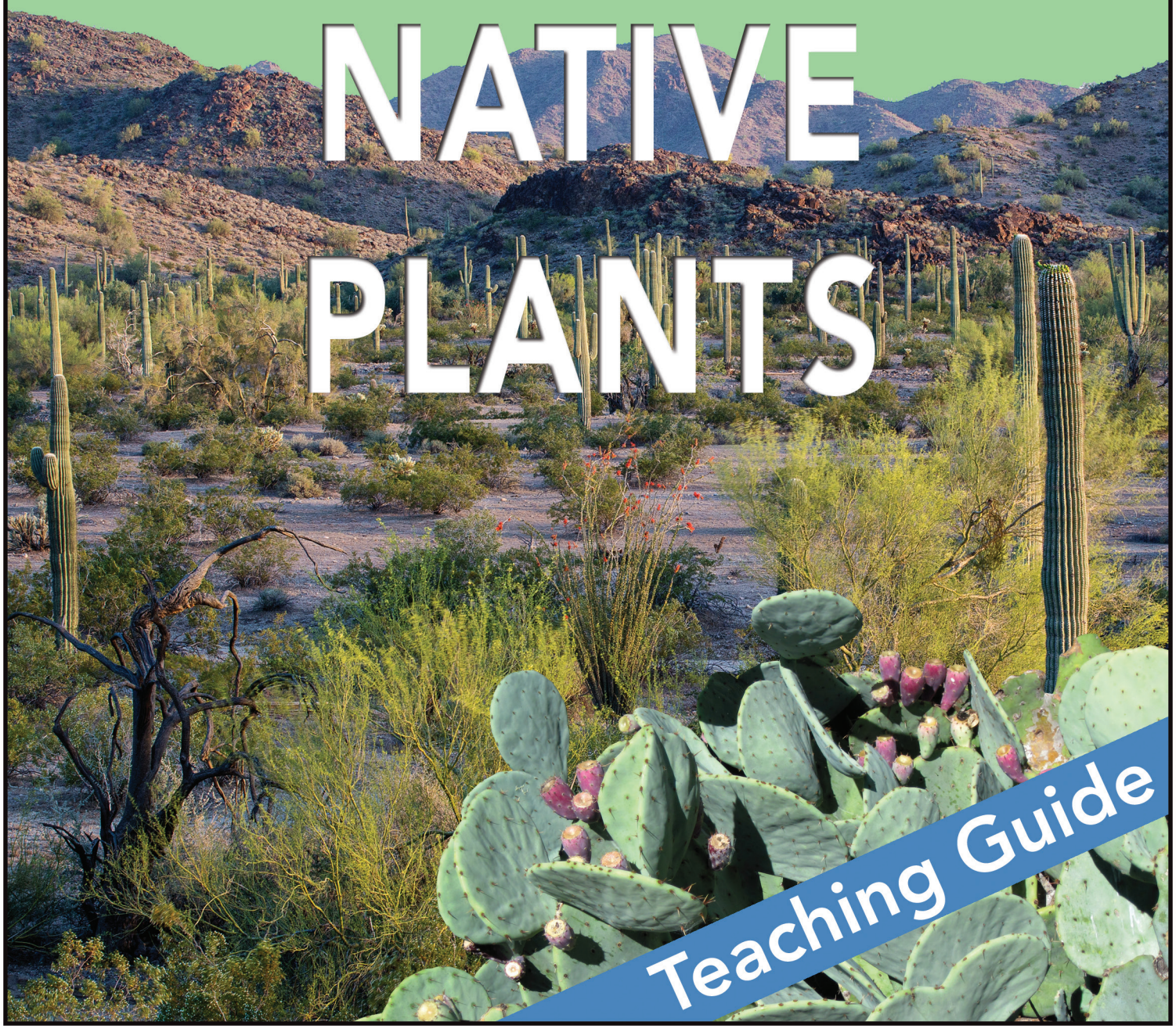
Bureau of Land Management

Classroom Investigation SERIES

LINK LEARNING to PUBLIC LANDS

NATIVE PLANTS



Teaching Guide

Dear Teacher,

Welcome to this classroom investigation unit on native plants on public lands. From its three activities, students will learn the importance of native plants, how native plants are threatened, and some of the factors that go into land use decisions.

The activities are designed to offer students speaking, drawing, and teaching roles as they progress through the unit. This unit is designed for middle school and high school students and can be adapted for upper elementary school students.

The activities engage students in using diverse cognitive skills such as interpreting written material, translating data into graphic form, and analyzing diverse views on a public issue with positions that are based on science and conflicting values.

The unit can be used to support a number of innovative strategies in education, such as:

Differentiated instruction: In groups, students take various roles, such as reporter and poster illustrator, that can accommodate a wide variety of strengths and challenges.

Social and emotional learning: Students participate in small groups with a rotating cast of their classmates during the activity on the benefits of native plants, and in the land use activity, they work to come to consensus on a question for which there is no clear right answer.

Interdisciplinary instruction: While the unit focuses on facts about native plants, it also addresses key concepts in social studies and English language arts. For social studies, students examine a public issue by looking at the same variables as land use managers; for English language arts, they read nonfiction passages and restate the information in their own words.

Civic education: The land use activity features respectful classroom discussion of a public issue, and an adaptation activity prompts students to research and discuss land use questions with local public officials.

Each activity should take one 45-minute class period, for a total of three periods. While each activity can stand alone, the three activities work best as a collective unit that progresses from identifying benefits of native plants, to examining threats to native plants, to considering how land use management decisions affect native plants.

Curriculum Connections

In its entirety, the unit is aligned with Next Generation Science Standard 08-ESS3-3: "Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment."

The activities address the following essential understandings:

- Healthy ecosystems feature a balance among competitors, pests, predators, and diseases, and native plants are essential to maintaining this balance.
- Native plants are increasingly under stress.
- The vast public lands of the U.S. provide a unique opportunity to conserve and restore native plant communities.
- Conserving and restoring native plant communities involves balancing benefits and costs, and the costs become steeper as threats build over time.

Front Cover: North Maricopa Mountains Wilderness, Arizona. Photo by Bob Wick

About the Bureau of Land Management

The Bureau of Land Management (BLM) cares for about 245 million acres of federally owned public lands, mainly in the Western United States and Alaska. These lands, representing about one-eighth of our nation's land area, belong to all Americans. In addition, the BLM administers 700 million acres of mineral estate across the entire country.

Public lands are used for many purposes. They support local economies, providing Americans with coal, oil and gas, forest products, livestock forage, and other commodities. As a haven for plants and wildlife, they play a critical role in habitat and resource conservation efforts. They embrace some of our country's most important historical, archaeological, and paleontological sites. Open spaces on public lands offer places for people to play, learn, and explore. In recent years, some BLM lands have been designated as part of the National Landscape Conservation System, a network of lands afforded special status and managed almost exclusively to conserve their scientific, cultural, educational, ecological, and other values.

The BLM is responsible for managing public lands under the principles of multiple use and sustained yield in a manner that best meets the current and future needs of the public. With so many resources and uses, the BLM's job is challenging. Thankfully, countless partners, volunteers, and communities provide invaluable support, helping the agency carry out its stewardship mission. To learn more about your public lands and how you can get involved, visit http://www.blm.gov.

The Importance of Native Plants

BLM lands are found throughout a range of diverse climates, soils, and elevations, and the native plants on BLM lands contribute significantly to our nation's biodiversity. BLM lands support many unique plant communities including some of the most iconic species in the U.S. From redwood trees in California to saguaro cactus in Arizona and from sagebrush in Nevada to prairie grasses in Montana, all can be found on public lands. These native plant species are widespread and well-known. Some less well-known species of native plants are found in only one location or just on public lands, and they are equally important when it comes to contributing to biodiversity and creating wildlife habitats.

Though there is not an accurate estimate of the number of native plant species that grow on BLM lands, these plants contribute food, medicines, and many products used by the American people. Native plants contribute to America's great outdoors by providing variety and beauty for us to see and experience in nature. Native plants are important for having healthy land and all that it provides for humans and other animals. Protecting all native plant species means people can continue to benefit from native plants today and discover new ways these plants might help improve our lives in the future.

Native plant species in the U.S. face numerous threats: habitat loss, overgrazing, wildfires, invasive species, chemical pollution, and climate change. Natural habitats have been degraded, and the genetic diversity so essential to stable, balanced ecosystems has declined. Today, on BLM lands, 170 native plant species could go extinct and are protected by listing

as threatened or endangered under the Endangered Species Act of 1973. Another 1,589 rare plants on BLM lands could be lost, unless they are carefully monitored.

As the nation's largest land manager, the BLM has a special responsibility—and unique opportunity—to slow or stop the decline of native plant species and communities.

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Activity 1, Benefits of Native Plants

Time Estimate:

45 minutes

For the Teacher

This activity addresses the following essential understanding:

- Healthy ecosystems feature a balance among competitors, pests, predators, and diseases, and native plants are essential to maintaining this balance.

Learning Objectives

Students will be able to (1) describe benefits provided by native plants; and (2) explain how some of the benefits of native plants are related to each other.

Overview

This activity prompts students to examine what native plants are and what roles they play for both nature and human culture. In North America, native species are generally recognized as those that existed on the continent prior to contact by Europeans in the late 15th century. After discussing some of the many benefits of native plants, students will describe to each other how native plants slow erosion, maintain balance among organisms, support pollinators, and diversify the food supply.

This is the first of three activities that introduce students to native plants on public lands. The second makes students aware of some of the threats to native plants, and a concluding activity focuses on the tradeoffs facing land managers who want to protect native plant communities.

Teacher Preparation

1. Make copies of the student handouts. Group 1 will receive Handout 1; Group 2 will receive Handout 2; etc.
2. Read the "Background Information" to become familiar with the benefits of native plants.

Background Information

Native plants help **slow soil erosion.**

Erosion occurs when rainfall dislodges soil particles and carries them off a slope, forming rills and gullies that can even trigger landslides. Native plants protect and help stabilize the soil. Mosses and lichen are especially effective at holding soil in place. Some of them produce sticky substances (polysaccharides) that retain nutrients in the soil and hold soil particles together. When nonnative plants move into an area, they can drive out the native mosses and lichen and even some native flowering plants. This makes the soil more likely to erode. When nonnative plants rapidly grow and spread over large areas, they are considered invasive plants.

A native plant community composed of a diverse mix of species and growth forms (such as trees, shrubs, and grasses) will slow erosion because of the way the plant roots affect soil health. Many native plants offer the added benefit of broad, extensive root systems that physically reinforce soils at all levels and increase penetration of water, which reduces erosion. Deep, woody roots lock soil layers together vertically; lateral roots connect plants in an interlocking grid horizontally; and fine feeder roots form a complex network through the upper soil layers.

In contrast, invasive plants tend to occur in monocultures (when only a single type of plant grows in an area). Successful invasives thrive in their new habitats because their natural competitors do not live there. Invasives often reproduce quickly, adapt rapidly to new situations, and may outcompete native plants for water or nutrients. With few or no natural checks on their growth, they are able to quickly occupy any disturbed or damaged lands. The result is often a near monoculture of invasives with a low diversity of plant forms and a simplified soil structure, which is a good setup for soil erosion.

Native plants help **maintain balance among organisms.**

Native plants offer food, cover, and nesting areas needed by animals in a particular ecosystem. As a result, plants significantly influence overall biodiversity as well as the fates of individual animal species adapted to highly specific habitats. Native plant species have generally adapted and evolved with the competing species, prey, predators, and diseases of an area over many thousands of years. So native plants are usually in reasonable ecological balance with their associates and competitors, and they have particular pests, predators, and diseases that limit their abundance.

Native plants **support pollinators.**

Most flowering plants can produce seeds only when pollen is transferred between flowers of the same species. This is often done by pollinators that visit flowers to gather nectar or pollen. Between 75 and 95 percent of all flowering plants rely on pollinators to aid in reproduction.

Most pollinators are invertebrates, including flies, beetles, bees, butterflies, and moths. Birds and bats serve as pollinators as well. Pollen grains attach to the animal's body; the pollinator then unknowingly transports those pollen grains as it moves from flower to flower to feed. When the animal visits a flower of the same type, the pollen may fall off and help the plant reproduce.

Some native plants depend on a particular pollinator that in turn depends on them. For example, Joshua trees in the Mojave Desert are pollinated only by yucca moths, and the moths lay their eggs only in Joshua tree flowers. These types of symbiotic pollinator relationships develop over long periods of time and have a high risk of collapsing when either partner's population declines.

Native plants help **diversify the food supply.**

Plants provide the fundamental services upon which most life depends. Through photosynthesis, plants convert water and carbon dioxide into the oxygen and sugars that provide the primary fuel for life. Plants are the foundation of virtually the entire terrestrial food chain, sustaining humans as well as wildlife.

Over the centuries, farmers around the world have selectively bred native wild plants into high-yield, disease-resistant crops. Today, 90 percent of the world's food comes from only 20 such plant species. As a result, the genetic makeup of each species of our main food crops lacks diversity, which can result in crop failure if the plants face an unfamiliar disease. For example, in 1970, a fungus destroyed 15 percent of the U.S. corn crop. Each year, researchers find hundreds of new potential sources of food from wild native plants, which could be developed into alternative or replacement food sources. Two food sources harvested from public lands are pinyon nuts in the southwest and wild mushrooms in the northwest.

Native plants are also used around agricultural fields to support honeybees and native pollinators. Monocultures of a single species often bloom only at a given time, and a diverse group of natives that bloom throughout the growing season can extend the season for pollinators. Also, native pollinators are increasingly relied upon for pollination as honeybees suffer losses.

Vocabulary

Biodiversity – the variety and variability among living organisms and the ecological complexes in which they occur (U.S. Congress, Office of Technology Assessment).

Ecosystem – a complex set of relationships among the living resources, habitats, and residents of an area (Michigan Technological University).

Native species – all species of plants and animals naturally occurring, either presently or historically, in any ecosystem of the United States. (U.S. Executive Order 11987).

Procedure

1. **Hook:** Ask students to brainstorm how people benefit from and use plants (they might list wood, oxygen, food, etc.). Let them know they will be researching a specific group of plants in today's class: native plants, or those that have been on the continent since before Europeans arrived and were not introduced by humans.
2. **Intro:** Explain that healthy ecosystems depend on native plants to survive and thrive. Healthy means all parts exist in balance: soil, water, plants, and animals. Note that native plants are essential to maintaining ecosystem balance. Let students know they will look at how ecosystems and people are better off where there are native plants.
3. **Describe learning and teaching groups:** Explain to students that they will be working in two different groups: a learning group and a teaching group. In the learning group, they will read and talk about one benefit of native plants. This will prepare them to become an "expert" teacher about that benefit later, in the teaching group.
4. **Learning group:** There are four learning groups, one for each benefit of native plants. Depending on how large the class is, there might be seven or eight students per learning group. In the learning group, students should read their group's handout and talk about how to explain it to other students. Once each learning group has finished discussing its benefit, have students count off 1 through 7 or 8 (depending on how many are in the group). Then assign students to a teaching group by asking all the "1s" to form a group, all the "2s," to form a group, all the "3s," to form a group, etc.
5. **Teaching group:** Every teaching group should have four students—one "expert" for each benefit. Each "expert" has 2 minutes to teach the other three members of the group about his or her benefit. First, the soil erosion "expert" explains how native plants reduce erosion. Then the balance among organisms "expert" describes how native plants support biodiversity. Then the pollinators "expert" explains how native plants support pollinators, and finally the food supply "expert" describes how native plants promote diversity in the food supply. By the end of the teaching group, all the students will know about the four benefits of native plants.
6. **Conclusion:** Reconfigure the class into one unit and ask: What makes a native plant a native plant, and why are native plants important?

Assessment

Circulate among groups during group work to ensure students are understanding and accurately relating the information on their handouts. If students struggle to answer the question during step 6 (conclusion), ask about specific benefits. For example, ask if anyone can explain how native plants help diversify the food supply or maintain balanced ecosystems.

Adaptations to Consider

- Ask students to work individually or in teams to create posters of local native plants, which should include each plant's attributes and benefits.
- Ask teams to develop 30- or 60-second radio advertisements, electronic brochures, or slideshows that explain a benefit of native plants.

In the Field

Create a field guide of local native plants, using the resources at ***http://fieldguides.cnps.org/.***

Native Plants Classroom Investigation

Activity 1, Benefits of Native Plants

Handout 1: Slow Erosion

Instructions:

- Read the material below.
- Discuss the material with others in your group.
- Be sure every member of the group takes notes and is ready to teach a new group about how native plants help slow erosion.
- Then, wait for further instructions from your teacher.

Background:

Have you ever ridden along a dirt road and felt your car bouncing a lot more than usual or seen that parts of the road look like little ditches? The road likely has been eroded by rainfall and rushing water. That fast-moving water does not just make your ride rougher. It can also harm water quality in streams and prevent some of the water from seeping into the ground to keep the soil healthy. Rushing water can carry soil into streams, which may harm some of the animals that live there. This leaves less soil for growing plants that support pollinators and other animals, including humans.

Mosses and lichen are especially effective at holding soil in place. Some of them produce sticky substances that retain nutrients in the soil and hold soil particles together. This helps to slow erosion and keep soil where it can do the most good.

Here are some of the specific ways native plants help slow soil erosion:

- Many native plants have broad root systems that are deep and interlocking to hold soil in place.
- Native mosses and lichen are especially effective at holding soil in place. Some produce sticky substances that retain nutrients in the soil and hold soil particles together.
- Some plants store a lot of water in their stems or leaves, which can reduce erosion.
- Water travels down the deep roots of native plants, so some precipitation goes below the soil surface instead of eroding the soil.

Task:

Read and talk about how native plants can slow soil erosion and why it is important, and make sure each student is ready to explain this to students in your next group.

Native Plants Classroom Investigation

Activity 1, Benefits of Native Plants

Handout 2: Maintain Balance among Organisms

Instructions:

- Read the material below.
- Discuss the material with others in your group.
- Be sure every member of the group takes notes and is ready to teach a new group about how native plants help maintain balance among organisms.
- Then, wait for further instructions from your teacher.

Background:

If you look briefly at a native plant or tree, you may think it stands alone. However, a closer look at native plants shows how connected they are to other organisms. They offer a lot of services, such as food, shelter, and nesting areas, to many animals. Native plants also benefit from some of these animals, which pollinate them so they can reproduce. Native plants have often had thousands of years to adapt to an area and its climate, predators, and competing species. This makes it less likely that one species can absolutely dominate the others.

Here are some of the specific ways native plants help maintain balance among organisms:

- Native plants offer food, shelter, and nesting areas needed by animals in a particular ecosystem.
- Native plant species have adapted and evolved with the competing species, prey, predators, and diseases of an area over many thousands of years. This lets them live in balance with other organisms.
- Because of the ecological balance they help maintain, native plants are often able to survive while supporting the survival of other organisms.

Task:

Read and talk about how native plants maintain balance among organisms and why it is important, and make sure each student is ready to explain this to students in your next group.

Native Plants Classroom Investigation

Activity 1, Benefits of Native Plants

Handout 3: Support Pollinators

Instructions:

- Read the material below.
- Discuss the material with others in your group.
- Be sure every member of the group takes notes and is ready to teach a new group about how native plants support pollinators.
- Then, wait for further instructions from your teacher.

Background:

Unlike most animals, plants are not able to move around to seek food, shelter, and opportunities to reproduce. Instead, plants often rely on mobile animals to help them reproduce. In fact, more than 75 percent of flowering plants depend on pollinators. Plants have to provide something to these animals to draw them in, such as food in the form of nectar. Sometimes, plants produce chemicals that help their pollinators fight diseases, which the aspen does for its bee pollinators. Or plants may provide a shelter in their leaves for the eggs of their pollinators, as the Joshua tree does for the yucca moth.

Here are some of the specific ways native plants help support pollinators:

- Native plants provide pollinators, such as bees, birds, and butterflies, shelter and a food source, such as nectar.
- Some native plants, such as milkweed, give their pollinator butterflies chemicals, which help the butterflies fight parasites.
- Some native plants, such as aspens, give their pollinator bees chemicals, which help the bees fight diseases.
- Joshua trees give their only pollinator, the yucca moth, space in their flowers where the moths lay eggs.

Task:

Read and talk about how native plants can support pollinators and why it is important, and make sure each student is ready to explain this to students in your next group.

Activity 1, Benefits of Native Plants

Handout 4: Diversify the Food Supply

Instructions:

- Read the material below.
- Discuss the material with others in your group.
- Be sure every member of the group takes notes and is ready to teach a new group about how native plants help diversify the food supply.
- Then, wait for further instructions from your teacher.

Background:

Imagine you own a car company that makes the best gigantic cars on the road, and then an oil crisis more than doubles the cost of gas. It might not matter that your cars are top quality, ideal for big families, and long-lasting. Once gas prices shoot up, people might stop buying your cars. If you don't have smaller and more efficient cars to sell, you are likely to go out of business. It's a good idea to offer a diverse set of cars for sale so you can quickly adapt to changing conditions.

A similar idea works for the food supply. Over the centuries, farmers have selectively bred native wild plants into high-yield, disease-resistant crops. This is a great success under current conditions. However, today, only 20 such plant species provide 90 percent of the world's food. The genetic makeup of the species of our main food crops is not very diverse. Crops can fail if the plants face a disease to which they have not adapted resistance. For example, in 1970, a fungus destroyed 15 percent of the U.S. corn crop. Diversity is the best way to be ready for sudden changes in conditions.

Here are some of the specific ways native plants help diversify the food supply:

- Varied and native plant-based food crops increase genetic diversity and reduce risk of crop failure and disease.
- Native plants are a potential source of food that could replace diseased or failed food crops.
- Native plants are a source of genetic material that can make the plants with which they are bred more resistant to disease and drought.
- Native plants near agricultural lands support native pollinators and honeybees, which in turn boost agricultural production.

Task:

Read and talk about how native plants support diversity in the food supply and why it is important, and make sure each student is ready to explain this to students in your next group.

Activity 2, Threats to Native Plants

Time Estimate:

45 minutes

For the Teacher

This activity addresses the following essential understanding:

- Native plants are increasingly under stress.

Learning Objectives

Students will be able to (1) describe key threats to native plants; (2) identify human and natural causes of the threats; and (3) explain how some of the threats of native plants are related to each other.

Overview

This activity prompts students to examine how native plants are threatened. The issue is urgent because across the nation, thousands of acres of public lands are being affected by wildfires, climate change, and invasive plants, which can harm livestock grazing areas, agricultural lands, and natural areas.

This is the second of three activities that introduce students to native plants on public lands. The first examines some of the benefits of native plants, and a concluding activity focuses on the tradeoffs facing land managers who want to protect native plant communities.

Teacher Preparation

1. Provide tape, markers, and two sheets of chart paper per group so groups can create posters. Ensure students have pens and paper so they can take notes about each other's posters.
2. Make copies of the handouts about threats. Group 1 will receive Handout 1; Group 2 will receive Handout 2; etc.
3. Read the "Background Information" to become familiar with the threats native plants face.

Background Information

Climate change threatens native plants.

Plants are likely threatened or endangered because of a human activity that caused habitat destruction and limited population numbers. These plants are now further threatened by climate change, and most native plants are at risk from climate change. Climate change can alter plant life stages, such as leaf emergence or flowering period, which may hinder survival and reproduction. Some studies estimate that plant species' ranges may shift up to 90 miles due to climate change, and individual endemic plants that grow only in certain soil types may fail to compete in new areas.

Milder winters and frequent droughts allow pests to thrive and migrate farther north, resulting in potential harm to native plants. Winters have been milder in many parts of the Rocky Mountains, making it easier for the mountain pine beetle to thrive and feed on more and more of the region's evergreen trees. In the past, winter temperatures in much of the Rockies have been around -34 to -40 degrees Celsius for weeks at a time, cold enough to kill any eggs beetles produce. As winters have become milder, the beetles, which can harm or kill evergreen trees in large numbers, have produced and hatched far more eggs. In addition, drought makes it harder for the trees to produce sap, which they use to repel the beetles. As droughts become more common, the trees are much less able to use sap for defense.

In the face of climate change, invasive plant species can also pose a particular threat to native plants because many invasives do well in changing conditions and can out-compete native plants for vital resources.

Wildfire threatens native plants.

In a healthy ecosystem with native plant communities, occasional wildfires often help maintain ecosystem balance. Fires can increase nutrients in the soil, help some native plants reproduce, and prevent invasive plants from entering an area. However, recent hotter, longer burning fires have begun to upset the balance. Such fires can change the soil that native plants depend on, making the soil retain less water. This can start a cycle in which invasive plants drive out native plants and establish themselves, shorten the time period between fires, and prevent the native plants from returning.

In sagebrush communities across the West, cheatgrass is an example of an invasive plant that dries quickly and burns easily, which makes an area more susceptible to wildfire. Cheatgrass is an invasive annual plant that quickly depletes soil moisture and reproduces faster than many native plants. It then establishes itself quickly on disturbed sites. Cheatgrass provides large amounts of connected fuel ("fuel continuity") between and underneath the sagebrush shrubs, which causes the fires to burn at higher temperatures. These fires can be so hot that the sagebrush is injured or dies. Cheatgrass also promotes larger and more frequent wildland fires. Because there is less time between fires, native perennial vegetation is unable to recover completely before the next fire. All the while, cheatgrass continues to spread, promoting larger, hotter, and more frequent fires.

Overgrazing threatens native plants.

Some plants can benefit from moderate amounts of grazing, as the animals may remove older leaves and provide room for newer leaves. Some plants have evolved with large grazing animals such as bison, deer, and elk. If great numbers of other animals such as cows, sheep, or horses graze an area, the land can reach a tipping point when grazing switches from being beneficial to being a threat to native plants.

Once too many animals graze in an area, native plants can start to lose a lot of their leaves, reducing the amount of sunlight they can intercept. The plants may then use their resources to replace the leaves that have been eaten, which can pull resources away from their roots. When native plants have shorter and weaker roots, invasive plants often take over.

Native plants also suffer when overgrazing causes the soil to become compacted and eroded, causing much of the precipitation to flow away rather than sink into the ground. As a result, less water is available for the native plants. Sometimes soil is severely eroded around plants, leaving them sitting on pedestals held in place by their roots.

Grazing animals have plant preferences, and they seek out plants that taste good to them. The tastiest ones are often native forbs and grasses in the plant community. The animals usually skip over or avoid the invasive plants that replace the native plants, so the animals may travel farther afield to seek out more of the native plants they prefer. This can start a cycle in which native plants in one area are overgrazed and invasive plants, which livestock do not want, move in. Then the livestock move on to new areas, graze on the native plants, and allow invasive plants to spread further.

To prevent this cycle of expanding the range of invasive plants, many ranchers are interested in preserving native plant communities and preventing overgrazing. Examples of best grazing practices include rotating livestock among pastures of land to control grazing's effects and building fences to keep livestock away from the most vulnerable plants.

Invasive species threaten native plants.

Invasive plant species often have characteristics that enable them to out-compete native plants for moisture, sunlight, nutrients, space, or reproductive advantage. For example, a nonnative plant may flower more frequently and produce more seeds than local native species. Invasive plants may also use water in the soil sooner in the year or more quickly than native species. Some plants even produce chemicals in their leaves or root systems that inhibit the growth of other plants around them. When invasive plants take over an area, animals that depend on the native plants can lose their habitat.

In a native ecosystem, species evolve together with checks and balances, such as natural predators and diseases. And competition between plant species for resources limits population growth of any one species. When an invasive species is introduced, it may have few limiting factors, and its population growth may eventually explode.

Nationally, millions of acres of public lands are being affected by invasive plants, and thousands of invasive plant species have

established populations in the U.S. Many of these invasive plants are known to adversely affect livestock pastures, natural areas, and agricultural lands.

Vocabulary

Invasive species – species that are not native to a particular ecosystem whose introduction causes or is likely to cause economic or environmental harm or harm to human health (BLM).

Overgrazing – when the amount of animal consumption of plants results in damage to vegetation or related resources (U.S. Code of Federal Regulations).

Procedure

1. **Hook:** Ask students to recall some of the benefits of native plants identified in Activity 1 (e.g., slowing erosion, maintaining ecosystem balance, diversifying the food supply), and then ask them to speculate on some problems that might arise if species of native plants were to become extinct.
2. **Intro:** Explain that in many places native plants are threatened by invasive plants, wildfires, overgrazing, and climate change. Explain that students will closely examine one of these threats in small groups and create a poster illustrating their threat. Then, divide the class into four roughly equal groups (one group for each of the threats), distribute the handouts based on the threat each group will address, and ask students to read and discuss the information on their handout. (Particularly large classes may require five or six groups. If so, some threats may be addressed by two groups.)
3. **Make poster 1:** Explain to students that each group will create a poster that describes and shows the threat it has been assigned. They should use text and drawings on the posters to illustrate and cover basic facts about the threat: what is the threat, how does it affect native plants, how does it contribute or relate to other threats? Encourage students to be creative when drawing their threat, and let them know their poster should be clear and easy enough for all other students in the class to understand. Make sure that once all the posters are displayed, there is enough space between them to allow students to walk around and view them comfortably in groups.
4. **Walk around:** Instruct each group to move from "station to station" to read each other's posters. Give students about 5 minutes at each station to look at the work of the other groups. Ask students to take notes about how their threat is related to the other threats. For example, the invasive species group may notice on the wildfire

poster that the invasive species cheatgrass is part of a wildfire cycle that threatens native plants. Call time at each 5-minute interval to let students know they should move on to the next group's poster. The walk around ends when all groups are back in front of their own posters.

5. **Make poster 2:** Ask students to create a new poster that shows the connections among threats. Instruct students to draw a vertical and horizontal line on a new piece of chart paper and label each of the four squares with a threat: wildfire, overgrazing, climate change, and invasive species. Then ask them to draw lines showing which threats are related to the others, and write a brief explanation on each line about how the threats are related. Before students draw the connection lines, the poster should look something like this:

Wildfire	Overgrazing
Climate Change	Invasive Species

6. **Report out:** Ask a reporter from each group to point out all the connections they saw among threats and to explain one or two of these connections as time permits. Ask the entire class which threat had the most lines coming into and out of its square. It is likely to be the invasive species box; follow up by asking why they think invasive species was the threat with the most connections to the others.

Assessment

Circulate among groups as they are creating their posters to assess the accuracy and clarity of their work.

The following website provides a sample rubric for student posters, including both design and substantive criteria: ***http://teacherweb.com/me/jaleonardmiddleschoolold town/ecologywebquest/page3.htm***

Adaptations to Consider

To demonstrate how invasive plants can threaten native plants, have students grow grasses and flowers as described in the activity "Weed Invaders" on this site: ***http://www.blm.gov/wo/st/en/res/Education_in_BLM/Learning_Landscapes/For_Teachers/science_and_children/mojave/index/mojave02a.html***

In the Field

- Grow native plants on your school grounds, using this guide: ***http://www.wnps.org/education/resources/documents/MiddleSchool/act23.pdf***

- Develop a rain garden on your school grounds. This guide provides instructions: ***http://www.cbf.org/Document.Doc?id=64***

Activity 2, Threats to Native Plants

Handout 1: Climate Change

Instructions:

- Read the material below, and discuss it with others in your group.
- Using the information below, create a poster to show other groups how climate change can threaten native plants.
- Then, wait for further instructions from your teacher.

Background:

Climate change affects different areas of the country in different ways. In the Northern Rocky Mountains, climate change has brought about warmer winters than in the recent past. This makes it easier for the mountain pine beetle to thrive and feed on more and more of the area's evergreen trees. In the past, winter temperatures in the forests have been around -34 to -40 degrees Celsius for weeks at a time, cold enough to kill any eggs beetles produce. As winters have become milder, the beetles have produced and hatched far more eggs. With a large growth in the beetle population, many more evergreen trees have been harmed or killed.

The warmer winters allow harmful pests like the beetle to thrive and migrate farther north. In some areas, the mountain pine beetle can now produce two generations per calendar year, which lets them damage trees much faster. The beetles can also survive at higher elevations (11,000 feet or about 3,300 meters now versus 9,000 feet or about 2,700 meters 30 years ago). In addition, drought makes it harder for the trees to produce sap, which they use to repel the beetles. As droughts become more common, the trees are less able to use sap for defense.

Climate change can also affect native plants by changing plants' life stages such as how long they flower and when leaves emerge. These changes may hinder the plants' ability to survive and reproduce. When native plants are weakened by climate change, invasive plant species can threaten the native plants. The invasives tend to do well in changing conditions and to out-compete native plants for vital resources.

Here are some of the specific ways climate change can threaten native plants:

- Climate change moves warmer temperature zones farther north and raises average temperatures at higher altitudes, making winters mild enough to increase the numbers of pests that harm native plants.
- Climate change can alter plant life stages such as when leaves emerge and when and how long plants flower. These changes can disrupt plant reproduction.
- Some invasive plants do better in warmer climates, meaning they may be able to out-compete native plants for vital resources.
- Some native plants are not adapted to warmer temperatures and are unable to survive.

Native Plants Classroom Investigation

Activity 2, Threats to Native Plants

Handout 2: Wildfire

Instructions:

- Read the material below, and discuss it with others in your group.
- Using the information below, create a poster to show students in the other groups how wildfire can threaten native plants.
- Then, wait for further instructions from your teacher.

Background:

In a healthy ecosystem with native plant communities, occasional wildfires often help maintain ecosystem balance. Fires can increase nutrients in the soil, help some native plants reproduce, and prevent invasive plants from entering an area. However, recent hotter, longer burning fires have begun to upset the balance. Such fires can change the soil that native plants depend on, making the soil retain less water. This can start a cycle in which invasive plants drive out native plants and establish themselves, shorten the time period between fires, and prevent the native plants from returning.

In sagebrush communities across the West, cheatgrass is an example of an invasive plant that dries quickly and burns easily, which makes an area more susceptible to wildfire. Cheatgrass is an invasive annual plant that quickly depletes soil moisture and reproduces faster than many native plants. It then establishes itself quickly on disturbed sites. Cheatgrass provides large amounts of connected fuel ("fuel continuity") between and underneath the sagebrush shrubs, which causes the fires to burn at higher temperatures. These fires can be so hot that the sagebrush is injured or dies. Cheatgrass also promotes larger and more frequent wildland fires. Because there is less time between fires, sagebrush is unable to recover completely before the next fire. All the while, cheatgrass continues to spread, promoting larger, hotter, and more frequent fires.

Here are some of the specific ways wildfire can threaten native plants:

- More wildfires are burning longer and hotter, damaging the soil and making it hold less water than native plants need.
- The changed conditions may be more suitable for invasive plants than for native plants, starting a cycle in which invasive plants become established and prevent native plants from returning.
- An example of an invasive plant is cheatgrass, which produces huge numbers of seeds, depletes soil moisture, and increases fuel for fires so they burn hotter and more often. This leaves less time for native plants to recover from wildfires.

Activity 2, Threats to Native Plants

Handout 3: Overgrazing

Instructions:

- Read the material below, and discuss it with others in your group.
- Using the information below, create a poster to show other groups how overgrazing can threaten native plants.
- Then, wait for further instructions from your teacher.

Background:

Some plants can benefit from moderate amounts of grazing, as the animals may remove older leaves and provide room for newer leaves. Some plants have evolved with large grazing animals such as bison, elk, and deer. If great numbers of other animals such as cows, sheep, or horses graze an area, the land can reach a tipping point when grazing switches from being beneficial to being a threat to native plants.

Once too many animals graze in an area, native plants can start to lose a lot of their leaves, reducing the amount of sunlight they can intercept. The plants may then use their resources to replace the leaves that have been eaten, which can pull resources away from their roots. When native plants have shorter and weaker roots, invasive plants often take over.

Native plants also suffer when overgrazing causes the soil to become compacted and eroded. This causes much of the precipitation to flow away as runoff rather than sink into the ground. As a result, less water is available for the native plants. Sometimes soil is severely eroded around plants, leaving them sitting on pedestals held in place by their roots.

Grazing animals have plant preferences, and they seek out plants that taste good to them. The tastiest ones are often native forbs and grasses in the plant community. The animals usually skip over or avoid the invasive plants that replace the native plants, so the animals may travel farther afield to seek out more of the native plants they prefer. This can start a cycle in which native plants in one area are overgrazed and invasive plants, which livestock do not want, move in. Then the livestock move on to new areas, graze on the native plants, and allow invasive plants to spread further.

To prevent this cycle of expanding the range of invasive plants, many ranchers are interested in preserving native plant communities and preventing overgrazing. For example, ranchers may rotate livestock among pastures and build fences to keep livestock away from the most vulnerable plant communities.

Here are some of the specific ways overgrazing can threaten native plants:

- When too many animals graze in an area, the area can be harmed, and native plants can lose many leaves, reducing the amount of sunlight they can intercept.
- With less sunlight, native plants develop shorter and weaker roots, which may make it easier for invasive plants to move in.
- Heavy grazing animals can cause the soil to become compacted and eroded, causing water to rush away. With less available water, native plants often struggle to thrive and reproduce.

Native Plants Classroom Investigation

Activity 2, Threats to Native Plants

Handout 4: Invasive Species

Instructions:

- Read the material below, and discuss it with others in your group.
- Using the information below, create a poster to show other groups how invasive species can threaten native plants.
- Then, wait for further instructions from your teacher.

Background:

Invasive plant species often have characteristics that enable them to out-compete native plants for moisture, sunlight, nutrients, space, or reproductive advantage. For example, a nonnative plant may flower more frequently and produce more seeds than local native species. Invasive plants may also use water in the soil sooner in the year or more quickly than native species. Some plants even produce chemicals in their leaves or root systems that inhibit the growth of other plants around them. When invasive plants take over an area, animals that depend on the native plants can lose their habitat.

In a native ecosystem, species evolve together with checks and balances, such as natural predators and diseases. And competition between plants species for resources limits population growth of any one species. When an invasive species is introduced, it may have few limiting factors, and its population growth may eventually explode.

Thousands of invasive plant species have established populations in the U.S. Millions of acres of public lands are being affected by invasive plant species. Many of these invasive plants are known to adversely affect livestock pastures, natural areas, and agricultural lands.

Here are some of the specific ways invasive species can threaten native plants:

- When an invasive species is introduced, it may have few limiting factors, and its population growth may eventually explode.
- Invasive plant species often have characteristics that enable them to out-compete native plants for moisture, sunlight, nutrients, space, or reproductive advantage. Invasive plants also may flower more often or produce more seeds.
- Some invasive plants produce chemicals in their leaves or root systems that make it harder for other plants to grow nearby.

Activity 3, Land Use Decisions

Time Estimate:

45 minutes

For the Teacher

This activity addresses the following essential understandings:

- The vast public lands of the U.S. provide a unique opportunity to conserve and restore native plant communities.
- Conserving and restoring native plant communities involves balancing benefits and costs, and the costs become steeper as threats build over time.

Overview

This activity encourages students to grapple with the tradeoffs that public land managers face as they balance native plant preservation with land uses such as recreation and tourism. The choice in the activity is whether to approve hiking trails on a parcel of land and, if so, which of two routes to select. Small groups of students analyze how various options may affect heritage areas, the tourist economy, hikers, and native plants.

This is the third of three activities that introduce students to native plants on public lands. The first examines some of the benefits of native plants, and the second looks at various threats to native plant communities.

Learning Objectives

Students will be able to (1) describe factors considered by planners when making public land use decisions; (2) take and defend positions on hypothetical but realistic land use planning questions; and (3) explain the costs and benefits of land use choices.

Teacher Preparation

1. Make copies of the three-page handout and Camina Vista map (one per student).
2. Read the "Background Information" to become familiar with some of the choices that public land managers face and the diverse views about what the managers should do.

Background Information

BLM public lands are managed for diverse uses such as supplying natural resources—minerals, timber, coal, natural gas, oil, renewable energy—and providing habitat for plants and animals. BLM public lands also provide open spaces where people can enjoy recreation and learn about evidence of our country's past, from ancient trilobites to 20th century ghost towns.

Public land managers must balance recreation, conservation, and economic values when deciding a land use question, and they listen to diverse voices representing a wide range of interests. People who depend on the hospitality industry want high levels of tourism activity and often endorse decisions that promote recreation. Outdoor enthusiasts who enjoy hiking in scenic areas, rock climbing, fishing, and mountain biking also usually want to see decisions that accommodate recreation. Alternatively, tribal leaders, historic preservationists, and conservationists often speak for minimizing human impact on the land, even if that means limiting recreational opportunities. This view may be seconded by those in farming and agriculture, who often depend on healthy plant communities to filter water and to support grazing animals and pollinators of food crops. Land use managers constantly explore ways to preserve biodiversity, maintain balanced habitats, attract visitors to the public lands, promote economic activity, and ensure that future generations can enjoy cultural and recreational resources.

Camina Vista is the fictional parcel of land at the heart of this activity, but the issues and perspectives are representative of those often faced by public land managers. Camina Vista is bisected by a paved road, includes a heritage site regarded as sacred by the local tribal nation, is currently without formal recreational opportunities, and is largely covered by native sagebrush that faces various threats, including the invasive plant cheatgrass.

It is essential for students to understand that there is not just one right answer for the dilemma in the activity. The students should appreciate the tradeoffs that land managers face when weighing the pros and cons of choices that may partially satisfy most stakeholders but are certain not to fully satisfy everyone.

Procedure

1. **Hook:** Ask students to think about decisions made by young people that have long-lasting effects versus ones that do not. Ask for a show of hands for which of the following choices have long-term consequences: whether to go to a movie or stay in, whether to stay in school or drop out, whether to have pizza or salad, whether to take college preparation courses or not. Note that public officials like mayors and presidents are often called upon to make long-lasting decisions, such as whether to open a new school or send the military overseas. These are decisions about which many smart and sincere people may disagree, often making them difficult to resolve.

2. **Intro:** Explain that public land managers make long-lasting decisions just as mayors and presidents do. Public land managers must consider the diverse views of many smart and sincere people before making decisions that can have consequences lasting decades or even centuries. Let students know they will get into small groups to look at and make choices about a land use issue just as public land managers would, considering various views and being aware that there is not just one right answer.
3. **Group instructions:** Distribute the student handout to everyone; ask them to read the scenario and examine the map; and explain that their job in the group is to choose an option by consensus. Divide students into groups of four or five, and ask the groups to select someone to report out. Provide about 20 minutes for the groups to consider the arguments and select one of the options, which include: do nothing, approve the short trail, approve the long trail, or approve both trails. Answer any clarification questions students may have; emphasize that there is not just one right answer; and discourage students from introducing factors that are outside the context of the activity (e.g., avoid the sagebrush, route Trail 2 through the wetlands, etc.).
4. **Report out:** Ask the reporter from each group to report the decisions their group reached. Keep a tally to show which groups made which choices. Ask reporters to identify which arguments were most persuasive and why, as well as how difficult the decision was to make. If any groups did not reach consensus, ask them why they were unable. For those groups that did reach consensus, ask why they rejected the choices they did not select, as well as why they made the choice they made.
5. **Conclusion:** Reconfigure the class into one unit. Ask for a show of hands for which students thought which factor was the most important: promoting economic development, protecting native plants, accommodating recreation, preserving native heritage. Ask students to comment on which tradeoff was most difficult, and ask if anyone changed his or her view from the beginning to the end of the activity and, if so, why.

Assessment

Circulate among groups as students discuss the land use issue, and listen for whether students are on topic and respectfully discussing the tradeoffs. Use student responses to the question in step 5 (conclusion) to gauge how well they understand the tradeoffs facing land managers.

Adaptations to Consider

- Instead of providing students with many of the pros and cons, ask them to come up with these by discussing in groups how each land use choice would affect native plants, hikers and other recreation interests, ecosystem balance, the local tourism economy, and the tribe. Then ask students to work together to make a consensus decision.

- Another alternative is to assign students the various roles, such as hikers, tourism promoters, tribal leaders, and conservationists. Group students by role, and ask them to develop a presentation and argue their positions in front of a panel of volunteer adults or neutral peers. Ask the panel to decide the trail siting question.

- Ask students to identify a land use issue in the community, research and gather information about it, and explore and debate possible solutions.

- Invite a land manager to talk with students about a recent difficult land use decision he or she had to make.

In the Field

Identify a federal, tribal, state, or local body that makes land use decisions; research one of their current land use issues; and plan a visit to observe them as they discuss a land use issue.

Native Plants Classroom Investigation

Activity 3, Land Use Decisions

Instructions:

- Read the scenario, things to consider, and pros and cons of each option. Look at the map, and examine the two possible routes for hiking trails in Camina Vista, a fictional area of public land.
- Your group needs to agree on a decision about the trails, and your choices include: (1) do not approve either trail; (2) approve Trail 1, the shorter trail; (3) approve Trail 2, the longer trail; and (4) approve both trails.
- Select a reporter for the group who will explain your group's choice to the rest of the class, including: (1) your decision, (2) the main reasons you made that choice, (3) how difficult it was to decide, and (4) the key tradeoffs you discussed.

Scenario

The Bureau of Land Management (BLM) is the federal agency that manages the Camina Vista public lands (see the Camina Vista map). The BLM is considering adding one or more hiking trails there. Camina Vista is home to a Native American heritage site, a sagebrush community, a bighorn sheep area, some invasive cheatgrass, a scenic vista, and a wetland. The sagebrush is threatened by cheatgrass and more frequent wildfires. Camina Vista is next to Walker Mesa, an established recreation area with trails that are part of a regional trail system. The area also has a north-south road going through it.

The BLM Camina Vista land managers have four options:

1. Do nothing, and leave the area as it is.
2. Authorize a shorter loop trail (Trail 1 on the map).
3. Approve a longer trail with a connector trail to Walker Mesa's system of trails covering hundreds of miles (Trail 2 on the map).
4. Approve both Trail 1 and Trail 2.

Things to consider:

- If either trail is built, a parking area, a visitor kiosk, and a restroom facility will have to be added.
- Trail 1 would lead visitors to a fishing area, but hikers would walk through cheatgrass and possibly spread its seeds into sagebrush areas.
- Trail 2 includes a rigorous rock scramble, a scenic overlook, a bighorn sheep area, and a connector trail to a larger trail system called Walker Mesa. Like Trail 1, Trail 2 leads hikers through cheatgrass, the seeds of which may be spread by hikers to sagebrush areas.

Pros and cons of each option

Approve Neither Trail

Pros:

- This choice would have the least impact on the sagebrush and the bighorn sheep in the ecosystem.
- This choice would ensure no one visits the heritage area, which is considered sacred ground by the tribe.
- If the cheatgrass threatening the sagebrush community can soon be brought under better control, Trail 1 could be approved in the future, but approving the trail now could heighten the risks of expanding the range of the cheatgrass.

Cons:

- Local businesses would miss out on money that hikers would have spent on food and lodging in the area.
- This choice would not allow users of the larger trail system in Walker Mesa to experience hiking in Camina Vista, nor would anyone make use of the fishing lake.
- Fewer visitors to public lands may result in fewer supporters of public lands.

Approve Trail 1 Only

Pros:

- Trail 1 would have less impact than Trail 2 on the sagebrush and the bighorn sheep in the ecosystem.
- Trail 1 would bring some additional visitors to the public lands, which may lead to some of them becoming supporters of public lands.
- Trail 1 would provide hikers with access to the fishing lake.
- Trail 1 would protect the heritage area, which is considered sacred ground by the tribe, from nearly all visitors.

Cons:

- Trail 1 would attract too few visitors to support new restaurants, campgrounds, hotels, and other businesses.
- Trail 1 would not connect to the trail system in Walker Mesa, so users of that larger system would not be able to experience hiking in Camina Vista, and Camina Vista hikers could not reach Walker Mesa.
- Because hikers have to go through cheatgrass to get to the lake, they could spread seeds, which could cause the cheatgrass to take over the nearby sagebrush.
- Hikers would not experience the scenic vista and the rock scramble on Trail 2.

Approve Trail 2 Only

Pros:

- With the scenic view and rock scramble, Trail 2 would likely attract enough new visitors to support new restaurants, campgrounds, hotels, and other businesses.
- Trail 2 would connect to the trail system in Walker Mesa, so users of that larger system would be able to experience hiking in Camina Vista, and hikers in Camina Vista could reach Walker Mesa.
- Trail 2 would likely increase the number of public lands supporters because they have visited and enjoyed the land.

Cons:

- Trail 2 would have more negative impacts on the sagebrush, allowing more cheatgrass to take hold in the area as hikers accidentally spread cheatgrass seeds and deposit them in sagebrush.
- Threats to the sagebrush would upset ecosystem balance by threatening other species that rely on the sagebrush.
- Trail 2 would bring hikers near the bighorn sheep and right next to—and possibly tempt hikers to enter—the Native American heritage area, which is considered sacred ground by the tribe.
- Trail 2 would not allow hikers to use the fishing lake along Trail 1.

Approve Both Trails

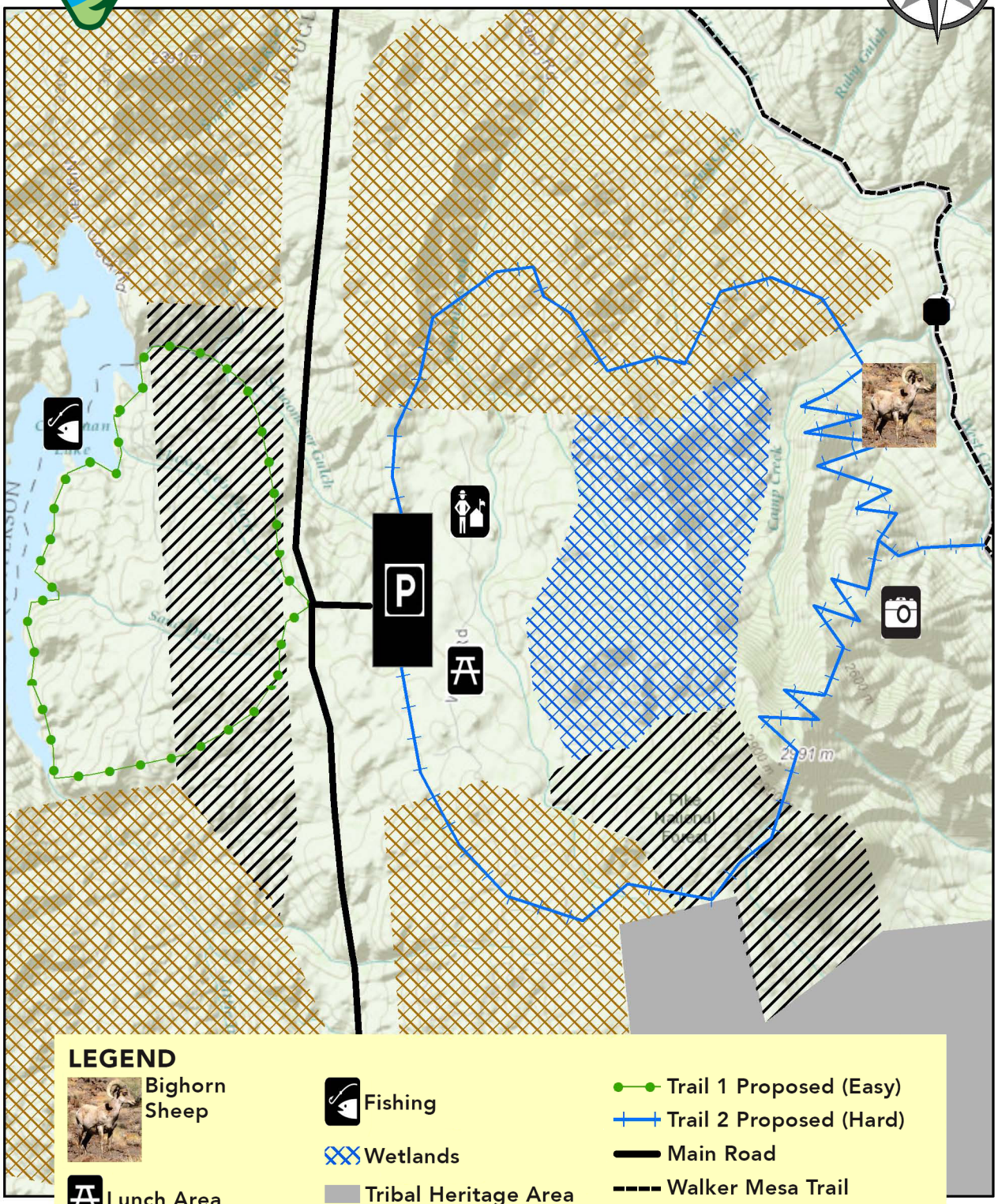
Pros:

- This choice would provide visitors with more trail choices to accommodate hikers with various levels of hiking ability, hikers interested in fishing, and those who want to see the scenic view and rock scramble.
- This choice would attract enough new visitors to support new restaurants, campgrounds, hotels, and other businesses.
- This choice would connect Trail 2 to the trail system in Walker Mesa, so users of that larger system would be able to experience hiking in Camina Vista, and hikers in Camina Vista could reach Walker Mesa.
- This choice would likely increase the number of public lands supporters because they have visited and enjoyed the land.

Cons:

- Because both trails would go through cheatgrass, hikers could accidentally spread seeds, which could cause cheatgrass to take over nearby sagebrush.
- Threats to the sagebrush would upset ecosystem balance by threatening other species that rely on the sagebrush.
- This choice would bring hikers near the bighorn sheep and right next to—and possibly tempt hikers to enter—the Native American heritage area, which is considered sacred ground by the tribe.

Camina Vista



Notes:

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