National Park Service
U.S. Department of the Interior

Yellowstone National Park

Native Fish Conservation Plan
Environmental Assessment

December 16, 2010

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Note to Reviewers and Respondents

You may submit written comments through the National Park Service (NPS) Planning, Environment and Public Comment website (http://parkplanning.nps.gov) or mail them to the address below. It is the practice of the NPS to make all comments, including names and addresses of respondents who provide that information, available for public review following the conclusion of the National Environmental Policy Act process. If you wish to request that the NPS withhold your name and/or address from public disclosure, you must state this prominently at the beginning of your comment. Respondents using the NPS website can make such a request by checking the box "Keep my contact information private." The NPS will honor such requests to the extent allowable by law; however, you should be aware that the NPS may be required to disclose your name and address pursuant to the Freedom of Information Act.

Address for written comments:

Native Fish Conservation Plan
Yellowstone National Park
P.O. Box 168
Yellowstone National Park, WY 82190

Comments are due by midnight, January 31, 2011.

Westslope cutthroat trout (*Oncorhynchus clarki lewisi)*

By Joseph R. Tomelleri, American Fishes

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Executive Summary

Yellowstone National Park proposes to conserve native fish from threats of non-native species, disease, and climate-induced environmental change. This Native Fish Conservation Plan and environmental assessment (EA) provides guidance and an adaptive framework for managing fisheries and aquatic resources over the coming two decades (anticipated 2011 – 2031).

The EA includes a review of the affected environment, the methods to be used to conserve native fish, and information on potential impacts to park resources from implementing the plan. The reason for taking action now is that, despite ongoing conservation efforts, native fish species continue to decline and could be lost from Yellowstone waters. The plan reflects the need to increase efforts to conserve native fish in the Yellowstone Lake ecosystem and in rivers, streams, and lakes elsewhere in the park.

Development of the plan included scientific review of current conservation efforts, projected changes in native fish status given known threats, a review of relevant emerging science and technology, and public and stakeholder input received during the public scoping process (March 29–April 30, 2010). The plan that emerged identified the following goals:

- Reduction in the long-term extinction risk for fluvial Arctic grayling (GRY), westslope cutthroat trout (WCT), and Yellowstone cutthroat trout (YCT);
- Restoration and maintenance of the important ecological role of native fishes; and
- Creation of sustainable native fish angling and viewing opportunities for the public.

The plan proposes to achieve these goals by accomplishing the following measureable objectives within the Yellowstone Lake ecosystem:

1. Increase large-scale suppression of lake trout (LKT) to reduce the population by 25% each year (annual fishing mortality rate of 0.56).
2. Maintain surface water access for spawning cutthroat trout in at least 45 (75%) of the 59 known, historical spawning tributaries.
3. Recover YCT abundance to the average observed during the five years following LKT discovery (1995–1999; average of 12,800 spawning YCT at Clear Creek).

And in other park streams, rivers, and lakes:

4. Preserve and/or restore genetically unaltered YCT to maintain their current spatial extent in streams (3,300 km, which is 75% of the 4,400 km that historically contained YCT).
5. Restore genetically unaltered WCT until they occupy at least 200 km (20% of 1,000-km historical WCT distribution).
6. Restore fluvial GRY until they occupy at least 200 km (20% of 1,000-km historical GRY distribution).

Four alternatives are evaluated in this EA.

1. The no-action alternative would result in a continuation of efforts at existing levels to conserve native fish.
2. The preferred alternative would conserve Yellowstone Lake YCT by increased netting of LKT (the carcasses returned to the lake) by private sector contract netters, and it would

conserve GRY, WCT, and YCT elsewhere in the park by using approved piscicides to remove non-native fish and restocking native species from genetically unaltered brood sources in the Greater Yellowstone Ecosystem.

3. The third alternative would implement the same actions as Alternative 2, except that LKT would be removed from Yellowstone Lake and marketed or donated by the contract netters.
4. The fourth alternative would attempt to conserve native fish using more limited methods; contract netters and piscicides would not be used.

Of the four alternatives, only alternatives 2 and 3 would fully meet plan objectives to preserve, protect, and restore the full range of the park's native fish species and natural ecosystem processes over the long term. Aquatic resources would be adaptively managed using a hierarchical series of desired outcomes, each chosen based on conservation value, technical feasibility, environmental impact analysis, and resource availability. Long-term monitoring of performance metrics would be used to track responses to conservation actions, guide the adjustment of these actions, and determine the success or failure of individual projects.

None of the alternatives would have more than moderate impacts to the environmental setting, including geology, water quality and quantity, wetlands, and vegetation; to fish and wildlife resources, including special status species; or to social and economic resources, including health and human safety, visitor use and experience, park operations, and wilderness areas. Alternative 2, the preferred alternative, would result in both short-term adverse and long-term beneficial impacts to these resources. None of the alternatives would result in impairment of park resources.

The park's goal is to provide a solid framework for native fish conservation. This EA would serve as a planning document to guide native fish conservation activities for the foreseeable future and to prepare annual work plans that would provide site-specific survey, permitting, and treatment plans. Park managers would use an adaptive management approach to native fish conservation, involving stakeholders and making adjustments to the plan when necessary based on experience and new information.

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Acronyms

AM	adaptive management
AFS	American Fisheries Society
AMI	aquatic macroinvertebrates
BKT	eastern brook trout (*Salvelinus fontinalis*)
BNT	brown trout (*Salmo trutta*)
CFR	Code of Federal Regulations
CWA	Clean Water Act
DO	Directors Order
DOA	Department of Agriculture
EA	environmental assessment
EFSC	East Fork Specimen Creek
EPA	Environmental Protection Agency
ESA	Endangered Species Act
GRY	fluvial arctic grayling (*Thymallus arcticus montanus)*
IDFG	Idaho Fish and Game
$KMnO_4$	potassium permanganate
LC_{50}	lethal concentration 50
LD_{50}	lethal dose 50
LKT	lake trout (*Salvelinus namaycush*)
mg/kg	milligram per kilogram
MOCC	Motorboat Operator Certification Course
MRA	Minimum Requirement Analysis
MSDS	Materials Safety Data Sheet
MTDEQ	Montana Department of Environmental Quality
MFWP	Montana Fish Wildlife & Parks
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NPS	National Park Service
ppb	parts per billion
ppm	parts per million
PPE	personal protective equipment
RBT	rainbow trout (*Oncorhynchus mykiss*)
RSI	remote site incubator
USACOE	U.S. Army Corps of Engineers

USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAR	Voluntary Angler Report
WCT	westslope cutthroat trout (*Oncorhynchus clarki lewisi*)
WHO	World Health Organization
WYDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department
YCR	Yellowstone Center for Resources
YCT	Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*)

1. Chapter 1: Purpose and Need

1.1 Introduction

The National Park Service (NPS) proposes to aggressively preserve and restore native fishes including the fluvial form of Arctic grayling (*Thymallus arcticus montanus*; GRY), westslope cutthroat trout (*Oncorhynchus clarki lewisi*, WCT), and Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*, YCT) throughout their historical ranges in Yellowstone National Park. These species and their important ecological roles within the park have been significantly compromised by introduced non-native species, disease, and climate change.

The purpose of this environmental assessment (EA) is to disclose expected impacts to the human environment from native fish conservation in the park. The human environment is defined as the natural and physical environment and the relationship of people with that environment. The project area consists of NPS waters within the park boundary, which include the headwaters of the upper Missouri River (including the Gallatin, Madison, and Yellowstone rivers) and the upper Snake River (including the Bechler and Falls rivers) and associated lakes, rivers and streams (fig. 1).

This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, regulations of the Council on Environmental Quality (40 CFR 1508.9), and the NPS Director's Order (DO-12, Conservation Planning, Environmental Impact Analysis, and Decision Making).

1.1.1 Background

By an Act of Congress 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" and "for the preservation from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders . . . and their retention in their natural condition." The world's first national park

> *preserves geologic wonders, including the world's most extraordinary collection of geysers and hot springs and the underlying volcanic activity that sustains them; preserves abundant and diverse wildlife in one of the largest remaining intact wild ecosystems on earth, supporting unparalleled biodiversity; preserves an 11,000-year-old continuum of human history, including the sites, structures, and events that reflect our shared heritage; and provides for the benefit, enjoyment, education and inspiration of this and future generations.*

Yellowstone National Park encompasses 2.2 million acres and is located primarily in the northwest corner of Wyoming, with portions extending into southwest Montana and southeast Idaho. It is the core of the greater Yellowstone area (GYA), an approximately 18-million-acre area that includes Grand Teton National Park and John D. Rockefeller, Jr. Memorial National Parkway to the south, seven national forests, three national wildlife refuges, three American Indian reservations, state lands, towns, and private property.

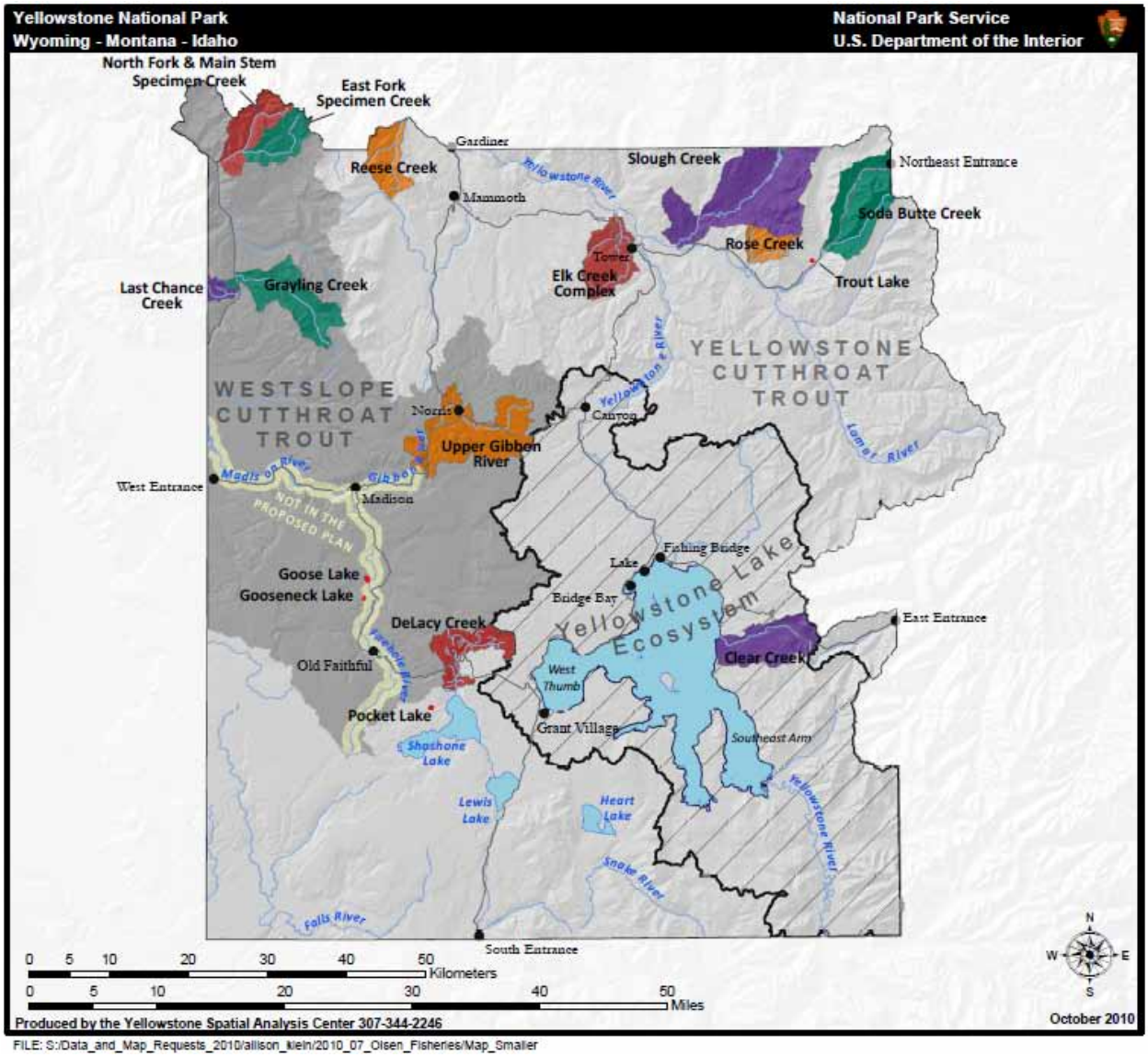

Figure 1. WCT and YCT historical ranges in Yellowstone National Park and the project areas proposed under the Native Fish Conservation Plan.

1.1.2 NPS Guidance

The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. The key management-related provision of the NPS Organic Act of 1916 is:

> *[The National Park Service] shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified … by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. (16 USC 1)*

Congress supplemented and clarified these provisions through a 1978 amendment to that act (the "Redwood amendment"), which added the following guidance:

> *The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the national park system and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress. (16 USC 1a-1)*

The National Parks Omnibus Management Act (Public Law 105-391, November 13, 1998, 112 STAT.3497, 105th Congress) further clarifies the NPS's responsibilities.

> *Recognizing the ever increasing societal pressures being placed upon America's unique natural and cultural resources contained in the national park system, the Secretary shall continually improve the ability of the National Park Service to provide state-of-the-art management, protection, and interpretation of and research on the resources of the national park system (16 USC 5911).*

NPS Management Policies (2006) define native species as "all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system. Native species in a place are evolving in concert with each other. Exotic species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as non-native, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place."

NPS Management Policies (2006) direct the Service to restore extirpated native plant and animal species to parks (Section 4.4.2.2, Restoration of Native Plant and Animal Species). In addition, all exotic plant and animal species that are not maintained to meet an identified park purpose are to be managed—up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species interferes with natural processes and the perpetuation of natural features, native species or natural habitats, or disrupts the genetic integrity of native species (Section 4.4.4.2, Removal of Exotic Species Already Present).

In summary, NPS guidance is clear. Yellowstone National Park is managed to conserve, perpetuate, and portray as a composite whole the indigenous aquatic and terrestrial fauna and flora, the geology, and the scenic landscape. Sport fishing has a historical precedent in the park, where it has been a major visitor activity for over 100 years. Yellowstone supports some of the world's most famous fisheries, and has been a destination for generations of anglers for over a century. However, as Yellowstone managers have witnessed and science has clearly demonstrated, non-native species introductions from the late 1880s through the mid-1900s have resulted in the degradation (through interbreeding) and losses (through predation and competition) of native cutthroat trout as well as Arctic grayling. Disease and climate change pose additional threats. NPS statute and policy support the implementation of this proposed plan to preserve and restore native fishes throughout their historical ranges in the park.

1.2 Existing Conditions

1.2.1 Rangewide Status of Native Fish

Native GRY, WCT, and YCT populations have declined considerably throughout their historical ranges during the last century. Numerous stressors, including habitat degradation and fragmentation from land use activities, have reduced distributions and abundance. For example, in the upper Missouri River drainage, WCT now occupy less than 5% of their historical range; the remaining populations persist as small-stream residents occupying isolated habitats ranging from several hundred feet to a few miles in extent. As a result, these populations face a high risk of extinction.

The current status of GRY, WCT, and YCT has led the Montana Natural Heritage Program and Wyoming Natural Diversity Database to list them as species of concern, at risk because limited and/or declining numbers, range, and/or habitat make them vulnerable to extinction. The state of Idaho lists WCT and YCT as species of greatest conservation need. Global and Montana state ranks for GRY, WCT, and YCT are G5/S1, G4/S2, and G4/S2, respectively (Montana Natural Heritage Program 2010). The U.S. Fish and Wildlife Service (USFWS) has been petitioned to list each of these fish as threatened under the Endangered Species Act of 1973. Listings of WCT and YCT were found to be not warranted, but the USFWS is currently reevaluating the status of Montana GRY.

1.2.2 Native Fish in Yellowstone Park

Yellowstone is home to hundreds of lakes and thousands of miles of flowing waters. Historically these waters contained 12 species of native fish, including 4 important sport fish, 4 minnows (*Cyprinidae*), 3 suckers (*Catostomidae*), and 1 sculpin (*Cottidae*) species. These native species provided food to both wildlife and human inhabitants. Reports on the abundance of cutthroat trout and grayling in waters across the park are common in the records of early park visitors and scientists.

While fish were widely distributed throughout the park, there were also vast areas of fishless water. When David Starr Jordan published the first extensive survey of Yellowstone fish in 1889, he described 40% of the park as the "Area Without Trout" (fig. 2), including the upper reaches of the Bechler, Fire Hole, Gibbon, and Gardner rivers (Jordan 1891). Also fishless were Lewis, Shoshone and most of the small lakes, as well as numerous tributaries isolated by waterfalls.

The huge diversity of aquatic habitats, from large rivers to tiny tributaries and immense lakes to small ponds, both fish bearing and fishless, supports an array of aquatic organisms. In addition to fish, the park's waters are home to amphibians, aquatic invertebrates, fish-eating birds, waterfowl, and mammals.

1.2.3 Parkwide Stocking of Waters

Soon after the park was established, its aquatic species composition began to change. This change was driven by the desire to establish recreation and sustenance fisheries in more park waters and by emerging fish culture technology that enabled long-distance transport of exotic sport fish. Park managers started planting native fish in fishless waters in 1881 and were bringing non-native species into the park by 1889 (Varley 1981). Most of the non-native fish introductions were trout species, most notably eastern brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*), but other species, including

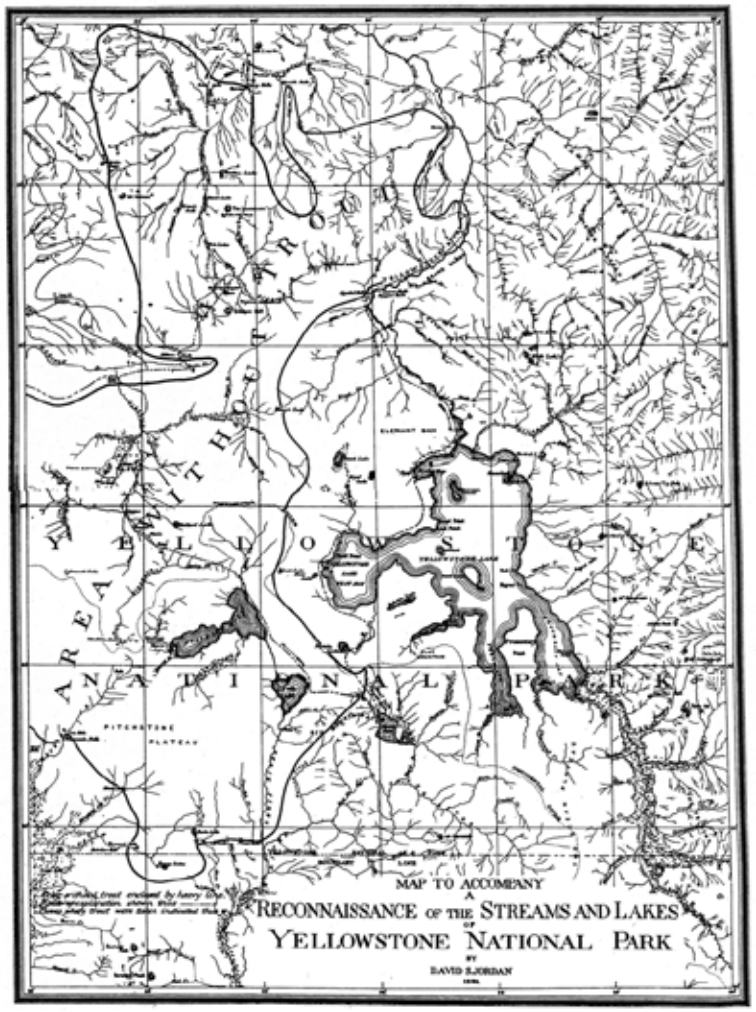

Figure 2. Map of original fish distribution in Yellowstone National Park, including vast fishless areas, produced by David Starr Jordan in 1889. (From Baron W. Everman, Report on the Establishment of Fish Culture Stations in the Rocky Mountain Region and Gulf States, U.S. Government Printing Office, 1892.)

yellow perch (*Perca flavescens)* and largemouth bass (*Micropterus salmoides)* were also stocked. The YCT of Yellowstone Lake were extensively used in the park's early stocking program both within and outside their native range. From the early 1880s to the mid-1950s, almost all park waters, including most remote backcountry locations, were stocked. Non-native sport fish became established in most major waters in the park except for Yellowstone Lake, its tributaries, Slough Creek, and a few other waters.

1.2.4 Paradigm Shift in Management

The 1950s marked a paradigm shift in fisheries management in Yellowstone. By the middle of the decade, stocking for recreational purposes was abandoned in favor of wild fish management and native species conservation. However, by then, over 300 million fish had been stocked in park waters and non-native species were firmly established in most lakes, rivers, and streams.

1.2.5 Current Status and Threats

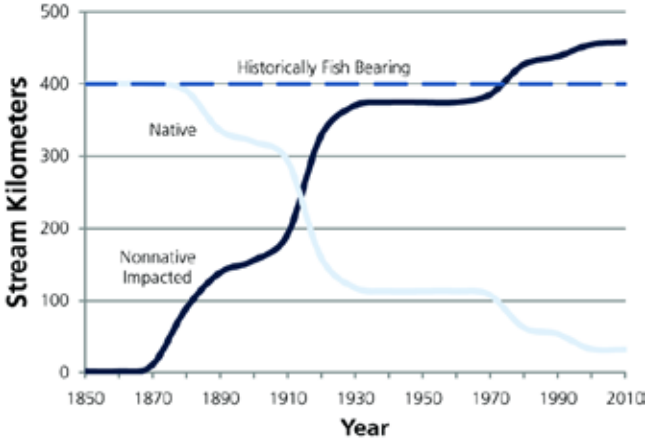

Figure 3. Historical fish population data for rivers in Yellowstone National Park. In 1850, 400 stream kilometers were populated with only native fish. As non-native fish introductions began, the number of kilometers inhabited by native species declined and non-natives increased, surpassing the number of historically populated kilometers by the late 1900s.

Non-native lake trout (*Salvelinus namaycush;* LKT) were illegally introduced to Yellowstone Lake in the mid-1980s and first appeared in angler catches in 1994 (see details of the Yellowstone Lake crisis below). The exotic parasite that causes whirling disease was found in 1998 and has greatly impacted YCT, particularly in the northern regions of the lake (Koel et al. 2006). These stressors, combined with several years of drought (late 1990s – early 2000s; Koel et al. 2005) have resulted in a relatively rapid, precipitous decline in the YCT population of Yellowstone Lake. At present, YCT persist at levels far below those ever previously recorded. Specifically, counts of spawning cutthroat trout by a weir and trap on Clear Creek (a large tributary on the lakes eastern shore; conducted since 1945) have fallen from a record high of 70,105 in 1978 to 241 in 2008. Counts made by visually surveying for spawning YCT in 9-11 tributaries along the west side of Yellowstone Lake (1989 – present) have fallen from an average of 74.2 cutthroat trout observed per visit to just 0.38 observed per visit in 2008. *These long term assessments suggest a 99% loss of spawning YCT has occurred over the past three decades on Yellowstone Lake.*

Across Yellowstone National Park, of the approximately 644 km of river habitat that originally supported native fish when the park was established, only 50 km still have native fish that are genetically unaltered (fig. 3), while approximately 736 km currently support non-native and/or hybridized (genetically altered) trout. At present, river dwelling (fluvial) GRY are completely gone from park waters; WCT remain only in Last Chance Creek (a small tributary to Grayling Creek) and in the East Fork of Specimen Creek (where they have been recently restored, fig. 1); and YCT face serious threats in the few waters where they remain.

Hybridization of cutthroat trout as a result of rainbow trout (RBT) range expansion continues to be the greatest threat to the park's remaining native fish populations in waters outside the Yellowstone Lake ecosystem (waters upstream of the upper falls at Canyon) and Heart Lake in the upper Snake River watershed (fig. 1). Two important cutthroat trout strongholds, Slough and Soda Butte creeks in the Lamar River watershed, have been invaded by RBT in just the last 10 years, and hybridization of the native cutthroat trout in those creeks has begun.

B. Ertel with YCT from Clear Creek weir. Photo by A. Wolf.

Yellowstone's native fish also face threats from global climate change and non-native fish diseases. Climate change has the potential to impact the timing and duration of spring run-off, summer low-water periods, and winter ice formation, all important environmental factors

for native fish. It is likely that changes in the timing and intensity of spring run-off, the main cue for cutthroat trout and RBT spawning in the park, increase the likelihood of native trout hybridization with RBT. Climate change may also influence the way in which fish are exposed and respond to whirling disease and new diseases that may emerge. Of particular concern is viral hemorrhagic septicemia, a virus that caused fish-kills in the Great Lakes in the mid-2000s and has continued to spread. Research suggests that the disease may be spread by fish-eating birds, a vector that could transfer the disease to remote locations.

Given the threats faced by the park's native fish populations, the continued loss of native fish strongholds, and the potential for further loss in the future, it is imperative that the NPS implement a plan to preserve and restore the park's native fish resources. Without proactive management of non-native species, critical habitats, and disease prevention, the trend of native fish loss will continue.

1.3 History of the Yellowstone Lake Crisis

1.3.1 Significance of Yellowstone Lake Cutthroat Trout

As recently as the late 1980s, Yellowstone Lake supported the largest inland population of cutthroat trout in the world (Gresswell and Varley 1988). The YCT are historically significant, noted by John Colter and many other early explorers of the lake area for their beauty and abundance. In fact, throughout Yellowstone's early history, the cutthroat trout played an important role locally for subsistence and nationally for recreation, as anglers were drawn from as far as the east coast (Byorth 2002). Initial work by the newly formed U.S. Fish Commission focused on Yellowstone Lake, and methods of trout propagation and movement were developed as 310 million cutthroat eggs were shipped across the U.S. and elsewhere from 1901 to 1956 (Varley 1981). Later, a paradigm shift in the NPS toward fisheries management with an ecological basis (Leopold et al. 1963) resulted in a redefinition of the YCT's role in Yellowstone Lake. The YCT is now recognized as a keystone species occupying a critical position within the ecosystem's food web (Schullery and Varley 1995). The species continues to have great economic significance, as they are highly sought by anglers and other visitors, especially non-anglers that visit the Fishing Bridge and Le Hardy Rapids areas to observe spawning fish each spring. Nowhere else in the country have cutthroat trout been as easily experienced in the wild by the non-angling public.

As described above, hybridization with other cutthroat trout subspecies or RBT has compromised a majority of YCT populations throughout the species' range, which is located primarily across portions of Idaho, Montana, and Wyoming (May et al. 2006). However, the cutthroat trout of Yellowstone Lake have remained genetically pure due to the physical isolation of the lake basin by the Upper and Lower Falls of the Yellowstone River. Because of their genetic purity and relative abundance (in comparison to small stream populations), at present they are extremely valuable for creation and enhancement of brood stocks. From 2000 to 2004, the Wyoming Game and Fish Department collected a small number of gametes to develop a brood stock now located at Ten Sleep. As one of only two captive YCT broods in existence, this resource is used to supplement native fisheries in many Wyoming waters, where the anglers can handle them and gain appreciation for their conservation.

1.3.2 Lake Trout Detection in 1994

By the 1950s, following half a century of liberal angler harvest and egg collections by the U.S. Sport Bureau of Fisheries, the YCT population of Yellowstone Lake was depressed and showing serious signs of potential collapse (Gresswell and Varley 1988). Only 3,161 YCT were counted ascending Clear Creek (one of 59 of the lake's tributaries used for spawning) in 1954, and angler success lake wide was very low. However, following restrictions on angler harvest and closure of the egg collection operations in the 1960s and 1970s, the population rebounded and became so abundant that >70,000 cutthroat trout were counted spawning in Clear Creek during the spring of 1979 (Jones et al. 1980). Biologists estimated 3.5 million YCT existed in Yellowstone Lake at that time, and the consumers of these fish, such as grizzly bears (*Ursus arctos*), bald eagles (*Haliaeetus leucocephalus*), ospreys (*Pandion haliaetus*), and river otters (*Lontra canadensis)* were numerous in the area. The ecosystem, it seemed, had returned to its pre-Euroamerican condition. With YCT increasing in abundance in the early- and mid-1980s, the lake appeared to most observers to be in a state of ecological bliss (Gresswell and Varley 1988).

The perception of Yellowstone Lake as a secure refuge for YCT changed abruptly on July 30, 1994, when a LKT was caught in the lake by an angler on a guided fishing trip (Kaeding et al. 1996). An August 11 NPS press release described the discovery of LKT in Yellowstone Lake, outlined the ecological consequences that could result from establishment of this highly piscivorous, non-native species, and offered a reward for information leading to the arrest and conviction of the person or persons responsible for illegally stocking the fish. Human culpability was assumed because natural movement of LKT into Yellowstone Lake from other park waters in which they are found was not possible. Regardless of the dispersal mode, LKT had been introduced and were well on their way to establishing themselves as the top predator in Yellowstone Lake.

1.3.3 New Reality Defined—Science Panel 1995

To assess the seriousness of LKT presence in Yellowstone Lake, the NPS convened a panel of experts from throughout the U.S. and Canada in 1995 (Varley and Schullery 1995). At that time, in the absence of knowledge of the behavior and habits of LKT in Yellowstone Lake, developing a program for limiting their expansion coupled with careful monitoring and application of adaptive management strategies were the panel's primary recommendations (McIntyre 1995). Control of the LKT population began in 1995 primarily by gillnetting at depths where YCT are rare, and secondarily by experimental gillnetting designed to gain information on LKT spatial and temporal distribution in the lake.

1.3.4 Intervention—Natural Resource Preservation Program, 1999

By 1999, the park had found two key spawning areas in the West Thumb of Yellowstone Lake where high concentrations of LKT occurred seasonally. The LKT population had been reduced by more than 15,000, with progressively more netted by limited NPS resources each year. After several years of bioenergetics research highlighted the LKT's impact on the YCT population (Ruzycki et al. 2003), it became apparent that a dedicated program was needed to curtail LKT population growth. However, significant funding to support such an effort had not been obtained. To complicate matters, the exotic parasite that causes whirling disease (*Myxobolus cerebralis*) was discovered in YCT from Yellowstone Lake during the fall of 1998 (Koel et al. 2006).

The development of a long-term LKT suppression program in Yellowstone Lake received NRPP funding in FY 1999–2001 (Bigelow et al. 2003) for a seasonal NPS crew to gillnet LKT, the purchase of a 32-foot Great Lakes-style gillnetting boat, and the retrofitting of an existing 28-foot NPS fisheries boat. With this additional support, park staff developed a comprehensive program for LKT suppression that consisted of intensive control netting, distribution netting, and spawner netting. During the control netting, the most important part of the suppression effort, 8–12 miles of gillnet were placed to catch LKT every day during most of the open water season (May–October). Distribution nets were set at randomly selected sites throughout the lake once each August in an attempt to assess spatial distribution and species composition, and the spawner nets were used to target larger, older LKT as they concentrated near spawning areas in August and September.

1.3.5 Sustained Suppression and Learning, NPS 2001

Although the specific mode of introduction to Yellowstone Lake has not been determined, park-supported otolith microchemistry research from Lewis Lake (Munro 2005) and genetic sampling (Stott 2004) from a few miles south of Yellowstone Lake provided strong evidence that the LKT were introduced in the mid- to late-1980s. Originating in Lake Michigan (Varley 1981), the LKT of Lewis and Yellowstone lakes are highly prolific, with each spawning female capable of depositing thousands of eggs. The gillnetting that was initiated in 1994 to determine the extent of the problem was ramped up to maximum capabilities of the park crew and equipment starting in 2001 with financial support from the 1999–2001 NRPP funding and the 2002 increase in the park's base funding for LKT suppression. To date, these funding resources have made possible the removal of approximately 500,000 LKT from Yellowstone Lake. Each year the gillnet catches have been successively higher. However, long-term monitoring of the cutthroat trout population suggests a concurrent decline to levels lower than ever recorded on the lake (Koel et al. 2008). After more than a decade of sustained LKT gillnetting and no evidence of cutthroat trout recovery, a comprehensive appraisal of the suppression program was warranted.

The loss of YCT from Yellowstone Lake is highly significant from both a park and range-wide perspective. Meyer et al. (2006) estimated a YCT population of 2.2 million (all sizes) in southeastern Idaho and the small portion of the subspecies' range in Nevada and Utah. On Yellowstone Lake, where population estimates were made using mark-recapture in 1979 (Jones et al. 1980) and sonar technology in 1992 and 1997 (McClain and Thorne 1993; Ruzycki et al. 2003), YCT abundance was approximately 3.5 million in 1979 (>350 mm length) (Jones et al. 1980) and fell to 1.2 and 1.7 million (>100 mm length) in 1992 and 1997, respectively (McClain and Thorne 1993; Ruzycki et al. 2003). Monitoring of YCT by NPS has been consistently conducted during this period and abundance indices reflect this trend. Evidence suggests that the loss of YCT since the introduction of LKT would be equivalent to or greater than a loss of all YCT currently existing in Idaho, Nevada, and Utah. However, the lake's YCT population demonstrated its ability to rebound following harvest and egg collection in the 1960s and 1970s (Gresswell and Varley 1988), and there is no reason to suggest that it could not recover again, if existing stressors were removed.

1.3.6 The Ecosystem Impacts of Lake Trout

As the LKT population has expanded, the YCT population has subsequently declined (fig. 4), resulting in impacts to multiple trophic levels within the Yellowstone Lake ecosystem. Declines have been documented in several important consumer species near the lake and its tributaries, including grizzly bears, bald eagles, ospreys, and river otters (McEneaney 2002; Koel et al. 2005;

Haroldson et al. 2005; Crait and Ben-David 2006; McEneaney 2007). The expanded LKT population and YCT loss have resulted in significant shifts in energy (nutrient) flow both within the lake and between the lake and its spawning tributaries (Tronstad 2008). Anglers are now catching far fewer cutthroat trout than in the past, and few have the desire or interest to change methods and focus on the LKT. (Current fishing regulations require all native fish caught in the park to be returned, unharmed, to the water in which they were caught.). Beyond the issue of reduced biodiversity or fish quality

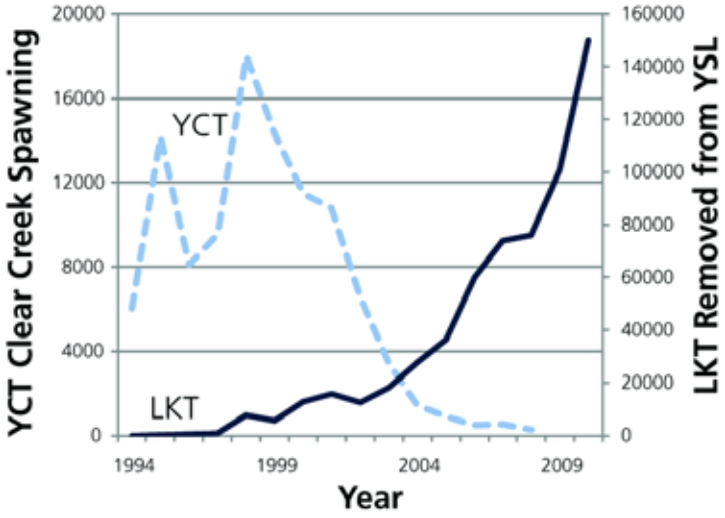

Figure 4. YCT spawning in Clear Creek, 1994–2009. The number of spawners decreased starting in 1998 while LKT removals from Yellowstone Lake increased. During the 2009 gillnetting season, NPS and contracting crews removed more than 100,000 LKT.

Beyond the issue of reduced biodiversity or fishery quality, LKT predation poses a high ecosystem threat in lakes (Quist and Hubert 2004). The LKT will never be an acceptable ecological substitute for YCT in the park. Due to their deepwater distribution most of the year and in-lake spawning, LKT are largely unavailable to terrestrial vertebrates that once exploited seasonally abundant YCT in the lake's shallows and tributary streams (Schullery and Varley 1995; Stapp and Hayward 2002). The YCT life history strategy has made them accessible to the many important consumer species that visitors treasure and expect to see at the lake. Only by addressing the following goals and objectives would those species and the natural functions of Yellowstone Lake be restored and preserved for the future.

1.3.7 Additional Review and Recommendations—Science Panel 2008

With expanding LKT catches in Yellowstone Lake despite increased effort, park staff sought peer review and expert guidance for the ongoing suppression program. During a week-long workshop in August 2008, a panel of 15 fisheries scientists (led by the U.S. Geological Survey and hosted by the NPS) critically evaluated the LKT suppression program in Yellowstone Lake, including its effects on LKT and YCT populations and associated ecosystem responses, and provided direction for future suppression and recovery activities (Gresswell 2009). Expertise of the panelists included LKT life history strategies, population dynamics, bioenergetics of predator-prey assemblages in large lakes, conservation genetics, and inland cutthroat trout.

The science panel found that: (1) not much time remains during which it will be possible to reverse the YCT decline and restore the population; (2) the current program has been effective at reducing LKT predation on YCT; however, (3) the program has not been effective at driving the LKT population into decline. The panel unanimously agreed that the battle with LKT could be won with a substantial increase in the suppression program over six or more years. The panel recommended that the NPS:

1. Implement a greatly intensified suppression program, including use of a contract fisheries operation with extensive knowledge, experience, large specialized boats, and associated gear to augment the ongoing NPS suppression efforts.

2. Estimate the exploitation rates required to force the LKT population into a decline.
3. Set and meet benchmarks for LKT control.
4. Develop a statistically sound long-term monitoring program for LKT.

NPS gillnetting vessel. Photo by Pat Bigelow

The panel noted that such a strategy has proven effective for government agencies suppressing LKT in other large western lakes, including Lake Pend Oreille in northern Idaho (Martinez et al. 2009). They emphasized that the park must maintain existing gillnetting efforts and long-term YCT monitoring. They felt that the increase in suppression efforts achieved by adding a professional contract fisheries operation to the program would likely trigger a decline in LKT and ultimately a positive response by the YCT. Professional (commercial) fishermen were capable of driving LKT to near extinction in the Great Lakes and many large lakes in Canada, and the panel asserted that the same result could be achieved on Yellowstone Lake. Following an intensive netting surge, the effort could be reduced to a "maintenance mode" of netting by NPS crews for purposes of LKT suppression and long-term monitoring. These recommendations are addressed within the alternatives of this environmental assessment.

1.4 *Climate Change Adaptation*

The Natural Resource Adaptation Strategy of the NPS Climate Change Response Program would be used for the conservation of native fish in Yellowstone National Park. Natural systems would be made more resilient to climate change by enhancing these key elements:

- availability of climate refugia (habitats that persist as climate changes)
- landscape corridors that allow plants and animals to move to more suitable locations
- healthy populations with sufficient genetic diversity to adapt
- blocks of natural landscape large enough to be resilient to large-scale disturbances and long-term changes
- lack of additional threats and stressors

The success of these adaptation strategies would be enhanced by taking a broad approach that identifies connections and barriers across the landscape. Networks of protected areas within a larger mixed landscape can provide the highest level of resilience to climate change. Yellowstone is at the core of the YCT historical range in Idaho, Montana, and Wyoming. Climate change models indicate that aquatic habitats in the park would be among the most suitable for supporting native fishes in the future. As such, and given the pristine condition of its surface waters, Yellowstone provides the greatest promise for creating and sustaining refugia for native fishes faced with threats of climate-induced change. Ensuring the persistence of native fishes would greatly help to ensure the persistence of the many other aquatic, terrestrial, and avian species that depend on them.

A Climate Change Response Steering Committee representing parks, regions, managers, and subject-matter experts has been established to provide guidance to the NPS. The steering committee has set up a strategic framework of advisors, interagency liaisons, and subcommittees to respond to expert suggestions and formulate recommendations. It serves both the Climate Change Response Program and the NPS National Leadership Council.

The effects of climate change would impact the ability of the NPS to meet its mission and comply with legal mandates. Most resource protection laws that the NPS must comply with were not written considering a changing climate. For decades the NPS has been striving for "natural" or "historical" conditions in the national parks, but such conditions will be more difficult or impossible to maintain under climate change. Even the concept of naturalness becomes convoluted in an era when human activities play a role in shaping global climate. Should the NPS mandate to leave parks "unimpaired" for future generations reference a historical state or a future one under an altered climate? As the scope and intensity of climate change increases, these kinds of questions will strain the current policy framework unless revisions are made.

Climate change is creating a new and dynamic decision-making environment in which we cannot assume a continuation of historical patterns. Effective decision making and planning will require decision support systems that are flexible to shifting conditions. Existing planning documents, such as NEPA review, park general management plans, and park resource stewardship strategies will incorporate climate change into all phases.

Although there will always be a need to learn more, park managers now have sufficient knowledge about climate change to take important steps. They need to determine the extent to which they can and should act to protect the parks' current resources while allowing the parks' ecosystems to adapt to new conditions. The NPS response must be immediate and bold in some areas, methodical and cautious in others, and adaptive to new information and guided by sound science in all cases. Many techniques will be used, evaluated, and refined over time as new methods become available and the science of climate change unfolds.

1.5 *Conceptual Framework for Native Fish Conservation*

For purposes of addressing the issues affecting native fish conservation in the park, its surface waters were put into two groups: (1) Yellowstone Lake, river, and tributaries upstream of the Upper Falls at Canyon; and (2) all Other Streams, Rivers, and Lakes within the park boundaries (fig. 1). These groupings provide a landscape context for the plan while recognizing that interactions occur within and across this landscape continuum.

A conceptual model (table 1) was developed to assist in identifying issues confronting these ecosystems and clarify which aspects of the ecosystems would likely respond as a result of management action. This conceptual model demonstrates the complex relations among:

- agents of change,
- stressors on native fish, and
- ecosystem responses.

Agents of change include natural processes and events as well as human activities. They are the source of stressors on native fish when they operate outside the range of natural variability and

acceptable limits of change. Ecosystem responses are defined as detectable changes or trends in any measurable value of the ecosystem's structure, function, or process that is considered indicative of ecosystem quality or integrity.

A preliminary list of *agents of change* appropriate to the park's ecosystems was organized into five broad categories (table 1):

- regional physical/chemical forces;
- biological introductions;
- angling;
- park infrastructure and operations; and
- local physical/chemical forces.

The degree to which each agent of change might contribute to a problem was considered and a list of potential stressors on native fish was compiled. Each stressor was matched to general management issues within the 2006 NPS Management Policies. The preliminary list of *ecosystem responses* was also grouped into five broad categories (table 1):

- biogeochemical cycling,
- productivity/biomass change,
- fish functional role,
- fish life history strategy, and
- avian/terrestrial fish consumers.

For example, within the Yellowstone Lake ecosystem, the LKT introduction is an *agent of change* that results in *stressors* on native fish in the form of fewer YCT produced or recruited to the spawning population, direct mortality, predation losses, and loss due to competition/displacement (table 1). These stressors can also result in *ecosystem responses* such as changes in nutrient flux/transport, primary and secondary production, fish functional roles and life history strategies, and impacts to avian and terrestrial fish consumers (See additional details on science and predictive modeling in Appendix A). The conceptual model is not intended to represent a comprehensive account of an entire ecosystem. It is a framework implicating known and/or hypothesized agents of change that stress native fish and result in negative ecosystem responses. The goal of this model is to illustrate relationships between agents of change and key ecosystem processes and variables. It serves to demonstrate the complexity of the park's ecosystem relations, many of which are unknown. Complexity is due to the fact that multiple agents of change can lead to multiple stressors, resulting in multiple ecosystem responses (table 1).

Table 1. Conceptual Ecosystem Model for the Native Fish Conservation Plan

AGENTS OF CHANGE	Increased water temperatures	Altered hydrologic events (timing of max. & min. flows	Altered hydrologic events (flow volume)	Sedimentation	*Lake level declines/tributary disconnect	Physiological stress & reduced fitness	*Fewer produced or recruited to spawning population	*Direct native fish mortality	*Predation by non-native fish	*Competition/ displacement	*Loss of genetic integrity (hybridization)
Regional Physical/Chemical Forces											
Increasing temperature (air)	X	X	X		X	X	X				
**Changing precipitation patterns (snowpack, runoff)*	X	X	X		X	X	X				
Wildland Fire Frequency Increased	X	X	X	X			X				
Biological Introductions											
**Historical fish stocking by management*							X	X	X	X	X
**Stocking of fish illegally (lake trout)*							X	X	X	X	
Aquatic nuisance species (New Zealand mudsnails)							X			X	
Disease dissemination (whirling disease)						X	X				
Angling											
Intentional illegal harvest							X	X			
Mis-identification resulting in harvest							X	X			
Catch & release mortality							X	X			
Park Infrastructure/Operations											
Fire suppression						X					
Backcountry trails & campsites				X		X					
Land management (stock use, herbicide treatments)				X		X					
Road improvements				X		X					
Water treatment facilities		X	X			X					
Local Physical/Chemical Forces											
Mine leaching of metals						X					
Dewatering of stream channel for agriculture	X	X				X		X			
Natural geothermal inputs	X					X					

Table 1 (continued):

ECOSYSTEM RESPONSE	Increased water temperatures	Altered hydrologic events (timing of max. & min. flows	Altered hydrologic events (flow volume)	Sedimentation	*Lake level declines/tributary disconnect	Physiological stress & reduced fitness	*Fewer produced or recruited to spawning population	*Direct native fish mortality	*Predation by non-native fish	*Competition/ displacement	*Loss of genetic integrity (hybridization)
Biogeochemical Cycling											
**Nutrient flux/transport altered*					X	X		X	X	X	
Productivity/Biomass Change											
**Primary production (algae) availability reduced*					X	X		X	X	X	
**Secondary production (inverts/zooplankton) availability altered/reduced*	X	X		X	X	X		X	X	X	
**Secondary production (fish) availability altered/reduced*	X	X		X	X	X		X	X	X	
Fish Functional Role as Secondary Consumers											
**Shift from invertivore (invert consumer) to piscivore (fish consumer/predator)*								X	X	X	
Fish Life History Strategy											
**Shift in spawning timing*	X	X									X
**Disrupt migration and/or shift in spawning location*			X	X	X		X				X
**Habitat volume (niche) available reduced*	X		X	X	X					X	
Avian/Terrestrial Tertiary Consumers											
**Displacement of grizzly bears from spawning streams*					X			X	X	X	
**Decline in native trout use by ospreys and eagles*					X			X	X	X	
**Increased physiological stress on river otters*					X			X	X	X	

Table 1. Conceptual ecosystem model for the Native Fish Conservation Plan. Cells with "X" are hypothesized linkages between agents of change, stressors on native fish, and ecosystem responses. Italic text with asterisks (*) and darkly shaded cells indicates elements to be addressed by the plan.

1.6 Purpose and Need

The purpose of this planning effort is to develop a parkwide native fish conservation plan that would guide efforts to protect and restore native fish. On Yellowstone Lake, this plan would include implementation of recommendations by the 2008 Science Review Panel (discussed above). The efforts would include aggressive actions to remove threats and stressors (non-native fish such as LKT), thereby creating refuges for native fish as climate change alters aquatic habitats across their respective historic ranges in the future. The efforts would use the NPS Natural Resource Adaptation Strategy via an integrated adaptive management plan (described in chapter 2). The Yellowstone Lake YCT population would be restored and other genetically unaltered cutthroat trout populations would be preserved and enhanced. In watersheds where native fish are already lost or have been significantly compromised by interbreeding (hybridization) with non-natives, fluvial GRY, WCT, and YCT would be restored.

A parkwide native fish conservation plan is needed to curtail on-going losses in native fish populations and resultant impacts to the natural food webs that they support. Introduced, non-native LKT, exotic whirling disease, and drought have driven the Yellowstone Lake YCT population to a fraction of former levels, making them functionally extinct within the ecosystem. There have been trophic implications of the YCT loss, as grizzly bears, otters, bald eagles, and ospreys have been impacted and displaced. Across the park, changing precipitation patterns combined with the lingering effects of historical and illegal stocking of non-native fish continue to result in shifts in ecosystem function (described above). Now, by removing the non-native fish and other non-natural components of the ecosystem, the NPS will strive to restore the natural ecosystem components that have been lost or degraded.

1.6.1 Overall Goals

The proposed plan is needed to achieve the following goals:

- Reduction of the long-term extinction risk for fluvial GRY, WCT, and YCT;
- Restoration and maintenance of the ecological role of native fishes; and
- Creation of sustainable native fish angling and viewing opportunities for the visiting public

1.6.2 Measurable Objectives

Measurable objectives are the guiding benchmarks to determine if the purpose and need for an action are being met. Monitoring to determine attainment of benchmarks will be conducted via a statistically sound, rigorous approach (see Chapter 2). At present the technology does not exist to fully eradicate LKT from Yellowstone Lake or to completely remove all non-native fish from large, complex river systems. Given these constraints, the measurable objectives for the Yellowstone Lake ecosystem are:

1. Increase large-scale suppression of LKT to reduce the population by 25% each year (annual fishing mortality rate of 0.56).
2. Maintain surface water access for spawning cutthroat trout in at least 45 (75%) of the 59 known, historical spawning tributaries.
3. Recover YCT abundance to the average observed during the five years following LKT discovery (1995–1999; average of 12,800 spawning YCT at Clear Creek).

Measurable objectives for the streams, rivers, and lakes outside the Yellowstone Lake ecosystem would preferably be met in project areas containing >50 km connected habitat to lessen vulnerability to disturbance. The cumulative result of multiple projects would be used to meet the following measureable objectives:

4. Preserve and/or restore genetically unaltered YCT to maintain their current spatial extent in streams (3,300 km, which is 75% of the 4,400 km that historically contained YCT).
5. Restore genetically unaltered WCT until they occupy at least 200 km (20% of 1,000-km historical WCT distribution).
6. Restore fluvial GRY until they occupy at least 200 km (20% of 1,000-km historical GRY distribution).

1.7 Timeframe

The Native Fish Conservation Plan for Yellowstone National Park is intended to guide activities over two decades following implementation (anticipated 2011 – 2031).

On the Yellowstone Lake Ecosystem, statistical models predict attainment of the measureable objective for LKT (Objective 1) within 10 years of initiating large-scale LKT suppression (Appendix A). Objective 2, for maintaining spawning tributary surface water connections, would be attained annually. *Once the LKT population has been reduced and spawning tributary connections have been maintained, it is anticipated that an additional 10 years (20 years following plan implementation) may be required for YCT recovery to abundance of Objective 3.* This timeframe is anticipated based on the time required for YCT recovery in the system (during the 1960s and 1970s) following closure of the YCT hatchery at Lake and implementation of restrictive YCT harvest regulations.

On streams, rivers, and lakes (other than Yellowstone Lake) it is required that NPS secure adequate funding to conduct projects, often in large part from external sources. Timeframes of projects which lie along park boundaries will be somewhat dependent upon continued work with partners (neighboring states, forests, and others). It is anticipated that NPS will be actively working in 1-2 project areas each year. *It is anticipated that the cumulative result of multiple projects would meet Objectives 4-6 within 20 years following plan implementation.*

1.8 Relationship to Other Plans and Policies

This plan meets the goals and objectives of four other related sets of plans and policies. It is consistent with:

- Restoration of WCT in the East Fork Specimen Creek Watershed (Koel and York 2006) which proposes construction of an in-stream fish barrier, non-native fish removal, and introduction of genetically pure WCT in the watershed. Projects of similar scope would be included in this plan/environmental assessment.
- NPS Management Policies 2006 (4.4.4 Management of Exotic Species), which require national parks to prevent the displacement of native species by exotic species.
- Executive Order 13112, which states that a federal agency cannot "authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has

prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions." The Executive Order requires federal agencies to identify invasive species and develop a plan that would prevent the introduction and reduce the risk of the spread of identified species. LKT are an aquatic invasive species that threatens native fish populations in Yellowstone National Park.

- Yellowstone's Resource Management Plan (NPS 1998), which identified conservation of stream communities and native cutthroat trout and controlling non-native aquatic species as a high-priority need.

1.8.1 Conservation Agreements with Partners

The NPS actively participates in the YCT Interstate Workgroup, the Montana Cutthroat Trout Steering Committee, and the Fluvial GRY Workgroup. Interagency conservation actions to preserve remaining GRY, WCT, and YCT and restore populations were described as critical needs in three conservation agreements to which the NPS is signatory. These include a memorandum of agreement for the rangewide conservation and management of YCT, a memorandum of understanding (MOU) and conservation agreement for WCT and YCT in Montana (http://fwp.mt.gov/wildthings/concern/yellowstone.html), and an MOU concerning the recovery of fluvial GRY (http://fwp.mt.gov/wildthings/concern/grayling.html).

The collaborating agencies and non-governmental organizations have developed conservation strategies for three types of cutthroat trout populations:

- Core populations—cutthroat trout that are not genetically altered; these populations have not been hybridized and can serve as donors of fish or gametes for restoration efforts.
- Conservation populations—all of the core populations plus populations that are <10% hybridized, have unique ecological and behavioral traits, and have coloration or other physical characteristics typical of the subspecies.
- Sportfish populations—wild or hatchery-sustained populations that are managed primarily for the benefit of recreational fisheries.

These classifications are consistent with the two strategies being used in the western U.S. to conserve native cutthroat trout. The first strategy emphasizes the conservation of genetic integrity by isolating cutthroat trout populations that have no evidence of genetic alteration to prevent future loss. The isolation is accomplished by use of a natural barrier (waterfall) or construction of an in-stream barrier. The smaller, isolated cutthroat trout populations will be more susceptible to population-level risks due to isolation, small population size, and temporal variability. However, their isolation makes them less susceptible to hybridization, competition and predation by introduced fish species, and the risks of the spread of aquatic nuisance species and diseases. The second strategy emphasizes maintaining metapopulations (i.e., gene flow connectivity among smaller populations) by protecting large areas of contiguous habitat, thus allowing cutthroat trout the best opportunity to express all life-history traits, especially migratory life histories. While metapopulations are less vulnerable to the risks of temporal variability, isolation, and small population size, their connectedness makes them more susceptible to risks from genetic introgression aquatic nuisance species, and disease. Because the risks inherent in these two conservation strategies are dramatically different, implementing them in concert helps ensure the long-term persistence of WCT and YCT.

1.9 Public Scoping

Scoping is a process to identify the resources that may be affected by a project proposal and explore possible alternatives for achieving the proposal's goals while minimizing adverse impacts. As described in more detail in chapter 5 of this EA, park staff conducted scoping within the NPS and external scoping with the general public and interested groups and through Native American consultation.

External scoping was initiated with the distribution of a March 29, 2010 letter to inform the public of the plan proposal and generate input on the preparation of this environmental assessment. The scoping letter was mailed to over 650 interested parties, including various federal and state agencies, affiliated Native American tribes, local governments, and local news organizations. Scoping information was also posted on the park's Planning, Environment, and Public Comments website.

During the 30-day scoping period, 245 public responses were received. Approximately 80% of the respondents supported the conservation plan. The remaining responses disagreed with one or more aspects of the plan. More information regarding external scoping can be found in chapter 5.

1.10 Impact Topics

Impact topics are resources that could be affected by the proposed range of alternatives. During internal scoping, the park's Native Fish Conservation Plan interdisciplinary team (ID Team) conducted a preliminary analysis to determine the context, duration, and intensity of effects that the proposal may have on park resources. If the magnitude of effects was determined to be at the negligible or minor level, there is no potential for significant impact and further impact analysis is unnecessary, therefore the resource was dismissed as an impact topic. However, if during internal scoping and further investigation, resource effects remained unknown or were at the minor to moderate level of intensity and the potential for significant impacts is likely, then analysis of that resource as an impact topic was carried forward.

1.10.1 Topics Retained for Further Analysis

Based on issues raised during internal scoping, comments received during public scoping, federal laws, regulations, orders, and the NPS 2006 Management Policies; the ID Team developed the following list of topics with potential for measurable impacts to be analyzed in this EA.

Environmental Setting

- Geologic resources
- Wetlands and waters
- Water quality and quantity

Biological Resources

- Aquatic resources (other than fish)
- Native fish resources
- Wildlife resources
- Vegetation

Special Status Species

Yellowstone species of management concern
Endangered and threatened species
USFWS species of concern

Social and Economic Resources

Health and human safety
Socioeconomics
Park operations
Visitor use and experience
Wilderness

1.11 Topics Dismissed from Further Consideration

The following impact topics were dismissed from further consideration based on the ID Team assessments and lack of concern identified during the April 2010 public scoping. For purposes of this section, an impact of negligible intensity is one that is "at the lowest levels of detection, barely perceptible, and not measurable." An impact of minor intensity is one that is "measurable or perceptible but is slight, localized, and would result in a limited alteration or a limited area." The rationale for dismissing these topics from further consideration in this plan is stated for each resource.

1.11.1 Environmental Topics and Resources

Air Quality: The Clean Air Act, as amended, recognizes the need to protect visibility and air quality in national parks. As mandatory Class I areas, national parks are given the highest level of air quality protection. In Class I airsheds, air quality is better than the National Ambient Air Quality Standards and there is little allowance for any deterioration. Because there is little industrial activity and relatively low population outside the park in northwest Wyoming and south-central Montana, the overall regional air quality of the park is good. The major sources of air pollutants in the park are vehicle emissions and smoke from wildland fires. Proposed project activities would not affect air quality in the park to the extent that it would exceed federal, state or local ambient air quality standards. Exhaust emitted by boats used for LKT suppression would be noticeable to visitors and employees at marina and boat launch areas on Yellowstone Lake, but only during start-up operations. Mitigation measures to reduce engine idling to negligible amounts reduces this impact noticeably. Overall, impacts to air quality are anticipated to be direct, short-term, and negligible.

Soundscape Management: The NPS policy on soundscape management is contained in Director's Order 47, Sound Preservation and Noise Management. The natural ambient soundscape is the aggregate of all the natural sounds that occur in a park, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive and are transmitted through air, water, and solid materials.

No heavy mechanized equipment would be used in sensitive and remote areas of the park, but may be used where a project area is in the frontcountry and accessible by road. Chainsaws would be used minimally to remove large trees to construct fish barriers. Helicopter flights and landings would occur to transport supplies and fish. Noise from boat motors would occur on

Yellowstone Lake and other small lakes. Motorized electric generators may be used to temporarily power floodlights and mechanical pumps at the piscicide neutralization stations. Impacts to natural soundscapes would be direct, short-term, and negligible to minor adverse. Noise impacts from project operations are analyzed under the Wilderness impact topic.

Lightscape Management: The 2006 Management Policies state that the NPS "will preserve, to the greatest extent possible, the natural lightscapes of the parks, which are natural resources and values that exist in the absence of human caused light." The project area is within the park's recommended wilderness and would not have any permanent artificial outdoor lighting. Temporary use of lighting would include lanterns, headlamps, and one or two floodlights to operate the piscicide neutralization stations on streams. Impacts from the use of night lighting are analyzed under the Wilderness impact topic. The lowest floodlight wattage necessary would be used and floodlights would be shielded to reduce glare and trespass light into the surrounding environment. Impacts to lightscapes would be direct, short-term, and negligible to minor. Light impacts from project operations are analyzed under the Wilderness impact topic.

Visual Quality Including Viewsheds: Yellowstone abounds with impressive viewsheds of the highest quality. The majority of the park's landscape appears untouched by humans and retains its primeval characteristics. Less than two percent of the park is developed and visitor use facilities are predominantly grouped along the figure-eight road system and in a handful of small communities, leaving substantial acreage in its natural condition. Because projects would not change the appearance of the park substantially, visual quality, including viewsheds, has been dismissed from further analysis as an impact topic.

Ecologically Critical Areas—Wild and Scenic Rivers: The mainstem of the Snake River, the Lewis River and the Lewis River channel between Lewis and Shoshone lakes were formally designated Wild and Scenic Rivers within the park on March 30, 2009 under the Omnibus Public Lands Management Act of 2009 (123 STAT. 991). Section 7(a) of the Wild and Scenic Rivers Act (Public Law 90-542, October 2, 1968) provides a specific standard for review of developments below, above, or on a stream tributary to a designated river. A Section 7 determination is required whenever a project meets all of these criteria: (1) it is proposed in the bed or banks of a river below, above, or on a stream tributary to a designated river; (2) it is proposed by a federal agency or requires some type of federal assistance such as a permit, license, grant or loan; and (3) it is likely to result in effects within a designated river. Developments such as fish barriers or weirs that meet these criteria may occur as long as the project would not have a "direct or adverse effect" on the values for which a river was designated to the national system of Wild and Scenic Rivers.

The "values for which a river was designated" are defined in Section 1(b) of the Wild and Scenic Rivers Act as the river's free-flowing condition, water quality, and outstandingly remarkable values (ORVs). Fisheries and water quality have been identified as two of many ORVs in the designated river sections through the Coordinated River Management Planning process currently underway. (The final plan is to be completed in 2012.) Both the Salmon and Lewis segments are within the historical distribution of YCT and other native fish species. Therefore, the need for habitat restoration for the fisheries ORV will be emphasized during the planning process.

Actions under this Plan would not take place within these segments or within tributaries to these segments. If such actions were determined necessary, further NEPA and Section 7 consultation

would take place. Therefore, it is not anticipated that the actions proposed by the alternatives in this EA would incur direct or adverse impacts to the designated portion of these rivers, which was therefore dismissed as an impact topic.

Caves and Paleontological Resources: No caves or paleontological resources would be impacted by any of the alternatives.

Marine or Estuarine Resources: No marine or estuarine resources would be impacted by any of the alternatives.

Possible Conflicts with Land Use Plans, Policies or Controls: Since the proposed actions would be conducted within park boundaries, no conflict with local, state, or Indian tribe land use plans, policies, or controls would occur.

Prime and Unique Farmlands: In August 1980, the Council on Environmental Quality directed federal agencies to assess the effects of their actions on farmland soils classified by the USDA Natural Resources Conservation Service as prime or unique. Both categories require that the land is available for farming uses. Land in the park is not available for farming and therefore do not meet the criteria for prime and unique agricultural lands.

Climate Change and Sustainability: A growing quantity of scientific evidence and current real world examples support the reality of anthropogenic global climate change. Impacts to national park resources are becoming inevitable in many resource areas, including decreased annual precipitation and snowpack, invasive species, habitat loss, severe weather events, and wildfire intensity. The NPS mission to protect the nation's natural and cultural heritage unimpaired for future generations is jeopardized by global climate change as resources are being lost at unprecedented rates. However, consideration of greenhouse gas emissions is not relevant to this environmental assessment because the impacts of all four alternatives are short-term in nature, would not emit significant amounts of greenhouse gases (>25,000 metric tons of carbon dioxide equivalent emissions), and will not influence the decision to implement the projects.

Environmental Justice: Executive Order 12898, General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires all federal agencies to incorporate environmental justice into their missions. Agencies must identify and address disproportionately high adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Federal agencies must also follow rules set under the Environmental Justice Guidance released by the Environmental Protection Agency in 1998.None of the alternatives proposed in this environmental assessment would have disproportionate adverse health or environmental effects on minorities or low-income populations or communities as defined in this EPA guidance.

Energy Requirements and Conservation Potential: While implementation of the proposed actions or alternatives would entail the use of motorized vehicles, boats, and equipment, this expenditure of energy is not considered a substantial use of national energy resources. Project operations are analyzed by minimum requirement analysis. Often energy use would be minimized by travel on horseback and foot to reach project areas. Therefore, energy requirements and conservation potential was dismissed as an impact topic.

Natural or Depletable Resources and Conservation Potential: Alternative 3 would involve the use of potentially depletable (consumptive) resources via the removal and marketing of LKT

by private sector contracted netters. Studies indicate that the quantity of nutrients that would be lost from Yellowstone Lake by the removal of LKT is negligible; the nitrogen in LKT that would be removed per day is only 0.3% of that naturally excreted by zooplankton (Tronstad et al. 2010). Therefore, natural or depletable resource requirements and conservation potential was dismissed as an impact topic.

Transportation and Parking: Roads and parking areas in the park are linked to the visitor experience, routine park operations, and emergency services. Activities related to native fish conservation would require the use of roads and parking areas. Large trailers with boats or stock (horses and mules) would periodically use park roads. Congestion of vehicles, trailers, and stock would occur for short periods at trailheads when restoring backcountry streams. Pull-outs along roadways would occasionally be used to access streams or lakes in the frontcountry. Parking at boat launches and marina areas would be used by park staff and contractors for LKT suppression. Therefore, native fish conservation activities could directly impact transportation and parking, but the impacts are anticipated to be short-term, and negligible.

1.11.2 Cultural Resources

As steward of many of the country's most important cultural resources, the NPS is charged with preserving historic properties for the enjoyment of present and future generations. According to the NPS's 2006 Management Policies and Director's Order 28 on Cultural Resource Management, management decisions and activities throughout the national park system must reflect awareness of the irreplaceable nature of these resources. The NPS is to protect and manage cultural resources in its custody through effective research, planning, and stewardship and in accordance with these policies and guidelines.

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of their undertakings on historic properties and to afford the Advisory Council on Historic Preservation an opportunity to comment in the consultation process. The term "historic properties" is defined as any site, district, building, structure, or object eligible for or listed in the National Register of Historic Places, which is the nation's inventory of historic places and repository of documentation on property types and their significance. Because the activities under this plan could be considered an undertaking, consultation with the appropriate State Historic Preservation office (MT, WY, or ID) would occur on a project-specific basis. Based on the following information, concurrence that no historic properties would be affected will be requested.

Historic Structures: Although hundreds of historic structures are located in Yellowstone National Park, none of the alternatives presented in this plan would affect these structures.

Archeological Resources: At least 11,000 years before present, during the Paleo-Indian Period, small, mobile human groups were present in the Yellowstone region that crafted stone weapons and tools to pursue and utilize large game. Left behind are evidence of Clovis, Folsom, and Cody Complex camps, quarry remains, and sites where animals were killed. The Archaic Period in the park was characterized by mobile groups who used a greater variety of plant foods and small game. The park area was most heavily used by these groups during the Late Archaic, from 1000 BC to AD 200. Later sites in the park may have been used by small groups who resided in lower valleys outside the park and sent parties into the area to hunt game and gather plant materials and other subsistence items. Archeological sites from this time include tipi rings, hunting blinds, and lithic scatters. Prehistoric camp sites throughout the last 10,000 or more years were

concentrated near streams and water sources. The now deeply incised stream banks were more habitable in the past -prior to becoming incised. All project-specific plans that include soil disturbance would require completion of Section 106 review prior to initiation of work. Impacts are anticipated to be direct, long-term, and negligible adverse.

Cultural Landscapes: The NPS Cultural Resource Management Guideline (NPS 1998) defines cultural landscapes as settings that humans have created in the natural world. Potential cultural landscapes include the park's primary road system, structures, and bridges, the Buffalo Ranch in the Lamar Valley, Old Faithful, Fishing Bridge, and Fort Yellowstone/Mammoth Hot Springs. However, none of the alternatives would affect these cultural landscapes.

Museum Collection: Museum objects are manifestations and records of behavior and ideas that span the breadth of human experience and depth of natural history (NPS 1998). No museum objects would be affected by the alternatives.

Indian Trust Resources: Indian trust resources are land, water, minerals, timber, or other natural resources that are held in trust by the United States for the benefit of an Indian tribe or individual tribal member. Trust resources would not be affected by the alternatives.

Ethnographic Resources: The NPS 2006 Management Policies define ethnographic resources as "the cultural and natural features of a park that are of traditional significance to traditionally associated peoples." Traditionally associated peoples are those who have an association with the landscape before it became a park. The tribes who are currently affiliated with Yellowstone and with whom consultation occurs are: Assiniboine and Sioux Tribes of Fort Peck, Blackfeet, Cheyenne River Sioux, Confederated Tribes of Salish and Kootenai, Couer d'Alene Tribe, Crow tribe, Crow Creek Sioux, Eastern Shoshone, Flandreau Santee Sioux, Gros Ventre and Assiniboine, Kiowa Tribe of Oklahoma, Lower Brule Sioux, Nez Perce of Lapwai, Nez Perce of Nespelem, Nez Perce of Colville, Northern Arapaho, Northern Cheyenne, Oglala Sioux, Rosebud Sioux, Shoshone-Bannock, Sisseton-Wahpeton Sioux, Spirit Lake Sioux, Standing Rock Sioux, and Yankton Sioux. Ethnographic resources have not been identified that would be affected by the alternatives.

2. Chapter 2: Alternatives

This chapter describes four alternatives that address the purpose and need for action. These alternatives were developed to explore the possible effects of a range of reasonable actions and strategies that are economically and technically feasible. Alternatives were considered if they met the Native Fish Conservation Plan purpose and needs as articulated in the goals and objectives (Chapter 1), while protecting the native fish, other natural resources, and the natural ecological processes of the park. The alternatives considered in this EA cover the range of what is physically possible, acceptable by policy, and feasible for local managers (i.e., all reasonable alternatives).

Criteria used in the selection of reasonable alternatives include:

- Potential for protecting the park's natural and cultural resources;
- Effectiveness, efficiency, and economy in preserving remaining native fish and controlling non-native fish in waters where they are causing harm to native fish and/or natural ecosystem function; and
- Ability to ensure human health and safety

Assumptions made in the selection of reasonable alternatives for the Yellowstone Lake Ecosystem include:

- There is a direct relationship between LKT netting effort and the number of LKT captured.
- Yellowstone Lake YCT will recover naturally (without large scale supplementation – stocking) once LKT are functionally removed.
- There will be a significant lag (in time) in the recovery of Yellowstone Lake YCT following LKT removal (YCT recovery may not be immediately perceptible).
- Large-scale supplementation (stocking) of YCT from existing hatchery broods would be detrimental (because it would reduce the genetic integrity of the population).

Assumptions made in the selection of reasonable alternatives for streams, rivers, and lakes (other than Yellowstone Lake) include:

- Modern genetic analysis techniques are accurate.
- A hybridized cutthroat trout population cannot naturally return to a genetically unaltered state.
- Once constructed, stream barriers will be maintained to ensure long term persistence of restored headwater populations.
- Without pro-active management, non-native fish will continue to expand and that expansion will be detrimental to native fish.

The four alternatives are described below. This chapter also includes a description of mitigating measures, alternatives considered but eliminated from further consideration, and an explanation of the environmentally preferred alternative as required by (40 Code of Federal Regulations [CFR] §1502.14e; 73 Federal Register 61292-61323). Table 2 summarizes each alternative's primary elements, tables 3 and 4 compare alternatives with plan objectives, and table 10 summarizes expected implementation impacts.

Table 2. Summary of Native Fish Conservation Plan Alternatives.

OBJECTIVE	**Alternative 1** Continuation of current management practices	**Alternative 2** Full use of native fish conservation techniques and lake trout returned to Yellowstone Lake	**Alternative 3** Full use of native fish conservation techniques and lake trout marketed and/or donated	**Alternative 4** Limited use of native fish conservation techniques
Yellowstone Lake				
Large-scale lake trout removal	Gillnetting by NPS crews only.	Gillnetting and large trap netting by NPS crews and private sector contract netters.	Gillnetting and large trap netting by NPS crews and private sector contract netters.	Gillnetting by NPS crews only.
Monitoring Yellowstone cutthroat trout and lake trout	Continue long term monitoring of YCT and LKT.	Continue long term monitoring of YCT and LKT.	Continue long term monitoring of YCT and LKT.	Continue long term monitoring of YCT and LKT.
Clear Creek weir reconstruction	Weir not rebuilt; YCT spawner monitoring discontinued.	Weir rebuilt; YCT spawner monitoring continued.	Weir rebuilt; YCT spawner monitoring continued.	Weir rebuilt; YCT spawner monitoring continued.
Enhancing Yellowstone cutthroat trout recruitment	Tributaries not reconnected; YCT eggs not introduced via RSIs.	Tributaries reconnected; YCT eggs introduced via RSIs.	Tributaries reconnected; YCT eggs introduced via RSIs.	Tributaries reconnected; YCT eggs introduced via RSIs.
New and experimental lake trout removal techniques	Support of research continues.	Support of research continues and new techniques applied.	Support of research continues and new techniques applied.	Support of research continues and new techniques applied.
Streams, Rivers and Lakes (excluding Yellowstone Lake)				
Fish barriers	Fish barriers not constructed.	Fish barriers constructed.	Fish barriers constructed.	Fish barriers constructed.
Non-native fish removal	Limited to mechanical methods (nets and electrofishing).	Includes use of approved piscicides (rotenone).	Includes use of approved piscicides (rotenone).	Limited to mechanical methods (nets and electrofishing).
Stocking native fish and brood source development	Restocking continues; brood sources limited to existing.	Restocking continues; new brood sources developed.	Restocking continues; new brood sources developed.	Restocking continues; new brood sources developed.
Inventory, monitoring, and research for aquatic organisms	Support of research continues; limited by lack of piscicide use.	Support of research continues; advanced by piscicide use.	Support of research continues; advanced by piscicide use.	Support of research continues; limited by lack of piscicide use.
Adaptive Management (AM) Strategy				
Developed for long-term guidance of Native Fish Conservation Plan	Native fish plan not established; AM strategy not implemented.	Native fish plan established; AM strategy implemented.	Native fish plan established; AM strategy implemented.	Native fish plan established; AM strategy implemented.

Table 2. Summary of Native Fish Conservation Plan alternatives.

Table 3. Summary of Fulfillment of Native Fish Conservation Plan Objectives

OBJECTIVE	**Alternative 1** Continuation of current management practices	**Alternative 2** Full use of native fish conservation techniques and lake trout returned to Yellowstone Lake	**Alternative 3** Full use of native fish conservation techniques and lake trout marketed and/or donated	**Alternative 4** Limited use of native fish conservation techniques
Yellowstone Lake				
Increase large-scale suppression of LKT to reduce the population by 25% each year (annual fishing mortality rate of 0.56).		X	X	
Maintain surface water access for spawning cutthroat trout in at least 45 (75%) of the 59 known, historical spawning tributaries.		X	X	X
Recover YCT abundance to the average observed during the five years following LKT discovery (1995–1999; average of 12,800 spawning YCT at Clear Creek).		X	X	
Streams, Rivers and Lakes (excluding Yellowstone Lake)				
Preserve and/or restore genetically unaltered YCT to maintain their current spatial extent in streams (3,300 km, which is 75% of the 4,400 km that historically contained YCT).		X	X	
Restore genetically unaltered WCT until they occupy at least 200 km (20% of 1,000-km historical WCT distribution).		X	X	
Restore fluvial GRY until they occupy at least 200 km (20% of 1,000-km historical GRY distribution).		X	X	

Table 3. Summary of fulfillment of objectives by alternative for the Native Fish Conservation Plan. (X = objectives met)

Table 4. Narrative Comparison of Alternatives and Overall Plan Objectives

Alternative 1: Continuation of current management practices Native fish conservation activities would be limited to 2000–2001 levels of intensity. No additional preservation or restoration activities would occur except those activities addressed in other NEPA documents. No programmatic native fish conservation program or adaptive management strategy would be implemented. **Meets Plan Objectives: No.** Non-native fish populations would be expected to expand. This alternative does not provide the tools necessary for preservation, protection, and restoration of native fish communities. Few formal procedures are in place to direct preservation or restoration activities, monitor/inventory/assess sensitive native species, or prevent further expansion of invasive non-native fish. *Alternative 1 would not meet plan objectives.*
Alternative 2: Full use of native fish conservation techniques and lake trout returned to Yellowstone Lake The full range of techniques (mechanical and chemical, by NPS crews and by private sector contractors) would be used to remove/suppress/control non-native fish. LKT carcasses would be returned to park waters to retain nutrients. A programmatic native fish conservation plan and adaptive management strategy would be implemented. **Meets Plan Objectives: Yes.** The maximum amount and full range of native fish species and natural ecosystem processes would be preserved, protected, and restored over the long term through implementation of a programmatic native fish conservation plan. *Alternative 2 would fully meet plan objectives.*
Alternative 3: Full use of native fish conservation techniques and lake trout marketed and/or donated The full range of techniques (mechanical and chemical, by NPS crews and by private sector contractors) would be used to remove/suppress/control non-native fish. Some LKT carcasses would be removed and marketed and/or donated by private-sector contract netters. A programmatic native fish conservation plan and adaptive management strategy would be implemented. **Meets Plan Objectives: Yes.** The maximum amount and full range of native fish species and natural ecosystem processes would be preserved, protected, and restored over the long term through implementation of a programmatic native fish conservation plan. *Alternative 3 would fully meet plan objectives*
Alternative 4: Limited use of native fish conservation techniques Chemical methods (piscicides) and private-sector contractors (including use of very large trap nets) would not be employed under this alternative; only electrofishing and gillnetting by NPS crews would be used to remove/suppress/control non-native fish. LKT carcasses would be returned to Yellowstone Lake to retain nutrients. A programmatic native fish conservation plan and adaptive management strategy would be implemented. **Meets Plan Objectives: No.** This alternative does not provide all tools necessary for preservation, protection, or restoration of native fish. Although this alternative eliminates potentially controversial control techniques, it does not provide a means to effectively control non-native fish. *Alternative 4 would not meet plan objectives.*

Table 4. Narrative comparison of alternatives and over-all plan objectives.

2.1 Alternative 1: No Action—Continuation of Current Management Practices

Alternative 1 would continue Yellowstone's current native fish conservation practices at levels consistent with those in place from 2001 to 2010, including:

- conservation of Yellowstone Lake YCT via gillnetting of LKT by NPS crews, May–October annually
- long-term monitoring of Yellowstone Lake YCT and LKT via netting programs consistent with methods used historically
- support of research to understand ecosystem consequences of LKT expansion and determine ways to mitigate for it
- assessment of the status and health of fish populations in **Other Streams, Rivers, and Lakes** by conducting inventories and surveys using standard techniques
- conservation of YCT in upper Soda Butte Creek via electrofishing of non-native brook trout by the NPS and partner agencies, one week annually
- prioritization and planning for YCT, WCT, and GRY restoration in streams, rivers, and lakes, requiring close collaboration with partner agencies and non-governmental organizations
- contribution of YCT and WCT gametes to support brood (hatchery) programs in Montana and Wyoming
- restoration of YCT, WCT, and/or GRY by completion of watershed-specific (project by project) environmental compliance (NEPA), as was completed for East Fork Specimen Creek WCT restoration in 2006
- support of research to determine best practices to use during watershed-scale fish restoration to ensure that non-target species, including macroinvertebrates and amphibians, remain unharmed

Alternative 1 implementation would not result in the reconstruction of the Clear Creek weir and YCT trap, and therefore monitoring of the migratory, spawning YCT from Yellowstone Lake, which began in 1945, would no longer take place.

2.2 Actions Common to Alternatives 2, 3 and 4: Adaptive Management Strategy

Adaptive management (AM) is a system of management practices based on clearly identified desired conditions and monitoring to determine whether management actions are achieving them and, if not, facilitating management changes that would best ensure that the desired conditions are met or re-evaluated (Walters and Holling 1990, Williams et al 2007; fig. 5). Adaptive management is a technique employed for charting a decision-making course along an uncertain path whose goal is to obtain an expected and desirable condition. An effective monitoring program is required to provide the navigational framework needed for successfully meeting the challenges of adaptively managing the path.

Embracing Uncertainty: Adaptive management recognizes that knowledge about natural resource systems is sometimes uncertain (43 CFR 46.30; Moir and Block 2001, Ruhl 2005). Adaptive management considers management actions and policy in a context analogous to experimental treatments. Thus, it embraces uncertainty by defining a set of quantitative responses that are consistent with management experience for each desired condition (hypothesized outcome). This is often accomplished through the use of various conceptual (see Chapter 1) or quantitative models. The evidence for achieving the conditions/outcomes is considered in a well-designed monitoring framework, just as one would expect from any research design. Sampling designs that monitor pre-determined performance metrics from the outset can help reduce uncertainty.

Integration of Management and Science: Adaptive management integrates science and management (Lee 1993). From a science perspective, management objectives become the primary response of interest and the source of questions being posed. From a management perspective, the management objectives remain the primary concern, but learning becomes an additional, explicit objective. Thus, management takes on a part of science (i.e., learning), and science takes on a part of management (i.e., the objectives). More detailed information about the use and implementation of AM is given in Adaptive Management: The U.S. Department of the Interior Technical Guide (Williams et al. 2007).

2.2.1 Adaptive Management and NEPA

Compliance with NEPA is a statutory and regulatory requirement for federal activities affecting the environment, whereas AM is a discretionary, learning based approach to structured decision making that may be used in conjunction with the NEPA process; it is a management tool that is consistent with NEPA's goal of informed decision making (USDOI 2010). Adaptive management and NEPA are similar in that both emphasize collaboration, working with partners or stakeholders, and learning as part of the management process. In AM, the need to learn is best expressed as one or more key questions with regard to uncertainty about the consequences of management actions. If such uncertainty motivates the use of an AM approach to a given situation, it is important to acknowledge the existence of this uncertainty in the NEPA process (Ruhl 2005; Thrower 2006). This acknowledgement informs the public involvement and shapes the analysis of environmental effects that is required for NEPA compliance.

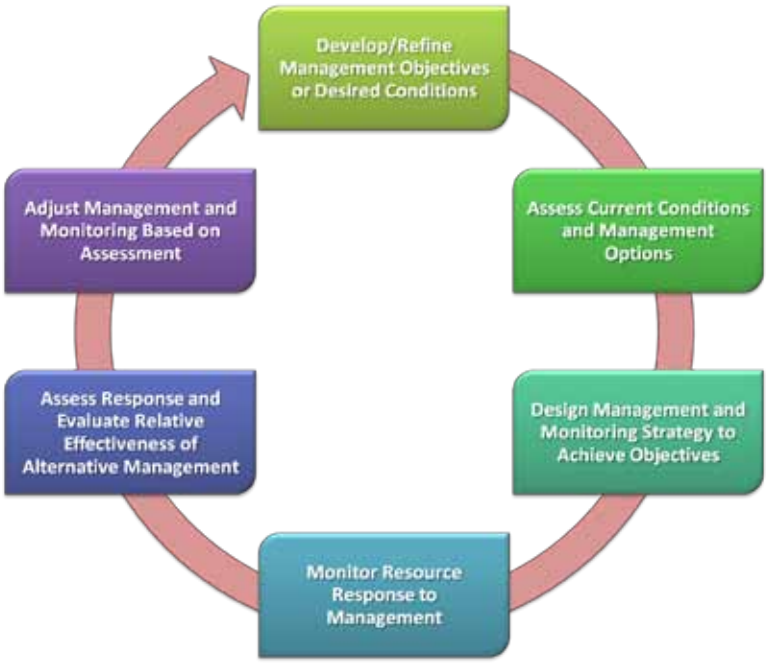

Figure 5. Generalized adaptive management model (adapted from the British Columbia Ministry of Forests and Range).

If management adaptations which could occur in light of new emerging information are fully documented and analyzed through the initial NEPA process,

this can reduce the need to supplement or prepare additional NEPA documents later on. However, if management adaptations would result in impacts beyond those originally identified in the plan, preparation of a new NEPA document would be required (40 CFR 1502.9c1).

Adaptive Management for Native Fish Conservation: Adaptive management is a major and integral feature of Alternatives 2, 3, and 4 in this EA. The AM approach would include statistically-valid long term monitoring to evaluate effectiveness of conservation actions. Stakeholders, such as the YCT Interstate Workgroup, the Montana Cutthroat Trout Steering Committee, the Fluvial GRY Workgroup, and the Science Review Panel for Yellowstone Lake, would continue to be regularly engaged.

The AM approach was chosen because of the varied environments and stressors impacting native fish across the park, and the fact that some uncertainty exists in the possible response by native fish following management action. For example, although initial science indicates LKT expansion in Yellowstone Lake could be curtailed by inflicting an annual total mortality of 60% (see Appendix A), it is not known precisely for how many years this level of mortality would need to be maintained or if the effort could eventually be reduced without resulting in an LKT resurgence. Similarly, the rate of Yellowstone Lake YCT recovery after the population is released from LKT impacts is also uncertain. It may be years before a positive YCT response is detected and decades before YCT regain their ecological role in the ecosystem. Because of these and other uncertainties, performance metrics would be closely monitored to track system responses to conservation actions and the results would be used to make adaptations and adjust management actions.

As described in chapter 1, the park's surface waters are considered in two domains for purposes of this EA: (1) Yellowstone Lake, river, and tributaries upstream of the Upper Falls at Canyon; and (2) all Other Streams, Rivers, and Lakes within the park's boundaries (fig. 1). A hierarchical series of desired conditions has been developed for each of these domains (tables 5 and 6). From a science perspective, each desired condition represents a hypothesized outcome for native fish given the initial state of the system and the conservation actions applied.

Monitoring will be conducted (see below) to determine if performance metrics are met and conservation actions influence native fish as predicted. If this is the case, hypothesized outcomes for native fish have also been met and the desired condition has been achieved.

Yellowstone cutthroat trout spawning in inlet of Trout Lake. Photo by T. Dodge

Table 5. Desired conditions, conservation actions, quantitative responses, and performance metrics for the Yellowstone Lake ecosystem

Desired Conditions	Conservation Actions	Quantitative Responses	Performance Metrics
Primary Restore YCT to pre-LKT abundances. Free YCT of all stress by LKT.	Gillnetting by NPS crews. Private sector, contract gillnetting. Private sector, contract deep-water trap netting. Incorporate new and emerging technologies.	YCT ascending Clear Creek increases to at least 41,800 annually. YCT ascending 11 front country tributaries are fully restored. YCT in lake netting assessment >15 per net/night. Restored angler YCT catch to approx.2.0 per hour (1980s levels)	Reduce LKT population growth rate to 0.75 for 10 years. CPUE of LKT in distribution gillnets is below 0.01 within 10 years. Other lines of evidence, including reduced angler LKT catch per hour to <0.05 within 10 years.
	Reconnect spawning tributary surface waters to the lake.		Each year 75% of tributaries maintain a surface water connection with the lake.
Secondary Restore YCT to abundance during early stages of LKT invasion. Significantly reduce LKT stress on YCT.	Gillnetting by NPS crews. Private sector, contract gillnetting. Private sector, contract deep-water trap netting. Incorporate new and emerging technologies.	YCT ascending Clear Creek increases to at least 12,800 annually. YCT ascending 11 front country tributaries significantly increases. YCT in lake netting assessment >10 per net/night. Restored angler YCT catch to approx. 1.5 per hour (1990s levels)	Reduce LKT population growth rate to 0.85 for 10 years. CPUE of LKT in distribution gillnets is below 0.1 within 10 years. Other lines of evidence, including reduced angler LKT catch per hour to <0.05 within 10 years.
	Reconnect spawning tributary surface waters to the lake.		Each year 75% of tributaries maintain a surface water connection with the lake.
Tertiary Restore YCT to abundances during later stages of LKT invasion. Moderately reduce LKT stress on YCT.	Gillnetting by NPS crews. Private sector, contract gillnetting. Private sector, contract deep-water trap netting. Incorporate new and emerging technologies.	YCT ascending Clear Creek increases to at least 4,600 annually. YCT ascending 11 front country tributaries moderately increases YCT in lake netting assessment >5 per net/night. Angler YCT catch per hour remains approx. 1.0 per hour. (2000s levels)	Reduce LKT population growth rate to 0.95 for 10 years. CPUE of LKT in distribution gillnets is <0.5 within 10 years.
	Reconnect spawning tributary surface waters to the lake.		Each year 75% of tributaries maintain a surface water connection with the lake.
	Reintroduce YCT to tributaries lacking use by spawners.		Establish a self-sustaining spawning population in tributaries within 6 years.

Table 5. Desired conditions, conservation actions, quantitative responses, and performance metrics for the Yellowstone Lake ecosystem. See the section 2.3.1.2. Conservation Actions, for descriptions of each action. Column labels A-D correspond to elements of the Adaptive Management Strategy conceptual model (fig. 6)

Table 6. Desired conditions, conservation actions, quantitative responses, and performance metrics for streams, rivers, and lakes other than Yellowstone Lake

Desired Conditions	Conservation Actions	Quantitative Response	Performance Metrics
Primary Restore genetically unaltered native fish populations to habitat secure from further invasion by non-natives.	Create a barrier to upstream movement by non-native fish.	Create and maintain a genetically unaltered, self-sustaining population (100% native alleles) of 100% native fish.	100% isolation of the project area from non-native fish invasion.
	Use piscicides to completely remove non-native and genetically altered fish.		100% removal of all hybridized and non-native fish from the project area.
	Restock genetically unaltered native fish to the project area.		Establish a genetically unaltered population (no detectable hybridization) in the project area.
	Create and maintain genetically unaltered native fish brood sources.		Develop a genetically unaltered, self-sustaining wild native fish brood stock capable of producing 10,000 eggs/year.
Secondary Protect and enhance already compromised native fish populations.	Create a barrier to upstream movement by non-native fish.	No net loss of native fish genetic integrity or growth of non-native fish populations in project area within 5 years of project implementation and a reduction in non-native fish abundance or improvement in native fish genetic integrity within 10 years.	100% isolation of the project area from non-native fish invasion.
	Selectively remove non-native and genetically altered fish using mechanical methods to the greatest extent possible.		Reduce abundance of non-hybridizing non-native fish by at least 90% over 10 years.
			Eliminate hybridizing non-native fish and first generation hybrids within one generation (~5 years).
			Maintain the genetic integrity of the existing population (no loss of genetic integrity).
	Supplement the existing native fish population with genetically unaltered native fish to improve its genetic integrity.		Improve the genetic integrity of the existing cutthroat trout population to at least 90% native species alleles (USFWS Core Population).
			Reduce hybridization of the existing cutthroat trout population by at least 50%.
Tertiary Limit the genetic influence and expansion of non-native fish.	Promote angler harvest of non-native fish through public education in target waters.	Reduce by 50% the rate of hybridization and/or the growth of non-native fish populations in target waters.	Increase angler harvest of non-native fish in target waters by 100% over 5 years.
	Reduce spawning success of non-native fish by limiting access to spawning areas.		Reduce first generation hybrids by 75% in target waters over 5 years.
	Reduce spawning success of non-natives by destroying embryos.		Reduce production of non-native fish and/or first generation hybrids by 50% over 5 years.
	Improve spawning success of native fish by improving access to spawning areas.		Improve the ratio of native to non-native 1-year-old fish by 100% over 5 years.

Table 6. Desired conditions, conservation actions, quantitative responses, and performance metrics for streams, rivers, and lakes other than Yellowstone Lake. See the "Conservation Actions" section in this chapter for descriptions of each action. Column labels A-D correspond to elements of the Adaptive Management Strategy conceptual model (fig. 6).

However, if the performance metrics or hypothesized outcomes are not met, knowledge gained through experience and research would be used to propose adjustments, each of which would be discussed with stakeholders and considered based on conservation value, technical feasibility, environmental impact analysis, and resource availability (fig. 6). Following these considerations, if the solution is reasonable and prudent, a decision to take additional conservation action would be made. If the solution is not reasonable or prudent, a new combination or adjustments to intensity of actions would be considered.

The most desirable condition would consistently be strived for in the AM strategy. If new technologies become available that could achieve a more desirable condition, each would be considered as described above with conservation actions applied as appropriate.

Stakeholders would be informed of significant adjustments to conservation actions through Yellowstone National Park press releases and/or information exchanged via publications or presentations at annual meetings, as appropriate.

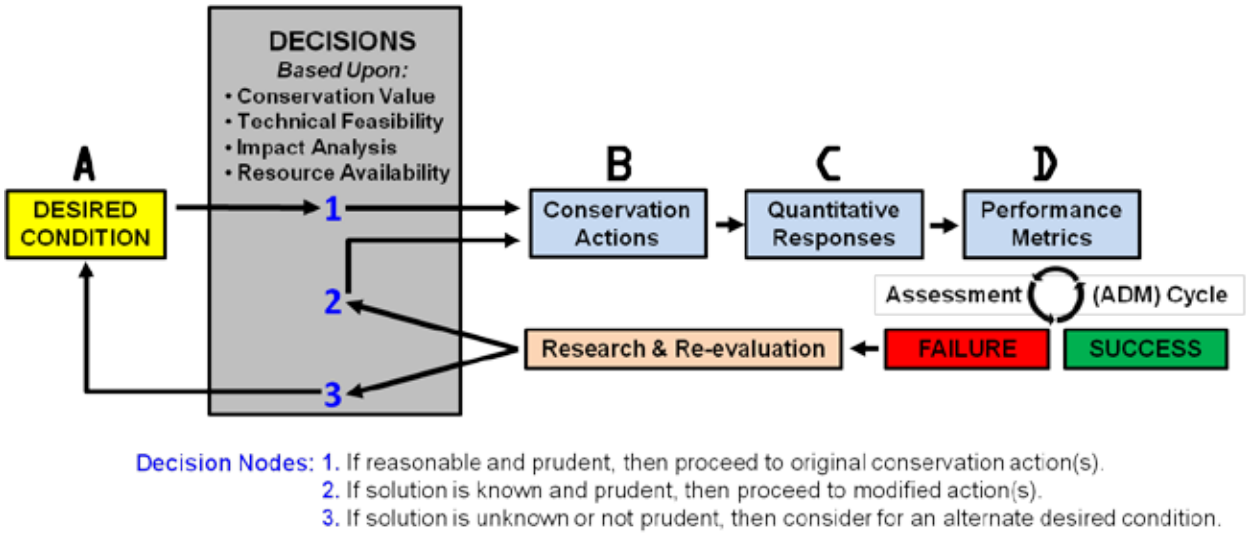

Figure 6. Adaptive management strategy conceptual model for native fish conservation in Yellowstone National Park. Desired conditions (A), conservation actions (B), quantitative responses (C), and performance metrics (D) are defined in the text and listed in Tables 5 and 6.

2.3 Alternative 2 (Preferred Alternative): Full Use of Native Fish Conservation Techniques and Lake Trout Carcasses Returned to Yellowstone Lake

2.3.1 Yellowstone Lake Ecosystem

The conservation of native fish in Yellowstone Lake would focus on the restoration of YCT, primarily through the suppression of LKT. The adaptive management framework (table 5; fig. 6) specifies conservation actions, defines success in terms of quantitative responses and performance metrics, and identifies potential pathways if conservation actions do not produce the desired result. All desired conditions were designed to meet the Native Fish Conservation Plan objectives set forth in chapter 1.

Scientific Basis: Details on the science supporting our proposed conservation actions are provided in **Appendix A**. The plan is based on model estimates of the removal (required netting efforts) necessary to initiate a LKT decline and attain each desired condition (Figures A-1 and A-2). The following represent the development of a formal adaptive process and benchmarks against which metrics derived from long term monitoring (see section in *Conservation Actions* below) can be compared.

Contingencies: Performance metrics derived from long term monitoring would be evaluated annually by NPS and science partners/stakeholders. If performance metrics do not indicate a positive trend/shift toward the quantitative response(s) and desired condition(s) originally sought, ADM modifications would be made immediately. These could include modifications to the conservation actions taken (e.g. amount of netting effort used) and/or to the hierarchical desired condition to be strived for.

2.3.1.1 Desired Conditions

The primary, secondary, and tertiary desired conditions are described below. Although the primary condition is the most desirable, because currently available LKT suppression methods are insufficient to achieve it, the secondary condition would initially be strived for. If the secondary desired condition cannot be achieved, the tertiary condition would be strived for. Not achieving at least the tertiary condition would be considered a failure to meet the Native Fish Conservation Plan objectives.

Primary Desired Condition

The primary desired condition would be characterized by YCT restored to pre-LKT abundances, and free from all stress by LKT. This condition would be achieved by a 100% eradication of LKT or a suppression of LKT to the point where the species has no measurable impact on the ecology of Yellowstone Lake. Quantitative responses to characterize this condition would include full recovery of YCT abundance to the average observed during the five years prior to LKT discovery (1987–1991; average of 41,800 spawning YCT at Clear Creek and lake-wide angler catch rates of approximately 2.0 YCT per hour).

The conservation actions expected to be necessary to reach this condition:

- Continue existing NPS LKT suppression efforts and add private sector contract netters to increase suppression efforts to at least 7,800 km of gillnet set each season, May–October (more than three times that of current levels; Appendix A; Figure A-2).
- Use private sector contract netters to set and maintain at least eight large, deep-water trapnets to eliminate LKT and reduce incidental YCT mortality.
- As they become available, incorporate new technologies capable of removing LKT eggs and/or juveniles at spawning sites and more effectively eradicating juveniles and adults throughout the lake.
- Reduce the LKT population growth rate to 0.75 for at least 10 successive years.
- Ensure that 75% of the lake's spawning tributary streams maintain a surface water connection with the lake to facilitate YCT spawning and fry escapement.

Secondary Desired Condition

The secondary desired condition would be characterized by YCT restored to abundances during the early stages of LKT invasion, significantly reducing LKT stress on YCT. This condition would be achieved by further curtailing LKT population expansion and significantly

reducing LKT abundance in Yellowstone Lake. Quantitative responses to characterize this condition would include recovery of YCT abundance to the average observed during the five years following LKT discovery (1995–1999; average of 12,800 spawning YCT at Clear Creek and lake-wide angler catch rates of approximately 1.5 YCT per hour).

The conservation actions expected to be necessary to reach this condition:

- Continue existing NPS LKT suppression efforts and add private sector contract netters to increase suppression efforts to at least 5,600 km of gillnet set each season (more than twice that of current levels; Appendix A; Figure A-2).
- Use private sector contract netters to set and maintain at least eight large, deep-water trapnets to eliminate LKT and reduce incidental YCT mortality.
- As they become available, incorporate new technologies capable of removing LKT eggs and/or juveniles at spawning sites, and more effectively eradicating juveniles and adults throughout the lake.
- Overall, reduce the LKT population growth rate to 0.85 for at least 10 successive years.
- Ensure that 75% of spawning tributary streams maintain a surface water connection with the lake to facilitate YCT spawning and fry escapement.

Tertiary Desired Condition:
The tertiary desired condition would be characterized by YCT restored to abundances during the later stages of LKT invasion, moderately reducing LKT stress on YCT. This condition would be achieved by curtailing further LKT population expansion and slightly reducing LKT abundance in Yellowstone Lake. Quantitative responses to characterize this condition would include maintaining YCT abundance at the average observed from 2001 to 2005 (4,600 spawning YCT at Clear Creek and lake-wide angler catch rates of approximately 1.0 YCT per hour).

The conservation actions expected to be necessary to reach this condition:

- Continue existing NPS LKT suppression efforts and add private sector contract netters to increase suppression efforts to at least 3,900 km of gillnet set each season (Appendix A; Figure A-2).
- Use private sector contract netters to set and maintain at least eight large, deep-water trapnets to eliminate LKT and reduce incidental YCT mortality.
- Incorporate new technologies capable of removing LKT eggs and/or juveniles at spawning sites, and/or more effectively eradicating juveniles and adults from throughout the lake.
- Overall, reduce the LKT population growth rate to 0.95 for the foreseeable future.
- Ensure that 75% of spawning tributary streams maintain a surface water connection with the lake to facilitate YCT spawning and fry escapement.
- Enhance YCT recruitment to the lake by re-introduction of YCT embryos to select spawning tributaries using remote site incubators.

Failure to Achieve a Desired Condition:
If desired conditions are not attained within 10 years of implementing the proposed actions, either due to inaccurate model-based predictions (Appendix A), flawed underlying assumptions, or ineffective technologies, then the NPS would continue actions to maintain the remaining YCT in Yellowstone Lake using best available methods and continued review by science partners. A Science Review Panel workshop would be held to discuss issues limiting

effectiveness and possible adjustments to actions that could improve effectiveness. NPS staff would continue to collaborate with experts to develop or improve technologies that more efficiently and effectively eradicate LKT. New or improved technologies would be considered for use on Yellowstone Lake and additional NEPA would be conducted prior to their implementation if they would result in impacts greater than those disclosed in this EA.

2.3.1.2 Conservation Actions

The following are examples of potential actions. Following the ADM strategy, these methods would be evaluated and updated seasonally (if necessary).

Gillnetting by NPS Crews

Gillnetting, which the NPS has used to suppress LKT in Yellowstone Lake each year since 1994, would continue under this alternative. NPS boats 8–12 m long and powered by four-cycle outboard, inboard/outboard, or inboard diesel engines would be moored at Bridge Bay marina near Lake Village (fig. 1).

The netting season begins as soon as ice is off the lake, typically mid-May to early June, and lasts through mid-October when cold weather threatens to freeze the water at Bridge Bay marina. The number of days boats and crews are on the water would be dictated mainly by the number of available staff and the number of available crew leaders with boat-operating experience; weather and mechanical failures are also factors. It is anticipated that NPS boats would be gillnetting on Yellowstone Lake at least four to five days per week.

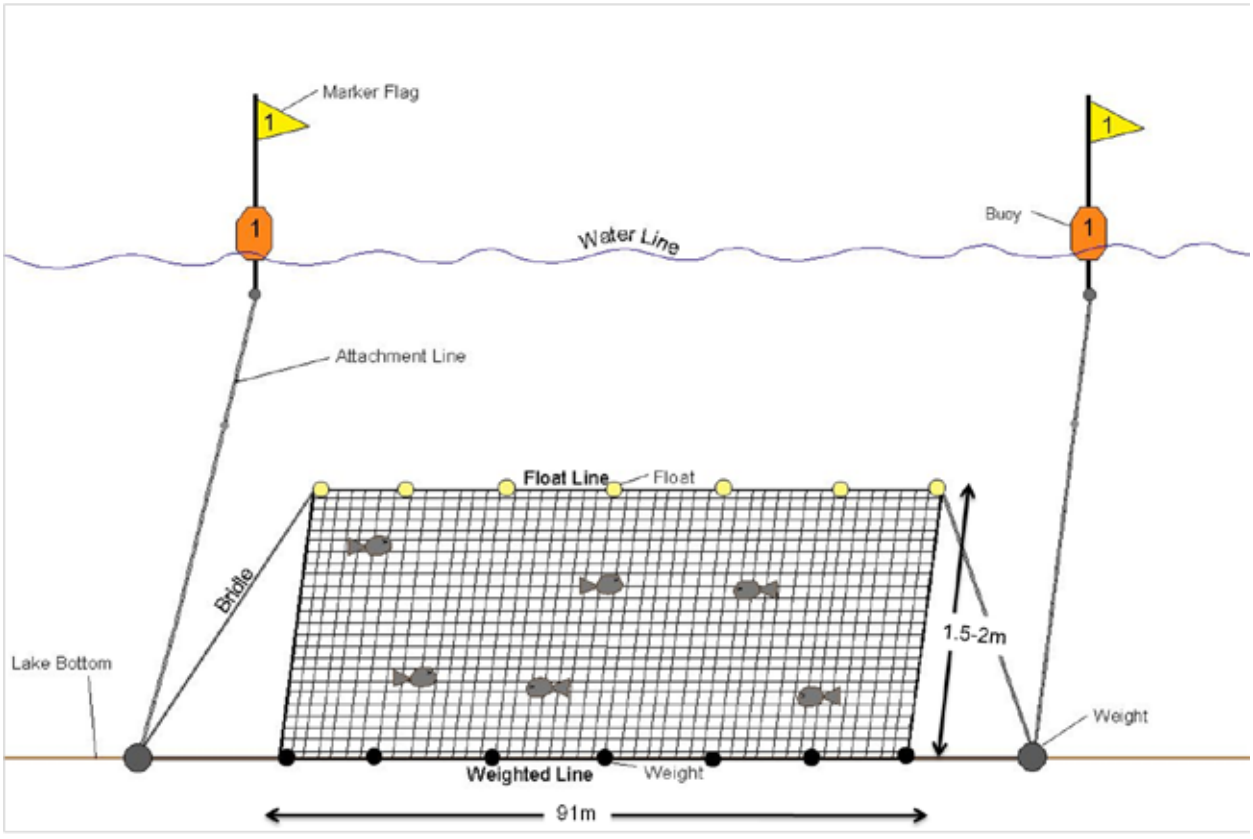

Figure 7. Diagram of a typical gillnet and dimensions used in Yellowstone Lake (not drawn to scale).

It is anticipated that gillnet locations would continue to be concentrated in the West Thumb (fig. 1), where LKT densities have been highest. However, if LKT become more abundant in other lake areas, such as the main basin and south arm regions, NPS gillnetting efforts would be expanded in those areas. Sonar and GPS equipment would be used for accurate net placement, recording, and locating set nets.

As an example, monofilament, small-mesh (19–44 mm) gillnets would be placed on the lake bottom in water typically 20–65 m deep (fig. 7). Gillnets would be 300 m ´ 2 m and set in gangs of 6 to 10 contiguous nets (at least 1800 m total length each), typically for five to seven days. On any given day during the open water season, up to 18 km of gillnet would be in place fishing for LKT. A hydraulic net lifter would be used to lift gillnets from the lake bottom and into the boats for processing by the crews.

NPS gillnetting would likely continue to target spawning LKT. From late August through early October, mature LKT congregate on spawning areas where they tend to be more susceptible to gillnets. Suspected spawning areas include Breeze Channel, Carrington Island, the West Thumb geyser basin, and Solution Creek (fig. 1). Additional locations would be netted for spawning LKT as they are identified. Large (38–89 mm) monofilament mesh gillnets to target spawning LKT would be set shallow (1–20 m depth) and placed for relatively short durations (typically one to four days) to reduce mortality of cutthroat trout by-catch.

All LKT air bladders would be punctured and their carcasses would be returned to deep areas of Yellowstone Lake. Any accidentally killed YCT would either be disposed of in the same manner or collected for data analysis. Live YCT would be rested/revived in on-board holding tanks prior to their release back into the lake.

Housing would be required for 12 or more NPS and volunteer crew members in the Lake Village area from May through October. Several trucks and trailers used for transportation would be present in public parking areas.

Private Sector Contract Gillnetting

The feasibility of using private sector contract netters to reduce the LKT was examined by NPS during 3 weeks in 2009 and 10 weeks in 2010. Under this alternative, these efforts would be greatly expanded in future years. Contractor boats would be at least 10 m long and compliant with Coast Guard approved safety equipment. Boat engines would be four-cycle outboard, inboard/outboard, and/or inboard diesel. The boats would be outfitted to process gillnets and moored at Bridge Bay marina in the fisheries' government dock space.

Contract gillnetting. Photo by Pat Bigelow.

Gillnets composed of small and large monofilament mesh would be 91 ´ 2 m and typically set in gangs 550 to 2,750 m in length between marking buoys and anchors. The gillnets would be placed on the lake bottom in water as deep as 65 m. A hydraulic net lifter would be used for net retrieval. Sonar and GPS equipment would be used for accurate net placement, recording, and

locating set nets. The contractor would provide the boat, captain and crew necessary to undertake all operations of docking, retrieval of nets, removing fish, preparing nets to be reset, and resetting nets, and would set 2,750 to 8,230 lineal m of gillnet per day. Nets would be set to target both juvenile and spawning LKT.

All LKT air bladders would be punctured and their carcasses would be returned to deep areas of Yellowstone Lake. Any accidentally killed YCT would be noted and disposed of in the same manner unless otherwise requested by the NPS. Live YCT would be rested/revived in on-board holding tanks prior to their release back into the lake.

Temporary housing would be required for three or more private sector contract crew members in the Lake Village area. One truck and trailer used for transportation would be present in public parking areas.

Private Sector Contract Trapnetting

Deep-water trapnets would be used by contractors to augment gillnetting efforts. This gear type would funnel and trap fish without entanglement, making it possible to separate captured YCT from the LKT and release them unharmed. The LKT would be killed, air bladders would be punctured, and carcasses would be returned to deep areas of Yellowstone Lake.

The trapnetting efforts by private sector contractors would require use of at least one large trapnet boat (12 to 16 m length) and a smaller boat (6 to 8 m length) that would be used for setting anchor lines, both of which would be moored nightly at Bridge Bay marina. The nets would be comprised of heavy (multifilament) mesh of varying sizes. The trapnets would be 9–15 m tall, and have trap boxes 6 m ´ 6 m ´ 12 m (fig. 8). The wings, hearts, and lead line mesh panels

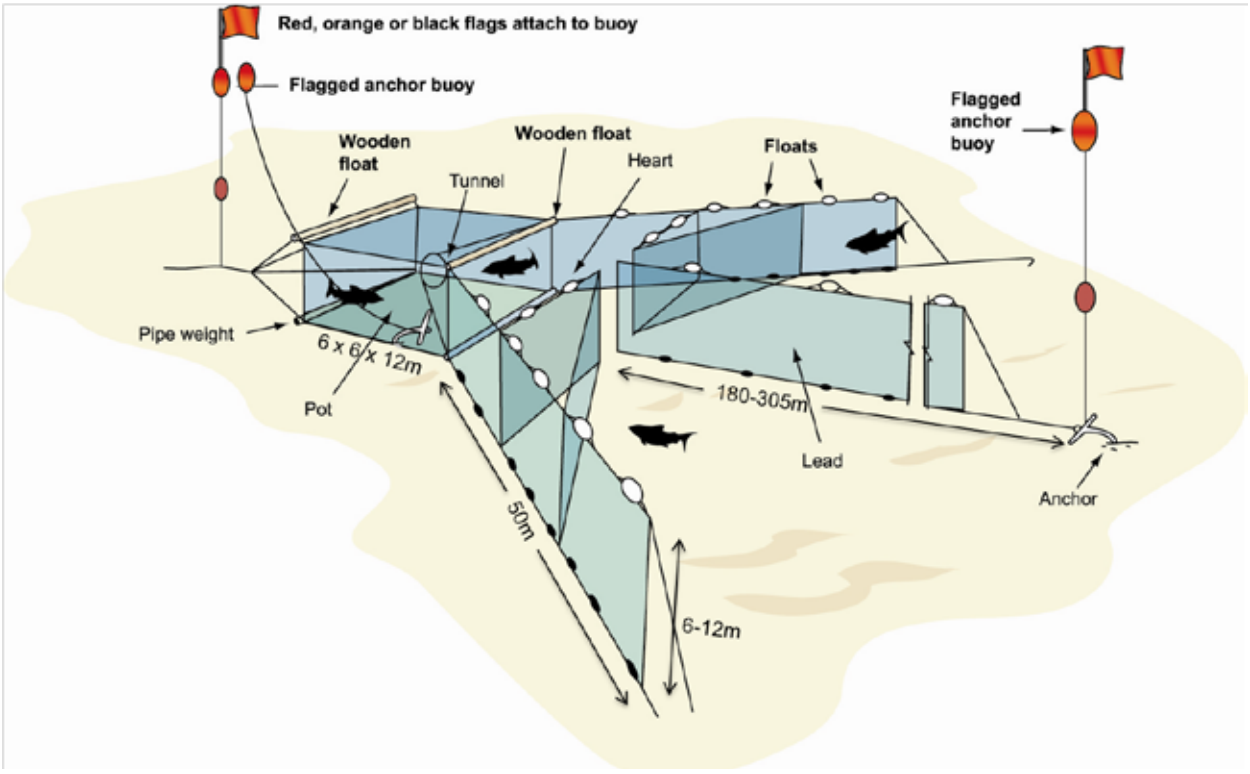

Figure 8. Diagram of a deep-water trap net with approximate dimensions similar to those used to remove lake trout from Yellowstone Lake.

would extend outward to direct the fish into a tunnel and then into the trap box. Lead lines would be up to 300 m long and up to nine 15-kg anchors would hold each net in place. A hydraulic lifting system would be used to check and move the trapnets.

Eight or more large trapnets would be set on Yellowstone Lake. It is anticipated each trap would be lifted and checked for fish two or three times per week throughout the open water season. Temporary housing would be required for two or three private sector contract crew members in the Lake Village area. Trucks and trailers (in addition to that used for gillnetting) would be present in public parking areas.

Improve Suppression Efficiency through Critical Reviews and Research

NPS will continue to regularly request science review panel evaluations (by USGS and/or other partners) to ensure appropriate direction and ultimate effectiveness of the Yellowstone Lake program.

NPS will continue to collaborate with outside partners to seek funding and lead research efforts. Research identified as critical to the program by the 2008 Science Review Panel include:

- Sonic (acoustic) tagging of LKT so the movements of individual fish can be monitored throughout the year and precise locations for LKT removal can be targeted;
- A rigorous LKT mark-and-recapture study, to develop a lakewide population estimate; and
- Analysis of existing hydroacoustic survey data and repeat of surveys to estimate LKT and YCT population sizes and spatiotemporal trends.

Ability to conduct these research efforts would be dependent primarily upon acquisition of funding by NPS and/or science partners. Ability to conduct a rigorous LKT mark-and-recapture study is also dependent upon the effectiveness of the deep water trap nets to capture LKT. Given the current abundance of LKT, at least 10,000 LKT would need to be captured, marked, and released in order to develop a useful LKT population estimate. It is not known at this time if catches by deep water trap nets will be sufficient to conduct a mark-and-recapture study for LKT.

NPS partners are researching new LKT suppression methods, and if proven effective and feasible, they would be incorporated into the Yellowstone Lake program. Examples of these include destruction of eggs and embryos at the spawning sites using electricity, suction, or piscicides (see below and Appendix B); trapping and removing young-of-the-year LKT as they leave the spawning sites; and use of attractants to concentrate LKT.

As other agencies address similar LKT problems, information on successes and failures would be shared and applied. NPS personnel annually participate in a regional LKT suppression working group to stay abreast of recent developments. Efforts to incorporate new and emerging technology would vary depending on existing conditions, technical limitations, consideration of ecological, socioeconomic, and other impacts, and available resources.

NPS would experiment with alternative suppression options and new technologies while monitoring effectiveness. However, no technologies would be incorporated if impacts would exceed those disclosed in this environmental assessment.

Reconnect Spawning Tributaries to Yellowstone Lake
If young YCT are stranded in tributary streams that become disconnected from Yellowstone Lake, re-establishing flows would enhance juvenile emigration and survival. Seasonal crews, most likely from the Montana Conservation Corps, would reconnect tributaries to Yellowstone Lake. They would be housed at the Yellowstone Lake developed areas and backcountry campsites, and reach remote locations in NPS boats at least 7 m long. They would use shovels and other hand tools at each tributary's confluence with the lake to remove obstructing gravel bars, logs, or debris. The gravel would be removed so that flows from the tributary are reconnected to the lake with surface depths of at least one inch to allow previously stranded juveniles to emigrate to the lake. Removed gravel and other materials would be placed along the beach nearby and manually dispersed to maintain a natural setting. All known YCT spawning tributaries would be checked repeatedly throughout the season, especially late July through September, to ensure surface water connections with the lake are maintained. Priorities would be given to those tributaries known to support the largest YCT spawning migrations. If YCT juveniles are encountered in the gravel during reconnection efforts, the project would be stopped and re-evaluated

Reintroduce YCT Embryos to Former Spawning Streams
If population monitoring (as described below) suggests that the LKT population has been sufficiently reduced to allow YCT recovery but the YCT population does not sufficiently respond, YCT would be reintroduced to tributary streams where it has been demonstrated that the natural YCT spawning population has been lost. The YCT would be introduced into tributaries as advanced embryos (eyed eggs) obtained either from YCT adults within the system or from a Yellowstone Lake brood source that was developed by the Wyoming Game and Fish Department and is currently located at the Ten Sleep State Fish Hatchery. The eggs would be introduced through the use of remote site incubators (RSIs) placed directly into flowing waters during the spring. After the eggs hatch and the young fry develop for several weeks, the fry can swim out of the incubator unassisted. The use of RSIs allows fish to hatch in the tributary and imprint to its waters, which should result in these fish returning to the tributary as adults to spawn. It also makes it possible to stock large numbers of fish with relatively little transportation effort. The main limitation of RSIs is their susceptibility to failure from clogging, changing water conditions, and disturbance by wildlife or people.

2.3.1.3 Monitoring Success

Identifying specific quantitative responses is crucial to the success of the proposed AM strategy for the Yellowstone Lake ecosystem. All of the desired conditions and conservation actions include performance metrics that are tied to the LKT population response and the resulting YCT population response (table 5). These metrics would be used to assess the success or failure of this important aspect of the Native Trout Conservation Plan.

Data collection for LKT population monitoring. Photo by P. Bigelow

Clockwise from top left: YCT serve a unique ecological role in YSL, NPS Photo; Contract trap netting (box is across boat and staff are checking for fish), P. Bigelow; YSL exhibits many of YNPs wilderness characteristics, J. Facendola; Gillnets being set by fisheries technicians in YSL, NPS Photo; New and emerging technologies for LKT suppression, P. Bigelow; Sandbar disconnecting YCT spawning stream from YSL.

LKT Population Monitoring
Through collaboration with USGS Montana Fishery Research Unit the NPS has initiated the development of a statistically robust lake trout monitoring program. This effort will include a complete review and statistical analysis of all existing data and will identify important data gaps. In August 2010 the existing distribution netting program was significantly expanded by NPS to ensure that adequate data were available for power analyses and other statistical procedures currently underway in this effort.

It is anticipated that to assess the status of the Yellowstone Lake LKT population, each August the NPS would conduct distribution netting in at least six randomly selected sites in each of four regions of Yellowstone Lake (24 sites total). Small multi-mesh (19–50 mm) and large multi-mesh (57–89 mm) monofilament gillnets would be set overnight on the lake bottom at three depth strata from 5 to 50 m. NPS boats moored at the Bridge Bay marina would be used to access the sites.

All fish would be removed and returned to the laboratory for processing, including weighing, measuring, assessing condition, and removing biological samples such as scales and otoliths (ear bones). All LKT and YCT carcasses would be fully examined for biological characteristics (e.g., age, growth, reproductive status) and health (e.g., presence of whirling disease or other pathogens).

The information acquired from the LKT captured during the August distribution netting would be used to monitor success of the LKT suppression effort based on two performance metrics: the mortality caused by netting (annual fishing mortality) and the catch per unit of effort (average number of LKT caught in 100 m of net each night). A third metric, the average LKT catch per hour by anglers, would be derived from the returned Volunteer Angler Report Cards.

YCT Population Monitoring
The NPS would monitor the YCT spawning population using a weir and trap at Clear Creek and by visual surveys of 11 small frontcountry tributaries. The lakewide population would be monitored by a fall netting assessment conducted at 11 sites across Yellowstone Lake and/or by the distribution netting program (described for LKT above). In addition, YCT catch per hour by anglers would be derived from the returned Volunteer Angler Report cards.

Clear Creek, a large tributary along the lake's eastern shore, has been used to assess the abundance, condition, sex ratio, and age and length structure of spawning YCT since 1945 through capture at a weir and trap from May to July each year. However, high spring flows damaged the structure in 2008, making the weir and trap unusable. (See "Reconstruction of Clear Creek Weir and Trap" below.) Under Alternative 2, the YCT would be trapped and counted manually and/or with electronic counters as they move upstream from Yellowstone Lake to spawn. NPS crews would be housed in a backcountry cabin adjacent to the creek and weir, and use boats to transport staff, equipment, and supplies from Bridge Bay several times each year.

Visual surveys of spawning YCT have been conducted each spring since 1989 on 9 to 11 tributaries along the lake's western shore between Lake and Grant (Reinhart 1990; Reinhart et al. 1995). Under Alternative 2, spawning reaches that have been delineated on each tributary would be walked in an upstream direction weekly from May through July and the observed YCT would be counted. No fish are physically caught or handled during this survey.

A *fall netting program* has been used to assess YCT population abundance and length structure in Yellowstone Lake each September since 1969 (Koel et al. 2005). Multi-mesh-size (experimental) gillnets (38.0-m length, 7.6-m graduated mesh panels of 19, 25, 32, 38, and 51 mm) would be placed in sets of five nets perpendicular to the shoreline overnight, in 0 to 5 m water at 11 sites throughout the lake (Jones et al. 1977). Crews housed at Lake Village would use 7-m boats to monitor the nets. All YCT carcasses would be examined for biological characteristics (e.g., age, growth, reproductive status) and health (e.g., presence of whirling disease or other pathogens).

Angler success has been assessed since 1979 via *Volunteer Angler Report Cards* distributed to those who purchase a special use permit for fishing (Jones et al. 1980). Under Alternative 2, information from the cards on time spent and the species and size of fish caught by anglers on Yellowstone Lake would continue to be used to assess the status of YCT.

Reconstruction of Clear Creek Weir and Trap

Clear Creek is an important YCT spawning tributary on the eastern shore of Yellowstone Lake. Park staff are working with Montana State University to select an appropriate design for reconstruction of the weir and trap at Clear Creek (fig. 9). Under this alternative, a new structure would be built at the same site, using the bulkheads from the previous weir and mostly of unnatural materials, including concrete blocks, cement, steel, and iron. The structure would be able to withstand high spring flows with as little impact to stream hydrology as possible and permit the visual counting, capture, and handling of YCT as they ascend the creek to spawn. It would also accommodate the future addition of a remote sensing fish counting device such as those used in many Pacific Northwest and Alaskan streams. This would not occur until adequate funding was available for purchase and long-term support of the system. However, the YCT could be counted without the complete weir in place, allowing natural flows to be maintained much more often during spring runoff and helping to maintain the integrity of the structure and surrounding habitat.

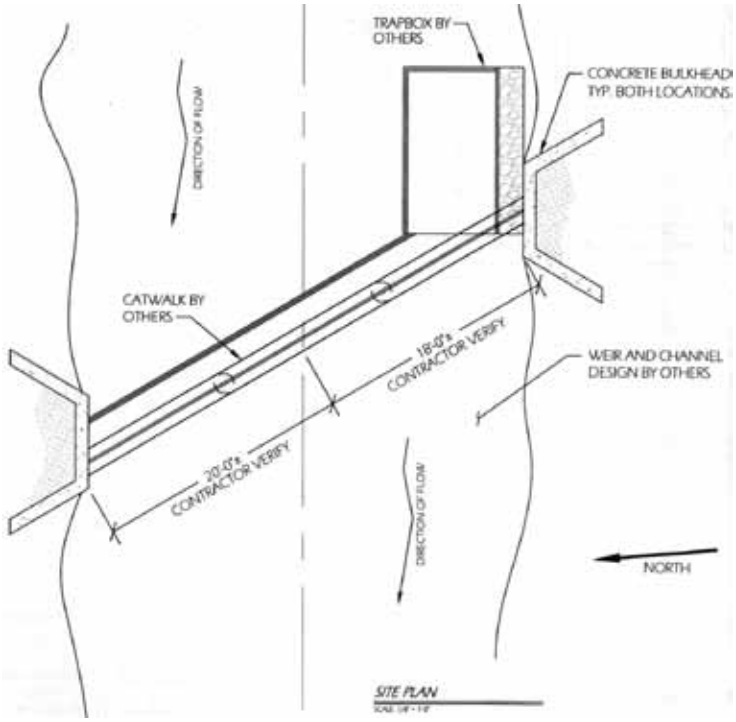

Figure 9. Conceptual design for reconstruction of the Clear Creek weir and fish trap. Produced by Montana State University's Engineer Department, Spring 2010.

2.3.2 Other Streams, Rivers, and Lakes

The conservation of native fish in streams, rivers, and lakes other than Yellowstone Lake would focus on the restoration of WCT, YCT and GRY populations across the park (fig. 1). This approach would emphasize projects that maximize conservation value, efficient use of resources, and likelihood of success. Projects and their desired outcomes would vary on a case by case basis largely depending on existing conditions, technical limitations, consideration of ecological, socioeconomic, and other impacts, and available resources. No impacts would exceed those disclosed in this environmental assessment.

All conditions would be evaluated in an adaptive management framework (table 6; fig. 6) that specifies conservation actions, defines success in terms of quantitative responses and performance metrics, and identifies alternatives to be considered if conservation actions do not produce a desired result. Desired conditions are for specific waters (project areas) within Yellowstone National Park. The *cumulative result* of multiple projects for AGR, WCT and YCT would be designed to meet the Native Fish Conservation Plan measureable objectives set forth in chapter 1.

Scientific Basis: Details on the science supporting our proposed conservation actions (e.g., use of piscicides) are provided in **Appendix B**. The following represent the development of a formal adaptive process and benchmarks against which metrics derived from long term monitoring (see section in *Conservation Actions* below) can be compared.

Contingencies: Performance metrics derived from long term monitoring would be evaluated annually by NPS and science partners/stakeholders. If performance metrics do not indicate a positive trend/shift toward the quantitative response(s) and desired condition(s) originally sought, ADM modifications would be made immediately. These could include modifications to the project area(s) chosen, the conservation actions taken and/or to the hierarchical desired condition to be strived for.

2.3.2.1 Desired Conditions

The primary, secondary, and tertiary desired conditions for streams, rivers, and lakes other than Yellowstone Lake are described below. Although the primary condition for a specific project area is the most desirable, where it cannot be achieved, the secondary condition should be strived for. If the secondary condition cannot be achieved, the tertiary condition is to be considered. Not achieving at least the tertiary condition would be considered a failure to meet the Native Fish Conservation Plan objectives.

Primary Desired Condition:
The primary desired condition would be characterized by restoration of a genetically unaltered population of native fish that is free of the presence of non-native fish and secure from future invasions. Quantitative responses to characterize the primary desired condition would be the creation and maintenance of a genetically unaltered, self-sustaining population (100% native alleles; no detectable hybridization) of 100% native fish.

The conservation actions expected to be necessary to achieve this condition:

- Isolate the project area from sources of non-native fish through the construction of artificial barriers or modification of existing natural features (cascades or small waterfalls) to create a

complete barrier to upstream fish movement. (Some project areas may already be isolated by a falls or other natural barrier and not require this action.)
- Remove all non-native and genetically altered fish from the project area using EPA-approved piscicides (see Appendix B).
- Restock genetically unaltered native fish to the project area.
- Create and maintain genetically unaltered native fish brood sources in suitable waters within the park and in facilities of neighboring states.

Secondary Desired Condition:
Situations would arise where the restoration of a genetically unaltered population of only native fish is not possible. In these cases, conservation actions would attempt to protect an already compromised native fish population from further degradation by isolating headwaters with a fish barrier, enhancing the genetic integrity of the existing population, and/or alleviating competition and predation from non-native fish. Quantitative responses to characterize the secondary desired condition would be a reduction in the abundance of non-native fish by at least 90% over 10 years and/or to improve the genetic integrity of an existing cutthroat trout population so that (1) it consists of at least 90% native species alleles, or (2) the extent to which the population was hybridized preceding project implementation is reduced by at least 50% (e.g., a native population with 95% native alleles would be improved to at least 97.5% native alleles).

The conservation actions predicted to be necessary to achieve this condition:

- Isolate the project area from sources of non-native fish through the construction of artificial barriers or modification of existing natural features (cascades or small waterfalls) to create a complete barrier to upstream fish movement. (Some project areas may already be isolated by a falls or other natural barrier and not require this action.)
- Selectively eradicate non-native and genetically altered fish through mechanical means (e.g., electrofishing, netting, and/or angling) to the greatest extent possible.
- Supplement the existing population by stocking genetically unaltered native fish to improve the genetic integrity of the existing native fish population. In the fisheries profession this is referred to as genetic swamping.

Tertiary Desired Condition:
Quantitative responses to characterize the tertiary desired condition are based on limiting the genetic influence and expansion of non-native fish and reducing by 50% the abundance of non-native fish and/or the degree of native fish population hybridization.

The conservation actions expected to be necessary to achieve this condition:

- Reduce spawning success of non-native fish by limiting access to spawning areas. In the fisheries profession this is referred to as selective passage.
- Reduce spawning success of non-native fish by destroying their embryos.
- Improve spawning success of native fish by improving access to spawning areas.
- Increase angler harvest of non-native fish.

Failure to Achieve a Desired Condition

If desired conditions are not attained within 10 years of implementing the proposed actions, either due to incomplete isolation due to barrier failure, incomplete elimination of non-native fish, illegal introduction of non-native fish into the project area, or any other event that leads to hybridization or introduction of non-native fish, subsequent management of the water body would be highly dependent on its historical status (fish-bearing or fishless condition). In historically fish-bearing waters, wild self-sustaining fish populations would be managed to provide maximum benefit and enjoyment for the public.

2.3.2.2 Conservation Actions

The following are examples of potential actions. Following the ADM strategy, these methods would be evaluated and updated seasonally (if necessary).

Barrier Construction/Modification

Fish barriers are commonly used to help preserve and restore native salmonids in the Intermountain West (see Appendix B). The barriers proposed under this alternative would be designed to completely preclude all upstream fish movement and ensure structural integrity and function across a wide range of water flows, including a 100-year flood event. Structures of this type are commonly at least 1.8 m (6 ft) in height with a vertical or near vertical drop onto an engineered hard flat surface or splash pad that prevents a plunge pool from forming at the base of the barrier. Research suggests that non-native fish common to the Yellowstone region are unable to jump over a structure 1.8 m high without a plunge pool below. Ideal locations for fish barriers are in high-gradient stream reaches with steep banks and exposed bedrock. For projects where they are deemed necessary, fish barriers would be located in the most downstream location suitable for construction in order to provide the largest possible area upstream for native fish restoration.

An example of a recently constructed fish barrier designed to facilitate native cutthroat trout restoration is the East Fork Specimen Creek (EFSC) fish barrier, which was constructed in 2008 by NPS fisheries staff, Montana Conservation Corps volunteers, and a local contractor (Intermountain Restoration, Wilsall, Montana). The EFSC barrier was built three miles into Yellowstone's backcountry using mostly native materials (logs and rocks) and hand tools. The off-site materials that were used, mostly concrete, were almost exclusively packed to the site on horses and mules; helicopter flights were kept to a minimum. The resulting barrier is approximately 1.8 m high at the center, roughly 18 m wide at the top, and includes a hand-poured concrete splash pad. Construction of the barrier took about one month. This barrier is expected to function without significant maintenance for approximately 10 years, although the true life expectancy of the barrier is unknown.

Although the EFSC barrier provides an example of backcountry fish barrier construction, ideally barriers would be constructed in or near road-accessible locations so that contractors with experience in similar projects can use heavy equipment and modern techniques to build more durable, predictably functioning structures, probably of concrete.

Whether in the backcountry or road-accessible locations, all construction of fish barriers would be done with the utmost consideration to minimizing the impact on the surrounding area and maximizing retention of "wilderness character". Barriers would be constructed in such a manner as to blend as well as possible with the surrounding landscape.

A barrier to upstream fish movement may also be created by modifying an existing natural feature, usually cascades, into a complete barrier. This method has been used with success in the region (see Appendix B). Park staff would identify features that were already partial barriers to fish movement and then assess the potential of modifying the feature into a complete barrier by redirecting stream flow using wing walls, filling plunge pools with material to eliminate jumping areas, using explosives to increase the height or angle of a feature, or some combination of these techniques. This method has several advantages, including creating the most reliable and durable barrier possible as well as often retaining the appearance of a mostly natural feature. The major drawback of this method is that it would alter a natural feature, possibly in a way that is not easily reversed.

Construction or modification of barriers would require the NPS to complete site-specific surveys for all potentially impacted natural and cultural resources and obtain all applicable state and federal permits. This surveying and permitting would be completed on a case by case basis before construction activities commenced.

Chemical Removal of Fish

Chemical fish toxicants (piscicides) have been used in fisheries management in North America for over 70 years (see **Appendix B**). The history of piscicide use in national parks is nearly as old, with the first application for the removal of non-native fish occurring in Yellowstone's Goose Lake in 1938 (table B-2). Piscicides are commonly used to control or eradicate non-native and undesirable fish species in both standing and flowing water. The two EPA-approved piscicides applicable to the proposed actions in Yellowstone, rotenone and antimycin a (hereafter antimycin). Both of these chemicals are very toxic to gill breathing organisms, affect fish at the cellular level, and are relatively non-toxic to humans or wildlife. The application of piscicides is closely regulated by multiple government agencies, including the Environmental Protection Agency, the Montana and Wyoming state departments of environmental quality, and NPS policy. All piscicide application would follow applicable permitting requirements and guidelines set forth by regulatory authorities.

The application of piscicide in the park would be a carefully planned and meticulously executed operation designed to minimize the possibility of impacts to human health and safety and non-target organisms such as larval amphibians and aquatic macroinvertebrates. The recent EFSC WCT restoration project, which provides an example of a safe and successful piscicide application, would be used as a model for the actions proposed here.

The goal of piscicide application in this EA is to remove all non-native and/or hybridized fish from a project area following barrier construction and/or modification. In a lake environment, the piscicide would be applied below the lake surface from a motorized boat. In a stream environment, the piscicide would be applied at multiple metered stations along the stream. In flowing water, piscicide application would always begin at the most upstream extent of the project area and progress downstream. In both lake and stream settings, all connected waters (springs, seeps, wetlands) found to contain fish would also be treated. The piscicide application would strictly follow EPA-approved label guidelines for treatment concentration, applicator safety, public safety, and all other requirements.

The application of piscicide would always be conducted in a manner that balances treatment efficacy with all available options to mitigate undesired effects. For instance, the timing and concentration of treatments would be designed to minimize the impacts on amphibian

populations and aquatic invertebrates to the greatest extent possible. Mitigation for treatment would also take the form of careful assessment of fish-bearing versus fishless waters in a project area to avoid unnecessarily treating areas from which non-target organisms could re-colonize.

A detailed discussion of the science and application of piscicides, including a thorough literature review of ecological and human health risks, can be found in Appendix B.

Stocking Native Species:
The native fish conservation actions proposed in this EA would require stocking genetically unaltered native fish following barrier construction and eradication of non-native fish from project areas. A variety of methods for introducing native fish are available and the recently completed EFSC WCT restoration project offers a model for the proposed action. Native fish embryos (eyed-eggs) would be placed in RSIs that have been positioned in flowing waters (stream, tributaries, and/or lake inlet/outlets). After the eggs hatch and the young fish (fry) develop for several weeks, the fry would be able to swim out of the incubator. A second method for introducing native fish is to stock directly into the project waters fry, juveniles, adults, or a combination of ages, that have been captured by electrofishing and netting.

These two methods of introducing native fish have distinct advantages and limitations. The use of RSIs allows fish to hatch in the project area and imprint to its waters, which should result in these fish returning to the project area as adults to spawn. The use of RSIs makes it possible to stock large numbers of genetically diverse fish with relatively little transportation effort. The main limitations of RSIs are their susceptibility to failure from clogging, changing water conditions, or disturbance by wildlife or people. The maintenance required to operate RSIs sometimes makes them difficult to use in remote settings. However, RSIs were an important tool in restocking High Lake of upper EFSC, which lies 10 trail miles into the backcountry.

Stocking live fish is accomplished by transporting them from a hatchery or wild population into the project area. The method requires little or no immediate post-stocking maintenance, can quickly restore recreational fishing, and is not susceptible to disturbance from wildlife or humans. However, the method is difficult in remote locations because a helicopter is required to move the fish with large amounts of water, and because the fish are not imprinted to the project area waters, it is suspected that they experience lower survival and reproductive success than their natal counterparts.

Developing and Maintaining Native Brood Stocks in the Wild:
Stocking native fish requires sources of genetically unaltered fish. Native brood stocks can be of hatchery or wild origin, and both would be used under Alternative 2. A few native fish brood sources are currently available (table 7) and more wild populations are proposed for development under this EA. The states of Montana and Wyoming both maintain hatchery brood stocks of YCT. Montana also maintains hatchery brood stocks of WCT and GRY, and coordinates efforts to maintain an Upper Missouri River WCT wild hatchery brood at Sun Ranch near Ennis.

Hatchery brood stocks can be a valuable tool in native fish restoration because they provide an abundant and accessible source of native fish. However, hatchery brood sources have several limitations: (1) they require active maintenance to both perpetuate the brood stocks and maintain their genetic diversity, (2) concerns exist over their ability to maintain wild fish characteristics after multiple generations in the hatchery environment, and (3) they present risks from health concerns and accidental mixing of species, especially if they share facilities with

Clockwise from top left: Wild egg collection on Last Chance Creek, D. Rupert; Helicopter aids in fisheries work, NPS Photo; Barrier built on the East Fork Specimen creek in 2008, K. Olsen; Piscicide drip stations and drinking water advisory sign, D. Rupert; RSI implementation, T. Koel; A. McGrady and trails livestock packing supplies to construction site, T. Koel.

Table 7. Existing and proposed native fish brood sources in the Greater Yellowstone Area

Species	Type	Brood	Location	Original Source	Managing Agency	Abundance	Availability
Existing brood stocks							
WCT	Hatchery	MO12	Anaconda, MT	West of Continental Divide	MFWP	Very High	Very High
WCT	Wild/Hatchery	Sun Ranch	Ennis, MT	Upper Missouri River tributaries	MFWP	High	High
WCT	Wild	Geode Creek	YNP, WY	Unknown	NPS	High	High
WCT	Wild	Last Chance Creek	YNP, MT	Aboriginal	NPS	Very Low	Low
WCT	Wild	High Lake	YNP, MT	Sun Ranch, Geode and Last Chance creeks	NPS	Moderate	Very Low
YCT	Hatchery	Big Timber	Big Timber, MT	McBride Lake, YNP	MFWP	Very High	Very High
YCT	Hatchery	Ten Sleep	Ten Sleep, WY	LeHardy Rapids, YNP	WGFD	Very High	Very High
YCT	Wild	Yellowstone Lake	YNP, WY	Yellowstone Lake	NPS	Low	Moderate
YCT	Wild	Antelope Creek	YNP, WY	Unknown	NPS	Low	Moderate
YCT	Wild	Goose Lake	Cooke City, MT	Aboriginal	MFWP	Moderate	Moderate
AGY	Wild/Hatchery	Axolotl Lakes	Big Timber, MT	Big Hole River	MFWP	Moderate	Moderate
Proposed brood stock development projects							
WCT	Wild	Goose Lake Chain	YNP, WY	Upper Missouri River tributaries	NPS	High	High
YCT	Wild	Trout Lake	YNP, WY	Trout and Yellowstone lakes	NPS	High	High

Table 7. Existing and proposed native fish brood sources in the Greater Yellowstone Area.

non-native fish. However, these risks have been successfully mitigated by genetic and health testing and careful hatchery management.

Wild brood stocks that complete their entire life cycle in the wild typically require no human intervention. They often exist in remote locations that are isolated from many threats but offer only limited access during spawning periods. Although they are sometimes considered preferable to hatchery broods, they also have limitations. Wild brood stocks of genetically unaltered native fish are rare, and even rarer are abundant sources that can be used extensively with little threat to the existing population and are in a location that is accessible during the spring spawning period. Many wild broods are remnant native fish populations consisting of only 100s of individuals or less, so the amount of eggs or fish that can be removed is greatly limited. Much like their hatchery counterparts, wild brood stocks require testing for genetic purity and overall health (presence of pathogens) on a regular basis. It is important to note that utilizing wild broods usually requires the use of hatchery facilities; after wild eggs are collected and fertilized, they are typically moved to a hatchery for incubation into an eyed-egg stage before being placed into RSIs in the project area.

Brood stocks that combine wild and hatchery elements are sometimes used in native fish conservation efforts in which the fish are raised in a near natural setting (such as a pond) without feeding or other manipulation. However, the reproductive capacity of these fish is non-existent or extremely limited, so they must be captured and spawned by hatchery managers. After the fertilized eggs are hatched, the fry are returned to the pond. Montana Fish, Wildlife and Parks maintains the Upper Missouri River WCT brood at the Sun Ranch in this manner.

Despite the rarity of suitable locations for developing wild brood stocks, at least two locations in the park meet all the criteria for developing highly valuable wild brood stocks: Goose Lake near the Firehole River for WCT and Trout Lake near Soda Butte Creek for YCT. Both locations currently contain non-native fish that would have to be eradicated, but both are easily accessible during the spawning period and are capable of supporting abundant, self-sustaining populations of genetically unaltered fish for native fish conservation projects without seriously jeopardizing native fish populations. We propose to develop wild brood sources for WCT and YCT through the eradication of non-native fish and, if necessary, introduction of genetically unaltered native fish to Goose and Trout lakes and potentially other suitable locations that are identified.

Mechanical Removal of Fish

Although angling, electrofishing, trapping, and netting can be effective in reducing the abundance and distribution of non-native fish; these methods of mechanical removal have succeeded in completely eradicating a non-native fish population only in very rare situations involving a small, simple habitat, not in Yellowstone. Complete removal of non-native fish from large and/or complex habitats would be impossible because fish able to escape the removal method can quickly re-establish the population. Mechanical removal methods would therefore only be used in the park in situations where limiting non-native fish influence is the only reasonable and prudent option. As explained above, this is the current situation in Yellowstone Lake.

The advantage of using mechanical removal methods is that they can be used to remove only the targeted fish species while returning desirable species to the project area unharmed. This is especially useful in situations where genetically unaltered cutthroat trout exist with non-hybridizing non-native species such as brook trout, brown trout, or LKT. Mechanical removal

would also be useful in situations where a cutthroat trout population has recently been invaded from a known source by hybridizing rainbow trout. In that instance, rainbow trout and early generation hybrids that are visibly identifiable could be removed to limit their genetic influence in the invaded stream reaches. This would be effective only if the removal occurred before the cutthroat trout population was extensively hybridized and the source of the invasion could be curtailed.

Genetic Swamping

Genetic swamping is the introduction of genetically unaltered native fish as embryos, juveniles, or adults into an already compromised (hybridized) native fish population for the purpose of increasing the percentage of native fish alleles in the receiving population. This method would be used in situations where a cutthroat trout population has been extensively hybridized and complete elimination of the population is not technically feasible or not acceptable due to environmental impacts. The goal of genetic swamping would be to increase the presence of cutthroat trout alleles to at least 90% or, if the population is already greater than 90% native, to decrease the non-native component by 50%. Introductions would be made in the same manner and from the same sources as described in "Stocking Native Species" above.

Angling

Angling can be used to limit the abundance, distribution, and influence of non-native fish. The park's fishing regulations are used to manage angling by the public. Fishing restrictions based on management objectives are established annually by the park superintendent, who may impose closures and establish conditions or restrictions in accordance with criteria and procedures stated in the Federal Code of Regulations (36 CFR, Chapter 7-1e2). This includes regulating the seasons and hours during which angling may take place, creel size and possession limits, the species of fish that may be taken and the methods of taking (36 CFR, Chapter 7-1e2).

The primary objectives of the park's fishing regulations are to maintain native fish abundance and genetic integrity, the park's overall ecological integrity, and a recreational fishery for park visitors. Recent examples of fishing regulation changes that have been implemented to achieve these objectives: (1) implementing a "must kill" regulation for all LKT caught in Yellowstone Lake; (2) establishing a drought fishing policy and implementing fishing closures during periods of heat stress; and (3) creating a framework for the park's fishing regulations based on the presence or absence of native fish. The park was divided into two zones: a Wild Trout Enhancement Area, where native and non-native fish are regulated to optimize a sport fishery; and a Native Trout Conservation Area, where angling is managed to maximize the conservation of native species, which includes allowing the increased take of non-native species.

Under Alternative 2, park staff would continue to review and implement the park's fishing regulations according to the Federal Code of Regulations. This would include removing protective regulations for nonnative fish at strategic locations to promote nonnative fish harvest. Locations within the park that serve as examples of where this would benefit native species include the Lamar River, Slough and Soda Butte creeks.

Selective Passage of Native Fish

Selective passage of native fish can be an active or passive method that allows native fish to reach important spawning areas while impeding non-native fish from accessing the same locations. Selective passage would be used in situations where native and non-native fish coexist in a large lake or river and migrate to the same tributary habitats to spawn. In a passive approach to

selective passage, a weir is placed in the spawning tributary when non-native reproduction or hybridization is most likely to occur and removed when the native fish are most likely to migrate.


Clear Creek weir and trap rebuild. NPS Photo.

Under an active approach to selective passage, all fish ascending a tributary are stopped by a weir, collected in a fish trap, and sorted by biologists so that the native fish are passed over the weir and the non-native fish are removed. Active selective passage would require intensive effort to monitor the fish trap and sort fish for passage. Criteria would need to be established to determine how fish are selected for passage. Selection criteria could be based on visual inspection of the fish or genetic testing. Visual inspection would cost less but pose more risk of passing hybridized fish. Using visual inspection to detect hybridization in individual fish, especially low-level hybridization, is difficult even for experienced biologists. Genetic testing can be done by marking and collecting genetic samples from all fish suspected to be genetically unaltered natives, then sending the samples for timely (48 hours) genetic analysis. Fish found to be genetically unaltered would be passed over the weir and hybridized fish would be removed from the population. Current genetic analysis is limited in its ability to detect low levels (<10%) of hybridization in individual fish, but genetic methods are constantly evolving and more accurate and timely tests are currently in development.

Destruction of Non-native Fish Embryos

The abundance and influence of non-native fish and first generation cutthroat trout hybrids could be limited by using electricity or piscicides to destroy their embryos in the stream or lake bottom where they spawn. Emerging technology may also allow embryos to be removed from the environment using suction. This approach would require careful application to avoid destroying native fish embryos in the same habitats. This could be accomplished by taking advantage of differences in spawning timing. For example, rainbow trout are known to spawn earlier than cutthroat trout do.

Improving Connectivity of Native Fish Habitats

A common issue encountered in the conservation of native fish is human-caused alteration of critical habitat, e.g., at road crossings where a culvert designed to carry stream flows under the road is constructed in a way that impedes fish movement. These barriers to fish movement are usually due to the culvert being perched so that it creates a jump barrier, or undersized and steep, causing water velocity to inhibit passage. Although Yellowstone has relatively few roads and very few dams or water diversions, some barriers to fish movement result from road culverts and three irrigation diversion structures on Reese Creek.

Occasionally these structures have been fortuitous for native fish. For example, a collapsed road culvert in the original section of Highway 191 isolates the only remaining historical population of WCT in the park, located in Last Chance Creek, a tributary of Grayling Creek. Similarly, a perched road culvert on Elk Creek has protected that stream's headwaters from invasion by brook trout. Elsewhere, however, road culverts or other features may currently or could become impediments to native fish accessing critical habitats. In these situations efforts would be undertaken to eliminate or mitigate the barrier by modifying or replacing road culverts and irrigation structures or constructing fish passage devices (fish ladders).

Fish passage can also be inhibited by natural events such as drought, sediment deposition, landslides, and log jams. In the case of Yellowstone Lake spawning tributaries, a combination of drought and sediment deposition has been shown to isolate streams from the lake at critical times. Although natural events that inhibit fish movement are generally not actively managed, if they directly threaten the persistence of important native fish populations or are caused by factors attributable to global climate change, active management would be considered. Potential activities include manually moving sediment or other impediments to fish passage, placing log structures in streams to change the pattern of sediment deposition, and removing or reducing log jams or rock slides to the extent necessary to allow fish passage. Any activity undertaken to this end would be done with careful consideration to maintain the wilderness character and natural function of the stream.

Historically-Fishless Water

In park waters that were historically fishless and have retained that condition, no native fish conservation actions are being considered by this EA. Native fish conservation activities are being considered in some locations that were historically fishless but are now populated by non-native fish. However, if native fish conservation is attempted in historically fishless water and a population of native fish (fish native to the drainage where the water exists) fails to become established, the water would be restored to fishless condition. Similarly, any currently and historically fishless water that is invaded by non-native fish in the future would be aggressively managed and restored to fishless condition through elimination of the invading, non-native species.

2.3.2.3 Monitoring Success

Identifying specific quantitative responses is crucial to the success of the proposed AM strategy for streams, rivers, and lakes other than Yellowstone Lake. All of the desired conditions and conservation actions include performance metrics tied to the abundance of native and/or non-native fish or the genetic composition of native fish populations (table 6).

Assessing Fish Abundance

Methods of measuring fish abundance would vary depending on which water is being sampled. In small streams, fish abundance would typically be measured by the depletion method, in which fish are captured by electrofishing during multiple passes through a known length of stream. After each pass fish are counted and held in a cage outside the sample reach. Three passes are usually required to produce an accurate population estimate. After the sampling, all native fish would be returned to the stream reach where they were captured. In this manner, population estimates would be collected from several locations throughout the stream. The estimates would be averaged and expanded to create a population estimate for the stream as a whole.

Measuring fish abundance in large streams, rivers, or lakes would be done using mark-and-recapture, in which as many fish as possible from the project water are captured, usually by electrofishing or netting. The captured fish are marked using fin clips or implanted tags, then released back into the water. Fish captured in the subsequent sampling are noted as either being marked or not marked from the original sampling. The overall number of fish captured and the proportion of marked vs. unmarked fish is used to estimate the population of the area sampled. In a lake the “area sampled” is usually the entire lake, but in rivers or streams the method estimates can be made for several reaches, averaged, and expanded to generate a population estimate for the entire river or stream.

Either depletion or mark-recapture would be used to produce population estimates of multiple fish species simultaneously. The collection of additional information from captured fish, such as length, weight, and age (based on scales), would allow population structure, growth rates, and biomass (size of population by weight) to also be estimated.

Assessing Genetic Composition

Over the past decade park staff have used four laboratories in the region to analyze fish genetics. Future analysis of fish genetics would be completed by a combination of these labs or by labs with similar expertise and capabilities. To collect genetic information from fish, a small piece (<1 gram) of the fish's fin is clipped off and preserved in alcohol for shipment to the lab. Samples are generally collected from the pelvic, anal, or caudal (tail) fins because these fins will regenerate, causing no long-term harm to the fish.

Genetic analysis techniques are constantly evolving, but currently can detect 1% or less hybridization with 99% confidence if about 25 fish are sampled. That means that in 99 out of 100 cases the analysis would be able to detect 1% hybridization in the fish population.

To analyze the genetics of an individual fish, about 10 genes are tested to determine whether they came from the native species or a non-native species. Although this method is effective for a large sample at the population level, it is limited in its ability to detect low levels of hybridization at the individual level. Early generation hybrids that have a high proportion of genes from each species are likely to be detected, but fish with a low proportion of non-native genes are likely to be misidentified as native For this reason, the technique can be used to assess the number of first generation hybrids in a population of fish, but not to identify lesser degrees of hybridization.

As a tool for assessing project success, genetic analysis could be used to determine the genetic makeup of an entire fish population or to identify the proportion of early generation hybrids in a population. As genetic analysis techniques become more powerful, it will be possible to test more genes per individual fish and detect lower levels of hybridization at the individual level. Any new technique for genetic analysis would be carefully reviewed by the scientific community before being implemented as part of Yellowstone's native fish conservation activities.

2.3.2.4 Examples of Potential Projects

This EA is designed to address a range of potential projects in streams, rivers, and lakes across the historical ranges of native fish in the park as summarized in table 8. However, it is not intended to provide a complete list of all projects to be completed under the Native Fish Conservation Plan. Additional projects may be developed based on emerging information and changing environmental conditions. Additional projects would be carried out using the techniques discussed above with impacts not exceeding those disclosed in this EA. Similarly, projects in table 8 may be removed from consideration or considered for less desirable conditions if they are found to be technically unfeasible, resources for completion are not available, or impacts are determined to be unacceptable. To clarify the types of activities being considered and range of waters where projects may occur, some examples are described below.

Grayling Creek

The proposed project would aim to achieve the primary desired condition (table 6) by restoring GRY and WCT to Grayling Creek on the park's west side. Project elements would include modification of a waterfall to create a complete barrier to rainbow trout and brown trout,

removal of all non-native and hybridized fish using piscicide, and stocking GRY and WCT until self-sustaining populations become established.

Grayling Creek is an expansive and remote drainage that flows through the park, Gallatin National Forest, and private ranchlands before reaching Hebgen Reservoir. Just upstream of the park boundary, a five-foot waterfall creates a nearly complete barrier to upstream fish movement, largely isolating approximately 32 miles of known fish habitat. Last Chance Creek, home of the only known native WCT population in the park, is an isolated tributary of Grayling Creek upstream of the waterfall. Historically, GRY and WCT were abundant downstream of the waterfall and WCT were known to exist upstream of the waterfall. It is unknown if GRY existed upstream of the waterfall. The construction of Hebgen Reservoir and the introduction of brown, rainbow, and YCT extirpated the grayling and left the remaining WCT population highly hybridized throughout the drainage except for Last Chance Creek.

Modification of the existing barrier would most likely involve construction of a wing-wall to direct all water over the center of the waterfall and filling of the existing plunge pool. Prior to modification, a certified engineer would prepare a detailed survey and design for the project and resource surveys would be conducted at the site to ensure that it would not result in any significant impacts to park resources. Completion of the modifications would likely require a small amount of mechanization and several short helicopter flights to transport equipment and materials too heavy to be moved by other means. Modifications to the waterfall would probably be completed during the first year of the project.

Table 8. Examples of Projects Under Consideration

Proposed Project	Benefitting Native Species	Adaptive Management Desired Condition (Initial)	Proposed Technique to Manage Non-native Fish (length treated with piscicide)	Proposed Barrier Type
De Lacy Creek	YCT	Primary	Piscicide (45 Km)	Existing natural lake (Shoshone Lake)
Elk Creek Complex	YCT	Primary	Piscicide (12 Km)	Existing natural cascade
Gibbon River (upper)	WCT and GRY	Primary	Piscicide (179 Km)	Existing natural falls
Goose Lake Chain	WCT	Brood stock[1]	Piscicide (5 Km)	Existing natural subsurface flows
Grayling Creek	WCT and GRY	Primary	Piscicide (72 Km)	Modified natural falls
Pocket Lake	YCT	Primary	Piscicide (3 Km)	Existing natural subsurface flows
Reese Creek	YCT	Secondary	Electrofishing	Existing diversion structures
Rose Creek	YCT	Tertiary	Electrofishing, angling, trapping at weir	Temporary weir
Slough Creek	YCT	Secondary	Electrofishing, angling	Concrete
Soda Butte Creek	YCT	Secondary	Electrofishing, angling	Modified natural falls
Specimen Creek	WCT	Primary	Piscicide (51 Km)	Concrete
Trout Lake	YCT	Brood stock[1]	Trap netting, angling	Existing natural subsurface flows

Table 8. Examples of projects under consideration for streams, rivers, and lakes other than Yellowstone Lake to benefit Arctic grayling, westslope cutthroat trout, and Yellowstone cutthroat trout.

Chemical removal of all fish from the project area would be completed during the second, third and possibly fourth year of the proposed project. All waters found to be fish bearing would be treated with an EPA-approved piscicide in a concentration sufficient to eradicate fish. Springs and seeps along the stream would also be treated to ensure that non-native fish could not find refuge from the treatment. The exact concentrations used to remove fish would be determined by testing the chemical in the field before the main treatment. These tests, called bioassays, would ensure that the minimum amount of chemical necessary to successfully complete the project was used. The piscicide would be neutralized at the downstream end of the project by applying potassium permanganate ($KMnO_4$). Park staff would conduct two treatments each year for up to three years or until the non-native fish have been eradicated.

Following complete elimination of the non-native fish, both GRY and WCT would be stocked into Upper Grayling Creek using RSIs and/or live fish. Native fish would come from genetically unaltered sources such as the state of Montana's GRY brood stock and the Sun Ranch WCT brood. Restocking would continue until self-sustaining populations were established, within an expected timeframe of three to five years.

Slough Creek

Slough Creek is a large tributary to the Lamar River in the north-central region of the park. Despite the stocking of numerous fish species in the Lamar River and Lower Slough Creek, the upper reaches of the stream retained a population of genetically unaltered YCT through the 20th century. Upper Slough Creek is a world famous angling location, beloved by locals and visiting anglers alike. It was long thought that this location was protected from an RBT invasion by a steep canyon reach above the Slough Creek Campground. However, genetic evidence of RBT was discovered upstream of the canyon early in the 2000s. Since then, RBT genetics have become more prevalent just upstream of the canyon and have also been found far upstream. Evidence suggests that RBT from Lower Slough Creek are able to pass the canyon reach, perhaps aided by low water conditions prevalent in the drought years of this decade. It has become clear that RBT will continue to invade Upper Slough Creek and further degrade the genetic integrity of its YCT population unless action is taken.

The proposed project on Upper Slough Creek would be designed to achieve the secondary desired condition (table 6). The project would attempt to halt further RBT invasion by creating a barrier in the Slough Creek Canyon and eliminating the RBT and early generation hybrids through selective angling and electrofishing. Angling harvest of RBT would be promoted in Upper Slough Creek and groups of anglers would be trained by park biologists to identify early generation hybrids so they could be targeted for removal. NPS staff and partner agencies would conduct electrofishing with the goal of eliminating as many RBT and hybrids as possible. The success of the project would be measured by its ability to halt the RBT invasion of Upper Slough Creek and hold steady or improve the genetic integrity of the YCT in the stream.

Rose Creek

Since RBT were stocked in the Lamar River system in the 1930s, they have altered the genetic makeup of the river's YCT population. Because of subtle differences in when they spawn, some genetically unaltered YCT have persisted in the system with the RBT and hybrids. However, evidence suggests that hybridization will increase if left unchecked. Considerable hybridization is occurring in Rose Creek, which is used by both RBT and YCT for spawning. The proposed project on Rose Creek would use selective passage and removal to achieve the tertiary desired condition (table 6).

Weirs and fish traps would be placed on the lower reaches of each branch of Rose Creek in the spring to capture all fish ascending the stream to spawn. The captured fish would be visually inspected, photographed, sampled, and sorted; YCT would be passed over the weir and RBTs and hybrids would be removed. The photographs and corresponding genetic samples would be used to assess the efficacy of visual identification of species and to inform future selective passage. The goal of this effort would be to reduce the number of RBT and first generation hybrids by at least 50% and improve the genetic integrity of the YCT in the stream by 50% over the first five years, at which point the project's efficacy would be assessed.

Goose and Trout Lakes

As mentioned above, high quality native fish brood stocks could be developed and maintained at at least two locations in the park. Trout Lake is a seven-acre lake in the Soda Butte Creek drainage in the northeastern part of the park that is home to a historical population of YCT. Beginning in the 1880s, the lake was stocked with YCT from other sources, including Yellowstone Lake. However, in 1935 the NPS began unsuccessful efforts to eliminate the YCT in order to develop a RBT hatchery which operated until 1955. Testing has indicated that now the lake contains genetically pure YCT and a small population of large, genetically pure RBT.

The presence of RBT presents a serious threat to the YCT remaining in Trout Lake, a relatively small system that lacks habitat complexity. Therefore, the proposed project would attempt to use trapnetting, gillnetting, electrofishing, and angling to eradicate RBT from Trout Lake, a project that would take approximately five years to complete, and which would be confirmed after at least two years of removal efforts without capturing RBT, by snorkel surveys, and by VAR reports. Genetic examination of the YCT in the lake would be conducted for at least five more years to confirm the absence of RBT alleles. If no RBT alleles were detected or RBT discovered, the lake would be used as a YCT brood source.

If mechanical means were deemed unsuccessful after five years, piscicide would be used to remove all fish from the lake, which would then be restocked with genetically unaltered YCT. An effort would be made to save some Trout Lake YCT or their progeny to restock the lake following RBT eradication.

Goose Lake and the unnamed lake to which it is connected by Goose Neck, are a historically fishless chain of lakes in the Firehole River drainage that has no outlet and is not connected to the Firehole River by any surface water. The Goose Lake chain has a long history of fish stocking and was the site of the first known piscicide application in any national park (Appendix B, table B-2). Yellow perch (*Perca flavescens)* were eradicated from Goose Lake using rotenone in 1938 and subsequently replaced with RBT that have persisted there. The proposed project would use piscicide to remove the RBT and replace them with a self-sustaining population of WCT which would be established using a combination of Upper Missouri River sources, similar to the Sun Ranch brood (table 7). However, unlike the Sun Ranch brood, the Goose Lake brood source would be able to reproduce without human manipulation. This brood would be one of only a few WCT broods, and perhaps the only highly abundant and highly accessible brood of wild Upper Missouri River WCT in existence.

In neither of the brood stock development cases described above would public access to the lakes be restricted except during piscicide treatments or to protect natural spawning of the native fish. Instead, the presence of native fish in easily accessible locations would be used as an opportunity to educate the public about issues related to native fish conservation. Catch and

release angling for WCT and YCT would also continue in the lakes, as it does for native fish in other park waters.

2.4 Alternative 3: Full Use of Native Fish Conservation Techniques and Lake Trout Marketed and/or Donated

Proposed actions under Alternative 3 are identical to those of Alternative 2, except that Alternative 3 would allow for the marketing of LKT by private sector contract netters. The netting and removal of LKT and other activities related to marketing of LKT, including fish processing, preserving, and shipment, would require additional staff working for or under sub-contract by the contract netters. The expectation is that revenues generated by the marketing of LKT removed from Yellowstone Lake could reduce NPS expenditures for the contract netting. Reduced costs per unit of contract netting would allow NPS to procure a greater number of units each season, exerting a greater level of suppression on the LKT. The contractor could market, sell, or donate the fish harvested. Fish not marketed or donated would be returned to deep water areas of Yellowstone Lake.

2.5 Alternative 4: Limited Use of Native Fish Conservation Techniques

Alternative 4 would continue existing NPS native fish management efforts and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake. No marketing of LKT by private sector contract netters would occur. The Clear Creek weir and fish barriers in streams would be constructed, and measures would be taken to assist native fish populations by reconnecting spawning tributaries, augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing native fish brood sources.

2.6 Permitting

All required local, state, and federal permits required for the actions proposed under this plan would be obtained prior to initiation of each applicable work element table 9).

Table 9. Anticipated Permits Required

Name of Permit/Authorization	Agency
Montana Stream Protection Act 124 permit	MFWP
318 Authorization: Short-term exemption from water quality standard for turbidity, Montana Water Quality Act	MTDEQ
308 Authorization: Short-term exemption from surface water quality standards for emergency remediation/pesticide application, Montana Water Quality Act, submitted for each year of application	MTDEQ
Clean Water Act Section 404 General Regional Permit	U.S. Army Corps of Engineers
Montana Wild Fish Transfer Form (Required to move fish from one Montana water to another)	MFWP

Table 9. Anticipated permits required for the implementation of the Native Fish Conservation Plan.

2.7 Mitigation Measures

The following mitigation measures, which were developed to minimize the incidence and severity of adverse effects, would be carried out as needed during implementation of any of the action alternatives.

2.7.1 Lake Trout Suppression

- Contractors would take proper precautions for aquatic nuisance species (cleaning, inspections, etc.) before putting their boats or other equipment into any body of water. All boats and equipment would be inspected by park staff prior to launching in Yellowstone Lake.
- A spill plan would be followed in case of a fuel leak on the ground or in the lake.
- Contractors and NPS personnel would avoid areas of Yellowstone Lake with known geological resources. Personnel would note areas where unusual bottom substrate is brought up in the nets and avoid these areas in the future.
- Contractors and employees would be directed to lift nets as the boat is operated over the nets rather than allowing the net lifter to drag the boat along. Dragging the net along the bottom would also be discouraged.
- Contractors and NPS personnel would avoid areas with high YCT by-catch as much as possible, check nets frequently to minimize YCT mortality, and check nets more often in areas where YCT are more likely to be caught. Net checks would be done daily or every other day in areas that are shallow during spawning season and new areas where catch rate is unknown. To minimize handling of and injury to YCT by-catch, personnel would quickly remove and release any captured YCT that appear alive and healthy. Park fish biologists would use information gained from other LKT removal projects to minimize catch and mortality of non-target species.
- The handling of LKT carcasses would be accomplished as much as possible on Yellowstone Lake. If fish carcasses are brought to shore for measurements, data recovery, marketing, or donation, storage and sanitation procedures would be followed to avoid attracting bears and other wildlife into developed areas. All lethally taken LKT or other fish mortalities would be disposed of by sinking them in water more than 65 m deep to avoid creating an attractant to wildlife.
- All gillnets would be marked with buoys at each end for visibility by boaters. Trapnets would be marked with three buoys and six bobber floats to delineate the extent of trapnet for visibility by boaters.
- Signs would be posted or available to the public at the marinas and visitor centers informing visitors of the LKT removal effort. A large map would be posted at Bridge Bay Marina marking net locations for visitor safety and awareness.
- Areas would be surveyed for Yellowstone sand verbena prior to initiation of any physical work to reconnect isolated tributaries. Tributaries with areas supporting or suspected to support Yellowstone sand verbena near the sand bars would be surveyed by vegetation specialists prior to initiating work. If impacts to Yellowstone sand verbena could not be mitigated, the tributary would be removed from further consideration for enhancement of YCT spawning access.

2.7.2 General Construction

- For each fish barrier constructed, interdisciplinary collaboration will take place to minimize the change to the stream's natural hydrologic conditions.
- Upon completion of hydrologic assessment/analysis for each fish barrier, a determination will be made as to extent of wetland resources impacted and whether project-specific Statement of Findings is warranted.
- Spawning stream work for weir development and barrier removal would not take place during the YCT spawning run when these areas are closed during the Bear Management Area restriction (until July 15th for most tributaries and August 11th for Clear Creek and the east shore of Yellowstone Lake).
- To minimize impacts to park visitors by trail and campsite closures, variations on construction and project timing would be considered. One option would be to conduct most work in the off-season or shoulder seasons (October–December and January–May).
- Sites would be surveyed for rare plant species, cultural resources, and wetlands before implementation of projects on a case by case basis.
- To the extent possible, the creation of social trails (the repeated use of the same pathway) by fisheries crews working near lakes and streams will be avoided to reduce long term trampling of vegetation and soil compaction. In any instance where a social trail is inadvertently created, upon completion of the project Yellowstone National Park resource protection specialists will be brought in to rehabilitate the area.
- Some trees may be removed, but other existing vegetation at the site would not be disturbed to the extent possible. Weed control methods would be implemented to minimize the introduction of noxious weeds. Because disturbed soils are susceptible to erosion until revegetation takes place, standard erosion control measures such as silt fences and/or sand bags would be used to minimize any potential soil erosion.
- All disturbed areas would be restored as nearly as possible to pre-construction conditions shortly after construction activities are completed. Revegetation and recontouring would be designed to minimize the visual intrusion of the structure. Revegetation efforts would strive to reconstruct the natural spacing, abundance, and diversity of native plant species.
- For each fish barrier constructed, regular monitoring of structural integrity and regular maintenance would be conducted to help assure that the restoration gains would be essentially permanent.

2.7.3 Cultural Resources

- Because archeological sites are known to be concentrated on stream banks and only a small portion of archeological sites are evident from surface deposits, shovel tests will be conducted to ensure that no buried cultural deposits will be disturbed at barrier or weir construction sites. If subsurface cultural material is found, the barrier will be moved to an area without buried cultural deposits.
- In the unlikely event that human remains, funerary objects, sacred objects, or objects of cultural patrimony are discovered during project implementation, provisions outlined in the Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001) would be followed. Project work would cease immediately and the NPS would consult with the affected tribe(s) and, if necessary, the Idaho, Montana, or Wyoming state historic preservation office. The location of any such ethnographic sites would remain undisclosed.

- If any cultural materials are discovered during construction, work in the area would halt immediately, the appropriate federal agency would be contacted and the materials evaluated by an archeologist or historian meeting the Secretary of the Interior's Professional Qualification Standards (48 FR 22716, Sept. 1983).

2.7.4 Use of Piscicides

- Mitigating the effects of piscicide on human health and safety would be ensured by strict adherence to all label guidelines and other applicable state, federal, local, and agency regulations pertaining to application, handling, storage, and transportation.
- Each project that requires piscicide use would be managed by a certified piscicide applicator.
- Risks from piscicides to the public would be mitigated using public awareness through press releases prior to project initiation and signage (placards) in and around the project area (trailheads, as well as information available at backcountry offices). In some cases the public would be temporarily restricted from entering the project area, particularly treated waters, during and after the treatment.
- Actions that would take place in backcountry and recommended wilderness areas would adhere to Yellowstone National Park's Minimum Requirement Policy. Approval of a Minimum Requirement Analysis would be required for each action that requires structures, flight landings, or mechanized equipment in recommended wilderness areas.
- Methods to mitigate piscicide use include: lowering piscicide concentration while still achieving complete eradication and adjusting treatment timing to avoid harming juvenile amphibians.
- Survey work would be completed prior to piscicide application to establish the distribution of target and non-target fish and presence of fishless water so that waters can be left untreated if treatment is not required.
- Mitigating the impacts to non-target organisms would also be accomplished by minimizing treatment concentration and duration as well as collecting and disposing of as many fish carcasses as possible immediately following treatment to avoid their consumption by bears and other animals.

2.7.5 Other Measures to Reduce Impacts to Grizzly Bears

- To reduce the potential for attracting grizzly bears to Yellowstone Lake operations, all fish captured during gillnetting operations will have bladders punctured and then be sunk.
- To reduce the potential for attracting grizzly bears, all chemically treated fish will be removed from streams.
- To reduce the potential for grizzly bear–human conflicts, contractors working on native fish restoration projects will be instructed regarding food, barbecue grill, and garbage storage while living and working in the park.
- To reduce the potential for human-caused grizzly bear mortality in developed areas where native fish will be restored, all human foods, garbage, and other anthropogenic attractants will be handled, stored, and disposed of in a bear-proof manner.
- Restored spawning streams will be closed to public access during spawning activity. Trails, picnic areas, lodging and campground loops in the vicinity of these streams will be closed when bear activity is observed during spawning. Specific Bear Management Area restrictions will be adhered to.

2.8 Alternatives Dismissed From Further Analysis

The Native Fish Conservation ID Team considered other alternatives based on comments received during public scoping. (See chapter 5 for more information about the scoping process.) Each alternative was discussed in relation to the purpose and need, overall goals, and measurable objectives proposed by this plan. The alternatives or actions that were considered but dismissed and the rationale behind dismissal are summarized here.

Consideration of Additional Aquatic Nuisance Species in the Scope of This Document
Aquatic nuisance species are the responsibility of each angler who visits the park. This topic was dismissed from consideration because a considerable amount of outreach is available through the park's backcountry offices and visitor centers, and additional information can be found at http://www.nps.gov/yell/planyourvisit/fishingexotics.htm

Use Non-native Species to Combat Lake Trout or Other Problems
Biological control (the introduction of predatory, pathogenic, or otherwise detrimental organisms to control non-native fish species) has been dismissed from consideration for a variety of reasons. While many biological control methods have been considered, including introducing whitefish (Corogonids), sea lampreys (*Petromyzon marinus*), sterile LKT, genetically altered LKT, Lake Baikal seals (*Pusa sibirica*), and fish pathogens, none are currently proposed for implementation because the ecological results of such measures are often very uncertain and difficult to reverse in the event of unexpected outcomes. Biological control methods may be considered in the future but are not proposed under this EA.

Manipulate Biological Ecosystem Components Other Than Non-Native Fish
Manipulation of biological ecosystem components other than non-native fish to benefit native fish has been considered. Specifically, the introduction of beavers has been suggested as a possible means for increasing the quality of native fish habitat within restoration areas. However, given the park's near pristine conditions and the presence of beavers throughout much of the park, beavers likely already occupy much of the habitat suitable to them and introducing beavers to habitats they do not currently occupy would probably be unsuccessful (Smith and Tyers 2008). It has also been suggested that manipulation of species like elk, wolves, bears, and pelicans could be used to benefit native fish. While these and other organisms may affect native fish, it is unlikely that they are responsible for significant native fish declines or that manipulation of those populations would result in significant recovery.

Eliminate All Non-native Fish from All Park Waters
The National Park Service seeks to strike a balance between managing fisheries resources for the preservation and restoration of unimpaired natural conditions, and the benefit and enjoyment of the public through angling and fish watching. While this EA focuses on conserving native fish, maintaining a diversity of high quality recreational fisheries is also important. For this reason the elimination of all non-native fish from all park waters has been dismissed from consideration. Notable areas precluded from consideration for conservation actions are the Firehole, lower Gibbon, and Madison rivers (mainstems proper) as well as Lewis and Shoshone lakes proper. Like most areas identified in the Wild Trout Enhancement Area in the park's fishing regulations (NPS 2009), these areas would continue to provide angling opportunities for LKT and other non-native fish. However, tributaries to these waters and lakes are being considered for restoration action. While elimination of LKT from Lewis and Shoshone lakes is not being considered, the suppression of other LKT populations may be considered if viable means within the scope of this EA could be identified. Elimination of all non-native fish from park waters has

also been dismissed from consideration because the technical limitations of current conservation practices render it essentially impossible. Even in large waters like Yellowstone Lake where eradication of non-native fish is the primary objective, complete eradication is likely impossible using current technology and some non-native fish would persist. The same is true for other large rivers and lakes.

Provide Angler Incentives for Lake Trout Suppression

Although incentives such as bounties or reward tags to encourage anglers to remove undesirable species have been considered a very effective tool in some places, the remote location and logistical challenges of fishing Yellowstone Lake make that option undesirable as part of this native fish conservation plan. Lakes and rivers where incentives have been viable, such as on Lake Pend Oreille in northern Idaho, are generally located near large population centers and have many experienced anglers nearby to draw from. Most anglers on Yellowstone Lake are visitors, passing through the area for only a short time and they overwhelmingly seek YCT rather than LKT. Even so, estimates from the Volunteer Angler Report program suggest that over 20,000 LKT are caught by anglers in Yellowstone Lake each year with no incentives (10-year average, NPS unpublished data).

The cost of an angler incentive program would also be a drawback. The Idaho Department of Fish and Game gives anglers $15 for each RBT and LKT caught on Lake Pend Oreille (IDFG 2010), and there are costs incurred for program infrastructure and implementation. Yellowstone currently spends approximately $3 or less per LKT removed by NPS crews. Furthermore, it would be difficult to verify that LKT turned in by anglers to receive a bounty were captured in Yellowstone Lake rather than nearby Lewis Lake, which has an abundant LKT population that is genetically very similar and more easily caught than are the LKT in Yellowstone Lake.

Forego Use of Piscicides

Non-piscicide based restoration methods (i.e., mechanical removal) cannot eliminate all non-native fish in most waters, and are therefore insufficient to achieve a primary desired condition as defined by this Native Fish Conservation Plan. Non-piscicide fish removals would be appropriate in cases where a secondary or tertiary desired condition is strived for. All piscicide-based restorations would be based on the best available information at the time of treatment.

Stock Fishless Waters

The waters once devoid of fish in Yellowstone include many small lakes and streams as well as some of the park's largest lakes and rivers. Most of these waters were isolated from downstream sources of fish by waterfalls and many were stocked with fish to provide angling opportunities by the 1950s. Large bodies of water like Lewis and Shoshone lakes and the Firehole River became home to non-native fish including brook trout and brown trout as well as lake trout and rainbow trout. However, many of the park's small lakes and streams remain in a natural fishless condition, and elsewhere stocked fish did not persist and the waters returned to a fishless condition. Although these waters are sometimes suggested as locations where native fish could be stocked to establish new populations, fishless waters are themselves important aquatic ecosystems where amphibians and aquatic macroinvertebrates exist without predation from fish. Waters that have retained or reverted to a fishless condition are therefore not being considered as potential sites for native fish conservation activities.

Launch a Large-Scale YCT Supplementation Program in Yellowstone Lake
The NPS has concluded that large-scale stocking of YCT into Yellowstone Lake should be dismissed from consideration because it may be harmful to the resident population. Although this has not been verified with objective, scientific research, it is anticipated that hatchery-raised YCT stocked into the Yellowstone Lake system may reduce the genetic integrity and overall fitness of the population. In addition, YCT stocked into tributaries known to harbor whirling disease would need to be reared to a large enough size so that they could avoid effects of the parasite.

Have Contractors Use Grant Boat Launch
The boat launch at Grant would not be considered for full-time use by private contractors for LKT suppression because it does not have safe docking facilities. It would require major renovations in order to improve current conditions, and would be considered for use on a temporary basis as deemed necessary by the contractor.

Have NPS Staff Market Lake Trout
This would require additional personnel and increase the costs of the program and the workload of the NPS crew, thus taking away from the removal effort as a whole. The Food and Drug Administration and the U.S. Department of Agriculture require anyone selling food to have a food safety system designed to guarantee the food being sold is safe to eat, regardless of whether the food is sold for human consumption or to be processed as pet food. Procedures, storage and processing facilities, trained staff, and the required volume of ice are not available to NPS crews.

2.9 Environmentally Preferred Alternative

The environmentally preferred alternative is determined by applying the criteria suggested in the National Environmental Policy Act of 1969 (NEPA, 42 U.S.C.A. § 4321 et seq., Public Law 91-190, 1970), as guided by the Council on Environmental Quality, which specifies that the environmentally preferable alternative is “the alternative that would promote the national environmental policy as expressed in NEPA Section 101 (40 CFR §1500 et seq.):

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
2. Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
3. Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
4. Preserve important historic, cultural, and natural aspects of our heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
5. Achieve a balance between population and resource use that would permit high standards of living and a wide sharing of life's amenities.
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Under Alternative 1 (No Action), native fish populations would likely continue to decline parkwide as individual native fish populations would be replaced by non-native fish. Fluvial Arctic grayling would continue to be absent from park waters. Alternative 1 would partially meet criteria 2 and 3 in that there would be no short-term resource degradation or risk to project

personnel health and safety from the use of piscicides. It would not meet criteria 1, 4, 5 and 6 because the park would not implement measures to conserve native fish species at risk of extinction in the park.

Alternative 2 (Preferred Alternative) is the NPS Environmentally Preferred Alternative because it would best meet the six criteria. Alternative 2 would preserve and restore native fish to the greatest extent possible in locations across the park and return LKT carcasses to Yellowstone Lake. It would meet criteria 1, 4, 5, and 6 because it would reverse the decline of native fish species in the park. It would not fully meet criteria 2 and 3 because it would result in a short-term degradation of natural resources, pose a short-term risk to project personnel health and safety from the use of piscicides, and result in long-term, minor adverse impacts to wilderness areas through the long-term use of in-stream fish barriers and weirs. However, it would partially meet criteria 2 in that it would result in the restoration of genetically unaltered native fish populations that would lead to a more productive environment.

Alternative 3 would preserve and restore native fish to the greatest extent possible in locations across the park. Under Alternative 3 some LKT carcasses would not be returned to Yellowstone Lake. Alternative 3 would meet criteria 1, 4, and 5 because it would reverse the decline of native fish species in the park. It would not fully meet criteria 2, 3, and 6 because it would result in a short-term degradation of natural resources, pose a short-term risk to project personnel health and safety from the use of piscicides, and result in long-term, minor adverse impacts to wilderness areas through the use of in-stream fish barriers and weirs. However, it would partially meet criteria 2 in that it would result in the restoration of genetically unaltered native fish populations that would lead to a more productive environment.

Alternative 4 would be limited in its ability preserve and restore native fish because it would not use contract netters to reduce LKT or piscicide to remove non-native fish from streams, rivers, and lakes. It would return LKT carcasses to Yellowstone Lake. It would partially meet criteria 2 and 3 in that there would be no short-term resource degradation or risk to project personnel health and safety from the use of piscicides. It would not fully meet criteria 1, 4, 5 and 6 because the park would not implement all possible measures to conserve native fish species at risk of extinction in the park.

Table 10. Environmental Impact Summary by Alternative for All Actions Combined.

Impact Topic	**Alternative 1** Continuation of Current Management Practices	**Alternative 2** Full Use of Native Fish Conservation Techniques and Lake Trout Returned to Yellowstone Lake	**Alternative 3** Full Use of Native Fish Conservation Techniques and Lake Trout Marketed and/or Donated	**Alternative 4** Limited Use of Native Fish Conservation Techniques
Environmental Setting				
Geologic Resources	Direct, short-term and long-term, negligible to moderate and adverse.	Direct, short-term and long-term, negligible to moderate adverse. Direct, long-term, minor, beneficial	Direct, short-term and long-term, negligible to moderate, adverse. Direct, long-term, minor, beneficial	Direct, short-term and long-term, negligible to moderate, adverse. Direct, long-term, minor, beneficial
Wetlands and Waters of the U.S.	Direct, short-term, negligible to minor adverse.	Direct, short-term and long-term, negligible to moderate adverse. Indirect, long-term, moderate beneficial.	Direct, short-term and long-term, negligible to moderate, adverse. Indirect, long-term, moderate beneficial.	Direct, short-term and long-term, negligible to minor, adverse.
Water Quality and Quantity	Direct and indirect, short-term, negligible to minor, adverse.	Direct and indirect, short-term, negligible to minor, adverse.	Direct and indirect, short-term, negligible to minor, adverse.	Direct and indirect, short-term, negligible to minor, adverse.
Biological Resources				
Aquatic Resources (Other than Fish)	Direct and indirect, short-term, negligible to minor, adverse. Indirect, short-term, negligible, beneficial	Direct and indirect, short-term and long-term, negligible to moderate adverse. Indirect, short-term and long-term, negligible to minor, beneficial	Direct and indirect, short-term and long-term, minor to moderate adverse. Indirect, short-term and long-term, negligible to minor, beneficial	Direct and indirect, short-term, negligible to minor adverse. Indirect, short-term, negligible, beneficial
Fish Resources	Direct and indirect, short-term, negligible to moderate, adverse. Direct and indirect, long-term, negligible to moderate beneficial	Direct and indirect, short-term and long-term, negligible to moderate adverse. Direct and indirect, long-term, moderate, beneficial	Direct and indirect, short-term and long-term, negligible to moderate adverse. Direct and indirect, long-term, minor to moderate, beneficial	Direct, short-term and long-term, negligible to moderate adverse. Direct, long-term, negligible to minor, beneficial
Wildlife Resources	Direct, short-term, negligible to minor adverse	Direct, short- and long-term, and negligible to minor adverse. Indirect, long-term, moderate, beneficial	Direct, short-term and long-term, negligible to minor adverse. Indirect, long-term, moderate, beneficial	Direct, short-term, moderate and adverse. Indirect, long-term, moderate, beneficial
Vegetation	Direct, short-term, negligible to minor and adverse.	Direct, short-term and long-term, negligible to minor and adverse.	Direct, short-term and long-term, negligible to minor and adverse.	Direct, short-term and long-term, negligible to minor and adverse.
Special Status Species	Direct and indirect, short-term and long-term, negligible to moderate, adverse. Direct, short-term, negligible, beneficial.	Direct and indirect, short-term and long-term, moderate and adverse. Indirect, long-term, moderate, beneficial.	Direct and indirect, short-term and long-term, moderate and adverse. Indirect, long-term, moderate, beneficial.	Direct and indirect, short-term and long-term, moderate and adverse. Direct, short-term, negligible, beneficial.

Table 10 (continued).

Impact Topic	**Alternative 1** Continuation of Current Management Practices	**Alternative 2** Full Use of Native Fish Conservation Techniques and Lake Trout Returned to Yellowstone Lake	**Alternative 3** Full Use of Native Fish Conservation Techniques and Lake Trout Marketed and/or Donated	**Alternative 4** Limited Use of Native Fish Conservation Techniques
Social And Economic Resources				
Health and Human Safety	Direct, short term, minor and adverse.	Direct, short-term and long-term, minor and adverse.	Direct, short-term and long-term, minor and adverse.	Direct, short term, minor and adverse.
Socioeconomics	Direct & in-direct, long-term, moderate and adverse	Direct & in-direct, long-term, moderate, and beneficial.	Direct & in-direct, long-term, moderate, and beneficial.	Direct & in-direct, long-term, moderate and adverse
Visitor Use and Experience	Direct & in-direct, long-term, moderate and adverse	Direct & in-direct, long-term, moderate, and beneficial.	Direct & in-direct, long-term, moderate, and beneficial.	Direct & in-direct, long-term, moderate and adverse
Park Operations	Direct, short term, negligible to minor, and adverse.	Direct, long term, minor, and adverse.	Direct, long term, minor, and adverse.	Direct, short term, minor, and adverse.
Wilderness	Direct & indirect, long-term, minor to moderate and adverse.	Direct & in-direct, short-term and long-term, minor adverse. Direct & in-direct, long-term moderate, and beneficial.	Direct & in-direct, short-term and long-term, minor adverse. Direct & in-direct, long-term moderate, and beneficial.	Direct & indirect, long-term, minor and adverse.

Table 10. Environmental impact summary by alternative for all actions combined.

3. Chapter 3: Affected Environment

This chapter describes existing environmental conditions for resources potentially affected by the alternatives set forth in this Native Fish Conservation Plan: natural resources, including geologic; wetlands and other waters, vegetation, aquatic and wildlife resources, species of management concern, and climate change and sustainability; and social and economic resources, including health and human safety, park operations, visitor use and experience, and wilderness.

3.1 Environmental Setting

3.1.1 Geologic Resources

Topography
Yellowstone National Park lies in a geologically dynamic region of the Northern Rocky Mountains. The park is noted for its geologic formations that have resulted from glaciation and volcanism. Major mountain ranges include the Absaroka, Gallatin, and Washburn. The Continental Divide traverses the park from its southeast corner to its western boundary. The average elevation is 2,479 m and ranges from 1,637 m in the north, where the Gardner River drains from the park, to 3,521 m in the east, at the summit of Eagle Peak in the Absaroka Range (Rodman et al. 1996).

Geology
The oldest geologic materials in the park are Precambrian (2.7 billion years before present), which occur in the Black Canyon of the Yellowstone River. Throughout most of its history (2.7 to 0.6 billion years before present), the Yellowstone region has generally been under large-scale tectonic compression. Subsequently, the area was eroded to a flat plain and then flooded by large seas that deposited layers of calcium carbonate, sand, and clay up to 3,050 m thick. Volcanic events 40 to 50 million years before present buried the region in andesite lava, ash, mud, and debris flows. These deposits, which make up the second most common geologic material in the park, are thousands of feet thick on the park's east and northwest sides. The mud and debris flows buried forest and formed the petrified or fossil forests in the park. At least three extensive glaciations have affected most of the park. Glaciers gouged mountains and valleys, creating the characteristic landforms and surficial deposits that dominate the current topography (Rodman et al. 1996).

Hydrothermal
Within the park is an active volcano that is responsible for more than 10,000 geothermal features, including geysers, hot springs, mudpots, and fumaroles. Its more than 300 geysers make up two thirds of all those found on Earth. The Yellowstone caldera, which lies entirely within the park, is approximately 55 km wide and 72 km long, with the last major eruption occurring about 640,000 years ago. The geothermal areas most accessible to park visitors because of their proximity to roads include the Upper and Lower geyser basins near the Firehole River, Norris Geyser Basin near the Gibbon River, Mammoth Hot Springs, Mud Volcano, and the West Thumb Geyser Basin, which is the largest geyser basin on the shore of Yellowstone Lake. The West Thumb was formed approximately 150,000 year ago, when a collapsed volcano filled with water, forming an extension of Yellowstone Lake. The thermal features at West Thumb are found on the lake shore as well as under the surface of the lake.

Several underwater geysers were discovered in the early 1990s. From 1999 to 2003, scientists from the USGS and a private company, Eastern Oceanics, surveyed the lake bottom using high-resolution, multi-beam swath sonar imaging, seismic reflection profiling, and a remote operating vehicle. The survey showed the northern half of the lake to be within the 640,000-year-old Yellowstone caldera and mapped previously unknown features, including large hydrothermal explosion craters, siliceous spires, hundreds of hydrothermal vents and craters, active fissures, and domal features containing gas pockets and deformed sediments (NPS 2010).

Soils

In 1996 Yellowstone Center for Resources (YCR) staff completed an extensive parkwide soils survey. Major fieldwork for this soil survey was done in 1994. Soil conditions were described between 1989 and 1995. More than 1,100 soil profiles, their environment, and their site location were described. This work led to the classification of more than 100 soil types in the park. There are many soil types in the project areas, but the Gallatin and Beartooth families are most prevalent within floodplain and riparian areas (Rodman et al. 1996). Gallatin Family soils are typically formed from base rich rock, such as limestone; Beartooth Family soils have a mineral horizon characterized by illuvial accumulation layer-lattice silicate clays. Both soil families are overlain with soil containing abundant organic matter, are generally more than 100 centimeters deep, and in some areas are saturated with ground water during the growing season. Gallatin Family soils form mainly in till and alluvium derived from andesite or rhyolite; Beartooth Family soils form in fan alluvium, stream alluvium, earthflow debris, and glacial till derived from a mixture of rock types (Rodman et al. 1996).

3.1.2 Wetlands and Other Waters

The park's wetlands, which cover more than 357 square miles, have been mapped as part of the USFWS National Wetland Inventory, a congressionally mandated program to identify, classify, and map all wetlands in the United States (Elliot and Hektner 2000). Three wetland types can be found in Yellowstone: 44% are lacustrine, which is defined as greater than 20 acres in size and having a water depth exceeding 6.6 feet at low water; 4% are riverine (rivers and streams), and 52% are palustrine (Elliot and Hektner 2000). Palustrine wetlands are described by the dominant life form (trees, shrubs, emergents, mosses and lichens, or aquatic plants) or, if vegetation covers less than 30% of the substrate, by the physiography and composition of the substrate (rock bottom, unconsolidated bottom, or unconsolidated shore). Wetlands provide essential habitat for Yellowstone's rare plants, reptiles, amphibians, and numerous insects, birds, mammals, and fish.

Proposed actions for fish restoration activities would take place mainly in lacustrine and palustrine environments. These wetland types have the capacity to support fish populations that are the focus of proposed actions in this Native Fish Conservation Plan. Actions to restore YCT would take place on Yellowstone Lake and its tributary streams within the Yellowstone Lake drainage. Actions taken to restore native fish populations elsewhere in the park may include lacustrine wetlands such as Trout, Goose, and Gooseneck Lakes and their tributaries; and riverine wetlands such as Grayling, Lost, Rose, Slough, and Soda Butte Creeks and their tributaries.

3.1.3 Water Quality and Quantity

Streams and lakes in Yellowstone are designated as Class I, Outstanding Natural Resource Waters, by the states of Wyoming and Montana as delegated by the Environmental Protection

Agency under the Clean Water Act, which means that long-term degradation of surface waters is prohibited and existing water quality must be maintained. Beginning in 2002, YCR Fisheries and Aquatic Sciences staff initiated a long-term water quality monitoring program that includes monthly sampling of 19 sites (12 at streams and 7 in Yellowstone Lake). Water quality information collected from these sites includes water temperature, dissolved oxygen, pH, specific conductance, turbidity, and total suspended solids. Several ions and nutrients metrics are also collected from stream locations.

Chemical, physical, and biological properties of the park's surface water vary considerably with season, location, elevation, geology, and proximity to thermal activity. Thermal areas affect water temperature, acidity, and dissolved chemicals. Generally, dissolved ion concentrations in Yellowstone waters are relatively low compared to other surface waters, especially in the spring during high runoff; higher concentrations are recorded in the fall and winter during low flow conditions. Distinct patterns of relative dissolved ion concentrations are observed in the Yellowstone and Madison River drainages. The most abundant ion in all watersheds is bicarbonate; concentrations of other major ions vary among watersheds. The Lamar River drainage has higher concentrations of calcium ions than the Yellowstone River mainstem, which has higher concentrations of sulfate. In addition to bicarbonate ions, both sodium and chloride are present in approximately equal proportions in the Madison River basin. Both phosphorus and nitrogen concentrations are generally very low in most park waters. In 2009, nitrate concentrations in Yellowstone River at the lake outlet were below the analytical detection limit (0.05 µg/L) for all 10 samples; total phosphorus concentrations ranged from not detectable to 0.060 µg/L. Of the park's major rivers, the Madison River tends to have the highest nutrient concentrations. In 2009 total nitrate was not detectable for 10 samples; total phosphorus ranged from 0.131 to 0.242 µg/L).

3.2 Biological Resources

3.2.1 Aquatic Resources Other Than Fish

Plankton

Planktonic or "free-floating" organisms can be found in lakes and wetlands throughout the park. These organisms include phytoplankton, which are free-floating microscopic plants, and zooplankton, which are microscopic animals.

Phytoplankton are tiny photosynthetic plants that float within the water column. The phytoplankton community includes diatoms, blue-green algae, green algae, and photosynthetic flagellates. Like other algae or vascular plants, phytoplankton transform sunlight and carbon dioxide into organic tissue through photosynthesis and are therefore considered "primary producers." When phytoplankton die, they become organic matter or food that is available for organisms at higher levels in a lake's food web. Because they are the first link in the aquatic food web, phytoplankton are vital components of lake ecosystems in Yellowstone.

Phytoplankton can play a major role in affecting water chemistry and the physical and biological properties of water. During daylight hours, photosynthesis transforms sunlight and carbon dioxide into organic tissue and produces dissolved oxygen. Adequate levels of dissolved oxygen are needed for all aquatic, gill-breathing animals to survive. At night, plants and animals use oxygen and give off carbon dioxide. Carbon dioxide can interact with water-producing carbonic

acid and thus lower pH, which is generally highest during late evening and lowest during early morning.

Zooplankton are microscopic animals that are free-floating in the water column, including protozoa, copepods, cladocera, and rotifers. They are the first consumer level in the food web, with most zooplankton feeding on algae and suspended detritus. *Daphnia* spp., the most commonly known genus of cladocera, are small plant-eating zooplankton that graze primarily on phytoplankton. Most zooplankton are preyed upon by larger macroinvertebrates and larval fish. The 49 zooplankton taxa that have been identified in Yellowstone include 11 copepods, 22 cladocera, and 16 rotifer species. Zooplankton are directly affected by fish predation and indirectly affected by changes in the food web caused by the introduction of fish species.

Aquatic macroinvertebrates include a large array of organisms that can be seen with the naked eye and are found in a wide range of rivers, streams, ponds, lakes and wetlands. They are an important food source for fish, amphibians, and some bird and mammal species. Study of aquatic macroinvertebrates in Yellowstone during the last several decades has identified 818 aquatic macroinvertebrate taxa representing 21 distinct taxonomic groups, including aquatic insects, gastropods (snails), bivalves (mussels and clams), hydracarina (water mites), annelids (segmented worms and leeches), amphipods (scuds), isopods (pillbugs), decapods (crayfish), hydroid (hydra), turbellaria (flatworms), porifera (freshwater sponge), and nematodes (unsegmented worms).

Macroinvertebrates are important indicators of the impacts of potential stressors to water quality, such as road construction, sewage spills, and mining activities. Mayflies, stoneflies and caddisflies are indicators of good water quality because they are typically sensitive to environmental change and most abundant in riffle habitats of streams where water quality is very good. Beetles, flies and midges, which are typically less sensitive to environmental change and have the highest densities where water quality has been compromised by natural or human-caused disturbances, are indicators of poor water quality.

3.2.2 Fish Resources

When Yellowstone National Park was established in 1872, about 40% of its area was barren of fish. Natural barriers such as waterfalls prevented the upstream movement of fish into these areas. Major drainages that were historically fishless include Shoshone and Lewis Lakes as well as the upper reaches of the Firehole and Gibbon rivers. During the park's early history, park administrators wanted to increase fishing opportunities for park visitors and so began moving native fishes to additional waters throughout the park and introducing non-native fish species. The park's native fish populations have been altered by this fish stocking as well as by overharvest, whirling disease, drought, dewatering of streams, and predation. Native and non-native fish provide angling opportunities for visitors as well as food for birds, otters, grizzly bears, and other wildlife (Varley and Schullery 1998).

3.2.2.1 Native Fish Species

The Yellowstone fishery is comprised of 12 native species. The following section presents general information on nine of these species (derived from Varley and Schullery 1998). The other three species (YCT and WCT, and GRY) are discussed under "Special Status Species" in this chapter.

Mountain whitefish (*Prosopium williamsoni*), which are native to the headwaters of the Missouri River Basin, are widely distributed in the western United States. In Yellowstone, mountain whitefish can be found in the Yellowstone River up to the mouth of the Grand Canyon and in several other branches, including the lower Gardner and Lamar Rivers. It is also found in the West Gallatin and Madison rivers as well as lower portions of Grayling and Duck creeks. In the Snake River drainage, it is common in the mainstem, the lower Lewis River, Heart River, and Heart Lake.

Longnose dace (*Rhinichthys cataractae*) typically have a maximum length of 5 to 6 inches. The species is widespread across temperate and mountainous portions of North America. In Yellowstone, it is found throughout the Yellowstone River drainage, including Yellowstone Lake and several of its tributaries; the Gardner River; the Madison and Gibbon rivers; and the Gallatin River. The species is also found in the Falls River and the Snake River, where it coexists with its near relative, the speckled dace.

Speckled dace (*Rhinichthys osculus*) are similar to the longnose dace but with a shorter snout. The species' distribution is restricted to west of the Continental Divide, from southern California to the Columbia River Basin, including the Snake River. In Yellowstone, they are found in the Snake River and its tributaries, including the Falls River and Polecat Creek. They are common in areas of Heart Lake and its outlet (Heart River), and in two of the lake's tributary streams, Beaver and Witch creeks.

Redside shiners (*Richardsonius balteatus hydrophlox*) are widespread in the Bonneville Basin and the Columbia River system. In Yellowstone, the species is native to the Snake River drainage, where it is most commonly associated with lakes. Redside shiners are commonly found in the shallower parts of Heart Lake and its outlet, and are known to spawn in two of its inlets, Beaver and Witch creeks. Also in the Snake River drainage, they are commonly found in Sheridan and Tanager Lakes, and in several small ponds near Snake Hot Springs.

Utah chubs (*Gila atraria*) have an elongated body with a maximum length of 12 to 13 inches. In Yellowstone, the chub is native to the Snake River and its tributaries, and is especially prevalent in the Heart River and Lake, including its tributary Witch Creek. In the 1950s or early 1960s, Utah chub was introduced into Lewis and Shoshone lakes. It is now the most abundant fish species in Lewis Lake and common in Shoshone Lake.

Mottled sculpins (*Cottus bairdi*) are scale-less fish that may resemble a small catfish. The species has a large, broad, flat head that is nearly as wide as it is long. Its eyes high are on the head and pointed upward, its mouth is very large, and it has gill covers that may possess several sharp stout spines. In Yellowstone, the species has been collected in the Snake River drainage and tributaries, including the Falls River and Heart Lake; the Yellowstone River and its tributaries, including the Lamar River; the streams of the Gallatin River drainage; the Madison River; the Firehole River up to Firehole Falls; and the Gibbon River up to Virginian Cascades. The mottled sculpin is the only fish species known to naturally occur in the Gibbon River above Gibbon Falls.

Longnose suckers (*Catostomus catostomus griseus*) are relatively long-lived fish (20+ years) that can grow to more than 22 inches in length. The species has a long, relatively slender body that is nearly cylindrical in cross section. In Yellowstone, the longnose sucker is native to the Yellowstone River below its Great Falls, including larger tributaries such as Slough Creek, Soda Butte Creek, and the Lamar and Gardner rivers. Its introduction into Yellowstone Lake led to its

distribution throughout the lake's tributaries. The sucker is now present in Sylvan, Alder, Trail, Riddle, and Squaw lakes, which originally held only cutthroat trout.

Mountain suckers (*Catostomus platyrhynchus*) rarely exceed 8 inches in length. East of the Continental Divide, this sucker can be found in the Yellowstone River drainage and the Madison River, including the lower Gibbon and Firehole rivers; west of the divide, it is in the Snake River drainage, including Heart Lake and Heart River.

Utah suckers (*Catostomus ardens*) are similar to the longnose sucker in that they can reach lengths of more than 22 inches, but unlike the longnose sucker, the Utah sucker has a large, short head. In Yellowstone, it has been found in Heart Lake and its inlet steams, the Heart River, and a small unnamed lake near Snake Hot Springs. The Utah sucker is primarily a lake dwelling fish but can often be found in larger rivers and small streams.

3.2.2.2 Non-native Fish Species

Since the park's inception, five non-native fish species that were stocked or introduced in park waters have established viable populations. Four of the species are native to North America (eastern brook trout, rainbow trout, lake trout, and lake chub) and the other is native to Europe (brown trout).

Eastern brook trout (*Salvelinus fontinalis*) are native to eastern and northeastern North America from the Carolinas to Hudson Bay and westward to northeastern Iowa, Minnesota, and Michigan. Introduction of brook trout in Yellowstone began in 1889 with stocking of fish in the upper Firehole River, which at that time was fishless. In the Madison River drainage, brook trout are abundant in the Duck and Maple creek drainages as well as in the upper Firehole and Gibbon rivers and many of their tributaries; in the Falls River Basin, in Robinson and Little Robinson creeks; in the Snake River drainage, primarily in the Lewis River system, including the tributaries to the Lewis and Shoshone lakes, and Pocket Lake; in the Yellowstone River drainage, in Tower, Lost, Elk, Blacktail Deer, and Lava creeks; and in the Gardner River and its tributaries, including Grizzly, Trilobite, and Faun Lakes, and Blacktail ponds. The brook trout introduced in the upper reaches of the Soda Butte Creek drainage outside park boundaries was initially isolated from lower portions of Soda Butte Creek by the McLaren mine tailings near Cooke City, Montana. Recently, however, Soda Butte Creek's channel was altered, enabling brook trout to move downstream and gain access to the upper Soda Butte Creek within the park. This population of brook trout currently threatens the cutthroat trout fishery in that river system.

Rainbow trout sampled from the Madison River. Photo by B. Crowley.

Rainbow trout (*Oncorhynchus mykiss*) are native to North America in waters draining into the Pacific Ocean from northern Mexico to the Kuskokwim River in Alaska. In Yellowstone, many RBT populations have hybridized with cutthroat trout. Pure populations are thought to exist in Tower and Carnelian creeks, upper parts of the Gibbon River, Buffalo Fork Creek, and Ribbon, Goose, and Gooseneck lakes. Un-hybridized populations may also exist in parts of the Gardner, Madison, Firehole, Gibbon, Lamar, Bechler, Falls, and lower Yellowstone rivers.

Lake trout (*Salvelinus namaycush*) have a native range that includes most of Canada and the northernmost parts of the United States from Montana to the northern New England states. These fish were introduced in Yellowstone in the early 1890s in Shoshone and Lewis lakes. Today, LKT can be found in Shoshone, Lewis, Heart, and Yellowstone lakes. The LKT in Yellowstone Lake are a result of an illegal introduction and were first documented there in 1994. They are a serious threat to the native YCT population. They generally feed and spawn in deeper portions of lakes than do native cutthroat trout, and are a poor substitute for wildlife that depends on cutthroat trout as a food source.

Brown trout (*Salmo trutta*) were first brought to North America in 1882 and were being stocked in Yellowstone waters by 1890. Today, brown trout can be found in the Madison River drainage (including Gibbon and Firehole rivers), Grayling and Duck creeks, Lewis Lake drainage, the lower Snake River, the Yellowstone River below Knowles Falls (near the park's northern boundary), and the Gardner River below Osprey Falls. They are reported to be in Heart Lake as well.

Lake chubs (*Couesius plumbeus*) reach a maximum length of 6 inches. The species is found from Alaska and British Columbia east to the Atlantic and north of the Arctic. In Montana and Wyoming it is widespread east of the continental divide. The species is native to both the upper Missouri and Yellowstone River drainages, but not in Yellowstone National Park.

3.2.3 Wildlife Resources

3.2.3.1 Mammals

Yellowstone National Park is home to the largest concentration of mammals in the lower 48 states, including 67 species. The following section provides basic information about some of the most common mammals in the park as well as those that often use aquatic habitats. Four additional mammal species (pronghorn antelope, wolverine, grizzly bear, and Canada lynx) are discussed under "Special Status Species" in this chapter.

Bison (*Bison bison*) are most often associated with sagebrush-grass communities. Within the Yellowstone River drainage, bison are most abundant in the Lamar and Hayden valleys of the north and central portions of the park respectively. On the west side of the park, bison are common throughout the Madison River drainage, which includes both the Firehole and Gibbon rivers. Based on the annual bison count, park staff, estimated the bison herd at 3,000 animals in March 2010.

Elk (*Cervus elaphus*) are the most abundant large mammal in the park. They feed in mixed forest and grassland habitat on grasses, sedges, herbs and shrubs, the bark of aspen trees, conifer needles, and aquatic plants. The ranges of six to seven elk herds overlap in the park during various portions of the year (NPS 2010). The two most visible elk herds are the northern range herd and the Madison-Firehole herd. The northern range herd is one of the largest free-ranging herds in North America, occupying an area that covers 600 square miles along the Lamar and Yellowstone river basins and overlapping the boundary between Wyoming and Montana. A third of this range is on public and private lands north of the park, where wild ungulates often compete with livestock for grassland in winter. Population counts show that the Northern Range herd has decreased 60% since 1994. Predation by wolves, grizzly bears, and other carnivores, hunting of elk migrating outside the park, and possibly drought effects on maternal condition and recruitment were factors contributing to this trend. The most recent elk count,

conducted in March 2010, estimated the northern range herd at slightly more than 6,000 animals. The size of the Madison-Firehole herd, which is believed to winter entirely within the park, fluctuates between 650 and 850.

Moose (*Alces alces shirasi*) are the largest members of the deer family in the park. A male moose can weigh nearly 1,000 pounds and stand more than seven feet at the shoulder. In the 1970s, an estimated 1,000 moose inhabited the park. Moose populations decreased after the fires of 1988 that burned important winter habitat (i.e., mature spruce/fir forests) in the northern portion of the park (Tyers and Irby 1995). It is estimated that less than 200 moose currently reside in the park. Moose can most often be seen feeding in riparian areas of streams and on aquatic plants, especially in the park's southwestern corner and the Soda Butte Creek, Pelican Creek, and Lewis and Gallatin River drainages (NPS 2010).

Mule deer (*Odocoileus hemionus*) are commonly observed throughout Yellowstone during the summer months when 2,300 to 2,500 migrate to higher elevations. The park's mule deer population is estimated to be stable or increasing. Less severe winters in recent years may have contributed to their increase (NPS 2010).

White-tailed deer (*Odocoileus virginianus*) are native to the northern Rocky Mountains but have never been abundant in or near Yellowstone. They are occasionally observed in the northern portions of the park, in the upper drainages of the Yellowstone River (NPS 2010).

Bighorn sheep (*Ovis canadensis*) typically inhabit higher elevation areas such as Mount Everts and Mount Washburn where they feed primarily on grasses and forage on shrubby plants in fall and winter. An estimated 250–275 bighorn sheep reside in the park (NPS 2010).

Black bears (*Ursus americanus*) can be found throughout the park but are most frequently seen on the northern range. They can usually be found in forest and forest edge habitat where they feed on rodents, insects, elk calves, fish, pine nuts, grasses and other vegetation. From 500 to 650 black bears are thought to reside in the park.

Beaver (*Castor canadensis*) generally occur where there is an abundant food supply. They are often responsible for creating wetland habitats through dam construction, which usually takes place on low gradient streams that have very little seasonal water fluctuations. Wetlands created by dam construction are used by a variety of insects, fish, birds, and mammals. An estimated 750 beaver are found throughout the park (NPS 2010)

River otter (*Lontra canadensis*) belong to the weasel family and can weigh up to 30 pounds. In Yellowstone, they feed primarily on fish, crayfish, and amphibians. They frequently occur and forage in social groups. As part of their social behavior, they often mark specific locations with feces and urine. This marking behavior may serve as important movement of nutrients from aquatic to terrestrial environments (Bowyer et al. 1995). They can be found in most river drainages in the park but are most often seen in the Yellowstone, Lamar, Madison, and Gallatin drainages.

Bats of eight species may be present in Yellowstone. The most common are the little brown bat (*Myotis lucifugus*), the big brown bat (*Eptesicus fuscus*), and the silver-haired bat (*Lasionycteris noctivagans*). These species, along with the long-legged myotis (*Myotis volans*), often forage over open water and along riparian corridors. Three other bat species that forage over open water but are found in lower densities are the long-eared myotis (*Myotis evotis*), Townsend's big-eared

bat (*Corynorhinus townsendii*), and the fringe-tailed bat (*Myotis thysanodes*). Hoary bats (*Lasiurus cinereus*) are generally found in low densities in forested habitats that often have abundant open areas for foraging (Keinath 2007).

3.2.3.2 Birds

Migratory birds are those that generally migrate south from their breeding grounds to wintering grounds each fall. They may winter in habitats throughout the Pacific Region and central North America or farther south into Mexico, Central and South America, and the Caribbean. In the spring, they return north to their breeding grounds, where they have young and the cycle repeats. Migratory birds generally follow one of four geographical flyways during their spring and fall migrations across North America. Most of the park is in the Central Flyway; west of the continental divide is in the Pacific Flyway.

In Yellowstone, 324 bird species have been documented, of which 148 nest in the park. Some species reside in the park year-round, e.g., the common raven (*Corvus corax*), Canada goose (*Branta canadensis*), dusky grouse (*Dendragapus obscures*), gray jay (*Perisoreus canadensis*), red-breasted nuthatch (*Sitta canadensis*), and mountain chickadee (*Poecile gambeli*), but most migrate to lower elevations and more southern latitudes beginning in September. Fall transients include tundra swans (*Cygnus columbianus*) and ferruginous hawks (*Buteo regalis*). A few species, including rough-legged hawks (*Buteo lagopus*) and bohemian waxwings (*Bombycilla garrulous*), migrate to the park for the winter from further north. Migration brings many birds back to the park from their winter journeys south; other birds are passing through to more northern nesting areas.

Bird surveys have been conducted in the park since the early 1900s. Park staff currently participate in five monitoring programs in order to identify trends for raptors, wetland birds, breeding birds, songbirds associated with willow communities, and birds in recently burned forest areas. The North American bird migration count has been conducted since 1992 to determine general population and arrival trends of migratory birds. A summary of the 1993–2009 data indicates that the numbers of species and birds observed during these surveys have remained relatively consistent.

Waterfowl

Of the 47 species of ducks, geese, swans, loons, grebes, pelican, and cormorants that have been documented in the park, 25 species have been documented to breed in the park, including the Canada goose (*Branta canadensis*), trumpeter swan (*Cygnus buccinators*), gadwall (*Anas strepera*), American wigeon (*A. americana*), mallard (*A. platyrhynchus*), blue-winged teal (*A. discors*), cinnamon teal (*A. cyanoptera*), northern shoveler (*A. clypeata*), northern pintail (*A. acuta*), green-winged teal (*A. crecca*), canvasback (*Aythya valisineria*), redhead (*A. americana*), ring-necked duck (*A. collaris*), lesser scaup (*A. affinis*), harlequin duck (*Histrionicus histrionicus*), bufflehead (*Bucephala albeola*), Barrow's goldeneye (*B. islandica*), common merganser (*Mergus merganser*), ruddy duck (*Oxyura jamaicensis*), common loon (*Gavia immer*), pied-billed grebe (*Podilymbus podiceps*), red-necked grebe (*Podiceps grisegena*), eared grebe (*P. nigricollis*), American white pelican (*Pelecanus erythrorhynchos*), and double-crested cormorant (*Phalacrocorax auritus*). Although they do not breed within the park, western grebes (*Aechmophorus occidentalis*) are very common on Yellowstone Lake in late fall and early winter. All of these species are likely to be encountered during fish restoration activities in the park. The status and trends of the common loon, double-crested cormorant, western grebe, white pelican, and trumpeter swan are addressed under "Special Status Species" later in this chapter.

Raptors
Of the 19 species of raptors that have been documented breeding in the park, the osprey (*Pandion haliaetus*), northern harrier (*Circus cyaneus*), and bald eagle (*Haliaeetus leucocephalus*) rely heavily on aquatic habitats and wetlands for foraging. The status and trend of these three species are described under "Special Status Species" later in this chapter. Other raptors that have been documented breeding in the park include the sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperii*), northern goshawk (*A. gentilis*), Swainson's hawk (*Buteo swainsoni*), red-tailed hawk (*B. jamaicensis*), golden eagle (*Aquila chrysaetos*), American kestrel (*Falco sparverius*), peregrine falcon (*F. peregrines*), prairie falcon (*F. mexicanus*), great horned owl (*Bubo virginianus*), northern pygmy owl (*Glaucidium gnoma*), great gray owl (*Strix nebulosa*), long-eared owl (*Asio otus*), short-eared owl (*A. flammeus*), boreal owl (*Aegolius funereus*), and northern saw-whet owl (*A. acadicus*). The peregrine falcon is discussed further under "Special Status Species" later in this chapter.

Wading Birds
This bird group spends a large portion of their time foraging shallow portions of lakes, rivers, and wet meadows. The 11 species of wading birds known to breed in the park are the American bittern (*Botaurus lentiginosus*), great blue heron (*Ardea herodias*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), American coot (*Fulica americana*), sandhill crane (*Grus canadensis*), killdeer (*Charadrius vociferous*), spotted sandpiper (*Actitis macularia*), long-billed curlew (*Numenius americanus*), Wilson's snipe (*Gallinago delicate*), and Wilson's phalarope (*Phalaropus tricolor*).

Perching Birds
Most bird species in Yellowstone are perching birds, including 95 species that have been documented nesting in the park, e.g., doves, swifts, hummingbirds, kingfishers, woodpeckers, flycatchers, jays, swallows, titmice, wrens, dippers, flycatchers, thrushes, warblers, blackbirds, sparrows, and finches. Many of these birds use wetland and riparian areas for feeding and nesting, e.g., the belted kingfisher (*Ceryle alcyon*), American dipper (*Cinclus mexicanus*), cliff swallow (*Petrochelidon pyrrhonota*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), and red-winged blackbird (*Agelaius phoeniceus*).

Gulls and Terns
Of the 14 species of gulls and terns that have been documented in Yellowstone, only 3 are known to have nested in the park: the Caspian tern (*Sterna caspia*), California gull (*Larus californicus*) and black tern (*Chlidonias niger*). The Caspian tern and California gull are fish-eating birds that nest on the Molly Islands in the southeast arm of Yellowstone Lake. Caspian terns nest on low parts of the island that are very susceptible to flooding and their population in the park has been small. California gulls build rocky depressions a little higher up but their nests are susceptible to flooding during high water years. Although historically gulls averaged approximately 90 nests per year, they have not nested on the Molly Islands since 2006; Caspian terns have not nested there since 2004. Neither of these bird species have special status with state or federal agencies. Black terns, which tend to inhabit more marshy areas of large lakes, are addressed under "Special Status Species" later in this chapter.

3.2.3.3 Reptiles

Six reptile species have been documented in Yellowstone.

Northern sagebrush lizard (*Sceloporus graciosus graciosus*) can be found in open sagebrush habitat, is limited within the park to the lowest elevation area along the park boundary near Gardiner, Montana, which typically experiences hot dry summers and a fairly mild winter compared to the rest of the park.

Rubber boa (*Charina bottae*) found throughout the park, is usually associated with forested habitat in mountainous terrain but can also be found in grasslands and sagebrush communities. They spend considerable time underground and are rarely seen. The rubber boa is a constrictor which primarily feeds on small mammals but occasionally eats salamanders, frogs, and invertebrates.

Bull snake (*Pituophis catenifer sayi*) is associated with low-elevation sagebrush plant communities and is found most frequently near the park's northern boundary in the area between Gardiner and Stevens Creek. The bull snake is a constrictor that primarily feeds on small mammals.

Western, or **prairie, rattlesnake** (*Crotalis viridis viridis*) belongs to a group generically known as pit vipers because they have a heat-sensitive pit between each eye and nostril. A heavy bodied snake with a lobed rattle at the tip of its tail, it is the only poisonous snake in the park. It prefers sagebrush habitat with rocky outcrops and, like the bull snake, it is associated with the lowest elevation areas of the park near Gardiner and primarily feeds on small mammals.

Wandering garter snake (*Thamnophis elegans vagrans*) and the valley garter snake (*Thamnophis sirtalis fitchi*) are very similar in appearance. They are often be found in wetland and aquatic areas where they typically feed on fish, amphibians, and small invertebrates. The wandering garter snake has the widest distribution of any reptile species in the park. The range of the valley garter snake is much more limited, having been documented only in the Bechler River drainage in the park's southwest corner.

3.2.3.4 Amphibians

Four amphibian species are known to reside in Yellowstone.

Blotched tiger salamander (*Ambystoma tigrinum melanostictum*) is the only known salamander species in Yellowstone. It is widespread in the park and very numerous in northern range wetlands. Adults usually breed in small ponds or fishless lakes with emergent vegetation that is used for egg attachment. Salamanders are the top aquatic predators in these systems, feeding on insects and other invertebrates (Koch and Peterson, 1995). Although the larvae, which are aquatic, generally have a uniform dark color, a population found in two small, fishless ponds with unusually high natural turbidity lacks most pigmentation and is mostly white with a pinkish tinge. Blotched tiger salamanders are preyed upon by fish, snakes, and several mammal and bird species.

Boreal chorus frog (*Pseudacris triseriata maculata*) is common throughout the park and prefers to breed in shallow ponds or temporary pools. It is the only amphibian species in the park with an audible call.

Boreal toad (*Bufo boreas boreas*) typically breeds in park areas with water chemistry characteristics that include a pH >8.0, high conductivity, and high acid-neutralization capacity; many of the sites have a geothermal influence (Koch and Peterson 1995). Boreal toad breeding areas are common in the upper Geyser Basin and have been documented in the Swan Lake Flats area. Boreal toads can also be found in riparian and riverine areas where they feed if adequate cover is available. Although declining throughout much of their range, boreal toads remain widespread throughout the park.

Columbia spotted frog (*Rana luteiventris*) is discussed under "Special Status Species" in this chapter.

The last anecdotal report of the plains spadefoot toad (*Spea bombifrons*) in Yellowstone was made in June 1982 in the Sentinel Creek drainage (a tributary to the Firehole River), approximately 1 km downstream of Fairy Falls. There has never been a validated sighting of this species in the park. In 2009, the U.S. Forest Service conducted surveys along the east shore of Hebgen Lake that confirmed a breeding population of plains spadefoot toads with adults within 0.8 km of Yellowstone. Surveys conducted in June 2010 by the U.S. Forest Service and Yellowstone personnel found 24 adult spadefoot toads in the same vicinity where they had been seen in 2009. Two breeding populations (larval spadefoot toads) were observed in the Madison Arm of Hebgen Lake approximately 1.6 km from the park boundary. In this area of Hebgen Lake, the toads seem to be associated with black volcanic sandy soils. Future plains spadefoot toad surveys are planned by Yellowstone personnel to determine if this species is present in the park in areas proposed for native fish restoration.

3.2.4 Vegetation

Roughly 1,150 native plant species and an additional 210 non-native plant species can be found in Yellowstone. The four plant species that NPS managers have designated as Species of Management Concern are described under "Special Status Species" later in this chapter.

Approximately 38% of the park's plant species are associated with wetlands, and 11% (species such as yellow water lilies (*Nuphar polysepala*) and cattails (*Typha spp.*), grow only in wetlands. Yellowstone's wetlands are home to many unusual plants. Of the 90 rare plant species known to occur in the park, more than half are associated with wetlands. Heat generated in thermal areas allows some plant species to survive in areas far north of their typical distribution. A red-flowered annual paintbrush (*Castilleja exilis*) that typically occurs in the southwest United States, can be found in park wetlands influenced by geothermal sources. A unique variety of yellow spikerush (*Eleocharis flavescens*) is found only in Yellowstone; its closest relatives grow in the southeastern United States. Tweedy's rush (*Juncus tweedyi*), which is also highly restricted in its distribution, occurs in several acidic thermal wetlands of the Yellowstone area. The park's wetlands are also home to many plant species that are often found in more northern latitudes, such as green keeled cotton-grass (*Eriophorum varidicarinatum*), False uncinia sedge (*Carex microglochin*), mud sedge (*Carex limosa*), and lesser panicled sedge (*Carex diandra*) (Elliot and Hektner 2000).

Forest communities, which cover 80% of the park, are mostly lodgepole pine (*Pinus contorta*), a fire dependent species. Lodgepole pine forest is often characterized by a very sparse understory composed mostly of elk sedge (*Carex geyeri*) or grouse whortleberry (*Vaccinium scoparium*). Other major forest communities include Douglas fir (*Pseudotsuga menziesii*), Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*), limber pine (*Pinus flexilis*), and

whitebark pine (*Pinus albicaulis*). Douglas fir and limber pine communities typically occupy lower elevations in the northern portions of the park, while spruce-subalpine fir forest communities can be found in mid-elevation areas having more fertile, moist soil conditions such as those in the Bechler River drainage. Whitebark pine dominated forests typically occur in the park at elevations over 8,400 feet. Major tree species associated with riparian or other damp areas include willows (*Salix spp.*), cottonwoods (*Populus spp.*), and quaking aspens (*P. tremuloides*) (NPS 2010). Prior to any action taking place in native fish restoration areas, park resource managers would be consulted and an intensive plant survey would be conducted. If it is thought that fish restoration activities would affect the localized population of any rare plant species, mitigation measures would be implemented. These could include considering alternatives for project implementation, transplanting specimens, collecting seeds, and/or reseeding a disturbed area.

Non-forest plant communities primarily include sagebrush-steppe and subalpine and alpine meadows. Sagebrush-steppe communities, which have sagebrush (*Artemisia spp.*) and a variety of grass species, occur in the northern range, Hayden and Pelican valleys, and Gardner's Hole. Mountain big sagebrush (*Artemisia tridentata*) dominates, along with several other kinds of sagebrush. Alpine meadows are grass-dominated plant communities found above the timberline. Hundreds of species of wildflowers inhabit all plant community types (NPS 2010).

Invasive plants can displace native plant species and change the nature of vegetation communities. Many grow in disturbed areas such as developments, road corridors, and thermal basins. They are also spreading into the backcountry. There are currently more than 210 exotic plant species in the park. Resource managers target the most invasive species for control or removal. Five of the most invasive plant species in the park are dalmation toadflax (*Linaria dalmatica*), spotted knapweed (*Centaurea maculosa*), Canada thistle (*Cirsium arvense*), ox-eye daisy (*Leucanthemum vulgare*), hounds tongue (*Cynoglossum officinale*), and leafy spurge (*Euphorbia esula*) (NPS 2010).

3.3 Special Status Species

3.3.1 Yellowstone Species of Management Concern

The Strategic Plan for Yellowstone (NPS 2000) was written to fulfill the requirements of the Government Performance and Results Act of 1993. This act ensures that daily actions and expenditures of resources are guided by long- and short-term goals set in pursuit of accomplishing an organization's primary mission, followed by performance measurement and evaluation. Part of the strategic plan includes goals set for preserving native species of special concern. These are animal and plant species that scientific evidence indicates need protection, restoration, and/or conservation within a park because they are declining or have exceptionally limited distribution.

North American pronghorn: Yellowstone's pronghorn population was one of only a few not exterminated or decimated by early in the 20th century and, as a result, was the source for re-establishing or supplementing populations throughout much of its range (Lee et al. 1994). These pronghorn express much of the genetic variation that was formerly widespread in the species, but is no longer present elsewhere (Reat et al. 1999). This population also sustains one of only two long-distance pronghorn migrations that persist in the greater Yellowstone region (White et al. 2007). There are serious concerns about its viability because low abundance (~200) and

apparent isolation have increased its susceptibility to random, naturally occurring catastrophes (NPS 2010; National Research Council 2002).

Wolverine

The wolverine is a wide-ranging mustelid that naturally exists at low densities throughout much of northern and western North America (Beauvais and Johnson 2004). Wolverines are highly adapted to extreme cold and life in environments that have snow on the ground all or most of the year (Aubry et al. 2007). In the contiguous United States, these habitats are highly mountainous and occur at elevations above 8,000 feet (Copeland et al. 2007). Overexploitation through hunting and trapping, as well as predator poisoning programs, likely caused wolverine populations to contract along the southern portion of their historical range in North America since the early 1900s (Banci 1994). However, recent surveys indicate wolverines are widely distributed in remote, montane regions of Idaho, Montana, Washington, and parts of Wyoming (68 FR 60113).

Wolverines have been detected in the Greater Yellowstone Ecosystem including the eastern, northern, and southern portions of the park (Beauvais and Johnson 2004; Copeland et al. 2007). Wolverines have protected status in Washington, Oregon, California, Colorado, Idaho, and Wyoming (Banci 1994). In Montana, wolverines are classed as furbearers and trapper harvests are managed through a quota system that limits the number of animals that can be taken. The USFWS has ruled that listing the wolverine in the contiguous United States as a threatened or endangered species, was not warranted based on the best available scientific and commercial information (68 FR 60112).

Bald Eagle

The USFWS removed the bald eagle from the list of endangered and threatened wildlife on August 8, 2007. Current data indicate populations of bald eagles have recovered in the lower 48 states, with an estimated minimum of 9,789 breeding pairs now compared to 417 active nests in 1963 (USFWS 2006). Nesting and fledgling bald eagles in Yellowstone increased incrementally from 1987 to 2005 (McEneaney 2006). Resident and migrating bald eagles are now found throughout the park, with nesting sites located primarily along the margins of lakes and shorelines of larger rivers. The bald eagle management plan for the Greater Yellowstone Ecosystem achieved the goals set for establishing a stable bald eagle population in the park, with a total of 26 eaglets fledged from 34 active nests during 2007 (McEneaney 2006). This is the most fledged eaglets ever recorded Yellowstone and the increasing population trend indicates habitat is not presently limiting the growth of the population.

Peregrine Falcon

The American peregrine falcon was removed from the list of endangered and threatened wildlife on August 25, 1999 due to its recovery following restrictions on organochlorine pesticides in the United States and Canada, and implementation of various management actions, including the release of approximately 6,000 captive-reared falcons (64 FR 46541). The U.S. Fish and Wildlife Service has implemented a post-delisting monitoring plan pursuant to the Endangered Species Act that requires monitoring peregrine falcons at three-year intervals that began in 2003 and will end in 2015. Monitoring estimates from 2003 indicate territory occupancy, nest success, and productivity were above target values set in the monitoring plan and that the peregrine falcon population is secure and viable (71 FR 60563). Peregrine falcons reside in Yellowstone from April through October, nesting on large cliffs. The number of

nesting pairs and fledglings in the park has steadily increased from zero in 1983 to 32 pairs and 47 fledglings in 2007 (Baril et al. 2010).

Trumpeter Swan
Trumpeter swans were nearly extinct by 1900, but a small group survived by remaining year round in the Greater Yellowstone Area. In 2005 there were approximately 34,800 trumpeter swans in North America (USFWS 2006). Yellowstone supports resident, non-migratory trumpeter swans through the year, and its areas of ice-free water that diminish as winter progresses provide limited, temporary habitat for migrants from the region, Canada, and elsewhere during the winter. The NPS is committed to the conservation of resident trumpeter swans and preserving habitat for winter migrants in Yellowstone because swans are part of the natural biota and a species with considerable historical significance. However, counts of resident, adult trumpeter swans in the park decreased from a high of 69 in 1961 to 6 in 2009. Causes of this decline are unknown, but may include decreased immigration, competition with migrants, and the effects of sustained drought and predation on productivity (McEneaney 2006). The Rocky Mountain trumpeter swan population operates at a scale larger than Yellowstone, and the dynamics of resident swans in Yellowstone appear to be influenced by larger sub-populations and management actions in the Greater Yellowstone Area and elsewhere.

White Pelican
American white pelicans were identified as a Species of Management Concern because nesting attempts decreased from >400 during the mid-1990s to 128 during 1999, and Yellowstone has the only nesting colony of white pelicans in the national park system (McEneaney 2002). Pelican control in the 1920s followed by human disturbances in the 1940s and 1950s kept the population at low levels. Since then, pelican numbers have increased but the number of nesting attempts and fledged juveniles fluctuates greatly from year to year. Flooding occasionally takes its toll on production, as does disturbance from humans or predators (McEneaney 2002). YCT is the main food for white pelicans in Yellowstone. In 2006, a total of 427 pelicans fledged 362 young. The 2009 data indicate that only 54 chicks fledged. Lower numbers than normal could be the result of nest inundation by above average June rains, or the declining YCT population may be partially responsible for reduced fledging and nest success.

Yellowstone Cutthroat Trout
A range-wide status review estimated that the conservation population (>90% genetic purity) of YCT occupy over 6,300 km within their native range in Idaho, Montana, Nevada, Utah, and Wyoming. Yellowstone Lake, at over 84,000 surface acres, is home to the largest population of YCT in existence (Varley and Schullery 1998) and is an important food source for many animal species in the park. In Yellowstone Lake, recent threats such as LKT introduction, drought, and whirling disease have severely diminished the ecological role of this fish.

Westslope Cutthroat Trout
Numerous stressors, including stocking of non-native fish, habitat degradation and fragmentation from land use activities, have reduced the distribution and abundance of WCT. The subspecies currently occupies only 19% to 27% of its historical range east and west of the Continental Divide in Montana and about 36% of its historical range in Idaho. Even some of the historically most secure populations in Glacier National Park and the Flathead Basin of Montana are in serious decline. In the upper Missouri river drainage, WCT now occupy less than 5% of their historical range. The remaining population persists as small-stream residents

occupying isolated habitats ranging from several hundred meters to a few kilometers in extent. As a result, these populations face a high risk of extinction. In Yellowstone, WCT are present in approximately 3 km of a small tributary to Grayling Creek, as a restored population in East Fork Specimen Creek, and as a population stocked in Geode Creek in the 1920s.

Arctic Grayling

Arctic grayling are listed as a Species of Special Management Concern by the NPS and the USFWS. Fluvial (stream-dwelling) GRY were once widespread in the Missouri River drainage, but wild grayling persist only in the Big Hole River, representing approximately 4% of their native range in Montana. In Yellowstone, fluvial GRY historically occupied waters of the Madison and Gallatin River drainages on the park's west side. Introduced populations of adfluvial (lake-dwelling) GRY exist in Wolf and Grebe lakes, which form the headwaters to the Gibbon River. A 2005–2006 study indicated that the small number of GRY in the Gibbon and Madison rivers are likely emigrants from Wolf and Grebe lakes and that the native fluvial GRY population has most likely been extirpated from the park.

Ross's Bentgrass

Ross's bentgrass (*Agrostis rossiae*) grows only in the geyser basin along the Firehole River and at Shoshone Lake. The temperature one inch beneath a patch of this grass is usually about 100ºF. As a result, it is one of the first plants to green up in warm pockets of geyserite, sometimes as early as January. Full bloom occurs in late May and early June. As soon as temperatures rise in the early summer, the plants dry out due to the sun's heat and the thermal heat from below. Ross's bentgrass is dead and hard to find by July (NPS 2010).

Whitebark Pine

Whitebark pine is a major component of the forest community in areas above 8,400 feet and a major understory component of lodgepole-dominated forests from 7,000 to 8,400 feet. Seeds of the whitebark pine are important food for grizzly bears and a variety of other wildlife species. Whitebark pine populations in Yellowstone have been declining due to native mountain pine beetles (*Dendroctonus ponderosae*) and non-native blister rust, which is caused by a fungus, *Cronartium ribicola* (Schwandt 2006).

Yellowstone Sand Verbena

Yellowstone sand verbena occurs along the shore of Yellowstone Lake. The taxonomic relationship of this population of sand verbena to other sand verbenas is a matter of debate. Sand verbenas are a member of the four o'clock family, very few members of which grow so far north. It may be distinct at the subspecific level, and is certainly reproductively isolated from the closest sand verbena populations, which are in the Bighorn Basin of Wyoming. Some plants occur near warm ground, so the thermal activity in Yellowstone may be helping this species survive (NPS 2010).

Yellowstone Sulfur Wild Buckwheat

One of several varieties of sulfur buckwheat that live in the park, the Yellowstone sulfur buckwheat grows along the edges of thermally influenced sites from Madison Junction to the Upper Geyser Basin. It differs from the more common varieties by the densely hairy upper surface of the leaves and by the bright yellow of its flowers (NPS 2010).

3.3.2 Endangered and Threatened Species

An endangered species is any species that is in danger of extinction throughout all or a significant portion of its range; a threatened species is one that, without conservation efforts, will likely become endangered in the foreseeable future. The purpose of the Endangered Species Act of 1973 is to provide a means in which the ecosystems upon which endangered and threatened species depend may be conserved and a program for the conservation of such species. Species listed as endangered or threatened have the full protections provided under the Endangered Species Act.

Gray Wolf

Gray wolves were native to the Yellowstone area when the park was established in 1872. Historically hunted for their hides and as predators, they were eliminated from the ecosystem by the 1930s. The USFWS released an environmental impact statement on wolf reintroduction in May 1994. In 1995 and 1996, 31 gray wolves from Canada were released in the park. As of January 2010, approximately 400–450 wolves lived within the Greater Yellowstone Area, and 120 wolves within the park (NPS 2010). Elk make up most of their diet, but they also feed on bison, deer, antelope and smaller prey. The gray wolf was delisted in March 2008, but a federal court reinstated Endangered Species Act protection in July 2008.

Grizzly Bear

A recovery plan for grizzly bear populations in the lower 48 contiguous United States was implemented because the species was listed as threatened in 1975 under the Endangered Species Act (USFWS 1982). The plan was developed to provide direction for the conservation of grizzly bears and their habitat to federal agencies responsible for managing land within the recovery zone. Management of grizzly bears in Yellowstone has been successful in enabling grizzly bear recovery and reducing bear-human conflicts, e.g., property damage, incidents of bears obtaining human food, bear-inflicted human injuries, and human-caused bear mortalities in the park (Gunther 1994; Gunther et al 2004). The USFWS removed grizzly bears in the Greater Yellowstone Area from the federal list of threatened and endangered wildlife on April, 30, 2007. However, a lawsuit led to a court ruling on September 21, 2009 that restored protection under the Endangered Species Act. The relisting takes into consideration the implications of global warming and other factors that could impact grizzly bears such as the decline of spawning cutthroat trout and white bark pine nuts that grizzly bears rely heavily on during certain times of the year. The grizzly bear population has been estimated at approximately 600 within the 5.5 million acres encompassed by the Greater Yellowstone Area, of which nearly 40% lies within the Yellowstone's boundaries. The park's bear management program is directed toward the recovery, maintenance, and management of the grizzly bear populations while also providing for visitor safety.

Canada Lynx

Historical information suggests that lynx were present but uncommon in Yellowstone from 1880 to 1980. Park files contain records of 73 direct or indirect (tracks) observations of lynx made by park visitors or employees from 1887 to 2003. On March 21, 2000, the USFWS listed the Canada lynx as threatened under the Endangered Species Act. In the U.S. Rocky Mountains, lynx occur in cool, moist coniferous forests that typically support heavy snow pack and snowshoe hares, the lynx's principal prey. A 2004 study that documented the presence and distribution of lynx in the park by snow tracking in the winter and setting hair-snares during the summer detected several lynx in the vicinity of Yellowstone Lake and the Central Plateau

(Murphy et al. 2004). A lynx was photographed by a visitor in the vicinity of the Indian Creek Campground in April 2010.

3.3.3 USFWS Species of Concern

"Species of Concern" is an informal term that commonly refers to species that are declining or appear to be in need of conservation. The following USFWS Species of Concern are those that inhabit Yellowstone, use wetland and aquatic areas, and are not already listed as a "Special Status Species."

Alexander's Rhyacophilan Caddisfly
Recent monitoring activities near a high elevation lake led to the discovery of this rare caddisfly taxa. Alexander's rhyacophilan caddisfly (*Rhyacophila alexanderi*) is a free-living caddisfly without a case that moves actively around cobbles and boulders searching for food, usually preferring smaller insects, especially midge and black fly larvae. Very little ecological information is available for this species. Only two other locations have been documented for this caddisfly, both in Montana. Larvae of this species typically inhabit clear, cold mountain springs in forested areas.

Columbia Spotted Frog
This species has experienced sharp declines throughout much of its range in the past decade because of habitat alterations and loss, in part due to recent drought conditions, spring developments, wetland degradation, water diversion, road and dam construction, fire, and loss of beavers. This frog species is very common throughout the park. Adults are often found along streams, rivers, lakes, ponds, and marshes. Eggs are usually laid in globular masses in quiet water. Emergent vegetation is needed for egg attachment.

Black Tern
The black tern inhabits biologically rich marshes and aquatic areas, and usually prefers marshes or marsh complexes greater than 50 acres. It nests in small, loose colonies, generally in areas of still water where 25% to 75% of the surface is covered by emergent vegetation that is well interspersed with open water. Nests are often abandoned as a result of disturbance. Adults feed on insects and small fish.

Common Loon
Only one or two common loon pairs nest on Yellowstone Lake during any given year. In Montana, common loons will generally not nest on lakes that are less than about 13 acres or over 5,000 feet in elevation. Small islands are preferred for nesting, but herbaceous shoreline areas, especially promontories, are also selected. Nursery areas are very often sheltered, shallow covers with abundant small fish and insects. Most Montana lakes inhabited by common loons are relatively oligotrophic and have not experienced significant siltation or other hydrological changes (Skaar 1990). Common loons generally dive from the surface and feed mainly on fish, but will eat any suitable prey they can readily see and capture, including amphibians and various invertebrates (McIntyre 1988). In Yellowstone, salmonids are their primary food on breeding lakes. The common loon has low abundance in Wyoming and is considered an uncommon summer resident; the breeding population is limited to the northwestern part of the state (NatureServe 2004).

Double-Crested Cormorant
In Yellowstone, double-crested cormorants nest on the Molly Islands, typically on the highest parts of the islands. Their nests consist of elevated sticks and weeds cemented by guano. The number of nesting pairs and fledglings fluctuates from year to year. Flooding and disturbance are the two principal factors affecting production. In 2001, a total of 111 double–crested cormorant nests were constructed, fledging 75 young.

Western Grebe
The western grebe inhabits marshes and lakes, usually with extensive areas of open water and bordered by tall emergent vegetation. It nests in colonies of hundreds on large inland lakes. Ideal nesting areas provide large clumps of emergent vegetation that blocks wave action. Large bulrush "islands" with inner open water areas and channels are good nesting sites. In Yellowstone it is a very common fall migrant.

Osprey
Ospreys are large raptors whose diet consists primarily of fish. They are breeding residents that build large nests composed primarily of sticks. Nesting sites have been observed near Yellowstone and Grebe lakes, Pelican Creek, and Yellowstone, Lamar, Madison, Firehole, and Gibbon rivers. Between 31 and 100 active osprey nests have been documented in the park during any given year. Ospreys and other fish-eating wildlife in Yellowstone are being monitored to find out if they are affected by the presence of LKT. Scientists have detected a recent decrease in osprey nests on Yellowstone Lake, which suggests the birds may be affected by the declining YCT population.

Northern Harrier
The northern harrier is a medium-sized hawk that often forages over open meadows and marsh lands searching for small rodents, its primary food. This species breeds throughout the northern hemisphere, nests on the ground, and typically migrates to more southern latitudes during the winter, though some remain in Yellowstone year-round. The northern harrier is one of the few species of raptors in which males and females have different colored plumage.

3.4 Social and Economic Resources

3.4.1 Health and Human Safety

The NPS is committed to providing high-quality experiences and opportunities for visitors and a safe working environment for employees. Human health and safety concerns associated with this Native Fish Conservation Plan include: hazards on Yellowstone Lake, such as hauling and lifting nets; fish handling; possible exposure to piscicide and drinking water implications; working in wilderness areas; operation and maintenance of boats; and driving on park roads.

3.4.2 Socioeconomics

Yellowstone plays a prominent role in the social and economic life of the GYA. Gateway communities have developed outside the park's five entrances: Cody, Dubois, and Jackson in Wyoming, and Cooke City/Silver Gate, Gardiner and West Yellowstone in Montana. The Montana gateway communities are at the park boundary or within a few miles while the Wyoming gateway communities are an hour's drive or more from the park boundary.

The gateway communities provide food, lodging, medical services, groceries, gasoline, other automotive supplies/services, gifts, souvenirs, and other goods and services to the public. The economic viability of the gateway communities depends heavily on the recreation and tourism traffic that is generated by Yellowstone and other public recreation destinations.

Less than two percent of the park is developed. Park infrastructure includes utilities, trails, roads, employee housing, administrative headquarters, and visitor services facilities in various areas throughout the park. These developed areas have evolved near popular scenic features of the park.

3.4.3 Park Operations

Park operations consist of NPS, concessioner, and contractor operations which encompass protection of natural resources; maintaining all roads, trails, buildings and other structures in a safe and aesthetically pleasing condition; preventing deterioration that would render them unsightly, unsafe, or beyond efficient repair and providing dining, shopping, and lodging opportunities to park visitors.

National Park Service Operations

The NPS provides operations and support for administrative services, resource management, cultural and natural resources, visitor facilities, visitor protection, and emergency services throughout the park. NPS employee housing and administrative offices are located at developed areas including Mammoth Hot Springs, Norris, Canyon, Tower, Northeast Entrance, Lake, Grant, Madison, South, Old Faithful, and West Yellowstone.

Administrative Services

The park's Administrative Division is responsible for budget and finance, fee collection, payroll, computer support, human resources, NPS mail, procurement, property, the supply center, and telecommunications. It is headquartered in Mammoth Hot Springs and has support staff stationed in most of the developed areas.

Yellowstone Center for Resources

The YCR provides scientific and practical support for a variety of park responsibilities, including resource management, cultural (historic architecture, NPS museum, research library, archeological, and ethnographic), and natural (geological, vegetation, aquatics, and wildlife). It is headquartered in Mammoth Hot Springs and has staff stationed in most of the developed areas. A main component of the Aquatic Sciences Section, which is part of the LKT suppression program, is stationed at Lake from May to October.

Maintenance

Parkwide operations include maintenance of museums, ranger stations, housing, campgrounds, warming huts, vault toilets, water and sewage systems, housing and other buildings, road maintenance, garbage collection, and maintaining the NPS vehicle fleet (snowmachines, snowcoaches, boats, cars, trucks and heavy equipment). In addition, NPS personnel maintain hundreds of miles of trails throughout the park.

Resource and Visitor Protection

Resource and visitor protection includes the backcountry office, communication center, corral operations, and law enforcement rangers. The backcountry office provides technical support for backcountry activities undertaken by both park visitors and park employees. During 2009,

Yellowstone had 39,736 overnight stays at backcountry campsites. The communication center is the central dispatch for all park communications. Corral operations provide practical support for livestock use and backcountry trips. Law enforcement rangers regularly patrol front-country and backcountry areas and are responsible for visitor and resource protection, emergency services, and structural fire response in all of the park's developed areas

3.4.3.1 Concession Operations:

Xanterra Parks and Resorts operate lodging, gift shops, and dining and camping facilities in the park's developed areas. At the Bridge Bay marina, they offer guided tours on Yellowstone Lake, guided fishing trips, boat rentals, and rental of boat docking slips. They also operate year-round bus tours during summer months and offer oversnow vehicle use in the winter. In 2009, park concessioners provided 1,074,288 overnight stays for park visitors.

Delaware North operates stores that sell gifts and souvenirs, groceries camping supplies, Yellowstone fishing licenses, and fishing tackle and equipment, and offer limited food and beverage service.

Yellowstone Park Service Station operates service stations in Mammoth Hot Springs, Canyon, Fishing Bridge, Grant Village, Old Faithful, and Tower that sell fuel, snacks, and refreshments. Most of the stations also offer vehicle towing and maintenance service for park visitors.

Medcor. Inc. operates medical clinics at Old Faithful, Mammoth, and Lake that provide care for NPS and concessions employees as well as park visitors.

The NPS has also issued approximately 45 Commercial Use Authorizations to businesses that provide guided fishing trips in the park and approximately 46 stock outfitters who can provide guided fishing trips into the backcountry.

3.4.4 Visitor Use and Experience

Visitation to Yellowstone has fluctuated between two million and more than three million visitors a year during the last decade, with about 3.3 million visitors in 2009 (NPS Public Use Statistics Office). About 60% to 70% of visitation occurs in June, July, and August. During winter, wheeled-vehicle travel is limited to the far northern portion of the park, when access to the interior is only by guided snow track vehicles. Access to the interior during spring and late autumn is by hiking, skiing, or bicycling on plowed roads.

Summer visitor use patterns generally reflect entrance traffic and the tendency of visitors to drive to the major developed areas. Old Faithful is the most popular developed area in the park, with 90% of visitors stopping at this area during 2006; more than 60% of summer visitors reported visiting Mammoth Hot Springs and Canyon Village, (Manni et al. 2007). The most common activities in the park were sightseeing/taking a scenic drive (96%) and viewing wildlife/bird watching (86%). For 59% of park visitors, sightseeing/taking a scenic drive was the primary reason for visiting the park (Manni et al. 2007).

Recreational activities that are most likely to be affected by this Native Fish Conservation Plan are backcountry campsite use, hiking, and angling. Impacts to the backcountry and by day use visitors and anglers were analyzed based on the sale of special use permits and other data routinely collected by park staff. In 2009, park staff issued a total of 5,638, backcountry permits,

2,986 boating permits, and 50,113 fishing permits. Anglers typically spend a total of 270,000 days fishing in the park each year.

In 2006, 90% of park visitors were from the United States (California, 12%; Utah, 10%; and 5% each from Idaho, Colorado, Washington, and Texas; and smaller percentages from 43 other states and Washington, D.C. (Manni et al. 2007). International visitors were from Canada (25%), Netherlands (17%), Germany (10%), United Kingdom (9%), Italy 7%), and 17 other countries. Visiting the park was the primary reason that 60% of the visitors came within 150 miles of the park; 53% of visitors were seeing Yellowstone for the first time (Manni et al. 2007).

3.4.5 Wilderness

In Yellowstone, 2,022,221 acres (91% of the park) are considered wilderness; the remaining 9% is administrative facilities, developed areas, and roads. Wilderness areas in the park are classified as "recommended" for wilderness designation (2,016,181 acres) or "potential" wilderness (6,040 acres) (NPS 1971). NPS Management Policies (2006) state that all wilderness categories, including suitable, study, proposed, recommended, and designated shall be managed for the preservation of wilderness characteristics, and that NPS management decisions pertaining to lands qualifying as wilderness will be made in expectation of eventual wilderness designation. All management decisions affecting these areas are to apply the concept of "minimum requirements."

Except for the South, Southeast, and Flat Mountain arms, which are recommended wilderness areas, Yellowstone Lake is non-wilderness. Specific areas where stream restoration would occur under this Native Fish Conservation Plan would take place in recommended wilderness areas in the park's backcountry.

4. Chapter 4: Environmental Consequences

This chapter analyzes the potential environmental consequences or impacts that would occur as a result of implementing the proposed project. The intent of this section is to provide an analytical basis for comparison of the four alternatives and the impacts that would result from the implementation of each. Impact topics have been selected for the analysis based on the potential for effects on important resources and other key issues identified during planning. This section is based on scientific and analytical review of information collected by the National Park Service and provided by other agencies.

Each impact topic is analyzed for the direct, indirect, and cumulative impacts from the alternatives. To address the inherent uncertainty of the AM strategy and potential responses from the action alternatives (alternatives 2, 3, and 4), each impact topic is analyzed for the direct, indirect, and cumulative impacts of success in achieving the primary, secondary, or tertiary desired conditions and in meeting plan objectives (Tables 5 and 6). Potential impacts are described in terms of type (i.e., beneficial or adverse, direct or indirect), context (i.e., local or regional), duration (i.e., short-term or long-term, seasonal or continuous), and intensity (i.e., negligible, minor, moderate, or major). The following definitions were used for all impact topics.

- **Beneficial**—a positive change in the condition of the resource or a change that moves a resource toward its desired condition.
- **Adverse**—a negative change in the condition of the resource or a change that moves a resource away from its desired condition.
- **Direct**—an effect that is caused by an action and occurs at the same time and place.
- **Indirect**—an effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.
- **Site-specific impact**—the action would affect relatively small areas within the park, centered on where the action takes place.
- **Local impact**—the action would affect areas within the park boundary.
- **Regional impact**—the action would affect resources in the park, on lands adjacent to the park, and in surrounding communities.
- **Short-term**—an effect which would no longer be detectable in a short amount of time as a resource returns to its pre-implementation condition; generally the duration of the project.
- **Long-term**—a change in a resource or its condition that does not return to pre-implementation levels and for all practical purposes is considered permanent.

At the beginning of each impact topic, *intensity threshold definitions* using the above terms have been established. These definitions are the key to understanding the impact analyses under each impact topic. These definitions provide explanations of types of actions that could elicit each intensity level (e.g. negligible, minor, moderate, major). *Please refer to these definitions when reviewing each impact analysis.* Table 10 provides a comparative summary of potential impacts of each alternative.

4.1 Cumulative Impacts

The Council on Environmental Quality regulations, which implement the National Environmental Policy Act of 1969 (42 USC 4321 et seq.), require assessment of cumulative

impacts in the decision-making process for federal projects. A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for both the no-action and preferred alternative.

Cumulative impacts were determined by combining the impacts of the preferred alternative with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects at Yellowstone National Park and, if applicable, the surrounding region. The geographic scope for this analysis includes actions within the park's boundaries, while the temporal scope includes projects within a range of approximately ten years. Given this, the following projects were identified for the purpose of conducting the cumulative effects analysis, listed from past to future.

- Administrative Activities (maintenance; ongoing): General maintenance activities that take place parkwide and could impact resources. Maintenance activities include, but not limited to: placing riprap along road segments to prevent erosion from adjacent streams (e.g. Soda Butte Creek and Gardner River); removing and replacing culverts; snow removal; and maintaining and reconstruction of trails and boardwalks,
- Administrative Activities (visitor, resource, and monitoring protection; ongoing): Visitor use and protection require administrative activities such as: patrolling front- and backcountry areas using boats, livestock, and motor vehicles; research and monitoring of wildlife and plant populations; and eradication of exotic plants by using chemicals and manual methods.
- Norris-Madison Road Reconstruction Project, 2001-2010: Road improvement was made on a 16.3 km (10 miles) segment of the Grand Loop Road between Madison Junction and Norris Junction. This road segment was widened to a 9.2 meter (30 feet) paved top including travel lanes and paved shoulders. The road segment between Gibbon Falls and Tanker Curve was realigned and followed an upland route above the canyon. Construction of a new bridge and removal of one existing bridge took place in 2010. Removal of 2.9 km (1.8 miles) of existing road along the Gibbon River was also completed in 2010.
- Wildland-Urban Interface Fuels Management, 2002: Included a reduction of fuel loads in three developed frontcountry areas and 31 backcountry areas. The three frontcountry areas, Lake Utility Area, East Entrance and Northeast Entrance areas covered approximately 119.4 acres. The area covering backcountry sites (30 cabin sites) ranged between 4-15 acres, plus treatment
- Canyon-Tower (Dunraven Road) Road Improvement Project, 2003-2007: The segment of the Grand Loop Road that comprises the Dunraven Road construction project stretches from Tower Junction to Canyon Junction, a total of 18.4 miles (29.3km). The entire road will be widened from its existing 19–22 feet to 24 feet and design will address needs for better drainage, more pullouts and parking areas, and slopes that can re-vegetate in the short, 2–3 month growing season. Design and construction are being accomplished in two phases. The first phase, from Chittenden Road to Canyon Junction, began in 2003 and was completed in 2005. The second phase from Chittenden Road to Tower Junction is scheduled to begin in 2011, but is dependent upon highway funding. The second phase of the project would include the Tower Fall Campground road, the Tower Fall store parking, and the entrance road to Roosevelt Lodge, again dependent on funding.
- Yellowstone Fire Management Plan, 2004: This is a comprehensive plan that allows fire to play its ecological role in the park while providing safety to firefighters and the public,

providing information to the public, and protection of developed areas. This plan allows for a variety of management tools that include mechanical treatments, use of wildland fires and suppression.

- Restoration of Westslope Cutthroat Trout in Specimen Creek Watershed, 2006-2012: This plan allowed for the chemical removal of non-native and hybridized fish from the East Fork Specimen Creek including High Lake. In 2006 fish were chemically removed from High Lake and native westslope cutthroat trout were subsequently stocked between 2007-2009, In 2008 a barrier was constructed on the lower portion of East Fork Specimen Creek to prevent upstream movement of fish. All fish in East Fork Specimen Creek were then removed via 2 separate chemical treatments in 2008 and 2009 with fish being restocked in 2010. Stocking efforts will continue in 2011 and 2012.
- Lamar River Bridge Reconstruction/Replacement, 2010: The Lamar River Bridge is scheduled to be replaced beginning fall of 2010. The current bridge would be replaced with a similar bridge adjacent and just upstream of its current location. Approximately one half mile of the Tower to Northeast Entrance road will be shifted to match the alignment of the new bridge. The old roadbed would then be rehabilitated, and the old bridge removed.
- Sylvan Pass Reclamation and Road Reconstruction, 2010: This project would reconstruct a portion of the East Entrance Road through Sylvan Pass, and rehabilitate an area that has for many years served as a source of gravel and rock for road reconstruction projects within the park. Design work for the Sylvan Pass project has been completed and construction is scheduled in 2010.
- Norris-Golden Gate Road Reconstruction, Future: Yellowstone National Park plans to reconstruct a portion of the Grand Loop Road between its intersection with Norris Campground, and north to a point just north of Swan Lake Flats, in an area known as Golden Gate.
- Tower-Roosevelt Comprehensive Plan, Ongoing: This plan will alter or improve visitor services, facilities (buildings, roads, and paved parking areas), and utilities while preserving the distinct and significant rustic western camp character and resources in the Tower-Roosevelt area.
- Old Faithful and Lake Comprehensive Plans, Future: These plans will alter or improve visitor services, facilities buildings, roads, and paved parking areas), and utilities while focusing on protecting these developed areas by managing growth and development.
- Climate Change: While climate change was dismissed as an impact topic because the contribution of greenhouse gases from proposed actions would be minimal, climate change could still contribute as a cumulative impact on resources. The following is a summary of impacts that could occur due to climate change in Yellowstone. This summary was developed using the document, Observed and Projected Ecological Response to Climate Change in the Rocky Mountains and Upper Columbia Basin; A Synthesis of Current Scientific Literature, published by the NPS in 2010.

  Temperatures in the Rocky Mountain region are generally expected to increase by approximately 1–2°C (2 – 4 °F) during the next 50 years with natural variation over years to decades. Precipitation is less well understood, but the projection for total annual precipitation suggests that the dominant pattern in North America will be a wetter climate in the northern tier and a drier climate in the southwestern United States.

  While there are likely to be regional variations, projected effects across the West include loss of glaciers, less snow, earlier peak flows, less streamflow, warmer water temperatures, more

frequent droughts, and more intense storms. Lower summer base streamflows reduce the amount of instream habitat for invertebrates and fish and cause a reduction in stream-side groundwater tables which are important for sustaining riparian vegetation communities. Reduced water depths may also increase the vulnerability of sensitive species (e.g., amphibians) to harmful ultraviolet radiation. In addition to the shift in the quantity of water, climate change may reduce water quality due to increased erosion and decreased dilution of pollutants. Decreases in snow cover and more winter rain on bare soil are likely to lengthen the erosion season.

How these effects when combined with other foreseeable futures actions may contribute to resource impacts from the proposed actions is difficult to quantify. What can be stated is during the years of the planned actions, climate change may contribute slightly (indirectly at the negligible to minor adverse level) but most likely not to the intensity that would, based on climate change alone, increase resource impacts. Climate change may in the long term make restoration efforts more difficult to successfully implement since changes in water level or temperature may be advantageous for non-native organisms, but the proposed actions in the plan, if implemented quickly and aggressively, may mitigate some of these impacts by re-establishing secure native communities.

4.2 Environmental Setting

4.2.1 Geologic Resources

Guiding Principles and Policies
The geologic setting is the fundamental underlying factor for the behavior and characteristics of a landscape. NPS geologic resources are important for their role in the ecosystem, their scenic grandeur, and their contribution to visitor enjoyment. Yellowstone was established specifically to protect geologic resources. The park contains geologic resources of international renown, including both geologic features and processes. For the purpose of this discussion, this topic includes soils, bedrock, streambeds and hydrothermal features. The NPS has developed policies and guidance on geologic resource management. Section 4.8 of the NPS Management Policies (2006) addresses geologic resource management. This policy states that the NPS will maintain, preserve, and protect geologic resources as integral components of the park's natural systems.

Methodology and Assumptions
Analysis of the potential impacts to soils, bedrock, streambeds, lakebeds, and hydrothermal structures are derived from available information on the impacts from possible projects and activities.

Intensity Level Definitions
The impact intensities for soils, bedrock, streambeds, lakebeds, and hydrothermal structures are as follows:

Negligible: An action that would result in a change to a natural physical resource, but the change would be so small that it would not be of any measurable or perceptible consequence. Soils, bedrock, streambeds, lakebeds, and hydrothermal structures would not be affected or the effects on these geologic resources would not be detectable.

Minor: An action that would result in a change to a natural physical resource, but the change would be small and localized and of little consequence. Effects on geologic resources would be detectable, although these effects would be localized and short-term.

Moderate: An action that would result in a change to a natural geologic resource; the change would be readily apparent and measurable, localized, and possibly long-term. Measurable effects could include physical disturbance, removal of large amounts of soil, streambed, or lakebed material, compaction, unnatural erosion, or physical damage to hydrothermal structures. The appearance of a geologic resource would be modified or its physical properties compromised. Mitigation measures proposed to offset adverse effects would include measures to ensure that topsoil is preserved, ground is reshaped into the natural contours, ground is de-compacted, and that there is no unnatural erosion of soils.

Major: An action that would result in a noticeable change to a geologic resource; the change would be measurable and result in a severely adverse or major beneficial impact. Effects on geologic resources would be readily apparent, measurable, severe, long-term, and occur on a regional scale. Entire features could be removed or the physical properties significantly altered severe compaction, and unnatural erosion. Mitigation measures proposed to offset adverse effects would be extensive and success would not be assured.

Duration: Short-term impacts to geologic resources would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.2.1.1 Alternative 1 (No Action): Impacts on Geologic Resources

Impact Analysis
Existing NPS efforts would continue on Yellowstone Lake to remove LKT and limited efforts would continue to monitor and remove non-native fish in other streams, rivers, and lakes. Nets would be set on the lakebed where they are most efficient in catching LKT. In Yellowstone Lake, the lakebed is a composition of fine and coarse sediments that include silt, sand, clay, fine and coarse gravels, and boulders. In addition, the lakebed is shaped by the same hydrothermal activity that occurs throughout the park with 672 hydrothermal features being documented (Morgan et al. 2003).

Yellowstone Lake
1a. Large-scale Lake Trout Removal: Existing LKT suppression efforts would continue on Yellowstone Lake. In 2009, approximately 330 km (205 miles) of nets were used to fish for LKT and these levels would be maintained. Impacts to geologic resources would occur under Alternative 1. Lake trout removal would be conducted using NPS crews, boats, and nets. Netting activities include net preparation, mending, and placement. Both net preparation and mending take place within developed paved areas of Lake Village and would not impact geologic resources. Net placement usually takes place in deep water areas of Yellowstone Lake at depths between 15-65 meters, which encompasses approximately 50 percent of the lake area. The maximum amount of lakebed that would be disturbed by netting activities in 2009 is estimated at 0.33 km^2 (0.13 mi^2) and this level of effort is expected to continue. However, most netting occurs in the West Thumb portion of Yellowstone Lake and areas are fished repeatedly making the

actual total of lakebed area disturbed by netting much smaller (less than 0.1 percent). The substrate of Yellowstone Lake would be disturbed temporarily as gillnets are moved across it when they are being deployed or retrieved. Because of the slight degree of disturbance, LKT removal is expected to have direct, short-term, negligible adverse effects on lakebed substrates.

Impacts to hydrothermal resources in Yellowstone Lake would occur under Alternative 1. There are 672 hydrothermal features that have been documented on the lakebed (Morgan et al 2002). These are comprised of explosion craters, siliceous spires, hundreds of hydrothermal vents and craters, active fissures, and domal features containing gas pockets and deformed sediments. Most of these hydrothermal features (458; 68.2%) are found within the depth strata that are fished for LKT. However, only 105 (15.6%) are in the western portion of the lake where most LKT removal efforts occur (Morgan et al. 2003). Hydrothermal features of Yellowstone Lake would be altered or damaged as gillnets are moved across the lake bottom when they are being deployed or retrieved. While only a small portion of features where the lake is being fished will be impacted, some features will be modified; therefore LKT removal is expected to have direct, short- and long-term, minor to moderate adverse effects on hydrothermal structures in Yellowstone Lake.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats and large nets. Monitoring would occur during the open water season, typically August and September, and take place near the lake's margin at depths ranging from 5-50 meters. LKT monitoring entails sampling at least six sites which are randomly selected from each of four regions of Yellowstone Lake (24 sites total) using 412 m (1,350 ft.) of net per site; YCT monitoring is conducted at 11 sites using 190 m (625 ft.) of net per site. During any given year, less than 1 percent of lakebed would be impacted by LKT and YCT monitoring activities. Yellowstone Lake substrate would be temporarily disturbed as gillnets are moved across it when they are being deployed or retrieved. Because of the slight degree of disturbance, LKT and YCT monitoring is expected to have direct, short-term, negligible adverse effects on lakebed sediments.

Impacts to hydrothermal resources would occur under Alternative 1. Yellowstone Lake bottom contains explosion craters, siliceous spires, hundreds of hydrothermal vents and craters, active fissures, and domal features containing gas pockets and deformed sediments. Many of these hydrothermal features are found in and around Yellowstone Lake. Even though monitoring nets will cover only a very small percentage of lakebed, because these areas are likely to have hydrothermal features, monitoring of LKT and YCT is expected to have direct, long-term, minor to moderate adverse effects on hydrothermal features within Yellowstone Lake.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to geologic resources would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to geologic resources would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue and could potentially occur anywhere throughout the Yellowstone Lake basin. The techniques are not yet fully developed and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have minor to moderate adverse impacts to geologic resources. Impacts beyond this level would require further NEPA analysis.

Other Streams, Rivers, and Lakes

1f. Fish Barriers or Weirs/Traps: No action would be taken to construct fish barriers in streams. No impacts to geologic resources would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. One week each year electrofishing BKT in Soda Butte Creek takes place. Electrofishing activities would lead to minor disturbance of streambed material as NPS crews work in the stream. Because electrofishing takes place over a short period of time and minimal streambed material is affected, these activities would lead to direct, short-term, negligible adverse impacts to geologic resources.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. These activities would involve walking within lake margins, stream channels and riparian areas which would cause compaction of soils and disturbance of stream and lake substrates. Impacts from soil compaction could be minimized through de-compacting efforts after project completion. Because soil compaction could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, negligible adverse impacts to geologic resources.

1i. Inventory, Monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on streams, rivers, and lakes other than Yellowstone Lake would continue. These include working in stream channels, lake margins, and other wetland areas. Most impacts would occur as NPS crews travel to and from collection sites. Impacts from soil compaction could be minimized through de-compacting efforts after project completion. Because soil compaction would be localized for a short period of time and minimized if occurred, these activities would lead to direct, short-term, negligible adverse impacts to streambeds and soils. No impacts would occur to hydrothermal features.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on soils in the park. Road maintenance activities would require disturbance and removal of soils by heavy equipment operation. Backcountry operations would include horse patrol and trail maintenance. Trail maintenance would involve localized removal of soils and overnight use of campsites and cabins that would lead to some soil compaction. Most facilities maintenance would take place in developed areas where soils may be removed for general operation practices. Impacts would be reduced by de-compacting soils after project completion. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on geologic resources as more people hike and camp in Yellowstone. Alternative 1 would lead to further negligible compaction of soils and minor to moderate alteration of hydrothermal features. Coupled with these past, present, and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level on geologic resources would remain negligible to moderate.

Alternative 1 Conclusion

Continued LKT suppression efforts would affect the geologic and hydrothermal features of Yellowstone Lake. The impacts to these features will be direct, short- and long-term, negligible (soils) or minor to moderate (hydrothermal structures) adverse impacts to geologic resources. In summary, Alternative 1 would have direct, short- and long-term, negligible to moderate adverse impacts to geologic resources in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would be minimal. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. In summary, Alternative 1 would have direct short-term, negligible adverse impacts to geological resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct, short- and long-term, negligible to moderate adverse impacts to parkwide geologic resources.

4.2.1.2 Alternative 2: Impacts on Geologic Resources

Impact Analysis
Impacts to geologic resources would occur under Alternative 2 from potential actions associated with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients. Proposed actions may include measures to assist native fish populations by construction of fish barriers, removing sand bars to reconnect isolated tributary streams on Yellowstone Lake, and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
2a. Large-scale Lake Trout Removal: This alternative would increase the amount of netting on Yellowstone Lake to at least 7,800 km gillnet sets each season (more than three times that of current levels) and add eight or more large trapnets. Lake trout removal efforts by NPS crews and by private sector contract netters would often occur in deep water areas of Yellowstone Lake at depths between 15-65 meters which encompasses approximately 50 percent of the lake area. Impacts to geologic resources would occur. Net preparation and mending take place in developed areas of Lake Village and would not have an impact to geologic resources. It is estimated that less than 0.1 percent of the lakebed will be affected by NPS netting activity and an additional 0.2 percent of the lakebed will be disturbed by contracted activities. Additional nets would be placed on 9 known spawning areas which cover approximately 1 percent of the lakebed. Gillnet activities would disturb lake substrates as gillnets are moved across the lake bottom when they are being deployed or retrieved. Because of the slight degree of substrate alterations, LKT removal is expected have direct, short-term, negligible adverse impacts to Yellowstone Lake sediments.

Impacts to hydrothermal resources would occur under Alternative 2. There are 672 hydrothermal features that have been documented on the lakebed (Morgan et al. 2003). These are comprised of explosion craters, siliceous spires, hundreds of hydrothermal vents and

craters, active fissures, and domal features containing gas pockets and deformed sediments. Most of these hydrothermal features (458, 68.2%) are found within the depth strata that are fished for LKT. However, only 105 (15.6%) are in the western portion of the lake where most LKT removal efforts occur (Morgan et al. 2003). Hydrothermal features of Yellowstone Lake would be altered or damaged as gillnets are moved across the lake bottom when they are being deployed or retrieved. While only a small portion of features where the lake is being fished will be impacted, some features will be modified; therefore LKT removal is expected to have direct, short- and long-term, minor to moderate adverse effects on hydrothermal structures in Yellowstone Lake.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect geologic resources in the vicinity of the confluence of Clear Creek with Yellowstone Lake. A new structure would be constructed on the same site as the old weir using some of the remaining structure (bulkheads) from the previous weir. The weir would be constructed mostly of unnatural materials including concrete blocks, mortar (cement), steel, and iron. The design would be structurally capable of withstanding high spring flows with as little impact to stream hydrology as possible. Current designs anticipate total activities would occur in an area approximately 60 feet wide by 150 feet wide, or 9,000 square feet (or 0.2 acres).

Operation and maintenance activities would further compact soils in the immediate vicinity of the weir. Mitigation measures proposed would include ensuring that soil and streambed material is preserved, the ground is de-compacted, and that there is no unnatural erosion of soils or long-term impacts to streambeds. The reconstructed weir will allow natural stream flows and would result in recovery of the stream channel both up and down stream. Therefore, while weir construction would have direct, short-term, negligible to minor adverse impacts to riparian soils and streambeds, the long term impacts would be minor and beneficial.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators may cause some soil compaction and reconnecting isolated tributaries would involve moving and placement of sand and gravel material on nearby, non-vegetated shoreline. Because mitigation measures described in Chapter 2 (interdisciplinary collaboration to minimize hydrologic changes, recontouring of disturbed areas, using standard erosion control methods, and de-compacting soils) would be implemented, impacts from enhancing YCT recruitment would be direct, short-term, negligible to minor and adverse to soils. No hydrothermal features would be affected.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes

2f. Fish Barriers or Weir/Traps: Barrier modification and construction would affect geologic resources under Alternative 2. As described in Chapter 2, fish barriers may include use of natural features, modification of natural features and barrier construction. Examples of modifying existing water features that serve as partial barriers include: redirecting stream flow using wing walls, filling plunge pools with material to eliminate jumping areas, using explosive to increase the height or angle of a feature, or some combination of these. Where no other feasible natural feature exists, complete construction of a fish barrier may be necessary on some streams. Fish barriers, if required, would be constructed from nearby native logs and rocks; rebar, wire mesh,

and mortar (cement). Barriers would alter soil and streambeds in a localized area of the construction site. For each project, individual assessments completed; if more than 1,011 m^2 (0.25 acres) of soils would be disturbed or removed for construction purposes, a separate wetlands statement of findings would be developed to address and mitigate impacts to wetland soils. Fish barriers will also prevent downstream movement of larger sediments such as sand, gravel and cobble. Barrier construction, maintenance, and monitoring would create social trails which would lead to soil compaction. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, interdisciplinary collaboration to minimize hydrologic changes, de-compact social trails, recontouring disturbed areas, regular monitoring of structural integrity and implementing standard erosion control measures) would be implemented, impacts to geologic resources would be direct, short-term, minor and adverse. No hydrothermal features would be impacted by barrier construction.

2g. Non-native Fish Removal: Chemical (piscicides) and mechanical (e.g., angling, electrofishing, trapping and netting) removal of fish would lead to impacts to geologic resources such as soils and streambed compaction. Soils can become compacted or disturbed by social trails that develop as successive chemical treatments may be necessary to completely eradicate non-native fish species. Mechanical removal of fish is expected to have similar impacts. Soils may become impacted and social trails may develop as equipment is installed and removed from selected areas. Some gear may slightly alter areas as it is moved across lake and stream substrates. Because mitigation measures described in Chapter 2 (ensuring survey completion, avoiding development of social trails, and de-compacting soils) would be implemented, chemical and mechanical removal of fish would have direct, short-term, negligible to minor adverse impacts to geologic resources. Hydrothermal structures would not be affected during this phase of the project.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters could be used to bring genetically pure native fish to the project waters. The addition of pack stock would increase potential for compacting soils. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, avoid development of social trails, and de-compacting soils) would be implemented, restocking native fish and brood source development would have direct, short-term, negligible to minor adverse impacts to geologic resources, primarily to soils, as projects are being implemented within certain watersheds. Hydrothermal structures would not be affected during

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative1 subtopic 1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reductions projects (as described under cumulative impacts) would continue to have adverse effects on geologic resources in the park. Road maintenance activities would require disturbance and removal of soils by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized removal of soil, and overnight use of campsites and cabins that would lead to development of social trails and soil compaction. Most facilities maintenance would take place in developed areas where minimal impacts to geologic resources would occur. However adverse impacts to geologic resources may occur because some soil material may be removed for general operation practices. Such impacts to geologic

resources would be reduced by using multiple entries to prevent development of social trails and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, hiking, and geyser watching would increase parkwide. An increase in recreational users will likely place additional pressures on geologic resources (including hydrothermal features) as more people hike and camp in Yellowstone. Alternative 2 would lead to further negligible compaction of soils and minor to moderate alteration of hydrothermal features. Coupled with these past, present, and foreseeable future actions, Alternative 2 would incrementally increase adverse impacts, but the overall impact level on geologic resources would remain negligible to moderate.

Alternative 2 Conclusion

Under Alternative 2, increased LKT suppression efforts would affect the geologic and hydrothermal features of Yellowstone Lake bottom. The impacts are expected to be direct, short- and long-term, and negligible (sediments) or minor to moderate (hydrothermal features) adverse impacts. Reconstruction of Clear Creek weir and trap would have direct, short-term, negligible to minor adverse impacts to riparian soils and streambed sediments. The reconstructed weir will allow natural stream flows and would result in recovery of the stream channel both up and down stream. Impacts to soils and streambed sediments due to the new weir design would be long-term, minor, and beneficial. In summary, Alternative 2 would have direct, short to long-term, negligible to moderate adverse and long-term, minor, beneficial impacts to geological resources in the Yellowstone Lake watershed.

Under Alternative 2, fish restoration activities on streams, rivers, and lakes would affect soils and streambeds. Fish barriers or weirs/trap construction would cause direct, short-term, minor adverse impacts to geologic resources. Chemical and mechanical fish removal would cause direct, short-term, negligible to minor adverse impacts to geologic resources. In summary, Alternative 2 would have direct, short to long-term, negligible to minor adverse impacts to geological resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 2 would have direct, short- and long-term, negligible to moderate adverse impacts as well as some long-term, minor beneficial impacts to parkwide geologic resources.

4.2.1.3 Alternative 3: Impacts on Geologic Resources

Impact Analysis
Proposed actions under Alternative 3 are identical to those of Alternative 2 except that Alternative 3 would also result in the marketing of LKT by private sector contract netters. The direct and indirect impacts of Alternative 3 to geologic resources would be identical to those described for Alternative 2 for all subtopics 2a-2i.

Cumulative Impact Analysis
As described for Alternative 2, when added to other past, present, and reasonably foreseeable future actions in the park, Alternative 3 (primary, secondary, or tertiary AM) would incrementally increase adverse impacts, but the overall impact level on geologic resources would remain negligible to moderate.

Alternative 3 Conclusion

As described for Alternative 2, increased LKT suppression effort would lead to direct, long-term, negligible (sediments) to moderate (hydrothermal features) adverse impacts to geologic resources under Alternative 3. Reconstruction of Clear Creek weir and trap would have direct, short-term, negligible to minor adverse impacts to riparian soils and streambed sediments. The reconstructed weir will allow natural stream flows and would result in recovery of the stream channel both up and down stream. Impacts to soils and streambed sediments due to the new weir design would be long-term, minor, and beneficial. In summary, Alternative 3 would have direct, short to long-term, negligible to moderate adverse and long-term, minor, beneficial impacts to geological resources in the Yellowstone Lake watershed.

As described for Alternative 2, fish barrier or weir/trap construction would lead to direct, short-term, minor adverse impacts to geologic resources outside the Yellowstone Lake watershed under Alternative 3. Chemical and mechanical fish removal would cause direct, short-term, and negligible to minor adverse impacts to geologic resources. In summary, Alternative 3 would have direct, short-term, negligible to minor adverse impacts to geological resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have direct, short- and long-term, negligible to moderate adverse impacts as well as some long-term, minor beneficial impacts to parkwide geologic resources.

4.2.1.4 Alternative 4: Impacts on Geologic Resources

Impact Analysis

Alternative 4 would result in a continuation of existing NPS native fish management efforts and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and nets. The Clear Creek weir and fish barriers in streams would be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing native fish brood source. The direct and indirect impacts of Alternative 4 to geologic resources would be identical to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g-1i; and Alternative 2, subtopics 2c, 2d, 2f.

Cumulative Impacts Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on geologic resources in the park. Road maintenance activities would require disturbance and removal of soils by heavy equipment operation. Backcountry operations include horse patrol and trail maintenance. Trail maintenance would involve localized removal of soils and overnight use of campsites and cabins that would lead to some soil compaction. Most facilities maintenance would take place in developed areas where soils may be removed for general operation practices. Impacts would be reduced by de-compacting soils after project completion. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore,

recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on geologic resources as more people hike and camp in Yellowstone. Alternative 4 would lead to further negligible compaction of soils and minor to moderate alteration of hydrothermal features. Coupled with these past, present, and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level on geologic resources would remain negligible to moderate.

Alternative 4 Conclusion

LKT suppression efforts would continue at their current level with no LKT removal by private sector contract netters. The impacts to geologic features are expected to be direct, short- and long-term, and negligible (sediments) or moderate (hydrothermal features) adverse. Because the Clear Creek weir and fish barriers in streams would be constructed, long-term, minor beneficial impacts would occur due to stream channel recovery. In summary, Alternative 4 would have direct, short- and long-term, negligible to moderate adverse and long-term, minor, beneficial impacts to geologic resources.

Fish restoration activities on streams, rivers, and lakes would be minimal. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, inventory and monitoring of aquatic organisms would continue, and limited native fish restoration activities would take place. In summary, activities under Alternative 4 would have direct, short- term, negligible adverse impacts to geologic resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have direct, short- and long-term, negligible to moderate adverse impacts as well as some long-term, minor beneficial impacts to parkwide geologic resources.

4.2.2 Wetlands and Waters of the U.S.

Guiding Principles and Policies
Executive Order 11990—Protection of Wetlands (42 Fed. Reg. 26961). This document directs the NPS to (1) provide leadership and take actions to minimize the destruction, loss, or degradation of wetlands; (2) preserve and enhance the natural and beneficial values of wetlands; and (3) avoid direct or indirect support of new construction in wetlands unless there are no practicable alternatives and the proposed actions include all practicable measures to minimize harm to wetlands.

Director's Order #77-1: Wetland Protection and the accompanying Procedural Manual #77-1, Wetland Protection, reissued February 2008. These documents establish NPS policies, requirements, and standards for implementing Executive Order 11990, which is described above. They set forth a "no net loss of wetlands" goal, first proclaimed in 1989 by President George Bush and sustained by subsequent Administrations. Proposed actions that have the potential to adversely impact wetlands must be addressed in a Statement of Findings and included in an EA. Section 4.2 of the Director's Order lists certain water-dependent actions that do not require preparation of a Statement of Findings. These include "Actions designed specifically for the purpose of restoring degraded (or completely lost) natural wetland, streams, riparian, or other aquatic habitats or ecological processes." Temporary disturbances to wetlands that are directly associated with and necessary for implementing the restoration are allowed under this exception. Actions causing a cumulative total of up to 0.25 acres of new long-term adverse impacts to natural wetlands may be allowed under this exception if they are directly

associated with and necessary for the restoration, such as small structures or berms, and provided conditions stated in Appendix 2 of the Director's Order are satisfied. The Director's Order indirectly defines "adverse" impacts to be "minimal" impacts greater than negligible for purposes of a Statement of Findings.

Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers (USACOE) issues permits for activities that result in the discharge of dredged or fill material into U.S. waters, including wetlands. Regulated activities range from depositing fill for building pads or roads to discharges associated with mechanized land clearing. The NPS Procedural Manual #77-1 procedural manual for wetland protection explains the relationship between Section 404 and the requirements of Director's Order #77-1.

Although portions of the USACOE 404 permit procedures (33 CFR 320-330) are similar to some of the requirements in Director's Order #77-1 and the Procedural Manual, there are significant differences in scope that warrant a separate NPS wetland protection process. First, the 404 permit program regulates only the discharge of dredged or fill material, while Executive Order 11990 covers a much broader range of actions that can have adverse impacts to wetlands, including ground water withdrawals, water diversions, nutrient enrichment, and other examples listed in Section 4.1.2. of the procedures. Second, the wetland definition used for the 404 permit program (33 CFR 328.3) is narrower than the Cowardin et al. (1979) wetland definition used for NPS compliance with Executive Order 11990 (see Section 4.1.1. of the procedures). Therefore, a broader range of aquatic habitat types falls under these procedures than under the wetland procedures of the 404 permit program. Third, the USACOE has "general permit" provisions that allow many projects affecting wetlands to proceed with minimal review.

All NPS actions with the potential to have adverse impacts on wetlands (as defined in Section 4.1.1) must comply with Director's Order #77-1 and the Procedural Manual, and those actions that involve placing dredged or fill material in wetlands or other "waters of the U.S." (as defined in 33 CFR 320-330) must comply with Section 404 of the Clean Water Act as well. In cases where both NPS and USACOE procedures apply, duplication of effort can be avoided by coordinating with the appropriate Corps of Engineers office early in the process of developing alternatives to assure that they are workable under both these procedures and Section 404 regulations. Also, if wetland compensation is necessary (Section 5.2.3. of the procedures), every effort should be made to assure that the same wetland restoration proposal meets the compensation requirements of both processes (NPS #77-1 2008).

Methodology and Assumptions
The methodology used for assessing impacts to floodplains, wetlands, and other waters is based upon available information on impacts from possible projects activities and will be evaluated on a case-by-case basis.

Intensity Level Definitions
The impact intensities for wetlands and other waters are as follows:

Negligible: Impacts would occur outside the regulatory floodplain, or there would be no perceptible change in an existing wetland area or function, ability of a floodplain to convey floodwaters, hydrologic function, and no changes to riparian vegetation and wildlife communities would occur. No measurable or detectable effect on the timing or intensity of stream flow would occur.

Minor: Impacts would be measurable and could change wetland or floodplain areas and functions, or hydrologic processes in a localized area. The impact would be measurable or perceptible, but slight, and would affect a few individuals of plant or wildlife species within an existing wetland or riparian area within the park. Changes to hydrology would be considered insignificant and short-term. An action would have measurable effects on the timing or intensity of flows. Any changes would require considerable scientific effort to measure and have barely perceptible consequences to wetland, riparian habitat, or hydrologic function.

Moderate: Impacts would be measurable and long-term but relatively local. Actions within the regulatory floodplain would interfere with floodplain function/values. The impact would be sufficient to cause a measurable change in the size, integrity, or continuity of the wetland or would result in a small, but permanent loss or gain in wetland acreage. Mitigation measures associated with the water resources, floodplains, and hydrology would be necessary. Impacts to existing wetland areas or floodplain functions could be mitigated by the restoration of impacted wetlands elsewhere in the park or modification of proposed facilities in floodplains. An action would have clearly detectable effects on the timing or intensity of flows and potentially would affect organisms or natural ecological processes. The action would have a measurable effect on plant or wildlife species within an existing wetland or riparian area, but all species would remain indefinitely viable within the park.

Major: Impacts would be readily measurable and have permanent consequences for an existing wetland area or floodplain function which could not be mitigated. The impact would be substantial and highly noticeable. Wetland and riparian species dynamics would be upset, and species changes would be noticeable on a regional scale. An action would have substantial effects on the timing or intensity of flows and potentially would affect organisms or natural processes. Mitigation measures would be necessary and extensive. The action would result in a measurable change in size, integrity, and continuity (all three) or a permanent loss of large wetland areas.

Duration: Short-term impacts to wetland and U.S. waters would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.2.2.1 Alternative 1 (No Action): Impacts on Wetlands and Waters of the U.S.

Impact Analysis
Existing NPS efforts often occur in wetland areas. Impacts to wetlands and other waters are unlikely to occur under Alternative 1.

Yellowstone Lake
1a. Large-scale Lake Trout Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Impacts to wetlands and other waters would not occur under Alternative 1. Gillnetting activities including net preparation, net mending, and net placement in Yellowstone Lake would not have an impact on wetlands and other waters. Net preparation and net mending

would take place outside all potential wetland and floodplain areas; net placement would occur in deep waters of Yellowstone Lake and not have an impact on wetland resources.

During September and October, nets are set in shallow water areas of the lake to catch LKT as they move onto and from spawning grounds. Currently, these nets cover less than 1 percent of the lake. Submerged aquatic vegetation is likely to be uprooted by LKT removal efforts as nets are pulled across the lake bottom. Because of the small percentage of shallow water areas impacted, LKT removal is expected to have direct, short-term, negligible adverse effects on aquatic vegetation within Yellowstone Lake.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats, and large nets. Monitoring would occur during the open water season, typically August and September. Monitoring activities would affect less than 1% of lakebed and therefore submerged vegetation along the shoreline of Yellowstone Lake (submerged vegetation up to 2 meters in depth along shorelines are considered wetlands) or floodplain characteristics including timing or intensity of flows. Therefore gillnet monitoring activities are expected to be direct, short term, adverse, but negligible to aquatic vegetation considered within a wetland.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to wetland and water resources would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to wetland and water resources would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. These research activities could potentially affect wetland and water resources within the Yellowstone Lake watershed. The techniques are not yet developed and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have negligible adverse impacts to wetlands. These techniques would not exceed the impacts to wetlands described in this document or related Statement of Findings.

Other Streams, Rivers, and Lakes
Most streams, rivers, and lakes where actions would occur are located within wetland and water resource areas.

1f. Fish Barriers and/or Weirs/Traps: No action would be taken to construct fish barriers in streams. No impacts to wetlands and water resources would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, and negligible to minor adverse impacts on wetland vegetation.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. These activities involve walking within lake margins, stream channels and riparian areas which would cause minor trampling of vegetation.

This trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, negligible to minor adverse impacts on wetland vegetation.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on stream and lakes other than Yellowstone Lake would continue. These include working in stream channels, lake margins, and other wetland areas. Most impacts would occur as NPS crews travel to and from collection sites and trample vegetation. This trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, negligible to minor adverse impacts on wetland vegetation.

Cumulative Impact Analysis
Ongoing administrative activities such as road construction and repair, and facilities maintenance would continue to have adverse impacts to wetland and water resources in Yellowstone. Road construction and repair would have direct and indirect adverse impacts to wetland and water resources. Direct impacts may result from roads being constructed in existing wetland areas thus disturbing wetland components and function such as soils, vegetation and hydrology. Mitigations to compensate for such action would be implemented. Indirect effects of road construction could lead to increased sedimentation and alter hydrology. Past and ongoing recreational use such as angling, camping, and hiking would continue parkwide. These activities trample wetland vegetation and soils resulting in direct, short-term, negligible adverse impacts to wetland and water resources. Alternative 1 would lead to further negligible to minor disturbance to wetland vegetation. Coupled with these past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level on wetland resources would remain negligible to minor.

Alternative 1 Conclusion

Continued LKT suppression efforts would affect wetland and water resources. In summary, Alternative 1 would be direct, short-term, negligible adverse impacts to wetland and water resources in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would have impacts. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. In summary, Alternative 1 would be direct, short-term, negligible to minor adverse impacts to wetland and water resources in outside of the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct, short-term, negligible to minor adverse impacts to parkwide wetland resources.

4.2.2.2 Alternative 2: Impacts on Wetlands and Waters of the U.S.

Impact Analysis
Impacts to floodplains and wetlands are likely to occur under Alternative 2 with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and

chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients. Proposed actions may include measures to assist native fish populations by reconnecting disjunct stream segments and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Impacts to wetland and water resources could occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions. The rebuilding of the Clear Creek weir and reconnecting spawning streams would have an effect on wetland and other waters.

2a. Large-scale LKT Removal: This alternative proposes to increase the amount of netting on Yellowstone Lake using the current level of NPS crews and additional private sector contract gillnetters. It proposes to increase the amount of netting on Yellowstone Lake to at least 7,800 km (4,846 miles) of net fished each season (more than three times that of current levels) and add eight or more large trapnets. Lake trout removal efforts by NPS crews and by private sector contract netters will usually take place in deep water areas of Yellowstone Lake at depths between 15-65 meters which encompasses approximately 50 percent of the lake bed. Non-native fish carcasses would be returned to park waters to retain nutrients. Because net preparation and net mending would take place outside all potential wetland and floodplain areas; and net placement would occur in deep waters Yellowstone Lake, there would be no impacts to wetlands or floodplain characteristics including timing or intensity of flows.

During September and October, nets are set in shallow water areas of the lake to catch LKT as they move onto and from spawning grounds. Currently, these nets would continue to cover less than 1 percent of the lake. Submerged aquatic vegetation is likely to be uprooted by LKT removal efforts as nets are pulled across the lake bottom. Because of the small percentage of shallow water areas impacted, LKT removal is expected to have direct, short-term, negligible adverse effects on aquatic vegetation within Yellowstone Lake.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect local wetland and water resources in the vicinity of the confluence of Clear Creek and Yellowstone Lake. Weir construction would take place in the stream channel and adjacent riparian areas. Completion of the weir could cause water to pool behind the structure and localized bank erosion is possible. Additionally, weir maintenance and operation could seasonally inundate wetland, riparian, and upland vegetation upstream of the weir. Reconstruction of the Clear Creek weir would result in impacts to 0.2 acre of wetland. However, the pre-existing structure was built and operated in a way that pooled water extensively and greatly altered sediment transport. As a result, large sediment deposits (sand and gravel bars) were created both upstream and downstream of the previous structure, diverting streamflows and causing extensive streambank erosion and undercut banks. The new weir is intended to be operated in a manner that will allow open (natural) flows, to prevent further sediment deposition and bank erosion. Compensation for impacts to 0.2 acre wetland by reconstruction of the Clear Creek weir would be rehabilitation of the existing severely degraded wetland habitat upstream and downstream of the site. Approximately 0.4 acre aquatic habitat (stream/wetland) would be rehabilitated to a natural condition.

Also, mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures, regular monitoring of structural integrity and interdisciplinary collaboration to minimize hydrologic changes) would be implemented. Because of these mitigating measures and because of the compensation described, impacts will be direct, short- and long-term, minor adverse impacts to vegetation.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would create short term trampling. Trampling would be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short to long term, negligible to minor impacts to wetland and water resources.

Reconnecting isolated tributaries would involve moving and placement of sand and gravel material on adjacent, non-vegetated shoreline. Prior to removing sandbars to reconnect tributary streams, areas for placement of sand would be identified through interdisciplinary collaboration. Also, areas would be surveyed for wetland resources by vegetation specialists. If wetlands were found and impacts could not be mitigated to the negligible level, the tributary would be removed from further consideration for enhancement of YCT spawning areas or wetlands would be compensated for on a tributary by tributary basis. Because these mitigation measures (described in Chapter 2) would be implemented, reconnecting tributaries would have direct, short- and long-term, negligible to minor adverse impacts to vegetation.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes

Impacts to water and wetland resources would occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on wetland and water resources in the park.

2f. Fish Barriers or Weirs/Traps: In-stream barrier construction and modification would most likely have the greatest effect on water and wetland resources under all potential actions listed under Alternative 2. While most streams will not require barrier construction because natural barriers exist, a few would require modification of natural features or barrier construction. Examples of modifying existing water features that serve as partial barriers include: redirecting stream flow using wing walls, filling plunge pools with material to eliminate jumping areas, using explosive to increase the height or angle of a feature, or some combination of the above. Complete construction of a fish barrier where no other feasible natural feature exists, may be necessary on some streams. Fish barriers, if required, would be constructed from nearby native logs, and rocks, non-natural rebar, wire mesh, and cement.

Fish barriers would alter steam hydrology and inundate wetland, riparian, and upland vegetation upstream of the weir. Disturbed areas would promote the introduction of non-native, invasive plants. For each project, individual hydrologic assessments would be completed; if more than 1,011 m^2 (0.25 acres) of wetlands would be disturbed or removed for construction purposes, a separate wetlands statement of findings would be developed to address and mitigate impacts to wetland soils. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures, regular monitoring of structural integrity and interdisciplinary collaboration to minimize

hydrologic changes) would be implemented, barrier construction and maintenance would have direct, short- and long-term, negligible to moderate adverse impacts to wetlands and other waters. Although it is the case that these activities would have adverse impacts, these activities would directly lead to long-term benefits of wetland resources from the restoration of native fish species.

2g. Non-native Fish Removal: Chemical and mechanical removal of fish could lead to impacts to wetland and water resources under Alternative 2. Both chemical and mechanical removal of fish requires use of gear such as nets or electrofishing equipment. During deployment, wetland resources would be trampled as NPS crews work in targeted areas. Chemical treatments would adversely impact fauna (aquatic invertebrates, larval amphibians) in wetland areas by killing localized populations. While these populations will return within 1 to 2 years, this adverse impact to wetland ecological function would be self compensating on a stream by stream basis because the restoration of native fish will in turn benefit wetland resources. Mechanical treatments would either temporarily displace wetland associated fauna or would shock or kill some individuals leading to direct, short-term, negligible adverse impacts to wetland and water resources. Therefore, direct, short-term and long-term, negligible to moderate adverse impacts are expected to occur within wetland and other waters during chemical and mechanical removal of fish. Although it is the case that these activities would have adverse impacts, these activities would directly lead to long-term benefits of wetland resources from the restoration of native fish species.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters would be used to bring genetically pure native fish to the project waters. These activities also involve walking within lake margins, stream channels and riparian areas which would cause minor trampling of vegetation. This trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, negligible to minor adverse impacts on wetland vegetation. These activities, along with foot traffic, would have a direct, short-term, negligible to minor adverse impact on wetland and water resources in localized areas.

2i. Inventory, Monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road construction and repair, and facilities maintenance would continue to have adverse impacts to wetland and water resources in Yellowstone. Road construction and repair would have direct and indirect adverse impacts to wetland and water resources. Direct impacts may result from roads being constructed in existing wetland areas thus disturbing wetland components and wetland function such as soils, vegetation and hydrology. Mitigations to compensate for such action would be implemented. Indirect effects of road construction could lead to increased sedimentation and alter hydrology. Past and ongoing recreational use such as angling, camping, and hiking would continue parkwide. These activities could have a direct, adverse impact to wetlands from trampling wetland vegetation and soils resulting in direct, short-term, negligible adverse impacts to wetland and water resources. Alternative 2 would lead to further disturbance to wetland resources. Coupled with these past, present and foreseeable future actions, Alternative 2 would therefore incrementally increase adverse impacts from negligible to moderate levels.

Alternative 2 Conclusion

Increased LKT suppression efforts would affect wetland and water resources. The impacts to wetland and water resources are expected to be indirect, short-term, negligible and adverse. Reconstruction of the Clear Creek weir and trap would have direct, long-term, minor adverse impacts to wetland and water resources. In summary, NPS activities under Alternative 2 (primary, secondary, or tertiary AM desired conditions) would have direct, short and long-term, negligible to minor adverse impacts as well as long-term minor beneficial impacts to wetland resources in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would affect wetland and water resources. Fish barriers or weirs/trap construction would cause direct, long-term, negligible to moderate adverse impacts to wetland and water resources. Chemical and mechanical fish removal would cause direct, short-term, negligible to moderate adverse impacts to wetland and water resources. In summary, Alternative 2 would have direct, short- and long-term, negligible to moderate adverse impacts to wetland and water resources as well as long-term, moderate beneficial impacts outside of Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 2 would have direct, short-and long-term, negligible to moderate adverse impacts as well as long-term, moderate beneficial impacts to parkwide wetland resources.

4.2.2.3 Alternative 3: Impacts on Wetlands and Waters of the U.S.

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would also result in the marketing of LKT by private sector contract netters. The direct and indirect impacts of Alternative 3 to wetland and water resources would be identical to those described for Alternative 2 for all subtopics 2a-2i.

Cumulative Impact Analysis
Alternative 3 would lead to further disturbance to wetland resources. Coupled with these past, present and foreseeable future actions, Alternative 3 would therefore incrementally increase adverse impacts from negligible to moderate levels.

Alternative 3 Conclusion

As described for Alternative 2, increased LKT suppression effort would result in indirect, short-term, negligible adverse; reconstruction of the Clear Creek weir and trap would have direct, long-term, minor adverse and beneficial impacts to wetland and water resources; enhancing YCT recruitment would have direct, short to long term, negligible to minor impacts. In summary, Alternative 3 could have direct, short- and long-term, negligible to minor adverse impacts as well as long-term minor beneficial impacts to wetland and water resources in the Yellowstone Lake watershed.

As described for Alternative 2, fish restoration activities on streams, rivers, and lakes would affect wetland and water resources. Fish barriers or weirs/trap construction would cause direct, long-term, negligible to moderate adverse impacts to wetland and water resources. Chemical and mechanical fish removal would cause direct, short-term, negligible to moderate adverse impacts to wetland and water resources. In summary, Alternative 3 would have direct, short-

and long-term, negligible to moderate adverse impacts as well as long-term, moderate beneficial impacts to wetland resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have direct, short-and long-term, negligible to moderate adverse impacts as well as long-term, moderate beneficial impacts to parkwide wetland resources.

4.2.2.4 Alternative 4: Impacts 4 on Wetlands and Waters of the U.S.

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and large nets. The Clear Creek weir and fish barriers in streams would be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing native fish brood sources. The direct and indirect impacts of Alternative 4 to wetland and water resources would be identical to those described for Alternative 2, subtopic 2a (except that no private sector contract netters would be used); 2b–2f, and 2h–2i. Impacts would be less than Alternative 3 for non-native fish removal (2g) because chemical treatments would not adversely impact fauna populations. Impacts to wetland resources would be identical to 1g (direct, short-term, negligible to minor and adverse).

Cumulative Impacts
Alternative 4 would lead to further disturbance to wetland resources, but less so than Alternatives 2 and 3. Coupled with these past, present and foreseeable future actions, Alternative 4 would incrementally increase adverse impacts, but the overall impact level on wetland resources would remain negligible to minor.

Alternative 4 Conclusion

Continued LKT suppression efforts would affect wetland and water resources. As described for Alternative 2, reconstruction of the Clear Creek weir and trap would have direct, long-term, minor adverse impacts to wetland and water resources. In summary, Alternative 4 would have direct, short- and long-term, negligible to minor adverse impacts to wetland and water resources in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would have impacts. As described for Alternative 2, fish restoration activities on streams, rivers, and lakes would affect wetland and water resources. Fish barriers or weirs/trap construction would cause direct, long-term, minor adverse impacts to wetland and water resources. Mechanical methods to remove non-native fish would cause direct, short-term, negligible adverse impacts to wetland and water resources. In summary, Alternative 4 would have direct, short- and long-term, negligible to minor adverse impacts to wetland and water resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have direct, short-and long-term, negligible to minor adverse impacts to parkwide wetland resources.

4.2.3 Water Quality and Quantity Resources

Guiding Principles and Policies
Section 4.6.3. of 2006 Management Policies addresses water quality in NPS units. It states that the pollution of surface and groundwater by point and nonpoint sources can impair the natural functioning of aquatic and terrestrial ecosystems and diminish the utility of park waters for visitor use and enjoyment. The NPS is to determine the quality of park surface and groundwater resources and avoid, whenever possible, the pollution of park waters by human activities occurring within and outside the parks. The NPS is to (1) work with appropriate governmental bodies to obtain the highest possible standards available under the Clean Water Act (CWA) for the protection of park waters; (2) take all necessary actions to maintain or restore the quality of surface waters and groundwater within the park consistent with the CWA and all other applicable federal, state, and local laws and regulations; and (3) enter into agreements with other agencies and governing bodies, as appropriate, to secure their cooperation in maintaining or restoring the quality of park water resources.

The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Under the CWA, the Environmental Protection Agency has implemented pollution control programs such as setting wastewater standards for industry and water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollution from a point source into navigable waters unless a permit was obtained. EPA's National Pollutant Discharge Eliminations System permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches.

Methodology and Assumptions
The NPS established a long-term water quality monitoring program in Yellowstone in 2002. The program includes 12 stream sites and 7 sites on Yellowstone Lake. Physical, chemical, and biological data have been collected at each stream site. This includes core water quality parameters (water temperature, dissolved oxygen, pH, specific conductance, and turbidity), suspended solids, ions, and nutrients. Aquatic invertebrates are sampled from select locations to supplement water quality data. Prior to initiating a native fish restoration project within a selected drainage, water quality information (core parameters and aquatic invertebrates) would be collected and processed. This information would be used to establish baseline information for water quality characteristics within a given watershed. NPS staff would also conduct a thorough literature review to evaluate the potential effects of native fish restoration activities on water quality.

Intensity Level Definitions
The impact intensities for water quality and quantity are as follows:

Negligible: Impacts would be very slight and, if detectable, highly localized. No impacts are expected to occur to water quantity, water temperature, dissolved oxygen, and pH. A slight, localized increase in turbidity may occur during piscicide

treatments, barrier construction, and boat operations in shallow water. A slight, localized increase in specific conductance may occur due to $KMnO_4$ application.

Minor: Impacts would be measurable and could affect a small area of the watershed. The impact would be measurable or perceptible but slight, and could affect one or more water quality parameters but would not exceed federal water quality standards. Changes to water quality and quantity would be considered short-term.

Moderate: Impacts would be measurable and long-term, and would affect a sizable area of the watershed. This impact would be sufficient to cause a measurable deviation from baseline water quality and water quantity measurements; mitigation measures would be needed to avoid exceeding federal water quality standards for one or more water quality parameters. An action would have a clearly detectable effect on water quality standards and aquatic organisms.

Major: Impacts are readily measurable and have permanent consequences which could not be mitigated for a large portion of the watershed or extend beyond the watershed. The impact would be substantial and highly noticeable. Aquatic plant and animal species would disappear permanently, with species changes occurring on a regional scale. The action would result in a detectable change in aquatic plant and animal communities throughout the region.

Duration: Short-term impacts to water quality and quantity would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.2.3.1 Alternative 1 (No Action): Impacts on Water Quality and Quantity Resources

Impact Analysis
Existing NPS efforts would continue on Yellowstone Lake to remove LKT and limited efforts would continue to monitor and remove non-native fish in streams, rivers, and lakes.

Yellowstone Lake
1a. Large-scale Lake Trout Removal: Impacts to water quality and quantity are unlikely to occur under Alternative 1. All current gillnetting activities, including net preparation, mending, placement and fish disposition in Yellowstone Lake would not likely have an impact on either water quality or quantity. Net preparation and mending would take place outside all potential wetland and floodplain areas; net placement would occur in deep areas of Yellowstone Lake but would not affect water quality or quantity. Fish disposition would occur in the deeper waters of Yellowstone Lake and decomposition of fish could lead to a slight increase in nutrient redistribution. Increases in nutrients (nitrogen and total phosphorus) could lead to localized increases in plankton populations which would increase suspended solids and decrease water clarity. Nitrogen and phosphorus are two of the more important nutrients that can cause a shift to a more productive state (Wetzel 2001). Yellowstone staff have been collecting water quality information from the Yellowstone Lake outlet since May 2006. Both nitrogen (nitrate, nitrite, ammonia) and total phosphorus are included in water quality analysis from this site. Since sampling began, all forms of nitrogen have remained below the analytical detection limit of 0.05

mg/l; total phosphorus concentrations are generally below 0.05 mg/l. There has been no noticeable change in Yellowstone Lake water quality at the lake outlet during LKT suppression efforts, even though numbers of LKT killed each year has increased from 60,000 in 2006 to nearly 101,000 in 2009. Additionally, the operation of motor boats could contribute small amounts of hydrocarbon products (e.g. oil and gas) that occur from routine boat operation. Because water quality has not noticeably changed during gill net operations and because motorboat operation is temporary and limited, current levels of fish deposition, gillnetting operations, and boat operation are expected to have indirect, short-term, negligible adverse affects on water quality in Yellowstone Lake.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats and large nets. Monitoring would occur during the open water season, typically August and September, with net placement occurring near the lake perimeter. All fish killed during these monitoring activities will be returned to Yellowstone Lake but is not expected to affect water quality or quantity, based on monitoring discussed in 1a. The operation of motor boats could contribute small amounts of hydrocarbons (e.g. oil and gas) that occur from routine boat operation. Because impacts are similar to those in 1a, this monitoring activity is expected to have indirect, short-term, negligible adverse impacts to water quality in Yellowstone Lake.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to water quality and quantity would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to water quality or quantity would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. These research activities could affect water quality in the Yellowstone Lake watershed. The techniques are not yet developed and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have negligible to minor adverse impacts to water quality. These new techniques would not exceed the impacts to any water quality described in this document.

Other Streams, Rivers, and Lakes

1f. Fish Barriers: No action would be taken to construct fish barriers in streams. No impacts to water quality or quantity would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Electrofishing would require walking in streams and would re-suspend sediments causing localized increases in turbidity and suspended solids. Electrofishing BKT in Soda Butte Creek would cause direct, short-term, negligible to minor adverse impacts to water quality because of these localized, temporary increases.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. This activity would cause localized temporary disturbance to stream sediments causing direct, short-term, negligible to minor adverse affects on water quality.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and aquatic species and supporting research on stream and lakes other than Yellowstone Lake would continue. These activities would cause localized, temporary disturbance to stream and lake sediments causing direct, short-term, negligible to minor adverse impacts to water quality in areas of sample collection.

Cumulative Impact Analysis
Ongoing administrative activities such as buoy maintenance, lake patrol, road construction, and facilities maintenance would continue to affect water quality in Yellowstone. Buoy maintenance and patrolling Yellowstone Lake requires the use of motorized boats. Boats can have an adverse affect on water quality by contributing hydrocarbons (oil and gas) to surface waters; road construction and facilities maintenance can adversely affect water quality by disturbing soils and hardening surfaces (e.g. paving) near stream corridors and promoting erosion and increased runoff, which can contribute to increased turbidity levels in adjacent surface waters. Past and ongoing recreational use such as boating, angling, camping, and hiking would continue parkwide, resulting in adverse localized, temporary impacts to water quality. Boating can contribute hydrocarbons to surface waters and hiking and camping activities can disturb soils which can promote erosion leading to increased sedimentation in adjacent streams and lakes. Alternative 1 would increase impacts to water quality and quantity temporarily. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 1 Conclusion

Continued LKT suppression efforts would affect water quality and quantity. In summary, Alternative 1 could have direct and indirect, short-term, negligible adverse impacts to water quality in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would be minimal. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. In summary, Alternative 1 would have direct, short-term, negligible to minor adverse impacts to water quality outside of the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct and indirect, short-term, negligible to minor adverse impacts to parkwide water quality or quantity related resources.

4.2.3.2 Alternative 2: Impacts Water Quality and Quantity Resources

Impact Analysis
Impacts to water quality would occur under Alternative 2. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams (non-native fish carcasses would be returned to park waters to retain nutrients). Proposed actions may include measures to assist native fish populations by removing sand bars to reconnect isolated tributary streams, augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams and/or developing a native fish brood source.

Yellowstone Lake

2a. Large-scale Lake Trout Removal: Impacts to water quality could occur under Alternative 2. This alternative proposes to increase the amount of netting on Yellowstone Lake and to return non-native fish carcasses to park waters to retain nutrients. In 2009, NPS continued their LKT suppression efforts, and private-sector contract gillnetters were used for a three-week period during the early part of the field season. Last year more than 100,000 LKT were killed and their carcasses returned to Yellowstone Lake. The number of LKT killed each year is expected to double or triple under proposed actions listed in Alternative 2. The overall effects of disposal of fish carcasses in the lake are expected to remain beneath the analytical detection limits for nitrogen and total phosphorus, because the volume of the lake would dilute any redistribution. Therefore, the overall impacts to water quality contributed from fish disposal are expected to be indirect, short-term, negligible and adverse. Additionally, an increase in boat traffic from private-sector contract gillnetters could contribute to increased hydrocarbon products in the water from routine boat operations. This increase in boat traffic could be as much as doubling that which the NPS lake trout removal program already contributes to hydrocarbon inputs. Because boat use is localized and temporary these impacts are expected to be indirect, short-term, negligible and adverse.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect water quality in the vicinity of Clear Creek and its confluence with Yellowstone Lake. Weir construction would take place in the stream channel and adjacent riparian areas. Weir construction would disturb streambed sediments and re-suspend fine particles during construction. This would cause localized increases in turbidity downstream of the construction site. The pre-existing structure was built and operated in a way that pooled water extensively and greatly altered sediment transport. As a result, large sediment deposits (sand and gravel bars) were created both upstream and downstream of the previous structure, diverting streamflows and causing extensive streambank erosion and undercut banks. The new weir is intended to be operated in a manner that will allow open (natural) flows, to prevent further sediment deposition and bank erosion. Subsequent activities related to maintenance and operation of the weir will also create temporary, localized increases in turbidity. Therefore, construction, operation and maintenance activities would have direct, short-term, negligible to minor adverse impacts to water quality because of the temporary nature of sedmentation/turbidity increases.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would entail walking in streams and adjacent riparian areas. This could lead to increased erosion and re-suspend sediments in the stream channel. Reconnecting isolated tributaries would involve hand-digging of sand which would alter soils and streambeds in localized areas near the Yellowstone Lake shoreline. Both these activities could temporarily lead to increased turbidities and reduced water clarity. Therefore using streamside incubators and reconnecting isolated tributaries would lead to direct, short-term, negligible to minor adverse impacts to water quality because of the temporary nature of the turbidity increases.

2e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. These research activities could affect water quality in the Yellowstone Lake watershed. The techniques are not yet developed and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have negligible

to minor adverse impacts to water quality. These new techniques would not exceed the impacts to any water quality described in this document.

Other Streams, Rivers, and Lakes

2f. Fish Barriers: Instream barrier construction and modification would have an effect on water quality. Barrier construction would disturb stream sediments, increasing turbidity temporarily and modify adjacent stream banks. Construction of fish barriers, especially the one proposed for Specimen Creek, would initially alter patterns of sediment transport and debris flow, temporarily impacting water quality. Barriers would act as sediment traps until the upstream pools formed by the barrier fills in with stream substrate. During the filling period, there would be an increase in erosion levels in the stream channel downstream of the structure, as sedment recruited from that area may not be replaced by sediment carried from above. Once the area upstream has completely filled, sediment transport continuity through the barrier reach would return to existing levels. During hydrologic assessment, such mitigations as a shallow depression at the crest of barriers would be designed to facilitate continuity if necessary. Because they are temporary and designs will facilitate return to previous conditions, these actions would lead to direct, short-term, minor adverse impacts to water quality downstream of the construction site. Additional NPS activities at the barrier site, including maintenance and monitoring, would lead to small increases in turbidity. Therefore, construction, operation, and maintenance of fish barriers would have direct, short-term, minor adverse impacts to water quality immediately downstream of the barrier.

2g. Non-native Fish Removal: Chemical removal of fish would involve the use of a piscicide (rotenone or antimycin A) and an oxidizer (potassium permanganate). Rotenone formulations typically use a hydrocarbon solvent to aid in the mixing of rotenone with water. Potassium permanganate is used to neutralize the piscicide and is purple in color. Rotenone associated hydrocarbon solvent would temporarily impact water quality because detectable levels of rotenone (50 ppb), antimycin (10 ppb), and permanganate (5 ppm) would persist for several hours in streams. Both piscicide and potassium permanganate applications would reduce water clarity and contribute new chemical components to stream systems for the application period and for several hours following application. Rotenone is highly toxic to fish (2-20 g/L) with a low toxicity to humans (300-500 mg/kg) (USFWS 2005). Antimycin is also highly toxic to fish, with salmonids being especially susceptible at application rates as low as 10 ppb. A concentration of 10 ppb is about 1,750 times less than the level determined by the Montana Department of Environmental Quality to be safe for long-term human consumption, and 175,000 times less than the safe level for short-term consumption. Neither piscicide is known to pose a long-term threat to surface or groundwater quality (USFWS 2005).As a result, piscicide application would cause direct, short-term, minor to moderate, adverse impacts to stream and lake water quality in the area being treated. As a result of these impacts human consumption of water would be restricted during and immediately after treatment in accordance with EPA label guidelines. Further information concerning piscicides can be found in the Health and Human Safety later in this chapter as well as Appendix B and piscicide product labels outlining human use of treated water found in Appendix D. Mechanical removal would use methods such as electrofishing and netting to capture and remove non-native fish. Mechanical removal of fish would require working directly within a stream or lake which would cause sediments to become re-suspended and reducing water clarity. These activities would lead to direct, short-term, minor adverse impacts to water quality.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters would be used to bring genetically pure native fish to the project waters. These activities, along with foot traffic, could have direct, short-term, negligible to minor adverse impacts to water quality, primarily as some streambed sediments may be temporarily disturbed and re-suspension of fine particles may occur.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis
Ongoing administrative activities such as buoy maintenance, lake patrol, road construction, and facilities maintenance would continue to affect water quality in Yellowstone. Buoy maintenance and patrolling Yellowstone Lake requires the use of motorized boat. Boats can have an adverse affect to water quality by contributing hydrocarbons (oil and gas) to surface waters; road construction and facilities maintenance can adversely affect water quality by disturbing soils near stream corridors and promoting erosion which can contribute to increased turbidity levels in adjacent surface waters. Past and ongoing recreational uses such as boating, camping, and hiking would continue parkwide, resulting in adverse impacts to water quality. Boating can contribute hydrocarbons to surface waters and hiking and camping activities can disturb soils which can promote erosion leading to increased sedimentation in adjacent streams and lakes. Alternative 2 would increase impacts to water quality and quantity temporarily. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 2 Conclusion

Increased LKT suppression efforts would not likely affect water quality. The impacts to water quality are expected to be indirect, short-term, negligible adverse. Reconstruction of the Clear Creek weir and trap would have direct, short-term, negligible to minor, adverse impacts to water quality. In summary, Alternative 2 would have direct and indirect, short-term, negligible adverse impacts to water quality in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would affect water quality. Fish barriers or weirs/trap construction would cause direct, short-term, negligible to minor adverse impacts to water quality. Chemical and mechanical fish removal would cause direct, short-term, minor adverse impacts to water quality. In summary, Alternative 2 would have direct, short-term, negligible to minor adverse impacts to water quality outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct and indirect, short-term, negligible to minor adverse impacts to parkwide water quality or quantity related resources.

4.2.3.3 Alternative 3: Impacts on Water Quality and Quantity Resources

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would result in the marketing of LKT by private sector contract netters. Even though there would be a decrease in disposal of fish carcasses, because detection limits would not be exceeded with increased disposal, the direct and indirect impacts of Alternative 3 to water quality would be similar to those described for Alternative 2, for all subtopics 2a-2i.

Cumulative Impact Analysis
Alternative 3 would lead to further disturbance to water quality and quantity related resources. Coupled with these past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, but the overall impact level on water quality and quantity related resources would remain negligible to minor

Alternative 3 Conclusion

Increased LKT suppression efforts would affect water quality. The impacts to water quality are expected to be indirect, short-term, negligible beneficial or negligible adverse. Reconstruction of the Clear Creek weir and trap would have direct, short-term, negligible adverse impacts to water quality. In summary, Alternative 3 would have direct and indirect, short-term, negligible to minor adverse and beneficial impacts to water quality in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would affect water quality. Fish barriers or weirs/trap construction would cause direct, short-term, and negligible to minor adverse impacts to water quality. Chemical and mechanical fish removal would cause direct, short-term, and negligible to minor adverse impacts to water quality. In summary, Alternative 3 would have direct, short-term, negligible to minor adverse impacts to water quality outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have direct and indirect, short-term, negligible to minor adverse and negligible beneficial impacts to parkwide water quality or quantity related resources.

4.2.3.4 Alternative 4: Impacts on Water Quality and Quantity Resources

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and large nets. The direct and indirect impacts of Alternative 4 to aquatic resources would be negligible; less than Alternatives 2 and 3 because of no piscicide use. Impacts would be similar though as described for Alternative 2, subtopic 2a except that private sector contract netters would not be used, 2b–2f, and 2h–2i.

Cumulative Impact Analysis
Alternative 4 would lead to further disturbance to water quality and quantity related resources. Coupled with these past, present and foreseeable future actions, Alternative 4 would incrementally increase adverse impacts, but the overall impact level on water quality and quantity related resources would remain negligible to minor

Alternative 4 Conclusion

LKT suppression efforts would continue at their current level with no LKT removal by private sector contract netters. The impacts from fish disposition and boat operation would be direct or indirect, short-term, negligible, and adverse. In summary, Alternative 4 could have direct and indirect, short-term, negligible adverse impacts to water quality and quantity related resources in the Yellowstone Lake watershed.

Fish restoration activities impacts on streams, rivers, and lakes would be less than Alternatives 2 and 3 because of no piscicide use. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, inventory and monitoring of aquatic organisms would continue, and limited native fish restoration activities would take place. Fish barriers or weirs/trap construction would cause direct, short-term, and negligible to minor adverse impacts to water quality. In summary, Alternative 4 would have direct, short-term, negligible adverse impacts to water quality and quantity related resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have direct and indirect, short-term, negligible to minor adverse impacts to parkwide water quality or quantity related resources.

4.3 Biological Resources

4.3.1 Aquatic Resources (other than fish)

Guiding Principles and Policies
Section 4.4.1.1.of the 2006 National Park Service Management Policy states that the NPS is to maintain all native plant and animal species and their habitat inside parks. "The Service will … use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks."

Methodology and Assumptions
In 2002, the Fisheries and Aquatics Section added an ecosystem health component to its fisheries program. This component currently consists of several monitoring plans, including water quality, aquatic invertebrates, amphibians, and fish. All facets of this program are used to guide native fish restoration activities in the park.

Intensity Level Definitions
The thresholds of change for the intensity of an impact on aquatic resources are defined as follows:

Negligible: Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them would be extremely unlikely to occur or not measurable. Ecological processes would not be affected. If impacts to individuals were to occur, they would be localized, short-term, and of no consequence to the species.

Minor: Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them would affect a small, localized portion of the species/range in the park. Short- or long-term disturbances to individuals may occur and/or a small amount of habitat could be permanently modified or removed. Impacts would not measurably affect the migration patterns or other demographic characteristic of the population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Mitigation measures to offset adverse impacts would be followed.

Moderate: Adverse or beneficial impacts to populations, their habitat, or the key ecosystem processes sustaining them would affect a moderate portion of the species/range in the park but would not affect the viability of the regional population. Short- or long-term disturbances could measurably affect the migration patterns, or other demographic characteristics of population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Impacts would not significantly increase the susceptibility of populations(s) in or near the park to environmental or demographic uncertainty (e.g., severe winters, droughts, disease epidemics, and skewed age or sex ratios). Mitigation measures to offset adverse impacts would be extensive, but successful.

Major: Adverse or beneficial impacts to populations, their habitat, or the key ecosystem processes sustaining them would be long-term and affect a large proportion of the species' range in a regional context. The susceptibility of populations(s) within the region to environmental or demographic uncertainty would significantly increase. Mitigation measures to offset adverse impacts would be extensive and may not be successful.

Duration: Short-term impacts to aquatic resources would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.3.1.1 Alternative 1 (No Action): Impacts on Aquatic Resources

Impact Analysis
Impacts to aquatic resources would likely occur under Alternative 1. Several actions are being proposed under this alternative, each of which could have a different effect on aquatic resources in the park.

Yellowstone Lake
1a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Suppression would be continued using NPS crews, boats, and nets throughout the open water season. LKT carcasses would be returned to Yellowstone Lake to improve program efficiency and retain nutrients. Use of motor boats would contribute small amounts of hydrocarbons (oil and gas) to Yellowstone Lake and negatively affect water quality, especially in confined areas such as the Bridge Bay marina and Grant boat launch. Hydrocarbons would negatively affect a limited amount of plankton, aquatic invertebrates, and amphibians by either affecting their respiration, interfere with feeding, or causing death. Pollution from motorized boats would cause direct, short-term, and negligible to minor adverse impacts to plankton, aquatic invertebrates, and amphibians. Returning LKT carcasses to Yellowstone Lake could increase nutrient availability and provide an additional food source for aquatic organisms thereby providing a beneficial effect. Because these impacts would affect a localized portion of populations, impacts to aquatic organisms from LKT suppression would be indirect, short-term, negligible adverse and beneficial. Amphibian populations are not expected to be impacted by LKT disposition.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats and large nets. Monitoring would occur throughout the open water season. All fish caught may be removed

from the lake to provide information needed to adequately evaluate the demographics and condition of each fish (e.g., external parasites, whirling disease, sex, sexual maturity, age, gamete somatic index, and fecundity). All fish carcasses will be returned to Yellowstone Lake to retain nutrients in the lake system. Use of motor boats would contribute small amounts of hydrocarbons (oil and gas) to Yellowstone Lake and negatively affect water quality, especially in confined areas such as the Bridge Bay Marina and Grant boat launch. Hydrocarbons would negatively affect a limited amount of plankton, aquatic invertebrates, and amphibians by either affecting their respiration, interfere with feeding, or causing death. Because these impacts are localized, pollution from motorized boats would cause direct, short-term, and negligible to minor adverse impacts to plankton, aquatic invertebrates, and amphibians. Returning fish carcasses to Yellowstone Lake could increase nutrient availability resulting in localized increases in food source thereby providing a beneficial effect. Impacts to aquatic organisms from monitoring would therefore be indirect, short-term, negligible adverse and beneficial for these groups of organisms. Amphibian populations are not expected to be impacted by LKT

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to aquatic resources would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to aquatic resources would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. These research activities could potentially affect aquatic resources within the Yellowstone Lake watershed. The techniques are not yet developed and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have negligible to minor adverse impacts to aquatic resources. New techniques would not exceed the impacts to aquatic resources described in this document.

Other Streams, Rivers, and Lakes
Most streams, rivers, and lakes where actions would occur would impact aquatic resources.

1f. Fish Barriers or Weirs/Traps: No action would be taken to construct fish barriers in streams. No impacts to aquatic resources would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. No additional actions would be taken to promote angler harvest of non-native fish in waters where they coexist with native fish. Existing levels of angler education would continue. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Electrofishing requires work within the stream channel. This activity could dislodge aquatic invertebrates and amphibians causing them to drift downstream and become more susceptible to predation. Electrofishing would cause temporary shock to some individual invertebrates and amphibians possibly leading to death. Therefore, electrofishing in Soda Butte Creek would have direct, short-term, negligible to minor adverse impacts to aquatic invertebrates and amphibians.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes from brood stock support/development would continue. Native fish would be captured using electrofishing and netting. Electrofishing and gamete collection requires working within stream channels. This activity could dislodge aquatic invertebrates and amphibians causing them to drift downstream and become more susceptible to predation. Electrofishing would cause

temporary shock to some invertebrates and amphibians possibly leading to death. Impacts would be similar to those described under Alternative 1g.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of aquatic resources and supporting research on streams and lakes other than Yellowstone Lake would continue. These efforts require direct work within wetland areas and would cause localized adverse impacts. Plankton and aquatic invertebrates could be dislodged making them more susceptible to predation. Typically, plankton is collected using a plankton net (130 mm opening) from 12 locations within a project lake. Plankton densities are generally low with less than 2,500 individuals being collected during a sample event. Aquatic invertebrate populations vary greatly and are dependent on water quality, habitat, and stream productivity. From 2002-2008, one hundred fifty-nine samples have been collected to evaluate aquatic invertebrate populations in Yellowstone. The number of invertebrates collected from each site has ranged from 32 m^2 – 17,645 m^2 (mean 2,673 m^2). Plankton and aquatic invertebrates would be collected, killed and preserved for identification, abundance estimates and calculating other population metrics. Most amphibians would be collected, observed on-site and released on-site; however, if some amphibians appear to be diseased, they may be collected and preserved for amphibian health studies. Because plankton, invertebrates and amphibians are sampled in localized areas and do not impact the overall population, inventory and monitoring efforts are expected to have direct, short-term, negligible to minor adverse impacts to aquatic invertebrates and amphibian populations.

Cumulative Impact Analysis

Ongoing administrative activities such as road construction and repair, buoy and facilities maintenance, and lake patrol would continue to affect some aquatic areas. Buoy maintenance and lake patrol require the use of motorized boats. Boats could contribute hydrocarbons to surface waters which would adversely affect a limited amount of aquatic organisms by either interfering with respiration, feeding or cause death. Road construction and facilities maintenance could disturb soils adjacent to stream and lakes leading to increased runoff and sedimentation. Increased sedimentation would adversely affect aquatic organisms by reducing in-stream habitat and either interfering with respiration, feeding, reproductive behavior or cause death. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational use such as boating, angling, swimming, camping, and hiking would continue parkwide. Increased boating could contribute hydrocarbons to surface waters which would adversely affect aquatic organism by interfering with respiration, feeding or causing direct mortality. Angling and swimming would cause trampling of streambed which could lead to reduced habitat or direct mortality of some aquatic organisms. Camping and hiking could lead to soil erosion and increase sedimentation in adjacent streams and lakes. Because increased sedimentation could reduce in-stream habitat, reduce visibility for feeding and alter behavior of some aquatic organisms temporarily which could lead to direct, short-term, negligible to minor adverse impacts. Alternative 1 would increase impacts to aquatic organisms. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 1 Conclusion

Continued LKT suppression efforts would likely have an indirect effect on aquatic resources. Boat operation would have indirect, short-term, negligible adverse impacts to aquatic resources; LKT disposition would have indirect, short-term, negligible beneficial impacts to aquatic

resources. In summary, Alternative 1 would have indirect, short-term, negligible adverse and negligible beneficial impacts to aquatic resources in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would be minimal. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. In summary, Alternative 1 would have direct, short-term, negligible to minor adverse impacts to aquatic resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have indirect and direct, short-term, negligible to minor adverse impacts and indirect, short term negligible beneficial impacts to aquatic resources in the park.

4.3.1.2 Alternative 2: Impacts on Aquatic Resources

Impact Analysis
Impacts to aquatic resources would occur under Alternative 2 with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients. Proposed actions may include measures to assist native fish populations by building fish barriers, reconnecting disjunct stream segments, and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
2a. Large-scale Lake Trout Removal: LKT suppression efforts as proposed under Alternative 2 would include netting by private sector contract netters in addition to NPS crews. Increased netting effort would increase the number of boats used on Yellowstone Lake and the number of LKT carcasses returned to park waters. In 2009, NPS continued their LKT suppression efforts and private-sector contract gillnetters were used for a three-week period during the early part of the field season. During 2009 more than 100,000 LKT were killed and carcasses were returned to Yellowstone Lake. The number of LKT killed each year is expected to double or triple under Alternative 2. LKT carcasses would be returned to Yellowstone Lake to improve program efficiency and retain nutrients. Use of motor boats would contribute small amounts of hydrocarbons (oil and gas) to Yellowstone Lake and negatively affect water quality, especially in confined areas such as the Bridge Bay Marina and Grant boat launch. Hydrocarbons would negatively affect plankton, aquatic invertebrates, and amphibians by either affecting their respiration, interfere with feeding, or causing death. Pollution from motorized boats would cause direct, short-term, negligible to minor adverse impacts to plankton, aquatic invertebrates, and amphibians. Because impacts may affect localized portions of populations, returning LKT carcasses to Yellowstone Lake could increase nutrients resulting in a more abundant food supply and possibly increased numbers of plankton and aquatic invertebrates in these localized areas. Impacts to plankton and aquatic invertebrates from LKT disposition would therefore be indirect, short-term, negligible and beneficial as LKT carcasses would supply an additional food source for these groups of organisms. Amphibian populations are not expected to be impacted by LKT disposition.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect aquatic resources in the vicinity of the confluence of Clear Creek and Yellowstone Lake. Weir construction would affect the stream channel and surrounding riparian areas. Plankton, aquatic invertebrates, and amphibians would be directly affected by the rebuilding of the weir. The streambed and riparian areas would be disturbed, displacing plankton, aquatic invertebrate, and amphibian populations. Completion of the weir would also seasonally alter local hydrology, causing water to pool behind the weir. Change in water velocities may cause an adverse change in community structure of the local plankton and aquatic invertebrate population and create more suitable habitat for amphibians. Therefore, impacts from this construction activity would be direct, short-term, negligible to minor and adverse to plankton, and aquatic invertebrates; direct, short- and long-term, negligible adverse and minor beneficial to amphibian populations.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would entail walking in streams and adjacent riparian areas. This could cause aquatic organisms to become trampled or dislodged making them more susceptible to predators. Reconnecting isolated tributaries would involve removing sandbars from the mouth of Yellowstone Lake tributary streams. Moving and placing sandbar material would displace aquatic invertebrates that live within the substrate. Therefore, use of streamside incubators and reconnecting isolated tributaries would lead to direct, short- to long-term, minor adverse impacts to aquatic invertebrates and amphibians.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes

2f. Fish Barriers or Weirs/Traps: Construction of fish barriers would affect aquatic resources in the vicinity of barrier construction. Barrier and weir construction would take place within the stream channel and surrounding riparian areas. This would cause aquatic invertebrates and amphibians to become dislocated making them more susceptible to predation. Completion of the barrier may alter local hydrology, causing water to pool. Change in water velocities may cause an adverse change in community structure of local plankton and aquatic invertebrate communities and create more suitable habitat for amphibians. Impacts from this construction activity would be direct, short-term, negligible to minor adverse to plankton, and aquatic invertebrates; direct, short-term, negligible adverse and minor beneficial to amphibian populations.

2g. Non-native Fish Removal: Chemical and mechanical methods to remove non-native fish would affect aquatic resources within the project watershed. Applied chemicals (piscicide and potassium permanganate) would affect waters being treated and downstream portions of the treatment area; mechanical removal would only affect waters in the immediate work area. Chemical treatments would have adverse affects to plankton, aquatic invertebrates, and amphibians. Susceptibility and degree of impact would vary among species and life history stage. In general, adult and juvenile zooplankton tend to be sensitive to chemical treatments, resulting in a marked decline in their population immediately after treatment. Response by aquatic invertebrates would depend on a variety of factors including species, exposure, and method of respiration. Typically, invertebrates that are affected by chemical treatment will be dislodged and drift downstream to avoid chemical exposure. Overall effects of chemicals on individual invertebrates can range from negligible (no effect) to death. Some invertebrate taxa may be entirely removed from the population. Because aquatic invertebrate populations are dynamic and highly variable, total recovery of some invertebrate taxa would be impossible to document,

but reestablishment of native fish would in the long term improve ecological function and hence diversity of these species.

Whether removal is chemical or mechanical, short-term indirect effects may occur when localized fish populations are removed and aquatic invertebrate or larval amphibian communities are reduced. Wildlife that depends on aquatic invertebrate communities may be displaced until the stream has recovered. For example, American dipper, a small, aquatic, insect-eating bird, may be affected by chemical removal of aquatic insects.

Larval amphibians are very susceptible to rotenone which can cause 100 percent mortality; adult amphibians do not seem to exhibit adverse affect from its application. Therefore, mitigation measures (e.g., timing, relocating, and rearing individuals) would be taken to avoid these sensitive periods in life histories of aquatic organisms (see Appendix B – for an in-depth discussion on impacts to non-target species).

Because of mitigation measures that would be followed and because these treatments will in the long term provide for restoration of native fish which would support a more naturally functioning system, chemical treatment to remove non-native fish would remain direct, short-term, minor to moderate adverse impacts to plankton, aquatic invertebrates and larval amphibians as well as indirect, long-term, minor and beneficial to populations within treated streams. Electrofishing and netting may affect plankton, aquatic invertebrates, and amphibians to a small degree by dislodging individuals, shocking individuals or from trampling. Therefore, mechanical removal efforts would have a direct, short-term, and negligible to minor adverse impacts to plankton, aquatic invertebrates, and amphibians.

2h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes from brood stock support/development would continue. Gamete collection would involve working within stream channels. Impacts would be similar to those described under Alternative 1h.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, buoy and facilities maintenance, and lake patrol would continue to affect some aquatic areas. Buoy maintenance and lake patrol require the use of motorized boats. Boats could contribute hydrocarbons to surface waters which would adversely affect some aquatic organisms by either interfering with respiration, feeding or cause death. Road construction and facilities maintenance could disturb soils adjacent to stream and lakes leading to increased runoff and sedimentation. Increased sedimentation would adversely affect aquatic organisms by either reducing in-stream habitat or interfering with respiration, feeding and reproductive behavior. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational use such as boating, angling, swimming, camping, and hiking would continue parkwide. Boating could contribute hydrocarbons to surface waters which would adversely affect aquatic organism by interfering with respiration, feeding or causing direct mortality. Angling and swimming would cause trampling of streambed sediments which could lead to reduced habitat or direct mortality of some aquatic organisms. Camping and hiking could lead to soil erosion and increase sedimentation in adjacent streams and lakes. Increased sedimentation could reduce in-stream habitat, reduce visibility for feeding and alter behavior of some aquatic organisms which could lead to direct, short-term, negligible to minor adverse impacts. Alternative 2 would increase

impacts to aquatic organisms. Coupled with past, present and foreseeable future actions, Alternative 2 would incrementally increase adverse impacts to the negligible to moderate level.

Alternative 2 Conclusion

Increased LKT suppression efforts would affect aquatic resources. The impacts to aquatic resources are expected to be indirect, short-term, negligible and beneficial. Reconstruction of the Clear Creek weir/trap and enhancement of YCT recruitment would have direct, short- and long-term, negligible to minor and adverse to plankton, and aquatic invertebrates; direct, short- and long-term, negligible adverse and minor beneficial to amphibian populations. In summary, Alternative 2 would have direct and indirect, short- and long-term, negligible to minor adverse impacts to plankton and aquatic invertebrates and indirect, short- and long-term, negligible to minor beneficial impacts to amphibians in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would affect aquatic resources. Fish barriers or weirs/trap construction would cause direct, short-and long-term, negligible to minor adverse impacts to plankton and aquatic invertebrates; direct, short- and long-term, negligible to minor adverse (plankton and aquatic invertebrates) and minor beneficial impacts to amphibians. Chemical and mechanical fish removal would cause direct, short- and long-term, minor to moderate adverse impacts to aquatic resources. In summary, Alternative 2 would have direct, short-and long-term, minor to moderate adverse as well as minor beneficial impacts to aquatic resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 2 would have direct and indirect, short- and long-term, negligible to moderate adverse impacts as well as indirect, short- and long-term, negligible to minor beneficial impacts to aquatic resources in the park.

4.3.1.3 Alternative 3: Impacts on Aquatic Resources

Impact Analysis

The direct and indirect impacts of Alternative 3 to aquatic resources would be very similar to those of Alternative 2, except non-native fish would be removed from park waters and marketed by private sector contract netters. Impacts to aquatic resources would occur under Alternative 3. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. For Alternative 3 subtopic 3a, large-scale LKT removal, there would not be similar impacts to plankton and invertebrate communities in Yellowstone Lake from removal of LKT carcasses; there may be some reduction in food supply enhancement since a portion of fish would be removed instead of disposed on in the lake, but impact levels would remain as in Alternative 2. Amphibian populations are not expected to be impacted by LKT disposition. The remaining impacts of Alternative 3 to aquatic resources would be identical to those described for Alternative 2 for all subtopics 2b-2i.

Cumulative Impact Analysis

Alternative 3 would increase impacts to aquatic organisms. Coupled with past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to moderate.

Alternative 3 Conclusion

Increased LKT suppression efforts would affect aquatic resources. The impacts to aquatic resources are expected to be indirect, short-term, negligible and beneficial. Reconstruction of the Clear Creek weir/trap and enhancement of YCT recruitment would have direct, short- and long-term, negligible to minor and adverse to plankton, and aquatic invertebrates; direct, short- and long-term, negligible adverse and minor beneficial to amphibian populations. In summary, Alternative 3 would have direct and indirect, short- and long-term, negligible to minor adverse impacts to plankton and aquatic invertebrates and negligible to minor beneficial impacts to amphibians in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would affect aquatic resources. Fish barriers or weirs/trap construction would cause direct, short-and long-term, negligible to minor adverse impacts to plankton and aquatic invertebrates; direct, short- and long-term, negligible to minor adverse (plankton and aquatic invertebrates) and minor beneficial impacts to amphibians. Chemical and mechanical fish removal would cause direct, short- and long-term, minor to moderate adverse impacts to aquatic resources outside the Yellowstone Lake watershed. In summary, Alternative 3 would have direct, short-and long-term negligible to moderate adverse and minor beneficial impacts to aquatic resources.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have direct, short-and long-term, minor to moderate adverse and indirect, long-term, negligible to minor beneficial impacts to aquatic resources in the park.

4.3.1.4 Alternative 4: Impacts on Aquatic Resources

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and nets. This effort would not result in a direct recovery of YCT in the Yellowstone Lake watershed. Clear Creek weir and fish barriers in streams would be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source. The direct and indirect impacts of Alternative 4 to aquatic resources would be identical to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g-1i; and Alternative 2, subtopics 2c, 2d, 2f. Impacts would be less than Alternatives 2 and 3 because piscicides would not be used.

Cumulative Impact Analysis
Alternative 4 would increase impacts to aquatic organisms. Coupled with past, present and foreseeable future actions, Alternative 4 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 4 Conclusion

LKT suppression efforts would continue at their current level with no LKT removal by private sector contract netters. The impacts to aquatic resources would be indirect, short-term, negligible to minor adverse and indirect, short-term negligible beneficial. In summary,

Alternative 4 would have indirect, short-term, negligible to minor adverse and indirect, short-term negligible beneficial impacts to aquatic resources in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would be minimal. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, inventory and monitoring of aquatic organisms would continue, and limited native fish restoration activities would take place. In summary, Alternative 4 would have direct, short-term, negligible to minor adverse impacts on aquatic resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions Alternative 4 would have indirect and direct, short-term, negligible to minor adverse and indirect, short-term, negligible beneficial impacts to aquatic resources in the park.

4.3.2 Native Fish Resources

Guiding Principles and Policies
Section 4.4.1.1.of the 2006 National Park Service Management Policy states that the National Park Service is to maintain all native plant and animal species and their habitat inside parks. "The Service will … use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks."

In response to the introduction of LKT into Yellowstone Lake, NPS fishing regulations were changed to address this issue. The current regulations divide the park into a native trout conservation area and a wild trout enhancement area. The native trout conservation area, which includes Yellowstone Lake, is aimed to conserve native trout in their historical, native drainages. The regulations require anglers to kill all LKT caught in Yellowstone Lake. Additionally, all native fish caught throughout the park are to be returned, unharmed, to the waters in which they were caught.

Methodology and Assumptions
In 2002, the Fisheries and Aquatics Section added an ecosystem health component to its fisheries program. This component currently consists of several monitoring plans, including water quality, aquatic invertebrates, amphibians, and fish. All facets of this program are used to guide native fish restoration activities in the park.

Intensity Level Definitions
The thresholds of change for the intensity of an impact on aquatic resources are defined as follows:

Negligible: Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them would be extremely unlikely to occur or not measurable. Ecological processes would not be affected. If impacts to individuals were to occur, they would be localized, short-term, and of no consequence to the species.

Minor: Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them would affect a small, localized portion of the species/range in the park. Short- or long-term disturbances to individuals may

occur and/or a small amount of habitat could be permanently modified or removed. Impacts would not measurably affect the migration patterns or other demographic characteristic of the population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Mitigation measures to offset adverse impacts would be followed.

Moderate: Adverse or beneficial impacts to populations, their habitat, or the key ecosystem processes sustaining them would affect a moderate portion of the species/range in the park but would not affect the viability of the regional population. Short- or long-term disturbances could measurably affect the migration patterns or other demographic characteristics of the population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Impacts would not significantly increase the susceptibility of populations(s) in or near the park to environmental or demographic uncertainty (e.g., severe winters, droughts, disease epidemics, skewed age or sex ratios). Mitigation measures would be extensive and successful.

Major: Adverse or beneficial impacts to populations, their habitat, or the key ecosystem processes sustaining them would be long-term and affect a large proportion of the species' range in a regional context. The susceptibility of populations(s) within the region to environmental or demographic uncertainty would significantly increase. Mitigation measures would be extensive and success would not be guaranteed.

Duration: Short-term impacts to fish resources would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.3.2.1 Alternative 1 (No Action): Impacts on Native Fish Resources

Impact Analysis
Impacts to native fish resources would likely occur under Alternative 1. Several actions are being proposed under this alternative, each of which could have a different effect on aquatic resources in the park.

Yellowstone Lake
1a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Suppression would continue using NPS crews, boats and large nets throughout the open water season. LKT carcasses would be returned to Yellowstone Lake to improve program efficiency and retain nutrients. Use of motor boats would contribute small amounts of hydrocarbons (oil and gas) to Yellowstone Lake. Hydrocarbons could negatively affect fish by temporarily affecting their respiration or interfere with feeding behavior. Therefore, pollution from motorized boats would cause direct, short-term, negligible adverse impacts to fish. Effects of returning LKT carcasses to Yellowstone Lake may lead to an increase in plankton and invertebrate populations which could provide an added food source for YCT and other native fish leading to long-term minor beneficial impacts to fish.

Large-scale LKT removal efforts will affect fish species in different ways. Under current suppression efforts, LKT densities would continue to grow, but at a slower rate than if suppression efforts were not to take place; YCT numbers would continue to decline, and LNS

numbers would be reduced as incidental by-catch. Gillnets are designed to catch and kill fish larger than 177mm. All LKT and LNS caught in nets would be killed, live YCT would be released. Over the past 5 years an average of 4,783 YCT per year have been captured during gillnetting operations. Of these, 44% are returned to the lake alive, however some additional mortality of fish likely occurs following release. Because of the small number of YCT killed in nets, relative to LKT killed, impacts to YCT are expected to be direct, short-term, minor and adverse. In the long-term negligible beneficial impacts to YCT and other native fish would occur due to slowing of the LKT population growth.

1b. Monitoring of LKT and YCT: Monitoring fish populations is a necessary tool to evaluate the efforts of the native fish restoration plan and to guide adaptive management principles. Long-term monitoring of LKT and cutthroat trout would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats, and large nets. Monitoring would occur throughout the open water season. Monitoring activities would involve the removal of all LKT; some YCT may be sacrificed to obtain biological information such as age, sexual maturity. In 2010 796 YCT were sacrificed as a result of monitoring activities on Yellowstone Lake. Impacts would be direct, short-term, minor and adverse because monitoring would affect a small number of YCT. Other native fish would not be affected by monitoring activities.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to fish resources would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to fish resources would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. These research activities would affect fish resources within the Yellowstone Lake watershed. The techniques are not yet developed and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have minor adverse impacts to aquatic resources. These new techniques would not exceed the impacts to any fish resources described in this document.

Other Streams, Rivers, and Lakes
Most streams, rivers, and lakes where actions would occur would have impacts to native fish.

1f. Fish Barriers or Weirs/Traps: No action would be taken to construct fish barriers in streams. No impacts to fish resources would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. No additional actions would be taken to promote angler harvest of non-native fish in waters where they coexist with native fish. Existing levels of angler education would continue. Existing actions to selectively remove BKT from upper Soda Butte Creek by electrofishing would continue. Electrofishing involves using electricity to stun fish. Fish are netted, weighed and measured. All BKT would be killed and native fish returned back to the stream. Native fish would be stressed from electricity and handling; some mortality could occur. Therefore, impacts to cutthroat trout would be direct, minor and adverse in the short-term but direct minor to moderate beneficial in the long-term due to the suppression of non-natives.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes from brood stock support/development would continue. Gamete collection would involve working

within stream channels, electrofishing, netting and handling fish. This would cause a small amount of mortality and therefore lead to direct, short-term, negligible adverse impacts to native fish. However, brood source development would supplement the existing native fish population and lead to direct, long-term, minor to moderate beneficial impacts to native fish species.

1i. Inventory, Monitoring, and Research for Aquatic Organisms: Inventory, monitoring, and research of aquatic organisms is necessary to assess the status and health of aquatic resources and support research on streams and lakes. Activities such as kick, Surber and dredge sampling for invertebrates, dip-netting amphibians, and conducting visual surveys for other aquatic organisms would take place in lakes, streams, and other wetland areas and could disturb resident fish. Inventory and monitoring of aquatic organisms would have direct, short-term, negligible adverse impacts to native fish because activities could temporarily displace fish in the vicinity of the disturbance.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on native fish in the park. Road maintenance activities would require occasional minor disturbance of native fish by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of native fish. Most facilities maintenance would take place in developed areas where minimal impacts to native fish would occur. However adverse impacts to native fish may become necessary because some native fish bearing waters may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to native fish can be reduced by minimizing time and disturbance in riparian areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on native fish as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use with negligible to minor adverse effects. Alternative 1 would increase impacts to native fish. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 1 Conclusion

Continued LKT suppression and monitoring efforts would have a direct effect on native fish resources. The impacts to native fish resources are expected to be direct, short-term, negligible to minor adverse for YCT and other native fish; and indirect negligible to minor beneficial impacts for YCT. However indirect long-term moderate adverse impacts to native fish would occur because the native fish populations in Yellowstone Lake would not be restored and expansion of non-native fish species would continue. In summary, Alternative 1 would have direct and indirect, short- and long-term, negligible to moderate adverse impacts to YCT and other native fish; and indirect negligible beneficial impacts for YCT in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would have a direct effect on native fish resources. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. In summary, Alternative 1 would have direct, short-term, negligible to minor adverse impacts for YCT; and indirect, long-term, minor to moderate beneficial impacts for YCT outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have indirect and direct, short-term, negligible to moderate adverse impacts and long-term negligible to moderate beneficial impacts to native fish in the park.

4.3.2.2 Alternative 2: Impacts on Native Fish Resources

Impact Analysis
Impacts to fish would occur under Alternative 2 from the potential actions associated with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients. Proposed actions may include measures to assist native fish populations by building fish barriers, removing sandbars to reconnect isolated tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Impacts to fish would occur under Alternative 2 from the potential actions associated with primary, secondary, or tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on fish resources.

2a. Large-scale Lake Trout Removal: LKT suppression efforts as proposed under Alternative 2 would include netting by private sector contract netters in addition to NPS crews. Increased netting effort would increase the number of boats used on Yellowstone Lake and the number of LKT carcasses returned to park waters. In 2009, NPS continued their LKT suppression efforts and private-sector contract gillnetters were used for a three-week period during the early part of the field season. During 2009 more than 100,000 LKT were killed and carcasses were returned to Yellowstone Lake. The number of LKT killed each year is expected to double or triple (200,000-300,000) under Alternative 2. The amount of YCT by-catch would be expected to rise proportionally to LKT removal, therefore impacts to YCT from increased LKT suppression would be minor and adverse in the short-term. However, increased LKT suppression would allow for recovery of YCT resulting in long-term moderate beneficial impacts to YCT and other native fish.

LKT carcasses would be returned to Yellowstone Lake to improve program efficiency and retain nutrients. Increased use of motor boats would contribute small amounts of hydrocarbons (oil and gas) to Yellowstone Lake surface waters. Hydrocarbons could affect small fish by interfering with respiration and feeding behavior. Pollution from motorized boats would be temporary and therefore cause direct, short-term, negligible adverse impacts to small fish.

Effects of returning LKT carcasses to Yellowstone Lake may lead to an increase in plankton and invertebrate populations, in addition to LKT carcasses, which could provide an added food source for YCT leading to long-term minor beneficial impacts to native fish. Minor to moderate

beneficial effects on fish populations in Yellowstone Lake are expected to occur from increased LKT suppression. Lake trout densities are expected to decline and YCT numbers are predicted to increase. Increased gillnet activities would therefore have direct, short-term, minor adverse effects on YCT; and indirect, long-term, minor to moderate beneficial impacts on YCT.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect fish resources in Clear Creek. Weir placement would affect the stream channel and surrounding riparian areas. Rebuilding and operation of the weir would affect YCT. Clear Creek is one of the major spawning streams for YCT in the Yellowstone Lake watershed. Construction of the weir would require work within the stream and adjacent riparian areas. Small numbers of fish and fish eggs could be disturbed or crushed from construction activities. Completion and use of the weir would affect the migration pattern of spawning YCT because weir impingement may cause some fish deaths, and handling of fish by NPS crews would cause additional stress to spawning fish. The presence of the weir may concentrate fish and allow them to be more susceptible to predation by birds and mammals. Impacts from rebuilding and operation of the weir are expected to be direct, short- and long-term, negligible to minor, and adverse to YCT but the information gained from rebuilding the Clear Creek will lead to indirect long-term minor to moderate benefits for native fish. Rebuilding the weir is not expected to have any effects on LKT.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into Yellowstone Lake. The YCT population would benefit short-term because YCT recruitment to the lake would increase and long-term because YCT supplementation would speed recovery of depleted populations. Overall there would be direct, short to long-term, minor to moderate beneficial impacts YCT. Other native fish would not be affected by YCT supplementation.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes
Impacts to fish would occur under Alternative 2 from the potential actions associated with primary, secondary, or tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on fish resources in the park.

2f. Fish Barriers or Weirs/Traps: Construction of fish barriers would affect native fish resources in the immediate vicinity upstream of the barrier because construction activities may temporarily displace some fish. Barriers would permanently affect the migration pattern of local fish, however, barriers would not be placed where native fish with migratory life history strategies currently exist. Native fish populations are expected to benefit through reduced predation, competition, and hybridization with non-native fish because barrier construction would create isolated habitats where native fish could thrive. Impacts from barrier construction are expected to be direct, short-term, negligible, adverse and minor to moderately long-term beneficial to fish resources.

2g. Non-native Fish Removal: Chemical and mechanical methods to remove non-native fish would affect native fish resources within the project watershed, particularly in areas where native fish populations, like sculpins, coexist with non-native fish. Applied chemicals would affect waters being treated and may affect downstream portions of the treatment area; mechanical removal would only affect waters in the immediate work area. Chemical removal,

which would kill all fish present within the treatment area, is used when complete eradication is necessary to restore native fish populations. Mechanical removal is used to selectively remove undesirable fish species. Both methods would have adverse affects on native fish populations found within restoration areas because some native fish could be killed or injured (for more detail see Appendix B). Therefore, the immediate effect of chemical removal would lead to direct, short-term, moderate adverse impacts to native fish. After restoration, all native fish species would be restocked and native fish populations would benefit from returning to their historic range within the park and reducing extirpation risk within the Yellowstone ecosystem. These impacts would be direct and indirect, long-term, and moderately beneficial.

2h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. Localized impacts to fish would occur because electrofishing would be employed as a capture method, fish would be temporarily held in cages, and gametes (eggs and sperm) would be collected from individual fish.. Electrofishing, handling, and retention could cause some direct injury or mortality to individual native fish. Collection of gametes would reduce the reproductive potential of individual native fish. Because low numbers of fish are collected and utilized for gamete collection no population level effect would be expected. Impacts from gamete collection are expected to be direct, short-term, negligible and adverse. However, the impacts from brood source development in the long-term would be direct, moderate, and beneficial because native fish brood sources would be used to restore native species to their historic range in Yellowstone National Park.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on native fish in the park. Road maintenance activities would require occasional minor disturbance of native fish by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of native fish. Most facilities maintenance would take place in developed areas where minimal impacts to native fish would occur. However adverse impacts to native fish may become necessary because some native fish bearing waters may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to native fish can be reduced by minimizing time and disturbance in riparian areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on native fish as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use at the negligible to minor impact level. Alternative 2 would increase impacts to native fish. Coupled with past, present and foreseeable future actions, Alternative 2 would incrementally increase adverse impacts, the overall adverse impact level would increase from negligible to moderate, but an overall, long-term, beneficial moderate impact would also occur.

Alternative 2 Conclusion

Increased LKT suppression efforts would impact native fish resources. While impacts to native fish resources are expected in the short term to be direct, negligible to minor adverse; in the long term, the YCT population in Yellowstone Lake will benefit directly at the minor to moderate level. Reconstruction of the Clear Creek weir and trap would have direct, short- and long-term, minor, adverse impacts to the YCT population as well as long term, indirect minor to moderate beneficial impacts. In summary, Alternative 2 would have direct, short- and long-term, negligible to minor adverse and indirect, long-term minor to moderate beneficial impacts to YCT in the Yellowstone Lake watershed.

Fish restoration activities on streams, rivers, and lakes would affect native fish resources. Fish barriers or weirs/trap construction would cause direct, short- and long-term, negligible to minor adverse impacts to native fish; direct, long-term, minor to moderately beneficial impacts to native fish. Chemical and mechanical fish removal would cause direct, short-term, moderate adverse impacts to native fish; and direct and indirect, long-term, moderate beneficial impacts to native fish. Gamete collection would have direct, short-term negligible adverse impacts as well as long-term, moderate beneficial impacts. In summary, Alternative 2 would have direct, short- and long-term, negligible to moderate adverse impacts, but indirect, long-term moderate beneficial impacts to native fish resources outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 2 would have indirect and direct, short- and long-term, negligible to moderate adverse impacts, but in the long-term, direct and indirect, moderate beneficial impacts to native fish resources in the park.

4.3.2.3 Alternative 3: Impacts on Native Fish Resources

Impact Analysis

The direct and indirect impacts of Alternative 3 to native fish would be very similar to those of Alternative 2, except that some LKT would be removed from park waters and marketed by private sector contract netters. This would only reduce the amount of LKT carcasses returned to Yellowstone Lake by a small fraction of the total LKT caught, therefore yielding similar impacts as Alternative 2. Impacts to natives would most likely occur under Alternative 3. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on native fish in the park. Road maintenance activities would require occasional minor disturbance of native fish by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of native fish. Most facilities maintenance would take place in developed areas where minimal impacts to native fish would occur. However adverse impacts to native fish may become necessary because some native fish bearing waters may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to native fish can be reduced by minimizing time and disturbance in riparian areas and by monitoring construction and maintenance activities. Park

visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on native fish as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use at the negligible to minor level. Alternative 3 would increase impacts to native fish. Coupled with past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, the overall adverse impact level would remain at negligible to moderate, but an overall, long-term, beneficial moderate impact would also occur.

Alternative 3 Conclusion

Increased LKT suppression efforts would impact native fish resources. The impacts to native fish resources are expected to be direct, short- and long-term, negligible to minor adverse, and direct, long-term, minor to moderately beneficial to YCT. Reconstruction of the Clear Creek weir and trap would have direct, short- and long-term, minor, adverse impacts to the YCT population as well as long term, indirect moderate beneficial impacts. In summary, Alternative 3 would have direct and indirect, short- and long-term, minor to moderately adverse impacts to LKT; and direct, short- and long-term, minor to moderately beneficial impacts to YCT. Marketing of some LKT by private contractors would not yield additional impacts to native fish.

Other Streams, Rivers, and Lakes

Fish restoration activities on streams, rivers, and lakes would affect native fish resources. Fish barriers or weirs/trap construction would cause direct, short- and long-term, negligible to minor adverse impacts to native fish; direct, long-term, moderately beneficial impacts to native fish. Chemical and mechanical fish removal would cause direct, short-term, negligible to minor adverse impacts to native fish; and direct and indirect, long-term, moderate beneficial impacts to native fish. In summary, Alternative 3 would have direct and indirect, short- and long-term, negligible to minor adverse impacts and long-term minor to moderate beneficial impacts to native fish resources in the park.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have indirect and direct, short-and long-term, negligible to moderate adverse impacts and long-term, minor to moderate beneficial impacts to aquatic resources in the park.

4.3.2.4 Alternative 4: Impacts on Native Fish Resources

Impact Analysis

Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and large nets. This effort would not result in a direct recovery of YCT in the Yellowstone Lake watershed. Indirect long-term moderate adverse impacts to native fish would occur because the native fish populations in Yellowstone Lake would not be restored and expansion of non-native fish species would continue. Clear Creek weir and fish barriers in streams would be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing

a native fish brood source. The direct and indirect impacts of Alternative 4 to fish resources would be identical to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g-1i; and Alternative 2, subtopics 2c, 2d, 2f. Impacts from piscicide use, as described in 2g would not occur, however indirect long-term moderate adverse impacts to native fish would occur because native fish populations in large and complex habitats would not be restored and expansion of non-native fish species would continue. Impacts from mechanical fish removal would be similar to those described in Alternative 2.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on native fish in the park. Road maintenance activities would require occasional minor disturbance of native fish by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of native fish. Most facilities maintenance would take place in developed areas where minimal impacts to native fish would occur. However adverse impacts to native fish may become necessary because some native fish bearing waters may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to native fish can be reduced by minimizing time and disturbance in riparian areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on native fish as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use at the negligible to minor level. Alternative 4 would increase impacts to native fish. Coupled with past, present and foreseeable future actions, Alternative 4 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 4 Conclusion

Continued LKT suppression and monitoring efforts would have a direct effect on native fish resources. The impacts to native fish resources are expected to be direct, short-term, minor adverse for YCT and other native fish; and indirect negligible beneficial impacts for YCT. In summary, Alternative 4 would have direct, short-term, minor adverse impacts to YCT and other native fish; and indirect short-term negligible beneficial impacts for YCT, but also long-term moderate adverse impacts for YCT because the expansion of LKT would continue in the Yellowstone Lake watershed.

Fish restoration activities, without the use of piscicides, on streams, rivers, and lakes would affect native fish resources. Fish barriers or weirs/trap construction would cause direct, short- and long-term, negligible to minor adverse impacts to native fish; direct, long-term, moderately beneficial impacts to native fish. Mechanical fish removal would cause direct, short-term, negligible to minor adverse impacts to native fish; and direct and indirect, long-term, negligible to minor beneficial impacts to native fish. However indirect long-term moderate adverse impacts to native fish would occur because native fish populations in large and complex habitats would not be restored and expansion of non-native fish species would continue. In summary, Alternative 4 would have direct, short- and long-term, negligible to minor adverse impacts to native fish and indirect, short-term, negligible to minor beneficial impacts to native fish, but

most importantly, indirect, long-term moderate adverse impacts to fish resources in the park because of the inability to adequately suppress LKT in Yellowstone Lake or to restore native fish to rivers and streams.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have indirect and direct, short-and long-term, negligible to moderate adverse impacts and indirect, long-term, negligible to minor beneficial impacts to native fish in the park.

4.3.3 Wildlife Resources

Guiding Regulations and Policies
There are federal laws governing wildlife not protected by the Endangered Species Act (1973), including the Migratory Bird Protection Act, the Bald Eagle Protection Act, and the Lacey Act. (Threatened and endangered species are considered separately under "Special Status Species" below.)

Section 4.4.1.1.of the 2006 National Park Service Management Policy states that the National Park Service is to maintain all native plant and animal species and their habitat inside parks. "The Service will … use management strategies that are intended to maintain the natural population fluctuations and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks."

Section 4.4.2 of 2006 Management Policies addresses management of native plants and animals in NPS units. It states that natural processes would be relied upon to maintain native plant and animal species and influence natural fluctuations in populations of these species.

Methodology and Assumptions
Impacts to native wildlife (mammals, birds, and reptiles) are analyzed in this impact topic based on the knowledge of park resource specialists and current literature. Impacts to Yellowstone Species of Management Concern and USFWS Threatened and Endangered Species, Candidate Species, and Species of Concern are analyzed under the Species of Concern impact topic.

Intensity Level Definitions
The thresholds of change for the intensity of an impact on wildlife resources are defined as follows:

Negligible: Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them would be extremely unlikely to occur or not measurable.

Minor: Adverse or beneficial impacts to individuals, their habitat, or the key ecosystem processes sustaining them would affect a small, localized portion of the species/range in the park. Short- or long-term disturbances to individuals may occur and/or a small amount of habitat could be permanently modified or removed. Impacts would not measurably affect the migration patterns, or other demographic characteristic of the population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change).

Moderate: Adverse or beneficial impacts for populations, their habitat, or the key ecosystem processes sustaining them would affect a moderate portion of the species/range in the park. Short- or long-term disturbances could measurably affect the migration patterns or other demographic characteristics of a population (i.e., age/sex structure, recruitment rates, survival rates, movement rates, population sizes, population rates of change). Impacts would not significantly increase the susceptibility of populations(s) in or near the park to environmental or demographic uncertainties (e.g., severe winters, droughts, disease epidemics, skewed age or sex ratios).

Major: Adverse or beneficial impacts for populations, their habitat, or the key ecosystem processes sustaining them would be long-term and affect a large proportion of the species' range across the region. The susceptibility of populations(s) throughout the region to environmental or demographic uncertainty would significantly increase.

Duration: Short-term effects would last only during the implementation of the project, including its mitigation and monitoring measures. Long-term effects would typically constitute a permanent impact.

4.3.3.1 Alternative 1 (No Action): Impacts on Wildlife Resources

Impact Analysis
Impacts to wildlife would likely occur under Alternative 1. Several actions are being proposed under this alternative, each of which could have a different effect on wildlife resources in the park. Several mammal and bird species are listed under the separate section, "Species of Concern."

Yellowstone Lake
1a. Large-Scale Lake Trout Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Impacts to most mammal, migratory bird, and reptile species would be negligible to minor under Alternative 1. Gillnet preparation and mending take place in paved areas of Lake. Use of motorized boats on Yellowstone Lake is likely to disturb mammal and migratory bird species that use the shoreline and open water habitats. There have been no documented cases of mammals being killed in gillnets during the past 10 years. Some water birds (ducks, loons, grebes, and cormorants) have been entangled in NPS gillnets and drowned, about two birds per year on average. Because of the small number of individuals affected, gillnets used to capture LKT would have negligible to minor impacts to aquatic mammals (e.g., river otter, beaver, and muskrat) and diving birds (e.g., ducks, loons, grebes, and cormorants).There are no aquatic species of reptiles in the park and no impacts would be expected under current NPS fisheries suppression efforts on Yellowstone Lake.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats and large nets. Monitoring would occur throughout the open water season and usually take place during August and September. Gillnet preparation and mending take place in paved areas of Lake Village. Use of motorized boats on Yellowstone Lake is likely to disturb (temporarily displace) some mammal and migratory bird species that use the Yellowstone Lake shoreline and open water habitats. During the past 10 years of monitoring efforts there have been no documented

cases of mammals being killed in gillnets. A few water birds (ducks, loons, grebes, and cormorants) have been entangled in NPS gillnets and killed during fish monitoring activities, about one bird per year on average. Because of the small number of individuals affected, gillnets used to capture LKT may have a negligible to minor impacts to aquatic mammals (e.g., river otter, beaver, and muskrat) and diving birds (e.g., ducks, loons, grebes, and cormorants). There are no aquatic species of reptiles in the park and impacts are expected to be negligible under current NPS fisheries monitoring efforts on Yellowstone Lake.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to wildlife would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to wildlife would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue and could potentially occur anywhere throughout the Yellowstone Lake basin. The techniques are yet undeveloped and impacts cannot be evaluated at this time. However, it is expected that some of these techniques would have negligible to minor adverse impacts to mammal, migratory bird, and reptile species in the Yellowstone Lake basin. These techniques would not exceed the impacts described in this document.

Other Streams, Rivers, and Lakes

1f. (1f) Fish Barriers or Weirs/Traps: No action would be taken to construct fish barriers in streams. No impacts to wildlife would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Direct, short-term, negligible to minor impacts may occur to some mammal, bird, and reptile species that use stream corridors within the project areas. These would most likely be due to disturbances (temporary displacement) to mammals such as moose, black bear, beaver, and river otter; some migratory birds such as ducks and the American dipper; and some snake species such as the wandering garter snake.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes from brood stock support/development would continue. Gamete collection locations are along stream corridors and would have negligible to minor disturbances to wildlife similar to those mentioned in subtopic 1g.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on stream and lakes other than Yellowstone Lake would continue. These efforts are low impact and concentrate on evaluating water quality, plankton, aquatic invertebrates, and amphibian species. Effects on wildlife would be negligible to minor with most effects occurring as crews travel to and from sample sites, temporarily displacing wildlife.

Cumulative Impact Analysis

Ongoing administrative activities such as lake patrol, hazing, wildlife monitoring, road construction, and facilities maintenance would continue to affect some wildlife resources. Noise from patrolling and other boating activities on Yellowstone Lake could have direct adverse disturbance impacts to wildlife species that utilize the lake and near shore habitats. These

impacts could range from minor disturbance to temporary movement of wildlife from feeding and nesting areas. Hazing efforts are carried out by park personnel to discourage wildlife (e.g. bears, wolves, and coyotes) from using developed areas and to move bison back into the park during winter months. Some wildlife would be permanently removed from the population if they become habituated to human food and pose a threat to human safety. Wildlife monitoring practices are used to document various demographics of wildlife populations in the park and may cause adverse impacts ranging from generalized disturbance to sedation and handling of the animals. Noise from road construction and facilities maintenance could disturb wildlife in localized areas. Impacts from these disturbances could range from no impact to movement away from the immediate area. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational uses such as boating, angling, camping, and hiking would continue parkwide. Boating activities would contribute noise disturbance and could affect some wildlife by interfering with feeding and resting behavior. Angling occurs parkwide during the summer months and could contribute to generalized disturbance of all wildlife species that occur near streams and lakes. Camping and hiking occur throughout the park and could lead to generalized disturbance which could affect feeding and resting behavior. Camping activities risk habituation of bears and other carnivores to human foods which could lead to some individual animals being euthanized. Both ongoing administration activities and increased visitor use could lead to impacts to wildlife populations throughout the park at the short-term negligible to minor level. Alternative 1 would increase impacts to wildlife. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor to piscivorous wildlife such as grizzly bears, river otters, white pelicans, double-crested cormorants, and ospreys.

Alternative 1 Conclusion

Alternative 1 would result in direct, short-term, and negligible to minor adverse impacts to wildlife from a continuation of current LKT removal and other activities on Yellowstone Lake.

Alternative 1 would result in direct, short-term, negligible to minor adverse impacts to wildlife from a continuation of current native fish conservation activities on streams, rivers, and lakes outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct, short-term, negligible to minor adverse impacts to piscivorous wildlife resource in the park.

4.3.3.2 Alternative 2: Impacts on Wildlife Resources

Impact Analysis
Impacts to wildlife would occur under Alternative 2. Several actions are being proposed under this alternative, each of which could have a different effect on different components of the park's wildlife.

Yellowstone Lake
Impacts to wildlife could occur under Alternative 2 given primary, secondary, or tertiary AM desired condition.

2a. Large-scale Lake Trout Removal: Existing NPS LKT suppression efforts would be supplemented by private sector contract netters, returning non-native LKT fish carcasses to park waters to retain nutrients. In 2009, NPS continued their LKT suppression efforts and private-sector contract gillnetters were used for a three-week pilot period during the early part of the field season. During 2009 more than 100,000 LKT were killed and carcasses were returned to Yellowstone Lake. The number of LKT killed each year would be expected to double or triple under Alternative 2. Gillnet preparation and mending would take place within paved areas of Lake Village. Increased use of motorized boats by NPS crews and private-sector contract netters on Yellowstone Lake would increase the potential for temporary displacement to mammal and migratory bird species that use shoreline and open water habitat. Increasing the number of gillnets used to capture LKT would increase the possibility of capturing aquatic mammals (river otter, beaver, and muskrat) and diving birds (ducks, loons, grebes, and cormorants). There have been no documented cases of mammals being killed in gillnets during the past 10 years. Some water birds (ducks, loons, grebes, and cormorants) have been entangled in NPS gillnets and drowned, an average of about two birds per year. This number would be expected to increase proportionally as more gillnets are deployed on Yellowstone Lake. There would be no measurable impacts to reptiles by NPS fisheries activities and private-sector contract netters. The adverse impacts to wildlife would not be measurable because the number of individuals affected is not expected to rise to a level that would impact a larger portion of wildlife species parkwide, impacts would remain the same as Alternative 1.

Increased LKT suppression would increase the spawning native fish available to wildlife species as a food source. These impacts would be indirect, long-term, moderate and beneficial.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect some wildlife in the vicinity of the confluence of Clear Creek and Yellowstone Lake. Weir construction and operation would take place in the vicinity of the stream channel and surrounding riparian areas. The weir would be operated and periodically attended from April through August. Because weir construction and operation would take place over a short period of time and affect a small area, there would negligible short-term adverse impacts to wildlife that use riparian area such as otter, black bear, beaver, muskrat, American dipper, and other migratory bird species because of temporary displacement.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries would be used to enhance YCT recruitment into the Yellowstone Lake population. Streamside incubators and reconnecting isolated tributaries may have limited impacts to wildlife. Because they may attract species due to curiosity or increased spawning, both of these proposed actions would cause some disturbance to streambeds and surrounding riparian areas. Impacts to wildlife species similar to those listed above in Alternative 2c would be affected by these proposed activities.

Indirect, long-term, moderately beneficial results would occur under this proposed action. As YCT numbers are anticipated to increase, wildlife that use this food source would also become more abundant.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes
Impacts to wildlife would occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions.

2f. Fish Barriers or Weir/Traps: Construction of fish barriers would affect wildlife in the immediate vicinity of barrier construction, which would be the stream channel and surrounding riparian areas. Wildlife that use riparian areas would most likely be affected by barrier construction, maintenance, and monitoring activities by being temporarily displaced. Completion of the barrier may alter local hydrology, causing water to pool and creating additional habitat for certain wildlife species. Impacts from this construction activity would be direct, short to long-term, minor adverse or beneficial to wildlife.

2g. Non-native Fish Removal: Chemical and mechanical methods to remove non-native fish would affect wildlife within the project watershed. Applied chemicals would affect waters being treated and downstream portions of the treatment area; mechanical removal would only affect waters in the immediate work area.

Chemical removal of fish would not directly affect wildlife in a project area because treatment concentrations of piscicides are below levels toxic to wildlife except for aquatic macroinvertebrates, fish, and larval amphibians (Appendix B). However, short-term indirect effects may occur when localized fish populations are removed and aquatic invertebrate or larval amphibian communities are reduced because the food source for some species would be reduced. Wildlife that depends on fish and aquatic invertebrate communities may be displaced until the stream has recovered. Piscivorous species such as river otter, bald eagles, and osprey would most likely be affected on larger streams; American dipper, a small, aquatic, insect-eating bird, may also be affected by chemical removal of fish and aquatic insects.

Chemical removal of fish, which would kill all fish present within the treatment area, is used when complete eradication is necessary to restore native fish populations. Mechanical removal is used to selectively remove undesirable fish species. Both methods would have some adverse affects on wildlife because the food source for some species would be reduced. Overall impacts from fish removal activities would be direct, short-term, and negligible minor adverse. Wildlife resources would benefit though when populations of native fishes are returned to park waters and when invertebrate and amphibian species repopulate treated streams.

Mitigation measures described in Chapter 2 (e.g., timing, relocating, and rearing individuals) would be taken to reduce the impacts chemical treatment would have on aquatic communities. Electrofishing and netting may affect some wildlife to a small degree. These removal efforts would require walking in stream channels and along lake shorelines. This would cause negligible or minor disturbance to some wildlife species, causing temporary displacement.

2h. Restocking Native Fish and Brood Source Development: As described for Alternative 1h.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis
Ongoing administrative activities such as lake patrol, hazing, wildlife monitoring, road construction, and facilities maintenance would continue to affect some wildlife resources. Noise from patrolling and other boating activities on Yellowstone Lake could have direct adverse disturbance impacts to wildlife species that utilize the lake and near shore habitats. These

impacts could range from minor disturbance to temporary movement of wildlife from feeding and nesting areas. Hazing efforts are carried out by park personnel to discourage wildlife (e.g. bears, wolves, and coyotes) from using developed areas or for moving bison back into the park during winter months. Some wildlife are permanently removed from the population if they become habituated to human food and pose a threat to human safety. Wildlife monitoring practices are used to document various demographics of wildlife populations in the park and may cause adverse impacts ranging from generalized disturbance to sedation and handling of the animals. Noise from road construction and facilities maintenance could disturb wildlife in localized areas. Impacts from these disturbances could range from no impact to movement away from the immediate area. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational use such as boating, angling, camping, and hiking would continue parkwide. Boating activities would contribute noise disturbance and could affect some wildlife by interfering with feeding and resting behavior. Angling occurs parkwide during the summer months and could contribute to generalized disturbance of all wildlife species that occur near streams and lakes. Camping and hiking occur throughout the park and could lead to generalized disturbance which could affect feeding and resting behavior. Camping activities risk habituation of bears and other carnivores to human foods which could lead to some individual animals being euthanized. Both ongoing administration activities and increased visitor use could lead to direct, short-term, negligible to minor adverse impacts to wildlife populations throughout the park. Alternative 1 would increase impacts to wildlife. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 2 Conclusion

Alternative 2 would have direct, short-term, negligible to minor adverse impacts to wildlife from the expansion of LKT removal on Yellowstone Lake and other operations on the lake; and indirect, long-term, moderately beneficial impacts from a successful LKT suppression program. Long-term use of the Clear Creek weir would result in direct, short- and long-term, negligible to minor adverse impacts.

In summary, Alternative 2 would have direct, short-term, negligible to minor adverse impacts to wildlife; increased populations of native fish in Yellowstone would have indirect, long-term, moderately beneficial impacts to piscivorous wildlife species such as grizzly bears, river otters, bald eagles, ospreys, white pelicans, and double-crested cormorants.

Alternative 2 would have direct, short-term, negligible to minor adverse impacts to wildlife resources from the removal of non-native fish using piscicides and other native fish conservation activities; and indirect, long-term, moderately beneficial impacts from successful preservation and restoration of native fish populations. Long-term use of in-stream fish barriers would result in direct, short- and long-term, negligible to minor adverse impacts.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 2 would have direct, short- and long-term, negligible to minor adverse impacts and indirect, long-term moderate beneficial impacts to piscivorous wildlife in the park.

4.3.3.3 Alternative 3: Impacts on Wildlife Resources

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2, except that Alternative 3 would result in the marketing of LKT by private sector contract netters. Marketing of fish would represent a short-term minor risk to wildlife through the increased traffic in the marina areas and the potential for LKT carcasses to attract wildlife, leading to human/wildlife conflicts. Mitigation measures described in Chapter 2 would be implemented to minimize the risk of wildlife exposure to fish carcasses. Otherwise, the direct and indirect impacts of Alternative 3 to wildlife resources would be identical to those described for Alternative 2 for all subtopics 2a-2i.

Cumulative Impact Analysis
As described for Alternative 2, when added to other past, present, and reasonably foreseeable future actions in the park. Alternative 3 would incrementally increase adverse impacts, but the overall impact level would have direct, short-term, negligible to minor adverse impacts to wildlife; increased populations of native fish in Yellowstone would have indirect, long-term, moderately beneficial impacts to piscivorous wildlife species such as grizzly bears, river otters, bald eagles, ospreys, white pelican, and double crested-cormorants. Alternative 3 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 3 Conclusion

Alternative 3 would have direct, short-term, negligible to minor adverse impacts to wildlife from the expansion of LKT removal on Yellowstone Lake and other operations on the lake; and indirect, long-term, moderately beneficial impacts from a successful LKT suppression program. Long-term use of the Clear Creek weir would result in direct, short- and long-term, negligible to minor adverse impacts.

In summary, Alternative 3 would have direct, short-term, negligible to minor adverse impacts to wildlife; increased populations of native fish in Yellowstone would have indirect, long-term, moderately beneficial impacts to piscivorous wildlife species such as grizzly bears, river otters, bald eagles, ospreys, white pelicans, and double-crested cormorants in the Yellowstone Lake watershed. Additional minor, short-term impacts from the marketing of LKT would occur during transport of fish, but mitigations in place would minimize these impacts.

Alternative 3 would have direct, short-term, negligible to minor adverse impacts to wildlife resources from the removal of non-native fish using piscicides and other native fish conservation activities; and indirect, long-term, moderately beneficial impacts from successful preservation and restoration of native fish populations. Long-term use of in-stream fish barriers would result in direct, short- and long-term, negligible to minor adverse impacts.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have direct and indirect, short- and long-term, negligible to minor adverse impacts and indirect, long-term moderate beneficial impacts to wildlife in the park.

4.3.3.4 Alternative 4: Impacts on Wildlife Resources

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing NPS crews, boats, and large nets. Clear Creek weir and fish barriers in streams would be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source. The direct and indirect impacts of Alternative 4 to wildlife would be identical to those described for Alternative 2, subtopic 2a (except that no private sector contract netters would be used), 2b–2e, and 2h–2i. No piscicides (2g) would be used and therefore no impacts would occur from them.

Cumulative Impact Analysis
As described for Alternative 2, when added to other past, present, and reasonably foreseeable future actions in the park. Alternative 4 would incrementally increase adverse impacts, but the overall impact level would have direct, short-term, negligible to minor adverse impacts to wildlife; most likely beneficial impacts to piscivorous wildlife species such as grizzly bears, river otters, bald eagles, ospreys, white pelican, and double crested-cormorants would be negligible in comparison to Alternatives 2 and 3. Alternative 4 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 4 Conclusion

As described for Alternative 1, there would be direct, short- and long-term, negligible to minor, adverse cumulative impacts to wildlife from a continuation of current LKT removal, long-term use of Clear Creek weir, and other activities on Yellowstone Lake.

As described for Alternative 1, there would be direct, short-term, and negligible to minor adverse cumulative impacts to wildlife from a continuation of current native fish conservation activities on streams, rivers, and lakes outside the Yellowstone Lake watershed. Because some YCT recruitment actions would occur under Alternative 4, indirect, long-term, moderate benefits would still occur..

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have indirect and direct, short-term, negligible to minor adverse impacts and indirect, long-term, moderate beneficial impacts to wildlife in the park.

4.3.4 Vegetation Resources

Guiding Regulations and Policies
Section 4.4 of the NPS Management Policies (2006) addresses biological resource management including general vegetation management. This policy states that the NPS is to maintain all plants native to park ecosystems. This is to be done by preserving native plant populations, restoring native plant populations when they have been extirpated in parks by past human-caused actions, and minimizing human impacts to native plant populations, communities, and ecosystems and the processes that sustain them.

Guidance for management of rare plants is found in NPS Management Policies Section 4.4.2.3 (Management of Threatened or Endangered Plants and Animals): "The National Park Service will inventory, monitor, and manage state and locally listed plant species of concern in a manner similar to its treatment of federally listed species to the greatest extent possible. In addition, the Service will inventory other native species that are of special management concern to parks (such as rare, declining, sensitive, or unique species and their habitats) and will manage them to maintain their natural distribution and abundance." Adverse impacts to rare plants would be avoided to the extent possible. Impacts that cannot be avoided would be minimized and if possible mitigated by seed collection and plant salvage from on-site or nearby suitable habitats prior to disturbance and re-established following project completion.

Methodology and Assumptions

Before each project is initiated, the immediate project area would be surveyed for sensitive and rare plant species, the park resource specialist would be consulted, and current literature reviewed. Individual surveys would evaluate and address potential for vegetation community introductions or promotion of non-native plant species.

Intensity Level Definitions

The thresholds of change for the intensity of an impact on vegetation are defined as follows:

Negligible: No rare plant species or uncommon plant communities would be affected. Individual native plants might be affected, but impacts would be localized, short-term, and of no consequence to the species.

Minor: Native vegetation would be affected, but impacts would occur in a relatively minor portion of the species' occurrence(s) within the park. Mitigation measures to offset adverse effects would be followed. Rare plants or uncommon plant communities could be present and individual plants could be affected, but proposed mitigation measures to avoid adverse impacts to the species or community would be effective.

Moderate: A sizable segment of native vegetation within the park would be affected, and proposed mitigation measures would be extensive. Rare plant species or uncommon plant communities could be affected, and proposed mitigation measures to offset adverse effects could be extensive.

Major: Effects on native vegetation within the park, potentially including rare plants or uncommon plant communities would be extensive and long-term. Proposed mitigation measures to offset the adverse effects would be extensive, and success of the mitigation measures would not be guaranteed.

Duration: Short-term effects would last only during the implementation of the project, including its mitigation and monitoring measures. Long-term effects would typically constitute a permanent impact.

4.3.4.1 Alternative 1 (No Action): Impacts on Vegetation

Impact Analysis

Yellowstone Lake

1a. Lake Trout Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. In 2009, approximately 330 km (205 miles) of nets were used to fish for LKT and these levels would be maintained. Since each net is left in the water for more than one day, this is equates to 1,600 km (994 miles) of net fished. Impacts to vegetation would occur under Alternative 1. Lake trout removal would be conducted using NPS crews, boats, and nets. Netting activities include net preparation, mending, and placement. Both net preparation and mending take place within developed paved areas of Lake Village and would not impact vegetation. Net placement usually takes place in deep water areas of Yellowstone Lake at depths between 15-65 meters, which encompasses approximately 50 percent of the lake area. The maximum amount of lakebed that would be disturbed by netting activities in 2009 is estimated at 0.33 km^2 (0.13 mi^2). However, most netting occurs in the West Thumb portion of Yellowstone Lake and areas are fished repeatedly making the actually total of lakebed disturbance much smaller. Most aquatic vegetation does not grow at these depths. Because of the small percentage of the lake being fished and because no rare or sensitive plants would be affected, LKT removal is expected to have direct, short-term, negligible adverse effects on aquatic and terrestrial vegetation within Yellowstone Lake.

During September and October, nets are set in shallow water areas of the lake to catch LKT as they move onto and from spawning grounds. Currently, nets cover less than 1 percent of the lake. Submerged aquatic vegetation is likely to be uprooted by LKT removal efforts as nets are pulled across the lake bottom. Because of the small percentage of shallow water areas impacted, LKT removal is expected to have direct, short-term, negligible adverse effects on aquatic vegetation within Yellowstone Lake.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats, and large nets. Monitoring would occur during the open water season, typically August and September, and take place near the lake's margin at depths between 5-50 meters. During any given year, less than 1 percent of the lakebed will be impacted by LKT and YCT monitoring activities. Submerged aquatic vegetation is likely to be uprooted by monitoring efforts as nets are pulled across the lake bottom. Because of the small percentage of lake and aquatic vegetation impacted, long-term monitoring of LKT and YCT is expected to have direct, short-term, negligible adverse effects on aquatic vegetation within Yellowstone Lake.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to vegetation would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to vegetation would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue and could potentially occur anywhere throughout the Yellowstone Lake basin. The techniques are yet undeveloped and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have negligible to minor

adverse impacts to vegetation. These techniques would not exceed the impacts to vegetation described in this document.

Other Streams, Rivers, and Lakes

1f. Fish Barriers: No action would be taken to construct fish barriers in streams. No impacts to vegetation would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Electrofishing activities would lead to minor trampling of some upland and wetland vegetation. This trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, and negligible to minor adverse impacts on vegetation.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. These activities involve walking within lake margins, stream channels and riparian areas which would cause minor trampling of vegetation. This trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, negligible to minor adverse impacts on vegetation.

1i. Inventory, Monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on stream and lakes other than Yellowstone Lake would continue. These include working in stream channels, lake margins, and other wetland areas. Most impacts would occur as NPS crews travel to and from collection sites and trample vegetation. This trampling could be minimized by avoiding the creation of social trails through vegetation. Because trampling could be minimized and will take place for short periods of time, it is expected these activities would lead to direct, short-term, negligible to minor adverse impacts on vegetation.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on vegetation in the park. Road maintenance activities would require disturbance and removal of soils and vegetation by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized removal of soil and vegetation, and overnight use of campsites and cabins that would lead to some vegetation trampling and development of social trails. Most facilities maintenance would take place in developed areas where minimal impacts to vegetation would occur. However adverse impacts to vegetation may become necessary because some plant material may be cleared and removed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to vegetation can be reduced by using multiple entries to prevent development of social trails and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will

likely place additional pressures on vegetation as more people hike and camp in Yellowstone. These activities trample vegetation and soils resulting in direct, short-term, negligible adverse impacts to vegetation. Alternative 1 would lead to further negligible to minor disturbance to vegetation. Coupled with these past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level on vegetation would remain negligible to minor.

Alternative 1 Conclusion

Continued LKT suppression efforts would likely have direct, short-term, negligible to minor adverse impacts to vegetation in the Yellowstone Lake watershed primarily due to trampling or disturbance of vegetation.

Fish restoration activities on streams, rivers, and lakes would impact vegetation. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. In summary, Alternative 1 would have direct, short-term, negligible to minor adverse impacts to vegetation outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct, short-term, negligible to minor adverse impacts on vegetation in the park.

4.3.4.2 Alternative 2: Impacts on Vegetation

Impact Analysis
Impacts to vegetation communities would occur under Alternative 2 from the potential actions associated with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients. Proposed actions may include measures to assist native fish populations by modification or construction of fish barriers, removing sand bars to reconnect isolated tributary streams on Yellowstone Lake, and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
2a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake in addition to using private sector contract netters. This alternative proposes to increase the amount of netting on Yellowstone Lake to at least 7,800 km (4,846 miles) of net fished each season (more than three times that of current levels) and adding eight or more large trapnets. Impacts to vegetation would occur under Alternative 2. Netting activities include net preparation, mending, and placement. Both net preparation and mending take place in developed paved areas of Lake Village and would not have an impact to vegetation. Lake trout removal efforts by NPS crews and by private sector contract netters will usually take place in deep water areas of Yellowstone Lake at depths between 15-65 meters which encompasses approximately 50 percent of the lake bed. Because most aquatic vegetation does not grow at these depths, LKT removal efforts is expected to have direct, short-term, negligible adverse effects on aquatic vegetation within Yellowstone Lake.

During September and October, nets are set in shallow water areas of the lake to catch LKT as they move onto and from spawning grounds. Currently, nets are placed at 9 known or suspected spawning areas which cover less than 1 percent of the lake surface. New spawning areas discovered in the future will add to this total but is not expected to exceed 1 percent. Netting in LKT spawning areas are likely to uproot aquatic vegetation as nets are pulled across the lake bottom. Because of the small percentage of shallow water areas impacted, LKT removal is expected to have direct, short-term, minor adverse effects on aquatic vegetation within Yellowstone Lake.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Under this alternative a new structure would be constructed on the same site as the old weir using some of the remaining structure (bulkheads) from the previous weir. The weir would be constructed mostly of unnatural materials including concrete blocks, cement, steel, and iron. The design would be structurally capable to withstand high spring flows with as little impact to stream hydrology as possible. Less than 1,011 m^2 (0.25 acres) of vegetation would be disturbed or removed for construction purposes. Disturbed areas would promote the introduction of non-native, invasive plants. Additionally, weir maintenance and operation could seasonally inundate wetland, riparian, and upland vegetation upstream of the weir. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures and interdisciplinary collaboration to minimize hydrologic changes) would be implemented, weir construction and operation would have direct, short- and long-term, minor adverse impacts to vegetation.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would cause localized trampling of vegetation and reconnecting isolated tributaries would involve moving and placement of sand and gravel material on adjacent, non-vegetated shoreline. Prior to removing sandbars to reconnect tributary streams, areas would be surveyed for plant species by vegetation specialist. If plant species of special concern (e.g. Yellowstone sand verbena) are found and impacts could not be mitigated, the tributary would be removed from further consideration for enhancement of YCT spawning areas. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures and interdisciplinary collaboration to minimize hydrologic changes) would be implemented, impacts from enhancing YCT recruitment would be direct, short- and long-term, minor and adverse to vegetation.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes

2f. Fish Barriers or Weirs/Traps: Barrier modification and construction would most likely have the greatest effect on vegetation of all the potential actions listed under Alternative 2. While most streams will not require barrier construction because natural barriers exist, the few would require modification of natural features or barrier construction. Examples of modifying existing water features that serve as partial barriers include: redirecting stream flow using wing walls, filling plunge pools with material to eliminate jumping areas, using explosive to increase the height or angle of a feature, or some combination of the above. Complete construction of a fish barrier where no other feasible natural feature exists, may be necessary on some streams. Fish barriers, if required, would be constructed from nearby native logs, and rocks, non-natural

rebar, wire mesh, and cement. For each project less than 1,011 m^2 (0.25 acres) of vegetation would be disturbed or removed for construction purposes. Disturbed areas would promote the introduction of non-native, invasive plants. Fish barriers would slightly alter steam hydrology and inundate wetland, riparian, and upland vegetation upstream of the weir not to exceed 1,011 m^2 (0.25 acres). Because mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures and interdisciplinary collaboration to minimize hydrologic changes) would be implemented, barrier construction and maintenance would have direct, short- and long-term, negligible to minor adverse impacts to vegetation.

2g. Non-native Fish Removal: Chemical (piscicides) and mechanical (e.g. angling, electrofishing, trapping and netting) removal of fish would lead to impacts to vegetation. During years chemical treatment occurs, a milky-white and purple color would be visible on treated waters for an estimated 10 days from the use of the proposed piscicides and neutralization agent. in a stream environment piscicide would be applied via metered application stations at multiple points along the stream. Potassium permanganate ($KMnO_4$) would be applied at 2.5% solution to chemically-treated waters at concentrations of 3 ppm and would dye the water purple. Reduced light penetration from $KMnO_4$ applications could reduce photosynthesis in aquatic vegetation; however, impacts would be negligible since application takes place over a relatively short period of time (and 2-3 days for streams). During fish removal efforts, vegetation would be trampled or disturbed from motorized boats, walking/wading along shorelines and riparian areas, accessing application stations, angling, electrofishing, and net deployment and retrieval. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures, and avoiding development of social trails) would be implemented, chemical and mechanical removal of fish would have direct, short-term, negligible to minor adverse impacts to vegetation.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters would be used to bring genetically pure native fish to the project waters. The addition of pack stock increases potential for trampling vegetation and introducing non-native species into disturbed areas. Because mitigation measures described in Chapter 2 (ensuring surveys be completed, revegetation of disturbed areas, implementation of weed control measures, and avoiding development of social trails) would be implemented, restocking native fish and brood source development would have direct, short-term, minor adverse impact on vegetation in localized areas.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reductions projects (as described under cumulative impacts) would continue to have adverse effects on vegetation in the park. Road maintenance activities would require disturbance and removal of soils and vegetation by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized removal of soil and vegetation, and overnight use of campsites and cabins that would lead to some vegetation trampling and development of social trails. Most facilities maintenance would take place in developed areas where minimal impacts to vegetation would occur. However adverse impacts to vegetation may become necessary because some plant material may be cleared and removed for general

operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to vegetation can be reduced by using multiple entries to prevent development of social trails and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on vegetation as more people hike and camp in Yellowstone. These activities trample vegetation and soils resulting in direct, short-term, negligible adverse impacts to vegetation. Alternative 2 would lead to further negligible to minor disturbance to vegetation. Coupled with these past, present and foreseeable future actions, Alternative 2 would incrementally increase adverse impacts, but the overall impact level on vegetation would remain negligible to minor due to mitigation measures that would be implemented.

Alternative 2 Conclusion

Alternative 2 would have direct, short-term, negligible to minor adverse impacts to vegetation from gillnetting activities. Long-term use of the Clear Creek weir and reconnecting Yellowstone Lake tributaries would result in direct, short- and long-term, negligible to minor adverse impacts. In summary, Alternative 2 would lead to direct, short-and long-term negligible to minor adverse impacts to vegetation in the Yellowstone Lake watershed.

Alternative 2 would have direct, short- and long-term, negligible to minor adverse impacts to vegetation from use of natural barrier features, barrier modification, and barrier construction and maintenance. Alternative 2 would have direct, short-term, negligible to minor adverse impacts to vegetation from the removal of non-native fish using piscicides and other native fish conservation activities, restocking native fish and brood source development, and research and monitoring activities. In summary, Alternative 2 would have direct, short-and long-term, negligible to minor adverse impacts to vegetation outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 2 would have direct, short- and long-term, negligible to minor adverse impacts on vegetation in the park.

4.3.4.3 Alternative 3: Impacts on Vegetation

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would result in the marketing of LKT by private sector contract netters. The direct and indirect impacts of Alternative 3 to vegetation would be identical to those described for Alternative 2, for all subtopics 2a-2i.

Cumulative Impact Analysis
Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reductions projects (as described under cumulative impacts) would continue to have adverse effects on vegetation in the park. Road maintenance activities would require disturbance and removal of soils and vegetation by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized removal of soil and vegetation, and overnight use of campsites and cabins that would lead to some vegetation trampling and development of social trails. Most facilities maintenance would take place in developed areas

where minimal impacts to vegetation would occur. However adverse impacts to vegetation may become necessary because some plant material may be cleared and removed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to vegetation can be reduced by using multiple entries to prevent development of social trails and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on vegetation as more people hike and camp in Yellowstone.

These activities trample vegetation and soils resulting in direct, short-term, negligible adverse impacts to vegetation. Alternative 3 would lead to further negligible to minor disturbance to vegetation. Coupled with these past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, but the overall impact level on vegetation would remain negligible to minor due to mitigation measures that would be implemented.

Alternative 3 Conclusion

Alternative 3 would have direct, short-term, negligible to minor adverse impacts to vegetation from gillnetting activities. The additional marketing of LKT would not add to impacts to vegetation in Yellowstone. Long-term use of the Clear Creek weir and reconnecting Yellowstone Lake tributaries would result in direct, short- and long-term, negligible to minor adverse impacts. In summary, Alternative 3 would lead to direct, short- and long-term, negligible to minor adverse impacts to vegetation in the Yellowstone Lake watershed.

Alternative 3 would have direct, short- and long-term, negligible to minor adverse impacts to vegetation from use of natural barrier features, barrier modification, and barrier construction and maintenance. Alternative 3 would have direct, short-term, negligible to minor adverse impacts to vegetation from the removal of non-native fish using piscicides and other native fish conservation activities, restocking native fish and brood source development, and research and monitoring activities. In summary, Alternative 3 would lead to direct, short- and long-term, negligible to minor adverse impacts to vegetation outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 3 would have direct, short- and long-term, negligible to minor adverse impacts on vegetation in the park.

4.3.4.4 Alternative 4: Impacts on Vegetation

Impact Analysis

Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and large nets. The Clear Creek weir and fish barriers in streams would be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, fish removal using angling, electrofishing and nets, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing native fish brood source. The direct and indirect impacts

of Alternative 4 to vegetation would be similar or slightly less than those described for Alternative 2, subtopic 2a (except that no private sector contract netters would be used), 2b–2f, and 2h–2i because less vegetation will be impacted. Impacts would remain within the ranges given in Alternative 2 though.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reductions projects (as described under cumulative impacts) would continue to have adverse effects on vegetation in the park. Road maintenance activities would require disturbance and removal of soils and vegetation by heavy equipment operation. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized removal of soil and vegetation, and overnight use of campsites and cabins that would lead to some vegetation trampling and development of social trails. Most facilities maintenance would take place in developed areas where minimal impacts to vegetation would occur. However adverse impacts to vegetation may become necessary because some plant material may be cleared and removed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Impacts to vegetation can be reduced by using multiple entries to prevent development of social trails and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on vegetation as more people hike and camp in Yellowstone.

These activities trample vegetation and soils resulting in direct, short-term, negligible adverse impacts to vegetation. Alternative 4 would lead to further negligible to minor disturbance to vegetation. Coupled with these past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, but the overall impact level on vegetation would remain negligible to minor due to mitigation measures that would be implemented.

Alternative 4 Conclusion

Alternative 4, as described for Alternative 1 subtopic 1a-1b, continued LKT suppression and monitoring efforts using existing NPS crews would likely have direct, short-term, negligible to minor adverse impacts to vegetation. Alternative 4, as described for Alternative 2 subtopic 2c-2e, rebuild and use of the Clear Creek weir and reconnecting Yellowstone Lake tributaries would result in direct, short- and long-term, negligible to minor adverse impacts to vegetation. In summary, Alternative 4 would lead to direct, short- and long-term, negligible to minor adverse impacts on vegetation in the Yellowstone Lake watershed.

Alternative 4, as described for Alternative 2 subtopic 2f, would have direct, short- and long-term, negligible to minor adverse impacts to vegetation from use of natural barrier features, barrier modification, and barrier construction and maintenance. Alternative 4, as described for Alternative 2 subtopic 2g-2i with the exception of chemical application, would have direct, short-term, negligible to minor adverse impacts to vegetation from the removal of non-native fish using mechanical means, restocking native fish and brood source development, and research and monitoring activities. In summary, Alternative 4 would lead to direct, short- and long-term, negligible to minor adverse impacts on vegetation outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have direct, short- and long-term, negligible to minor adverse impacts on vegetation in the park.

4.4 Special Status Species

Guiding Principles and Policies
Protective measures for threatened and endangered species are provided pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). Section 7(c) of the Endangered Species Act of 1973, as amended, is required for any federal action that is a major construction activity in order to determine the effects of the proposed action on listed and proposed species. The lead federal agency is responsible for review of proposed activities to determine whether listed species would be affected. If the proposed activities may affect a listed species, then the federal agencies should contact the U.S. Fish and Wildlife Service to discuss consultation requirements. If the federal agency determines the program or project "may affect, is likely to adversely affect" any listed species, then formal consultation should be initiated with the U. S. Fish and Wildlife Service. Alternatively, informal consultation can be continued so that the U.S. Fish and Wildlife Service can assist with determining how the project could be modified to reduce impacts to listed species to the "may affect, not likely to adversely affect" threshold. If it is concluded that the project "may affect, not likely to adversely affect" listed species, the federal agency should request that the U.S. Fish and Wildlife Service review the assessment and concur with the determination of "may affect, not likely to adversely affect."

Methodology and Assumptions
Impacts to Yellowstone Species of Special Management Concern, USFWS Threatened and Endangered Species, Candidate Species, and informal list of Species of Concern were analyzed based on scientific literature and the knowledge of NPS and other resource specialists.

Intensity Level Definitions
The impact intensities for special status species are as follows:

Negligible: Special status species would not be affected or the effects would be at or below the level of detection, would be short-term, and the changes would be so slight that they would not be of any measurable or perceptible consequence to the species' population.

Minor: Effects to special status species would be detectable, although the effects would be localized, and would be small and of little consequence to the species' population. Mitigation measures, if needed to offset adverse effects, would be simple and successful.

Moderate: Effects to special status species would be readily detectable, long-term and localized, with consequences at the population level. Mitigation measures needed to offset adverse effects would be followed and likely successful.

Major: Effects to special status species would be obvious, long-term, and would have substantial consequences to the species' population in the region. Mitigation measures would be needed to offset adverse effects would be extensive and success would not be guaranteed.

Duration: Short-term effects would last only during the implementation of the project, including mitigation and monitoring measures. Long-term effects would constitute a permanent impact.

4.4.1.1 Alternative 1 (No Action): Impacts on Special Status Species

Impact Analysis
Several current NPS activities could affect special status species under Alternative 1, each of which could have a different effect on various species in this category. The special status species, which are described in Chapter 3, Affected Environment, include aquatic invertebrates, fish, amphibians, birds, and mammals.

Yellowstone Lake
1a. Large-scale Lake Trout Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Existing NPS LKT suppression efforts use gillnets to target and remove LKT from Yellowstone Lake. Non-native fish carcasses would be returned to park waters to retain nutrients, which is not likely to affect any special status species. Gillnet preparation and mending take place in developed paved areas of Lake Village and would not impact special status species. Use of motorized boats on Yellowstone Lake could disturb some special status species that use near shore and open water habitats by temporarily displacing these species when in the vicinity. None of the mammal species listed as special status species would be affected by gillnet activity; for example, the current level of gill netting is not expected to increase spawning rates in the Yellowstone Lake watershed, therefore there would be no effect on the grizzly bear.

Over the past five years an average of 4,783 YCT per year were captured during gillnetting operations. Of these, 44% were returned to the lake alive; however, some additional mortality likely occurs following release. During the past 10 years some diving birds such as the double-crested cormorant, western grebe, and common loon have been entangled in NPS gillnets and drowned (about two birds each year on average). The gillnets are typically set deep (15-65 meters) in areas where the greatest catch of LKT occurs and the by-catch of non-target species is minimized. Most birds killed in gillnets are caught during LKT spawning when nets are set in shallow areas. Amphibian and plant species would not be affected by LKT gillnetting activities. Therefore, impacts would be negligible to minor and adverse for special status species. Because this action is expected to only continue to slow the expansion of the LKT population in Yellowstone Lake, impacts would be direct, short-term, negligible and beneficial, but direct, long-term, moderate adverse to the YCT population.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, boats, and large nets, and would occur during the open water season, usually August and September. Gillnet preparation and mending take place in developed paved areas of Lake Village and would not affect special status species. Use of motorized boats on Yellowstone Lake could disturb special status species that use shoreline and open water habitats. Some gillnets used to monitor LKT and YCT populations would be set in shallow areas of the lake and would have similar negligible to minor impacts to some special status species including YCT as stated in 1a. During the past 10 years special status species such as common loons, grebes, and cormorants have been entangled in NPS gillnets and killed during fish monitoring activities, less than one bird per year on average. Amphibian and plant species would not be affected by LKT and YCT monitoring efforts. In

2010, monitoring LKT and YCT resulted in the capture and mortality of 798 YCT. Because this action only takes place a few weeks out of the year, impacts would be direct, short-term, minor adverse to the YCT population in Yellowstone Lake.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to special status species would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to special status species would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue and could potentially occur anywhere throughout the Yellowstone Lake basin. The techniques are yet undeveloped and impacts cannot be evaluated at this time. However, it is expected that some of these techniques may have adverse impacts to special status species in the Yellowstone Lake basin. Any potential impact on special status species would be evaluated on a case-by-case basis. These new techniques would not exceed the impacts to any special status species described in this document.

Other Streams, Rivers, and Lakes
Most streams, rivers, and lakes where actions would occur could impact special status species.

1f. Fish Barriers: No action would be taken to construct fish barriers in streams. No impacts to special status species would occur with the exception of YCT, WCT, and GRY. In areas where non-native species are encroaching on native species habitat, increasing potential competition and hybridization, a long-term, moderate adverse effects would occur from not implementing these actions.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue; these fish will be removed from the site. Negligible impacts could occur from disturbance to special status species such as YCT, Columbia spotted frog (due to electroshock), bald eagle, and grizzly bear (due to temporary displacement while removal activities are occurring).

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes from current sources of WCT to support brood stock development for programs in Montana and Wyoming would continue. Gamete collection locations are along stream corridors and would have negligible to minor impacts to the same special status species as in subtopic 1g. Direct, negligible, short term effects would occur to WCT because of the capture, handling, and collection of gametes from WCT individuals. However, close population monitoring and careful adherence to appropriate collection methods would occur to ensure collections would remain below levels sufficient to exceed negligible effects.

1i. Inventory, Monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on streams and lakes other than Yellowstone Lake would continue. These efforts are low impact and focus on evaluating water quality, plankton, aquatic invertebrates, and amphibian species. Impacts to special status species would be negligible to minor, with most impacts occurring as crews travel to and from sample locations and affecting the same special status species as in subtopic 1g and also WCT.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, hazing activities, and facilities maintenance would continue to have adverse effects on special status species in the park. Road reconstruction and maintenance and backcountry operations include the use of heavy equipment, horse and boat patrols, and trail maintenance. These would cause temporary displacement of special status species from generalized disturbance; feeding and resting behavior of wildlife species may be interrupted and some special status plant species may be adversely impacted from equipment working in construction areas. Use of trails, waters (boat patrol), and backcountry campsites and cabins could also temporarily displace or disrupt special status species. Effects from these activities would be direct, short-term, and negligible because of the short duration of the activity. Hazing activities usually take place near developed areas where wildlife has become habituated to the presence of humans. The grizzly bear and wolf are the two species most likely affected by hazing activities. Most facilities maintenance would take place in developed areas where minimal impacts to special status species would occur. However adverse impacts to some species may occur because they are disturbed by noise and people associated with maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational use such as angling, camping, and hiking would continue parkwide. These activities could lead to negligible to minor adverse impacts because special status species can become disturbed from human activity. Alternative 1 would increase impacts to special status species. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor.

Alternative 1 Conclusion

Alternative 1 would result in direct, short-term, and negligible to minor adverse impacts to special status species from continuation of current native fish management practices, with the exception of YCT. YCT may experience some direct, short-term, negligible benefits, but the expected continued expansion of the LKT population within Yellowstone Lake under this alternative would lead to direct, long-term, moderate adverse impacts to the YCT population. In summary, Alternative 1 would lead to direct, short-term, negligible to minor adverse impacts to special status species except for YCT in the Yellowstone Lake watershed. Under Alternative 1, YCT would experience some direct, short-term negligible beneficial impacts, but in the long term would experience direct, moderate adverse impacts because this action is expected to only to slow the expansion of LKT.

Alternative 1 would result in direct, short-term, negligible to minor adverse impacts to special status species from continuation of current native fish management practices, with the exception of WCT and YCT. The continued expansion of non-native fish species population within Yellowstone National Park, with the associated increase or continuance of competition and hybridization with native species expected under this alternative would lead to direct and indirect, long-term, moderate adverse impacts to both YCT and WCT. In summary, Alternative 1 would lead to direct, short-term, negligible to minor adverse impacts to special status species along with direct and indirect, long-term, moderate adverse impacts to both YCT and WCT outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 1 would have direct and indirect, short- and long-term, negligible to minor adverse impacts to

special status species, short-term negligible beneficial impacts to YCT and indirect, long-term, moderate adverse impacts to YCT.

4.4.1.2 Alternative 2: Impacts on Special Status Species

Impact Analysis
Impacts to special status species would occur under Alternative 2 with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients and improve program efficiency. Proposed actions may include measures to assist native fish populations by barrier construction, reconnecting disjunct stream segments and supplemental augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Impacts to special status species would occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions. Several actions are proposed under this alternative, each of which could have a different effect on special status species in the park.

2a. Large-scale Lake Trout Removal: Existing NPS LKT suppression efforts would be supplemented by private sector contract netters and total netting effort could increase up to three-fold. In 2009, NPS continued LKT suppression efforts and private-sector contract gillnetters were used for a three-week period during the early part of the field season. During 2009 more than 100,000 LKT were killed and carcasses were returned to Yellowstone Lake. The number of LKT killed each year would be expected to increase up to 250,000 annually under proposed actions listed in Alternative 2. These carcasses would continue to be returned to the lake to maintain program efficiency and retain the nutrients within the lake and is expected to cause no impacts to special status species. Increased use of motorized boats on Yellowstone Lake would disturb special status species that use shoreline and open water areas. Because of the increased potential for entrapment in nets and disturbance by motorized boats, gillnet activities would have a direct, minor to moderate and adverse effect on special status bird species. Incidental by-catch of YCT, as described under Alternative 1, subtopic 1a, would continue. Potential increases would be offset by mitigation measures described in Chapter 2 (avoidance of areas with high YCT by-catch, proper handling and release of live YCT, frequency of checking nets, etc.) and resultant recovery of the YCT population within the lake.

The recovery of YCT to the tributary streams of Yellowstone Lake would provide a long-term moderately beneficial impact on grizzly bears as YCT would again become an available food source. However, in and near developed areas, the return of YCT could increase the incidence of human/bear conflicts and could precipitate a long-term, negligible to minor adverse impact on grizzly bears in these areas. In order to mitigate this effect, mitigation measures listed in Chapter 2 will ensure that NPS can reach a ‘may affect, not likely to adversely affect” determination in consultation with the FWS.

2b. Monitoring of LKT and YCT: As described for Alternative 1, subtopic 1b.

2c. Clear Creek Weir: Rebuilding of the weir would affect some special status species in the vicinity of the confluence of Clear Creek and Yellowstone Lake. Weir construction and

operation would take place in the vicinity of the stream channel and surrounding riparian areas. The weir would be operated and periodically attended from April through August. These activities would temporarily displace special status species. Impacts would be adverse, short-term, and negligible to minor to special status species such as grizzly bear, white pelican, osprey, and bald eagle, which occasionally feed in the area.

2d. Enhancing YCT Recruitment: Streamside incubators, which, would be used to enhance YCT recruitment into the Yellowstone Lake population, would have negligible to minor adverse impacts to special status species because of temporary displacement of these species during placement and monitoring activities. Species similar to those listed in above in subtopic 2c, would be affected by these proposed actions.

Reconnecting isolated tributaries would increase the potential for juvenile YCT which have become stranded during low flows, to emigrate into the lake. This action would have negligible to minor adverse impacts to special status species by causing temporary displacement of these species during reconnection activities (relocation of sand and gravel from the tributary mouth to nearby locations). Species similar to those listed above in subtopic 2c, would be affected by these proposed actions.

The rare plant, Yellowstone sand verbena, can occur in areas with tributary actions would take place. Prior to removing sandbars to reconnect tributary streams, areas would be surveyed for plant species by vegetation specialist. If the Yellowstone sand verbena would be found and impacts could not be mitigated, the tributary would be removed from further consideration for enhancement of YCT spawning areas. This action would not be undertaken in the developed areas.

2e. New and Experimental Techniques: As described for Alternative 1, subtopic 1e.

Other Streams, Rivers, and Lakes
Impacts to special status species would occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions. Several potential actions are being proposed under this alternative, each of which could have a different effect on special status species in the park.

2f. Fish Barriers or Weir/Traps: Construction of fish barriers would affect special status species in the immediate vicinity of barrier construction. Special status species that use riparian areas would most likely be temporarily displaced by barrier construction, maintenance, and monitoring activities. Completion of the barrier would negligibly alter local hydrology, causing a minor amount of water (< 0.25 acres) to pool Possibly fish (WCT or YCT) would congregate below the barrier or weir during springtime spawning migrations, increasing their vulnerability to predation. In the case of a barrier, fish below the barrier would be purposefully excluded from the upstream area in order to protect the native species upstream. A weir/trap combination would slow or temporarily stop the progress of migrating fish, including YCT and WCT. However, operation of the facility would be such that fish would be allowed to migrate regularly (daily during peak migration periods; semi-weekly during periods outside of peak migrations or when numbers are low). Impacts during the construction phase of this activity would be direct, short-term and negligible to minor for special status species which use the area. Impacts during the operation phase of this activity would be long-term, minor adverse in the case of delaying migration for either WCT or YCT. They would be long-term, minor beneficial to YCT or WCT in instances where the operation reduces non-native fish species access to important spawning or other habitat areas of native fish species

2g. Non-native Fish Removal: Chemical and mechanical methods to remove non-native fish would affect special status species within the project watershed. Applied chemicals would affect the treatment area and downstream reaches of the stream. Chemical removal, which would kill all fish present within the treatment area, is used when complete eradication is necessary. Individual YCT or WCT could be killed, but only when they are part of a hybridized population which has been selected for removal, thus having no affect on either YCT or WCT at the population level. Special status species, such as grizzly bear or otter, could be temporarily displaced when localized fish populations are removed and aquatic invertebrate communities are reduced. Piscicide application would likely cause direct mortality to juvenile Alexander's Rhyacophilan caddisfly and larval Columbia spotted frogs. Mitigation measures such as timing of application (treatments would not occur during juvenile or larval stages of these species) to minimize these effects. Other species of special concern would not be directly affected by piscicide application because treatment concentrations are lower than toxic levels (Appendix B). Electrofishing or netting is used to selectively remove undesirable fish species and would only affect waters in the immediate work area. Electrofishing and netting may affect some wildlife to a small degree by temporarily displacing them from the project area because these removal efforts would require walking in stream channels and along lake shorelines. Overall impacts to special status species from fish removal activities would be direct, negligible to minor and adverse. This level is possible for the Rhyacophilan caddisfly and larval Columbia spotted frogs, because mitigation measures (e.g., timing of treatment, relocating and rearing individuals) would be taken to minimize the impacts that chemical treatment would have on aquatic communities.

2h. Restocking Native Fish and Brood Source Development: As described for Alternative 1h.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, hazing activities, and facilities maintenance would continue to have adverse affects on special status species in the park. Road activities and backcountry operations could cause temporary displacement of special status species through generalized disturbance; feeding and resting behavior of special status species may be interrupted and some special status plant species may be adversely impacted from equipment working in construction areas. Hazing activities usually take place near developed areas where special status species has become habituated to the presence of humans. The grizzly bear and wolf are the two species most likely affected by hazing activities. Most facilities maintenance would take place in developed areas where minimal impacts to special status species would occur. However adverse impacts to some species may occur because they are disturbed by noise and people associated with maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational use such as angling, camping, and hiking would continue parkwide. These activities could lead to negligible adverse impacts because special status species could be disturbed or temporarily displaced, especially in high use areas. Alternative 2 would increase impacts to special status species. Coupled with past, present and foreseeable future actions, Alternative 2 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor due to mitigation measures that would be followed.

Alternative 2 Conclusion

Alternative 2 would have direct, short-term, negligible to moderate adverse and moderate long-term beneficial impacts to special status species from the LKT removal efforts and other operations on Yellowstone Lake. Long-term use of the Clear Creek weir would result in direct, long-term, negligible to minor adverse impacts. Impacts to Yellowstone sand verbena would be avoided; tributaries with this species would not be treated. In summary, Alternative 2 would lead to direct, short- and long-term negligible to minor adverse and indirect, moderate long-term beneficial impacts to special status species in the Yellowstone Lake watershed.

Alternative 2 would have direct and indirect, short-term, negligible to moderate adverse impacts to special status species from the piscicide application and other native fish conservation activities. Long-term use of fish barriers would result in direct, long-term, negligible to minor adverse impacts. In summary, Alternative 2 would have direct and indirect, short-term, negligible to minor adverse impacts to special status species outside the Yellowstone Lake watershed.

In conclusion, increased populations of native fish in Yellowstone National Park would have indirect, long-term, moderately beneficial impacts to some special status species such as grizzly bear, bald eagles, osprey, and white pelican and direct, long-term, moderately beneficial impacts to YCT and WCT. However, the return of YCT could also increase the incidence of human/bear conflicts and could precipitate a long-term, minor adverse impact on grizzly bears in these areas. In order to mitigate this minor adverse effect, mitigation measures listed in Chapter 2 will be used to reduce bear-human interactions, conflicts, and confrontations so that management removals of grizzly bears are not necessary and therefore NPS can reach a 'may affect, not likely to adversely affect" determination in consultation with the FWS. When added to other past, present, and reasonably foreseeable future actions in the park, there would be direct and indirect, short- and long-term, moderate and adverse impacts, as well as indirect, long-term, moderately beneficial impact to special status species.

4.4.1.3 Alternative 3: Impacts on Special Status Species

Impact Analysis

Proposed actions under Alternative 3 are identical to Alternative 2, except that Alternative 3 would result in the marketing of LKT by private sector contract netters. Marketing of fish would represent a short-term minor risk to special status species through the increased traffic in marina areas and the potential for LKT carcasses to attract wildlife during transition between boats, temporary storage facilities, and trucks leading to increased human/wildlife conflicts. Otherwise, the direct and indirect impacts of Alternative 3 to special status species would be identical to those described for Alternative 2 for all subtopics 2a-2i. To avoid risk of food attractant to special status species such as grizzly bear, fish handling, storage, and transfer facilities would be cleaned with each use. In order to mitigate this minor adverse effect, mitigation measures listed in Chapter 2 will be used to reduce bear-human interactions, conflicts, and confrontations so that management removals of grizzly bears are not necessary and therefore NPS can reach a 'may affect, not likely to adversely affect" determination in consultation with the FWS.

Cumulative Impact Analysis

Alternative 3 would increase impacts to special status species. Coupled with past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, but the

overall impact level would remain at negligible to minor due to mitigation measures that would be followed.

Alternative 3 Conclusion

Impacts to special status species for Alternative 3 in the Yellowstone Lake watershed would be similar to Alternative 2 with the addition of impacts from marketing LKT.

Impacts to special status species for Alternative 3 outside the Yellowstone Lake watershed would be the same as those listed for Alternative 2.

In conclusion, increased populations of native fish in Yellowstone National Park would have indirect, long-term, minor to moderately beneficial impacts to some special status species, such as grizzly bear, bald eagle, osprey, and white pelican and direct, long-term, moderately beneficial impacts to YCT and WCT. However, the return of YCT to developed areas could also increase the incidence of human/bear conflicts and could precipitate a long-term, minor adverse impact on grizzly bears in these areas. In order to mitigate this minor adverse effect, mitigation measures listed in Chapter 2 will be used to reduce bear-human interactions, conflicts, and confrontations so that management removals of grizzly bears are not necessary and therefore NPS can reach a 'may affect, not likely to adversely affect" determination in consultation with the FWS. When added to other past, present, and reasonably foreseeable future actions in the park, there would be direct and indirect, short- and long-term, moderate and adverse impacts, as well as indirect, long-term, moderately beneficial impact to special status species.

4.4.1.4 Alternative 4: Impacts on Special Status Species

Impact Analysis

Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and large nets. The Clear Creek weir and fish barriers in streams would not be constructed. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

The direct and indirect impacts of Alternative 4 to special status species would be identical to those described for Alternative 1, subtopics 1a-1c and 1f and Alternative 2, subtopics 2d, 2e, 2h, and 2i. No piscicides (2g) would be used and therefore no impacts would occur from their use. However, all other removal methods discussed in subtopic 2g would be the same. Impacts to bird species would be negligible to minor and adverse because of the limited potential for entanglement in gillnets. No mammalian special status species would be affected by this limited level of activity; for example, the current level of gill netting is not expected to increase spawning rates in the Yellowstone Lake watershed, therefore there would be no effect on the grizzly bear. Recovery of YCT in Yellowstone Lake would not be expected to occur. Complete eradication of hybridized or non-native species within selected segments of targeted watersheds would not be likely to occur. Therefore, the expected continued expansion of non-native fish species population within Yellowstone National Park, with the associated increase or

continuance of competition and hybridization with native species, would lead to direct and indirect, long-term, moderately adverse impacts to both YCT and WCT.

Cumulative Impact Analysis

As described for Alternatives 1 and 2, ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, hazing activities, and facilities maintenance would continue to have adverse effects on special status species in the park. Road reconstruction and maintenance and backcountry operations include the use of heavy equipment, horse and boat patrols, and trail maintenance. These would cause temporary displacement of special status species from generalized disturbance; feeding and resting behavior of wildlife species may be interrupted and some special status plant species may be adversely impacted from equipment working in construction areas. Use of trails, waters (boat patrol), and backcountry campsites and cabins could also temporarily displace or disrupt special status species. Effects from these activities would be direct, short-term, and negligible because of the short duration of the activity. Hazing activities usually take place near developed areas where wildlife has become habituated to the presence of humans. The grizzly bear and wolf are the two species most likely affected by hazing activities. Most facilities maintenance would take place in developed areas where minimal impacts to special status species would occur. However adverse impacts to some species may occur because they are disturbed from noise and people associated with maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Past and ongoing recreational use such as angling, camping, and hiking would continue parkwide. These activities could lead to negligible to minor adverse impacts because special status species can become disturbed from human activity. Alternative 4 would increase impacts to special status species. Coupled with past, present and foreseeable future actions, Alternative 4 would incrementally increase adverse impacts, but the overall impact level would remain at negligible to minor due to mitigation measures that would be followed.

Alternative 4 Conclusion

Alternative 4 would result in direct, short-term, and negligible to minor adverse impacts to special status species from continuation of current native fish management practices, with the exception of YCT. The expected continued expansion of the LKT population within Yellowstone Lake under this alternative would be direct, long-term, moderate adverse and direct, short-term, negligible beneficial to the YCT population. In summary, Alternative 4 would lead to direct, short-term, negligible to minor adverse impacts to special status species except for YCT in the Yellowstone Lake watershed. Under Alternative 4, YCT would experience some direct, short-term negligible beneficial impacts, but in the long term would experience direct, moderate adverse impacts because this action is expected only to slow the expansion of LKT.

Alternative 4 would result in direct, short-term, negligible to minor adverse impacts to special status species from continuation of current native fish management practices, with the exception of WCT and YCT. The continued expansion of non-native fish species population within Yellowstone National Park, with the associated increase or continuance of competition and hybridization with native species expected under this alternative would lead to direct and indirect, long-term, moderate adverse impacts to both YCT and WCT. In summary, Alternative 1 would lead to direct, short-term, negligible to minor adverse impacts to special status species along with direct and indirect, long-term, moderate adverse impacts to both YCT and WCT outside the Yellowstone Lake watershed.

In conclusion, when combined with past, present, and foreseeable future actions, Alternative 4 would have direct and indirect, short- and long-term, negligible to minor adverse impacts, short-term negligible beneficial impacts to YCT and indirect, long-term, moderate adverse impacts to YCT.

4.5 Social and Economic Resources

4.5.1 Health and Human Safety

Guiding Principles and Policies
The National Park Service is concerned about the safety of visitors to its parks and cooperates with proposals to enhance visitor safety as long as those proposals do not result in a derogation of NPS resources or conflict with the current or planned use of NPS property (NPS 2006). The safety of staff, volunteers, and contractors is also a top priority for the NPS.

The 2006 NPS Management Policies state that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. The policies also state, "While recognizing that there are limitations on its capability to totally eliminate all hazards, the National Park Service and its concessionaires, contractors, and cooperators will seek to provide a safe and healthful environment for visitors and employees" (sec. 8.2.5.1). Further, the NPS will strive to "protect human life and provide for injury-free visits" (sec.8.2.5.1).

Methodology and Assumptions
The analysis of human health and safety were based on previous experience with projects of similar scope and characteristics. Analyses of the potential intensity of impacts to safety were derived from the available information on the park and best professional judgment.

Intensity Level Definitions
The impact intensities for safety are as follows:

Negligible: The impact on visitor or park personnel safety would not be measurable or perceptible.

Minor: The impact on visitor or park personnel would be measurable or perceptible, but it would be limited to a relatively small number of visitors or park personnel at localized areas. Mitigation measures would be followed to offset any adverse effects.

Moderate: The impact on visitor or park personnel would be measurable and perceptible and would involve a large number of visitors or park personnel in many areas of the park.

Major: The impact on visitor or park personnel would be substantial. Impacts to the safety of park visitors and park personnel would be readily apparent throughout the park.

Duration: Short-term impacts would last only during the implementation of the project, including mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.5.1.1 Alternative 1 (No Action):Impacts on Health and Human Safety

Impact Analysis
Impacts to health and human safety would likely occur under Alternative 1. Several actions are being proposed under this alternative, each of which could have a different effect on health and human safety in the park. Because Alternative 1 would not result in recovery of YCT in Yellowstone Lake, impacts to health and human safety from changes in grizzly bear use (fishing) of spawning streams in or near developed areas would not occur.

Yellowstone Lake
1a. Large-scale LKT Removal: Operation of a large-scale gillnetting and trap netting effort on a large high-elevation lake has multiple inherent risks to staff and the general public. Project staff would have the greatest direct exposure to project activities and therefore would face the highest risk. Threats of serious injury or death originate from the potential for catastrophic accidents such as boats capsizing, sinking, running aground, or catching fire, or a lightning strike. Outside of direct impacts from catastrophic accidents, any event that results in persons intentionally or unintentionally entering Yellowstone Lake poses risks from hypothermia and drowning. Potential risks from routine daily operations include: (1) cuts and abrasions from handling knives, ropes, and net materials,(2) slips, trips, and falls on and around boats, docks, and staging areas, (3) muscle strains and pulls from lifting and moving large and/or heavy objects, and (4) repetitive stress injuries from constant bending, pulling, untangling fish from gillnets, and other activities.

Dangers to the public are minimal. The most apparent danger is collision with netting equipment (buoys) and NPS vessels. Other dangers could include risk to small craft from an NPS boat wake.

No catastrophic accidents have occurred in association with the NPS gillnetting effort over the past 10 years; however, five minor accidents have occurred: three cuts, one muscle strain, and one repetitive stress injury. All reported injuries occurred on NPS-operated boats. No accidents involving the general public and the large-scale LKT removal effort have been reported.

Accidents, as well as near-miss incidents, are reported to the Yellowstone Safety Office and lessons learned are immediately relayed to project staff and incorporated into future safety training. Training is the primary tool used to reduce the incidence of accidents. All NPS boat operation is done or directly supervised by DOI MOCC certified operators. All project staff receive initial job hazard training upon arrival and are required to complete and sign a Job Hazard Analysis prior to beginning work. Regular safety sessions are held to provide safety reminders, assess new or dynamic conditions, and review accidents. Safety equipment is another means of mitigating risks from accidents. All NPS boats regularly used for large-scale LKT removal are outfitted with fire extinguishers, sound devices, visible distress signaling devices (daylight and nighttime flares), life rafts, survival suits, first aid kits, sonar/radar, NPS- and marine-band radios, and throwable flotation devices. All project staff are required to wear personal floatation devices while on NPS boats. Staff are also provided with personal protective equipment, including puncture-resistant gloves, ear-protection headphones, wet-weather clothing, and waterproof footwear. Guidelines for safe operation of boats, especially in regard to inclement weather, are another safety mitigation measured used on Yellowstone Lake. NPS boats avoid exposure to high winds, extreme cold, and electrical storms when possible. If inclement weather, particularly thunderstorms, develop unexpectedly, NPS crews halt work and

seek shelter to the greatest extent possible. Risks to the general public are mitigated by making net-marker buoys highly visible (four feet tall, topped with a brightly colored flag) and by practicing safe boat operation practices taught in the MOCC certification course.

Impacts to the health and safety park staff and the general public from continued NPS LKT suppression efforts would be direct, short-term, minor, and adverse because of the risks of injury described above

1b. Monitoring YCT and LKT: The risks to health and human safety associated with monitoring YCT on Yellowstone Lake proposed in Alternative 1 are identical to the risks for large-scale LKT removal described in Alternative 1.

1c. Clear Creek Weir Reconstruction: The weir would not be reconstructed and therefore no impacts to health and human safety would result.

1d. Enhancing YCT Recruitment: The recruitment of YCT would not be enhanced and therefore no impacts to health and human safety would result.

1e. New and Experimental LKT Removal Techniques: New and experimental LKT removal techniques except for piscicide application, would be researched and potentially implemented. Impacts to health and human safety from these activities would be similar but not exceed the risks associated with large-scale LKT removal (1a) and non-native fish removal (1e). Therefore, risks to health and human safety would be direct, short-term, minor and adverse from new and experimental LKT removal techniques.

Other Streams, Rivers, and Lakes

1f. Fish Barriers: Fish barriers would not be constructed and existing natural features would not be modified into fish barriers unless identified in other NEPA documents. There would be no impact on health and human safety from fish barriers under Alternative 1.

1g. Non-native Fish Removal: Large-scale removal of non-native fish would not be conducted in streams, rivers, and lakes (excluding the Yellowstone Lake watershed and activities identified in other NEPA documents) under Alternative 1. No impacts to health and human safety would result from large-scale removal of non-native fish in streams, rivers, and lakes (excluding the Yellowstone Lake watershed) under Alternative 1.

1h. Stocking Native Fish and Brood Source Development: Stocking native fish would not be conducted in streams, rivers, and lakes (excluding the Yellowstone Lake watershed and activities identified in other NEPA documents) under Alternative 1. No impacts to health and human safety would result from stocking native fish and brood source development under Alternative 1.

1i. Inventory, Monitoring, and Research for Aquatic Organisms: There would be no risk to the public because the scope of the activities is limited to a very small area. However, inventory, monitoring and research for aquatic organisms has the potential to impact health and human safety for the people conducting the activities, which would entail crossing and wading in streams, electrofishing, use of small motorized and non-motorized boats, working in inclement weather, and working in a wilderness setting.

Crossing and wading in streams presents the risk of injury from slips, trips, and falls as well as the potential for immersion in cold water. In extreme cases, falls into streams could result in death from drowning or hypothermia, but would more often result in minor to moderate physical injury. Electrofishing risks injuries associated with electrocution, ranging from minor discomfort to death. Because the electrical currents typically used for electrofishing are relatively low, the risk of severe injury or death is low; however, due to the nature of electrocution significant risks do exist. The risks posed by the use of small motorized and non-motorized boats are similar to the risks of using large boats (described in 1a); however, small boats are less stable and more likely to sink or capsize, especially in inclement weather. There are inherent risks to health and human safety associated with the distance from medical care in much of the park. Illnesses, allergies, minor injuries, and burns can become life-threatening if medical care is not obtained promptly. Working in Yellowstone also entails exposure to inclement and extreme weather conditions and sometimes dangerous wildlife, particularly bears and bison. Working with the horses and mules needed to move large amounts of equipment long distances in the park's backcountry also poses risks, including the possibility of severe injury and death.

Staff, researchers, and volunteers with Yellowstone's fisheries program have been conducting the activities described above since the park's inception. In the last 10 years, three injuries associated with inventory, monitoring, and research for aquatic organisms have occurred: one crushed finger, one repetitive stress injury, and one severe burn.

Accidents, as well as near-miss incidents, are reported to the Yellowstone Safety Office and lessons learned are immediately relayed to project staff and incorporated into future safety training. Training is the primary tool used to reduce the incidence of accidents. All project staff receive initial job hazard training upon arrival and are required to complete and sign a Job Hazard Analysis prior to beginning any of the tasks described above. Regular safety sessions are held to provide safety reminders, assess new or dynamic conditions, and review accidents. Safety equipment is another means of mitigating risks from accidents. All project staff are required to wear personal floatation devices while on NPS boats. While electrofishing staff are required to wear electrical gloves and waders in streams or rubber-bottomed shoes in boats. Like operations on Yellowstone Lake, all motorized NPS boat operation is done or directly supervised by DOI MOCC certified operators. Guidelines for safe operation of boats, especially with regard to inclement weather, are another safety mitigation measure. NPS boats avoid exposure to high winds, extreme cold, and electrical storms when possible. If inclement weather, particularly thunderstorms, develops unexpectedly NPS crews halt work and seek shelter to the greatest extent possible. All project staff are provided appropriate camping gear for trips into wilderness areas as well as bear spray (a non-lethal chemical bear deterrent). For all wilderness trips staff carry an NPS radio that allows instant communication with park safety services, as well as a first aid kit designed to address common backcountry injuries and illnesses.

Because of the risks described above coupled with mitigation measures discussed, the impacts to health and human safety from inventory, monitoring and research for aquatic organisms is direct and indirect, short-term, minor, and adverse.

Cumulative Impact Analysis

The States of Idaho, Montana, and Wyoming and the U.S. Forest Service routinely conduct activities to preserve and monitor fish populations near park boundaries. In addition there has

been and are expected to be localized areas of increased risk to health and human safety from on-going park maintenance and construction activities in areas of visitor use.

In addition, Yellowstone National Park is a wilderness park with a portion of the mission dedicated to providing enjoyment value to visitors. There are many inherent health and safety challenges for humans that pursue their recreational interests, especially in backcountry locations. Every year geothermal features scald a few people that get too close and contact the extremely hot water. The weather can turn cold, creating conditions for hypothermia and frostbite, and the high elevation can cause dehydration for those who fail to consume enough fluids. Some wildlife species can bite, gore, and trample people that approach too closely within the comfort zone of individual animals. While these same risks are present for employees, orientation to and familiarity with safety risks generally make employees more aware and cautious about health and safety needs.

The cumulative impacts to health and human safety would be minor, adverse, localized, and seasonal within the park because the field operation periods are short and/or the work areas are not easily accessed by the public. Safety briefings are a part of each day's operations and all individuals on the field crews continuously evaluate the safety risks for themselves and their colleagues. Alternative 1 would increase impacts to health and human safety. Coupled with past, present and foreseeable future actions, Alternative 1 would incrementally increase adverse impacts, but the overall impact level would remain at minor.

Alternative 1 Conclusion

Only existing levels of NPS gillnetting and other activities would continue on Yellowstone Lake and would not result in the recovery of YCT. Alternative 1 would result in direct, short-term, minor adverse impacts to health and human safety in the Yellowstone Lake watershed because of the potential for cuts and abrasions from handling knives, ropes, and net materials; slips, trips, and falls on and around boats, docks, and staging areas; muscle strains and pulls from lifting and moving large and/or heavy objects; and repetitive stress injuries from constant bending, pulling, untangling fish from gillnets, and other activities.

Only existing levels of NPS activities to conserve native fish in streams, rivers, and lakes would occur and would not result in the substantial recovery of native fish. Alternative 1 would result in direct, short-term, minor adverse impacts to health and human safety outside the Yellowstone Lake watershed because of the potential for slips, trips, and falls while crossing and wading in streams; electrical shock when electrofishing; and drowning and/or hypothermia when using small motorized and non-motorized boats, working in inclement weather, and working in a wilderness setting.

In conclusion, when combined with other past, present, and foreseeable future actions, this alternative would have direct, minor, short-term cumulative impacts to health and human safety.

4.5.1.2 Alternative 2: Impacts on Health and Human Safety

Impact Analysis

Impacts to health and human safety would occur under Alternative 2 from the potential actions associated with primary, secondary, or tertiary AM desired conditions.. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to

Yellowstone Lake to retain nutrients. Proposed actions may include measures to assist native fish populations by reconnecting disjunct stream segments and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source. Each action could have a different effect on health and human safety in the park.

Yellowstone Lake

2a. Large-scale LKT Removal: Gillnetting and trap netting efforts would be increased under this alternative and the potential for impacts to human health and safety would be expected to increase proportionally. The addition of contract netters into the large-scale LKT removal program would reflect an increase in risks identical to those described in Alternative 1(1a). However, no accidents have been reported by the contractors during the two-year pilot study of contract netting on Yellowstone Lake.

Contract netters use techniques similar to those of the NPS to mitigate health and human safety risk, including a requirement to have NPS and marine-band radios, GPS, and sonar equipment onboard. Radar is also recommended but not required. Contract netters follow all safety protocols developed by the U.S. Coast Guard for commercial fishery operations, including: man overboard drills, CPR training, immersion (survival) suit testing (all crew members must be able to retrieve and get into survival suits in less than 60 seconds). However, they are not required to follow all protocols required on DOI vessels. Contractors would be required to provide statistics related to their safety record and this information would be part of the process used to select contractors.

Similar to Alternative 1, impacts to health and human safety from Alternative 2 would be direct, minor, short-term, and adverse because of the risks described above.

2b. Monitoring YCT and LKT: The risks to health and human safety associated with monitoring YCT on Yellowstone Lake proposed in Alternative 2 are identical to the risks for large-scale LKT removal described in Alternative 1(1b).

2c. Clear Creek Weir Reconstruction: Reconstruction of the weir would involve the use of hand and power tools, movement of large, heavy objects like rocks, logs, and concrete, and repetitive manual labor like shoveling. These activities pose a risk of minor to serious physical injury, including lacerations, contusions, and muscle strains or pulls. Construction of the weir would also involve the movement of large amounts of materials by motor boat across Yellowstone Lake. Project staff would either be transported to the site by boat, on foot, or by horseback. Movement of staff and materials poses risks similar to those described in 1a and 1h above. All construction activities would be carried out or directly supervised by staff or contractors trained to use appropriate tools and methods. Clear Creek is far from medical care, so first aid kits and staff trained in CPR and first aid would be present at all times. Radios would also be present at all times and available to contact NPS emergency service if necessary. The weir site is not easily accessible to the public and no health and human safety risks to the public are anticipated due to the construction activities.

Because of the risks described above impacts to health and human safety from the Clear Creek weir reconstruction would be direct, minor, short-term, and adverse.

2d. Enhancing YCT Recruitment: The activities associated with enhancing YCT recruitment are similar to those described in 1h (wading in streams, working with stock (horses and mules),

working in wilderness areas, and working in inclement weather) and therefore impacts to human health and safety are expected to be similar for this activity. Therefore, impacts to health and human safety from enhancing YCT recruitment under Alternative 2 would be direct, minor, short-term, and adverse.

2e. New and Experimental LKT Removal Techniques: New and experimental LKT removal techniques, including piscicide application, would be researched and potentially implemented. Impacts to health and human safety from these activities would be similar, but not exceed, the risks associated with large-scale LKT removal (1a) and non-native fish removal (2g, below).

Other Streams, Rivers, and Lakes

2f. Fish Barriers: Backcountry fish barrier construction would be very similar to the Clear Creek weir construction (2c) and would have similar impacts to health and human safety. Modification of existing natural features into fish barriers would also be similar but may include the use of explosives to alter bedrock features. Because the use of explosives presents the risk of serious injury or death from mishandling or accidents, only trained staff or contractors would be present at sites when explosives were being employed. The public would be restricted from accessing the vicinity of any sites when explosives were being used. Construction of fish barriers near roads and not in wilderness-like areas would also involve the use of large, heavy machinery similar to that used during small road construction projects. Machinery would only be operated by trained and certified NPS staff or contractors and only trained project staff or contractors would be admitted entry to construction sites during active construction. The general public would be restricted from entering the vicinity of project area during construction. All project staff present during the use of explosives or heavy machinery would be required to wear hearing protection. Project staff would be transported to the sites by boat, on foot, or by horseback. Movement of staff and materials poses risks similar to those described in 1a and 1h above. All construction activities would be carried out or directly supervised by staff or contractors trained to use appropriate tools and methods. Fish barrier activities would sometimes include working in a wilderness setting far from medical care with similar impacts as those described in 1i. Radios would be present at all times and available to contact NPS emergency service if necessary. Because of the risks described above, impacts to health and human safety from fish barriers under Alternative 2 would be direct, minor, short-term, and adverse.

2g. Non-native Fish Removal: Large-scale removal of non-native fish would occur in streams, rivers, and lakes (excluding the Yellowstone Lake watershed) using a variety of methods including electrofishing, gill and trap netting, and application of piscicides. Impacts to health and human safety from electrofishing (1i) and netting (2a) are described above. Piscicides are chemical toxicants applied with the intent of killing fish. Two chemicals registered by the Environmental Protection Agency and approved for use as piscicides are currently relevant to the proposed actions: antimycin which is derived from the bacterium *Streptomyces griseus*, and rotenone, which is extracted from the roots of several plant species in the bean (Leguminaceae) family. Both piscicides deprive aquatic gilled organisms of oxygen by interfering with cellular respiration and both are degraded by photolysis (sunlight) and hydrolysis (water movement). Rotenone is highly toxic to fish (2-20 g/L) with a low toxicity to humans (300-500 mg/kg) (USFWS 2005). Antimycin is also highly toxic to fish, with salmonids being especially susceptible at application rates as low as 10 ppb. A concentration of 10 ppb is about 1,750 times less than the level determined by the Montana Department of Environmental Quality to be safe for long-term human consumption, and 175,000 times less than the safe level for short-term

consumption. Neither piscicide is known to pose a long-term threat to surface or groundwater quality (USFWS 2005).

A 2.5% potassium permanganate ($KMnO_4$) solution would be used as an oxidizing agent to detoxify the effects of both piscicides. The application of this product would produce a dark purple color to the treated waters for the duration of each treatment. There are no reports available regarding short- or long-term effects of $KMnO_4$ exposure in humans. The impact of piscicide application and KMn04 neutralization and subsequent exposure would be short-term, negligible adverse to the public, park staff, and project personnel.

The label requirements for rotenone state that public entry into the project area could occur immediately after a completed rotenone treatment. The label requirements for antimycin are more restrictive, proscribing entry until at least 48 hours after caged sentinel fish survive an antimycin and neutralization treatment. Both of these label requirements are very likely to become more restrictive in the near future. Applications of piscicide in the park would always follow the most current label requirements.

Press releases and information signs for visitors and park staff would be posted at the trailheads and along major trails leading to and through project areas and used to raise public awareness of piscicide application plans prior to treatment. In addition, the public would be informed as to the nearest location of potable water and/or natural waters that are safe for human consumption. The park would transport potable water to project areas to provide drinking water for visitors and project personnel as needed.

Liquid emulsifiable formulations of rotenone (Prenfish) have an aromatic solvent odor that is likely due to the associated hydrocarbon solvents (CDPR 1998) and not the rotenone itself. The odor may last for several days depending on climatic conditions, but it has not been linked to any human health problems (Finlayson et al 2000). CFT Legumine (Prentox Inc.) may have less odor compared with other liquid rotenone formulations because of the reduction of hydrocarbon-based solvents. For this reason CFT Legumine would be used unless unavailable. Powdered rotenone (Prentox Inc.) has an odor of wet chalk or a dirt-like odor that lasts for several days. Both liquid and powdered types of rotenone would likely be used under Alternative 2. Antimycin has an acetone odor that could last up to several days. Potassium permanganate ($KMnO_4$) is an odorless oxidizer often used to remove foul tastes and odors from drinking water. Impacts to health and human safety from odors are anticipated to be direct, short-term, and negligible adverse.

An accidental spill of rotenone could be contained within the immediate vicinity. All waters flowing out of a project area could be safely neutralized with a $KMmO_4$ station established near the downstream end of the project area. Project personnel would staff the treatment and $KMnO_4$ stations 24 hours per day until the neutralization is complete.

To mitigate impacts of piscicides and $KMnO_4$ exposure to project personnel, they would wear safety equipment and be trained on the safe handling and application of the piscicides and $KMnO_4$. Safety equipment includes eye and skin protection and a respirator. Chemicals would be transported, handled, applied, and stored according to the label specifications to minimize the possibility of human exposure or spill.

Appendix B includes procedures to follow in case of an accidental spill, the required safety equipment to be used by project personnel, and detailed information about the regulation, application, and effects of piscicide treatments.

Because of the risks described above, impacts to health and human safety from non-native fish removal, including the use of piscicides would be direct, minor, short-term, and adverse.

2h. Stocking Native Fish and Brood Source Development: Stocking native fish would involve many of the same activities as 1i, including electrofishing, wading in streams, and working in wilderness areas. Stocking native fish would also likely include transport of project staff by helicopter, which is required to move fish in a timely manner. Only project staff and contractors would take part in helicopter operations for native fish stocking. Native brood source development would have potential impacts to human health and safety like those described for stocking native fish; the potential impacts of piscicide application would be similar to those described in 2g. Because of the risks described above, impacts to health and human safety from stocking native fish and brood source development would be direct, minor, short-term, and adverse.

2i. Inventory, Monitoring, and Research for Aquatic Organisms: Impacts to health and human safety from Inventory, Monitoring, and Research for Aquatic Organisms would be identical to those described in 1i.

Cumulative Impact Analysis

The States of Idaho, Montana, and Wyoming and the U.S. Forest Service routinely conduct activities to preserve and monitor fish populations near park boundaries. There has been and are expected to be localized areas of increased risk to health and human safety from on-going park maintenance and construction activities in areas of visitor use. Impacts to health and human safety from piscicide application could also be considered as cumulative to those from the application of herbicide for non-native plant control.

In addition, Yellowstone National Park is a wilderness park with a portion of the mission dedicated to providing enjoyment value to visitors. There are many inherent health and safety challenges for humans that pursue their recreational interests, especially in backcountry locations. Every year geothermal features scald a few people that get too close and contact the extremely hot water. The weather can turn cold, creating conditions for hypothermia and frostbite, and the high elevation can cause dehydration for those who fail to consume enough fluids. Some wildlife species can bite, gore, and trample people that approach too closely within the comfort zone of individual animals. While these same risks are present for employees, orientation to and familiarity with safety risks generally make employees more aware and cautious about health and safety needs.

The cumulative impacts to health and human safety would be minor, adverse, localized, and seasonal within the park because the field operation periods are short and/or the work areas are not easily accessed by the public. Safety briefings are a part of each day's operations and all individuals on the field crews continuously evaluate the safety risks for themselves and their colleagues. Alternative 2 would increase impacts to human health and safety but mitigation measures would minimize these impacts. Coupled with past, present and foreseeable future actions, Alternative 2 would incrementally increase adverse impacts, but the overall impact level would remain at direct, short-term, minor and adverse.

Alternative 2 Conclusion

Alternative 2 would result in direct, short-term, minor adverse impacts to health and human safety in the Yellowstone Lake watershed from large-scale LKT removal and other activities on Yellowstone Lake because of the potential for cuts and abrasions from handling knives, ropes, and net materials; slips, trips, and falls on and around boats, docks, and staging areas; muscle strains and pulls from lifting and moving large and/or heavy objects; and repetitive stress injuries from constant bending, pulling, untangling fish from gillnets, and other activities. Alternative 2 would result in the recovery of YCT to Yellowstone Lake tributaries in and near developed areas, and it is likely that grizzly bears would return to fish these streams during the spring YCT spawning period, increasing the likelihood for bear-human conflicts and resulting in minor, long-term, adverse impacts to health and human safety.

Alternative 2 would result in direct, short-term, minor, adverse impacts to health and human safety outside the Yellowstone Lake watershed from large-scale non-native fish removal using piscicides and other methods as well as other native fish conservation activities on streams, rivers, and lakes because of the potential for slips, trips, and falls while crossing and wading in streams; electrical shock when electrofishing; and drowning and/or hypothermia when using small motorized and non-motorized boats, handling piscicides, working in inclement weather, and working in a wilderness setting.

In conclusion, when combined with other past, present, and foreseeable future actions, Alternative 2 would have minor, short- and long-term cumulative impacts to health and human safety.

4.5.1.3 Alternative 3: Impacts on Health and Human Safety

Impact Analysis

Impacts to health and human safety would occur under Alternative 3 from the potential actions associated with primary, secondary, or tertiary AM desired conditions. Proposed actions under Alternative 3 are identical to those of Alternative 2 except that Alternative 3 would result in the marketing of LKT by private sector contract netters. Consumption of fish requires consideration of the risk of exposure to mercury. Guidelines for consumption of Yellowstone Lake LKT with regard to mercury have been developed (1 meal per month for LKT >470 mm and up to 12 meals per month for smaller LKT; Koel et al. 2008) and would be disclosed to the public where LKT were marketed. The direct and indirect impacts of Alternative 3 to health and human safety would be identical to those described for Alternative 2, for all subtopics 2a–2i. Similar to Alternative 2, impacts to health and human safety from Alternative 2 would be direct, minor, short-term, and adverse because of the risks described above.

Cumulative Impact Analysis

Cumulative effects of Alternative 3 on health and human safety would be similar to those discussed in Alternative 2, with the addition of an increase in Yellowstone Lake LKT consumption by humans, which would be similar and cumulative to current consumption of Yellowstone Lake LKT caught by anglers. Thus, when combined with other past, present, and foreseeable future actions, this alternative would have negligible to minor, short and long term cumulative impacts to health and human safety. Alternative 3 would increase impacts to human health and safety but mitigation measures would minimize these impacts. Coupled with past, present and foreseeable future actions, Alternative 3 would incrementally increase adverse impacts, but the overall impact level would remain at direct, short-term, minor and adverse.

Alternative 3 Conclusion

Alternative 3 would result in direct, short- term, minor adverse impacts to health and human safety in the Yellowstone Lake watershed that is similar to Alternative 2, with the addition of an increase in Yellowstone Lake LKT consumption by humans. Alternative 3 would result in the recovery of YCT to Yellowstone Lake tributaries in and near developed areas, and it is likely that grizzly bears would return to fish these streams during the spring YCT spawning period, increasing the likelihood for bear-human conflicts and resulting in minor, long-term, adverse impacts to health and human safety.

Alternative 3 would result in direct, short-term, minor adverse impacts to health and human safety outside the Yellowstone Lake watershed from large-scale non-native fish removal using piscicides and other methods as well as other native fish conservation activities on streams, rivers, and lakes.

In conclusion, when combined with other past, present, and foreseeable future actions, Alternative 3 would have minor, short and long term, minor, adverse cumulative impacts to health and human safety.

4.5.1.4 Alternative 4: Impacts on Health and Human Safety

Impact Analysis
Impacts to health and human safety would likely occur under Alternative 4. Several actions are being proposed under this alternative, each of which could have a different effect on health and human safety in the park. For Yellowstone Lake, these impacts would be similar to those described in Alternative 1 for all Yellowstone Lake subtopics 1a–1e. For streams, rivers, and lakes (excluding the Yellowstone Lake watershed), the impacts would be similar to those described in Alternative 2 except that piscicides would not be used and therefore would not represent a risk to health and human safety. Impacts to health and human safety from Alternative 4 would be direct, minor, short-term, and adverse.

Cumulative Effects
Cumulative effects of Alternative 4 on health and human safety would be similar to those of Alternative 2 except that piscicides would not be applied. Thus, when combined with other past, present, and foreseeable future actions, this alternative would have negligible to minor, short and long term cumulative impacts to health and human safety. Alternative 4 would increase impacts to human health and safety. Coupled with past, present and foreseeable future actions, Alternative 4 would incrementally increase adverse impacts, but the overall impact level would remain at direct, short-term, minor and adverse.

Alternative 4 Conclusion

Alternative 4 would result in direct, short-term, minor adverse impacts to health and human safety in the Yellowstone Lake watershed from large-scale LKT removal and other activities on Yellowstone Lake.

Other Streams, Rivers, and Lakes
Alternative 4 would result in direct, short-term, minor adverse impacts to health and human safety outside the Yellowstone Lake watershed from large-scale non-native fish removal by mechanical methods as well as other native fish conservation activities on streams, rivers, and lakes.

In conclusion, when combined with other past, present, and foreseeable future actions, Alternative 4 would have minor, short- term cumulative impacts to health and human safety.

4.5.2 Socioeconomics

Guiding Principles and Policies
NPS Management Policies do not specifically address socioeconomics; however, nearly every action or proposal that is evaluated in this NEPA process has either a direct or indirect effect on socioeconomics.

Methodology and Assumptions
This section analyzes how native fish conservation alternatives would likely impact recreational use in the GYA and how impacts to such use would impact economic activity (expenditures and employment) within the area.

When Yellowstone National Park was established in 1872, it was the only wildland under active federal management. Early visitors fished and hunted for subsistence, as there were almost no visitor services. Fish were viewed as a resource to be used by anglers and provide park visitors with fresh meals. Largely because of these activities and the popularity of Yellowstone's fisheries, recreational angling became an accepted activity at national parks throughout the country. Today, angling remains a popular pastime for those visiting, living near, and working in Yellowstone National Park. Nearly 50,000 special use fishing permits are issued annually. Along with a permit, each angler receives a volunteer angler report (VAR) card, providing anglers with an opportunity to share their fishing success and opinions about the park's fishing opportunities. Initiated in 1973, the VAR responses provide a rich dataset for park managers to monitor trends in angler success, preferences, and other metrics. The NPS also maintains records on visitors' use of specific waters for fishing, front and backcountry campsites, and guided fishing trips.

During a typical year, park visitors spend a total of 270,000 days fishing in the park and catch 700,000 fish, releasing 95% of them. Most anglers fish for an average of 2.8 hours each day during a typical outing and fish 1.6 days during the season. Native cutthroat trout are the most sought after species, typically comprising >50% of all fish caught. Native fish species (cutthroat trout, mountain whitefish and Arctic grayling) typically comprise 55% of all fish caught. Yellowstone Lake is the most popular destination for fishing, as approximately one of every seven anglers in the park fishes there. Anglers have caught nearly 70,000 YCT on Yellowstone Lake annually in recent years.

Regarding the economic impact of the YELL fisheries, no recent surveys of anglers (or visitors that view fish) have been conducted, but peer-reviewed articles and analyses based on surveys conducted in the 1990s do exist. Kerkvliet et al. (2002) used the results of a 1993 survey of anglers at five blue-ribbon fishing sites in and near Yellowstone National Park to estimate the economic value that anglers attach to their fishing experiences. They estimated that fishermen place a value of between US$172 and $977 on a day of fishing. For Yellowstone National Park, these estimates translate into a total value of between $67.5 and $385 million for angling parkwide annually.

Varley and Schullery (1995) conducted an analysis to determine the value of the YCT of the Yellowstone Lake ecosystem (the Yellowstone River, Yellowstone Lake, and the tributaries to the lake) and their socioeconomic impact on the GYA. The conservative estimate of the nominal

one year (1994) economic value of the sport fisheries in the Yellowstone Lake ecosystem was $36,021,900. Consequently, the cumulative 30-year value of the cutthroat trout sport fishery if the LKT introduction had not occurred was estimated at $1.08 billion. The consonant value if LKT populations were vigorously controlled and did not exceed 20-30% of the trout biomass in the lake was $685 million. If no significant LKT control was carried out and their population approached 70–80% of the trout biomass, the 30-year value of the sport fishery was expected to decline to $440 million. This last scenario represents a three-decade economic erosion of $640 million, which was considered the long-term net economic effect of LKT introduction if park managers failed to take action. Further, if LKT expansion is greater than projected and the decline in YCT is worse than expected, and this results in the YCT population becoming extinct or nearly so at the end of 30 years, they estimated that the total ecological restoration of the YCT in Yellowstone Lake and its outlet stream and tributaries would have a one-time cost of a minimum of $31 million, or a multiple year (replacement-in-kind) of $182 million.

The YCT of the Yellowstone Lake Ecosystem and all native species parkwide have declined since the early-1990s economic surveys were conducted, and the actual socioeconomic impacts have not been measured. However, there is good evidence that economic value would return to the GYA following fishery improvements/recovery in Yellowstone National Park. In a recent case study of the Snake River in Idaho and Wyoming, Loomis (2006) determined a 100% increase in angler catch would increase angler use by 64.5% and create a corresponding increase in annual economic value and jobs. A similar relationship was found for increases in the size of fish caught. Present day catch rates are less than one YCT per hour of fishing on Yellowstone Lake. This is >100% lower than angler catch rates prior to LKT impacts (>2 YCT per hour in the 1980s). If results of Loomis (2006) from the upper Snake River are applicable to Yellowstone Lake, a recovery of YCT to early- or pre-LKT abundances would bring an enormous recovery in economic value and jobs.

While Yellowstone National Park's native fish do stand alone as being important to anglers, other visitors, and the GYA economy, it is the natural consumers of these fish that most people come to see. More people travel to Yellowstone to view wildlife in a natural setting than come to see the world-famous geysers (Biel 2006, Duffield 1989). The catastrophic decline of Yellowstone Lake YCT has resulted in a commensurate decline in use of spawning tributaries by grizzly bears (Koel et al. 2005). Recent investigations also suggest a staggering decline in use of the Yellowstone Lake ecosystem by ospreys, eagles, and river otters.

A recovery of YCT would provide for increased economic value due to improved angling success; however, the indirect economic benefits gained through a commensurate return of fish-eating wildlife, so they are present for viewing by all visiting public, would have a much larger overall beneficial economic impact.

Intensity Level Definitions
The impact intensities for socioeconomics are as follows:

Negligible: The impact on socioeconomics would not be measurable or perceptible.

Minor: The impact on socioeconomics would be measurable or perceptible, but it would be limited to a relatively small number of businesses at localized areas within the park.

Moderate: The impact on socioeconomics would be measurable and perceptible and would involve a large number of businesses within many areas of the park and across the GYA.

Major: The impact on socioeconomics would be measurable and perceptible and would involve a large number of businesses across the Intermountain West, including several states outside the GYA.

Duration: Short-term impacts to socioeconomics would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.5.2.1 Alternative 1 (No Action): Impacts on Socioeconomics

Impact Analysis
Existing NPS efforts occur on all areas of Yellowstone Lake and across the park from May to October annually. Impacts to socioeconomics by these activities could occur under Alternative 1.

Yellowstone Lake
Visitors have access to all areas of Yellowstone Lake where existing NPS operations to suppress LKT occur. Nearly 3,000 boating permits are issued annually, with a majority used on Yellowstone Lake; in addition, each year approximately 17,000 (one-third) of all anglers in the park visit the lake. Existing NPS operations to suppress LKT are centered at Lake Village and Bridge Bay Marina. Impacts of LKT predation on YCT are detectable ecosystem-wide.

1a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Suppression would be conducted using only NPS crews, boats, and gillnets. Suppression would occur throughout the open water season. Crews would occasionally occupy backcountry campsites and remote backcountry cabins. Because existing levels of LKT suppression are not curtailing LKT population growth, only slowing it, this effort would need to continue into the foreseeable future. This effort would not result in an indirect recovery/return of grizzly bears or other YCT consumers to the lake area. This effort would not result in an indirect increase in wildlife viewing opportunities or an increase in park visitation. Socioeconomic impacts associated with this action would therefore be based on continued degradation to the Yellowstone Lake ecosystem and would be direct and indirect, short-term, minor to moderate and adverse because of the continued decline of YCT.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake primarily in August and September, although some would occur throughout the open water season with existing levels of NPS crews, boats, gillnets, and associated gear. Crews would occasionally occupy backcountry campsites and remote backcountry cabins. Although these actions would be visible to visitors using Yellowstone Lake, they are not likely to lead to significant changes in visitor behavior impacting socioeconomics.

1c. Clear Creek Weir: No action would be taken to rebuild the weir, and therefore no impacts to socioeconomics would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries; therefore no impacts to socioeconomics would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue at present levels. Most research would be conducted in the West Thumb and near or within areas of high visitor use, including Grant boat launch and the West Thumb geyser Basin. Existing levels of crews hired by universities could be housed in the Lake and Grant villages, and rely on businesses and services in these areas. This increase in staffing would be negligible when compared to park visitation, and therefore would have no impact to socioeconomics.

Other Streams, Rivers, and Lakes

Visitors have access to all areas of the park where existing NPS operations to conserve native fish in streams, rivers, and lakes occur. Total special use permits issued were 5,638, 2,986, and 50,113 for backcountry trips, boating, and fishing, respectively in 2009. Existing NPS operations to conserve native fish in streams, rivers, and lakes occur parkwide.

1f. Fish Barriers: No action would be taken to construct fish barriers in streams, and therefore no impacts to socioeconomics would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Crews include NPS staff as well as staff of Montana FWP and Gallatin National Forest. Crews would occasionally occupy frontcountry campsites and road pullouts, and often use businesses and services in the communities of Silver Gate and Cooke City. The highly-accessible YCT of Soda Butte Creek are regarded as one of the top five fisheries in the park. There would be no significant change in this fishery or its use by anglers. However, lack of additional action to conserve native fish in other streams, rivers, and lakes parkwide would result in significant declines in angler use.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. Gamete collection locations may be near backcountry trails and/or campsites. Crews, equipment and supplies are often transported with stock and helicopter. These efforts require frequent trips by NPS staff and partners through gateway communities where food and fuel is purchased. Brood source maintenance requires hiring of staff in several communities in Wyoming and Montana.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on streams and lakes other than Yellowstone Lake would continue. Crews often occupy backcountry campsites, use pack stock and travel on backcountry trails. Existing levels of crews hired by universities would be housed in the park or in gateway communities and rely on businesses and services in these areas.

Cumulative Impact Analysis

Ongoing administrative activities will continue throughout the park. Areas with road construction may contribute direct short-term, minor adverse impacts to socioeconomics. These projects may cause traffic to be delayed or rerouted in the park. This could cause visitors to alter or adjust travel plans which may affect local businesses. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere.

Therefore, visitor expenditures (lodging, fuel, groceries, dining, gifts) would also be expected to increase annually. Alternative 1, when coupled with other past, present, and reasonably foreseeable future actions would not incrementally increase overall cumulative impacts.

Past and present native fish conservation actions in Yellowstone are not known to have directly impacted the commercial outfitters and guides, lodging, or other businesses (food, fuel, fishing, wildlife viewing, and outdoor gear). Future impacts to commercial outfitters and guides, lodging, or other businesses could result if visitation were to increase to the point of limiting the availability of marina dock space, backcountry campsites, or lodging, resulting in a minor adverse impact. Native fish populations would only partially be restored and there would be no recovery of native fish consumer species, resulting in indirect, long-term, moderately adverse impacts to socioeconomics. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 1 would have direct and indirect, long-term, moderately adverse impacts to socioeconomics.

Alternative 1 Conclusion

Yellowstone Lake
Only existing levels of NPS gillnetting would continue on Yellowstone Lake, which would not result in a recovery of YCT. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, and other businesses (food, fuel, fishing, wildlife viewing, and outdoor gear) as opportunities for angling, viewing, and enjoyment of YCT and YCT consumers declined. Direct and indirect, long-term, moderately adverse cumulative impacts to socioeconomics would occur.

Other Streams, Rivers, and Lakes
Native fish restoration activities on streams, rivers, and lakes would be minimal, resulting in little of no preservation or restoration of native fish. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, and other businesses (food, fuel, fishing, wildlife viewing, and outdoor gear) as opportunities for angling, viewing, and enjoyment of native fish and native fish consumers declined. Direct and indirect, long-term, moderately adverse cumulative impacts to socioeconomics would occur.

4.5.2.2 Alternative 2: Impacts on Socioeconomics

Impact Analysis
Impacts to socioeconomics would most likely occur under Alternative 2 with primary, secondary, and tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish (non-native fish carcasses would be returned to park waters to retain nutrients) in Yellowstone Lake and other park lakes and streams. Proposed actions may include measures to assist native fish populations by reconnecting disjunct stream segments and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Impacts to socioeconomics would occur under Alternative 2 given primary, secondary, and tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on socioeconomics in the park. Existing NPS operations

to suppress LKT are centered at Lake Village and Bridge Bay Marina. Impacts of LKT predation on YCT are detectable ecosystem-wide.

2a. Large-scale LKT Removal: LKT removal efforts by NPS crews and by private sector contract netters would occur daily from May through October on Yellowstone Lake. Large (up to 12 m) boats, crews, and equipment would be used. NPS crews and private sector contract crews would occupy housing and trailer sites in the Lake Village developed areas. Large boats used for LKT suppression would be present in Bridge Bay Marina and use fuel provided by concessioners or distributors within the GYA. The presence of private sector contract netters in the park during LKT removal would beneficially impact socioeconomics. The reduced abundance of LKT by these actions would increase survival of YCT, providing greater opportunities for angling, viewing, and enjoyment of YCT in Yellowstone Lake, Yellowstone River, and tributary streams. The actions would also result in a return of grizzly bears, otters, ospreys, and other species that prey on YCT in the Yellowstone Lake ecosystem. These combined impacts would lead to direct and indirect, long-term, moderate benefit to park socioeconomics because of increased use and associated expenditures (lodging, fuel, food, gifts, angling tackle, etc)

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: The weir site lies largely out of public view and away from established trails. Construction of the weir would affect socioeconomics in the Yellowstone Lake area and in gateway communities through the procurement of equipment and supplies for the project. Private sector contractors would conduct engineering analyses and prepare conceptual designs. NPS boats or pack stock would be used to transport crews, equipment, and supplies from Bridge Bay or Nine Mile trailhead to the weir site. NPS and Montana Conservation Corps (MCC) crews assigned to the project would use the Clear Creek cabin as well as housing units in the Lake Village developed areas. Increased expenditures by crews due to this action are not expected to impact park socioeconomics. However, project expenditures, as described above would lead to direct, short-term, minor beneficial socioeconomic impacts. Annual operation of the weir would not have an impact to socioeconomics.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. NPS and MCC crews assigned to the project would use backcountry campsites, the Clear Creek cabin as well as housing units in the Lake Village developed areas. These actions would result in increased juvenile YCT survival in Yellowstone Lake, Yellowstone River, and tributary streams, and increased opportunity for visitor angling, viewing, and enjoyment of YCT. These actions would also result in a return of grizzly bears, otters, ospreys, and other species that prey on YCT in the Yellowstone Lake ecosystem. Because of these increases, impacts to socioeconomics would be direct, long-term, moderate and beneficial.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes

Impacts to socioeconomics could occur under Alternative 2 given primary, secondary, and tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on socioeconomics in the park. NPS operations to conserve native fish in streams, rivers, and lakes would occur parkwide.

2f. Fish Barriers: Fish barriers, if required, would be constructed using equipment and supplies procured primarily from regional sources. Large crews (often >20) would be required to complete fish barrier construction and rehabilitation of the adjacent areas. NPS employees, SCA interns, and MCC crews assigned to the project would occupy RV sites and housing units within the park and gateway communities. Private sector contractors would carry out hydrologic and engineering analyses, prepare conceptual designs, and lead construction activities in backcountry sites. NPS pack stock would be used to transport crews, equipment, and supplies along park trails. Helicopters working under contract with NPS Wildland Fire Operations would also be used for transport. Vehicles requiring fuel and maintenance would be extensively used. Backcountry campsites including stock use sites would be closed for extended periods to allow for use by NPS crews conducting barrier construction. Campsite closures could impact commercial outfitters and guides; however, these impacts would be temporary and local.

2g. Non-native Fish Removal: In years when chemical treatment occurs, equipment and supplies would be procured from regional and national sources. Large crews (often >20) would be required to conduct non-native fish removals. NPS crews assigned to the project would occupy RV sites and housing units within the park and gateway communities. Backcountry campsites including stock use sites would be closed for extended periods to allow for use by NPS crews conducting removal operations. NPS pack stock would be used to transport crews, equipment, and supplies along park trails. Helicopters working under contract with NPS Wildland Fire Operations would also be used for transport. Vehicles requiring fuel and maintenance would be extensively used. During periods of piscicide use, the treated streams and/or lakes would be restricted for use as sources of drinking water. Visitors would be required to pack adequate water for their stay or camp in another watershed. Following removal of non-native fish, the treated waters would be fishless until restocked. In the short term, angling opportunities would locally decline. Socioeconomic impacts would be attributable to reduced angler and visitor use in the area and would be short-term, negligible, and adverse.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters would be used to bring genetically pure native fish to the project waters. Helicopter flights and landings would occur each year during restocking efforts. Resource advisors would be present to educate backcountry visitors during the project. Signs would be placed at trailheads and trail junctions to inform the public about the project and its impacts. Native fish returned to streams, rivers, and lakes would provide for angling opportunities. Socioeconomic impacts from this action would be direct, short-term, minor, and adverse attributable to reduced expenditures associated with decreased use while the project is ongoing. After native fish are restored to the area, impacts to socioeconomics would be direct, long-term, and moderate, attributable to expenditure associated with increased opportunities to angle, view, and enjoy native fish species in their native habitat. An indirect, long-term, minor benefit to socioeconomics would be expenditures associated with the use of restored native fish by predators in the restored watersheds.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Cumulative impacts to socioeconomics were determined by combining Alternative 2 impacts with other past, present, and reasonably foreseeable future actions having impacts to socioeconomics. Other existing activities affecting socioeconomics include guided road tours, outfitted backcountry trips, horse and wagon rides, hotels, cabins, RV parks, campgrounds,

backcountry camping, guided fishing trips, food, fuel, and gear and outdoor supplies. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 2 would have direct and indirect, long-term, moderately beneficial impacts through the presence of restored native fish populations.

Alternative 2 Conclusion

Yellowstone Lake
Alternative 2 would result in a surge in LKT removal from Yellowstone Lake by NPS and private sector contract netters and a recovery of YCT to the system. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, or other businesses (food, fuel, fishing, wildlife viewing, and outdoor gear) because of increased expenditures associated with increases in viewing, angling, and enjoying restored YCT and YCT consumers in the Yellowstone Lake ecosystem. These impacts would be detectable across the GYA. Long-term, moderately beneficial cumulative impacts to socioeconomics would occur.

Other Streams, Rivers, and Lakes
Alternative 2 would result in native fish being preserved and restored to streams, rivers, and lakes throughout the park. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, or other businesses (food, fuel, fishing, wildlife viewing, and outdoor gear) because of increased expenditures associated with increases in viewing, angling, and enjoying restored native fish and their consumers in their native habitat. These impacts would be detectable across the GYA. Long-term, moderately beneficial cumulative impacts to socioeconomics would occur.

4.5.2.3 Alternative 3: Impacts on Socioeconomics

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would result in the marketing and/or donation some of the LKT captured by private sector contract netters. The netting and removal of LKT and other activities related to the marketing of LKT, including fish processing, preserving, and shipment, would require additional staff working for or under sub-contract by the contract netters. Possibly, allowing contractors to generate money by marketing some of the LKT they capture would allow them to reduce their costs to Yellowstone. This could allow NPS to procure an increased amount of contracted netting each season, exerting a greater level of LKT suppression than would be available otherwise. Other direct and indirect impacts of Alternative 3 to socioeconomics would be similar to those described for Alternative 2, subtopics 2a–2i.

Cumulative Impact Analysis
When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 3 would have direct and indirect, long-term, moderately beneficial cumulative impacts because of activities associated with the recovery of YCT and associated YCT consumer species in the Yellowstone Lake ecosystem and the increase in native fish species throughout park waters.

Alternative 3 Conclusion

Yellowstone Lake
Alternative 3 would result in a surge in LKT removal from Yellowstone Lake by NPS and private sector contract netters and a recovery of YCT to the system. This alternative would also result in the marketing and/or donating of LKT by the contract netters. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, or other businesses (food, fuel, fishing, wildlife viewing, and other outdoor gear) because of increased expenditures associated with increases in viewing, angling, and enjoying restored YCT and YCT consumers in the Yellowstone Lake ecosystem. These impacts would be detectable across the GYA. Long-term, moderately beneficial cumulative impacts to socioeconomics would occur.

Other Streams, Rivers, and Lakes
Alternative 3 would result in native fish being preserved and restored to streams, rivers, and lakes throughout the park. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, or other businesses (food, fuel, fishing, wildlife viewing, and other outdoor gear) because of increased expenditures associated with increases in viewing, angling, and enjoying restored native fish and their consumers in their native habitat. These impacts would be detectable across the GYA. Long-term, moderately beneficial cumulative impacts to socioeconomics would occur.

4.5.2.4 Alternative 4: Impacts on Socioeconomics

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts, and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Suppression would be conducted with existing levels of NPS crews, boats, and gill nets. This effort would not result in an indirect recovery/return of grizzly bears or other YCT consumers to the lake area. This effort would not result in an indirect increase in wildlife viewing opportunities or an increase in park visitation. The direct and indirect impacts of Alternative 4 to socioeconomics would be similar to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g–1i; and Alternative 2, subtopics 2c, 2d, 2f.

Cumulative Impact Analysis
Similar to Alternative 1, native fish populations would only partially be restored and there would be no recovery of native fish consumer species, resulting in indirect, long-term, moderately adverse impacts to socioeconomics. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 4 would have direct and indirect, long-term, moderate, and adverse cumulative impacts to socioeconomics.

Alternative 4 Conclusion

Yellowstone Lake
Only existing levels of NPS gillnetting would continue on Yellowstone Lake, which would not result in a recovery of YCT. This alternative would result in direct and indirect impacts to commercial outfitters and guides, lodging, and other businesses (food, fuel, fishing, wildlife viewing, and outdoor gear) as opportunities for angling, viewing, and enjoyment of YCT and

YCT consumers declined. Direct and indirect, long-term, moderately adverse cumulative impacts to socioeconomics would occur.

Other Streams, Rivers, and Lakes
Because piscicides would not be used to restore native fish to streams, rivers, and lakes under Alternative 4, the native fish would only be partially preserved in very limited areas and impacts to commercial outfitters and guides, lodging, or other businesses (food, fuel, fishing, wildlife viewing, and other outdoor gear) would occur as visitor use of the areas decreased accordingly. Direct and indirect, long-term, moderately adverse cumulative impacts to socioeconomics would occur.

4.5.3 Park Operations

Guiding Principles and Policies
NPS Management Policies do not contain a specific chapter on park operations; however, virtually every action or proposal that is evaluated in this NEPA process has either a direct or indirect effect on park operations. There are also a number of director's orders that pertain to park operations as well.

Methodology and Assumptions
Essential park operations include interpretation, maintenance, administration, law enforcement, visitor protection, and resource management. Park staff manage nine visitor centers, museums, and contact stations; 1,700 administrative buildings, 12 campgrounds with more than 2,150 sites; 466 miles of roads; 15 miles of boardwalk; 1,100 miles of trails with 92 trailheads; and 301 backcountry campsites. Natural and cultural resources include one threatened and endangered species; 412 species of mammals and birds, birds, fish, reptiles and amphibians; over 10,000 hydrothermal features; 1,500 archeological sites; 379,000 cultural objects and natural science specimens; and 5,000,000 items in the park archives. The NPS employs more than 800 people during the peak summer season, and park concessioners employ an additional 3,400 people.

Implementation of the proposed plan would affect the operations of the park including: the number of employees needed, the type of duties that need to be conducted, who would conduct these duties and when, how activities would be conducted, and administrative procedures. Potentially staff would need to be hired to carry out implementation of the native fish conservation plan. Potentially private sector contractors would need to be used to meet project objectives. The proposed actions would affect park operations on and near Yellowstone Lake continuously spring through late fall, and near stream, river, and lake restoration activities in other park areas during the period that those operations occur.

Intensity Level Definition
The impact intensities for park operations are as follows:

Negligible: Park operations would not be affected or the effect would be at or below the lower levels of detection, and would not have an appreciable effect on park operations.

Minor: The effect would be detectable, but would be of a magnitude that would not have an appreciable adverse or beneficial effect on park operations. If mitigation were needed to offset adverse effects, it would be relatively simple and successful.

Moderate: The effects would be readily apparent and would result in a substantial adverse or beneficial change in park operations in a manner noticeable to staff and the public. Mitigation measures would probably be necessary to offset adverse effects and would likely be successful.

Major: The effects would be readily apparent and would result in a substantial adverse or beneficial change in park operations in a manner noticeable to staff and the public, and be markedly different from existing operations. Mitigation measures to offset adverse effects would be needed, could be expensive, and their success could not be guaranteed.

Duration: Short-term impacts to park operations would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.5.3.1 Alternative 1 (No Action): Impacts on Park Operations

Impact Analysis
Existing NPS efforts occur on all areas of Yellowstone Lake and across the park from May to October annually. Impacts to park operations by these activities would occur under Alternative 1.

Yellowstone Lake
NPS operations to suppress LKT would be centered primarily near Lake Village and Bridge Bay Marina, but operations could occasionally base from the Grant boat launch. Actual LKT suppression would occur on and around Yellowstone Lake, but would be concentrated in West Thumb, Breeze Channel, and along the western shore of the lake from Breeze Point to Plover Point

1a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake. Suppression would be conducted using only NPS crews, boats, and nets. Suppression would occur throughout the open water season. Crews would seasonally occupy housing units and boats would occupy docks, both of which require upkeep and maintenance. Existing operations primarily use two relatively large boats (8-10 m), two pickup trucks, and boat and trailers that require routine maintenance by park staff. While crews are operating on Yellowstone Lake, Communications Center staff are needed to monitor weather, other hazards, and the status of boat crews. Occasionally Visitor Protection staff are required to assist crews with training and other boat operations. Visitor Protection and Interpretive staff are required to inform visitors on the need for LKT removal and general locations and descriptions of netting operations.

Park administrative staff would be required to assist with staffing, procurement, and budget-related activities. Additional impacts would occur with the onset of cold weather in the fall due to outdated water systems. If not left running during cold weather, water pipes supplying the housing and office buildings could freeze and break. This puts an extra burden on park staff and operations at this time. When LKT suppression activities subside in the fall, boats must be winterized and stored for the winter. Park staff would be required to clear snow loads from the roof of the large gillnetting boat, which is stored in the open at Bridge Bay Marina October through April. . Gillnets and associated gear (buoys, lines, weights, net boxes, fish tubs) used by

current levels of LKT removal would be stored in park buildings in the Lake Village area. These facilities must also be maintained by park staff. Under this action, these levels of impacts are expected to continue to be direct, short-term, and negligible.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake. Monitoring would be conducted using NPS crews, two 22-ft boats, associated boat trailers, one crew cab pickup truck, and netting gear. Monitoring would occur primarily in August and September. Crews would occasionally occupy backcountry campsites and remote backcountry cabins which are maintained by park staff. In addition, because personnel, equipment (vehicles and boats), supplies (nets), and actions (fish netting) are similar to those used for LKT suppression, impacts by the monitoring activity include all those listed for subtopic 1a above.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to park operations would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to park operations would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. Research could be conducted throughout Yellowstone Lake, but likely would be concentrated in the West Thumb, near areas of high visitor use, including Grant Village and the West Thumb geyser basin. Park operations could be impacted by the need for an interpreter during periods when research is being conducted within the public view. Impacts could also occur from researcher use of park facilities, including housing and RV sites. Research on Yellowstone Lake also requires the park research permit office to review proposals and move them through the approval process before implementation. Time is required by discipline experts on the Research Permit Review Team to consider and approve requests to conduct research in the park.

Other Streams, Rivers, and Lakes
NPS operations to conserve native fish in streams, rivers, and lakes would occur parkwide.

1f. Fish Barriers: No action would be taken to construct fish barriers in streams. No impacts to park operations would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Crews would occasionally occupy frontcountry campsites and road pullouts. These activities would slightly impact local visitor protection and maintenance staff working in the Soda Butte Creek area insofar as they would be needed to facilitate fish removal operations and explain this action to the public. Because BKT removal efforts take place over a short period of time, it is expected these activities would lead to direct, short-term, and negligible adverse impacts on park operations.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. Crews, equipment, and supplies are often transported with stock and helicopter. Park operations are impacted by the need to care for pack and riding stock and maintain backcountry trails and campsites. Wildland fire and contracted flight staff are needed to facilitate helicopter flights and landings. Visitor protection

and interpretive staff time would increase upon recovery of the native fish populations and associated natural ecosystem processes in limited areas. Because restocking native fish and brood source development take place over a short period of time, it is expected these activities would lead to direct, short-term, and negligible adverse impacts on park operations.

1i. Inventory, Monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on streams and lakes other than Yellowstone Lake would continue. Crews often occupy backcountry campsites, use pack stock and travel on backcountry trails. Park operations are impacted by the need to care for pack and riding stock and maintain backcountry trails and campsites. Impacts could also occur from researcher use of park facilities, including housing and RV sites. Research also requires the park research permit office to review proposals and move them through the approval process before implementation. Time is required by discipline experts on the Research Permit Review Team to consider and approve requests to conduct research in the park. Inventory, monitoring, and research for aquatic organisms is not expected to add significant additional time to park resources. Because of the actual impacts to park operations are relatively small, it is expected these activities would lead to direct, short-term, and negligible adverse impacts on park resources.

Cumulative Impact Analysis
Cumulative impacts to park operations were determined by combining Alternative 1 impacts with other past, present, and reasonably foreseeable future actions having impacts in areas of native fish conservation activities. Past activities considered in this analysis include park operations by interpretation, maintenance, administration, visitor protection, and resource management personnel. Park operations most affected by this alternative are those within the Lake Village, Bridge Bay, and Grant areas on Yellowstone Lake; however, park operations would be affected in other park areas as native fish conservation actions in streams, rivers, and other lakes occur. Impacts to park operations, including all associated needs for employing staff to conduct these actions (administrative, housing at both Lake Village and Mammoth, vehicles, etc), would continue in the current condition. Additional burdens on park operations typically include fire management actions, e.g., prescribed and wild fires, human use, emergency services, aircraft over-flights, and construction projects. Beneficial impacts have also resulted from these activities, including improved access and quality of housing and other facilities. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 1 would have direct, short-term, negligible to minor adverse impacts.

Alternative 1 Conclusion

Yellowstone Lake
Short-term adverse impacts to park operations would result primarily from the continued need to support fisheries crews by providing housing, office and lab space, maintenance and storage of vehicles and boats, backcountry cabin, campsite, and trail maintenance, and the need to interpret operations to visitors. These impacts would change very little from current conditions because operations would change very little. When combined with past, present, and foreseeable future actions, Alternative 1 would have direct, short-term, negligible to minor adverse cumulative impacts in the Yellowstone Lake watershed.

Other Streams, Rivers, and Lakes
Alternative 1 would provide only limited preservation of native fish in the park's streams, rivers, and lakes. Short-term adverse impacts to park operations would result primarily from the need

to support a limited number of native fish conservation crews by providing housing, office, and lab space; maintenance and storage of vehicles and equipment; and the need to interpret operations to visitors.

Fish restoration activities on streams, rivers, and lakes would be minimal. Removal of BKT from Soda Butte Creek, collection of native fish gametes/brood source development, and inventory and monitoring of aquatic organisms would continue. When combined with past, present, and foreseeable future actions, Alternative 1 would have short-term, negligible to minor adverse impacts to park operations outside the Yellowstone Lake watershed.

4.5.3.2 Alternative 2: Impacts on Park Operations

Impact Analysis
Impacts to park operations would occur under Alternative 2 with primary, secondary, and tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients within the lake. Proposed actions may include measures to assist native fish populations by reconnecting isolated stream segments and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Actions proposed under Alternative 2 to suppress LKT are centered near Lake Village and Bridge Bay Marina, but also occasionally base out of Grant boat launch. Actual LKT suppression would occur on and around Yellowstone Lake, but would be concentrated in West Thumb, Breeze Channel, and along the western shore of the lake from Breeze Point to Plover Point

2a. Large-scale LKT Removal: LKT removal efforts by NPS crews and by private sector contract netters would occur daily from May through October on Yellowstone Lake. Large boats (up to 12 m), crews, and equipment would be used. Nets and weights would be placed on the lake bottom and attached, via rope to marking buoys on the lake surface. NPS crews and private sector contract crews would occupy frontcountry housing units and RV sites, most likely at Lake Village. Boats used for LKT suppression would be present in marinas, use dock space, and require delivery and availability of appropriate fuels. The reduced abundance of LKT by these actions would increase survival of YCT. This would result in more YCT available for visiting anglers and wildlife viewers on Yellowstone Lake, Yellowstone River, and tributary streams. These actions would then indirectly impact park operations by the need to provide essential services to the increased park visitation.

The contracting process requires a significant amount of guidance/oversight by the park's contracting office and administrative staff., oversight by an NPS Contracting Officer Representative and an on-site NPS work Inspector. The presence of contractor staff, boats, and other equipment/supplies at Yellowstone Lake places an additional burden on local maintenance, visitor protection, and interpretive staff and associated resources. This action, because of the addition of the contracted netting operation, would increase the level of impacts to park operations in areas of marina operations, some gear storage, and administrative, visitor protection, interpretive, and some maintenance staff. Because of the added use of private sector

contract crews, overall level of these impacts would be direct, short-term, and negligible to minor adverse to park operations.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: The weir site lies away from established trails in a remote location along the east shore of Yellowstone Lake. Construction of the weir would affect park operations on Yellowstone Lake and at Lake Village and Bridge Bay Marina. The weir would be constructed in part by non-natural rebar, wire mesh, concrete blocks, and mortar that would need to be hauled to the weir site. This would be done by either boat and pack stock. Boats would be used to transport crews and equipment from Bridge Bay to the weir site. Pack stock and NPS corral operations staff would be used to transport crews, equipment, and supplies to the weir site along the Nine Mile Trail. Upon completion of the weir, long-term monitoring of spawning YCT would again be conducted annually. Crews conducting this monitoring would use the Clear Creek cabin, requiring its continued maintenance by park staff. The majority of impacts, which would occur during the construction phase of the weir, would be direct, short-term, minor, and adverse; annual operation of the weir would be conducted by as few as two crew members at a time and would be direct, short-term, negligible and adverse.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries would be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would require boat and vehicle trips to transport crews and equipment. Reconnecting isolated tributaries to Yellowstone Lake would require boats and vehicles to transport crews and equipment. Trails and campsites near the project must be maintained by NPS crews. Backcountry campsites would be closed for extended periods to allow for use by NPS/MCC crews conducting gravel and sand removal operations. These actions would result in more YCT available for visiting anglers on Yellowstone Lake, Yellowstone River, and tributary streams. The actions would also result in a return of grizzly bears, otters, ospreys, and other species that prey on YCT in the Yellowstone Lake ecosystem. These animals would then be available for viewing, resulting in additional visitation to the Yellowstone Lake area. Because reconnecting isolated tributaries require a coordinated effort and could take place over a month period, impacts are expected to be direct, short-term, minor and adverse.

2e. New and Experimental Techniques: As described for Alternative 1, subtopic 1e.

Other Streams, Rivers, and Lakes

Actions proposed under Alternative 2 to conserve native fish in streams, rivers, and lakes would occur parkwide. Crews would seasonally occupy housing units which require upkeep and maintenance. Existing operations primarily use two to four vehicles and one horse trailer that require routine maintenance by park staff. While crews are operating in the backcountry Communications Center staff are needed to monitor weather, other hazards, and the status of crews. Occasionally Visitor Protection staff are required to assist crews with training. Visitor Protection and Interpretive staff are required to inform visitors on the importance on native fish to the ecosystem.

Operations would be based out of both Mammoth and Lake Village. Park administrative staff would be required to assist with staffing, procurement, and budget-related activities. Additional impacts would occur with the onset of cold weather in the fall due to outdated water systems for office, lab, and housing buildings at Lake Village. If not left running during cold weather, water pipes supplying the buildings could freeze and break.

2f. Fish Barriers: Fish barriers, if required, would impact park operations primarily for Fisheries, Communications Center, Backcountry Patrol, Corral Operations, and Wildland Fire staff. Stock and helicopters would be used to transport equipment and supplies to the barrier sites. Trails and campsites near barrier sites must be maintained by NPS crews. Backcountry campsites including stock use sites would be closed for extended periods to allow for use by NPS crews conducting barrier construction. Impacted vegetation and soils rehabilitation would be directed by NPS resource advisors. Artificial fish barriers would require routine maintenance and repair, creating short-term impacts for park operations. Because impacts would occur over a several month period during summer months, impacts are expected to be direct, short-term, minor and adverse.

2g. Non-native Fish Removal: Non-native fish removal would have an impact on park operations similar to that of barrier construction, primarily for Communications Center, Backcountry Patrol, Corral Operations, and Wildland Fire staff. Stock and helicopters are used to transport equipment and supplies to the removal sites. Trails and campsites near the project must be maintained by NPS crews. Backcountry campsites including stock use sites would be closed for extended periods to allow for use by NPS crews conducting removal operations. Resource advisors would be required to educate backcountry visitors during the projects. Signs would be placed at trailheads and trail junctions to inform the public about the project and its impacts. Interpretation staff would be required to coordinate these activities. Public Affairs Office staff would be required to write and distribute press releases and respond to public inquiries about the removal operations. Because impacts would occur over a several month period during summer months, impacts are be direct, short-term, minor and adverse.

2h. Restocking Native Fish and Brood Source Development: As described for Alternative 1 subtopic 1h.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Cumulative impacts to park operations were determined by combining Alternative 2 impacts with other past, present, and reasonably foreseeable future actions having impacts in areas of native fish conservation activities. Past activities considered in this analysis include essential park operations by interpretation, maintenance, administration visitor protection, and resource management personnel. Park operations most affected by this alternative are those within the Lake Village, Bridge Bay, and Grant areas; however, park operations would be affected in other park areas as native fish conservation actions in streams, rivers, and lakes occur. Additional burdens on park operations typically include administrative actions associated with recruiting and hiring seasonal staff, corral operations, fire management actions, e.g., prescribed and wild fires, human use, emergency services, aircraft over-flights, and construction projects. Beneficial impacts have also resulted from these activities, including improved access and quality of housing and other facilities. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 2 would have direct, long-term, minor, adverse cumulative impacts mainly because of increased staffing and activity for both lake trout suppression and other native fish restoration activities.

Alternative 2 Conclusion

Yellowstone Lake
Long-term, adverse impacts to park operations would result primarily from the need to support the LKT suppression contracted netting operation, including dock space, increased marina activity, and the need to interpret operations to visitors. Implementation of native fish conservation practices under Alternative 2 and ongoing park operations would result in direct, long-term, minor, adverse cumulative impacts because of increased suppression activity on Yellowstone Lake, increased need for visitor protection and interpretation staff to inform public of the operations, and the presence of contract netting operation at Lake Village.

Other Streams, Rivers, and Lakes
Long-term, adverse impacts to park operations would result primarily from the need to support native fish conservation crews by providing housing, office and lab space, maintenance and storage of vehicles and equipment, helicopter and backcountry (stock) support; and the need to interpret operations to visitors. Implementation of native fish conservation practices under Alternative 2 and ongoing park operations would result in direct, long-term, minor, adverse cumulative impacts.

4.5.3.3 Alternative 3: Impacts on Park Operations

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would allow the marketing of LKT by private sector contract netters. The activities related to marketing LKT, including fish processing, preserving, and shipment, would occur within marinas and nearby parking areas. These activities would require space typically available for conducting routine operations and the assistance of maintenance, interpretive, and resource protection staff. Indirect impacts could include resource management staff if the need arises to deter bears from frequenting the areas. The direct and indirect impacts of Alternative 3 to park operations would be greater than those described for Alternative 2, subtopic 2a, short-term, and, depending on the volume of LKT marketed, minor to moderate Impacts under this alternative would also include and be identical to those described for Alternative 2, subtopics 2b–2i.

Cumulative Impact Analysis
Cumulative impacts to park operations were determined by combining Alternative 3 impacts with other past, present, and reasonably foreseeable future actions having impacts in areas of native fish conservation activities. Past activities considered in this analysis include essential park operations by interpretation, maintenance, administration visitor protection, and resource management personnel. Park operations most affected by this alternative are those within the Lake Village, Bridge Bay, and Grant areas; however, park operations would be affected in other park areas as native fish conservation actions in streams, rivers, and lakes occur. Additional burdens on park operations typically include administrative actions associated with recruiting and hiring seasonal staff, corral operations, fire management actions, e.g., prescribed and wild fires, human use, emergency services, aircraft over-flights, and construction projects. Beneficial impacts have also resulted from these activities, including improved access and quality of housing and other facilities. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 3 would have direct, long-term, minor, adverse cumulative impacts mainly because of increased staffing and activity for both lake trout suppression and other native fish restoration activities.

Alternative 3 Conclusion

Yellowstone Lake
Short-term, adverse impacts to park operations would result primarily from the need to support LKT suppression crews and activities related to the marketing of LKT (e.g., fish processing, preserving, and shipment) by providing housing, office and lab space, maintenance and storage of vehicles and boats for NPS crews, trailer sites to the contract crews, and the need to interpret operations to visitors. Implementation of native fish conservation practices under Alternative 3 and ongoing park operations would result in direct, short-term, and minor to moderate adverse cumulative impacts.

Other Streams, Rivers, and Lakes
Short-term adverse impacts to park operations would result primarily from the need to support native fish conservation crews by providing housing, office and lab space, maintenance and storage of vehicles and equipment, helicopter and backcountry (stock) support, and the need to interpret operations to visitors. Implementation of native fish conservation practices under Alternative 3 and ongoing park operations would result in direct, short-term, minor, adverse cumulative impacts.

4.5.3.4 Alternative 4: Impacts on Park Operations

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Netting and removal of LKT would occur on Yellowstone Lake. The Clear Creek weir and fish barriers in streams would be constructed in remote areas, requiring assistance from Communications Center, Backcountry Patrol, Corral Operations, and Wildland Fire staff. Proposed actions would include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source. All of these activities would require some assistance from other park divisions in the form of staff time, equipment and stock. The direct and indirect impacts of Alternative 4 to park operations would be similar to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g–1i; and Alternative 2, subtopics 2c, 2d, 2f.

Cumulative Impact Analysis
Similar to Alternative 1, when added to other past, present, and reasonably foreseeable future actions in the park, Alternative 4 would have direct, short-term, minor adverse cumulative impacts.

Alternative 4 Conclusion

Yellowstone Lake
Short-term adverse impacts to park operations would result primarily from the need to continue to support LKT suppression crews by providing housing, office and lab space, maintenance and storage of vehicles and boats, and the need to interpret operations to visitors. Little change would result to current native fish management practices and ongoing park operations with this alternative and would result in direct, short-term, minor, adverse cumulative impacts.

Other Streams, Rivers, and Lakes
Short-term adverse impacts to park operations would result primarily from the need to continue to support a limited number of native fish conservation crews by providing housing, office and lab space, maintenance and storage of vehicles and equipment, and the need to interpret operations to visitors. Continuation of current native fish management practices and ongoing park operations would result in little change under this alternative and would therefore lead to direct, short-term, minor, adverse cumulative impacts.

4.5.4 Visitor Use and Experience

Guiding Principles and Policies
The NPS Management Policies 2006 state that enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of national parks and that the NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy them (Section 1.4.3).

Visitor experience, as it relates to native fish conservation, includes access, visual quality, noise, encounter levels, and opportunities for solitude. Other aspects of visitor experience, such as recreation opportunities including angling, would generally be affected by the actions proposed.

Yellowstone National Park's 2009 visitation was over 3.2 million people (NPS, 2010). Recreation activities include hiking, backpacking, camping, viewing (nature, wildlife, cultural sites, and scenic canyon and valley vistas), experiencing thermal features (geysers, mudpots), photography, painting, lodging at several historic hotels, fishing, boating, horseback riding, and enjoying backcountry wilderness areas or front country social settings.

Methodology and Assumptions
The purpose of this impact analysis is to determine if the actions to conserve native fish in the park are compatible or in conflict with the purpose of the park, its visitor use and experience goals, and the direction provided by the NPS Management Policies. Thus, these policies and goals were integrated into the impact thresholds. To determine impacts, the current and past uses of an area were considered and the potential effects of native fish conservation activities on visitor use and experience were analyzed. The primary impacts analyzed in this section include the impact on visitor use and experience, both positive and negative, of protecting and restoring native fish.

Impacts to backcountry and day use visitors and anglers were analyzed based on routine permit and other data collected by park staff. The total number of special use permits for backcountry trips in 2009 was 5,638; boating, 2,986; and fishing, 50,113. Anglers typically spend a total of 270,000 days fishing in the park each year. The thresholds of change for the intensity (i.e., degree) of impacts to visitor use and experience, including recreation and angling are defined below.

Intensity Level Definitions
The impact intensities for visitor use and experience are as follows:

Negligible: Impacts associated with native fish conservation activities would be slight, and if detectable, would be very short-term and highly localized. Visitors would not likely be aware of them or affected by them. There would be no noticeable

change in visitor use and experience in any defined indicators of visitor satisfaction or behavior.

Minor: Impacts would be detectable but short-term and localized. Visitors would likely be aware of impacts associated with implementation of the alternative, but recreational use and/or experience would not be diminished or improved. Changes in visitor use and/or experience would be slight and detectable, but would not appreciably limit or enhance critical characteristics of the visitor experience. Visitor satisfaction would remain stable.

Moderate: Impacts would be detectable and could be short- or long-term, but would not be localized. Visitors would be aware of impacts associated with implementation of the alternative and visitor use and/or experience would be diminished or improved somewhat. A few critical characteristics of the existing visitor experience would change, and the number of visitors engaging in a specified activity would be altered. Some visitors participating in that activity or visitor experience might be required to pursue their choices in other available local or regional areas. Visitor satisfaction at the park would begin to either decline or increase.

Major: Impacts would be detectable, frequent, long-term, and cover a large area. Visitors would be readily aware of impacts associated with implementation of the alternative and visitor use and/or experience would be substantially diminished or increased. A number of critical characteristics of the existing visitor experience would change and/or the number of participants engaging in an activity would be greatly reduced or increased. Large numbers of visitors overall who desire to continue using and enjoying that activity or visitor experience would be required to pursue their choices in other available local or regional areas. Overall visitor satisfaction would markedly decline or increase.

Duration: Short-term impacts to visitor use and experience would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.5.4.1 Alternative 1 (No Action): Impacts on Visitor Use and Experience

Impact Analysis
Existing NPS efforts occur on all areas of Yellowstone Lake and across the park from May through October annually. Impacts to visitor use and experience from these activities could occur under Alternative 1.

Yellowstone Lake
Visitors have access to all areas of Yellowstone Lake where existing NPS operations to suppress LKT occur. Nearly 3,000 boating permits are issued annually, with a majority used on Yellowstone Lake. In addition, each year approximately 17,000 (one-third) of all anglers in the park visit the lake.

1a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake using only NPS crews, boats, and gillnets. Suppression would occur throughout the open water season. Net-marking buoys would be placed throughout the lake,

and gillnets would be set in popular fishing locations. Fishing tackle would be lost due to entanglement in nets. NPS crews would occasionally occupy backcountry campsites and remote backcountry cabins. Because existing levels of LKT suppression are only slowing, not curtailing, LKT population growth, this effort would need to continue into the foreseeable future. Current operations are not expected to either decrease the LKT population or lead to the recovery of the YCT population in Yellowstone Lake. Because current operations are not projected to recover YCT population in the Yellowstone Lake this would lead to diminished opportunities for native fish angling, viewing and enjoyment in the Yellowstone Lake leading to direct, long-term, minor to moderate adverse impacts to visitor use and experience.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and YCT would continue on Yellowstone Lake using NPS crews, boats, and gillnets. Monitoring would occur throughout the open water season. Net-marking buoys would be placed in select locations on the lake, and gillnets could be set in popular fishing locations. Fishing tackle could be lost due to entanglement in nets. NPS crews would occasionally occupy backcountry campsites and remote backcountry cabins. Because monitoring activities take place over a short period of time (a few weeks), there would be direct, short-term, negligible adverse impacts to visitor use and experience.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to visitor use and experience would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to visitor use and experience would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue. Research could be conducted throughout Yellowstone Lake, but likely would be concentrated in the West Thumb, near areas of high visitor use and experience, including Grant Village and the West Thumb geyser basin. Visitors to these areas would see the activities (crews, boats and equipment); however, research should not hinder access or restrict use in any significant way. Therefore, developing new and experimental techniques to remove LKT would have indirect, short-term, negligible adverse impacts to visitor use and experience.

Other Streams, Rivers, and Lakes

Visitors have access to all areas of the park where existing NPS operations to conserve native fish in streams, rivers, and lakes occur. The total number of special use permits for backcountry trips in 2009 was 5,638; boating, 2,986; and fishing, 50,113.

1f. Fish Barriers: No action would be taken to construct fish barriers in streams, therefore no impacts to visitor use and experience would occur.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. Existing actions to remove BKT from upper Soda Butte Creek by electrofishing would continue. Crews would occasionally occupy frontcountry campsites and road pullouts. Visitors would see the activities of crews and equipment along the creek. Anglers could be temporarily displaced by the operations but have access to areas upstream and downstream of the activity and to other high quality fishing streams in the vicinity. Because non-native fish

removal would take place over a short period of time (hours or less for any given stream segment) impacts would be direct, short-term, minor adverse to visitor use and experience.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. Gamete collection locations may be near backcountry trails and/or campsites. Crews, equipment, and supplies are often transported with stock and helicopter. Visitor use and experience could be locally impacted by NPS use of sites and trails. Visitor experience could be impacted locally by helicopter flights. These impacts would be of very short duration (less than hours) except in the immediate project area, and therefore direct, short-term, and minor during transport of gametes. In the immediate project area, while fish and gametes are being collected, although disruptions would continue over a longer time frame, impacts would still only last for a matter of hours and would therefore would also be direct, short-term, and minor.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on streams and lakes other than Yellowstone Lake would continue. Crews would occasionally occupy backcountry campsites, use pack stock, and travel on backcountry trails. Visitor use and experience could be locally impacted by NPS use of sites and trails and by actual research activity. Because these activities are expected to occur over a short period of time, impacts to visitor use and experiences would be direct, short-term, negligible to minor and adverse

Cumulative Impact Analysis
Cumulative impacts to visitor use and experience were determined by combining Alternative 1 impacts with other past, present, and reasonably foreseeable future actions having impacts in areas designated for native fish conservation. Past activities considered in this analysis include fire management actions e.g., prescribed and wild fires, human use, aircraft over-flights, and construction projects. These actions have caused adverse impacts including increased noise, decreased visibility from smoke, traffic delays from construction, and overall aesthetics. Beneficial impacts have also resulted from these activities, including improved access and quality of experiences throughout the park. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 1 would not incrementally increase overall cumulative impacts. However, Alternative 1 would have direct, short-term, minor adverse impacts to park visitor use and experience.

Alternative 1 Conclusion

Yellowstone Lake
Under Alternative 1 there would be no LKT removal by private sector contract netters. This alternative would result in a failure to recover YCT and restore native YCT consumer species (e.g., grizzly bears, eagles, ospreys, and otters) in the Yellowstone Lake ecosystem. These impacts and impacts from other ongoing Yellowstone administrative and recreational activities would result in direct, with the loss of YCT angling and viewing opportunities in the lake, and indirect, with the loss of benefits provided by YCT consumer species, long-term, moderately adverse cumulative impacts to visitor use and experience.

Other Streams, Rivers, and Lakes
Alternative 1 would provide only limited preservation of native fish in the park's streams, rivers, and lakes. This alternative would result in further loss of native fish populations. These impacts and impacts from other ongoing administrative and recreational activities would result in direct

and indirect, long-term, moderately adverse cumulative impacts to visitor use and experience because of the lost opportunity to angle, view, and enjoy native species in their native habitat.

4.5.4.2 Alternative 2: Impacts on Visitor Use and Experience

Impact Analysis
Impacts to visitor use and experience would most likely occur under Alternative 2 with primary, secondary, and tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish, and non-native fish carcasses would be returned to park waters to retain nutrients and increase program efficiency. Proposed actions may include measures to assist native fish populations by reconnecting disjunct stream segments and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Impacts to visitor use and experience would occur under Alternative 2 given primary, secondary, and tertiary AM desired conditions. Actions proposed by Alternative 2 to suppress LKT are centered near Lake Village and Bridge Bay Marina, but impacts of this effort would be detectable ecosystem-wide.

2a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake and be supplemented with contracted netting effort. Suppression would be conducted using NPS and contracted crews, boats, and large nets. Suppression would occur throughout the open water season. Net-marking buoys would be placed throughout the lake and gillnets would be set in popular fishing locations. Fishing tackle would be lost due to entanglement in nets. NPS crews would occasionally occupy backcountry campsites and remote backcountry cabins. This effort could result in an indirect recovery/return of grizzly bears or other YCT consumers to the lake area. Benefits include an indirect increase in wildlife viewing opportunities and an increase in park visitation. This action would also result in fewer LKT available to the angling public in Yellowstone Lake. However, while this action would have indirect, long-term, moderate impacts to the angling public at Yellowstone Lake, these impacts would be minimized because LKT are readily available in high numbers and relatively large sizes in nearby lakes including Lewis Lake in Yellowstone National Park, Jackson and Jenny lakes south of Yellowstone in Grand Teton National Park, and in Buffalo Bill Reservoir east of Yellowstone. Therefore, overall impacts of this action would be direct (resulting from increased YCT) and indirect (resulting from benefits increased YCT provide to consumer species), beneficial, long-term, and moderate.

2b. Monitoring of LKT and YCT: As described for Alternative 1, subtopic 1b.

2c. Clear Creek Weir: Construction of the weir would affect visitor use and experience in the vicinity of the confluence of Clear Creek and Yellowstone Lake. A popular activity is canoeing and kayaking along the east shore where visitors pass by Clear Creek. The weir would be visible from the lake but not from the hiking trail (Nine Mile trail). It would be constructed from natural and unnatural materials. Non-natural rebar, wire mesh, concrete blocks, and mortar would be needed to ensure stability within the stream bank and the stream. Noise from chainsaws used in the construction of the weir would be heard from nearby trails and from visitors in boats on Yellowstone Lake. Chainsaws would be used minimally to cut large diameter

logs and to cut stumps flush with the surface of the ground to reduce any visual impacts. Boats would be used to transport crews, equipment, and supplies from Bridge Bay Marina to the weir site. Pack stock would be used to transport crews, equipment, and supplies to the site along Nine Mile trail. Crews would use Clear Creek cabin and nearby campsites. Although some visual and noise disturbance would occur to visitors during the construction phase of this action, these negative impacts would be short-term and minor. Annual operation of the facility would not impact visitor use and experience.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries may be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would require boat and vehicle trips to transport crews and equipment, and beach landings by boats in areas around Yellowstone Lake near tributary inlets. Although incubators placed in streams could be seen by visitors hiking off-trail, incidence of this occurring would be low due to their remote locations . Reconnecting isolated tributaries to Yellowstone Lake could require boats, vehicles, and horses to transport crews and equipment, and beach landings by boats at 50 or more locations around Yellowstone Lake. Crews would be using hand tools to open stream mouths to the lake. Much of this activity could occur near backcountry campsites, popular fishing locations, or geothermal areas frequented by visitors. Overall impacts of this action could impact visitor use and experience in the areas of work; however, impacts would be direct, short-term, minor, and adverse.

2e. New and Experimental Techniques: As described for Alternative 1, subtopic 1e.

Other Streams, Rivers, and Lakes
Impacts to visitor use and experience would occur under Alternative 2 given primary, secondary, and tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on visitor use and experience in the park. Visitors have access to areas of the park where activities under this alternative would occur on streams, rivers, and lakes.

2f. Fish Barriers: Fish barriers, if required, would be constructed to minimize obvious non-natural materials (including the in-stream splash pad below the barriers). They would be placed so as to not be directly visible from nearby trails, if possible; however, the barriers would be noticeable as non-natural structures if closely inspected. Noise from chainsaws used in the construction of fish barriers and from helicopters transporting equipment and supplies could be heard from trails and campsites that are near barrier sites. Crews with personal gear and light equipment would hike in or be transported by stock. Backcountry campsites, including stock use sites, would be closed for extended periods to allow for use by the NPS crews. Visitors could see the activities of crews and equipment along the creek. Anglers could be temporarily displaced by the operations. Visitor use and experience could be locally impacted by NPS use of sites and trails. Visitor experience could be impacted locally by flights. Therefore, this action would have direct, short-term, minor adverse impacts on visitor use and experience. Because of efforts to keep barriers as natural looking as possible, long-term visual impacts from the barrier to visitor use and experience would be negligible. However, other direct, long-term, moderate beneficial effects to visitor use and experience would be the increased opportunity to view, angle, and enjoy native fish species in their native habitat.

2g. Non-native Fish Removal: During the years that the proposed piscicides and neutralization agent are used, a purple color and oily sheen would be visible on treated waters for an estimated

40 days each year Noise from helicopters and outboard motors could occur during late summer and early fall in project watersheds. The neutralization stations would be operated 24 hours a day, requiring lanterns and one or two floodlights at night during this period. Generators may be used to power floodlights and mechanical pumps at the neutralization stations. Crews with personal gear and light equipment would hike in or be transported by stock. Backcountry campsites, including stock use sites, would be closed for extended periods to allow for use by NPS crews conducting removal operations. During periods of piscicide use, the treated streams and/or lakes would be restricted for use as sources of drinking water. Resource advisors would be present to educate backcountry visitors during the project. Signs would be placed at trailheads and trail junctions to inform the public about the project and its impacts. Visitors would be required to pack adequate water for their stay or camp in an alternate watershed. Visitors could see the activities of crews and equipment along the creek. Visitor use and experience likely would be locally impacted by NPS use of sites and trails. Visitor experience could be impacted locally by flights. Following removal of non-native fish, the treated waters would be fishless until restocked one to two years after treatment to ensure the treatment was 100% effective. Therefore, in the short term, impacts would be direct and indirect, moderate, and adverse because of the temporary loss of fish, amphibians, and other invertebrates in the project area. Angling and fish viewing opportunities would locally decline. However, direct, long-term, moderate beneficial effects to visitor use and experience, as described under the following subtopic (2h) would follow soon after this action was completed.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters would be used to bring genetically pure native fish to the project waters each year during restocking efforts. Incubators could be seen by visitors hiking off-trail, as they would be placed in streams and remain for several weeks. Resource advisors would be present to educate backcountry visitors during the project. Signs would be placed at trailheads and trail junctions to inform the public about the project and its impacts. Brood source development would require the capture of native fish, usually in backcountry locations and away from public view. Visitors could see the activities of crews and equipment along the creek. Anglers could be temporarily displaced by the operations. Visitor use and experience could be locally impacted by NPS use of sites and trails. Visitor experience could be impacted locally by flights. Native fish returned to streams, rivers, and lakes would provide increased opportunity for visitor angling, viewing, and enjoyment of native fish species in their native habitat. An indirect benefit to visitor use and experience would be the use of restored native fish by predators in the restored watersheds. Overall impacts to visitor use and experience for this action would be direct, long-term, moderate, and beneficial.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Cumulative impacts to visitor use and experience were determined by combining Alternative 2 impacts with other past, present, and reasonably foreseeable future actions having impacts in areas designated for native fish conservation. Past activities considered in this analysis include fire management actions, e.g., prescribed and wild fires, human use, aircraft over-flights, and construction projects. These actions can cause adverse impacts including increased noise, decreased visibility from smoke, traffic delays from construction, and overall aesthetics. Beneficial impacts have also resulted from these activities, including improved access and quality of experiences throughout the park. When added to other past, present, and reasonably foreseeable future actions in the park, Alternative 2 would have direct and indirect, long-term,

moderately beneficial cumulative impacts because of increased numbers of native fish species in multiple park waters.

Alternative 2 Conclusion

Yellowstone Lake
Short-term, minor, adverse impacts to visitor use and experience would occur in the Yellowstone Lake ecosystem resulting from crew presence on Yellowstone Lake; use of mechanized equipment including boats; and nets and other equipment required to monitor fish populations and remove non-native fish. However, beneficial impacts from restoration of native ecosystems would be direct (to YCT) and indirect (through YCT consumers), large scale, long-term, and moderate. Overall, actions due to native fish conservation activities and ongoing administrative and recreational use would result in direct and indirect, short-term minor adverse and long-term, moderate, beneficial cumulative impacts.

Other Streams, Rivers, and Lakes
Short-term, minor, adverse impacts to visitor use and experience across the park would result from crew presence, specifically in backcountry areas; use of piscicides and mechanized equipment including rafts and nets and other equipment required to monitor fish populations and remove non-native fish. However, beneficial impacts from restoration of native ecosystems would be direct (to native fish species) and indirect (through native fish species consumers), large scale, long-term, and moderate. Actions due to native fish conservation activities and from ongoing administrative and recreational use would result in direct and indirect, short-term minor adverse and long-term, moderate, beneficial cumulative impacts.

4.5.4.3 Alternative 3: Impacts on Visitor Use and Experience

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would result in the marketing of LKT by private sector contract netters. The netting and removal of LKT and other activities related to marketing of LKT, including fish processing, preserving, and shipment, would occur within view of visitors, primarily at marinas and nearby parking areas. Other direct and indirect impacts of Alternative 3 to visitor use and experience would be identical to those described for Alternative 2, for all subtopics 2a–2i.

Cumulative Impact Analysis
As described for Alternative 2, when added to other past, present, and reasonably foreseeable future actions in the park, Alternative 3 would have direct and indirect, long-term, moderately beneficial cumulative impacts because of increased numbers of native fish species in multiple park waters.

Alternative 3 Conclusion

Yellowstone Lake
Short-term adverse impacts to visitor use and experience in the Yellowstone Lake ecosystem would result from crew presence on Yellowstone Lake; use of mechanized equipment including boats; and nets and other equipment required to monitor fish populations and remove non-native fish. Beneficial impacts from restoration of native ecosystems would be both direct and indirect, large scale, long-term, and moderate. Overall, actions due to native fish conservation

activities and from ongoing administrative and recreational use would result in direct and indirect, short-term minor adverse and long-term, moderately beneficial cumulative impacts.

Other Streams, Rivers, and Lakes
Short-term adverse impacts to visitor use and experience across the park would result from crew presence, specifically in backcountry areas; use of piscicides and mechanized equipment including rafts, nets, and other equipment required to monitor fish populations and remove non-native fish. However, beneficial impacts from restoration of native ecosystems would be both direct and indirect, large scale, long-term, and moderate. Actions due to native fish conservation activities and from ongoing administrative and recreational use would result in direct and indirect, short-term, minor, adverse and long-term, moderately beneficial cumulative impacts.

4.5.4.4 Alternative 4: Impacts on Visitor Use and Experience

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Netting and removal of LKT would occur within view of visitors. The Clear Creek weir and fish barriers in streams would be constructed in remote areas that could be accessed by visitors. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source. All of these activities would occur within view of some visitors. The direct and indirect impacts of Alternative 4 to visitor use and experience would be similar to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g–1i; and Alternative 2, subtopics 2c, 2d, 2f.

Cumulative Impact Analysis
As described for Alternative 1, when added to other past, present, and reasonably foreseeable future actions in the park, Alternative 4 would not incrementally increase overall cumulative impacts. However, Alternative 4, would have direct and indirect, long-term, moderate, and adverse impacts to park visitor use and experience.

Alternative 4 Conclusion

Yellowstone Lake
Under Alternative 4 there would be no LKT removal by private sector contract netters. This alternative would result in a failure to recover YCT and restore native YCT consumer species (e.g., grizzly bears, eagles, ospreys, and otters) in the Yellowstone Lake ecosystem. These impacts and impacts from other ongoing Yellowstone administrative and recreational activities would result in direct and indirect, long-term, moderately adverse cumulative impacts to visitor use and experience.

Other Streams, Rivers, and Lakes
Alternative 4 would provide only limited preservation of native fish in the park's streams, rivers, and lakes. This alternative would result in further loss of the park's native fish populations and would diminish the quality of experience for visitors. These impacts and impacts from other

ongoing park administrative and recreational activities would result in direct and indirect, long-term, moderately adverse cumulative impacts to visitor use and experience.

4.5.5 Wilderness

Guiding Principles and Policies
Most of Yellowstone National Park is a recommended wilderness area. The NPS requires that park units apply a minimum requirement analysis (MRA) in management decisions affecting wilderness areas. The attached MRA (Appendix B) describes the minimum requirement and tools necessary to accomplish the proposed project and mitigation measures needed to minimize impacts to wilderness areas and backcountry visitors.

Although difficult to measure, wilderness character consists of multiple components, including a state of naturalness and an "untrammeled" state, as well as conditions for solitude, primitive and unconfined experiences, personal challenge, self-sufficiency, and an escape from the reminders of modern society. As well as a state, wilderness character denotes an intention and a commitment to the spirit of an intangible.

Naturalness in wilderness refers to the area being influenced primarily by the forces of nature rather than human efforts to manipulate, control, or direct attempts to provide particular benefits. On a species level, naturalness considers the numbers, populations, cycles, and interactions of individual species in a self-willed manner. Relevant human influences on naturalness may be direct or indirect, and may result from actions taken within or outside of the wilderness areas.

Wilderness experiences for visitors are largely self-directed and individual, based on one's state of mind. However, wilderness managers have an obligation to provide a setting in which people may find opportunities for solitude, primitive and unconfined experiences, risk, challenge, and self-sufficiency. Important components which can be managed include privacy, isolation, freedom from constraints, and an absence of the reminders of modern society and human noise and distractions. Auditory or visible signs of human intrusion, including generators, aircraft over-flights for research and wildland fire management, and mechanized maintenance equipment can also detract from the naturalness of wilderness areas.

Methodology and Assumptions
The methodology used to analyze the potential impacts to recommended wilderness areas is an analysis of expected changes to the character of recommended wilderness areas under the different alternatives. Changes to the defining qualities of recommended wilderness areas are assessed.

Intensity Level Definitions
The impact intensities for wilderness areas are as follows:

Negligible: Impacts would be very slight, and if detectable, would be highly localized. Visitors in wilderness areas would not likely be aware of them.

Minor: Impacts would be detectable but would be relatively localized. Visitors in wilderness areas would likely be aware of the impacts and their wilderness experience would be somewhat diminished.

Moderate: Impacts would be detectable and not localized, affecting a moderate area of the watershed. Visitors in wilderness areas would be aware of the impacts and their wilderness experience would be moderately diminished.

Major: Impacts would be highly detectable, frequent, and affect a large proportion of the watershed or extend beyond the watershed. Visitors in wilderness areas would be readily aware of the impacts and their wilderness experience would be significantly diminished.

Duration: Short-term impacts to wilderness areas would last only during the implementation of the projects, including their mitigation and monitoring measures. Long-term impacts would constitute a permanent impact.

4.5.5.1 Alternative 1 (No Action): Impacts on Wilderness

Impact Analysis
Existing NPS efforts often occur in proposed wilderness areas. Impacts to wilderness areas would occur under Alternative 1.

Yellowstone Lake
The South, Southeast and Flat Mountain arms of Yellowstone Lake are within recommended wilderness areas.

1a. Large-scale LKT Removal: Existing NPS LKT suppression efforts would continue on Yellowstone Lake, including the South, Southeast, and Flat Mountain arms. Suppression would be conducted using NPS crews, boats and nets. Suppression would occur throughout the open water season. Crews would occasionally occupy backcountry campsites and remote backcountry cabins. Continuation of LKT suppression at existing effort levels would not curtail lake trout population growth or expansion, and would not result in a recovery of YCT. This alternative would result in indirect, long-term, minor adverse impacts to wilderness experience because native YCT and YCT consumer species (e.g., grizzly bears, eagles, ospreys and otters) would not return to wilderness areas of Yellowstone Lake and direct, short term, minor adverse impacts to wilderness recreationists that may be temporarily disturbed during suppression actions.

1b. Monitoring of LKT and YCT: Long-term monitoring of LKT and cutthroat trout would continue on Yellowstone Lake, including the wilderness arms. Monitoring would be conducted using NPS crews, boats, and nets. Monitoring would occur throughout the open water season. Crews would occasionally occupy backcountry campsites and remote backcountry cabins. Continuation of LKT monitoring would result in indirect, short term, minor adverse impacts to wilderness experience because wildlife (lending to the wilderness experience) may be temporarily displaced and because some wilderness recreationists may be temporarily disturbed during monitoring.

1c. Clear Creek Weir: No action would be taken to rebuild the weir. No impacts to wilderness areas would occur.

1d. Enhancing YCT Recruitment: No action would be taken to introduce YCT via remote site incubators or reconnect isolated tributaries. No impacts to wilderness areas would occur.

1e. New and Experimental Techniques: Research to understand LKT impacts and improve ways to mitigate for them would continue and could potentially occur in the wilderness arms of the lake. However, most research would be conducted in the West Thumb, outside of proposed wilderness areas. Because development of new and experimental techniques would occur outside most wilderness areas, impacts would be direct, short-term, and negligible to minor; development of new and experimental techniques within wilderness (if necessary) will not exceed the impacts to wilderness described elsewhere in this document.

Other Streams, Rivers, and Lakes
Most streams, rivers, and lakes where actions would occur are within proposed wilderness areas.

1f. Fish Barriers or Weirs/Traps: No action would be taken to construct fish barriers, weirs, or traps in streams. No action would be taken to place structures that block access to spawning areas by non-native fish or to enhance access to spawning areas by native fish. No physical impacts to wilderness areas would occur. However, native fish would continue to be lost as non-native fish expanded into wilderness areas degrading native fauna, thereby causing indirect, long-term, moderate adverse impacts to wilderness.

1g. Non-native Fish Removal: No action would be taken to remove fish from streams using piscicides. No additional actions would be taken to promote angler harvest of non-native fish in waters where they coexist with native fish. Existing levels of angler education would continue. Existing actions to remove BKT from upper Soda Butte Creek, which is not within proposed wilderness, would continue. No direct impacts to wilderness areas would occur. However, native fish would continue to be lost as non-native fish expanded into wilderness areas degrading native fauna, thereby causing indirect, long-term, moderate adverse impacts to wilderness.

1h. Restocking Native Fish and Brood Source Development: Efforts to collect gametes for brood stock support/development would continue. Gamete collection locations are within proposed wilderness areas. Crews, equipment and supplies are often transported with stock and helicopter and will be analyzed to mitigate impacts under an MRA. These temporary disturbances would be direct, minor and adverse.

1i. Inventory, monitoring, and Research for Aquatic Organisms: Efforts to assess the status and health of fish and supporting research on streams and lakes other than Yellowstone Lake would continue. Crews often occupy backcountry campsites, use pack stock, and travel on backcountry trails in proposed wilderness areas. Crews, equipment and supplies are often transported with stock and helicopter and will be analyzed to mitigate impacts under an MRA. These temporary disturbances would be direct, minor and adverse.

Cumulative Impact Analysis
Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on wilderness in the park. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of wilderness. Most facilities maintenance would take place in developed areas where minimal impacts to wilderness would occur. However adverse impacts to wilderness may become necessary because some backcountry areas may temporarily be disturbed for general operation practices. Additionally, Yellowstone's

hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Wilderness activities, including occasional flight landings (research and wildland fire management), occasional use of mechanized equipment to maintain backcountry trails, and some structures for backcountry patrol and resource monitoring, would be managed under existing or new MRAs. Impacts to wilderness can be reduced by minimizing time and disturbance in remote areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on wilderness as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use. Coupled with these past, present, and foreseeable future actions, Alternative 1 should not incrementally add to the overall cumulative adverse or beneficial effects on wilderness in Yellowstone Lake or other streams, rivers, and lakes.

Alternative 1 Conclusion

Yellowstone Lake
Under Alternative 1 there would be no LKT removal by private sector contract netters. This alternative would result in a failure to recover YCT and a failure to restore native YCT consumer species (e.g., grizzly bears, eagles, ospreys, and otters) in the Yellowstone Lake ecosystem. These impacts and impacts from other ongoing park administrative and recreational activities would result in direct and indirect, short and long-term, minor to moderate, adverse cumulative impacts to wilderness areas.

Other Streams, Rivers, and Lakes
Alternative 1 would provide only limited preservation of native fish in the park's streams, rivers, and lakes. This alternative would result in further loss of native fish populations in wilderness areas and would diminish the wilderness experience for visitors. These impacts and impacts from other ongoing park administrative and recreational activities would result in direct and indirect, short and long-term, minor to moderate, adverse cumulative impacts to wilderness areas.

4.5.5.2 Alternative 2: Impacts on Wilderness

Impact Analysis
Impacts to fish would occur under Alternative 2 from the potential actions associated with primary, secondary, or tertiary AM desired conditions. This alternative would use mechanical and chemical techniques to remove, suppress, and control non-native fish in Yellowstone Lake and other park lakes and streams. Lake trout carcasses would be returned to Yellowstone Lake to retain nutrients. Proposed actions would include measures to assist native fish populations by reconnecting isolated stream segments and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source.

Yellowstone Lake
Impacts to wilderness areas would occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on wilderness areas.

2a. Large-scale LKT Removal: The South, Southeast, and Flat Fountain arms of Yellowstone Lake are within recommended wilderness areas. LKT removal efforts by NPS crews and private sector contract netters would often occur in these areas. Large boats, crews, and equipment would be visible and audible. Nets and buoys would be visible on the lake surface. NPS crews and private sector contract crews could occupy backcountry campsites along the lake shoreline. Wilderness mitigations including an approved MRA outlined in Chapter 2 would be implemented. Increased LKT suppression would in the long term, curtail lake trout population growth or expansion, and would result in a recovery of YCT. This alternative would therefore result in indirect, long term, moderate, beneficial impacts to wilderness experience because native YCT consumer species (e.g., grizzly bears, eagles, ospreys and otters) would return to wilderness areas of Yellowstone Lake. Direct, short term, minor adverse impacts would occur to wilderness recreationists that may be temporarily disturbed during suppression activities.

2b. Monitoring of LKT and YCT: As described for Alternative 1b.

2c. Clear Creek Weir: Clear Creek also lies within proposed wilderness areas. Construction of the weir would affect wilderness in the vicinity of the confluence of Clear Creek and Yellowstone Lake. Wilderness mitigations including an approved MRA outlined in Chapter 2 would be implemented. The weir would be constructed from natural and unnatural materials. Non-natural rebar, wire mesh, concrete blocks, and mortar would be needed to ensure stability within the stream bank and the stream. Noise from chainsaws used in the construction of the weir would be heard from nearby trails and from boats on Yellowstone Lake. Chainsaws would be used minimally to cut large-diameter logs and to cut stumps flush with the surface of the ground to reduce any visual impacts. Boats would be used to transport crews, equipment, and supplies from Bridge Bay Marina to the weir site. Pack stock would be used to transport crews, equipment, and supplies to the weir site along the Nine Mile Trail. Crews would use the Clear Creek cabin and nearby campsites. These temporary disturbances will have direct, short term, minor adverse impacts to wilderness recreationists.

2d. Enhancing YCT Recruitment: Streamside incubators and reconnecting isolated tributaries would be used to enhance YCT recruitment into the Yellowstone Lake population. Use of incubators would require boat and vehicle trips to transport crews and equipment, and beach landings by boats in remote, wilderness areas. Incubators could be seen by visitors hiking off-trail, as they would be placed in streams and remain for several weeks. Reconnecting isolated tributaries to Yellowstone Lake would require boats, vehicles, and horses to transport crews and equipment, and would require beach landings by boats in remote, wilderness areas. Wilderness mitigations including an approved MRA outlined in Chapter 2 would be implemented. These temporary disturbances will have direct, short term, minor adverse impacts to wilderness recreationists.

2e. New and Experimental Techniques: As described for Alternative 1e.

Other Streams, Rivers, and Lakes

Impacts to wilderness areas would occur under Alternative 2 given primary, secondary, or tertiary AM desired conditions. Several actions are being proposed under this alternative, each of which could have a different effect on wilderness areas. Wilderness mitigations outlined in Chapter 2 would be implemented.

2f. Fish Barriers or Weirs/Traps: Fish barriers built in wilderness areas, if required, would be constructed from nearby native logs and rocks; non-natural rebar, wire mesh, and mortar

(concrete) would be needed to ensure barrier stability within the stream bank and the stream. Weirs and traps would be constructed mostly of unnatural materials such as steel and aluminum but are unlikely to be constructed in wilderness areas, with the exception of Clear Creek (see above). Fish barriers, weirs, and traps would be constructed to minimize obvious non-natural materials (including the in-stream splash pad below the barriers) and would be placed so as to minimize visibility from nearby trails, if possible; however, these structures would be noticeable as non-natural structures up close. Noise from chainsaws or other tools used in the construction of fish barriers, weirs, and traps would be heard from nearby trails and at campsites that are near the placement sites. Chainsaws would be used minimally to cut large-diameter logs and to cut stumps flush with the surface of the ground to reduce any visual impacts. Wilderness mitigations including an approved MRA outlined in Chapter 2 would be implemented. Any resource impacts to vegetation and soils would be rehabilitated under the guidance of NPS resource advisors. Fish barriers would in the long term, result in a recovery of YCT to some streams within recommended wilderness. This alternative would therefore result in indirect, long term, moderate, beneficial impacts to wilderness experience because native YCT consumer species (e.g., grizzly bears, eagles, ospreys and otters) would return to wilderness areas of Yellowstone Lake. Direct, short term, minor adverse impacts would occur to wilderness recreationists that may be temporarily disturbed during construction.

2g. Non-native Fish Removal: During the years chemical treatment occurs, a milky-white or purple color from the use of the proposed piscicides and neutralization agent would be visible on treated waters for an estimated 10 days each year. Noise from helicopters and outboard motors could occur during late summer and early fall in project watersheds. The neutralization stations would be operated 24 hours a day, requiring lanterns and one or two floodlights at night during this period. Generators would be used to power floodlights and mechanical pumps at the neutralization stations. Wilderness mitigations including an approved MRA outlined in Chapter 2 would be implemented. Crews with personal gear and light equipment would hike in or be transported by stock. These temporary disturbances would be direct, minor and adverse. Promotion of non-native fish harvest by anglers could result in increased use of targeted areas, resulting in vegetation trampling along stream or lake margins (social trails) within recommended wilderness areas leading to direct, short and long term, minor adverse impacts to wilderness recreationists not expecting trails in these areas.

2h. Restocking Native Fish and Brood Source Development: Following non-native and hybridized trout removal, pack stock and helicopters would be used to bring genetically pure native fish to the project waters. Helicopter flights and landings would occur each year during restocking efforts. Resource advisors would be present to educate backcountry visitors during the project. Signs would be placed at trailheads and trail junctions to inform the public about the project. . These temporary disturbances would be direct, minor and adverse. Brood source development would require the capture of native fish, usually in backcountry locations away from public view.

2i. Inventory, monitoring, and Research for Aquatic Organisms: As described for Alternative 1i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on wilderness in the park. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance

would involve localized temporary disturbance of wilderness. Most facilities maintenance would take place in developed areas where minimal impacts to wilderness would occur. However adverse impacts to wilderness may become necessary because some backcountry areas may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Wilderness activities, including occasional flight landings (research and wildland fire management), occasional use of mechanized equipment to maintain backcountry trails, and some structures for backcountry patrol and resource monitoring, would be managed under existing or new MRAs. Impacts to wilderness can be reduced by minimizing time and disturbance in remote areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on wilderness as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use. Coupled with these past, present, and foreseeable future actions, Alternative 2 should not incrementally add to the overall cumulative adverse effects on wilderness around Yellowstone Lake or other streams, rivers, and lakes; and will increase beneficial impacts to wilderness in Yellowstone Lake and other streams, rivers, and lakes.

Alternative 2 Conclusion

Yellowstone Lake
Alternative 2 would have direct, short-term, minor adverse impacts to wilderness areas of Yellowstone Lake from noise, visual intrusion, boats, net buoys, and crew operations. Long-term use of the Clear Creek weir to monitor YCT would have direct long-term, negligible adverse impacts. The resulting recovery of YCT from conservation actions under Alternative 2 would add indirect, long-term, moderately beneficial impacts to wilderness areas. Overall, there would be direct and indirect, short-term minor adverse and long-term, moderately beneficial cumulative impacts.

Other Streams, Rivers, and Lakes
Alternative 2 would have direct, short-term, negligible to minor adverse impacts to wilderness areas across Yellowstone from the use of piscicides, noise, visual intrusion, rafts, and crew operations. Long-term use of in-stream fish barriers would result in direct long-term, minor adverse impacts. The resulting recovery of native fish populations from conservation actions under Alternative 2 would add indirect, long-term, moderately beneficial impacts to wilderness areas. Overall, there would be both direct and indirect, short- and long-term minor adverse and long-term, moderately beneficial cumulative impacts.

4.5.5.3 Alternative 3: Impacts on Wilderness

Impact Analysis
Proposed actions under Alternative 3 are identical to Alternative 2 except that Alternative 3 would result in the marketing of LKT by private sector contract netters. Some netting and removal of LKT would occur within recommended wilderness areas. Activities related to marketing of LKT, including fish processing, preserving, and shipment, would not occur within recommended wilderness areas. The direct and indirect impacts of Alternative 3 on wilderness areas would be identical to those described for Alternative 2, for all subtopics 2a–2i.

Cumulative Impact Analysis

Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on wilderness in the park. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of wilderness. Most facilities maintenance would take place in developed areas where minimal impacts to wilderness would occur. However adverse impacts to wilderness may become necessary because some backcountry areas may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Wilderness activities, including occasional flight landings (research and wildland fire management), occasional use of mechanized equipment to maintain backcountry trails, and some structures for backcountry patrol and resource monitoring, would be managed under existing or new MRAs. Impacts to wilderness can be reduced by minimizing time and disturbance in remote areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on wilderness as more people hike and camp in Yellowstone. These activities would lead to further disturbance of native fish from added use. Coupled with these past, present, and foreseeable future actions, Alternative 1 should not incrementally add to the overall cumulative adverse or beneficial effects on native fish in Yellowstone Lake or other streams, rivers, and lakes. Coupled with these past, present, and foreseeable future actions, Alternative 3 should not incrementally add to the overall cumulative adverse effects on wilderness around Yellowstone Lake or other streams, rivers, and lakes; and will increase beneficial impacts to wilderness in Yellowstone Lake and other streams, rivers, and lakes.

Alternative 3 Conclusion

Yellowstone Lake

Alternative 3 would have direct, short-term, minor adverse impacts to wilderness areas of Yellowstone Lake from noise, visual intrusion, boats, net buoys, and crew operations. Long-term use of the Clear Creek weir to monitor YCT would have direct long-term, negligible adverse impacts. The resulting recovery of YCT from conservation actions under Alternative 3 would add indirect, long-term, moderately beneficial impacts to wilderness areas. Overall, there would be direct and indirect, short-term minor adverse and long-term, moderately beneficial cumulative impacts.

Other Streams, Rivers, and Lakes

Alternative 3 would have direct, short-term, negligible to minor adverse impacts to wilderness areas across Yellowstone from piscicides, noise, visual intrusion, rafts, and crew operations. Long-term use of in-stream fish barriers would result in direct long-term, minor adverse impacts. The resulting recovery of native fish populations would add indirect, long-term, moderately beneficial impacts to wilderness areas. Overall, there would be direct and indirect, long-and short-term minor adverse and moderately beneficial cumulative impacts.

4.5.5.4 Alternative 4: Impacts on Wilderness

Impact Analysis
Alternative 4 would result in a continuation of existing NPS native fish management efforts and removal of non-native fish with only limited techniques. Piscicides and private sector contract netters would not be used, and non-native fish carcasses would be returned to Yellowstone Lake to retain nutrients. No marketing of LKT by private sector contract netters would occur. Netting and removal of LKT would occur within recommended wilderness areas. The Clear Creek weir and fish barriers in streams would be constructed within recommended wilderness areas. Proposed actions may include measures to assist native fish populations by reconnecting spawning tributaries and augmentation of native fish populations by genetic swamping, use of remote site incubators, selective passage of native fish into spawning streams, and/or developing a native fish brood source. The conservation actions under Alternative 4 would not result in a recovery of Yellowstone Lake YCT and only very limited preservation/restoration of native fish in other park streams, rivers, and lakes. The direct and indirect impacts of Alternative 4 on wilderness areas would be similar to those described for Alternative 1, subtopics 1a, 1b, 1e, 1g–1i; and Alternative 2, subtopics 2c, 2d, 2f.

Cumulative Impact Analysis
Ongoing administrative activities such as road reconstruction and maintenance, backcountry operations, facilities maintenance, and hazard fuels reduction projects (as described under cumulative impacts) would continue to have adverse effects on wilderness in the park. Backcountry operations include horse and boat patrol, and trail maintenance. Trail maintenance would involve localized temporary disturbance of wilderness. Most facilities maintenance would take place in developed areas where minimal impacts to wilderness would occur. However adverse impacts to wilderness may become necessary because some backcountry areas may temporarily be disturbed for general operation practices. Additionally, Yellowstone's hazard fuels reduction projects require the removal of excess fuel (trees) from developed areas. Wilderness activities, including occasional flight landings (research and wildland fire management), occasional use of mechanized equipment to maintain backcountry trails, and some structures for backcountry patrol and resource monitoring, would be managed under existing or new MRAs. Impacts to wilderness can be reduced by minimizing time and disturbance in remote areas and by monitoring construction and maintenance activities. Park visitation is expected to increase each year as a result of population growth in nearby communities and elsewhere. Therefore, recreational use such as angling, camping, and hiking would increase parkwide. An increase in recreational users will likely place additional pressures on wilderness as more people hike and camp in Yellowstone. These activities would lead to further disturbance of wilderness from added use. Coupled with these past, present, and foreseeable future actions, Alternative 4 should not incrementally add to the overall cumulative adverse or beneficial effects on wilderness around Yellowstone Lake or other streams, rivers, and lakes.

Alternative 4 Conclusion

Yellowstone Lake
Under Alternative 4 there would be no LKT removal by private sector contract netters. This alternative would result in a failure to recover YCT and a failure to restore native YCT consumer species (e.g. grizzly bears, eagles, ospreys, and otters) in the Yellowstone Lake ecosystem. These impacts and impacts from other ongoing park administrative and recreational

activities would result in direct and indirect, long-term, minor, adverse cumulative impacts to wilderness areas.

Other Streams, Rivers, and Lakes
Alternative 4 would provide only limited preservation of native fish in the park's streams, rivers, and lakes. This alternative would result in further loss of native fish populations in wilderness areas and would diminish the wilderness experience for visitors. These impacts and impacts from other ongoing park administrative and recreational activities would result in direct and indirect, long-term, minor, adverse cumulative impacts to wilderness areas.

5. Chapter 5: Consultation and Coordination

Based on this EA, if the project would significantly affect the human environment, a notice of intent to prepare an environmental impact statement would be issued. Conversely, a finding of no significant impact would be issued if it is determined that there would be no significant impact from this project.

5.1 Internal Scoping

Internal scoping was conducted by an interdisciplinary (ID) team of professionals from Yellowstone National Park. Team members initially met on January 26, 2010 to discuss the actions to be covered under the plan as well as the issues, concerns, and impacts associated with the potential actions. On May 25, 2010, the team discussed the substantive comments received during the scoping period, developed measurable objectives and alternatives, and discussed the level of NEPA appropriate for the scope of work proposed. The team met again on June 15, 2010, to discuss resource impacts associated with the proposed actions, compile impacts for the Environmental Screening Form, develop alternatives, and identify document analysis needs.

5.2 External Scoping

External (or public) scoping to identify issues and concerns began on March 29, 2010, with a press release, a mailing of over 650 scoping newsletters to interested parties, and posting of the scoping newsletter on the NPS Planning, Environment and Public Scoping website. Four public meetings were held during April 2010 in locations surrounding the park: Bozeman (28 participants) and West Yellowstone (6), Montana; and Cody (20) and Jackson (6), Wyoming. These meetings were held to solicit comments on the proposed issues, alternatives, and impact topics for the EA. A total of 245 pieces of correspondence were received during the scoping period in the form of written letters, comments submitted at the website, meeting comment forms mailed in, form letters, and faxes from individuals, state government agencies, businesses, and nonprofit organizations. Public scoping ended April 30, 2010.

A local newspaper, the *Powell Tribune*, published an article based on information from the scoping meeting in Cody. The article focused almost exclusively on the LKT suppression program. Two additional articles were published subsequent to the initial article with a similar LKT focus.

The Yellowstone compliance staff read each piece of correspondence, selected 398 comments for further analysis and assigned each of them one of 22 codes. The ID team analyzed the comments that were considered substantive, including those that suggested alternatives or actions, and issues to be addressed in the EA. Non-substantive comments are typically those that are opinion based, including “for” and “against” comments. Approximately 80% (195) of the total correspondence stated support for both LKT suppression and native fish restoration. Other comments included support of the decision to exclude the Firehole, Madison, Gibbon, and the Gallatin rivers from this EA, and lack of support solely for LKT suppression or solely for native fish restoration.

Most of the substantive comments regarding LKT suppression involved issues to address in the EA (e.g., purpose and need, climate change), piscicide use, possible alternatives, fishing

regulations, and fish disposition. The ID team discussed the applicability of each substantive comment as a group and placed each into one of these categories: no action alternative, preferred alternative with adaptive management, actions considered but dismissed, preferred alternative with fish market incentives, and nuts and bolts (points to address in the EA). The EA writing team used these lists to develop the various sections of the EA while being mindful of addressing the comments of the public.

5.3 Consultation with Associated Tribes

Twenty-six Native American tribes were contacted at the beginning of the scoping period with a newsletter to announce the opportunity for tribes to comment and attend public scoping meetings. Newsletters were mailed to the following tribes to assist in determining if there were any ethnographic concerns with the proposed actions and if they wanted to be involved in the environmental compliance process.

Kiowa Tribe of Oklahoma
Shoshone-Bannock Tribes
Flandreau Santee Sioux Tribe
Sisseton-Wahpeton Sioux Tribe
Crow Creek Sioux Tribe
Yankton Sioux Tribe
Lower Brule Sioux Tribe
Rosebud Sioux Tribe
Cheyenne River Sioux Tribe
Oglala Sioux Tribe
Turtle Mountain Band of Chippewa Indians
Spirit Lake Sioux Tribe
Crow Tribe
Northern Cheyenne Tribe
Confederated Salish and Kootenai Tribes
Assiniboine & Sioux Tribes, Fort Peck
Chippewa Cree Tribe
Gros Ventre and Assiniboine Tribes
Confederated Salish and Kootenai Tribes
Comanche Tribe of Oklahoma
Eastern Shoshone Tribe
Northern Arapaho Tribe
Shoshone-Bannock Tribes
Nez Perce Tribe
Coeur d'Alene Tribe
Confederated Tribes of the Umatilla Indian Reservation

No ethnographic resources were identified as a result of this scoping. If any ethnographic resources are identified subsequently, impacts to them will be mitigated in consultation with the tribes.

5.4 National Historic Preservation Act

The undertakings described in this document are subject to Section 106 of the National Historic Preservation Act under the terms of the 2008 Servicewide Programmatic Agreement among the NPS, the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers.

No historic properties have been identified that will be impacted as a result of the actions proposed in the alternatives. However, individual actions proposed are undertakings per 36 CFR Part 800, Protection of Historic Properties, and will require Section 106 review. Prior to implementation of individual actions, Yellowstone will initiate and complete Section 106 compliance.

5.5 Endangered Species Act

Initial discussions have taken place with the USFWS on threatened and endangered species under 50 CFR Part 402, which implements the Endangered Species Act (16 USC 1531 et seq.). These consultations would be completed following review of this EA by the USFWS. As part of the consultation process, the NPS would seek USFWS concurrence with its determination of the "may affect, not likely to adversely affect" determination for the federally listed threatened grizzly bear and the "no effect" determinations for the federally listed threatened Canada lynx, designated critical habitat for the Canada lynx, and for the federally listed gray wolf.

5.6 Preparers and Contributors

NPS Preparers:

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Glossary of Terms

Allele—a constituent component of a gene. Most genes are comprised of two alleles, one from each parent, which control the same inherited characteristic.

Bioaccumulation—the accumulation of toxic chemicals through the consumption of water or food. The chemicals concentrate in the tissues of living organisms.

Bioconcentration—the tendency of a chemical to accumulate in the tissues of a living organism to levels in excess of the concentration in the surrounding environment. Chemicals may enter the tissue through absorption, ingestion or inhalation.

Bioconcentration factor—a measure of the extent of chemical partitioning at equilibrium between a biological medium such as fish tissue and an external medium such as water.

Biomagnify (biological magnification)**—t**he process by which chemicals found in water are concentrated in lower life forms and re-concentrated substantially during their movement through the food chain, leaving the organisms at the highest trophic levels with the highest accumulated levels of chemical.

Catch per unit effort (CPUE)—a measure of relative abundance often used in fisheries management. Catch is usually a count of fish while effort is a measure of energy expended. CPUEs are used to report angler success rates (number fish per hour of angling) or netting success rates (number of fish captured per 100 m of net fishing one night).

Drift (pesticide)—unintentional physical movement of pesticide away from the target treatment area during the application period.

Fish toxicant—See piscicide.

Fishing mortality—number of fish in a population that die over a given time period solely due to fishing pressure. In this document fishing mortality rate refers to the percentage of the population which would die because of fishing annually. This does not translate to a direct decrease in population abundance because new fish are added to the population annually.

Gametes—the cells of sexually reproducing organisms that fuse together during fertilization to form an embryo. Animal gametes are commonly known as eggs and sperm.

General use pesticide—pesticide that may be applied by the public without specific training or certification.

Genetically unaltered—containing no detectable non-native genetic material.

Hatchery brood—a source of fish that spends their entire life cycle in the hatchery environment.

Hatchery/wild brood—a source of fish that use both a hatchery and wild environment during their life cycle, e.g., a population that is maintained in a pond but is unable to naturally reproduce.

Introgression (introgressive hybridization)—movement of genes from one species into the gene pool of another species resulting in a complex mixture of parental genes.

LC_{50}—the median lethal concentration; the concentration of a substance in air or water that is required to kill half of the members of a tested population within a set amount of time (usually four hours). The LC_{50} is generally measured in grams of substance per kilogram of body weight.

LD_{50}—the median lethal dose; the dose required to kill half the members of a tested population within a set amount of time. LD_{50} is generally measured in grams of the substance per kilogram of body weight.

Littoral zone—the part of a lake that is close to shore.

Metapopulation—a group of spatially separated populations of the same species that interact at some level.

Native brood stock—a source of genetically unaltered native fish that can be used for conservation activities. Native brood stocks can be hatchery, wild, or a combination of both.

Phenotypic—the physical expression of an organism's genes.

Piscicide—a chemical pesticide designed to kill fish, including the EPA-approved chemicals rotenone and antimycin.

Piscivore (piscivorous, piscivory)**—**a carnivorous animal that eats fish.

ppb—parts per billion; a measurement of the concentration of a chemical in solution, equal to one part in a billion, or 1 microgram (µg) per liter (0.000001 grams per liter, 0.00016 ounces per gallon).

ppm—parts per million; a measurement of the concentration of a chemical in solution, equal to one part in a million, or 1 milligram (mg) per liter (0.001 grams per liter, 0.16 ounces per gallon).

Remote site incubator (RSI)—device used to hatch fish eggs *in situ*.

Restricted use pesticide—pesticide that may be applied only by or under the direct supervision of trained and certified applicators.

Undesirable fish species—broadly defined as any native or non-native species that is detrimental to meeting an established fisheries management objective. Often refers to non-sport fish that compete with or otherwise diminish sportfish populations. All non-native fish within Yellowstone's native fish conservation area (see the park's fishing regulations) are considered undesirable.

Wild brood—a source of fish that spend their entire life cycle in the wild and are capable of self-sustaining natural reproduction. Fertilized eggs collected from a wild brood are often taken to a hatchery during the sensitive period of development before being stocked.

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