

BOATING ON YELLOWSTONE'S RIVERS;
AN ANALYSIS AND ASSESSMENT

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U.S. Department of the Interior
Yellowstone National Park

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I. INTRODUCTION

Yellowstone National Park consists of 3,472 square miles (8,992 square kilometers) in the northwest corner of Wyoming and adjacent Montana and Idaho. The park is a high volcanic plateau of moderate relief, surrounded by mountain ranges near or outside the boundaries. Cradled in Yellowstone's coniferous forests are the headwaters of three great rivers: the Snake, which begins in the southern part of the park and heads west to the Columbia; the Madison, which is formed by the junction of two streams along whose banks are found a great majority of the world's geysers and hot springs; and the Yellowstone, which, like the Madison, finds its way into the turbid Missouri, but only after passing through deep canyons and over major waterfalls.

The park is the core of the Greater Yellowstone Ecosystem, a six million acre area of predominantly public land, including Grand Teton National Park and the John D. Rockefeller Memorial Parkway, and the Shoshone, Bridger-Teton, Targhee, Gallatin, and Custer National Forests. Geologically, this is a unique area, and one of worldwide significance. The Yellowstone caldera represents some of history's most powerful vulcanism, and the existing thermal features evidence the fragility of the earth's crust. The region experiences frequent seismic activity and continuing uplift at rates far above the norm. And the Teton Range provides spectacularly beautiful examples of faulting, erosion, and glaciation.

Biologically, the area is unique in the lower forty-eight states for its unmatched display of native American mammals. Resident species include elk, bison, moose, mule deer, pronghorn (antelope), bighorn sheep, grizzly and black bear, mountain lion, bobcat, lynx, wolverine, coyote, red fox, beaver, river otter, badger, weasel, marmot, pine marten, pika, jackrabbit, and snowshoe hare. The gray wolf may occasionally roam through the area, but is considered extinct from Yellowstone at present. It and the grizzly bear are protected under the 1973 Endangered Species Act. In addition to the mammals, some of the rarest American birds inhabit the ecosystem, including the endangered bald eagle, peregrine falcon, and whooping crane, as well as golden eagles, trumpeter swans, prairie falcons, harlequin ducks, and sandhill cranes. The fish species in Yellowstone include the world's largest population of wild cutthroat trout, the native Montana grayling, mountain whitefish, and non-native brook, brown, and rainbow trout which remain from earlier days when fish were stocked into the park. Preserved in the native populations are many unique genetic strains of fish, found only here.

Historically, Yellowstone represents the beginning of a worldwide movement to protect and conserve significant natural resources. In 1872 it became the world's first national park, and remains one of the largest. In 1974, UNESCO honored Yellowstone as a Biosphere Reserve, and in 1978 it was designated a World Heritage Site. As a recreational resource for millions of persons, the park and the

surrounding area provide a spectrum of opportunities ranging from wilderness hiking and camping to viewing an abundance of birds, wildlife, and natural features from on or near the roadside. Fishing is one of the most popular activities in the area and supports a considerable portion of the tourist industry in the region.

Boating has not traditionally been a major use of Yellowstone rivers. The first recorded trip on a park river occurred in 1872, when Captain William Jones of the Corps of Engineers led an expedition from the outlet of Yellowstone Lake to the Grand Canyon. Two members of the party built a clumsy raft that capsized, causing them to lose nearly all their equipment in the Le Hardy Rapids, named for the topographer in the party (Haines, 1977). Another early trip was made by Lieutenant Gustavus Doane and a party of six soldiers who dragged a 22-foot, double-ended wooden boat into Heart Lake in the winter of 1877. From there they hoped to explore the Snake River from its source to its junction with the Columbia River. The expedition was plagued by disaster, and members were lucky to struggle alive into Fort Hall, (Idaho) after wrecking their boat.

Automobiles were allowed into the park in 1915, and visitation increased dramatically. However, it appears that few park visitors were interested in floating streams until the 1930's, when enough boats were used on the Madison River to create conflicts with fishermen. On May 30, 1950, a regulation went into effect that closed all rivers and streams in the park to boating. The reason stated at that time was that increased use and heavy fishing pressure during the post-war [WWII] period was detrimental to the fishery resources (YNP, 1950), although one former ranger recalls that there were concerns for how boating would affect wildlife. There is little indication of controversy over the regulation at that time.

In the 1950's, the nation began to experience a boom in outdoor recreation which led to a tremendous increase in use of national parks. Between 1955 and 1974 visitation to parks more than tripled, from 14 million to 46 million (Runte, 1979). A corresponding increase in river floating struck those parks that permitted boats. Annual floaters on the Colorado River in Grand Canyon National Park went from 1,067 in 1966 to 16,428 in 1972. Grand Teton National Park recorded 18,714 persons floating the Snake River in 1966 and 83,096 in 1975. Commercial outfitters on the Green and Yampa Rivers in Dinosaur National Monument went from 2 in 1967 to 14 in 1976 (Huser, 1977).

Throughout this increase in river popularity, while other parks established use restrictions or limits on boating, there was little pressure to open Yellowstone Park rivers to boats. The park annually receives a few inquiries about boating on rivers, and rangers occasionally cite parties for illegal river use. While interest in recreational river boating remains high, guided scenic float trips declined 14.7 percent in 1985 on the Snake River in and south of Grand Teton National Park.

The primary interest in boating Yellowstone's rivers has been expressed by whitewater kayakers. Lundstrom and Staley documented their illegal run of the Black Canyon of the Yellowstone in a regional magazine (1980), and enthusiasts asked the park to reconsider its long-standing policy on river boating.

In 1982, the park's Natural Resource Management Plan was approved. The recommended course of action for river management was an interdisciplinary effort to collect baseline data on park rivers and the potential impacts of boating on those waters. In the summer of 1985, a staff team was established to begin the inventory and environmental assessment of park rivers. Initial assumptions made were that: (1) only non-motorized boating was to be considered, and (2) whole rivers or major segments of rivers and streams within the park would be evaluated; minor tributaries and stretches less than five miles long would not be analyzed. The purpose of this was to keep the analysis from becoming unnecessarily complex and fragmented; although certainly there are shorter segments of river which are floatable.

This document is a product of that analysis. It presents the findings from the inventory and assessment of physical, biological, and social impacts likely to result from allowing floating on park rivers. It also presents alternatives based on park management goals, regional supply and demand, and resource considerations.

A draft of this document was prepared and released for public comment in 1986. After a public comment period of approximately 90 days, the park analyzed and incorporated comments from the individual and group respondents.

II. PARK MANAGEMENT GOALS AND CONSTRAINTS

On March 1, 1872, Yellowstone National Park was "dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people...for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within...and their retention in their natural condition" (17 Stat. 32).

The Act of May 7, 1894, "provided for the protection of birds and animals within Yellowstone, prohibited hunting, and regulated fishing" (28 Stat. 83, as amended).

The Wilderness Act of 1964 (78 Stat. 890) and Yellowstone's subsequent Wilderness Recommendation (1972) require that areas proposed for inclusion in the National Wilderness Preservation System be managed so as not to preclude their eventual designation.

The Endangered Species Act of 1973 (87 Stat. 884) requires the park to identify threatened and endangered species and their critical habitat requirements; to "seek to conserve" said species, using "all methods and procedures... to bring any endangered or threatened species to the point at which measures..are no longer necessary"; and to consult with the U.S. Fish and Wildlife Service and receive a no-jeopardy opinion on management actions that could affect listed species.

The National Historic Preservation Act of 1966 (80 Stat. 915, as amended) mandates that the park identify significant historic and cultural resources and consider the effects of proposed actions on those resources.

The park's Statement for Management (NPS, 1986) provides operational guidelines for Yellowstone. Objectives that particularly relate to this river use analysis state that the park will:

- * Perpetuate the natural ecosystems within the park in as near natural conditions as possible for their inspirational, educational, cultural, and scientific values for this and future generations.
- * Permit natural processes to function within the park ecosystem with minimum disturbance by man's activities.
- * Predicate public use, protection, development, interpretation, and management of the natural and cultural resources on documented data obtained through appropriate investigation and research.
- * On a cooperative basis with other agencies, develop Greater Yellowstone Ecosystem guidelines for the management of threatened and endangered species.
- * Minimize visual intrusion of human development on park resources.

- * Manage the fishery resource to restore and preserve native fish populations.
- * Identify, evaluate, and protect the cultural resources of the park.
- * Provide for the highest quality experience for each visitor to Yellowstone National Park.
- * Eliminate trash and structural debris from the backcountry.
- * Make the public aware of unusual environmental conditions and hazards and provide reasonable visitor protection.

The park's Natural Resource Management Plan (1982) is the document which guides application of these general principles into specific park research, monitoring, and management programs. The operational goals related to specific issues and biophysical resources must be tied to public use of these resources.

Yellowstone's Master Plan (1973) recognizes that parks no longer exist as isolated entities and that there is need for a regional outlook in planning. The Master Plan also states that "in the face of visitor projection figures, all planning for public use of national parks must give priority to the preservation and maintenance of the natural values for which each park was established." The Director of the National Park Service, in his 12-Point Plan for managing for the agency (1985), reiterated that priority: "to seek a better balance between visitor use and resource management..we intend to favor preservation in cases where the likely effects of more use are expected to be adverse."

III. AFFECTED ENVIRONMENT

Sitting astride the Continental Divide, Yellowstone forms an extensive and critical watershed that provides the country below with high quality, pristine waters which remain relatively undisturbed by modern man's activities. This watershed and its related resources play a significant role in the stability and maintenance of the Greater Yellowstone Ecosystem (Anderson, 1983).

The surface water resources cover 2.2 million acres of slightly more than 10 percent of the park's land. This includes approximately 168 lakes, 604 streams -- most of which are unnamed -- and 11 rivers (Anderson, 1983). Permanent or "live" streams total 2,373 miles (5,864 km) of park water.

The riparian zones of the park are inhabited by all of the resident bird and wildlife species. The importance of the park's waterways cannot be minimized in this high volcanic plateau. For vast acreages, vegetative cover is relatively uniform, and precipitation comes mainly from snowmelt during a short period in spring. Many a visitor to the park finds the endless acres of lodgepole pine trees monotonous; it is certainly not the best habitat for seeing many birds and mammals. Yellowstone can be likened biologically to a desert, where the rivers serve as oases for the native wildlife. The wildlife and the watchers are found in or near the water, where vegetation is lush and more diverse.

Yellowstone's recreational fishery is a resource of worldwide renown. In addition to providing a food base for numerous predatory birds and mammals, upwards of 150,000 persons annually fish in park waters, and at least as many use nonconsumptive viewing areas such as Le Hardy Rapids and Fishing Bridge (Yellowstone National Park, 1982). A number of the park waters have had their fish populations severely impacted by heavy fishing pressure. As a result, to protect the fish population for their biological and recreational importance, a number of management measures are now used. These measures include catch and release or fly fishing-only regulations and closing some stretches of river to fishing.

Human activity has always centered around the park's waterways. Though little archaeological work has been done in Yellowstone, surveys reveal that hunting-gathering-fishing groups used the park at least as far back as 7100 years ago (Wright, 1982). Known sites on the Gardner and Yellowstone Rivers include one Native American burial site and a number of hunting camps. More recently, the earliest 19th-century explorers to the Yellowstone country continued the logical practice of using rivers as pathways into unknown territory. In 1807, John Colter followed the Snake, Yellowstone, and Lamar Rivers

into what is now park land. The Washburn and Hayden survey parties of 1870 and 1871 followed the Yellowstone, Firehole, and Madison Rivers around the park, and today the main park road parallels 9 of the 11 rivers in the park.

An average of 2.2 million visitors have enjoyed Yellowstone annually for the past five years. Surprisingly few people hike the park's backcountry, and mostly all use trails, which helps confine the site impacts and the effects on wildlife. Much of the park's recreational use focuses around park riverways. Picnicking, camping, hiking, fishing, and sightseeing are all existing uses of river zones. Some of the more accessible rivers already receive heavy use along their banks.

A. Major Rivers in the Park

Of the 11 major waterways in the park, the Yellowstone is the most well-known. This great undammed river flows for 115 miles through the park, in some of the remotest backcountry and along the most visible segments of park road. Along its banks are seen all four of the park's endangered species as well as most of the other native wildlife. The Snake River, so famous as a scenic foreground for the Grand Teton mountains, actually begins in Yellowstone. The Lewis River contributes major flow to the Snake, just before it exits Yellowstone's south boundary.

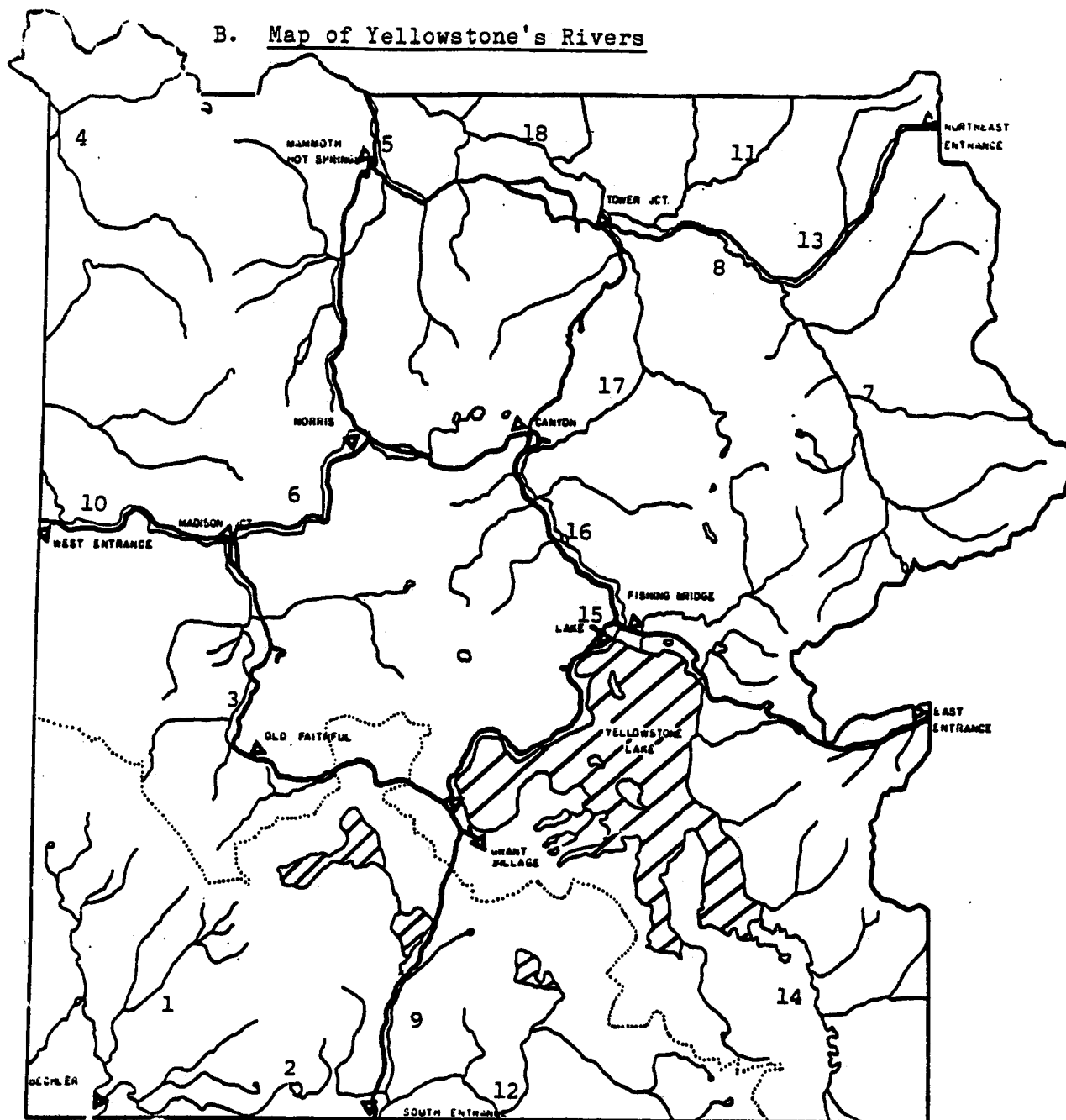
Two rivers make their start in the park's southwest corner. The Bechler River, for which the area is named, provides prime wildlife and bird habitat along its 20-mile length; it empties into the Falls River, the second major waterway emerging from the Bechler region. This region of the park was the subject of early controversy over placing irrigation reservoirs in parks. A 1920 bill to authorize water impoundments in the Cascade Corner "died of popular condemnation" (Haines, 1977). Today, this corner of the park is one of the most popular backcountry areas in Yellowstone.

In the west central section of the park are the Firehole, Gibbon, and Madison Rivers. Nearly two-thirds of the world's geysers are found in the thermal basins along the Firehole and Gibbon Rivers. The thermal influence on these waters is substantial enough to affect water quality, fish, ungulates, and predators. As these two waters meet, they form the Madison River, a major tributary of the Missouri River and one of the country's most popular fly-fishing streams. These three riverways all provide critical habitat for the park's threatened and endangered species.

The northwest corner of Yellowstone contains the headwaters of the Gallatin and Gardner Rivers. The Gallatin flows for 32 miles before leaving the park, to later meet the Madison and the Jefferson at Three Forks Junction, Montana, to form the Missouri. The Gardner River passes through elk winter range in Gardner's Hole before turning north and running down Sheepeater and Gardner Canyons to join the Yellowstone. These canyons support a number of rare bird species.

Out of the Absaroka Mountains along the northeast border of Yellowstone flow Soda Butte and Slough Creeks and the Lamar River. All three are popular with fishermen, and places along the banks already show signs of repeated human use. The Lamar Valley is one of few great, wide-open breaks in Yellowstone's otherwise timbered landscape, and the lightly-traveled road through the valley provides excellent wildlife viewing opportunities.

B. Map of Yellowstone's Rivers



- | | |
|--|---|
| 1. Bechler River | 12. Snake River |
| 2. Falls River | 13. Soda Butte Creek |
| 3. Firehole River | 14. Yellowstone, SE boundary to
Yellowstone Lake inlet |
| 4. Gallatin River | 15. Yellowstone, Fishing Bridge to
Sulphur Caldron |
| 5. Gardner River | 16. Yellowstone, Sulphur Caldron to
Chittenden Bridge |
| 6. Gibbon River | 17. Yellowstone, Chittenden Bridge to
Tower Bridge |
| 7. Lamar River, headwaters to Soda
Butte Creek | 18. Yellowstone, Tower Bridge to
Gardiner boundary |
| 8. Lamar River, Soda Butte Creek
to Yellowstone River | |
| 9. Lewis River | |
| 10. Madison River | |
| 11. Slough Creek | |

C. Regional Boating Opportunities

Boating opportunities are readily available on the lakes and ponds within the park and in numerous rivers and streams outside the park boundary. The River Information Digest (IWC, 1985) lists 38 sections of whitewater streams managed by federal agencies in Idaho and 30 in Wyoming, Montana, and Colorado. Private and commercial river runners are abundant in the surrounding three states. In Montana, the Blackfoot, West Gallatin, Stillwater, Clark Fork, Swan, Flathead, and the Madison and Yellowstone Rivers outside the park all provide a variety of boating opportunities. Two outfitters run whitewater raft trips on the Yellowstone River just north of the park, and many private boaters also use this stretch of river. A small section of the Gallatin River is also closed north of the park to Big Sky resort. but boating is allowed on most stretches of the rivers adjacent to or departing from Yellowstone National Park.

In Idaho, 82 river guides operate on 8 different rivers: 65 on the Salmon River, 27 on the Snake, 5 on the Selway, 4 on the Bruneau, 16 on the Owyhee, 5 on the Lochsa, 3 on the Clearwater, and 3 on the Payette. (Some outfitters operate on more than one river.) Ten of these outfitters specialize in kayak trips alone. These rivers also support private boating use.

Wyoming boasts 20,000 miles of streams. Notable among them are the Snake, Shoshone, Gros Ventre, Hoback, Grey, Popo Agie, Salt, Green, Wind, New, Ham's Rivers, and the Clark's Fork of the Yellowstone. In 1985, 200,000 boaters went down the Snake River in and just south of Grand Teton National Park. Fifteen outfitters offer trips on the Snake south of Yellowstone, and two on the Shoshone just east of the park. Private canoeing and kayaking is permitted on rivers in Grand Teton National Park, and in 1985, approximately 32 percent of boating use was by private, non-commercial use.

D. Use Trends and Anticipated Demand

Roderick Nash, speaking at a River Recreation Symposium in 1977, said, "the future of river recreation is not hard to discern. The trend is upward." In fact, so many large western rivers are popular with boaters that other national park and forest managers have established use limits or restrictions. Among the parks that have established user limits on their rivers are Grand Canyon, Canyonlands, and

Grand Teton National Parks, and Dinosaur National Monument. The latter's lottery system is being contested by private boaters (Marston, 1985). "The demand for permits to run the west's most popular rivers far surpasses the supply" (Udall, 1985).

It is highly likely that Yellowstone's rivers, once opened, would receive significant amounts of boating use within several years. The opportunity exists for commercial outfitters to offer guided day and overnight boat trips on both scenic flat water and whitewater. Commercial guided fishing trips could also be provided, giving anglers access to previously inaccessible stretches of streams. Private rafters, kayakers, and canoeists could all be expected to use the rivers. With the continuing popularity of river boating and the heavy river use levels in other national parks, Yellowstone should expect to manage considerable numbers of boaters within a very short time and, perhaps more importantly, higher numbers of anglers.

E. Specific Components of the Yellowstone Environment

Yellowstone is managed "so as to conserve, perpetuate, and portray as a composite whole the indigenous aquatic and terrestrial fauna and flora, geology, and scenic landscape" (Yellowstone National Park, 1982). However, a resource so vast and varied can best be understood by examining its component features. The park environment includes the biophysical components, the cultural resources, and the people who enjoy the park, both on-site and from a distance.

To effectively analyze Yellowstone in relation to potential river boating, the planning team broke down the park environment into nine key descriptive factors. These are more completely explained in the following pages.

IV. POTENTIAL EFFECTS ON KEY FACTORS IN YELLOWSTONE'S ENVIRONMENT

Preceding sections of this document introduce the general picture: the Yellowstone environment, park management goals and legal mandates, and the regional importance of rivers and their use to the biophysical and socioeconomic scene. The following section presents the anticipated environmental effects that boating would have on specific park resources. Key facets of the natural, historical, and human environment are of particular concern to park managers and users, but specific effects should be viewed in addition to, not in place of, the impact of any proposed new activity on the park environment as a whole.

A. Methodology

At the start of the river analysis process, a team of park staff was formed to inventory all the floatable rivers and streams within the park and identify the likely effects on natural and cultural resources. The planning team also recognized the need to address human aspects, such as conflicts between user groups and safety concerns. To begin, 18 major segments of rivers and streams were defined, based on natural breaks and current or historic use patterns. These are as follows:

1. Bechler River	20.5 mi.
2. Falls River	31.0 mi.
3. Firehole, Kepler Cascades to Madison River	46.8 mi.
4. Gallatin River	31.9 mi.
5. Gardner River	31.0 mi.
6. Gibbon River	42.3 mi.
7. Lamar, Headwaters to Soda Butte Creek	24.1 mi.
8. Lamar, Soda Butte Creek to Yellowstone confluence	11.9 mi.
9. Lewis, Lewis Lake outlet to Snake River	13.2 mi.
10. Madison River	18.3 mi.
11. Slough Creek	16.2 mi.
12. Snake River, Heart River to south boundary	18.2 mi.
13. Soda Butte Creek	16.0 mi.
14. Yellowstone, SE boundary to Yellowstone Lake inlet	26.2 mi.
15. Yellowstone, Fishing Bridge to Sulphur Cauldron	6.1 mi.
16. Yellowstone, Sulphur Caldron to Chittenden Bridge	9.9 mi.
17. Yellowstone, Chittenden Bridge to Tower Bridge	22.0 mi.
18. Yellowstone, Tower Bridge to Gardiner/boundary	23.2 mi.

Other creeks in Yellowstone that might support boats for short stretches during part of the year were not included in the inventory. General physical characteristics and boating impacts apply to these brief stretches of water as well.

Next, the planning team selected nine major environmental factors to include in the inventory of park rivers. These were then divided into categories of high, medium, and low influence on the development of alternatives. It should be emphasized that all nine factors were selected because of their importance to park visitors and resource protection; a factor may have been rated "low" because it is relatively easier for park staff to manage than a "high" level factor. Factors were selected and weighed prior to completing the river inventory to reduce staff bias in documenting potential impacts of opening rivers to boating.

To complete the inventory, members of the river team visually surveyed the 18 segments, relied on additional park staff who were familiar with particular rivers, and consulted park maps, resource management files, and fisheries surveys. The U.S. Fish & Wildlife Service unit stationed in Yellowstone has floated many of the park waterways in conjunction with their fisheries work, and their reports provided significant information in absence of having park staff float the rivers.

After the river inventory was completed, the planning team constructed a matrix, displaying the river segments and the presence or absence of the nine weighted factors along each. The matrix is included in this document under the ALTERNATIVES section.

B. Nine Key Facets of the Park Environment

High level factors were distinguished due to their premier importance according to Yellowstone's Organic Act and subsequent legislation. These are:

1. Threatened and endangered species
2. Significant geothermal features
3. Historical and archaeological sites

Medium level factors are also specifically mentioned in Yellowstone's legislation, NPS Management Policies, or recognized existing park uses and user groups:

4. Birds and wildlife, (those not covered under A)
5. Fish
6. Conflicts with other park users

Low level factors involve resources and management concerns for which legislation and policy guidance is less rigid or for which mitigation of impacts and concerns is more feasible:

7. Vegetation
8. Sanitation
9. Safety hazards

1. Threatened and endangered species

There are five species of birds and mammals formally listed under the Endangered Species Act that either reside in or pass through Yellowstone National Park. The American peregrine falcon, bald eagle, whooping crane, and gray wolf are listed as endangered for the states of Wyoming, Montana, and Idaho. The grizzly bear is listed as threatened. The legal protection for species listed under both designations is the same:

Each federal agency shall..insure that any action authorized, funded, or carried out by such agency..is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction of adverse modification of habitat.. (87 Stat. 884).

a. The Peregrine Falcon

In 1983, Yellowstone entered into a cooperative program to reintroduce peregrine falcons (Falco peregrinus) through hacking at or near historic eyries. Hacking refers to placing young falcons in a box at a potential nest site and feeding them until they begin to make their own kills. The first site chosen was at a historic nest site along the Madison River. Typically, several seasons of releases are required for success (Sherrod, et al, 1981). The park's Resource Management Plan calls for continuation of the existing hack site if necessary through at least 1987 and for an additional five sites. A second hack site was operated in the Slough Creek area in the summers of 1986 and 1987 in cooperation with the State of Wyoming and the Peregrine Fund. The Resource Management Plan calls for monitoring the sites and preventing human disturbance to peregrines while nesting.

The park had at least five historic peregrine nesting sites (Oakleaf, pers. commun.). Historical eyries are very important because, regardless of lapse of time since occupancy, these sites are usually the first to be re-occupied (U.S.F.S., from Snow, 1972). In 1984 a peregrine pair was discovered near a historic eyrie in the Grand Canyon of the Yellowstone. They nested there in 1985, 1986, and 1987 and produced young. This was the first pair of birds to establish a wild nest in Wyoming since recovery efforts began. Increased observations in 1987 indicate that peregrines may be more numerous than and widespread in the park.

Nesting cliffs generally exceed 200 feet high (U.S. Fish & Wildlife Service, 1985) and overlook a large prey base (Oakleaf, pers. commun.). Peregrines feed on shorebirds and other small birds, using surprise and speed to capture their prey in river canyons and marshes (Sherrod, op.cit.). In northwest Wyoming, clutches are probably laid during the latter half of April; incubation lasts approximately 33 days, and young fledge 5-6 weeks later but remain dependent on the adults for food and defense for 3-4 more weeks. Hence, the period of sensitivity around the eyrie extends from at least March 1 through July 31 (U.S.F.S., n.d.).

According to Sherrod, et al. (1981), there seem to be four critical habitat requirements for both hack sites and nesting peregrines: (1) isolation from too much disturbance, (2) security from other predators, (3) protection from the elements, and (4) an adequate food supply. While widespread use of pesticides such as DDT was the primary cause of the peregrine's endangered status, human disturbance during crucial phases of nesting chronology was also a major reason for their decline throughout the United States (U.S.F.S., from Snow, 1972). Although the need for isolation does not necessarily indicate that no human activity should take place (Sherrod, op.cit.), the Peregrine Falcon Recovery Plan (U.S. Fish & Wildlife Service, 1985) calls for restricting human activities (in excess of those which have historically occurred) within 1 mile of nesting cliffs between February 1 and August 31. It is also important to consider the effect of activities that might displace the peregrines' food supply away from the river zones.

In addition to the existing locations of peregrine activity, historic sites were along the lower Yellowstone River, in the Grand Canyon of the Yellowstone, and along the Gardner and the Little Firehole Rivers. These and other locales where endangered falcons are sighted will remain sensitive to existing and increased human activity, at least until peregrines are firmly reestablished in the Yellowstone Ecosystem.

b. The Whooping Crane

Whooping cranes (Grus americana) were recorded in the park in the first half of this century (Drewein, et al 1985). Allen (1952) documents sightings in 1914, 1930, and 1945, and two dozen additional sightings are on file, most of them since 1977. In 1985, the park had at least

five sightings of whooping cranes; three were in Hayden Valley, one was in the southeast corner of the park, and one was in the Firehole River Valley. In 1986 and 1987, two whooping cranes summered in the southeast and southwestern corners of the park. Yellowstone serves as summer residence for approximately 200 sandhill cranes, and in 1975 a "foster parent" program was begun by placing whooping crane eggs in sandhill nests at Grays Lake, Idaho (Ditzler, 1984). This program has continued with limited success; no breeding whooping crane pairs have yet been established from the Grays Lake group, but it is assumed that this is where Yellowstone's whooping cranes are coming from. The Resource Management Plan does not at present specifically address whooping cranes, but research and monitoring of these cranes is on-going.

The only population of whooping cranes that survived into the 20th century semiannually migrates across the Great Plains from wintering grounds on the Texas coast to summering grounds in Wood Buffalo National Park, Alberta. Historically there were several migration routes, such as the route through West Texas into Old Mexico still used by sandhill cranes, and it is believed the whooping cranes regularly travelled with them to wintering areas in the central intermountain region (Allen, 1952). According to the U.S. Fish & Wildlife Service, the whooping crane would be considered a historic resident in Yellowstone (Lewis, pers. commun.).

The Whooping Crane Recovery Plan (U.S. Fish & Wildlife Service, 1986) has three major recovery actions. One of these is to establish a successful nesting population at Grays Lake, Idaho and vicinity. Though the plan does not at present specifically address Yellowstone, the recent increase in sightings and studies on the sandhill crane population in the park calls for increased attention to the status of whooping cranes here. According to Lewis (pers. commun.), any areas now occupied by sandhill cranes are potential whooping crane habitat. A 1984-85 study of sandhills (Dreweine, et al 1985) accounted for 209 cranes at 47 locations, including sites along nearly all of the river segments analyzed in this plan.

The main observed difference in the species' breeding habitats is that sandhills are more commonly found in upland areas. Timing of breeding and associated behaviors are similar. Cranes arrive in Yellowstone in early to mid-April and begin the nesting season. Whooping cranes prefer to nest in marshy, riparian habitats where they build large nests of rushes and sedges in or near the water (Guthery, 1976). Incubation

is about 29-31 days, and except for very brief intervals, one member of the pair remains on the nest at all times. Both birds leave the nest site when approached by man, though males are more inclined to chase off territorial intruders. During the first 20 days after hatching, families generally stay within 1.8 km of the nest site (U.S. Fish & Wildlife Service, 1986). Food requirements are less strict; whoopers are quite omnivorous and not too fastidious in selecting food (Flath, 1975). Their diet includes frogs, snakes, snails, grasshoppers, and roots of marsh vegetation (Guthery, 1976). Southern migration usually begins in late August or September.

Survival of whooping cranes depends on many factors; they are limited by their low reproductive rates and are subject to considerable mortality from weather, predation, and hazards along their long migration route. Should whooping cranes begin to establish in Yellowstone, the major need is to protect nests and feeding areas. The presence of boaters in occupied riparian zones could displace cranes away from their nests during the sensitive period of nesting, incubation, and child-rearing. Whooping cranes are extremely wary on the breeding grounds, and will not remain long near human activity (U.S. Fish and Wildlife Service, 1986). Neither do they easily relocate; pairs breed for life and show considerable fidelity to their breeding territories, nesting in the same vicinity each year (ibid).

Yellowstone provides potential breeding habitat for whooping cranes along most all of its rivers. Nationwide concern for the whooping crane's survival calls for us to increase monitoring, specify management actions in the park's Resource Management Plan, and seriously consider the effects that increased river use could have on this endangered species.

c. The Bald Eagle - (Haliaeetus leucocephalus)

The park is a member of the Greater Yellowstone Bald Eagle Working Group, which prepared a management plan in 1983 to supplement the Bald Eagle Recovery Plan. The Greater Yellowstone Ecosystem supports the largest known breeding population in the Rocky Mountains south of the boreal forest. The overall objective in the ecosystem is to maintain 62 breeding pairs, fledging an average 53 young per year. The park supports migratory wintering eagles, as well as resident birds which nest in

Yellowstone during the summer. In 1987, 11 pair of bald eagles nested in the park, two of which were along river segments.

The population is separated into 3 units; specifically in the Yellowstone Unit, the goal is to maintain 15 nesting pairs (Wyoming Game and Fish Dept., 1983). In order to maintain population stability, at least 50 percent of occupied nests must be productive, and about one bird per nest must be fledged (Yellowstone National Park, 1982). Nesting begins in mid-April, young are hatched in mid-May and fledged in August (Swenson et al, 1985). In 1982, only 1 of 8 nests produced a fledgling; in 1985, the goal was met with 6 fledged from 11 occupied nests (Greater Yellowstone Ecosystem Working Team report, Oct. 9, 1985). Numbers in the Yellowstone Unit remained relatively stable from 1960 to 1982, suggesting that the population may be at carrying capacity (Swenson et al, 1985).

The park's Resource Management Plan lists four requirements for successful breeding: (1) proximity to large lakes and/or major streams, (2) presence of readily available and dependable food sources, (3) freedom from human intervention or disturbance, and (4) favorable climatic influences. In Yellowstone, the birds nest in large, living trees. Fish, such as spawning cutthroat trout, and aquatic birds are the primary food sources during breeding season. Most nests are within 1,500 feet of water, and human disturbance has caused abandonment of nests and mortality of young in the Greater Yellowstone Ecosystem and elsewhere (Wyoming Game and Fish Dept., 1983). Inactive nests along the Madison River, Yellowstone River at Fishing Bridge, and the Lewis River channel may have been abandoned due to human activity nearby.

The recommended course of action in the Resource Management Plan is minimization of human disturbance. Specific actions based on research studies include: (1) closing campsites within .6 mile of active nests, and (2) restricting activities in the vicinity of active nests that might disturb eagles, or that might adversely affect eagle feeding areas. Increased visitor activity in the river zones where eagles nest and feed could cause displacement and decline of the bald eagle population that has recently appeared to stabilize.

d. The Gray Wolf

The Northern Rocky Mountain wolf (Canis lupus irremotus) is a subspecies of the gray wolf. Though periodic sightings or wolf sign are reported in Yellowstone, Weaver (1978) concluded that evidence did not indicate a viable wolf population in the park. The park's Resource Management Plan calls for developing a plan to reintroduce wolves, and the U.S. Fish & Wildlife Service's Recovery Plan (USDI, 1987), calls for translocating wolves into Yellowstone as an experimental population.

Prime wolf habitat within the park may be the northeastern and northern sections of the park in the Soda Butte, Lamar, and upper Yellowstone basins. Most wolves killed in the early 1900's came from this area, and these valleys support large herds of elk, bison, deer, moose, and mountain sheep - all potential prey for the wolf (Schneider, 1981). Though sightings historically occurred elsewhere, including the Firehole and Hayden Valleys and the Gallatin Range, all the reported wolf dens in Yellowstone were located in the north central part of the park, from Blacktail Deer Plateau to Specimen Ridge (Weaver, 1978). Dens are typically located on south or southwest aspects of moderately steep slopes and usually within 30-200 meters of surface water. Denning may occur from late March to late April or possibly early May.

Wolves are highly social and territorial animals, and different social units (pairs/packs) may use different combinations of key habitat components. Those key components are: (1) a sufficient, year-round prey base of vulnerable ungulates (big game) and alternate prey, (2) suitable and somewhat secluded denning and rendezvous sites, and (3) sufficient space with minimal exposure to humans (U.S. Fish & Wildlife Service, 1987).

e. The Grizzly Bear - (Ursus arctos horribilis)

Grizzly bears in the lower forty-eight states occupy less than 1 percent of their historic range (Storer and Trevis, 1955). Yellowstone is one of only two large wilderness complexes which provide core habitat for a viable population. According to Knight and Eberhardt (1984), the Yellowstone population is isolated from the other remnant grizzly populations and occupies an area roughly double that of the national park. Thus, management of this threatened species is not done in a

vacuum; in recent years the National Park Service and other agencies involved in bear management have increased interagency communication and cooperation. These other agencies include the U.S. Forest Service, the U.S. Fish & Wildlife Service, and the state wildlife management agencies of Wyoming, Montana, and Idaho.

Several management documents outline the course of the grizzly bear program, and the program receives annual staff review and revision in response to on-going research and direction by the Interagency Grizzly Bear Study Team (IGSBT) and the Interagency Grizzly Bear Committee (IGBC). In addition, the program is frequently reviewed by the U.S. Fish & Wildlife Service, under the Endangered Species Act's Section 7 requirement for consultation. Bear management is the top priority of 35 projects in the park Resource Management Plan. An Environmental Impact Statement for the Grizzly Bear Management Program was completed in October of 1982, and includes interagency Guidelines for Management Involving Grizzly Bears in the Greater Yellowstone Area.

The management objective is to preserve and maintain natural populations of bears and to provide for safety of park visitors (USDI, 1982). The means to accomplish this goal include: education of park staff and visitors; reduction of unnatural bear attractants before bear-human contacts occur; area closures or use restrictions; prompt removal and relocation of problem bears from developed areas; statistics and monitoring of bear activity and incidents; continued research; regional solid waste management; and efforts to reduce conflicting areas and mortalities inside and outside the park.

Protection of bear habitat and the species will remain first priority in bear management. Selected backcountry areas will be closed to seasonal use or be otherwise restricted to provide visitor safety and to protect bears and bear habitat from undue human use (Yellowstone National Park, 1982). The Park Service is currently preparing an environmental impact statement that will review options for managing human use in a prime area of bear habitat near Fishing Bridge.

To protect the species itself, a major emphasis of current management is on reducing and minimizing man-caused mortalities of bears, especially females. According to Knight and Eberhardt (1984), adult female mortality is the key issue in maintaining the grizzly bear population of Yellowstone National Park. There will always be a level of human/bear interaction creating the

potential for confrontations and/or habituation and subsequent management control actions (U.S. Fish and Wildlife Service, 1982). During consultation, the Fish and Wildlife Service wrote that management under the current policy did not appear to be contributing excessive mortality to the grizzly population. However, "a trend toward increased people/bear conflicts can be expected to result in increased management induced mortality."

Recent research in the park has added to our knowledge of human/bear interactions. U.S. Fish & Wildlife biologists analyzed bear and angler use in the vicinity of a fish weir on a cutthroat spawning stream, before and after closure of the area in 1983. Results showed that the greater the human impact in the area, the less the bears made use of it. Sixty-five percent of the variation in bear use was explained by the levels of angler use (U.S. Department of Interior, Fish and Wildlife Service, 1984). The inverse relationship between bear use and angler use of the area would indicate that keeping human use of prime bear habitat as low as possible would maximize bear use of the areas.

In 1984-85, a study was designed to monitor effects of human activity on bear use in Pelican Valley and to evaluate the effectiveness of area closures as a management tool (Gunther and Rankin, 1985). Eighty-four percent of the observed bears were grizzlies. The study encompassed seven periods which varied from no visitor use to moderate and high levels of use. Tests compared bear sightings (independent of the number of animals seen per sighting) during closed periods to those during periods of use and found a significant inverse relationship. A linear regression model predicted an average of one bear sighting per day would be lost for every 20 persons using this valley, or for every five backcountry user groups. Similarly, bear sightings within 1/4 and 1/2 mile of campsites were negatively affected by visitor presence. While there are variations in the reactions of different grizzly bears, and other factors could affect the number of bear sightings in any period, the data suggests that some bears were being displaced by human activity. The displaced bears may have completely left the area or changed their activity patterns in order to avoid disturbance by people.

A 1984 study was designed to simulate grizzly bear-nonmotorized recreationist interactions and quantitatively describe the effect on grizzly bear spatial use, habitat use, and activity patterns. In four

different sites throughout Yellowstone, researchers approached radio-collared grizzlies, either simulating day-use activity or establishing a mock campsite. Bear activity was monitored for at least 24 hours prior to disturbance and 4 hours afterward. Simulated recreational activity explained a significant portion of the variation in the activity of grizzlies. Six of seven disturbances resulted in the immediate displacement of bears for a distance atypical of normal movement, and the daily activity was disrupted in pattern, intensity, and continuity. Human activity appeared to redistribute bears from open or edge areas to timbered areas, resulting in grizzlies using less suitable habitat further from natural openings and perennial water (Schleyer, et al, 1984). The researchers stated that "it appears that even temporary displacement may result in the bear using fringe habitats where forage is minimal and/or the likelihood of man-caused mortality is high." They indicated additional data is necessary prior to any changes which would affect human activity in grizzly bear habitat.

The Guidelines for Management identify five grizzly management situations for the ecosystem. Nearly all of Yellowstone is Situation 1, in which the probability is "very great that major federal activities or programs may affect..the grizzly" (USDA, 1979). According to this document, "grizzly-human conflict minimization will receive the highest management priority," and "uses which can affect grizzlies and/or their habitat will be made compatible with grizzly needs or such uses will be disallowed or eliminated." Research indicates that human activity in various areas (not specifically analyzed in this report) of the park has caused displacement of bears. Geographic or temporal displacement on a large enough scale could reduce the park's carrying capacity for bears by effectively decreasing bear use of prime habitat (Jope, 1982, in Gunther and Renkin, 1985).

2. Significant geothermal features

Yellowstone's geysers, hot springs, mud pots, and fumaroles were the major attractions which lured early exploratory parties into what is now the park and were largely responsible for its being set aside as the world's first national park. Geysers are very rare, yet there are over 300 of them in Yellowstone, more than the total amount of geysers in the rest of the world (Bryan, 1979). In addition to having the most famous geyser (Old Faithful) and the largest geyser (Steamboat), Yellowstone is the last essentially undisturbed major geothermal area in the world, making this resource of paramount importance (Yellowstone National Park, 1982). The park's Resource Management Plan calls for improved and continued procedures for mitigating vandalism and misuse of thermal features. "Safeguarding the rare and fragile geothermal resources of Yellowstone will continue as the primary goal" (Yellowstone National Park, 1982).

The famous features, the other, lesser-known geysers, and thousands of hot springs and thermal vents are of great importance to scientists doing pure and applied research. And of course, they are one of the primary reasons millions of visitors annually visit the park. In the park's early years, defacing the formations around the geysers and hot springs was an often-mentioned problem; the park's early protectors had to guard against visitors wanting to "bring up fence rails and sink them in a pool or chip the fretted treasury of the formations" (Haines, 1977). Marler (1973) cites many examples of vandalism in his inventory of Yellowstone's thermal features. Since there are so many thermal features in the park, there is some danger in taking minor ones for granted, and many of today's visitors no more recognize the sensitive nature of this resource than did the first tourists to Yellowstone.

In most of the park's thermal areas, the predominant mineral is siliceous sinter or geyserite, which forms very slowly, sometimes at the rate of only one-hundredth of an inch per year. Most deposits vary from a few inches to a few feet thick; obviously, such specimens took many, many years to form (Bryan, 1979). Though chemically, geyserite is about the same composition as quartz, one of the hardest rocks (Marler, 1953), sinter and geyserite crumble and break easily under human feet and hands. At Mammoth Hot Springs, the mineral is calcium carbonate, or travertine, which deposits more rapidly, but is soft and subject to vandalism.

Another aspect of the geothermal resources is the life within the hot springs. The kinds of organisms that live in these hot waters are so perfectly adapted that they are found in no other environment (Brock and Brock, 1971). The bacteria and algae give color to Yellowstone's hot springs, and also support a food chain of ephydrid flies, mites, spiders, wasps, beetles, and birds. The algae mats are easily scarred by persons scraping them with sticks or by throwing rocks or debris into features.

Boating on park rivers has several potential effects on the thermal resources. First, it could provide increased access to areas which are now relatively inaccessible. This applies to backcountry features such as those along the Snake River, as well as to those along the Firehole and Gibbon Rivers. Visitors seldom attempt to wade the streams, whether it is water temperature or the roughness of the streambed or caution which dissuade them. However, in boats, visitors might be more likely to approach thermal features on or near the banks, and to beach the craft to take a closer look. Increased access could result in increased use of streamside "hotpots" and removal of algae growth such as is observed at the popular "Boiling River" site. It could also result in vandalism to geyser vents. There is a possibility that visitors could break through thin crust or be burned by an unexpected geyser eruption. Second, dragging a boat up and down the bank, or through the common shallow stretches of many park streams, could damage sinter formations. Finally, Yellowstone's thermal features are the most unique of park resources, as the opportunity to view thermal phenomena worldwide is so rare. The natural scene for the viewer and photographer needs to be considered wherever thermal features are found along streams.

3. Historical and archaeological sites

The historical and archaeological resources of Yellowstone represent the human history of the world's first national park. A Cultural Resources Management Plan is currently being prepared which will further define park goals and actions with regard to these resources. Meanwhile, Servicewide policy states that "resource managers and professionals at all levels shall take positive action to perpetuate unimpaired the cultural resources...; and to prevent adverse effects on these resources." Also, "conscious efforts shall be made to insure that park operations, visitor use, activities, and services do not unnecessarily intrude on the historic scene by introducing visible, audible, or atmospheric elements that are out of character with the historic environment" (NPS Management Policies, 1978).

Historically, Yellowstone's rivers were natural access ways into the region. While there is evidence that early visitors came to fish and make additional use of the water resources, the park lacks a comprehensive review of its archaeological resources. Of the 13 rivers and streams analyzed for potential boating, only the Snake River has received a total survey for archaeological sites. Only 10 percent of the park has received a systematic survey for archaeological sites. Most of this has occurred in developed areas and for preconstruction activities along the Yellowstone Lake shore, main road, and campgrounds. The incomplete list of known sites along river segments has no bearing on how many sites may actually exist, nor does it indicate the significance of these sites or future evaluations along river basins. We do not know to what degree these sites retain their value. There are 25 known sites along the Yellowstone River, 12 on the Gardner, 9 on the Lamar, 8 on Falls River, 6 on the Madison, 5 on the Snake, and 3 on Slough Creek (Capek, pers. commun.).

Projects which involve archaeological resources must comply with section 106 of the National Historic Preservation Act. This generally requires an archaeologist to make an on-site survey to locate and assess the condition and integrity of known archaeological sites in relation to potential impact. Specific sites of concern are put-in and take-out points along the river banks. Potential impacts to these resources include trampling of archaeological sites and removal of artifacts or evidence of human habitation. Mitigation of such impacts is often possible. A concern of cultural resource managers is that increased access to currently isolated areas may disturb heretofore undisturbed (and unknown) sites.

Historic resources of concern here are several of the known sites and scenes used or viewed by early explorers to the Yellowstone region. These include fords of the Yellowstone River in the Hayden Valley and near Tower Falls, old soldier stations, Baronett Bridge, and the view of the Lamar Valley as described by Osborne Russell in 1835:

"There is something in the wild romantic scenery of this valley which I cannot nor will I attempt to describe but the impressions made upon my mind while gazing from a high eminence on the surrounding landscape...were such as time can never efface from my memory...I must content myself to...leave this beautiful valley [sic] in obscurity until visited by some more skillful admirer of the beauties of nature who may chance to stroll this way at some future period."

While Yellowstone today is far from the isolated, pristine wilderness seen by Colter, Russell, and others, it presents the occasional view of a landscape beyond the roadside, which appears unchanged by humans over the course of a century or two.

4. Birds and wildlife

There are 57 known species of mammals in the park, and over 200 species of birds have been observed here. In front country areas that have been visited by large numbers of people for years, wildlife and some birds are quite habituated to human activity. Examples include the elk and bison which spend significant portions of the year in the Mammoth Hot Springs or Old Faithful developed areas, and some of the park's bolder coyotes. In the lightly used backcountry areas, these same species can be quite skittish and may move quickly to avoid small parties of users.

Boyle and Samson (1985) identified 536 references concerning effects of nonconsumptive outdoor recreation on wildlife, including 37 that pertained specifically to boating. Some of the sources concerned uses which would likely be associated with river recreation, such as hiking, camping, shore recreation, wildlife observation, and photography. Of eight groupings of similar types of activities, boating was cited as having negative impacts mostly on birds, whereas five different activities were more often cited as affecting mammals.

a. Relationship between boating and birds

Human visits to songbird and waterfowl nests can increase the chance of nest losses through predation and nest abandonment, and colonially nesting birds are particularly vulnerable to disturbance (Bart, 1977, Buckley and Buckley, 1978). The latter group includes the following species common to Yellowstone: white pelican, double-crested cormorant, great blue heron, black-crowned night heron, the herring, California and ring-billed gulls, and Caspian and black terns. Birds and wildlife are also affected by the sight and sound of recreationists, and waterfowl have exhibited behavioral changes and movements to less disturbed areas in response to boating (Liddle and Scorgie, 1980).

Sandhill cranes are intolerant of human disturbance on their May-June nesting grounds, which are in wet meadows and marshy areas along streams and rivers (Drewien, 1973). Canada geese prefer quiet water with hiding space as protection during nesting and molting (usually in April), when adults cannot fly (Seideman, 1985). One of Yellowstone's most abundant birds, the dipper, lives and nests along park rivers and stream. Nests are built in April, and incubation occurs in late May; pairs return to the same breeding site each year. Brown (1982) reports

that dippers will remain as long as people do not stay on the stream for long periods.

Declining trumpeter swan productivity in the greater Yellowstone area has been attributed to human disturbance (Gale and McEneaney, 1985); the park recently began experimental habitat enhancement of nesting territories in an effort to off-set this decline. Harlequin ducks, one of the rarest waterfowl species in the region, arrive on some whitewater sections of Yellowstone's rivers in late April or early May to mate and nest on islands or shore sites close to the water. Females with broods are rarely seen because they are extremely wary of human activity and keep to secluded pools between whitewater stretches (Thompson, 1985). Kuchel (1977) reported that harlequins required pristine stream ecosystems and relative seclusion for successful breeding. Swenson (1975) found that osprey reproduction was significantly lower on Yellowstone Lake than along streams; human disturbance was suspected as a factor because most stream nests are in areas which receive little human use (prior to the July 15 opening of fishing season on the Yellowstone River). Data showed that nesting success was greater when nests were more than 1 km from backcountry campsites, and there was some indication that boating could also affect nest success.

b. Boating and mammals

Local habitat changes caused by trampling, soil compaction, and reduction of vegetation result in a loss of habitat diversity which may affect the variety of species present (Speight, 1973, Liddle, 1975). The primary effect of people on small mammals is indirect through modification of the structure of the vegetation (Garton, et al 1977).

Inadvertently, visitors can displace animals from trails, though disturbance usually has a negligible influence on large mammal distributions and movements (Chester, 1976, June, 1981). Chester, researching in Yellowstone's backcountry, found that most species observed were alerted to human presence and ran away; moose were most likely to stand their ground, and bears were least likely. May-June and September-October periods had the most potential for frequent human-wildlife interactions. Reactions of moose to disturbance vary from flight to seeming disinterest (LeResche, 1966). In areas of heavy tourist pressure in Yellowstone, moose appeared to develop considerable tolerance for human disturbance,

moving slowly and returning soon; but in a control area, visitor presence caused moose to run from the area and not return until at least the next day (McMillan, 1954). Studies on elk show a variety of responses, and many of Yellowstone's elk are quite habituated to humans. However, telemetered elk in a Wyoming study area preferred to be one-half mile distant from people who were camping, picnicking, or fishing (Ward, et al, 1973). In an Alberta study, passive harassment of elk resulting from human activities reduced elk use of open grasslands (Morgantini and Hudson, 1979).

Bighorn sheep are generally noted to be sensitive to human use and encroachment of their habitat (DeForge, 1976; Geist, 1976a). Grand Teton National Park recently initiated a study of river otters in areas of frequent river use, but there is no indication yet of how boating has affected this species. Cats, weasels, martens, and other mustelids are poorly represented in the literature on human impacts. Because of their elusiveness, they are difficult to study and are infrequently seen. Many of these animals require remote wildlands, and undoubtedly man's invasion of the backcountry has affected them (Ream, 1980). Existing park users affect birds and wildlife in varying degrees. In heavily used areas, it is not uncommon to see wildlife habituate to the presence of humans and tolerate a much closer presence than is tolerated in isolated areas.

Where large mammals are habituated, disturbance by wildlife observers appears to be minor (Schultz and Bailey, 1978); however, habituated animals may become more vulnerable to poaching (Singer, 1975). Black bears may become easily habituated to human food sources; habituated bears are more likely to cause human injuries (Singer and Bratton, 1976) and be trapped, translocated, or removed from Yellowstone (Brown, pers. commun.).

In other parks and recreation areas where river boating is present, numerous species of birds and mammals appear to live compatibly with humans. Unfortunately, these areas lack baseline information about the number and dynamics of wildlife populations prior to river use. It might be expected that many species would habituate to an increased human presence on park rivers, though we cannot predict how soon. Nor can we reliably be confident that all species would adapt to any substantial amount of human use in areas in which they are not accustomed to being disturbed.

5. Fish

Yellowstone supports approximately 1.3 percent of the nation's trout anglers, who spend an estimated \$4 million annually in and around the park (U.S. Department of Interior, 1985). Since angling is an anomaly in a park where other "consumptive" removals of the resource are not allowed, emphasis is placed on making angling less consumptive. The present objectives of fisheries management in the park are to manage the fishery as a part of the total park ecosystem and to preserve and restore native species and aquatic habitats.

Legislative mandates and National Park Service policies have prevented significant degradation of the aquatic habitat in Yellowstone. Since 1954, fish planting has been restricted to native species restoration programs. Currently, angler use presents the greatest potential impact on park fisheries. In numerous instances within the park, increases in angler use and subsequent increases in harvest have led to substantial alterations of native trout populations. The more accessible roadside waters have historically been most affected. Restrictive regulations have curtailed negative impacts; however, available data suggest that use can reach a level where angler numbers must be limited (Gresswell, pers. commun.).

The U.S. Fish & Wildlife Service Fisheries Assistance Office in Yellowstone estimates that the greatest potential impact of boating on stream fisheries would be increased accessibility to the aquatic resources. A number of the park's popular fishing streams already show signs of heavy use along their banks. Also, substantial increases in angler use could be expected on a large proportion of park waters that are now relatively inaccessible. Although restrictive regulations could be used to reduce impacts to fish populations, it is difficult to apply restrictions until after effects are noticed in the age-structure of fish populations. Areas which now have a low level of harvest could receive significant increases in use and impacts; in areas that already sustain heavy fishing pressure, the cumulative impact of increased access and angling could also alter the health of fish populations.

In examining the effects of recreation on anadromous fisheries in the west, researchers suggested that recreational activities other than fishing apparently do not directly affect fish. These activities may, however, affect components of fish habitat, including cover, food, space, and spawning area (Clark, et al, 1985). Streambank uses can affect fish habitat also. Riparian vegetation provides shade and an insulating canopy, preventing adverse water temperatures in

summer and winter. It also acts as a filter to prevent addition of sediment, and its roots provide streambank stability and cover for rearing salmonids. It directly influences the food chain of a stream ecosystem by providing organic detritus and terrestrial insects and by controlling aquatic productivity that depends on solar radiation. Most significant changes in vegetation result from initial light recreational use (Settergren, 1977; Cole, 1979) and possibly includes soil compaction, reduced organic matter, decreased soil moisture, tree mortality, and loss of ground cover. Streambanks that are not already heavily used, such as those which are least accessible on foot or horseback, are the most likely to be affected by river boating and its associated streambank use.

6. Conflicts with other park uses

The fundamental challenge in managing a national park is to balance resource preservation with a variety of public uses. In Yellowstone, major traditional uses include fishing, hiking, camping, picnicking, wildlife watching, and photography. There is little deliberate effort on the part of the National Park Service to discriminate in favor of some uses and against others, except that, in line with National Park Service policy, most "consumptive" uses of the resource are not allowed in Yellowstone. (Fishing is a notable exception to this rule.) Because of the limited capacity of the resource to sustain some types of use, such as vehicular traffic off roads, some recreation activities are prohibited. Also, there have been limitations placed on use types because they conflict with other traditional and popular uses of the park. An example is the historical restriction on boating park rivers, which appears from the scant record to have been based on conflicts with fishermen. This does not imply that one use is "better" than another, only that all users cannot be accommodated in one place to the satisfaction of all users.

Conflicts between groups of recreationists are not uncommon and are mentioned often in literature concerning river management. However, most of the research and writing involves allocation of use between commercial and private boaters. The question of preserving riverine environments which have not experienced the boom in river recreation from additional use has rarely been addressed. Nevertheless, opening park rivers to a use which has not been here for three decades has the potential to cause considerable conflict with existing users. In a wildland situation, certain experiences, such as solitude, can be disrupted by the presence of others (Roggenbuck and Schreyer, 1977). The expectation of solitude is likely to be high among persons hiking or horseback riding into a proposed wilderness or backcountry of the park; their perception of solitude is based on the number and size of parties encountered (McCool, pers. commun.). In a 1978 study of Yellowstone's backcountry users, experiencing solitude received the highest "importance rating" of 13 activities preferred by day users. We might then expect tolerance for viewing boaters and watercraft to be greater in front country areas or in areas in which there is considerable existing use, than in more lightly used backcountry areas. Also, the existing river users' perceptions of resource impact are likely related to whether they perceive Yellowstone as wilderness or already considerably impacted.

Since many of the currently popular activities (fishing, wildlife watching, photography) involve the presence of wildlife along the rivers, the impact of boaters on other users corresponds to the effects of boating on wildlife and endangered species. Tolerance of boaters and watercraft on rivers would likely depend on whether and how soon birds and wildlife habituated to the boaters' presence and how much use occurred in popular viewing areas. Permanent displacement of fish populations, calving elk or bison, nesting waterfowl, and other riverine inhabitants would likely cause long-term conflicts between boaters and other park users of river zones.

7. Vegetation

Two major categories of vegetation will be affected by boating on the rivers and streams of the park: aquatic vegetation and riparian vegetation surrounding access points and resting places.

Nonmotorized boats will have little direct effect on the aquatic vegetation except in shallow areas, where plants could be disturbed or destroyed. However, there is the potential for indirect impact of introduced exotic plants. Several plants listed as noxious weeds by the neighboring states are common along the watercourses near the park. (Noxious listing conveys a legal responsibility on private landowners to prevent the weeds from going to seed, and the park wishes to maintain a cooperative stance in this matter with surrounding states.) Small fragments of vegetation can easily attach to boats and associated equipment, and aquatic species are especially capable of this means of dispersal (Despain, pers. commun.). Eurasian milfoil is one of several species that has significantly changed the aquatic plant community in numerous waters around the country, and it has been recently reported in western Montana.

Thermal waters near the streams present a special problem. Many exotic species are restricted to warmer water and would not normally pose a threat to cold rivers. However, the influx of hot water from Yellowstone's thermal areas make adjacent rivers vulnerable to warm water exotics. Also, the thermal waters support aquatic species that are quite disjunct. Two subtropical species are known to occur in Yellowstone; there is need to study and describe these communities and species and to prevent influx of exotic vegetation.

The effects of boating on riparian vegetation are likely to be more noticeable and possibly more severe than those on aquatic plants. Recreationists do not "use" entire sites uniformly. They generally tend to congregate at and move along specific sites and routes, such as boat launches, sanitary facilities, scenic attractions, and straight-line paths between them. The impact of use on the soil and vegetation is greatest, if not exclusively, on these sites of concentration (Settergren, 1977). In measuring bare soil, loss of ground vegetation, exposed tree roots, increased site size, and soil compaction, the initial use and resultant change in ground cover is noticeable. Some researchers found that, following this initial change, very little additional impact results with increased use (Frissell and Duncan, 1965). However, with river recreation, the impacted areas may be sparsely scattered along many miles of waterway (Settergren, op.cit.). The level

of impact is difficult to predict and would vary with the number of launching and take-out sites, riverside campsites, sanitary facilities, and scenic attractions to be found along a floatable river segment. Impacts would be highest on areas not now receiving substantial human use.

8. Sanitation

Yellowstone's draft Water Resource Management Plan (1983) describes the present quality of park waters as excellent, except for sporadic discharge of partially treated sewage effluent and acid mine drainage which has affected Soda Butte Creek for decades. Regulations and standards deal predominantly with sewage treatment and drinking water intake systems in the park. The plan recommends an overall policy of "continued non-degradation."

The management of human waste has become a major challenge in many recreation sites, including heavily used river parks such as the Grand Canyon and Canyonlands. Human use can lead to increased coliform bacteria, which presents a potential human health hazard (Knudsen, et al, 1977). Along the heavily used Colorado River in Grand Canyon National Park, total viable coliform bacteria exceeded desirable water quality standards at several sites throughout most of the year (Sommerfield, 1976), and contaminants were not restricted to porta-potty dumpsites but migrated up to 8 inches away. However, not all of the coliform count was related to recreational use and sewage effluent from the dumpsites had minimal effect on river water quality overall due to dilution and biological decay (Deacon and Baker, 1976).

In a study of health hazards from human wastes in wilderness conducted in the Bridger Range, Montana, results showed that shallow burial of human waste (the "cat-hole" method), contrary to popular belief, did not render feces harmless in a short period of time. Regardless of depth of burial, bacterial numbers remained for several weeks during summer and were still appreciable eight weeks after deposition. A regularly used latrine will have a continual population of bacteria and viruses but may be appropriate in sites of concentrated use (Temple, et al, 1982), such as frequently used campsites and beaching points. Some parks, such as Grand Canyon, require river users to pack out all waste material.

The accumulation of litter and lost equipment would necessitate increased maintenance activity. Visitor tolerance for litter is likely much lower in places perceived as pristine or backcountry than in heavily used areas. These impacts would be relatively easy to mitigate with trash collection, a "pack-in, pack-out" policy, and visitor education.

9. Safety hazards

A major concern of managers is the protection of visitors' health and welfare. The risk involved in many recreational activities that occur in Yellowstone (and other parks) varies based on the participant's knowledge and experience, environmental conditions, and somewhat on luck. The National Park Service assumes some responsibility for the users of park resources; liability is determined on a case-by-case basis. Generally, the government must be guilty of negligence in order to pay financial damages to accident victims. In order to avoid being considered negligent, managing agencies use information and education systems, regulations, use limitations or zoning, patrolling, search and rescue programs, and enforcement to promote public safety (Lewis and Marsh, 1977).

There is a faction of the public that promotes the notion of the recreationist's "right to risk," especially in wilderness areas (Gladney, 1985). Yellowstone's rivers offer the potential for boating experiences which range from calm, easy canoe trips to expert kayak adventures. High water during spring snowmelt poses safety problems in numerous streams, however, as do other natural impediments (log jams, hydraulics, waterfalls), cold water temperature, poor equipment, and unprepared boaters.

Heavily used river recreation areas make use of various systems to increase the likelihood of safe river use, including registration systems, equipment inspections, and visitor education programs. Grand Teton National Park provided the following information concerning costs of river management in 1984 and 1985. The river management staff includes one GS-9 permanent ranger, one seasonal GS-6 supervisor, and three GS-5 seasonal boat rangers, who perform rescue operations, safety inspections, and monitor concession float trips, for a total cost of \$55,813. Their initial outlay for equipment was a minimum of \$4,515 for a 12-foot raft, one kayak, and accompanying equipment (paddles, life jackets, safety helmets). In 1982, there were 3 commercial rescues involving up to 20 people. Cost of each major rescue is over \$1,000 (excluding equipment); most occur after 4:00 p.m. which causes increased overtime costs. The park averages 45 rescues per year. Most of their river use is in fairly calm water and via commercial scenic float trips, as opposed to challenging water. To properly administer a river boating program in Yellowstone, the park should anticipate such additional expenditures of budget and staff time.

A river rating system suggested by C. Walbridge of the American Whitewater Association (1985) is used to describe whitewater stretches of Yellowstone's 18 floatable river segments (Appendix A) as follows:

- Class I Easy - River speed 4-6 mph (less than hard back-paddling speed.) A few riffles and small waves. Few or no obstructions.
- Class II Medium - Frequent but unobstructed rapids. Easy eddies and bends. Course generally easy to recognize. River occasionally exceeds hard back-paddling speed. Waves up to 3 feet. Some maneuvering necessary.
- Class III Difficult - Maneuvering necessary. Numerous rapids with high irregular waves often capable of swamping an open canoe. Main current may swing under bushes, branches, or overhangs. Course not easily recognizable. Scouting may be necessary.
- Class IV Very Difficult - Long extended stretches of rapids. High irregular waves with boulders directly in current. Difficult broken water, eddies, and abrupt bends. Inspection frequently necessary. Rescue difficult. Generally not possible for open canoe.
- Class V Exceedingly Difficult - Long, difficult, rocky rapids with completely irregular water that must be run "head-on." Very fast eddies, abrupt bends, and vigorous cross currents. Rescue conditions very difficult. Closed boat only. Ability to Eskimo roll essential.
- Class VI Limit of Navigability - Previously mentioned difficulties increased to the limit. Only negotiable at favorable water levels. Cannot be attempted without risk of life.

V. ALTERNATIVES

A. River Analysis Decision Matrix

The matrix was, as previously explained, designed prior to ranking any rivers on resource values in order to reduce bias on the part of the planning team.

The team identified 18 major segments of rivers and streams based on natural breaks and current or historic use patterns. Other creeks in Yellowstone that might support boats for short stretches during part of the year were not included in the inventory.

The planning team selected nine major environmental factors to include in the inventory of park rivers. These were then divided into categories of high (5 points), medium (3 points), and low (1 point) influence on the development of alternatives. It should be emphasized that all nine factors were selected because of their importance to park visitors and resource protection.

To complete the inventory, members of the river team visually surveyed the 18 segments, relied on additional park staff who were familiar with particular rivers, and consulted park maps, resource management files, and fisheries surveys. River segments were assigned a relative value by a consensus of the team ranging from 1 to 5 which represented the expected level of impact (5 being the highest) for each of the 9 categories. The relative value of adverse impacts was then multiplied by the weighted factor of 5, 3, or 1 for the high, medium, or low categories, respectively.

The values in each element of the matrix were then summed to obtain a relative ranked value of impacts expected on each river segment from boating activity. The team endeavored to be consistent in assigning values to each factor. The top high-impact rating, a "5," under endangered species, was consistently applied when at least three of the park's endangered species are present or key habitat is found along that segment. Under historical and archaeological sites, due to the lack of survey data and to the likelihood that all major river segments supported some prehistoric inhabitants (as is common in the Northern Rockies), rivers were not assigned numerical scores. Despite the lack of complete archaeologic surveys and evaluations of the importance of known sites, there is a legal responsibility to protect the likely archaeologic sites and the known historic sites that exist along our river banks. The known information on cultural resources is displayed in the matrix, but is not used in the ranking.

Fisheries that already receive heavy fishing pressure received high impact ratings because Fish and Wildlife Service personnel believe that increased fishing pressure is likely to have noticeable consequences on fish populations. With respect to safety issues, no river was rated perfectly "safe"; several of the planning team members are experienced kayakers whose evaluations of river hazards were relied upon by other team members.

High ratings of impact do not mean that other recreational uses, existing or not existing in the park, do not also cause environmental impacts. However, the issue at present is whether to allow a particular new use, the cumulative impacts of which may be more noticeable than any effects directly attributable to boating.

The decision matrix presented in the following pages arrays the major floatable riverways and their comparative ranking with regard to environmental impacts. It is important to examine not only the total score and ranking but also the decision charts for specific environmental impacts that are likely to occur on a particular segment of river. The scoring system provides a method of evaluating the relative, though not the real, severity of resource impact. The ranking of rivers came out as follows.

(Maximum possible impact score = 110)

(Highest score indicates highest environmental impact due to boating)

RANK	RIVER SEGMENT	IMPACT SCORE
1.	Firehole, Kepler Cascades to Madison River	106
2.	Yellowstone, Sulphur Caldron to Chittenden Bridge	101
3.	Gibbon River	97
4.	Yellowstone, Fishing Bridge to Sulphur Caldron	96
5.	Madison River	90
6.	Snake River, Heart River to south boundary	87
7.	Yellowstone, Chittenden Bridge to Tower Bridge	87
8.	Gardner River	85
9.	Yellowstone, Tower Bridge to Gardner/boundary	84
10.	Lamar, Soda Butte Creek to Yellowstone confluence	80
11.	Slough Creek, park boundary to Lamar River	80
12.	Soda Butte Creek, NE boundary to Lamar confluence	80
13.	Bechler River	72
14.	Lamar, headwaters to Soda Butte Creek	68
15.	Yellowstone, SE boundary to Yellowstone Lake inlet	67
16.	Gallatin River	61
17.	Lewis River, Lewis Lake outlet to Snake River	56
18.	Falls River	50

B. No Boating/No Action

At the present time, there is no boating on park rivers, with the exception of the Lewis River channel connecting Lewis and Shoshone Lakes. Maintaining the status quo would have no additional effect on the park environment and require no mitigation. This alternative is reflected as a score of zero on the decision matrix which ranks 18 river segments on 9 weighted factors of environmental concern.

C. Boating on Selected Rivers

The alternative to no action is to open all waters or selected river segments to boating.

Again, the potential impacts of opening one or more of Yellowstone's rivers can be seen on the decision matrix. The highest scores occurred on rivers that contained more than one endangered species, thermal features, critical wildlife habitat and viewing opportunities, likely presence of historic and/or archaeologic sites, and well-established user patterns which would be disrupted if boating were allowed. Thus, the highest impact is foreseen on the Firehole, the Yellowstone River from Fishing Bridge through Hayden Valley to the Grand Canyon, and the Madison and Gibbon Rivers. These segments all score from 85 to 96 percent of the maximum possible level of impact.

Levels from 70-80 percent are reflected in segments such as the lower Lamar and Yellowstone River stretches, and Slough and Soda Butte Creeks. These lack the major thermal features but provide critical wildlife and waterfowl habitat and opportunities to view these native species, affect some endangered species, and provide opportunities to enjoy solitude or a wilderness experience.

The river segments rating the lowest impact scores are those rivers which are relatively inaccessible, such as the Bechler, Falls, and upper Yellowstone Rivers, and the Lewis and Gallatin Rivers, portions of which are close to the park roadway but provide less variety of wildlife habitat and viewing opportunities. A river's size, lack of access, and lower subsequent use levels are reflected in a lower rating; those rivers less likely to be used would cause less conflict with other users and less need for management of sanitation and bank impacts. However, the lowest score of 50 reflects 46 percent of the total possible; this is still far from the no impact/no action alternative.

In order to allow boating on any one of these river segments, it will be necessary to enter into formal consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act, since all of the rivers contain habitat for, or presence of, one or more threatened or endangered species.

Also, the existing level of archaeological survey work in the park is insufficient to indicate the importance of known sites, and many riversides have not yet been surveyed. Impacts to major archaeological sites cannot be mitigated once they have been disturbed, but often disturbance can be prevented. Also, though many sites could exist in Yellowstone, they may not be labeled as "significant."

If the Boating on Selected Rivers alternative is selected, a River Management Plan must be prepared. This document should specify boating restrictions, use limits or allocation systems, and how such limits will be managed (such as by permit, lottery, etc.). The plan should also specify put-in and take-out points on all rivers to be opened, appropriate facilities and signing, and site mitigation and monitoring efforts. It should address liability concerns and commercial uses, such as use licenses or concessions permits, and preventive safety measures or requirements. It should specify boating seasons based primarily on resource concerns, such as nesting waterfowl or spawning trout, and on safety considerations such as high or low water levels. And the plan should delineate preferred methods for disposing of waste and appropriate types of rescue and management equipment and skills that are necessary to run a river use program in Yellowstone.

VI. FINDINGS AND RECOMMENDATION

This document contains an inventory of the major floatable river segments within Yellowstone National Park and an assessment of the environmental concerns related to river boating. The following conclusions summarize this report.

A. Findings

- * The river corridors of the park, especially those in the backcountry, offer a view of the environment that's as nearly untamed as when the Yellowstone region was first explored.
- * Yellowstone's rivers remain in fairly pristine condition due to historical use limitations. The major alteration to their natural state has been caused by management and use of the fishery resources; fishing is now controlled by a series of bait and catch restrictions, though use numbers remain high.
- * The world's greatest array of geysers and hot springs is found along many of the rivers of Yellowstone National Park. Thermal features strongly influence the distribution of insect, bird, plant, and animal species. Restricting boating has helped to limit the human presence on the natural setting for the park's rare and unique thermal features.
- * Rivers serve as natural barriers between humans and wildlife. Restricting use of rivers has limited the amount of wildlife disturbance and displacement, while allowing the majority of park visitors to view native birds and wildlife in their natural setting.
- * Boating would open up access to large segments of rivers, particularly in the backcountry of Yellowstone, which have essentially been the exclusive domain of the native wildlife. The initial impact on these species could be severe, particularly on nesting waterfowl and endangered species. The mitigation and management measures which could assist such sensitive species will be constrained by remote access to many river segments and the realities of having a small staff to manage a very large, dispersed resource.
- * The concern for the five endangered species which could or do reside here is paramount. Yellowstone is actively involved in trying to separate humans from grizzly bears in prime bear habitat; much of this activity focuses on riparian zones. The peregrine falcon is just beginning to reestablish in the Yellowstone ecosystem, particularly inside the park. Whooping crane sightings have increased in the past five years, as has the likelihood that they will reside here. The bald eagle's status in the ecosystem has been improving, but the population

has not yet reached the recovery goals of the Bald Eagle Management Plan. There is renewed interest in reintroduction of the gray wolf to the ecosystem.

- * The cumulative effects of any additional intensive recreational use, added to current use levels, may be more noticeable than impacts directly attributable to boating. The park is participating in interagency efforts to better analyze cumulative effects on the ecosystem's resources; this system will be continually refined in forthcoming years and should be applied to issues such as this.
- * Boating park rivers presents a high potential for conflict with other user groups whose enjoyment relates directly to seeing a portion of Yellowstone which is still largely undisturbed -- the riparian zones and their related native inhabitants.
- * River banks should be surveyed to determine the amount and significance of prehistoric and historic cultural sites.
- * Based on analysis reflected in the decision matrix, the least affected of park rivers would still likely receive impact to a significant number of environmental factors. These impacts would be attributable not to the sport of boating, per se, but to the increased access to inaccessible rivers and streambanks which boating could provide.
- * There are numerous rivers in the west and in the Greater Yellowstone Ecosystem, which provide a variety of boating opportunities. Yellowstone's current limitation on river boating offers visitors a unique viewing opportunity among the spectrum of river experiences available.
- * Based on analysis reflected in the decision matrix, the least affected of park rivers would still receive nearly 50 percent of the total possible impacts attributed to boating.

B. Recommendation

Due to the high level of potential impact that river boating has on the biophysical environment of Yellowstone National Park, the No Boating/No Action alternative is recommended.

VII. CONSULTATION WITH OTHERS

The following parties have been contacted in regard to development of this document:

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IX. APPENDIX**A. River Segment Descriptions**

BECHLER RIVER

Length: 20.5 miles

Description

The Bechler River flows for 20 miles out of the southwest corner of the park, from the Continental Divide to the Falls River near the Cave Falls Road. The drainage is popularly thought to be one of the most attractive areas of Yellowstone, due to the many waterfalls, the open meadows with views of the Grand Tetons to the south, and the variety of vegetation. The Bechler's broad mainstream is formed by the confluence of the Phillips, Gregg, and Ferris Forks at Three Rivers Junction, and from there the river drops 800 feet in elevation through the 5.9-mile Bechler Canyon. In these upper reaches, the channel width varies from 29 to over 100 feet, and at least 36 springs and tributaries (some of surprisingly high volume) add to the flow. Emerging from the canyon, the river plunges suddenly over 45-ft. Iris Falls and then over the impassable Colonnade Falls. The latter is actually two falls, the upper being 35 feet and the lower, 67 feet. Streambed character varies from bedrock, boulder, and cobblestone to sand and gravel. Fallen trees and log jams are common throughout the canyon. In the lower section, a fallen giant from a spruce-fir forest containing some of the largest trees in the park can easily span the channel. At the mouth of Bechler canyon, the river begins its meander through several miles of tall grasses, sedges, and willows in Bechler Meadows. During peak runoff this section overflows its banks and floods the entire meadow, usually lasting from mid-June to early or mid-July. At the meadow's southern end, the gradient increases and bedrock again appears in the streambed. Channel width ranges from 100-200 feet. The river is lined with lodgepole pine and spruce-fir along this last four miles. One half mile above the Falls River, it drops 15 feet over Bechler Falls.

Boating Potential

The Bechler River is accessible only by trail. Three Rivers is 15.2 miles from the Lone Star trailhead near Old Faithful and 14.8 miles from the Cave Falls trailhead. Boats would have to be packed up the trail. Rafters or kayakers could negotiate Bechler Canyon but would have to portage Iris and Colonnade Falls, shallow areas, and log jams. All types of boats could cross Bechler Meadows, and most could travel from Rocky Ford to the Falls River. Shallow water, scattered boulders, fallen trees, and Bechler Falls are the major hazards in the lower segment. Sections of Boundary Creek which meander across the meadows are floatable, but dense willows and the narrow channel make it less appealing. Above 100-ft. Dunanda Falls, portions of the creek might be floated by kayak, though numerous portages around obstructions would be necessary.

Potential impacts

1. Threatened and endangered species - In 1984, a whooping crane was identified with a group of sandhills in Bechler Meadows. According to historical records, whoopers were believed to have nested here in the early decades of the 20th century. A few grizzly bears are sighted each year along the south boundary. Habitat is not viewed as critical here by Mattson of the Interagency Grizzly Bear Study Team. Bald eagles are occasionally seen between the meadows and Cave Falls.
2. Significant geothermal features - The Three Rivers area contains a number of large and beautiful hot springs, including one outstanding superheated streamside pool with a vividly colored algae mass as it overflows into the creek. This area already receives heavy backcountry use and shows site damage. Aquatic invertebrates are abundant in the area of thermal activity. A minor thermal area with warm seeps is located above Bechler Ford and is a popular campsite. One small pond contains a tropical plant which requires extra protection due to its disjunct distribution (Despain, pers. commun.).
3. Historical and archaeological sites - There are no known surveys of the drainage. The Bechler Ranger Station was built in 1911 as a soldier station and is reputed to be the most intact soldier station remaining in Yellowstone.
4. Birds and wildlife - Bechler Meadows supports a large variety of wildlife. Its willows provide some of the park's highest quality moose and sandhill crane habitat; several sandhill pairs nest here each year. Elk, Canada geese, and river otter summer in the meadows; black bear and beaver are occasionally seen. Trumpeter swans historically nested along the river, and five resided on the river in 1985. Harlequin ducks, shorebirds, mallards, and mergansers have been observed on the Bechler. Osprey have successfully nested at Rocky Ford for many years.
5. Fish - A population of pure Yellowstone cutthroat trout exists above Colonnade Falls. Below the falls are rainbows and rainbow/cutthroat hybrids. Many long-time anglers and rangers in the area feel that the size of fish has declined in the past twenty years. Some data suggests a decrease in fish over 18" since 1974. A substantial increase in angler use associated with boating could significantly impact numbers and sizes of rainbow and hybrids in the lower section. (The meadows are the most favorable trout habitat in this river.) Impacts to the fish populations would eventually affect piscivorous birds and mammals.
6. User conflicts - The Bechler corner is one of Yellowstone's major destinations for backpackers seeking a wilderness experience; increased use of campsites is a potential conflict. The many waterfalls in this region add to the appeal for photographers, to whom the sight of boats

might be an intrusion. Heavy stock use also may conflict with boaters by competing for campsites and room on the trails. The river currently receives an average of 1,860 angler days per year. Fishermen who did not choose to use boats to improve their stream access would likely be vocal in their objection to recreational boaters in Bechler Meadows.

7. Vegetation - Aquatic vascular plants and mosses are scattered along the streambed in the meadows section. Many campsites on the Bechler are already restricted to "no fire" use due to site impacts. In shallow areas and put-in/take-out points the impacts on soil and vegetation could be severe. Boaters or managers would also be tempted to remove deadfall and log jams for convenience or safety. Existing impacts on meadow vegetation is at present fairly isolated, but would be expected to increase and disperse with boater use. Displacement of aquatic vegetation and secondary effects on the plant eaters would be expected.
8. Sanitation - Trail access is the only means of reaching the Bechler River. Management of human waste, litter, and monitoring of water quality would have to be handled by backcountry personnel. Use levels in the area are already moderately heavy. Disposal of fish entrails in the water and burial of human waste may already be insufficient methods; with increased use we would expect increased impact.
9. Safety hazards - Waterfalls, cascades, shallow water, rocks, log jams, overhanging trees, undercut banks, and cable suspension bridges for hikers are all potential hazards. High water and spring flooding pose hazards. Iris and Colonnade Falls are impassable; Bechler Falls is a Class III rapid. The remoteness of the area would slow rescue operations.

FALLS RIVER

Length: 31.0 miles

Description

The Falls River parallels the park's southern boundary, flowing westward for 31 miles before exiting the park. Its waters drain off of the Pitchstone Plateau above Beula Lake. About 1/4 mile downstream is an unnamed 10-ft. waterfall, the first of many that the river was named for. About 1 mile below the lake, the river passes through narrow meadows and along lodgepole forests with heavy deadfall. The gradient increases moderately, and there is a 16-ft. waterfall. The stream continues through a shallow canyon and a wet meadow before crossing the Old Marysville road. West of the road are Cascade Acres, Terraced Falls, a combined upper and lower drop of 150 feet, and Rainbow Falls, 100 feet high. The river resumes a meandering course, where undercut banks support tall willows and deep pools are common. The Falls River is joined by Mountain Ash Creek and the Bechler, then plunges 20 feet over Cave Falls. The falls is 250 feet across and is named for a large overhanging cave in the basaltic rock on the river's north side. A secondary road from Ashton, Idaho, ends at Cave Falls; 1 mile below the falls the river crosses the park boundary.

Boating Potential

The river is accessible by trail from Cave Falls, a 26-mile drive from Ashton. It can also be reached from the Grassy Lake road that connects Ashton and Marysville, Idaho, with the John D. Rockefeller Parkway just outside Yellowstone's South Entrance. Both roads are not passable before mid-June. From Grassy Lake Reservoir, a short portage would access the upper reaches of the Falls River. However, deadfall, shallow sections, and the numerous waterfalls make the river impractical except to decked boats such as whitewater canoes and kayaks. Terraced and Rainbow Falls must be portaged.

Potential Impacts

1. Threatened and endangered species - Migrating bald eagles use the river, especially during autumn. Grizzly bears are reported occasionally; Mattson views negative effects as unlikely from river use. However, they do periodically move through this area into the north end of Grand Teton/Rockefeller Parkway. The Forest Service has limited use in the area in recent years due to its being grizzly habitat. Due to sandhill crane presence in the adjoining open meadows, the area is potential whooping crane habitat.
2. Significant geothermal features - None.
3. Historical and archaeological sites - A partial survey revealed 8 sites. The Old Marysville road, a historic route from Idaho across the Tetons, cuts across this area near the river.

4. Birds and wildlife - Harlequin ducks, moose, and trumpeter swans inhabit the river zone. Sandhill cranes use open parks along the river. Otter are found here, and Calf Creek has had an active beaver lodge in recent years. Black bear presence is fairly heavy in the park's southwest corner. Currently, little use affects the wildlife here.
5. Fish - An apparently pure population of cutthroat trout can be found above an unnamed waterfall high in the drainage at an elevation of 7,220 feet. Below this fall, there are rainbow trout and rainbow/cutthroat hybrids in the mainstem and tributaries. Use of boats on the Falls River could substantially increase angler use and subsequently impact the rainbow/hybrid trout. Any reduction in population size or structure would also affect piscine predators.
6. User conflicts - An average of 1230 anglers use the Falls River each year. This area is popular with backcountry users who access via the Cave Falls or the Flagg Ranch-Ashton road; Union Falls is an especially popular destination. The area's remoteness and aesthetics make it highly photogenic and users likely have an expectation of a wilderness experience.
7. Vegetation - The area is largely wetlands with very low use; any increase in hikers, anglers, or boaters would likely increase trampling and removal of vegetation along the river banks.
8. Sanitation - Access to upper stretches of the Falls River is only by trail, and increased use could be reflected in the amount of litter and human waste seen on the banks. Due to the area's remoteness, sanitation would be somewhat harder to manage than in the park interior.
9. Safety hazards - There are at least six waterfalls that are Class V or VI. These require expertise and care by even the best kayakers. The remoteness of the area would mean slower access by rescuers in the event of emergencies, but the Flagg Ranch-Ashton Road and the Cave Falls road do provide some vehicular access into the area.

FIREHOLE RIVER

Length: 46.8 miles

Description

The Firehole River originates as two small, cold springs at the base of Trischman Knob, west of Grants Pass at an elevation of 8,360 feet. For its upper 9 miles it is cold, narrow, and historically fishless as it meanders through high meadows. Several miles east of Old Faithful it encounters the first thermal features, near Lone Star Geyser, then passes through a steep, 1 1/4-mile long canyon which ends in 150-ft. Kepler Cascades. Below the falls, the river enters the Upper Geyser Basin, the world's highest concentration of geysers and hot springs. Here millions of gallons of thermal effluent per day run into the Firehole River; 25 percent of its total flow comes from the hot springs and geysers. As it flows north for 37.5 miles through the Upper, Midway, and Lower Basins, the river mostly parallels the Grand Loop road. On its way, it passes through Fountain Flats, a large, open section of the Lower Geyser Basin. Approximately 4 miles south of the confluence with the Gibbon River, the Firehole enters a canyon bounded by lodgepole pine forests and rhyolite lava flows. Two substantial drops are found in the canyon: Firehole Cascades, and 39-ft. Firehole Falls. Two miles below the falls, the river meets the Gibbon and becomes the Madison River.

Stream width varies from 20-100 feet, and depth from 6 inches to 10 feet. The pH is mildly alkaline (7.3 to 8.0), and the maximum summer water temperature measured is 87°F. In winter, the Firehole is open water, measuring 47-56°F. The stream's alkalinity makes for diverse communities, and even more individuals of each species than are present in the more acidic waters (Varley and Schullery, 1983).

Boating Potential

Above Kepler Cascades, the river is accessible only by foot or bicycle from the Lone Star trailhead. Kepler Cascades is not passable by boat. Below, the river is easily accessible from the Old Faithful area and the Grand Loop road. The main park road is snow covered from November until April in most years; the segments from West Yellowstone and Mammoth are the first sections to be opened in spring. Although long stretches are quite shallow, most of the river could be run by boat, kayak, or raft until one gets to Firehole Canyon. The canyon contains numerous rapids, and Firehole Falls is a straight vertical drop of 25 feet with a major hydraulic at the base. Take-out below the falls is extremely difficult.

Potential Impacts

1. Threatened and endangered species - Grizzlies frequently use the Firehole Valley, particularly in spring when they feed on winterkilled ungulates around the geyser basins. (The valley from Black Sand Basin to Nez Perce Picnic Area has been closed from mid-March until Memorial Day weekend since 1982 to reduce the chance of bear-human conflicts during this

period.) Mattson indicates that bears would likely be aware of or affected by humans in spring, summer, and fall along the Firehole. In recent years, bald eagles have been present both in summer and during migration. In September of 1985, two whooping cranes were observed flying over the meadows of Fairy Creek within 1 mile of the Firehole River. Since several pairs of sandhill cranes annually use the Fountain Flats area, this is likely critical habitat for the endangered whooping crane as well.

The Fountain Flats area of the Firehole Valley was a major area for wolf sightings until the mid-1970s, when sightings dropped off throughout the park. The Little Firehole, a tributary stream which flows into the mainstem from the west near Biscuit Basin, is recorded to have had a historic peregrine falcon eyrie.

2. Significant geothermal features - The Firehole River flows through the largest concentration of hot springs and geysers in the world. Some of the features extend into and across the river. Among these are Riverside, Giant, Fan, and Mortar Geysers, all major features that erupt over 50 feet high. Other geysers or hot springs which bank the river or flow into it include Lime Kiln, Witches Cauldron, and Island Geyser in the Upper Basin; Flood Geyser, and Excelsior Geyser at Midway Geyser Basin; and Ojo Caliente, Azure Spring, and Fortress Geyser in the Lower Basin. Fragile sinter shields adjoin and underlie the stream; though deposition rates vary, it often takes hundreds of years to build up an inch of silica or geyserite (Bryan, 1979). To protect thermal features, there is no off-trail travel in the thermal areas, and swimming is prohibited in the Upper Geyser Basin and the immediate area of Midway Geyser Basin. The river is quite shallow between Midway and Lower Basins, and here the sinter of the riverbed would be easily damaged by boat or foot traffic.
3. Historical and archaeological sites - There are no known surveys along the Firehole River. However, there was likely some Native American use of the area; trappers did traverse the area in the first half of the 18th century. The geyser basin was a major stop on the path of the Washburn expedition of 1870, whose documentation of thermal features and other natural curiosities led two years later to the creation of the world's first national park. The Nez Perce Indians crossed the river and encountered early park visitors during their flight from the Cavalry in 1877. Near Nez Perce Picnic Area and the Firehole River is the site of Marschall House, one of the earliest park hotels.
4. Birds and wildlife - Since the thermal features keep the river ice-free and the adjacent ground bare or covered with a lighter-than-average snowpack, ungulates, waterfowl, and predators are drawn to these areas. A 1985-86 winter count of the Firehole-Madison elk herd totalled approximately 600 animals (Singer, in-house report). Female elk stay near the river banks during calving season in May and June. The Mary Mountain bison herd, currently numbering about 1,000 (aerial census, mid-winter 1985), spends autumn, winter, and spring in the valley. They

calve in April, May, and perhaps June, particularly in the meadows of Fountain Flats. Black bears roam the valley, and families of coyotes live from the Upper Geyser Basin to Fountain Flats. Osprey roost along the river. Canada geese are plentiful and reside year round in the river zone. Several sandhill crane pairs have nested in the Lower Geyser Basin meadows since at least 1976. Great blue herons are regularly observed along the riverbank in all seasons, also. Trumpeter swans are sometimes seen just above Firehole Canyon in winter and upstream from the water intake. Harlequin ducks have been observed in spring above Firehole Cascades (McEneaney, pers. commun.). Killdeer, dippers, other shorebirds, and ducks live along the river.

5. Fish - Historically, the Firehole above the falls was barren of fish. Since the late 19th century it has contained non-native brook, rainbow, and brown trout. Brookies dominate above Kepler Cascades; rainbows tolerate the higher water temperatures of the river in the geyser basins better than other fish species. Below Firehole Falls, browns, rainbows, and mountain whitefish dominate.
6. User conflicts - Fly fishing is the predominant activity in the river zone. This is already the fourth most popular fishery in the park (U.S. F&WS) with 21,000 angler days in 1985. Information suggests definite conflicts between boaters and shore anglers in most areas where the two activities coincide. On the river's edge, the major activities are observing wildlife and geysers and hot springs. The opportunities to photograph geyser eruptions are unmatched anywhere in the world. At present, although swimming is allowed in parts of the river, there is little of this activity; it is prohibited near thermal features at Midway Geyser Basin in order to prevent conflicts with other users. Wildlife viewing from the roadside may be rivaled in a few other places within Yellowstone but is especially good during the spring and early summer calving season. The Old Faithful area receives as many as 25,000 visitors per day during the summer.
7. Vegetation - A unique plant, Agrostis rossiae (Ross' bentgrass) grows on thermal ground in the Upper, Midway, and Lower Basins and is known nowhere else in the world. Yellowstone has a Memorandum of Agreement with the Fish and Wildlife Service to protect this plant, which will not be listed as endangered as long as NPS provides sufficient protection for it and its habitat.

This is one of five rivers in the park with significant numbers of aquatic vascular plants. Boat use of the river would significantly alter the vegetative communities (Lentsch, pers. commun.). The warmer water temperature makes this waterway more subject to invasion by exotic aquatic species, such as Eurasian milfoil.

8. Sanitation - The river's proximity to the main road and picnic areas would possibly reduce the impact on stream banks below the geyser basins. The domestic water intake that serves Old Faithful is just above Kepler

Cascades and would possibly be affected by upstream use. This stretch is already closed to fishing to protect water quality for the 800,000-gallon water system. Natural mineral concentrations in the river are naturally high; arsenic, mercury, flouride, and lead are present in concentrations high enough to make the river below Old Faithful unacceptable as a source of drinking water.

9. Safety hazards - Thermal features on and in the river have the potential to burn incautious visitors. Some deadfall adds to the danger in the canyon. The water is extremely hazardous in Firehole Canyon, though the falls are not as high as some others in the park. Below the falls, rescue would be difficult if not impossible (Bennett, pers. commun.).

GALLATIN RIVER

Length: 31.9 miles

Description

Near Three Rivers Peak in the northwest corner of Yellowstone, the Gallatin River begins. It flows out of Gallatin Lake and drops through spruce-fir then lodgepole forests. The Gallatin is moderately rocky, shallow, and narrow in its upper stretches. It is clear, snow-fed, and fast, at least until late July or early August; maximum width is about 15 feet. This river flows down out of the Gallatin Range for 32 miles within the park, about half of the mileage paralleling U.S. Highway 191. Waters in the drainage are of high alkalinity, and the riverbanks are often overgrown with willows. Along the Gallatin highway, the river is calm within the park, although north of the boundary it enters the Gallatin Canyon where it becomes more rapid.

Boating Potential

The river is accessible from Highway 191 or the Fawn Pass trail. There is some moderate whitewater but no rapids or cascades to impede boaters. Along the road it is barely deep enough to float a canoe most of the summer.

Potential Impacts

1. Threatened and endangered species - Grizzly bears frequent the willow banks and high meadows of the Gallatin Range. This area is the number one of cub production in Yellowstone (Knight, 1985). A significant number of bears are likely to be aware of or affected by river use in spring and summer (Mattson, internal report). From 1982-85, Bighorn Pass trail was closed, and hikers crossing the range via Fawn Pass were advised to travel in parties of 4 or more persons to reduce the likelihood of bear-human encounters. A peregrine falcon hack site was placed north of the park in 1985 near Crown Butte, but the Forest Service believed it is far enough removed from the river to not be significantly affected.
2. Significant geothermal features - None.
3. Historical and archaeological sites - There are no known surveys. There was Indian movement through Gallatin Canyon along the old Bannock Trail route, and there possibly were seasonal hunting or fishing camps along the river.

4. Birds and wildlife - The Gallatin elk herd moves down out of the mountains to rut in autumn and winter in the Gallatin Valley. Moose are common along the river, as are muskrats and other small mammals. An active beaver lodge can be seen near milepost 25 on the road; others probably bank-den along the river here. Red-tailed hawks are abundant; mule deer and an occasional black bear are seen.
5. Fish - The Montana grayling can no longer be found in the drainage, but some possibly pure populations of native westslope cutthroat trout have been located. Yellowstone cutthroat, rainbow, rainbow/cutthroat hybrids, and mountain whitefish are also found. Angler use in the area has increased steadily since 1973, and is currently almost five times greater (2,650 days/year) than 13 years ago. This exceptional use suggests that protective measures may be necessary to sustain natural population sizes and structures. Boating would be expected to cause even greater increases in angler pressure.
6. User conflicts - Some conflict could occur with backcountry hikers due to an increased number of contacts with other people in an area where number of encounters affects the perception of solitude. River use is more likely along the road. The major conflicts would be with fishermen and with observers along the roadside who might object to seeing boats in their camera frames. The Gallatin ranks twelfth in total angler use between 1973-1986; and the 2650 anglers, mostly fly fishermen, could conflict with boats on the narrow river corridor.
7. Vegetation - Aquatic vascular plants are scattered throughout the main channel; this is one of five major rivers with significant numbers of aquatic plants in the park. Due to relatively low levels of use in the upper reaches, vegetative loss from trampling is minimal at present.
8. Sanitation - Littering and waste disposal could be handled at roadside sites along the Gallatin Highway, but it would be expected that visitors would beach wherever possible and disperse waste. There are at present no sanitary facilities along the river.
9. Safety hazards - Basically non-existent except for the threat of hypothermia.

GARDNER RIVER

Length: 31 miles

Description

The Gardner originates as a small, clear stream near the base of Joseph Peak in the Gallatin Range. It soon meets Fawn Creek and meanders, less than 20 feet wide, across the windy, treeless expanse of Gardner's Hole on Swan Lake Flats. Near Indian Creek Campground, just off the Mammoth-Norris road, Panther, Obsidian, and Indian Creeks all join the Gardner River. The river then crosses the road, turns north, and follows the columns of Sheepsteater Cliffs away from road and trail access. Less than a mile from the Sheepsteater turnoff, the river drops over the lava flows, through a 30-foot fall and into the narrow, steep-walled Sheepsteater Canyon. It emerges in the mossy, 150-foot Osprey Falls, surrounded by Douglas fir, and limber and lodgepole pine forests. The falls is visible and accessible by steep trail from the Bunsen Peak road. Above the falls is 23 miles of river; below, it passes under the Mammoth-Tower road bridge to meet incoming Lava Creek and continues for 8 miles in the Gardner Canyon. Here it has a rocky bottom, is several feet deep, and is lined by willows and occasional conifer and aspen trees. The river follows the North Entrance road, crossing the 45th latitudinal parallel where just upstream, thermal runoff meets the river. The resulting mix of hot and cold water has become known as "Boiling River." This is one of the few places in Yellowstone where people can legally swim in heated water (they must be in the river, not the thermal features). Moving northward, the last few miles of the Gardner are rimmed by the cliffs below McMin Bench. Just below the north gate, the Gardner empties into the Yellowstone River.

Boating Potential

Short stretches upstream from Sheepsteater Cliffs are floatable, and the stream is accessible by foot or horse from the Sportsman Lake trail. Just north of Indian Creek, 1/2-1 mile of the river is within sight of the Grand Loop road. Sheepsteater Canyon is not passable by boat and has no foot trails to portage on. Below Osprey Falls, a long steep trail could be used to reach the river. Below this canyon and Lava Creek, there would be ample, fast water during spring runoff but minimal depth for boating during most of the year.

Potential Impacts

1. Threatened and endangered species - Along the upper Gardner, above Swan Lake Flat, grizzlies are frequently sighted in summer. Falcons are seen each spring along the lower stretches of the Gardner; some sightings have been confirmed as peregrine falcons. Two of the historic peregrine falcon eyries in the park were on the Gardner River at Osprey Falls and Eagle Nest Rock (Oakleaf, pers. commun.). Bald eagles are observed along the lower stretches during fall and winter surveys.

2. Significant geothermal features - None exist above Lava Creek; there is a well-known hot spring which pours into Boiling River. In contrast to the silica-based features of the Firehole Valley, this is a travertine hot spring area. Travertine is much softer than geyserite, making it less subject to breakage but also subject to damage from human trampling. In and along the river, thermophilic algae grows in thick strands during winter and is practically non-existent in summer and fall due to human use.
3. Historical and archaeological sites - A partial survey of the river revealed 12 archaeologic sites. Obsidian chips have been found along the lower portion of the river. The Sheepeater Cliffs/Gardner's Hole area was the only region of Yellowstone where Indians are thought to have lived year round. The river flows just northeast of historic Fort Yellowstone, and a major travel route to the fort developed along the river. A number of historic sites are known between Lava Creek and the mouth of the river, including McGuirk's Medicinal Hot Springs, Chinese garden, and Teepee Ring.
4. Birds and wildlife - The Gardner River below Osprey Falls flows through critical late winter range for most of the park's ungulate species. Elk rut and calve along the upper reaches and frequent the lower miles of the river during winter and spring. Up to 200 bison have recolonized the Mammoth-Gardiner area in the last few years. Deer and moose inhabit the riparian zone, especially in the vicinity of Lava Creek. Bighorn sheep winter atop McMinn Bench and often move down off the cliffs to feed along the river below the 45th parallel. Golden eagles and prairie falcons nest in the cliffs of the Gardner River Canyon. Near the confluence with Lava Creek, resident beavers and otter are often observed, and beaver have been observed in the Canyon itself (Meagher, pers. commun.). Additional beaver sign (lodges, dams, freshly-cut trees) is heavy in this area.

This area is inhabited by a number of birds, including species uncommon in the higher, inner reaches of Yellowstone. Osprey nest between the mouth of the Gardner and Osprey Falls. Harlequin ducks, fairly rare in the region, have summered in the rapids below the falls. Yellowstone annually records the highest numbers of American dippers in the country during its Christmas Audubon bird count; most of these are found along the Gardner River. Swallows nest in the cliffs above the river, and many riparian songbirds are present in the willows and brush during summer. MacGillivray's warblers, lazuli buntings, and gray catbirds regularly occur here but are rarely reported elsewhere in the park.

5. Fish - Brook trout are found above Osprey Falls; brown, rainbow, brook, and cutthroat trout, and whitefish live below the falls. Brown trout from the Yellowstone River outside the park migrate up to 40 miles to spawn in the Gardner; this is one of few brown trout spawning tributaries in the upper Yellowstone River basin. Researchers are currently investigating whether it is an important spawning area for native cutthroat trout as well.

6. User conflicts - The river receives over 4,800 angler days of use annually, making it the sixth most heavily used stream in Yellowstone. Near Indian Creek is one of the few spots in the park where children under age 12 can fish with bait worms. Due to the small size of the river, direct conflict could occur between anglers and boaters. Boiling River is one of only two rivers in the park where visitors swim in large numbers. The Gardner River Canyon is popular with photographers, particularly during the bighorn sheep rut in late autumn. Hikers and participants in interpretive walks find the Gardner one of few accessible places in fall, winter, and spring, due to the lighter snowpack.
7. Vegetation - Thermophilic algae are already severely disturbed and/or denuded in the Boiling River area. Dragging boats around the hotpotting area would increase damage to the already trampled natural vegetation in this vicinity. Warmer water is more likely to be invaded by exotic aquatic plant species which attach themselves to boats and can be transported in from other areas of the country. Trampling of vegetation would occur at other access sites along the river.
8. Sanitation - Just west and north of Indian Creek Campground is the water intake point for the Mammoth area, access to which is currently restricted. A sanitary facility is being constructed at the 45th parallel to help handle use along the riverside. Much of the river is close to road access, which would make waste management somewhat easier than along backcountry river segments.
9. Safety hazards - Sheepeater Canyon is impassable, Class VI water, and there is no safe portage route. River access immediately below Osprey Falls is steep and dangerous. Below Lava Creek the water is floatable during runoff but would be fast and dangerous.

GIBBON RIVER

Length: 42.3 miles

Description

The Gibbon River originates as the outlet of Grebe Lake at 8,028 feet elevation in the Washburn Range. It flows west and south over the edge of the Yellowstone caldera below 84-foot high Gibbon Falls, to Madison Junction. Here it joins the Firehole River to become the Madison. In its upper miles, the Gibbon is a shallow, gentle stream with occasional riffles and cascades, lined with lodgepole forests. It drops 1,228 feet over its length for an average gradient of less than 1 percent per mile. The width varies from 12 to 30+ feet. During peak runoff in late May through June, the river exceeds its bank and floods adjacent meadows near Norris Junction and in Elk Park and Gibbon Meadows. Major cool tributaries of the river are Canyon, Secret Valley, Gibbon Meadows, Solfatara, Castle, and Virginia Creeks. About 20 percent of the river's flow is from thermal sources (Varley and Schullery, 1983). Highly acidic levels of thermal effluents are received from Monument, Gibbon, and Norris Geyser Basins, and Terrace, Beryl, Chocolate, and Iron Hot Springs. The Gibbon River is unique due to its high natural acidity, which contributes to the diversity of aquatic organisms, and this plus water temperature makes the growing season exceptionally long (Varley and Schullery, 1983). Below the geyser basins, the streambed is rocky and often covered with sharp rhyolite outcrops and silica deposits. There are five major drops in the Gibbon River; in addition to the major falls there is a 25-foot Upper Gibbon and a 25-foot Little Gibbon Falls, 60-foot Virginia Cascade, Gibbon Cascade, and the Gibbon River Rapids. Downstream from Virginia Meadows, the Gibbon is visible from the Norris-Canyon road for nearly its entire length.

Boating Potential

The upper 5.8 miles is only accessible by trail; the other 20.5 miles is paralleled by the park road and easily accessed from numerous pullouts. Deadfall blocks much of the stream, especially near the geyser basin, and it is too shallow to run except during peak runoff in May and June. Little Gibbon Falls, Virginia Cascade, and Gibbon Falls often lack enough water to support a kayak; Gibbon Falls is unsuitable for most boaters. At least three falls would require portages. Gibbon Cascades is quite shallow, but the stream is gentle below Gibbon Meadows.

Potential Impacts

1. Threatened and endangered species - The Gibbon is one of few streams in Yellowstone that possibly supports Montana grayling, which is an uncommon species in its native state. Mattson suggests that grizzly bears could be impacted by river use, since they have a proclivity to use riparian habitats in the vicinity of the lower reaches during all seasons. They use the meadows which harbor lush vegetation, carrion, and calving elk and bison in spring. Bald eagles feed on bison and elk carcasses in

February and March and frequently fly the Gibbon Canyon, but there is no present nesting activity known. The presence of sandhill cranes here each summer indicates the area's potential for whooping cranes.

2. Significant geothermal features - Iron and Beryl Springs are major hot springs located just west of the Grand Loop road and the Gibbon River 5-6 miles south of Norris Junction. Hot springs exist on the stream banks and bottom the length of Gibbon Cascades; notable are the Chocolate Pots, two hot springs with built-up, algae-laden sinter mounds on the west bank. Features also dot the banks from Elk Park to Gibbon Falls. There is heavy deposition of crusty silica at locales where thermal runoff empties into the river and on the river bottom.
3. Historical and archaeological sites - There have been no archaeologic surveys; however, an abundance of obsidian points and flakes are found along exposed banks. Native Americans likely hunted seasonally around the thermal basins or meadows. In the Norris area are several historic sites, such as Larry's Lunch Counter and the Soldier Station.
4. Birds and wildlife - Elk inhabit the meadows along the river nearly all year. Gibbon Meadows and Elk Park are particularly significant spring calving and summer resting grounds. In recent years, bison have begun to winter in the meadows. Deer and moose use the river in summer, and otter have been observed in the Gibbon. Black bears, mountain lions, coyotes, and an occasional wolverine are reported in the meadows. Trumpeter swans were observed on the Gibbon River at several times in 1985. Canada geese, ducks, herons, and dippers feed or nest along the river. Sandhill cranes summer in the meadows, and as many as 4 great blue herons have been observed at one time in islands on the Gibbon River. In late summer of 1985, great gray owls were regularly observed near Norris Campground, which adjoins the river, and near the confluence with the Firehole River. Behind Norris Geyser Basin, spotted sandpipers, killdeer, and snipe nest close to shore, and marsh wrens, rare in the park, are found here (Zarki and Manns, pers. commun.).
5. Fish - Grayling, which were found in the river above the falls through 1940, have been found as scattered individuals, above and below the falls in recent years. This species was native to this stream but now maintains itself only in Cascade, Wolf, and Grebe lakes. Rainbow, brook, and reputedly some of the park's largest brown trout are here, introduced to the Gibbon early in the park's history. Some native cutthroat are present (Varley and Schullery, 1983). The abundant deadfall along this stream provides good fish habitat.
6. User conflicts - Fly fishing pressure is already heavy on the river. The river is the fifth most popular fishery in the park, supporting over 12,000 angler days annually since 1973. The Gibbon River's narrow size would bring anglers and boaters into direct conflict. Visitors frequent the riverbanks and meadows, watching and photographing elk, bison, and other wildlife during all seasons. Gibbon Falls is a major stop for private vehicles and tour groups and is heavily photographed.

7. Vegetation - Thermophilic algae in the features along the river zone are sensitive to trampling and removal. Pond lilies, rare outside of still waters, are found in the river above Gibbon Canyon. Aquatic vegetation is generally rare in park waters, but this stream is one of few with significant numbers of aquatic vascular plants. Such species are particularly susceptible to alteration by boating. The Gibbon, due to thermal influence, is also more likely than colder streams to be invaded by exotic plant species.
8. Sanitation - Since most of the river parallels the road, the disposal and management of human waste is likely to be easily handled through picnic areas and roadside pull-offs; facilities already exist at two picnic areas south of Norris.
9. Safety hazards - Gibbon Falls is Class VI and must be portaged. Two other falls are Class VI. There is a danger of visitors being scalded in thermal features at several spots along the river zone; at least one prior accident along the river resulted in a tort claim against the government.

LAMAR RIVER - Headwaters to Soda Butte Creek

Length: 24.1 miles

Description

The Lamar River is the largest tributary of the Yellowstone River within the park. It begins high in the Hoodoo Basin, a remote section of backcountry in the easternmost part of the park. The high peaks, steep ridges, and U-shaped valleys of the Absaroka Range and the Mirror Plateau support a network of tributaries that flood the Lamar in late spring. The river passes through canyons, dense forests, and numerous logjams and deadfall on its way to Cache Creek, about 4 miles south of the junction with Soda Butte. The river is very turbid during snowmelt and after thunderstorm activity, and the streambed consists of cobble and boulders and sand and gravel bars with washed up trees and logs in many places. Below Cache Creek, the river widens out into the meadows of the Lamar Valley. Here the river is about 25 feet wide with some deep pools. It meets Soda Butte Creek coming in from the east-northeast; the confluence is a major pull-off along the park roadway.

Boating Potential

The Lamar River trail provides nonmotorized access to the river for 22 miles south of the Cooke City-Tower road. There is ample water to support boats, but due to the numerous impediments in the river, floatability is not good.

Potential Impacts

1. Threatened and endangered species - Bald eagles have been observed annually at the confluence of the Lamar and Soda Butte Creek; there is no nesting activity in the area. In this remote section of backcountry, grizzly bears are occasionally encountered by the hikers and horse parties that venture up the trail. Patrol cabins show signs that bears have attempted to break in and steal cached food. The Lamar Valley is the first area of the park to be free of snow in the spring. Incidence of grizzlies along the river is high in this season, and a significant number of bears are likely to be affected by river use during this period of time (Mattson, internal report).

The Lamar Valley was one of the last places that wolves were known to exist in Yellowstone, and the park has received unconfirmed sighting reports from this area throughout the last decade. It is possible that gray wolves still move through this area.

2. Significant geothermal features - A few unnamed cold springs and gas vents are found along the upper Lamar River.

3. Historical and archaeological sites - The Lamar River has been partially surveyed, and nine sites have been identified along the entire length of the stream. The Bannock Trail crosses the Lamar Valley; it was a route used by native Americans to cross the mountains to and from hunting grounds on the plains to the east.
4. Birds and wildlife - Several golden eagles nest along the river zone. The foot trail is a natural travel route down the narrow canyon for bison and elk, which summer in the high meadows and migrate to the lower Lamar Valley for fall and winter. Moose reside in the valley, and pronghorn summer here. Coyotes, black bear, mountain lion, and badger also use this valley. River otter frequent the river near the confluence (McEneaney, pers. commun.) and the upper Lamar from Miller Creek to Cold Creek. A 1986 survey of mountain lions in Yellowstone revealed the presence of several resident lions, sign from which was found in the Slough Creek/Lamar/Tower area.
5. Fish - Cutthroat and rainbow-cutthroat hybrids dominate in the Lamar River. The strain of the trout in the upper river are pure, and increased use could cause a more noticeable impact on that population. The geologic, climatic, hydrologic, and biologic factors in this drainage promote a large amount of sediment production. Factors (such as increased human use) which increase sediment production potentially could affect trout populations in the Lamar River.
6. User conflicts - Anglers are one of the user groups with whom boaters would likely conflict. Above Cache Creek, angler use is light (487 user days per year, average); from Cache Creek to and below the confluence with Soda Butte Creek is one of the park's most popular fly fisheries. Commercial outfitters regularly use this area to escort horse parties into the backcountry for a wilderness experience; the users' perception of solitude is largely based on the number of encounters with other backcountry parties and could be affected by increased use along the river trail. The Lamar Valley is a prime place for wildlife watching. Although the drive from Tower Junction to the Northeast Entrance is the most lightly used of park roads in summertime, it offers a windshield view of undeveloped, primitive countryside. In spring, fall, and winter, when interior park roads are snowed in, this road is open and quite popular with visitors photographing and observing wildlife.
7. Vegetation - Riparian vegetation is relatively abundant; river banks are very unstable in many locations and could slump with increased use along the riverside.
8. Sanitation - In the upper Lamar, minimal increases in use could impact water quality. Nearer the road, it would be easier to manage, but no sanitary facilities are available.

9. Safety hazards - Deadfall is as much a problem here than the class of water. However, during spring runoff, the river is powerful and dangerous. The upper Lamar is difficult and hazardous to ford until mid-July and becomes powerful following thunderstorms. There are numerous series of Class II, III, and IV rapids in this segment.

LAMAR RIVER - Soda Butte Creek to Yellowstone River confluence

Length: 11.9 miles

Description

From the confluence of Soda Butte Creek and the Lamar, the river is wide, deep, and turbid during spring runoff. It winds through a large glacial valley, bordered on the south by Specimen Ridge and Amethyst Mountain, where 30-50 million years ago the native redwood and magnolia trees were petrified. The first 6 miles of the mainstem meanders east-northeast with occasional rapids. Gravel bars and boulders evidence annual flooding. The Lamar freezes over in winter, in contrast to the park's thermally-influenced waters. Halfway to the end of the river it enters steep-walled Lamar Canyon, a series of rapids with large boulders and hydraulics. Along the riverbanks are some of the oldest exposed rocks in Yellowstone, which substantially predate the recent volcanics that affected the majority of the park's topography. As the river reemerges from the canyon, it winds through boulder-strewn whitewater for 5.9 miles until its junction with the Yellowstone River.

Boating Potential

Access to most of the river in this section is easily gained from the main road, which is open year round from Gardiner to Cooke City, Montana. Takeout on the lower end of the Lamar River involves a half-mile portage cross-country to the road. The first 6 miles would be floatable by raft, canoe, or kayak, though the water level becomes quite low in late summer. The Lamar canyon is expert kayak water, and the short stretch between the canyon and the Yellowstone is easy, assuming a floater would exit before meeting the larger river.

Potential Impacts

1. Threatened and endangered species: Grizzly bears are drawn to the area in spring by winterkill. Mattson indicates moderate grizzly use near the confluence in spring; in summer a significant number of bears would likely be aware of or affected by river use (internal report, 1986). As many as six bald eagles have been seen at the confluence at one time, and several are counted along the river during the annual Christmas bird counts. The area contained some historic nests, but no current nesting is known. Numerous reports of peregrine falcons prior to 1960 (Oakleaf letter, May 29, 1986) indicate historic nesting near the confluence with Soda Butte Creek. A peregrine falcon was reported in November of 1985 (Robinson, pers. commun.), and the Peregrine Fund has proposed placing a hack site in a nearby area in the summer of 1986. The hack site will not be on the Lamar River, but the river valley could provide some of the prey base. Historic nesting sites are most likely to be reoccupied.

Between 1967 and 1977, one or two wolf-like canids were observed each year in the northeast corner of the park, with sightings concentrated along the Lamar River and Soda Butte Creek (Weaver, 1978). The park also had indications of wolf activity in the Lamar Valley in the late winter of 1986.

2. Significant geothermal features - None.
3. Historical and archaeological sites - In a partial survey for archaeological sites, nine have been already identified. A major archaeological site is at Rose Creek, next to the Buffalo Ranch. The site of Harry Yount's cabin is in the flood plain near the confluence; Yount was a gamekeeper hired by the park's second superintendent, Philetus Norris. The view of the valley is historically important due to Osborne Russell's famous description of its appearance in 1835, and his account of meeting a band of Sheepeater Indians there is the most complete record of these historic park residents (Manns, pers. commun.).
4. Birds and wildlife - Bison and elk winter in great numbers in the valley and calve here in spring. It is the primary summer range for the park's population of pronghorn. Moose, mule deer, bighorn sheep, badger, and red fox are commonly spotted. Coyote packs and family groups are found here. Golden eagles nest in the cliffs along Specimen Ridge, and prairie falcons, sandhill cranes, ravens, and trumpeter swans reside here as well as many songbirds and owls. Harlequin ducks are seasonally seen in the canyon, and river otter are common inhabitants of the calmer stretches. Beaver reside in the wide, main part of the Lamar Valley. A 1986 survey of mountain lion sign revealed the presence of resident cats, one of which appeared to be in the Lamar-Slough Creek-Tower area.
5. Fish - Native cutthroat and rainbow-cutthroat hybrids occupy the river. Here, as in the upper Lamar, the production of suspended sediment is high and matter of research interest at the current time. Its effect on the fish population and the effect of increased use on sediment loading has not been determined.
6. User conflicts - Wildlife viewing, photography, and birdwatching are popular activities in the valley, particularly in early spring and late autumn, when other park roads are inaccessible to automobiles. During summer, this is the most lightly used of main park roads and provides a quiet, visual experience quite different from that available on the Grand Loop. In spring, fall, and winter, it is the most accessible roadway and is frequented by visitors observing wildlife. The other main user group likely to conflict with boaters is anglers. This is the seventh most popular fishery in Yellowstone, with an average of 4,550 angler days per year. Use and harvest reached levels which required catch and release only angling beginning in 1973.

7. Vegetation - There is some riparian vegetation which would be sensitive to trampling. Much of the sagebrush-grassland nearby would be fairly resilient to moderate levels of human use; take-out and put-in sites would be denuded.
8. Sanitation - Due to the road's proximity to the river, sanitary facilities could be provided along the banks to handle human waste.
9. Safety hazards - The Lamar River canyon is treacherous, whether a visitor enters by boat or foot. The canyon contains Class III and IV rapids and large boulders which pose safety hazards. High water volume and low water temperature pose safety threats along the entire stretch during snowmelt. If a boater were to miss takeout, they would find themselves in the turbulent lower Yellowstone River.

LEWIS RIVER - Lewis Lake Outlet to Snake River

Length: 13.2 miles

Description

The Lewis River begins at the outlet of Shoshone Lake in the south central portion of the park. It flows 4.5 miles south into Lewis Lake; this short stretch is known as the Lewis River channel. It is narrow, tree-lined, and has a gravelly to rocky bottom; by late July or August, in many years there is not enough water to float a canoe. This upper portion of the Lewis River is the only riverway in the park currently open to boating. At the southern tip of Lewis Lake, the river reemerges and rushes through several rapids before plunging 30 feet over Lewis Falls. Then the river continues calmly for 3.1 miles before entering the Lewis River canyon. For 7.6 miles through the steep-walled canyon, this is a series of moderately difficult rapids, bounded by adjacent ash flow tuffs left over from the Yellowstone's caldera-forming activity. The last 1.3 miles of the Lewis River is fast-moving until it empties into the Snake River near the park's south gate. Several streams and springs add to the river above and below the falls; the width varies from 21 to 42 feet, and the depth averages 3.5 feet.

Boating Potential

The river parallels the South Entrance road after emerging from Lewis Lake, although once in the canyon it is far below road height. Portions of the river are easy to negotiate, such as between Lewis Lake and the falls. The canyon itself is suitable for expert kayakers or rafts when the water level is high in spring.

Potential Impacts

1. Threatened and endangered species - Bald eagles roost in the canyon; in recent years there has been an active nest near the south end of Lewis Lake and one along the Lewis River channel. Grizzlies are sometimes observed in the summertime by hikers on the trails to Shoshone Lake. Mattson did not expect a significant number of grizzly bears would be affected by river boaters.
2. Significant geothermal features - There are a few hot springs in the area known as Clark Falls, and Crawfish Creek, a tributary of the Lewis River near Moose Falls, has major thermal input.
3. Historical and archaeological sites - There have been no known surveys for archaeologic sites.

4. Birds and wildlife - Black bears, moose, trumpeter swans, owls, coyotes, elk, deer, pine marten, and river otter occupy the river zone. There is a beaver dam and lodge just below the falls which is active most years. Common loons stop here and on Lewis Lake during migration, and geese and other waterfowl reside here. Sandhill cranes have occasionally been observed in the meadows along the river. Osprey nested in 1987 along the lakeshore near the outlet to the Lewis River channel.
5. Fish - Brook, brown, and lake trout, and whitefish are present in the river. Brown trout spawn in the Lewis River channel, and the roadside section of the Lewis River has the best catch rate for brown trout of any stream in Yellowstone (U.S. Fish and Wildlife Service Annual Report, 1985). Since levels of use and harvest were judged to have an adverse effect on the fishery, this roadside section has been regulated under catch and release since 1973.
6. User conflicts - The river receives about 4,500 angler days of use each year. Fishermen traditionally fish the calm water stretches where casual boaters could use this river, and angler use is very high between Lewis Falls and the head of the Lewis River Canyon. The Lewis River channel is the only river segment in the park currently open to boats, since it connects Lewis and Shoshone Lakes. Some conflicts between boaters and anglers has occurred along this segment in previous years. Conflict is also possible with persons photographing moose, elk, swans, and other wildlife along the Lewis River.
7. Vegetation - There are aquatic macrophytes in the river below Lewis Falls. Some degradation has already occurred in the Lewis River channel, caused by boats being dragged up the channel in late summer when river level is quite low.
8. Sanitation - Where the water is calm enough to afford a take-out, users could access the banks to disperse waste. Along the southernmost stretch of park road, one picnic area close to the confluence of the Snake and Lewis Rivers is accessible to floaters.
9. Safety Hazards - The water in the canyon and below the falls would impede some boaters and is very shallow from July to September. Takeout above the canyon would be possible. Deadfall and logjams provide impediments to boaters. Access into the canyon is very hazardous, and rescue would be difficult.

MADISON RIVER

Length: 18.3 miles

Description

Near the famed campsite of the Washburn-Langford-Doane expedition, the junction of the Firehole and Gibbon rivers forms the Madison River. It is generally a wide, slow-moving river as it flows westward, paralleling the park's West Entrance road for 18.3 miles. It exits the park just north of the town of West Yellowstone and flows north-northwest through Hebgen and Earthquake Lakes. From its start at Madison Junction, it moves past sedge meadows and the cliffs of Three Brothers and Mount Haynes. About six miles downstream, it flows into the West Yellowstone basin, bordered by lodgepole stands and beaver lodges. Width varies from 84 to 220 feet, and depth ranges from 8 inches to 10 feet. Halfway between the Madison Junction and West Yellowstone, the river forms a large oxbow bend and crosses the road under Seven-Mile Bridge. Just east of this halfway point the riparian zone is quite marshy; dead snags and lush vegetation characterizes the land south of the park road. For the next 5 miles the road follows the river closely, maintaining a fairly placid course, then it moves north along a mile of old road and soon passes out of the park.

Boating Potential

The Madison is easily accessible, calm water, with no falls or major obstructions to endanger boaters. Anyone floating downstream from the Barns access road, approximately two miles inside the West Entrance, would have to take out north of West Yellowstone to meet the road.

Potential Impacts

1. Threatened and endangered species- Since 1983, there has been a peregrine falcon hack site on the cliffs due south of the Madison River. Through 1985, 14 falcons have been released here, and the birds feed along the river zone, hunting their small prey birds during the summer months before they leave the park. There is an active bald eagle nest at the confluence of the Gibbon and Madison Rivers. The meadows adjoining the river are frequented by grizzly bears in spring, when elk and bison are calving, and in fall, when the brown trout spawn. Mattson indicates the possibility of a significant number of bears being affected by river use in spring.
2. Significant geothermal features - There is hot spring runoff into the river just south of H-loop of Madison Campground.

3. Historical and archaeological sites - A partial survey revealed six archaeological sites to date. The Washburn expedition of 1870 is known to have camped here on their last night in what is now the park. Tradition holds that the party discussed dividing up the Yellowstone region in order to profit from their discovery but finally decided to promote the idea of instead making it a "nation's park" (Haines, 1977). While historians debate the truth of this legend, the site is nevertheless important to the history of Yellowstone and the National Park idea.
4. Birds and wildlife - In 1985, Yellowstone's only successful trumpeter swan nest was in the territory 1/4 mile south of Seven-Mile Bridge; it produced 5 cygnets in 1983, 1 in 1984, and 5 again in 1985. A second pair, thought to be offspring of the productive pair, has lived on the river the past several years. Swans congregate on the river by the hundreds during the winter. Elk and bison are observed all year along the river; both calve in the meadows near the river's beginning. Coyotes and black bears scavenge the meadows for winterkilled ungulates in spring, and predators hunt here for other small prey in the summer and fall. Beavers have been active on the river throughout this decade and have lodges at several locations on the river. A family of river otter are often reported near Nine-Mile Hole also.

Canada geese and sandhill cranes inhabit the river's edge. Osprey often feed from the dead snags along the water; in 1987, six pair nested successfully between Seven Mile Bridge and the park boundary at Baker's Hole. Moose make use of the willows in this stretch. There is an active great blue heron nest west of the Barns, and abundant other waterfowl are found along the Madison. In the first months of 1986, researchers did a preliminary search for mountain lions residing year round in the park. They found none along the Madison, but this is considered the only likely wintering area beyond the lower elevations of the northern range.

5. Fish - Brown and rainbow trout, whitefish, and an occasional grayling, cutthroat, or brook trout are found in the Madison. The spawning runs of browns, rainbows, and whitefish from Hebgen Lake into the river are significant. The Madison River is one of the finest fly fishing streams in the United States. The slightly warmed water and its mineral characteristics make it excellent trout habitat, thus providing a significant food base for predatory birds and mammals.
6. User conflicts - Fly fishermen make West Yellowstone their national headquarters, and would doubtless object strenuously to heavy boating use that might affect their fishing use. It is the second most heavily fished water in the park, with an average of 17,800 angler days of use since 1973. Boats were prohibited on this river inside the park beginning in the 1930's, before the parkwide restriction which is still in effect. Increased access in stretches away from the road would likely receive increased fishing pressure. The swan brood at Seven-Mile Bridge is perhaps the most photographed in the country, both by amateur and professional photographers. Likewise, there is high potential for boats

to affect the view easily seen from the West Entrance road and to displace the observable wildlife from the river zone. Heavy roadside visitation along the West Entrance road presently displaces many elk to the river's edge; boating would leave them no place to flee in the narrow meadows along the Madison River.

7. Vegetation - According to the Fish & Wildlife Service, the nature of the aquatic vegetation in the river makes it potentially susceptible to significant degradation from boats.
8. Sanitation - Since the river is very near the road for nearly its entire length in the park, visitor access to and maintenance of sanitary facilities would be easier here than in the backcountry. However, there are no facilities currently available along this segment.
9. Safety hazards - None inherent in the river itself.

SLOUGH CREEK

Length; 16.2 miles

Description

Slough Creek originates at the base of Pinnacle Mountain, about 30 miles northeast of Gardiner, Montana, in the Gallatin National Forest. It crosses into the park at an elevation of 6,660 feet, moving south through miles of open meadows with occasional Douglas fir and aspen along its banks. The gradient varies between a flat meandering stretch, moderate rapids between the first and second meadows, and a precipitous cascading section between the first meadow and Slough Creek Campground that drops 350 feet in 2 miles. Alluvial fans, undercut banks, and flood plains are numerous along the course of this mostly placid creek. Stream width varies from 25 to 75 feet, and its maximum depth is 10 feet. A number of snow-fed streams enter into its flow, including Cutoff, Elk Tongue, Plateau, and Buffalo Creeks. Sixteen miles after it enters the park, it empties into the much larger Lamar River.

Boating Potential

From its confluence with the Lamar River 4.5 miles upstream to the campground, the creek is easily reachable from the gravelled campground road. Above the campground, access is available to hikers or stock parties who follow the bank or the 11-mile Slough Creek trail. Portions of the creek are suitable for novice floaters; the section between the first meadow and the campground would need to be portaged most of the time due to low water.

Potential Impacts

1. Threatened and endangered species - Grizzly bear use of the area is high; there have been seven bear incidents in the area since 1980. A significant number of grizzlies are likely to be aware of or affected by river use in spring and fall (Mattson, internal report). Two pair of sandhill cranes nested along the banks in 1985, which indicates potential whooping crane habitat. No known bald eagle nests are along the creek, but they are regularly observed circling over the valley. In 1986, the Park Service and the Peregrine Fund have planned to put in a peregrine hawk site along the creek. There are periodic sightings in the area, and the birds will feed in the riparian habitat.
2. Significant geothermal features - None.
3. Historical and archaeological sites - A partial survey has thus revealed three archaeologic sites. The old Silvertip Ranch road through the park to private holdings outside the boundary holds potential for historic artifacts; there are several old poachers' cabins near the park's north boundary line.

4. Birds and wildlife - The meadows along the river provide year round forage for elk; bison, moose, and deer also use the habitat. Mink, beaver, and otter are all observed here. Coyotes and badger occupy the area meadows in this northern section of Yellowstone more commonly than in its higher elevation, forested regions. Trumpeter swans are present in the area each year but have not nested along the creek. Sandhill cranes summer in the meadows near the lower patrol cabin. Black bears feed on the grassy slopes above the creek. A 1986 survey for resident mountain lions in Yellowstone revealed the presence of several individual cats. Of 13 tracks found in three months, 3 were along Slough Creek.
5. Fish - Slough Creek is one of few park streams with a robust population of pure Yellowstone cutthroat trout, located above the cascades at the campground. A 1980 habitat evaluation revealed the highest percentage of optimum trout habitat in the park, but trout densities are relatively low compared to other park waters. The high degree of fishing pressure required instituting catch and release regulations in 1973. On the average, trout from Slough Creek are caught and released 6-9 times in the course of a summer. Rainbow-cutthroat hybrids, longnose dace, and mountain sucker inhabit the section below the cascades. This is the only stream in the Lamar drainage where mottled sculpin are found.
6. User conflicts - This is the fifth most popular fishery in Yellowstone. Angler use has averaged 7,000 days per year since 1973. This is a blue-ribbon fly-fishing stream, and numerous articles have been written concerning the angling opportunities on Slough Creek within the past 10 years. A significant organized response could be expected in response to any form of boating on this stream. Seven backcountry campsites along the creek receive heavy use; the backcountry users' perception of solitude could be affected by increasing numbers of parties using the area. The lower part of the creek valley, like the Lamar Valley, is accessible to vehicular traffic when the park interior is snowed in. Thus it receives heavy winter and spring use by persons watching and photographing birds and wildlife, such as calving elk and bison, and the unobstructed views along the open river meadows.
7. Vegetation - Algae and periphyton are common, according to a 1980 trout habitat evaluation. Banks are relatively unstable in the lower section and very susceptible to degradation, which could increase siltation in the creek.
8. Sanitation - Users would disperse along the banks of this mostly backcountry creek. Management of litter and human waste would have to be handled by backcountry personnel above the campground.
9. Safety hazards - There are moderate hazards in the center section rapids, which are Class II and III.

SNAKE RIVER - Heart River to South Boundary

Length: 18.2 miles

Description

In the southeast corner of the Yellowstone plateau is the source of one of the west's major waterways. The Snake River is formed by the joining of small creeks that flow out of the mountains west of the Continental Divide. The upper Snake is a barely navigable river of shallow depth except during runoff when it may flood to six times its normal summer size. It flows northwest to meet the Heart River 4.1 miles south of Heart Lake. From here down, the river is characterized by cobble and silt substrate and large sand and gravel bars with washed up trees and logs. There are six more major tributaries on the stream below the Heart River: Basin, Harebell, Coulter, Red, and Forest Creeks, and the Lewis River. As the Snake continues south and west, it passes through open valleys, grassy meadows, and the ever-present lodgepole pine forests. Two major canyons above the Lewis junction contain rapids. Stream banks are often undercut from 1 to 7 feet below the top. Depth is barely enough to support a boat most of the year. Hot springs flow into the river at various spots, such as just below the Heart River junction and at Snake River Hot Springs near Forest Creek. Just outside the south boundary of the park, the Snake River enters another canyon, then meanders through willow thickets next to the road connecting Yellowstone with Grand Teton National Park.

Boating Potential

The river is barely navigable due to stream width and depth during much of the summer, and deadfall. Access is only by trail, following the popular Heart Lake trail 8 miles and continuing south along the Snake River for 4 miles, or the South Boundary trail near the South Entrance station.

Potential Impacts

1. Threatened and endangered species - Grizzly bears often use the game and human trails along the river, sheltered by the dense willows and heavy downfall. Grizzlies often den in the vicinity and emerge from March to May to begin searching for food. A significant number of grizzlies are likely to be aware of or affected by river use in spring, summer, and possibly fall (Mattson, internal communication). They have a proclivity to use both forest and non-forest riparian habitats in spring, non-forest in summer, and forest in fall. The 1986 bald eagle survey found an active nest along the river. Sandhill cranes nested in the area in since at least 1980, which indicates potential whooping crane habitat.
2. Significant geothermal features - Snake River Hot Springs, in the lower reaches of the river within the park, is a popular spot for backcountry hikers who use the South Boundary trail. There is substantial illegal

hotpotting in the springs and its runoff; few of the visitors legally swim where the runoff empties into the river. Litter, illegal camping and pets, and trampling are all associated with use of this feature.

3. Historical and archaeological sites - The river has been partially surveyed for archaeological sites, and five have been found so far. The area was likely used by native Americans for hunting and fishing and by beaver trappers who frequented the Jackson Hole region. Two soldier stations were built along the river also.
4. Birds and wildlife - Black bears, pine martens, and coyotes use the forest and meadows along the rivers edge. Three active beaver dams can be found along the Snake River. River otter can often be observed near the confluence of the Lewis and Snake Rivers. Elk migrating to and from wintering grounds in Jackson Hole frequent game trails along the river; a small population stays all year in the area. Moose inhabit the southern meadows of the park and are probably most abundant here of anywhere in Yellowstone; they feed in the river zone. Canada geese and sandhill cranes nest here. Harlequin ducks migrate upriver in spring, and numerous other waterfowl are observed.
5. Fish - Mountain whitefish is the most frequently sampled species. Cutthroat and brown trout are also common, especially during their spawning seasons (early summer and fall, respectively). The finespotted-cutthroat is a distinct subspecies found in this river, and some rainbow-cutthroat hybrids are found.
6. User conflicts - The Heart Lake area is one of Yellowstone's most popular backcountry hiking and camping areas. The area is already heavily impacted compared to other backcountry locations in Yellowstone. Users portaging boats to the Snake River via this trail could increase trail use and compete for campsite permits with outfitters and backpackers. Both the South Boundary and Snake River trails following the river are used mostly by horse parties seeking a wilderness experience. These users perception of solitude would likely be negatively affected by increased numbers of parties encountered. An average of 1,100 angler days are recorded annually, mostly near the south gate; this user group perceives conflict with additional river use.
7. Vegetation - Runoff from Snake River Hot Springs is enough to raise the river temperature 1.1°C below the feature. The slightly warmer water temperature makes the river more sensitive to influx of exotic aquatic plants, which could be transported in on boats.
8. Sanitation - No facilities for waste or litter disposal are available; the riverside would have to absorb this.
9. Safety hazards - Class II and III rapids and heavy downfall present moderate risk and much inconvenience to floaters. The cold water temperature above the thermal feature and the frequency of bears in the area present additional hazards to visitors.

SODA BUTTE CREEK

Length: 16.0 miles

Description

Soda Butte Creek begins outside the park's Northeast Entrance, passing through an old historic mining district and the hamlet of Silver Gate before entering the park just south of the Tower-Cooke City road. It is 3-10 feet wide and quite shallow except during spring flooding, with a gravelly bottom and eroded banks in some spots. The riverside vegetation is thick lodgepole and spruce-fir forests; some dense willow thickets are along the stream also. There is deadfall across the creek in numerous spots. Several miles inside the park's northeast gate, Soda Butte Creek contains several series of rapids. It continues on, entering the narrow-walled Icebox Canyon, named because its steep north-facing sides receive so little sun that ice remains on the walls into June each year. The canyon contains a series of three natural barriers: a 20-foot double waterfall, followed by a 200-foot velocity chute and cascade, and a 16-foot cascade. Below the canyon, the creek begins to open up into a wide, flat meadow called Round Prairie, near Pebble Creek Campground. Downstream, the river passes through another short canyon and into the sagebrush steppe of the Lamar Valley. The river passes its namesake, a large, still active travertine mound called Soda Butte. Three miles below the thermal feature, Soda Butte Creek empties into the Lamar River.

Soda Butte Creek was heavily contaminated by mine tailings from the McLaren mine, which operated on the creek banks at the confluence of Soda Butte and Miller Creeks, just east of Cooke City, from 1933 until 1953. Gold, copper, and silver were removed using cyanide and arsenic, which leached into the creek long after mine closing. Serious bank erosion around the tailing increased in 1957. Gradually, fish life moved downstream in the creek, and by 1967 no fish were found above the park boundary. Monitoring has continued on Soda Butte Creek within the park and shows some recovery, but this trend has been confounded by increased fishing pressure, periodic surges of pollutants from the mine tailings, and domestic sewage pollution from Cooke City. A 1970 EPA survey found ferrous hydroxide was the major pollutant still leaching from the tailings. (Soda Butte Creek provides water for the towns of Cooke City and Silver Gate.) Water quality is extremely poor compared with other streams in the park.

Boating Potential

Most of the creek is within 1/4 mile of the park road. Water level is quite shallow in mid-late summer, and Icebox Canyon would impede canoeists. Logjams and deadfall create frequent impediments to travel in the upper reaches.

Potential Impacts

1. Threatened and endangered species - Grizzly bears use the valley as a major travel route, especially in spring. Mattson predicts that a significant number of grizzlies are likely to be aware of or affected by river use in spring and possibly summer (1986, internal report). As many as six bald eagles have been observed at one time near the confluence of Soda Butte Creek and the Lamar River; there has been no recent nesting activity. Peregrine falcons are sometimes reported near the confluence, and those released from the 1986 hack site on Slough Creek could feed near the confluence.
2. Significant geothermal features - Soda Butte; but it is not directly on the creek.
3. Historical and archaeological sites - There have been no archaeological surveys on the creek. Soda Butte was a late 19th century landmark on the road to the Cooke City mines, and there was an old ranger station nearby which was moved about 1936 to the Buffalo Ranch. Squatters staked out claims and built cabins along the river, including one gamekeeper's cabin, a mail station, and squatter's buildings near the thermal feature (Haines, 1977). The site of Red Siwash's saloon is located on the far side of the creek at Round Prairie.
4. Birds and wildlife - Moose are often seen along the stream between Pebble Creek and Silver Gate. The riparian meadows are frequented by large numbers of elk, especially cows with calves in June. Several dozen bison can regularly be observed upstream along the creek from the Lamar Valley and the Buffalo Ranch. Bighorn sheep have wintered since at least 1979 on the bluff across from the confluence of Soda Butte Creek and the Lamar River (Jackson grade). Beaver are also active in this area. Black bears graze in summertime on the hillsides between Soda Butte and the Northeast Gate. Mountain lions, coyotes, badgers, nesting birds, waterfowl, and otter are all common here. Golden eagles nest in the adjacent cliffs. A wolverine was sighted near the butte in recent years.
5. Fish - Cutthroat and rainbow-cutthroat hybrids inhabit the creek. The creek held little fish life for many years due to acid mine drainage upstream from Cooke City but has been recovering and is gaining in popularity with anglers. The creek has fairly high suspended sediment levels, which could increase with additional use and potentially affect the recovery of the fishery.

6. User conflicts - In the past decade, it received 3,800 angler days of use per year, on average. Most of this use is between Pebble Creek campground and the Lamar confluence. Boaters could conflict with anglers and wildlife watchers traveling the Northeast Entrance road. This road is the only segment open year round to automobiles, and photographers and wildlife observers would likely object to increased users displacing animals along the river.
7. Vegetation - Light algae and moss levels have been measured in the creek. Stream velocity prevents adequate masses of rooted aquatic vegetation from developing. The stream banks are relatively erodible naturally, and trampling on streamsides would increase erosion into the creek.
8. Sanitation - Soda Butte Creek parallels the park road from Silver Gate to the Lamar River. There are sanitary facilities available at Pebble Creek and Warm Springs Picnic Area; litter could be collected by someone walking the stream, though the brush is thick in places.
9. Safety hazards - Icebox Canyon is steep and narrow, with Class III water. The poor water quality poses some problem for a visitor who might unsuspectingly drink the water. Toxic materials may be found in the stream, seeping from mine tailings.

YELLOWSTONE RIVER

The Yellowstone River remains the last great undammed river in the lower forty-eight states (Varley and Schullery, 1983). From its headwaters just south of the park it winds through hundreds of acres of wilderness, the pristine waters of Yellowstone Lake, the depths of the Grand Canyon and the Black Canyon of the Yellowstone, to pass out the north boundary. By then it has flowed for 115 miles and has become a major tributary of the Missouri River.

Because of its length and the varied nature of the river within the park, it is divided into five distinct segments for the purposes of analysis.

YELLOWSTONE RIVER - SE BOUNDARY TO YELLOWSTONE LAKE INLET

Length: 26.2 miles

Description

The source of the river is outside the park's southeastern boundary, in Wyoming's Absaroka Mountains. The Yellowstone winds northward through the marshy meadows of the Thorofare, a small creek, picking up water from many feeder streams and leaving an occasional oxbow as evidence of its prior course. In its early stretches it not at all resembles the mighty river it becomes just across the length of the park, except during May and June when snowmelt causes annual scouring. From the boundary elevation of 7,874 feet, the river drops very slightly along its 26-mile journey to the southeast arm of Yellowstone Lake. On the way, it passes through the most isolated backcountry reaches of the park. This is gentle water, except for one rapid above Cabin Creek and some downed logs as it flows through pine and fir forests. Width varies from 50 to 150 feet. Extreme flooding of the channel has occurred in the past, such that alluvial gravel, sand, and silt deposits are evident in many locations equal to four times the stream's typical mid-season width. In the distant past at various times, the lake has flowed south and west instead of north, at the mercy of Yellowstone's violent geologic upheaval.

Boating Potential

The source of the river is only accessible by hiking or riding a minimum of 12 miles from the nearest road or by kayaking or canoeing upstream from the southeast arm of the lake. Snow, downed trees, and swollen stream crossings make the trail impassable until about mid-July. The river is easily floatable water.

Potential Impacts

1. Threatened and endangered species - Grizzly bears make good use of several dozen of the 126 tributaries into Yellowstone Lake, especially during trout spawning from late May through mid-July (Carty, 1986). They are present in riparian habitat throughout the park's southeast corner and beyond, into the Teton Wilderness. A significant number of bears could be affected by river use in spring (Mattson, 1986 internal report). Bald eagles nested in the delta in 1985 and 1986. During the summer of 1985, a whooping crane accompanied by a pair of sandhill cranes occupied the wetlands along the river delta.
2. Significant geothermal features - None.
3. Historical and archaeological sites - This area has not been surveyed, but the Thorofare rangers have found numerous old campsites, chips, scrapes, and points which are up to 5,000 years old (Marschall, pers. commun.).
4. Birds and wildlife - This marshy delta is some of the most important waterfowl habitat in Yellowstone. From May through July this is the main feeding ground for white pelicans nesting on the nearby Molly Islands, one of only two active pelican rookeries in Wyoming. Two pairs of sandhill cranes nested here in 1984, one successfully, and at least one pair nested in 1983 and 1985. Three osprey nests are along this reach, and one trumpeter swan pair regularly nests in the delta. The riparian habitat supports beaver, river otter, muskrat, mink, elk, and black bear. This area is extremely important moose habitat for Yellowstone.
5. Fish - Native cutthroat trout are found here, and "the dense concentrations of fish that occur in many tributaries during spawning offer a near-perfect re-creation of primitive America" (Varley and Schullery, 1983). Increased access to and use of the river could have a measureable effect on this fishery.
6. User conflicts - There are few visitors who can access this region of Yellowstone, due to the time and energy it takes to reach the Thorofare region. It is likely that hikers who reach this area would object to the presence of boats in the wilderness zone that they struggled to reach. Fourteen backcountry hiker or stock party sites along the river supported 600 person-use nights in 1986. In research in other wilderness areas, backcountry users' perception of solitude closely relates to the number of other users and groups seen (Stankey, 1972). Stock parties may be more tolerant of increased use, and boats could be hauled into the Thorofare region on horseback. Fishing is permitted from the Southeast Arm of Yellowstone Lake to the park's south boundary, and this wild area received an average 725 days of angler use each year between 1976 and 1985.

7. Vegetation - This is one of few areas in Yellowstone with significant development of willows along the stream channel. The riparian vegetation provides quality habitat for animals and birds.
8. Sanitation - Due to this area's isolation and its wetland conditions, backcountry users would disperse to dispose of human waste. They are expected to haul out their trash; backcountry personnel would have to monitor and clean up waste sites.
9. Safety hazards - Deadfall and logs pose a minor hazard in the river. Yellowstone Lake, which could be used by boaters to access the river delta, is deep and cold, and often hazardous to boaters throughout the summer.

YELLOWSTONE RIVER - FISHING BRIDGE TO SULPHUR CALDRON

Length: 6.1 miles

Description

Passing through Yellowstone Lake, the river emerges again on its northward course at a historically popular spot called Fishing Bridge. This stretch of the Yellowstone River is wide and gentle, 2-15 feet deep. With the first mile from the bridge, the river is filled with spawning cutthroat each June and July. In the first century of the park, it was popular sport to toss a fishing line over the bridge and catch one's limit (which at one time was 20 or more fish per day) within minutes. Due to historically heavy fishing pressure on Yellowstone Lake and the river, the fish population collapsed, and fishing was banned from the bridge in 1973.

Mean discharge recorded at the lake outlet gauging station ranges from a low of 408 cubic feet per second (cfs) in March to a high of 3,590 cfs in July, averaging 1,320 cfs. Due to the moderating influence of Yellowstone Lake, this stretch of river is seldom prone to spring flooding after the lake ice cover melts in late May or early June. It is likewise devoid of a heavy load of silt and sand, which is dumped in the lake. Temperature extremes are moderated, and more plankton and insects are found, resulting in even better habitat for trout (Varley and Schullery, 1983).

North of Fishing Bridge the river flows through open terrain, bordered by sage and grasses. The Yellowstone moves north for 3-1/2 miles, then drops over LeHardy Rapids, a favorite spot for visitors to observe spawning trout, birds of prey, and waterfowl. Here, incidentally, the landscape is being measured as currently uplifting 1.4-2.0 cm a year. Two miles north of the rapids, the river drops past the Sulphur Caldron and Mud Volcano thermal area, receiving a considerable influx of acidic water. There are large gas vents in the river near these thermal features.

Boating Potential

The proximity of the park roadway makes easy access to the river at Fishing Bridge and at several roadside pullouts downstream. The river's depth and width are ample for floating. Le Hardy Rapids provides some impediment to boaters; it was named for a party of explorers from the Hayden survey of 1871 who wrecked their boat on the rapids.

Potential Impacts

1. Threatened and endangered species - Grizzly bears move along the Yellowstone river corridor, particularly in spring, when significant numbers of bears could be affected by or aware of human use of the river. The Fishing Bridge area is critical enough grizzly bear habitat that the park has proposed removing most visitor facilities from the area within

several miles of the river. The 1984 Report to the Director on Fishing Bridge and the Yellowstone Ecosystem says that this area, due to its ecological diversity and richness, is superb grizzly bear habitat (USDI, 1984). Bear sightings and incidents reveal high historical and present levels of bear use in this vicinity. Bald eagles also fish the spawning stream, and there is a nest, inactive since 1983, between the lake outlet and Sulphur Caldron. In 1985 and 1986 a pair of sandhill cranes nested near Mud Volcano, and in 1985 a whooping crane was reported to be flying over the Yellowstone River south toward the lake.

2. Significant geothermal features - The Sulphur Caldron is a major feature with runoff into the Yellowstone River, and the Mud Volcano area was one of considerable interest to early explorers in the region. This area is very active and growing today.
3. Historical and archaeological sites - A partially systematic survey of the river revealed 25 sites thus far. One very significant site near Fishing Bridge contains the "only known native American burial site from the Park" (Wright, 1982). The site is dated to 4675 B.P. The Nez Perce Indians and the U.S. cavalry, during the flight of the Nez perce in 1877, crossed the traditional Buffalo Ford, about 4 miles north of Fishing Bridge junction. There is an old soldier station site near Mud Volcano.
4. Birds and wildlife - Bison frequently summer and winter in the Sulphur Caldron area. Bison and elk calve there in the spring. Harlequin ducks migrate through Yellowstone and are most often seen on LeHardy Rapids, as are herons, kingfishers, dippers, geese, and other shorebirds and ducks. A male harlequin wintered at Fishing Bridge in 1985-86, the first on record to do so. Pelicans and gulls congregate here to feed on adult fish and steal the catch of mergansers. Osprey fish the river near the lake outlet; three osprey nests are found along this stretch of water. Black bears are sighted in the area in summertime. Coyotes roam the river valley, and moose, muskrat, beaver, and otter have been often observed from on or near the Fishing Bridge.
5. Fish - This segment of river is the premier spawning ground for the native Yellowstone cutthroat trout, due to high concentrations of spawning gravel. Not too far distant in the park's past, the river, like the lake, was severely overfished, and the population has not recovered yet (Varley and Schullery, 1983). Protective catch and release fishing regulations were initiated on this segment in 1973. From 1 mile downstream of the lake, fishing is allowed between July 15 and October 31. Protection of the spawning run and restoration of the age and size classes of cutthroat were the reasons for closing Fishing Bridge to fishing activity that same year.
6. User conflicts - This is the number one stream fishery in the park, with an average of nearly 38,000 angler days each year between 1980 and 1984. It is also one of the most intensively fished stretches of water in

North America, with an average of 6,200 angler days per mile. Fishing Bridge remains a major attraction for visitors observing trout and piscivorous (fish-eating) predators. An average of 165,000 visitors per year used the bridge from 1978 to 1985, simply to watch and photograph fish and their predators. During this same period, an annual average of 43,000 persons watched trout trying to jump the barrier to upstream migration at Le Hardy Rapids, and the construction of a new boardwalk and viewing platform in 1984 caused an additional increase in use of almost 100 percent. Close to 191,000 visitors stopped at Le Hardy Rapids in 1985. The Howard Eaton hiking trail follows the east bank of the Yellowstone River and receives moderate to heavy day use during years when it is not closed due to grizzly bear activity.

7. Vegetation - Streamside vegetation would be subject to trampling at put-in and take-out sites along the river. Due to ease of visitor access, use levels would likely be high and erosion and compaction correspondingly heavy.
8. Sanitation - Proximity to the Grand Loop Road would provide ease of disposal and management. Use levels would likely be high and the amount of litter and human waste correspondingly heavy.
9. Safety hazards - The river is relatively calm, save the Class II water of Le Hardy Rapids and the danger of getting burned on the east bank near Sulphur Caldron. However, a segment such as this would attract many users, including novices, and the river capable of causing drowning accidents.

YELLOWSTONE RIVER - SULPHUR CALDRON TO CHITTENDEN BRIDGE

Length: 9.9 miles

Description

North of Sulphur Caldron, this wide, deep stretch of the Yellowstone River meanders gently on into the broad expanse of Hayden Valley. This ancient lakebed is a grass, shrub, and wetland enclave for a 6.4-mile stretch which is one of the park's most scenic riverways. The river valley is bounded to the west by the Central Plateau and its lodgepole forests. Though the valley itself becomes an almost blinding white landscape through the long winter months, some river water remains open, making it an attractant for park wildlife all year round. In several spots, the river shows its former course in remnant oxbows. Adding to the river's flow are the waters of Trout, Elk Antler, Thistle, Sour, Otter, and the naturally tainted Alum Creek. These tributaries offer some of Yellowstone's most diverse bird habitat, particularly when the mud flats are exposed. During migration and in mid-summer, waterfowl and shorebirds heavily use these areas. The river from Sulphur Caldron to Alum Creek was closed to fishing in 1965 in order to prevent interference with wildlife and visitor observations of the native species. At the northern end of the valley, near where Sour Creek comes in, the Yellowstone River straightens its course, becomes more tree-lined, and follows the Grand Loop road for approximately 3 more miles to Chittenden Bridge. This bridge, over a spur road to Artist Point scenic overlook, marks the turning point on the heretofore gentle river.

Boating Potential

The waterway from Sulphur Caldron to Chittenden Bridge is all calm water. Depth and width are ample to support boats, and the road provides easy access within 1/2 mile of the river throughout this segment.

Potential Impacts

1. Threatened and endangered species - The Hayden Valley traditionally has been important habitat for grizzly bears. High numbers of bears, especially sows with cubs, are sighted by practiced observers in the spring. A significant number of grizzlies are likely to be affected by river use in fall and possibly in summer (Mattson, internal report). During the Craigheads' 13-year research study on the species, their work was concentrated in this valley, partly because of the presence at that time of the Trout Creek garbage dump, which was frequented by bears. Today the bears graze along the hillsides throughout the valley. There are no backcountry campsites in the Hayden Valley; overnight use and off-trail travel are not allowed.

An active bald eagle nest can be found most years near Alum Creek. There are annual reports of peregrine falcons, and in 1985, whooping cranes were reported to be flying south along the Yellowstone River near Sulphur Caldron.

2. Significant geothermal features - Runoff from the Sulphur Caldron and nearby features, as well as thermal features on the banks of Alum and Sour Creeks, flows into the Yellowstone River.
3. Historical and archaeological sites - A partial systematic survey revealed 25 sites along the Yellowstone. Most of those sites are south of this segment.
4. Birds and wildlife - The largest of the park's bison herds summers in the Hayden Valley-Mary Mountain area and use it as a calving and breeding ground. Portions of the herd winter here. Elk graze the sagebrush and grass-covered slopes, and both ungulate species participate in the rutting season here. Moose are commonly seen along the riverbanks in summertime. Predators such as coyotes, cougar, and badgers hunt small mammals and prey on winterkill in the area. Hundreds of trumpeter and whistling or tundra swans settle onto the river during migration south in late autumn and early winter. Great blue herons, Canada geese, several species of ducks, shorebirds, and white pelicans live along the river. Muskrat are abundant in the riparian zone. Fishhawks (ospreys) can be seen perched in snags above the river, as can an occasional great horned owl. One of the most likely places to spot river otter is on the Yellowstone River near Chittenden Bridge.
5. Fish - The Yellowstone cutthroat trout is the major fish species. Fishing pressure on the population is already heavy along the section which is legally fishable, from Alum Creek to Chittenden Bridge.
6. User conflicts - Between 1980 and 1984, angler days per year averaged 2,650 on the stretch between Alum Creek and Chittenden Bridge. Fishing has been banned on the segment from Sulphur Caldron to Alum Creek since 1965, due to its high scenic value and its use as year round wildlife habitat. For much the same reasons, it is this stretch which prompted river boating to be banned in the park starting in 1950. Potential is high for boater conflict with fishermen but is perceived to be even higher with sightseers and photographers. The Hayden Valley is a major site for watching and photographing birds and wildlife, and it is one of the relatively few places in the park where vistas are great and visibility is open for miles. An estimated 1.5 million visitors annually stop here on their scenic drive through Yellowstone.

7. Vegetation - There are some aquatic macrophytes in the river channel. Trampling on the river banks would increase to and at access points; use of this river would likely be heavy by boaters due to its calm water and proximity to the park road. The thermal influx into the river at Sulphur Caldron makes this segment more subject to invasion by non-native aquatic plants than colder riverways.
8. Sanitation - Access to the road would make management along this segment relatively easy. Use would undoubtedly be heavy, and impacts on water quality and streambank erosion and compaction correspondingly high.
9. Safety hazards - The river is calm, but the current is deceptively strong and deep enough to cause drowning. There is minor hazard near the thermal areas and in the remote possibility that someone would drink water from Alum Creek or the other tributaries.

YELLOWSTONE RIVER - CHITTENDEN BRIDGE TO TOWER BRIDGE

Length: 22.0 miles

Description

As the river turns slightly east past Chittenden Bridge, the character of the Yellowstone changes. The river narrows to 50 feet and plunges over the first of its two major waterfalls, the 109-foot Upper Falls of the Yellowstone. Below this drop, the river continues down canyon 1/3 mile to the even more spectacular Lower Falls. The second drop is 308 feet, and one of Yellowstone's primary scenic attractions. Above the falls, the river is 12-20 feet deep, and an estimated 64,000 gallons of water plunges over the falls every second. The hydrothermally altered rock walls of the Grand Canyon of the Yellowstone angle 800 to 1,200 feet down toward the river, which continues to be whitewater for most of the canyon's 20-mile length. Few visitors have observed the canyon bottom closehand; the only trails down require steep hikes and even then do not access the riverside for any length. A 30-foot fall exists below Inspiration Point. Thermal features grace the canyon bottom, visible from rim overlooks. The Grand Canyon drops over 1,000 feet in elevation as it moves northward around Mount Washburn in a very inaccessible stretch of park backcountry. It emerges as visible again at the Tower Falls overlook, a 17-mile drive from the Canyon area. Where Tower Creek and its own impressive waterfall drop over lava cliffs to meet the Yellowstone, the river remains far below the level of the park road. The bottom is still rocky, with one possible ford just south of the base of Tower Falls where the canyon walls are steep and crumbly. Thermal features continue to adjoin the river from Tower to Calcite Springs and even at Tower Bridge where the river passes under the main road going from Roosevelt to the Northeast Entrance.

Boating Potential

The falls are impassable; the river below the Lower Falls has occasionally been successfully attempted by the daredevil, illegal kayaker. It would be a dangerous and challenging ride for expert boaters along the entire stretch of river from below the falls to Tower Bridge. Access is by foot down the steep, 5.5-mile trail to Seven-Mile Hole, by scree slopes that lead to Three-Mile and Five-Mile Holes, or via a strenuous hike from Tower to Agate Creek.

Potential Impacts

1. Threatened and endangered species - As of January 1986, the only wild peregrine falcon nest in the park exists in the canyon below the falls. Although historic records are scant, it is likely that more than one eyrie existed in the canyon. Bald eagles are often seen fishing in the canyon from overlooks into the Grand Canyon and at Tower Falls overlook. Grizzly bears have been tracked to den sites on the sidewalls of the

canyon and make regular use of the dense vegetation lining the canyon rims and bottom during spring, summer, and fall. The river is bordered on the west by the Antelope Creek Bear Management Area, which has been closed to all public use since 1982. Agate Creek, a tributary of the Yellowstone River northeast of Mount Washburn, is a major spawning stream and grizzly food source. A significant number of bears is likely to be aware of or affected by river use during spring, summer, and especially in fall.

2. Significant geothermal features - From the Lower Falls to Tower, occasional features emerge along the canyon bottom and sidewalls. Fragile Calcite Springs, just north of Tower Creek, and nearby thermal features were some of the first observed by the Folsom, Cook, and Peterson expedition in 1869 and the Washburn expedition in 1870, since historical entrance to the park was generally from the north, following the Yellowstone River.
3. Historical and archaeological sites - The thermal features, as stated above, were some of the first scenes viewed by the park's earliest explorers. The most important ford in the park crossed the Yellowstone River just above the mouth of Tower Creek. This was part of the Bannock Indian trail.
4. Birds and wildlife - In 1987, ten pair of osprey nested in the Grand Canyon north of the falls. Historical counts of nests range from 5 (Turner, 1968) to 25 (Skinner, 1917). Bighorn sheep inhabit the cliffs between Mt. Washburn and Specimen Ridge north of Tower and are often observed on the sidewalls of the lava flows near Tower Fall, particularly in late winter and spring. Elk and bison are sometimes seen along the river below Tower Fall, despite the steepness of the terrain. A family of river otter live in the Chittenden Bridge area. A 1986 survey for mountain lions in Yellowstone revealed several resident individual cats; two of thirteen tracks found were in the Tower-Antelope Creek area.
5. Fish - The native Yellowstone cutthroat trout abounds here; Agate Creek is a major spawning tributary. The river also contains whitefish.
6. User conflicts - Fishing pressure from Lower Falls to Quartz Creek averaged 1,450 angler days annually between 1976 and 1984; Quartz Creek to the Tower Bridge averaged 4,900 days per year. A backcountry campsite at Agate Creek receives moderate use. The river trail currently provides access to one of few remaining free-flowing sections of river where backcountry visitors won't see boaters; these users' perception of solitude would likely be negatively affected by seeing river parties. Overlooks in the Grand Canyon and the Tower Falls areas are among the most popular vista points in the park. Upwards of 1 million persons annually drive the North and South Rim drives along the canyon, and the Lower Falls is probably as photographed as Old Faithful.

7. Vegetation - Little is known about the aquatic vegetation in this remote area. The river and the banks receive low use now, such that their condition is fairly pristine; increased use in any numbers could have a high initial impact.
8. Sanitation - Disposal of human waste and litter would be the responsibility of the users and would likely be dispersed along the river zone.
9. Safety hazards - Below the falls, the river is Class III, IV, and V water. Access can be as dangerous as is the water, although put-in is relatively easy at Seven-Mile Hole. Technical rescue using climbers, helicopter, or watercraft would be life-threatening to emergency personnel. The Antelope Creek bear management area is frequently used to accept bears translocated from other areas and poses a danger to anyone hiking through the area.

YELLOWSTONE RIVER - FROM TOWER BRIDGE TO GARDINER/NORTH BOUNDARY

Length: 23.2 miles

Description

This final in-park segment of the Yellowstone continues to be deep, fast, and powerful as it flows in a northeasterly direction from Tower Bridge. Just north of the road crossing, the water level occasionally drops to a level which exposes sand and gravel bars from the rocky river bottom. Around the first bend in the river is the historic Baronett Bridge, remnants of which are still visible along the banks. The bridge was built by an enterprising mountain man in 1871 and partially burnt by Nez Perce Indians during their flight from the U.S. Cavalry in 1877. It was hastily rebuilt by the Army, and strengthened by Barronett and Superintendent Norris the following year. Travelers used it in that condition until 1902 (Haines, 1977). Turning west where the Buffalo Fork comes in, the Yellowstone remains whitewater. Numerous tributaries enter the river in the next 20 miles, beginning with Hellroaring Creek. The river depth is about 80 feet under the bridge at Hellroaring. In May and June during peak snowmelt, the turbidity of the river has prompted recent research to determine sources of sedimentation and its effect on the northern range. The river has long been dangerous to hikers and fishermen who enter the water to fish or climb the opposite bank. Downstream from Hellroaring Creek, a trail parallels the river for its entire length to the park boundary. A traveler on this route passes through moderate conifer forests, past wide, sandy beaches, and across talus slopes. The trail continues through the Black Canyon of the Yellowstone at elevations between 5,000 and 6,000 feet, over Knowles Falls, and finally emerges out into the last few miles of sagebrush flats near Gardiner, Montana.

Boating Potential

The river is suitable for whitewater boats through the Black Canyon. Knowles Falls is runnable by kayak and fairly easily portaged around by rafters and canoeists, but three other major portages are along this segment. The potential is high here for a scenic, backcountry whitewater experience. The long portages over steep terrain and uneven loose rock would be prohibitive for small rafts but not longer boats such as J-tubes; advance scouting of rapids would be necessary for kayakers. Road access is convenient only at Tower Bridge and at Gardiner. Trail access along much of the route is possible, should someone desire to pack in a boat by foot or horse.

Potential Impacts

1. Threatened and endangered species - The Black Canyon has been identified by Wyoming Game and Fish biologists and the Peregrine Fund as a potential reintroduction site for peregrine falcons. Grizzly bears are frequently reported from the Yellowstone River trail in the spring, when a

significant number of bears would likely be affected by river use. Bear use of the area is high in spring and moderately high in early summer when succulent vegetation and carrion are abundant (Mattson, pers. commun.). Bald eagles use this stretch of river seasonally. Weaver (1978) documented at least one wolf-like sighting between 1967 and 1977 in this lower segment of the Yellowstone.

2. Significant geothermal features - None.
3. Historical and archaeological sites - Baronett Bridge dates to 1871, and portions on the bank can still be seen. There are two significant historic cabin sites in the vicinity of the bridge. A preliminary archaeological investigation identified 14 open lithic sites along this river segment (Taylor, 1964). A Crow Indian treaty marker was still visible by the river in the late 1970's. Also, some of the earliest post-trapper activity in Yellowstone was placer mining for gold near the mouth of Crevice Creek.
4. Birds and wildlife - The lower elevation of this river segment makes it the most likely spot for the park's only population of mountain lions, research investigation for which began in January 1986. Since 1980, over 50 percent of both wolverine and mountain lion sightings in the park have been made in the Yellowstone River drainage north of Tower. The completed three-month initial survey revealed the presence of resident cougar in the park; 6 of 13 tracks found were on or near this river segment. Elk and bison move down the river trail, especially in late winter and early spring. Bighorn sheep are often seen early and late in the season below Knowles Falls. Moose and deer feed on willows along the river bank, and otter inhabit the zone. Beaver are currently active between Tower Bridge and the mouth of the Lamar, on the west side of the Yellowstone. Osprey and hawks hunt prey from the cliffs above the Black Canyon, and an active osprey nest is found on the river at Hellroaring Creek. Black bears, like grizzlies, search for winterkill and den along the lower Yellowstone. Harlequin ducks ride the rapids in spring and early summer downstream from Tower Bridge to below the mouth of the Lamar. Prairie falcons are often reported and have historically nested along the lower Yellowstone River. Otter were observed in 1987 on the river near Blacktail cabin.
5. Fish - Native cutthroat trout predominate, but rainbows, hybrids, and brown trout are found below Knowles Falls. The Black Canyon is a popular backcountry angler destination.
6. User conflicts - Fishermen and hikers are the user groups now existing along this segment. Varley and Schullery (1983) state that the Yellowstone River below the falls "provides the chance to experience a rare setting in today's world: a large, free-flowing river that is not paralleled by a road or filled with boats." An average of 1,700 angler days per year are recorded here. Backcountry use is light during the peak heat of summer, but this trail is one of few in the park which is accessible early and late in the season, when snowfall makes most park

trails difficult going. Sixteen backcountry campsites received 2,459 use nights in 1984. Day use is estimated to be twice that. These backcountry users perception of solitude, which is a common expectation, would likely be affected by increased numbers of parties encountered, should river use occur. A study in 1982 (Tyson) documented major abuse of the resource base in the Black Canyon. Nine campsites were identified as moderately to very heavily degraded by erosion, tree mutilation, illegal firepits, and irreversible soil alteration.

7. Vegetation - Trampling at access routes and put-in and take-out points would increase the amount of disturbed or denuded vegetation.
8. Sanitation - There are ample places for river users to reach the banks, but management of human waste and litter would be hampered by the limited road access.
9. Safety hazards - The entire segment is at least moderate whitewater, and in places this is Class V water. Knowles Falls presents a challenge but can be portaged. The river is deceptive; water is swift, deep, and cold, and has claimed several lives. Rescue would be life-threatening to rescue personnel.

B. List of Preparers

This document was prepared by an interdisciplinary team based at Yellowstone National Park. The team members are listed below.

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