



More than 1,300 plant taxa occur in Yellowstone National Park. The whitebark pine, shown here and found in high elevations in the Greater Yellowstone Ecosystem, is an important native species in decline.

## Vegetation

The vegetation communities of Yellowstone National Park include overlapping combinations of species typical of the Rocky Mountains as well as of the Great Plains to the east and the Intermountain region to the west. The exact vegetation community present in any area of the park reflects the consequences of the underlying geology, ongoing climate change, substrates and soils, and disturbances created by fire, floods, landslides, blowdowns, insect infestations, and the arrival of nonnative plants.

Today, the roughly 1,386 native taxa in the park represent the species able to either persist in the area or recolonize after glaciers, lava flows, and other

major disturbances. Yellowstone is home to three endemic plant species, at least two of which depend on the unusual habitat created by the park's thermal features. Most vegetation management in the park is focused on minimizing human-caused impacts on their native plant communities to the extent feasible.

### Vegetation Communities

There are several vegetation communities in Yellowstone: higher- and lower-elevation forests and the understory vegetation associated with them, sagebrush-steppe, wetlands, and hydrothermal.

#### Quick Facts

##### Number in Yellowstone

Native plant taxa: more than 1,300:

- Hundreds of wildflowers.
- Trees: nine conifers (lodgepole pine, whitebark pine, Engelmann spruce, white spruce, subalpine fir, Douglas-fir, Rocky Mountain juniper, common juniper, limber pine) and some deciduous species, including quaking aspen and cottonwood.
- Shrubs: include common juniper, sagebrush (many species), Rocky Mountain maple.
- Three endemic species (found only

in Yellowstone): Ross's bentgrass, Yellowstone sand verbena, Yellowstone sulfur wild buckwheat.

Nonnative plant species: 225.

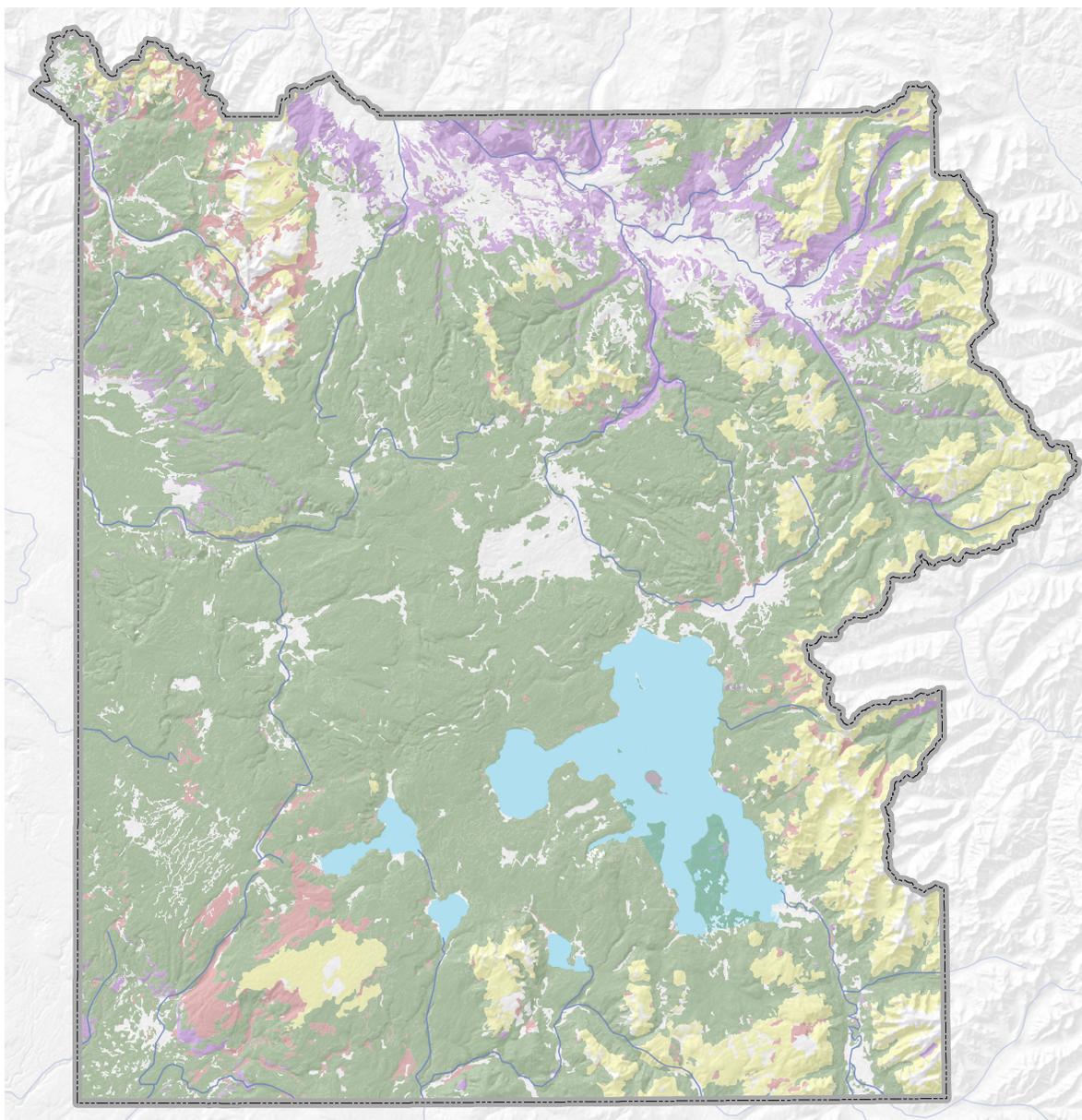
##### Characteristics

- Vegetation in Yellowstone is typical of the Rocky Mountains.
- Elements of the Great Plains and Great Basin floras mix with Rocky Mountain vegetation in the vicinity of Gardiner and Stephen's Creek.
- Hydrothermal areas support unique plant communities and rare species.

##### Management Issues

- Controlling nonnative species, which threaten native species, especially near developed areas; some are spreading into the backcountry.
- Park partners are monitoring whitebark pine and forest insect pests.
- Biologists survey areas for sensitive or rare vegetation before disturbance such as constructing a new facility.
- Park managers are restoring areas of disturbance.

## Vegetation Communities in Yellowstone National Park



**■ Lodgepole pine forests**

Dominate more than 80% of the total forested area. Can be seral (developing) or climax. Climax forests underlain by rhyolite.

**■ Spruce-fir forests**

Engelmann spruce/subalpine fir dominate older forests. Usually found on moist and/or fertile substrates. Climax forests underlain by andesitic soils.

**■ Whitebark pine forests**

Major overstory component above 8,400 feet. Major understory component of lodgepole-dominated forests from 7,000 to 8,400 feet. Seeds are ecologically important food for a variety of wildlife species.

**■ Douglas-fir forests**

Associated with the Lamar, Yellowstone, and Madison river drainages below 7,600 feet.

Often less than 20 inches annual precipitation. More frequent historic fire interval (25–60 year) than other forest communities in the park.

**□ Non-forest**

Includes grasslands, sagebrush, alpine meadows, talus, and hydrothermal environments.

Encompasses the moisture spectrum from dry sagebrush shrublands to wet alpine meadows. Provides the winter and summer forage base for ungulates.

**Other communities not shown on map**

*Aspen*—found in small clones interspersed among the sagebrush/forest ecotone (transition zone) along the Yellowstone, Madison, and Snake river drainages.

*Wetland*—includes various grass, forb, rush, sedge, and woody species.

*Riparian*—typically streamside vegetation includes cottonwoods, willows, and various deciduous shrubs.

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## Staff Reviewers

Roy Renkin, Vegetation Management Specialist



Douglas-fir forests occur at lower elevations and are associated with the Lamar, Yellowstone, and Madison river drainages in Yellowstone National Park.

## Forests

Forests cover roughly 80% of the park and lodgepole pine comprises nearly all of that canopy. Lodgepole pine, Engelmann spruce, subalpine fir, whitebark pine, and limber pine are found at higher elevations.

Douglas-fir forests occur at lower elevations, especially in the northern portion of the park. The thick bark of Douglas-fir trees allows them to tolerate low-intensity fire. Some of the trees in these forests are several hundred years old and show fire scars from a succession of low intensity ground fires. In contrast, lodgepole pine trees have very thin bark and can be killed by ground fires.

At higher elevations, older forest is dominated by Engelmann spruce and subalpine fir, especially in areas that grow on andesite, a volcanic rock, such as the Absaroka Mountains. These forests may have been dominated by lodgepole pine at one time,

but have been replaced by Engelmann spruce and subalpine fir in the absence of fire and presence of non-rhyolitic soil (a non-volcanic soil). Engelmann spruce and subalpine fir can also be common in the understory where the canopy is entirely composed of lodgepole pine.

In rhyolitic soils (another volcanic substrate), which are poor in nutrients needed by fir and spruce, lodgepole pine remains dominant. At higher elevations such as the Absaroka Mountains and the Washburn Range, whitebark pine becomes a significant component of the forest. In the upper subalpine zone, whitebark pine, Engelmann spruce, and subalpine fir often grow in small areas separated by subalpine meadows. Wind and desiccation cause distorted forms known as krumholtz where most of the “tree” is protected below snow.

## Common Conifers

### Higher-Elevation Species

#### Lodgepole Pine (*Pinus contorta*)

- Most common tree in park, 80% of canopy
- Needles in groups of twos
- Up to 75 feet tall

#### Engelmann Spruce (*Picea engelmannii*)

- Often along creeks, or wet areas
- Sharp, square needles grow singly
- Cones hang down and remain intact, with no bract between scales
- Up to 100 feet tall

### Subalpine Fir (*Abies lasiocarpa*)

- Only true fir in the park
- Blunt, flat needles
- Cones grow upright, disintegrate on tree
- Up to 100 feet tall

### Limber Pine (*Pinus flexilis*)

- Needles in groups of five
- Young branches are flexible
- Up to 75 feet tall
- Often on calcium-rich soil

### Whitebark Pine (*Pinus albicaulis*)

- Grows above 7,000 feet
- Needles in groups of five
- Up to 75 feet tall

### Lower-Elevation Species

#### Douglas-Fir (*Pseudotsuga menziesii*)

- Resembles the fir and the hemlock, hence its generic name *Pseudotsuga*, which means “false hemlock”
- Cones hang down and remain intact, with three-pronged bract between scales
- Up to 100 feet tall

#### Rocky Mountain Juniper (*Juniperus scopulorum*)

- Needles scale-like
- Cones are small and fleshy
- Up to 30 feet tall

## Lodgepole Pine

The lodgepole pine (*Pinus contorta*) is by far the most common tree in Yellowstone. Early botanical explorers first encountered the species along the West Coast where it is often contorted into a twisted tree by the wind, and thus named it *Pinus contorta* var. *contorta*. The Rocky Mountain variety, which grows very straight, is *Pinus contorta* var. *latifolia*. Some American Indian tribes used this tree to make the frames of their tipis or lodges, hence the name “lodgepole” pine.

### Description

Lodgepoles are the only pine in Yellowstone whose needles grow in groups of two. The bark is typically somewhat brown to yellowish, but a grayish-black fungus often grows on the shady parts of the bark, giving the tree a dark cast.

The species is shade intolerant; any branches left in the shade below the canopy will wither and fall off the tree. Lodgepoles growing by themselves will often have branches all the way to the base of the trunk because sunlight can reach the whole tree.

### Reproduction

Like all conifers, lodgepole pines have both male and female cones. The male cones produce huge quantities of yellow pollen in June and July. This yellow pollen is often seen in pools of rainwater around the park or at the edges of lakes and ponds.

The lodgepole’s female cone takes two years to mature. In the first summer, the cones look like tiny, ruby-red miniature cones out near the end of the branches. The next year, after fertilization, the cone starts rapidly growing and soon becomes a conspicuous green. The female cones either open at maturity releasing the seeds, or remain closed—a condition called serotiny—until subjected to high heat such as a forest fire. These cones remain closed and hanging on the tree for years until the right conditions allow them to open. Within a short period of time after the tree flashes into flame, the cones open up and release seeds over the blackened area, effectively dispersing seeds after forest fires. Trees without serotinous cones (like Engelmann spruce, subalpine fir, and Douglas-fir) must rely on wind, animals, or other agents to carry seeds into recently burned areas.

### Habitat

Lodgepole pines prefer a slightly acid soil, and will



Lodgepole pine forests are the most common in Yellowstone. A lodgepole’s serotinous cones need to be exposed to the high heat of a forest fire for the seeds to be released. The other cones open when the seeds within are mature (end of the second summer).

grow quickly in mineral soils disturbed by fire or by humans (such as a road cut). Their roots spread out sideways and do not extend deeply—an advantage in Yellowstone where the topsoil is only about 6 to 12 inches deep, but a disadvantage in high winds. Lodgepole pines are vulnerable in windstorms, especially individuals that are isolated or in the open.

Besides reseeding effectively after disturbance, lodgepole pines can grow in conditions ranging from very wet ground to very poor soil prevalent within the Yellowstone Caldera. This flexibility allows the species to occur in habitat that otherwise would not be forested.

Because lodgepole pines are dependent on sunny situations for seedling establishment and survival, the trees do not reproduce well until the canopy opens up significantly. In the Yellowstone region, this allows the lodgepole pine forest to be replaced by shade-loving seedlings of subalpine fir and Engelmann spruce where the soil is well-developed enough to support either of these species. In areas of nutrient poor soil, where Engelmann spruce and subalpine fir struggle, lodgepole pines will eventually be replaced by more lodgepole pine trees as the forest finally opens enough to allow young lodgepoles to become established.

## Whitebark Pine

Whitebark pine (*Pinus albicaulis*) is a high-elevation tree of the northern Rocky Mountains and the Pacific Northwest, where it grows in nearly homogeneous stands on harsh, dry terrain but is more often found with other conifers in moister, more protected sites. It often grows in areas with poor soils, high winds, and steep slopes that are inhospitable to other species. It retains snow and reduces erosion, acts as a nurse plant for other subalpine species, and produces seeds that are an important food for grizzly bears and other wildlife.

Whitebark pine is experiencing unprecedented mortality throughout its range. A primary cause is white pine blister rust (*Cronartium ribicola*), an introduced pathogen. Whitebark pine is also vulnerable to infestation by native pine beetle, factors related to climate change (increased droughty periods), and altered wildland fire regimes.

An estimated 20–30% of whitebark pine trees taller 1.4 meters tall are infected with blister rust in the Greater Yellowstone region. As of 2015, 1,471 of the more than 5,000 monitored trees had died, including 70% of those in the >10 cm in diameter size classes. (The mountain pine beetle prefers larger trees for laying their eggs; the larvae feed on the inner phloem of the bark.) In addition, the Greater Yellowstone Network estimated that by the end of 2013, 27% of whitebark pine trees >1.4 meters tall had died. Despite the high percent of large trees that have died, there are trees that are still producing cones and regeneration is occurring. The network estimated an average growth of 53 small trees per 500 meters squared by the end of 2011.

Aerial surveys, which measure the spatial extent of mortality rather than the percentage of individual dead trees counted on the ground, have generally produced higher whitebark pine mortality estimates in the Greater Yellowstone Ecosystem. This could be because larger trees, which occupy more of the area in the forest canopy visible from the air, are more likely to be attacked by beetles. In 2013, an aerial survey method called the Landscape Assessment System was used to assess mountain pine beetle-caused mortality of whitebark pine across the Greater Yellowstone Ecosystem. Results of the one-time study indicate that nearly half (46%) of the GYE whitebark pine distribution showed severe mortality, 36% showed moderate mortality, 13% showed low mortality, and 5% showed trace levels of mortality.



The needles of a whitebark pine are clustered in groups of five.

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### Staff Reviewer

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## Understory Vegetation

Understory vegetation differs according to precipitation, the forest type, and the substrate. Lodgepole pine forest is often characterized by a very sparse understory of mostly elk sedge (*Carex geyeri*), or grouse whortleberry (*Vaccinium scoparium*). Pinegrass (*Calamagrostis rubescens*) occurs frequently under Douglas-fir forest but is also common under other forest types, especially where the soil is better developed or more moist. In some areas of the park such as Bechler and around the edges of the northern range, a more obviously developed shrub layer is composed of species such as Utah honeysuckle (*Lonicera utahensis*), snowberry (*Symphoricarpos* spp.), and buffaloberry (*Shepherdia canadensis*).

## Forest Insect Pests

The conifer trees of Yellowstone face six major insect and fungal threats. The fungus is a nonnative species, but the insects are native to this ecosystem. They have been present and active in cycles, probably for centuries. A scientist studying lake cores from the park has found some of their insect remains in the cores, indicating their presence even millions of years ago. However, in the last 10 years, all five insects have been extremely active, which may be due to the effects of climate change.

The primary cause of tree mortality in the Yellowstone is native bark beetles. The beetles damage trees in similar ways: their larvae and adults

consume the inner bark. If the tree is girdled, it dies. Their feeding activity can girdle a tree in one summer, turning the crown red by the following summer. The needles usually drop within the next year, leaving a standing dead tree. Isolated pockets of red-needled trees are scattered throughout the park. Forest structure, tree health, and climate are the major factors determining the extent of an outbreak; drought and warmer temperatures can make forests more vulnerable to infestation.

### Pest Activity

The severity of insect-caused tree mortality has been considerable throughout the West for over a decade, and the insects have spread to previously unaffected plant communities. Several native bark beetle species in the Scolytidae family have altered extensive areas within Greater Yellowstone. Forest structure, tree health, and climate are the major factors in determining whether an outbreak expands; drought and warmer temperatures can make forests more vulnerable to infestation.

Recent evaluation has shown decreases in infection and infestation rates since 2001, suggesting that resistance may be slowly increasing. Although activity by both Douglas-fir beetle and Engelmann spruce beetle has declined to endemic (natural to Yellowstone) levels since 2000, other forest insects of ecological significance remain active. Mountain pine beetle activity was largely confined to the northwest

## Forest Insect Pests

### Number in Yellowstone

Six forest pests

#### Mountain Pine Beetle

##### *(Dendroctonus ponderosae)*

- Affects whitebark, lodgepole, and limber pine.
- The tree defends itself by increasing resin (pitch) production, which can "pitch out" the insect from the tree and seal the entrance to others.
- Look for globs of resin, often mixed with wood borings, on the bark.
- Adults emerge in mid-summer.

#### Engelmann Spruce Beetle

##### *(Dendroctonus rufipenni)*

- Affects Englemann spruce, rarely lodgepole pine.

- Larvae feed for two years.
- Look for reddish dust on the bark and at the base of the tree in early summer.

#### Douglas-Fir Beetle (*Dendroctonus pseudotsugae*)

- Affects Douglas-fir.
- Larvae also consume outer bark.

#### Western Balsam Bark Beetle (*Dryocoetes confusus*)

- Affects subalpine fir.

#### Western Spruce Budworm (*Choristoneura occidentalis*)

- Affects Douglas-fir, true firs, spruce.
- Larvae defoliate trees and can destroy cones and seeds.

- Look for clumps of chewed needles on branch tips.

#### White Pine Blister Rust

- A nonnative disease caused by a fungus, *Cronartium ribicola*.
- Affects whitebark and limber pines.
- The disease impacts the tree's ability to transport nutrients and produce cones, and may eventually kill the tree.
- Look for cankers (lesions) on the bark.

#### Management Issues

- Research supported by the National Park Service will investigate the interactions between insect infestations and wildfire.

portion of the park, in high-elevation whitebark pine and lower elevation lodgepole pine, peaking in 2009 with annual decreases in mortality since then. Defoliation of Douglas-fir and Engelmann spruce by the western spruce budworm is present in the park throughout the lower Lamar and along the Yellowstone and Lamar River valleys, but spread considerably less in recent years. These trends appeared to continue in 2011, when the park was only partially surveyed.

#### **Future of Insect Outbreaks in Yellowstone**

Landscape-scale drought and the availability of suitable host trees have contributed to the initiation and persistence of insect outbreaks. Healthy trees can defend themselves from beetle attack by “pitching out” adult females as they try to bore into the tree. Extreme winter temperatures can kill off overwintering broods and wet summer weather impedes the insects from invading additional trees. Insect activity also decreases as the larger and more susceptible trees are killed off. Spruce beetles have declined because they have killed almost all of their preferred food source (spruce trees more than 10 inches in diameter).

Recent and ongoing studies supported by the National Park Service are investigating the interaction between insect infestations and wildfire. Researchers have focussed on how bark beetle epidemics may affect fire behavior in lodgepole-dominated forests and comparing the resulting fire hazard with that in Douglas-fir forests.

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#### **Staff Reviewer**

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Other vegetation communities in Yellowstone include sagebrush-steppe, wetlands, and hydrothermal communities. Sagebrush-steppe occurs in the northern range in Yellowstone.

## Other Vegetation Communities

### Sagebrush-steppe

This vegetation type occurs in the northern range; Hayden, Pelican, and Madison valleys; Swan Lake Flats, and along many of the rivers and creeks. Mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*) dominates, along with several other kinds of sagebrush. Several grass species, such as Idaho fescue (*Festuca idahoensis*), also dominate sagebrush-steppe. Other species of the sagebrush steppe include mountain brome, needlegrasses, yampah, sticky geranium, and several species of upland sedges. The northern range can be spectacular with wildflowers in late June and early July.

In 2015, a long-term sagebrush steppe monitoring program was initiated to track the changes in plant cover and species composition over many years with an emphasis on invasive species. Data loggers will be used to assist staff with correlating any changes in the vegetation with climate change.

### Wetlands

#### Where to See

Some wetlands located near roads:

- **Northeast Entrance Road**, beginning east of Yellowstone Picnic Area: listen for frogs in spring, look for sandhill cranes throughout the Lamar Valley.
- **Firehole Lake Road**: listen for frogs and look for elephant's head flowers where the road begins.
- **Dunraven Pass area**: look for abundant wildflowers in high elevation wetlands near the road.
- **Norris Geyser Basin, Back Basin**: near Puff 'n' Stuff Geyser, look for dragonflies.
- **All thermal areas**: look for ephydrid flies, thermophiles, and other life forms.

### Wetlands

Yellowstone's wetlands include lakes, rivers, ponds, streams, seeps, marshes, fens, wet meadows, forested wetlands, and hydrothermal pools. They occupy over 357 square miles (924 km<sup>2</sup>) of Yellowstone: 44% are lakes and ponds larger than 20 acres or having water deeper than 6.6 feet at low water; 4% are rivers and streams; 52% are shallow water systems that dry up most years. Approximately 38% of park's plant species—including half of the rare plants—are associated with wetlands and 11% grow only in wetlands. Wetlands provide essential habitat for Yellowstone's rare plants, thermal species, reptiles and amphibians, and for numerous insects, birds and fish.

### Hydrothermal Communities

Yellowstone is the best place in the world to see hydrothermal phenomenon such as geysers and hot springs. Fascinating and unique plant communities have developed in the expanses of thermally heated ground. Many of the species that occur in the geyser basins are actually species that tolerate tremendously different conditions, and thus grow all over the western United States. Other species, though, are typical of the central Rockies, or are regional endemics.

Hydrothermal plant communities demonstrate in very short periods of time that change is fundamental in any natural system. In a few days, the ground can heat up, perhaps triggered by an earthquake, and kill plants, while an adjacent area may cool, allowing plants to invade a previously inhospitable place.

#### Staff Reviewer

Stefanie Wacker, Vegetation Ecologist



The appearance of wildflowers announce spring in the park. Enjoy the wildflowers, but don't pick them.

## Wildflowers

Wildflowers such as lupine and arnica often grow under the forest canopy, but the most conspicuous wildflower displays occur in open meadows and sagebrush-steppe. The appearance of beauties, glacier lilies, and steer's head announce spring in the park. Soon colors splash the slopes, especially on the northern range—yellow from arrowleaf balsamroot, white from phlox, reds and oranges from paintbrush, and blue from penstemon and lupine. Goldenrod and asters indicate the coming of fall.

## Finding Flowers

Elevation, relative temperatures, soil types, and precipitation patterns all play a role in what you find blooming in various areas at different times of the year. In addition, far-reaching events such as fires can cause spectacular blooms of species that thrive on the conditions these events create.

Remember that many of Yellowstone's wildflowers are also very important parts of animal diets. The bulbs of spring beauty and glacier lily, for example, are vital spring foods of the grizzly bear. Wild strawberries are collected by ground squirrels and chipmunks; the seeds of most wildflowers are used by birds and insects. Even the petals of many flowers are eaten by animals. Bees and other insects collect nectar and pollen.

## Exotic Species

Exotic plants—escaped domestics and “weeds”—can be found in Yellowstone. Look for them in disturbed sites such as roadsides where they have little initial competition. Dalmation toadflax, yellow sweetclover, ox-eye daisy, and other exotics compete unnaturally with native plants. For this reason, and for the continued integrity of the Yellowstone ecosystem, these exotics are controlled.

The Yellowstone is a wild-flower garden. Wander where you will, you have the ever-new charm, the finishing touch, the ever-refreshing radiance of the wild flowers.

— Enos Mills, *Your National Parks*, 1917

## More Information

Occasional wildflower sightings are posted on <http://www.nps.gov/yell/learn/nature/wildflowers.htm> and <https://www.facebook.com/YellowstoneNPS>

## Staff Reviewer

Heidi Anderson, Botanist and Wetland Ecologist



Yellowstone is home to three endemic plant species, or species that occur only in Yellowstone and nowhere else in the world. Yellowstone sand verberna, shown here, is only found along the shore of Yellowstone Lake.

## Rare Plants

The Greater Yellowstone region has few endemic plant species, or species that occur only in Yellowstone and nowhere else in the world. Endemic species occur in unusual or specialized habitats such as hydrothermal areas. Within Yellowstone, only three endemic species occur: Ross's bentgrass (*Agrostis rossiae*), Yellowstone sand verberna (*Abronia ammophila*), and Yellowstone sulfur wild buckwheat (*Eriogonum umbellatum* var. *cladophorum*).

Several other unusual species live in the Greater Yellowstone Area: warm springs spike rush, which grows in warm water; and Tweedy's rush, sometimes the only vascular plant growing in acidic hydrothermal areas.

### Ross's Bentgrass

Yellowstone's geothermally influenced plant communities contain species that must be able to tolerate a wide range of conditions. Although most of these species are widespread in range and occur at diverse elevations, not all of them are common. A unique grass of the geyser basins is Ross's bentgrass (*Agrostis rossiae*). This species is highly restricted in range, growing in "vapor dominated" sites in the thermal areas, such as crack systems, the walls of thermal springs, or geothermally influenced depressions. Together, the widespread species and the local endemic form an interesting plant community in geothermal areas.

#### Distribution

Ross's bentgrass grows only in the geyser basins in the Firehole River drainage and at Shoshone Geyser Basin. Even within the thermal areas of Yellowstone's geyser basins, the right conditions to support Ross's bentgrass are rare and highly scattered. Thermal habitats are distinguished primarily by their elevated

soil temperatures, and heat stress is the primary factor controlling the distribution of plants within them. This species seems to require locations providing the right combination of moisture and warmth that create a natural greenhouse. As a result, this grass is one of the first plants to green up in warm pockets of geysers—sometimes as early as January.

In the right conditions, Ross's bentgrass can grow profusely, sometimes with several hundred plants in a very small area. Although Ross's bentgrass is considered a poor disperser of seed, this trait may be adapted to thermal habitats that tend to be small and scattered. A seed bank in the thermal area may be more advantageous to a thermal species than dispersing seed into habitat where the plant is unlikely to survive. Most of the known sites of Ross's bentgrass, less than 12 acres of occupied habitat in total, have been mapped using the Global Positioning System (GPS).

#### Life History

Because the seeds of Ross's bentgrass germinate from December to January, the plants are a conspicuous green presence in the thermal areas by late winter. Flowers are produced in May and early June when the plants reach their maximum size of 1.5–7.8 inches (4–20 cm), after which they dry out and die as the soil temperature rises. Flowers may be present in February and March, but the plants typically do not produce viable seed that early. Full bloom occurs in late May and early June. As soon as temperatures rise in the early summer, the plants dry out due to the sun's heat from above and the thermal heat from below. Ross's bentgrass is already dead and hard to find by July.

#### Life in Thermal Areas

Although the temperature an inch beneath Ross's



Ross's bentgrass is native to the geyser basins along the Firehole River.

bentgrass can be 100°F, it does not appear to be especially heat tolerant. It survives only in thermal areas because their lethal summer temperatures impose a short growing season advantageous to annual plants with precocious flowering and prevents competition from slower growing perennials.

Any plant growing in thermal areas must be able to deal with constant change. A successful plant in the geyser basins must be able to shift location relatively easily as one major thermal change or several changes could eradicate the entire population. Apparently, Ross's bentgrass deals with this problem efficiently. Its seed dispersal mechanism probably includes traveling on the muddy hooves of bison and elk who inhabit thermal areas during the winter. Nonnative species, such as cheat grass, pose the only known threat; as they spread in thermal areas, they eventually may out-compete Ross's bentgrass.

### Research

Recent genetic research indicates that another *Agrostis* found in thermal areas, which was previously considered the same species as the perennial *A. scabra* (ticklegross), is actually an annual more closely related to *A. rossiae* as well as to *A. scabra* var. *geminata* in Lassen Volcanic National Park and *A. pauzhetica* from the Kamchatka Peninsula of Russia. The thermal *Agrostis* complex needs to be more closely investigated to determine the taxonomy and correct scientific name for this other annual bentgrass in Yellowstone's thermal areas.

Sometimes both of the thermal *Agrostis* occur in the same area, but generally they do not grow directly

adjacent to each other. While Ross's bentgrass occurs only along the Firehole River drainage and Shoshone Geyser Basin, the other *Agrostis* is commonly encountered at thermal areas throughout the park. Both *Agrostis* are typically surrounded on cooler ground by non-thermal ticklegross, which is common in the park interior and reproductively isolated from the thermal plants by its later flowering time. The primary threat to Ross's bentgrass is fast-growing, invasive annual species such as cheat grass, bluegrass, and chickweeds. These species are restricting the presence of *A. rossiae* at several locations in the Upper Geyser Basin.

### More Information

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## Yellowstone Sand Verbena

Yellowstone sand verbena (*Abronia ammophila*) occurs along the shore of Yellowstone Lake. Taxonomists debate the relationship of this population of sand verbena to other sand verbenas. It may be distinct at the subspecific level, and is certainly reproductively isolated from the closest sand verbena populations in the Bighorn Basin of Wyoming east of the park.

The presence of a sand verbena at 7,700 feet elevation in the northern Rockies is unexpected, as most members of this North American genus occur in the Southwest or along the Pacific Coast. One speculation by botanists is that the warmth provided by the geothermal activity in the area enabled a genus which had evolved in a warmer climate to gradually adapt to conditions in Yellowstone. Today, Yellowstone sand verbena tolerates the long, cold winters and uses the brief summer to bloom and reproduce.

### Distribution

The entire occupied habitat of Yellowstone sand verbena plants is 1.48 acres. Herbarium specimens of Yellowstone sand verbena indicate that the species was previously more widely distributed along the lake shore. These early collections provide evidence that Yellowstone sand verbena has been extirpated at several sites (including near Fishing Bridge museum and the Lake Hotel) since 1900. In the last 30 years, an additional site has been extirpated, suggesting that as much as half of the population has been lost, probably due to trampling.

In 1998 about 8,326 plants were documented along the lake shore. The previous two years had been very wet, resulting in a high level of recruitment with many young plants, some of which would probably not survive drier conditions. In 2010, the population was estimated at 3,600 plants.

### Life History

The Yellowstone sand verbena grows close to the sand surface and rarely rises more than three inches from the surface of the sand. Some individuals occur near warm ground, so the thermal activity in Yellowstone may be helping this species survive. The flowers are white and the foliage is sticky, and bloom from mid-June until a killing frost.

Although it was once thought that the species was an annual, it has a significant taproot that extends at least several feet deep into the sand in mature plants.



Yellowstone sand verbena in the park is isolated from other populations.

Sand verbenas as a group are known to be sensitive to disturbance, suggesting that increased activity on the lake shore may have contributed to the species' decline as the result of wildlife and humans walking across the area. An increase in visitor use of the area could lead to trampling, erosion, and the introduction of nonnative plants.

Research has shown that the plants are capable of self-pollination as well as out-crossing using insect pollinators. Self pollination may sustain Yellowstone sand verbena in the absence of pollinators but it may lead to inbreeding depression. Many types of insects visit the flowers, but pollination occurs primarily from moths and bumblebees. Insect visitation is sporadic and adversely impacted by precipitation and turbulent winds. Genetic exchange among the sites is unlikely due to the significant distance between them and the low numbers at three of the sites. The location of nearly all of the plants on the lake's north shore places the species at risk of extinction due to random events affecting the population.

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## Yellowstone Sulfur Buckwheat

Approximately 250 species of wild buckwheat are found in the world, with most of the species occurring in arid regions of the western United States. The group has undergone rapid evolution, leading to numerous closely related taxa. The sulfur buckweats (*Eriogonum umbellatum*), of which there are 41 recognized varieties in the West, exemplify this rapid speciation. Several varieties of sulfur buckwheat live in the park, but the variety endemic to the park, Yellowstone sulfur buckwheat (*Eriogonum umbellatum* var. *cladophorum*), is only found in the Firehole River drainage.

### Description

Yellowstone sulfur buckwheat differs from the more common varieties with its bright yellow flowers and very hairy, somewhat gray looking leaves. The other bright yellow buckwheat in the area, Piper's wild buckwheat (*Eriogonum flavum* var. *piperi*), blooms early in the summer, well before Yellowstone sulfur buckwheat, and on close examination the flowers are hairy on the exterior.

The close relative of Yellowstone sulphur buckwheat has creamy yellow flowers without hairs, greenish leaves, and blooms before Yellowstone sulfur buckwheat. Even though these two taxa are considered members of the same species, there has been no sign of interbreeding or hybridization. Growing on mildly influenced geothermal ground, this plant community includes several species that are more commonly encountered at lower elevations or as components of the Great Basin flora. Superficially, these areas in the vicinity of the park's geyser basins look relatively barren, but the plant species representing different areas of the West form a unique plant community that can be found nowhere else.

### Distribution

Yellowstone sulfur buckwheat is adapted to survive on barren, slightly geothermally influenced open



Yellowstone sulfur buckwheat is only found in Yellowstone National Park.

areas. It apparently does not tolerate any shading, so it is a conspicuous component of relatively dry plant communities adjacent to the park's thermal areas. The geographic range of this variety is highly restricted, having been found only from the Upper, Midway, and Lower geyser basins to the vicinity of Madison Junction. Adaptation to life in a geothermal setting means that this taxon has to be able to move with changes in the geothermal system. Yellowstone sulfur buckwheat is capable of recolonizing disturbed areas, as demonstrated by its presence near the Old Faithful Inn and Visitor Education Center, and other locations in the Upper Geyser Basin.

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### Staff Reviewers

Heidi Anderson, Botanist and Wetland Ecologist



Yellowstone works to prevent the spread of invasive plant species, which can displace native species, change vegetation communities, affect fire frequency, and impact food for wildlife.

## Invasive Plants

Invasive nonnative plants can displace native plant species, including some endemic to the park's geothermal habitats, change the nature of vegetation communities and affect fire frequency and the distribution, foraging activity, and abundance of wildlife. These changes can profoundly affect the entire ecosystem. For example, nonnatives that are unpalatable to wildlife may replace preferred native plants, leading to changes in grazing activity. In turn, this stresses plants not adapted to grazing.

Invasive plants have altered views of the park's cultural landscapes and historic districts. Seeds may be spread by people and their vehicles, wild and domestic animals, and sand and gravel used for construction and maintenance work. The most

vulnerable areas have been disturbed by human use: along the roads, trails, and rivers; though they are spreading from developed areas to the backcountry. Restoring native plants in an area that has become infested is extremely difficult.

In addition to about 1,386 native plant species, 225 nonnative species have been documented in the park through ongoing survey efforts. Not all of these nonnative species are still present in the park, but most of them are.

## Managing Invasive Plants

Controlling all the invasive plants—some well-established—is unrealistic. Staff prioritize treatments based on the threat they pose to native plant communities and the likelihood for successful control.

### Quick Facts

**Number in Yellowstone**  
225 species

#### Canada Thistle (*Cirsium arvense*)

- Throughout the park and adjacent national forests.
- Airborne seeds enable it to spread widely throughout the park, invading wetlands. Forms dense monocultures, thus radically changing an area by forcing out native vegetation.

#### Dalmatian Toadflax (*Linaria dalmatica*)

- Northern portions of the park, especially around Mammoth.
- Highly invasive, replaces native plants.

#### Houndstongue (*Cynoglossum officinale*)

- Primarily found in Mammoth and East Entrance.

- May have been introduced by contaminated hay used by both the National Park Service and concessioners in their horse operations.
- Seeds easily attach to the coats of animals, and thus spread along animal corridors.
- Highly invasive.

#### Leafy Spurge (*Euphorbia esula*)

- Small patches in Bechler and along roadsides, so far being successfully controlled but spreading actively in Paradise Valley north of the park and outside Bechler on the Caribou-Targhee National Forest.
- Becomes a monoculture.
- Extremely hard to control because of deep underground stems (up to 30 feet) and dense vegetation.

#### Ox-eye Daisy (*Leucanthemum vulgare*)

- Mammoth and Madison areas.
- Can become dominant in meadows, is unpalatable to elk and other wildlife.
- Control efforts have substantially curtailed infestation; monitoring and evaluation continue.

#### Spotted Knapweed (*Centaurea maculosa*)

- Along roadsides and in the vicinity of Mammoth.
- Aggressive species that, once established, forms a monoculture.
- Aggressive control efforts underway to prevent a catastrophic change in park vegetation.

#### Management Issues

Resource managers target the most invasive species for control or removal.

## Words to Know

**Native species** have occurred, now occur, or may occur in a given area as a result of natural processes. Native plants evolve within their own ecological niche in concert with other native plants.

**Nonnative species** (also known as exotic, foreign, non-indigenous, alien, or weeds) live outside their natural range and arrived there by human activity, either deliberate or accidental. Nonnative species typically have few biological controls to keep their populations in check.

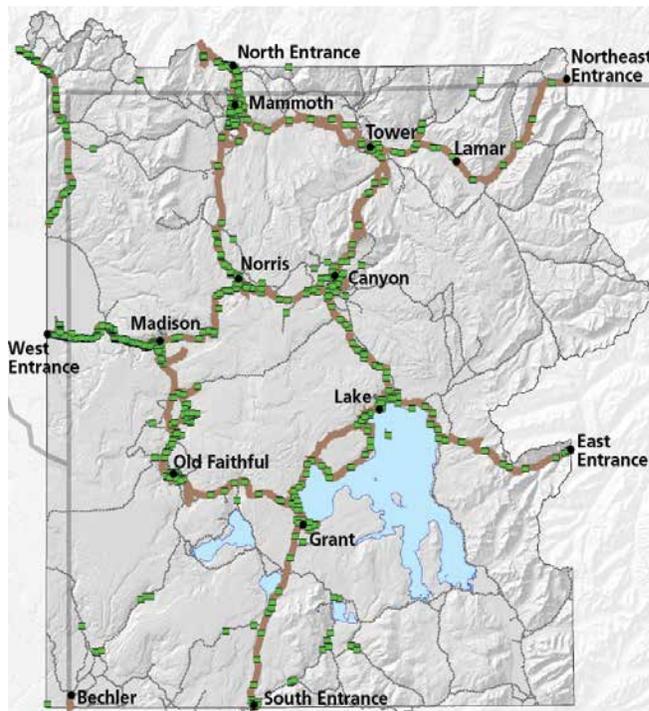
**Invasive species** have the potential to thrive and spread aggressively outside their natural range, and can include native species. A naturally aggressive plant may be especially invasive when it is introduced into a new habitat. An invasive species that colonizes a new area often has an ecological advantage because the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat. An invasive plant that sustains itself outside cultivation is considered naturalized and has not “become” native.

Some infestations can be eradicated if the species is treated when the outbreak is still small; other species, such as spotted knapweed (*Centaurea maculosa*), are so common that stopping them from spreading is the primary goal. This strategy has helped prevent high priority invasive species from moving into wilderness areas where control is more difficult.

Nonnative vegetation was found on 7,189 acres of the 7,914 acres inventoried in 2015. Sometimes exotic plants are found in pure populations with few native plants, but are most often mixed within native plant communities. Based on program priorities for species, the equivalent of 120 acres of pure non-native populations were treated during 2015. Physical removal is the preferred method of control when feasible, but pulling or cutting of some of the perennial species serves to stimulate new growth, and the use of herbicides becomes necessary to control aggressive species over large areas. Plants were physically pulled or clipped on 20 acres while the remaining 100 acres were treated with herbicides. Most of the 36 species targeted for treatment are listed by the states of Idaho, Montana, or Wyoming as “noxious weeds,” which means they are detrimental to agriculture, fish and wildlife, aquatic navigation, or public health.

### Preventing the Spread of Invasive Plants

Prevention efforts include control of construction materials entering the park, equipment inspections at park entrances, allowing only certified weed-free hay



A total of 120 acres (green circles) of invasive plants were treated in 2015. Most treatment areas are along roadways and in developed areas, though trails and some backcountry areas were also treated.

to be transported through the park, restrictions on the use of hay in the backcountry, and planting native species where ground disturbance has occurred.

To improve nonnative plant management throughout the region, park staff work with land managers from other government agencies, the Greater Yellowstone Coordinating Committee’s Weed Subcommittee, and the National Park Service’s Rocky Mountain Exotic Plant Management Team. The park uses Integrated Pest Management—chemical, biological, sociological, and mechanical methods—to control some of the nonnative plants. The park also cooperates with adjacent state and county Weed Control Boards to share knowledge and technology related to nonnative plant detection and control.

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### Staff Reviewers

Roy Renkin, Vegetation Management Specialist



Park managers sometimes restore disturbed areas infested by invasive nonnative plants to native vegetation. The area enclosed by this sturdy fence was an irrigated field; park managers are restoring native plants

## Restoring Native Plants

In 1932, President Hoover added more than 7,000 acres of land to Yellowstone National Park to provide low-elevation winter wildlife habitat near Gardiner, Montana. The addition included 700 acres of irrigated agricultural fields.

Park managers stopped irrigating the fields and planted a nonnative perennial grass, crested wheatgrass (*Agropyron cristatum*), that they hoped would tolerate the arid conditions and provide wildlife forage. It thrived for many decades, but was never suitable forage. Eventually another, more aggressive, nonnative plant—an annual mustard, desert alyssum (*Alyssum desertorum*)—moved in. Alyssum germinates very early and uses up most of the soil moisture before other species even get started. It also exudes a chemical that inhibits soil bacteria needed by native plants.

Park managers are restoring native vegetation to this area, following recommendations of arid land

restoration specialists. In 2008 and 2009, they fenced four pilot plots totaling 50 acres, where they are controlling nonnative plants with herbicides and growing cover crops to increase soil organic matter and moisture-holding capacity and restore soil microbial communities. After two to three years, they will seed the plots with native species.

Managers expect the fencing to remain for 10 to 15 years while the native plants become established. The fencing prevents elk and other ungulates from grazing on the young plants.

Restoration of this area will proceed in multi-year phases to allow native plants to become established under natural conditions, to provide time for managers to monitor and refine their methods, and to provide winter wildlife habitat.

Some of these restoration plots are adjacent to the Old Yellowstone Trail, an unpaved road that parallels the Yellowstone River west of Gardiner, Montana.

