life of lava beds

Cover: Two young great horned owls wait for a meal. These raptorial birds are a living symbol of the management goal for Lava Beds National Monument and similar areas of the National Park System: to preserve environments where the natural order prevails and all wildlife, including predatory species, can live free of interference by man.

The life of lava beds

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As dawn slipped across the glassy surface of Medicine Lake, swirls of sulfurous fumes rose from volcanic vents, and retiring nocturnal creatures were replaced by animals of the daylight. Far below, at the foot of the mountain, lay another lake, as yet unnamed by European man. Between the lakes was a realm of pine forest, shrubs, and bunchgrass, populated by rodents, hoofed mammals, predators, and many lesser animals. It was a land of violent change, with cinder cones and stark lava flows still barren of vegetation breaking the continuity of forest, brushland, and grassy plain.

On the flank of the primeval volcano, birds began to sing. Mice, groundsquirrels, and chipmunks scurried over and tunnelled under the pine needles. Mule deer sought tender browse, and in more open grassy areas bighorns warily surveyed their domain. Even as they fed, these animals were alert to danger, for enemies were ever on the prowl. Bobcats were retiring from the early morning hunt, but coyotes still searched for the unwary. A cougar fed silently upon a mule deer it had killed in the predawn darkness.

Aloft, other eyes began the search for food. A bald eagle winged across the lake while a red-tailed hawk circled over the open grassland in search of small animal prey. Turkey vultures perched on an old pine snag, waiting for the air currents rising from the warming land to become strong enough to lift their heavy bodies in soaring flight.

The Indian inhabitants of this austere but flourishing land trod lightly. They were part of its web of life rather than disrupters of its natural processes. They fished in the lakes, hunted waterfowl and deer, and gathered plants and seeds. They built houses from shoreline reeds

and made canoes from reeds or hollowed logs. If unfriendly tribes threatened, they sought refuge in the rugged lava flows.

The rhythms of life and death in Lava Beds continued through the seasons and years. Then came the white man, with strange animals and strange implements; and life changed for both the Indians and the wildlife.

Top: **Cinder Butte; Mt. Shasta in background.** ***Bottom:*** **Red-tailed hawk.**

Lava flows and lava tubes

At first glance, Lava Beds National Monument seems to be a chaotic, jumbled expanse of rugged, broken material derived from volcanic upheavals. But faulting of the earth's crust has been important, too, in shaping this landscape. Massive faults—fractures of the earth's crust with resultant vertical displacement—caused the formation of Tule Lake Basin and the long bluffs that rise abruptly northwest of the park. Part of one of these fault scarps, Gillems Bluff, looms over the park road at Devils Homestead.

In late Pleistocene times (2 to 3 million years ago) molten rock began to flow from the south. The center of this activity was the Medicine Lake Highland, a shield volcano nearly 20 miles in diameter, built of andesitic lava.

The broad, domelike character of shield volcanoes results from the emissions of highly fluid lava flows that spread widely as thin, nearly horizontal sheets. As the highland grew in size, its flows extended to the shores of Tule Lake, forming the Modoc Lava Beds, part of which now makes up Lava Beds National Monument. Some of these flows may have originated from near the summit of the volcano; but many early smaller ones and most of the recent flows broke from the mountain's flanks.

Relatively large flows streaming down the north flank of the Medicine Lake Highland encountered the uneven terrain of previous flows. These rivers of molten rock split into smaller streams, winding back and forth across the slopes. Some of the advancing flows spread, covering large areas, but streams continued to carry the bulk of the rapidly moving lava. As cooling took place, the more slowly moving material solidified. Where currents carried vast

amounts of molten rock, the cooling process was slower, beginning along the edges, top and bottom, where heat could escape into the surrounding rock and atmosphere. This pattern of cooling and hardening enabled the streams of molten rock—constricted, insulated by hardened lava on all sides, and fed from above—to move rapidly, feeding the slowly advancing head of the flow and splitting and rejoining in a system of braided streams.

Gradually, as the eruption subsided, the volume of the lava rivers decreased. The streams of molten rock slowed and finally flowed from their channels, by now fairly solid and naturally arched. These channels are the lava tubes that criss-cross the area today. Some molten mate-

Schonchin Butte (fire tower on summit); Gillems Bluff behind the cinder cone and Tule Lake Sump in middle distance.

Top: **Valentine Cave (open to visitors).**
Bottom: **A small cave opening near the Black Lava Flow.**

rial dripped from the ceilings, congealing into drip pendants (lava-cicles) and flow ridges. The levels of the streams were marked by elevated channels or curbings along the walls, where the surface edges of the streams cooled and stuck to the tubes.

The final remnants of a lava stream were "frozen" in the bottom of the tube, and the appearance of the floor today indicates the conditions and movement of the last small rivulets. Here and there large fragments broke from the ceilings of tubes, forming obstacles on the floor around and over which the molten material flowed. Other pieces fell as the rock continued to cool and as freezing and thawing loosened them hundreds of years later.

Openings in many of the lava tubes were made when ceilings collapsed; other openings may have resulted from explosions of accumulated hot gases. Through these natural entrances plants and animals invaded the passageways.

Meanwhile, on the surface, other features were built. The surfaces of lava flows ordinarily are not smooth and regular. Conforming somewhat to irregularities beneath, the flows here began to break and buckle as crusts formed and the pressure of moving lava from above pushed on. Gases that escaped from the cooling material collected in pockets and caused the surface to be pushed upward into lava domes. General cooling and contraction of the surface opened large cracks.

Flows overlapped other flows. Thick, viscous lava carried by gas bubbles plopped out of surface cracks, piling up into spatter cones, or chimneys. Gaseous eruptions caused the fountaining of very fluid lava and built cinder cones, called "buttes" in this region. The lava sprayed into the air, cooled into cinders as it fell back

to earth, and piled up around the vents to form these nearly symmetrical cones. Occasionally, molten rock would also flow smoothly from these vents, building flows from the base of the cones.

This, then, is the geological setting: extensive flows of *pahoehoe* (smooth or ropy lava), and occasional flows of *aa* (broken, clinkery lava), marked by cinder and spatter cones and cut by deep natural cracks and trenches. Late eruptions have added a layer of pumice over much of the area.

Top: **Black Lava Flow, a vast expanse of jumbled *aa* lava in the southwestern corner of the monument. *Bottom:* Ross Flow, of smooth *pahoehoe* lava.**

Life communities

Plant and animal pioneers

From a distance this land of lava flows may appear harsh and inhospitable. A close look, however, reveals that it has a surprising richness of plant and animal life. The process by which life forms occupied this rocky terrain was a slow one, stretching over centuries. It is still going on; you can see the beginning stages on the most recent lava flows.

The first plants to gain a foothold on the rocks are lichens. These are actually two different kinds of plants living together in a mutually beneficial partnership. Each lichen has a fungus that provides support and moisture and an alga that, possessing chlorophyll, manufactures food for the plant, utilizing carbon dioxide from the atmosphere and the water collected by the fungus. Acids secreted by lichens, along with weathering, begin the process of breaking down the rock into soil. As organic matter from dead lichens is added to the broken-down lava and pumice, higher plants find conditions suitable for growth and reproduction. Mosses, grasses and other herbaceous plants, shrubs, and trees appear as each series of plants alters the environment in such a way as to provide

Lichens grow first on new lava landscapes. Higher plants take root when enough soil has accumulated in the crevices.

a favorable home for the next stage. And each new assemblage of plants supports a new population of animals, both plant eaters and the flesh eaters that depend on them.

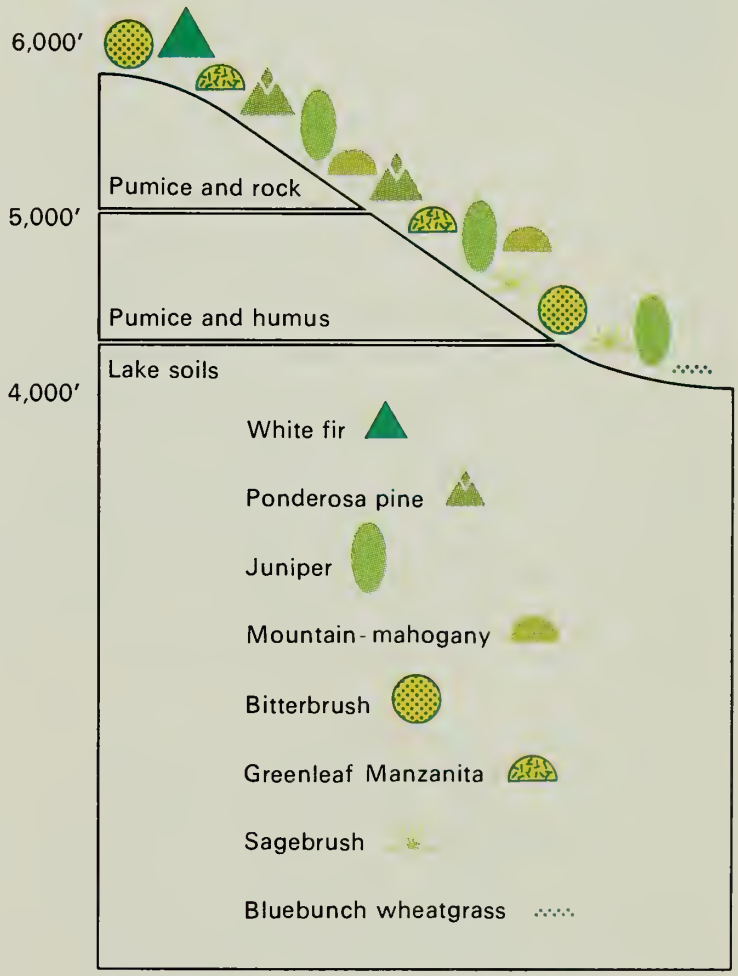
The grouping or association of plants and animals that occupies an area is called a *community*. The physical basis of the community in which an animal lives, along with all the plants and other animals that occupy it, constitutes the *habitat* of that animal.

Biologists generally call the whole complex of interacting plants and animals, and the soil, air, water, and other physical elements of a definable area—in other words, the plant-and-animal community and its physical base—an *ecosystem*. An ecosystem can be as small and simple as a rotting log with the fungi, insect larvae, and other life in it; or it can be as vast and complex as the Southern Appalachian hardwood-and-conifer forest, which has literally thousands of species of plants and a rich and varied array of large and small animals.

A number of factors determine what community exists in a given area. Among the most important are soil conditions, moisture and drainage, exposure, terrain, the nature of adjacent communities, and the activities of man. In this park the physical factors tend to vary from north to south; the lowest, flattest, and generally driest terrain is in the north sector.

A community is most often named after its dominant plant species or type: lily pond, cattail marsh, hardwood forest, etc. Thus, in Lava Beds National Monument we have three major communities: the Sagebrush-bunchgrass, the Juniper-brushland, and the Pine Forest. Though they have some plants and animals in common and are separated by overlapping or transitional zones rather than by sharp boundaries, each community is identifiable as a particular association of interacting organisms.

Soil-vegetation profile of Lava Beds



The plant communities of Lava Beds National Monument occupy zones roughly corresponding to altitude belts.

The Sagebrush-bunchgrass Community

In the lower, northern section of the park, a community dominated by sagebrush and bunchgrass has developed. The soils here are heavier, due to their relatively greater age and their proximity to Tule Lake, which at times of high water undoubtedly deposited soil in some areas. The altitude range is roughly 4,000 to 4,500 feet above sea level. Precipitation may be slightly less here than at higher elevations in the park, and the snow does not stay as long in winter. These factors influenced the establishment of the grassland, but alone they are not enough to maintain it. In the absence of fire, the vegetation would continue to change, in the process of succession described above. Periodic fires caused by summer thunderstorms, however, if they are allowed to burn, tend to perpetuate the existing vegetation.

This stabilizing influence of fires is explained by several factors. The dominant plants found in this community, mostly bluebunch wheatgrass and other grasses, have developed a tolerance of fire. The crowns of the grasses are close to the ground, where fast-moving fire does the least damage; and their tightly clumped or bunched form protects many of the inner, growing shoots. Big sagebrush, a shrubby plant that along with the grasses is dominant in this community, is very vulnerable to burning. Though it comes back rapidly after a fire, the frequency of fires in the past has kept it from forming dense stands that would crowd the grasses out.

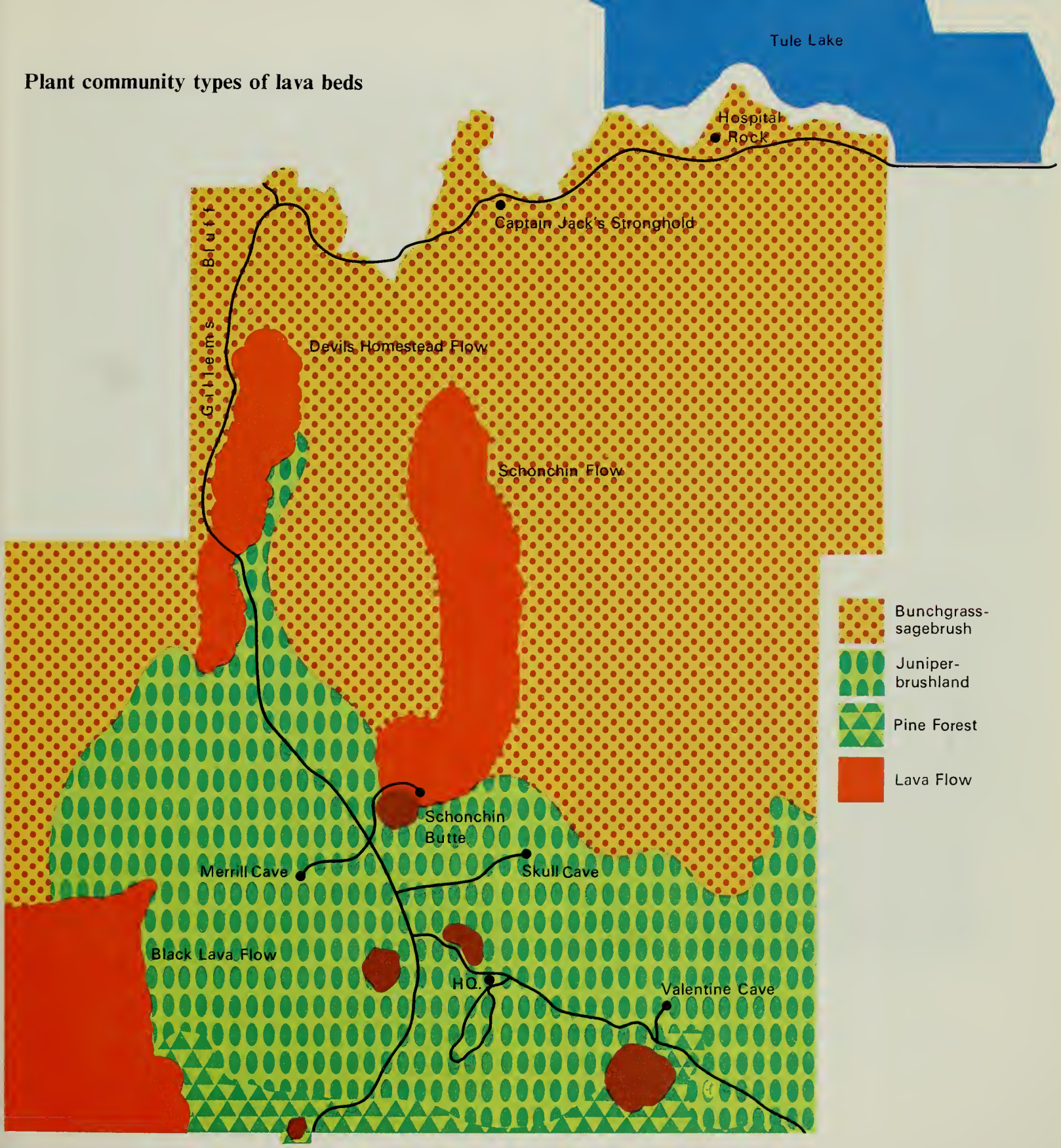
Encroachment by western juniper from the juniper-brushland is another factor tending to change the grassland. Here again frequent fires have helped. Seedling junipers are quite susceptible to fire and cannot survive in frequently burned areas; thus, under natural conditions of periodic fire, junipers are held back in the grassland.

The sagebrush-bunchgrass, like other communities, has its characteristic association of animals. Some species are common to more than one community of the park, but many are found only here. Why? First, the same factors of temperature, precipitation, soils, and frequent fires to which certain plants have become adapted add up to a physical habitat suitable for some animals but not for others. Moreover, the availability of plant food, water, shelter from the elements, escape cover, and suitable breeding places can be critical in determining the makeup of the animal component of the community.

To one familiar with the well watered eastern and northern forests and meadows, the sagebrush-bunchgrass community has a rather austere look, suggesting a sparse population of animals scratching out a hard living from sunscorched vegetation. But appearances are deceiving, for this community, though based on relatively few species of plants, supports a teeming population of invertebrates and rodents that in turn provide sustenance for a host of reptiles, mammals, and birds.

Belding's ground squirrels, kangaroo rats, yellowbelly marmots, blacktail jackrabbits, and cottontails are common small mammals of this community. Valley quail, meadowlarks, and sage grouse are among the characteristic bird species. Many other small mammals and birds, as well as larger mammals and raptors, live or seek food in this community. The rodents, many birds, and most insects feed primarily on vegetation; the rabbits, mule deer, pronghorn, and bighorn are strictly plant eaters. These animals are killed and eaten by large and small predators: snakes, badgers, skunks, coyotes, bobcats, hawks, and owls. The remains of all these plant eaters

Plant community types of lava beds



Top: **Bunchgrasses are dominant plants in the lower elevations of Lava Beds.**
Bottom: **The mourning dove, primarily a seed eater, is found in all communities of the monument.**

and predators furnish food for scavengers and for bacteria and other micro-organisms that break them down and return them to the soil.

Some animals are residents of the community during only part of the year. This is especially true of the migratory birds, most of which fly south in the fall and return in spring to breed in the park. Deer, drawn by tender green shoots of grass, milder temperatures, and lighter snows, come from higher elevations in winter and spring. Pronghorn inhabit the community the year around, but are uncommon in the park and are seldom seen. The bighorn, absent from the park for many years, is again a resident; its story is told elsewhere in this booklet. These three mammals, like smaller plant eaters, are subject to predation; the young, especially, are taken by coyotes and bobcats, and occasionally by golden eagles. Cougars, not abundant in the park, take adults as well. But unusually heavy

Above: **The California quail is a year-round resident of the Sagebrush-bunchgrass Community.** ***Left:*** **The black-tail jackrabbit occurs in both the Sagebrush-bunchgrass and the Juniper-brushland communities.**

losses of deer, pronghorn, or bighorn can seldom be attributed to predators alone. Starvation, disease, parasites, and severe winter weather account for a share and sometimes make great inroads in the population of a species. Accidents and poaching, too, contribute to deer loss.

All these influences, processes, and actions are factors in the complex and dynamic yet orderly interplay of organisms and natural forces that we call "the web of life." Piecing together the elements in the web of any ecosystem is much like trying to put together a jigsaw puzzle whose pieces are constantly changing in shape and size and number. The next chapter—before we look at the park's other life communities—will explore this fundamental concept of nature.

The coyote is a predator, the blue-tailed skink an insectivore, and the pronghorn strictly a plant eater.

The web of life

In the communities of Lava Beds certain natural processes constantly work to maintain the existing association of interdependent plants, plant-eating animals, and flesh eaters. One of these processes, which might be called *the flow of energy,* illustrates the basic ecological principle that all animals depend upon green plants for their existence. We can show this by means of a "food chain" diagram.

sagebrush→sage grouse→coyote

The arrows lead from a food species to an animal that eats it. The sage grouse gets energy from the sagebrush it eats. Some of this energy is passed on to the coyote that eats the sage grouse. Every food chain starts with a green plant and ends with a flesh eater.

Another food chain in the sagebrush-bunchgrass is:

bluebunch wheatgrass→meadow vole→coyote

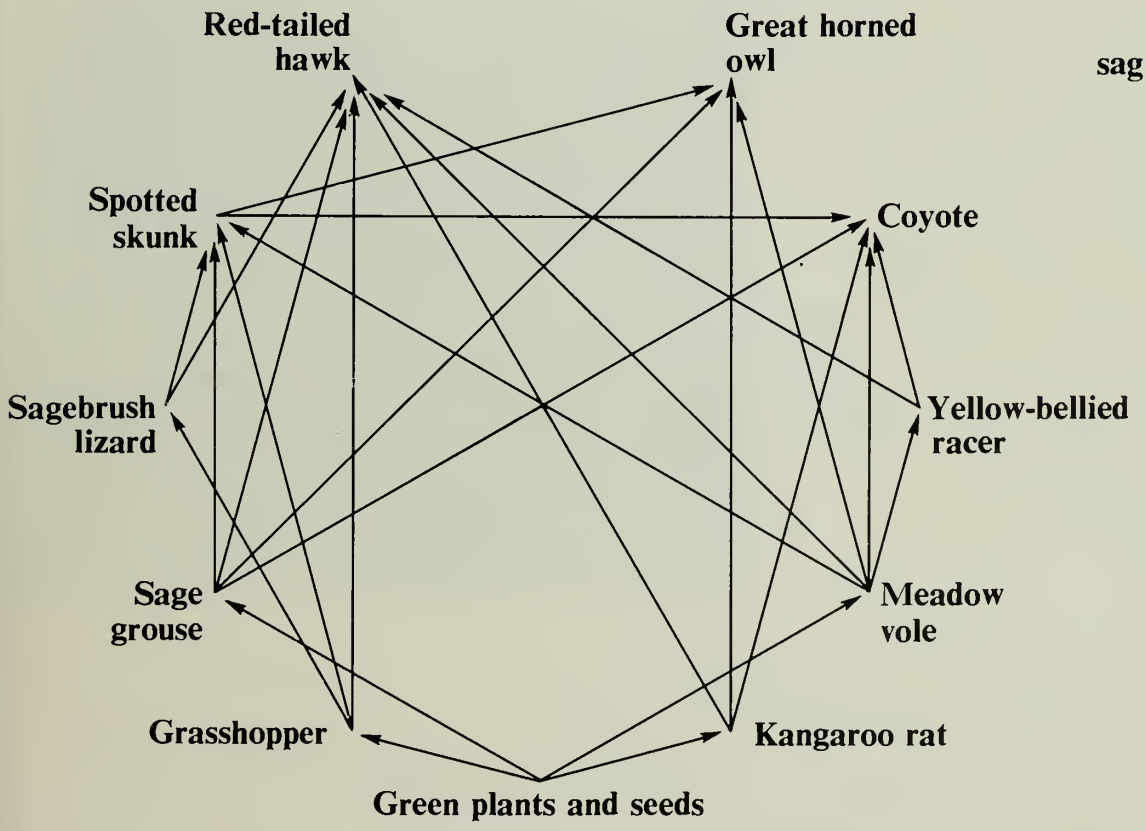
A food chain may have more than three links, for animals that prey upon others are often themselves eaten by larger animals:

bunchgrass (seeds)→kangaroo rat→ yellow-bellied racer→red-tailed hawk

or

bunchgrass→grasshopper→ sagebrush lizard→spotted skunk→ great horned owl

If we combine these food chains, we have the beginnings of the food web for the sagebrush-bunchgrass ecosystem.

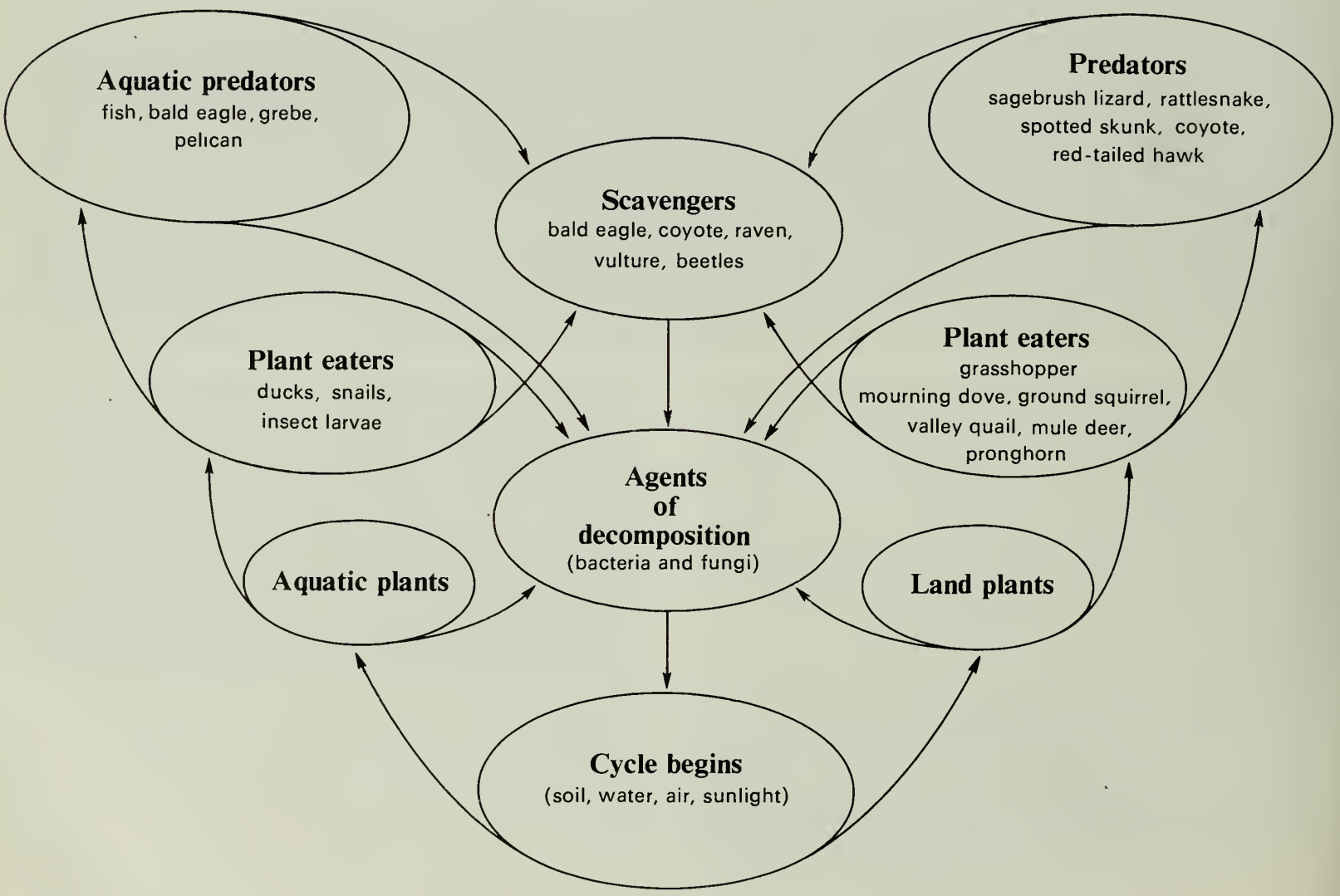


The food web in the sagebrush- bunchgrass is much more complex than this diagram suggests.

But this hardly begins to show the whole picture of the tangled web of living forms existing here. Imagine how complex our diagram would be if we combined all the food chains we could make up for the community. We can simplify the task of diagramming the ecosystem, however, by classifying all the animals into groups, as we did with "green plants"in the diagram below. Then, adding the missing elements of *decay, scavengers, plant nutrients, soil, water,* and *air,* and *sunlight*—the source of energy—we can draw a fairly complete, if generalized, picture of the sagebrush-bunchgrass.

No ecosystem functions entirely independently of other ecosystems around it. Lava Beds National Monument lacks lakes, ponds, or streams within its boundaries; but an adjacent ecosystem, Tule Lake Sump, exerts considerable influence on the life of Lava Beds. This aquatic community is a mere remnant of a vast, shallow lake, famed for its enormous

The life cycle of the Lava Beds/Tule Lake ecosystem.



concentrations of water birds, that was drained many years ago for agricultural purposes. Some of the animals of the region range over both ecosystems. Some predators of the sagebrush grassland feed upon waterfowl and other animal life of the lake. The diagram, therefore, has been constructed to include both Tule Lake Sump and the sagebrush-bunchgrass. This reflects a truer picture of the interrelationships of the life you will see as you drive into the park from the northeast.

The Juniper-brushland Community

Driving through Lava Beds from north to south, after passing through the sagebrush-grassland you will come to a different plant community. It lies farther up the slope of the Medicine Lake Highland, roughly between 4,500 and 5,000 feet elevation, and is here called the Juniper-brushland Community because western juniper and woody shrubs are the dominant plants.

Soils here, containing a great deal of pumice, are lighter than those of the sagebrush-bunchgrass. Fires, which favor grasses and hinder the reproduction and growth of juniper and many other shrubby species, occur less frequently here than at the lower elevations.

The Juniper-brushland Community occupies roughly the middle elevations of the monument.

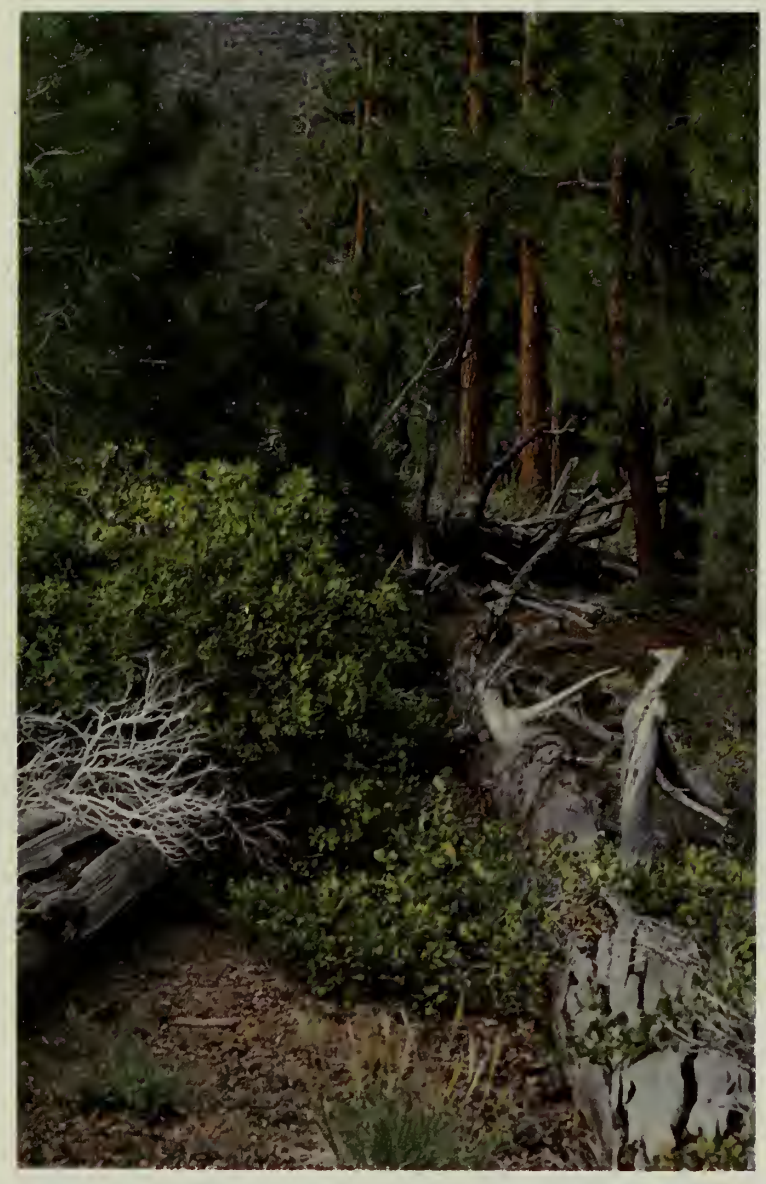
Above: **An ancient juniper near Black Crater.** *Right:* **Both Lava Beds pack rats, the dusky-footed and bushy-tailed woodrats, live in the juniper-brushland. The dusky-footed sometimes builds its nest in a juniper tree.**

The juniper-brushland exists in a rather thin belt, restricted by fire at lower elevations and by temperatures above.

This community is home to some of the animals found in the grassland. Bighorn formerly frequented the grassy openings and lower fringes; coyotes hunt here; and blacktail jackrabbits and valley quail are occasionally sighted. Bobcats are more common here in the brush and rocks than they are in the grassland. California (Beechey's) ground-squirrels, and woodrats are common brushland dwellers. Meadowlarks give way here to scrub and piñon jays and western robins.

Mule deer winter in this community, often in large numbers. Lacking the bitter temperatures and deep snows of higher elevations, this environment supports thick growths of northern antelopebush (antelope bitterbrush) and mountain-mahogany, both favored mule-deer foods. Some of the deer remain throughout the year, but many return to higher country as summer approaches.

Mule deer, mountain cottontail, and western fence lizard, all common residents of the juniper-brushland.



The ponderosa forest at the base of Eagle Nest Butte.

The Pine Forest Community

Ponderosa pine reaches its lower limit in the higher parts of the juniper-brushland. Low precipitation, soil conditions, and altitude limit its downward spread to about 4,600 feet elevation. Between 5,000 and 5,600 feet it thrives in association with another group of plants. White fir, scattered sugar pine, and greenleaf manzanita mix with it above the juniper-brushland to make up what we may call the Pine Forest.

Here, too, fires burned, though less frequently than in the sagebrush-bunchgrass and juniper-brushland communities. The fires created an open, parklike forest with scattered shrubs and grasses. These fires may have occurred only every 30–50 years, but before the park was established they were frequent enough to preserve the openness of the forest. Here, snows are deeper and stay longer. Temperatures are cooler the year around.

Here again, as in the transition from grassland to brushland, the roster of animals reflects the differences in climate and plantlife. Some of the animals of this pine forest, of course, can be found in other communities. Deer spend summer in these higher elevations. The goldenmantle ground squirrel and yellowpine chipmunk replace the Belding's and California ground squirrels of the lower communities. Rabbits are absent, except for an occasional mountain cottontail. Bobcats are present, but coyotes usually stick to lower elevations. Because of the summering deer herds and the relative remoteness of the pine forest, cougars live here too. Steller's jays and Clark's nutcrackers are the common birds. Mountain quail and blue grouse replace the valley quail and sage grouse of lower elevations.

Above: **The blue grouse (a subspecies of the dusky grouse) is found only at higher elevations of the monument.** ***Left:*** **The golden-mantled ground squirrel, a true hibernator, actually spends most of its life asleep underground.**

Top: **A bobcat is occasionally encountered in a lava-tube cave.** ***Above:*** **Pikas, typically found in rock slides, find suitable habitat in the jumbled rocks at cave entrances.** ***Right:*** **A bird's nest can be seen in the entrance of Upper Ice Cave.**

Life in the caves

While the caves of Lava Beds are not considered a separate community in the strict sense, they have a definite character and a special climate, and are inhabited by particular plants and animals that can adapt to cave conditions.

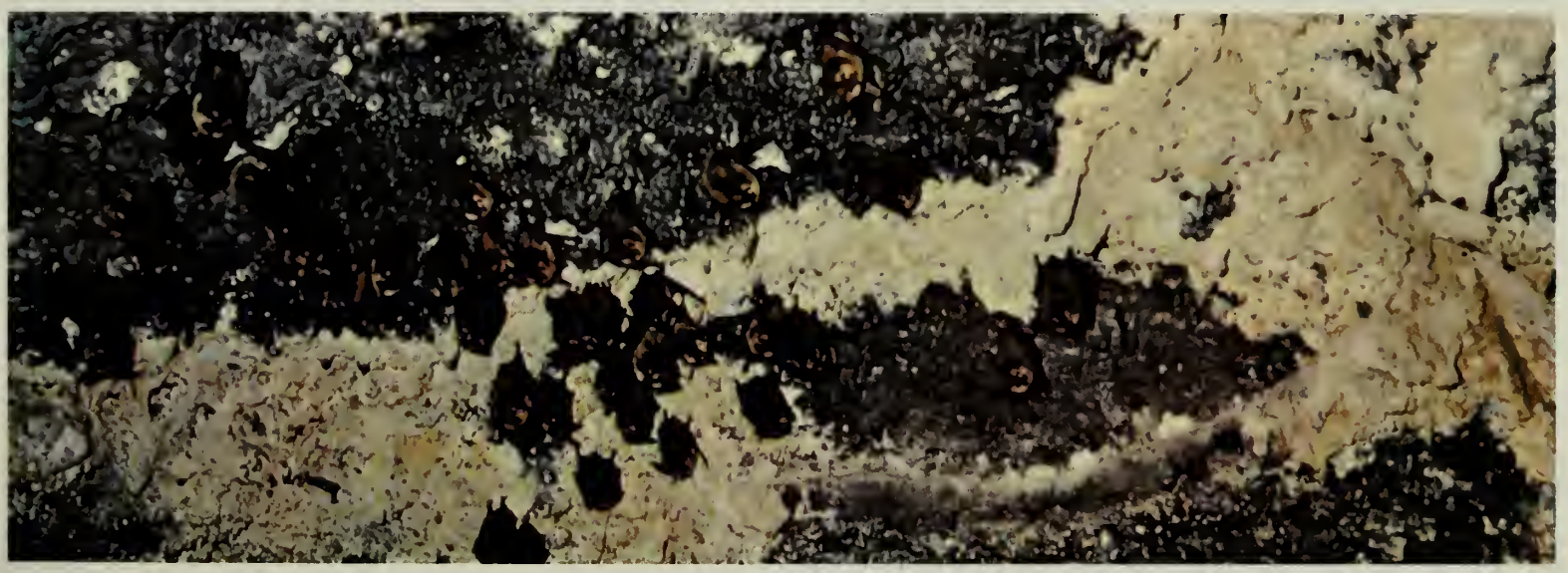
Cave climates vary widely, even in this park. Some are cold throughout the year and contain ice even through the summer. Others are very humid. Some, very wet in winter, dry out considerably in summer. Some have air circulating between surface openings and some do not. All are relatively dark. In most, if you walk far enough from the entrance you will find yourself in total darkness.

The cave entrances at Lava Beds are depressions where the roofs of lava tubes have collapsed. Many plants are found in these exposed locations. One common species is the fragrant fernbush, or desert sweet. Farther in-

side the caves but still in a location where some sunlight reaches, ferns and mosses may grow. Lichens and algae coat many of the rocks with a thin veneer of colorful plant life.

The depths of the caves are virtually devoid of plantlife. Fungus grows on the droppings of cave-dwelling animals, and occasionally a seed deposited in woodrat droppings will germinate and send a slender, white stalk upward searching for light. The seedling finds little or no light and eventually perishes.

Few animals penetrate the darkness of the caves. Pikas nest in the jumbled rocks at cave entrances, and occasionally a coyote or bobcat will hunt around a cave's mouth. Bats and rodents are the only mammals that penetrate deeply into the caves. The bulky nests of bushytailed woodrats can be found in crevices in the walls and ceilings, sometimes far from the entrance. Deermice are occasionally seen beyond the range of sunlight, and bats, of course, can be seen in many secluded passageways. In some caves where the opening is a hole in the roof of the tube you will see skeletons of mammals that fell through and were unable to escape.



Above: **Big brown bats (or western big-eared bats) sleeping on the ceiling of Blue Grotto Cave.** ***Left:*** **a dusky-footed woodrat in its nest in Catacomb Cave.**

The bighorn in the lava beds

The rough terrain and severe environment of Lava Beds were hospitable enough for the hardy, wary, and sure-footed bighorn, which made its home on this lava-strewn landscape until this century. Sustained by the grasses and shrubs of the uplands, it managed to hold its own against nature and man—surviving the snows of winter, the claws and fangs of predators, and the arrows of the Indians. Then came the settlers with firearms and with livestock that not only rapidly depleted the range but brought diseases and parasites to the wild population.

Under increased hunting pressure and with decreasing forage due to overgrazing by domestic stock, and introduced diseases, the bighorn population dwindled. The weakened remnant was unable to withstand the severe winter of 1889–90, and during the last decade of the century no live bighorns were seen in Lava Beds. Reports of bighorn sightings per-

sisted, but were almost never confirmed. (Some sightings were undoubtedly of domestic sheep and goats.) The last report for northeastern California was in 1913.

Today, 60 years after the demise of the bighorns, visitors to Lava Beds can again with sharp eyes and a bit of luck see some of these splendid hoofed animals. The restoration of this symbol of the vanishing wilderness has come about through the foresight and careful planning of managers, biologists, and conservation officials.

The move to re-establish bighorns in Lava Beds began in the early 1960's when Lava Beds National Monument Superintendent William J. Kennedy, Dr. Charles Yokum, Oscar Deming, and others discussed the possibility. Soon after, the Secretary of the Interior's Committee on Wildlife Management in the National Parks recommended that bighorn reintroduction be attempted in some areas of the National Park System. With this potent support, a proposal began to take shape, and in 1969 a memorandum of agreement signed by five agencies—the California Fish and Game Department, the Bureau of Sport Fisheries and Wildlife, the Bureau of Land Management, the Forest Service, and the National Park Service—provided for a cooperative bighorn transplant project.

In 1971, eight bighorn ewes and two rams were trapped in British Columbia, trucked to Lava Beds, and released in an 1100-acre enclosure straddling the boundary of Lava Beds National Monument and Modoc National Forest. The site had been carefully chosen to provide ideal habitat for these dwellers of rocky slopes and high grasslands. Gillems Bluff, a precipitous fault scarp lying just inside the eastern boundary of the enclosure, offers excellent breeding space and escape terrain. The rim of the escarpment, looming over the

park road, is a good place to spot the bighorns.

In May 1972, four of the ewes bore lambs, two of which survived. In May 1973 all eight ewes had lambs. This brought the Lava Beds bighorn population to 20—a doubling in less than two years.

Long-range success of the bighorn project hinges on many factors. The vegetation apparently provides an abundance of the necessary food; and provisions have been made to assure a continuing water supply. But the bighorns must face the perils of predation and occasional extreme winters. The lambs are vulnerable to cougars, bobcats, coyotes, and possibly eagles. Poaching, which played a big part in the disappearance of the bighorns, must be guarded against. Forest Service and National Park Service biologists and rangers, in the meantime, are keeping a careful eye on the animals. When management is satisfied that the herd is healthy and secure and is increasing steadily, family groups of bighorns will be transplanted into other areas of northeastern California. Then the fence will come down and the Lava Beds bighorns will be free to establish their own range.

If the Lava Beds bighorn restoration is a success, it will encourage other reintroduction programs in the National Park System—not only for large hoofed mammals but also, possibly, for predators such as wolves, grizzlies, and cougars, which have disappeared from much of their former territory.

Man and nature in the lava beds

Close study of Lava Beds National Monument reveals that the natural processes that determined the makeup of plant-and-animal communities over thousands of years have not been allowed to operate unhindered since the white man arrived on the scene. We know that Indians lived here long ago, because we have found petroglyphs and pictographs that they left. These prehistoric inhabitants of the region apparently were able to exist as functioning members of the community rather than as disrupters and despoilers. Because of their limited numbers and their mode of life—hunting and gathering from the land—they made little change in the environment.

Later, in historic times, other tribes made use of the lava beds. Among these were the Modocs, for whom the rough terrain and harsh conditions provided a refuge from land-greedy whites. Because of their intimate knowledge of the land and its plants and animals, one band of these Indians was able to hold out against a 4-month siege by a unit of the U.S. Army bent on their capture or destruction.

When the new white settlers occupied the land, they attempted to exploit it to the fullest rather than accommodate to the natural order that had prevailed for thousands of years. Before long, man's intrusions had upset the balance among land, plantlife, and wildlife and had wrought great changes in all.

Extensive damage to the natural environment occurred from the mid-1800's, when settlers introduced livestock in great numbers. In 1906, as many as 1,000 head of horses were being grazed in the area. Later, cattle and sheep were introduced, crowding out the horses. Severe winters in 1912 and 1917 caused the death of much stock, largely because overgrazing had depleted the vegetation. The lava

Pictographs, *left*, which are prehistoric writings or paintings, and petroglyphs, *above*, which are rock carvings, decorate the walls of some of the lava-tube caves.

beds were made a part of the National Forest system in 1920. But by then the range had severely deteriorated. Human population in the region had increased as the herds of domestic animals grew.

Some grazing continued during U.S. Forest Service administration of the area. Eventually, though, the unique scientific and historic values of Lava Beds were recognized, and in 1925 the area was set aside by Presidential proclamation as a National Monument. Life tenure grazing permits were granted to ranchers then using the area. In 1933, when Lava Beds was transferred to the National Park Service, this and other disturbing influences were still at work. Some were related to efforts to protect the park.

From 1920 to the present time, fire has been rigidly and uniformly suppressed at Lava Beds. Today the buildup of fuel from dead trees and brush makes wildfire a potentially dangerous thing. Its absence, moreover, is causing changes in the plant communities of the monument. Grazing opened the grassland to invading plants that do not naturally occur there, and the lack of fire as a controlling agent permits these intruding plants to spread. The invasion of sagebrush into the grassland had effects on the wildlife, too. For example, it brought about the replacement of the Columbian sharp-tailed grouse by the sagebrush grouse, a species more adapted to the altered habitat. Juniper, no longer checked by fire, is spreading into lower elevations. Higher up in the mountains, thickets of mountain-mahogany, antelopebush, and

Above: **Captain Jack's Stronghold, a natural fortress used by the Modoc Indians in the winter of 1872-73.** ***Right:*** **Juniper, normally checked by fire, has spread into the Sagebrush-bunchgrass Community in recent years.**

other shrubs shade out young ponderosa pine seedlings. The parklike appearance of the coniferous forest is impaired by undergrowth.

Most of Tule Lake has been drained for conversion to cropland and now exerts only a limited influence on the grasslands. With the disappearance of the lake and the exploitation of the land by man, the bighorn disappeared, and pronghorn dwindled and are now only infrequent visitors to the area.

Development of the park has had further disruptive effects. The goal of the National Park Service is to present a view of Lava Beds as near as possible to what it was a century or more ago. Efforts to restore vanished wildlife species, to allow the natural influences of wildfire to return, and to educate the visiting public on the importance of a natural balance of plants, plant eaters, and predators are part of the management program. But there are some built-in handicaps that must be coped with. New roads, parking places, picnic areas, campgrounds, and trails change the vegetative cover and drainage patterns. Visitors coming to enjoy the area have a direct impact on its ecology and change the behavior patterns of the animals. There is still some grazing of domestic animals.

Left: **Marmots, burrowing rodents, are found in the lower elevations.** ***Above:*** **Domestic sheep, still allowed to graze in the Sagebrush-bunchgrass Community, compete with marmots and other native plant eaters.**

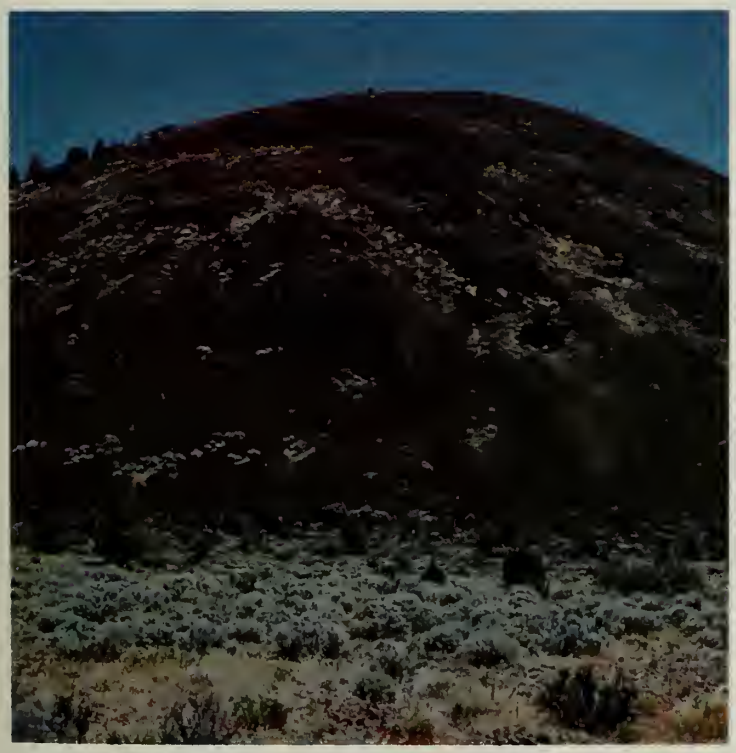
A golden eagle soars over two bighorn rams on Gillems Bluff.

Wildlife watching in the lava beds

Few activities will do so much to enhance your visit to the park as will the pursuit with camera and binoculars of its wild inhabitants. A few tips will help you go about this rewarding pastime. There is no need to limit yourself to the popular sport of bird-watching, if you will take a little time to learn where and when to find the rodents, reptiles, and larger animals. The table in this booklet indicates where the common vertebrate animals live and what time of day they are most active. Your greatest aid in wildlife watching will be an understanding of the ecology of the area.

As you move through Lava Beds National Monument look for changes in the plant cover. Close observation will reveal that the animal life varies with the vegetation. The differences between communities are due largely to differences in altitude and climate; to differences in soil character and depth; to the effects of fire or the absence of it; to man's alteration of the adjoining environments, notably the drainage of Tule Lake; and to the immediate impact of man's presence in the monument.

But generally the changes in animal and plant life are gradual rather than abrupt. You will not move suddenly from the grassland to the pine forest, but will pass through a transition zone where plants and animals characteristic of each are found. You will find junipers, for example, at the lowest altitudes of the sagebrush-grassland community, though not flourishing as they do at the higher altitudes. Some species are dominant in two communities.



Because of this lack of noticeable dividing lines between the communities, and because few conspicuous species serve as ready signposts, you will have to use your powers of observation and your skills in identification to find the clues. The diagrams in this booklet of the park's three communities, with key species indicated, will help you. Irregularities in the natural pattern, however, can confuse you. There are enclaves of one community reaching into or surrounded by another. At the same elevation on a butte, the north-facing slope may contain a community different from that on the south slope, which gets more direct sunlight. Cinder cones and lava flows present conditions that favor one type of plant over another.

These are a few of the many factors dictating which plants will be found in a given site and where each will exist in greatest abundance. Keep them in mind. Learn the key plant species; carry field guides; and look sharply. Your search for the wild creatures of Lava Beds will be rewarded.

Above, left: **The cooler, shadier, moister northern slope of Schonchin Butte is clothed in brush and small trees.**
Below, left: **The southern slope, exposed to the sun, appears almost barren of vegetation.**

Protecting the life communities

A key word in preservation of the native wildlife in any park is *habitat*. A favorable habitat is an environment in which a species can find, in sufficient quantity and quality, its basic needs: food, water, air, shelter from the elements, protection from enemies, and space for living and breeding. It is particularly hard to assure these conditions in a park such as Lava Beds, where limited territory and purely artificial boundaries mean that many animals are not confined to the manageable area. For some species, such as the bald eagle and cougar, Lava Beds does not embrace enough territory for the natural range of an individual.

Living space also entails freedom from crowding or disturbance by humans. Some restrictions on the movements and behavior of visitors, consequently, must be imposed. Disturbing nesting sites, molesting predators, collecting specimens, cutting vegetation, taking pets on the trails, and, of course, setting fires are among the prohibited activities.

The managers of Lava Beds, faced with the responsibility to provide for both the preservation of the natural scene and the enjoyment of it by the people, must seek to reconcile the demand for visitor access, accommodations, and services with the needs of wildlife. Your cooperation and understanding and your observance of the necessary rules will help. If you wish to play a larger role in the cause of environmental protection and improvement, join a community or national organization whose aims you endorse. Many of these groups are dedicated to the preservation of natural areas and wildlife.

Great horned owls, with few natural enemies, are at the top of the food chain. Long persecuted by man, they are protected in national parks.

A reminder: In national parks and monuments, all native wildlife is protected. Do your hunting with camera or binoculars. If you see a rattlesnake in or close to the campground or headquarters, do not molest it; notify a ranger, and he will remove it—without harming it—to a remote area. Enjoy all reptiles and mammals from a distance. And remember: you are an intruder in their home environment.

Bald eagles, vanishing from most of their range and in danger of extinction from environmental poisons, are still seen at Lava Beds. Rattlesnakes, as a part of the natural community, are also protected.

Representative vertebrates of Lava Beds

Reptiles	Remarks
W. Fence Lizard ⁂●▲	Most common reptile
Blue-tailed Skink (Western) ⁂●▲	Secretive
Yellow-bellied Racer ⁂●▲	
Gopher Snake ⁂●▲	Most common snake
W. Rattlesnake ⁂●▲	Diurnal—seldom encountered

Birds	
Red-tailed Hawk ⁂●▲	Nests in park
Sage Grouse ⁂	Transient
California Quail ⁂●	
Western Meadowlark ⁂	
Great Horned Owl ⁂●▲	Nests in park
Western Robin ●	
Scrub Jay ●	Year-round
Piñon Jay ●	Migrant
Steller's Jay ▲	
Clark's Nutcracker ●▲	Resident
Mountain Bluebird ⁂●▲	Resident
Oregon Junco ●▲	
Mountain Quail ▲	Rare
Blue Grouse ▲	Rare

Mammals	Remarks
Meadow Vole ("field mouse") ⁂	
Dusky-footed Woodrat ●	Also in caves
Bushy-tailed Woodrat ⁂●	Also in caves
Belding's Ground Squirrel ⁂	
Yellow-pine Chipmunk ●▲	
Heerman's Kangaroo Rat ⁂	
Yellow-belly Marmot ⁂	Near grass, water
Golden-mantled Ground Squirrel ●▲	
Blacktail Jackrabbit ⁂●	Diurnal
Mountain Cottontail ⁂●	
Pika ●	Shy
Beechey's Ground Squirrel ●	Abundant
Mule Deer ⁂●▲	Abundant
Bighorn ⁂●	Re-established 1971
Coyote ⁂●▲	Abundant
Bobcat ⁂●▲	Common
Cougar ⁂●▲	Rare
Pronghorn ⁂●	Resident

Sagebrush-bunchgrass ⁂
Juniper-brushland ●
Pine Forest ▲

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