



# Interpreting Biological Diversity at Craters of the Moon National Monument and Preserve

Natural Resource Report NPS/UCBN/NRR—2007/019



**ON THE COVER**

A view from the south side of Inferno Cone.

# Interpreting Biological Diversity at Craters of the Moon National Monument and Preserve

Resource Report NPS/UCBN/NRR—2007/019

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# Preface

## NPS Mission and Interpretive Connections

The mission of the National Park Service (NPS) is “to conserve the natural and cultural resources and values of the national park system for the enjoyment of this and future generations” (NPS 1999). Like a village, the national parks require a variety of specialists in order to function properly and to fulfill long-term goals. NPS employees and volunteers contribute to the fulfillment of this mission in a variety of ways. Our job as interpreters, or the teachers/philosophers in our “village,” is to provide opportunities for people to learn about the Monument and understand how they can care for it.

One of the best ways to help people make connections with these awesome resources is by providing interpretive opportunities. What exactly are interpretive opportunities? There is a simple equation that interpreters use, it is as follows:

$$(KR + KA) \times AT = IO$$

KR = Knowledge of the Resource

KA = Knowledge of the Audience

AT = Appropriate Techniques

IO = Interpretive Opportunity

It’s important that interpreters learn as much as they can about the resources they are interpreting. This is knowledge of the resource (KR). Communicating knowledge of the resources is the foundation of what interpreters do, but providing the information alone does not mean that visitors will then care about the resources (Lacome 2003).

Interpreters must learn to articulate this

knowledge in such a way as to help the visitor link resources in the park to meaningful ideas and concepts. Once interpreters have made their own connections with park resources it is much easier for them to gain perspective on how others might connect to the resource in their own way. According to Lacome (2003), “interpretation appropriately acknowledges multiple perspectives, creates balance and depth, and fosters dialogue, rather than presenting a single truth.”

Once a comprehensive knowledge of the resource(s) has been established it is important to acquire knowledge of the audience (KA). It’s important to keep in mind demographic information about visitors. How old are they? Where are they from? How long are they here? What sorts of park activities have they or are they going to participate in?

Meeting visitors “where they are” is imperative to helping them make connections with the resource(s). It is easy to forget that visitors would not have come here unless there was something about the place that already had some value to them. Having an understanding of the knowledge of the audience enables us to use our information about the resource(s) in appropriate and meaningful ways that will benefit visitors (Lacome 2003).

The use of appropriate techniques (AT) can help make park resources more relevant to visitors. Lacome (2003) states, “the “technique” of interpretation is the fun and creative part.” Your choice of techniques can affect which meanings of the resource(s) (KR)

connect with your audience (KA) (Lacome 2003).

When choosing an appropriate technique an interpreter must use skills that effectively present information, utilize methods that engage and involve the audience, maintain organization and style, and also display appropriate enthusiasm about the resource(s). Sometimes an appropriate technique is letting the resource speak for itself; interpreters do not always have to think of multiple creative ways to help spark connections (Lacome 2003).

When this equation is properly applied the result is an interpretive opportunity (IO), creating a meaningful experience for visitors, which encourages them to learn more or care more about a resource. As interpreters it is important to foster and allow for those intellectual and emotional opportunities to take place (Lacome 2003).

These interpretive opportunities can lead to curiosity, curiosity to reflection, reflection to understanding, understanding to appreciation, and appreciation to preservation. One key way to facilitate these visitor connections is to relate the resources to concepts visitors are already familiar with.

### **Upper Columbia Basin Network Connection**

To effectively carry out the NPS mission, the Director of the NPS approved the Natural Resource Challenge in 1999 to encourage national parks to focus on the preservation of the nation's natural heritage through science, natural resource inventories and expanded resource monitoring (NPS 1999). As part of

the Challenge, the national park system was divided into 32 inventory and monitoring networks. The parks of the Upper Columbia Basin Network (UCBN) include Big Hole National Battlefield (BIHO), City of Rocks National Reserve (CIRO), Craters of the Moon National Monument and Preserve (CRMO), Hagerman Fossil Beds National Monument (HAFO), John Day Fossil Beds National Monument (JODA), Lake Roosevelt National Recreation Area (LARO), Minidoka Internment National Monument (MIIN), Nez Perce National Historical Park (NEPE), and Whitman Mission National Historic Site (WHMI).

Each network is required to prepare a vital signs monitoring plan. The purpose of this plan is to establish prioritized vital signs (i.e., indicators of ecosystem health/integrity), explain the approach used to develop sampling designs and protocols, and outline the administrative and budgetary framework of the Network. In addition, the report includes a management plan that guides the long-term management of data essential to the monitoring program.

The UCBN monitoring plan identifies a suite of 14 vital signs chosen for monitoring that will be implemented in the UCBN over the next five years. Water quality monitoring is fully integrated within the UCBN monitoring program. The water quality monitoring protocol includes monitoring of aquatic macro-invertebrates, surface water dynamics, and water chemistry.

## Craters of the Moon National Monument and Preserve Monitoring Connections

Eleven of the fourteen UCBN monitoring program vital signs will be monitored at CRMO. These eleven vital signs are:

1. **Aspen**
2. Aquatic macroinvertebrates
3. **Bats**
4. **Invasive/exotic plants**
5. **Land cover and use**
6. **Limber Pine**
7. Riparian vegetation
8. **Sagebrush-steppe vegetation**
9. **Sage-grouse**
10. Stream/river channel characteristics
11. Water chemistry

Of these eleven vital signs, seven were selected to be included in this training manual based on their relevance to visitors (noted above in bold face). The four vital signs not addressed are of relevance as well, but are less likely to be interpreted based on their physical locations within the Monument.

Like a doctor, monitoring the status and trend of these vital signs over a long-term period of time will provide scientific information for making management decisions and assist resource managers in assessing the overall ecological condition of the park. Monitoring protocols are being written and implemented for each vital sign. These protocols are “detailed study plans that explain how data is to be collected, managed, analyzed, and reported.”

# Introduction

This document brings together information about the Craters of the Moon resource management and interpretive programs as well as the Upper Columbia Basin Network inventory and monitoring program to help interpreters increase their knowledge of biological resources, vital signs, and suggested techniques for interpreting these resources and programs at Craters of the Moon.

“Interpretive Opportunity” side boxes are presented throughout the document and give suggestions for interpretive techniques. It’s important for interpreters to not only gain the necessary knowledge of the resource and to assess the audience’s knowledge as discussed previously, but also to be aware of a variety of appropriate techniques that can be used to interpret those resources.

A long-range interpretive plan was completed by CRMO in 2007. It describes the primary

interpretive themes for the Monument and provides recommendations for the future of the Monument’s interpretive program. (CRMO 2007d).

The six primary themes encompass ideas and/or concepts that are critical to visitor understanding and appreciation of the significance of Craters of the Moon. Each primary theme has a set of subthemes that help further explain specific concepts. Two of the six primary themes focus on the biological resources in Monument, as opposed to the geological or historical components of the Monument (CRMO 2007d). The two biological resource themes relate to: 1) ecosystems and sagebrush-steppe, and 2) kipukas. In this manual each vital sign was placed into one or both of these biological resource theme categories to better explain the connection to interpretation (Table 1).

**Table 1. Vital Sign Connections to Interpretive Themes**

Vital Sign	Ecosystems and Sagebrush-steppe	Kipukas
Aspen	X	
Bats	X	
Invasive/Exotic Plants	X	X
Land Cover and Use	X	
Limber Pine	X	
Sagebrush-steppe Vegetation	X	X
Sage Grouse	X	X

The biological resource themes chosen for use in the CRMO interpretive plan are explained in detail below:

### *Ecosystem & Sagebrush-steppe*

#### **Primary Theme:**

The geology of Craters of the Moon has created unique and unexpected habitats that provide for the survival of a surprising diversity of plant and animal species. This vast lava and sagebrush plain also provides for critical human needs throughout the region.

#### **Subthemes:**

- Plants and wildlife have found ingenious ways to survive and thrive through the extreme seasonal and more gradual long term climatic changes in this desert region. Many plants and animals utilize the relatively cool and moist cracks and lava tube caves in order to survive.
- Due to habitat degradation elsewhere, populations of sage grouse, and other sagebrush obligate species, are increasingly isolated in areas with relatively healthy sagebrush-steppe plant communities, like Craters of the Moon.
- The vast quantities of water stored by the lava rock aquifer below the Snake River Plain provides for human livelihood and survival throughout southern Idaho.

### *Kipukas*

#### **Primary Theme:**

Searing lava flows that initially destroyed everything in their path today protect some of the last islands of intact sagebrush-steppe communities on the Snake River Plain.

#### **Subthemes:**

- Because many of the smaller kipukas in the Monument have been isolated from human activities, they provide important examples of what is “natural.”
- The relatively pristine kipukas also provide important information to scientists about how disturbed plant and animal communities elsewhere may be restored to natural conditions.

These themes can be used in conjunction with the “Interpretive Opportunity” side boxes throughout the document. These side boxes are provided to help interpreters brainstorm techniques and other theme ideas for their own interpretive programs. The themes stated above represent a few of the overall concepts interpreters hope to pass along to visitors and the public at large at Craters of the Moon (CRMO 2007d).

# Vital Signs

## Aspen

### Background

Quaking aspen (*Populus tremuloides*) are one of the few broad leaved trees found at Craters of the Moon. These deciduous trees have rounded leaves that are bright green until the fall, when they turn yellow or orange. They grow in stands or groves as a result of a clonal reproduction and they are able to reproduce many genetically identical trees from a single root system (Johnson 1999).

Normally, quaking aspens are found in shallow and rocky soils, including infertile dry sands, rich loams (mixtures of sand, clay, and silt), and waterlogged mineral soils, and peats (partially carbonized vegetable matters). The soil at Craters of the Moon is often anything but moist (Rook 2006). However, sites with suitable soil moisture do exist in a few areas of the Monument.

Quaking aspen are often found in upland sites away from permanent stream courses. Aspen stands are very moisture dependent and the moisture that they obtain here is primarily due to snow melt. Winter winds often pile snow in large drifts. Areas where these large drifts occur are suitable for aspen. Aspen stands are found primarily in the northern end of the Monument, in the foothills of the Pioneer Mountains, and on the north facing slope of Big Cinder Butte and in Snow Drift Crater. Very small aspen stands are also found along the edge of lava flows in places such as in Wapi Park.

Quaking aspen were chosen as a vital sign in-



Quaking Aspen (*Populus tremuloides*)

indicator for the Monument for several reasons. Aspen populations have been on the decline in the western United States for several decades. Within Idaho the loss is estimated at sixty-one percent. Across the west scientists are studying the status of aspen and searching for trends just as we are. Some scientists have theorized that their decline is due to climate change (Garrett et al. 2007).

Aspen are sparse in Craters of the Moon, but when they do occur they are some of the richest biologically areas in the intermountain west. These areas are biologically rich because their moist soil and shade contribute to the growth of a high diversity of herbaceous plants. This in turn provides shelter and food sources for animals in the area (Garrett et al. 2007).

## Interpretive Opportunity: Aspen



The best place to interpret and view Aspen is on the south side of the Broken Top Loop Trail. There is a grove on the east side of Big Cinder Butte. Aspen have many interesting growing characteristics but they also have some interesting uses. Native Americans would use the white powder found on their trunks as a natural sunscreen and as a fungicide. The inner bark also has aspirin like qualities, and 15% of its bark performs photosynthesis while its leaves quake (i.e., rotate) in the sun allowing sunlight to hit other leaves to help conduct photosynthesis as well. Also, quaking aspens shoot off rhizomes to start new trees so when visitors think they are seeing a forest of individual trees, they are really just seeing a single organism. Simply put, aspen are just clones of each other. In fact, one single clone in Utah, known as “Pando,” stretches across over 105 acres and is thought to be the largest individual organism on earth.

### Concepts:

Adaptations (quaking aspen leaves help conduct photosynthesis in the tight shaded groves).

## Monitoring Efforts

Monitoring protocols have been established to monitor aspen along with all of the other vital signs. Each vital sign monitoring protocol has a set of parameters that are measured to determine the current status and any trends that may be occurring. For example, for aspen, three parameters are tracked:

1. The density of live and dead trees stems is measured. This is important because a low density of live aspen, or a trend towards dead stems, could indicate a die-off of the entire aspen clone.
2. Conifer density within aspen stands is also estimated because high levels of conifer encroachment in aspen stands (greater than 25% cover) affect the reproduction of aspen and the stand may eventually convert entirely to a conifer stand.
3. Lastly, regeneration or growth of young saplings is observed to determine whether or not reproduction in aspen population is occurring (Garrett et al. 2007).

Permanent transects (specific areas within stands that are measured repeatedly over time) have been chosen and mapped with a global positioning system (GPS) instruments. On-site transects record the diameter, height,

and density of aspen. These measurements will take place every five years to document change (Garrett et al. 2007). Once these protocols have implemented for several years, we can begin to assess the overall health of aspen in the Monument.



# Bats

## Background

Fourteen species of bats are found in Idaho and eleven of these species are present at Craters of the Moon during certain times of the year. Some bats prefer shelter in cracks or crevices in the lava, while others favor the conditions found in lava tubes (caves), and still others choose tree roosts.

Species that are most likely to utilize cracks and crevices for sleeping during the day include the little brown bat (*Myotis lucifugus*), and the long-legged bat (*Myotis volans*). The hoary bat (*Lasiurus cinereus*) utilizes aspen and conifer foliage for roosts. The only full time lava tube dwellers (not to say they do not leave the caves) are the Townsend's big-eared bat (*Corynorhinus townsendii*), the big brown bat (*Eptesicus fuscus*), and the California bat (*Myotis californicus*). The other five species, the long-eared bat (*Myotis evotis*), the fringed bat (*Myotis thysanodes*), the yuma bat (*Myotis yumanensis*), the pallid bat (*Antrozous pallidus*), and the western small-footed bat (*Myotis ciliolabrum*) are variable in their roosting habitats and utilize both cracks and crevices as well as lava tubes, and occasionally buildings (Madison et al. 2004).

Cave dwelling bat species use caves for winter hibernation (sites known as hibernacula) and for raising their young in summer months (maternity colonies), although the same cave is not always used for both. Bats select sites within caves which provide stable air temperatures within a fairly narrow range. During both hibernation and raising of young, bats are very sensitive to human disturbance from



Townsend's Big Eared Bat  
(*Corynorhinus townsendii*)

people entering caves. At CRMO, as well as many other areas, cave access is restricted during these periods.

Townsend's big-eared bat is of special management concern both nationally and at Craters of the Moon. It is a medium size bat with extremely long ears and small glandular lumps on each side of its snout. Maternity colonies of this species form during spring to raise pups in caves and mines, and they utilize the habitat for winter hibernation as well. Both Townsend's big-eared bat maternity colonies and hibernacula occur within the Monument (CRMO 2005). Though this species is widely distributed throughout the West, few maternity colonies and hibernacula have been documented elsewhere due to their enigmatic habits; therefore Craters of the Moon serves as an ideal place to preserve Townsend's big-eared bats.

Townsend's big-eared bats travel long distances to forage at night, particularly in agricultural fields. They can travel over ten miles during a single evening. Ninety percent of

their diet is composed of insects, and they prefer feeding on moths. A bat population can consume thousands of insect pests in one evening.

The overall decline in bat populations is bad news for Idaho farmers, because bats help control pest insects that destroy or damage crops. Spraying of these agricultural products with pesticides can have a detrimental effect on bat populations (Texas Parks & Wildlife Department 2007).

## Monitoring Efforts

Townsend's big-eared bats are a major focus of bat monitoring at Craters of the Moon. Monitoring efforts include:

1. Recording the current status and trends of the Townsend's big-eared bat occupancy of lava tube caves through acoustic monitoring. This monitoring records and graphically displays the pattern of sound waves (inaudible to people) particular to individual species of bats, enabling us to detect changes in Townsend's big-eared bat populations without disturbing the animals in their roosts.

## Interpretive Opportunity: Bats

A fun activity visitors can participate in is called Bat and Moth. This activity is aimed more for kids and might make for a good junior ranger activity, but adults can play as well. Some bats make a high pitched squeaking sound to find insects. These sounds (usually too high-pitched for human ears to hear) bounce off objects in their path. Bats are able to determine what an object is and their distance from it, simply by listening to their own echoes. Bats also make noises that humans can hear including clicking sounds, whinings, and squeaks. Participants are going to mimic this process called echolocation. Have participants make a circle holding hands while a few participants are inside the circle. One person inside the circle is blindfolded and they are the bat. The other participants inside the circle are moths. This activity is similar to "Marco Polo" except it is "Bat Moth." So the blindfolded person says "bat" and the moths return the call with "moth." The bat is pretending to send out a high-pitched



### Concepts:

Adaptations (echolocation).

sound while the moths are pretending to be the bat's echo bouncing off the moth back to the bat's ears. Once moths are tagged they join the outer circle. Make sure you have plenty of room to do this activity and that people on the outside of the circle are keeping the participants on the inside safe.

2. Monitoring efforts will also document occupancy status and trends of bat species in riparian areas during the summer pup-rearing season. Riparian areas are of importance as they provide foraging and commuting habitat (Garrett et al. 2007).

Bat detection will be accomplished by use of a solar-powered ANABAT. An ANABAT bat detector records the number of calls or minutes of activities per unit time (e.g. minutes, hours, nights) by echolocating bats (Garrett et al. 2007).

Half of the bat species in the western US are considered at risk. In areas with numerous riparian corridors they can also serve as a sign of environmental change. Bats comprise a significant portion of the mammal species diversity to Craters of the Moon. They also benefit residents of Idaho by controlling pest insect populations.

## Related Interpretive Interests

### *Lava Tubes*

Over three hundred documented caves are within the Monument (CRMO 2007b) and most are lava tubes that were formed when molten lava flowed through subterranean channels. When eruptions ceased, the lava drained away leaving long shaped caves. Other caves are formed from deep cracks in lava rock along the Great Rift or by small domed “blisters,” left by big bubbles of gas just below the surface.

Many of the lava tubes provide year round refuge for animals. Several species of bats, invertebrates, rodents, and many other animals occupy or visit caves during some season

for shelter or water. Lava tubes are generally cool and moist, holding a temperature of 40-60 degrees Fahrenheit year round. In some lava tubes wind blown snow and snow melt infiltrating from the surface create deposits of ice upon which water collects during the summer. Even during the driest months of summer, moisture condenses inside many lava tubes and collects in tiny pools. These sources are typically the only free water available to animals on the lava fields during the dry season.

### *Invertebrates*

Hundreds of different invertebrates populate lava tubes. Invertebrates found in lava tubes can be anything from mites and spiders, to centipedes, millipedes, crickets, beetles, and even blind beetles. All of these invertebrates have adapted to life in lava tubes in their own ways.



Blind Cave Leiodid Beetle  
(*Glacicavicola bathyscioides*)

The blind cave leiodid beetle (*Glacicavicola bathyscioides*) is one of a kind. It is only found in lava tubes in Idaho. This species is found in areas of caves where natural light is absent.

The Idaho blind cave beetle does not have eyes and is typically found deep in lava tubes that are not regularly disturbed by people.

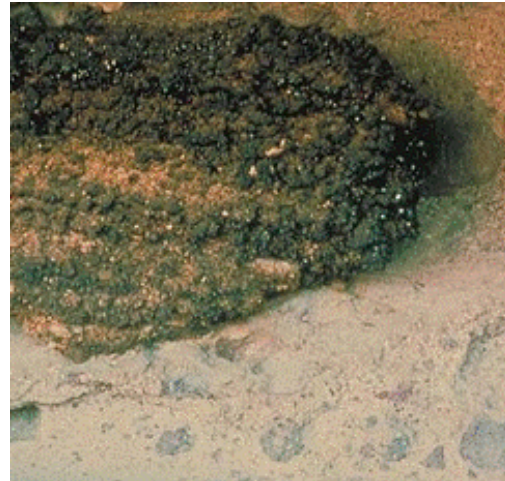
### *Bushy-tailed Woodrats*

Along with bats and invertebrates, several rodent species inhabit caves. Lava fields within Craters of the Moon provide an ideal habitat for bushy-tailed woodrats (*Neotoma cinerea*). They commonly build their nests in lava tubes. These rodents prefer green vegetation, but will eat twigs, nuts, seeds, and mushrooms while caching large quantities of green or dried vegetation in crevices or cracks of the lava tubes. Bushy-tailed woodrats are often preyed upon by larger bird and mammal predators and when alarmed they will engage in hind foot-drumming as a warning to others (eNature 2005).



**Bushy-tailed woodrat**  
(*Neotoma cinerea*)

One of the most characteristic aspects of bushy-tailed woodrat behavior is midden-building. They build their middens (areas of trash disposal) in the lava tubes. These middens consist of plant material, feces, and other materials, which are cemented with crystallized urine. The urine crystallization process results from the high amounts of dissolved



**Bushy-tailed  
Woodrat  
midden**

calcium carbonate and calcium oxalates that are obtained by the woodrats in their diet. Nests are often found within the midden and this is where the females raise their young. They nest in the middens but cache their food elsewhere. Bushy-tailed woodrats are awake and moving around all year in the Monument and do not hibernate (Trapani 2003.)

Most bushy-tailed woodrats do not venture more than 500 yards from their home and they are unsocial solitary rodents, except between mothers and daughters. They help each other with resources by overlapping their territories. As a result, more male bushy-tailed woodrats are likely to visit since there are two females present when territories overlap (Trapani 2003).

Bushy-tailed woodrats are attracted to shiny objects and often steal shiny items from campsites or buildings. Paleontologists and paleoclimatologists study the middens produced by bushy-tailed woodrats because they preserve easily dated plant fossils and animal bones that can be of great help in trying to understand and piece together the paleo-environment (Trapani 2003).

## *Pika*

Pika (*Ochotona princeps*) are small mammals related to rabbits that live in high elevation alpine areas and within the lava fields at Craters of the Moon. They are more often heard than seen, and make a conspicuous high pitched call that sounds a bit like “eek.” High temperature is their main limit to distribution. They can only persist at lower and warmer elevations when cooler thermal refugia are available. At Craters of the Moon, the cooler cracks in the lava provide such thermal refugia and pika are only active on the surface when temperatures are relatively cool. Temperatures ranging from 77.9-84.9 degrees Fahrenheit or higher can be lethal in as little as six hours (Beever 2002).

Thick fur that protects pika against cold temperatures in the winter makes them vulnerable to warm temperatures. The thick fur coat inhibits evaporative cooling during high temperatures. Pikas have emerged as potential sentinels of global warming. Localized extirpations of pika (extinction of local populations) have been documented in several Great Basin mountain ranges. As temperatures warm, pika must retreat to higher elevations, seeking cooler temperatures. Pika may be limited to the higher elevation areas of CRMO due to temperature increases as the lower elevation declines but the elevation threshold has not yet been identified. Given the predicted warming scenarios for the 21st century, it is possible that pika will be extinct in the wild by the end of the century. NPS staff have conducted surveys of pika in the Monument to determine the species’ status. Long-term monitoring may follow the survey efforts (Beever 2005).



Rocky Mountain PBS

Pika  
(*Ochotona princeps*)

## *Surface Animals*

Although there is a general lack of food and light in the lava tubes, some surface animals ranging from deer to sage-grouse may visit the entrances of lava tubes for shelter and water. Foxes, bobcats, badgers, and even mountain lions may den in or near the entrance to a lava tube. Visitors are much more likely to see smaller mammals like ground squirrels, chipmunks, or other rodents in a lava tube than a bear or other large mammal. Though now extirpated from the Snake River Plain, grizzly bear skeletal remains have been found in lava tubes at Craters of the Moon.

## *Birds*

Along with the eleven species of bats found in the Monument, many birds also make their homes at Craters of the Moon. Ravens, violet green swallows, rock doves, great horned owls, rock wrens, and mountain bluebirds often nest in cracks and crevices that may

include cave entrances. Birds are some of the most visible animals at Craters of the Moon. Even in the heat of a summer afternoon or the bitter cold of a January morning, ravens and Clark's Nutcrackers can be seen in many areas of the Monument. 216 species of birds have been documented here. Birds at the park include year-round residents, migrants, and some arctic and alpine birds that winter here (CRMO 2007a).

Much of the Monument is covered by sagebrush shrubland and many specialist species can be found here. Birds such as Brewer's Sparrows, Sage Sparrows, Sage Thrasher, and Sage-grouse are dependent on large intact sagebrush-steppe habitat, and are found in much higher numbers here than in similar areas with more human activity. Limber pine, rocky mountain juniper, and Utah juniper stands growing in lava flows, as well as cinder gardens and kipuka areas offer habitat to woodpeckers, flycatchers, chickadees, nuthatches, warblers, sparrows, and finches. These patches of trees in the midst of a vast sea of shrub lands and barren lava flows are a beacon to many migrating birds, such as warblers, sparrows, and flycatchers, which reside here for brief periods in the spring and fall (CRMO 2007a).

During the long, cold winters that are characterized by blowing snow and temperatures well below freezing, birds are still found at Craters of the Moon. Ravens, nutcrackers, and chickadees live here all year. Mountain and arctic birds that stay for the winter include Black and Gray Crowned Rosy-finches, Rough-legged Hawks, Northern Shrikes, Snow Buntings, and in some years even Snowy Owls or Gyrfalcons.

Several non-native birds make their homes at Craters as well. Some species such as the Chukar (*Alectoris chukar*) and Gray Partridge (*Perdix perdix*) may not have a significant impact on native species. Others can be a serious problem for native species. These exotic invaders include Rock Doves (*Columba livia*), found primarily in lava tubes, and European starlings (*Sturnus vulgaris*) and House Sparrows (*Passer domesticus*), which evict native birds from their nests.



Violet Green Swallows (*Tachycineta thalassina*)

### *Non-vascular Plants*

The most common non-vascular plant species found in the lava tubes at Craters of the Moon are lichens and mosses. Lichens are organisms consisting of an outer fungal body that encloses photosynthetic algae. They represent a symbiotic relationship between fungus and algae. Several types of lichen can be found on lava rocks with an array of colors.

Lichens are especially sensitive to air pollution. They have been used since the 1960s to study the past and current status of air quality. The effects that have been studied include the

presence or absence of sensitive species, species diversity, morphological changes, changes in photosynthetic and respiration rates, nitrogen fixation ability, death or injury to cells or tissues, and accumulation of pollutants within lichen tissues. This information is valuable because lichens obtain most of their nutrients from the atmosphere. Lichens can be studied in conjunction with vascular plants to determine whether a contaminant source is coming from the air or from the soil. Since lichens grow slowly, live long, and do not shed leaves or other parts, they concentrate the substances they are exposed to and provide a long-term reflection of environmental factors (Pearson & Rope 1990). The federal Clean Air Act designated the Craters of the Moon Wilderness Area as a Class 1 area in 1977. This designation affords special protections in the form of higher air quality standards and protection of air quality related values such as visibility.

Lichens help create soil for other plants to grow in by breaking off small fragments of rock, which are then either overtaken by moss and kept in place or blown off into crevices. The algae component of lichen produces an acid, which slowly dissolves the rock; the fungus then absorbs the water and prevents the sun from drying the algae out (Ebi 2006).

Mosses serve another role at Craters of the Moon. Mosses are “nature’s second line of attack in its war against rocks” (Kornfeld 2000). Essentially after lichens have become established, mosses can move in and hold on to any loose soil that the lichen creates. Mosses are most likely to be seen in larger lava tubes at the Monument because they prefer damp shady places. Mosses depend on external moisture but they have evolved spe-

cial methods of dealing with long dry periods (Kornfeld 2000).

Lichens and mosses are not only important because they are the primary and only non-vascular plants found in the caves, but also because they are an environmental indicator of air pollution and without lichens, mosses might not be able to grow. Certain lava tube dwelling mites and spiders are dependent on mosses for shelter. Mosses also help provide camouflage for other invertebrates and store important minerals and nutrients (Kornfeld 2000).



Mosses on lava rocks.

## Interpretive Opportunity: Lichens

Lichens can be seen throughout the Monument and on every guided walk. Great viewing spots include 1) inside the lava tubes (caves), 2) along the Broken Top Loop Trail, and 3) on rocks on the right side of the trail just before the overlook on the Evening Stroll Trail. There is a great saying to help visitors remember what lichen are and where they are found: “Alice Algae took a lichen to Freddy Fungus but their romance is on the rocks.”



### Concepts:

Symbiotic relationship (between an algae and a fungus), new life (lichen breaks down rock to form soil which helps start new life).



# Invasive/Exotic Plants

## Background

Invasive exotic plants can be defined as extremely competitive introduced plant species that are not native to a particular area. Most originated on other continents and when introduced to North America (intentionally or accidentally by humans) were able to spread rapidly in the absence of the insects and/or diseases which had kept them in check in their native lands. These plants threaten native plant communities by outcompeting native plants for water and nutrients and ultimately displacing native plants and altering ecosystems. Invasive/exotic plants are being spread throughout the West by humans, wildlife, and wind dispersal.

Ten species of plants, designated as noxious weeds in Idaho (harmful to human interests), have been identified in the Monument as of 2007: spotted knapweed (*Centaurea biebersteinii*), diffuse knapweed (*Centaurea diffusa*), Russian knapweed (*Acroptilon repens*), rush skeletonweed (*Chondrilla juncea*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), Scotch thistle (*Onopordum acanthium*), dalmatian toadflax (*Linaria dalmatica*), field bindweed (*Convolvulus arvensis*), and Dyer's woad (*Isatis tinctoria*). These noxious weeds have been targeted for mapping, treatment, and prevention programs. Many other non-native plants which have not been designated as noxious also occur within the Monument.

Disturbed areas such as roadsides, intensively grazed areas, and recently burned areas are

Rush Skeletonweed  
(*Chondrilla juncea*)



Cheatgrass  
(*Bromus tectorum*)

Leafy Spurge  
(*Euphorbia esula*)



particularly susceptible to invasion by exotics (CRMO 2005), although some exotics like Rush Skeletonweed and Cheat grass have demonstrated an ability to invade areas with healthy undisturbed soils and vegetation.

The Bureau of Land Management (BLM) and the National Park Service (NPS) have initiated integrated noxious weed programs to target them for mapping, treatment, and prevention initiatives. Efforts to control these species include the use of mechanical and chemical techniques, as well as limited use of biological control agents. Education and public

awareness are emphasized by both agencies. Cooperative weed management areas have been developed across the state to facilitate cooperative efforts of local, state, federal government as well as private landowners and organizations. Involvement in Cooperative Weed Management Areas has resulted in strong community commitment and cost-effective management of noxious weeds (CRMO 2005).

Other invasive/exotic plants, such as Cheatgrass (*Bromus tectorum*), are also extremely detrimental to sagebrush-steppe. Cheatgrass is a common and widespread invader throughout the West and was introduced in the early 1900s when domestic sheep grazed the area. Cheatgrass is extremely competitive and readily invades and dominates disturbed land. It can also be a component of undisturbed or otherwise healthy sagebrush-steppe. For example, Cheatgrass has been documented in several kipukas having no history of disturbances such as livestock grazing or fire. This annual grass outcompetes native vegetation and perpetuates a more frequent fire regime, which further discourages the regrowth of native species and encourages more Cheatgrass (CRMO 2005).

Cheatgrass invasions have been a key management concern for the NPS and BLM. The CRMO Monument Management Plan proposes more aggressive disturbed land rehabilitation and restoration techniques. Approximately 80,000 acres of annual grassland and low-elevation sagebrush-steppe dominated by cheatgrass have been identified in the BLM areas of the Monument as needing management intervention to restore functional sagebrush communities (CRMO 2005).

## Monitoring Efforts

Invasive/exotic plants are becoming more and more of a threat to natural and cultural resources. Early detection and control when infestations are small is the usually only way to eradicate these species. Monitoring efforts include:

1. Early detection and documentation of initial populations and new occurrences of invasive/exotic plants before they become established.
2. Once occurrences have been detected, current estimates and trends of the established weeds are documented for removal by means of GPS (Garrett et al. 2007).

The invasive/exotic plant protocol is still under development. Current efforts include recording the presence and location of invasive/exotic plants through global positioning systems (GPS) and adding these records to a comprehensive Geographic Information System (GIS) database. These tools allow analysis of the distribution of weeds and guide invasive/exotic plant crews to previously mapped infestations where they can spot spray or use other control techniques to control invaders.

Invasive/exotic plant management and control programs are essential and are a high priority at Craters of the Moon and on many other public lands. The presence/absence of invasive/exotic plants is a vital sign for Craters of the Moon because they are the greatest threat to natural resources.

## Land Cover and Use

### Background

The resiliency of a protected area is closely tied to the ecological integrity of the surrounding landscape. Conditions of the surrounding landscape and activities on that landscape influence the efficacy of protected area management efforts to maintain or enhance biodiversity (Schonewald-Cox 1988). Land cover composition, configuration, and connectivity help shape the complex of species occurring in an area, movements of individual organisms, and energy and material flows (Dunning et al. 1992; Taylor et al. 1993).

Monitoring long-term changes in land cover composition, configuration, and connectivity will help establish broader context for protected areas like Craters of the Moon, and can help natural resource managers determine patterns in land use change which may threaten the area's future ecological integrity.

A common way to examine land cover is to map the cover of different vegetation types. Table 2 shows the approximate acreage for nine of the major vegetation types found in Craters of the Moon.

**Table 2. Approximate Acreage of Major Vegetation Types**

Vegetation Type	Approximate Acreage in Monument
Low-elevation Sagebrush-steppe	157,000
Annual Grassland (exotic)	31,000
Perennial Grassland (seeding and native)	153,000
Mid-elevation Sagebrush-steppe	9,400
Lava (bare and vegetated)	399,000
Mountain Shrub	400
Aspen	60
Conifer (Douglas fir)	140
Riparian	670

## *Vegetation Types Defined*

1. **Low-Elevation Sagebrush-steppe:** Usually consists of basin and Wyoming big sagebrush and threetip sagebrush, although, it may overlap with mid-elevation sagebrush-steppe.
2. **Annual Grasslands (exotic):** Non-native grasses.
3. **Perennial Grassland (seeded and native):** Non-Native grasses like crested wheatgrass or native bunch grasses.
4. **Mid-Elevation Sagebrush-steppe:** Places where mountain big sagebrush and antelope bitterbrush are interspersed with sagebrush generally occur at higher elevations in the Monument, where temperatures are cooler and where there is also more precipitation.
5. **Lava (bare and vegetated):** Any lava dominated surface.
6. **Mountain Shrub:** Communities dominated by mountain big sagebrush, low sagebrush, and mountain snowberry. This vegetation occupies slopes and ridges of the Pioneer Mountains.
7. **Aspen:** Aspen groves found predominantly in upland sites.
8. **Conifer:** Douglas fir stands found on relatively steep, north-facing slopes of older cinder cones and the Pioneer mountains, and open stands of limber pine and juniper.
9. **Riparian:** Places where springs, streams, lakes, and marshes on the lower slopes of the Pioneer Mountains support wetlands.

Historical evidence indicates that, prior to the establishment of the Monument on May 2, 1924 by President Calvin Coolidge, land use in the area included limited mining, livestock grazing, hunting, and even limited logging (Blakesley 1988).

On November 9, 2000, a Presidential Proclamation expanded Craters of the Moon National Monument from roughly 54,000 acres to approximately 753,000 acres. President Clinton signed this proclamation to ensure protection of the entire Great Rift volcanic rift zone and its associated features. The Proclamation directed the National Park Service (NPS) and the Bureau of Land Management (BLM) to cooperate in managing the area, with each agency having management authority over specific portions (CRMO 2007f). In general the exposed lava fields are administered as part of the National Park System and the surrounding lands with more extensive vegetative cover are administered by BLM as part of the National Landscape Conservation System.

On August 21, 2002 Congress passed a law designating the NPS portion of the expanded Monument as a National Preserve with hunting authorized. While the BLM and the NPS operate under different laws, regulations and policies (which apply to different portions of the Monument and Preserve), they jointly developed a framework for cooperative management of the area in the form of the Monument Management Plan completed in 2006 (CRMO 2007f).

Now Craters of the Moon National Monument and Preserve includes approximately 738,000 acres of BLM and NPS administered

federal land. Within the greater Monument boundary lie 8,000 acres of state land, and 7,000 acres of private land (CRMO 2007f). Hunting continues on the NPS Preserve and BLM Monument and livestock grazing will continue on the BLM Monument. Large areas of agricultural land and small but expanding areas of residential development occur near Monument boundaries.

## Monitoring Efforts

The Upper Columbia Basin Network will use aerial photography and satellite imagery to monitor land cover and use at Craters of the Moon. Land cover distribution is an important description of the Monument's landscape. Changes in land cover both within and adjacent to the Monument can strongly influence park resources. Monitoring efforts will strive to:

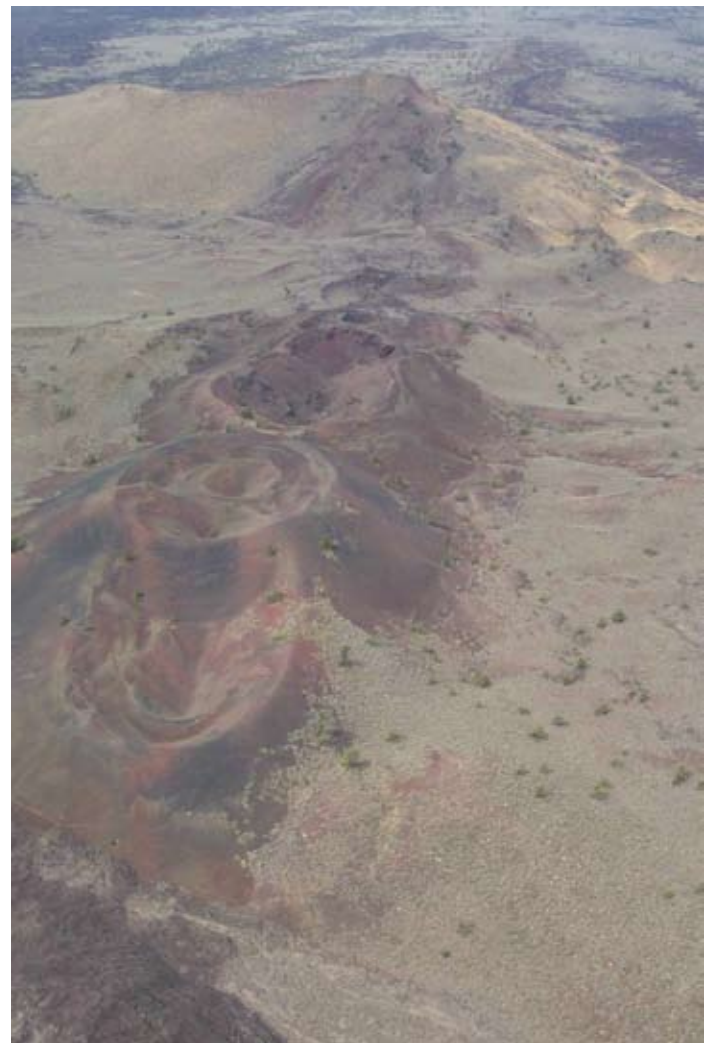
1. Determine long-term trends in land cover distribution within and adjacent to the Monument.
2. Determine patterns of relevant land cover types within and adjacent to the Monument, and evaluate how changes over time in these patterns influence the Monument's natural resources (Garrett et al. 2007).

To measure these objectives aerial photos and/or satellite imagery will be obtained and compared every five years. This data will be analyzed and basic land use classes such as urban/developed, agricultural, residential, and basic land cover types will be identified.

Land cover and land use serves as a vital sign at Craters of the Moon because changes in land cover and uses influence a host of

biological, physical, and chemical resources within the Monument. A reduction of an important land cover type or a modification in the composition of a set of land cover types can result in changes to a broad range of resources in the Monument. Long-term monitoring of land cover distribution and composition, through mapping and pattern analysis techniques, will provide Craters of the Moon natural resource managers with another set of information tools to apply toward maintaining and enhancing the Monument's biodiversity (Garrett et al. 2007).

An aerial photo of the Monument interior.





**An aerial photo of the visitor center area.**

# Limber Pine

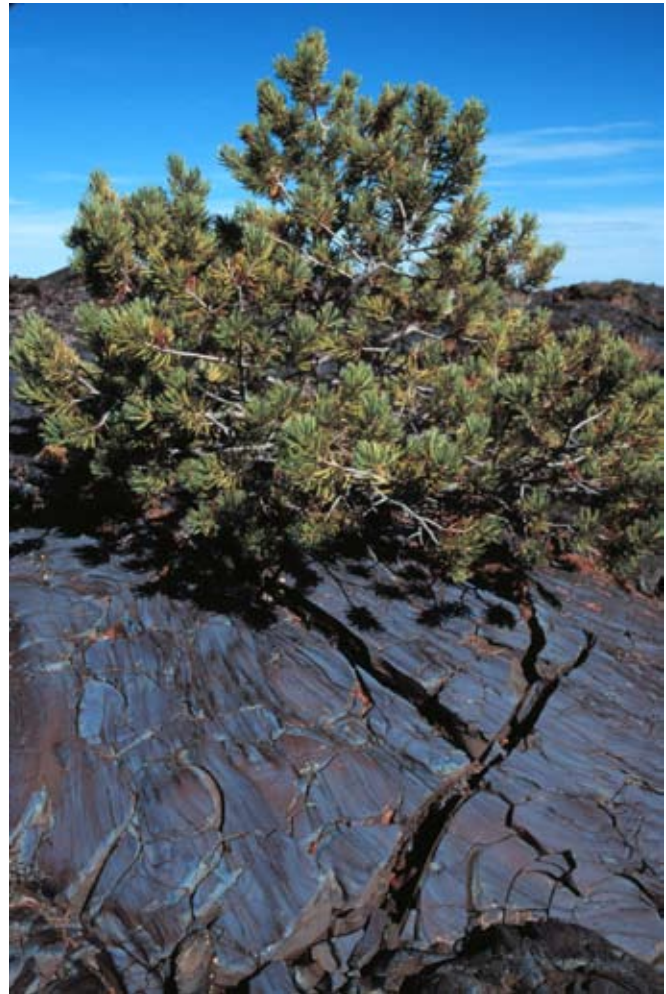
## Background

Limber pine (*Pinus flexilis*) is the dominant tree on lava flows in the northern third of the Monument. Limber pines are long-lived, slow-growing trees of small to medium size. They grow at elevations between 3,000 ft. and 12,500 ft., but do not typically occur at elevations below 6,000 ft. except where barren rocky conditions exist (Steele 1990).

Limber pines grow best on certain types of soils and in the central Idaho mountains they are found largely on rocky ground with soils derived from sedimentary rocks (Steele 1990). However, at Craters of the Moon limber pines can be found growing with roots deep in the cracks on the lava and alongside windswept cinder cones. Within portions of the Monument, such as the north side of Inferno Cone, limber pines are well adapted and almost grow dense enough to form a closed canopy forest. In most areas, however, they grow in open stands or just as scattered solitary trees.

Young limber pines are often found growing in places where as a sapling they were protected somewhat from high winds; as adults they can survive and grow in these harsh elements with a well established root system. Limber pines account for a large percentage of the tree cover within the Monument (CRMO 2007c).

Limber pine branches are very flexible (hence the scientific name *Pinus flexilis*). The flexibility in the branches allows for easy movement in strong winds and effortless snow shed in



An example of a healthy limber pine (*Pinus flexilis*).

heavy snow without doing damage to the tree itself.

Though they are adapted to harsh conditions, high winds often cause branch flagging. Frequent strong winds pick up soil and cinders in the summer, and ice and snow in the winter act as abrasives. These wind blown materials abrade the terminal buds on the windward side of the tree leaving more successful limbs on the leeward side of the tree; making the trees appear like a flag blowing in the wind. Limber pines are monoecious: male and

female cones are born separately on the same tree. As with most pines, the male cones that contain the pollen dominate the lower part of the tree and the female cones develop at the end of the main branches in the upper part of the tree. The female cones have scales and are shaped like a pine cone but they are the larger of the two. The male cones are more bud-like in their structure in the spring, and then turn into small clusters of spirals that may be green or yellow in the summer and fall (Steele 1990). On a healthy limber pine this is the ideal structure of cone distribution.

The arrangement of cones helps eliminate self-pollination but allows the pollen from the male cones to pollinate female cones of other limber pines in the area.

### *Dwarf Mistletoe*

Dwarf mistletoe can be a damaging parasite to limber pine and several other pines. Limber pine dwarf mistletoe (*Arceuthobium cyanocarpum*) is the species that specifically affects the limber pines at Craters of the Moon. It is one of the most important parasites of high elevation five needle pines in the west, second only to white pine blister rust (*Cronartium ribicola*) (Taylor 1999).

Mistletoe is dependent on limber pine for water and nutrients. It triggers the host tree to supply more water and nutrients to a particular area on the tree where it has established residency. As water and nutrients are sent to that infection site a slight swelling begins to appear. This is the first symptom of dwarf mistletoe. Swellings become visible one to two years after infection begins. As water and nutrients are routed to the infection sites, new growth begins to occur. Witches' brooms are

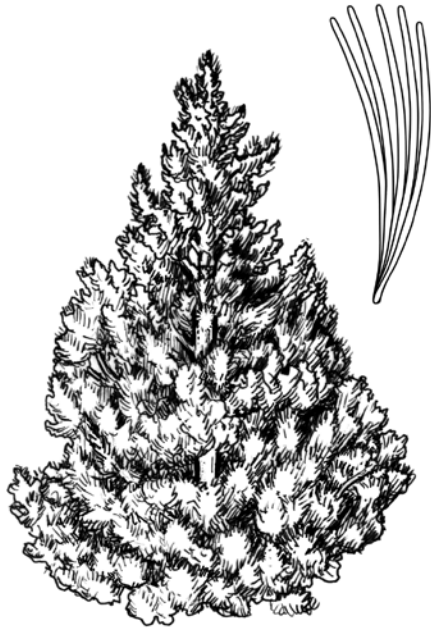
the most striking symptom of dwarf mistletoe; they occur at these new growth sites. Witches' broom is a very dense branching pattern evident in many of the limber pines surrounding the scenic loop drive (Taylor 1999).

Overall, dwarf mistletoe reduces the vigor and growth of infected trees by appropriating water and nutrients, and disturbing the normal physiological processes of the tree. Heavy dwarf mistletoe infections increase the susceptibility of the trees to attacks by bark beetles (although bark beetles have rarely been observed at Craters of the Moon) and to other environmental stresses. In some cases, it may kill the tree by slowly robbing it of food and water. Death occurs slowly in most cases, usually over a span of decades, and depends on the severity of infection and on the vigor and size of the tree (CRMO 2007c).

Several factors influence the spread of this parasite. They can range from stand composition and tree spacing to bird and animal impact. Nearly all spreads are local and result from the discharge of seeds. Birds and animals are responsible for most of the long distance seed distribution when seeds stick to their bodies and are discarded later onto susceptible trees (Taylor 1999). Dwarf mistletoe infestations of limber pine are common around the loop road but appear much less common and even rare in limber pine at lower elevation areas of the Monument

There are no chemical or biological controls available at this time to contain this parasite. Taylor (1999) states that, "The greatest opportunity to control dwarf mistletoe is through the removal of infected limber pines and the encouragement of mistletoe-free regenera-





### Interpretive Opportunity: Limber Pine

In order to illustrate a limber pine's flexibility you can tie a small limber pine branch into a knot. The branch will bend easily and not harm the tree. You can also have visitors "shake hands" with a limber pine so they can feel first hand its flexibility (Be sure to untie the branch after the demonstration).

#### Concepts:

Survival, endurance, perseverance, and adaptability.

### Interpretive Opportunity: Dwarf Mistletoe

There are many places in the Monument to view dwarf mistletoe & witches' broom. Dwarf mistletoe will most likely be seen by visitors during guided walks on the Evening Stroll Trail and the Broken Top Loop Trail. The first limber pine visitors see on the right side of the trail during the broken top loop is an example of a healthy limber pine. Once visitors reach the top of the first hill there is a great example of a dwarf mistletoe infestation and its result, witches' broom.

#### Concepts:

Dependency  
(Dwarf Mistletoe depends on Limber Pines in this ecosystem).



tion.” Control efforts at Craters of the Moon in the 1960s removed 6,000 limber pine trees, but was still unsuccessful in eliminating the disease. Today, National Park Service management policies recognize dwarf mistletoe as a native parasitic organism that has been a part of the Craters of the Moon limber pine ecology for thousands of years (CRMO 2007c).

### *White Pine Blister Rust*

A bigger concern than dwarf mistletoe at Craters of the Moon is white pine blister rust (*Cronartium ribicola*), a non-native fungus. This organism was introduced from Europe in the early 20th Century, and affects five needle pines throughout North America. At Craters of the Moon, white pine blister rust was first detected in 2006.

The infection intensity of white pine blister rust varies but can be very severe. According to the U.S. Department of Agriculture, white pine blister rust is most severe when late summers (July-September) are cool (below 67 degrees Fahrenheit) and damp. Therefore, this infection is usually found farther north in Idaho and Montana, though white pine blister rust has been found as far south as New Mexico (Anderson 1977). In the Monument, white pine blister rust has only been found in limber pines within the Little Cottonwood and Leach Creek Drainages.

White pine blister rust has a complex life cycle. This cycle requires two hosts, a pine, and either a currant or gooseberry plant. Recent studies have also found that alternate hosts can now contribute to this infection, (i.e. Indian paint brush (*Castilleja coccinea*) and snapdragon (*Antirrhinum majus*)). Five needle pine species of all ages are susceptible;



White Pine Blister Rust (*Cronartium ribicola*)

however seedlings and young trees are often less resistant to this infection and have a higher fatality rate (Laskowski 2007).

White pine blister rust generally starts on the plant surface and eventually works its way into the pine through openings in the needles or through a wound. The fungus then grows into a twig and infects the branch which will

begin to swell. After two to three years the rust forms spores in a blister type shape that will eventually rupture. When the blisters rupture they release bright orange colored spores that infect the alternate host (currants, gooseberry, etc.). While hosted on these alternate plants the rust produces more spores that are released into the air and infect other susceptible pines in the area. The rust is then shed from the alternate host when the plant naturally drops its leaves in the fall (Laskowski 2007).

The rust infection can kill a tree slowly over several years. Once the fungus is inside the needle and it grows down into the branch it can ultimately reach the main stem of the tree. The rust can then kill the cambium (the tissue in the plant that produces new cells) causing what scientists refer to as a canker (a fungal disease that causes localized damage to the bark). This canker prevents water and nutrients from passing through that particular area, therefore, resulting in the loss of branches (Laskowski 2007). According to Michele Laskowski, “If the canker forms on the main stem, it will cause top kill and often ultimately causes the tree to die.”

It can take 3-6 years for the infection to kill a large tree. Since blister rust is an introduced species, genetic resistance of native limber pines is limited and mortality rates are typically high. On average, over a third of the limber pine in the northern Rocky Mountains have been killed by blister rust, and about 75 percent of the remaining live trees are infected with it (CRMO 2007c).

In the summer of 2006, the first white pine blister rust infections were found within the Monument. While the infected trees appear

to be small in number and isolated, National Park Service personnel are surveying other limber pine stands at Craters of the Moon to determine how widespread the infection is within the Monument. Monitoring may enable resource managers to detect and hopefully eradicate white pine blister rust as it is found.

This introduced disease could eliminate much of the limber pine population within Craters of the Moon. Since many plant and animal species at Craters of the Moon rely on food and shelter provided by limber pines these losses would have a cascading effect on the ecosystem.

## Monitoring Efforts

Limber pine monitoring efforts focus primarily on white pine blister rust because of its potential to eradicate all limber pines in the Monument. Limber pine monitoring objectives include:

1. Conducting early detection status surveys for possible blister rust infections.
2. Estimating trends in the proportion, severity, and survivorship of infected limber pines. Determining the proportion of infected trees and the severity of the infections provides an understanding of the magnitude of the problem and the vulnerability of limber pines in the Monument (Garrett et al. 2007).

These objectives are measured by taking surveys of limber pines from May through July. This is the best time for viewing the orange spore sacs, and aecial blisters (fruiting bodies of the rust fungi) produced by the active canker (Garrett et al. 2007).

Limber pines are a significant species within the Monument and play a vital role in the ecosystem. They serve as a vital sign of the ecosystem due to their links to the different species found at Craters of the Moon. One significant role that limber pines play is as a food source for animals. Their large seeds within the pine cones provide food for Clark's Nutcrackers and several different squirrels. Limber pines were also important in this area historically. The Shoshone-Bannock consumed these pine nuts as an important part of their diet (Sharashkin 2004).

Limber pines also provide shelter for several animal species. Many squirrels build nesting

cavities in these pines as well as seek shelter beneath their canopies. Limber pines provide places for migratory birds to rest when crossing the Snake River Plain and also help with watershed protection. The presence of their roots helps stabilize cinder cones, snow, soil, and in some cases even rocks. These trees survive in a harsh environment and have proven to thrive here despite winds, invasive/exotic plants, heat, drought and heavy snows (Garrett et al. 2007).

## Related Interpretive Interests

### *Clark's Nutcracker*

The Clark's Nutcracker is one of many species that rely on limber pine at Craters of the Moon. The Clark's Nutcracker (*Nucifraga columbiana*) has a unique dependent relationship with limber pines. Essentially limber pines could not exist without Clark's Nutcrackers and vice versa. Craters of the Moon contains pines that provide suitable habitat and food sources for these birds. The birds' primary food comes from the trees and the



Photo by A. Wilson

The Clark's Nutcracker (*Nucifraga columbiana*)

birds helps the trees reproduce by dispersing their seeds.

Clark's Nutcrackers are gray medium sized birds with long, sharp, tweezer-like beaks. Their tweezer-like beaks allow them to extract the pine nuts from the female limber pine cones, which serve as a primary food source. Clark's Nutcrackers have excellent spatial memory. This characteristic enables them to cache thousands of seeds in the fall and then relocate these caches during the winter (Seattle Audubon Society 2006).

They also have a pouch beneath their tongue that can store fifteen to seventeen pine nuts at a time. These birds can transport pine nuts for at least fourteen miles from the food source before they cache them. It's been

estimated that Clark's Nutcrackers can cache about 25,000 pine nuts in a year. Cache sites that these birds choose often are on wind-swept ridges with southerly aspects where not as much snow accumulates and where the ground is more exposed in the early spring (Steele 1990). They can generally find their caches up to nine months later (Seattle Audubon Society 2006). Caches that are not found at Craters of the Moon often germinate and limber pine seedlings appear in following years. These two species work symbiotically and could not survive without the other.

## Interpretive Opportunity: Clark's Nutcracker

Clarks Nutcrackers can be seen all throughout the Monument. Many interpreters carry a laminated picture of the Clarks Nutcracker for visitor viewing. If you can find a female pinecone on the ground you can challenge a visitor to carefully extract a pine nut without breaking the cone. This can illustrate how the Clark's Nutcracker beak is tweezer-like to be able to extract the pine nuts.

### Concepts:

Mutualism (Neither of these species could exist at Craters of the Moon without the other).



U.S. Fish and Wildlife Service Photo by John and Karen Hollingsworth

# Sagebrush-steppe Vegetation

## Background

Sagebrush-steppe vegetation is the predominant vegetation type covering much of the Snake River Plain. Sagebrush-steppe ecosystems occur within high desert regions which have hot dry summers and cold relatively wet winters. The plant communities found within these ecosystems generally consist of shrubs intermixed with perennial grasses and forbs. The shrubs include several species of sagebrush, antelope bitterbrush, and rabbit brush.

The Snake River Plain is a dry region due to the rain shadow effect of mountain ranges to the west. As winter storms hit the mountains that surround the plain, air rises and the temperature cools causing water vapor to condense and fall mostly on the windward side of the mountains leaving the leeward side dry. Annually these mountain ranges can block 6-14 inches of precipitation that would otherwise have reached this area (Yzquierdo 2005).

Sagebrush-steppe thrives in these conditions and is the most extensive vegetation community in the Monument (Map 1). Sagebrush-steppe covers all areas where adequate soil deposition or development has occurred (CRMO 2005).

The structure and composition of most sagebrush-steppe vegetation has undergone major changes since European settlers arrived (Yzquierdo 2005). With the reduction of sagebrush-steppe in southern Idaho from cultivation, fire, and weed invasion, some of the sagebrush communities in the Monument are among the best remaining examples of this vegetation type on the Snake River Plain (CRMO 2005).

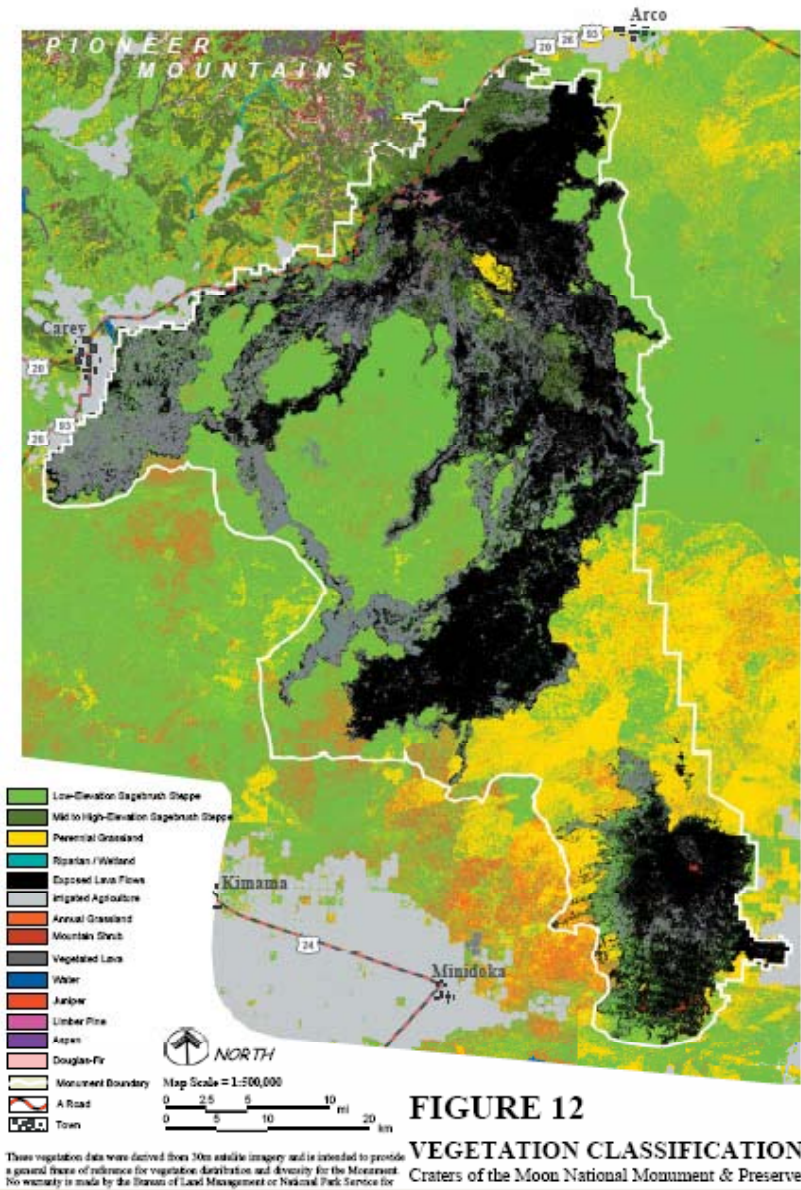


An example of sagebrush-steppe vegetation.

At first glance sagebrush-steppe may appear to create a monotonous landscape within the Monument; however, a remarkable diversity of plant and community types are evident in the short growing season of spring and early summer. Many factors influence the density, cover, and health of vegetation: differences in soil depth and development; the precipitation gradient which ranges from 10 to 16 inches; the elevation gradient ranging from 4,000 to 7,500 feet; historical and current land management practices; invasive species; and fire frequency. In turn, vegetation structure and composition influence the ability of the community to resist invasive species infestation; its susceptibility to, as well as recovery from, fire; and land management activities imposed upon the landscape (CRMO 2005).

Map 1. Vegetation Classifications for Craters of the Moon National Monument and Preserve

Note: Sagebrush-steppe is one of the predominant vegetation types and is seen here in green.



Monitoring Efforts

Sagebrush-steppe ecosystems are one of the most threatened ecosystems in the Intermountain West. Determining trends in sagebrush-steppe communities is essential for understanding these communities and creating management strategies to better preserve these vulnerable ecosystems. Monitoring efforts include:

1. Estimating the current status and trends in particular plants species (e.g. *Artemisia spp.*) in this ecosystem as well as understory vegetation (e.g. perennial grasses etc.).
2. Documenting diversity and species composition (Garrett et al. 2007).

Since sagebrush-steppe vegetation makes up a large majority of the vegetation coverage in the Monument, and is home to many plant and animal species of concern, it is critical to the Monument’s overall health; it serves as a vital sign. A sagebrush-steppe vegetation monitoring protocol is in development.

Significant portions of sagebrush-steppe vegetation in the monument are managed as rangeland for livestock grazing, and the BLM monitors grazing effects on rangeland resources. Also, much of the vegetation has the potential to be altered by, or has already been altered by changing fire regimes. Monitoring helps resource managers detect changes that could result from declines in native flora and fauna, decreased soil stability, and a reduction in hydrologic functions (which could in turn affect the Eastern Snake River Plain Aquifer).

Sagebrush-steppe vegetation provides food and cover for plants and animals to thrive

in this harsh landscape. Dominate shrubs provide shade and coverage for many forbs that could not otherwise survive. Shrubs also provide shelter for animals. Ground squirrels, chipmunks, foxes, and many birds utilize this vegetation. Bitterbrush provides an important source of nutrition for the area's deer herd. Sagebrush-steppe vegetation is a vital part of the Monument that should be monitored and protected so that future generations can enjoy the diversity of life that these landscapes offer.

### Interpretive Opportunity: Sagebrush-steppe Vegetation

Sagebrush steppe vegetation covers a large amount of the area viewed by visitors. One good location to interpret sagebrush-steppe vegetation is on the Broke Top Loop Trail at the overlook. It is a good spot to discuss sagebrush adaptations such as the tiny hairs that cover the leaves to hold moisture, along with their extensive lateral root systems that go approximately 2-4 inches below surface soil to capture surface moisture and their deep tap roots (approximately 16 feet deep) that tap into moisture below the surface. Carrying a measuring tape and pulling out 16 feet of tape can help visitors visualize the actual size of these roots. Visitors can also look at the sagebrush and you can explain that its pale color allows it to reflect light. These are just two adaptations that many of the sagebrush steppe vegetation plants have.

#### Concepts:

Adaptations, survival.





## Related Interpretive Interests

### *Soils*

Soil has a profound effect in the sagebrush-steppe environment. The soils of the Monument are variable, reflecting the differences and interactions between parent material, topography, vegetation, climate, fire history, and time. The most significant differences involve the presence or absence of recent lava flows and cinder deposits, the degree of soil development on older volcanic substrates and the deposition of windblown soil (loess) (CRMO 2005).

Surface lava flows, which occupy two-thirds of the Monument, are made up of basalt lava rock. The soils on the younger basalt flows and cinder beds are limited to the initial decomposition of rock and cinders and more importantly to the deposition of windblown loess within crevices, cracks, and fissures. Plants at Craters of the Moon often establish and grow in little to no soil. As time progresses, soil development continues and more vegetation is established (CRMO 2005).

During recent geologic time (the last ice age), the region has periodically received layers of windblown dust from sources further west. These loess deposits have resulted in many of the deeper soils on the eastern Idaho foothills and the leeward sides of lava flows within the Eastern Snake River Plain (CRMO 2005). Loess deposits have allowed for a large diversity of plants to grow thus providing a diversity of food for animals as well. Loess is a tan-colored material of silt size and was ground up by glaciers in the mountains and carried down into the plains by the rivers that drain them. From there winds re-deposited

the sediments far beyond the reach of rivers. Loess is made up of several different rock compositions thus creating a soil that can support a large array of plant systems (CRMO 2000b).

The loess soils in the Monument and surrounding area developed from rocks deposited during a sequence of geologic events that began almost 600 million years ago. For approximately 500 million years, ancient seas intermittently covered the region, depositing limestone and other sedimentary rocks typical of ocean floors. Beginning about 17 million years ago, fault block mountain building has pushed up the rocks, exposing them to weathering and soil development processes. The many mountain ranges in the Basin and Range Province have developed in this way. Recent earthquake activity is evidence that these mountain-building processes continue today (CRMO 2005).

### *Climate*

Extremes of weather and climate prevail at Craters of the Moon across seasons and elevations. From the foothills of the Pioneer Mountains in the northern end of the Monument to the Snake River in the south, weather conditions vary significantly. As elevation decreases from north to south, temperatures increase and precipitation decreases. The average annual precipitation ranges from 16 inches at the Monument Visitor Center to just under 10 inches near the Snake River at Minidoka Dam (CRMO 2006). Most of the precipitation occurs in the winter as snow.

In February, average snow depth ranges from 26 inches at the north end of the Monument to just 2 inches at the south end of the Monu-

## Interpretive Opportunity: Lava Flowers

Choose two volunteers to be wind blown seeds. Have one “grow” from a crack and have the other attempt to “grow” on the surface of the lava. Interview the seeds and have them describe the conditions they are encountering. Based on the feedback from the seeds have the audience choose which seed has the greatest potential to flourish and why (presence of soil, moisture, and protection from the wind). Now point out to the audience the growth pattern of all the plants around them. . .they are all growing in the cracks!



Dwarf Monkeyflower (*Mimulus nanus*)

### Concepts:

Microclimates, soil quality, survival.

ment. The intense summer sun bakes the black lava, generating surface temperatures greater than 170 degrees Fahrenheit on the hottest days. Dry winds are a common occurrence, especially in the afternoon, and may reach 40-50 miles per hour. July through October the average monthly precipitation is less than one inch. Winter transforms Craters of the Moon into a dramatic landscape of black lava covered with white snow, while fall and spring are milder (CRMO 2006). Despite harsh weather conditions many plant and animal species can thrive in this landscape.

### *Special Status Plant Species*

There are two special status plant species found in the Monument, Obscure Phacelia (*Phacelia inconspicua*) and Picabo Milkvetch (*Astragalus onicifomis*). Obscure Phacelia is one of Idaho’s rarest plants, with only six area occurrences statewide. It occurs on the north and east-facing slopes of volcanic mountains

and buttes. Picabo Milkvetch can be found in sandy soils in the north-central portion of the Eastern Snake River Plain (CRMO 2005). Areas of likely habitat within and surrounding the Monument have been systematically surveyed for both obscure phacelia and Picabo milkvetch.



Obscure Phacelia (*Phacelia inconspicua*)



Picabo Milkvetch (*Astragalus onicifomis*)

### *Special Status Animal Species*

In the summer of 2007 sixty-five animal species were listed as being of special status in Idaho, warranting special management attention. Of these, a few attract the most public attention.

The reintroduction of wolves in central Idaho and Yellowstone in the mid-1990s and their current status often generate inquiries. Gray wolves (*Canis lupus*) are known to have infrequently occurred in the vicinity of the Monument. In the spring and winter of 2001, a pack was observed and tracked by wolf researchers just north of the Monument. The pack was thought to have been following migrating elk and deer. In addition, individual wolves and wolf sign have been observed within the boundary of the Monument, with several sightings in this area since 2000 (CRMO 2005).

Bald Eagle (*Haliaeetus leucocephalus*) nests have been documented just west of the Monument near Carey Lake. Transient, wintering Bald Eagles have been sighted throughout

Blaine, Butte, Minidoka, and Power Counties, including parts of the Monument (CRMO 2005). Bald Eagle populations are considered recovered and consequently were removed from the Endangered Species list by the U.S. Fish and Wildlife Service in 2007.

Pygmy rabbit (*Brachylagus chihi*) populations have experienced severe declines throughout their range. This small rabbit generally prefers mature sagebrush stands with a dense canopy cover. Pygmy rabbits have been documented in several areas of the Monument. Records ranging from the 1930s through 2006 indicate locations from the south to the north but no verified sightings have occurred in recent years.

The Monument also contains several cave and cave-related species of concern, including seven species of bats. As of 1999, three maternity colonies of Townsend's big-eared bat (*Corynorhinus townsendii*) had been identified in Idaho, with two of these occurring in the Monument. Numerous hibernacula (chambers where animals hibernate, in our case lava tubes) have been identified in the Monument for these and other bat species. Six other cave roosting bats are classified as species of concern as well. In addition to bats, other cave species of concern, include two cave obligate harvestmen (*Speleomaster lexi* and *Speleomaster pecki*), a cave obligate mite (*Flabellorhagidia pecki*), and the blind cave leiodid beetle (*Glavcavicola bathyscioides*) (CRMO 2005).

## Interpretive Opportunity: Plants and Wildlife

A good way to introduce visitors to the variety of flora and fauna at Craters of the Moon is with a game called “What am I?” Distribute cards with pictures and descriptions of some common plants and animals to visitors. Attached to each card is a loop of string that is used to hang the card around each participant’s neck but facing away from them, so the participant can’t view the card’s contents. The goal of the game is for participants to figure out what plant or animal they are by asking questions (e.g., Am I an animal? Do I have fur? Do I eat plants?) Because this activity depends on interaction, encourage participants to move around and ask questions of others; also, encourage those without cards to provide help and hints to others. Give participants five or ten minutes to figure out what plant or animal they are, then bring the group back together to discuss survival methods and/or adaptations of a few of the plants or animals. This activity works well with all ages as well as mixed groups, and can be incorporated into interpretive walks and programs.



Mule Deer (*Odocoileus hemionus*)



Bitterroot (*Lewisia rediviva*)

### Concepts:

Adaptation, survival,  
diversity of life.



Red Fox (*Vulpes vulpes*)

## Interpretive Opportunity: Hairy Plants

Many of the plants and shrubs of the high desert grow hairs on their leaves to protect themselves from the hot, arid conditions of the high desert. Provide a hand lens and encourage visitors closely examine the leaves of a dwarf buckwheat, scorpionweed, or rubber rabbitbrush, all of which are coated in white hairs. The hairs provide a variety of benefits: capturing water from rain or dew; inhibiting evaporation by stilling the wind as it blows across the leaf's surface; and by giving the leaves a whitish color, reflect light/heat away from the plant, again inhibiting evaporation. By providing a hand lens and asking visitors to describe the plant's leaves, visitors will find adaptive qualities they otherwise might have missed and perhaps look more critically at other plants.

### Concepts:

Adaptation, climate.



Dwarf Buckwheat (*Eriogonum ovalifolium*)



Rubber Rabbitbrush (*Chrysothamnus nauseosus*)

## *Kipukas*

Kipukas are essentially islands of sagebrush-steppe vegetation surrounded by younger lava. Some kipukas contain relatively undisturbed native sagebrush-steppe communities. There are over 500 kipukas in the Monument. Most kipukas have been protected from alteration due to their remoteness and large lava buffers. However, other kipukas have been disturbed by fire, livestock grazing, recreation, or invasive/exotic plant invasion. The condition of resources within these kipukas is being surveyed by the National Park Service (CRMO 2005).

Several very large kipukas are known locally as parks. Laidlaw Park, Paddelford Flat, and Little Park dominate the central portion of the Monument. These “parks” technically meet the definition of a kipuka, but are referred to as “parks” due to their larger size, accessibility, and land use. There is road access to and within these parks, and livestock grazing has been a historical use since at least the 1920s. All three parks are dominated by sagebrush-steppe vegetation, as well as areas dominated by annual and perennial grasslands due to the effects of recent wildfires (CRMO 2005).

The abundance of native species and the quality of these sagebrush steppe communities depends on management practices and cumulative effects of environmental responses. For example, the northern parts of Laidlaw Park have not been overgrazed, retain sufficient shrubs native forbs and grasses, and support sage-grouse. However, historic overgrazing, frequent wildfires, aroga moth infestations, cheatgrass invasion, and noxious weeds have negatively affected Paddelford Flat and the southern portions of

Laidlaw Park. In addition, the southern part of Laidlaw Park receives less rainfall than the northern part, making it less resilient to disturbance (CRMO 2005).

### Interpretive Opportunity: Kipukas



Round Knoll Kipuka

Kipukas are most likely to be pointed out and interpreted on the Evening Stroll Overlook and the Broken Top Loop Overlook. Round Knoll can be seen well from both of these sites. You can help visitors visualize a kipuka by having them imagine making a hill out of a plate of mashed potatoes and then pouring gravy around the base of the mound of potatoes. So essentially the mashed potato island is a kipuka and the gravy at the base represents lava. While this illustration is helpful and might help visitors understand what a kipuka can look like, it should be noted that some kipukas are very flat.

#### Concepts:

Preservation

## *Fire*

One of the most common disturbances that can completely alter sagebrush-steppe communities is fire. Between 1970 and 2002, approximately 330,000 acres have been burned by wildfires within the boundary of the expanded Monument, primarily on BLM-administered land. About a third of this acreage has burned two or more times (CRMO 2005).

Peak fire years occurred in 1971 (29,000 acres), 1981 (22,000 acres), 1992 (61,000 acres), 1996 (31,000 acres), and 1999 (87,000 acres). About half of Laidlaw Park and Paddelford Flat and nearly all of Little Park have remained unburned in the last decade. Relatively small fires have burned on vegetated lava and in kipukas, notably Little Prairie in 1992 (1,900 acres) and Echo Crater in 2000 (632 acres). Overall, fires within the original Monument boundaries represent only 8 percent of the total area burned since 1970 (CRMO 2005).

Fire plays a key role in determining the diversity and condition of vegetation communities. Large tracts of sagebrush have been lost due to extensive wildfires, and fires have perpetuated invasive/exotic annual grasslands. However, fire also plays an important role in the maintenance of some vegetation types, including aspen and mountain shrubs (CRMO 2005).

Native Americans historically used fire to manipulate vegetation and wildlife. Since the 1900s, sheepherders used fire in the Monument to reduce shrub cover and encourage herbaceous plant growth. Well-documented records prior to 1950 are not available; however, traditional practices throughout south-

ern Idaho are known to have included the use of fire to eliminate sagebrush and promote grass growth (CRMO 2005).

In 1982, the BLM made a proposal to burn approximately 19,000 acres to break up continuous tracts of sagebrush; create more diverse wildlife habitat; reduce fuel loads; and improve forage for domestic livestock and wildlife. The burning of approximately half of this acreage was accomplished by 1992, at which time large wildfires occurred in the area and the use of prescribed fire was curtailed. The use of prescribed fire was re-initiated in 2001, when small areas within the Monument were burned to reduce cheatgrass, in conjunction with herbicide and seeding treatments (CRMO 2005).

The length and timing of the fire season is highly dependent on annual weather and fuel conditions. Generally, the season can extend from mid-May through mid-October. Warm, dry, and windy weather associated with thunderstorm cells can result in lightning activity with or without rain. Ignition of vegetation can occur from natural sources, primarily lightning, or from human sources such as vehicles, campfires, or cigarettes (CRMO 2005).

Areas most at risk for large, destructive wildfires are the rangelands in the southern part of the Monument where fuel loading is high due to an abundance of cheatgrass in the understory. Ignitions on vegetated lava are rare; however, there is a risk that fires near the edge of the lava can lie low for a period of time and then ignite adjacent rangelands if weather conditions become hot or windy. Fires in isolated kipukas remain localized and small, because the surrounding lava limits spread (CRMO 2005).

The northern end of Laidlaw Park, in particular, and other isolated areas in the Monument contain good examples of sagebrush-steppe vegetation, which could potentially be lost or degraded by invasive/exotic or noxious weeds following a fire. In areas of the Monument north of the highway, mountain shrubs, aspen, and Douglas fir communities might benefit somewhat from fire; however, watershed protection in Little Cottonwood Creek (which provides potable water in the Monument) and the protection of research and group campsite facilities necessitate aggressive suppression (CRMO 2005).

Fire management in the Monument is directed by the current Bureau of Land Management (BLM) Land Use Plans, the Fire Management Plan for South Central Idaho, and the Craters of the Moon National Monument Wildland Fire Management Plan within the original Monument boundaries. Under these plans, all wildfires are suppressed except for naturally ignited fires in designated wilderness, which may be managed for resource benefit (CRMO 2005).



A fire at Craters of the Moon.



# Sage-grouse

## Background

The Greater Sage-grouse (*Centrocercus urophasianus*) relies heavily on sagebrush-steppe vegetation. Since 1950, 148 sage-grouse leks (display areas where males perform mating rituals while females look on) have been documented within the Monument. Between 1979 and 1983, 83 leks were active, and between 1999 and 2003, there were 53 active leks. These observations (made by the Idaho Department of Fish and Game) indicate a 36 percent decrease in sage-grouse leks over the past 25 years (CRMO 2005).

The decline in the sage-grouse population may be a result of several different factors. It could be the result of human impact due to habitat alteration (habitat fragmentation, fire suppression, hunting, domestic livestock grazing, etc.). It could be related to an increase in predators, or it could even be associated with weather or climate change over time. The decline may also be due to a combination of all of these factors (Van Kooten et al. 2007).

Sage-grouse leks are essential to the survival of this species. A lek is a central location where males seek to draw the attention of females. Scientists use leks to estimate population sizes, and they are therefore important for inventorying and monitoring populations as well. Leks generally occur in open areas (approx. .1 to 5 hectares in size) that are surrounded by sagebrush with a 15% to 38% canopy cover and a grass and forb understory. The presence of these plant species is essential to the success of these leks (Van Kooten et al. 2007).



Greater Sage-grouse (*Centrocercus urophasianus*)

Loss of habitat or fragmentation of habitat alone could account for the decline of the sage-grouse population (Van Kooten et al. 2007). Leks are important to overall breeding, but it is critical that the leks are close to breeding grounds. Nesting sites are vital to reproductive success but they are also where most fatalities in sage-grouse populations occur.

Wildfires can also have an effect on sage grouse habitat. If fires are too infrequent or too intense it can change the landscape drastically. Van Kooten et al. (2007) states that, “in the case of infrequent fires, due to fire suppression, more intense fires can eventually devastate an area turning it from a perennial range (suitable habitat) to annual grasslands, primarily cheatgrass (*Bromus tectorum*), that is considered detrimental to sage-grouse.”

The state of Idaho considers sage-grouse a game species and regulates hunting within the BLM Monument and the NPS Preserve. Scientists suggest that when hunting does occur that “takes” be limited to 10% of the population and that hunting should cease when a

population is below 300 breeding birds (Van Kooten et al. 2007).

Both hunting and livestock grazing and their effects on sage-grouse populations are controversial. Recent studies have not provided a direct relationship between livestock grazing and the decline in sage-grouse populations. However, “indirect evidence suggests that grazing by livestock or wild herbivores may have negative impacts on sage grouse populations,” states Van Kooten et al. (2007).

Predation is also an issue for sage-grouse populations and evidence shows that predation is the largest single source of mortality for these populations. Major nest predators include ground squirrels (*Spermophilus spp.*), ravens (*Corvus spp.*), and coyotes (*Canis latrans*); whereas, Golden Eagles (*Aquila chrysaetos*) are known primarily for adult predation. Humans often try to control predator populations, therefore, potentially producing an effect on sage-grouse populations. However, little information about the effects of predator control on sage-grouse populations is available (Van Kooten et al. 2007).

## Monitoring Efforts

Monitoring sage-grouse has been a cooperative effort with the Idaho Department of Fish and Game (IDFG). State wildlife managers already have a lek monitoring program, providing an opportunity to work collaboratively and share information. Current sage-grouse monitoring efforts include:

1. Working with the IDFG to estimate trends in the occupancy and abundance of male sage-grouse leks through annual lek counts in and adjacent to the Monument.

2. Identifying potential critical sage-grouse habitat areas within the Monument and conducting periodic status surveys in these areas to estimate occupancy and abundance (Garrett et al. 2007).

Sage-grouse leks are currently monitored by the IDFG. IDFG shares this information and is working with the UCBN, and the University of Idaho, College of Natural Resources, on developing a GIS-based model of potential sage-grouse habitat. Vegetation maps are then produced which help identify potential seasonal habitat since sage-grouse utilize different habitats based on the season.

Habitat is vital to the survival of sage-grouse since there has been a concurrent decrease in sage-grouse numbers and sagebrush steppe habitat throughout much of the western United States. Sage-grouse serve as a vital sign at Craters of the Moon for several reasons. The Monument provides lek and nesting habitat that is rapidly disappearing in environments outside the Monument. Sage-grouse have different habitat requirements during each season and depend on sagebrush as a source of their diet in the winter; therefore habitat preservation is critical here because Craters of the Moon provides an important stronghold in the evermore fragmented sagebrush-steppe vegetation outside the Monument (Garrett et al. 2007).

## Interpretive Opportunity: Sage-grouse

This interpretive opportunity is a good one to pair with sagebrush-steppe vegetation. Sage-grouse tend to eat leaves, buds, stems, flowers, fruits, and insects found in sagebrush-steppe vegetation. You could point out an example of sagebrush and pass around a leaf from the plant and have visitors smell it. It has a strong distinct smell and as a result most animals won't eat it. However, sage-grouse enjoy it because of its taste and because it is composed of 24% protein. They are one of the few animals that can eliminate the tar found in the sagebrush plant.

### Concepts:

Adaptations



# Conclusion

Hopefully this document has familiarized you with the biological resources at Craters of the Moon National Monument and Preserve, their importance, and has helped spark ideas about how to interpret this information to visitors. It is essential that we care for the resources of Craters of the Moon and that we provide visitors with opportunities to care about the resources so that they will help us in the preservation of this majestic Monument.

Each vital sign is an indicator of the Monument's overall health, and they are all interrelated. For example, a decline in sagebrush-steppe vegetation can allow for invasive/exotic plants to increase, which could fragment sage-grouse habitat and result in population declines, which in turn could change the land cover pattern altering ecosystems throughout the Monument. Each vital sign can positively affect or adversely affect other vital signs.

This is why the Upper Columbia Basin Network Inventory and Monitoring Program is important to assessing the health of the resources for which the Monument was established. Creating protocols that will be used to monitor changes on a regular basis is crucial. Inventorying and then monitoring these vital signs over a long period of time is the only way to assess improvements, declines, and/or threats to these vital signs.

This is the most current information available but it is important to keep updated on changes on the information presented in this document. For more information on the UCBN Inventory and Monitoring plan visit <http://science.nature.nps.gov/im/units/ucbn>. This site provides access to current inventory and monitoring information as well as updated revisions to protocols and reports.

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### **Recommended Resources for Further Information:**

1. Craters of the Moon National Monument and Preserve Proposed Management Plan/Final Environmental Impact Statement. Published by the National Park Service & the Department of the Interior. Available at <http://www.id.blm.gov/planning/craters/index.htm>.
2. Vital Signs Monitoring Plan. Published by the Upper Columbia Basin Network and the National Park Service. Available at <http://science.nature.nps.gov/im/units/ucbn/>
3. Craters of the Moon National Monument and Preserve Long-Range Interpretive Plan. Published by the National Park Service and the Department of the Interior.



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