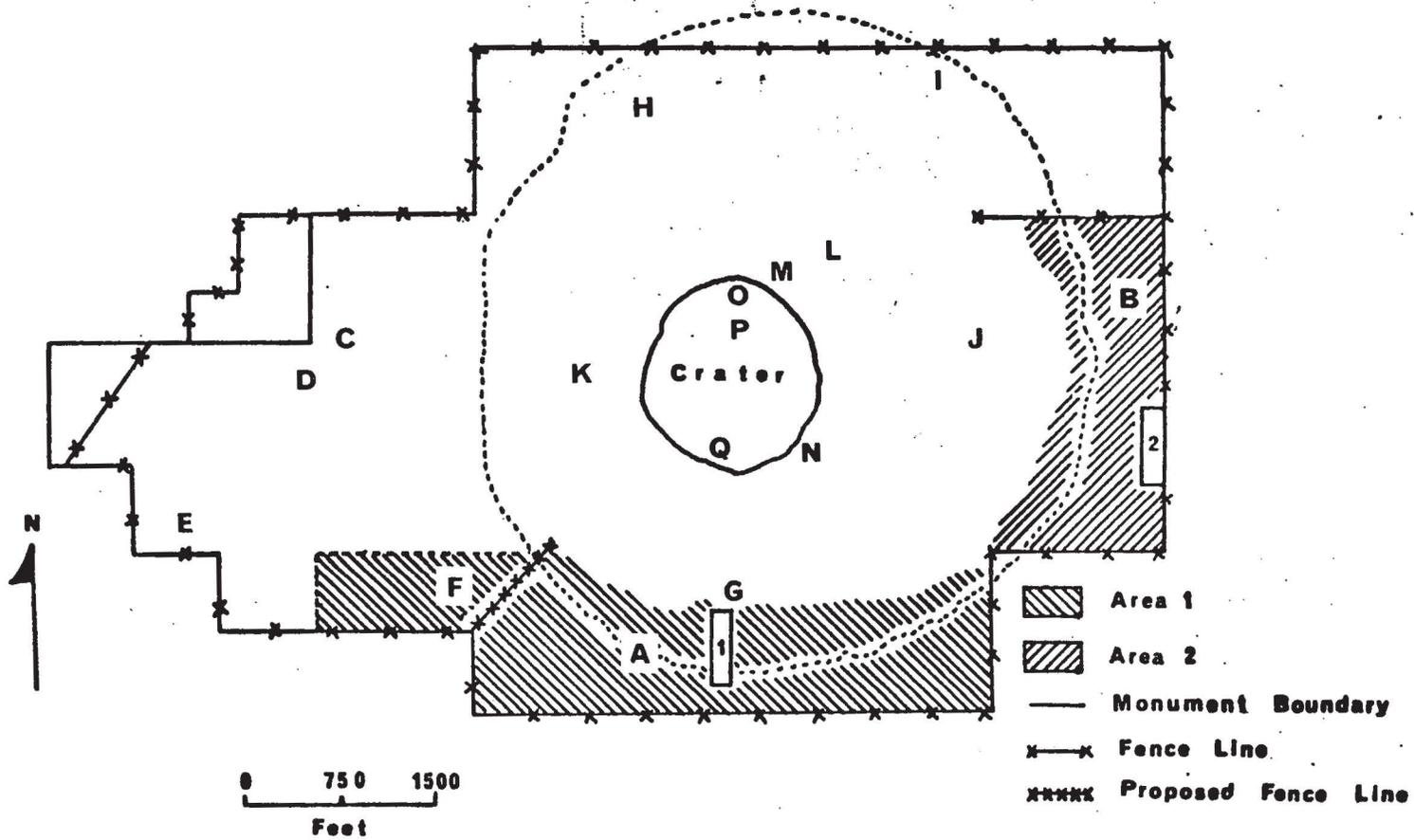


Fig. 1. Map of Capulin Mountain National Monument, New Mexico showing Areas 1 and 2, and general location of habitat types. The approximate base of the mountain is shown by a dashed line. Enclosure 1 on Area 1 and Enclosure 2 on Area 2 are shown as numbered rectangles, Locations of habitat types are represented by letters A-Q.

Table 1. Average ground cover percentages inside Enclosure 1 on Area 1 during 1976. The number of 100-point transects is enclosed in parentheses; the number following the parentheses represents the date of the transect. Annuals are indicated by an asterisk.

Species	May (3) 19	June (3) 4	July (3) 19	August (3) 2	September (3) 11
Blue Grama <u>Bouteloua gracilis</u> (H.B.K.) Griffiths	25	30	18	18	30
Russian Thistle * <u>Salsola Kali</u> L.	5	6	9	8	14
Prairie-sagewort <u>Artemisia frigida</u> Willd.	4	3	3	3	4
Squirrel-tail <u>Sitanion hystrix</u> (Nutt.) J.G. Smith	2	1	2	2	7
Ragweed * <u>Ambrosia</u> c.f. <u>acanthicarpa</u> Hook		3	2	3	4
Big Bluestem <u>Andropogon Gerardi</u> Vitman		3	3	4	2
No Common Name <u>Artemisia Carruthii</u> Wood.	4	1	2	2	2
Goose Foot * <u>Chenopodium</u> spp.		1	2	4	3
Side-oats Grama <u>Bouteloua curtipendula</u> (Michx.) Torr.		1	1	4	2
Three awn <u>Aristida</u> spp.	3	1		1	1
Spanish Bayonet <u>Yucca angustifolia</u> Pursh.	<1			1	<1
Unknown Grass		5		<1	
Four-Wing Saltbush <u>Atriplex canescens</u> (Pursh) Nutt.	4				
Common Horehound <u>Marrubium vulgare</u> L.	1	1		1	1
Common Sunflower <u>Helianthus annuus</u> L.			1	<1	1
Little Bluestem <u>Schizachyrium scoparium</u> (Michx.) Nash	1		<1	<1	<1
Careless Weed * <u>Amaranthus Palmeri</u> Wats				1	1
Mint family Labiatae			1		
Prickly Poppy * <u>Argemone</u> spp.			1		

Table 1. (Cont.)

Species	May (3) 19	June (3) 4	July (3) 19	August (3) 2	September (3) 11
Western Wheatgrass <u>Agropyron smithii</u> Rydb.					<1
Litter	22	17	23	13	9
Grasses and Forbs	50	56	47	60	76
Browse (shrub) density	11	14	12	11	11
Tree density	15	12	13	11	11
Bare ground and erosion pavement	28	25	29	27	15

Table 2. Average ground cover percentages outside Enclosure 1 on Area 1 during 1976. The number of 100-point transects is enclosed in parentheses; the number following the parentheses represents the date of the transect. Annuals are indicated by an asterisk.

Species	May (2) 19	June (2) 4	July (2) 13	August (2) 3	September (2) 11
Blue Grama <u>Bouteloua gracilis</u> (H.B.K.) Griffiths:	14	10	17	21	24
Russian Thistle * <u>Salsola Kali</u> L.	4	5	10	9	18
Side-oats Grama <u>Bouteloua curtipendula</u> (Michx.) Torr.	3	2	4	5	9
Prairie-sagewort <u>Artemisia frigida</u> Willd.	3	6	6	2	1
Big Bluestem <u>Andropogon gerardi</u> Vitman	5	5	4		2
Goose Foot * <u>Chemopodium</u> spp.		3	3	3	2
No Common Name <u>Artemisia Carruthii</u> Wood.	1		4		5
Ragweed * <u>Ambrosia c.f. acanthicarpa</u> Hook		1	3	1	4
Careless Weed * <u>Amaranthus Palmeri</u> Wats				3	5
Squirrel-tail <u>Sitanion hystrix</u> (Nutt.) J.G. Smith		1	2	2	3
Common Horehound <u>Marrubium vulgare</u> L.	1	1	3	1	2
Little Bluestem <u>Schizachyrium scoparium</u> (Michx.) Nash	2	5	1		
Unidentified forb		7			
Four-wing Saltbush <u>Atriplex canescens</u> (Pursh) Nutt.	5				
Three awn <u>Aristida</u> spp.	1	1			
Unidentified grass			1	1	
Spanish Bayonet <u>Yucca angustifolia</u> Pursh.		1		1	
Desert Morning Glory <u>Ipomoea</u> spp.					1
Common Sunflower * <u>Helianthus annuus</u> L.				1	

Table 2. (Cont.)

Species	May (2) 19	June (2) 4	July (2) 13	August (2) 3	September (2) 11
Litter	19	18	16	13	17
Grasses and forbs	38	46	56	55	70
Browse (shrub) density	14	16	11	13	13
Tree density	22	20	15	19	19
Bare ground and erosion pavement	44	37	28	26	16

Table 3. Average ground cover percentages inside Enclosure 2 on Area 2 during 1976. The number of 100-point transects is enclosed in parentheses; the number following the parentheses represents the date of the transect. Annuals are indicated by an asterisk.

Species	May (3) 17	June (3) 5	July (3) 7	August (3) 3	September (3) 11
Blue Grama <u>Bouteloua gracilis</u> (H.B.K.) Griffiths	18	11	17	19	11
Prairie-sagewort <u>Artemisia frigida</u> Willd.	14	12	9	7	12
Big Bluestem <u>Andropogon Gerardi</u> Vitman	14	12	12	7	11
No Common Name <u>Artemisia Carruthii</u> Wood.	<1	<1	7	12	7
Side-oats Grama <u>Bouteloua curtipendula</u> , (Michx.) Torr.	4	2	3	6	7
Spanish Bayonet <u>Yucca angustifolia</u> Pursh	5	3	2	5	3
Little Bluestem <u>Schizachyrium scoparium</u> (Michx.) Nash	3	2	2	1	3
Squirrel-tail <u>Sitanion hystrix</u> (Nutt.) J.G. Smith	1	1	2	5	6
Russian Thistle * <u>Salsola Kali</u> L.			1	4	3
Common Sunflower * <u>Helianthus annuus</u> L.		1	1	<1	
Three Awn <u>Aristida</u> spp.	<1	1	<1	1	1
Western Wheatgrass <u>Agropyron smithii</u> Rydb	1		<1	<1	
Unknown species				1	
Groundsel <u>Senecio</u> spp.					1
Careless Weed * <u>Amaranthus palmeri</u> Wats				1	1
Gum Weed <u>Grindelia</u> spp. Willd.			<1	<1	
Common Horehound <u>Marrubium vulgare</u> L.			<1		
Crucifer <u>Erysimum capitatum</u> (Dougl.) Greene			<1		
Prickly Poppy * <u>Argemone</u> spp.				<1	

Table 3. (Cont.)

Species	May (3) 17	June (3) 5	July (3) 7	August (3) 3	September (3) 11
Unknown					
<u>Artemisia</u> spp.				<1	
Stick leaf					
Loasaceae					<1
Litter	21	28	23	15	16
Grasses and forbs	62	46	57	69	71
Browse (shrub) density	2	1	1	2	2
Tree density	<1	<1	<1	<1	<1
Bare ground and erosion pavement	19	26	20	16	11

Table 4. Average ground cover percentages outside Enclosure 2 on Area 2 during 1976. The number of 100-point transects is enclosed in parentheses; the number following the parentheses represents the date of the transect. Annuals are indicated by an asterisk.

Species	May (2) 18	June (2) 5	July (2) 11	August (2) 3	September (2) 12
Blue Grama <u>Bouteloua gracilis</u> (H.B.K.) Griffiths	20	22	16	21	20
Russian Thistle * <u>Salsola Kali</u> L.	1	5	11	19	18
Big Bluestem <u>Andropogon Gerardi</u> Vitman	5	4	3	3	7
Prairie-sagewort <u>Artemisia frigida</u> Willd.	4	5	3	3	6
No Common Name <u>Artemisia Carruthii</u> Wood.		1	8	6	
Spanish Bayonet <u>Yucca angustifolia</u> Pursh.	2	1	2	1	4
Common Horehound <u>Marrubium vulgare</u> L.		1	1	3	3
Common Sunflower * <u>Helianthus annuus</u> L.		1	1	3	3
Little Bluestem <u>Schizachyrium scoparium</u> (Michx.) Nash	2	3	1	1	3
Side-oats Grama <u>Bouteloua curtipendula</u> (Michx.) Torr.	1		1	3	2
Careless Weed * <u>Amaranthus Palmeri</u> Wats				5	4
Squirrel-tail <u>Sitanion hystrix</u> (Nutt.) J.G. Smith				2	2
Goose Foot * <u>Chenopodium</u> spp.			2		1
Gum Weed <u>Grindelia</u> spp. Willd.			1	1	
Unidentified grass			1		
Unidentified forb		1			
Four-wing Saltbush <u>Atriplex canescens</u> (Pursh) Nutt.	1				
Western Wheatgrass <u>Agropyron smithii</u> Rydb.					

Table 4. (Cont.)

Species	May (2) 18	June (2) 5	July (2) 11	August (2) 3	September (2) 12
Litter	19	13	15	8	9
Grasses and forbs	33	41	48	71	71
Browse (shrub) density	2	3	3	2	2
Tree density	3	4	2	3	3
Bare ground and erosion pavement	49	47	36	22	19

Table 5. Comparisons of percentages of three categories: 1) litter, 2) grasses and forbes, and 3) bare ground and erosion pavement inside (numbers outside parentheses) and outside (number inside parentheses) Exclosure 2 on Area 2.

Category Examined	<u>Month</u>				
	May	June	July	August	September
Litter	21 (19)	28 (13)*	23 (15)**	15 (8)**	16 (9)**
Grasses and forbes	62 (33)*	46 (41)	57 (48)	69 (71)	71 (71)
Bare ground and erosion pavement	19 (49)*	26 (47)*	20 (36)*	16 (22)**	11 (19)**

* $P = \leq 0.05$

** $P = 0.05 - 0.20$

Table 7. Age classes for browse species surveyed for annual utilization. Numbers are average numbers of plants from 4, 100-point paced transects,

Species	Age Class			
	Young	Mature	Decadent	Dead
Pinyon <u>Pinus edulis</u>	1	7	0	0
Gambel Oak <u>Quercus gambelii</u>	4	11	2	2
Four-wing Saltbush <u>Atriplex canescens</u>	1	4	2	0
Gooseberry <u>Ribes spp.</u>	1	1	0	0
Thimbleberry <u>Rubus Neomexicanus</u>	7	1	1	0
Mountain Mahogany <u>Cercocarpus montanus</u>	2	9	4	1
Common Chokecherry <u>Prunus virginiana</u>	5	1	1	0
Squaw Bush <u>Condalia spathulata</u>	1	0	0	0
Prairie-sagewort <u>Artemisia frigida</u>	18	0	0	0
White Sage <u>Artemisia ludoviciana</u>	17	0	1	0
No Common Name <u>Pericome caudata</u>	0	1	1	0

Table 8. Percentage composition and form classes for browse species surveyed for annual utilization. Numbers are average numbers of plants from 4, 100-point paced transects. Form classes are as follows: A-all available, no hedging; B-all available, moderately hedged; C-all available, severely hedged; D-partly available, little or no hedging; E-partly available, moderately hedged; F-partly available, severely hedged; G-mostly unavailable; H-unavailable.

Species	% Composition	Form Class							
		A	B	C	D	E	F	G	H
Pinyon <u>Pinus edulis</u>	10	1	1	1	2	4	2	1	0
Gambel Oak <u>Quercus gambelii</u>	18	3	6	8	0	1	1	0	0
Four-wing Saltbush <u>Atriplex canescens</u>	6	2	3	1	0	0	0	0	0
Gooseberry <u>Ribes spp.</u>	1	0	1	1	0	0	0	0	0
Thimbleberry <u>Rubus Neomexicanus</u>	8	6	2	1	0	0	0	0	0
Mountain Mahogany <u>Cercocarpus montanus</u>	16	0	2	12	0	1	1	0	0
Common Chokecherry <u>Prunus virginiana</u>	6	2	2	2	0	0	0	0	0
Squaw Bush <u>Condalia spathulata</u>	1	1	0	0	0	0	0	0	0
Prairie-sagewort <u>Artemisia frigida</u>	18	9	7	2	0	0	0	0	0
White Sage <u>Artemisia ludoviciana</u>	18	13	3	1	0	0	0	0	0
No Common Name <u>Pericome caudata</u>	1	1	1	0	0	0	0	0	0

Table 9. Measurement (in.) of height and diameter of Pinyon (Pinus edulis Engelm) and of Western Yellow Pine (Pinus ponderosa Laws). Each species of tree was examined on separate 1-ha plots. Number in the sample, N; range, R; Mean, M; and 1 standard deviation, SD.

Feature measured	Pinyon				Western Yellow Pine			
	N	R	M	SD	N	R	M	SD
Diameter, breast height	207	1-15	3	3	56	1-30	9	5
Tree height	313	4-459	115	88	74	11-1009	205	173

Table 10. Percentage of branch damage and percentage of trunk girdling on Pinyon and on Western Yellow Pine. Each species of tree was examined on separate 1-ha study plots. Number in the sample, N; range, R; Mean, M; and 1 standard deviation, SD.

Kind of Porcupine damage	Pinyon				Western Yellow Pine			
	N	R	M	SD	N	R	M	SD
Branch damage/tree	313	0-100	35	39	74	0-100	87	23
Amount trunk girdling/tree	313	0-100	35	34	74	0-100	70	36

Table 11. A list of herptiles and mammals sighted, identified on the basis of signs (tracks, scats, etc.), or collected from the various habitat types on Capulin Mountain National Monument.

Common name	Scientific name	Author
HERPTILES:		
Western Spadefoot	<u>Scaphiopus hammondi</u>	Baird
Lesser Earless Lizard	<u>Holbrookia maculata</u>	Girard
Eastern Fence Lizard	<u>Sceloporus undulatus</u>	(Bosc, in Latreille)
Short-horned Lizard	<u>Phrynosoma douglassi</u>	Bell
Six-lined Racerunner	<u>Cnemidophorus sexlineatus</u>	(Linnaeus)
Racer	<u>Coluber constrictor</u>	Linnaeus
Gopher Snake	<u>Pituophis melanoleucus</u>	(Daudin)
Plains Garter Snake	<u>Thamnophis radix</u>	(Baird and Girard)
Western Rattlesnake	<u>Crotalus viridis</u>	(Rafinesque)
MAMMALS:		
Fringed Myotis	<u>Myotis thysanodes</u>	Miller
Small-footed Myotis	<u>Myotis leibii</u>	(Audubon and Bachman)
Desert Cottontail	<u>Sylvilagus auduboni</u>	Gray
Colorado Chipmunk	<u>Eutamias quadrivittatus</u>	(Say)
Rock Squirrel	<u>Spermophilus variegatus</u>	Erxleben
Botta's Pocket Gopher	<u>Thomomys bottae cultellus</u>	Eydoux and Kelson
Hispid Pocket Mouse	<u>Perognathus hispidus</u>	Baird
Ord's Kangaroo Rat	<u>Dipodomys ordii</u>	Woodhouse
Western Harvest Mouse	<u>Reithrodontomys megalotis</u>	(Baird)
Deer Mouse	<u>Peromyscus maniculatus</u>	(Wagner)

Table 11. (Cont.)

Common name	Scientific name	Author
White-footed Mouse	<u>Peromyscus leucopus</u>	(Rafinesque)
Brush Mouse	<u>Peromyscus boylii</u>	(Baird)
Piñon Mouse	<u>Peromyscus truei</u>	(Schufeldt)
Northern Grasshopper Mouse	<u>Onychomys leucogaster</u>	(Wied-Neuwied)
White-throated Woodrat	<u>Neotoma albigula</u>	Hartley
Mexican Woodrat	<u>Neotoma mexicana</u>	Baird
Porcupine	<u>Erethizon dorsatum</u>	(Linnaeus)
Coyote	<u>Canis latrans</u>	Say
Gray Fox	<u>Urocyon cinereoargenteus</u>	(Schreber)
Bobcat	<u>Lynx rufus</u>	(Schreber)
Mule Deer	<u>Odocoileus hemionus</u>	(Rafinesque)

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