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Yellowstone National Park

SITE INFORMATION

Country: United States of America (USA)
Inscribed in: 1978
Criteria: (vii) (viii) (ix) (x)
The vast natural forest of Yellowstone National Park covers nearly 9,000 km2; 96% of the park lies in Wyoming, 3% in Montana and 1% in Idaho. Yellowstone contains half of all the world's known geothermal features, with more than 10,000 examples. It also has the world's largest concentration of geysers (more than 300 geyers, or two thirds of all those on the planet). Established in 1872, Yellowstone is equally known for its wildlife, such as grizzly bears, wolves, bison and wapitis. © UNESCO

SUMMARY

2020 Conservation Outlook

Good with some concerns

The state of biodiversity-related World Heritage values is stable or declining slightly with a number of challenges that will continue to require attention. The geological and geomorphological World Heritage values are stable. The park is well managed and has numerous plans and partnerships to address most threats. Yellowstone National Park visitation rose to historic levels of 4.2 million and 4.1 million visits in 2016 and 2018, respectively. Meanwhile, staffing levels have remained flat since 2000. While these factors pose a challenge, Yellowstone is constructing a visitor use strategy that understands and responds to increased visitation. External threats from climate change, invasive species, mining outside the park, barriers to connectivity for bison and grizzly bears, and park finance pose the greatest risk to the values, integrity and Outstanding Universal Value of the park. The maintenance of some of the values of the site in the future will depend upon cooperative efforts among the National Park Service, other federal and state agencies, non-governmental organisations and the private sector.

FULL ASSESSMENT

Description of values

Values

World Heritage values

▶ **Exceptional natural beauty** **Criterion:(vii)**

The extraordinary scenic treasures of Yellowstone include the world's largest collection of geysers, the Grand Canyon of the Yellowstone River, numerous waterfalls and great herds of wildlife. The Park's geyser and hot spring basins have value not only for their own qualities but as further evidence of the significance of the region's volcanism and as geological agents of change. The Park contains some 500 geysers, including the world's tallest active geyser; more than found in all the Earth's other geyser regions combined. There are more than 10,000 geothermal features and active travertine terraces (National Park Service, 2014a; World Heritage Committee, 2006). Violent volcanic history of the landscape has created numerous deeply incised watersheds, creating incised and topographically irregular landscape, and about 350 waterfalls over 15 feet high in the Park (World Heritage Committee, 2006; Marcus et al., 2012; National Park Service, 2014a).

▶ **Outstanding examples representing volcanism and on-going geological processes** **Criterion:(viii)**

Yellowstone is one of the world's foremost sites for the study and appreciation of the evolutionary history of the Earth. The world's largest recognized caldera (45km by 75km) is contained within the park. There is visible evidence of 55 million years of volcanism, volcanic depositions preserving 27 layers of fossilized forests, half of the world's active geysers and thousands of hot springs and continuing earthquake activity. Three catastrophic eruptions have occurred in the past 2.1 million years; these were some of the largest in the Earth's history. The latest caldera-forming eruption occurred 640,000 years ago (World Heritage Committee, 2006).

▶ **Outstanding fossil examples of Earth's history** **Criterion:(viii)**

Nearly 150 species of fossil plants, ranging from small ferns and rushes up to large Sequoia and many other tree species, have been identified in the Park's abundant fossil deposits (World Heritage Committee, 2006).

▶ **Outstanding examples representing significant on-going ecological and biological processes in the northern temperate zone** **Criterion:(ix)**

The Park is one of the few remaining intact large ecosystems in the northern temperate zone of the Earth. As the site of one of the few remaining intact large ecosystems in the northern temperate zone of the Earth, Yellowstone's ecological communities provide unparalleled opportunities for conservation, study and enjoyment of large-scale wildland ecosystem processes. The Park is recognised as the core of a far larger ecological entity, the Greater Yellowstone Ecosystem. A significant improvement in ecological integrity was accomplished by the restoration of gray wolves (Canis lupus) to Yellowstone National Park (Marcus et al., 2012; National Park Service, 2014a, State Party of the USA, 2015).

▶ **Natural plant succession** **Criterion:(ix)**

All flora in the park are allowed to progress through natural succession with no direct management being practiced. Forest fires, if started from lightning, are often allowed to burn where possible to permit the natural effects of fire to periodically assert itself (World Heritage Committee, 2018).

▶ **The only wild, continuously free-ranging bison** **Criterion:(ix)**

The park's bison are the only wild, continuously free-ranging bison remaining of herds that once covered the Great Plains and, along with other park wildlife, are one of the greatest attractions (World Heritage Committee, 2018).

▶ **Significant habitats for in-situ conservation of rare or endangered species** **Criterion:(x)**

Yellowstone National Park is one of North America's foremost refuges for rare plant and animal species, and also functions as a model for ecosystem processes. The Park protects the ecosystem components necessary for the continuity of its life forms and, at the macro level, forms the core of the extensive wildlands surrounding the Park, which allow for a much more expansive and secure home for rare species than would be provided by the Park alone (Noss et al., 2002; National Park Service, 2014a, State Party of the USA, 2015). At the micro level, the hydrothermal features create habitats for microbes that provide links to primal life and insights for studying medical and environmental issues (National Park Service, 2014b).

▶ **Natural laboratory for studying species and ecosystem relationships** **Criterion:(x)**

The grizzly bear (Ursus arctos horribilis) is one of the worlds' most intensively studied and best-understood bear populations. This research has led to a greater understanding of the interdependence of ecosystem relationships (World Heritage Committee, 2018). The wolves in Yellowstone are one of the most intensively studied populations in the world with important contributions to understanding wold ecology and ecosystem affects (Yellowstone Science, 2016).

Other important biodiversity values

▶ **An area of probable refugia during climate warming**

Because of its high elevation, Yellowstone National Park and neighbouring areas of the Greater Yellowstone Ecosystem have a high probability of serving as refugia as the climate warms. Yellowstone Park may harbour many species currently in temperate and boreal ecosystems, while the nearby Beartooth Plateau and Wind River Mountains may harbour many alpine and subalpine species. In some cases, species of concern may continue to persist within the ecosystem and the Park; in many other cases, species that are currently common and widespread may become rare and confined to smaller areas as climatic zones move upwards in elevation. It is likely that areas with the same climate as Yellowstone Lake will become much restricted in the region as the climate warms (World Heritage Committee, 2006).

▶ **Global Leadership**

Largely because of leadership in ecosystem management, Yellowstone has become a world centre for dialogue about natural-area conservation and is perhaps the world's leading laboratory for experimentation in the values and ideas that drive modern conservation. As the world's first national park, Yellowstone serves as an inspiration for conservation.

Assessment information

Threats

Current Threats **High Threat**

Climate change has already changed the structure and composition of ecosystems in the Park resulting in more arid conditions, an increase in the size and frequency of forest fires, increases in water temperature

that provide optimal conditions for the spread of aquatic invasive species such as Myxobolus cerebralis, a parasite that causes whirling disease in cutthroat trout and other species. Mountain Pine Beetle (Dendroctonus ponderosae) infestations, exacerbated by climate change have resulted in a 79% mortality of whitebark pine (Pinus albicaulis) a keystone species in the Greater Yellowstone Area that is also threatened by the introduced disease, white pine blister rust. The park has no visitor use management plan yet visitor use levels are at historic levels and are creating congestion problems and safety issues. These current threats pose a significant threat to the Outstanding Universal Value of the area. Threats to geologic resources are very low.

▶ **Recreational Activities** — **Low Threat**
(Gateway Development) — Outside site

Gateway communities at the Park's entrances provide many services that need not be duplicated in the Park, thus reducing the visitor development needs in the Park and lessening the impact of those needs on the Park's values. However, the type and scale of development at the gateway communities may impact the natural beauty of the Park as well as animal movements between the Park and the surrounding Greater Yellowstone Ecosystem.

▶ **Other Ecosystem Modifications** — **Low Threat**
(Barriers to grizzly bear and wolf population connectivity) — Outside site

Restriction of grizzly bear range was identified by the World Heritage Committee (WHC) in 2010 as a threat to be addressed (Berger, 2004). While early studies expressed that isolation of the Yellowstone population over the past 100 years has led to a reduction in genetic variability and reduced the demographic viability of the population (Craighead and Vyse, 1996, Knibb, 2008; World Heritage Committee, 1978), recent genetic data indicates that the population has grown since the 1980s with no loss in genetic diversity. Meanwhile, the effective population size has increased 4 –fold over a 25 year period (Kamath et., al. 2015). To date, no radio-collared grizzly bears are known to have successfully travelled to the Selway-Bitterroot or the Northern Continental Divide Grizzly Bear Recovery Zones from Yellowstone, but they have expanded their range in recent years into closer, smaller areas of secure habitat.

▶ **Other Ecosystem Modifications** — **Low Threat**
(Limited/ restricted bison migration) — Outside site

Bison (Bison bison) are an iconic feature of Yellowstone and the national mammal of the U.S.A. However, the threat of brucellosis transmission to cattle and the real and perceived conflicts, such as competition for grasses, public safety and property damage, has limited the tolerance for bison that range outside the Park. To address these issues and the management of bison generally inside the Park, an Interagency Bison Management Plan (IBMP) was developed in 2000 by officials from the Park and the State of Montana. The plan has undergone several iterations and addresses the sustainable population in the Park and attendant management measures. The plan has been influenced by public reviews and research (State Party of the USA, 2015; 2016; Halbert et al., 2012) and, as a result, more tolerance and support for bison has emerged and additional strategies are under consideration to facilitate the migration of bison beyond the park boundary. In August 2019, 55 male bison that repeatedly tested negative for brucellosis and had been quarantined, were transferred to the Fort Peck Indian Reservation in Poplar, Montana (National Park Service, 2019). While this cooperative management has reduced the threat, bison are still restricted from their traditional migration routes outside of the park during winter months. However, tolerance for movement of Yellowstone bison outside the park within Montana has expanded some since 2016 (IUCN Consultation, 2020). Bison numbers have increased markedly during the past decade, being less vulnerable to wolf predation than are other ungulates in the park, the future dynamics of bison are unknown (Boyce, 2018).

▶ **Other Ecosystem Modifications** — **High Threat**
(Whitebark pine (Pinus albicaulis) mortality) — Inside site, widespread(15-50%)
Outside site

Whitebark pine plays an important role in retaining snow, reducing erosion, acts as a nurse plant for other subalpine species and produces seeds that are an important food for birds, grizzly bears and other

wildlife. A 2013 aerial survey showed approximately 46% mortality of whitebark pine inside the Park. White pine blister rust, caused by the nonnative fungus, Cronartium ribicola, slowly damages and can eventually kill infected whitebark pine trees. Periodic outbreaks of native mountain pine beetle (Dendroctonus ponderosae), quickly decimate infested whitebark pine forests. Beetles preferentially attack larger, mature whitebark pine. The historical suppression of wildland fire has resulted in more frequent, bigger, and hotter wildfires. Finally, climate change exacerbates each of these stressors. Specifically, warmer temperatures enable mountain pine beetle to reproduce in one-year rather than multi-year cycles. Between 2007 and 2009, this shift resulted in a mountain pine beetle epidemic that killed 80% of the oldest trees in the ecosystem. (National Park Service, 2020f, 2020g).

► Other Biological Resource Use

Low Threat

Inside site, extent of threat not known
Outside site

(Trophy Hunting of wolves/grizzly bears outside Park affecting sustainable populations)

Other targeted species names
gray wolf (Canis lupus), grizzly bear (Ursa arctos horribilis)

The gray wolf (Canis lupus), eliminated from the Park by the 1920s under a different park management philosophy, was successfully reintroduced into the Park in 1995 (State Party of the USA, 2015; Povilitis, 2015). Similarly, the grizzly bear (Ursus arctos horribilis), generally eradicated from the western United States except in Yellowstone, found refuge in the Park.

These two iconic species, along with a number of other species, represent Yellowstone. As wildlife generally has little understanding of park boundaries, hunting outside the Park can have a significant effect on those animals that generally inhabit the park. Some wolves will leave the Park and be hunted (Povilitis, 2015). Hunting can risk reducing overall wolf population size (Creel and Rotella 2010), longevity of family lineages, and intergenerational transfer of adaptive genetic and cultural information (Haber 1996; Haber and Holleman 2013).

Yellowstone has partnered with neighbouring States and associated foundations to increase the knowledge of these species and conduct public outreach and lessen the impact of hunting outside the Park. These partnerships include the Interagency Grizzly Bear Committee, Wyoming Bear Wise Project and the Yellowstone Ecosystem Committee (State Party of the USA, 2015).

In 2017, grizzly bears were removed from the U.S.A. Endangered Species List by the U.S. Fish and Wildlife Service, though the Endangered status was reinstated by court action in 2018. The court ruled that the government did not adequately consider the role of connectivity of isolated grizzly subpopulations in ensuring genetic variability (Washington Post, 2018). In 2019, the court decision was appealed by the federal government to a higher court where a further decision is forthcoming.

► Invasive Non-Native/ Alien Species

High Threat

Inside site, widespread(15-50%)
Outside site

(Invasive/Introduced species)

Other invasive species names
lake chub (Couesius plumbeus), brown trout (Salmo trutta), rainbow trout (Oncorhynchus mykiss), Myxobolus cerebralis, Potamopyrgus antipodarum, Redrimmed melania (Melanoides tuberculatus), Dalmatian Toadflax (Linaria dalmatica), mountain goat

Fish from outside the Park, including non-natives such as eastern brook trout (Salvelinus fontinalis) and lake trout (Salvelinus namaycush), which compete with native species, were introduced as early as 1890. Lake trout were discovered in Yellowstone Lake in 1994 and they increased greatly, while native cutthroat trout declined. Lake trout control measures began in 1995 and although numbers have been reduced, eradication is virtually impossible. Other non-native aquatic species include lake chub (Couesius plumbeus), brown trout (Salmo trutta), rainbow trout (Oncorhynchus mykiss), Myxobolus cerebralis, a parasite that causes whirling disease in cutthroat trout and other species, New Zealand mud snails (Potamopyrgus antipodarum) and Red-rimmed melania (Melanoides tuberculatus) (National Park Service, 2020c). In 2016 the Greater Yellowstone Coordinating Committee published an Aquatic

Invasive Species Cooperative Strategic Plan that calls for a) preventing new introductions and limiting the spread of existing populations; b) abating ecological, socioeconomic, and public health and safety impacts resulting from infestations of aquatic invasive species; and c) providing a cooperative environment that promotes coordination among all Greater Yellowstone Area stakeholders (Greater Yellowstone Coordinating Committee, 2016). There are 225 documented non-native species of plants in Yellowstone. They include Canada Thistle (Cirsium arvense), Dalmatian Toadflax (Linaria dalmatica), Houndstongue (Cynoglossum officinale), Leafy Spurge (Euphorbia esula), Ox-eye Daisy (Leucanthemum vulgare) and Spotted Knapweed (Centaurea maculosa) (National Park Service, 2020d). Non-native bird species include Eurasian collared dove (Streptopelia decaocto), starling (Sturnus vulgaris) and house sparrow (Passer domesticus) (National Park Service, 2014). Few non-native mammals are established in the park other than mountain goats, Oreamnos americanus. The impacts from these invasive and introduced species are felt throughout the Park and result in loss of native habitats and species.

► **Recreational Activities** **Low Threat**

(Increased visitation) Inside site, scattered(5-15%)

Annual Yellowstone National Park visitation has increased close to 45% since the early 2000s with much of the increase in the past five years. Yellowstone visitation rose to historic levels of 4.2 million and 4.1 million visits in 2016 and 2018, respectively. Staffing levels have remained relatively flat since 2000. The increase in visitation poses a number of challenges with overcrowding, vandalism, loss of natural light and sound quality and reduction in wildlife viewing opportunity having been reported (Jorgenson, et al., 2019, National Park Service, 2014a). This increase in visitation has also brought safety issues including traffic volumes in high-use corridors approximately 30% higher than roads and parking lots can safely handle and since 2008 a 90% rise in motor vehicle accidents, 60% more ambulance use, and 130% more search and rescue efforts. Vehicular demand has been projected to exceed capacity between 2021 and 2023 (Otak, Fehr and Peers, 2017, 2018, Jorgenson, et. al., 2019). However, a 2018 Visitor Use Study indicates that visitor experience levels remain high, and monitoring efforts show no population level impacts or resource impairment at current visitation levels (IUCN Consultation, 2020). Moreover, impacts from increasing visitation, whether on resources, staff/operations, or experience, are reportedly very localized and site-specific (IUCN Consultation, 2020).

The site management are working to evaluate and respond to increasing visitation in the following key areas: 1) impacts on resource conditions; 2) impacts on staffing, operations, and infrastructure; 3) impacts on visitor service levels; and 4) impacts on gateway communities and partners. The park has and will continue to use a range of data to develop actions that improve performance in the four key areas. Recent and upcoming park actions include major projects at the Grand Canyon of the Yellowstone, a new North Entrance station, pilot projects to alter traffic and parking, mapping efforts and on-the-ground surveys to analyse social trails and resource impacts, evaluation of shuttle systems, improvements at Norris Geyser Basin, road improvement projects, and a West Yellowstone Gateway study (IUCN Consultation, 2020).

► **Habitat Shifting/ Alteration, Temperature extremes** **High Threat**

(Climate Change) Inside site, throughout(>50%)
Outside site

Future climate models for the Greater Yellowstone Area (GYA) all predict increasing temperatures, but differ in whether to expect more, the same, or less precipitation (National Park Service 2020j). Increased evapotranspiration driven by warmer temperatures is projected to be large enough, however, to result in overall drier conditions, regardless of the precipitation scenario. Conditions in Yellowstone, therefore, are projected to become hotter and drier, especially during the summer and fall. In Mammoth Hot Springs, the five-year running mean of average annual daily maximum temperature has increased by 1.2° Celsius (2.1°F) and the average annual daily minimum temperature has increased by 2.2° Celsius (3.9°F) during 1941–2016 (Yellowstone Center for Resources, 2018, National Park Service, 2020g).

Total annual precipitation at Mammoth Hot Springs since 1976 has been generally below the long-term mean of 38.9 cm (15.3 inches). The five-year running mean of annual peak snowpack at the Northeast Entrance has declined 30% since 1966, from 38.2 cm to 26.5 cm (15.02 inches to 10.44 inches). Analyses of streams during 1950–2010 in the Central Rocky Mountains, including those in the Greater

Yellowstone Ecosystem, show an 89% decline in stream discharge (National Park Service, 2020j).

Snowy conditions have been prevailing for a shorter period during the year. The 10-year running mean of winter length at the Northeast Entrance SNOTEL station has decreased 15% during 1966–2017, from 216 to 183 days. Even if precipitation recovers to historical levels, which models indicate is possible, increased temperatures and evapotranspiration will reduce water availability (National Park Service, 2018, 2020g).

Impacts from these climate change-induced conditions include a) an increase in size and frequency of fires due to climate change; b) declining air quality in summer months due to increased forest fires; c) increases in temperature and water temperature may increase suitability for the spread of aquatic invasive species and invasive plants (Yellowstone Center for Resources, 2018); and, d) increased frequency of and intensity of insect outbreaks including bark beetle infestations have resulted in a 79% mortality rate of mature whitebark Pine trees (National Park Service, 2020j).

Potential Threats

High Threat

While the current threats from climate change and invasive species are high, future projections of these threats are even higher and are highly likely to lead to geyser eruption interval lengthening, greater frequency and intensity of forest fires, greater incidence of beetle infestations to the important whitebark pine tree and changes to the seasonal growth patterns of vegetation that is likely to seriously disrupt wildlife migrations, one of the key resources for which Yellowstone is globally treasured. The potential threat of Zebra mussels and Quagga mussels also pose an extreme threat as they could remove nutrients from the base of the food web, potentially starving native fish and wildlife. The potential threat of mining near the northern border of Yellowstone also poses a grave danger to the Yellowstone River through its tributaries as both exploration and mining can potentially pollute waters with heavy metals and acid runoff.

► Habitat Shifting/ Alteration

High Threat

(Climate change)

Inside site, throughout(>50%)
Outside site

By the middle of the 21st century (2030-2059), average temperatures in the Greater Yellowstone Area in the spring are expected to warm by 1.6 to 2.4°C (2.9° to 4.3°F), in the summer by 2.6 to 3.0°C (4.7° to 5.4°F), in the fall by 2.3 to 2.7°C (4.3° to 4.9°F) and 1.7 to 2.3°C (3.1° to 4.1°F) in the winter (National Park Service, 2020i). There is an overall continued decline in snowfall projected for Yellowstone over the coming decades most pronounced in spring and summer (National Park Service, 2020j).

Impacts:
Potential impacts of decreased snowpack and less precipitation leading to extended periods of drought in the region in the future may lead to a) result in geyser eruption intervals lengthening and perhaps even cessation of geysering due to the inability of geysers to replenish themselves (Hurwitz, et al., 2008); b) increase the size and intensity of forest fires, which is also exacerbated by the presence of dead and dying Whitebark pine trees widespread across the park (National Park Service, 2020j).

Increased temperatures across the park in the future are projected to lead to, a) increases in the frequency, intensity, severity, and average annual extent of wildland fires. Models project that numerous aspects of fire behavior will change, including longer fire seasons, more days with high fire danger, increased natural ignition frequency and fire severity, more frequent large fires, and more episodes of extreme fire behavior; b) promotion of beetle infestations from increased forest fires and the intensity of those fires; c) longer growing seasons and changes in seasonal growth patterns will likely disrupt vegetation growth and development, causing plants to bud, flower, fruit and die at different times of the year than they do now. Those changes, in turn, would alter or seriously disrupt wildlife migrations, in particular, elk (Cervus canadensis) that move through the park (Rickbeil, et al. 2019), one of the key resources for which Yellowstone National Park is globally treasured (National Park Service, 2020j).

► **Earthquakes/ Tsunamis** — **Low Threat**

(Earthquakes)

Inside site, extent of threat not known
Outside site

Earthquakes have the potential to destroy the existing geothermal features but conceivably, establish new ones. Earthquakes are frequent within the park and are part of what makes the landscape unique and ever changing and therefore represent a low threat.

► **Mining & Quarrying** — **High Threat**

(Mining near the North boundary of the Park)

Inside site, extent of threat not known
Outside site

In the 1990s, the threat of a large gold and silver mine near Cooke City, Montana, just beyond the northeast boundary of Yellowstone National Park, and its resulting inscription on the List of World Heritage in Danger in 1995 was addressed through an arrangement between the Federal Government and the mining company. In the arrangement, the mining company agreed not to develop the mine and U.S. Congress assigned funds for the clean-up of a century's worth of accumulated tailings and other toxic overburden (World Heritage Committee, 1977). In 2016, the Federal Government placed a two-year moratorium on mining of approximately 30,000 acres of national forest land in different areas of the Greater Yellowstone Ecosystem, this time near Emigrant and Jardine, Montana. In 2019, the Yellowstone Gateway Protection Act was passed by the U.S. Congress and signed into law by the president establishing a permanent prohibition on mining of the 30,000 acres near Jardine and Emigrant. However, valid mining claims still exist on private lands along the northern border of the park near Jardine. One claim is owned by U.S.A-based Crevice Mining Group LLC (IUCN Consultation, 2020). Mining near Jardine could affect viewsheds and water quality in the Yellowstone River in and outside the park.

► **Invasive Non-Native/ Alien Species** — **High Threat**

(Aquatic invasive species)

Inside site, widespread(15-50%)

Other invasive species names
zebra mussels (Dreissena polymorpha) and quagga mussels (Dreissena bugensis)

At least nine aquatic invasives species already exist in Yellowstone waters, including New Zealand mud snail, red rimmed melania, six non-native fish, and whirling disease. Non-native aquatic invasive species that currently inhabit or have been documented in nearby states include zebra mussels (Dreissena polymorpha) and quagga mussels (Dreissena bugensis). These species are mostly spread into pristine waterbodies through boats and can result in significant loss of microscopic plants and animals from the base of the food web, potentially starving native fish and wildlife. However, these species have yet to be identified within the site and the Park requires a boating permit and a Yellowstone aquatic invasive species inspection before entry. Watercraft equipped with sealed internal water ballast tanks are temporarily banned in the park to minimize the risk of introducing aquatic invasive species (National Park Service, 2020).

Overall assessment of threats — **High Threat**

Climate change, invasive species and infestations are having or pose significant impact on the ecology of Yellowstone National Park, future projections suggest profound changes to the park that require managers to now collaborate at ecosystem and regional scales. Many of these threats are beyond the control of park managers but are nonetheless significant, widespread and threaten the site's values, integrity and Outstanding Universal Value. High levels of visitor use remains a threat but is being addressed through planning and management actions.

Protection and management

Assessing Protection and Management

▶ Management system — Mostly Effective

The management system in place, supported by the Foundation Document and numerous natural resource management plans prepared with public input, is generally adequate. The park lacks a visitor use management plan despite record visitation levels in the five years prior to 2020 and is continually challenged by funding to adequately address needs in all areas (National Park Service, 2014a, 2020n, State Party of the USA, 2014).

▶ Effectiveness of management system — Highly Effective

The effectiveness of the management system of the site is highly effective and likely to maintain the site's values over the medium term. Longer term effectiveness will depend on the development of capacity and support to influence outside the Park's boundary (World Heritage Committee, 2006; National Park Service, 2014a).

▶ Boundaries — Some Concern

The boundaries are legislated and clearly marked. As noted, some areas outside the park boundary are important for the migration of some park species including elk and bison. Cooperative interagency planning is assisting in expanding and protecting migratory routes (World Heritage Committee, 2008, 2010; National Park Service, 2014a), though bison have limited access to winter range outside the park. However, tolerance for movement of Yellowstone bison outside the park within Montana has expanded some since 2016 (IUCN Consultation, 2020).

▶ Integration into regional and national planning systems — Mostly Effective

The Park is guided by Service-wide policy for planning in National Parks. Park managers participate in the Greater Yellowstone Coordinating Committee, the Great Northern Landscape Conservation Cooperative, NPS Climate Change Response Program and the Interagency Grizzly Bear Committee as well as a number of interagency management plans (State Party of the USA, 2014). Although there can be tension in the relationships with surrounding States due to varying resource management objectives, the site has enjoyed models of success include mining reclamation and improved water quality.

▶ Relationships with local people — Mostly Effective

Gateway communities adjacent to the Park benefit financially from the presence of the Park and its visitors (National Park Service, 2017) and are generally supportive of park management. Some ranchers and hunters disagree with park management practices dealing with bison and large predators and perceived and/or real impacts to livestock and ungulate populations (State Party of the USA, 2008). To address this issue, park resource managers work with other federal and state agencies. At present, bison management remains a significant issue, although hunting outside the park has the potential to impact park resources. Negotiations continue to find a balance. The Park has an extensive public and institutional outreach programme at the community and international level to involve others in park management.

Indigenous participation in park management includes hosting a Native American internship programme where interns participate in natural and cultural resource management. Additionally management consults regularly with tribal representatives through site visits, staff exchanges and formal government-to-government meetings.

The Park's Twitter feed has more than 826,900 followers (@YellowstoneNPS, 2020).

▶ Legal framework — Mostly Effective

The site is governed by the federal statutes that established the Park and the federal laws that established the National Park Service, as well as laws pertaining to air quality, water quality, environmental policy, wild and scenic rivers, wilderness, endangered and threatened species, historic

preservation, relationships with tribes, archeological resources protection and other pertinent legislation. These statutes are mostly effective in maintaining the Outstanding Universal Value of the site. However, discrepancies between national and state laws regarding wild bison remain a challenge for bison migration. Tolerance for movement of Yellowstone bison outside the park within Montana has expanded some since 2016 (IUCN Consultation, 2020).

► Law enforcement — Highly Effective

Enforcement of visitor behaviour, permits and management of park resources is governed by federal statutes and regulations and conducted by park staff effectively. The Park has custodial facilities. Legislation allowing fire arms presents legal enforcement challenges (State Party of the USA, 2014).

► Implementation of Committee decisions and recommendations — Highly Effective

Yellowstone National Park was inscribed on the World Heritage List in 1978 and subsequently inscribed on the World Heritage list in Danger in 1995. Over the years, the Park has continued to report on winter use and its impact on other users and park wildlife, mining activities outside the park, threats to bison, threats to cutthroat trout, water quality issues, road impacts and visitor use impacts (Rasker & Hansen, 2000; State Party of the USA, 2003; 2008), the 1973 Master Plan, the assessment of the risk to grizzly bears from declining whitebark pine and the investigation of the severity of pine beetle infestation and the role of changing temperatures. The WHC has commended Yellowstone over that time period for the substantial progress made in finding effective solutions to conservation issues affecting the Park, particularly relating to bison migration, suppression of the lake trout population, mitigation of human–grizzly bear conflict, improvement in addressing the impacts of winter visitor use, and mining and road impacts. Most recently, the WHC encouraged Yellowstone to establish effective cooperative relations between the Park and private landowners and State land and wildlife regulatory agencies in lands surrounding the Park, in the interest of achieving long-term conservation goals for the Park's bison, grizzly and wolf populations (Weber, 2004; Garrott et al., 2009; Clark & Rutherford, 2014). In 2015, Yellowstone submitted its report addressing these issues (State Party of the USA, 2015).

► Sustainable use — Highly Effective

The use of the Park's resources for conservation and recreation purposes, in keeping with the multiple resource use plans, appears sustainable and resource use on the park's perimeter is managed considering its impact on the Park's resources (World Heritage Committee, 2005). In 2012, the Park completed a Strategic Plan for Sustainability (National Park Service, 2014a). The implementation of the plan included a mini-hydro project, the installation of power-saving units on emergency vehicles, employee ride-sharing and bus transportation and building renovations to LEED certification.

► Sustainable finance — Some Concern

The Park is funded at adequate levels compared to other World Heritage sites and ranks higher in funding for most needs than many National Parks in the United States. Funding comes from the Federal Government, a share of entry fees, concession fees, and private funds. However, despite dramatic increases in visitor use levels since 2000, staffing levels have remained flat and the park is continuously challenged by funding to address needs in all areas (National Park Service, 2014a, 2020n, State Party of the USA, 2014).

► Staff capacity, training, and development — Some Concern

Generally speaking, staff are adequately trained and utilisation of external resources such as nearby universities increases capacity. Bureaucratic record keeping ensures institutional memory. Despite record visitation levels, park staffing levels have remained flat since 2000 (National Park Service, 2020n).

► Education and interpretation programs — Highly Effective

The Park places value on education for park visitors as well as engaging in extensive programmes to reach those who are not physically in the Park. Some programmes are outstanding and others are

adequate (National Park Service, 2014a). Visitor behaviour around wildlife remains an education issue (IUCN Consultation, 2017).

► Tourism and visitation management — Some Concern

As arguably the most internationally known park, and with some 4 million visitors annually, the understanding and promotion of Yellowstone is self-evident. The Park's Foundation Document was approved in 2014 and guides resource protection and management, visitor use and facility development (National Park Service, 2014a).

Visitation to the park has increased close to 45% since the early 2000s with much of the increase since 2015. Yellowstone visitation rose to historic levels of use at 4.2 million visits in 2016. The increase in visitation, particularly in Summer months has brought with it a degradation of visitor experiences including congested traffic and trail conditions, general overcrowding, vandalism, loss of natural light and sound quality and reduction in wildlife viewing opportunity (Jorgenson, et al., 2019, National Park Service, 2014a), albeit very localized and site-specific (IUCN Consultation, 2020).

These factors pose a challenge, however the management is establishing a visitor use strategy that understands and responds to increased visitation in the following key areas: 1) impacts on resource conditions; 2) impacts on staffing, operations, and infrastructure; 3) impacts on visitor service levels; and 4) impacts on gateway communities and partners. The park has and will continue to use a range of data to develop actions that improve performance in the four key areas. Recent and upcoming park actions include major projects at the Grand Canyon of the Yellowstone, a new North Entrance station, pilot projects to alter traffic and parking, mapping efforts and on-the-ground surveys to analyze social trails and resource impacts, evaluation of shuttle systems, improvements at Norris Geyser Basin, road improvement projects, and a West Yellowstone Gateway study (IUCN Consultation, 2020).

► Monitoring — Highly Effective

Inventorying and monitoring (from geologic, visitor use, to biological values) occurs constantly in the Park, and the Park participates in region-wide monitoring as well (e.g. the Greater Yellowstone Network Vital Signs Monitoring Program) (Yellowstone National Park, 2007; Rasker & Hansen, 2000; Noss et al., 2002; Jean et al., 2005; World Heritage Committee, 2005).

► Research — Highly Effective

The Park has encouraged purposed and empirical research at both the personal and institutional level and conducts its own research to support park management (National Park Service, 2014a).

Overall assessment of protection and management — Mostly Effective

The management system in place, supported by the Foundation Document and numerous natural resource management plans prepared with public consultation, is effectively implemented in order to maintain the site's values in the medium term due to highly effective monitoring, research and a legal framework in the National Park system that is well enforced to the extent possible. Of some concern to the protection and management of the site's values is the management of tourism, as visitation has increased to record levels in the five years prior to 2020, without the concurrent increase in staffing capacity to adequately manage such high levels of visitation. Nonetheless, overall the protection and management of the site, and its World Heritage values, is mostly effective in the medium term, but will likely be challenging in the long term.

► Assessment of the effectiveness of protection and management in addressing threats outside the site — Some Concern

The external threats impact the overall state of protection and management and challenge park management, and park resources, to focus on issues beyond their direct control.

Within the Park, the Foundation Document and associated plans adequately guide effective park management.

▶ **Good practice examples**

As a provider of global leadership in park management, Yellowstone has numerous examples of best practice including the encouragement of research on the Park's natural and cultural resources, assessing the environmental impacts of proposed modifications, engagement of others in park management and effective participation in issues outside the direct control of the Park.

State and trend of values

Assessing the current state and trend of values

World Heritage values

▶ **Exceptional natural beauty**

Low Concern
Trend:Data Deficient

Climate change, invasive species and species infestations and more frequent fire threaten to change the landscape. Despite this, the exceptional natural beauty of Yellowstone is resilient to most threats and can be considered of low concern overall.

Changing seasonal patterns (e.g., earlier spring runoff peaks, shorter winters, longer summers, snowpack changes will likely disrupt vegetation growth and development, causing plants to bud, flower, fruit and die at different times of the year than they do now. Those changes, in turn, would alter or seriously disrupt wildlife migrations, in particular, herds elk (Cervus canadensis) that move through the park (Rickbeil, et al. 2019), one of the key resources for which Yellowstone National Park is globally treasured and for which tourists flock to Yellowstone to admire (National Park Service, 2020j).

Visitor congestion in the summer months causes overcrowding on frontcountry trails and at attractions such as the geysers and other geothermal features. "Bison jams" and other wildlife near roadways slow traffic and can sometimes decrease visitor experience, especially for repeat visitors. Full parking lots may prevent some visitors from accessing some of the natural beauty of Yellowstone. However such impacts are lagrely localised and limited to a small number of 'hotspots' (IUCN Consultation, 2020). The park is currently evaluating these issues and has commissioned 2 studies on traffic mobility and parking to identify congestion areas and a study on visitor use (Otak, Fehr and Peers, 2017, 2018, Jorgenson, et. al., 2019). Moreover, a 2018 visitor use study showed that in general visitors are still very satisfied with their Yellowstone experience (IUCN Consultation, 2020).

Geological phenomena, particularly earthquakes, are constantly altering the hydrology and the geothermal structure of the Park, but this has always been the case (UNESCO, 1998; State Party of the USA, 2014).

▶ **Outstanding examples representing volcanism and on-going geological processes**

Good
Trend:Stable

The geologic record is well protected from human alteration and is unlikely to be threatened by environmental factors such as climate, weather, pollution, fire or floods (UNESCO, 1998).

▶ **Outstanding fossil examples of Earth's history**

Good
Trend:Data Deficient

The park's palaeontologic resources are extensive and scientifically valuable, however, it is estimated that only 3% of the park's potentially fossil-bearing units have been assessed (National Park Service, 2020k). Park Foundation and planning documents protect these from road building and infrastructure

development, but illegal collecting can impact fossil-bearing units (National Park Service, 2020k).

▶ Outstanding examples representing significant on-going ecological and biological processes in the northern temperate zone

Low Concern
Trend:Stable

There is some minor concern about biological evolution in that species requiring large areas to survive and/or depending upon gene flow from other populations (such as grizzly bears, bison, wolverine (Gulo gulo), lynx (Lynx canadensis), fisher (Martes pennanti)) may be too isolated to maintain genetic diversity over long periods of time. However, there is a reasonable possibility that connectivity may be preserved between Yellowstone and other large intact populations since approximately one migrant per generation should maintain homozygosity. In addition, gene flow can be maintained by management actions: transplanting individual animals into the system from other populations. Recent genetic data on the Yellowstone grizzly bear population indicates that the population has grown since the 1980s with no loss in genetic diversity. Meanwhile, the effective population size has increased 4 –fold over a 25 year period (Klamath et., al. 2015). If gene flow were restricted, however, evolution would nevertheless continue; but likely at different rates and in different directions than it would in a system unaffected by isolation due to human activities (World Heritage Committee, 2012).

▶ Natural plant succession

High Concern
Trend:Data Deficient

Projected changes from "natural" succession due to climate change, including more frequent forest fires, are predicted to change species composition of forests (Westerling, et al. 2011; Clark et al., 2017). Meanwhile invasive grasses (e.g., cheatgrass) alter fire regimes and inhibit sagebrush steppe regeneration. Other climate change modeling predicts that higher temperatures in the future will result in increased mortality of mature whitebark pine trees due to more frequent and intense pine beetle infestations Climate models project vegetation types will shift upward in elevation. Sagebrush and juniper communities are projected to expand from valley bottoms upslope into the lower forest zone and the Yellowstone Plateau. Climate suitability for the dense and productive Douglas-fir and aspen forests now in the lower forest zone is projected to deteriorate for these species. Ponderosa pine, a species not currently found in the GYE, is projected to have suitable habitat in this zone by the end of the century (Hansen et al. 2015). Despite these changes to natural plant succession in Yellowstone, that will be widespread and will affect the composition and distribution of species, Yellowstone will nonetheless continue to provide opportunities for natural plant successions for hundreds of other species, not sensitive to climate change and will provide refugia for many climate-affected species.

▶ The only wild, continuously free-ranging bison

Low Concern
Trend:Stable

Bison (Bison bison) in Yellowstone continue to be the only free-ranging population in the U.S.A. and are one of the main attractions for tourists. However, the threat of brucellosis transmission to cattle and the real and perceived conflicts, such as competition for grasses, public safety and property damage, has limited the tolerance for bison that range outside the Park. To address these issues and the management of bison generally inside the Park, an Interagency Bison Management Plan (IBMP) was developed in 2000 by officials from the Park and the State of Montana. The plan has been influenced by public reviews and research (State Party of the USA, 2015; 2016; Halbert et al., 2012) and, as a result, more tolerance and support for bison has emerged and additional strategies are under consideration to facilitate the migration of bison beyond the park boundary. In August 2019, 55 male bison that repeatedly tested negative for brucellosis and had been quarantined, were transferred to the Fort Peck Indian Reservation in Poplar, Montana (National Park Service, 2019). While this cooperative management has reduced the threat, they are still restricted from their traditional migration routes outside of the park during winter months. However, tolerance for movement of Yellowstone bison outside the park within Montana has expanded somewhat since 2016 (IUCN Consultation, 2020). Presently the population of bison in Yellowstone have sufficient genetic diversity to maintain their viability despite the confinement of most of the population inside the park and the yearly culling of hundreds per year.

▶ Significant habitats for in-situ conservation of rare or endangered species

Low Concern
Trend:Stable

Many habitats are changing; some due to human activities, but most due to climate change. There is a potential risk that wolves inside the Park may not be numerous enough to survive in the long term if packs outside the Park are not managed with that objective, although data is lacking to detemine this with any confidence. Similarly, if grizzly bears are removed from the Endangered list and hunted outside the Park, the effect of the hunting pressure would increase the concern on the viability of their long term survival. The introduction of exotic species has also changed many habitats. Lake trout in Yellowstone Lake have made much of that aquatic habitat unusable by native cutthroat trout which lake trout prey upon. Plants such as spotted knapweed, leafy spurge and Russian thistle (Salsola tragus) have affected wildlife habitat outside Yellowstone; it is possible that they will also increase within the Park in the future. There is potential for species such as zebra mussels and other aquatic organisms which have proven to be invasive in areas close to the park to gain a foothold. Intensive screening of watercraft can reduce the possibility of aquatic invasive species, but other sources such as mud on the soles of hiking and wading boots are very difficult to control (UNESCO, 1998).

▶ Natural laboratory for studying species and ecosystem relationships

Good
Trend:Stable

Yellowstone has some of the most high-profile research projects among U.S.A national parks and has one of the most active research programs. In 2018, permitted researchers came from more than 30 states and 8 foreign countries and on average, 115–150 scientific researchers are permitted to use study sites in the park, and many more conduct research at the park's Heritage and Research Center. Ninety six percent of the research is related to biology, physical sciences, microbiology and ecology (National Park Service, 2020m). Current research includes, but is not limited to, a) monitoring plant and animal populations affected by changing climate conditions; b) the interrelationships between carnivores, herbivores and vegetation on Yellowstone's northern range; c) population ecology studies on mammals such as wolves, elk, bison, grizzly bears, bighorn sheep, mountain goats, and moose; d) understanding the effects of landscape-scale disturbances (such as fires, insect outbreaks, and disease outbreaks) on the park's forests.

Summary of the Values

▶ Assessment of the current state and trend of World Heritage values

Low Concern
Trend: Deteriorating

Overall, the values for which Yellowstone National Park was inscribed onto the World Heritage list remain of low concern, however many of these are negatively affected by climate change, invasive species and visitor congestion. The park, however, is constructing a visitor use strategy that understands and responds to increased visitation. Limitations of natural bison migration outside of the Park due to political and economic reasons resulting in the loss of hundreds of these iconic animals every year continues to be a concern. However, tolerance for bison movement outside the park within Montana has expanded some since 2016 and there is now a program that transfers live bison to tribes (IUCN Consultation, 2020). There is some concern about biological evolution in that species requiring large areas to survive and/or depending upon gene flow from other populations (such as grizzly bears, bison, wolverine, lynx, fisher) may be too isolated to maintain genetic diversity over long periods of time. Recent genetic data on the Yellowstone grizzly bear population, however, indicates that the population has grown since the 1980s with no loss in genetic diversity. Also, efforts are being made to address connectivity and range expansion (National Park Service, 2016). Natural phenomena of the site and their scenic value are well protected. There are no geothermal energy production sites that impinge upon the Park's hydrological and geothermal systems. The geologic record is well protected from human alteration and is unlikely to be threatened by environmental factors.

▶ **Assessment of the current state and trend of other important biodiversity values**

Low Concern
Trend: Data Deficient

Yellowstone continues to provide global leadership and inspiration on other biodiversity values. The issue of climate change in the Park and its attendant impact on natural plant succession is a concern that requires constant monitoring. Yellowstone continues to provide probable refugia during climate warming because of its high elevation, large size and strong protection measures in place. Continued monitoring of large mammal populations needs to be maintained to ensure the integrity of an exceptional database of multi-species interactions. This is of particular concern because bison numbers have changed markedly in recent years, and it is not known how this population will behave in the future.

Additional information

Benefits

Understanding Benefits

▶ **Carbon sequestration,**
Soil stabilisation,
Water provision (importance for water quantity and quality),
Pollination

Environmental services reflect those representative of the Continental Divide between the Atlantic and Pacific oceans.

Assumption of an increasing trend is intuitive.

▶ **Outdoor recreation and tourism,**
Natural beauty and scenery

The national park is a destination for many people and an important resource to the regional economy especially during summer and winter months.

Assumption of an increasing trend is intuitive.

▶ **Importance for research,**
Contribution to education,
Collection of genetic material

The management of the national park and its OUV are exemplars for other protected area managers. The value of the national park and its OUV by the citizens of the United States of America lends to its ability to receive financial support to study and address management challenges and threats to its OUV as well as common protected area issues.

Assumption of an increasing trend is intuitive.

▶ **History and tradition,**
Wilderness and iconic features,
Sacred natural sites or landscapes,
Sacred or symbolic plants or animals,
Cultural identity and sense of belonging

The Park is valued by the general populace of the United States of America and the conservation world as a conservation icon and model for addressing park management issues.

Assumption of an increasing trend is intuitive.

Summary of benefits

The conservation benefits of the Yellowstone World Heritage Site are critical and important to the U.S.A. and the world.

Projects

Compilation of active conservation projects

№	Organization	Brief description of Active Projects	Website
1	US National Park Service	Each year, there are numerous research projects undertaken on the site. In 2018, permitted researchers came from more than 30 states and 8 foreign countries and on average, 115–150 scientific researchers are permitted to use study sites in the park, and many more conduct research at the park's Heritage and Research Center. Ninety six percent of the research is related to biology, physical sciences, microbiology, and ecology (National Park Service, 2020m). Current research includes, but is not limited to a) monitoring plant and animal populations affected by changing climate conditions; b) the interrelationships between carnivores, herbivores and vegetation on Yellowstone's northern range; c) population ecology studies on mammals such as wolves, elk, bison, grizzly bears, bighorn sheep, mountain goats, and moose; d) understanding the effects of landscape-scale disturbances (such as fires, insect outbreaks, and disease outbreaks) on the park's forests.	Information on both independent and government managed conservation projects is available through the Yellowstone Centre for Resources. https://www.nps.gov/yell/learn/management/ycr.htm.
2	Yellowstone Forever	Yellowstone Forever is the result of a merging of the Yellowstone Association and the Yellowstone Foundation. It is expected that the organisation will sponsor conservation projects as well.	https://www.yellowstone.org/

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