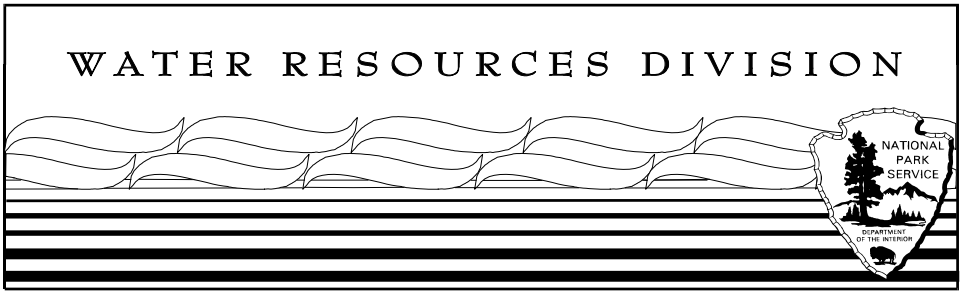
PROTECTION OF NATIVE YELLOWSTONE CUTTHROAT TROUT IN YELLOWSTONE LAKE – YELLOWSTONE NATIONAL PARK WYOMING

Patricia E. Bigelow
Todd M. Koel
Dan Mahony
Brian Ertel
Barb Rowdon
S. Thomas Olliff

Technical Report NPS/NRWRD/NRTR-2003/314



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NPS Aquatic Resources Center
Yellowstone National Park, Wyoming

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Introduction

Yellowstone National Park (YNP) represents 91% of the current range of Yellowstone cutthroat trout, Oncorhynchus clarki bouvieri, and contains 85% of the historical lake habitat for this subspecies (Varley and Gresswell 1988, Gresswell 1995). Yellowstone cutthroat trout are designated as a "Species of Special Concern-Class A" by the American Fisheries Society (Williams et al. 1989). Throughout their historical range, cutthroat trout have been subjected to continual threats to their long-term existence. In the western United States, salmonid population declines have been attributed to hybridization with other cutthroat trout subspecies and rainbow trout Oncorhynchus mykiss (Gresswell 1995), aquatic habitat degradation (May 1986), whirling disease epizootics (Vincent 1996, Nehring and Walker 1996), and excessive angler harvest (Varley and Gresswell 1988, Thurow et al. 1988). These ongoing threats to remaining Yellowstone cutthroat trout populations have generated enough concern that a formal petition to list this particular subspecies as "threatened" throughout its range was submitted to the U.S. Fish and Wildlife Service (USFWS) in 1998. In 2002 the Fly Fishermen Federation listed the Yellowstone Lake cutthroat trout population as the most threatened trout population in the United States. At the present time, interagency conservation plans are being developed to halt further declines in the abundance and long-term viability of the subspecies.

In addition to being the largest population of Yellowstone cutthroat trout in existence, the YNP population is a valuable resource for several other reasons. Only two other cutthroat subspecies [westslope cutthroat trout (Oncorhynchus clarki clarki) and Snake River finespotted cutthroat trout (Oncorhynchus clarki behnkii)], the fluvial form of Arctic grayling (Thymallis arcticus), and mountain whitefish (Prosopium williamisoni) are native to YNP (Behnke 1992, Varley and Schullery 1998, Koel et al. 2003). Cutthroat trout play a significant role as both predator and prey in the Yellowstone Lake ecosystem and provide an important link to the terrestrial community as prey for numerous avian and mammalian predators and scavengers including the grizzly bear Ursus horribilus, otter Lutra canadensis, and bald eagle Haliaeetus leucocephalus (Schullery and Varley 1995). Cutthroat trout play an important role in transporting nutrients from the Lake back to the terrestrial system during their spring spawning migration up several of the lake's tributaries. The cutthroat trout population in Yellowstone Lake also supports a world-famous recreational fishery with an estimated value of more than $36 million to the regional economy in 1994 (Varley and Schullery 1995). Anglers from all over the United States and from several foreign countries fish for these prized trout.

The cutthroat trout population in Yellowstone Lake has fluctuated considerably during the 20th century, primarily due to historical high levels of angler harvest and hatchery-related egg collections (Gresswell et al. 1994; Koel et al. 2003). Until recently, National Park Service (NPS) and US Fish and Wildlife Service (USFWS) fishery managers considered that negative impacts to the Yellowstone Lake cutthroat trout population were restricted to these historical influences. Closure of the hatcheries in the 1950's and numerous changes in angling regulations appeared to provide adequate protection to these fish up through the mid-1980's (Gresswell and Varley 1988). Indices such as increasing abundance, average size of spawning fish, and satisfactory catch rates by anglers provided evidence that the population had stabilized from previous overexploitation (Gresswell and Varley 1988).

However, when a 17-inch lake trout was caught in Yellowstone Lake by an angler in July 1994, park fishery biologists immediately became concerned about the future of the cutthroat trout population (Kaeding et al. 1995). Lake trout introductions have been implicated in declines of native cutthroat trout populations in several western North American Lakes: Bear Lake, Idaho-Utah (Ruzycki and Wurtsbaugh 1995); Lake Tahoe, California-Nevada (Cordone and Frantz 1966); Heart Lake, Yellowstone National Park (Dean and Varley 1974); Jackson Lake, Grand Teton National Park (Behnke 1992); and other large

deep lakes in the Rocky Mountain region. Where nonnative lake trout and native cutthroat trout occur together, cutthroat trout populations have often declined, exhibited lower growth and truncated size distributions, or have disappeared. The mechanisms of these impacts vary among waters, but include direct predation and competition for shared resources. Discovery of lake trout in Yellowstone Lake coincided with apparent declines in abundance of spawners in several lake tributaries. In Yellowstone Lake, the establishment of a lake trout population could have considerable ecosystem-level ramifications. Lake trout are large piscivores that could potentially consume thousands of smaller trout. The resultant reduction of native cutthroat trout could have serious trophic-level adverse impacts to numerous aquatic and terrestrial native consumers.

To assess the seriousness of lake trout establishment in Yellowstone Lake, NPS convened a panel of experts from throughout the United States and Canada (Varley and Schullery 1995). Their task was to determine if the situation was as dire as first perceived and to provide strategies for elimination or control of this large predator in Yellowstone Lake. A large majority of the biologists agreed that without some type of intervention, a 70% or greater reduction in cutthroat trout abundance was highly probable within 50 to100 years. However, a concerted gill netting effort, combined with angler harvest, might reduce losses to less than 30% of the existing population (McIntyre 1995).

NPS gillnetting efforts for lake trout removal

The history of the NPS lake trout removal program on Yellowstone Lake (Figure 1) can be separated into three phases: 1) a pilot phase to determine extent of the problem and learn more about how best to target lake trout; 2) an intensive netting phase where knowledge gained the first few years was applied; and 3) the current phase, with increased netting efforts and efficiency.

The pilot phase began immediately after lake trout were discovered in 1994 and lasted through 1996. Initial attempts to locate additional lake trout in 1994 were mostly unsuccessful, while catching numerous cutthroat trout. We discovered cutthroat trout use much deeper portions of the lake than previously believed. Learning from this experience and incorporating suggestions from the panel of experts, efforts in 1995 and 1996 concentrated on determining lake trout distribution and population age structure. A variety of mesh sizes were used in gillnets to determine which would be most effective at what depths. Cutthroat trout by-catch was greatly reduced. We determined the highest densities of lake trout reside in the West Thumb portion of Yellowstone Lake and we discovered what we believe is the lake trout's primary spawning area, near Carrington Island.

From 1997 through 1999, an intensive netting phase, knowledge gained in the first 3 years was applied to increase gill netting effort and efficiency. By combining information on high density areas, depths where cutthroat trout are not found, and using longer nets, netting effort was greatly increased. By leaving nets set over longer periods, decreasing handling time, efficiency was also greatly increased.

Between 1996 and 1999, YNP personnel removed more than 15,000 lake trout from Yellowstone Lake. However, the greater the effort expended, the more lake trout were caught, indicating we were not limiting the population. Furthermore, the endeavor was severely taxing the fisheries program in YNP. Much of the available resources were being directed toward lake trout removal at the expense of neglecting other important fishery issues in YNP such as whirling disease, population monitoring, and restoration work. It became very apparent additional resources were needed. Fortunately, these were provided by a grant through the Natural Resources Preservation Program (NRPP), allowing the third and current phase of our lake trout removal program.

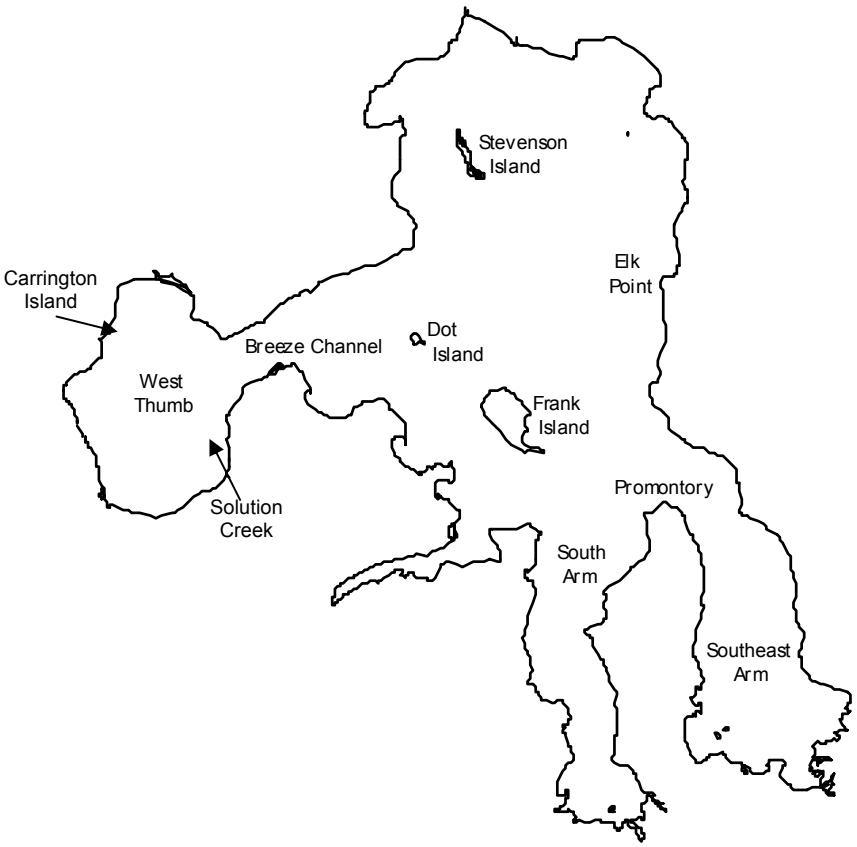


Figure 1.—Map of Yellowstone Lake, Yellowstone National Park. Lake trout densities are highest in the West Thumb portion of the lake. Main spawning areas are near Carrington Island, Solution Creek, and Breeze Channel.

The current program consists of significantly increased gillnetting effort for lake trout and monitoring of both the cutthroat and lake trout populations throughout Yellowstone Lake. NRPP provided the necessary funds to purchase over 16 km of new gill nets, a boat designed specifically for gillnetting on Yellowstone Lake, state-of-the-art hydroacoustic equipment for population monitoring, and salaries for additional staff time.

Presently, NPS fisheries personnel employ three basic gillnetting strategies: control, distribution, and spawner sets. Control nets continue to be our most effective method for removing lake trout from Yellowstone Lake. This netting effort primarily targets the smaller lake trout (less than 450mm TL) in water 50 to 75 m deep to maximize the removal of lake trout while minimizing the by-catch of Yellowstone cutthroat trout. Small-mesh, monofilament gillnets ranging from 19 mm to 44 mm bar measure are fished from May through October. Larger mesh control nets (51 mm to 89 mm) are fished between ice off and the beginning of thermal stratification in an attempt to capture larger lake trout when

they are found in shallower water 5 to 15 m deep.

Distribution nets are deployed, generally in August, for two purposes: 1) to monitor distribution of lake trout in Yellowstone Lake compared to past years; and 2) to give estimates of the percentage of lake trout versus cutthroat trout at various depths and locations of the Lake. The first purpose gives insight into the potential lake trout population expansion in the Lake. The second gives important data necessary for partitioning species composition while interpreting hydroacoustic data collected on Yellowstone Lake (discussed below).

Spawner nets target spawning lake trout from early September through mid-October when they move onto their spawning grounds. Monofilament gillnets ranging in size from 51 to 70 mm bar measure are fished at two known spawning locations in West Thumb and another possible spawning site in Breeze Channel (Figure 1). Several other locations throughout West Thumb are sampled as time permits in an attempt to locate other holding areas for lake trout preparing to spawn.

Results from these efforts to date have been encouraging. During 2000, the initial year of NRPP funding, refinements in netting techniques combined with additional seasonal personnel dedicated to the netting program resulted in a doubling of gillnetting effort from that of the previous year (Figure 2). Lake trout catch increased from 5,700 lake trout in 1999 to almost 12,800 in 2000. Effort (measured in units of 100 m of net set over one night) also more than doubled, increasing from 1,600 units to 3,300 units in 2000.

In 2001, a major improvement to the lake trout removal program was the addition of the NRPP funded boat, the NPS Freedom, designed specifically for gill net operations on Yellowstone Lake (Photograph 1). This vessel arrived mid-June and was used throughout the 2001 field season. It greatly improved working conditions for employees (running water, heat, adequate working space, adequate safety features) and efficiency of the gill net operations (Photograph 2). Gillnet effort increased approximately sevenfold over the 1999 level to almost 11,300 units of effort (Figure 2). A total of 15,722 lake trout were removed from Yellowstone Lake in 2001. Catch rate (catch per unit effort) was reduced by more than half compared to the 2000 rate.

In August, 2001, personnel from Idaho Department of Fish and Game donated time and equipment to repeat hydroacoustic surveys done in 1997 and 1998. Density estimates in the West Thumb area of the Lake, where the highest densities of lake trout exist, were reduced 10% from previous years (Dr. Melo Maiolie, personal communication).

Effort again increased in 2002: over 12,000 lake trout were removed from Yellowstone Lake using almost 15,000 net units. Catch rate dropped for the third year in a row and was the lowest seen since 1995 (Figure 2). 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 3). Overall number of spawners caught was down from 2001.

Analysis of lake trout removal efforts have been encouraging. Since 1995, 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. Catch rates, total numbers, numbers and sizes of spawning adults caught in fall sets all appear to be declining. Increased resources, including nets and staffing, have allowed better lake coverage (Figure 4); total catch and catch rate continue to decline. Bioenergetics modeling (estimates of how many cutthroat trout a lake trout

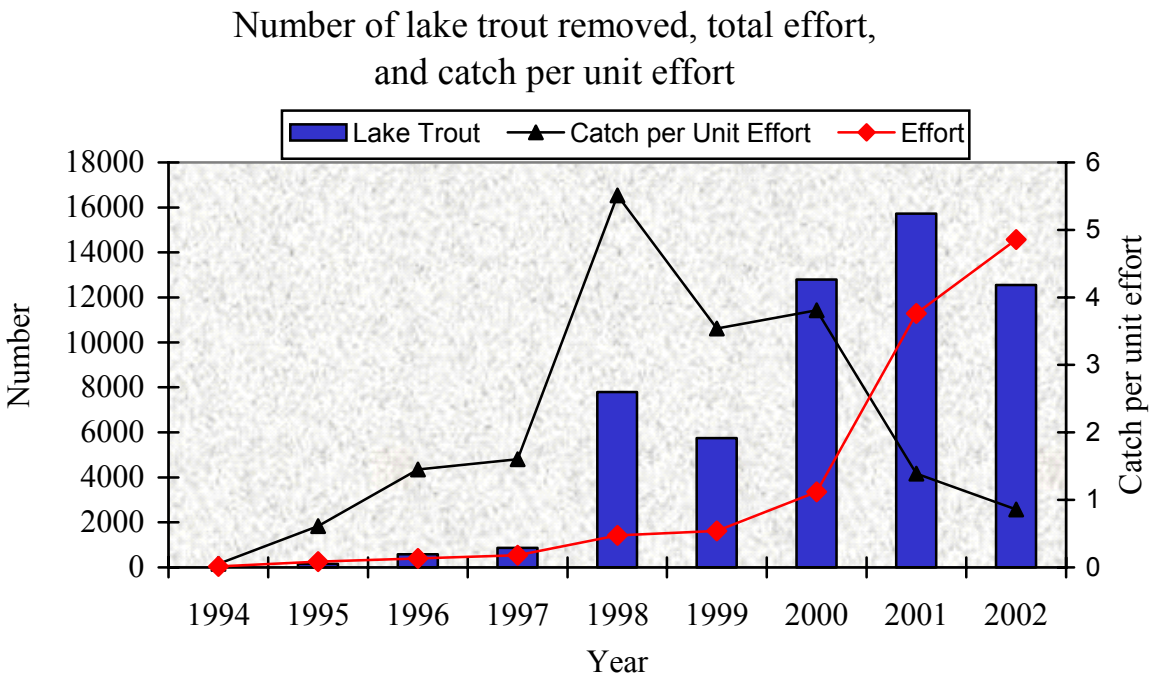


Figure 2.—Number of lake trout removed each year since verified in Yellowstone Lake, along with catch-per-unit-effort, 1994 through 2002. Each unit of effort equals 100 m of gill net set over one night.

Photograph 1.—Purchase of the gillnetting boat NPS Freedom has greatly improved gillnetting efficiency on Yellowstone Lake, allowing an increase in number of nets set and of areas covered by sets.

Photograph 2.—Interior design of the NPS Freedom provides a much safer and efficient working environment for processing gillnets and catch data, Yellowstone Lake, 2002.

potentially consumes) suggests that a mature lake trout can eat between 50 to 90 cutthroat trout per year (Ruzycki and Beauchamp 1997, Photograph 3). Thus, the lake trout control project has saved a large number of cutthroat trout from predation by lake trout.

Hydroacoustic analysis of lake and cutthroat trout populations

Gillnet catch data is augmented by use of state-of-the-art hydroacoustic equipment. This equipment was obtained with NRPP funds in 2001 and first used during the 2002 field season. Surveys for estimating fish densities are conducted lake wide three times throughout the ice-off season and more intensively in areas of high interest, such as the West Thumb portion of the lake, as time permits. Data collected during 2002 is currently being analyzed.

Assessment of Yellowstone cutthroat trout population

Although very encouraged by catch rates and numbers of lake trout removed to date, the true measure of our success is the status of the Yellowstone cutthroat trout population in Yellowstone Lake. Therefore, a critical component of evaluating the efficacy of this program is monitoring population trends of the Yellowstone cutthroat trout in the lake. Toward this end, we are continuing to conduct our fall cutthroat trout assessment (initiated in 1969) and to monitor spawning run strength on Clear Creek (initiated in 1945). Although some biases exist with both these data series, they provide excellent long-term trend data for monitoring the health of this population.

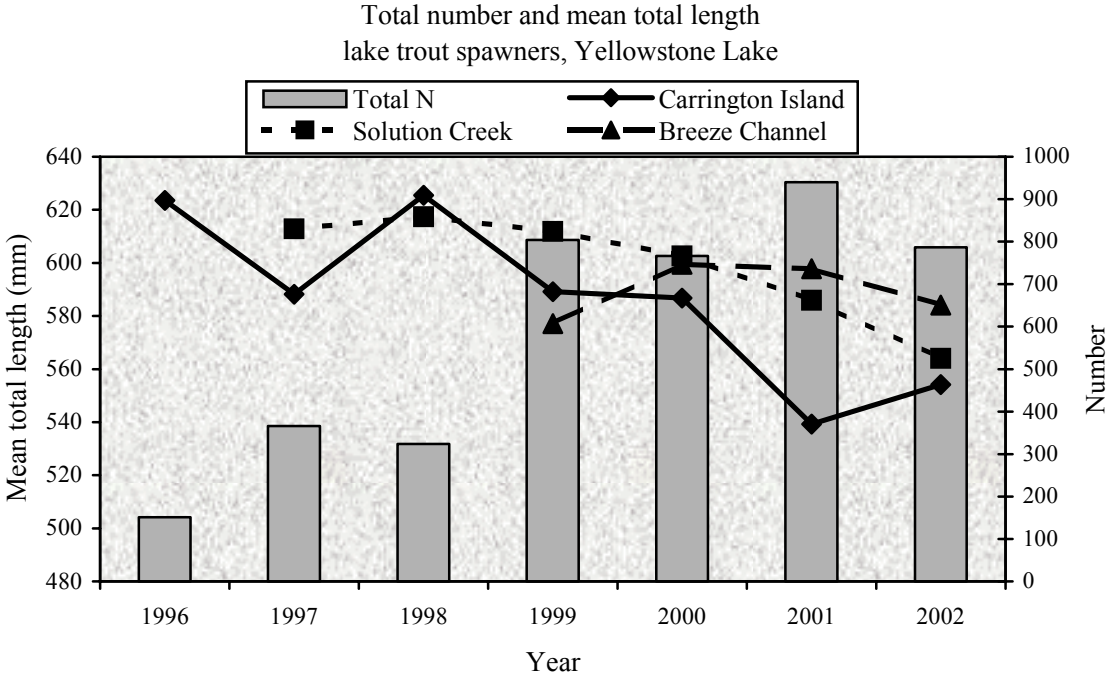


Figure 3.─Total number and mean total length of lake trout removed from or near spawning areas, Yellowstone Lake, 1994-2002.

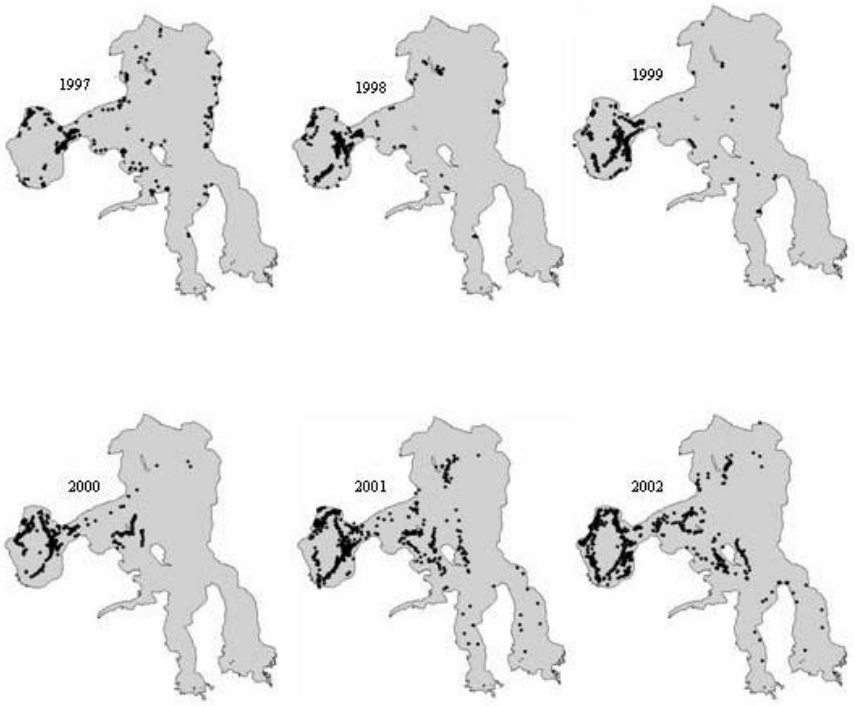
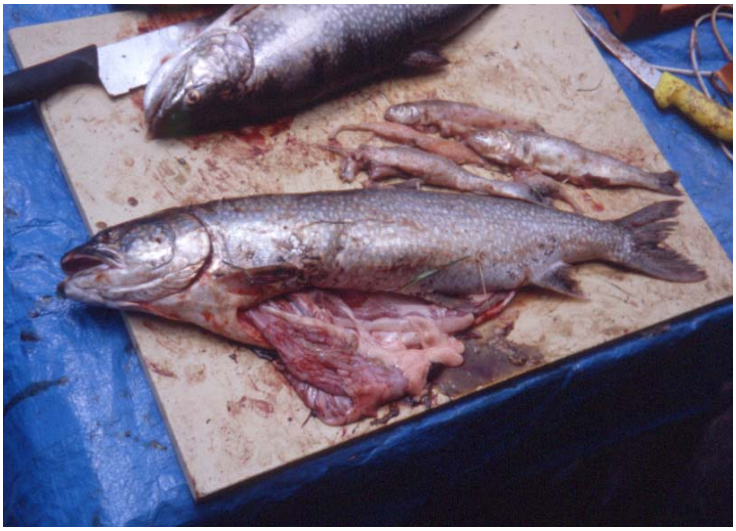


Figure 4.─Lake trout removal gillnet sites, Yellowstone Lake, 1997-2002: additional resources have increased the areas of coverage substantially over levels in 1990's.



Photograph 3.—Lake trout in Yellowstone Lake have proved to be voracious predators on native Yellowstone cutthroat trout. Five cutthroat trout of varying sizes were found in the gastro-intestinal tract of this lake trout, Yellowstone Lake, 1997.

Using multi-mesh-size gillnets set in shallow water at 11 sites throughout Yellowstone Lake we have been able to collect valuable cutthroat trout population information over time. Data collected in 2002 continue to show some very disturbing trends. Number of fish collected per net has reached the lowest point recorded since the lake netting program began in 1969 (Figure 5, Dean and Mills 1970). The reduction in catch has been 0-21% each year (average of 11% per year) since 1994, the year lake trout Salvelinus namaycush were first discovered in Yellowstone Lake (Kaeding et al. 1995; Koel et al. 2003). Examination of length-frequency data from the fall netting survey shows a severe decline in the number of adult cutthroat trout in Yellowstone Lake (Figure 6). Entire age classes are virtually missing from the lake population. In 2002, few fish were caught between the lengths of 300 to 430 mm. Historically these have been the sizes of the majority of cutthroat trout that we have noted in spawning tributaries such as Clear Creek (Jones et al. 1993). 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 may be having a significant effect, contributing to the preservation of Yellowstone cutthroat trout in this system.

The Yellowstone cutthroat trout population decline has also been seen in total numbers of upstream-migrating cutthroat trout at Clear Creek, a major spawning tributary on the lake's eastern side (Figure 5). 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.

Long-term prospects

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. We still do not know the true extent of

our lake trout population lakewide. Given the available habitat in Yellowstone Lake, the effect of an expanding lake trout population will be very real if control efforts are eliminated. Also, we have been unsuccessful at developing a technique to remove lake trout in the mid-size range (400 to 600 mm total length). This component of the population co-exists with our cutthroat trout population, making it impossible to effectively gill net them without incurring an unacceptable mortality rate on cutthroat trout as well. We are still investigating new methods to begin targeting this segment of the population before they reach full maturity and perhaps pioneer new spawning sites.

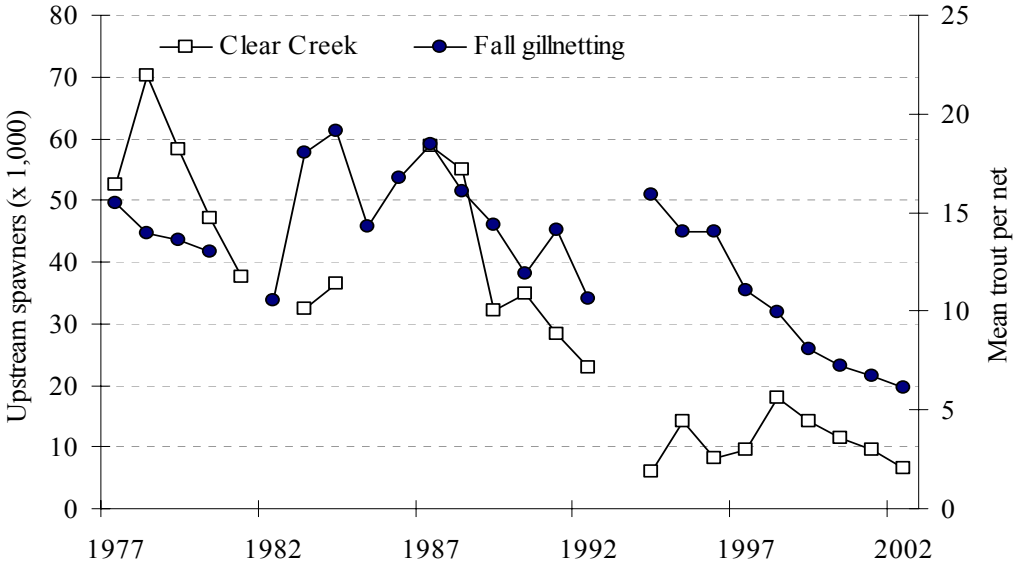


Figure 5.—Annual trend data for Yellowstone cutthroat trout in Yellowstone Lake. Clear Creek data represents number of cutthroat trout moving upstream in one of Yellowstone Lake's more important spawning tributaries. Fall gillnetting is trend data collected lake wide for population assessment. Both data series show an alarming downward trend.

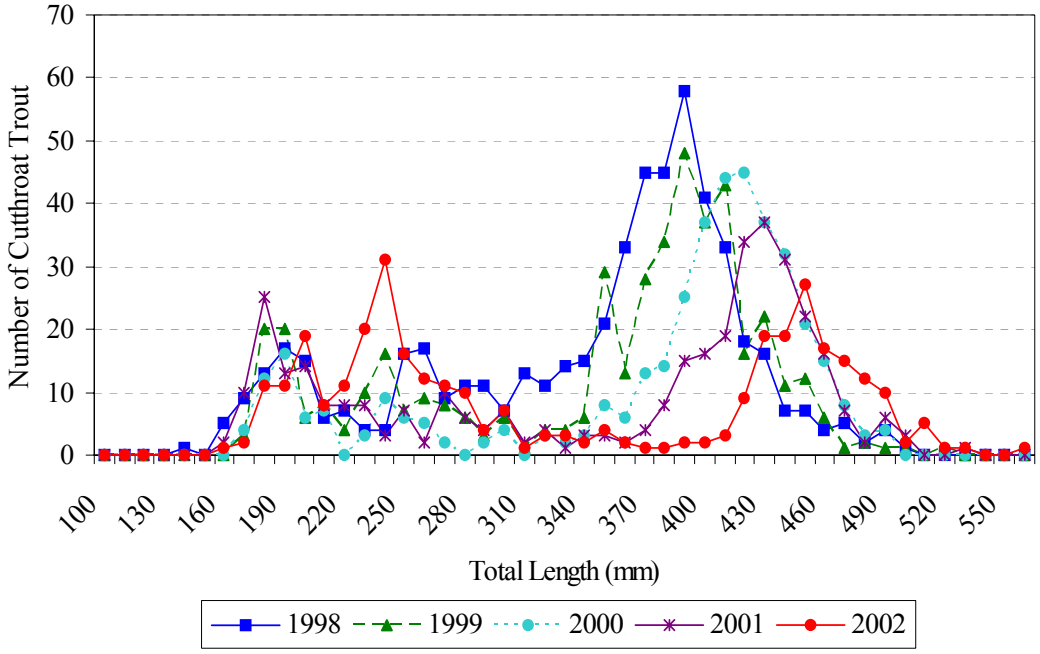


Figure 6. Length frequency data for cutthroat trout collected during fall gillnetting, 1998 – 2002 in Yellowstone Lake. Data show a steady erosion of the adult spawning population from 1998 to 2002. It appears, however, an increase in juvenile recruitment may have occurred in the last two years.

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