Greater Yellowstone is a fire-adapted ecosystem. Smoke may be visible from ongoing fires during the fire season, typically July through September.

Fire

Fires are a natural part of the Greater Yellowstone Ecosystem (GYE). Native plant species have evolved to thrive after periodic fires. Evidence of pre-1872 fires found in soil profiles, charcoal, and old-growth trees indicates fires have occurred in Yellowstone for over 14,000 years. The ecosystem's processes, such as nutrient cycling and plant community composition, are heavily influenced by the natural process of fire. However, fire suppression by European Americans altered these natural fire regimes. Without regular fires, biodiversity declined, and leaf litter accumulated faster than nutrients can return to the soil. Now, the National Park Service (NPS) aims to restore fire's natural role in parks where feasible.

In Yellowstone, lightning often ignites numerous forest fires during summer, with most extinguishing naturally. Occasionally, large wind-driven fires can impact millions of acres—a fire of this magnitude occurred in Yellowstone in 1988. The fire season typically lasts from July to September, influenced by climate, suppression efforts, and weather conditions.

Ignition

Afternoon thunderstorms that release little precipitation occur frequently in the northern Rockies. Yellowstone receives thousands of lightning strikes in a typical summer, but most do not result in fires. A snag struck by lightning may smolder for several days and then burn out because surrounding fuels are too moist to sustain combustion or too sparse to allow the fire to spread. Most of the park's forests have few shrubs; understory fuels are predominantly young trees. The moisture content of both live and dead vegetation tends to drop as summer progresses, temperatures increase, and relative humidity decreases. Fuels have often dried out enough to ignite the first wildfire of the year by July.

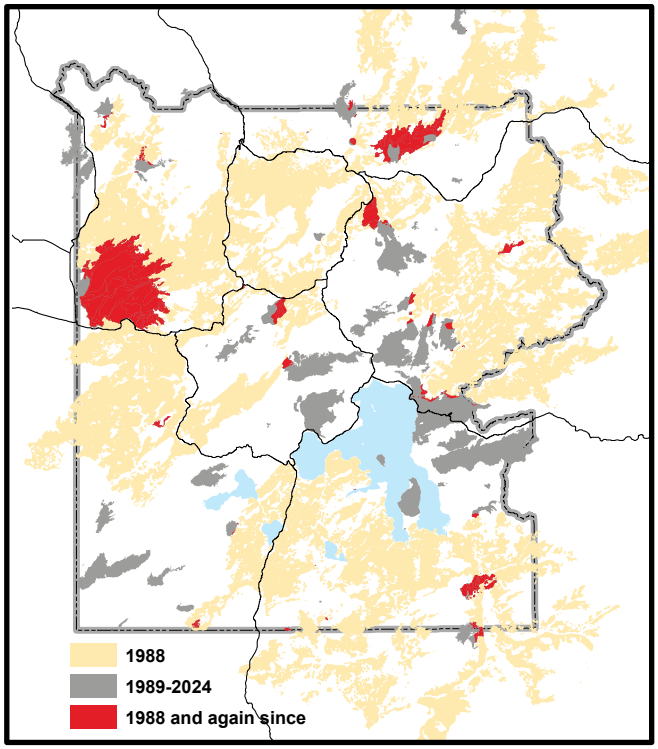
A forested area that has burned recently enough to contain only young stands of trees usually doesn't have enough combustible fuel to carry a fire, except under extreme weather and climate conditions. But as the years pass, trees that don't survive the competition for light and other resources die and eventually fall over. On living trees, older branches die and fall off as they are shaded by new foliage growing above. As a stand grows older and taller, the canopy becomes more broken. This allows enough light to reach the forest floor for a shade-tolerant understory to be established. The accumulation of fuel on the forest floor, and the continuity of fuels from forest floor to understory to canopy, make older stands more vulnerable to fire. Some forests in Yellowstone may not have burned in at least 300 years and may be particularly prone to lightning ignition.

Fire Behavior

Nearly all of Yellowstone's plant communities have burned at one time or another, but their varied characteristics cause fires to behave differently. To quickly assess a fire start and its potential to spread, park staff

use different vegetation communities as indicators of fuel load, dominant vegetation, and time since the last fire or other disturbance.

The moisture content of dead and downed woody debris, climate, and weather trends are the main factors that determine the severity of a given fire season. While fires can occur no matter the fuel moisture, many times conditions are too wet for fires to spread. In fact, 88% of all fires burn fewer than 10 acres in the park. However, in Yellowstone, when 1,000-hour fuel moistures fall below 12%, fires can grow quickly. If extreme drought continues, most forest types and ages are likely to burn.



Burned areas in Yellowstone from 1988 to 2024. Until 2016, the large fires of the 2000s were burning in areas largely unaffected by the 1988 fires. In 2016 alone, 42,425 acres burned in 1988 fire scars.

To determine how much water is in the fuel, Yellowstone fire monitoring staff weigh and oven-dry fuel samples to determine the moisture content. In a normal fire season, 1,000-hour fuels within the park may average 14–20% fuel moisture. (Dead fuels are classified according to size, and how long they take to dry out when completely soaked; "1,000-hour fuel moisture" refers to the moisture in large fuels such as downed timber that would generally dry out within 42 days. Kiln-dried lumber is 12%.)

Fire behavior is generally not observed until 1,000-hour fuel moisture contents are less than 18%, and only minimal areas are burned until moisture levels drop to 12%. At that point, a fuel moisture threshold is crossed; lightning strikes in forested areas can quickly result in observable smoke and, if fuel and vegetation conditions are right, the fire spreads. Below 12% fuel moisture, younger and more varied forest types may burn, especially when influenced by high winds. During extreme drought years, 1,000-hour fuel moistures may drop as low as 5%.

Quick Facts

Numbers in Yellowstone

- In 2024, 5.6 acres burned from 9 known wildfire starts. All but one were lightning caused and the largest was the Riverside Fire at 4 acres.
- Since 1972, when reliable fire records began, the park has averaged 24 fires, and 5,466 acres burned per year. The number of fires has ranged from five to 78 each year, and acres burned has ranged from one to 793,880 each year.
- The most active fire year since 1988 was 2016, with 70,285 acres in Yellowstone burned.
- In Yellowstone, approximately 78% of fires are caused by lightning, and 22% are human-caused.
- During the last 30 years (1994–2024), Yellowstone has averaged fewer fires per year, but more acres burned per year, than in previous decades.
- About 76% of fires in Yellowstone never reach more than 0.1 hectares (0.25 acres) in size.
- About 92% of fires in Yellowstone never burn more than 40 hectares (100 acres).

Characteristics

- Yellowstone's landscape has been shaped by naturally caused fire for 14,000 years. Factors affecting fire size and severity include: vegetation type; location; time since the last fire; moisture in the dead and down logs; length of drought; temperature; humidity; and wind.

Management Issues

- The park is required to protect human life as well as the approximately 2% of Yellowstone's 2.2 million acres that are considered developed from the threat of fire—while at the same time letting fire carry out its ecological role as much as possible.

Depending on the forest type, fuel moisture, weather, and topography, fires can grow in size by isolated or frequent torching and spotting (transport of burning material by wind and convection currents), or by spreading from tree crown to crown. Fires in Yellowstone's subalpine forests seldom spread significantly through ground fuels only. Like weather, terrain can be either an ally or adversary in suppressing unwanted wildfires. A few natural barriers such as the ridge from Electric Peak south to Mt. Holmes; Yellowstone Lake; and the Absaroka Mountains along the eastern boundary of the park are likely to prevent the spread of a low-to-moderate-intensity fire, but high-intensity fires may cross these features by spotting two to three miles ahead.

Fire managers may be able to predict a fire's behavior when they know where the fire is burning (vegetation, topography) and the fuel moisture content. However, predicting fire is much more difficult during prolonged drought periods, such as those in 1988, 2003, and 2016.

Ongoing research in Yellowstone is also showing that forests experiencing stand-replacing fires can affect fire behavior for up to 200 years. When a fire encounters a previously burned forest, its intensity and rate of spread decrease, except under prolonged drought conditions. In some cases, the fire moves entirely around the burned area. Thus, fire managers have another tool for predicting fire behavior: they can compare maps of previous fires with a current fire's location to predict its intensity and spread.

Ecological Consequences of Fire

In the first years after a major fire, new vistas appear while the lush growth of new, young trees emerges from the burned ground. Today, decades after the 1988 fires, those young trees are renewed forests, once again filling in vistas. Some visitors still feel the Yellowstone they knew and loved is gone forever. But Yellowstone is not a museum—it is a functioning ecosystem in which fire plays a vital role.

Vegetation

Some of the vegetation in the GYE has adapted to fire and, in some cases, is dependent on it. Certain plant communities require the removal of the forest canopy to become established. They are the first to inhabit sites after a fire. Other plants growing on the forest floor are adapted to survive at a subsistence level for long periods of time until fires open the canopy. Fire creates a landscape more diverse in age, which reduces the probability of disease or fire spreading through large areas.

Serotinous cones are one of the two types of cones produced by lodgepole pines, which make up nearly 80% of the park's forest. Serotinous cones will not release their seeds until the resin sealing them melts, requiring a temperature of at least 113°F (45°C). This adaptation helps ensure the seeds do not disperse until fire creates conditions that favor the establishment of lodgepole pine seedlings: diminished litter on the forest floor and plenty of sunlight through an open canopy.

Of the fires that occur in Yellowstone National Park, 76% are less than 0.25 acres and another 12% range from 0.25 to 9.9 acres. These smaller, less intense fires play a role in this ecosystem by helping to thin out smaller trees and brush, and boost the decay process that provides nutrients to the soil.

Some fires burn with higher intensity and rapid rates of spread. These large, fast-moving fires send plumes of smoke thousands of feet into the air and receive much of the public's attention. These large fires (>100 acres) only occur 8% of the time in the park.

Fire can limit trees in the meadows of Yellowstone. For example, Douglas-fir seeds require conditions that exist only in rare microhabitats in these meadows. If a seed reaches such a microhabitat during a favorable year, a seedling may develop. Once the tree is growing, it begins to influence the immediate environment. More tree habitat is created and a small forest island eventually appears. Periodic fire kills the small trees before they have a chance to become islands, thus maintaining the open meadow.

The thick bark on mature Douglas-fir trees resists damage from surface fires. Historically, in areas like the park's northern range, frequent surface fire kept most young trees from becoming part of the overstory. The widely scattered, large, fire-scarred trees in some of the dense Douglas-fir stands in the northern range are probably remnants of these communities.

Although Engelmann spruce and subalpine fir have thin bark, they grow in cool, moist habitats where conditions that enable fires to burn are infrequent. In 1988, 28% of the park's whitebark pine burned, though it grows in open, cold, high-altitude habitats that accumulate fuel very slowly and have only a short season between snowmelt and snowfall during which fires can ignite and carry. Caches of whitebark pine seeds collected by red squirrels and Clark's nutcrackers and the hardiness of whitebark pine seedlings on exposed sites give this tree an initial advantage in burned areas over conifers dependent on wind to disperse seeds. However, this slow growing and long-lived tree is typically more than 60 years old before reaching full cone production, and young trees may die before reproducing if the interval between fires is too short or if faster-growing conifers outcompete them.

Some soils respond quickly after fires, but other soil types may continue to support less vegetation.

Tree seedlings sprout and grow at variable rates between the surviving trees and the fallen and standing snags. As root systems of standing dead trees decay and lose their grip on the soil, the trees fall— sometimes hundreds at once in the presence of a strong wind. However, many trees remain upright for more than a decade after dying by fire or other causes.

Fires may stimulate regeneration of certain species of shrubs and trees, but their growth is also affected by other influences such as climate and wildlife browsing. Aspen have thin bark, but the clones are connected by a network of underground roots that can survive even very hot surface and crown fires. Although the above-ground stems may be killed, fire stimulates the sprouting of suckers from the roots, and fire leaves bare mineral soil suitable for the establishment of aspen seedlings.

Soils in Yellowstone that support little vegetation have been largely unaffected by fire. Soils that have dense, diverse vegetation before a fire are likely to respond quickly after the fire with a variety of species and nearly complete cover. Though above-ground parts of grasses and forbs are consumed by fire, the below-ground root systems typically remain unharmed, and for a few years after a fire these plants commonly increase in productivity because fire rapidly releases nutrients from wood and forest litter.

Trees in greater Yellowstone are adapted to fire. This serotinous cone from a lodgepole pine tree was opened by fire, allowing it to release its seeds.

The regrowth of plant communities begins as soon as moisture is available, which may be within days at some sites.

Wildlife

Wildfires do not significantly affect the abundance of most wildlife species in Yellowstone. Relatively few animals died as a direct result of the large fires in 1988, and most of those deaths were caused by smoke inhalation. Of Yellowstone's seven native ungulate species, only the moose experienced a population decline after 1988. Although moose population estimates are imprecise, it appears that with less willow and subalpine fir available for winter browse, and snow accumulating more deeply with many forest canopies gone, moose winter mortality increased in 1989.

Mortality in all ungulate species was unusually high in the winter after the fires, but it is difficult to know how much of that was the result of burned forage rather than drought, large herd sizes, and the relatively severe winter. Elk, bison, and deer populations soon rebounded.

Of the 38 grizzly bears wearing radio transmitters when the fires began, 21 had home ranges burned by one or more of the fires. Thirteen of those bears moved into burned areas after the fire front had passed, three adult females without young stayed within active burns as the fire progressed, three bears remained outside the fire perimeters, one adult female was not located for another two years, and another adult female was never located again at all. Large predators such as grizzly and black bears, cougars, and wolves simply move out of the way of a fire. Bears have been observed frequently grazing in burned areas after the vegetation has started to return due to the increase in vegetation in years following a fire. Even the fires in 1988 had no discernible impact on the number of grizzly bears in the GYE.

Wildlife continue to use burned areas after fires.

Rodents probably have the highest fire-related mortality of any mammals. Although many can escape fires in burrows, they can die of suffocation as fires come through. They also become more exposed to predators because they temporarily lose the cover of grasses and other plants. But, because of their capacity to have multiple litters with many young per year, rodents quickly repopulate burned areas.

Most birds are not directly harmed by fires, and some benefit. Raptors hunt rodents fleeing a fire, but young still in their nests may die. Post fire habitat changes help some birds. Cavity-nesting birds, such as Barrow's goldeneye, flickers, and bluebirds have many dead trees for their nests. Robins and flickers find ants and worms more easily. Boreal owls, however, may lose some of the mature forests they need.

History of Fire Management

Fire suppression in Yellowstone began with the arrival of the US Army, which was placed in charge of protecting the park in 1886. The Army, which was in Yellowstone until 1918, successfully extinguished some fires in the belief that suppression would help save the forests. However, it is difficult to determine how much effect a small group of men could have had on overall fire size or the extent of fires in a large park without motorized vehicles or good roads. Fire suppression was most successful on the northern range, which is relatively accessible from the park headquarters in Mammoth Hot Springs.

More effective fire fighting techniques and airplanes became available after World War II, but even then, fire suppression did not result in a significant increase in fuel loads except perhaps on the northern range. Records indicate fire was almost completely excluded (suppressed) from the Douglas-fir, sagebrush steppe, and aspen communities on the northern range from 1886 until 1987.

By the 1940s, ecologists recognized fire was a natural and unavoidable change agent in many ecosystems, including relatively arid portions of the Rocky Mountains. In the 1950s and 1960s, other parks and forests began to experiment with controlled burns. In 1972, Yellowstone became one of several national parks to initiate programs that allowed some lightning-caused fires to burn. Two backcountry areas in

History of Fire Management in Yellowstone

For the first 100 years of the park's existence, managers believed fires had to be extinguished to preserve park resources. Subsequent scientific research revealed

- fires have occurred in Yellowstone for as long as there has been vegetation to burn,
- fire plays a role in creating the vegetation patterns of the landscape,
- fire is a part of the ecosystem park managers want to preserve, and
- suppressing fires alters the natural landscape and diminishes diversity.

History

- 1886–1918: US Army suppresses fire in Yellowstone.
- 1940s: More effective fire suppression techniques become available after World War II. Around the same time, ecologists recognize fire is a natural and unavoidable change agent in many ecosystems.
- 1972: Yellowstone begins allowing some natural fires.
- 1972–1987: 235 natural, unsuppressed fires burned 33,759 acres—mostly in two dry years: 1979 and 1981.
- Spring 1988: Approval of a new fire management policy for Yellowstone is suspended.
- 1988: 793,880 acres burn in Yellowstone, sparking an increase in the public understanding and acceptance of the role of fire in wildland areas.
- 1989: A national policy review team reaffirms the importance of natural fire policies in national parks and wilderness areas.
- 1992: Yellowstone issues a new fire management plan incorporating the 1989 review team's recommendations.
- 2004: Yellowstone's fire management plan is revised.
- 2009: Yellowstone begins operating under the 2009 Federal Wildland Fire Policy, which allows the park to manage fires for multiple objectives.
- 2014: Yellowstone's fire management plan is revised.

the park totaling 340,000 acres, Mirror Plateau and Two Ocean Plateau, were designated as locations where natural fires could burn.

After three years, during which 10 fires burned a total of 831 acres in the two fire zones, the non-suppression area was expanded to include most of the park, except for developed areas and a buffer zone on the park boundary. Starting with Yellowstone National Park and Bridger Teton National Forest in 1976, cooperative agreements were adopted among all greater Yellowstone federal lands that by 1986 allowed natural fires to burn across shared public land boundaries.

From 1972 to 1987, 235 fires were allowed to burn 33,759 acres in Yellowstone. The summers of 1982–1987 were wetter than average, which may have contributed to the relatively low fire activity during that period. Yellowstone's fire managers began revising the park's fire management plan. The new plan permitted some lightning-caused fires to burn under natural conditions; provided for suppressing fires that threatened human life, property, special natural features, and historic and cultural sites; and recommended prescribed burns when and where necessary and practical to reduce hazard fuels. It was in the final stages of approval in spring 1988.

However, Yellowstone's "new" fire management plan was suspended in July 1988 as a consequence of the large fires that occurred that summer. After these fires, a national policy review team examined the national fire policy again and reaffirmed the importance of natural fire policies in national parks and wilderness areas. However, the report also offered recommendations, including the establishment of more specific criteria to determine under what circumstances fires are permitted to burn and more reduction of hazard fuels near developed areas. These recommendations were incorporated into Yellowstone's 1992 fire management plan. Other revisions occurred to the park's fire management plan in 2004 and 2014.

Monitoring fire behavior and weather on the Maple Fire, 2016.

Fire Management

Our Goals

- **We let wildfire carry out its ecological role while protecting people and structures.** Yellowstone National Park operates under the 2009 Federal Wildland Fire Policy. These guidelines allow fire personnel to manage a lightning-caused fire for multiple objectives. For example, fire personnel can suppress one side of a fire to protect structures and people, while allowing another side to burn to achieve natural fire benefits.
- **We work across boundaries to manage fires.**
- Wildfire is a great example of interagency cooperation and coordination. Federal agencies, state and local governments, and private contractors all play a role in managing fire in the park.
- **We work to reduce hazardous fuels near developed areas.** Fuels management includes both planned prescribed burns and other mechanical treatments to change and/or reduce wildland fuels. The goal of Yellowstone National Park's fuels management program is to reduce hazardous fuel loads near developed areas.
- **We monitor the effects of planned fire management actions**. The Yellowstone fire effects monitoring crew collects information on the long-term effects of fire and fire management activities. The crew collects data on fuel loads, plant populations, tree regeneration, nonnative species and other aspects of the park's ecosystems. Monitoring is a major component of the adaptive management process.

Managing a Natural Process

The National Park Service may allow lightning-ignited fires to burn in Yellowstone provided they are not a threat to human life and property. In an average year, Yellowstone has approximately 24 fires, 80% of which are caused by lightning. The park protects human life as well as the approximately 2% of Yellowstone's 2.2 million acres that are considered developed (e.g., roads, buildings, and other infrastructure), which includes almost 2,000 buildings, from the threat of fire while at the same time letting wildfire carry out its ecological role in the landscape as much as possible.

The Antelope Fire of 2010 was an example of managing a fire for multiple objectives. It was suppressed on its west flank to protect people using the roads and other values at risk. It was monitored, but not suppressed, as it moved south and east away from developed areas.

Working Across Boundaries

Fire management requires interagency cooperation and coordination. For example, the NPS sometimes relies on Forest Service smokejumpers to assist with the park's remote fires. In return, the National Park Service sends its helicopter or engine to the Silver Gate or Cooke City areas, which are located on or adjacent to the Custer Gallatin and Shoshone national forests. Programmable radios ensure communication between NPS and Forest Service dispatch, which improves firefighter safety. The NPS also works with its partners to develop community wildfire protection plans to help plan and prepare for a wildfire that may threaten homes.

Wildland Fire Program

Dispatch

Yellowstone's Wildland Fire and Aviation Dispatch Center handles fire reports from lookouts, visitors, and park employees, and dispatches appropriate resources to the scene. If additional resources are needed, the dispatch office fills requests with park resources or forwards them to the Billings Interagency Dispatch. The office also manages requests for Yellowstone resources to be dispatched outside the park. Besides tracking all resources for park incidents and areas just outside its boundaries, the dispatch office oversees search and rescue operations, special incidents, flight-following for various aircraft, and ordering and tracking medevac flights for medical emergencies.

Engines

Yellowstone has one wildland fire engine staffed from May through October. The engine supports local fire management and large firefighting efforts nationwide. Engine crews handle initial attacks near roads but can also reach remote fires by hiking or flying in. They assist with fireline production, structure protection, and helicopter operations, using water to create wetlines that minimize vegetation impact and erosion. For structure protection, the crew conducts structure triage, uses sprinklers, foil wrap, and fuel

reduction techniques. Yellowstone also maintains a variety of pumps and water handling equipment for different firefighting needs.

Helitack

The Yellowstone Helitack Crew is a ten-person crew that responds to wildfires as well as search and rescue operations (SAR). They manage and staff a Type 3 Helicopter based at Mammoth Hot Springs, seven days a week from mid-June until October.

Our helitack crew is trained in all aspects of safe helicopter operations, including size-up and initial attack of wildfires as well as passenger and cargo transport by short haul and longline.

When fire activity in Yellowstone is low, the helicopter and crew assist other forests and parks all over the United States with wildfire and SAR operations. When not working on wildfires or assisting with search and rescue operations, crew members assist with fuels projects, hazard tree removal, and assisting the many other park operations where their skills and unique talents are needed.

Lookouts

The Yellowstone Fire Management Office maintains two fire lookout stations located on Mt. Washburn (10,219 feet) and Mt. Sheridan (10,308 feet). Only Mt. Washburn is continuously staffed from mid-June until the end of the fire season in the fall.

The lookouts serve two primary functions: fire detection and fire monitoring. Each lookout tower is staffed with a trained fire lookout who is provided with cell phones, radios, and high-quality optical equipment. Additionally, each station has a conventional Osborne fire finder—a sighting device used to calculate azimuth and range.

Fuels Management

Yellowstone National Park's fuels management program aims to reduce hazardous fuel loads near developed areas through planned prescribed burns and mechanical treatments. Fuels include all plant material that can ignite, influencing fire behavior and its effects on ecosystems. By reducing hazardous fuels, the program enhances firefighter safety, protects structures during wildfires, and mitigates the risk of severe fire to human communities while preserving the health of the Yellowstone ecosystem.

Effects Monitoring

The National Park Service's Fire Effects Monitoring Program in Yellowstone focuses on assessing the impacts of planned fire management activities. The dedicated crew collects data on fuel loads, plant populations, tree regeneration, and non-native species to understand the long-term effects of fire. This monitoring aids in adaptive management. Additionally, the crew provides crucial information on weather and fuel conditions through a network of weather stations and monitors precipitation, drought indices, and lightning occurrences to gauge fire danger. During wildfires, they gather data on fire behavior, fuels, vegetation, and weather to assist fire managers in predicting fire dynamics.

A summary of fire seasons is available at **https://www.nps.gov/yell/learn/management/fire-management.htm**

More Information

Barker, R. 2005. *Scorched Earth: How the fires of Yellowstone changed America*. Island Press/Washington.

Franke, M.A. 2000. Yellowstone in the afterglow: lessons from the fires. YCR-NR-2000-3. Mammoth, Wyo.: Yellowstone Center for Resources.

Greenlee, J., ed. The ecological implications of fire in Greater Yellowstone: proceedings of the second biennial conference on the Greater Yellowstone Ecosystem. Fairfield, Wash.: *International Association of Wildland Fire*.

Higuera, P.E. et. al. 2010. Linking tree-ring and sediment-charcoal records to reconstruct fire occurrence and area burned in subalpine forests of Yellowstone National Park, USA. The Holocene.

International Association of Wildland Fire: www.iawfonline.org

National Interagency Fire Center: www.nifc.gov

National Park Service Fire and Aviation Management: www.nps.gov/fire

Renkin, R.A. and D.G. Despain. 1992. Fuel moisture, forest type, and lightning-caused fire in Yellowstone National Park. *Canadian Journal of Forestry Research* 22(1):37–45.

Simard, M. et al. 2011. Do mountain pine beetle outbreaks change the probability of active crown fire in lodgepole pine forests? *Ecological Monographs* 81(1): 3–24.

Turner, M.G., et al. 2003. Surprises and Lessons from the 1988 Yellowstone Fires. *Frontiers in Ecology and the Environment*. 1(7):351–358.

Westerling, A.L. et al. 2011. Continued warming could transform Greater Yellowstone fire regimes by mid-21st century. *Proceedings of the National Academy of Science*.

Yellowstone Science. 2009. 9th Biennial Scientific Conference: The '88 Fires: Yellowstone and Beyond. 17(2).

Staff Reviewers

John Cataldo, Fire Management Officer