



Nearly 300 bird species have been sighted in Yellowstone National Park, including raptors, songbirds, shorebirds, and waterfowl. About 150 species build their nests and fledge their young in the park.

Birds

Records of bird sightings have been kept in Yellowstone since its establishment in 1872. These records document nearly 300 species of birds to date, including raptors, songbirds, shorebirds, and waterfowl. Approximately 150 species nest in the park. The variation in elevation and broad array of habitat types found within Yellowstone contribute to the relatively high diversity. Many of the birds are migratory species. There are currently no federally listed bird species known to breed in Yellowstone National Park.

The Yellowstone National Park bird program monitors a small portion of its breeding bird species to gather information on reproduction, abundance, and habitat use. Data is collected on multiple species from a wide variety of taxonomic groups, and

has been maintained for 25 or more years for several species. Long-term monitoring efforts help inform park staff of potential shifts in ecosystem function, e.g., climate change effects, for Yellowstone's bird community and may guide future conservation of the park's birds and their habitats.

Climate Change

The timing of the availability of food sources for birds may change with rising temperatures and changing weather patterns. Birds are sensitive to shifts in seasonal weather patterns and show a relatively rapid response to these fluctuations. For example, climate change has been shown to influence migration patterns, population size and distribution, the timing of reproduction, and nesting success for birds. Through monitoring, birds can be used as environmental health indicators to help managers detect changes in ecosystem function and, if necessary, take appropriate management action.

The Yellowstone bird program monitors the spring arrival of species to the park, as well as the timing of nest initiation and fledging for several raptor species, which may be useful in observing the effects of climate change in Yellowstone.

More Information

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Quick Facts

Number in Yellowstone

285 documented species; approximately 150 species nest in the park.

Species of Concern

- Trumpeter swan
- Golden eagle
- Common loon

Current Management

The Yellowstone National Park bird program monitors the park's bird species, including species of concern. The program's core activities are monitoring raptors (bald eagles, ospreys, peregrine falcons, golden eagles), wetland birds, and passerine/near passerine birds (songbirds and woodpeckers).

FREQUENTLY ASKED QUESTION:

Where are good birding locations?

That depends on what kind of birds you want to see, the time of day you are looking, and your location in the park. In general, riparian areas and wetlands, especially those with shrubby willows, aspen, and cottonwoods attract the greatest diversity and abundance of songbirds.

Hayden Valley is one of the best places to view water birds and birds of prey. Shorebirds feed in the mud flats at Alum Creek. Sandhill cranes often nest in the valley. Ducks, geese, and American white pelicans cruise the river. Bald eagles and osprey hunt for fish along the river; northern harriers fly low looking for rodents in the grasses. Great gray owls are sometimes seen searching the meadows for food (these birds are sensitive to human disturbance). Blacktail Ponds and Floating Island Lake, between Mammoth and Tower Junction, and the Madison River west of Madison Junction are also good places to look for birds.

Many birds, such as American robins and common ravens, are found throughout the park. Other species live in specific habitats. For example, belted kingfishers are found near rivers and streams while Steller's jays are found in moist coniferous forests.

Spring is a good time to look for birds. Migration brings many birds back to the park from their winter journeys south; other birds are passing through to more northern nesting areas. Songbirds are singing to establish and defend their territories; and many ducks are in their colorful breeding plumages,

which makes identification easier.

Watch for birds on early morning walks from mid-May through early July. At all times, but especially during the nesting season, birds should be viewed from a distance. Getting too close can stress a bird (as it can any animal) and sometimes cause the bird to abandon its nest. As with all park wildlife, visitors should keep at least 25 yards away from birds and their nests.

Most birds migrate to lower elevations and more southern latitudes beginning in August. At the same time, other birds pass through Yellowstone. Hawk-watching can be especially rewarding in Hayden Valley late August through early October. In early November, look for tundra swans on the water.

Birds that can be viewed in Yellowstone year-round include the common raven, Canada goose, trumpeter swan, dusky grouse (formerly blue grouse), gray jay, black-billed magpie, red-breasted nuthatch, American dipper, and mountain chickadee. A few species, such as common goldeneyes, bohemian waxwings, and rough-legged hawks migrate here for the winter.

Visitors may report sightings with a bird observation form, available at www.nps.gov/yell/learn/nature/wildlife-sightings.htm and at visitor centers.

Please note: The use of audio bird calls is illegal in the park.

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Staff Reviewers

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Great horned owls are one of more than a dozen raptor (birds of prey) species in Yellowstone.

Raptors

The park supports 19 breeding raptor species. Additional species use the Yellowstone landscape during migrations and seasonal movements. The bird program monitors bald eagles, ospreys, and peregrine falcons. Bald eagles and peregrine falcons were previously listed as endangered and threatened species and the park has continued monitoring since their delisting. The osprey is monitored because of the decline of one of their primary food sources—the cutthroat trout in Yellowstone Lake. Other species that occur in the park such as golden eagles and Swainson's hawks are of growing conservation concern throughout their ranges in the United States.

Yellowstone Raptor Initiative

The Yellowstone Raptor Initiative was a five-year (2011–2015) program designed to provide baseline information for golden eagles (*Aquila chrysaetos*), red-tailed hawks (*Buteo jamaicensis*), Swainson's hawks (*Buteo swainsoni*), American kestrels (*Falco sparverius*), prairie falcons (*Falco mexicanus*), and owls as focal species. In addition to surveys conducted by park biologists, the initiative relied on citizen science to acquire valuable data on raptors in the park.

Surveys located 28 pairs of golden eagles, and more likely breed within the park. Observed breeding success was low on average and should be the subject of research in the future.

Researchers were surprised at the high density of red-tailed hawks in the northern range compared to other regions of similar habitat. Red-tailed hawks also exhibited variable breeding success and efforts to monitor this species using citizen science are ongoing.

Swainson's hawks proved a difficult species to survey in Yellowstone. Most studies have focused

on their association with agricultural land, and the park represents a somewhat unorthodox habitat for Swainson's hawks.

Surveys demonstrated that at least 17 species of raptor use Hayden Valley as a migration corridor, comparable to that observed at other migration sites in the Intermountain Flyway. The Initiative provided the first look at owl distribution and occurrence in the park. Continued surveys, especially in the park interior, will improve our knowledge and understanding of this under-studied group of raptors. Finally, while not monitored during this study, accipiters are of growing conservation concern, particularly northern goshawks, and should be considered in future raptor studies.

Owls

Owl surveys continued after the completion of the Raptor Initiative in 2015, enabled by volunteers. Surveys provide an index of sites that attract advertising males of several northern forest owl species. Over the eight years of study, the greatest owl species diversity was observed in 2018, following a low in 2017. In 2018, observers detected individuals of six owl species: boreal owl (6), great horned owl (8), northern saw-whet owl (6), northern pygmy-owl (2), long-eared owl, and great gray owl (1).

For the second year in a row, a nesting pair of long-eared owls was observed in Indian Creek Campground. While long-eared owls have long been assumed to breed within the park, these are the first recorded nests by this species.

Bald Eagles

The bald eagle (*Haliaeetus leucocephalus*) was named the national symbol of the United States by Congress in 1782. Found near open water from Mexico to Alaska, bald eagles may range over great distances but typically return to nest in the vicinity where they fledged. In Greater Yellowstone they feed primarily on fish, but also on waterfowl and carrion. Numbers declined dramatically during most of the 1900s due to habitat loss, shooting, and pesticide contamination. In 1967, the US Fish and Wildlife Service listed the bald eagle as an endangered species in 43 states, including Idaho, Montana, and Wyoming. Habitat protection, restrictions on killing, and restrictions on pesticide use led to population growth and delisting of the species in 2007. Bald eagles nesting in north-western Wyoming are part of the Rocky Mountain breeding population that extends into Idaho and Montana.

Population

Bald eagles, which may reuse the same nest year after year, occupy territories near the park's major rivers and lakes. The number of eaglets that fledge each year depends partly on weather and can fluctuate widely. Juveniles may migrate west in the fall but adults often stay in the park year-round. Historically, about half of the park's known bald eagle nests have been in the Yellowstone Lake area, where the



Bald eagles are a recovered endangered species.

productivity and success rates are generally much lower than in the rest of the park. However, in 2018, only seven of seventeen active nests in the park were on Yellowstone Lake. Of those seven, three were successful and fledged four young in total. A recent study found little evidence to support the claim that cutthroat trout declines have resulted in lower nesting success for bald eagles on Yellowstone Lake.

Outlook

Research has shown that human presence can disturb eagle nesting and foraging, therefore nest areas in national parks may be closed to visitors. Yellowstone manages nest sites on a case by case basis.

Bald Eagle Quick Facts

Number in Yellowstone

- In 2018, park staff monitored 32 bald eagle territories. Of 16 active nests 9 (56%) successfully fledged young.
- 11 young were produced. Productivity for active nests in 2018 (0.7 young per nesting female), was just below average (0.73).

Identification

- Large, dark bird; adult (four or five years old) has completely white head and tail.
- Females larger than males, as is true with most predatory birds.
- Immature bald eagles show varying amounts of white; they can be mistaken for golden eagles.

Habitat

- Bald eagles are usually found near water where they feed on fish and waterfowl. They also generally nest in large trees close to water.

Behavior

- In severe winters, eagles may move to lower elevations such as Paradise Valley, north of the park, where food is more available. On these wintering areas, resident eagles may be joined by migrant bald eagles and golden eagles.
- Feed primarily on fish and waterfowl, except in winter when fish stay deeper in water and lakes and rivers may be frozen. Then they eat more waterfowl. Eagles will also eat carrion in winter if it is available.

- Form long-term pair bonds.
- Some adults stay in the park year-round, while others return to their nesting sites by late winter.
- Lays one to three eggs (usually two) from February to mid-April.
- Both adults incubate the eggs, which hatch in 34 to 36 days.
- At birth, young (eaglets) are immobile, downy, have their eyes open, and are completely dependent upon their parents for food.
- Can fly from the nest at 10–14 weeks old.
- Some young migrate in fall to western Oregon, California, and Washington.

Golden Eagles

Golden eagles (*Aquila chrysaetos*) are large, long-lived raptors that feed on grouse, small mammals (e.g., rabbits, marmots, and ground squirrels), and carrion. Across the western USA, and in Wyoming in particular, there are growing concerns about the status of golden eagle populations due to broad-scale energy development (wind, gas) and increasing human activity. To better understand the current population status and the drivers of population trends across the ecosystem, park biologists began focused study of golden eagles in Yellowstone in 2011.

Surveys located 28 golden eagle territories inside the park, 20 within the northern range alone. The resulting density in northern Yellowstone (one territory per 49.7 km²) is relatively high. Likewise, territory occupancy rates from 2011 to 2018 have been consistently high (100%). In contrast, low average productivity at these nests (0.36 young/occupied territory) is driven by both infrequent nesting attempts and low nest success. For example, in 2018, researchers monitored 22 occupied territories; 9 pairs nested and 6 nests were successful in fledging 7 young. With such low productivity, the Yellowstone golden eagle population may be dependent on outside immigration, although much about the status of the park's golden eagle population remains unknown.

In other studies, reproductive failure of eagles and other raptors has been correlated with weather (e.g., high failure in high precipitation years), often interacting with food availability. Ongoing research is investigating golden eagle habitat use in Yellowstone's northern range to better understand local population dynamics.

Outlook

In response to broad concerns about golden eagle populations, Wyoming has initiated a golden eagle working group and the US Fish and Wildlife Service has instituted a western US study modeling eagle habitat suitability, human development risks, lead exposure, and large-scale movements. Better understanding of the ecology of YNP eagles requires study of their food habits, toxicology, survival, and movement both within and outside the park. In recent years, extensive data relating to these key topics have been collected in two study areas flanking the park to the north and east and complimentary research within the park is ongoing.



Golden eagles are named for the yellow feathers at the base of the neck.

More Information

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Osprey

Like many other birds of prey, osprey (*Pandion haliaeetus*) populations declined due to pesticide use in the mid-1900s and rebounded in the latter part of the century, after the banning of pesticides such as DDT. The first study of osprey in Yellowstone National Park occurred in 1917 by M. P. Skinner, the park's first naturalist. It was not until 1987 that the Yellowstone National Park bird program began monitoring breeding osprey annually, although an extensive survey on reproduction, diet, and habitat was conducted during the 1970s.

Ospreys are surveyed via fixed-wing aircraft and by ground-based surveys from May through August. During the survey flights, the majority of nests are monitored for occupancy and breeding activity. In addition, all suitable lakes and rivers are surveyed for potential new territories and nest sites.

Since monitoring began, Yellowstone's population of osprey has declined, particularly on and around Yellowstone Lake. Nest success has remained relatively stable, with about 50% of nests producing one to two young per year.

Research

A recently completed study conducted by park biologists found a significant relationship between the declines in cutthroat trout and osprey reproduction at Yellowstone Lake. Recent increases in the number of young cutthroat trout caught by the Yellowstone fisheries program during the fall netting assessment are encouraging. An increase in cutthroat trout production may lead to an increase in nesting pairs of ospreys and improved nesting success at Yellowstone Lake.



Ospreys are monitored by park staff. In 2017, 27 active nests were monitored in Yellowstone.

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Quick Facts

Number in Yellowstone

- In 2018, 25 active nests were monitored, ~59% were successful, above the 32-year average (52%).
- Productivity for active nests in 2018 (1 young per nesting female) was also above the 32-year average (0.89).
- The single active osprey nest on Yellowstone Lake in 2018 was not successful.

Identification

- Slightly smaller than the bald eagle.
- Mostly white belly, white head with dark streak through eye.
- Narrow wings, dark patch at bend.
- Fledglings have light edges to each dark feather on their backs and upper wing surfaces, which gives them a speckled appearance.

Habitat

- Dependent on fish for food, osprey are usually found near lakes (such as Yellowstone Lake), river

valleys (such as Hayden, Madison, Firehole, and Lamar valleys), and in river canyons (such as the Gardner Canyon and the Grand Canyon of the Yellowstone River).

Behavior

- Generally returns to Yellowstone in April and leaves in September.
- Builds nest of sticks in large trees or on pinnacles close to water.
- Lays 2–3 eggs in May to June.
- Eggs hatch in 4–5 weeks

Peregrine Falcons

The peregrine falcon is among the fastest birds, flying at up to 55 mph and diving at more than 200 mph when striking avian prey in mid-air. Peregrine populations began to decline in the 1940s because of pesticide contamination. One of three North American subspecies, the peregrine in Greater Yellowstone (*Falco peregrinus anatum*) was considered extirpated by the 1970s. As part of a national reintroduction program, captive-bred peregrines were released in Yellowstone and Grand Teton national parks during the 1980s. They typically reside in Greater Yellowstone from March through October, when their favored prey—songbirds and waterfowl—are most abundant. During winter they migrate as far south as Mexico or Central America.

History

In 1962, Rachel Carson sounded an alarm about the irresponsible use of pesticides with her landmark book *Silent Spring*. Among the dangers she described were the adverse effects of chemicals—particularly DDT—on the reproductive capacity of some birds, especially predatory species such as the bald eagle and peregrine falcon. Her book raised public awareness of this issue, and was one of the catalysts leading to the United States banning some of the most damaging pesticides.

The peregrine falcon was among the birds most affected by the toxins. It was listed as Endangered in 1970. Yellowstone National Park was a site for peregrine reintroductions in the 1980s, which were discontinued when the peregrine population began



TOM STANTON

Peregrine falcons are a recovered endangered species in Yellowstone.

increasing following restrictions on organochlorine pesticides in Canada and the United States, habitat protection, and the reintroduction program. The falcon made a comeback in much of its former range, and was delisted in 1999.

In Yellowstone, the most nesting pairs recorded was 32 in 2007, and they produced 47 fledglings. Although nesting pairs may reuse the same eyrie for many years, their remote locations on cliff ledges makes it impractical to locate and monitor activity at all eyries in a single year.

Yellowstone National Park's protected conditions and long-term monitoring of peregrines provide baseline information to compare against other populations in the United States. Continued monitoring is essential, not only for comparisons with other populations, but also because peregrine falcons and other raptors are reliable indicators of contaminants such as polybrominated diphenyl ether (PBDE), and of climate change. For example, to assess the levels

Quick Facts

Number in Yellowstone

- In 2018 park staff monitored 28 of the 36 known peregrine breeding territories. Twelve territories were occupied.
- Seven of the 8 active pairs with known breeding outcomes fledged 15 young in 2018 (88% nest success). Above the 31-year average (71%) and the highest observed since 2003.
- In 2018 average productivity was 1.9 young per occupied territory. Above the 31-year average (1.54 young per breeding pair), and the

highest observed since 2003.

Identification

- Slightly smaller than a crow.
- Black "helmet" and a black wedge below the eye.
- Uniformly gray under its wings. (The prairie falcon, which also summers in Yellowstone, has black "armpits.")
- Long tail, pointed wings.

Habitat

- Near water, meadows, cliffs.

- Nests on large cliffs over rivers or valleys where prey is abundant.

Behavior

- Resident in the park March through October, when its prey—songbirds and waterfowl—are abundant.
- Lays 3–4 eggs in late April to mid-May.
- Young fledge in July or early August.
- Dives at high speeds (can exceed 200 mph/320 kph) to strike prey in mid-air.

of PBDE and other contaminants, scientists collect eggshell remains after peregrines have left their nests for the season.

Recovery in Yellowstone

While the organochlorines found in peregrine eggshell fragments and feather samples have declined significantly, several studies indicate that certain flame retardant chemicals developed in the 1970s for use in electronic equipment, textiles, paints, and many other products leach into the environment and have been found in birds of prey at levels that impair their reproductive biology. In 2010, 2011, 2013, and 2014 eggshell fragments, feathers, and prey remains were collected from nest sites in Yellowstone after fledging occurred. Comparative data on eggshell thickness, which is an indicator of environmental contaminants, is within the range considered normal for the Rocky Mountain Region.

The major cause of peregrine endangerment is no longer a threat and YNP's peregrine population appears stable. Furthermore, although both

productivity and nesting success have remained below the 31-year average for the last 5 years, both measures have increased slightly since 2015. The relatively low nesting success and productivity in the last decade warrants continued close monitoring of this species and may require further study to determine the cause(s).

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American white pelicans, sometimes mistaken for trumpeter swans at a distance, and other colonial nesting birds nest primarily on the Molly Islands in the southeast arm of Yellowstone Lake.

Wetland Birds

Approximately 30% of the bird species that breed in Yellowstone depend on wetlands. Scientists are concerned about these species because wetlands are expected to diminish as global and local temperatures increase. Yellowstone has years of data about the rate and success of nesting for some wetland species, but little information about changes in the timing of nesting activity—an indicator of climate change.

Colony Nesting Birds

Colonial nesting birds nest primarily on the Molly Islands in the southeast arm of Yellowstone Lake. These two small islands are cumulatively just 0.7–1.2 acres in size, depending on lake water levels, yet hundreds of birds have nested there in a single year.

Prior to the late 1970s, the Molly Islands were surveyed only intermittently. Some data goes back to 1890 when nesting American white pelicans (*Pelecanus erythrorhynchos*) and California gulls (*Larus californicus*) were first noted in the area. Caspian terns (*Hydroprogne caspia*) are suspected of nesting on the Molly Islands as early as 1917, although information on breeding status was not collected until 1933. Double-crested cormorant (*Phalacrocorax auritus*) nests were confirmed by 1928.

Currently, pelicans, California gulls, and double-crested cormorants nest with varying rates of success. Photographic interpretation from three aerial surveys conducted June through August 2018, showed approximately 197 pelican nests that fledged an estimated 51 young; 33 nesting double-crested cormorants fledged an estimated 21 young. Though California gulls were observed on the island, none attempted to nest. As in recent years, no Caspian terns were observed on the islands.

Habitat

Birds nesting on the Molly Islands are subject to extreme environmental conditions ranging from flooding, frosts that can occur at any time of year, and high winds. As a result, birds nesting there experience large year-to-year fluctuations in the number of nests initiated and fledglings produced. Populations of American white pelicans, California gulls, and double-crested cormorants have declined over the last 20 years. Caspian terns have not nested on the islands since 2005.

The reasons for the decline in colonial nesting birds are not well understood, but a previous study indicates that high levels of water in Yellowstone Lake are associated with low reproduction for nesting pelicans. Notably, quick spring melt-off events can cause a significant rise in the water level on Yellowstone Lake and flood the Molly Islands.

The decline in cutthroat trout, a known food source for the Molly Island colonial nesting birds, may also influence nesting success. Furthermore, bald eagles on Yellowstone Lake that formerly depended on cutthroat trout may have switched prey to target the flightless and vulnerable young of these colonial nesting species.

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Common Loons

The park's common loon (*Gavia immer*) population is one of the most southerly breeding populations in North America. The majority of Wyoming's population of breeding common loons occurs in Yellowstone. The common loon is listed as a Species of Special Concern in Wyoming because of its limited range, small population, sensitivity to human disturbance, and loss of breeding habitat outside of Yellowstone. Wyoming's breeding loon population is isolated from populations to the north by more than 200 miles, limiting immigration from other populations. Since the mid-2000s, Wyoming's population has declined by 38%. Yellowstone's loon population has declined since surveys began in 1989, with a more dramatic decline in 2006. However, detailed data from a study initiated in 2012 indicate that the number of loons present in the park can vary widely from year to year. Continuing research will try to analyze any trends in productivity, nesting success, and number of breeding pairs to attempt to determine why some years are more productive than others.



The common loon is a species of concern in Yellowstone.

Population

In 2018, biologists and park staff checked at least 28 known or historic loon territories. Seventeen of the territories were occupied by at least one loon. In total, the park housed 35 adult loons and 16 pairs. Eleven pairs attempted to nest, and two of those failed. The nine successful pairs produced nine loonlets during 2018.

Quick Facts

Number in Yellowstone

- In 2018, 35 loons in total. 16 territorial pairs. Nine successful nests produced 9 young.

Identification

- Breeding adults (March–October) have black and white checkering on back, a black bill, red eyes, and iridescent green head and neck. The neck has a black and white chinstrap and distinctive collar.
- Loon chicks hatch with a blackish-brown down and white belly and retain this plumage for two weeks. Body feathers emerge at 4½ weeks on the chick's upper back. By six weeks, brown down only remains on the neck and flanks.
- Gray juvenile plumage is present at seven weeks.
- Juveniles and winter adults have dark upperparts and white underparts.

Habitat

- Summer on ponds or lakes: large lakes, such as Yellowstone, Lewis, and Heart Lakes; and smaller ones such as Grebe and Riddle Lakes.

- Winter on open water.
- May be found foraging or resting on larger, slow moving rivers.
- Nest sites are usually on islands, hummocks in wetlands, or floating bog mats.
- Pairs nesting on lakes smaller than 60 acres usually require more than one lake in their territory. Lakes smaller than 15 acres are rarely used.

Behavior

- Primarily eat fish (4–8 inches).
- Unable to walk on land.
- Migrate in loose groups or on own, not in organized flocks. Arrive at summer lakes and ponds at or soon after ice-off.
- Four common calls: wail—for long distance communication, yodel—used as a territorial signal by males only, tremolo—a staccato call, usually by an agitated adult, and hoot—a contact call, often between adults or adults and their young.

- Females generally lay two eggs, typically in June.
- Males and females share incubation duties equally. Chicks hatch after 27–30 days. Both adults also care for their young.
- Chicks are able to fend for themselves and attain flight at 11–12 weeks.
- In late summer, adults form social groups, especially on larger lakes, before leaving in October.

Management Concerns

- The breeding population in Wyoming is isolated; populations to the north are more than 200 miles away.
- Loons can be bioindicators of the aquatic integrity of lakes, responding to lead and mercury levels.
- All factors affecting loon reproduction in Yellowstone are unknown, but human disturbance of shoreline nests has a negative impact.

Distribution

In the western United States, common loons breed in Idaho, Montana, Washington, and Wyoming. The total western US breeding population is estimated at 90 territorial pairs. In 2018, Yellowstone National Park hosted 70% of the state's total loon population and 73% of the breeding pairs. Furthermore, YNP loons produced 69% of the ecosystem's fledged chicks, highlighting the park's important role in regional loon population stability and persistence. Western populations of breeding common loons are known to overwinter from Washington south to California. Spring and fall migrants in Wyoming represent breeding populations from Saskatchewan that overwinter around Mexico's Baja California peninsula.

Outlook

There are several threats to Wyoming's loon populations. Direct human disturbance to shoreline nests and chicks lowers survival rates, as do the loss of breeding habitats and water level fluctuations (e.g., erratic spring flooding).

Contaminants like lead (from sinkers) and mercury, in combination with hazards on wintering grounds (e.g., marine oil spills and fishing nets) challenge loon reproduction and survival even further. Visitors to Yellowstone's lakes can help minimize disturbance of loon nests by staying on trails during the breeding season, avoiding shorelines, and, as with all wildlife species, giving adult and fledgling loons plenty of space.

Several loons are killed every year on Yellowstone Lake by gill nets as bycatch in the park's effort to remove invasive lake trout from the lake. Ongoing research will better assess patterns in gillnetting mortalities to improve coordination with fisheries crews, reducing the threat to local loons while allowing for continued lake trout removal.

Fish are the primary prey of loons. As part of a multi-park study on mercury concentration in fish, fish from various lakes where loons nest were screened for mercury. Fish were sampled from Beula, Grebe, Yellowstone, and Lewis Lakes. Fish from Beula, Grebe, and Yellowstone lakes exceeded the threshold at which fish-eating birds may be affected by mercury toxicity. Fish from Lewis did not exceed that threshold although they still contained mercury.

Loons are long-lived; they have relatively low chick production and a poor ability to colonize new breeding areas. Given the very small size and isolation of Wyoming's breeding loon population, it is at a particularly high risk of local extinction.

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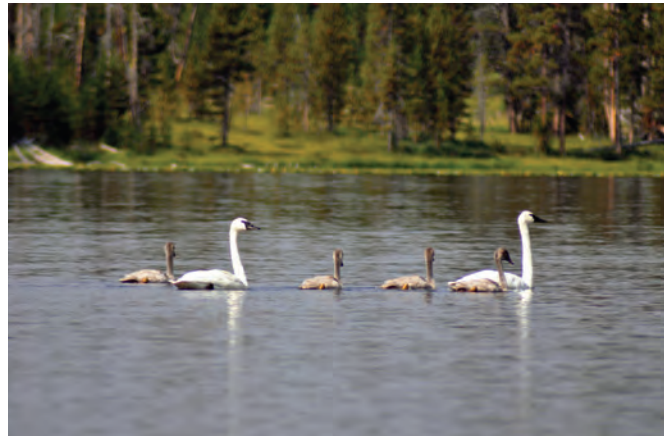
Trumpeter Swans

The trumpeter swan (*Cygnus buccinator*), named for its resonant call, is North America's largest wild waterfowl, with a wingspan of up to eight feet. These swans require open water, feed mainly on aquatic plants, and nest in wetlands. Although they once nested from Alaska to northern Missouri, trumpeter swans were nearly extirpated in the lower 48 states by 1930 due to habitat loss and hunting. A small population survived in the Greater Yellowstone Ecosystem of approximately 70 birds. With intensive management, this population provided the basis for widespread swan recovery later in the century.

As a result of conservation measures, populations across the continental United States began increasing. As of 2015, there are approximately 63,000 trumpeter swans in North America. Swans in the Greater Yellowstone Ecosystem played a significant role in the population resurgence, but by the early 1960s, cygnet production in Yellowstone and subsequent recruitment of adults into the breeding population began declining.

Population

The park's resident trumpeter swan population increased after counts began in 1931 and peaked at 72 in 1961. The number began declining shortly after and dropped further after the Red Rock Lakes National Wildlife Refuge feeding program ended and winter ponds were drained in the early 1990s. Other factors contributing to the decline may include predation, climate change, and human disturbance. In 2018 park biologists observed 24 trumpeter swans



A pair of trumpeter swans successfully fledged four cygnets (young) on Grebe Lake in 2012.

in Yellowstone, including three territorial pairs. Only one pair attempted to nest, but the nest was unsuccessful.

Eight young trumpeter swans were released in Yellowstone in 2018, four in Hayden Valley on the Yellowstone River, and four on the Madison River. Staff hope that these released swans will become bonded to their release location and return the following spring. In total, the park has released 31 cygnets over a six-year period. Although several individuals are frequently seen within the park boundaries during the breeding season, none of the released cygnets have nested within the park yet.

Swans typically take at least four years to reach sexual maturity, so biologists are hopeful these young birds may breed in coming years. The release program is part of an ongoing effort to augment Yellowstone's swan populations and increase the number of breeding pairs that nest inside the park.

Quick Facts

Number in Yellowstone

24 resident swans in 2018.

Trumpeter swans are increasing in the Rocky Mountains, stable in the Greater Yellowstone Ecosystem, but declining in Yellowstone National Park.

Identification

- White feathers, black bill with a pink streak at the base of the upper mandible.
- During migration, can be confused with the tundra swan. Trumpeters are larger, have narrower heads, have a pink mandible stripe, have no yellow spot in front of the eye.

Habitat

- Slow-moving rivers or quiet lakes.
- Nest is a large, floating mass of vegetation.

Behavior

- Feed on submerged vegetation and aquatic invertebrates.
- Low reproduction rates.
- Can fail to hatch eggs if disturbed by humans.
- Lay 4–6 eggs in June; young (cygnets) fledge in late September or early October.
- Usually in pairs with young in

summer; larger groups in winter.

Management Concerns

- Limiting factors in Yellowstone appear to be flooding of nests, predation, possibly effects of drought caused by climate change, and less immigration into the park from outside locations.
- Because swans are sensitive to human disturbance during nesting, nest areas are closed to public entry.

Nearly all Rocky Mountain trumpeter swans—including several thousand that migrate from Canada—over-winter in ice-free waters in the Greater Yellowstone Ecosystem, but only a portion of them remain here to breed.

The best available scientific evidence suggests that Yellowstone provides marginal conditions for nesting and acts as a sink for swans dispersing from more productive areas. This effect has been compounded in recent decades by reduced wetland areas (due to long-term drought or warmer temperatures) and community dynamics (e.g., changes in bald eagle diets due to the limited availability of cutthroat trout in Yellowstone Lake.). Trumpeter swan presence in the park may therefore be primarily limited to occasional residents and wintering migrants from outside the park. Concern about the Greater Yellowstone Ecosystem population has resulted in cooperative efforts between state and federal agencies to monitor swan distribution and productivity.

Across the region, federal agencies currently survey swans in September to estimate the resident swan population and annual number of young cygnets produced.

Outlook

Trumpeter swans are particularly sensitive to human disturbance. Because of this, park managers restrict human activity in known swan territories and nesting areas. Scientists are also conducting studies to better determine the habitat requirements for nesting swans and the drivers for the observed local population decline.



Trumpeter swans are a species of concern in Yellowstone.



Current nesting range of trumpeter swans.

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Songbirds, like this mountain chickadee, and woodpeckers comprise the majority of bird species in Yellowstone National Park.

Songbirds and Woodpeckers

Songbirds and woodpeckers, or passerine and near passerine species, comprise the majority of bird species in Yellowstone National Park. They are monitored through counts in willow stands, recently burned forests, old growth forests, and grasslands/sagebrush steppe; the North American Breeding Bird Survey; fall migration surveys; and a summer and early fall banding station.

Willows

Willow stands are one of a few deciduous wetland habitats in the Greater Yellowstone Ecosystem. Bird diversity is considerably higher in wetland habitats than in grasslands, shrublands, and upland coniferous forests. Several Yellowstone bird species only breed in willow communities including Wilson's warbler (*Cardellina pusilla*), willow flycatcher (*Empidonax traillii*), and gray catbird (*Dumetella carolinensis*).

From the early 1900s, growth of willows and other woody vegetation on Yellowstone's northern range was stunted (suppressed) by elk browsing, reduced beaver populations, consumption by fire, and/or climate change. Correlated with the recovery of several large predator species in the park, some willow stands in the northern range have grown taller and thicker since the mid-1990s, creating a range of growth conditions in current willow stands.

Monitoring of willow–songbird communities in Yellowstone began in 2005. Scientists compare the presence and abundance of breeding songbirds across different willow stand conditions. In 2018, park staff recorded 35 songbird species in willows. Species richness (diversity) was higher in taller than in suppressed willows. Recovered willow stands provide shrubby cover for ground and low nesting species such as song sparrows. Suppressed willows appear to provide habitat for generalist and grassland/

sagebrush species. Willow stands are slowly changing and biologists plan to regularly reassess the vegetation characteristics as bird communities continue to be monitored.

Old Growth Forests

While the importance of old growth forests to songbirds is poorly understood, mature forests provide nesting habitat and foraging opportunities for many species that young stands do not. Climate warming may cause more frequent and severe fires in Yellowstone National Park, which could disproportionately impact old growth forest that, by definition, takes longer to regenerate post-burn.

Due to the potential loss of this habitat type as the climate changes, park biologists initiated songbird surveys in three old growth forest types in 2017 to document the bird communities that currently use them. No surveyed forests had a major disturbance (i.e., wildfire) in at least 100 years, although forest structure and tree species composition varied. In 2018, observers recorded 24 species and the most abundant species were yellow-rumped warbler (*Setophaga coronata*), dark-eyed junco (*Junco hyemalis*), pine siskin (*Spinus pinus*), and American robin (*Turdus migratorius*). Species richness increased with forest complexity from 11 species in lodgepole-dominated forests to 19 species in a mixed Douglas fir/spruce forest.

Burned Landscapes

Birds are among the first returning vertebrates to a forests affected by fire. Birds that nest in cavities of trees depend on forest fires to provide their habitat—and different species depend on different effects of forest fires. For example, black-backed (*Picoides arcticus*), American three-toed (*P. dorsalis*), and hairy (*P. villosus*) woodpeckers use trees that burned in



Three-toed woodpeckers nest in trees that burned in low to moderately severe fires, and hunt for the beetles in the bark.

low to moderately severe fires, two to four years after the fire. Northern flickers (*Colaptes auratus*) move into severely burned areas three years after a fire. Standing dead trees left behind after a fire attract bark and wood-boring beetles—primary prey for woodpeckers. Nest cavities created by woodpeckers are later used by chickadees, nuthatches, bluebirds, owls and some species of duck.

Because fire size, frequency, and intensity is expected to increase with climate change, scientists are studying how the different bird species use different types of post-burn forests and they are developing monitoring methods for the future.

Grasslands/Sagebrush Steppe

Grasslands are a threatened habitat type across the continent and grassland songbirds are the most imperiled songbird guild in North America. In Yellowstone, grasslands and sagebrush steppe are impacted by invasive plants, changing intensities of ungulate browse, and climate change. In 2018, bird program staff and volunteers initiated songbird surveys in sagebrush steppe and grassland plots across the northern range, in areas of relatively high and low bison grazing intensity.

We observed 29 species of songbird in grasslands and sagebrush steppe in 2018. Brewer's sparrow (*Spizella breweri*) and vesper sparrow (*Poocetes gramineus*) were the most abundant species in plots of both high and low grazing intensity. Two species, green-tailed towhee (*Pipilo chlorurus*) and western meadowlark (*Sturnella neglecta*), were more abundant in low grazing intensity plots. Continued

surveys will reveal patterns in grassland bird populations through time and in response to changing habitat conditions.

Breeding Bird Surveys

Breeding bird surveys are a continent-wide monitoring effort coordinated by the US Geological Survey, the Canadian Wildlife Service's Research Center, and Mexico's National Commission for the Knowledge and Use of Biodiversity (CONABIO). Since the 1980s, Yellowstone National Park has participated in these long-term surveys conducted throughout North America. The surveys are road-based with the registered observer recording all birds seen and heard within a quarter mile radius; survey points occur every half mile. Surveys conducted in June, during the height of the songbird breeding season, occur on three routes: Mammoth (Indian Creek to Tower Junction), Northeast Entrance (Tower Junction to Round Prairie), and the Yellowstone Route (Dunraven Pass to Mary Bay).

In 2018, surveyors detected more than 3,100 individuals of 82 species. The greatest species diversity (55) and individual bird abundance (2,254) were observed along the Yellowstone route through the interior. Large flocks of Canada geese along the Yellowstone River accounted for 75% of all observations along the interior route. Canada goose numbers were relatively stable from 1987 to 2010, after which they increased substantially.

Fall Migration

Fall migration represents an important and vulnerable part of the annual cycle for many songbirds. As they make the long journey south to winter range, migrating songbirds must find appropriate places to rest and refuel. During this season, the songbird community within Yellowstone National Park changes, accommodating species and individuals who do not breed here, but are just passing through. In addition to breeding season efforts, Bird Program staff monitor autumn songbirds in willow stands, old growth forest, and grassland/sagebrush steppe to better document patterns in habitat use by fall resident and migrating passerines.

Songbirds, particularly migrants, were most abundant and diverse in willows in the fall, consistent with patterns seen during the breeding season. In sagebrush steppe, migrants were more frequent and more

diverse than resident songbirds, while old growth largely provided fall habitat for resident species. Yellow-rumped warbler, mountain chickadee, and American pipit were the most common fall songbird species in willows, mature forest, and sagebrush steppe, respectively. These surveys highlight the year-round importance of Yellowstone to the resident and migrant avian community.

Banding Station

While songbird counts can provide good estimates for songbird diversity and abundance, they do not provide any information about measures of demography, i.e. reproduction and survival. To improve our understanding of songbird demography in the park, the bird program operated a mist-netting and songbird banding station in 2018, located in a willow-lined riparian corridor on the northern range. During the breeding season, researchers participated in the international MAPS (Monitoring Avian Productivity and Survivorship) program, operated by the Institute for Bird Populations. To help assess use of riparian habitats by juvenile and migrating songbirds, we continued banding operations into the fall, through late September.

In 2018, we captured 292 birds belonging to 32 different species, including 14 songbird species which were not identified during point count surveys of the same creek corridor. The most commonly captured species in the breeding season were yellow warbler and warbling vireo and, in the fall, Wilson's warbler. Continued netting and banding efforts in future years



Biological technicians take vital statistics and measurements from a Yellow warbler while fitting the bird with a band.

will provide additional demographic information that will help researchers better understand songbird population dynamics within the park.

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American avocets are one of the nearly 300 bird species that are found in Yellowstone National Park. These shorebirds sweep their upturned bills back and forth through shallow water to collect aquatic invertebrates.

Other Notable Birds

American Dippers

The dark gray American dipper (*Cinclus mexicanus*) bobs beside streams and rivers. Also called the water ouzel, the dipper dives into the water and swims in search of aquatic insects. Thick downy feathers made waterproof with oil from a preen gland enable this bird to thrive in cold waters.

Ravens

Several raven relatives live in Yellowstone, including the common raven (*Corvus corax*). Common ravens are smart birds, able to put together cause and effect. Ravens are attracted to wolf kills and may follow wolves while they hunt elk. Wolves also provide better access to carrion, as ravens are not able to rip open thick skin on their own. Ravens are willing to eat almost anything and are frequently seen near parking lots searching for food—some have even learned to unzip and unsnap packs. Do not feed them.

Recent surveys indicate 200–300 ravens are present in the northern range of Yellowstone and 53% of those are in wolf habitat, away from human areas. Before wolf reintroduction, nearly 74% of ravens



Ravens are common and seen frequently in developed areas throughout the year.

likely used human areas. Researchers are further investigating seasonal and spatial patterns in raven habitat use, and their relationships with humans and wolves, by monitoring raven movements using satellite transmitters.

Sandhill Cranes

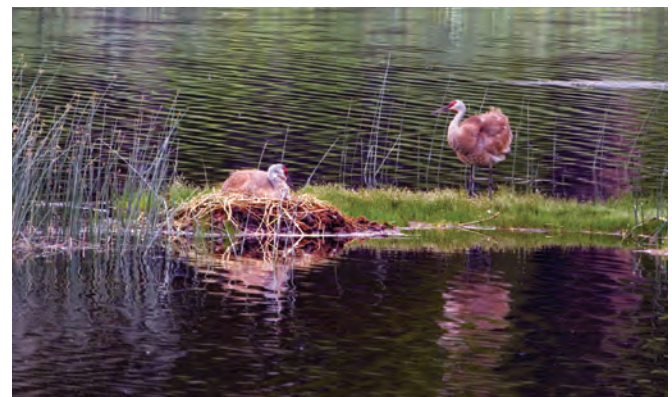
Sandhill cranes (*Grus canadensis*) nest in Yellowstone each summer. Their guttural calls announce their presence long before most people see them as their gray feathers blend in well with their grassland habitat. The tallest birds in Yellowstone, they stand about 4 feet (1.2 m) high. They have a wingspan of approximately 6.5 feet (2 m) and are often mistaken for standing humans or other animals at a distance.

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Sandhill cranes are the tallest birds in Yellowstone.



Yellowstone cutthroat trout are found in Yellowstone National Park and are a keystone species. They provide an important source of energy for many species of birds and mammals.

Fish and Aquatic Species

For millennia, humans harvested Yellowstone fish for food. From the park's inception more than a century ago, fishing has been a major form of visitor recreation. It is this long-standing tradition and integration with the parks' cultural significance that allows the practice of recreational fishing to continue in Yellowstone National Park today. In some cases, it also contributes to the National Park Service goal of preserving native species. The biological significance of fish to ecosystems makes them an ongoing subject of study and concern.

History

About 8,000–10,000 years ago twelve species (or subspecies) of native fish, including Arctic grayling, mountain whitefish, and cutthroat trout, dispersed to this region following glacier melt. These native fish species provided food for both wildlife and human inhabitants. The distribution of native fish species was originally constrained by natural waterfalls and watershed divides. These landscape features provided a natural variation of species distributed across the landscape and vast areas of fishless water. At the time Yellowstone National Park was established in 1872, approximately 40% of its waters were barren of

Quick Facts

Number in Yellowstone

- 11 native species
 - Arctic grayling
 - cutthroat trout (Yellowstone and westslope)
 - mountain whitefish
 - longnose dace, speckled dace
 - reidside shiner
 - Utah chub
 - longnose sucker, mountain sucker, Utah sucker
 - mottled sculpin.
- 5 nonnative species
 - brook trout
 - brown trout
 - lake trout
 - lake chub
 - rainbow trout.

History

- When the park was established, many of its waters were fishless.
- Park waters were stocked with native and nonnative fish until the mid-1950s.
- Stocking changed the ecology of many Yellowstone waters as nonnative fish displaced or interbred with native species.
- By the 1960s, native trout populations were in poor condition and the angling experience had declined.
- By the late 1980s, native trout had recovered in some areas due to restrictions in fish harvest.

- In 2001, fishing regulations changed to require the release of all native fishes caught in park waters.

Threats

- Lake trout were illegally introduced into Yellowstone Lake.
- Whirling disease and New Zealand mud snails are present in some waterways.
- Competition and hybridization occurs with nonnative rainbow trout in Slough Creek and Tower Creek.

fish—including Lewis Lake, Shoshone Lake, and the Firehole River above Firehole Falls.

Park inhabitants and visitors fished for sustenance and survival in this wild, remote place. While most hunting was curtailed by early park management, fishing was not only allowed but encouraged. Driven by the desire to establish recreational fishing in more park waters and new technology that enabled the long-distance transport of fish; early park managers stocked fish into fishless waters, reared fish in hatcheries, and introduced several nonnative species. The majority of the nonnative fish introductions were trout species (lake trout, brook trout, brown trout, and rainbow trout), but other species were also introduced.

Constrained by geography, the native fish within the stocked waters were forced to live together with the nonnatives, be displaced to downstream habitats, or die out. The ranges and densities of Yellowstone's native trout and grayling were substantially altered. Nonnative species contributed to the decline in the park's native fish population by competing for food and habitat, preying on native fish, and degrading the genetic integrity of native fish through hybridization. By the 1930s, managers realized the destructive impact caused by nonnative fish. As a result, the National Park Service (NPS) created a formal stocking policy to discontinue these efforts.

Even though stocking of nonnatives stopped, stocking of Yellowstone cutthroat trout from Yellowstone Lake continued both within and outside the species' native range. Overall, from the early 1880s to the mid-1950s, more than 300 million fish were stocked throughout Yellowstone. Today, about 40 lakes have fish; the others were either not stocked or have reverted to their original fishless condition.

Influences of Some Nonnative Species

Aquatic nuisance species disrupt ecological processes because they are not indigenous to the ecosystem. Invasive organisms can cause species extinction, with the highest extinction rates occurring in freshwater environments. Aquatic nonnative species that are having a significant detrimental effect on the park's aquatic ecology include lake trout in Yellowstone Lake; brook, brown, and rainbow trout in the park's streams and rivers; and the parasite that causes whirling disease. Though there are other aquatic nonnative species in the park, their impacts do not appear to be as significant.

Conservation

Yellowstone's approach to native fish conservation has greatly evolved over the past two decades, as continued losses of native fish and altered ecology were realized. Management now focuses on large-scale actions to preserve and restore native fish faced with nonnative threats. The success of these activities requires a broad approach; includes a wide range of partners and stakeholders; and utilizes independent scientific oversight, assessment, and periodic adjustments to ensure conservation goals are being met.

Despite changes in species composition and distribution, large-scale habitat degradation has not occurred in park waters. Water diversions, water pollution, and other such impacts on aquatic ecosystems have rarely occurred in Yellowstone. Consequently, fish and other aquatic inhabitants continue to provide important food for mammals like bears, river otters, mink, and at least sixteen species of bird.

Fishing in Yellowstone

About 50,000 of the park's four million visitors fish each year. Fishing has been a popular recreation activity for visitors here for more than 100 years, and many people come to Yellowstone just to fish. Though angling is an anomaly in a national park—where the primary purpose is to preserve natural environments and native species in ways that maintain natural conditions—fishing can help support preservation of native species.

Anglers Assist with Native Species Conservation

The activities necessary to preserve and restore native fish varies by species and drainages across the park. In order to promote the preservation of native fish in Yellowstone, the park has designated the Native Trout Conservation Area for special management.



Many people, like this angler on the Gardner River, come to Yellowstone to fish.

FREQUENTLY ASKED QUESTION:

Why is fishing lead-free in Yellowstone?

Birds, such as loons, waterfowl, cranes, and shorebirds, are vulnerable to lead poisoning. While we can do little about natural hazards, we can minimize the effects of lead on these species. Yellowstone National Park bans most lead tackle. (Terminal tackle must be lead-free; large down-rigger weights used to fish for deep-dwelling lake trout are permissible because they are too large to be ingested.)

Within that area, fishing regulations are structured so that recreational anglers help selectively remove non-native species from the area without damaging the native fishery. In some areas, angler harvest will help to save the native fish and the natural ecosystems they support.

Anglers contribute to the fisheries database by filling out a Volunteer Angler Report card that is issued with each fishing license. This information helps monitor the status of fisheries throughout the park. Angler groups have also lent support to management actions, such as closing the Fishing Bridge to fishing in the early 1970s. Yellowstone cutthroat trout support a \$36 million annual sport fishery. The money generated from fishing licenses helps fund research on aquatic systems and restoration projects.

Decisions about how best to achieve native fish preservation and recovery goals must be based in sound scientific research and be consistent with the mission of the National Park Service. In past years, a team of fly-fishing volunteers assisted the Yellowstone fisheries program with several other projects, including removal of nonnative species, evaluation of fish barrier efficacy and success, a study to determine injury and mortality rates when using barbed versus barbless hooks, surveys to determine species composition, and logistical support for large multi-agency projects. Their extensive help collecting data and biological samples allows park biologists to learn about many more areas than park staff would have time to access.

Fishing Regulations

Fishing regulations in Yellowstone National Park are structured to strongly support native fish conservation goals. Complete regulations are available at all ranger stations, visitor centers, online at www.nps.gov/yell/planyourvisit/fishdates.htm, and in stores where fishing licences can be purchased.

In summary:

- Fishing is only allowed from the Saturday before Memorial Day through the first weekend in November.
- A park permit is required, state fishing licenses are not valid.
- Tackle must be lead-free and barbless. No organic or scented bait is allowed. Felt-soled footwear is prohibited.
- All cutthroat trout, Arctic grayling, and mountain whitefish must be released.
- Lake trout must be killed if caught in Yellowstone Lake and its tributaries.
- Nonnative brook and rainbow trout must be killed in the Lamar River drainage and the Yellowstone River draining above Knowles Falls.

Certain waters are closed to protect rare or endangered species, nesting birds, critical habitat, or to provide undisturbed vistas.

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The three native species most popular with Yellowstone anglers are: Arctic grayling, cutthroat trout (above; two subspecies: Yellowstone cutthroat trout and westslope cutthroat trout), and mountain whitefish.

Native Fish Species

Yellowstone's native fish underpin natural food webs, have great local economic significance, and provide exceptional visitor experiences. Though policies of the National Park Service provide substantial protection from pollution and land-use practices that often degrade habitat, historic management efforts by the park service subjected native species to the effects of nonnative fish introductions, egg-taking operations, commercial fishing, and intensive sport-fishery harvest into the middle of the twentieth century.

To reverse declining native fish populations and loss of ecosystem integrity, the National Park Service now takes action to promote their recovery. A Native Fish Conservation Plan/Environmental Assessment was completed in 2010. The National Park Service aims to reduce long-term extinction risk and restore the ecological role of native species, including fluvial Arctic grayling, westslope cutthroat trout, and Yellowstone cutthroat trout, while ensuring sustainable native fish angling and viewing opportunities for visitors. Scientific peer review continues to provide guidance for future efforts on Yellowstone fisheries. The National Park Service strives to use the best methods available for addressing threats, with a focus on direct, aggressive intervention, and welcomed assistance by visiting anglers.

Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*)

Yellowstone cutthroat trout (YCT) are the most widespread native trout of the park and were the dominant fish species here prior to Euroamerican settlement. They are an important species in Yellowstone National Park, upon which many other species depend. They provide an important source of food for an estimated 16 species of birds, and mammals including bears, river otters, and mink.

Genetically pure YCT populations have declined throughout their natural range in the Intermountain West, succumbing to competition with and predation by nonnative fish species, a loss of genetic integrity through hybridization, habitat degradation, and angling harvest. Many of the remaining genetically pure YCT are found within the park. State and federal wildlife agencies classify YCT as a sensitive species. However, the US Fish and Wildlife Service does not warrant listing the YCT as a threatened species under the Endangered Species Act.

Description

- Red slash along jaw and fine spots common to all cutthroat varieties
- Body mostly yellow-brown with darker olive or gray hues on the back, lighter yellow on sides.
- Highly variable black spotting pattern.

Distribution

- Native to the Yellowstone River, Snake River, and Falls River drainages.
- Require cold, clean water in streams or lakes.

Behavior

- Spawn in rivers or streams in late April through mid-July.
- Most important foods are aquatic insects—mayflies, stoneflies, caddisflies, etc.—and other small aquatic animals, plus terrestrial insects that fall into the water.
- Also eat smaller fish, fish eggs, small rodents, frogs, algae and other plants, and plankton.

Population

The Yellowstone cutthroat trout population in the Yellowstone Lake ecosystem has declined substantially since the mid-1980s. Lake-wide sampling began

in 1968 and in 2014 the average number of YCT caught at survey sites reached a recent high of 28.4 fish per 100 meters of net. Average number of fish declined in 2016 (18.2/100 meters of net), but steadily increased in 2018 (26.11/100 meters of net).

Monitoring at Clear Creek, a Yellowstone Lake tributary, began in 1945. The number of YCT spawning there peaked at more than 70,000 in 1978 and fell to 538 by 2007. The decline is attributed to predation by nonnative lake trout, low water during drought years, and the nonnative parasite that causes whirling disease.

Two-thirds of the streams that were part of the species' native habitat outside the Yellowstone Lake watershed still contain genetically pure YCT; in other streams they have hybridized with rainbow trout.

History

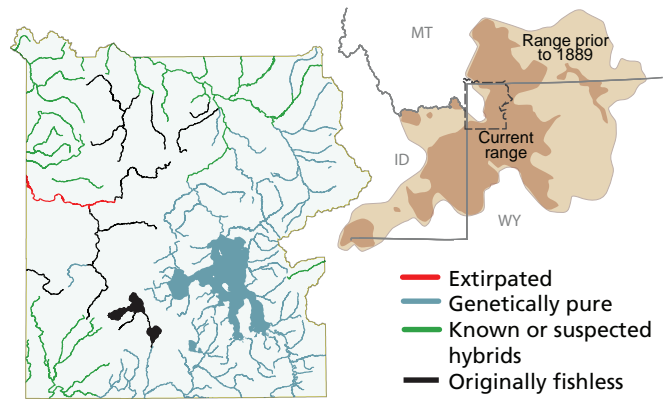
Yellowstone Lake and the Yellowstone River together contain the largest inland population of cutthroat trout in the world. While the Yellowstone cutthroat trout is historically a Pacific drainage species, it has (naturally) traveled across the Continental Divide into the Atlantic drainage. One possible such passage in the Yellowstone area is Two Ocean Pass, south of the park in the Teton Wilderness.

The variety of habitats resulted in the evolution of various life history types among Yellowstone cutthroat trout. Some populations live and spawn within a single stream or river (fluvial), some live in a stream and move into a tributary to spawn (fluvial-adfluvial), some live in a lake and spawn in a tributary (lacustrine-adfluvial), and still others live in a lake and spawn in an outlet stream (allacustrine). Life history diversity within an ecosystem helps protect a population from being lost in a single extreme natural event.

Habitat remains pristine within Yellowstone National Park, but nonnative fish species pose a serious threat to native fish. In Yellowstone Lake, lake trout are a major predator of cutthroat trout. Brown, brook, and rainbow trout all compete with cutthroat trout for food and habitat. Rainbow trout pose the additional threat of hybridizing with cutthroat trout. Because of the lack of barriers in the lower reaches of most drainages, nonnative fish have been dispersing upstream and have replaced, or threaten to replace, cutthroat trout.

Restoration

The objectives of Yellowstone's Native Fish Conservation Plan (2010) include recovery of YCT



Past and present range of the Yellowstone cutthroat trout.

abundance in the lake to that documented in the late 1990s, maintaining access for spawning YCT in at least 45 of 59 Yellowstone Lake's historical spawning tributaries, and maintaining or restoring genetically pure YCT in the current extent of streams occupied by pure or hybrid YCT.

Lamar River: Because no barriers to upstream fish migration exist in the mainstem Lamar River, descendants of rainbow trout stocked in the 1930s have spread to many locations across the watershed and hybridized with cutthroat trout. Genetic analysis indicates that cutthroat trout in the headwater reaches of the Lamar River remain genetically unaltered.

To protect the remaining Yellowstone cutthroat trout, the NPS has implemented a selective removal approach. A mandatory kill fishing regulation on all rainbow trout caught upstream of the Lamar River bridge was instituted in 2014. Selective removal by electrofishing has been conducted annually through the Lamar Valley since 2013.

In 2015, 136 fish were sampled downstream of the Lamar River bridge. Based on field identification, 48% were Yellowstone cutthroat trout, 19% were rainbow trout, and 31% were hybrids. The majority of these fish were tagged with radio transmitters or passive integrated transponder (PIT) tags as part of an ongoing research project to determine if Yellowstone cutthroat, rainbow, and hybrid trout are using the same areas to spawn and spawn timing and to inform management actions.

Slough Creek: In Slough Creek, rainbow/cutthroat trout hybrids have been found with increasing frequency over the past decade. Unlike the Lamar River, Slough Creek is smaller, and a barrier to upstream fish movement has been constructed. With a barrier in place and rainbow trout no longer allowed passage into the system, existing rainbow and hybrid trout

can be effectively managed with angling and electrofishing removal.

Soda Butte Creek: Brook trout became established in Soda Butte Creek outside of the park boundary and spread downstream into park waters in the early 2000s. Initially, brook trout were isolated in headwater reaches by a chemical barrier created by mine contamination upstream of Cooke City, Montana. When the mine tailings were removed, brook trout passed downstream and began to negatively impact the cutthroat trout. To date, no brook trout have been found in Soda Butte Creek downstream of Ice Box Falls.

For nearly two decades, interagency electrofishing surveys were enough to keep brook trout populations low, but did not prevent range expansion. Over time, brook trout spread downstream and became a threat to the Lamar River. In addition, rainbow trout hybridization continued to be identified in cutthroat trout upstream of Ice Box Falls.

In 2013 Ice Box Falls was modified to be a complete barrier to upstream fish movement, thus entirely eliminating the threat of nonnative fish traveling upstream. Nearly 450 brook trout were removed during the chemical treatment in 2015. Only two brook trout were collected from Soda Butte Creek during a second treatment in 2016. In 2017, two rounds of eDNA sampling, as well as electrofishing surveys, found no evidence of brook trout in the system. This is a good indication that a complete kill was achieved in the drainage.

Elk Creek Complex: There is a natural cascade barrier in Elk Creek just upstream from its confluence with the Yellowstone River. The cascade prevented fish from naturally populating the system, so the Elk, Lost, and Yancey creeks complex of streams (Elk Creek Complex) was fishless when first stocked with cutthroat trout in the early 1920s. In 1942, the streams were stocked with brook trout, resulting in the complete loss of cutthroat trout.

The Elk Creek Complex was treated with rotenone annually from 2012 to 2014 to remove brook trout. Once clear of brook trout, reintroduction of native Yellowstone cutthroat trout began. Antelope and Pebble creeks provided fish for stocking the Elk Creek Complex in October 2015. Additional stocking took place in 2016 and 2017. Natural reproduction was also documented in 2017 during electrofishing surveys.

Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*)



Historically the most abundant and widely distributed subspecies of cutthroat trout throughout the West, the westslope cutthroat trout (*Oncorhynchus clarkii lewisi*, WCT) occupies less than 5% of its former range in the upper Missouri River drainage. It evolved from a common ancestor of the Yellowstone subspecies, and shares their food and habitat requirements. By the 1930s, WCT were nearly eliminated from park streams because of the stocking of competing trout (nonnative brook and brown trout) and interbreeding with nonnative rainbow and Yellowstone cutthroat trout. In most of its remaining habitat (an estimated 64% of the approximately 641 stream miles it once occupied in the park), it exists only in hybridized form.

Description

- Red slash along jaw and fine spots, common to all cutthroat varieties, along top and tail.
- Greenish gray in color.
- Larger, irregular spots along lateral line and toward gills and head.
- Crimson streak above the belly.
- Sometimes mistaken for rainbow trout.

Distribution

- Genetically pure population only exists in Last Chance Creek and Oxbow/Geode Creek complex.
- Restored populations growing in the East Fork Specimen and Grayling creeks, Goose and High lakes, and the upper portion of the Gibbon River drainage including Wolf and Grebe lakes and surrounding tributaries streams.
- Hybridized populations found in many river drainages in the Madison Basin.

Restoration

Native species restoration depends on secure brood

sources. A brood should be accessible, safe from contamination, self-sustaining, genetically diverse, abundant, of traceable origin, and pose no risk to existing wild populations.

Genetically pure WCT have only persisted in one tributary of the Madison River drainage (now called Last Chance Creek), and in the Oxbow/Geode Creek complex where they were introduced in the 1920s. In 2006, Yellowstone began efforts to restore WCT in East Fork Specimen Creek and High Lake by constructing a fish barrier, removing hybridized and non-native fish, and stocking genetically pure WCT. In 2016 and 2018, surveys conducted throughout East Fork Specimen Creek indicated a naturally reproducing population of westslope cutthroat trout, with all fish appearing healthy. The long-term goal for this watershed is to integrate East Fork Specimen Creek into a larger westslope cutthroat trout restoration project that includes the North Fork to improve the resilience of this isolated population to natural threats.

Another restoration project is being conducted in Goose Lake and two other small, historically fishless lakes in the Firehole drainage. Nonnative fish removal was conducted in 2011 and staff stocked fry from 2013 to 2015. A population survey in 2018 yielded 18 fish that ranged from 15-20 inches in length. The long-term project goal is to one day use this pure westslope population as a brood source, providing offspring for restoration projects elsewhere within the upper Missouri River system.

The largest WCT restoration effort in Yellowstone is the Grayling Creek project (See: Arctic grayling), which will restore WCT to over 20 stream miles of native habitat. Another large restoration project is the upper Gibbon River. In 2017, native fish restoration began on the upper portion of Gibbon River, above Virginia Cascades. This project encompasses more than 18 stream miles and 232 lake acres (Wolf, Grebe, and Ice lakes). In fall 2017 and spring 2018, park biologists introduced westslope cutthroat trout and Arctic grayling to Wolf and Grebe lakes. Fish removal continued on the upper Gibbon River in 2018 between Virginia Cascades and Little Gibbon Falls. Complete removal of non-native fish in this section of river will take 1-2 years. Future restoration projects will be in North Fork Specimen and Cougar creeks. Once these projects are completed, an additional 61 kilometers (38 miles) of stream will be restored fish native to Yellowstone

Arctic Grayling (*Thymallus arcticus montanus*)



Fluvial (entirely stream-dwelling) Arctic grayling were indigenous to the park in the headwaters of the Madison and Gallatin rivers and to the Gibbon and Firehole rivers below their first falls. Fluvial grayling were eliminated from their entire native range within the park by the introduction of competing nonnative fishes such as brown trout and brook trout, and the fragmentation of migration pathways by the construction of the Hebgen Dam outside the park. Grayling within the upper Gallatin River drainage disappeared around 1900, while grayling in the upper Madison River drainage disappeared by 1935. The only known populations left in the park were adfluvial (primarily lake-dwelling) descendants of fish that were stocked in Cascade and Grebe lakes.

Description

- Large sail-like dorsal fin
- Large scales
- Dark spots on the front half of its body.
- Sometimes confused with mountain whitefish.

Behavior

- Spawning behavior of fluvial populations is unknown. Adfluvial populations migrate to streams in June. Spawn over many types of stream bed, from sand to coarse rubble.
- Similar to trout, they eat true flies, caddisflies, and small crustaceans. Younger, smaller fish feed on zooplankton.

Distribution

- Cascade, Grebe, Wolf, and Goose lakes.
- Gibbon River. Sometimes found in Madison and Firehole rivers.

Restoration

One of the goals of the park's 2010 Native Fish Conservation Plan is to restore fluvial grayling to

approximately 20% of their historical distribution. The upper reaches of Grayling Creek are considered the best site for immediate fluvial grayling restoration. Near the park boundary, a small waterfall exists in the creek (which flowed directly into the Madison River prior to the construction of Hebgen Dam in 1914). It is not known if grayling were ever present upstream of the waterfall, but they were abundant downstream.

The Grayling Creek restoration project aims to establish Arctic grayling and westslope cutthroat trout to 95 kilometers (59 miles) of connected stream habitat in one of the most remote drainages in the species historic range within Yellowstone.

In summer of 2013 a barrier was completed at the waterfall to prevent upstream movement of nonnative fish. During August 2013, a crew of 27 biologists from Yellowstone National Park, Montana Fish, Wildlife and Parks, Gallatin National Forest, Turner Enterprises, and US Fish and Wildlife Service treated the stream segment with piscicide to remove all fish. A second treatment took place in 2014. Restocking the Grayling Creek watershed with native fluvial Arctic grayling and westslope cutthroat trout began in 2015 and continued through 2017. The effort included moving approximately 950 juvenile and adult westslope cutthroat trout to lower reaches of Grayling Creek, above the project barrier. In addition, 54,200 westslope cutthroat trout eggs and 210,000 fluvial grayling eggs were placed in remote-site incubators throughout the upper watershed. In 2018, park biologists began to monitor the success of our reintroduction efforts on upper Grayling Creek. This monitoring effort will continue through the fall 2019.

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Mountain Whitefish (*Prosopium williamsoni*)



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The mountain whitefish (*Prosopium williamsoni*) is a slender silver fish, sometimes confused with Arctic grayling. It lives in Yellowstone's rivers and streams and requires deep pools and clear, clean water. This species is very sensitive to pollution. The mountain whitefish has persisted in its native waters, unlike the Arctic grayling. Mountain whitefish are commonly caught by anglers in most of the park's large rivers. They are less common in smaller streams.

Description

- Yellow or olive green to dark gray. No spots
- Body nearly round on cross-section
- Small mouth with no teeth

Behavior

- Spawns in fall.
- Generally feeds along the bottom, eating aquatic insect larvae, and competes with trout for the same food.

Distribution

- Throughout the Snake and Lewis rivers
- Heart Lake and its tributaries
- The Yellowstone River below Lower Falls, and the Lamar, Gardiner, Madison and Gibbon rivers.

Mottled Sculpin (*Cottus bairdi*)

The mottled sculpin lives in shallow, cold water throughout Yellowstone except in the Yellowstone River above Lower Falls and in Yellowstone Lake. This species eats small insects and some fish, and is consumed by trout.



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Minnows

Yellowstone's minnows are small fish living in a variety of habitats and eating a variety of foods. All four species occurring in Yellowstone are eaten by trout:

- Utah chub (*Gila atraria*): Largest of the minnows (12 inches); native to Snake River drainage; seems to prefer slow, warm waters with abundant aquatic vegetation.
- Longnose dace (*Rhinichthys cataractae*): Most often found behind rocks and in eddies of cold, clear waters of the Yellowstone and Snake river drainages, and can be found in Yellowstone Lake.
- Redside shiner (*Richardsonius balteatus*): Minnow of lakes; native to the Snake River drainage; has been introduced to Yellowstone Lake, where it might compete with native trout because its diet is similar to that of young trout.
- Speckled dace (*Rhinichthys osculus*): Lives in the Snake River drainage.

Suckers



Suckers are bottom-dwelling fish that use ridges on their jaws to scrape flora and fauna from rocks. They are eaten by birds, bears, otters, and large cutthroat trout. Sucker species can be distinguished by their habitat:

- Mountain sucker (*Catostomus platyrhynchus*): cold, fast, rocky streams and some lakes.
- Longnose sucker (*C. catostomus*): Yellowstone River drainage below the Grand Canyon; Yellowstone Lake and its surrounding waters (introduced). Equally at home in warm and cold waters, streams and lakes, clear and turbid waters.
- Utah sucker (*C. ardens*): Snake River drainage.

Concurrent with the decline in cutthroat trout is a steady, long-term decline in the introduced longnose

sucker population within Yellowstone Lake. The mechanism causing this decline is unclear. Longnose suckers occur, primarily, throughout the shallow-water, littoral zones of the lake, and spawn along the lake shore and in tributaries during the spring. Predation by lake trout during the summer is not significant but it is possible that consumption of suckers by lake trout is higher during winter when water temperatures are extremely cold, allowing lake trout to exploit shallow water habitats where the suckers reside.

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Preparing for restoration

Liberalization of creel limits, mandatory kill regulations for anglers, and electrofishing by biologists are effective tools for the selective removal of nonnative species. However, in some instances these tools cannot completely eliminate the invaders. In those cases, barriers and chemical treatments are considered. Some natural barriers already exist; sometimes modifications to natural structures can complete barriers to upstream migration. In a few places, barriers must be completely fabricated. Once native trout are protected from invasion, selective removal continues or, if necessary, chemical treatment is used to eliminate nonnative species. Following reduction or removal of unwanted species, stocking boosts or restores cutthroat trout populations.

Piscicides are toxins which remove fish from habitats where nets, electrofishing, angling, traps, or other mechanical methods are impractical or ineffective. With the exception of sea lamprey control in the Great Lakes, all fish removal projects in the United States use piscicide containing the natural compounds rotenone or antimycin. Biologists in Yellowstone National Park have used rotenone in formulations approved by the Environmental Protection Agency in High Lake and East Fork Specimen Creek (2006-2009), Goose Lake (2011), Elk Creek (2012-2014), Grayling Creek (2013-2014), Soda Butte Creek (2015-2016), and upper Gibbon River, and Wolf, Grebe, and Ice lakes to remove nonnative fish species.

Rotenone occurs in the roots, stems, and leaves of tropical plants in the pea family (*Fabaceae*). Ingestion has a relatively minor effect on land animals because the enzymes and acids of the digestive system break it down. Rotenone must be absorbed into the bloodstream, usually across the gill membrane, to be harmful. It kills by inhibiting the biochemical reaction some cells use to turn nutrients into energy. Essentially, rotenone starves the cells, causing death.

To treat a section of stream, rotenone is dripped in at a rate determined by the volume, speed, and temperature of the water. Further downstream, potassium permanganate is

added to the water to neutralize the rotenone. Rotenone is quickly broken down in the environment by sunlight and readily binds to sediments or organic matter in the water. The rapid degradation and dissipation mean that managers have a short window of time to successfully remove nonnative fish.

Unfortunately, piscicides impact all gill-breathing aquatic organisms, like non-target fish species (i.e., native fishes), larval amphibians, and macroinvertebrates. To reduce potential impacts on non-target organisms specialists use a minimum dosage of rotenone, for short periods of time. Biologists limit treatment areas and leave recovery intervals between treatments. All treatments in Yellowstone National Park have been, and will continue to be, conducted during late summer or fall to avoid impacts to amphibians in early developmental stages. Research conducted during these treatments provides strong evidence benthic macroinvertebrates and amphibians in Yellowstone have not been significantly impacted in the long-term.



Rotenone drip station.

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Many nonnative fish were introduced to Yellowstone to meet the expectation of recreational anglers.

Nonnative Fish Species

Nonnative fish distribution and their influence on native fish are not static. While they have not been intentionally stocked since the 1930s, nonnative fish continue to advance into new habitats and hybridize with or displace native fish that previously persisted in the face of extreme environmental change for thousands of years.

Hybridization of cutthroat trout resulting from rainbow trout range expansion continues to be the greatest threat to the park's remaining native fish populations in waters outside the Yellowstone River headwaters, Yellowstone Lake, and the Snake River headwaters.

Not all of the movement by nonnative fish in Yellowstone has occurred naturally. Nonnative lake trout, intentionally introduced by managers in 1890 to Lewis and Shoshone lakes, and illegally introduced (possibly intentionally) to Yellowstone Lake in the mid-1980s, first appeared in angler catches in 1994. The lake trout population expanded and, over the following decade, caused a rapid decline in the Yellowstone cutthroat trout population in Yellowstone Lake.



Eastern Brook Trout (*Salvelinus fontinalis*)



Eastern brook trout was the first nonnative species introduced in Yellowstone. They were stocked in the (then fishless) Firehole River in 1889. Brook trout are native to the eastern and northeastern United States from Hudson Bay down to the Carolinas and through the Great Lakes.

Description

- Sides spotted with red, pink, or yellow dots, haloed with blue.
- Light spots on dark skin.
- Back, dorsal, adipose, and tail fins have a marbled (vermiculated) appearance.
- Lower fins have a vivid white stripe on the tip

Behavior

- Spawn in fall between September and December. Have a strong tendency to return to natal streams.
- Food selection similar to other trout, but tend to feed on a wider variety of foods.

Distribution

- Widely distributed in most river drainages due to historic stocking.
- Not present in the Gallatin River, Yellowstone Lake, or the Yellowstone River above the Upper Falls.

Brown Trout (*Salmo trutta*)



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The brown trout is the only nonnative fish species in Yellowstone that is not native to North America. This European species was introduced to Yellowstone in the later part of the 19th century and was recorded as two different species: the Von Behr and the Loch Leven brown trout. These are now thought to be two varieties of the same species and most of the populations in Yellowstone are indistinguishable.

Description

- Dark in color, olive, brown, or yellow.
- Pale halos around black spots.
- Vibrant red or orange spots.

Behavior

- They spawn in fall, between September and January, migrating to small tributaries of large rivers, upstream in small rivers, or to lake inlets.
- Brown trout eat mostly insects, crustaceans, and mollusks but have a reputation for eating much larger prey: other fish, crayfish, birds, mice, frogs, and snakes.

Distribution

- Widely distributed in Gallatin, Gibbon, Firehole, Madison, Lewis, Snake, Gardner, and Yellowstone rivers.
- Not present in Yellowstone Lake or the Bechler or Falls rivers

Rainbow Trout (*Oncorhynchus mykiss*)



Rainbow trout are native to North America in waters that drain to the Pacific Ocean from northern Mexico to Alaska. Of the nonnative fish in Yellowstone, the rainbow trout has the closest geographic origin. As the most adaptable members of the salmonid family, they have been successfully introduced throughout the world.

Description

- Silvery body, red lateral band, often white on the edge of lateral fins.
- Numerous black spots on head and back, none on belly

Behavior

- Spring spawning between April and July. Select populations spawn in fall.
- Eats aquatic and terrestrial insects, crustaceans, mollusks and earthworms.
- Eat more algae than other trout.

Distribution

- Widely distributed due to historic stocking efforts.
- Not present in Yellowstone Lake.
- Not present in the Yellowstone River above the Upper Falls or the Snake River.

Cutthroat x Rainbow Trout Hybrids

In waters where rainbow trout have been introduced, either by intentional, historic stocking or by invasion from a downstream source, the result has been a serious degradation of the cutthroat trout population through interbreeding of the two species. Cutthroat/rainbow trout hybrids will have characteristics (coloration and spotting patterns) that are consistent with both species, making identification often difficult. In all cases, hybridized cutthroat trout that have any indication of a red/orange jaw slash are fully protected by catch-and-release regulation.



Presently, hybridized cutthroat trout exist throughout the Bechler, Falls, Gallatin, Gardner, and lower Lamar rivers, and the Yellowstone River below the Upper Falls.

Lake Trout (*Salvelinus namaycush*)



Lake trout are native to Canada, Alaska, the Great Lakes, New England, and parts of Montana. Lake trout were intentionally stocked in Lewis and Shoshone lakes in 1890 by the US Fish Commission (a predecessor of today's US Fish & Wildlife Service). The species was first documented in Yellowstone Lake in 1994. Evidence from chemical patterns in lake trout ear bones sampled in the late 1990s indicate that they were introduced illegally from nearby Lewis Lake some time in the 1980s. Despite major efforts to remove them by gillnetting, the lake trout have had a significant ecological impact on the native Yellowstone cutthroat trout, an important food for other native animals. Lake trout differ from cutthroat trout as potential prey because they can grow larger, occupy deeper areas of the lake, and spawn in the lake instead of in shallow tributaries.

Description

- Dark gray body with white spots; numerous spots on head.
- Deeply forked tail.
- Often white on the edge of fins.

Behavior

- Lake trout are voracious, efficient predators.
- Frequently live 20–25 years and grow very large. The Wyoming state record catch weighed 50 pounds (23 kg).
- Fall spawners (September/October). A 12-pound female could produce up to 9,000 eggs annually.
- About 30% of a mature lake trout's diet is cutthroat trout. They can eat up to 41 cutthroat trout per year and can consume cutthroat trout up to 55% of their own size.

Distribution

- Heart, Lewis, Shoshone, and Yellowstone lakes.

Population in Yellowstone Lake

Lake trout are a serious threat to the native Yellowstone cutthroat trout population and, as a result, the National Park Service (NPS) has worked to suppress the population. Although lake trout need energy-rich prey to continue to grow, they can persist for years with minimal food resources. Nonnative lake trout could decimate the native cutthroat trout population and then persist at high numbers on other foods, giving cutthroat trout no chance to recover. Lake trout also consume foods that have historically fed cutthroat trout in Yellowstone Lake, thereby making cutthroat trout recovery impossible until the lake trout population is suppressed.

Taking Action

In 1995, after confirming lake trout were successfully reproducing in Yellowstone Lake, the NPS convened a panel of expert scientists to determine the likely extent of the problem, recommend actions, and identify research needs. The panel recommended that the park suppress lake trout in order to protect and restore native cutthroat trout. The panel also indicated that direct removal efforts such as gillnetting or trapnetting would be most effective but would require a long-term, possibly perpetual, commitment.

Lake trout gillnetting begins as ice is leaving the lake in spring and continues into October. Gillnet operations remove lake trout from the population and also provide valuable data—numbers, age structure, maturity, and potential new spawning areas—leading to more effective control. Incidental catch of native cutthroat trout is minimized by fishing deeper waters not typically used by cutthroat trout.

As initial gillnetting efforts expanded, the number



Since 2009, the park has contracted a commercial fishing company to increase the catch of lake trout.

of lake trout removed from the population also increased. This suggested the lake trout population was continuing to grow. In 2008 and 2011, scientific panels were convened to re-evaluate the program and goals. The panel concluded netting is still the most viable option for suppressing lake trout. Both reviews also indicated a considerable increase in suppression effort would be needed over many years to collapse the lake trout population.

Starting in 2009, the park contracted a commercial fishing company, to increase the take of lake trout through gillnetting. From 2011 to 2013, they also used large, live-entrapment nets that allow removal of large lake trout from shallow water while returning cutthroat trout to the lake with little mortality.

Anglers are encouraged to fish for lake trout, and are required to kill all lake trout caught in Yellowstone Lake and its tributaries. Of the total lake trout removed from Yellowstone Lake, anglers have removed approximately five percent.

Lake Trout Response to Increased Suppression Efforts

More than 3.14 million lake trout have been removed from Yellowstone Lake since 1994. In 2018, National Park Service and contracted crews captured more than 297,000 lake trout—the majority of which were two-year-old fish. This is a 25% drop in catch, despite further increases in effort. The largest decreases were seen in the smallest meshes used, indicating a decrease in young fish. Catch rates in the larger mesh sizes continued to decrease as well and dropped from 3.2 lake trout per net night in 2012 to 1.1 lake trout in 2018.



Student Conservation Association interns hold a large lake trout from Yellowstone Lake.

The number of lake trout caught during distribution surveys remained relatively constant from 2010-2017, ranging from 347–575 fish annually, with a mean total length from 309–330 millimeters (12–13 in.). Over the past seven years, biologists have seen a gradual decrease in the number of large adult (sexually mature) lake trout caught during the surveys.

Increases in catch can reflect increased efficiency, increased abundance, or both. Improvements in gear, knowledge, and experience can lead to more efficient removal, despite a decreasing population. Hence, independently monitoring the effectiveness and effects of suppression activities, as well as updating population models, is an important aspect of the program.

Quick Facts

The Issue

Nonnative lake trout in Yellowstone Lake threaten the survival of native Yellowstone cutthroat trout and species that depend on them.

Background

- 1890s: The park stocked fish; lake trout were introduced to Lewis and Shoshone lakes.
- 1980s–1990s: Lake trout illegally introduced into Yellowstone Lake
- 1994: First verified lake trout caught in Yellowstone Lake.
- A mature lake trout can eat ~41 cutthroat trout per year.

- The cutthroat trout population in Yellowstone Lake is ~10% or less of historic highs.
- Many wildlife species, including the grizzly bear, otter, and bald eagle, depend on cutthroat trout for a portion of their diet.
- Most predators can't catch lake trout because the trout live in deep water, spawn in the lake, and are large.

Current Status

- Gillnetting has removed more than 3.14 million lake trout since 1994.
- Anglers catch approximately 20,000 lake trout each year.

- Population models estimate a 70% decline in age 6+ lake trout since 2012.
- Lake trout recruitment remains strong. However, 2018 results indicate that is beginning to decrease as well.

Outlook

With continued aggressive control efforts, fisheries managers expect to reduce lake trout numbers and lessen impacts to cutthroat trout. Recent monitoring indicates Yellowstone cutthroat trout in Yellowstone Lake are starting to rebound and the lake trout population is in decline.

Population modeling has shown that the lake trout population expanded through 2012, but increased gillnetting has begun to reduce lake trout numbers and biomass (total weight) in Yellowstone Lake, particularly in older age classes. Abundance models show no population growth for lake trout age 2–3 years, a decrease in fish 3–5 years, and a 70% decrease 6 years and older. Total annual mortality rates have been steadily increasing over the past several years and have exceeded 50% in three of the last four years. In addition, the total biomass of lake trout removed annually has increased from 0.5 kilograms per hectare to over 4.0 kilograms per hectare. If this trend continues, it predicts an eventual population crash.

Research guides methodology

In 2010, Yellowstone developed the Native Fish Conservation Plan. This adaptive management plan guides efforts to recover native fish and restore natural ecosystem functions based on scientific assessment.

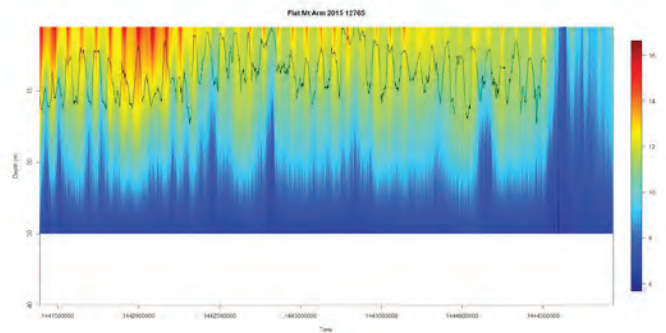
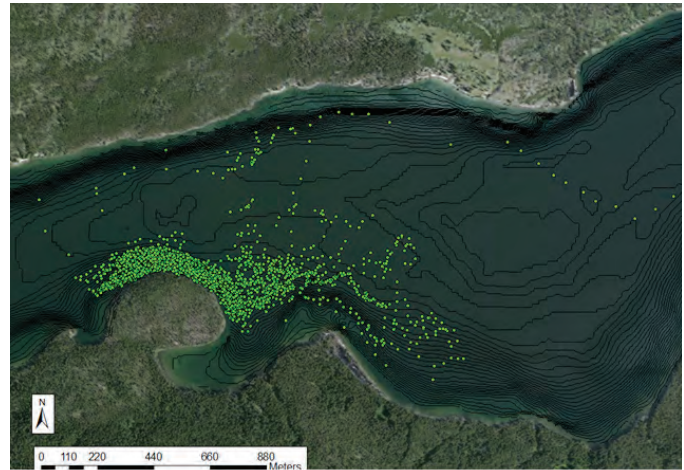
In 2011, the National Park Service and the US Geological Survey launched a movement study to target lake trout embryos in spawning beds and identify general and seasonal movement patterns. The results helped gillnet operators to target lake trout more efficiently.

In 2013, NPS and Montana State University conducted a mark/recapture study of lake trout in Yellowstone Lake. In order to estimate population size, 2,400 lake trout were tagged and released back into the lake. More than 86% of tagged fish were recaptured. Results produced an estimate of the number of lake trout present in the lake: 367,650 fish greater than 210 millimeters (8.3 in.) long.

The mark-recapture study also helped estimate rates of capture for four size classes. This effort removed 72% of lake trout 210–451 millimeters (8.3–17.8 in.) in length, 56% for fish 451–541 millimeters (17.8–21.3 in.) long, 48% for fish 541–610 millimeters (21.3–24.0 in.) long, and 45% for fish more than 610 millimeters (>24.0 in.) long. These results supported previous estimates and highlighted the difficulty in catching older, mature lake trout, which eat the most native cutthroat trout and have the highest reproductive success.

Future of Lake Trout Control

With current technology, lake trout probably cannot be eliminated from Yellowstone Lake. However, ongoing management of the problem can significantly



Telemetry results show the location of a fish (above) and the depth profile of the same fish (below).

reduce lake trout population growth and maintain the cutthroat trout population, which is a critical ecological link between Yellowstone Lake and its surrounding landscape.

Reducing the lake trout population to a level that will have only minor impacts to the cutthroat trout population is predicted to take until 2025—provided we maintain current high levels of suppression effort. Given the high reproductive potential of this lake trout population, it will rebound immediately and dramatically if we reduce the suppression effort.

Present research efforts by Yellowstone National Park biologists and collaborating scientists at the USGS Montana Cooperative Fishery Research Unit and Montana State University focus on killing lake trout embryos on spawning sites. So far, only 50 acres of lake trout spawning areas have been identified by tracking tagged fish, visual observations during SCUBA diving, and remote observations with underwater cameras.

One technique uses lake trout carcasses from the gillnetting operation to kill lake trout embryos. Carcasses are shredded and placed on the rocky areas where lake trout naturally spawn. Natural

decomposition of the shredded fish decrease the dissolved oxygen in the areas around the embryos, making the spawning site inhospitable. Tests showed almost complete mortality of lake trout embryos at the treatment site within a couple of weeks. This technique shows great potential for increasing the effectiveness of the suppression program. A similar technique uses pellets of vegetative materials which, limited research has shown, are less of an attractant to bears, easier to handle, and just as effective at killing embryos. These options will be explored further in the coming field season.

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Lake Chub (*Couesius plumbeus*)



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Though native to the Missouri and Yellowstone river drainages in Montana and Wyoming, the lake chub is not native to Yellowstone National Park waters. It was most likely introduced by bait fishermen into Yellowstone Lake, McBride Lake, and Abundance Lake in the Slough Creek drainage.

Description

- Dull gray or blueish gray
- Rarely more than 6 inches long.

Behavior

- Inhabits cooler lakes and streams, prefers small creeks to large rivers.
- Spring spawner
- Compete with small trout for food, but likely provides fodder for trout over 16 inches.

Distribution

- Established but uncommon in Yellowstone Lake. Removed from Lake Abundance in 1969.
- Well-established in the Slough Creek drainage.

Unsuccessfully Introduced Nonnatives

At the end of the nineteenth century/early twentieth century, it was commonly believed among park managers and anglers that nature sometimes needed human “help” to make fisheries better. These introduced fish are no longer found in Yellowstone.

Yellow perch (*Perca flavescens*)

In the early 1900s, yellow perch were introduced to Goose Lake and other small lakes in the Lower Geyser Basin. In 1938, fisheries managers removed them from Goose Lake in an attempt to keep the perch from spreading to the Firehole River.

Atlantic salmon (*Salmo salar*)

In 1908, land-locked Atlantic salmon were stocked in Yellowstone Lake and in Duck Lake near West Thumb.



The lake trout, introduced to Yellowstone Lake, is one of several aquatic nonnative species having a significant detrimental effect on the park's aquatic ecology.

Aquatic Invasive Species

An aquatic invasive species disrupts ecological processes because it is not indigenous to the ecosystem. Invasive organisms can cause species extinction, with the highest extinction rates occurring in freshwater environments. In addition to nonnative fish in Yellowstone, three aquatic invasive species are having a significant detrimental effect:

- *Myxobolus cerebralis*, a parasite that causes **whirling disease** in cutthroat trout and other species.
- **New Zealand mud snails** (*Potamopyrgus antipodarum*), which form dense colonies and compete with native species; and
- **Red-rimmed melania** (*Melanooides tuberculatus*), a small snail imported by the aquarium trade starting in the 1930s, was discovered in the warm swimming area at the confluence of the Boiling River with the Gardner River in 2009.

Preventing the arrival of additional aquatic invasive species is critical because eliminating them after they become established in a watershed is usually

impossible and efforts to reduce their impact can be extremely expensive. Each summer a small team of park technicians inspect the crafts brought in by park visitors before they put their boats or angling gear in the water. They inspect visitor's equipment and



A team of park staff and volunteers inspect all visitor watercraft before they put their boats or angling gear in the water to prevent the arrival of more aquatic nuisance species.

Quick Facts

The Issue

Aquatic invaders can irreversibly damage the park's ecosystems.

Current Status

- In the US currently, more than 250 nonnative (from another continent) aquatic species and more than 450 nonnative (moved outside their natural range) aquatic species exist.
- At least 8 aquatic invasive species exist in Yellowstone's waters: two mollusks, five fish, and one nonnative disease-causing

microorganism (whirling disease). Three of these species are having a significant detrimental effect (lake trout, New Zealand mud snails, and whirling disease).

- Park staff continues to educate visitors about preventing the spread of aquatic invasive species.

What You Can Do

Read and follow the instructions provided in the fishing regulations, and remember to **inspect, clean, and dry** all gear.

- It is illegal to use any fish as bait in Yellowstone National Park.
- It is illegal to transport fish among any waters in the Yellowstone region.
- It is illegal to introduce any species to Yellowstone waters.
- Watercraft must be inspected and may be required to undergo decontamination.

decontaminate it, if necessary. Such decontamination is usually adequate to prevent the entry of most aquatic invasive species.

Arrival in Yellowstone

During the late 1880s when the Army administered Yellowstone, the US Fish Commission (a predecessor of today's US Fish and Wildlife Service) stocked nonnative fish in some park waters. These stockings comprise the first known, deliberate introductions of nonnative fish to Yellowstone. Four trout species were widely introduced—brook, brown, lake, and rainbow. Rainbow trout hybridize with native cutthroat trout, thus diluting genetic diversity. All four compete with and prey upon native fish.

Other aquatic invasive species, such as the New Zealand mud snail and the parasite causing whirling disease, probably arrived via unaware boaters and anglers carrying the organisms from other locations around the country. We may never know exactly how those species were introduced to the park, but anglers can help prevent other species from arriving.

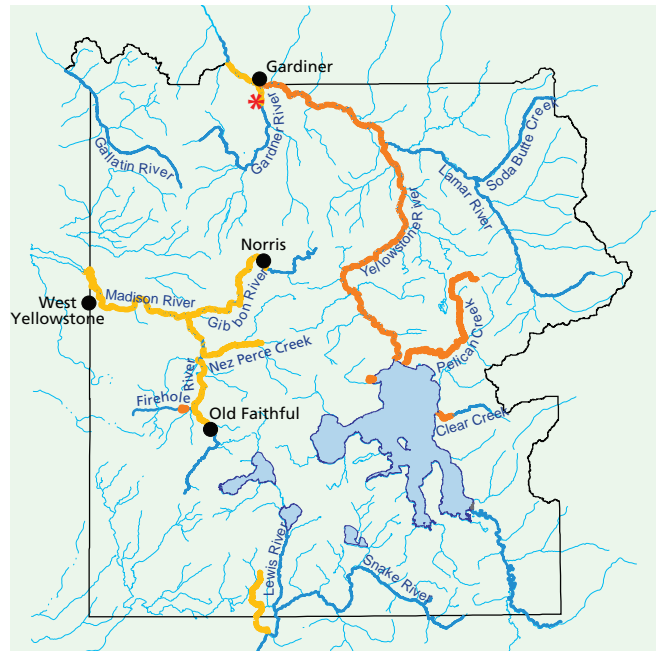
New Zealand Mud Snails

The New Zealand mud snail (*Potamopyrgus antipodarium*) is an invasive species that became established in the western United States since the 1980s. In suitable habitat, especially in geothermal streams with high primary production, it can form dense colonies on aquatic vegetation and rocks along streambeds, crowding out insect communities—a primary food for immature trout and other native species.

New Zealand mud snails consume a large amount of algae, which is a primary food for native aquatic invertebrates. Its overall impact on algae is likely to affect entire stream food webs. With its protective shell, the mud snail provides little if any nutrition as prey and may pass through a fish alive. Scarcely a quarter-inch long, mud snails may cling to boats, waders, and other fishing gear by which they are inadvertently transferred to another watershed. Because the species can reproduce asexually, a single mud snail is all that is required to establish a new colony.

Population

First detected in the park in 1994, New Zealand mud snails are now in all of the major watersheds. Although the mud snail is abundant in several streams, it remains absent or uncommon in other Greater Yellowstone streams, suggesting that its



- Whirling disease
- New Zealand mud snails
- * Red-rimmed melania

Locations in Yellowstone National Park where whirling disease, New Zealand mud snails, or red-rimmed melania have been documented.

upstream population density and distribution is limited by colder temperatures, low productivity, and unstable substrates associated with spring runoff.

Impacts of Mud Snails

Once mud snail colonies become established in a stream, removing them without disrupting native invertebrate populations is not feasible with any known method. Mud snail research in Greater Yellowstone aims to determine the species' impacts on other aquatic organisms and stream ecology. A study of the Gibbon and Madison rivers found that 25–50% of the macroinvertebrates were mud snails, and the areas they occupied had fewer native mayflies, stoneflies, and caddisflies—insects important in the diet of salmonids and several bird species.



New Zealand mud snails shells resting on a dime.

Red-rimmed Melania

The red-rimmed melania (*Melanoides tuberculatus*), a small snail imported by the aquarium trade starting in the 1930s, was discovered in the warm swimming area at the confluence of the Boiling River with the Gardner River in 2009. The following year, a survey of 18 of the park's most popular hot springs found melania only in the Boiling River soaking area and downstream approximately 1 km. The species has a narrow temperature tolerance (18–32°C) and is unlikely to survive downstream of the Boiling River during the winter, but it could become established in other thermal water in the park.

Whirling Disease

Whirling disease is caused by a microscopic parasite from Europe (*Myxobolus cerebralis*) that can infect some trout and salmon; it does not infect humans. It has been detected in 25 states. During the parasite's life cycle, it takes on two different forms as spores and requires two hosts: a common aquatic worm (*Tubifex tubifex*) and a susceptible fish. Cutthroat trout are susceptible, especially during the first months of life. The parasite feeds on the fish's cartilage, and the infection can cause skeletal deformities, a blackened tail, and whirling swimming behavior. Because the fish cannot feed normally and are more vulnerable to predation, whirling disease can be fatal. No practical treatment exists for fish infected with this disease or for the waters containing infected fish.

Whirling Disease

The Issue

Whirling disease is a parasitic infection of fish caused by a microscopic protozoan that destroys the cartilage of juvenile trout, resulting in skeletal deformities and sometimes whirling behavior. Seriously infected fish have a reduced ability to feed or escape from predators and mortality is high.

Background

- The disease was first described in Europe more than 100 years ago. It was detected in the United States in the mid-1950s, and in Yellowstone in 1998.
- It most likely came to the US in frozen fish products.
- Recent laboratory tests suggest cutthroat trout are highly susceptible. Lake trout and grayling appear immune to the disease, and brown trout are resistant, but can be infected and can carry the parasite.
- There is no practical treatment.

Presence in Yellowstone

Whirling disease was first detected in Yellowstone in 1998 in cutthroat trout from Yellowstone Lake. It has since been found in the Firehole River and throughout the Yellowstone Lake watershed. In the lake, the infection has spread to about 20% of the cutthroat trout. The parasite is most prevalent in the two known infected tributaries, Pelican Creek and the Yellowstone River downstream of the lake outlet. Infection has been most severe in Pelican Creek, which once supported nearly 30,000 upstream-migrating cutthroat trout. Significant declines in Pelican Creek's spawning population have been attributed to the combination of whirling disease and predation by nonnative lake trout in Yellowstone Lake. The finding of adult fish in the lake with the parasite's spores that survived their initial infection suggests some resilience of Yellowstone cutthroat trout to whirling disease.



These rainbow trout show the characteristic black tail and skeletal deformities indicative of whirling disease.

Studying the Disease

Yellowstone National Park's cutthroat trout spawning streams, which vary widely in thermal, hydrological, and geological characteristics, provide an exceptional opportunity to study whirling disease in native trout. Park staff have been working with Montana State University's Department of Ecology to measure how the infection rate might vary in different stream conditions. Certain fish-eating birds have also been shown to disperse the parasite. Research has shown that the parasite can pass through the gastrointestinal tract of some birds, such as great blue herons, and remain alive.

Results of a 2012 survey suggest that whirling disease risk remains very high in Pelican Creek. Overall however, it does not appear that whirling disease has spread widely throughout spawning tributaries to Yellowstone Lake. In addition, prevalence of infection in juveniles and adults within the lake remains

low. Despite this, there are still many unknowns concerning the parasite, particularly in the unique environmental context of Yellowstone.

Park staff emphasize prevention by educating people participating in water-related activities—including anglers, boaters, or swimmers—to take steps to help prevent the spread of the disease. This includes thoroughly cleaning mud and aquatic vegetation from all equipment and inspecting footwear before moving to another drainage. Anglers should not transport fish between drainages and should clean fish in the body of water where they were caught.

Incoming Threats

The aquatic invasive species which pose the greatest risk to ecologic, recreational, and economic values in the Yellowstone area include zebra and quagga mussels, Asian clams, Asian carp species, Eurasian watermilfoil, hydrilla, flowering rush, and viral hemorrhagic septicemia. Fisheries biologists believe several of these species are moving toward Yellowstone. Their arrival might be avoided if anglers remember:

- Remove all plants, animals, mud, sand, and other debris from your boat, boots, and equipment.
- Do not dump water from other sources into Yellowstone waters.
- Drain your boat bilge area, live well, and other compartments away from all waters.
- Dry all equipment in the sun for 5 days or use high-pressure, hot (>140°F) water (available at car washes outside the park) to clean your boat, trailer, waders, boots, and equipment.

Dreissenid Mussels

Zebra mussels (*Dreissena polymorpha*) and closely related quagga mussels (*Dreissena bugensis*), collectively called dreissenids, are of particular concern given their ability to attach to watercraft, survive many days out of water, and cause irreparable harm.

Zebra mussels are native to Eastern Europe and western Asia. They were first discovered in North America in 1988 in Lake St. Clair, one of the water bodies connecting the Great Lakes. It is believed that this invasive species was introduced through ballast water discharges from international shipping.

Following their initial invasion, zebra mussels spread quickly across most of the eastern United States and Canada. Zebra mussels are inadvertently



Zebra mussel colony.

transported to new water bodies by boaters who trailer their boats between infected bodies of water.

Zebra mussels drastically alter the ecology of infested water bodies and may severely impact ecosystems. Once established, these efficient filter-feeders consume significant biomass of phytoplankton, depleting the foundation of the aquatic food web. Zebra mussels can attach to most hard surfaces, forming mats that may be up to 18 inches thick. Mussels can impact recreation activities and associated economies by covering docks, boats, and beaches; in addition to causing severe infrastructure and economic damage by blocking water supply pipes of power and water treatment plants, irrigation systems, and industrial facilities.

Zebra mussels' native predators from Europe, certain types of birds and fish, are not present in North America. Though some ecologically similar species do exist, they do not appear to have significant impact on

On Yellowstone's Doorstep

On November 8, 2016 the State of Montana Department of Fish, Wildlife, and Parks announced that laboratory studies had identified invasive mussel larvae in water samples from the Tiber and Canyon Ferry reservoirs.

Extensive sampling has found no adult or larval mussels—but environmental DNA in the Tiber Reservoir tested positive for mussels in 2017. No evidence was found in 2018, however, prevention and inspection efforts on the reservoirs will double in 2019.

Testing has confirmed that nearby Glacier National Park remains free of quagga and zebra mussels.

Another aquatic invader of concern is curly leaf pondweed (*Potamogeton crispus*) which has been identified in local areas and waterways adjacent to the park.

reducing established mussel populations. Annual testing of Yellowstone and Lewis lakes has been negative for Dreissenid mussels as of 2017.

Asian Carp

The **bighead carp** (*Hypophthalmichthys nobilis*), **black carp** (*Mylopharyngodon piceus*), and **silver carp** (*Hypophthalmichthys molitrix*) occur in at least 24 states. They out-compete native fish, reduce forage for other fish, and can transmit disease. Silver carp are also known for their ability to jump great distances out of the water when boats travel near them, causing injury to boaters.

Silver carp are native to Southeast Asia and east Russia and were intentionally introduced into the United States in 1973 in an attempt to improve water quality, increase fish production in culture ponds, as biological control and as food fish. The species now occurs in at least 18 states and is naturally reproducing. Both the silver and the bighead carp compete for food (zooplankton) with native fish.

Black carp are native to Asia and east Russia and were unintentionally introduced in the early 1970s as a stowaway with intentionally introduced grass carp. Black carp now occur in at least 5 states. Black carp may reduce populations of native mussels and snails through predation and negatively affect the aquatic ecosystem. None of these species are currently found in Wyoming, or Montana.

These invasive species may continue to be spread intentionally or through accidental introductions as fish or fish eggs and through water currents.

Asian Clam

Since the introduction of *Corbicula fluminea* to the United States in 1938, it has spread into many of the major waterways and is now found in 46 of the United States states. The species have not been completely distinguished, but most varieties are small light-colored bivalves, yellow-green to light brown in color.

The native ranges are in temperate to tropical southern Asia west to the eastern Mediterranean; Africa, except in the Sahara desert; and southeast Asian islands south into central and eastern Australia. The Asian clam is a filter feeder that removes particles from the water column. It can be found at the sediment surface or slightly buried. Its ability to reproduce rapidly, coupled with low tolerance of cold temperatures (2-30°C), can produce

wild swings in population sizes from year to year in northern water bodies.

Eurasian watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) has spread to all of the United States except Hawaii and Wyoming. In 2007, it was found in Montana.

This nonnative aquatic plant lives in calm waters such as lakes, ponds, and calm areas of rivers and streams. It grows especially well in water that experiences sewage spills or abundant motorboat use, like Bridge Bay.

Eurasian water-milfoil colonizes via stem fragments carried on boating equipment, emphasizing why boats should be thoroughly cleaned, rinsed, and inspected before entering Yellowstone National Park.

Plankton

Three nonnative plankton species which can displace the native zooplankton that are important food for cutthroat trout may be on their way. These nonnative zooplankton have long spines, which make them difficult for young fish to eat.

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Amphibians are valuable indicators of environmental stressors such as disease or climate change. Researchers monitor amphibian populations in the park.

Amphibians

Amphibians are an important part of Yellowstone's aquatic and terrestrial ecosystems. Many of Yellowstone's reptiles, birds, mammals, and fish prey on larval and adult amphibians and amphibians, in turn, eat a variety of vertebrate and invertebrate species. Amphibians are also sensitive to disease, pollution, drought, variations in annual snowpack, and the arrival of nonnative species; these documented sensitivities make them valuable indicators to environmental change. Amphibians often congregate in large numbers for breeding or overwintering. As a result, they can be adversely affected by localized disturbance or the loss of individual breeding or overwintering sites. Amphibian populations that are affected by one or more of these stresses may exhibit changes in their distribution or abundance. These changes can, in turn, have cascading effects on other aspects of the ecosystem.

Declines in amphibian populations are occurring globally in areas where habitat destruction is

pervasive, but also in protected areas. About one-third of all amphibian species are believed to be threatened with extinction. Yellowstone includes some of the most climatologically and topographically complex landscapes in the lower 48 states and therefore provides a valuable study area to examine how climate may influence amphibian distribution and trends. Information about the status and trends of amphibians here may shed light on declines documented in other high-elevation locations or other protected areas around the West.

Population

Annual surveys since the early 2000s have documented four amphibian species as widely distributed in Yellowstone: boreal chorus frogs, Columbia spotted frogs, western tiger salamanders, and western toads occur in wetlands and ponds throughout Yellowstone. In 2014, the plains spadefoot (*Spea bombifrons*) was confirmed in Yellowstone through genetic analyses. These toads are rarely seen because

Quick Facts

Number in Yellowstone

5 species: Western tiger salamander, boreal chorus frog, Western toad, Columbia spotted frog, and plains spadefoot toad.

Identification

Toads are not taxonomically different from frogs. The species called "toads" are associated with drier skin and more terrestrial habitats.

Status

- Columbia spotted and boreal chorus frogs are widely distributed with many breeding sites in the park.

- Western tiger salamanders are common and abundant on the northern range and Hayden Valley.
- Western toads are abundant in some areas.
- None of the park's amphibians are federally listed as threatened or endangered.
- Scientists are concerned about the Western toad, which has declined sharply in other parts of the West.

Research

- 2000: Researchers begin inventorying amphibians.

- 2005: Long-term amphibian monitoring begins in Yellowstone.
- 2014: A breeding population of plains spadefoot (*Spea bombifrons*) was confirmed near Fountain Flat Drive.

Survival in winter

To survive the winter, some Yellowstone amphibians go into water that does not freeze (spotted frogs), others enter underground burrows (salamanders and toads), and others (boreal chorus frog) tolerate freezing and go into a heart-stopped dormancy for the winter in leaf litter or under woody debris.

they spend most daylight hours underground. Currently, a single breeding population is known to exist within Yellowstone. However, monitoring efforts are underway to locate additional breeding sites because plains spadefoots typically do not disperse far from their natal pond.

In Yellowstone, amphibians depend on limited suitable habitat with shallow, quiet waters needed for egg laying and larval development. Annual differences in snowpack and precipitation change the extent and location of wetland sites, resulting in considerable year-to-year variation in amphibian reproduction. Breeding data collected across the park and since 2006 show that annual variations in breeding are common. Multi-year monitoring data indicate that amphibian populations using small, shallow isolated wetlands are most susceptible to drought or changes in precipitation. In contrast, amphibian populations occupying deeper wetlands and ponds appear to be more stable through time.

Since the 1950s, air temperatures have increased across this region and changes in the flooding patterns or the complete drying of wetlands have been documented. Since 2006, annual visits to approximately 250 wetlands across Yellowstone have further documented annual variation in the availability of wetlands. This data suggests that in hot, dry years (e.g., 2007) upwards of 40% of the park's wetlands dry up. In cool, wet years (e.g., 2011) most wetlands across the park are flooded and available to support amphibian breeding. Further warming is anticipated for this region and could contribute to the drying of wetlands and influence the distribution and abundance of amphibians and other wetland dependent species.

Disease agents, such as ranavirus and chytrid fungus (*Batrachochytrium dendrobatidis*), could also affect the survival and reproduction of amphibian populations in Yellowstone. Ranavirus has been found in tiger salamanders and Columbia spotted frogs collected from die-offs since 2008 and been involved with die-offs of all four widely distributed species in the region. Chytrid fungus does not necessarily cause a fatal infection and usually appears in Columbia spotted frogs and western toads following metamorphosis. The DNA of the chytrid fungus has been identified in skin swabs collected from both species in Yellowstone, though the impacts at the population level have not been determined. Since 2015, 44% of tissue samples (tail clips) collected

Amphibian or Reptile?

Both amphibians and reptiles are ectothermic ("cold-blooded"), meaning they derive body heat from outside sources rather than generate it internally. Reptiles have scaly, dry skin. Some lay eggs; others bear live young. Amphibians have thin, moist glandular skin permeable to water and gases. The young must pass through a larval stage before changing into adults. Amphibious means "double life" and reflects the fact that salamanders, toads, and frogs live in water as larvae and on land for much of the rest of their lives.

from larval amphibians (frog and toad tadpoles) have tested positive for ranavirus. These findings highlight that several factors, including host susceptibility and environmental conditions, may determine whether an infection is lethal and results in a die-off or a decline in population abundance.

Studying Amphibians in Yellowstone

The Greater Yellowstone Network (GRYN) has led a collaborative monitoring of wetlands and amphibians in Yellowstone since 2006. Long-term monitoring of amphibian populations provides an opportunity to observe trends that may not be apparent at local scales or in areas with more direct human influences on habitat quality.

Amphibians are monitored at catchments (or watersheds), which average approximately 500 acres in size. On average, 30 catchments are revisited during annual monitoring visits (up to 24 in Yellowstone, and 7 in neighboring Grand Teton National Park). All wetlands within the selected catchment are visited each summer, when two independent observers search for amphibians breeding evidence (i.e., eggs, larvae, or recently metamorphosed individuals) and document important habitat characteristics and the presence or absence of surface water.

The objectives of GRYN's annual monitoring are to estimate the proportion of monitored catchments and wetlands used for breeding by each native amphibian species annually, to consider whether the rate and direction of use may be changing through time, and to document the number of wetlands within catchments that are potentially suitable for amphibian breeding.

This annual monitoring is then combined with local climate data to carefully examine the links between climate, wetlands, and amphibians. Taken together, amphibian and wetland monitoring data

from the last decade, coupled with local climate information, will help support predictions of amphibian occurrence under different climate scenarios.

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Western Tiger Salamander (*Ambystoma mavortium*)



Identification

- The only salamander in Yellowstone.
- Adults range up to 9 inches, including the tail.
- Head is broad, with a wide mouth.
- Color ranges from light olive or brown to nearly black, often with yellow blotches or streaks on back and sides; belly is dull lemon yellow with irregular black spots.
- Larvae, which are aquatic, have a uniform color and large feathery gills behind the head; they can reach sizes comparable to adults but are considerably heavier.

Habitat

- Breeds in ponds and fishless lakes.
- Widespread in Yellowstone in a great variety of habitats, with sizable populations on the northern range .

Behavior

- Adult salamanders come out from hibernation in late April to June, depending on elevation, and migrate to breeding ponds where they lay their eggs.
- Mass migrations of salamanders crossing roads are sometimes encountered, particularly during or after rain.
- After migration, salamanders return to their moist homes under rocks and logs and in burrows.
- Feed on adult insects, insect nymphs and larvae, small aquatic invertebrates, frogs, tadpoles, and even small vertebrates.
- Preyed upon by a wide variety of animals, including mammals, fish, snakes, and birds such as sandhill cranes and great blue herons.

Boreal Chorus Frog (*Pseudacris maculata*)



Identification

- Adults reach 1 to 1.5 inches in length, and females are usually larger than males; newly metamorphosed juveniles are less than 1 inch long.
- Brown, olive, tan, or green (sometimes bicolor) with a prominent black stripe on each side from the nostril through the eye and down the sides to the groin; three dark stripes down the back, often incomplete or broken into blotches.

Habitat

- Common, but seldom seen due to its small size and secretive habits.
- Live in moist meadows and forests near wetlands.
- Lays eggs in loose irregular clusters attached to submerged vegetation in quiet water.

Behavior

- Breeds in shallow temporary pools or ponds during the late spring.
- Calls are very conspicuous, resemble the sound of a thumb running along the teeth of a comb.
- Males call and respond, producing a loud and continuous chorus at good breeding sites, from April to early July, depending on elevation and weather.
- Usually call in late afternoon and evening.
- Tadpoles eat aquatic plants; adults mostly eat insects.
- Eaten by fish, predacious aquatic insect larvae, other amphibians, garter snakes, mammals, and birds.

Western Toad (*Anaxyrus boreas*)



JEFF ARNOLD

Identification

- Yellowstone's only true toad species which is confirmed to breed in the park.
- Adults range up to about 4 inches, juveniles just metamorphosed from tadpoles are only 1 inch long.
- Stocky body and blunt nose.
- Brown, gray, or olive green with irregular black spots, lots of "warts," and usually a white or cream colored stripe down the back.
- Tadpoles are usually black and often congregate in large groups.

Habitat

- Once common throughout the park, now appears to be much rarer than spotted frogs and chorus frogs; scientists fear this species has experienced a decline in the ecosystem.
- Adults can range far from wetlands because of their ability to soak up water from tiny puddles or moist areas.
- Lay eggs in shallow, sun-warmed water, such as ponds, lake edges, slow streams, and river backwaters.

Behavior

- Tadpoles eat aquatic plants; adults eat algae, insects, especially ants and beetles, worms and other small invertebrates.
- Sometimes active at night.
- Defends itself against predators by secreting an irritating fluid from numerous glands on its back and behind the eyes.
- Eaten by snakes, mammals, ravens, and large wading birds.

Columbia Spotted Frog (*Rana luteiventris*)



Identification

- Common in suitable wetland habitat.
- Maximum length is about 3 inches, newly metamorphosed juveniles less than one inch long.
- Upper surface of the adult is gray-brown to dark olive or even green, with irregular black spots; skin is bumpy; underside is cream-colored and may be splashed with brilliant orange on the thighs and arms on many but not all individuals.
- Tadpoles have long tails and may grow to 3 inches long.

Habitat

- Found all summer along or in rivers, streams, smaller lakes, marshes, ponds, and rain pools.
- Lay eggs in stagnant or quiet water, in globular masses surrounded by jelly.

Behavior

- Breeds in April to early June, depending on temperatures and elevation.
- Tadpoles metamorphose and grow into adults between July and September.
- Tadpoles eat aquatic plants, adults mostly eat insects but are highly opportunistic in their food habits (like many other adult amphibians).

Plains Spadefoot Toad (*Spea bombifrons*)



Identification

- A single breeding population has been identified in the Lower Geyser Basin east of Fairy Creek in Yellowstone National Park.
- Protruding eyes with vertical pupils, and a prominent bony boss (raised bump) between the eyes.
- Have a single, dark tubercle, or “spade,” on each of their hind feet .

Habitat

- Uses its spade to dig shallow summer burrows or deeper winter burrows. Newly metamorphosed animals may burrow in mud near their natal pond or hide in cracks in the hard earth.
- Typically occur in warmer climates in the western United States, and it has been speculated that spadefoots may be found in geothermally influenced habitat in Yellowstone that facilitates overwinter survival.

Behavior

- Breeds in ephemeral pools following significant rainfall.
- Tadpoles develop from eggs in 2 to 6 days.
- Produces cannibalistic and noncannibalistic tadpole body types.
- Tadpoles develop for 3 to 6 weeks before metamorphosis.



Reptiles are not well studied in Yellowstone National Park. The bullsnake (shown here) is one of six, and the largest, reptile species found in the park.

Reptiles

Yellowstone provides a valuable study area; information about the status and trends of reptiles here may shed light on declines documented in other high-elevation protected areas of the western United States. Many reptiles congregate to breed or overwinter, and they can be adversely affected by disturbance or loss of key sites.

Quick Facts

Number in Yellowstone

They are less studied than amphibians in Yellowstone. There are 6 confirmed species:

- bullsnake
- prairie rattlesnake
- rubber boa
- sagebrush lizard
- common garter snake
- terrestrial garter snake.

Status

- None of the park's reptiles are federally listed as threatened or endangered.
- Researchers began inventorying reptiles and amphibians in 2000.

Bullsnake (*Pituophis catenifer sayi*)

Identification

- A subspecies of the gopher snake, is Yellowstone's largest reptile, ranging from 50 to 72 inches long.
- Yellowish with a series of black, brown, or reddish-brown blotches down the back; the darkest, most contrasting colors are near the head and tail; blotches are shaped as rings around the tail.
- Head resembles a turtle's in shape, with a protruding scale at the tip of the snout and a dark band extending from the top of the head through the eye to the lower jaw.

Habitat

- In Yellowstone, found at lower elevations; drier, warmer climates; and open areas such as near Mammoth.

Behavior

- Lives in burrows and eats small mammals—behavior that gave the gopher snake its name.
- Often mistaken for a rattlesnake because of its appearance and its defensive behavior: when disturbed, it will coil up, hiss loudly, and vibrate its tail against the ground, producing a rattling sound.

Prairie Rattlesnake (*Crotalis viridis*)



Identification

- Can be more than 48 inches in length.
- Greenish gray to olive green, greenish brown, light brown, or yellowish with dark brown splotches down its back that are bordered in white.

Habitat and Behavior

- Only dangerously venomous snake in the park.
- Lives in the lower Yellowstone River areas of the park, including Reese Creek, Stephens Creek, and Rattlesnake Butte, where the habitat is drier and warmer than elsewhere in the park.
- Usually defensive rather than aggressive.
- Only two snake bites are known during the history of the park.

Rubber Boa (*Charina bottae*)



Identification

- Infrequently encountered in Yellowstone, perhaps due to its nocturnal and burrowing habits.
- One of two species of snakes in the United States related to tropical boa constrictors and pythons.
- Maximum length of 28 inches.
- Back is brown or greenish-brown, belly is lemon yellow; scales are small and smooth, making it almost velvety to the touch.

Habitat and Behavior

- Eats small prey including mammals, amphibians, lizards, other snakes, and even small birds.
- May spend great deal of time partially buried under leaves and soil, and in rodent burrows.
- Usually found in rocky areas near streams or rivers, with shrubs or trees nearby.
- Recent sightings have occurred in the Bechler region and Gibbon Meadows.

Similar species:

The racer (*Coluber constrictor*) can be found from southern British Columbia, east to Maine, and south across the US to southern Florida and southern California. Racers, as their name implies, are fast and sleek snakes, unlike the slow-moving rubber boa.

Racers also have larger eyes than rubber boas and round pupils. Any sightings of this species should be reported to resource managers.



Sagebrush Lizard (*Sceloporus graciosus*)



Identification

- Only lizard in Yellowstone.
- Maximum size of five inches from snout to tip of the tail; males have longer tails and may grow slightly larger than females.
- Gray or light brown with darker brown stripes on the back set inside lighter stripes on the sides, running the length of the body; stripes not always prominent and may appear as a pattern of checks down the back; underside usually cream or white.
- Males have bright blue patches on the belly and on each side, with blue mottling on the throat.

Habitat

- Usually found below 6,000 feet but in Yellowstone lives up to 8,300 feet.
- Populations living in thermally influenced areas are possibly isolated from others.
- Most common along the lower portions of the Yellowstone River near Gardiner, Montana, and upstream to the mouth of Bear Creek; also occurs in Norris, Shoshone, and Heart Lake geyser basins, and other hydrothermal areas.

Behavior

- Come out of hibernation about mid-May and active through mid-September.
- Diurnal, generally observed during warm, sunny weather in dry rocky habitats.
- During the breeding season males do push-ups on elevated perches to display their bright blue side patches to warn off other males.
- Feed on various insects and arthropods.
- Eaten by bullsnakes, terrestrial gartersnakes, prairie rattlesnakes, and some birds.
- May shed tail when threatened or grabbed.

Common Gartersnake (*Thamnophis sirtalis*)



Identification

- Medium sized snake up to 34 inches long.
- Nearly black background color with three bright stripes running the length of the body; underside is pale yellow or bluish gray.
- Most distinguishing characteristics of this species in our region are the irregular red spots along the sides.

Habitat

- Thought to be common in the past, now in decline for no apparent reason.
- Closely associated with permanent surface water.
- In Yellowstone area, observed only in the Falls River drainage in the Bechler region and three miles south of the south entrance along the Snake River.

Behavior

- Generally active during the day.
- In the Yellowstone area it eats mostly toads, chorus frogs, fish remains, and earthworms; can eat relatively poisonous species. Reliance on amphibian prey may contribute to reports of declines of this species in the greater Yellowstone area.
- Predators include fish, birds, and carnivorous mammals.

Terrestrial Gartersnake (*Thamnophis elegans*)



JEFF ARNOLD

Identification

- Most common reptile in the park.
- 6 to 30 inches long.
- Brown, brownish green, or gray with three light stripes—one running the length of the back and a stripe on each side.

Habitat

- Usually found near water in all areas of the park.
- Eats small mammals, fish, frogs, tadpoles, salamanders, earthworms, slugs, snails, and leeches.

Behavior

- May discharge musk from glands at the base of the tail when threatened.
- Gives birth to as many as 20 live young in late summer or fall.

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