UNIVERSIDAD POLITECNICA DE VALENCIA

ESCUELA POLITECNICA SUPERIOR DE GANDIA

Licenciado en Ciencias Ambientales

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DE VALENCIA

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"Yellowstone National Park: History, features and management of the National Park"

TRABAJO FINAL DE CARRERA

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GANDIA, 2011

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History, features and management of the National Park

1. Introduction

Yellowstone National Park is located between the states of Wyoming, Idaho and Montana with an extension of 8,983'18 km^2. This is an area with a highly geothermic activity, having several geysers and hot springs inside the park. In fact, Yellowstone is a "supervolcano", where several explosions took place during history. The highest point in the Park reaches 3,116 meters in the Mount Washburn. The continental divide line cross the park and two main rivers start here: Yellowstone and Snake River.

Lodgepole pines cover most of the surface of the park, although there are too lot of grassland. In 1988 there were several fires which affected large part of the park, causing the deforestation of great zones, even though it is recovering. Its megafauna is one of the best conserved in Northern America, highlighting the American bison, where the National Park has played an important role in the recovery of the specie. Elks, moose, wolf, coyotes, pronghorns and black and grizzly bears are other species that can be found in the park.

The first white explorers entered in the region during the Lewis and Clark expedition, in 1806. In 1872, it was established as the first National Park in the world by the eighteenth president of the United States, Ulyses Grant. And in 1978, UNESCO declared the park as a World Heritage Site. Yellowstone National Park had 3,640,185 visitors in 2010 (NPS[1], M.s).

Image 1. Yellowstone National Park map

2. History

2.1 Geological history

2.1.1 Formation

The Yellowstone National Park is located in the Rocky Mountains. This is a mountain range in western North America formed by the collision of the Pacific Ocean plate with the North America plate. The Oceanic plate, being heavier than the continental rocks, slid down through a trench along the continent's western edge. This caused the folded of the continental plate, piling it up in stacks that were shoved eastward (Cannings, 2005).

But what characterizes Yellowstone National Park is its thermal activity. According to the hypothesis formulated by J. Tuzo Wilson, a hotspot is a region existing below the plates that provides, via thermal plumes, localized sources of high heat energy (USGS[1], M.s). North America plate has been moving to the west, so Yellowstone hotspot has been affected different parts of the North America continent, as it is shown in the image (Image 1). This has formed too a graben, known now as Snake River Plain.

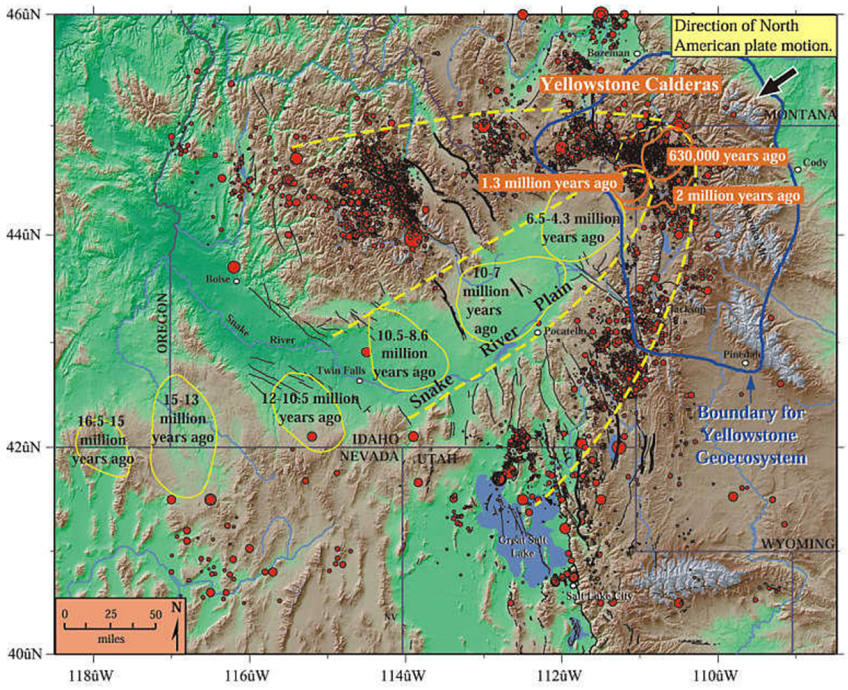

Image 2. Direction of the North America plate and the localization of the Yellowstone hotspot in millions of years ago (there have been about 15 to 20 caldera-forming eruptions)

Yellowstone has erupted several times during the history. It is possible to compare the eruptions calculating the volume of ash and pumice erected by the volcano (Image 2). Using this method, the biggest eruptions occurred in Yellowstone has been (GVP, M.s):

- Huckleberry Ridge ash: 2450 km^2 of magma erupted in 2.1 million years ago (to compare, 6000 times greater than the volume released in the 1980 eruption of the Mount St. Helens)
- Mesa Falls ash: 280 km^2 of magma erupted in 1.3 million years ago
- Lava Creek ash: 1000 km^2 of magma erupted in 0.64 million years ago

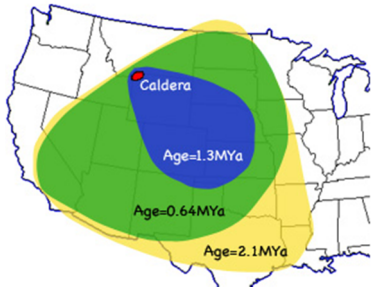

Image 3. Yellowstone ash falls

Howell Williams, in his work *The Geology of Crater Lake National Park* defined the Caldera cycle (Image 3A). The land above a magmatic system is partially supported by the magma, especially because magma is hot and buoyant. When an eruption expels high volumes of magma, the structural support for the land is lost and it collapse, by gravity, forming a great depression (USGS[2], M.s). The current caldera was created by a cataclysmic eruption that occurred 640.000 years ago (the Lava Creek ash) (Image 3B).

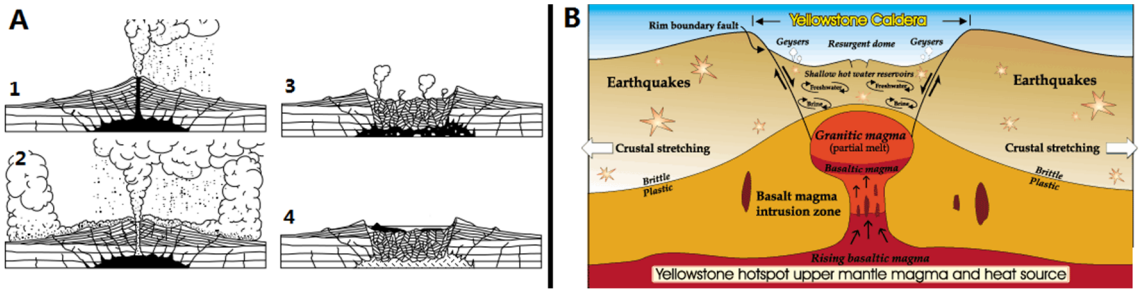

Image 4. A: Caldera cycle, 1. Eruption begins, 2. High amount of magma has been released, 3. Collapse, 4. Isostatic equilibrium; **B:** Yellowstone Caldera

Some of the lava flows happened in this last eruption run in the middle of the caldera, forming a 350 km^2 basin that now is Yellowstone Lake. The original lake was 60 meters higher than today (USGS[3], M.s). Traditionally, it was thought that the lake always drained to the north, to the Atlantic Ocean, refusing other theories (Howard, 1937). But, although the north side of the lake are rising (Meyer and Locke, 1986), now there is a new theory which indicates that, initially, the lake possibly drained to the Pacific Ocean via the Snake River (NPS[2], M.s).

2.1.2 Geological features

Yellowstone is a region with a high geothermic activity. One of the most known places is the Old Faithful geyser. But there are several more geysers: between 300 and 500, the larger geysers locale in the world (TBI, 2011). A **geyser** is a hot spring that periodically erupts,

throwing water in the air. It is needed three components for geysers exist: an abundant supply of water, an intense source of heat and a special system of plumbing (Image 5A). The first two things are quite common, but the plumbing system is critical: it must to be constructed with minerals strong enough for support high pressure and there must be volume where the water can be stored (Glennon, M.s).

Hot water circulates from up to down in the plumbing system, turning some to steam. Meanwhile, colder water flows the porous rock near the surface, mixing two waters in the plumbing system. The steam bubbles formed at depth rise and meet the cooler water, heating it and reaching the boiling point. But, the water lying above produces high pressure and a rise of the boiling point (which depends not only of the temperature but also of the pressure); it is like a pressure cooker. The filling and heating process continue until the geyser is full or nearly full of water. More hot water becomes to stream and a time will come where the bubbles can no longer access freely to the surface because the high quantity of them (somewhere they encounter a constriction in the plumbing system). This forces some water up and out the geyser. This loss of water reduces the pressure and the boiling point. So, more water turns to stream; the steam expands 1,500 times its original volume of water, producing an explosion and ejecting the water so rapidly that it is thrown into the air (Image 5B). When the eruption has ended, the entire process of filling, heating and boiling will be repeated, leading another eruption (Scott, 2008).

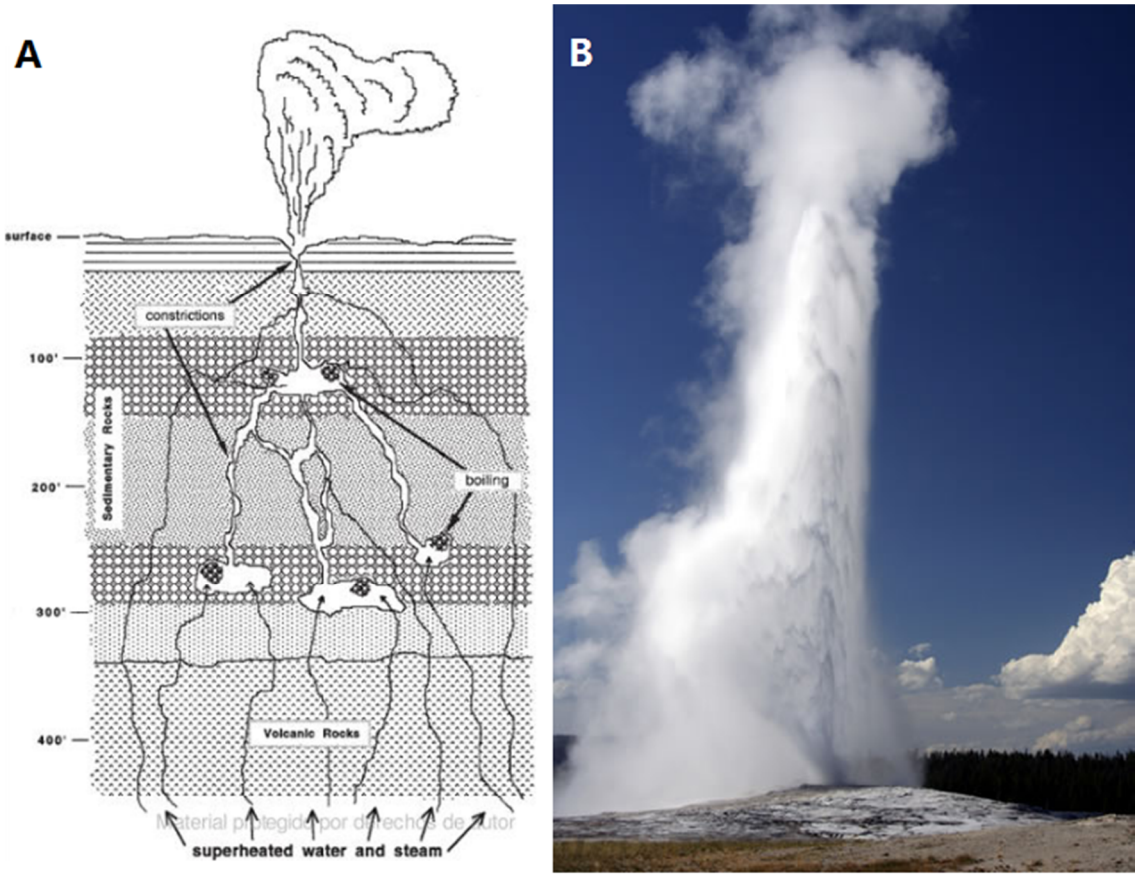

Image 5. A: Plumbing system of a geyser; **B:** Old Faithful geyser

Old Faithful geyser is the most famous in the park. It erupts every 30-127 minutes during 1'5-5 minutes and it reaches 32'3-56'1 meters. There are few geysers which erupt regularly. This, with the frequency and the size of its eruption makes it one of the most attractive sites in the park. But, one day it will stop to erupt (Scott, 2008).

Another main attractive in Yellowstone National Park is its numerous **hot springs**. A hot spring is a natural spring where geothermically heated water reaches the surface. The plumbing system of a hot spring has no constrictions, which allows that cold water in the surface can be replaced by hotter water from below. This circulation prevents that water reaches the temperature needed to set an eruption (NPS[3], M.s).

Mammoth hot springs is one of the most visited sites in the park (Image a6). This is a system of hot springs were calcium carbonate have been sediment during the years, mixing with carbon dioxide present in the water and forming travertine limestone. This has formed several terraces, and the water here present can reach up to 75ºC (TBI, 2011).

Grand prismatic spring is the third largest hot spring in the world (Image 6B). Here, as in many other hot springs, some archaea and cyanobacteria lives, coloring the spring from red to green, depending on the chlorophyll or carotenoids they have. The center of the spring is blue intense due to the high depth (USGS[4], M.s).

Image 6. A: Mammoth Hot Springs; **B:** Grand Prismatic Spring

Another geological feature that can be found in Yellowstone is **fumaroles**. They are vents from which volcanic gas escapes into the atmosphere. Fumaroles have so little water that it all flashes into steam before reaching the surface (NPS[4], 2011). And **mudpots** can be found in Yellowstone too. It is a kind of fumarole in a pool with bubbling mud. Various gases escape through the wet clay mud, causing it to bubble. Some microorganisms use hydrogen sulfide, which rises from deep within the earth, as an energy source (NPS[5], 2011).

2.1.3 Recent activity

The last giant eruption in Yellowstone was 640,000 years ago, which created the actual caldera. Since then, about 80 non explosive eruptions occurred, some with lava flows (basalt or rhyolite), being the most recent 70,000 years ago (the lava flow in Pitchstone Plateau) (USGS[5], M.s).

Earthquakes are common in the area. As a seismically active area, from 1,000 to 3,000 earthquakes are registered during the year. Most of them are not appreciated (less than 3 in Richter scale), but sometimes, higher earthquakes happen (Image 7A). Some quakes are caused by rising magma and hot-ground-water movement, but many others are due to the regional faults that cross the area related to crustal stretching and mountain building (USGS[5], M.s). The most significant earthquake registered in the area was the Hebgen Lake Earthquake, in 1959, with a magnitude of 7,3-7,5 in Richter scale. It caused 90 million ton landslide along the Madison River, blocking the river and forming a new lake, the Quake Lake (Image 7B, 7C). There were significant damage in the area and 29 persons died in the event (Healy, 1999).

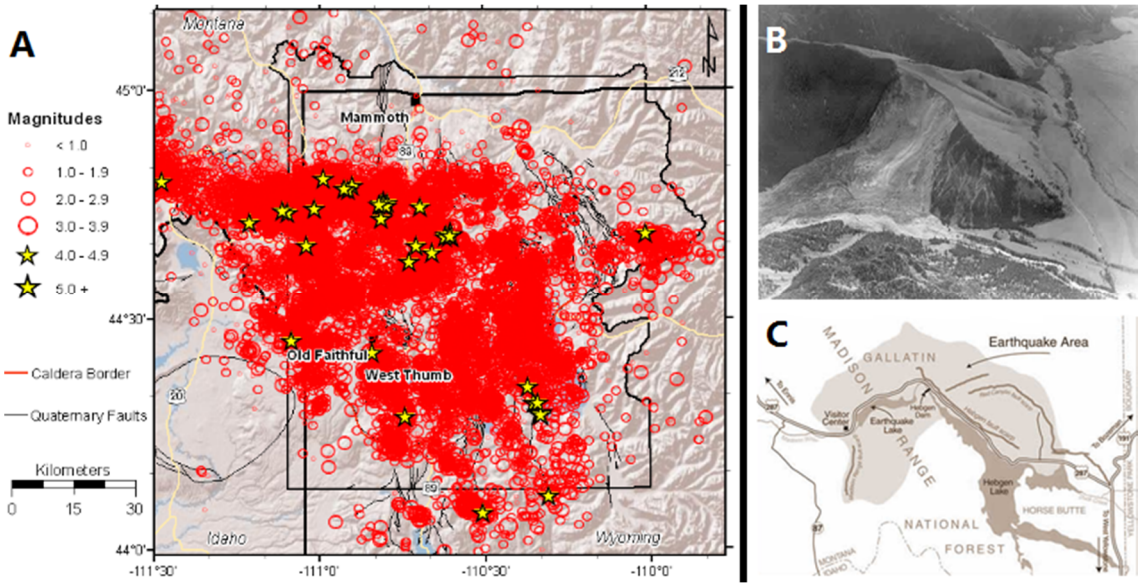

Image 7. A: Earthquakes measured by the UUSS & USGS combined catalog, between 1973 and June 30, 2011; there have been 38,327 earthquakes in this period; **B:** Landslide in the Madison River in 1959; **C:** Main area affected by the Hebgen Lake Earthquake

Yellowstone Caldera is rising, as a normal process in the Caldera cycle described before. But from 2004, it is measured that it rise at a rate of 7 centimeters per year, more than three times faster than has ever been measured (Lovett, 2007). Caldera-forming eruptions are used to occur every 600,000 or 700,000 years. And the last one was 640,000 years ago. This both things have created an alarm in a part of the society, which claims that a big eruption in Yellowstone is coming. But, although this is possible, there is not scientific evidence this is

going to occur. Neither even a lava flow in a short time. It is very unlikely to happen a caldera-forming eruption in the next thousand or even 10,000 years. (NPS[6], M.s).

2.2 Recent history

2.2.1 Early history and name origin

Human history of Yellowstone goes more than 10,000 years ago. Blackfeet, Cayuse, Coeur d'Alene, Bannock, Kiowa, Nez Perce, Shoshone, and Umatilla, among others, visited geysers, conducted ceremonies, hunted, gathered plants and minerals, and engaged in trade.

Minnetaree Indians called "Mi tse a-da-zi", that means Yellow Rock River, to the Yellowstone River. French trappers, which enter in contact with this Indians, translated it as a "Roche Jaune". But, with the purchase of Louisiana and following a general policy of anglonization, Lewis and Clark called the river as Yellowstone River. It was this river which, later, gave the name to the National Park (Macdonald Jr, M.s).

2.2.2 First white explorers

When United States purchased the Louisiana territory to France in 1803 (which few weeks before belonged to Spain), an expedition was prepared for get better knowledge of this new territories and mapping it. This was the Lewis and Clark expedition (1804-1806), the first transcontinental expedition to the Pacific Ocean by the United States (Woodger and Toropov, 2004). The Lewis and Clark expedition navigated by the Yellowstone River and passed near of what is now the National Park, but they did not found any thermal activity evidence. But, a member of this expedition who remained in the mountains, John Colter, made a journey in the 1807-1808 winter which took him to the park. He discovered, at least, one of its thermal areas, becoming the first white explorer who entered to the region.

Many trappers visited the area the next years, trading some of them with fur. By 1851 there were several missions that helped to the knowledge of Yellowstone, mapping the area. During the gold rush, many prospectors visited the park. Some Idaho and Montana mines were rich in gold, and many thought that Yellowstone area could be too. But, no important strikes were found. Between 1869 and 1871, three important explorations (Folsom party, Washburn party and Hayden party) were definitive for the knowledge of Yellowstone. Their combined efforts (reports, lectures, photographs, articles, ...) provided a basis for the reservation of the Yellowstone wonders in the public interest (Haines, 1974).

2.2.3 National Park

The reports of the lasts expeditions with a park movement convinced the U.S. Congress to protect that land. And, besides of the public opinion, some private companies lobbied the government for its establishment. An example of this is the Northern Pacific Railway, where its new line with a railway station in Livingston (Montana) was thought that could be really busy by park visitors.

Finally, the March 1st of 1872, the U.S Congress created the National Park, being the United States president Ulysses S. Grant. This was the first National Park in the world, creating a major conservation precedent. A summary of the Yellowstone National Park Act, 1872 says:

> The areas around the headwaters of Yellowstone river "*is hereby reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people; and all persons who shall locate or settle upon or occupy the same, or any part thereof, except as hereinafter provided, shall be considered trespassers and removed therefrom." "All timber, mineral deposits, natural curiosities, or wonders"* within it to be retained *"in their natural condition,"* though roads, bridle-paths, and buildings for the accommodation of visitors may be permitted.

2.2.4 Twentieth Century

Initially, the U.S. Army managed the park. Army strengthened and enforced regulations, guarded major attractions, and patrolled the vast interior of the park. But that was not the usual work of the army and they did not satisfy the knowledge of the park visitors. So, in 1916, a new federal agency was created: the National Park Service (NPS). Their function was to conserve and manage those areas. But NPS not only manage National Parks, but also historical monuments (NPS[7], M.s). According to the NPS, National Parks are "generally large natural places having a wide variety of attributes, at times including significant historic assets. Hunting, mining and consumptive activities are not authorized."

Tourism increased over the years. Roads, lodges and other facilities were built for their accommodation. Feeding bears was one of the most famous attractions. But, to avoid the alteration of nature by tourist, some restricting measures had to been applied, like to stop feeding animals in the park. In 1978, United Nations declared the park as a World Heritage Site.

One of the most important events in that century was the great fires in 1988. That was the larger wildfire recorded in United States. Several fires affected the area during the summer of 1998, burning 5,689 kilometers square (Image 8). Today, its consequences are still visible, with huge areas of young pines (Franke, 2000).

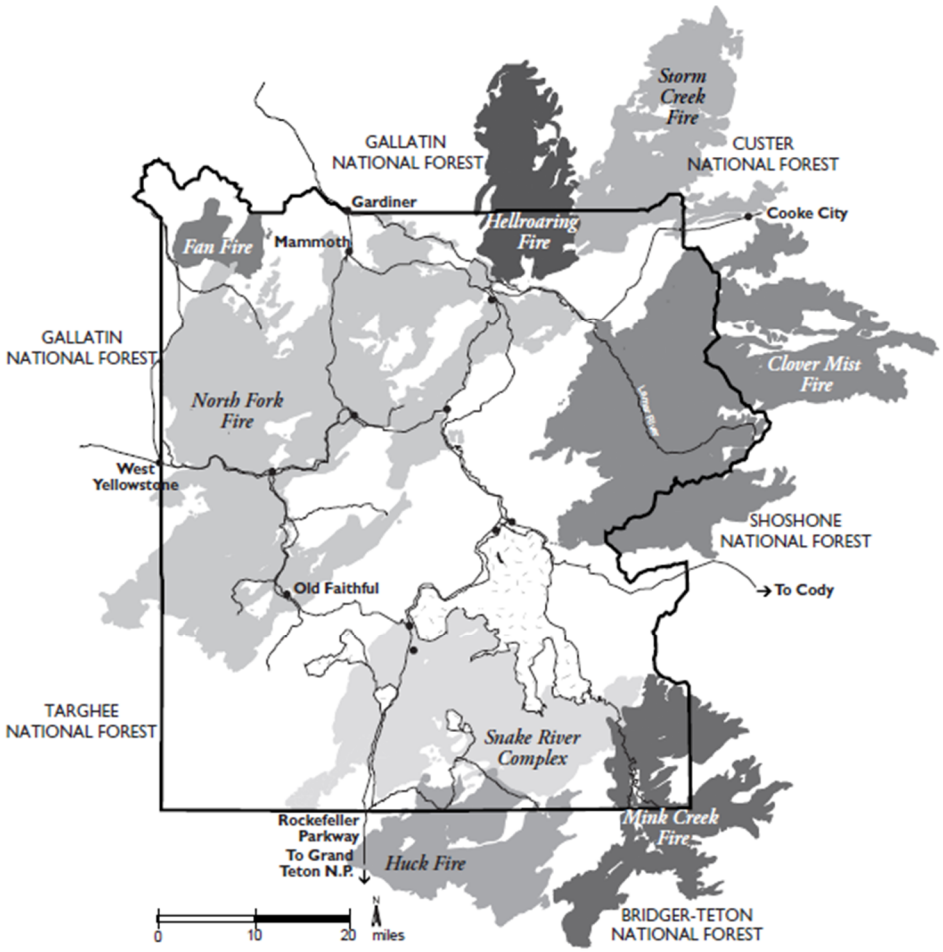

Image 8. Areas affected by fires in Yellowstone in 1988

3. Features

As it is shown in the point 2.1.2, there are many geological features in the park. Another one is Yellowstone Lake, at 2,357 meters above the sea level. With 350 km^2 of surface, this is the largest freshwater lake above 2,100 meters of altitude in North America. The average depth is 42 meters, being the deepest 120 meters. The maximum length is 32 km, the maximum width 24 km, and the total shore length is 177 km. There are six islands in the lake.

Yellowstone Lake is located in Yellowstone caldera. The highest point at this caldera is the Mount Sheridan with 3,142 meters of elevation and occupies most of the Yellowstone National Park.

4. Fauna and flora

4.1 Fauna

4.1.1 Mammals

The megafauna are one of the major attractive of the National Park. Here we can find good populations of bison, elks, coyotes, and moose, among others. The park has played an important role in the conservation of some of this species.

Wolves (Image 10A) were very common in the northern Rocky Mountains by mid-19th century. But the hunting of its prey caused the depopulation of wolves. Moreover, they were widely hunted because they were considered an undesirable predator for cattle and livestock industry, and due to its hazard to human population. By 1926 wolves disappeared from the park. This caused an overpopulation of elk, which overgrazed most of the areas in the park and avoid the growth of some tree species like aspens and cottonwood. This alteration of the habitat led the government to reintroduce wolves in the area. With this, they expected to reduce populations of elk by 5%-30%, deer 3%-19%, moose 7%-13%, and bison up to 15% (FWS, M.s). In 1995, the 14 first gray wolves were introduced from Jasper National Park, Canada, where there is a similar climate, and 17 wolves more were reintroduced in 1996. But elk population has decreased more than expected (Elling, 2009) (Image 9).

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Population	21	51	86	112	118	119	132	148	174	171	118	136	171	124	96	97

Image 9. Evolution of the population of wolves in Yellowstone National Park (NPS[8], M.s)

Coyotes (Image 10B) were abundant in the park since it was first explored. The wolf extirpation caused an increase of the coyote's population during the mid-century. But with the reintroduction of wolves, their population decreased, although it still is an abundant specie in the park. Coyotes prefer the valleys of the park, but they can be found in the whole area. Their main preys are small mammals, basically rodents, although in winter, the percent of big mammals preyed are bigger, mostly weakened deer (Murie, 2001).

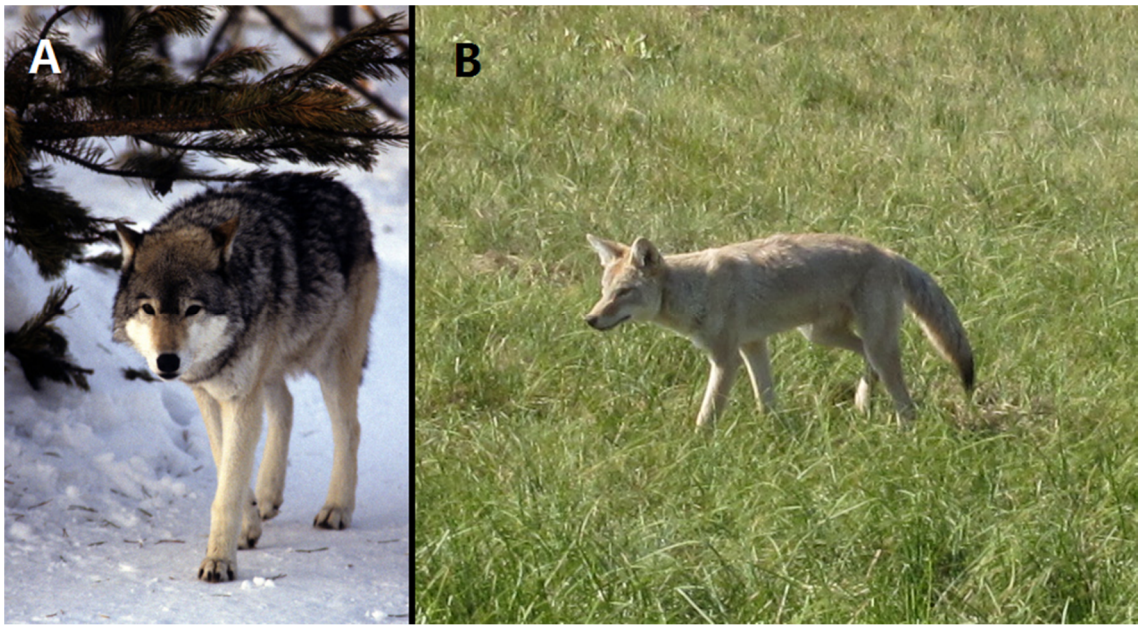

Image 10. A: Gray wolf; **B:** Coyote

The **black** (Image 13A) and **grizzly bear** (Image 13B) are the two species of bears that can be found in Yellowstone National Park. Both had a constant presence in the park, but their population grew up by the 20th mid-century due to the garbage that tourists let near the roads. They learned to eat that so that was really common to see a bear near a road. But the increase of bear-caused injuries to humans (Image 11) led the authorities, in 1970, to eradicate that source of food, causing starving in the bear population. After some years its population stabilized again and now there are 500-650 black bears and 280-610 grizzlies.

Season	Human injury	Property damage / anthropogenic foods	Gardens and orchards	Beehives	Livestock depredations	Total
Spring	1	32	0	5	6	44
Estrus	4	73	1	6	70	154
Early hyperphagia	7	133	3	10	251	404
Late hyperphagia	23	209	40	12	109	393
Total	35	447	44	33	436	995

Image 11. Grizzly bear–human conflicts reported by season in the Greater Yellowstone Ecosystem, 1992–2000 (Gunther *et al.*, 2004)

Their diet is widely influenced by the seasons. Meanwhile during the spring ungulates are the main source of food, in summer the spawning cutthroat trout is one of its most important food (Image 12).

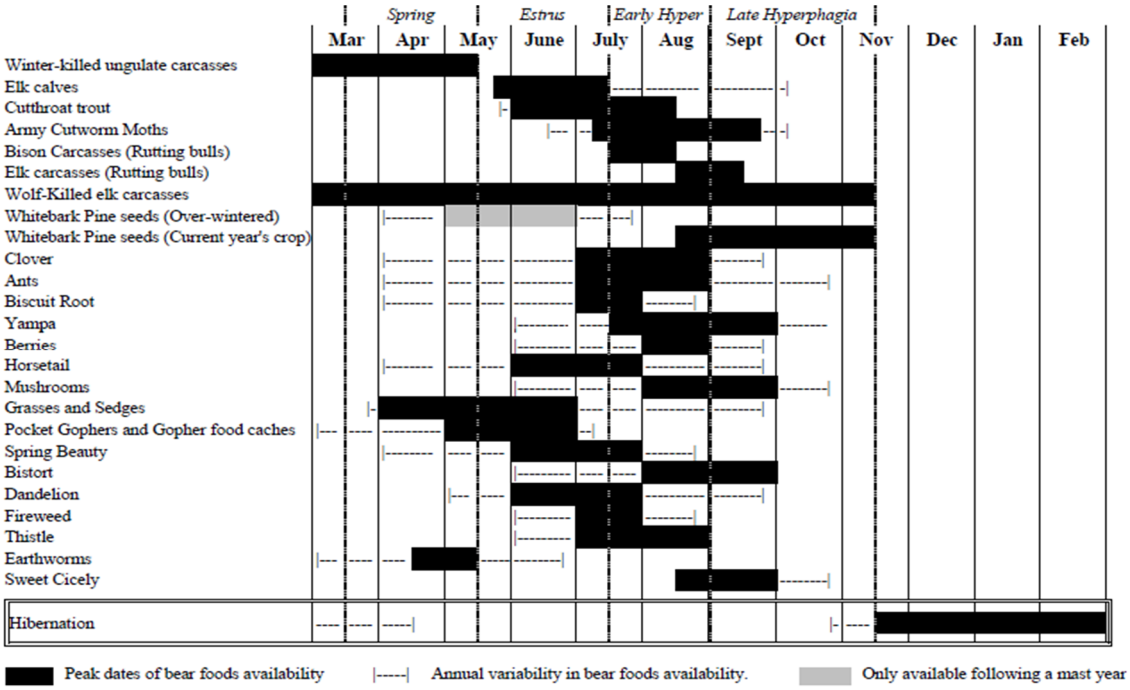

Image 12. Seasonal availability of common bear foods in the Greater Yellowstone Ecosystem (NPS[9], M.s)

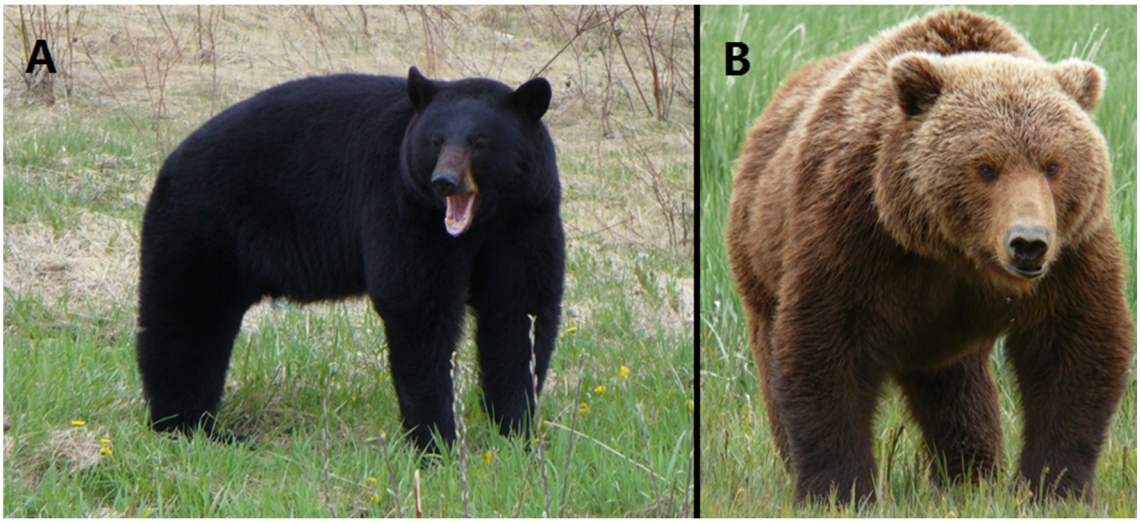

Image 13. A: Black bear; **B:** Grizzly bear

There are two species of lynx in Yellowstone: **bobcats** (Image 14A) and **canadian lynx** (Image 14B). Both have a similar diet: small mammals (hares, rabbits or mice) or some weakened deer. Bobcats are really elusive, solitary and nocturnal, so there have been few sights in the last years (43 reports since 1960). But, it is believed that there still are bobcats in the park, especially in the north part, where there is less snow in winter (NPS[10], M.s). Canadian lynx is in a similar situation; there has been 57 reports of sights in the period 1883-1995 and only two since 1995 (NPS[11], M.s).

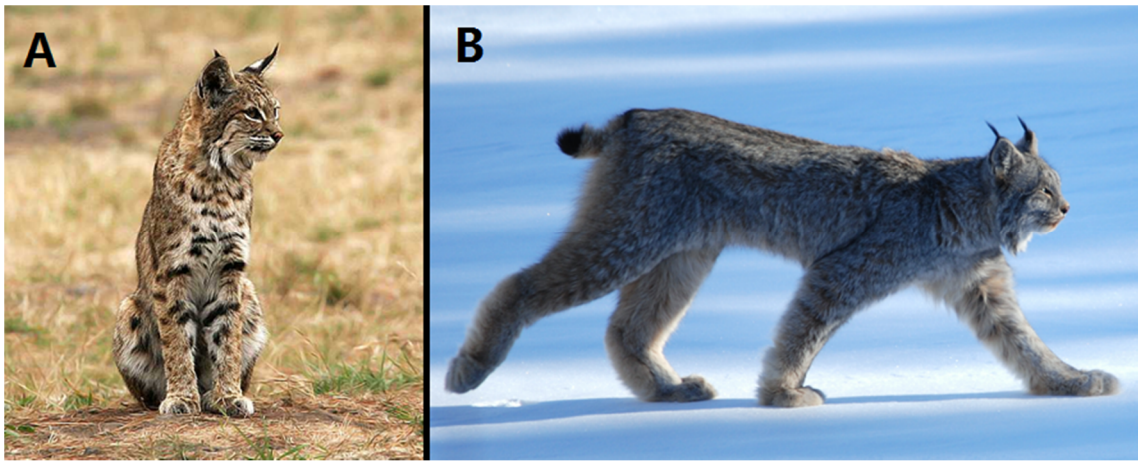

Image 14. A: Bobcat; **B:** Canadian lynx

Cougars can be found in Yellowstone. In fact, it is the largest cat family living in the park. The current population is estimated to be 15-17 animals and is thought to be increasing. Marten, weasels, badgers and river otter are some other mammals really common in the park (Annex 1).

Elks (Image 15A) are the most common large animal in the park, with more than 30,000 elks in summer and from 15,000 to 23,000 in winter. Its continuous presence in the area is recorded since, at least, the last 1,000 years. Bulls grow antlers annually; they are usually shed in March or April, and begin regrowing in May. Most of them migrate in winter to surrounding areas due to the low temperatures, but many stay in the northern area of the park, where there is the lowest altitude and fewer snow than in the rest of the National Park.

The largest member of the deer family is **moose** (Image 15B). When the park was established, its presence in Wyoming was rarely. The protection from hunting and the reduce of fires helped to increase the number of moose since the 500 that actually are in the park. Their palmate antlers are shed every year and its diet consist of different grasses (NPS[13], M.s).

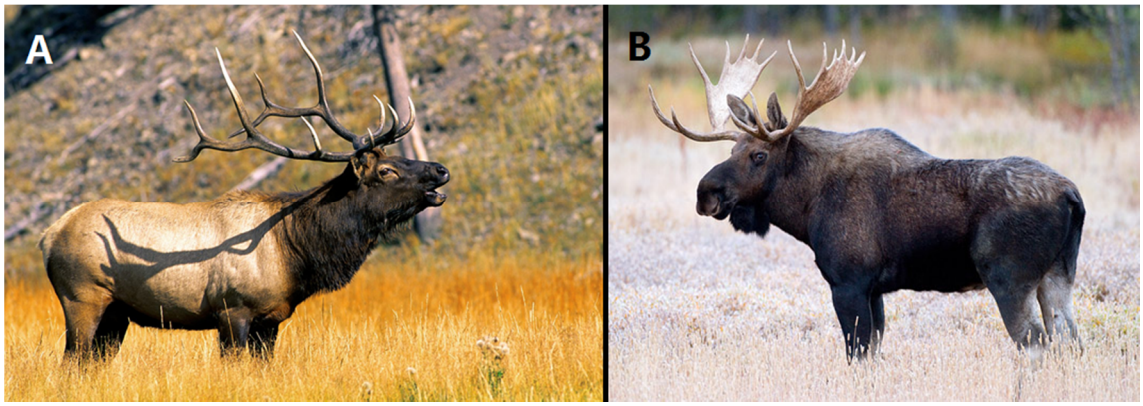

Image 15. A: Elk; **B:** Moose

Probably, the most characteristic large mammal in the park are **bison** (Image 17 A and B). It is the largest land mammal in North America; bulls (male) can weigh up to 900 kilograms, meanwhile cow (female) weighs up to 450 kilograms. Shoulder height can range from 150 to 190 centimeters. They can reach 50 kilometer per hour and can be very aggressive. Their life expectancy is about 15 years in the wild. Bison breed from mid-July to mid-August and bear one calf in April or May. There are two subspecies: the mountain bison (*Bison bison athabascae*) and the plain bison (*Bison bison bison*).

They are nomadic grazers. Bison move to lower elevation ranges in response to accumulating snow. Madison and Yellowstone river valleys are some regions where they usually stay in winter, along with the surroundings geothermic areas. In summer, they return to the plateau for grazing.

Bison invaded North America from Eurasia crossing the Bering Strait during the Pleistocene (10,000 years ago), replacing a previous immigrant bison. They inhabited wide areas of North America, from Oregon to the Appalachian Mountains. But, in the late 19th century, they were hunted since nearly extinct the specie; their valuable skins and the promotion of the government for the elimination of a competition to the livestock industry for graze and to weaken the Native Americans were some of the motives for their hunting.

The present population in Yellowstone derives from the 21 plains bison reintroduced in 1902 from Texas and Montana, and a remnant of less than 50 of the original wild population of mountain bison. With the gradual change in policy to the preservation of bison, the population began to increase. By 1920, culling in big herds was done because they believed that bison and elks were overgrazing the park (Meagher, 1973). This maintained the population by 1,000 bison but, when the authority stopped with this intensive management in 1967, the population increased constantly. Nowadays, there are about 3,500 bison in the National Park (Image 16).

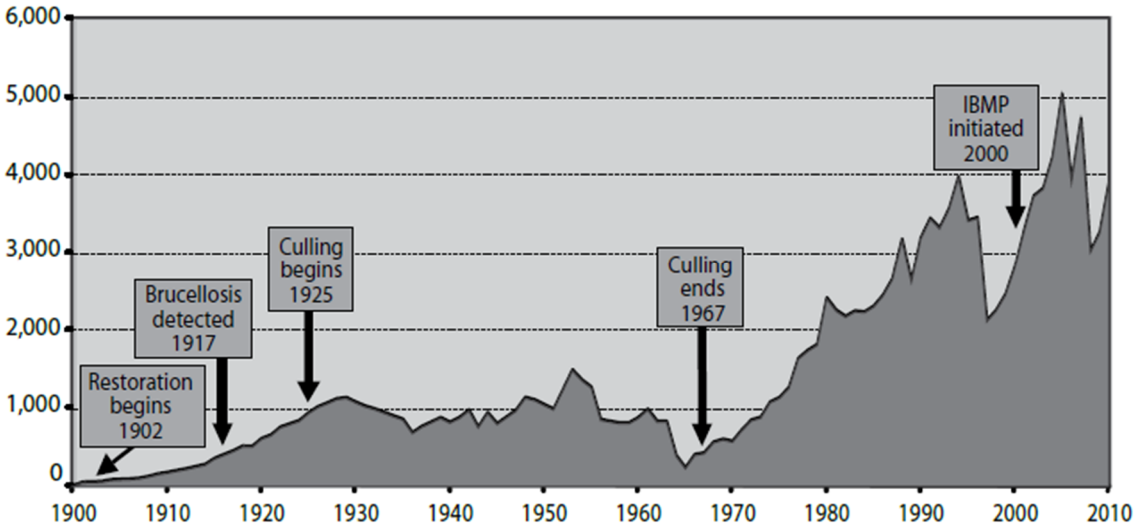

Image 16. Bison population, from 1900 to 2010 (NPS[14], M.s)

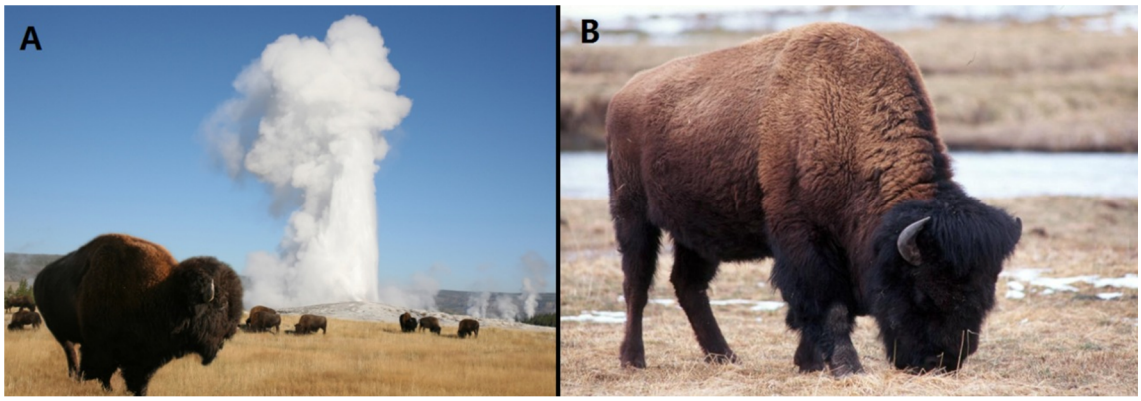

Image 17. A: Bison in Old Faithful Geyser; **B:** A bison grazing

Bighorn sheep was once numbered in millions in western United States, but their population was reduced to a few hundred. In 1897 no one was seen in the National Park, but by 1912 there were more than 200. Nowadays there is a population of 100-150 in the park. The males have large, curved horns borne, meanwhile the borne ones of the female are shorter (Image 18). The other hoofed mammals in Yellowstone National Park are in the Annex 2.

Image 18. Bighorn sheep

There are many **bats** in the Yellowstone National Park (Annex 3). Most of them are nocturnal and are rarely sight by visitors, because you have to know where to see them. The bats from Yellowstone feed exclusively on insects, capturing them in flight using their sensitive ears to echolocate (Image 19). Flying is energetically expensive, so they require much energy to survive. Bats live in four different habitats: caves and cave-like structures, rock cliffs and crevices, trees, and human-made structures. All of these habitats require this three features: roosts, foraging areas, and open water (Keinath, 2007).

Image 19. A long-eared myotis (*Myotis evotis*) that has just captured a red moth

Snowshoe hares are rare and acyclic in Yellowstone. Many sites supported no hares, and sites with hares had low numbers. As Hodges *et al.* (2009) say "Yellowstone provides hares with few, low-quality habitats that are patchily distributed. Hares may be proficient at locating and using the best of these sites, but many areas, including lodgepole pine stands with low sapling densities, do not support hares at all." **Jackrabbits** have decreased a lot its population in the last years; no jack rabbit sightings could be confirmed in Yellowstone since 1991 (SD, M.s). A list of them can be found in the Annex 4, and a list of the shrews in the National Park in the Annex 5.

Beaver (Image 20A) is a specie of rodent with an important ecological role. It is a keystone specie; the dams that they build in the rivers (Image 20B) create a new wetland habitat, increasing the biodiversity. The reintroduction of wolves helped to increase the number of beaver in Yellowstone; this scared elk from rivers –where they are more visible to its predator- and produced an increase of aspen trees. The rise of wood allowed beaver to build more dam and to have access to more food. Nowadays there are 9 beaver colonies with a total population of 500 beaver (YP, M.s).

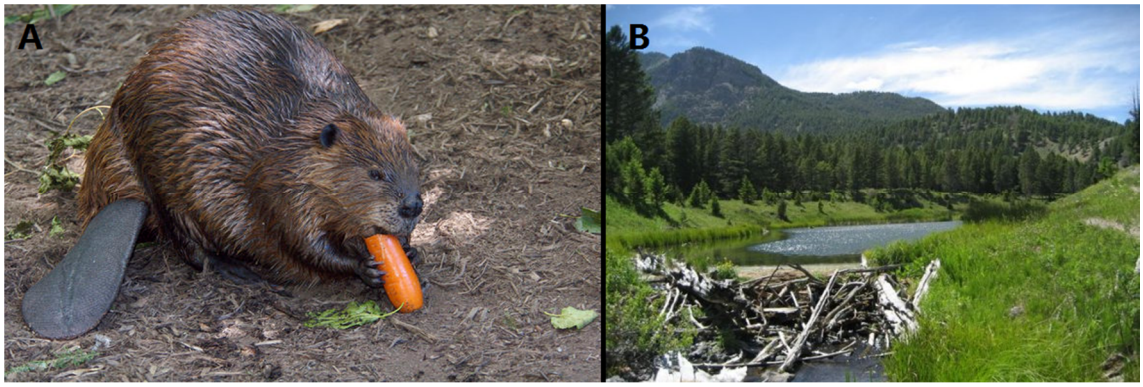

Image 20. A: Beaver; **B:** A beaver dam in Yellowstone National Park

Squirrels are really common in Yellowstone. Golden-mantled ground squirrel ranges from 23 to 30 centimeters in length. Red squirrels are smaller in size and have a reddish fur with a white venter. Other gopher, mice and porcupine present in the park are listed in the Annex 6.

4.1.2 Birds

Yellowstone is home to a wide variety of birds. Although its high altitude, some are permanent residents, like bald eagles or trumpeter swans, but many others are just migrants. 30 percent of the birds in Yellowstone depend on wetlands, like the **trumpeter swan** (Image 21A). This species is considered endangered in the park. By 1900 it was nearly extinct due to human encroachment, habitat destruction, and the commercial swan-skin trade, surviving only small populations in different parts of North America. The management of the trumpeter swan allowed a good recuperation of its population; nowadays there are more than 20,000 trumpeter swans in North America, but only a few hundred of them visit the park in winter.

There are more than a dozen raptor species in Yellowstone. **Peregrine falcon** is one of them (Image 21B). Their population was extremely affected by DDT and other toxins used by 20th mid-century, but their population has recovered since then. Its presence in Yellowstone had been discontinued. Today there is a stable population in the park which is a positive issue, because they are reliable indicators of contaminants. Another raptor is **bald eagle** (Image 21C). As the peregrine falcon, they were affected by the toxins, although its presence in Yellowstone National Park is really stable.

There is one endangered bird species in Yellowstone: **whooping crane** (Image 21D). They are easily identified by their strikingly bold white body plumage, black wingtips, black facial feather markings, red crown patch, black legs and feet, yellow-black bi-colored bill, and yellow eyes. Although there are fossils evidence of this bird dated several millions years, during the last 200 years their population was not abundant. By 1890s whooping crane was nearly extirpated from most of its range due to human population. In 1999 there were only 183 birds in the wild in North America, only two of them in the Rocky Mountains. It is expected that soon they will disappear from the Great Yellowstone Area and there are no plans in a short-term for reintroduce the species (NPS[16], M.s).

In the Annex 7 there are lists of all the bird sights in Yellowstone National Park since its establishment in 1872.

Image 21. A: Trumpeter swan; **B:** Peregrine falcon; **C:** Bald eagle; **D:** Whooping crane

4.1.3 Fish

Fishing was a common activity in the first visitors. As there were no visitor services, they fished for survive. By 1889 the first non-native fishes were introduced in some rivers for the enjoyment of the tourists: brook trout, rainbow trout, brown trout and lake trout. There were a management program for planting more than 31 million native and nonnative fish in Yellowstone between 1881 and 1955. This introduce of non-native species was well accepted because fishing was very popular. But, 48% of Yellowstone's waters were once fishless. This produced several consequences in the aquatic ecosystems of Yellowstone: displacement of some native species, hybridizations and predation over native fish.

The management of fisheries has changed radically by 1950s. The main goals now are the maintenance of natural biotic associations or, where possible, restoration to pre-Euro-

American conditions. There are 18 species of fish in Yellowstone National Park, 13 of them considered native, and 5 introduced (Annex 8). The Fisheries Program is focused on the preservation of Yellowstone Lake cutthroat trout, the restoration of fluvial populations of native trout, and the research and monitoring needed to support these critical activities (Koel *et al.*, 2010).

4.1.4 Amphibians

There are only four amphibians in Yellowstone (Image 22) (Annex 9). Glacial activity, cold and dry conditions complicate the presence of this animals. No one of them are endangered, but its population are in decline (as the other amphibians in the rest of Western America) probably due to drought, pollution, disease, predation, habitat loss and fragmentation, introduced fish and other non-native species (NPS[17], M.s).

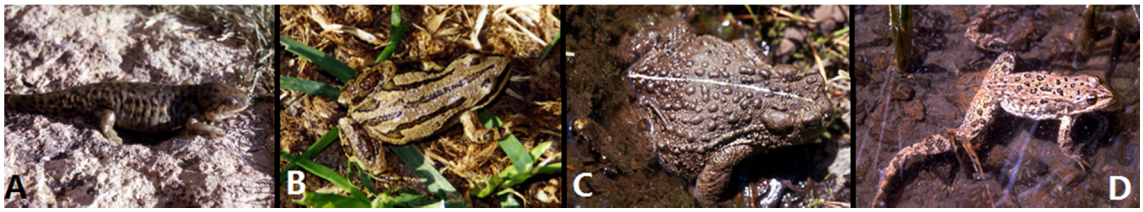

Image 22. A: Blotched tiger salamander; **B:** Boreal chorus frog; **C:** Boreal toad; **D:** Columbia spotted frog

4.1.5 Reptiles

Six species of reptiles are in Yellowstone (Image 23) (Annex 10). Cool and dry conditions limit their presence in the park. And, like amphibians, their populations are declining due to, probably, the same reasons (NPS[18], M.s)

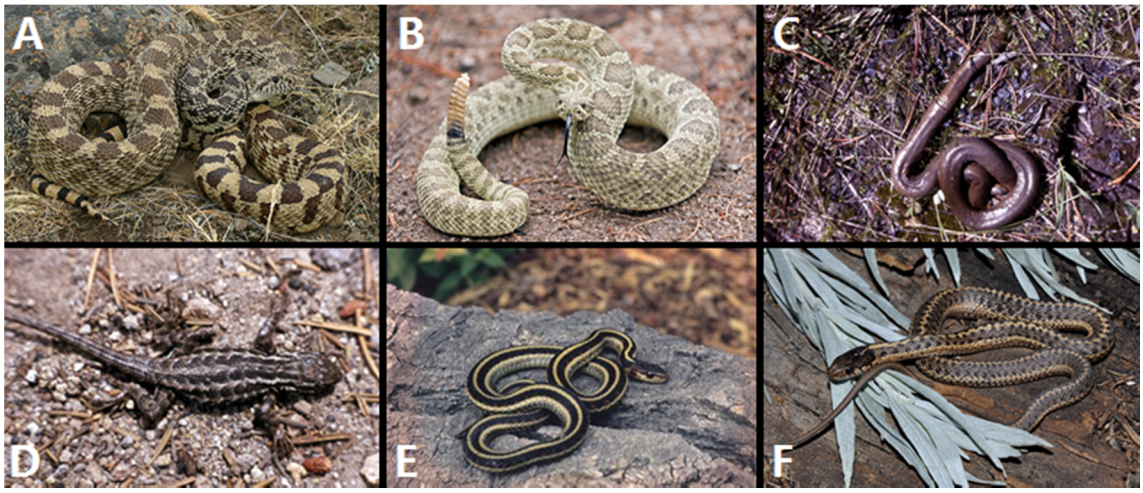

Image 23. A: Bullsnake; **B:** Prairie rattlesnake; **C:** Rubber boa; **D:** Sagebrush lizard; **E:** Valley garter Snake; **F:** Wandering garter snake

4.2 Flora

Yellowstone National Park has 1,150 native species of vegetal and more than 199 exotic ones. It is composed, primary, by the typical Rocky Mountain species and some of the Great Plains. The different forests in the park are shown in the Image 24A.

Lodgepole pine forests cover 80% of the park surface. It is dominated by the **lodgepole pine** (*Pinus contorta*) (Image 24B), which is the most common species in the park. This species is usually more than 23 meters tall and it is shadow intolerant. As a conifer, there are male and female trees; the pollen is released in June and July, and the fertilized cone takes two years to mature. When the mature is reached, the cone can be opened and release the seeds, or can remain closed –if the conditions are not good- during three or four years. Its roots are not deep –an advantage in Yellowstone, where the topsoil is between 180 and 360 centimeters deep-, causing a high vulnerability to wind storms.

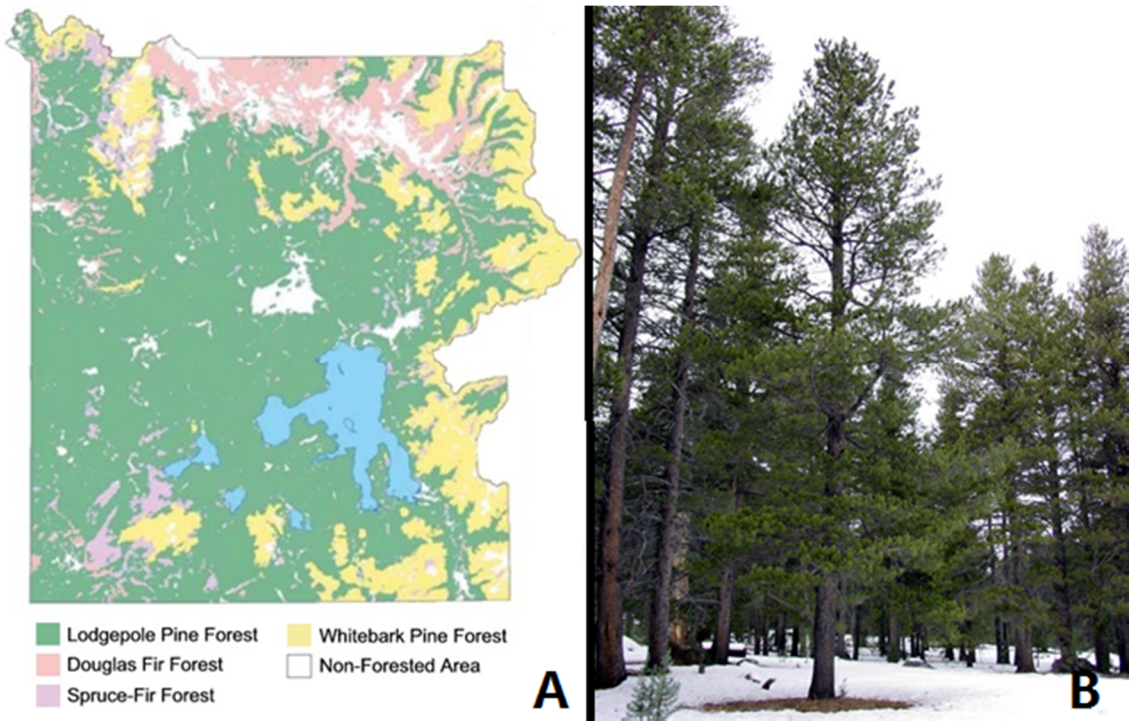

Image 24. A. Different forests in Yellowstone National Park; **B:** Lodgepole pine

Through the time, in absence of fire and in non-rhyolitic soils, the lodgepole pine can be replaced by a forest of **subalpine fir** (*Abies lasiocarpa*) (Image 25A) and **Engelmann spruce** (*Picea engelmannii*) (Image 25B). Subalpine fir is the only pure fir in the park; cones grow upright, which disintegrate on tree, and the tree can reach more than 30 meters tall. Engelmann spruce often grows along creeks and wet areas, and it can reach too more than 30 meters tall. Both species usually grow in small areas separated by subalpine meadows.

Douglas fir forests occur at lower altitudes. The **douglas fir** tree (*Pseudotsuga menziesii*) (Image 25C) has a thick bark, which allows it to tolerate low-intensity fire. That is why there ca be found several hundred years old douglas fir in the park. It can reach more than 30 meters tall.

At high elevations, **whitebark pine** (*Pinus albicaulis*) (Image 25D) is the dominant species. Above 2,500 meters high it is the major component. Its seeds are ecologically important food for a variety of wildlife species (Hektner *et al.*, 2011).

The other two conifer species present in the park are:

- Limber pine (*Pinus flexilis*)
- Rocky mountain juniper (*Juniperus scopulorum*)

Quaking aspen (*Populus tremuloides*) are found in small clones interspersed among the sagebrush/forest ecotone along the main rivers. This tree reproduces, most often, by cloning; the reproduction with seeds is related to fires. Their populations, really affected by the overgrazing of elks, are now increasing thanks to the reintroduction of wolves. Also in the riparian areas cottonwood, willows and various deciduous shrubs can be found too.

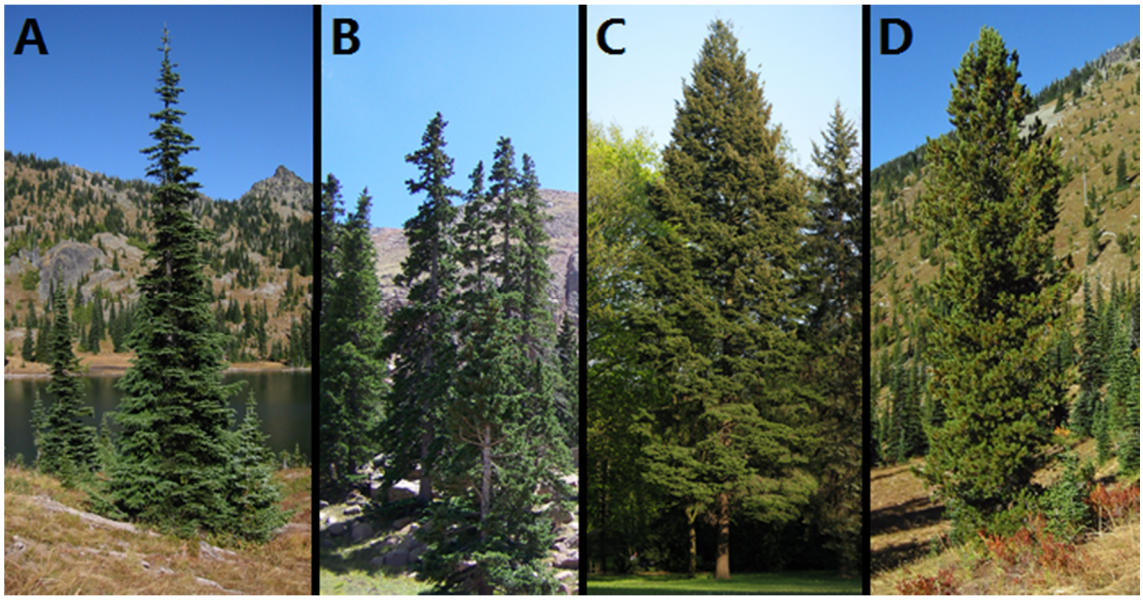

Image 25. A: Subalpine fir; **B:** Engelmann spruce; **C:** Douglas fir; **D:** Whitebark pine

Grasslands and sagebrush also grow in the park. And, like this, many other wildflowers (Annex 11). There are only three endemic species in Yellowstone: sand verbena *(Abronia ammophila),* Ross's bentgrass *(Agrostis rossiae),* and Yellowstone sulfur wild buckwheat *(Eriogonum umbellatum var. cladophorum).*

Yellowstone is also home of many different lichens (186 species) and bacteria. At least 406 species of thermophiles live in the park. Some of these bacteria give the green/red/yellow colors of the hot springs.

5. Management

Yellowstone National Park is managed by the National Park Service (NPS). This is a federal agency, founded in 1916, that replaced the role of the U.S. Army in the management of these parks. According to the NPS statutes, its purpose is "to conserve the scenery and the natural and historic objects and the wild life therein, and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations". The agency not only manages natural parks, but also monuments and other historical properties. For accomplish that purpose, NPS has this principles:

- Providing the best possible service to park visitors and partners.
- Collaborating with federal, state, tribal, and local governments, private organizations, and businesses to work toward common goals.
- Providing opportunities for citizens to participate in the decisions and actions of the National Park Service.
- Educating park visitors and the general public about their history and common heritage.
- Empowering a diverse workforce committed to excellence, integrity, and quality work.
- Providing developmental opportunities and training so employees have the "tools to do the job" safely and efficiently.
- Integrating social, economic, environmental, and ethical considerations into the decision-making process.
- Instilling a performance management philosophy that fosters creativity, focuses on results, and requires accountability at all levels.
- Incorporating research findings and new technologies to improve work practices, products, and services.
- Sharing technical information and expertise with public and private land managers.

NPS has about 3,500 employers every year in Yellowstone National Park. The jobs they do are widely different: hoteliers in the different lodges of the park, security, informants, environmental specialists, … Also, many volunteers join the NPS helping in different tasks.

Tourists are allowed to visit the park. A 20$ toll is paid for every car that enters in the area. Moreover, there are different camping areas to rest with different rates for the night.

NPS has several projects ongoing in order to conserve the wildlife in its natural conditions. Monitoring, reintroduction, elimination of foreign species, statistical information, … are some of the different projects they do. Some examples of this are the wolf reintroduction commented in the point 4.1.1 or the management of the fisheries in 4.1.3.

One of the most characteristic management in Yellowstone is the management of fires. Human-caused fires are rapidly suppressed (there is an office that study the origin of the fires), but natural-caused fires (mostly all due to lightning strikes) are allowed to burn as long as they do not threaten people, property or resource values (Image 26). Fire is a natural process; many species has developed resistance to it (like douglas fir); many others need the fire to spread its

seeds; some species only grow after a fire. So that is why fires are let to burn; it is the best way to conserve the natural ecosystem in Yellowstone. Natural, historical fire return intervals in Yellowstone range from 20-25 years for shrub and grasslands in the Northern to 300 years or more for lodgepole pine forests on the central plateau (NPS[20], M.s).

Name	Cause	Start	Status	Size (acres)
Antelope	lightning	sep-14	out 10/28	5,51
Lookout	lightning	sep-14	out 10/28	0.1
Avalanche	lightning	ago-25	out 10/5	0.5
Lava	human	ago-22	out 8/22	0.1
Arthur 2	lightning	ago-18	out 10/28	200
Buffalo	lightning	08-may	out 8/10	0.1
Slough Creek	human	jul-20	out 7/21	1
Beach	lightning	jul-18	out 10/28	520
Doane	lightning	07-nov	out 8/10	0.25
Recycle	powerline	07-feb	out 7/2	0.1
Grandma	lightning	abr-23	out 4/28	0.1

Image 26. 2010 fire report

6. Annex

Annex 1. List of the bears, cats, dogs, raccoons and weasels present in the park (NPS[12], M.s)

Bears, Cats, Dogs, Raccoons, & Weasels

Common name	*Scientific name*	*Habitat*	*Population*	*Spanish common name*
Black Bear	*Ursus americanus*	forests, meadows	500–650	Oso negro
Grizzly Bear	*Ursus arctos horribilis*	forests, meadows	280–610	Oso grizzly
Coyote	*Canis latrans*	forests, meadows, grasslands	common	Coyote
Gray Wolf	*Canis lupus*	forests, meadows	>100	Lobo
Fox	*Vulpes sp.*	meadows	occasional	Zorro
Bobcat	*Lynx rufus*	forests, meadows	may be widespread	Lince rojo
Cougar	*Puma concolor*	mountains, rocky areas	15–17	Puma
Lynx	*Lynx canadensis*	subalpine forests	few	Lince del Canadá
Raccoon	*Procyon lotor*	rivers, cottonwoods	rare	Mapache boreal
Badger	*Taxidea taxus*	sagebrush	common	Tejón norteamericano
Fisher	*Martes pennanti*	forests	rare, if present	Marta pescadora
Marten	*Martes americana*	coniferous forests	common	Marta americana
Mink	*Neovison vison*	riparian forests	occasional	Visón americano
River Otter	*Lontra canadensis*	rivers, lakes, ponds	common	Nutria de río norteamericana
Striped Skunk	*Mephitis mephitis*	riparian to forest	rare	Mofeta rayada
Long-tailed Weasel	*Mustela frenata*	willows to spruce/fir forests	common	Comadreja de cola larga
Short-tailed Weasel	*Mustela erminea*	willows to spruce/fir forests	common	Armiño
Wolverine	*Gulo gulo*	alpine, coniferous forests	rare	Glotón

Annex 2. List of hoofed mammals present in the park (NPS[12], M.s)

Hoofed Mammals

Common name	*Scientific name*	*Habitat*	*Population*	*Spanish common name*
Elk (Wapiti)	*Cervus canadensis*	meadows, forests	15,000–25,000	Wapití o ciervo canadiense
Moose	*Alces alces*	riparian, forests	<500	Alce
Mule Deer	*Odocoileus hemionus*	forests, grasslands, shrub lands	2,300–2,500	Ciervo mulo
White-tailed Deer	*Odocoileus virginianus*	forests, grasslands, shrub lands	occasional	Ciervo de cola blanca
Bison	*Bison bison*	meadows, grasslands	>3,500	Bisonte americano
Bighorn Sheep	*Ovis canadensis*	cliffs, mountain slopes	250–275	Muflón canadiense
Mountain Goat	*Oreamnos americanus*	alpine meadows, rocky slopes	175–225	Cabra blanca o de las rocosas
Pronghorn	*Antilocapra americana*	sagebrush, grasslands	200–250	Antílope americano

Annex 3. List of bats present in the park (NPS[12], M.s)

Bats

Common name	*Scientific name*	*Habitat*	*Population*	*Spanish common name*
Big Brown Bat	*Eptesicus fuscus*	roost in sheltered areas	common	Murciélago moreno
Fringe-tailed bat	*Myotis thysanodes*	roost in cliffs, large snags	uncommon	
Hoary Bat	*Lasiurus cinereus*	roost in trees	uncommon	Murciélago ceniciento o gris
Little Brown Bat	*Myotis lucifugus*	roost in caves, buildings, trees	common	
Long-eared Bat	*Myotis evotis*	roost in cliffs, buildings	uncommon	
Long-legged Bat	*Myotis volans*	roost in tree cavities, cliffs, buildings	common	Murciélago de patas largas
Silver-haired bat	*Lasionycteris noctivagans*	roost in trees, including snags	common	Murciélago canoso
Western small-footed Bat	*Myotis ciliolabrum*	roost in rocky areas, caves	rare, if present	
Townsend's Big-eared Bat	*Corynorhinus townsendii*	roost in caves	uncommon	
Yuma Bat	*Myotis yumanensis*	roost in caves, buildings, trees	rare, if present	

Annex 4. List of pikas, hares and rabbits present in the park (NPS[12], M.s)

Pikas, Hares, Rabbits

Common name	*Scientific name*	*Habitat*	*Population*	*Spanish common name*
Snowshoe Hare	*Lepus americanus*	forests, willows	common	Liebre americana
White-tailed Jackrabbit	*Lepus townsendii*	sagebrush, grasslands	common	Liebre de Townsend
Desert Cottontail	*Sylvilagus audubonii*	shrub lands	common	Conejo del desierto
Mountain Cottontail	*Sylvilagus nuttallii*	shrub lands	common	Conejo de Nutall
Pika	*Ochotona sp.*	rocky slopes	common	Pica

Annex 5. List of shrews present in the park (NPS[12], M.s)

Shrews

Common name	*Scientific name*	*Habitat*	*Population*	*Spanish common name*
Dusky Shrew	*Sorex monticolus*	moist meadows, forests	common	Musaraña oscura
Masked Shrew	*Sorex cinereus*	moist meadows, forests	common	Musaraña enmascarada
Water Shrew	*Sorex palustris*	moist meadows, forests	common	Musaraña acuática norteamericana
Preble's Shrew	*Sorex preblei*	moist meadows, forests	rare, if present	Musaraña de Preble
Dwarf Shrew	*Sorex nanus*	moist meadows, forests	rare	Musaraña enana americana

Annex 6. List of beaver, squirrels, mice and porcupine present in the park (NPS[12], M.s)

Beaver, Squirrels, Gopher, Mice, Porcupine

Common name	*Scientific name*	*Habitat*	*Population*	*Spanish common name*
Beaver	*Castor canadensis*	ponds, streams	500	Castor
Least Chipmunk	*Neotamias minimus*	forests	common	
Uinta Chipmunk	*Neotamias umbrinus*	forests	common	
Yellow Pine Chipmunk	*Neotamias amoenus*	forests	common	Ardilla de pino amarillo
Yellow-bellied Marmot	*Marmota flaviventris*	rocky slopes	common	Marmota de vientre amarillo
Golden-mantled Ground Squirrel	*Callospermophilus lateralis*	forests, rocky slopes	common	Ardilla de manto dorado
Northern Flying Squirrel	*Glaucomys sabrinus*	forests	occasional	Ardilla voladora norteamericana
Red Squirrel	*Sciurus vulgaris*	forests	common	Ardilla roja
Uinta Ground Squirrel	*Urocitellus armatus*	sagebrush, meadows	common	
Northern Pocket Gopher	*Thomomys talpoides*	sagebrush, meadows, forests	common	
Deer Mouse	*Peromyscus maniculatus*	grasslands	common	Ratón ciervo
Western Jumping Mouse	*Zapus princeps*	riparian	occasional	
Muskrat	*Ondatra zibethicus*	streams, lakes, ponds	common	Rata almizclada
Heather Vole	*Phenacomys sp.*	sagebrush to forests	occasional	
Long-tailed Vole	*Microtus longicaudus*	moist meadows	common	
Meadow Vole	*Microtus pennsylvanicus*	moist meadows	common	
Montane Vole	*Microtus montanus*	moist meadows	common	Topo de las praderas
Red-backed Vole	*Myodes sp.*	dense forests	common	
Water Vole	*Microtus richardsoni*	riparian	occasional	
Bushy-tailed Woodrat	*Neotoma cinerea*	rocky slopes	common	
Porcupine	*Erethizon dorsatum*	forests, sagebrush, willows	common	Puercoespín norteamericano

Annex 7. Birds sights in Yellowstone National Park since its establishment in 1872 (NPS[15], M.s)

The legend used in the tables is:

B: Breeders: Species known to have nested or produced dependent young
b: breeder?: Species suspected of breeding, but not yet confirmed
W: Winter (Dec.–Feb.): Resident, observed most winters 1975–2006
w: winter (Dec.–Feb.): Observed fewer than 5 winters 1975–2006
T: Transient: >20 records usually observed during migration, but can occur at any time of the year
***:** < 20 records usually observed during migration, but can occur at any time of the year
+: Yellowstone National Park welcomes additional information regarding this species

Swans, Geese & Ducks

Common name	*Scientific name*	*Situation*
Greater White-fronted Goose	*Anser albifrons*	*
Snow Goose	*Chen caerulescens*	T
Ross's Goose	*Chen rossii*	T
Canada Goose	*Branta canadensis*	BW
Cackling Goose	*Branta hutchinsonii*	*
Brant	*Branta bernicla*	*
Trumpeter Swan	*Cygnus buccinator*	BW
Tundra Swan	*Cygnus columbianus*	T
Whooper Swan	*Cygnus cygnus*	*
Wood Duck	*Aix sponsa*	+T
Gadwall	*Anas strepera*	Bw
Eurasian Wigeon	*Anas penelope*	*
American Wigeon	*Anas americana*	Bw
American Black Duck	*Anas rubripes*	*
Mallard	*Anas platyrhynchos*	BW
Blue-winged Teal	*Anas discors*	Bw
Cinnamon Teal	*Anas cyanoptera*	B
Northern Shoveler	*Anas clypeata*	BW
Northern Pintail	*Anas acuta*	BW
Green-winged Teal	*Anas crecca*	BW
Canvasback	*Aythya valisineria*	B
Redhead	*Aythya americana*	B
Ring-necked Duck	*Aythya collaris*	B
Greater Scaup	*Aythya marila*	*
Lesser Scaup	*Aythya affinis*	B
Harlequin Duck	*Histrionicus histrionicus*	+B
Surf Scoter	*Melanitta perspicillata*	*
White-winged Scoter	*Melanitta fusca*	*
Black Scoter	*Melanitta nigra*	*
Long-tailed Duck	*Clangula hyemalis*	*
Bufflehead	*Bucephala albeola*	BW
Common Goldeneye	*Bucephala clangula*	*w
Barrow's Goldeneye	*Bucephala islandica*	BW
Hooded Merganser	*Lophodytes cucullatus*	+B
Common Merganser	*Mergus merganser*	BW
Red-breasted Merganser	*Mergus serrator*	+T
Ruddy Duck	*Oxyura jamaicensis*	B

Caracaras, & Falcons

Common name	*Scientific name*	*Situation*
Crested Caracara	*Caracara plancus*	*
American Kestrel	*Falco sparverius*	+Bw
Merlin	*Falco columbarius*	+T
Gyrfalcon	*Falco rusticolus*	*+
Peregrine Falcon	*Falco peregrinus*	B
Prairie Falcon	*Falco mexicanus*	+Bw

Rails, Gallinules, & Coots

Common name	*Scientific name*	*Situation*
Yellow Rail	*Coturnicops noveboracensis*	*
Virginia Rail	*Rallus limicola*	+Bw
Sora	*Porzana carolina*	B
American Coot	*Fulica americana*	Bw

Cranes

Common name	*Scientific name*	*Situation*
Sandhill Crane	*Grus canadensis*	B
Whooping Crane	*Grus americana*	+

Plovers, & Lapwings

Common name	*Scientific name*	*Situation*
Black-bellied Plover	*Pluvialis squatarola*	*
Snowy Plover	*Charadrius alexandrinus*	*
Semipalmated Plover	*Charadrius semipalmatus*	*
Killdeer	*Charadrius vociferus*	Bw

Stilts, & Avocets

Common name	*Scientific name*	*Situation*
Black-necked Stilt	*Himantopus mexicanus*	*
American Avocet	*Recurvirostra americana*	T

Partridges, Grouse, Turkeys, & Quail

Common name	*Scientific name*	*Situation*
Chukar	*Alectoris chukar*	*
Gray Partridge	*Perdix perdix*	+B
Ruffed Grouse	*Bonasa umbellus*	BW
Dusky Grouse	*Dendragapus obscurus*	
Wild Turkey	*Meleagris gallopavo*	*

Loons

Common name	*Scientific name*	*Situation*
Red-throated Loon	*Gavia stellata*	*
Pacific Loon	*Gavia pacifica*	+
Common Loon	*Gavia immer*	+B

Grebes

Common name	*Scientific name*	*Situation*
Pied-billed Grebe	*Podilymbus podiceps*	Bw
Horned Grebe	*Podiceps auritus*	+T
Red-necked Grebe	*Podiceps grisegena*	+B
Eared Grebe	*Podiceps nigricollis*	B
Western Grebe	*Aechmophorus occidentalis*	T
Clark's Grebe	*Aechmophorus clarkii*	*T

Pelicans

Common name	*Scientific name*	*Situation*
American White Pelican	*Pelecanus erythrorhynchos*	B

Sandpipers, Phalaropes, & Allies

Common name	*Scientific name*	*Situation*
Greater Yellowlegs	*Tringa melanoleuca*	T
Lesser Yellowlegs	*Tringa flavipes*	T
Solitary Sandpiper	*Tringa solitaria*	T
Willet	*Catoptrophorus semipalmatus*	T
Wandering Tattler	*Heteroscelus incanus*	*
Spotted Sandpiper	*Actitis macularia*	B
Upland Sandpiper	*Bartramia longicauda*	*
Long-billed Curlew	*Numenius americanus*	+B
Hudsonian Godwit	*Limosa haemastica*	*
Marbled Godwit	*Limosa fedoa*	T
Ruddy Turnstone	*Arenaria interpres*	*
Red Knot	*Calidris canutus*	*
Sanderling	*Calidris alba*	*
Semipalmated Sandpiper	*Calidris pusilla*	*
Western Sandpiper	*Calidris mauri*	*
Least Sandpiper	*Calidris minutilla*	*
White-rumped Sandpiper	*Calidris fuscicollis*	*
Baird's Sandpiper	*Calidris bairdii*	*
Pectoral Sandpiper	*Calidris melanotos*	*
Dunlin	*Calidris alpina*	*
Stilt Sandpiper	*Calidris himantopus*	*
Short-billed Dowitcher	*Limnodromus griseus*	*
Long-billed Dowitcher	*Limnodromus scolopaceus*	*
Wilson's Snipe	*Gallinago delicata*	BW
Wilson's Phalarope	*Phalaropus tricolor*	+B
Red-necked Phalarope	*Phalaropus lobatus*	*

Cormorants

Common name	*Scientific name*	*Situation*
Double-crested Cormorant	*Phalacrocorax auritus*	B

Bitterns & Herons

Common name	*Scientific name*	*Situation*
American Bittern	*Botaurus lentiginosus*	+B
Great Blue Heron	*Ardea herodias*	BW
Great Egret	*Ardea alba*	*
Snowy Egret	*Egretta thula*	*
Tricolored Heron	*Egretta tricolor*	*
Cattle Egret	*Bubuluc ibis*	*
Green Heron	*Butorides virescens*	*
Black-crowned Night-Heron	*Nycticorax nycticorax*	*

American vultures

Common name	*Scientific name*	*Situation*
Turkey Vulture	*Cathartes aura*	+T

Ibises & Spoonbills

Common name	*Scientific name*	*Situation*
Glossy Ibis	*Plegadis falcinellus*	*
White-faced Ibis	*Plegadis chihi*	T

Kites, Hawks, Eagles, & Allies

Common name	*Scientific name*	*Situation*
Osprey	*Pandion haliaetus*	B
Bald Eagle	*Haliaeetus leucocephalus*	BW
Northern Harrier	*Circus cyaneus*	+Bw
Sharp-shinned Hawk	*Accipiter striatus*	+Bw
Cooper's Hawk	*Accipiter cooperii*	+BW
Northern Goshawk	*Accipiter gentilis*	+Bw
Red-shouldered Hawk	*Buteo lineatus*	*
Broad-winged Hawk	*Buteo platypterus*	*
Swainson's Hawk	*Buteo swainsoni*	+B
Red-tailed Hawk	*Buteo jamaicensis*	Bw
Ferruginous Hawk	*Buteo regalis*	+T
Rough-legged Hawk	*Buteo lagopus*	*
Golden Eagle	*Aquila chrysaetos*	+BW

Skuas, Gulls, Terns, & Skimmers

Common name	*Scientific name*	*Situation*
Parasitic Jaeger	*Stercorarius parasiticus*	*
Laughing Gull	*Larus articilla*	*
Franklin's Gull	*Larus pipixcan*	+*
Bonaparte's Gull	*Larus philadelphia*	*
Mew Gull	*Larus canus*	*
Ring-billed Gull	*Larus delawarensis*	T
California Gull	*Larus californicus*	B
Herring Gull	*Larus argentatus*	*
Sabine's Gull	*Xema sabini*	*
Caspian Tern	*Sterna caspia*	+B
Common Tern	*Sterna hirundo*	*
Arctic Tern	*Sterna paradisaea*	*
Forster's Tern	*Sterna forsteri*	*
Least Tern	*Sterna antillarum*	*
Black Tern	*Chlidonias niger*	+B

Auks, Murres, & Puffins

Common name	*Scientific name*	*Situation*
Long-billed Murrelet	*Brachyramphus perdix*	*

Pigeons, & Doves

Common name	*Scientific name*	*Situation*
Rock Pigeon	*Columba livia*	BW
Band-tailed Pigeon	*Patagioenas fasciata*	*
Eurasian Collared-Dove	*Streptopelia decaocto*	+*
White-winged Dove	*Zenaida asiatica*	*
Mourning Dove	*Zenaida macroura*	+B

Cuckoos, Roadrunners, & Anis

Common name	*Scientific name*	*Situation*
Black-billed Cuckoo	*Coccyzus erythropthalmus*	*+

Owls

Common name	*Scientific name*	*Situation*
Barn Owl	*Tyto alba*	*+
Flammulated Owl	*Otus flammeolus*	*+
Western Screech-Owl	*Megascops kennicottii*	*+
Eastern Screech-Owl	*Megascops asio*	*+
Great Horned Owl	*Bubo virginianus*	+BW
Snowy Owl	*Nyctea scandiaca*	*+
Northern Pygmy-Owl	*Glaucidium gnoma*	+BW
Burrowing Owl	*Athene cunicularia*	*+
Great Gray Owl	*Strix nebulosa*	+BW
Long-eared Owl	*Asio otus*	*+B
Short-eared Owl	*Asio flammeus*	+B
Boreal Owl	*Aegolius funereus*	+BW
Northern Saw-whet Owl	*Aegolius acadicus*	+BW

Goatsuckers

Common name	*Scientific name*	*Situation*
Common Nighthawk	*Chordeiles minor*	B

Swifts

Common name	*Scientific name*	*Situation*
Vaux's Swift	*Chaetura vauxi*	*
White-throated Swift	*Aeronautes saxatalis*	B

Hummingbirds

Common name	*Scientific name*	*Situation*
Black-chinned Hummingbird	*Archilochus alexandri*	*+
Calliope Hummingbird	*Stellula calliope*	+B
Broad-tailed Hummingbird	*Selasphorus platycercus*	+B
Rufous Hummingbird	*Selasphorus rufus*	+B

Woodpeckers, & Allies

Common name	*Scientific name*	*Situation*
Lewis's Woodpecker	*Melanerpes lewis*	+B
Red-headed Woodpecker	*Melanerpes erythrocephalus*	*
Red-bellied Woodpecker	*Melanerpes carolinus*	*
Wiliamson's Sapsucker	*Sphyrapicus thyroideus*	B
Yellow-bellied Sapsucker	*Sphyrapicus varius*	*
Red-naped Sapsucker	*Sphyrapicus nuchalis*	B
Downy Woodpecker	*Picoides pubescens*	BW
Hairy Woodpecker	*Picoides villosus*	BW
White-headed Woodpecker	*Picoides albolarvatus*	*
American Three-toed Woodpecker	*Picoides dorsalis*	+Bw
Black-backed Woodpecker	*Picoides arcticus*	+BW
Northern Flicker	*Colaptes auratus*	BW
Pileated Woodpecker	*Dryocopus pileatus*	*+

Tyrant flycatchers

Common name	*Scientific name*	*Situation*
Olive-sided Flycatcher	*Contopus cooperi*	B
Western Wood-Pewee	*Contopus sordidulus*	B
Willow Flycatcher	*Empidonax traillii*	B
Least Flycatcher	*Empidonax minimus*	*T
Hammond's Flycatcher	*Empidonax hammondii*	B
Gray Flycatcher	*Empidonax wrightii*	+B
Dusky Flycatcher	*Empidonax oberholseri*	B
Cordilleran Flycatcher	*Empidonax occidentalis*	+B
Say's Phoebe	*Sayornis saya*	*
Ash-throated Flycatcher	*Myiarchus cinerascens*	*
Western Kingbird	*Tyrannus verticalis*	T
Eastern Kingbird	*Tyrannus tyrannus*	T
Scissor-tailed Flycatcher	*Tyrannus forficatus*	*

Kingfishers

Common name	*Scientific name*	*Situation*
Belted Kingfisher	*Ceryle alcyon*	BW

Shrikes

Common name	*Scientific name*	*Situation*
Loggerhead Shrike	*Lanius ludovicianus*	+T
Northern Shrike	*Lanius excubitor*	+W

Larks

Common name	*Scientific name*	*Situation*
Horned Lark	*Eremophila alpestris*	BW

Starlings, & Allies

Common name	*Scientific name*	*Situation*
European Starling	*Sturnus vulgaris*	BW

Jays, Magpies, & Crows

Common name	*Scientific name*	*Situation*
Steller's Jay	*Cyanocitta stelleri*	BW
Blue Jay	*Cyanocitta cristata*	*w
Pinyon Jay	*Gymnorhinus cyanocephalus*	*W
Clark's Nutcracker	*Nucifraga columbiana*	BW
Black-billed Magpie	*Pica hudsonia*	BW
American Crow	*Corvus brachyrhynchos*	BW
Common Raven	*Corvus corax*	BW

Vireos

Common name	*Scientific name*	*Situation*
Yellow-throated Vireo	*Vireo flavifrons*	*
Blue-headed Vireo	*Vireo solitarius*	*
Warbling Vireo	*Vireo gilvus*	B
Philadelphia Vireo	*Vireo philadelphicus*	*
Red-eyed Vireo	*Vireo olivaceus*	*

Swallows

Common name	*Scientific name*	*Situation*
Tree Swallow	*Tachycineta bicolor*	B
Violet-green Swallow	*Tachycineta thalassina*	B
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	B
Bank Swallow	*Riparia riparia*	B
Cliff Swallow	*Petrochelidon pyrrhonota*	B
Barn Swallow	*Hirundo rustica*	B

Titmice, Nuthatches, & Creepers

Common name	*Scientific name*	*Situation*
Black-capped Chickadee	*Poecile atricapillus*	+BW
Mountain Chickadee	*Poecile gambeli*	BW
Red-breasted Nuthatch	*Sitta canadensis*	BW
White-breasted Nuthatch	*Sitta carolinensis*	BW
Pygmy Nuthatch	*Sitta pygmaea*	*
Brown	*Certhia americana*	BW

Wrens

Common name	*Scientific name*	*Situation*
Rock Wren	*Salpinctes obsoletus*	B
Canyon Wren	*Catherpes mexicanus*	*
House Wren	*Troglodytes aedon*	Bw
Winter Wren	*Troglodytes troglodytes*	*w
Sedge Wren	*Cistothorus platensis*	*
Marsh Wren	*Cistothorus palustris*	+bW

Dippers

Common name	*Scientific name*	*Situation*
American Dipper	*Cinclus mexicanus*	BW

Wagtails, & Pipits

Common name	*Scientific name*	*Situation*
American Pipit	*Anthus rubescens*	BW
Sprague's Pipit	*Anthus spragueii*	*

Wood-Warblers, Tanagers, Grosbeaks, Sparrows, Buntings, Blackbirds, & Allies

Common name	*Scientific name*	*Situation*
Tennessee Warbler	*Vermivora peregrina*	*
Orange-crowned Warbler	*Vermivora celata*	+B
Nashville Warbler	*Vermivora ruficapilla*	*
Virginia's Warbler	*Vermivora virginiae*	*
Yellow Warbler	*Dendroica petechia*	B
Chestnut-sided Warbler	*Dendroica pensylvanica*	*
Cape May Warbler	*Dendroica tigrina*	*
Yellow-rumped Warbler	*Dendroica coronata*	Bw
Townsend's Warbler	*Dendroica townsendi*	*
Blackburnian Warbler	*Dendroica fusca*	*
Yellow-throated Warbler	*Dendroica dominica*	*
Prairie Warbler	*Dendroica discolor*	*
Palm Warbler	*Dendroica palmarum*	*
Bay-breasted Warbler	*Dendroica castanea*	*
Blackpoll Warbler	*Dendroica striata*	*
Black-and-white Warbler	*Mniotilta varia*	*
American Redstart	*Setophaga ruticilla*	*
Prothonotary Warbler	*Protonotaria citrea*	*
Ovenbird	*Seiurus aurocapilla*	*
Northern	*Seiurus noveboracensis*	+B
MacGillivray's Warbler	*Oporonis tolmiei*	B
Common Yellowthroat	*Geothlypis trichas*	B
Hooded Warbler	*Wilsonia citrina*	*
Wilson's Warbler	*Wilsonia pusilla*	B
Yellow-breasted Chat	*Icteria virens*	*
Scarlet Tanager	*Piranga olivacea*	*
Western Tanager	*Piranga ludoviciana*	B
Green-tailed Towhee	*Pipilo chlorurus*	Bw
Spotted Towhee	*Pipilo maculatus*	+BW
American Tree Sparrow	*Spizella arborea*	+W
Chipping Sparrow	*Spizella passerine*	B
Clay-colored Sparrow	*Spizella pallida*	*
Brewer's Sparrow	*Spizella breweri*	B
Field Sparrow	*Spizella pusilla*	*

Common name	*Scientific name*	*Situation*
Black-chinned Sparrow	*Spizella atrogularis*	*
Vesper Sparrow	*Chondestes gramineus*	B
Lark Sparrow	*Amphispiza grammacus*	*
Black-throated Sparrow	*Amphispiza bilineata*	*
Sage Sparrow	*Amphispiza belli*	*
Lark Bunting	*Calamospiza melanocorys*	*
Savannah Sparrow	*Passerculus sandwichensis*	B
Grasshopper Sparrow	*Ammodramus savannarum*	*
Le Conte's Sparrow	*Ammodramus leconteii*	*
Fox Sparrow	*Passerella iliaca*	Bw
Song Sparrow	*Melospiza melodia*	BW
Lincoln's Sparrow	*Melospiza lincolnii*	Bw
Swamp Sparrow	*Melospiza georgiana*	*w
White-throated Sparrow	*Zonotrichia albicollis*	*w
Harris's Sparrow	*Zonotrichia querula*	*W
White-crowned Sparrow	*Zonotrichia leucophrys*	Bw
Dark-eyed Junco	*Junco hyemalis*	BW
McCown's Longspur	*Calcarius mccownii*	*
Lapland Longspur	*Calcarius lapponicus*	*
Snow Bunting	*Plectrophenax nivalis*	*W
Rose-breasted	*Pheucticus ludovicianus*	*
Black-headed	*Pheucticus melanocephalus*	*
Lazuli Bunting	*Passerina amoena*	B
Indigo Bunting	*Passerina cyanea*	*
Bobolink	*Dolichonyx oryzivorus*	*
Red-Winged Blackbird	*Agelaius phoeniceus*	Bw
Western Meadowlark	*Sturnella neglecta*	B
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	B
Rusty Blackbird	*Euphagus carolinus*	*
Brewer's Blackbird	*Euphagus cyanocephalus*	Bw
Common Grackle	*Quiscalus quiscula*	*w
Brown-headed Cowbird	*Molothrus ater*	B
Bullock's Oriole	*Icterus bullockii*	*
Baltimore Oriole	*Icterus galbula*	*

Old World Warblers, Gnatcatchers, Old World Flycacthers, & Thrushes

Common name	*Scientific name*	*Situation*
Golden-crowned Kinglet	*Regulus satrapa*	BW
Ruby-crowned Kinglet	*Regulus calendula*	B
Blue-gray Gnatcatcher	*Polioptila caerulea*	*
Western Bluebird	*Sialia mexicana*	*
Mountain Bluebird	*Sialia currucoides*	B
Townsend's Solitaire	*Myadestes townsendi*	BW
Veery	*Catharus fuscescens*	*
Swainson's Thrush	*Catharus ustulatus*	B
Hermit Thrush	*Catharus guttatus*	B
American Robin	*Turdus migratorius*	BW
Varied Thrush	*Ixoreus naevius*	*

Mockingbirds, Thrashers, & Allies

Common name	*Scientific name*	*Situation*
Gray Catbird	*Dumetella carolinensis*	+Bw
Northern Mockingbird	*Mimus polyglottos*	*w
Sage Thrasher	*Orescoptes montanus*	B
Brown Thrasher	*Toxostoma rufum*	*

Waxwings, & Sliky-Flycatchers

Common name	*Scientific name*	*Situation*
Bohemian Waxwing	*Bombycilla garrulous*	W
Cedar Waxwing	*Bombycilla cedrorum*	+BW
Phainopepla	*Phainopepla nitens*	*

Finches, & Allies

Common name	*Scientific name*	*Situation*
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	+BW
Black Rosy-Finch	*Leucosticte atrata*	BW
Pine Grosbeak	*Pinicola enucleator*	BW
Purple Finch	*Carpodacus purpureus*	*
Cassin's Finch	*Carpodacus cassinii*	BW
House Finch	*Carpodacus mexicanus*	+BW
Red Crossbill	*Loxia curvirostra*	BW
White-winged Crossbill	*Loxia leucoptera*	Bw
Common Redpoll	*Carduelis flammea*	+W
Hoary Redpoll	*Carduelis hornemanni*	+W
Pine Siskin	*Carduelis pinus*	BW
Lesser Goldfinch	*Carduelis psaltria*	*
American Goldfinch	*Carduelis tristis*	W
Evening Grosbeak	*Coccothraustes vespertinus*	W

Old World Sparrows

Common name	*Scientific name*	*Situation*
House Sparrow	*Passer domesticus*	BW

Storks

Common name	*Scientific name*	*Situation*
Wood Stork	*Mycteria americana*	*

Annex 8. Fish in Yellowstone National Park; I: Introduced, N: Native (Koel *et al.*, 2010)

Family	*Common name*	*Scientific name*	*Status*	*Missouri*	*Snake*	*Yellow-stone*	*Spanish common name*
Salmonidae	Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	Native	I	I	N	
	Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Native	N			
	Finespotted Snake cutthroat trout	*Oncorhynchus clarki behnkei*	Native		N		
	Rainbow trout	*Oncorhynchus mykiss*	Non-native	I	I	I	Trucha arcoiris
	Mountain whitefish	*Prosopium williamsoni*	Native	N	N	N	
	Brown trout	*Salmo trutta*	Exotic	I	I	I	Trucha de río
	Eastern brook trout	*Salvelinus fontinalis*	Non-native	I	I	I	Trucha de arroyo
	Lake trout	*Salvelinus namaycush*	Non-native		I	I	
	Brook grayling	*Thymallus arcticus montanus*	Native	N		I	
Catostomidae	Utah sucker	*Catostomus ardens*	Native		N		
	Longnose sucker	*Catostomus catostomus*	Native			N	
	Mountain sucker	*Catostomus platyrhynchus*	Native	N	N	N	
Cyprinidae	Lake chub	*Couesius plumbeus*	Non-native			I	
	Utah chub	*Gila atraria*	Native	I	N		
	Longnose dace	*Rhinichthys cataractae*	Native	N	N	N	
	Speckled dace	*Rhinichthys osculus*	Native		N		
	Redside shiner	*Richardsonius balteatus*	Native		N	I	
Cottidae	Mottled sculpin	*Cottus bairdi*	Native	N	N	N	

Annex 9. Amphibians in Yellowstone National Park (NPS[17], M.s)

Common name	*Scientific name*	*Habitat*	*Spanish common name*
Blotched Tiger Salamander	*Ambystoma tigrinum melanostictum*	In most of the park	Salamandra tigre del este
Boreal Chorus Frog	*Pseudacris triseriata maculata*	Moist meadows and forests near wetlands	
Boreal Toad	*Bufo boreas boreas*	Adults can range far from wetlands	
Columbia Spotted Frog	*Rana luteiventris*	Rivers, streams, smaller lakes, marshes, ponds, and rain pools	Rana moteada de Columbia

Annex 10. Reptiles in Yellowstone National Park (NPS[18], M.s)

Common name	*Scientific name*	*Habitat*	*Spanish common name*
Bullsnake	*Pituophis catenifer sayi*	Lower elevations, drier, warmer climates, and open areas	Serpiente de Gopher
Prairie Rattlesnake	*Crotalis viridis viridis*	Drier and warmer of the park	Cascabel de las praderas
Rubber Boa	*Charina bottae*	Rocky areas near streams or rivers, with shrubs or trees nearby	
Sagebrush Lizard	*Sceloporus graciosus graciosus*	Thermally influenced areas	
Valley Garter Snake	*Thamnophis sirtalis fitchi*	In permanent surface water	Culebra rayada
Wandering Garter Snake	*Thamnophis elegans vagrans*	Near water	

Annex 11. Wildflowers in Yellowstone National Park (NPS[19], M.s)

White Flowers

Common name	*Location*	*Blooming period*
Marsh marigold	Wet meadows, parkwide & Beartooth Mountains	May–July
Northern bedstraw	Northern range	July–August
White geranium	Moist areas, parkwide	July–August
Phlox	Parkwide	May–July
Wild strawberry	Parkwide	May–July
Yampa	Meadows, parkwide	July–August
Cow parsnip	Wet areas, parkwide	July–August
Evening primrose	Gardiner/Mammoth areas	May–June
Ladies tresses	Thermal areas, meadows	July–August
Woodland star	Meadows, parkwide	May–June
Yarrow	Parkwide	June–September
Pussytoes	Parkwide	June–July
Spring beauty	Parkwide	April–June
Bistort	Meadows, parkwide & Beartooth Mountains	June–August

Yellow flowers

Common name	*Location*	*Blooming period*
Arnica	Parkwide	June–August
Groundsel	Parkwide	June–September
Yellow bell	Hayden Valley, Dunraven Pass	May–June
Glacier lily	Lake area, Dunraven Pass	May–June
Cinquefoil	Parkwide	June–August
Stonecrop	Barren areas, parkwide	June–August
Yellow monkeyflower	Thermal areas, bogs, creeks	May–August
Rabbitbrush	Northern range	August–September
Balsamroot	Northern range	June–July
Prickly pear cactus	Gardiner/Mammoth area	June
Yellow pond lily	Ponds, slow streams, parkwide	July–August
Sulfur buckwheat	Parkwide	June–August
Globeflower	Wet areas, Beartooth Mountains	May–June
Helianthella	Dunraven Pass	July–August
Yellow violet	Moist meadows, parkwide	May–June

Red–Pink flowers

Common name	*Location*	*Blooming period*
Shooting star	Meadows, parkwide	May–June
Prairie smoke	Meadows, parkwide	June–July
Coralroot	Forest floor, parkwide	June–July
Bitterroot	Northern range	May–June
Elephant head	Moist meadows, parkwide	June–July
Twinflower	Moist forests	June–July
Paintbrush	Parkwide	June–August
Wild rose	Northern range	June–July
Sticky geranium	Northern range, meadows, parkwide	June–August
Fireweed	Parkwide	July–August
Lewis monkeyflower	Dunraven Pass	July–August

Blue–Purple flowers

Common name	*Location*	*Blooming period*
Fringed gentian	Geyser basins & meadows, parkwide	May–August
Harebell	Parkwide	July–August
Wild flax	Dry meadows, parkwide	June–August
Penstemon	Meadows, parkwide	June–August
Lupine	Parkwide	June–August
Forget-me-not	Northern range	June–July
Phacelia	Northern range, Dunraven Pass	May–July
Stickseed	Northern range	June–July
Bluebells	Meadows & along streams	May–July
Clematis	Mammoth/Tower area	May–June
Larkspur	Meadows, parkwide	May–August
Monkshood	Moist areas, parkwide	June–August
Wild iris	Northern range	June
Pasqueflower	Northern range	May–June
Aster/fleabane	Parkwide	May–September

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