WILDFIRES ON BIG SAGEBRUSH/ANTELOPE BITTERBRUSH RANGE IN NORTHEASTERN CALIFORNIA: IMPLICATIONS FOR DEER POPULATIONS

Douglas R. Updike
Eric R. Loft
Frank A. Hall

ABSTRACT

Between 1983 and 1988, wildfires burned more than 159,000 acres (64,300 ha) of big sagebrush (Artemisia tridentata)/antelope bitterbrush (Purshia tridentata) winter range used by mule deer (Odocoileus hemionus) in Lassen County in northeastern California and Washoe County in northwestern Nevada. As in much of the Great Basin, these burned areas are frequently recolonized by cheatgrass (or downy brome) (Bromus tectorum) and some native perennial grasses, to the detriment of sagebrush and bitterbrush regeneration. Recently burned areas provide no browse, thermal cover, or hiding cover for deer. In the early 1950’s, deer in the area consumed 63 percent (by volume) browse and 28 percent grass during December. In December 1987, dry cheatgrass comprised 80 percent by volume while bitterbrush was almost nonexistent in deer diets. Many deer died in winter 1987 because of storms that made high-quality herbaceous forage unavailable and because there was little browse available as a result of fire. The deer population has been in a downward trend since 1964, and is down 28 percent since 1983. Management options are suggested to help mitigate the modification of deer habitat and consequent loss of deer.

INTRODUCTION

Winter is a maintenance or survival period of the year for deer and their behavior and activities are directed towards maintaining a balance between energy intake and expenditure (Hobbs 1989). High-energy forage and thermal cover are important for mule deer (Odocoileus hemionus) survival on Great Basin winter ranges (Leckenby and others 1982). Because winter forage is usually insufficient for maintaining deer condition, the duration and severity of the season is considered a primary factor determining how long deer survive on the winter range (Wallmo and others 1977). As quality winter forage and thermal cover are reduced, the period of time that deer can energetically maintain themselves is also reduced (Hobbs 1989).

From September through December, bitterbrush (Purshia spp.) has historically been the most important winter range food in Lassen and Washoe Counties of northeastern California and northwestern Nevada for mule deer on winter range (Hormay 1943; Lassen and others 1952; Dasmann and Blaisdell 1954; Leach 1956). From January to March, sagebrush (Artemisia spp.) has historically been the dominant forage source (Leach 1956; Tueller 1979). The alien cheatgrass (Bromus tectorum) has become important in the diet during spring and during the fall if wet, mild weather produces a “green-up” (Bentley and Talbot 1951; Young and others 1987).

Hobbs (1989) developed a simulation model that predicted that mortality of deer would increase as shrub forage digestibility decreased in severe winters. In the model, digestibility is influenced by the availability of shrub and herbaceous vegetation as modified by snow depth. Herbaceous forage becomes less available as snow depth increases. During mild winters when herbaceous forage is available, declines in herbaceous forage digestibility increased mortality more than declines in shrub digestibility. Hence, in severe winters, mule deer in shrub-steppe communities must rely heavily on browse, while in mild winters, both shrub and herbaceous forages are important. The model assumes that, over time, both shrub and herbaceous vegetation are present on the winter range, but in Lassen and Washoe Counties that is increasingly not the case. Analogous to decreasing digestibility of shrub forage is to severely decrease the availability of shrub forage resulting from fire.

Fires in the Lassen-Washoe range occur primarily during summer months due to lightning storms. Human-caused fires along highways and railroad rights-of-way are also common, but are more likely to be kept small because of their accessibility. Some prescribed fires during summer have been used to reduce sagebrush and juniper (Juniperus occidentalis) abundance and increase the production of herbaceous vegetation for livestock (Bureau of Land Management, Eagle Lake Resource Area files). The primary result of summer fire in the Great Basin is the eradication of big sagebrush (A. tridentata) for a period of time (Pickford 1932; Blaisdell 1953). Natural regeneration of bitterbrush following summer fire is also poor on these western Great Basin ranges (Hormay

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Douglas R. Updike is associate wildlife biologist and Eric R. Loft is wildlife biologist, California Department of Fish and Game, 1416 Ninth St., Sacramento, CA 95814; Frank A. Hall is wildlife biologist, California Department of Fish and Game, 728-600 Fish and Game Road, Wendel, CA 96136.

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One consequence of summer fires has been the proliferation of cheatgrass, which reduces natural bitterbrush seedling recruitment (Holmgren 1956; Hubbard and Sanderson 1961; Young and others 1972). Efforts to rehabilitate these ranges may be difficult if not done before cheatgrass establishes itself, or if herbivores are not controlled for the first few years (Evans and Young 1978). In this paper, we develop the hypothesis that summer fires on these ranges are detrimental to the energy balance of wintering deer and their survival because of the extensive conversion of shrubland to grassland and associated loss of browse and thermal cover.

**METHODS**

The study area is located on the east side of the Sierra Nevada between Reno, NV, and Susanville, CA (fig. 1). Deer migrate to the area from summer ranges in the Sierra Nevada. Fire records from 1957 to 1988 within the winter range boundaries of the Doyle deer herd in southern Lassen and Washoe Counties were obtained from the Susanville and Carson City Bureau of Land Management offices and the California Department of Forestry. Polygons of fire occurrences were plotted on topographic maps. Only fires over 300 acres (121 ha) were included, because smaller fires were generally delineated with only a symbol by the agencies and did not have a detailed map. Occurrence of repeat fires, those areas that have burned more than once in the study years, was calculated to determine whether those areas are predisposed to burn because of the recent burning and presence of flammable herbaceous vegetation (Young and others 1987).

**Food Habits**—We compared mule deer food habits data collected during December of 1951 and 1952 (n = 30) and December 1987 (n = 16). Deer were collected during both periods on winter ranges in Washoe County, NV, and were analyzed by the same researcher (Leach 1956; Leach 1988). Deer collected in 1987 were from an area that had burned many years previously and is adjacent to the site of the 1951-52 collections. Mean frequency of occurrence and percent volume of plant species in the stomach contents were determined for each deer.

**Deer Population Estimates**—Estimates of deer population numbers in the affected area were determined using a Lotus 1-2-3 (Lotus Development Corp.) simulation of the POP-II population model (White 1985). The model was considered valid when a 25-year simulation of the annual harvest and herd composition agreed with field data, and when the simulated population trend agreed with an independent method used to estimate the population (Fowler and others 1985).

**RESULTS**

Fires burned about 49,000 acres (19,800 ha) of winter range between 1957 and 1982 (figs. 1 and 2). From 1983 through 1988, fires burned at least an additional 159,000 acres (64,300 ha). Repeat fires, those areas that burned at least two times between 1957 and 1988, comprised about 7,000 acres (2,830 ha) (about 3 percent of the total burned area).
Food Habits—Diets of mule deer collected during December 1951 and 1952 consisted of 28 percent grass, 63 percent browse, and 9 percent forbs (table 1). Cheatgrass was the only grass species found in the stomachs, and the majority of it was green. The major browse species consumed were big sagebrush, antelope bitterbrush (*P. tridentata*) and curlleaf mountain-mahogany (*Cercocarpus ledifolius*). Arrowleaf balsamroot (*Balsamorhiza sagittata*) was the dominant forb eaten.

Diets of deer collected during December 1987 consisted of 80 percent cheatgrass, almost all of it dry, and about 20 percent browse (table 1). Less than 1 percent of the diet was forbs. Sagebrush and rabbitbrush (*Chrysothamnus* spp.) were the principal browse foods eaten. No bitterbrush was found in the diet. The mix of forages in the diet was less in 1987 than in the 1950's (fig. 3).

Body fat indices of 31 deer collected in 1987 indicated that 28 were in poor to fair condition, three were in good condition, and none were in excellent condition (Shor 1988).

Deer Population Estimates—Between 1962 and the present, the December deer population in the study area peaked at about 15,500 animals in 1964 and has declined since (fig. 4). Between 1983 and 1988, the December population estimate dropped about 28 percent to a new low in recent decades of about 7,100 deer.

Table 1—Volume of plants (percent) in stomach contents of mule deer collected in December on mule deer winter range in Washoe County, NV

<table>
<thead>
<tr>
<th>Plant species</th>
<th>1951 and 52 (n = 30)</th>
<th>1987 (n = 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheatgrass (dry)</td>
<td>6</td>
<td>79</td>
</tr>
<tr>
<td>Cheatgrass (green)</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Total grass</td>
<td>28</td>
<td>80</td>
</tr>
<tr>
<td>Browse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big sagebrush</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>Antelope bitterbrush</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>Rabbitbrush</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Curlleaf mountain-mahogany</td>
<td>5</td>
<td>trace</td>
</tr>
<tr>
<td>Other browse</td>
<td>9</td>
<td>trace</td>
</tr>
<tr>
<td>Total browse</td>
<td>63</td>
<td>20</td>
</tr>
<tr>
<td>Forbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balsam root</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Alfalfa (<em>Medicago sp.</em>)</td>
<td>2</td>
<td>trace</td>
</tr>
<tr>
<td>Filaree (<em>Erodium sp.</em>)</td>
<td>trace</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Other forbs</td>
<td>2</td>
<td>trace</td>
</tr>
<tr>
<td>Total forbs</td>
<td>9</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
DISCUSSION

Since the 1951-52 study, the available forage for mule deer in Lassen and Washoe Counties has been modified by fire. Past research and current observations suggest that summer fires in sagebrush-steppe communities eliminate valuable browse used by mule deer in winter. To a limited extent, small openings created by fire in dense sagebrush communities would be desirable to deer by increasing the patchiness of a given area. However, on the scale of the extensive wildfires in the 1980's, large areas of winter range have become a fairly homogeneous stand of herbaceous vegetation. Adequate thermal and hiding cover for deer are lacking on these burned ranges. Although deer were not collected from exactly the same sites, browse in the diet has decreased from about 60 percent to about 20 percent. Browsing pressure on remaining bitterbrush stands is high. Almost no forbs were found in the diet in 1987 and the volume of green and dry grass increased about three-fold.

Weather conditions from September to November determine the availability of green annual grasses and forbs (Bentley and Talbot 1951). If a germinating rain and mild temperatures do not occur, the only herbaceous forage available may be dry vegetation from the previous spring. From November to the following spring, snow depth also determines availability of herbaceous vegetation. Hence, annual herbaceous forage is an unreliable source of energy for wintering deer in some years.

Leach (1956) and Tueller (1979) considered grass consumption by deer in winter to be proportional to availability. Studies of wintering mule deer food habits indicate an average diet consisting of 74 percent shrubs and trees, 15 percent forbs, and 11 percent grass (Kufeld and others 1973).

Deer in this study had a higher proportion of grass in the diet than in any of the studies summarized by Kufeld and others (1973). They assigned rankings to indicate the relative importance of plant species to mule deer diets in winter (fig. 5). Sagebrush and bitterbrush were among the most important species. Cheatgrass was also important in mild winters that ensured its availability. By comparison, squirreltail (Sitanion hystrix), which is one of the most abundant postfire species on prescribed-burn sites in the Lassen-Washoe range, was considered a poor source of winter forage for deer. Squirreltail is one of the most successful native species at coming back after fire (Wright 1971), but we are not convinced that its abundance alone is justification for using summer fire as a range improvement technique. Longhurst and others (1977) concluded that conversion of shrubland to grassland, and grass seedings, were generally unsuitable for wildlife.

Forage of dry matter digestibility less than 50 percent may not provide sufficient energy for deer to maintain their body weight (Ammann and others 1973). Succulent green grass is typically of high digestibility; however, cured grass has a higher lignin content and lowered digestibility (Carpenter 1976). The minimum crude protein requirement to maintain deer condition is about 7 percent of the dry matter content (Welch and McArthur 1979). The 'Lassen' antelope bitterbrush shrub variety has a winter crude protein content of about 8 percent (Shaw and Monsen 1986). However, crude protein levels for grasses in winter are generally lower than the maintenance requirement (Welch and others 1986). Poor body condition and mortality of study deer in 1987 were most likely attributable to a negative energy balance from consuming dry cheatgrass of low digestibility and low crude protein.

The condition of deer and carrying capacity for deer has been reduced because of the decrease in shrub vegetation on the Lassen-Washoe winter ranges. This has made deer much more susceptible to an energy deficit and subsequent mortality in severe winters when herbaceous forage is covered by snow, and in winters when there is no fall greenup of herbaceous vegetation. When deer condition and range carrying capacity are reduced, the effect should be reflected in reduced numbers of deer if the winter range is a limiting factor. Prior to the extensive fires, the summer ranges of these deer was considered the most limiting factor (Fowler and others 1985). Since 1983, however, the winter range appears to have become more limiting because of the cumulative loss of shrub vegetation. The declining deer population reflects these limiting conditions.

SUGGESTED PRESCRIPTIONS

We suggest the following management prescriptions to help mitigate the decline in deer habitat quality and deer numbers:

![Figure 5—Histogram of relative importance of common winter forages to mule deer in the study area (adapted from Kufeld and others 1973).](image-url)
(a) Quantify pre- and postburn vegetation composition. Because of the 1950's-1960's research efforts in the area, many vegetation and deer use transects exist for monitoring trends. Those in unburned as well as burned areas should be examined again in anticipation of future wildfires to assess their impacts. For prescribed fires, pre-burn data on stand characteristics should be required.

(b) Consider the impact of prescribed fire on deer and the plant community. In light of the devastating wildfires, we view summer prescribed fires that reduce shrub abundance to be detrimental to Great Basin deer winter ranges. Options exist for burning degraded sagebrush ranges at cooler seasons of the year to maximize bitterbrush and sagebrush survival and regeneration (Bunting and others 1987).

(c) Give higher priority and faster response time to fires on these winter ranges. Simultaneous fires in other areas may take priority over deer winter range fires because timber and developments may be in danger of burning. Also, some view fires in the sagebrush range as a good range livestock practice because they will convert brush to grass. We agree that burning anywhere that cheatgrass is a component risks the perpetuation of the remaining native plant community (B. L. Kay, pers. commun.; Young and others 1987). The remaining high-quality winter ranges are becoming fewer.

(d) Consider rehabilitation of range for wildlife with seeding of bitterbrush (Shaw and Monsen 1986) and other browse species, such as sagebrush (Welch and others 1986), in addition to seeding grass species.

(e) Control livestock and wildlife browsing/grazing pressure during the recovery phase by limiting stocking rate and by liberalizing deer harvest to take more antlerless deer.

To achieve these objectives will require cooperation among the agencies involved and probably some concessions by each. A great deal of work on bitterbrush ecology in the area was done in the 1950's by range and wildlife researchers. It has successfully been seeded and transplanted into deer and cattle exclosures on recently burned range in an intensive effort, but no reasonable method of establishing bitterbrush that can become established given the presence of cheatgrass as a competitor? There is consolation in knowing that good deer wintering habitat in this study area usually provides desirable summer shrub and herbaceous forage for livestock as well (Hormay 1943). The difficulty has been avoiding overuse of such habitats at either season of the year.

REFERENCES


Proceedings—workshop on livestock and wildlife-fisheries relationships in the Great Basin; 1977
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