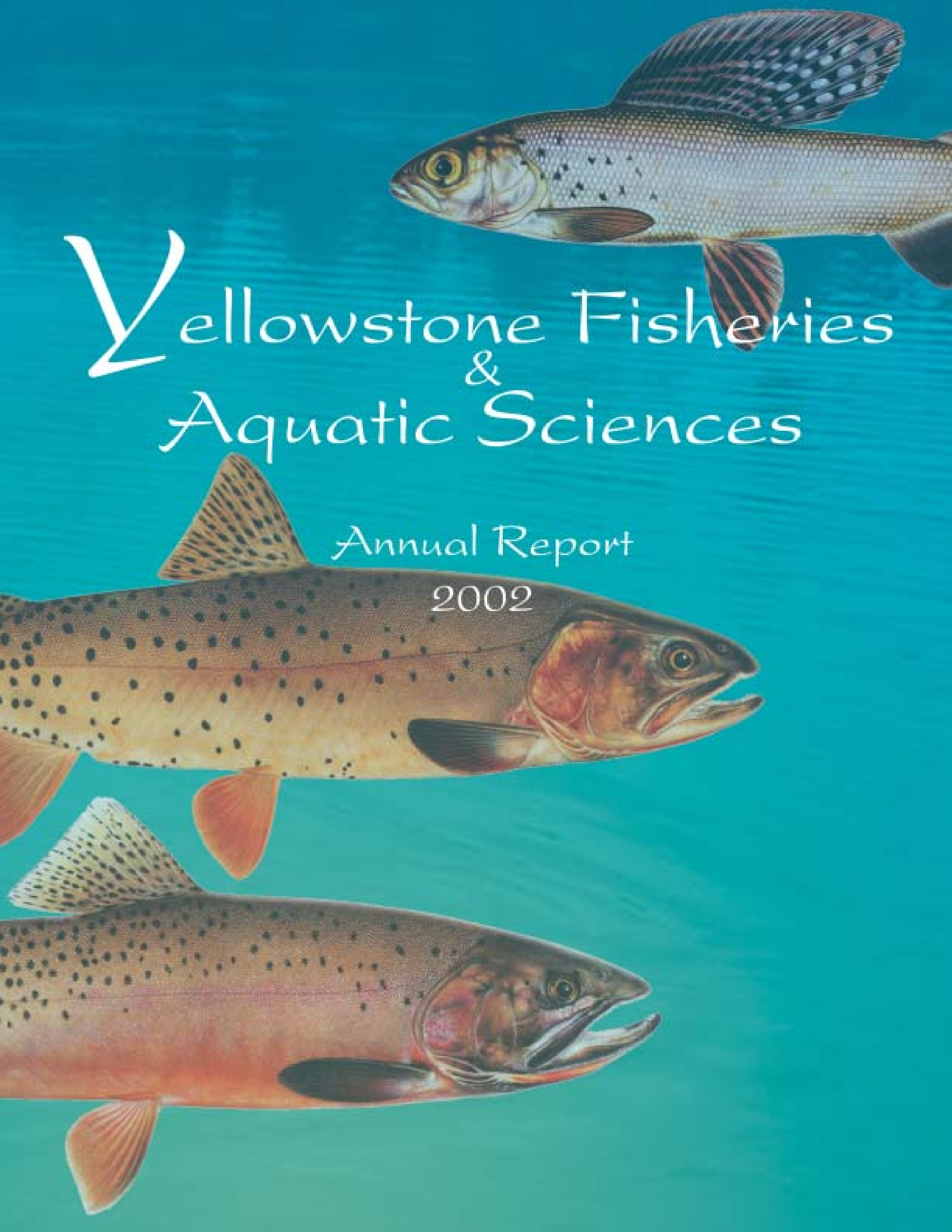
Yellowstone Fisheries & Aquatic Sciences

Annual Report 2002



Yellowstone cutthroat trout

Yellowstone Lake in Yellowstone National Park is home to the premier surviving inland cutthroat trout fishery in North America. Two significant threats to the native Yellowstone cutthroat trout, discovered over a five-year period during the 1990s, irreversibly altered the future of this thriving and diverse ecosystem. Without swift and continuing action, negative affects on this trout population—a keystone energy source for at least 42 species of mammals and birds and a recreational focus for visitors—have the potential to produce ecosystem-wide consequences.

Predatory, nonnative lake trout, illegally introduced to the lake at least 20 years ago and not discovered until 1994, can consume over 40 Yellowstone cutthroat trout annually. They have the potential to decimate the Yellowstone Lake fishery in our lifetime without heightened and maintained management efforts. Lake trout also occupy an ecological niche unavailable to cutthroat-eating predators, imperiling the many species, such as grizzly bears, bald eagles, and river otters, that depend on the cutthroat for survival.

Whirling disease, a parasite that attacks the developing cartilage of young fish resulting in skeletal deformity, whirling behavior, abnormal feeding, and increased vulnerability to predation, was first detected in Yellowstone Lake in 1998 and in the Firehole River in 2000. This devastating disease further threatens already declining Yellowstone cutthroat trout populations. Although whirling disease is currently believed to be concentrated in the northern regions of the Yellowstone Lake watershed, several other tributaries have already been identified as high risk.

In addition to native trout preservation, aquatics program goals include restoration of isolated but genetically pure westslope cutthroat trout, monitoring to track aquatic ecosystem health and to expedite early warnings for other invasive exotic species, and encouragement of public involvement in various fisheries programs.

The stakes are high, raising the bar for innovative management. The increased magnitude of the problems faced by the park's fisheries and the accelerated rate at which they are occurring are straining Yellowstone's resources. This annual report describes historic and continuing park aquatics programs as well as specific initiatives for 2002. It is a scientific call for action—action urgently needed to assure cutthroat trout survival and overall fishery health in Yellowstone National Park.

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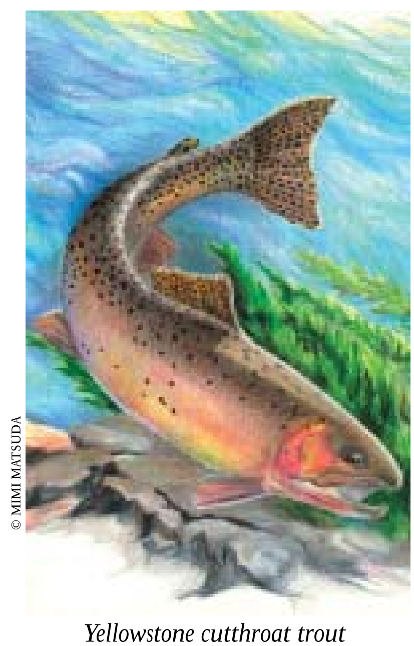

Yellowstone cutthroat trout

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Background

Created in 1872, Yellowstone National Park was for several years the only wildland under active federal management. Early visitors fished and hunted for subsistence, as there were almost no visitor services. At the time, fishes of the park were viewed as resources to be used—by sport anglers and to provide park visitors with fresh meals. Fish-eating wildlife, such as bears, ospreys, otters, and pelicans, were regarded as a nuisance, and many were destroyed as a result.[1]

Maintenance of natural biotic associations or, where possible, restoration to pre-European conditions have emerged as primary goals.

To supplement fishing and to counteract this "destructive" consumption by wildlife, a fish "planting" program was established in Yellowstone. Early park superintendents noted the vast fishless waters of the park, and immediately asked the U.S. Fish Commission to "see that all waters are stocked so that the pleasure seeker can enjoy fine fishing within a few rods of any hotel or camp."[2] The first fishes from outside the park were planted in 1889–1890, and included brook trout in the upper Firehole River; rainbow trout in the upper Gibbon River; and brown trout and lake trout in Lewis and Shoshone Lakes.[3] During the early history of the park, stocked fisheries were extremely important. The harvest-oriented fish management program accounted for the planting of over 310 million fish in Yellowstone between 1881 and 1955. In addition, from 1889 to 1956, some 818 million eggs were stripped from Yellowstone trout and shipped throughout the U.S.[4]

NPS PHOTO

Tremendous numbers of cutthroat trout were once harvested by sport anglers and commercial fishermen.

NPS PHOTO

NPS fisheries worker removing cutthroat trout from the Pelican Creek trap for egg-taking operations in 1936.

Largely due to these activities in Yellowstone National Park and the popularity of its fisheries, recreational angling became a long-term, accepted use of national parks throughout the country. In Yellowstone, fisheries management, as we understand that term today, began with the U.S. Army and was assumed by the National Park Service in 1916. Fish stocking, data gathering, and other monitoring activities began with the U.S. Fish Commission in 1889, were continued by the U.S. Fish and Wildlife Service until 1996, and have been the responsibility of the National Park Service since 1996.

Since 40 percent of Yellowstone's waters were once fishless,[5] the stocking of nonnative fishes has had profound ecological consequences. The more serious of these include displacement of intolerant natives such as westslope cutthroat trout and grayling, hybridization of Yellowstone and westslope cutthroat trout with each other and with nonnative rainbow trout, and, most recently, predation of Yellowstone cutthroat trout by nonnative lake trout. Over the years, management policies of the National Park Service have drastically changed to reflect new ecological insights, as highlighted in the Leopold Report of 1963.[6] Subsistence use and harvest orientation once guided fisheries management. Now, maintenance of natural biotic associations or, where possible, restoration to pre-European conditions have emerged as primary goals.

A perceived conflict exists in the National Park Service mandate that states the people will "use and enjoy", and also "protect and preserve" our pristine, natural systems.[7] To date, we know of 18 fish species or subspecies in Yellowstone

National Park;[8] 13 of these are considered native (they were known to exist in park waters prior to Euro-American settlement) and five are introduced (nonnative or exotic; see Appendix i). Fisheries management efforts in Yellowstone are currently focused on preservation of native species, while allowing for use of these fisheries by visiting anglers through a complete catch-and-release regulation. As our primary mission is the preservation of natural ecosystems and ecosystem processes, we will not emphasize maintenance of established nonnative fish stocks. Along with native fish preservation, our Fisheries and Aquatic Sciences Section (Aquatics Section) activities include native fish restoration, stream and lake inventory and monitoring, and a new emphasis on aquatic ecosystem health including water quality and macroinvertebrate monitoring of lakes and streams to serve as an early warning for advancing invasive exotic species.

TOPOGRAPHY TAKEN FROM MAP PUBLISHED IN 1886, BY THE U.S. GEOLOGICAL SURVEY

Fisheries authority David Starr Jordan produced this map of Yellowstone waters in 1889, showing the large portion of the western side of the park as an AREA WITHOUT TROUT, *in anticipation of the extensive stocking program that followed. (From Baron W. Evermann, Report on the Establishment of Fish Cultural Stations in the Rocky Mountain Region and Gulf States, U.S. Government Printing Office, 1892).*

2002 Summary

At the end of the 2002 field season in early November, annual population assessments for native Yellowstone cutthroat trout indicated yet another year of decline in Yellowstone Lake members of this precious subspecies. A total of 6,613 upstream-migrating cutthroat trout were counted at Clear Creek, down from 9,581 in 2001 and the lowest count since 1994. Catches by our annual fall netting program averaged 5.1 cutthroat trout per net, the lowest catch recorded since the initiation of the program in 1969. Reductions in cutthroat trout catch have averaged 11 percent per year since 1994, the year lake trout were first discovered in Yellowstone Lake.

While catch and release angling certainly contributes to total annual mortality of Yellowstone cutthroat trout, the relatively recent illegal introduction of nonnative lake trout and the presence of the invasive exotic parasite *Mxyobolus cerebralis* (which causes salmonid whirling disease) appear to be increasing the severity of these declines. An all-out effort has been launched to remove as many lake trout as possible and control the expansion of this destructive population. The Aquatics Section acquired a new gillnetting boat, the NPS *Freedom*, in 2001. Designed after commercial vessels in the Great Lakes, this boat provides a safe work environment for processing the nearly 10 miles of gill net that are in place each day during the open water season (May–October). Since 1994, more than 56,200 lake trout have been removed from Yellowstone Lake via gillnetting, with 12,549 fish removed in 2002 alone.

Intensive research on whirling disease has been conducted since 1998 when it was first discovered in Yellowstone Lake. To date, examination of 12 spawning tributaries located throughout the lake basin and the Yellowstone River below Fishing Bridge indicates a

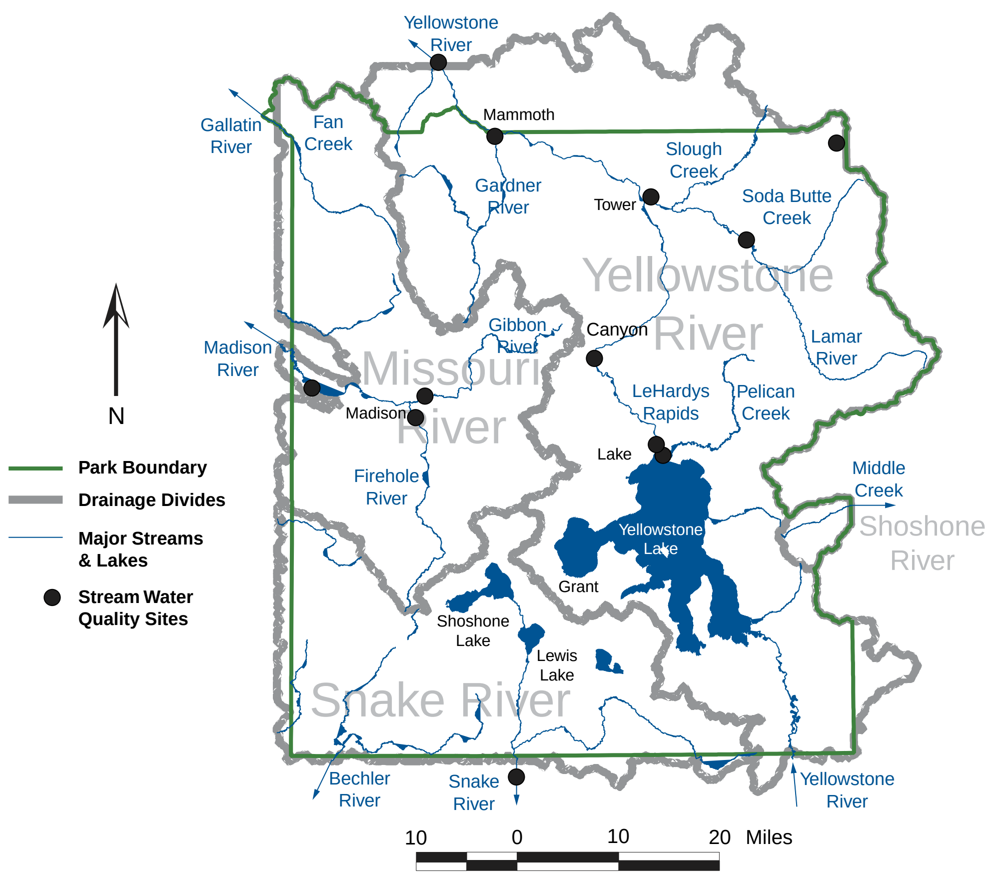


Figure 1. Major surface waters of Yellowstone National Park with 12 stream sites established for long-term monitoring of water quality. Labels for Fan Creek and Soda Butte Creek indicate locations but streams are not shown.

concentration of this disease near Fishing Bridge and in lower Pelican Creek.

The status of westslope cutthroat trout in Yellowstone National Park has been a serious concern for several years. Intensive research and monitoring to date indicates that the only remaining genetically pure population of this precious subspecies exists in the remote North Fork of Fan Creek. Efforts are underway to ensure the stability of this population and to assist with brood stock development efforts for westslope cutthroat trout in Montana's Upper Missouri River system.

Stream fish surveys have been conducted throughout the park to monitor population abundance, genetic integrity, and overall fish health. Many of these surveys are conducted in association with ongoing road reconstruction projects. Of special note is a major survey of the Gibbon River fisheries (1999–2002) and the first two years of sampling to assess the fishery status of Slough Creek.

In 2002 we initiated a new program aimed at tracking the ecological health of aquatic systems in Yellowstone National Park. The quality of the park's surface waters is now monitored biweekly at 12 fixed sites located near the confluences of major streams and rivers (Figure 1). The physical and chemical

The Yellowstone Center for Resources lake trout gillnetting boat Freedom, *christened in 2002.*

characteristics of Yellowstone Lake are monitored seasonally to assist the targeting of nonnative lake trout. Macroinvertebrates are now sampled using regionally standardized methods to allow for easy comparison of data among agencies.

Public involvement with the Aquatics Section has greatly increased primarily through the incorporation of many volunteers. In 2002 alone, 81 volunteers dedicated 6,382 hours of their time to our projects. A highlight of the year was the development of the Yellowstone Volunteer Fly-fishing Program, where volunteer anglers from across the United States participated in five specific fisheries projects throughout the park.

The interior of the NPS Freedom *provides a safe work space for processing lake trout gill nets. Worker in the foreground is long-term international volunteer, Silvia Matesanz. The lake trout program benefits from thousands of hours of donated time by volunteers each year.*

Yellowstone Cutthroat Trout Preservation

The South Arms of Yellowstone Lake may act as refuges for cutthroat trout due to the low numbers of lake trout found there.

Yellowstone Lake and its tributaries represent the majority of undisturbed natural habitat and the home to the last stronghold of remaining genetically pure Yellowstone cutthroat trout (*Onchorhynchus clarki bouvieri)*.[9] Now faced with pressure by nonnative and exotic invaders, the Yellowstone Center for Resources and Aquatics Section consider the preservation of this subspecies a top management and research priority. Ecosystem-level degradation is a possibility if the cutthroat trout population of Yellowstone Lake is allowed to decline.[10]

Maintaining Long-term Monitoring Programs

Annual assessment of the Yellowstone cutthroat trout population of Yellowstone Lake has been conducted by counts of upstream-migrating spawners at Clear Creek, Bridge Creek, and Arnica Creek; by dip-netting adult spawners at LeHardys Rapids; and by a netting program on the lake conducted during September each year.

Using multi-mesh-size gill nets set in shallow water at 11 sites throughout Yellowstone Lake, the Aquatics Section has been able to collect valuable cutthroat trout population information over time (Figure 2). Data collected in 2002 continued to show some very disturbing trends. The number of fish collected per net has reached the lowest point recorded since the lake netting program began in 1969 (Figure 3).[11] The reduction in catch has been 0–21 percent each year (averaging 11% per year) since 1994, the year lake trout (*Salvelinus namaycush)* were first discovered in Yellowstone Lake.[12] Examination of length-frequency data from the fall netting survey shows a severe decline in adult cutthroat trout numbers in Yellowstone Lake (Figure 4).

Entire age classes are virtually missing from the lake population. In 2002, few fish between the lengths of 300 and 430 mm were caught. Historically most cutthroat trout noted in spawning tributaries such as Clear Creek[13] and at LeHardys Rapids of the Yellowstone River[14] have fallen in this size range. Despite this, we see an apparent increase in juvenile cutthroat trout in 2001 and 2002 as an encouraging sign and an indication that the lake trout removal program's effects may be significant, making a major contribution to the preservation of Yellowstone cutthroat trout.

The South Arms of Yellowstone Lake may act as refuges for cutthroat trout due to the low numbers of lake trout found there. Our long-term netting site near Peale Island in the South Arm produced 132 cutthroat trout (and no lake trout) over one night. This represented a larger catch than all other sites—39 percent of all cutthroat trout sampled by the September 2002 netting program.

The Yellowstone cutthroat trout population decline is also evident in total numbers of upstream-migrating cutthroat trout at Clear Creek, a major spawning tributary on the lake's eastern side (Figure 3). A total of 6,613 upstream-migrating cutthroat trout were counted at Clear Creek, down from 9,581 in 2001 and the lowest count since 1994. Fish counting stations were also operated on Arnica and Bridge Creeks. In Arnica Creek, 455 cutthroat trout were counted migrating upstream during the 2002 field season. Problems with our counting system coupled with a bank washing out around our counting station prevented us from obtaining an accurate count. Our total is considered a minimum estimate. We have not

had a season without mishap at Arnica Creek, so it is unfair to make comparisons to past counts. Repairs have been made and the counting station was moved to a new location in 2002 to aid in obtaining a more accurate count in the future. In Bridge Creek, 373 cutthroat trout were counted migrating upstream from late-April to mid-June, 2002. This represents a 67 percent decrease from the 2001 total of 1,140, and an 84 percent decrease since monitoring began in 1999.

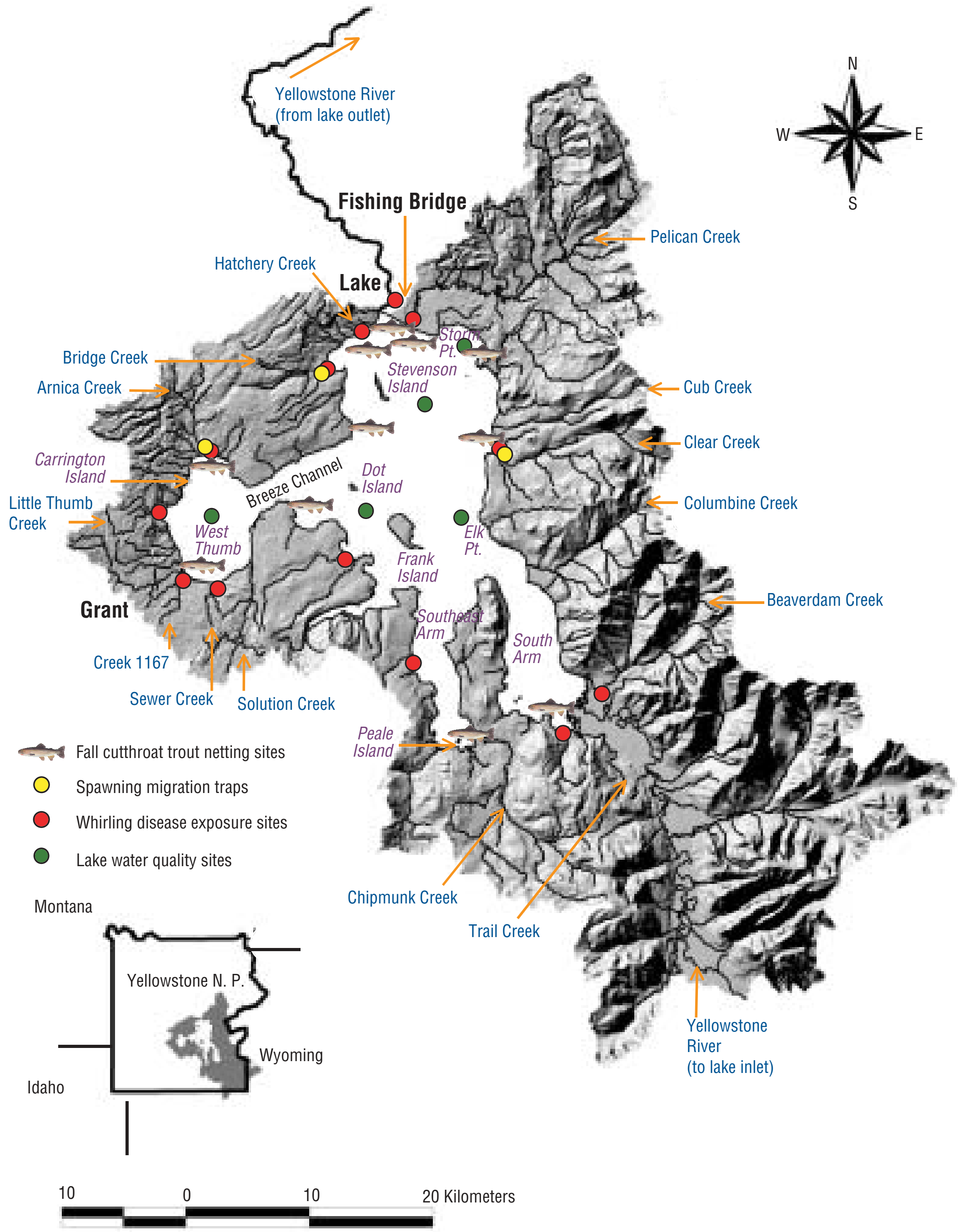


Figure 2. Yellowstone Lake and several major tributary drainages within Yellowstone National Park.

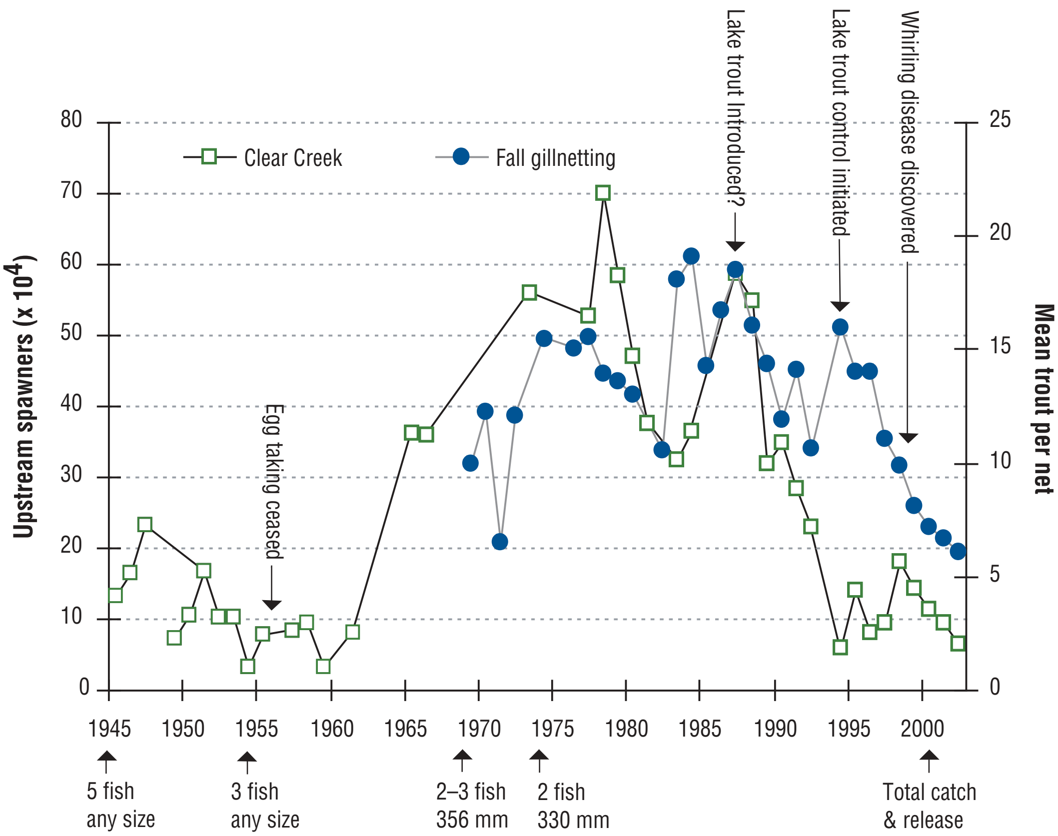


Figure 3. Total annual number of upstream migrating Yellowstone cutthroat trout at Clear Creek and mean number of cutthroat trout collected per net by fall gillnetting on Yellowstone Lake. Arrows indicate dates of changes in sport fishing restrictions and other significant events including the likely year for lake trout introduction as indicated by otolith microchemistry.

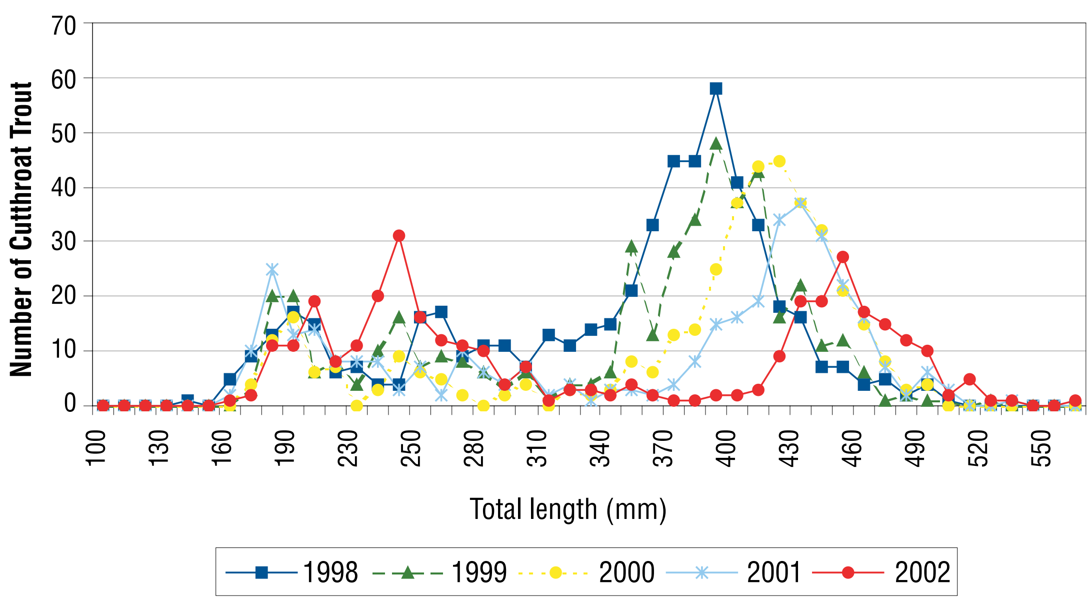


Figure 4. Length frequency data collected from Yellowstone cutthroat trout, Yellowstone Lake, during fall netting assessments, 1998 through 2002. Note the severe decline in adults greater than 300 mm over time. Also note an increase in juveniles during 2001 and especially 2002.

Removal of Nonnative Lake Trout from Yellowstone Lake

Following the discovery of lake trout in Yellowstone Lake in 1994, efforts have intensified to counteract this nonnative threat.[15] In June 2001, the addition of a new boat, the NPS *Freedom*, designed specifically for gill net operations on Yellowstone Lake, greatly improved operation efficiency and working conditions for employees. This helped increase the gillnetting effort approximately nine-fold over the 1999 level (Figure 5).

Over 12,000 lake trout were removed from Yellowstone Lake in 2002 using approximately 14,570 net units (one net unit is 100 m of net set over one night). On a typical day during the open water season on Yellowstone Lake, nearly 10 miles of gill net are in place for lake trout. Catch rate (catch per unit of effort) has declined for the third year in a row and was the lowest seen since 1995. Mean total length of lake trout caught near Solution Creek and in Breeze Channel during spawning showed a decrease from previous years; it rose slightly at Carrington Island, the main lake trout spawning site (Figure 6). Overall number of spawners caught was down from 2001.

Since 1994, more than 56,200 lake trout have been removed from Yellowstone Lake via gillnetting. The majority of these fish have come from West Thumb and Breeze Channel where most of the gillnetting effort is concentrated. Bioenergetics modeling (estimates of how many cutthroat trout a lake trout potentially consumes) suggests that an average mature lake trout will consume 41 cutthroat trout per year.[16] Thus, the control project has saved a large number of cutthroat trout from lake trout predation.

Although recent numbers from the lake trout removal program are encouraging, we have by no means declared victory over the lake trout crisis in Yellowstone Lake. Lake trout densities in the West Thumb remain high and a serious threat to the Yellowstone cutthroat trout. Given the available habitat in Yellowstone Lake, the effect of an expanding lake trout population will be very real if control efforts are reduced or eliminated. Model simulations indicate that a 60 percent or greater decline in the cutthroat population could be expected within 100 years if the lake trout population were permitted to grow uncontrolled.[17] Also, we have been unsuccessful at developing a technique to remove lake trout in the mid-size range (400–600 mm total length). This component of the population coexists with our cutthroat trout population, making it impossible to effectively gillnet them without also incurring an unacceptable mortality rate in cutthroat trout. We are still investigating new methods to target this segment of the population before the fish reach full maturity and perhaps pioneer new spawning sites.

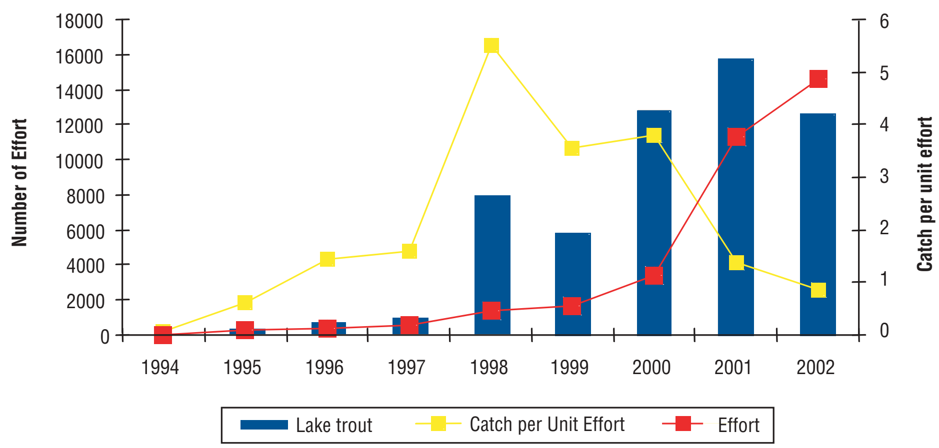


Figure 5. Total number of lake trout removed by gillnetting in Yellowstone Lake with total gillnetting effort and catch per unit of effort, 1994–2002. Each unit of effort represents 100 meters of gillnet set over one night.

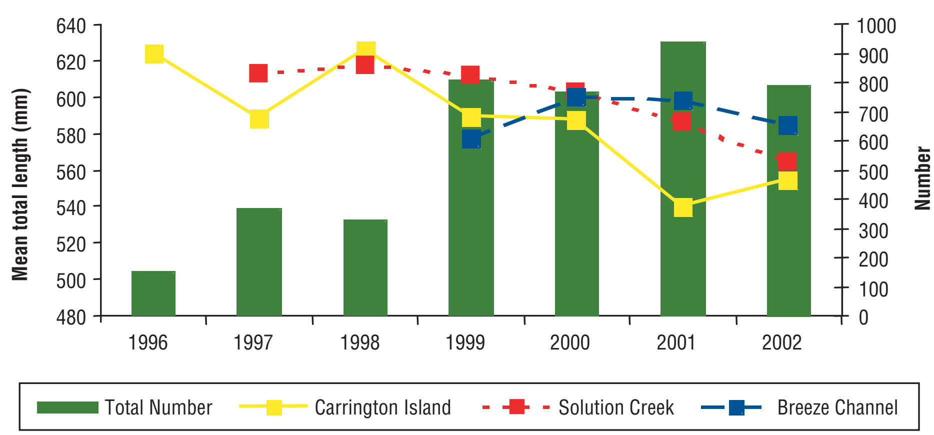


Figure 6. Total number and mean total length of lake trout removed from or near spawning areas, Yellowstone Lake, 1994–2002.

Where Did Those Lake Trout Come From?

Identification of the Source Population of Lake Trout in Yellowstone Lake Using Otolith Microchemistry

Adapted from an article by
Andrew R. Munro, and Thomas E. McMahon, Montana State University;
James R. Ruzycki, Yellowstone National Park

Where did those lake trout come from? When were they introduced to Yellowstone Lake? Although we may never know "who did it," scientists recently narrowed the "where" and "when" possibilities using some fascinating detective work.

Lake trout were first discovered in Yellowstone Lake in 1994. Although Lewis and Heart Lakes were stocked with lake trout in the 1890s, Yellowstone Lake was never officially stocked. Lewis Lake, located 10 highway kilometers (6.2 miles) from the West Thumb of Yellowstone Lake, is considered the most likely source for lake trout, as road access exists to both lakes. Heart Lake is accessible only by trail 13 km (8 miles) from Yellowstone Lake. Since both Lewis and Heart Lakes are located across the Continental Divide from Yellowstone Lake and not connected to its drainage, it is unlikely that lake trout moved there by natural means.

Since 1994, more than 56,200 lake trout have been removed from Yellowstone Lake via gillnetting.

Lake trout otolith "fingerprints" helped unravel questions of both stocking origin and timing. Otoliths are calcium carbonate structures located in the inner ears of fish that grow by continually adding new layers, and they are used to age fish. Trace elements from the water, such as strontium, are incorporated into the new layers of otolith, imparting a unique elemental signature, or fingerprint, that can then be used to help identify where a fish lived at different times of its life.

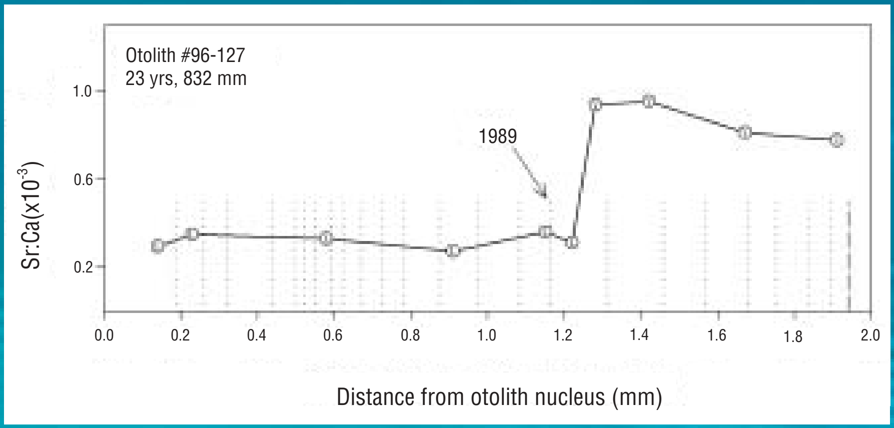
During lake trout removals in 1996–97, some comparatively large fish were captured in Yellowstone Lake. Aquatics biologists suspected that these larger fish could be original transplants.

We analyzed otolith microchemistry of 20 of these fish and compared them to lake trout thought to have spent their entire lives in Yellowstone Lake. We also compared them to lake trout from Lewis and Heart Lakes.

Strontium/calcium (Sr:Ca) ratios in the otolith edge representing recent years taken from the suspected transplants matched the Sr:Ca of lake trout that had spent all of their lives in Yellowstone Lake.

Cross section of an otolith.

Figure 7. **The shift in the strontium/calcium ratio noted in 1989 provides evidence that these lake trout inhabited both Lewis and Yellowstone Lakes.**



In contrast, the Sr:Ca near the center of the otoliths, reflective of the environment the fish experienced during their first year of life, was much lower in 18 out of 20 of the suspected transplants and did not match that of lake trout in Yellowstone Lake. This lower ratio, however, did match that of Lewis Lake fish, making it the likely source of the introduced lake trout.

We estimated the date of introduction by measuring otolith Sr:Ca from three fish suspected to be transplants. The location where ratios changed were compared with annual banding patterns in hopes of estimating the year that unauthorized introduction(s) took place. Low Sr:Ca ratios from the early growth period of these three fish increased abruptly about three-fold to the edge of the otolith. The inner zone matched that of Lewis Lake fish while the outer zone matched suspected offspring sampled from Yellowstone Lake. The abrupt increase occurred about 1989 in two of the fish (Figure 7) but not until 1996 in the third. We also analyzed two 10–11 year old fish with Sr:Ca ratios in both zones matching other Yellowstone Lake fish, suggesting they were naturally reproduced in the lake.

These studies suggest that lake trout have been naturally reproducing in Yellowstone Lake since 1986 or 1987. Many lake trout were transplanted into Yellowstone Lake from Lewis Lake, or from a lake with a similar Sr:Ca fingerprint, and the introductions began as early as the mid-1980s and possibly continued as late as 1996. Our initial detective work will guide management strategies to prevent future illegal introductions.

Understanding the Effects of Whirling Disease

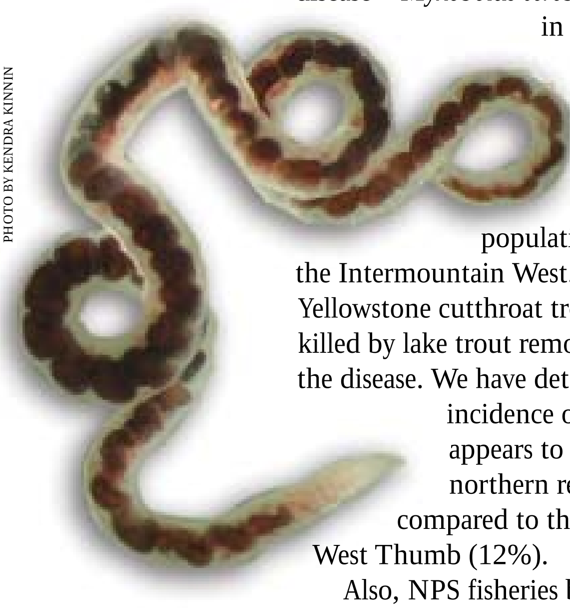


PHOTO BY KENDRA KINNIN

The microscopic worm Tubifex tubifex *is the alternate host for the whirling disease life cycle and a focus of study for understanding this disease in Yellowstone.*

The causative agent of salmonid whirling disease—*Myxobolus cerebralis*—was first detected in Yellowstone Lake in 1998.[18] This discovery immediately caused great concern because the disease has devastated wild trout populations in other waters of the Intermountain West.[19] Annually, adult Yellowstone cutthroat trout that are incidentally killed by lake trout removal efforts are tested for the disease. We have determined that the incidence of whirling disease appears to be higher in the northern region of the lake (19%) compared to the south arms (9%) or West Thumb (12%).

Also, NPS fisheries biologists have exposed age-zero Yellowstone cutthroat trout to lake tributary waters each year since 1999 in an attempt to determine the distribution of *M. cerebralis* in the basin, and the characteristics of the environment that are conducive to the disease. In 2001, positive tests for the presence of *M. cerebralis* were obtained from trout exposed in the Yellowstone River and Pelican Creek (Table 1). Fishes exposed in all other streams did not become infected, including those exposed at Clear Creek, where a single fish tested positive during September 2000. Lower Pelican Creek in the vicinity of the road viaduct is highly infected. All Yellowstone cutthroat trout exposures conducted there to date have resulted in positive tests for the presence of whirling disease. These exposure tests were repeated in 2002 and laboratory examination of fishes is now being conducted to determine the extent of infection.

In 2001 and 2002, we completed the first survey of *Tubifex tubifex* worms and substrate conditions in the same streams used for exposures of trout.[20] *T. tubifex* is the alternate host and is required for whirling disease to

Table 1. Results of Yellowstone cutthroat trout sentinel fry exposure testing 1999–2001. Positive (Pos) indicates the causative agent of whirling disease (Myxobolus cerebralis) *was detected in the cutthroat trout fry. The average histological score (Avg Histo) is from lab examination and is based on ranking from 0–5, with 5 being the most severe infection.*

Stream	Year	Period	Dates	Pos/Neg	Avg Histo
Yellowstone River	1999	1	08/12–08/23	Pos	0.20
	2000	1	09/12–09/23	Neg	0.00
	2000	2	09/25–10/05	Neg	0.00
	2000	3	10/09–10/19	Neg	0.00
	2001	1	07/14–07/23	Pos	0.40
	2001	2	08/07–08/17	Pos	0.07
	2001	3	08/29–09/07	Neg	0.00
Pelican Creek	2000	1	09/12–09/23	Pos	2.76
	2001	1	07/12–07/23	Pos	4.00
	2001	2	08/07–08/17	Pos	1.00
	2001	3	08/29–09/07	Pos	2.72
Clear Creek	1999	1	08/12–08/23	Neg	0.00
	2000	1	09/12–09/23	Pos	0.02
	2000	2	09/25–10/05	Neg	0.00
	2000	3	10/09–10/19	Neg	0.00
	2001	1	07/12–07/23	Neg	0.00
	2001	2	08/07–08/17	Neg	0.00
	2001	3	08/29–09/07	Neg	0.00

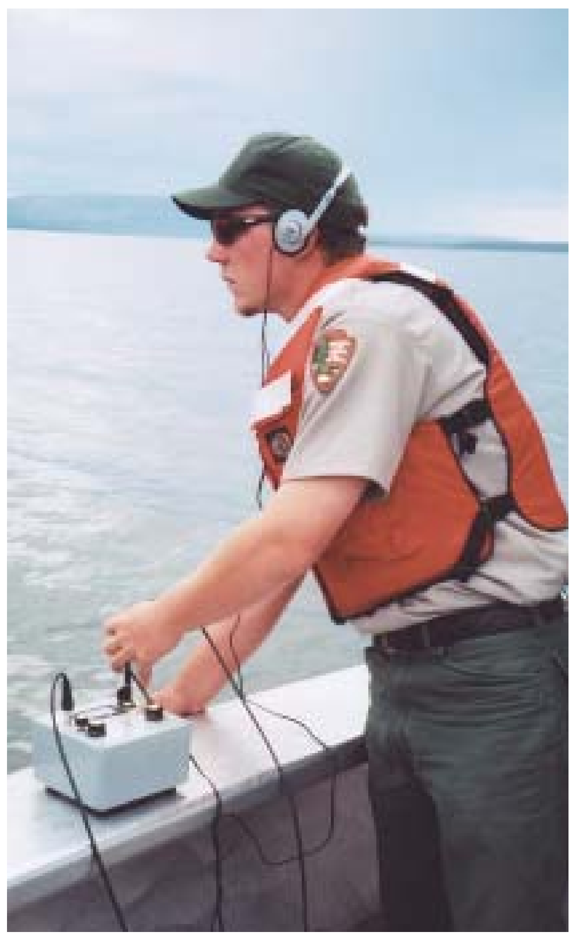
persist in streams. We located *T. tubifex* hosting actinospores in Yellowstone River, Bridge Creek, Arnica Creek, Little Thumb Creek, Creek 1167, Sewer Creek, and Beaverdam Creek. Recent results of genetic examination of these worms has determined that the infection in Yellowstone River and Pelican Creek (from worms sampled in 2002) is indeed *M. cerebralis*, the parasite that causes whirling disease.

There is a high risk of infection in additional tributaries to Yellowstone Lake that are suitable for the persistence of the disease. Results from our analyses of landscape-level basin characteristics indicate that Beaverdam Creek, Trail Creek, and Chipmunk Creek, tributaries to the South and Southeast Arms of Yellowstone Lake, are likely candidates for infecting migrating Yellowstone cutthroat trout with *M. cerebralis*. These tributaries flow through broad deltas with abundant fine sediments (similar to Pelican Creek) prior to entering the lake. Additionally, the Yellowstone River and/or its tributaries in the vast region above Yellowstone Lake may harbor whirling disease. To date, we have not had the ability to conduct exposure studies or take fish samples in this extremely remote section of the park. Our overall goal is to determine the portion of our annual Yellowstone cutthroat trout year class that we are losing to whirling disease each year. Results will have implications for management in Yellowstone National Park and also for many other regional managers concerned about whirling disease and native cutthroat trout conservation.

Movement Patterns Within Yellowstone Lake

Whirling disease research has suggested young Yellowstone cutthroat trout are becoming infected primarily in the Yellowstone River and Pelican Creek. We were interested in determining the movement patterns of spawning adults from these streams and Clear Creek, the site of our long-term spawning migration trap, in Yellowstone Lake. Twenty-four Yellowstone cutthroat trout adults were fitted with ultrasonic tags and tracked from July through September 2002. Ten fish locations were identified representing six of the 24 tagged fish. Of these, three fish were tagged at the Yellowstone River near Fishing Bridge, two were tagged at Pelican Creek near the road viaduct, and one was tagged at the Clear Creek fish trap. Eight of the ten tag locations and relocations occurred in the northern region of the lake near Storm Point, Pelican Creek, the Yellowstone Lake outlet, and Stevenson Island. The greatest movement we observed was by a Clear Creek fish relocated in the West Thumb near Arnica Creek, and by a Yellowstone River fish relocated south of Elk Point along the lake's eastern shore. This research provides additional evidence that Yellowstone cutthroat trout can disperse widely throughout Yellowstone Lake following spawning in specific tributary streams.

Volunteers on a T. tubifex *search.*



NPS Fisheries Technician Mike Ruhl listens for the signal from an ultrasonic tagged cutthroat trout in Yellowstone Lake, July 2002.

Hydroacoustic Surveys to Document Population Change

Surveys using state of the art hydroacoustic equipment, for estimating fish densities, were conducted three times throughout Yellowstone Lake during the 2002 field season. Thorough analysis of hydroacoustic data collected this past field season will allow us to determine areas of high density, size ranges of fish in given areas, and depths at which fish are residing. Combining this data with detailed bathymetry data produced by the U.S. Geological Survey will allow us to identify lake areas where we need to either increase or decrease our lake trout gillnetting effort to improve efficiency. We will also be able to use this technology to evaluate the effectiveness of our removal efforts by estimating lake trout and cutthroat trout population densities annually.

PHOTO BY MIKE STARK OF THE *BILLINGS GAZETTE*. REPRINTED WITH PERMISSION.

NPS Fisheries Biologist Patricia Bigelow measures the angle of sonar equipment attached to the side of the fisheries boat Hammerhead. *Bigelow uses the sonar equipment to determine and track densities of cutthroat trout and nonnative lake trout in Yellowstone Lake.*

Westslope Cutthroat Trout Restoration

Population Surveys

For the past few decades, park fishery personnel have been gathering population abundance data and size structure information about the westslope cutthroat trout (*Onchorhynchus clarki lewisi)* residing in Fan Creek. This native trout was historically abundant in the Gallatin and Madison Rivers, but currently only remnant populations reside in headwater sections of the Gallatin River watershed. Since 1998, fish population estimates have been conducted periodically at the mainstem monitoring site (WC3) and at several 100-meter sections in each of the two forks of Fan Creek (Figure 8). Multiple samplings indicate that the abundance of westslope cutthroat trout is relatively low throughout the watershed. The consistently higher densities of trout in the North Fork were observed in areas with abundant woody debris in the stream channel. Westslope cutthroat trout from the drainage were typically small (less than 200 mm total length), although several individuals from the East Fork measured more than 10 inches (Figure 8). Preliminary age analyses in 2001 suggested that at least three distinct year classes of cutthroat trout reside in Fan Creek. Another native species, the mottled sculpin (*Cottus bairdi),* was frequently collected at all sites except the upstream areas of the North Fork of Fan Creek.

Genetics Surveys

Surveys initiated by park fishery biologists in the early 1990s suggested that the most likely concentrations of genetically pure westslope cutthroat trout were located in the Gallatin and Madison watersheds. With the advent of non-lethal analyses in the past several years (i.e., use of fin tissue rather than major organs), the Aquatics Section has expanded this genetic inventory. More than 300 individual fish have been sampled, but only about half of them have been analyzed thus far. Data from multiple samplings indicate that the only genetically pure population of westslope cutthroat trout in the park resides in Fan Creek (Figure 9). Although five genetically pure westslope cutthroat trout were collected near the confluence of Fan Creek and the Gallatin River in 1997, subsequent samplings upstream suggest that the population has hybridized with Yellowstone cutthroat trout, rainbow trout (*Onchorhynchus mykiss*), or both, in most of the Fan Creek mainstem. Depending on the particular site, population level hybridization varied from low to moderate. For example, 25 of 31 trout analyzed in the East Fork of Fan Creek were genetically pure cutthroat, but the population level purity is only 81 percent due to nonnative genetic material being present in the other six fish.

Data obtained from multiple samplings indicates that the only genetically pure population of westslope cutthroat trout in the park resides in Fan Creek.

Life History Strategies at Fan Creek

To achieve adequate protection of westslope cutthroat trout in the Fan Creek watershed, park biologists needed a more complete understanding of seasonal distribution and movements. We began a cooperative graduate study in fall 2000 to examine some of these patterns (see Acknowledgments). During the following 18 months, 30 adult and subadult westslope cutthroat trout were radiotagged and tracked. As this study nears completion, three preliminary findings are worth noting. First, a large majority of the tagged fish could be regarded as resident fish that migrated only a few kilometers over the course of the year. Second, many of the tagged fish migrated downstream in

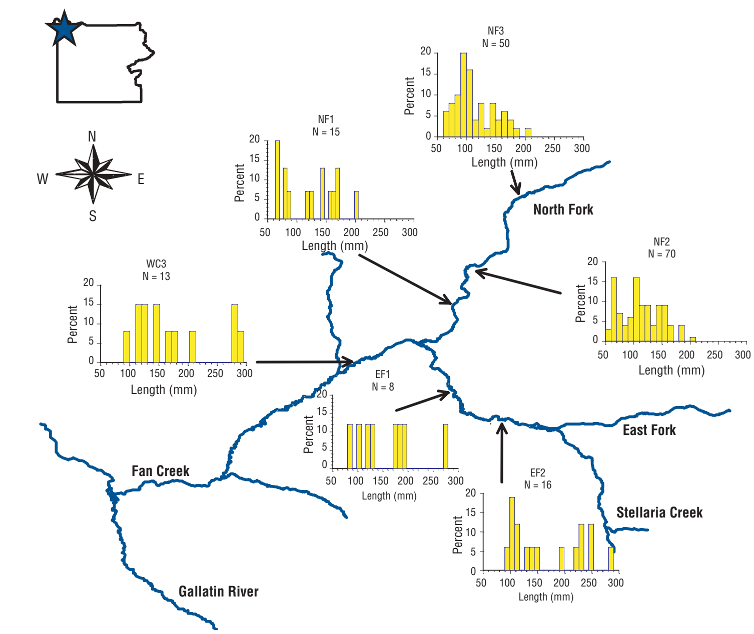


Figure 8. Relative length frequencies of westslope cutthroat trout at sample sites in the Fan Creek drainage, 2002.

late fall. The reason for this movement is unknown; however, similar results were observed during 1998 genetic surveys, when low-gradient meadow stream sections that contained abundant numbers of cutthroat trout during the summer were barren in the fall as fish apparently moved to more complex, forested habitats downstream. Finally, the largest concentration of spawning cutthroat observed in 2002 was located in the North Fork of Fan Creek. This is also the portion of the watershed containing the genetically pure population.

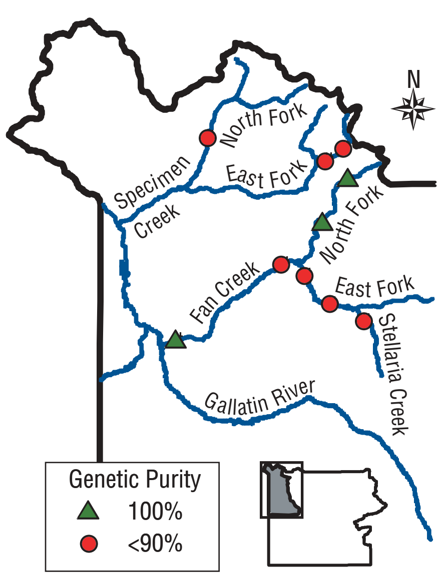


Figure 9. Genetic purity of westslope cutthroat trout in the Gallatin Range, 1998–99. The North Fork Fan Creek population is the only known genetically pure population remaining in Yellowstone National Park.

Restoration Potential

Along with protection of aquatic resources as pristine ecosystems, preservation and restoration of native species is one of the most important aquatic management objectives in Yellowstone National Park. The electro-fishing, genetic, and radio-tagging fishery surveys of the past several years have demonstrated that the once abundant westslope cutthroat trout is now confined to a single, small tributary in the northwest corner of the park. Unlike many other areas in historical westslope cutthroat trout range, habitat degradation and continuous high angler harvest rates are not implicated in the decline of westslope cutthroat trout in Yellowstone National Park. Extensive stocking and subsequent establishment of populations of nonnative competing species (rainbow trout and brown trout (*Salmo trutta*)) and interbreeding with rainbow trout and Yellowstone cutthroat trout have led to serious reductions in resident westslope cutthroat trout populations.

The current status assessment of westslope cutthroat trout indicates that the North Fork Fan Creek population is the only viable population in the park and should be considered an "at risk" population. Although these fish are protected from habitat degradation or strong impacts by anglers, the evidence from our surveys reveals that these fish could be affected by nonnative fish species. The capture of a nonnative brown trout at the WC3 site in 2002 indicates an apparent lack of barriers and the vulnerability of the headwater cutthroat trout populations to invasion from downstream sources.

Complete protection requires that the North Fork Fan Creek population be permanently isolated from invading species. To address this objective, a three-phase approach will be utilized. First, plans are being developed to select a site and design a barrier that will prevent upstream migration of competing species into the North Fork. After the barrier is constructed and shown to be effective, removal of hybridized individuals (primarily in the East Fork of Fan Creek) will be initiated to lessen opportunities of hybridization. Concurrently, a brood stock derived from the North Fork westslope cutthroat trout population will be developed in cooperation with Montana and Wyoming state fishery agencies. As ongoing abundance estimates and genetic testing dictate, juvenile fish produced from the North Fork of Fan Creek population will be available for restoration projects at suitable sites in nearby streams.

Stream Fishery Surveys and Fish Health

Population Surveys

Traditionally, these projects have involved long-term monitoring to describe the responses of a fish population to a particular type of angler impact (e.g., minimum size, reduced creel, or catch and release regulations). As the number of threats to fish populations increases, these studies have become shorter term (i.e., 3–5 years) so park management can attempt to respond to impacts in a more timely manner.

For the third consecutive year, we sampled four separate sections of the Gibbon River. The principal objective of this study was to monitor impacts to portions of the stream near areas of major road reconstruction. The Madison-to-Norris road reconstruction is probably one of the most ambitious projects that the park has undertaken in recent years. In addition to typical modernization of much of the existing road, several kilometers of road are to be removed and a new route and bridge over the Gibbon River will be built. Thus the potential for increased sediment input into the stream and resulting habitat degradation is very high. More importantly, this project represents one of the first attempts to restore a stream segment that has been seriously affected by historical road building. Much of the work will occur in an area that was originally barren of fish, but the sections downstream from Gibbon Falls (Tuff Cliffs and Canyon Creek sample areas) historically contained westslope cutthroat trout and the riverine form of arctic grayling. Cutthroat trout have been eliminated from the Gibbon River, but occasionally grayling are captured. Our secondary objective in this study is to examine effects of the construction project on the few grayling that may reside in the lower sections of the stream.

No grayling were captured during 2002 in the Gibbon River and only two were caught the previous year. Brown trout was the most common fish collected at each of the four sample areas and was the only species captured in the Tanker Curve section. Rainbow trout were only captured downstream from Gibbon Falls. Estimated abundance of brown trout has varied among years, but typically averages from 400 to 800 fish per kilometer (Figure 10). This widespread high density of a competitive nonnative species could be one of the factors contributing to the rarity of native grayling throughout the Gibbon River watershed.

Another multiple year road construction survey was conducted at Antelope Creek, which enters the Yellowstone River just upstream from Tower Falls. The stream contains a population of small Yellowstone cutthroat trout. Abundance and average size of these fish were similar to that noted for the headwater population of westslope cutthroat trout in Fan Creek. Because access to tributary streams is extremely limited throughout most of the Grand Canyon of the Yellowstone, the cutthroat trout residing in Antelope Creek may represent an unusual local adaptation to restricted habitat.

In response to concerns related to perceived excessive angler use and potential riparian damage, the fisheries staff initiated a multi-year population assessment of Yellowstone cutthroat trout in Slough Creek. In the mid-1990s, annual angler use occasionally exceeded 25,000 hours but has since returned to levels observed ten years earlier. Concurrently, hourly catch rates declined to below one fish per hour. With this information as background, some of the more heavily used portions of Slough Creek were sampled in 2001 and 2002. Preliminary results

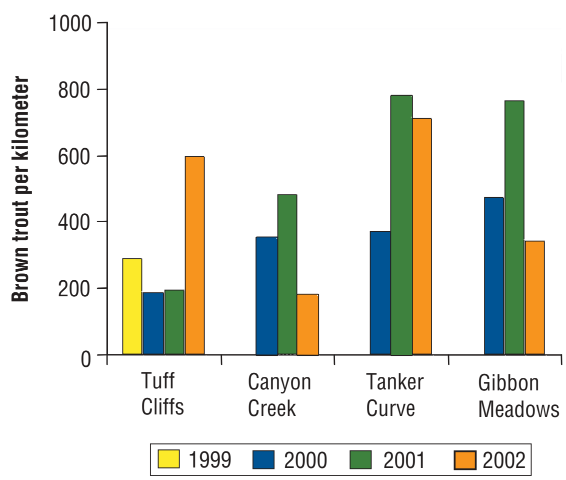


Figure 10. Population abundance of brown trout estimated by electrofishing at road reconstruction sites, 1999–2002.

NPS fisheries technicians Anna Maki and Mike Ruhl use electrofishing gear to sample fishes in the upper Gallatin River, August 2002.

indicate that the Yellowstone cutthroat trout population has changed little since the stream was last sampled in 1989.[21] Despite high levels of angler use in this catch and release fishery, we estimate that there are several hundred adult cutthroat trout (longer than 330 mm) per kilometer in Slough Creek.

Surveys for Fish Health

In addition to population abundance, overall physical health of specific fish populations is important to fishery management objectives in the park. Most of the work has focused on whirling disease; more than 60 rainbow trout and brown trout from the Firehole River were sampled in 2002. However, other surveys are also conducted to monitor the status of populations in the park. As part of the U.S. Fish and Wildlife Service National Fish Health Survey, park biologists periodically collect fish that are lethally sampled and examined for a variety of parasitic infections and bacterial and viral diseases. In 2002, rainbow trout and brook trout from Tower Creek were collected and submitted for analyses. Water from this particular stream is being proposed for dust abatement during Dunraven Road reconstruction. Because Antelope Creek parallels portions of the project, a source of pathogen-free water is needed. As part of the national baseline survey, we also submitted several dozen mountain whitefish *(Prosopium williamsoni)* from the Snake River for analyses. Finally, 25 rainbow trout and brown trout from a tributary of Fan Creek were collected and submitted for disease analyses. These fish will function as "surrogates" for fish health testing in the Fan Creek watershed. This allows us to assure that pure cutthroat trout are not sacrificed, yet still obtain critical information about the disease-free status of the watershed. Results from these health status surveys are pending.

Genetics Surveys

Preservation of native trout genes is an important management priority in Yellowstone. As nonlethal analysis techniques are now available, extensive sampling of small or other at risk populations is possible. In addition to the large amount of sampling of suspected westslope cutthroats in the Gallatin River watershed, fin tissue samples for genetic determination have been collected from Antelope Creek, Slough Creek, Soda Butte Creek, and Gneiss Creek, a tributary of the Madison River. At all of these sites, the possibility of hybridization with nonnative rainbow trout may have occurred. Several hundred fish have not yet been analyzed. Large backlogs of samples at the analytical laboratories and funding constraints continue to delay determination of the genetic status of these important fish populations.

Invasive Aquatic Exotic Species Threaten the Park

In addition to the parasite that causes whirling disease, Yellowstone National Park aquatic systems have been invaded by the New Zealand mudsnail *(Potamopyrgus antipodarum)*. Mudsnails are extremely small (about 4–5 mm long) and highly prolific.[22] First found in the park in 1994, mudsnails now occupy the Firehole, Gibbon, Madison, and Gardner Rivers, Polecat Creek, and likely others. Recent research indicates that these animals have been out-competing and displacing native invertebrates. Dr. Billie Kerans at Montana State University reported that mudsnails comprised 25–50 percent of macroinvertebrates in the Gibbon and Madison Rivers, and that fewer native mayflies, stoneflies, and caddisflies occur in areas occupied by mudsnails.[23] The effect of these invaders on fish is unknown, but recent research indicates that mudsnails can pass completely through the gut of a fish unharmed while offering no nutritional value.

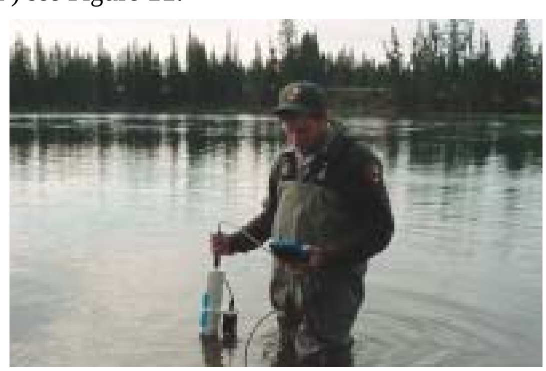
It would be nice to think that the waters of Yellowstone National Park could remain in a relatively pristine condition for future generations to enjoy, but this will not be the case without changes to the way we manage the movement of equipment, boats, and other gear among waters in our region. Presently, invasive exotic aquatic species occur in streams, rivers, and lakes (both near the coasts and inland) all across the United States.[24] While we may never know exactly how the parasite that causes whirling disease and the New Zealand mudsnail were introduced to the park, anglers can help prevent the additional spread of these animals, or of the many other invasive exotic species approaching our boundaries (e.g., zebra mussels, Eurasian watermilfoil, round goby).

Anglers should thoroughly clean all mud, plants, and debris from fishing equipment and inspect footwear before leaving the angling site. We also recommend treating waders and boots with a 10 percent bleach solution. Boaters entering the park must completely remove plant material or any other debris from trailers and boat hulls; bilge areas and livewells must be thoroughly drained and likewise cleared of debris. The entire boat should be cleaned with hot (higher than 140° F) water and allowed to dry for several days. Boat transport is a primary method by which these harmful animals are moving among waters in our country. Only through actions like these will we be able to stop the additional spread of invasive exotics.

Establishment of Long-term Water Quality Monitoring

During 2002, we initiated a water quality monitoring program in Yellowstone National Park. The goal of this program is to evaluate the ecological integrity of park ecosystems by monitoring a variety of aquatic environments. Twelve water quality sites were established on major river basins (Figure 1). Biweekly sampling was initiated in May and is now being continued throughout the year. For each sample location, field instruments are used to collect temperature, dissolved oxygen, pH, conductivity, and turbidity. These parameters are easy to collect, influence abundance and distribution of aquatic organisms, and are universally used in most water quality programs.

Temperature and dissolved oxygen readings varied considerably throughout the 2002 season and at various locations. These differences are primarily due to seasonal temperature changes, altitude differences, and thermal influences that affect many of the water quality sites. Highest average temperatures occurred on the Firehole River, which is heavily influenced by thermal activity, with temperatures ranging from 17.9° C to 25.7° C (64.2°F to 78.3°F) see Figure 11. Lowest average temperatures occurred on upper Soda Butte Creek with ranges between 3.8° C and 14.6° C (38.8°F to 58.3°F) from 28 May–27 September. Pelican Creek, a slow moving tributary of Yellowstone Lake, exhibited the lowest recorded dissolved oxygen concentration of 6.1 mg/L on 02 July.



NPS Aquatic Ecologist Jeffery Arnold lowers a monitoring probe into the Yellowstone River as a part of the long-term water quality monitoring program, August 2002.

Limnology of Yellowstone Lake

Five water quality sites were reestablished on Yellowstone Lake during the 2002 season (Figure 2). Biweekly sampling was initiated in June and continued through September. This work is extremely important because the physical and chemical conditions within Yellowstone Lake dictate fish distribution patterns. For example, thermocline (region of great water temperature change) establishment during July will typically cause lake trout to retreat to lower depths within the lake (Figure 12).

> **The new program for monitoring macroinvertebrates will also serve as an early warning system for the presence of additional exotic invasive species entering the park.**

Macroinvertebrate Monitoring

Aquatic macroinvertebrate monitoring was initiated to supplement water quality data and establish current inventories and distributional patterns. The new macroinvertebrate monitoring program will also serve as an early warning system for the presence of additional exotic invasive species entering the park. Aquatic macroinvertebrates are ideal biotic indicators—easy to collect, relatively immobile, long in life span, and sensitive to environmental changes. Because macroinvertebrates are sensitive to environmental stressors, changes in community structure will indicate pollution problems (physical or chemical) that may not be detectable with routine, chemical water quality analysis. During 2002, the Aquatics Section worked in conjunction with the Greater Yellowstone Vital Signs Monitoring Network to conduct invertebrate studies within three National Park Service units (Bighorn Canyon National Recreation Area, Grand Teton National Park, and Yellowstone National Park). Yellowstone staff sampled a total of 40 sites during August and again in October to assess aquatic macroinvertebrate communities, inventory species distributions, and evaluate overall health of various lotic environments.

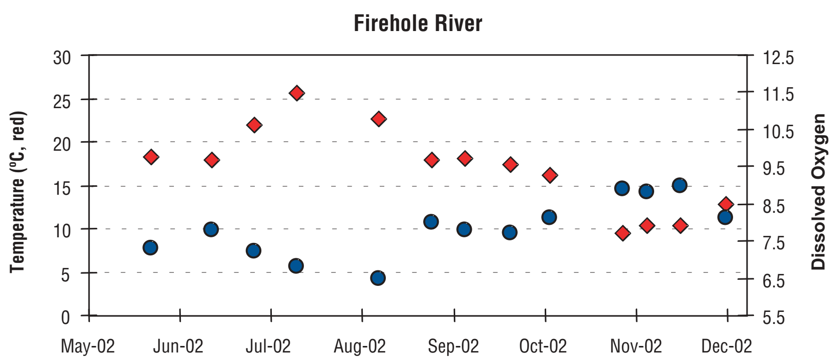


Figure 11. Water quality monitoring is documenting long-term trends in critical parameters such as temperature and dissolved oxygen of significant waters in the park. During the summer of 2002, the Firehole, Madison, and lower Gibbon Rivers were closed to fishing for several weeks due to high water temperatures.

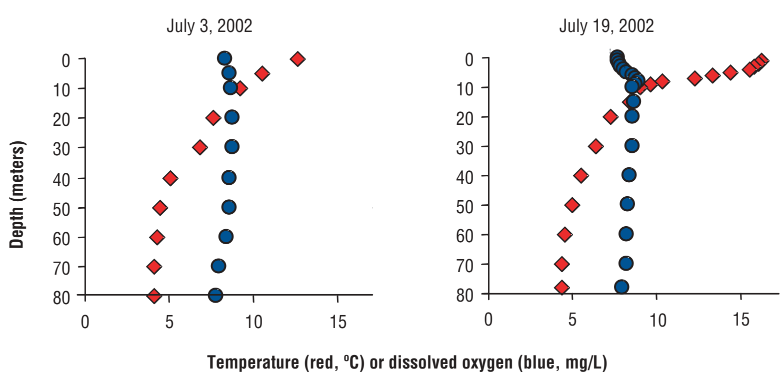


Figure 12. Understanding the physical and chemical characteristics of Yellowstone Lake will be extremely useful for efforts to target and remove nonnative lake trout.

Angling in the Park

Trends from the Volunteer Angler Report Cards

Visitation at Yellowstone National Park has been at an all-time high of 2.9–3.1 million each year since 1991. In 2002, 55,092 fishing permits were issued. A voluntary angler report card is provided with each permit and anglers have the opportunity to provide critical information to the Aquatics Section by returning these cards to the park.

Recent data from these report cards suggest that the average angler in Yellowstone typically fishes 2–3 days for about three hours each day. Greater than 80 percent of single-day anglers will land one or more fish, with cutthroat trout being the most frequently captured, followed by rainbow trout, brook trout (*Salvelinus fontinalis*), and brown trout. Most anglers (more than 80%) have reported being satisfied with their overall fishing experience while in Yellowstone, and more than 70 percent of anglers have reported being satisfied with numbers and sizes of fish landed. The most popular fishery in the park is Yellowstone Lake, which consistently attracts more than half of all anglers. The average angler on Yellowstone Lake lands about one cutthroat trout for every hour of fishing (Figure 13). In recent years, the average size of cutthroat trout caught in Yellowstone Lake has increased to more than 400 mm (Figure 14). This trend is similar to that noted by our Aquatics Section September netting program, in that large cutthroat trout have comprised a significant proportion of the catch (Figure 4).

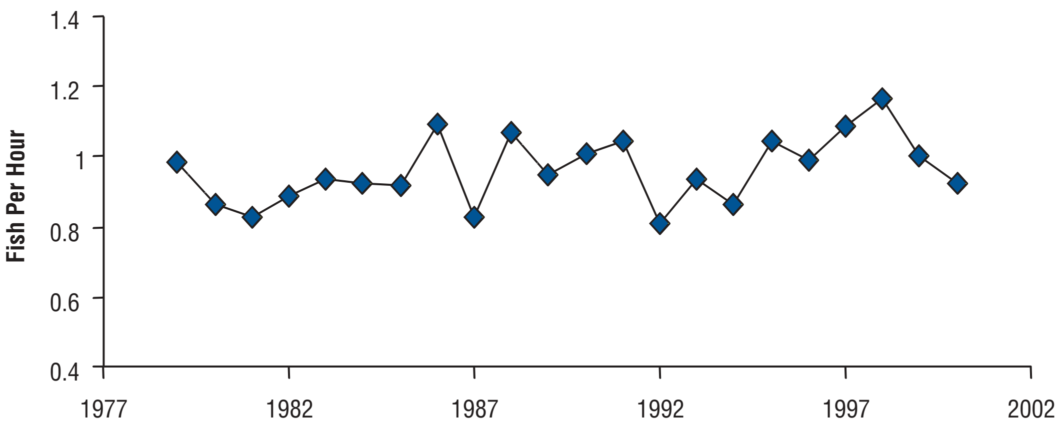


Figure 13. Yellowstone Lake remains the primary destination for over 50 percent of anglers visiting the park. Despite apparent declines in cutthroat trout densities there, the catch rate by anglers has remained very good at about one cutthroat caught per hour of fishing.

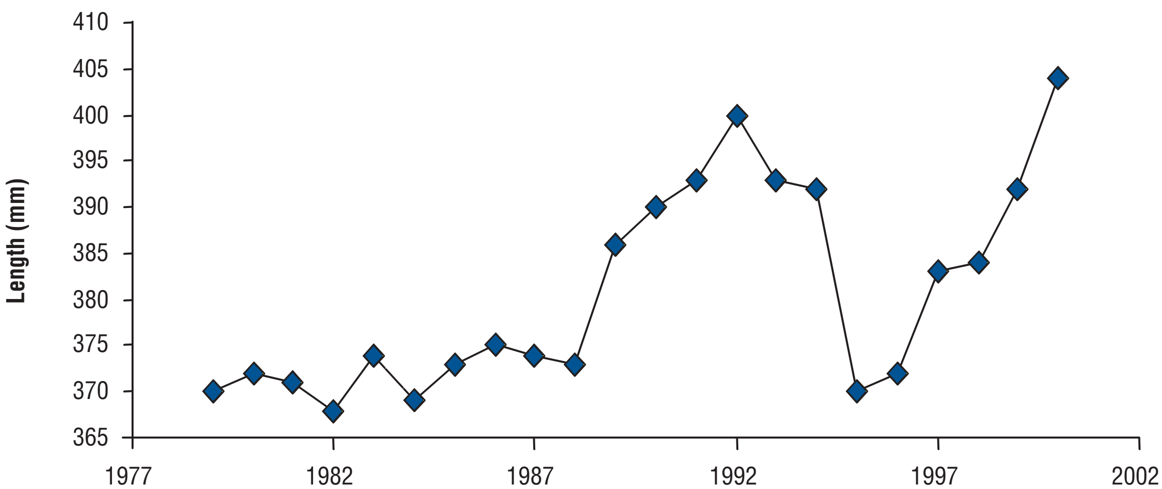


Figure 14. Average length of cutthroat trout landed by anglers in Yellowstone Lake. A significant increase in size of cuttroat trout in recent years is consistent with results of collections of NPS long-term monitoring programs.

Public Involvement

Yellowstone's fisheries programs benefited from 81 volunteers who dedicated a total of 6,382 hours in 2002.

Yellowstone Volunteer Fly-fishing Program

Much of the effort by Yellowstone's fisheries staff in recent years has been redirected at emerging crises such as lake trout removal and whirling disease, yet there are a multitude of other fisheries issues and questions to be addressed. There are an estimated 2,650 miles of streams and 150 lakes with surface waters covering 5 percent of Yellowstone's 2.2 million total acres. Realizing that NPS staff could not address many issues, a new program was established to incorporate fly-fishing volunteers and use catch-and-release angling as a capture technique to gather biological information on fish populations located throughout the park. In 2002 the Volunteer Fly-fishing Program was coordinated by Dr. Timothy Bywater, an avid fly-fisherman and long-time supporter and promoter of Yellowstone's fisheries. Projects addressed included:

- determination of the range of hybridized Yellowstone cutthroat trout in the Lamar River and its major tributaries;
- documentation of the Pebble Creek fishery;
- status and genetic uniqueness of brook trout in special regulation lakes;
- status and genetic uniqueness of westslope cutthroat trout in Grayling Creek; and
- documentation of the status and movement patterns of grayling originating in Grebe and Wolf Lakes of the Gibbon River system.

Dr. Timothy Bywater (left) coordinated the fly-fishing volunteer program, leading anglers to sites throughout the park.

Under this incredibly successful program, 40 volunteer anglers from across the United States traveled to the park and participated as an active component of the Aquatics Section. Solid bonds have been developed between the angling community and the Yellowstone fisheries biologists. Volunteers experienced first-hand many fisheries issues, and biological data collected will assist in our understanding of the park's fisheries status. However, the program suffers from a complete lack of funding; we are actively searching for support to continue this valuable work.

Long-term Volunteer Assistance

The Aquatics Section recruits long-term (more than 12 week) volunteers from the Student Conservation Association and other sources (see Appendix ii). Volunteers stay in park housing at Lake and work a full-time schedule similar to paid NPS seasonal staff. All aspects of the Aquatics Section are affected and greatly benefit from both long- and short-term volunteer support. In 2002, 81 volunteers dedicated a total of 6,382 hours.

Educational Programs

Aquatics Section staff continued to provide a variety of short-term educational programs for visiting schools and other interested groups. Of special note in 2002 was the incorporation of four high school scholars from St. Steven & St. Agnes School, Washington D.C. and their leader, Mansir Petree. This group spent over a week in the park interior working closely with NPS fisheries biologists, primarily on tributary spawning migration trap operations.

Collaborative Research

The Yellowstone Center for Resources through the Aquatics Section has provided direct and indirect support for collaborative research with scientists at other institutions, primarily universities. The studies address some of the most pressing issues faced by NPS biologists and other regional managers of aquatic systems.

Projects by Graduate Students

Graduate Student: Carrie Brooke (Master of Science candidate). *Committee Chair:* Dr. Al Zale, U.S. Geological Survey Cooperative Fisheries Research Unit and Department of Ecology, Montana State University. *Title:* Life history strategies of native westslope cutthroat trout in Fan Creek, Yellowstone National Park.

Graduate Student: Silvia Murcia (Master of Science candidate). *Committee Chair:* Dr. Billie Kerans, Department of Ecology, Montana State University. *Title:* Relating *Myxobolus cerebralis* infection in native Yellowstone cutthroat trout *Oncorhyncus clarki bouvieri* with environmental gradients at three spawning tributaries to Yellowstone Lake in Yellowstone National Park.

Other Research and Collaboration

The Aquatics Section continued to support a variety of other research projects in Yellowstone National Park. Of special mention is the research by the Great Lakes WATER Institute, University of Wisconsin at Milwaukee; Marquette University, Milwaukee; the U.S. Geological Survey, Denver; and Eastern Oceanics, Connecticut. Scientists from these institutions set up a laboratory at Lake and outfit the NPS Aquatics Section boat the *Cutthroat* with a submersible remotely-operated vehicle, or ROV, and study the physical, chemical, and biological characteristics of Yellowstone Lake, especially associated with hydrothermal vent systems.

A limited number of Yellowstone cutthroat trout gametes are collected by Montana Department of Fish, Wildlife and Parks from McBride Lake (Slough Creek drainage) and by Wyoming Game and Fish Department from the Yellowstone River at LeHardys Rapids. The Aquatics Section also intends to provide gametes from a small number of genetically pure westslope cutthroat trout from the North Fork of Fan Creek to the new broodstock development program at the Sun Ranch in the Madison Valley. In all cases, gametes are used for enhancement of native cutthroat broodstock and restoration activities in Montana and Wyoming. Each year, age-zero Yellowstone cutthroat trout from the broodstock (LeHardys Rapids origin) in Wyoming are returned to the park for whirling disease exposure studies.

PHOTO BY JEFFERY ARNOLD

NPS Supervisory Fisheries Biologist, Dr. Todd Koel, assists students searching for exotic New Zealand mudsnails on the Gardner River, September 2002.

Acknowledgments

Much appreciated administrative support for the Aquatics Section was given by Becky Anthony, Rene Farias, Melissa McAdam, Joy Perius, Beth Taylor, and Colleen Watson.

Jeff Lutch, who served as a Biological Technician for the Aquatics Section in 1995–2001, made significant contributions to our understanding of Yellowstone's fisheries, especially regarding the current status of westslope cutthroat trout in the Gallatin Range.

Many additional dedicated individuals from within Yellowstone National Park have contributed to the success of Aquatics Section activities; unfortunately we cannot mention them all here. However, we would like to especially thank Dave Hill, Earl McKinney, Susan Ross, Bruce Sefton, Melinda Sefton, Art Truman, Mark Vallie, Lynn Webb, and Dave Whaley from Lake Maintenance; Rick Fey and Kim West from Lake District rangers; and Wally Wines from Ranger Corral Operations.

The Aquatics Section is supported through Yellowstone Center for Resources base funding and by anglers visiting Yellowstone National Park through a portion of the fees collected from the Fishing Special Use Permits each year. We have received additional funding (2001–2002) from the following sources:

- Federal Highway Administration, Park Roads and Parkways Program
- Greater Yellowstone Coordinating Committee
- National Park Service, Natural Resource Challenge, Natural Resource Preservation Program
- National Park Service, Recreational Fee Demonstration Program
- National Park Service, Rocky Mountain Region, Cooperative Ecosystem Studies Unit
- National Park Service, Inventory and Monitoring Program, Vital Signs Monitoring Program
- National Partnership for the Management of Wild and Native Coldwater Fisheries, Whirling Disease Initiative
- Whirling Disease Foundation
- Yellowstone Association
- Yellowstone Park Foundation

We thank the many volunteers who have dedicated their time and also a great deal of other expense to our Aquatics Section; without them, much of what we do would not be possible.

Fly-fishing anglers from Trout Unlimited, Fly Fishing Federation, Henry's Fork Foundation, and many other organizations in the region and throughout the United States contributed hundreds of hours of time and costs associated with travel to our Volunteer Fly-fishing Program; for that we are extremely grateful.

Through collaboration with the U.S. Fish and Wildlife Service's Bozeman Fish Health Laboratory, the U.S. Geological Survey's Western Fisheries Research Center in Seattle, the Department of Ecology at Montana State University, the Montana Department of Fish, Wildlife and Parks, and the Wyoming Game and Fish Department, we have been able to learn a great deal about whirling disease in the Yellowstone Lake basin. We thank all the individuals from these agencies for their kind support.

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Appendices

Appendix i. Fish Species List

Native (N) and introduced (nonnative or exotic, I) fish species and subspecies known to exist in Yellowstone National Park waters including the upper Missouri (Missouri, Madison, and Gallatin Rivers), Snake River (Snake), and Yellowstone River (Yell R.) drainages.

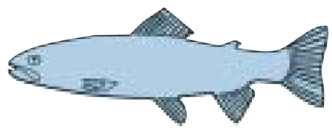
Family	Common Name	Scientific Name	Status	Missouri	Snake	Yell R.
Salmonidae	Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	Native	I	I	N
	westslope cutthroat trout	*Oncorhynchus clarki lewisi*	Native	N		
	finespotted Snake River cutthroat trout	*Oncorhynchus clarki behnkei*	Native		N	
	rainbow trout	*Oncorhynchus mykiss*	Nonnative	I	I	I
	mountain whitefish	*Prosopium williamsoni*	Native	N	N	N
	brown trout	*Salmo trutta*	Exotic	I	I	I
	eastern brook trout	*Salvelinus fontinalis*	Nonnative	I	I	I
	lake trout	*Salvelinus namaycush*	Nonnative		I	I
	Montana grayling	*Thymallus arcticus montanus*	Native	N		I
Catostomidae	Utah sucker	*Catostomus ardens*	Native		N	
	longnose sucker	*Catostomus catostomus*	Native			N
	mountain sucker	*Catostomus platyrhynchus*	Native	N	N	N
Cyprinidae	lake chub	*Couesius plumbeus*	Nonnative			I
	Utah chub	*Gila atraria*	Native	I	N	
	longnose dace	*Rhinichthys cataractae*	Native	N	N	N
	speckled dace	*Rhinichthys osculus*	Native		N	
	redside shiner	*Richardsonius balteatus*	Native		N	I
Cottidae	mottled sculpin	*Cottus bairdi*	Native	N	N	N

Appendix ii. Long-term Volunteers, 2002

Name	Period of Involvement	Hours
Anderson, Krisi	08/11/2002–11/02/2002	480
Clark, Kali	05/19/2002–08/10/2002	480
Favrot, Scott	04/15/2002–09/29/2002	960
Ivan, Lori	02/24/2002–03/20/2002	240
Ivans, Kelly	08/04/2002–10/26/2002	480
Jamin, Valerie	06/16/2002–08/10/2002	480
Lillesand, Michael	05/26/2002–08/17/2002	480
Matesanz, Silvia	08/11/2002–10/19/2002	480
Owens, Nathan	08/11/2002–11/02/2002	480
Steed, Amber	06/02/2002–09/29/2002	680

Appendix iii. Seasonal Staff, 2002

Name	Period of Involvement
Bear, Beth	01/01/2002–09/27/2002
Bywater, Timothy	06/03/2002–08/18/2002
Delheimer, Matt	05/19/2002–11/02/2002
Farias, Rene	01/01/2002–09/22/2002
Gale, Steve	01/01/2002–09/19/2002
Harnish, Ryan	05/19/2002–10/22/2002
Kasitz, Jon	05/19/2002–08/14/2002
Kinnin, Kendra	06/30/2002–09/22/2002
Maki, Anna	07/14/2002–11/02/2002
Morgan, Theresa	06/02/2002–11/02/2002
Rowdon, Barb	01/01/2002–12/31/2002
Ruhl, Mike	05/19/2002–10/26/2002
Seibel, Amanda	05/19/2002–08/30/2002
Wethington, Don	05/05/2002–11/02/2002
White, Davina	04/21/2002–10/18/2002



westslope cutthroat trout