The Greater Yellowstone Ecosystem (GYE) is one of the largest, relatively intact temperate zone ecosystems on earth.

At the heart of the ecosystem is Yellowstone National Park. The magnificence of Yellowstone cannot be overstated. Each of its separate parts—the thermal features, the wildlife, the lakes, the Grand Canyon of the Yellowstone, and the petrified forest—could easily stand alone as a national park. That they are all at one place is testimony to Greater Yellowstone's abundant diversity and its natural wealth.

GYE Basics

- 12–18 million acres; 18,750–28,125 square miles (see box below for why it varies)
- states:Wyoming,Montana,Idaho
- encompasses state lands, two national parks, portions of six national forests, three national wildlife refuges, Bureau of Land Management holdings, private and tribal lands
- managed by state governments, federal government, tribal governments, and private individuals
- largest elk herd in North America
- largest free-roaming, wild herd of bison in U.S.
- one of two grizzly populations in contiguous U.S.
- only U.S. wintering ground for trumpeter swan
- home to the rare wolverine and lynx

In Yellowstone National Park:

60 mammals
311 bird species; 148 species nest here
18 fishes: 12 native, 6 non-native
10 reptiles and amphibians
12,000+ insect species, including 128 species of butterflies
1,700+ species of vascular plants

How big is GYE?

Sizes,boundaries,and descriptions of any ecosystem can vary—and the GYE is no exception. The park most often uses the two figures listed above, and most often uses the map shown.

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Biological Diversity

Biological diversity is one of the benchmarks measuring the health of an ecosystem. Biodiversity can be measured two ways: the number of different species (also called richness) and the abundance of each species (also called eveness). The diversity of plants and animals within the greater Yellowstone ecosystem is as great as that found anywhere in the lower 48 states.

Significantly, Greater Yellowstone's natural diversity is still essentially intact. With the exception of the black-footed ferret, the region appears to have retained or restored its full historic complement of vertebrate wildlife species—something truly unique in the wildlands of the contiguous 48 states.

The extent of wildlife diversity is due in part to the different habitats found in the region, ranging from high alpine areas to sagebrush country, thermal areas, forests, meadows, and myriad other habitat types. All of these are connected, including linkages provided by streams and rivers that course through the changing elevations.

Despite the size of the ecosystem, Greater Yellowstone's' biodiversity is in jeopardy. Many of its plant and animal species are considered to be rare, threatened, endangered, or of special concern. This includes more than 135 plants, hundreds of invertebrates, at least six fish species, several species of amphibians, at least 20 bird species, and 18 species of mammals. The numbers are estimates because, even in this vital region, comprehensive inventories have not been completed. Carnivorous mammals represent more than half of the mammals in danger, including the grizzly bear, wolverine, fisher, and lynx.

Habitat modification—beyond the levels of natural disturbance—poses a serious threat to both biodiversity and to ecosystem processes. Such modifications fragment habitats and isolate populations of plants and animals from each other and cut them off from processes necessary for survival.

YELLOWSTONE'S ENDANGERED & THREATENED

Endangered
Gray wolf (designated experimental and nonessential)
Whooping crane

Threatened
Grizzly bear
Bald eagle
Lynx—listed in 2000

Species of concern
Information needed; not all confirmed in the park.

Mountain plover—Migrant
Arctic grayling
Wolverine
Spotted bat
Preble's shrew— one record in Yellowstone
Long-billed curlew —Migrant
Burrowing owl—Migrant
Ferruginous hawk—Migrant
Trumpeter swan
Harlequin duck
Black tern—Occasional
Loggerhead shrike—Migrant
Northern Goshawk
Western boreal toad
Spotted frog
Ross' bentgrass—Endemic
Yellowstone sand verbena —Endemic

Cycles and Processes

Cycles and processes are the building blocks in the foundation of any ecosystem. They include photosynthesis, predation, decomposition, climate, and precipitation.They facilitate the flow of energy and raw materials. Living things absorb, transform, and circulate energy and raw materials and release them again. Cycles and processes provide the connections within the ecosystem. Without them, the system would collapse.

Lifeforms are active at all levels. Plants draw energy from the sun and cycle minerals such as carbon, sulfur, and nitrogen through the system. Herbivores, ranging from grasshoppers to elk, feed on the plants and, in turn, provide food for predators like coyotes and hawks. Decomposers—bacteria, fungi, other microorganisms—link all that dies with all that is alive.

The ecosystem is constantly changing and evolving. The burning of forest fires is one example of such an integral, dynamic process. Fires rejuvenate forests on a grand scale. Some species of plants survive the intense burning and resprout. The serotinous cones of lodgepole pines pop open in heat generated by fires, spreading millions of seeds on the forest floor. After fire sweeps through an area, mammals, birds, and insects quickly take advantage of the newly created habitats. Fires recycle and release nutrients and create dead trees or snags that serve a number of ecological functions, such as the addition of organic matter to the soil when the trees decompose. (See Chapter 4.)

Ecosystem Management

Though still evolving, ecosystem management is gaining support among conservationists and resource managers who recognize that most protected parks and reserves represent fragments of much larger ecosystems. Ecosystem management addresses the whole ecosystem, including preserving individual components and the relationships and linkages between them. Maintaining healthy, functioning ecosystems more effectively preserves species than do emergency measures to bring back threatened species from the brink of extinction.

Ecosystem management includes human activities as part of management and protection of ecosystems. Development proposals are evaluated using methods such as "cumulative effects analysis," which considers combined effects of all development—not just one activity—on an entire area, not just a few species.

In the past, GYE has been managed as individual units drawn along political lines. The result has been fragmented, inconsistent, and sometimes contradictory management. Since the 1980s, however, the ecosystem management approach has been gaining support. For example, the supervisors, superintendents, and regional officials for the two national parks and six of seven national forests in the ecosystem meet periodically as the Greater Yellowstone Coordinating Committee to discuss common issues and seek solutions.

GYE is included in the Yellowstone to Yukon Conservation Initiative, or "Y2Y." More than 170 organizations, institutions, and foundations based in Canada and the United States are working together on this project to ensure the long-term survival of wildlife in the Northern Rockies from the Greater Yellowstone Ecosystem to the Yukon Highlands —a distance of 1,900 miles. Ecosystem management on this scale is needed for wide-ranging wildlife species, such as grizzly bears and wolves; Y2Y seeks to build and maintain a life-sustaining system of core protected reserves and connecting wildlife corridors. Existing national, state, and provincial parks and wilderness areas will anchor the system while the creation of new protected areas and cooperation of landowners will provide the additional cores and corridors.

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Mountain goats *(Oreamnos americanus)* are not native to Yellowstone, but live here now. They were introduced nearby in the 1940s and 1950s. They may damage native plants and compete with the native bighorn sheep. No decision has been made about what to do if goats become established here.

Winter in the GYE

Deep snow, cold temperatures, and short days characterize winter in the Greater Yellowstone Ecosystem, and all the plants and animals here live with these conditions. For example, all of the conifers retain their needles through the winter, which extends their ability to photosynthesize. Deciduous trees like aspens and cottonwoods contain chlorophyll in their bark, enabling them to photosynthesize before they produce leaves. Animals exhibit a wide variety of physical, physiological, and behavioral adaptations, some of which are described here.

How Animals Adapt

Behavioral

- Red squirrels and beavers cache food before winter.
- Some birds roost with their heads tucked into their back feathers to prevent heat loss.
- Chickadees roost in small cavities.
- Deer mice huddle together to stay warm.
- Ungulates like deer, elk, and bison sometimes follow each other through deep snow to save energy.
- Small mammals find insulation, protection from predators, and ease of travel by living beneath the snow.
- Grouse roost overnight by burrowing into the snow for insulation.

Morphological/Physical

- Mammals molt their fur in fall. Incoming guard hairs are longer and protect the underfur. Colorless guard hairs are hollow, containing trapped air that provides insulation. Additional underfur grows each fall and consists of short, thick, often wavy hairs designed to trap air. A sebaceous (oil) gland, adjacent to each hair canal, secretes oil to waterproof the fur. Mammals have muscular control of their fur, fluffing it up to trap air when they are cold and sleeking it down to remove air when they are warm.
- River otters' fur has long guard hairs with interlocking spikes that protect the underfur, which is extremely wavy and dense to trap insulating air. Oil secreted from sebaceous glands prevents water from contacting the otters' skin. After emerging from water, they replace air in their fur by rolling in the snow and shaking their wet fur.
- Snowshoe hares, long-tailed weasels, and short-tailed weasels turn white for winter. White color provides camouflage but may have evolved primarily to keep these animals insulated as hollow white hairs contain air instead of pigment.
- Snowshoe hares have large feet to spread their weight over the snow; martens and lynx grow additional fur between their toes to give them effectively larger feet.
- Moose have special joints that allow moose to swing their legs over snow rather than push through snow as elk do.
- Bison have a large hump of shoulder muscles powering their massive heads as they sweep snow aside in search of food.
- Chickadees' half-inch-thick layer of feathers keeps them up to 100 degrees warmer than the ambient temperature.

Biochemical/physiological

- Mammals and waterfowl exhibit countercurrent heat exchange in their limbs that enables them to stand in cold water: Cold temperatures cause surface blood vessels to constrict, shunting blood into deeper veins that lie close to arteries. Cooled blood returning from extremities is warmed by arterial blood traveling towards the extremities, conserving heat.
- At night, chickadees undergo regulated hypothermia. Their body temperature drops from 108°F to 88°F, which lessens the sharp gradient between the temperature of their bodies and the external temperature, resulting in a 23% decrease in the amount of fat burned each night.
- Chorus frogs tolerate freezing by becoming severely diabetic in response to cold temperatures and the formation of ice within their bodies. At this point the liver quickly converts glycogen to glucose, which enters the blood stream. Within eight hours, blood sugar rises 200–fold. When a frog's internal ice content reaches 60–65%, the frog's heart and breathing stop. Within one hour of thawing, the frog's heart resumes beating.

Types of Snow

Temperature Gradient Snow or depth hoar forms through snow metamorphosis during cold air temperatures when water moves from warmer snow near the ground to colder snow near the surface. Snow crystals grow in size, forming sugar snow where small mammals burrow.

Equitemperature Snow forms as new crystals of snow become rounded and snowpack settles.

Rime Frost forms when supercooled water droplets contact an object and freeze in place.

Hoar Frost forms when water vapor sublimates onto a surface. Formation of surface hoar occurs when nighttime temperatures are very low.