

Yellowstone Cutthroat Trout Preservation



Yellowstone Cutthroat Trout Long-term Monitoring

Impacts of historical egg-taking operations and liberal angler harvest regulations for Yellowstone Lake cutthroat trout have long been noted in counts of upstream-migrating fish at Clear Creek (Figure 4). Only 3,161 cutthroat trout ascended Clear Creek in 1954, just two years prior to the cessation of fish culture operations on Yellowstone Lake (Figure 5). With the end of culture operations and the implementation of restrictive angling regulations, the population rebounded during the 1960s and 1970s; 70,105 cutthroat trout were counted at Clear Creek in 1978 (Jones et al. 1979; Gresswell and Varley 1988). Although there was variation among years, the increasing trend in cutthroat trout abundance within Yellowstone Lake was also indicated by the fall netting assessment. An average of 10.0 fish were caught per net by this assessment in 1969; in 1984, 19.1 fish were caught per net.

Contemporary data suggest that a significant decline has occurred in the Yellowstone Lake cutthroat trout population. The number of upstream-migrating cutthroat trout counted at Clear Creek was 917 during 2005 (Figure 5). This count was down from 1,438 in 2004; 3,432 in 2003; and 6,613 in 2002, and was the lowest count made at Clear Creek since 1945, the first year total annual counts were recorded there. The fish-counting station that has been operated since 1999 on Bridge Creek, a small northwestern tributary, was not operated in 2005 because of the near-total absence of cutthroat trout observed there during 2004 (Koel et al. 2005a, 2005b).

During 2003–2005, however, the fall netting assessment (Figure 5) provided some

of the first indications that the cutthroat trout population may be responding positively to efforts to remove non-native lake trout from Yellowstone Lake. An average of 7.4, 7.9, and 7.4 fish were caught per net in 2003, 2004, and 2005, respectively. Prior to 2003, there had been a reduction in catch by the fall netting program of 0–21% each year (averaging 11% per year) since 1994, the year lake trout were

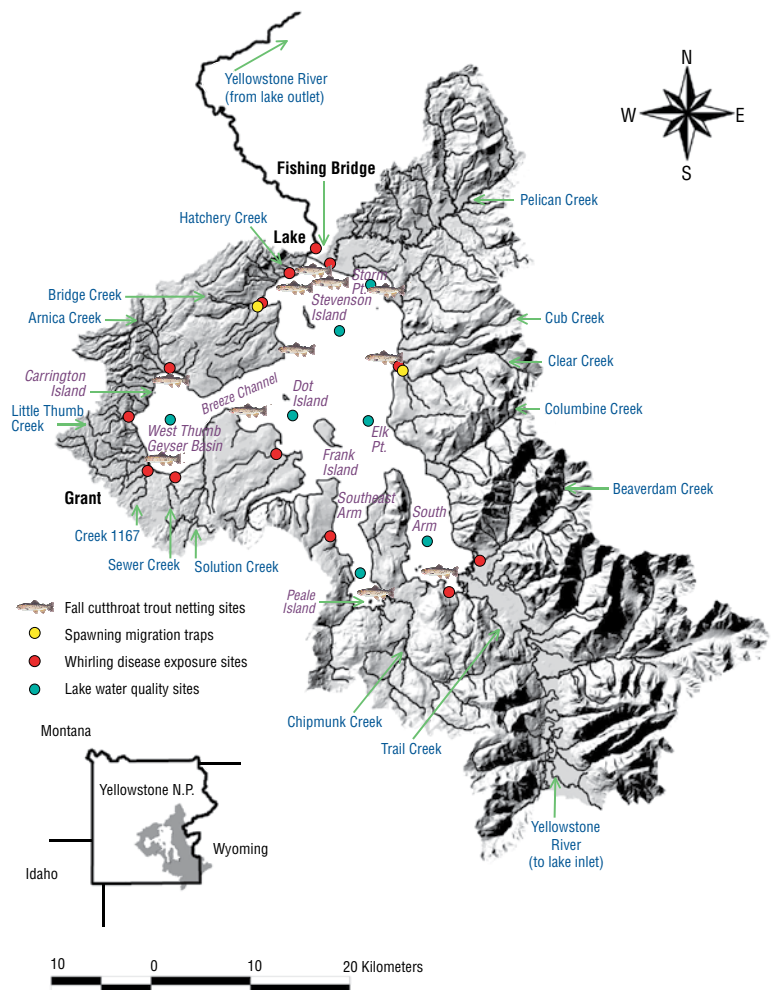


Figure 4. Yellowstone Lake and several major tributary drainages within Yellowstone National Park.

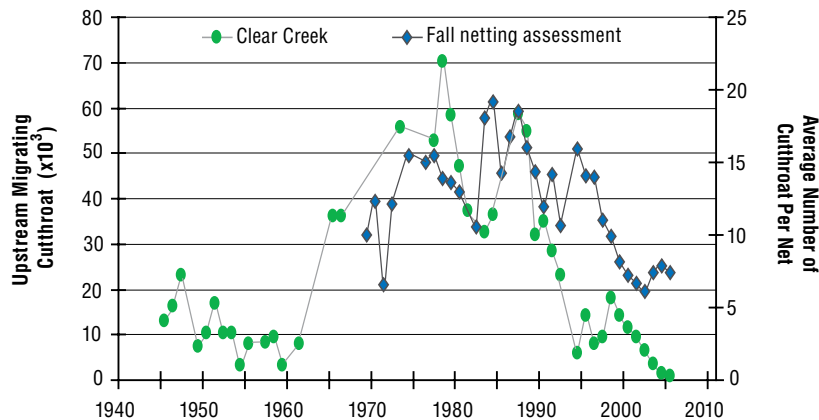


Figure 5. Number of upstream-migrating cutthroat trout counted at the Clear Creek spawning migration trap (1945–2005) and mean number of cutthroat trout collected per net during the fall netting assessment on Yellowstone Lake (1969–2005).

first discovered in Yellowstone Lake. Although dramatic increases in cutthroat trout within Yellowstone Lake are not yet being seen, the within-lake netting assessment suggests that cutthroat trout abundance has at least somewhat stabilized.

Length–frequency data from the fall netting program, 1997–2005, indicated an increase in length and reduction in numbers of adult cutthroat trout (>325 mm) in Yellowstone Lake (Figure 6). In 2004 and 2005, fewer fish between the lengths of 325 and 425 mm were collected compared to the number collected in earlier years. Historically, most cutthroat trout sampled in spawning tributaries such as Clear Creek were in this size range (Jones et al. 1993). However, an apparent increase in numbers of juvenile cutthroat trout (100–325 mm) has been noted in recent years (2002–2005). Many of these juveniles have been collected in the



University of Wyoming graduate research assistant Lusha Tronstad with a Yellowstone cutthroat trout at Clear Creek.

southern arms of Yellowstone Lake, which may act as refugia for cutthroat trout due to the low numbers of lake trout and low incidence of *M. cerebralis* in these areas (Koel et al. 2006). It is hoped that in the coming years, these juvenile cutthroat trout will recruit to the spawning population and appear in the lake’s spawning streams, including Clear Creek. The cutthroat trout are an important component of the Yellowstone Lake ecosystem; impacts to bears and anglers have resulted from the population decline (Koel et al. 2005b).

Lake Trout Suppression Program

A total of 36,438 lake trout were removed from Yellowstone Lake in 2005, which is more than were removed during any previous year of the suppression program (Figure 7). Of these, 35,088 lake trout were removed via gillnetting and 1,338 were removed by electrofishing (described below). The ratio of lake trout killed to cutthroat trout sacrificed remained low (only 0.04 cutthroat trout was lost for every lake trout killed). The overall gillnetting effort was maintained at a high level in 2005—7% higher than in 2003, and more than 22% higher than in 2004. Despite these high levels of removal effort, catch per unit of effort rose slightly for the third year in a row, to an average of 1.81 lake trout removed for every 100 meters of net placed in the lake over a period of one night (unit of effort). This catch rate was higher than those of 2003 and 2004, but remained dramatically below levels seen during the early years of the suppression program; in 1998, an average of 5.16 lake trout were caught with each unit of effort.

The majority of gillnets were set to target young lake trout residing at depths greater than those occupied by cutthroat trout (these are termed “control sets”; Figure 8). Small mesh (25–38-mm bar mesh) gillnets were placed on the lake bottom in water typically 40–65 m deep. As in past years, lake trout carcasses were returned to the lake to avoid removing nutrients from the system. On a typical day during June through September, more than 10 miles of control sets were in place fishing for lake trout

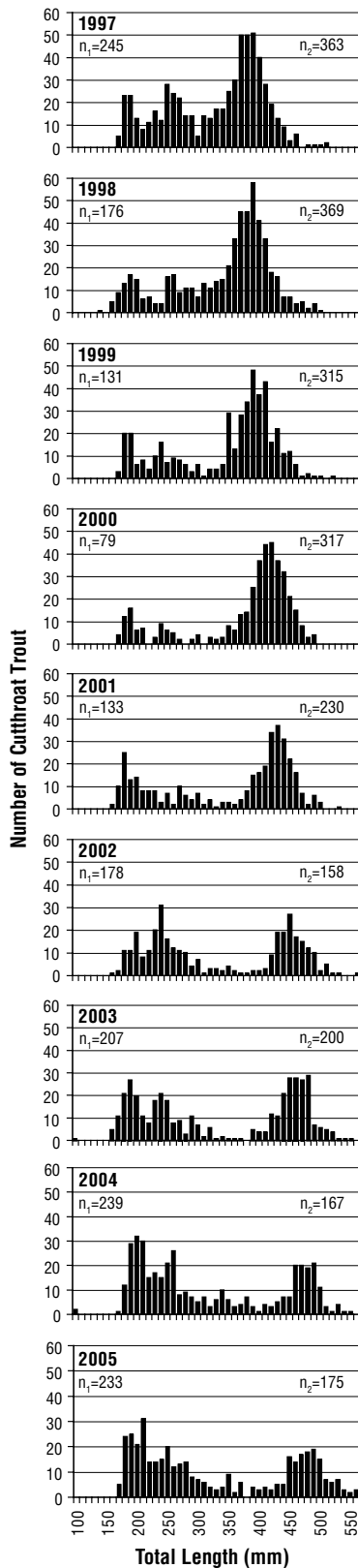


Figure 6. Length–frequency distributions of cutthroat trout collected during the fall netting assessment on Yellowstone Lake with total number of trout <325 mm (n_1) and >325 mm (n_2), 1997–2005.

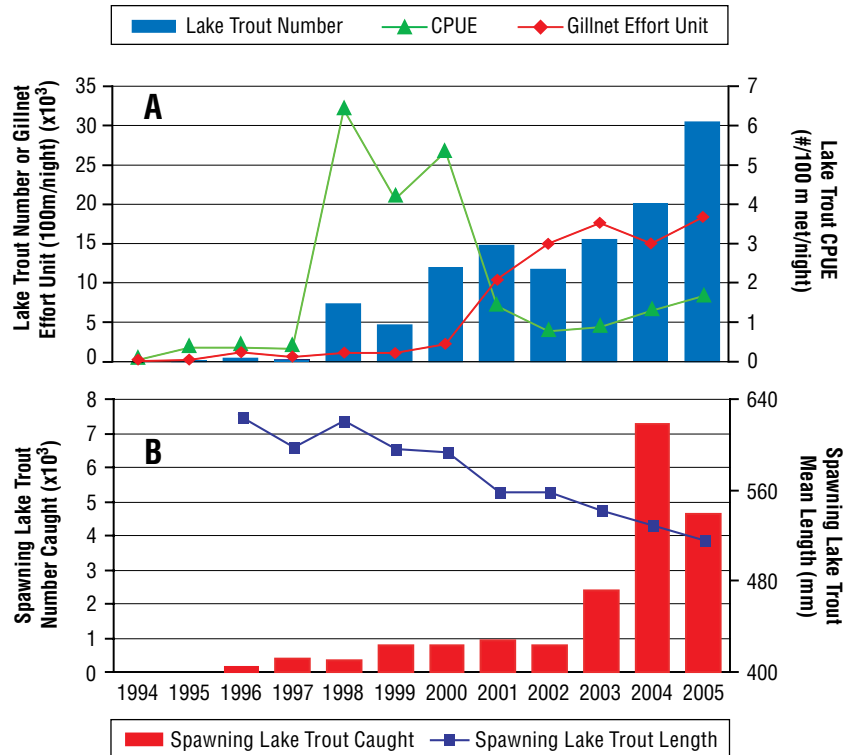


Figure 7. (A) Number of lake trout removed, gillnet units of effort (1 unit = 100 m of net/night) used, and lake trout catch per unit of effort obtained by the lake trout removal program on Yellowstone Lake during the entire gillnetting season, 1994–2005. (B) Number and mean length of mature lake trout removed near spawning locations (Breeze Channel, Carrington Island, Geyser Basin, and Solution Creek) on Yellowstone Lake during late August–early October, 1996–2005.

on Yellowstone Lake (Figure 9). These control sets removed 30,449 lake trout (87% of the total gillnet catch) from Yellowstone Lake. More than 53% of this catch occurred in 25-mm bar mesh gillnets, the smallest size used consistently; 20% of that occurred in October. Apparently, these fish had only recently grown to a size large enough to become entangled in our gear. These increases are likely results of strong year class production in 2003, when large numbers of spawning lake trout were observed.

Lake trout in Yellowstone Lake congregate from late August until early October for spawning. This has proved a prime time to target mature fish. Approximate locations of three spawning areas are known in Yellowstone Lake, and include areas near Carrington Island, west of the mouth of Solution Creek, and northeast of West Thumb Geyser Basin (Figure 4). These spawning areas were intensely gillnetted during the spawning season using net sizes ranging from 38- to 76-mm bar mesh. A fourth area south

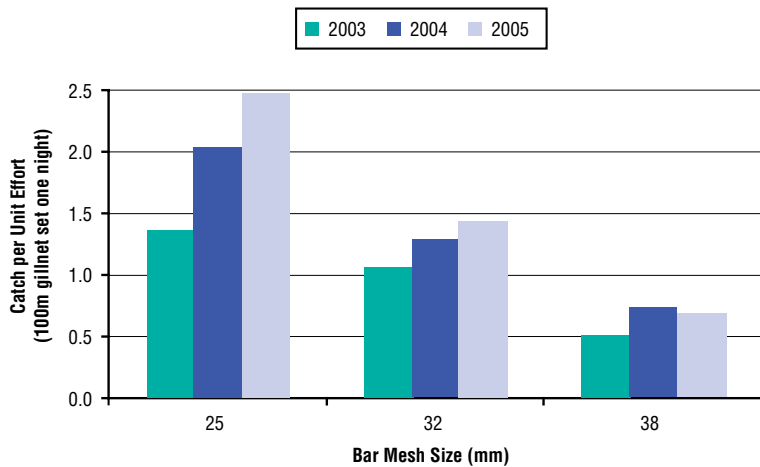


Figure 8. Catch per unit effort (1 unit = 100 m of net/night) by bar mesh size for control nets in Yellowstone Lake, 2005. The increase in catch for the smallest mesh used correlates well with recent increases in catch of mature lake trout during spawning season, indicating strong recruitment.

of Grant Village in West Thumb was targeted for mature fish in 2005. This area proved very productive and may indicate another spawning site in the vicinity. Nets were also deployed in Breeze Channel (a corridor into West Thumb from the lake's main basin) and sporadically throughout West Thumb. With these spawner gillnet sets, 4,568 lake trout were removed from Yellowstone Lake in 2005 (Figure 7). The size of lake trout caught near spawning areas continued to decrease from that observed in previous years. Mean total length (515.7 mm) was more than 12 mm less than that of 2004, and has shown a steady decline since the inception of the program. Also as observed in previous years, the females were larger than males (mean total lengths of 549.8 and 514.5 mm, respectively). The ratio of male-to-female spawning lake trout

caught was 1.60:1 in 2005.

For the second consecutive year, electrofishing was used to remove mature lake trout congregated for spawning. The U.S. Fish and Wildlife Service (Ahsahka, Idaho) again allowed Yellowstone to use their electrofishing boat. With this assistance, the Carrington Island site was electrofished on eight nights during September and an additional 1,338 lake trout were removed from the population.

Despite high catches of both young and adult (spawning) lake trout, there is reason to be optimistic about the impacts the program is having. Overall catch rate of lake trout remains low, and nearly 139,000 lake trout in all have been eradicated from Yellowstone Lake. If left



Fisheries technician Brad Olszewski prepares gillnets on board the Freedom.



NPS Fisheries technician Nicole Schamberry with a gillnetted lake trout.



Freedom skipper Don Wethington removes lake trout from a gillnet.

in the lake, each lake trout (and each surviving offspring) could have consumed at least 41 cutthroat trout each year (Ruzycki et al. 2003). Therefore, the suppression program has saved an incredibly large number of cutthroat trout. The mean size of mature lake trout continues to decline and there appear to be fewer older, larger, and therefore most detrimental, lake trout in the system each year. Another encouraging sign is the decline noted in angler catch-per-hour of lake trout for the second consecutive year. In past years, this index has been a good indication of the strength of the following year's spawning numbers. However, continued increases in overall catch rate by gillnetting underscore the importance of maintaining efforts to keep this predatory population controlled. Lake trout densities in the West Thumb remain high, and a serious threat to the Yellowstone cutthroat trout.

Lake Trout Growth Potential

To determine age and growth of lake trout, a sample of 404 fish was collected in July–early October 2005. Otoliths were collected for aging, maturity levels were assessed, and total length was measured for each fish. Immature lake trout comprised 34% (138) of fish collected, and females comprised 46% (184) of the sample. Ages ranged from 1 to 16 years old, and total length ranged from 190 to 902 mm. Using this information, an age-length key was applied to all lake trout collected from spawning areas in Yellowstone Lake (Figure 10).

The oldest lake trout sampled was a 16-year-old mature male captured in Breeze Channel on September 29, in 19 m of water. The heaviest lake trout removed from Yellowstone Lake in 2005 was also the heaviest ever recorded; this mature female was caught in Breeze Channel, weighed 22.5 lbs, and was just under one meter in total length (921 mm). This lake trout was caught in a gillnet set in 20 m of water on September 23. Neither of these two fish had spawned in 2005 when they were captured.

Lake trout are known to be a long-lived fish species; a specimen 65 years old was reported in Canada's Northwest Territories (Behnke 2002). However, less than 2% of the spawning

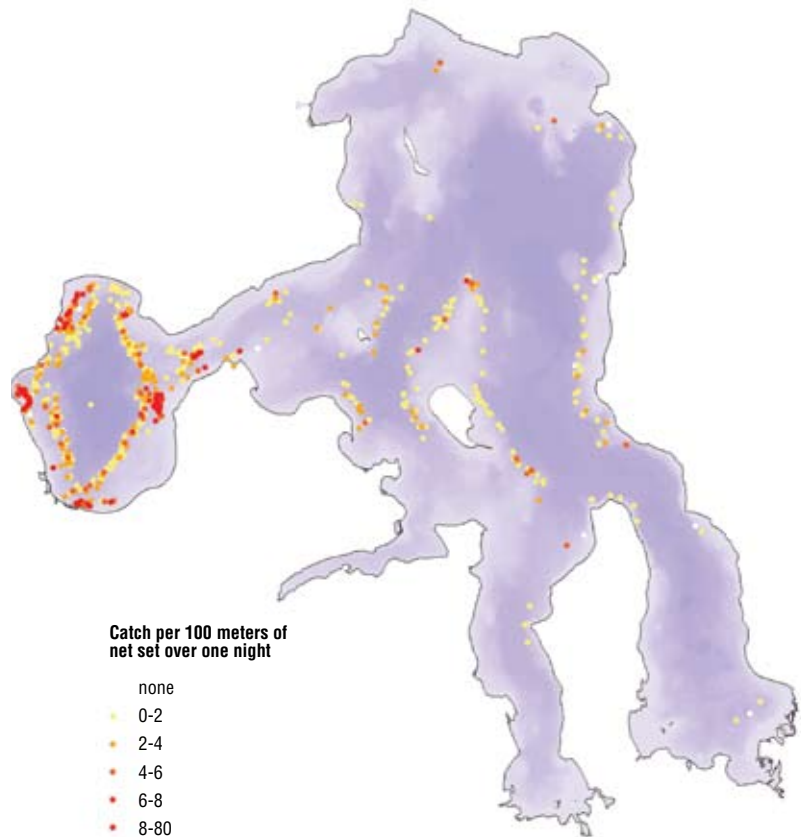


Figure 9. Locations of gillnets set to remove non-native lake trout from Yellowstone Lake in 2005.

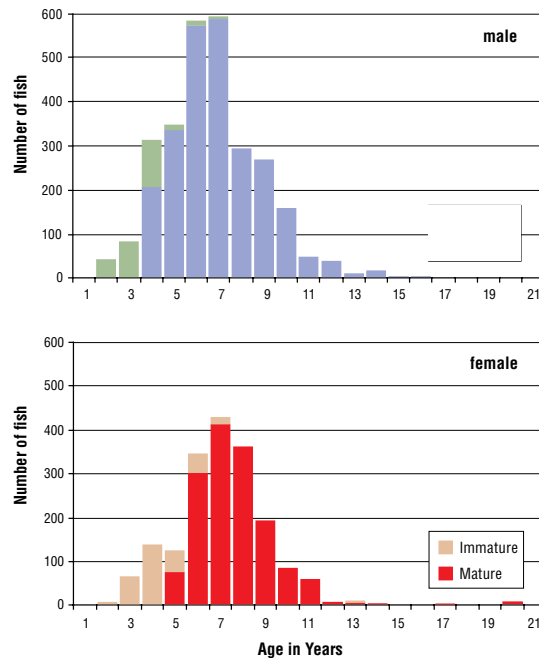


Figure 10. Relative abundance, by estimated age, of male and female lake trout caught on or near spawning areas late August through early October 2005.



The Yellowstone Center for Resources lake trout gillnetting boat Freedom at Bridge Bay.


Surveys using hydroacoustic (fish sonar) gear will be used to assess seasonal shifts among lake areas, and potentially, congregations near spawning sites in the fall.

lake trout population of Yellowstone Lake is more than 13 years old. Our aging information suggests that this is a relatively young, exploited population. Many of the adults being caught were likely attempting to spawn for the first time. Aging structures will continue to be collected in future years, and ratios of older lake trout to younger lake trout will continue to provide evidence of the effectiveness of the suppression program.

Goals to Improve Suppression Efficiency

Results of the lake trout suppression program clearly emphasize the importance of locating and targeting additional spawning areas in Yellowstone Lake, if they exist. Although approximately 5% of the total effort was expended on gillnet sets in spawning areas during 2004 and 2005, they accounted for 27% and 13% of the total catch for those years, respectively. (It should be noted, however, that spawner sets are checked daily, and require a much greater time commitment than do

control sets, checked weekly or even bi-weekly.) Furthermore, the spawning lake trout, due to their size, are likely more detrimental to cutthroat trout than those caught in the smaller-mesh size control nets.

Given the importance of spawning areas for targeting lake trout, we have initiated research to identify other currently unknown or potentially new potential spawning areas throughout Yellowstone Lake. Substrate size and distribution data are being collected using an underwater video system in areas where computer models predict spawning habitat may exist. The video will also enable staff to obtain exact timing of lake trout spawning and delineate boundaries of known spawning sites. Surveys for lake trout using hydroacoustic (fish sonar) gear will be used to assess seasonal shifts among lake areas and, potentially, congregations near spawning sites in the fall. Areas that have a high potential for supporting spawning can be monitored in future years; if spawning lake trout are found at those sites, they can be included in the suppression program as key locations for gillnetting or electrofishing. 

Restoration of Fluvial Populations of Native Trout



Westslope Cutthroat Trout Restoration Goals

The purpose of westslope cutthroat trout (WCT) restoration is to reverse the declining trend in WCT genetic integrity and ensure the persistence of native, genetically pure WCT within Yellowstone National Park. There is an urgent need to isolate remote headwater habitats, completely remove all non-native and hybridized fishes, and restore genetically pure WCT. Goals of the project are to (1) reduce long-term extinction risk for WCT within Yellowstone, and (2) provide a secure refugium for genetically pure WCT. It is proposed that genetically pure WCT be reintroduced in East Fork Specimen Creek (EFSC) and introduced into High Lake to secure this subspecies within additional waters of Yellowstone. Work planned for 2006–2007 includes (1) completing the NEPA process, (2) beginning the removal of non-native fish within High Lake and the introduction of WCT and development of a refugium there, (3) creating

an artificial barrier of logs and other natural materials at the downstream reach of EFSC to prevent movement of non-native and hybridized trout into the restoration area, and (4) beginning the removal of non-native and hybridized fish within EFSC.

Our long-term goals include the creation of a barrier to upstream movement of fish from the Gallatin River in the area of the Highway 191 road bridge, followed by a restoration of the North Fork and mainstem Specimen creeks. If this were possible, the result would be an entire watershed restored to native westslope cutthroat trout in the park. Grayling Creek, Duck Creek, and other watersheds within the natural, historic range of WCT are also being evaluated and seriously considered for restoration within the park.

Westslope Cutthroat Trout Status

Unlike many other areas within the historical range of WCT, habitat degradation and excessive harvest rates by anglers were not responsible for the decline of this subspecies in park waters. Rather, the extensive stocking and subsequent establishment of populations of non-native competing species, including brook trout and brown trout, and interbreeding of rainbow trout and YCT during the first half of the twentieth century, led to a serious reduction in the park's resident WCT, and in their near extinction from most park streams by the 1930s (Varley and Schullery 1998). Survey efforts from 1994 to 2003 were directed toward obtaining additional information from

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NISS/DAN MAHONY



Pool habitat of the East Fork Specimen Creek, the location for westslope cutthroat trout restoration.

In 2005, a genetically pure WCT population was found in an isolated, unnamed tributary to Grayling Creek.

what was thought to be the only genetically pure WCT population remaining in the park, located in North Fork Fan Creek. Life history (radiotelemetry) studies (Zale 2003), habitat inventories, macroinvertebrate assessments, and water quality surveys were completed on this system, and the most appropriate site for an in-stream fish barrier was selected for stabilization and long-term protection of the WCT there. However, NPS plans to assist with a WCT broodstock development program at the Sun Ranch in the Madison River Valley were suspended in 2003, when additional genetic analyses by the Wild Trout and Salmon Genetics Laboratory, University of Montana, revealed previously undetected rainbow trout alleles in the North Fork Fan Creek donor population (Koel et al. 2004). Through collaboration with the Idaho Department of Fish and Game, Eagle Fish Health Laboratory, we obtained a “second doctor’s opinion” in 2005 regarding the status of the North Fork Fan Creek WCT genetic status. Eleven markers (10 nuclear and 1 mitochondrial) were examined from 35 fish obtained in the upper reaches of North Fork Fan Creek in 2003. Only a single rainbow trout allele was detected among a total of 570 tested, yielding a result of 99.82% genetic purity among alleles and 97.1% genetic purity among individuals. The North Fork Fan Creek WCT are now considered a “conservation population,” but not a “core population” as originally thought. Consequently, the NPS re-evaluated the park’s WCT restoration program. Other watersheds originally supporting WCT but now containing highly-hybridized populations were assessed to determine which might provide the highest probability for successfully restoring a viable, genetically pure population of WCT in the park. The East Fork Specimen Creek has been chosen as the location for our first WCT restoration in the park (described below).

Genetically Pure Population Discovered within the Park

Following the confirmation of WCT hybridization in North Fork Fan Creek, it was thought that all genetically pure WCT

populations had vanished from Yellowstone. However, in June 2005, fisheries biologists from the U.S. Forest Service (USFS) were informed by David Klatt, a West Yellowstone resident, and Chad Kashmir, a local USFS law enforcement ranger, of an isolated cutthroat trout population in an unnamed tributary of Grayling Creek



Headwater springs in the Gallatin National Forest (top) give rise to approximately 2 km of pristine stream habitat within Yellowstone (middle), supporting >700 WCT (bottom).

Table 1. Estimated extent of range and current genetic status of cutthroat trout in Yellowstone National Park.

	All cutthroat trout		Yellowstone cutthroat trout		Westslope cutthroat trout	
	km of stream	% of total stream lengths	km of stream	% of total occupied stream lengths	km of stream	% of total occupied stream lengths
Extent of range						
Historically fishless	5,044	48%	4,096	48%	948	48%
Cutthroat trout present	5,477	52%	4,446	52%	1,031	52%
Total	10,521		8,542		1,979	
	km of stream	% of total stream lengths where all cutthroat were present	km of stream	% of total stream lengths where YCT were present	km of stream	% of total stream lengths where WCT were present
Current genetic status						
Extirpated	371	7%	0	0%	371	36%
Pure	3,340	61%	3,338	75%	2	0%
Hybridized	1,766	32%	1,108	25%	659	64%



A roadbed placed prior to any stocking of rainbow trout has served to isolate and preserve WCT in the unnamed Grayling Creek tributary.



Abandoned roadbed along Grayling Creek.

(Madison River drainage). The USFS, in turn, informed Aquatics Section staff. Park biologists have subsequently determined that more than 700 trout reside there, and through collaboration with the Idaho Department of Fish and Game's Eagle Fish Genetics Lab, confirmed that the population is 100% genetically pure WCT, that is, a "core population" suitable for use as source fish for restoration projects in the upper Missouri River drainage (Ruhl and Koel 2005). The subterranean nature of the unnamed tributary and placement of a roadbed prior to any introductions of rainbow trout to Grayling Creek have served to isolate and preserve the genetic integrity of the WCT population there.

Recent analyses using geographic information systems (GIS) suggested that approximately 1,031 stream kilometers within the park originally supported genetically pure WCT (Table 1). They have been extirpated from an estimated 36% of stream (371 km) and exist in hybridized form in most of the remaining 64% of stream (659 km). At present, the only known genetically pure WCT population in the park exists in approximately 2 km of habitat in the unnamed tributary to Grayling Creek.

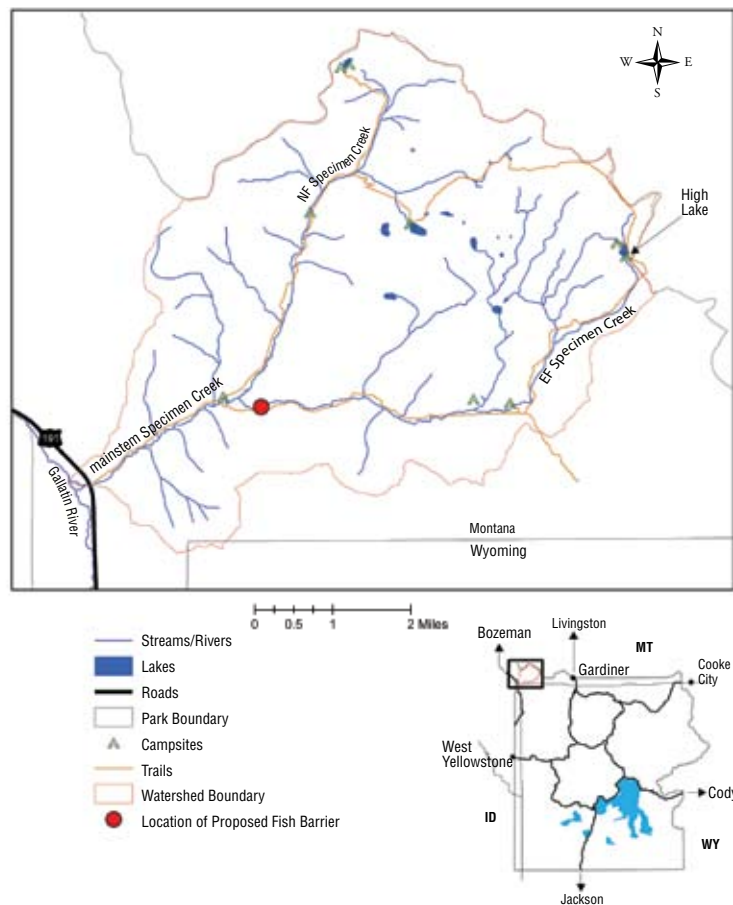


Figure 11. The Specimen Creek watershed in northwestern Yellowstone National Park.

East Fork Specimen Creek as a Focus for Restoration

A requirement for westslope cutthroat trout restoration is that the watershed be large enough to support a population that would remain resilient when faced with natural disturbance by drought, fire, and/or flood. The EFSC watershed meets these criteria. This watershed originates in the high, rugged Gallatin Mountain Range (Figure 11). Several small headwater lakes and spring seeps feed this fork as well as North Fork Specimen Creek (NFSC) and several smaller, unnamed tributaries. Due to natural barriers to fish movement upstream, these lakes were historically fishless. In 1937, however, the NPS stocked these lakes with YCT (which are not native to the upper Missouri River drainage) (USFWS 1971). These fish, over time, have

migrated downstream, while rainbow trout from the Gallatin River have moved upstream into the watershed. Due to interbreeding among the species, genetic integrity of the native WCT has been severely compromised; the EFSC watershed currently supports a highly hybridized (<80% pure) WCT population (Koel et al. 2003). Because the EFSC watershed WCT are not considered a “conservation population” (which requires more than 90% genetic purity), the fish are prime candidates for complete removal and replacement with a genetically pure strain.

High Lake, situated at the subalpine headwaters of EFSC, comprises 7.1 surface acres, has a maximum depth of 19.4 feet, and rests at 8,500 feet (2,600 m). A single outlet stream on the south shore serves as a primary source of flows for the EFSC. A natural waterfall (15 feet height) approximately 200 yards downstream from the outlet of High Lake prevents fish from ascending the drainage, and is the reason High Lake was historically fishless. For introduced WCT, High Lake would serve as a significant buffer to many watershed-scale natural disturbances, such as wildfire, drought, and flood. Unlike EFSC or other similar stream systems, the lake environment is not prone to high and abrupt variation in flows, water temperatures, and other environmental conditions that have a strong influence on survival of cutthroat trout. High Lake, over time, would provide a secure refugium and a source of WCT for the EFSC through downstream emigration by fry and adults.



Fisheries technician Brian Ertel at the location for the East Fork Specimen Creek fish barrier.

Of all the lakes in the Specimen Creek watershed stocked with YCT in 1937, only High Lake continues to support YCT. The Bozeman Fish Hatchery was the source for these stocked YCT, and the current population within High Lake is not a unique form warranting preservation. They have resulted in the degradation of WCT within the EFSC watershed, and their removal is required as a part of any WCT restoration attempts there. Many other high mountain lakes in the Intermountain West presently contain stocked YCT populations, including lakes within protected national park or wilderness areas. Due to the significant productive potential of High Lake and its greater overall contribution of flow (habitat availability) and trout abundance, EFSC was chosen over the North Fork as the focus for WCT restoration within the park.

During July 2005, the environmental compliance process was initiated to lead toward potential restoration of WCT in Specimen Creek. An interdisciplinary team was assembled and resource issues were identified. Public scoping for the project occurred October 25–November 30, 2005, and included public meetings in Bozeman (November 16) and West Yellowstone, Montana (November 17). Writing of the draft environmental assessment was initiated in late 2005, with plans for NPS and public review by spring/early summer 2006 (Koel and York 2006).



Fisheries biologists Pat Bigelow (left) and Dan Mahony leaving the Specimen Creek trailhead for High Lake. Fisheries horses (left to right) are Ethan, Pat, Sammy, and Scotty.

Sources for Genetically Pure Westslope Cutthroat Trout

The genetically pure WCT population in the unnamed Grayling Creek tributary provides an incredible opportunity for enhancement of this subspecies within Yellowstone National Park. This isolated WCT population has many aspects of an unexploited fishery, including a wide range in size structure (Ruhl and Koel 2005). Given the life history strategy of these fish, which must involve only a very limited amount of movement among habitats each year, the population would be an excellent choice for replication into similar, headwater systems elsewhere in the park, such as EFSC.

Additional potential sources of genetically pure WCT for the proposed project include recently developed broodstock at the Sun Ranch in the Madison River Valley, Montana; the MO12 WCT broodstock held at Washoe Park State Trout Hatchery (Anaconda, Montana), and, potentially, the WCT population that remains in North Fork Fan Creek within the park (Koel et al. 2004). Park staff will continue to monitor the North Fork Fan Creek WCT population to track any potential changes there in genetic purity. Analyses have indicated 99.8% genetic purity among alleles examined for rainbow trout introgression in North Fork Fan Creek.

For introduced WCT, High Lake would serve as a significant buffer to many watershed-scale natural disturbances, such as wildfire, drought, and flood.



NPS Fisheries technician Kevin Olsen and Supervisory Fisheries Biologist Todd Koel prior to returning westslope cutthroat trout netted from the unnamed Grayling Creek tributary.

NPS/MIKE RUHL

The overall goal for fluvial YCT restoration within Yellowstone National Park is to restore YCT to streams in the park's northern range watersheds.

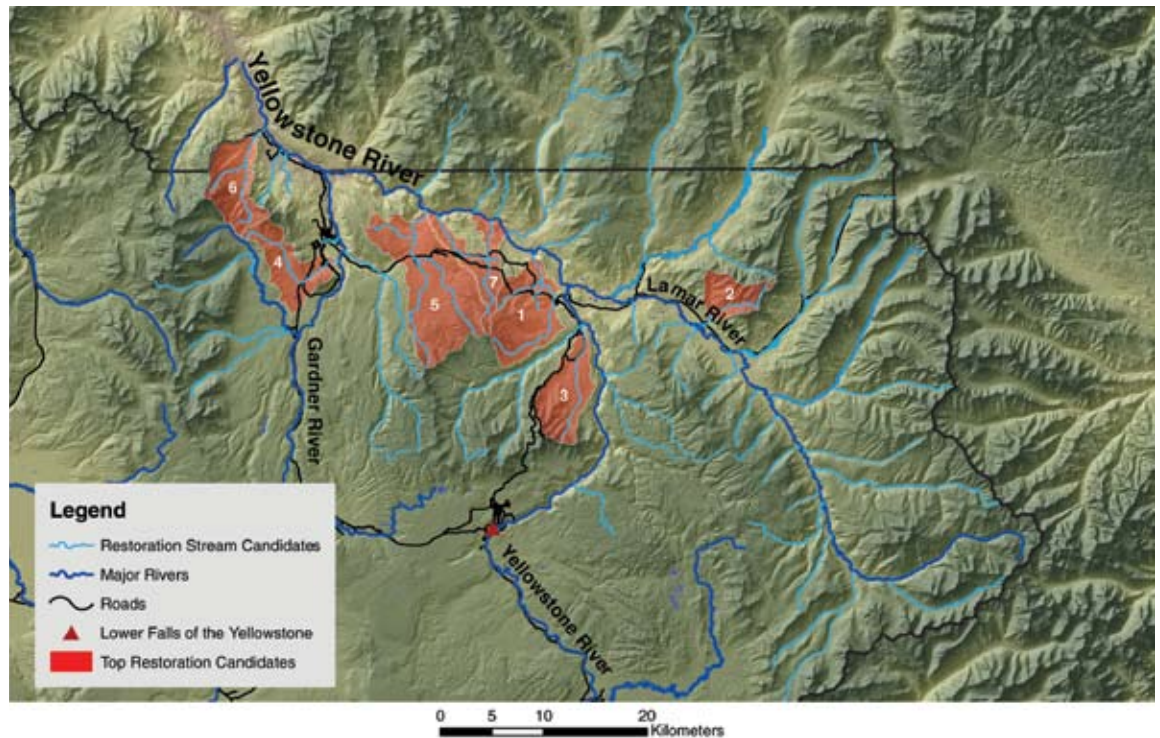


Figure 12. Yellowstone's northern range, including major rivers and tributary watersheds considered for potential cutthroat trout restoration. Watersheds receiving highest priority from prioritization ranking are highlighted in red and numbered by rank: 1) Elk Creek complex, 2) Rose Creek, 3) Antelope Creek, 4) Glen Creek, 5) Blacktail Deer Creek, 6) Reese Creek, 7) Oxbow/Geode Creek complex.

Yellowstone Cutthroat Trout Restoration Goals

The Yellowstone Lake basin and the Yellowstone River upstream of the upper falls at Canyon have long stood as one of the last strongholds of Yellowstone cutthroat trout. Despite fluctuations in abundance attributed to early egg-taking operations and intensive angling, the cutthroat trout population in Yellowstone Lake remained relatively strong into the early 1980s. Problems that arose were addressed through changes in management policies, that is, cessation of egg-taking operations and implementation of restrictive angling regulations. Despite widespread introductions of non-native salmonids into many other park waters, the Yellowstone Lake basin largely avoided the establishment of species known to compete or hybridize with Yellowstone cutthroat trout. However, the discovery of lake trout in 1994, and the subsequent discovery of whirling disease four years later, have left the

future of Yellowstone cutthroat trout in the Yellowstone Lake basin in question (Koel et al. 2005).

These developments have led managers to seek ways to increase the prevalence of genetically pure YCT within the park outside of the Yellowstone Lake basin. The overall goal for fluvial YCT restoration within Yellowstone National Park is to restore YCT to streams in the park's northern range, that is, the Gardner, Lamar, and lower Yellowstone river watersheds (downstream of the lower falls). The northern range is comprised of several major watersheds with more than 50 named streams and hundreds of unnamed tributaries (Figure 12). Streams of the northern range were chosen for restoration, in part, because of their accessibility; the logistics for completing stream restorations in this region are very good. In addition, Middle Creek, a tributary that enters the North Fork Shoshone River near the East Entrance, may provide an opportunity for YCT restoration. Specific objectives for 2006–2008 are to (1)

finalize the prioritization of watersheds and specifically identify those that provide the greatest likelihood of success for restoration; (2) complete amphibian, invertebrate, water quality, wetland/rare plants, and other resource surveys of watersheds chosen for YCT restoration; and (3) complete the required planning documents and NEPA process that will lead to on-the-ground YCT restoration. After restoration has begun, the newly created YCT populations will be available for future restoration efforts within Yellowstone National Park and elsewhere.

Yellowstone's Northern Range Restoration Initiative

The rivers and associated tributaries of the northern range once represented a vast amount of YCT habitat. However, with the exception of the upper Lamar River and a few isolated waters such as upper Soda Butte Creek and Pebble Creek, almost all of the medium and large streams in this region now support populations of non-native salmonids or rainbow-cutthroat trout hybrids. To date, a paucity of data has inhibited our complete understanding of the status of YCT on the northern range.

In order to identify streams where conservation action is necessary, or where restoration efforts would have a high probability of success, initial efforts in 2005 included the centralization of information regarding current and historic species composition; genetic integrity of cutthroat trout present; current fish distribution; presence and location of



One focus of northern range restoration initiative activities is Rose Creek, a tributary of the Lamar River at the Lamar Buffalo Ranch.

existing or potential barriers to upstream fish movement; road and trail accessibility or other logistical components; and length, flow, and physicochemical information for nearly all named streams on the northern range. The first step was a review of historical information held by the Aquatics Section. The parameters listed above were placed into a spreadsheet containing 58 streams from Yellowstone's northern range. From this spreadsheet, data gaps were identified and sampling priorities established. The remainder of the 2005 season was spent filling in the most important pieces of missing data through field investigations.

Field Surveys Document Remaining Populations

Field investigations sought to answer four basic questions: (1) What species, if any, are present in the stream? (2) What is the genetic status of any cutthroat trout found within the stream? (3) What is the upstream extent of fish distribution in the watershed? and (4) Are any existing or potential barriers to upstream fish movement present in the system? Staff walked streams, locating potential barriers and electrofishing to determine fish distributions. Fin clips were taken from all fish resembling cutthroat trout until a sufficient sample size ($n = 30$) to determine the genetic status of

NPS/MIKE RUHL



The falls on Amphitheater Creek create a natural fish barrier.

A second previously undocumented and potentially pure cutthroat population was discovered in the Oxbow/Geode Creek complex in 2005.



Cutthroat trout from the Oxbow/Geode Creek complex.



Yellowstone cutthroat trout from Rose Creek.

each population was reached. The up- and downstream side of every suspected natural or human-created barrier to fish movement was sampled. This method identified barriers above which naturally or artificially established populations do not exist.

Amethyst Creek, Amphitheater Creek, Crystal Creek, Elk Creek, Geode/Oxbow Creek, Lost Creek, Lupine Creek, Pebble Creek, Reese Creek, Rose Creek, and Yancey Creek were sampled in 2005. Barriers not previously shown in Yellowstone's fish barrier database were identified on Amphitheater, Elk, Lost, and Yancey creeks, where upstream extent of fish distribution was limited to the portions of the streams below the barriers. Extent of fish distribution was also documented for Rose and Reese creeks. A previously undocumented and potentially pure cutthroat population was discovered in the Oxbow/Geode Creek complex. These fish are likely the result of stockings conducted in 1922–1924 (Varley 1981). It is not known if these waters were historically fishless or what the broodsource of the stockings was. However, it does appear that the portion of Geode Creek upstream of the Grand Loop Road is isolated by the existing road culvert. Because the road pre-dates the stocking record, it is likely that if the broodsource was genetically pure, then the population that currently occupies the stream has retained that status. What is uncertain is which subspecies is represented in the Oxbow/Geode Creek complex, as Dr. Robert Behnke has initially identified the trout, through images provided, as WCT. Sufficient genetic samples have been collected from locations above and below the Grand Loop Road to determine



Fin clips are taken to determine genetic status of trout populations. Fin clipping does not limit life quality or expectancy of the fish.

whether the fish are YCT or WCT, and if hybrids are present in the population; analysis is pending.

Prioritization of Northern Range Watersheds

All of the watersheds included in the Northern Range Restoration Initiative that do not already contain pure-strain YCT are being considered as candidates for restoration. Many of the parameters that influence the likelihood of successful restoration are considered in the database that is being compiled. Data collected through library research, GIS analysis, and field investigations were used to develop a prioritization matrix containing a set of 12 parameters, all given equal weight in the prioritization analysis. Several systems have already been identified as candidates providing a high probability of restoration success. These include Reese Creek, Rose Creek (watershed above the Lamar Ranger Station), Blacktail Deer

Creek, and Elk/Yancey/Lost creeks (Elk Creek complex). No waters that have retained their original, historically fishless condition will be considered as a candidate for YCT restoration.

Arctic Grayling Status within the Gibbon River


In Yellowstone National Park, fluvial (stream-resident, year-round) Arctic grayling originally existed in the Madison River, and in the Gibbon and Firehole rivers below the falls of these streams (Kaya 1992; 2000). Non-native brown trout introductions and the creation of Hebgen Lake quickly led to what appeared to be the complete loss of fluvial Arctic grayling within the park by the mid-1900s.

In recent years, both anglers and electrofishing surveys have consistently found Arctic grayling throughout the Gibbon River, leading to a re-evaluation of the status of fluvial Arctic grayling within Yellowstone National Park. In fact, anglers have reported catching grayling in the Gibbon River in all but one year since 1979. Determining whether or not a viable population of fluvial Arctic grayling exists, however, is somewhat complicated because in the 1920s, adfluvial (lake-dwelling) Arctic grayling were intentionally stocked into historically fishless Grebe and Wolf lakes, at the headwaters of the Gibbon River. Although grayling are now regularly found in the Gibbon River above and below all three of its barriers to upstream fish movement, including Gibbon Falls, it is not known if these fish are truly fluvial or if they



One of 12 sites along the Gibbon River where fry traps were placed in 2005 to capture Arctic grayling.

are merely strays moving downstream from the headwater lake populations. The Aquatics Section has initiated research with the specific goal of determining whether there is a viable population of fluvial Arctic grayling within the Gibbon River system. Work planned for 2005–2006 includes (1) tagging grayling and tracking movements of juvenile and adult fish at Grebe and Wolf lakes and in the mainstem Gibbon River above and below Gibbon Falls; (2) conducting intensive surveys for spawning grayling during late May, June, and early July in the Gibbon River and suitable tributary streams; (3) conducting intensive surveys for young-of-the-year (YOY) grayling using fry traps from June to October in the Gibbon River; and (4) relating spatial dynamics and any observed variation of adult/juvenile/YOY grayling to thermal, flow, and other environmental characteristics of the Gibbon River system.

This work is being completed through a collaborative effort with the U.S. Geological Survey's Montana Cooperative Fisheries Research Unit. Results will have immediate relevance for the park's management and conservation of fluvial Arctic grayling, if indeed they are found to persist here. 

Although grayling are now regularly found in the Gibbon River, it is not known if these fish are truly fluvial or if they are merely strays moving downstream from the headwater lake populations.

NPS/BILL VOIGHT



Arctic grayling in Gibbon River.