Fire History and Ecology, Lava Beds National Monument

ARLEN H. JOHNSON
Research Assistant
College of Forest Resources
University of Washington
Seattle, Washington

and

GARRETT A. SMATHERS
Chief Scientist
National Park Service Science Center
Bay St. Louis, Mississippi

INTRODUCTION

One of the major management objectives of the National Park Service is the preservation and, if necessary, restoration of the natural and/or historic scene on the lands under its administration. With this in mind, Garrett Smathers in 1966, then Chief Park Naturalist for Lava Beds National Monument, outlined the major changes which had occurred in the monument's biota since approximately 1870 (Smathers, 1966).

In his analysis of these changes, he indicated that one of the possible causal factors was the existing policy of fire exclusion. This policy which had existed since the turn of the century had altered the natural fire frequency and in turn altered or eliminated the effects of fire on plant community structure and composition. In addition, he pointed out that many of the changes which had oc-

curred were not irreversible and that restoration could be facilitated if fire were allowed to perform its natural role in the ecology of the area.

Smathers therefore planted the seed from which the present study of Lava Beds fire ecology originated. This study has been made possible by means of a research contract between the Pacific Northwest Region of the National Park Service and the University of Washington. Under the direction of Dr. Robert Martin, principal investigator for this project, research will be conducted over a 2-year period with the following objectives in mind.

The primary objective of this study is to develop fire policy recommendations for the management of Lava Beds National Monument which will aid in the restoration and preservation of "pristine" conditions by natural means.

Before this objective can be met, however, the following contributing objectives must first be accomplished.

1. Determine as accurately as possible the pre- and postsettlement fire and vegetation history of the area which is now Lava Beds National Monument.
2. Conduct experimental fires in each of the present communities under various conditions and during different seasons of the year to evaluate fire effects on community structure and composition.
3. Develop dynamic fuel models for each of the major vegetation types.
4. Compile data on wildfires as they occur, evaluating rate of spread, energy release, fuel consumption and short-term effects on plant communities.

In as much as our first field season has only recently concluded, there is little in the way of results or final conclusions to present at this time. I would like to take this opportunity, however, to present some of Garrett Smathers' and my own observations and feelings regarding the fire ecology of Lava Beds National Monument and inform you on what has been accomplished since the project began and what is planned for the future.

STUDY AREA

Lava Beds National Monument is located in extreme northern

California, approximately 35 miles south-southeast of Klamath Falls, Oregon. Encompassing 46,238 acres, it lies roughly 40 miles east of the crest of the southern Cascades on the northern flank of the Medicine Lake Highlands and exhibits elevations from 4000 to 5700 feet (1219 to 1737 meters).

The climatic regime of the area might best be classified as temperate semi-arid. Summers are relatively hot with the mean maximum temperature being 77°F (25°C). Winters and springs in contrast are cool to cold with a mean minimum temperature of 24°F (−4.4°C). Mean annual precipitation is approximately 13 inches (33 centimeters) and occurs primarily during winter and spring. Severe fire weather therefore occurs most frequently during the months of July, August, and September.

Geologically the features of the Lava Beds landscape are of very recent origin and, as the name connotes, are the result of volcanic activity. Cinder and splatter cones dot the landscape, lava flows cover the surface or lie below more recent accumulations of pumice and cinders. Below the surface a labyrinth of lava tubes honeycombs the area.

PAST LAND USE AND ABUSE

It was primarily the presence of these geologic features which led to the establishment of the monument on November 21, 1925. Also of importance was the fact that the major battles of the Modoc Indian War of 1873 occurred in the rugged lava flows at the northern end of the monument. This conflict was unique in two ways, it was the first and only Indian war to occur in California and secondly it was the first Indian war to be extensively photographed. While these photographs were intended only to record various aspects of this military campaign, they also inadvertently recorded much concerning the vegetation of the northern portion of the monument. This fact takes on added significance when we realize that the first settlers in the area arrived in the late 1850's and early 1860's (Brown, 1970) and that prior to 1873 their presence had little effect on the Lava Beds flora and fauna. These photographs therefore provide us with our first and only glimpse of the "pristine" landscape.

By 1900, a number of homesteads had been established within the

present monument boundaries. With the settlers came domestic livestock; cattle, horses, and sheep. Knox (1953) relates that one homesteader reported his family ranged a thousand head of horses in the Lava Beds at the turn of the century and that another early settler claimed to have grazed 30,000 head of sheep on the northern end of the monument in the year 1917. It was during this period of heavy grazing that woody species such as western juniper (*Juniperus occidentalis* Hook.) were able to successfully invade the bunchgrass-sagebrush community. It was also during this period that most of the exotic species gained a foothold (Cronemiller, 1935; Knox, 1953). So successful were these exotics such as cheat grass (*Bromus tectorum* L.) and related forbs in colonizing the over-grazed areas, that they still retain a dominant position in the community today.

When the monument was established in 1925, it was placed under the National Forest Service for administration. Under Forest Service landuse policy, grazing of livestock and related activities were still permitted in the monument (Cronemiller, 1935). In 1933, when the National Park Service took over the administration of the Lava Beds, a new type of land management policy was applied. Although this new policy was designed to protect, conserve, and provide for the enjoyment of the Lava Beds, it failed to recognize some very important ecological factors. Among these was the need for fire.

Under the new management policies, a more vigorous and concerted effort was made to surpress wildfires; a management practice that encouraged further invasion of the bunchgrass-sagebrush community by higher woody plants and led to a general increase in brush species throughout the monument. This policy of fire suppression has continued up to the present time but will hopefully be altered in the near future.

VEGETATIONAL CHANGES

That fire exclusion can result in significant changes in an area's biota has been recognized for some time and has been documented through research and observation in a number of National Parks, Monuments, and Wilderness areas (Kilgore, 1972; Frissell, 1973; Heinselman, 1973; Houston, 1973; Loope and Gruell, 1973). That

this has occurred in Lava Beds National Monument is suggested by the changes which have occurred over the past 100 years.

Now, although exact knowledge of the past is impossible, records and accounts of early travelers and settlers in the region, remnants of past communities, and studies of floras which have evolved under similar climatic and geologic conditions permit a theoretical reconstruction of the 1873 scene. At that time three major communities existed within the present monument boundaries. These were a grassland community, a woodland community, and a coniferous forest community (Smathers, 1966) (Figs. 1 and 2).

Of these three, the coniferous forest community has undergone the least amount of change in the intervening 100 years, but effects of fire exclusion are still apparent. The community dominant was then, as it is now ponderosa pine (*Pinus ponderosa* Dougl. ex Loud.) with white fir (*Abies concolor* [Gord. & Glend.] Lindl.) and incense cedar (*Libocedrus decurrens* Torr.) present as codominants at the higher elevations and on northern exposures. Early travelers to southern Oregon and northern California remarked on the park-like appearance of ponderosa forests in this region. Today this forest is filled with an understory of mountain mahogany (*Cercocarpus ledifolius* Nutt. in T & G.) and antelope bitterbush (*Purshia tridentata* [Pursh] DC.). Although these two were undoubtedly components of the original community, frequent fires then held them in check. Today the presence of these shrub species not only reduces pine reproduction but also greatly increases the fuel loadings and therefore the possibility of a conflagration which might destroy the entire community (Fig. 3).

The woodland community which held an ecotonal position between the coniferous forest and the grassland was characterized by an association of ponderosa pine and western juniper. Early descriptions indicate that the ponderosa in this community did not grow as tall as it did in the coniferous forest community. In general it had a short stout bole accompanied by a dense crown and gnarled limbs (Cronemiller, 1935). This condition suggests that ponderosa pine was not completely physiologically adapted to this site. In any event, a drought and western pine beetle (*Dendroctonus brevicomis)* infestation in the 1920's eliminated most of the ponderosa pine from

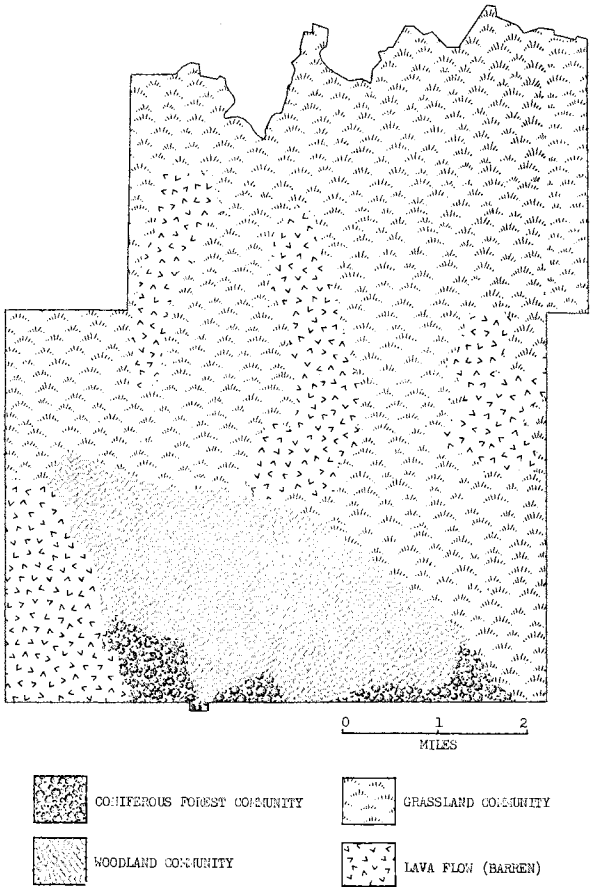

Fig. 1. Major floristic communities of Lava Beds National Monument, 1873.

this zone. Today the previous woodland community could more accurately be termed a juniper-chaparrel community. Although mountain mahogany and antelope bitterbush undoubtedly existed in the original community, frequent surface fires most likely relegated these species to those areas of rough volcanic substratum or areas where surface fuels were light and discontinuous. This is evidenced by the fact that the oldest and most decadent stands of

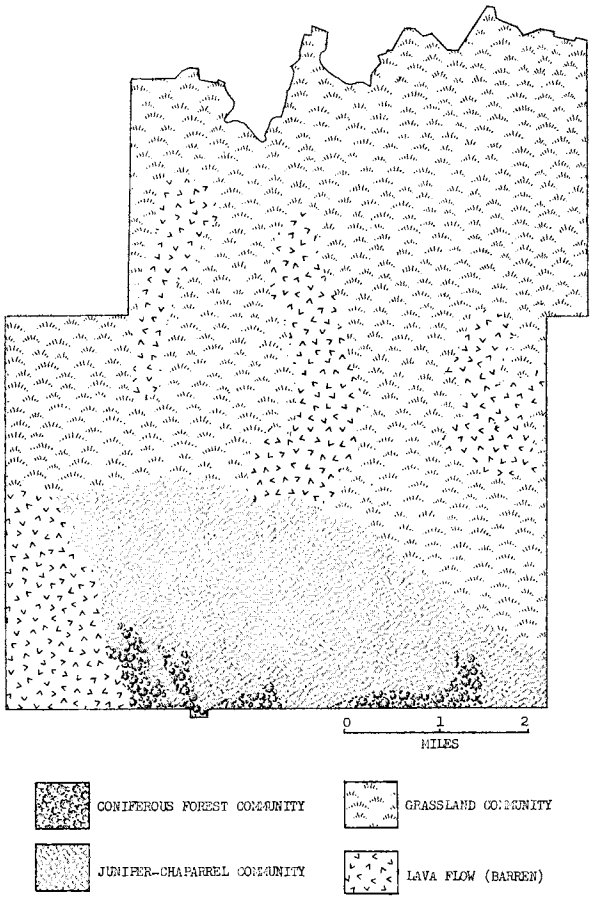

Fig. 2. Major floristic communities of Lava Beds National Monument, 1974.

mountain mahogany and bitterbush are most frequently observed on the roughest and most barren of areas. As the policy of fire exclusion became more effective, these two species along with western juniper formed extensive stands preventing reestablishment of ponderosa pine and once again producing a severe fire hazard (Fig. 4).

As was mentioned previously, the grassland community was extensively photographed in 1873 during the Modoc Indian War. These

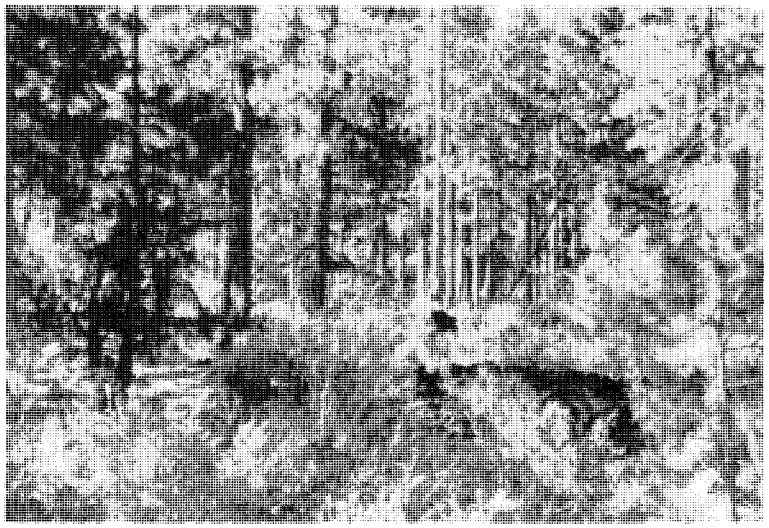

Fig. 3. Coniferous Forest community, 1974. Fire exclusion in this community has led to an increase in the percent cover of shrub species in the understory, an increase in the frequency of white fir on some sites and a transition from even-aged to uneven-aged stands.

Fig. 4. Juniper-chaparral community, 1974. Numerous ponderosa pine snags in this community indicate the past codominance of this species with western juniper. Although fire exclusion played no part in the demise of the ponderosa it has resulted in extensive stands of mountain mahogany and western juniper.

photographs indicate a bunchgrass-sagebrush association with the dominant grass species no doubt being bluebunch-wheatgrass (*Agropyron spicatum* [Pursh] Scribn. & Smith) (Fig. 5).

This original bunchgrass-sagebrush community has now been replaced by a community of native and exotic pioneer dominants, exhibits a considerable encroachment of western juniper, and displays an increase in the percent cover of sagebrush (*Artemisia tridentata* Nutt.) (Fig. 6). Most of these changes are a direct result of overgrazing prior to the 1930's but suppression of wildfires most certainly compounded the effects of these abuses.

FIRE HISTORY

This account of the various changes which have occurred in the past 100 years and the manner in which fire exclusion was involved in effecting these changes assumes that prior to 1873 fire was more than simply an infrequent disruptive force, that it was in fact a vital force shaping and maintaining the various floristic communities. Is this assumption valid?

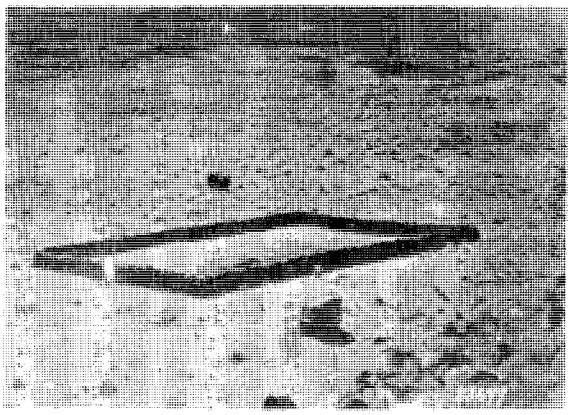

Fig. 5. Bunchgrass—sagebrush community, 1873.

Fig. 6. Bunchgrass—sagebrush community (1974) from the same point as Figure 5. Note the invasion of western juniper and the increase in the percent cover of sagebrush. These changes resulted from a combination of overgrazing and fire exclusion.

Although accurate fire records exist for only the past 41 years, they give insight into the natural fire frequency of the area. In these 41 years a total of 75 lightning caused fires have occurred for an average of 1.88 fires per year. If we look at a breakdown of these fires by the communities in which they occurred, we find the following: 64 percent of these fires occurred in the grassland community with an average fire frequency of one fire each 0.86 years; 27 percent occurred within the original woodland community for an average fire frequency of one fire each 2.1 years, and finally 9 percent occurred in the coniferous forest community with a fire frequency of one fire each 5.8 years. Surprisingly then, these records indicate the relative fire frequencies one would expect for these three communities. This then brings up a very basic question. Do the differences in fire frequencies result from the fact that there are three different communities or are the three communities the result of differences in fire frequency? This question is somewhat

like the one concerning the chicken and the egg. I believe, however, that the changes which have been outlined point more strongly to the latter case rather than the former. That is, the three communities evolved in the past because of differences in fire frequency in different areas of the monument.

In order to gain a greater understanding of the fire history of the coniferous forest community and woodland community, a considerable portion of the past field season was spent collecting sections from a total of 83 fire-scarred ponderosa pine snags throughout the southern portion of the monument.

Although there has not been sufficient time to analyze these sections, we are hopeful that by utilizing techniques of dendrochronology we will be able to reconstruct the fire history for the past 250 to 300 years. These data of fire frequency and annual acreage burned will be very useful when attempts are made to utilize prescribed fire to reverse some of the changes wrought by fire exclusion.

FUTURE PLANS

Plans for the future involve a number of experimental burns throughout the spring and summer of 1975. These will be conducted within each of the present plant communities under various environmental conditions in order to determine short-term effects of fire on community structure and composition. Within the time frame of this study, long-term effects will be difficult to document but hopefully any changes which occur will be periodically monitered far into the future by park service personnel. Knowledge gained in this manner regarding the effects of fire on the various species components of each community will provide insights into how natural and prescribed fire might be utilized to favor native species over exotics and restore the "natural" community structure and composition.

Also slated for next year will be the development of dynamic fuel models for each of the major vegetation types. This knowledge will prove necessary in those areas where for various reasons natural fire will never be allowed and prescribed fire alone will be utilized.

These models will also provide guidelines as to how long any area should be allowed to remain fire free.

Finally, out of this study, fire policy recommendations will be developed. Hopefully meaningful recommendations can be made which can aid management personnel whose task it will be to reintroduce fire into a system which has existed under a policy of fire exclusion for the past century.

SUMMARY

Over the past 100 years, it is noted that a number of changes have occurred within the major floristic communities which now exist within the boundaries of Lava Beds National Monument. A number of these changes, it is felt, have resulted directly or indirectly from past policies of fire exclusion. This is the hypothesis which will be tested by the present study. From this fire study, recommendations will be developed which will hopefully aid in restoring the "pristine" landscape through the restoration of fire to its place as a viable environmental force.

ACKNOWLEDGEMENTS

Without the support and cooperation of Superintendent Paul Haertel and the staff of Lava Beds National Monument, this study would not have become a reality. Guidance and assistance of Dr. Robert Martin, Project Leader USFS Fire Science Project, University of Washington, has also been invaluable. The assistance of Doyle L. Kline (presently Resource Management Specialist, Southwest Region Office of the National Park Service) in compiling fire atlas information for the 1966 Resources Management Plan for Lava Beds National Monument is also hereby acknowledged.

LITERATURE CITED

Brown, Dee. 1970. Bury my heart at wounded knee. Holt, Rinehart and Winston, New York.

Cronemiller, Fred P. 1935. Notes on the history of Lava Beds National Monument. (Unpublished manuscript on file at Lava Bed National Monument library).

Frissell, Sidney S., Jr. 1973. The importance of fire as a natural ecological factor in Itasca State Park, Minnesota. Quaternary Research 3(3):397-407.

Heinselman, M. 1973. Fire in the virgin forests of the Boundary Waters Canoe Area, Minnesota. Quaternary Research 3(3):329-382.

Houston, Douglas B. 1973. Wildfires in northern Yellowstone National Park. Ecology 54(5): 1111-1117.

Kilgore, Bruce M. 1972. Fires role in a Sequoia forest. Naturalist 23:26-27.

Knox, Raymond G. 1953. Annual forest report, 1953. (Unpublished manuscript on file at Lava Beds National Monument library.)

Loope, Lloyd L. and George E. Gruell. 1973. The ecological role of fire in the Jackson Hole area, Northwestern Wyoming. Quaternary Research 3(3):425-443.

Smathers, Garrett A. 1966. A resources management plan for Lava Beds National Monument. (Unpublished manuscript on file at Lava Beds National Monument library.)