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PLANT COMMUNITIES AND MAMMAL HERBIVORES
AT
CRATERS OF THE MOON NATIONAL MONUMENT

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ABSTRACT

This is a preliminary review of herbivorous mammals in the lava fields of Craters of the Moon National Monument in southeastern Idaho. This geologically and geographically unique area warrants extensive and detailed ecological research. Knowledge of the mechanisms of primary ecological succession and the interdependence between the plants and animals in each of the vegetational communities are critical for management and preservation programs. The plant communities in this 53,000 acre area include conifer forests, sagebrush, and grasslands, and sparsely vegetated lava formations. The diversity of herbivorous mammals does not appear to correlate with the wide variety of habitats in this area. The published species list for CRMO indicates the presence of six Lagomorph species, and fourteen rodent species. The latest study of plant communities in the Monument describes twenty-six separate communities. The small caching mammals may extend the range of various species of plants by dispersing the seeds of that species, or they may influence the species' vigor by grazing or browsing. The presence of dusky-footed woodrat, and mountain cottontail is probably a result the interaction between the two mammals, the rocky substrate and the vegetation. The pika colony is

slightly outside the species' normal range, but well within its expected habitat on the rocky outcroppings of the young lava fields . Certain other species commonly found on the Snake River Plain such as ord's kangaroo rat, and sagebrush vole, are absent from similar habitats at CRMO. Introduced plant communities , topography, soil and substrate characteristics, and infrequent lightning-caused fires have substantial effects upon the diversity and abundance of plants and herbivorous mammals at CRMO.

INTRODUCTION

LITERATURE

Current literature regarding CRMO ecology is limited to two papers (Griffith, 1984 and Day, 1985), and the only previous paper published was Essler's original paper in 1941. Literature regarding communities of the Snake River Plain in general is also quite limited so the remainder of the papers that I have used are the results of studies of similar habitats in other areas. Sagebrush habitats and Douglas-fir habitats have been studied for management purposes, so there is some literature available, but bitterbrush, limber pine, and lava flows have hardly been studied at all for their plant and mammal populations. Most of the published work that I found dealt with the managerial aspects of the communities. Sagebrush and grasses have been studied for their potential as range for domestic stock and game species, and the effects of fire have been the impetus for a great deal of these studies.

The Douglas-fir forest is important as a lumber resource, and the effects of logging and re-seeding operations have been studied in several locations.

LOCATION

Craters of the Moon National Monument (CRMO) is located on the Snake River Plain (SRP) of southeastern Idaho, and covers the north and central portions of the complex of lava fields and cinder cones known as the Great Rift. The north end of the monument extends from the northern edge of these basaltic lava fields into a small canyon in the the Pioneer Range (a portion of the granitic intrusion which makes up the entire northern part of the state). The basaltic lavas of the SRP cover the southern portion of the state from Wyoming to Oregon along the Snake River to a width of approximately 150 miles. The flows range in age from 2,000 to 15,000 years old near the Great Rift (Kuntz, unpublished 1965). East and west of the monument the lava is older, and it increases in age with distance from the Great Rift. Kuntz estimates that the oldest lava beds, within 100 km of the monument, are 200,000 years old, and lava further than that is 500,000 years old. This northern limit of the high, cold desert of the Great Basin is unusual for its relative youth and for its volcanic origins. The severely arid climate and short growing season have, however, accelerated seasonal changes and suppressed successional changes much the same as the rest of this desert area. There is so little successional change that the mechanisms of succession and community

change are very difficult to separate from the effects of changes in climate.

Wells (1983) postulates that the climatic changes since the last ice-age, approximately 18,000 years before present, have caused sequential changes in Great Basin vegetation. All the plant communities in the Great Basin have been affected by the climatic and topographical changes that have occurred during the drying and warming trends since the ice age. The volcanic activity in the area of CRMO has prevented a single, uniform community from covering this area, so that it now has the appearance of an area still undergoing primary succession. Each eruption produces a new surface of rock, but the development of the plant community does not necessarily progress through seral stages to a climatic climax community.

The present theories indicate that new lava at CRMO should take 15,000 years to progress from bare rock to sagebrush steppe, and that the entire area will be covered with the sagebrush steppe community. This does not take into account the following facts: 1) eruptions have occurred in cycles of approximately 1,500 years so that in 15,000 years 10 eruptive cycles may occur to produce new landscape. 2) Climatic changes in the Great Basin have been significant in time spans less than 1/10 th of that time. 3) The accepted maximum duration for any seral stage is 500 years, and if no cumulative, directional change occurs within that time, a dominant association is said to exist. 4) Herbivores within a

community modify the progression of that seral stage, sometimes this means that they prevent the plants of the succeeding stage from becoming established.

SUCCESSION

Classical theories of succession propose that plants directly influence the success or failure of other plants to become established in an area through their preparation of the local environment (relay floristics), or through their division of the available resources (competition). Seral stages develop and progress into new communities through the introduction and development of certain species. This appears as distinct stages of a cumulative and directional progression. Stages lasting more than 500 years are accepted as the climax community in that habitat. In deserts this is often the first community that becomes established (initial floristics). Succession is arrested in the initial seral stage because of the harsh climate. The effects of intermittent fire and of herbivore browsing may also cause an unexpected dominant community.

Eggsler (1941) predicted that the entire SRP would have sagebrush as the climatic climax community, but this may not be the case. The various plant communities are largely able to maintain themselves through competition and through their interactions with the mammal herbivores at the monument.

VEGETATIVE TYPES

There have been two studies of CRMO vegetation, one in 1941 by W.A. Essler, and the other in 1985 by T.A. Day. Essler tried to correlate every aspect of his data with Clement's theory of succession and climax community to predict the future vegetation of the monument. It now provides a preliminary study of the vegetation which may be used as a base for studies of change. Day provides us with a fairly detailed map of the plant communities in the area by defining twenty-six different recognizable plant associations, and plotting their ranges within the monument.

In this paper I have grouped together those associations of similar components into the following four categories: Cinder gardens and exposed lava flows, limber pine/antelope bitterbrush (Pinus flexilis/Purshia tridentata), sagebrush/grassland (Artemisia spp./perennial bunch grasses), and Douglas-fir (Pseudotsuga menziesii) forests. No reliable geographic association has been discovered which exclusively limits the range of these groups, but there is a wide range of lava formations that may affect the distribution of plant species in this area. Explanations for the range and abundance of these groups have relied upon theories of succession, but, like the other explanations, no consistent pattern can be found.

VEGETATION

Cinder gardens are exposed cinder beds, usually on the southwest facing slopes, with ephemeral spring flowers and scattered dwarf buckwheat (Eriogonum cushionensis var. depressum). These may be the same types of communities which covered the cones soon after the lava cooled.

Exposed lava fields, younger than 15,000 years, are also mostly bare. The surface of the flows support only lichens, but there are many species of plant that colonize the cracks and crevices which interrupt the flow surface. The types of species that are able to live in the crevices seem to change as the crack fills with wind-borne soils (Essler, 1941). Flows that are older than 15,000 years have accumulated enough soil that the entire surface of the flow may be thinly covered. In areas such as these the Artemesia/grass community dominates, and it is the old flows of the SRP, covered with thick stands of Artemesia, that seem to indicate that this community will dominate throughout the monument as well.

The Artemesia/grass group varies considerably from place to place. Artemesia tridentata is common throughout, but there are many different species of bunch-grass that may dominate the understory. The dominant grass varies from site to site. Arno and Gruell suggest that these grasses were the dominant community before the influence of European man, but there are is little known in this area.

Conifers grow in many areas of the monument. Pinus flexilis communities grows in several large patches and almost exclusively with Purshia tridentata, but Pseudotsusa menziesii forests seem to be found in association with snowberry and only on a few cones at the north end of the park.

MAMMALS

TABLE 1
HERBIVORES AT CRMO (From the species list for CRMO)

LAGOMORPHS	
PIKA	<u>Ochotona princeps</u>
WHITE-TAILED JACKRABBIT	<u>Lepus townsendi</u>
SNOWSHOE HARE	<u>Lepus americanus</u>
BLACK-TAILED JACKRABBIT	<u>Lepus californicus</u>
MOUNTAIN COTTONTAIL	<u>Sylvilagus nuttalli</u>
PYGMY RABBIT	<u>Brachylagus idahoensis</u>
RODENTS	
YELLOW-BELLIED MARMOT	<u>Marmota flaviventris</u>
GOLDEN-MANTLED GROUND SQUIRREL	<u>Spermophilus lateralis</u>
LEAST CHIPMUNK	<u>Eutamias minimus</u>
YELLOW-PINE CHIPMUNK	<u>Eutamias amoenus</u>
RED SQUIRREL	<u>Tamiasciurus hudsonicus</u>
NORTHERN POCKET GOPHER	<u>Thomomys talpoides</u>
GREAT BASIN POCKET MOUSE	<u>Perognathus parvus</u>
WESTERN HARVEST MOUSE	<u>Reithrodontomys mesalotis</u>
DEER MOUSE	<u>Peromyscus maniculatus</u>
BUSHY-TAILED WOODRAT	<u>Neotoma ceneris</u>
MOUNTAIN VOLE	<u>Microtus montanus</u>
LONG-TAILED VOLE	<u>Microtus longicaudis</u>
WESTERN JUMPING MOUSE	<u>Zapus princeps</u>

No detailed survey of the mammals at CRMO has been made, but there is a short list of species which may be found on the monument. Some small mammals are associated with a single plant community, but the majority of them are found in several (Bert and Grossenholder, 1964). The herbivores are listed in Table 1. These animals consume seeds, fruits,

leaves, bark, and stems of (specific?) plants in their habitat, and in this manner they may suppress, stimulate, or disperse the plant. Only a few of these interactions have been studied and fewer still have been correlated to the vigor of the plant community that they inhabit. I believe that in many cases, the benefits of herbivory are not limited to the consumer.

Indirect effects of the substrate on any vertebrate predators or dispersers may also have a significant effect on dispersal and vigor in certain plants. Small rodents such as the golden-mantled ground squirrel (Spermophilus lateralis), least and yellow-pine chipmunks (Eutamias minimus and E. amoenus), and deer mice (Peromyscus spp.) harvest and store the seeds of shrubs and conifers in subterranean caches. Rodent caches are typically of proper depth and in an optimal site for germination, and, if left unrecovered, the seeds are available for germination and growth. Herbivores may depress the rate of succession by preferentially feeding on the climax species or by stimulating the growth of members of the dis-climax so that seedlings are excluded. Neither the dependence of the plant upon its mammalian associates nor the successional results of these associations have been studied in more than a handful of cases.

DISCUSSION

CINDERS AND LAVA

The cinder gardens and the exposed lava flows have quite a lot of bare volcanic material around and between the plants. The lack of adequate cover may limit the mammals which are able to colonize them. The cinder gardens are nearly completely bare of vegetation in every season except early spring when the ephemerals grow and reproduce.

Perognathus and Eutamias may use these seed resources during the spring, but there is so little cover, even in the spring, that foraging is dangerous. The cinders are used extensively as pathways by the deer moving through the area (Griffin, 1984), but seem to have few resident species (Meyer, unpublished).

The lava beds are very sparsely populated, and the plants that are found here are limited to places where soil can accumulate. There are no mammal studies for habitat such as this, but casual observations reveal populations of pika (Ochotona princeps), marmot (Marmota flaviventris) in the jumbled areas of the broken flows. These animals are usually found in rocky areas at higher elevations, so their requirements may be dependant upon the substrate characteristics rather than the plant community characteristics. Bushy-tailed woodrats (Neotoma ceneris) are also commonly seen on the lava flows, and their sign is limited to those areas in and immediately around the lava tube caves.

LIMBER PINE/ANTELOPE BITTERBRUSH

Day (1935) lists Purshia tridentata in five separate communities and all but one of these include P. flexilis. This association comprises over half of the vegetative cover at CRM0. Purshia is known as a preferred browse for mule deer (Odocoileus hemionus) (Peek et al., 1978), and is being studied to facilitate management of the deer as an important game species. P. flexilis, however, has little economic value to stimulate interest in its life requirements. What little is known about this tree comes from studies of its association with Clark's nutcracker, which is its principal dispersing agent (Lanner and Vander Wall, 1980). There may be an important interaction between these two species. The pioneering P. flexilis may protect the seedlings of Purshia from environmental extremes, and allow the seedling to become established in harsh areas by acting as a nursery tree. The growing Purshia fixes atmospheric nitrogen into organic ammonium. The ammonium provides a source of nitrogen for the pine. Nitrogen is not found in significant quantities in lava (Eggleston, 1941), but it is a necessary element for plant growth (Barbour et al., 1982). Humphrey's study of plant succession after fire in Artemisia-grass habitats (1984) found Purshia growing in all stages of plant succession, and not associated with any specific stage or shrubby plant type.

Purshia in high vigor may suppress seral change. Peek and others (1978) find that moderate browsing by O. hemionus

increased twig production in Purshia and prevent other shrubs from becoming established because their heavy growth prevented the growth of many other plants. These investigators expect the ponderosa pine/P. tridentata community to progress to P. menziesii/snowberry in the absence of deer browsing.

Rodents commonly associated with the P. flexilis/Purshia community are seed harvesters and cachers. The deer mouse is such a great consumer of Purshia seed that managers have used several rodenticides to prevent them from harvesting seeds planted during re-vegetation programs (Everett and Stevens, 1981). In a natural harvesting situation, the food caching activity of deer mice may act to disperse the seeds of Purshia (Abbott and Quink, 1970). The rodents and the large population of mule deer at CRMO ($x=450$, Griffith, 1984) might be keeping this community healthy.

ARTEMESIA/GRASS

Literature regarding the small mammal populations in plant communities similar to those at CRMO is limited, and concerns primarily the Artemesia and Pseudotsuga communities. The Artemesia complexes are the dominant plant community on the SRF, and it would appear that it should dominate CRMO as well.

There is some debate about whether the Artemesia species are the historically predictable dominants, or whether the bunch-grasses deserve that title. Wells (1983) postulates that the bunch-grasses may become dominant in areas where the

cycle of infrequent fires (ca. 40 year intervals) has not been eliminated through human influence. Where there are no fires, Artemesia species are dominant, and most of the recent research on Artemesia communities is for range management. The effects of fire and the successional trends in these habitats are included in most studies. Frequent fires favor the annual grasses, while the perennial species seem to do best in areas which have been burned in 25-30 year cycles (Humphrey, 1984).

Very few studies have been done on undisturbed sites in Artemesia habitat, but there are several which discuss the change in rodent population in the years succeeding a burn. The early rodent studies in Artemesia habitats were done in the east where the brush communities bordered the pine forests. Management of these marginal forest areas depended upon the results of studies like Beck and Vogl's observation of small rodents in several seral stages of brush prairie in Minnesota (1970). Two species of Peromyscus (P.leucopus and P.maniculatus), a red-backed vole (Clethrionomys gapperi) and the thirteen-lined ground squirrel (Spermophilus tridecemlineatus) were caught in the various seral stages, and while the total number of animals caught did not vary significantly, the relative abundance of these species differed markedly from one seral stage to another.

Control areas, unburned for over 35 years, showed highest numbers of C. gapperi and P.leucopus while numbers of P.maniculatus and S.tridecemlineatus were greatest in areas

with frequent and/or recent burns. Except for P. maniculatus, these species are not known to occur at CRMO, but there are other voles and ground squirrels present which may exhibit similar preferences.

McGee (1982) shows similar results from a Wyoming Artemisia site where burns in different seasons were studied. P. maniculatus and S. armatus populations increased significantly after a burn, but Zapus princeps, Microtus montanus, and E. minimus populations were reduced severely, and C. gapperi was eliminated entirely. He suggests that "Species with rather specific niche requirements cannot sustain populations on severe fall burns" because of greatly reduced cover.

Some Idaho sagebrush mammals have been studied recently, and the Idaho National Engineering Lab (INEL) is responsible for most of that work. The studies of small mammal populations in Artemisia have been conducted by INEL staff on the 600 sq mi reserve that the lab boundaries create.

Two of the six species of lagomorphs that are found at CRMO have been studied by this group. Mountain cottontail (Sylvilagus nuttalli) frequents the rock pile areas near bushy-tail woodrat (Neotoma ceneris) dens where there is sufficient cover. Black-tail Jackrabbit (Lepus californicus) and pygmy rabbit (Brachylagus idahoensis) were also observed on the site, but not in the vicinity of the woodrat dens (Johnson and Hansen, 1979). B. idahoensis populations were only observed at distances greater than 5 km from the den sites.

Their distance may have been affected by the Artemesia populations in the immediate vicinity of the dens because, as White et al. (1982) point out, the rabbits forage preference for A. t. vasyana varies at the population level. The investigators also suggest that this could lead to an understanding of wintering sheep and mule deer range preferences. Sheehy and Windward's test (1981) showed that mule deer prefer the subspecies vasyana, but that this did not fully explain the winter range distribution of the deer.

The most recent study available from INEL covers the rodent populations on Artemesia and Crested wheat-grass sites. The comparison of species on these two sites should provide an accurate description of the behavior of rodent populations in similar habitats at CRMO. P. maniculatus was the most common, followed by Reithrodontomys ordii, in both types of habitat. Both were most common in the crested wheat-grass site. The vole (M. montanus) was found almost exclusively on the grass, the jumping mouse (Fergusnathus parvus) preferentially in the grass, and the only pocket gopher (Thomomys talpoides) was captured in the grass areas. Conversely the sagebrush vole (Lagurus curtatus) and least chipmunk (E. minimus) were found only in the sagebrush.

The appearance of D. ordii, T. talpoides, and L. curtatus in areas of similar vegetation, and in close proximity to CRMO suggest that these species should be monitored closely. Their utilization of the sagebrush and

grassland habitats on the basalt lava flows may be a measure of the maturity of the vegetation, or the soil development in the area of the rift.

DOUGLAS-FIR FOREST

The *P. menziesii* forests in the monument are restricted to fairly small sections of cinder cones and creek canyons in the northern end of the monument (Daw, 1985), but, because of the economic importance of the tree, many investigations of similar plant communities have been completed. In 1959, J.S. Gashwiler trapped small mammals on and around logged and burned areas of virgin *P. menziesii* forest. His results showed that disturbed areas have decreased numbers of certain voles and chipmunks, and that those types of areas also have increased numbers of *P. maniculatus*. Small populations of flying squirrel and snowshoe hare were eliminated by the disturbance, but individual *O. princeps* and *N. ceneris* were found only on the disturbed areas.

The increased population of *P. maniculatus* on disturbed sites caused much concern among the lumber interests during reforestation projects because the mouse harvests and stores large quantities of conifer seeds. *P. maniculatus* consume 200-300 douglas-fir seeds per day in the laboratory (Ahlgren, 1966), and large stores of seed remain in the soil after logging and/or burning which is still available to the rodent population. Re-seeding projects could be severely damaged by this activity. Abbott and Quink (1970) further established

the potential destructiveness of the deer mouse by documenting the high cache-recovery rate for both C. gapperi and Peromyscus. This means that there would be fewer seeds left to germinate and that P. menzesii will take longer to become re-established.

The rodents were blamed for the failure of re-forestation projects, but it wasn't until 1979 that the actual harvesting efforts of these mice were studied. Sullivan's (1979) paper studied caching by mice when the seeds were broadcast rather than supplied from trays. The seeds were presented at the same density as that of a re-seeding project, and these seeds were not cached.

The latest study of Idahoan small mammals falls neatly into the established patterns of rodent use in successional forest habitats. The community of spruce and fir (Abies and Picea species) does not grow in or near CRM0, however the patterns of use are quite similar to studies of P. menzesii. Populations of P. maniculatus, E. ruficaudis, Z. princeps, and C. gapperi in areas of forest that have been recently burned follow the patterns described for the other sites. For the first ten years after a fire, vole, chipmunk and jumping mouse populations are very low, and deer mouse populations are high. The middle age (11-79 year) stands showed increases in chipmunks and jumping mice but these dropped again after 80 years. The deer mouse population dropped in the middle years, but, surprisingly, increased after the 80 year mark. C. gapperi started with no individual present in the early

stages, but the population rose gradually throughout the maturation of the forest to a maximum in the oldest stands.

CONCLUSIONS

There has been no study of the small mammals of the lava fields and cinder cones of Craters of the Moon National Monument in southern Idaho, but we can make some predictions based upon studies of similar habitats in other areas. The younger areas with the most rock exposed may be used by O. princeps and M. flaviventris. Artemesia communities in areas with rocky outcroppings afford the cover necessary for N. caeneris and S. nuttalli. These two species often occupy the same den area. B. idahoensis is very closely tied to the Artemesia community and chooses forage based on population characteristics rather than subspecies or species characteristics.

The Artemesia community is developing on lava flows at an extremely slow rate, if at all, due to the slow accumulation of soil. The communities in these parts of CRMN provide an ideal place to monitor the effects of changing substrate upon plant communities (from rocky to sparse vegetation to thin soil to deep soil/closed canopy).

Pocket gopher (T. talpoides) has been observed at CRMN, but other fossorial mammals (badgers, L. curtatus, D. ordii) that occupy similar communities in the surrounding lava plains have not been found here. The maturity of a community also

influences the types of animals present. The early stages of a community development, for example directly after a burn, support mouse species and ground squirrels (P. maniculatus, S. armatus, S. townsendii), while mature shrub and grass communities support jumping mice (Z. princeps), Microtus species, grasshopper mice, lagomorphs (Lepus californicus, L. americanus, L. townsendi, S. nuttalli, B. idahoensis), and chipmunks (E. minimus, E. ruficaudus).

Mature conifer forest is where redbacked voles (C. gapperi) are most likely to be found. Mammals in recently disturbed conifer forests appear to depend primarily upon the seed source. As the forest matures, the resident mammals depend upon the soil and low cover, until lastly the duff layer under the canopy determines the distribution of C. gapperi. These relationships need to be explored in order to predict the succession of mammals in the community at CRMO.

The very close relationship between certain species of mammal and specific species of plants indicates that communities depend upon activity of mammals as much as mammals depend upon the presence of the plants. Specifically the pairs Artemisia/E. minimus, Artemisia tridentata vasayana/B. idahoensis, and O. hemionus/P. tridentata should be looked at closely to determine the possibility of mutualism/proto-cooperation.

The substrate influence may be better understood by studying the fossorial and rock-dwelling species. It appears that O. princeps and M. flaviventris need the most rocky exposure, followed by N. ceneris and S. nuttalli, which require

more vegetative cover. The fossorial rodents D. ordii and T. talpoides occupy similar habitats in areas adjacent to CRMQ, but need a depth of soil that is only available on lava flows older than those at CRMQ.

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