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INVENTORY AND SURVEY OF FISHERIES IN LOWLAND LAKES AND RESERVOIRS OF THE RED ROCK, RUBY, BEAVERHEAD, AND BIG HOLE RIVER DRAINAGES OF SOUTHWEST MONTANA

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ABSTRACT

Fisheries data trends are updated for the 2000 - 2001 period for selected lakes and reservoirs in southwest Montana. Fisheries and storage data trends were gathered for Clark Canyon Reservoir. Analysis of plant success for wild strains of rainbow trout, rainbow trout spawning migrations, wild brown trout populations, and angler use trends are presented. Fisheries data, rainbow trout stock success, wild brown trout population information, and angler use trends are presented for Ruby Reservoir. Analysis of fisheries recovery in the aftermath of the 1994 dewatering event at Ruby Reservoir is presented and discussed. Evaluation of stocks of McBride Yellowstone strain cutthroat trout is presented for Elk Lake in addition to an analysis of native Arctic grayling, lake trout, and burbot populations. The wild lacustrine rainbow trout population of Hidden Lake is evaluated and discussed in terms of its unique stability and apparent ability to reproduce in a lacustrine environment. The genetic analysis of the lake trout population of Twin Lakes, located in the upper Big Hole River drainage, is described with particular emphasis on native glacial relict status of the population.

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INTRODUCTION

Southwest Montana provides a diversity of angling opportunity in lacustrine environments in the form of numerous lakes, reservoirs, and ponds. While the majority of these lentic fisheries are sustained in alpine lakes, a substantial amount of opportunity is provided by "lowland" lakes which are readily accessed by vehicle. Because of their accessibility, these waters tend to support relatively heavy angler use and require regular sampling to monitor fish populations. Concomitant with their accessibility, most of these lowland waters are provided with ample developed campground and boat launch facilities which also tends to increase angler use. In addition to their accessibility, many of the lowland lakes are noted for their productivity, trophy fisheries, unique species composition, scenic qualities, or some combination of these factors. These factors, when coupled with easy accessibility, can result in heavy angling pressure and high angler expectations. Many of these waters are stocked periodically with hatchery trout to support harvestable populations under heavy use. Such waters must be monitored to insure maximum survival and angler use of hatchery stocks. In cases where self sustaining wild populations or sensitive native species provide all or part of the angler use, they must be monitored on a regular basis to insure that regulations or stocking programs are tailored to maintain populations in balance with habitat limitations and angler use.

Waters discussed in this report include two major irrigation reservoirs constructed on mainstem rivers, two relatively large natural lakes, and a natural mountain lake. All five of these waters have sustained heavy angling pressure relative to their size.

Clark Canyon and Ruby Reservoirs are man made impoundments on the Beaverhead and Ruby Rivers. Both reservoirs were constructed to provide stored irrigation reserves and flood control. Clark Canyon is managed by the Bureau of Reclamation and two boards of water users. It provides about 257,000 acre-feet of storage and 5,900 acres of surface at the top of the flood control pool although normal operating pools result in a lake of about 4,000 to 5,000 acres. Clark Canyon provides sport fisheries for introduced rainbow and brown trout, native burbot and mountain whitefish. The occasional capture of westslope cutthroat trout and brook trout has occurred sporadically over time. Native nongame species occupying the reservoir include white and longnose sucker. Introduced nongame species include the common carp and the redside shiner which was recently discovered in 1998. The rainbow trout population is provided largely through annual plants of hatchery fish while other fish populations are wild and self sustaining. The reservoir generally has supported about 40,000 angler-days of recreation per year although recent trends have demonstrated a marked increase. Dynamics of the trout populations of Clark Canyon were last reported by Oswald (2000 a). Ruby Reservoir is managed by the Montana Dept. of Natural Resources and the board of water users. The reservoir stores about 39,000 acre-feet at full pool and provides fisheries for rainbow, cutthroat, and brown trout and mountain whitefish. Rainbow and cutthroat trout have been stocked to augment wild populations in the past and attempts have also been made to manage the reservoir as a wild self sustaining fishery. Ruby Reservoir has supported angler use of about 2,000 to 4,000 angler-days per year although the most recent management direction has resulted in a dramatic increase in pressure. The trout populations of Ruby Reservoir were last described by Oswald (2000 a). Land management agencies provide ample campground and boat launch facilities on both reservoirs.

Elk and Hidden Lakes are accessed through the uppermost Centennial Valley and are located within the boundaries of the Beaverhead National Forest. Both lakes are natural and sit at elevations slightly over 6,500 feet. The fishery of Elk Lake was first described by Lund (1974) while Oswald (1989) described the rainbow trout fishery of Hidden Lake. Elk Lake is located in a glacial rift and occupies 283 acres with a maximum depth of 70 feet. The lake has been stocked with rainbow trout and, in more recent history, McBride Yellowstone cutthroat trout. Elk Lake also has supported a wild population of Arctic grayling, and currently supports wild populations of lake trout, and burbot. The lake trout and burbot populations are considered native (Vincent 1963 and Holton 1990) while the status of the grayling population is unknown due to heavy stocking of the species in the 1950's. Two national forest campgrounds are located on Elk Lake and a private lessee operates a fishing camp on national forest property. Elk Lake has supported an estimated 2,000 to 3,000 angler days of recreation per year. The trout populations of Elk Lake were last described by Oswald (2000 a). Hidden Lake is the uppermost of a chain of lakes which are in the Madison River drainage and occupies 149 acres. These lakes are located in the ancient river channel which drained a large Pleistocene lake which occupied the Centennial Valley (Feth 1961) and are not connected by tributary surface flow. The lake received four limited plants of rainbow trout in the mid 1930's and 1940's. From this base, a wild, self sustaining population of rainbow trout was established and persists to the present. Several undeveloped camp sites are scattered around the lake and a private lessee from the Elk Lake Camp provides boat rental and dock. Hidden Lake supports about 1,000 to 2,000 angler-days of recreation per year. The status of the trout population was last described by Oswald (2000 a).

Twin Lakes is a large alpine lake located on the Beaverhead National Forest. It is situated in the Beaverhead Mountains on the west side of the upper Big Hole Valley. Unlike most alpine lakes in the vicinity, Twin Lakes is easily accessed by maintained roads and supports a large, developed public campground. Twin Lakes is located at an elevation of 7,235 feet, has a surface acreage of 75 acres, and is 72 feet deep. It has received plants of cutthroat and rainbow trout and Arctic grayling in the past but all stocking ended after 1963 in favor of wild trout management. Currently, Twin Lakes supports wild populations of lake trout, burbot, and brook trout, as well as other species which represent relatively minor components of the sport and nongame fisheries. The lake trout population is considered to be one of four native populations in Montana (Vincent 1963 and Holton 1990). Due to developed access, scenic setting, and the unique lake trout population, Twin Lakes has supported 500 to 1,000 angler days per year.

METHODS

Sampling of fish populations in lakes and ponds was largely accomplished through the setting of floating 6 X 125 foot experimental gill nets off defined points, rock formations, or other structural features. Sets were made at the same location and samples collected at the same time each year to minimize variation due to location or season. The smallest bar mesh was always set inshore. Nets were fished overnight, generally for 10 to 12 hours. Experimental nets contained five bar mesh sizes ranging from 3/4 to 2 inch opening. In Elk Lake and Twin Lakes, sinking gill nets of similar construction to the floaters were set overnight to specifically sample lake trout and burbot populations.

All salmonids captured in nets were enumerated, measured to the nearest 0.1 inch, and weighed to the nearest 0.01 pound. Scale samples were collected from selected fish, mounted on acetate slides, and examined on a microfiche viewer to determine age.

Characteristics of rainbow trout spawning migrations from Clark Canyon Reservoir were gained primarily through electrofishing procedures in the Red Rock River. Electrofishing sampling methods used a mobile anode and boat mounted cathode to draw fish for capture. A 3500 watt generator was employed as power source and current was rectified to continuous DC through the use of a Leach box. All trout captured during spawning migrations were fitted with color coded individually numbered Floy type tags.

Collection of Elk and Twin Lakes lake trout genetic samples for PCR analysis consisted of adipose removal under relatively sterile conditions to minimize the possibility of cross contamination. Samples were preserved in 95% nondenatured ethanol and shipped to the USGS Great Lakes Science Center in Ann Arbor, Michigan for analysis. Lake trout which could be released were fitted with individually numbered Floy type tags.

A limited winter creel census was continued on Clark Canyon and Ruby Reservoirs through the report period. The creel census on each reservoir was conducted one day per week, for approximately 6 weeks per winter sample period, on weekend days to maximize the number of interviews. A roving creel clerk gathered information on numbers of anglers, residency, hours fished, catch, and harvest. Due to the limited nature of the census, data were limited to catch and harvest rates and could not be used to estimate pressure or total harvest. All pressure estimates used in this report were generated from the MDFWP statewide mail creel census which is conducted on a regular basis.

Statistics describing storage volume, pool elevation, and surface acreage in Clark Canyon Reservoir were calculated from U.S. Bureau of Reclamation data. Storage volumes for Ruby Reservoir were summarized from USGS Water Resources Data Reports.

RESULTS

CLARK CANYON RESERVOIR

Reservoir Storage Trends

Minimum storage pool in Clark Canyon Reservoir, as determined from end of irrigation season storage, is depicted in Figure 1 for the 1987-2001 period. Minimal drought storage pools of the 1989-1992 period approached or dropped below 40,000 acre feet. Reservoir storage improved in 1993-1994 and recovered fully over the five year period 1995 - 1999, often exceeding 140,000 acre feet (Oswald 2000 a). Severe drought conditions over the past two years dramatically reduced storage resulting in a record low minimum pool of 29,992 acre feet in September of 2001. Relationships depicted by Oswald (1993) showed that reservoir surface was reduced to 2,000 acres during severe drought drawdowns between 1989 and 1992. Under these same relationships, reservoir surface remained above 4,000 acres, and often exceeded 5,000 acres at minimum pool for the 1995-1999 period. Current storage conditions of less than 30,000 acre feet have reduced the reservoir surface substantially below 2,000 acres.

Rainbow Trout

Recent rainbow trout plants in Clark Canyon Reservoir are presented in Table 1. Oswald (1993) described the evaluation of the Arlee and DeSmet strains of rainbow trout and incipient data for the Eagle Lake strain in the reservoir. Plants since 1991 have been composed entirely of young-of-the-year Eagle Lake strain of rainbow trout which have averaged about 4.0 - 4.5 inches in length at the time of plant (Oswald 2000 a). Plants are generally made in early June to coincide with a favorable thermal regime and the exponential growth phase of the cladoceran zooplankton community. Stocked fish are dispersed by boat to mitigate predation and encourage an efficient use of forage and habitat niche. The 2001 plant substantially exceeded the average for the past nine years but coincided with the lowest minimum pool recorded since the reservoir was filled in 1964.

Table 1. Recent plants and mean plant for the period of record of young-of-the-year Eagle Lake strain rainbow trout in Clark Canyon Reservoir.

YEAR	NUMBER	YEAR	NUMBER
1993	202,164	1998	200,368
1994	197,616	1999	193,074
1995	200,703	2000	200,000
1996	209,848	2001	248,428
1997	186,718	Mean	204,324

Rainbow trout population trends from 1980 through 2001 are depicted in Figure 2. Oswald (2000 a) described the progression in the evaluation of plants of the Arlee, DeSmet and Eagle Lake stains of rainbow trout over the 1980 - 1999 period. Since 1991, all plants have consisted of young of the year Eagle Lake strain rainbow trout. Following 1988, rainbow trout numbers declined dramatically with declining reservoir storage pools and surface acreage. Recovering storage pools in 1993 (Figure 1) were accompanied by increased numbers of Eagle Lake strain rainbow trout per net. The 1992-1999 sampling period was marked by relatively stable numbers of rainbow trout ranging between 8.4 per net in 1994 and 14.0 per net in 1995 and averaging 11.4 per net for the period (Oswald 2000 a). Per net capture rates of 11.6 in 2000 and 10.8 in 2001 continued this trend and did not alter the 11.4 per net average although a slight decline with declining storage pools is evident since 1998. Oswald (2000 a) noted that survival of rainbow trout plants to Age I (Figure 3) closely mimicked total rainbow trout abundance trends from 1980 through 1993. During this period, Age I plant survivors composed the preponderance of the total rainbow trout sample for each year, generally representing about 2/3 of the sample population. In 1994 and 1996 through 1999, survival to Age I was relatively limited and older fish dominated the per net samples generally composing about 2/3 of the sample population (Oswald 2000 a). The 2000 and 2001 samples continued this declining trend in plant survival as reservoir storage pools declined markedly. The 2001 yearling sample of 0.8 per net is similar to observed lows recorded in 1991 and 1994 under drought influenced reservoir storage pools.

Rainbow trout spawning migrations from Clark Canyon Reservoir were monitored by multiple electrofishing sampling runs in the Red Rock River in 1994 and 1997-1999 and by operation of a weir trap in 1995 and 1996 (Oswald 2000 a). Numbers of spawning Eagle Lake rainbow trout (Figure 4) were also monitored via electrofishing during the 2000 and 2001 spawning seasons. Spawning rainbow trout numbers had been maximized under stable flow regimes in 1994 and declined to a minimum of about 100 per sample run in 1997 under conditions of high snowpack, high flow regimes and cold ambient temperature regimes which characterized the 1995 - 1997 period in southwest Montana. Numbers of spawning fish recovered in 1998 to slightly more than 200 per sample run and numbers continued to increase in 2000 to an observed high of 280 per sample run in 2001 under relatively stable flow and temperature conditions. Recapture rates (Figure 5) also declined below 20% under relatively stable flow and temperature conditions during the 2000 and 2001 spawning seasons. Oswald (2000 a) attributed the high 1999 recapture rate to cold ambient temperature regime which did not result in diurnal temperatures attaining 50 degrees F. during any one of six sample runs conducted during March, April, and May. Length frequency analyses of the rainbow trout spawning migrations of 1997-2001 are presented in Figures 6 through 11. Spawning runs were dominated by Age III and older fish in all years with a relatively high contribution of Age II fish occurring in 1999 and 2001. The strong showing of Age II fish could be directly correlated with relatively strong survival of the 1997 and 1999 plants (Figure 3). Oswald (2000 a) noted that a substantial increase in modal length occurred between 1997 and 1999. This was indicative of a spawning rainbow trout population dominated by older larger fish and was similar to the response of the De Smet rainbow population response observed between 1990 and 1993 (Oswald 1993). This age and size domination of the spawning Eagle Lake rainbow population was continued in the 2000 - 2001 spawning seasons (Figures 9 and 10) with modal peaks occurring at 23.0 - 23.4 inches in both samples. The length frequency analysis further indicates that the 1999 - 2001 spawning migrations were dominated by Age IV and older rainbow trout. The dominance of the Clark Canyon Reservoir rainbow trout population by large mature fish is further demonstrated by substantial increases in the weight of the fish captured over the 2000 - 2001 spawning seasons (Figure 11).

Brown Trout

Wild brown trout population trends over the 1980-2001 period are depicted in Figure 12. Oswald (1993) described a gradual trend for decreasing numbers of brown trout following upon ageing of the reservoir, establishment of larger rainbow trout populations, and low storage pools and tributary flows associated with drought conditions. The recent trend has been reflective of increasing wild brown trout populations from 1995 through 1999 with relatively strong recruitment (Oswald 2000 a). The 2000 - 2001 samples continued to exhibit extremely high capture rates for brown trout, exceeding mean values of all sample years but 1999. High numbers of brown trout were associated with strong recruitment, ample Red Rock River flow regimes, and ample reservoir storage pools in the 1995 - 1999 period. Declining reservoir storage pools in 2000 and 2001 have not resulted in population decline through the 2001 sample, however, numbers of Age I brown trout declined to 0.8 per net in 2000 and 0.2 per net in 2001.

Angler Use Trends

Trends in angling pressure on Clark Canyon Reservoir are presented in Figures 13 and 14. Recent pressure estimates depict a substantial increase in angler days over the 1993-1999 period to levels approaching or exceeding 50,000 angler days per year. Low angler participation in 1991 is reflective of low storage pools marking the 1989-1992 period (Figure 1). The 2001 pressure estimate data will be analyzed as it becomes available to determine if a similar decrease in angler use will accompany the current drought affected storage pools. Nonresident angling pressure has increased at a higher rate than resident use (Figure 15) attaining its highest recorded level with the 1997 sample demonstrating virtually equal participation between resident and nonresident anglers. The 1999 sample exhibited a slight decline in nonresident use while resident pressure continued to increase.

Winter creel catch rates for rainbow trout from 1989 through 2001 are depicted in Figure 15. Very low catch rates in 1989 and 1990 were associated with low storage pools and declining populations but a similarly low rate was also associated with relatively high total rainbow trout and Age I rainbow trout numbers in 1993 (Figures 2 and 3). The highest rainbow trout catch rate of 0.5 per hour was recorded in 1992 and was associated with high spring numbers of Age I Eagle Lake rainbow but other high collection densities of Age I rainbow did not necessarily correlate with high winter catch rates. In most years, rainbow trout catch rates vary between 0.2 to 0.3 fish per hour , averaging 0.2346 fish per hour, and appear to be independent of rainbow trout density. This is certainly apparent for the 1994-2001 period under Eagle Lake rainbow trout management. The 2000 and 2001 creel surveys revealed catch rates of 0.23 and 0.24 fish per hour, virtually representing the empirical average catch rate. The 1999 - 2001 creel surveys were reflective of the domination of the rainbow trout population by large fish with 16% of the rainbow trout harvest exceeding 5.00 pounds in weight in 1999. The percent contribution of these large fish decreased to 10.2% of the observed harvest in 2000 but increased markedly to 32.7% of the harvest in 2001.

Winter creel catch rates for the wild brown trout (Figure 16) are far lower than those observed for rainbow trout and remain extremely constant at approximately 0.03 fish per hour. This consistency in brown trout catch rate appears to be independent of brown trout density as reflected in Figure 12 for the 1989-2001 period and, particularly, for the 1997 - 2001 peak in brown trout density.

RUBY RESERVOIR

Reservoir Storage Trends

Minimum storage pool in Ruby Reservoir, as determined from end of irrigation season storage, is presented in Figure 17. The drought period from 1988 through 1992 was marked by extremely low storage pools dropping to a minimum of only 500 acre feet in 1992. Storage in 1993 recovered strongly under very wet summer climatic conditions, but dropped precipitously in 1994 under extreme drought. In early September 1994, the reservoir was emptied resulting in a large fish kill in both the reservoir and the Ruby River immediately downstream from the dam (Oswald 2000 b). The resultant response included the formation of the Governor's Ruby River Task Force which impressed a minimal storage pool of 2,600 acre feet and fisheries target pools of 6,000 acre feet and 10,000 acre feet. Following the 1994 dewatering, storage remained relatively abundant from 1995 through 1998 based on wet climatic conditions and strong winter snowpack but dry climatic conditions in 1999 dropped the reservoir to the minimum fisheries target pool. Continued drought conditions in 2000 and 2001 reduced storage to recorded lows since the 1994 establishment of the Ruby River Task Force. Storage pools dropped to 3,300 acre feet in 2000 and 3,500 acre feet in 2001.

Rainbow Trout

Oswald (1993) described management of Ruby Reservoir under wild rainbow trout populations from 1981 through 1987. From 1988 through 1991, the reservoir was stocked with four different strains of rainbow including the domestic Arlee strain and the wild DeSmet, Hebgen Lake, and McConaughy strains in an attempt to maintain a fishery through conditions of drought and low storage pools. From 1992 through 2001, Ruby Reservoir has been stocked with the wild Eagle Lake strain of rainbow trout. Plants are composed of young-of-the-year fish which generally average approximately 5.0 inches in length and are stocked in late June or early July to minimize spillway loss from the reservoir. The recent stocking history of Ruby Reservoir is presented in Table 2.

Table 2. Recent plants and mean plant for the period of record of young-of-the-year Eagle Lake strain rainbow trout in Ruby Reservoir.

YEAR	NUMBER	YEAR	NUMBER
1993	50,105	1998	49,725
1994	50,358	1999	49,507
1995	45,347	2000	35,106
1996	51,668	2001	50,000
1997	58,359	MEAN	48,908

Trends in the abundance of rainbow trout in Ruby Reservoir are presented in Figure 18 for the 1979-2001 period. Rainbow trout densities over the 1979-1999 period were discussed by Oswald (2000 a). Despite low storage pools during the 1988-1992 period, rainbow trout numbers increased markedly in 1992-1994 attaining a maximum collection density of 31.0 per net in 1992. These high numbers were based largely on strong survival to Age I from the 1990-1992 plants. The complete dewatering of the reservoir in September 1994 left an impoverished fishery and nearly barren reservoir. In September 1994, approximately 3,000 surviving rainbow trout were captured by electrofishing in the Ruby River tailwater downstream from the dam. These fish were marked with a permanent adipose fin removal and returned to the reservoir. The 1995 gill net sample revealed a depleted rainbow trout population at a collection density of 5.2 per net. Of the 27 rainbow trout captured in the gill nets, 25 exhibited the permanent adipose removal indicative of a fishery that was virtually composed of rainbow trout that had been artificially returned to the reservoir the prior fall. From 1996 through 1999, survival of stocked Eagle Lake rainbow was high and numbers increased markedly to 101.3 per net in 1999 although the 1999 sample was collected in fall under low storage conditions and is not directly comparable to the spring samples of all of the prior years. The 2000 - 2001 collections are indicative of a declining trend in rainbow trout density associated with declining reservoir storage pools. The 2001 collection density of 20.6 fish per net was the lowest observed since 1996 when only one post dewatering plant age class was present in the reservoir. The 2001 collection also fell below the long term average of 22.1 fish per net for the period of record and fell markedly below the post dewatering event mean of 43.8 fish per net. Survival of planted rainbow trout to Age I is depicted in Figure 19 for the 1994 - 2001 period. Extremely high survival of planted fish to Age I was observed in 1998 followed by strong recruitment success in 1999 and 2000. The rapid decline in rainbow trout numbers in 2001 was associated with an even greater decline in yearling survival. While highs and lows in yearling survival in 1998 and 2001 were also associated with above and below average plants in the prior year (Table 2), the percent deviation from the mean is not proportional to the deviation from the mean plant.

Length range and mean length of rainbow trout in Ruby Reservoir (Figure 20) has varied little since stocking of wild strains of rainbow commenced in 1989. Maximal mean length and minimal length range occurred in 1995 in the aftermath of the dewatering event. Despite reestablishment efforts required to maintain a rainbow trout fishery in the reservoir following 1994, mean length remained relatively constant from 1996 through 1999 at approximately 13.0 to 13.5 inches while length range expanded to a maximum in 1998 and 1999 as older, larger fish were produced in the population. In the 2000 and 2001 samples, length range was attenuated with the loss of larger fish in the population while the mean length increased markedly in 2001. Length frequency analyses are provided for the 1996-2001 period in Figures 21-26. This period depicts the length frequency distributions of the Eagle Lake Rainbow trout populations following the 1994 dewatering event and subsequent plants. Following the dewatering event of 1994, the 1996-2000 period demonstrates strong recruitment of Age I and II fish into the population and the reestablishment of a population age structure by 1998 and 1999 (Figures 21-24). Despite high population numbers, the bulk of the 1998 - 2000 populations remained dependant on Age I and

Age II recruits. Advantageous colonization of an understocked system by the earliest post - 1994 plants resulted in the highest modal length for Age I fish in 1996 and for Age II fish in 1997. This situation quickly stabilized as rainbow trout density increased with yearling modal length occurring at the 11.0 - 11.4 half inch group in spring samples in 1997 through 2000. The 2001 sample exhibited a sharp decline in the number of Age I fish in the distribution and yielded the lowest observed modal length for both Age I and Age II fish since the reestablishment of rainbow trout populations after 1994.

Brown Trout

Population trends for wild brown trout in Ruby Reservoir are presented in Figure 27 for the 1979-2001 period. Brown trout numbers remain well below those observed for rainbow trout and declined markedly during the low reservoir storage pools of the 1988-1992 period. Following the 1994 dewatering event, no brown trout were captured in 1995 or 1996 as was the case for mountain whitefish, another wild game species. Recovery of brown trout began with the 1997 sample although numbers remained low through 2000 when compared with the period prior to 1990. No brown trout were collected in the 2001 sample. Relatively strong recruitment of juvenile brown trout was noted in the 1998 sample but did not result in significant population increases in any of the following years.

Angler Use Trends

The estimated angling pressure for Ruby Reservoir is presented in Figure 28 for the 1984-1999 period. Ruby Reservoir has sustained angling use averaging about 2,000 angler days per year prior to the 1997 pressure estimate. In 1989, angler use declined to 636 angler days based on low storage pools and declining trout populations but, in 1993, pressure rose to 3,297 angler days with burgeoning populations of rainbow trout. The 1997 and 1999 pressure estimates represent a dramatic increase in angler use with the 1999 estimate of 11,962 angler days representing more than a threefold expansion of the prior observed high. This dramatic increase in angling activity is based on the success of the rainbow trout recovery following 1994.

In 1997, a weekend winter roving creel survey was initiated on Ruby Reservoir. The survey was initiated based on relatively heavy observed angler use of the expanding rainbow trout population. Winter catch rates for rainbow trout (Figure 29) steadily increased from 1997 through 1999 and have been very high when compared with other southwest Montana reservoirs. Despite high numbers of rainbow trout in the population, catch rates declined markedly in the 2000 - 2001 season but recovered to 0.99 fish per hour in 2001-2002 despite rapidly declining rainbow trout numbers. As rainbow trout numbers and catch rates have generally increased since 1996, the average size of the rainbow trout harvested has steadily declined (Table 3). While the 1997 - 1999 size declines could probably be attributed to increased rainbow trout density and increasing numbers of mature fish in the population, the continued size declines in 2000 and 2001 were associated with diminishing densities and declining reservoir storage pools.

Table 3. Average size of Eagle Lake strain rainbow harvested in winter creel census of Ruby Reservoir, 1997 - 1999.

YEAR	MEAN LENGTH	MEAN WEIGHT
1997-1998	15.8 inches	1.30 pounds
1998-1999	15.4 inches	1.22 pounds
1999-2000	14.6 inches	1.04 pounds
2000-2001	13.5 inches	0.85 pounds
2001-2002	13.3 inches	0.85 pounds

ELK LAKE

Yellowstone Cutthroat Trout

Elk Lake has received plants of McBride Lake strain Yellowstone cutthroat trout since 1986. Oswald (1993) reported on experimental usage and varying success of overwintered yearling fish versus young-of-the-year fish in Elk Lake. The annual alternation of Age I and young-of-the-year plants was abandoned in 1994 in favor of annual plants of overwintered yearling fish. The yearlings can be planted earlier and at a much larger average size than the young-of-the-year plants. Recent Elk Lake cutthroat plants are summarized in Table 4.

Table 4. Recent plants of McBride Lake Yellowstone strain cutthroat trout in Elk Lake.

YEAR	YEARLING NUMBER	YOY NUMBER
1993		250,000
1994	9,867	
1995	10,125	251,512
1996	10,100	
1997	12,699	
1998	16,333	
1999	15,753	
2000	17,100	
2001	22,560	

Numbers of Yellowstone cutthroat trout collected in gill nets over the 1981-2001 period are presented in Figure 30. Oswald (1993) discussed trends associated with the failure of recruitment of YOY plants as opposed to the success of overwintered yearling plants. The recent trend since overwintered yearlings were used on an annual basis has been an increase in number per net (Oswald 2000 a). While 1985-1994 samples averaged 14.4 fish per net, the 1995-2001 samples yielded a mean of 21.9 fish per net. The 1998 sample density of 47.7 per net was the highest capture rate since large consecutive yearling plants were made in 1982 and 1983. The missing age classes which typified the Elk Lake cutthroat trout population from 1983-1995 (Figure 31) have been filled by consecutive plants of a survivable age and size. The 1998 sample revealed a minimum of four age classes. The missing Age II class in 1999 was due to cold ambient temperature regimes which resulted in Age II fish avoiding capture due to small size. Subsequent samples on June 30 revealed an average length of only 8.4 inches for the Age II fish. This year class was also absent as Age III fish in the 2000 sample and was a causal factor contributing to the low collection densities for cutthroat trout observed in 1999 and 2000. Cutthroat trout densities rebounded to 19.0 per net in 2001 with all age classes represented in the sample. The numbers of Age IV and older fish captured in the 2000 and 2001 samples exceeded those of all of the other sample years from 1981 to the present.

Arctic Grayling

The status of the Arctic grayling of Elk Lake was last reported by Oswald (2000 a). Trends in numbers of Arctic grayling collected through the 1981-2001 sampling period are depicted in Figure 32. Grayling numbers most frequently held at 10 to 12 per net through 1987. As drought conditions dominated the climate from 1985 through 1994, flows in Narrows Creek during the spawning season became sporadic or nonexistent. As a result of this lack of spawning habitat over a prolonged period, Arctic grayling numbers declined rapidly from 1989 through 1994. No grayling have been collected from 1995 through 2001 leading to the presumption that Arctic grayling have been eliminated from Elk Lake.

Lake Trout

The status of the Elk Lake native lake trout population was last reported by Oswald (2000 a). Lake trout numbers appear relatively stable at low density (Figure 33) varying between about 0.8 and 1.6 per net since 1991 when sinking gill nets were incorporated into the sampling program to increase lake trout capture efficiency. This increased sampling efficiency has eliminated the extremely low collection rates, or absence of lake trout from the sample, which marked the 1984-1988 period. Analyses of mean length, length range, and composite length frequency over the 1991-2001 period (Figures 34 and 35) also demonstrate stability within the sample population. Mean length varied only slightly with length frequency analysis demonstrating that the majority of lake trout sampled range between 16.5 and 19.5 inches in length. The collection of juvenile fish was limited to the 1994, 1998, and 2001 samples limiting any speculation on recruitment into the population.

In 1999, genetic samples were collected from 14 Elk Lake lake trout, preserved, and mailed to the USGS Great Lakes Science Center in Ann Arbor, Michigan for analysis. The purpose of this endeavor was to gain more insight into the native status of the Elk Lake lake trout population. Results of the mitochondrial genetic analysis strongly suggest that the Elk Lake fish represent an uncontaminated native stock of glacial relict origin (M.B. Curtis USGS Great Lakes Laboratory, Personal Communication). Despite the close proximity of Elk Lake to Yellowstone National Park, no genetic contamination of the native stock from lake trout introduced into some of the lakes of the Park in 1890 was detected. Moreover, the genetic analysis of the fish is indicative of a "genetic bottleneck" caused and maintained by low numbers of breeding individuals in the population. The findings of Ms. Curtis concur with the findings of Wilson and Hebert (1998) who determined that the native Montana lake trout represented a distinct C3 haplotype with glacial origins in the northern portions of Alaska and Canada.

Burbot

The incorporation of sinking gill nets into the Elk lake sampling program in 1991 provided for the sampling of a second native glacial relict species, the burbot. The burbot population of Elk Lake was first described by Oswald (2000 a). Collection trends for Elk Lake burbot are presented in Figure 36. Collection rates have varied between 5.5 and 23.0 per net with little evidence of any dominating trends in burbot numbers in May samples. The 1993-1997 period appeared to exhibit a declining trend in the burbot population while the 1998 - 2001 period was marked by increasing numbers of burbot in the sample. Both trends appeared to be driven by recruitment success or lack thereof. In 1999, additional genetic sampling of lake trout provided for burbot samples from overnight sets in late June and September. The June sample yielded a capture of 26.5 burbot per net and the September sample yielded 31.8 burbot per net, both samples exceeding the highest observed prior capture rate in May.

The length range and mean length for burbot in Elk Lake (Figure 37) suggest a relatively slow rate of growth and limited ultimate size for the species. Low mean lengths observed in 1993 and 1998 were associated with relatively high burbot collection densities (Figure 36) and suggested relatively strong recruitment into the population. A composite length frequency analysis (Figure 38) indicates a pronounced age structure within the population which was not apparent in the lower density lake trout.

HIDDEN LAKE

Hidden Lake has been managed as a wild rainbow trout fishery since limited plants were introduced in the mid 1930's and 1940's. Trends in wild rainbow trout populations were last reported by Oswald (2000 a). Recent trends in Hidden Lake rainbow trout populations (Figure 39) reflect increasing rainbow trout numbers from a relatively strong and stable population base. The high per net densities observed in 1997 and 1998 were accompanied by evidence of strong recruitment of Age II fish into populations that maintained strong bases of Age III and Age IV fish. The slight population decline suggested in the 1999 and 2000 samples was primarily due to lower numbers of Age II and Age III fish in the samples. Length range and mean length of the rainbow trout collected (Figure 40) has demonstrated a highly stable population structure throughout the sample period. Length frequency analysis (Figure 41) for the 1993-2001 period depicts the age structure of the population and demonstrates a sample population dominated by mature, Age IV and older, fish. The length frequency distribution of the 2000-2001 samples also depicts populations dominated by older, larger fish.

TWIN LAKES

The fish populations of Twin Lakes have been sampled sporadically since 1964 and were last reported in detail by Oswald (2000 a). In the interest of better determining the native genetic status of the lake trout of Twin Lakes, an intensive sampling effort was conducted in 1998 (Oswald and Roberts 1998) resulting in the setting of 20 overnight experimental gill nets between July 17 and October 8, 1998. The 1998 sampling effort resulted in a clearer description of the fish populations of Twin Lakes than had previously existed. Trends in lake trout numbers over the 1964-1998 period revealed that, prior to 1998, lake trout numbers varied between 1.0 and 5.0 per net. The highest capture rates were noted in the 1964, 1986 and 1990 samples. Intensive sampling in 1998 revealed a capture rate of 0.6 per net. The length frequency distribution of fish collected in the 1998 sampling program revealed the presence of only two age classes of fish. The juvenile year class was composed of fish in the 12.0-13.9 inch length range while the mature age group consisted entirely of fish in excess of 30 inches in length. The disparate size classes indicative of sporadic success in lake trout recruitment was also observed in the 1964 and 1986 samples. In contrast with Elk Lake, the length range and mean length of the lake trout from Twin Lakes samples has varied widely over the sample period (Oswald 1993).

In 1998 and 1999, genetic samples were collected from 14 Twin Lakes lake trout, preserved, and mailed to the USGS Great Lakes Science Center in Ann Arbor, Michigan for analysis. The purpose of this endeavor was to gain more insight into the native status of the Twin Lakes lake trout population and greatly expand a limited sample which had been subjected to mitochondrial analysis in 1994 (Wilson and Hebert 1998). Results of the mitochondrial genetic analysis strongly suggest that the Twin Lakes fish represent an uncontaminated native stock of glacial relict origin (M.B. Curtis USGS Great Lakes Laboratory, Personal Communication). Moreover, the genetic analysis of the fish is indicative of a "genetic bottleneck" caused and maintained by low numbers of breeding individuals in the population. The findings of Ms. Curtis concur with the findings of Wilson and Hebert (1998) who determined that the native Montana lake trout represented a distinct C3 haplotype with glacial origins in the northern portions of Alaska and Canada.

DISCUSSION

CLARK CANYON RESERVOIR

Minimum storage pools in Clark Canyon Reservoir recovered markedly from the 1985 - 1994 drought period generally exceeding 140,000 acre feet of storage representing surface areas of 4,000 to 5,000 acres. Oswald (1993) generated relationships linking poor rainbow trout plant survival and poor rainbow and brown trout condition factors to limited reservoir surface acreage at low storage pools. Oswald further suggested that 3,000 surface acres was an adequate minimum to provide sufficient production to insure good rainbow trout plant survival and good adult trout condition. Storage pools over the 1995-1999 period were abundant and far exceeded this minimum. Recent limited storage pools in 2000 and 2001 were symptomatic of another drought condition in southwest Montana. While the 2000 storage pool of about 60,000 acre feet was capable of sustaining the minimum 3,000 surface acre lake, the 2001 minimum pool resulted in a record low for the history of the reservoir. The 2001 pool of 29,992 acre feet was associated with a dramatic drop in plant survival similar to those observed in 1991 and 1994.

Total rainbow trout numbers have recovered significantly since the low storage pools which marked the 1989-1992 period. Rainbow trout numbers rebounded to average 10.0 per net during the 1992-1994 period and became relatively stable to average 11.9 per net during the 1995-2001 period. This most recent average is indicative of a near threefold improvement in rainbow trout density over the era in which the reservoir was managed with the domestic Arlee strain and a twofold improvement over conditions of low storage pools in the 1989-1991 period.

Stocks of the domestic Arlee strain and wild DeSmet and Eagle Lake strains were evaluated in Clark Canyon Reservoir over the 1980-1993 period (Oswald 1993). Plants since 1991 have been composed entirely of the wild Eagle Lake strain of rainbow trout which has performed in a manner comparable to the DeSmet. Plants have continued to be composed of young-of-the-year fish but planting dates have been advanced to early June to take advantage of the exponential growth phase of the cladoceran zooplankton community and favorable surface temperatures (Berg 1974). Plants have also been dispersed by boat to mitigate predation and more rapidly expand habitat niche availability.

Despite ample storage pools and modified stocking protocol, survival of planted fish to Age I has been relatively low or moderate for 1996-2000 period. High plant recruitment was noted in 1992, 1993, and 1995 following declining rainbow populations in the 1989-1991 period. While plant recruitment to Age I has recently been limited, total rainbow trout numbers and total numbers of large fish greater than 4.0 pounds in weight have been high. In the substantial majority of years from 1980 through 1995, Age I rainbow trout composed 50% or more of the rainbow trout sample population. The percentage of Age II and older fish averaged 74.7% of the rainbow trout sample population over the 1996-1999 period. The most recent samples demonstrated a 79.3% contribution by Age II and older fish in 2000 and a 92.6% contribution in 2001. Moreover, recent samples have exhibited some of the highest collection densities of wild brown trout observed over the sampling history of the reservoir. The data strongly suggest that ample storage pools have provided for an immediate recovery of plant survival and rainbow trout condition, however, large numbers of older, larger fish may be limiting plant survival and recruitment in recent years through competition and predation. The situation appears exacerbated by record low storage pools in 2001.

Rainbow trout spawning runs have been monitored in the Red Rock River since management strategies shifted to the use of wild strain DeSmet and Eagle Lake stocks. Oswald (1993 and 2000a) last described the composition of DeSmet and Eagle Lake strain spawning migrations. The spawning runs of 1994, 1995 and 1998 were relatively strong while the spawning runs of 1997 and 1999 were somewhat limited by cold ambient thermal regimes. Multiple electrofishing runs in 1999 resulted in a very high incidence of recapture of fish participating in the run and were marked by water temperatures that never attained the 50°F mark. Spawning runs in 2000 and 2001 were substantially improved due to stable flow regimes and normal ambient temperatures. Modal length frequency and numbers of fish greater than four pounds in weight advanced substantially over the 1997-2001 spawning runs demonstrating increased numbers of larger, mature rainbow trout at ample reservoir storage. The monitoring of the spawning migrations has also incorporated an Eagle Lake strain egg collection since 1995. The Clark Canyon Eagle Lake rainbow trout population has become an effective wild brood source to provide fertilized eggs for rearing as overwintered yearlings for plants in other reservoirs. The Clark Canyon source has provided 300,000 to 500,000 fertilized Eagle Lake strain eggs annually for this purpose since the program was incorporated.

Angler use of Clark Canyon Reservoir has increased substantially in the recent past. While pressure has increased, plants into Clark Canyon have remained relatively constant and numbers of rainbow trout have stabilized at approximately 12 fish per net with recent years dominated by older larger fish. Angler success, as measured via winter creel census has remained relatively constant also, however, an increasing amount of angler dissatisfaction has been expressed during creel census sampling. While anglers have been satisfied with the large average size of fish in the catch, most of the dissatisfaction has revolved around lower numbers of Age I and Age II fish which tend to increase the catch rate of the average angler. In order to increase plant survival with burgeoning populations of large rainbow trout and increased numbers of brown trout, it might be advantageous to incorporate an additional plant of overwintered yearling Eagle Lake strain rainbow into the current management program. This could provide some increase in survival advantage and utilize some of the progeny of the Red Rock egg collection in the natal system while providing a means of compensating for increases in pressure. A yearling plant of approximately 75,000 overwintered yearling Eagle Lake rainbow is planned for Clark Canyon Reservoir in May and early June, 2002.

Recent abundant populations of wild brown trout exceeded former collection highs observed shortly after Clark Canyon was impounded in 1964. The brown trout population dropped to observed lows over the drought influenced 1988-1994 period but recovered significantly during the abundant flow years of 1995-1999. High numbers of brown trout have been maintained through 2000 and 2001 despite declining reservoir storage pools. Recruitment, however, has shown a substantial decline in both years. High numbers of rainbow trout combined with record high numbers of brown trout have resulted in the highest observed trout populations in the history of the reservoir.

RUBY RESERVOIR

The rainbow trout populations of Ruby Reservoir increased markedly through 1994 under management with multiple wild strains of rainbow trout following rapid population declines in the late 1980's (Oswald 1993). In September of 1994, Ruby Reservoir was completely dewatered resulting in a large fish kill in the reservoir and the downstream Ruby River (Oswald 2000 b). This event precipitated the formation of a Governor's Ruby River Task Force in 1995 which established a minimum reservoir pool of 2,600 acre feet and Fisheries Target Pools for Optimum (10,000 acre feet) and Minimum (6,000 acre feet) recommended storage for fisheries maintenance (RRTF Final Report 1995). From the inception of this pool management program, reservoir storage pools remained above or very close to the Optimum Target Pool of 10,000 acre feet through 1998. Plants of Eagle Lake rainbow from 1995 through 1998 flourished resulting in record high rainbow trout populations observed in 1998 and 1999 (Oswald 2000 a). Rainbow trout population decline began to occur in 2000 following a drop in minimum pool which approximated the Minimum Fisheries Target Pool of 6,000 acre feet. The subsequent drop in pool to 3,300 acre feet in 2000 resulted in a substantial decline in rainbow trout numbers. It also resulted in a significant decline in recruitment to Age I and a major shift in the length frequency distribution within the population in the 2001 samples. The 1998 peak and 2001 decline in recruitment to Age I followed above and below average plants (Table 2) in the respective prior years. While this might suggest that the survival to Age I was correlated directly to the abundance of the prior year's plant, the relationship was not proportional. That is, the 1997 plant was 19.3% above the plant mean while the number of Age I rainbow in 1998 was 104% above the mean for recruit survival. Similarly, the 2000 plant was 28.2% below average while the number of Age I fish in 2001 was 82.5% below average. This suggests that mechanisms other than the abundance of the plant were more important causal factors in determining stock survival to Age I. Oswald (1993) found no significant correlation between rainbow trout survival and the abundance of the prior year's plant in Clark Canyon Reservoir. There was, however, a strong relationship between reservoir surface acreage at minimum storage pool and survival of stocked rainbow trout to Age I. The data strongly suggest that declines in reservoir storage from the Optimum Fisheries Target Pool to the Minimum Fisheries Target Pool resulted in a population decline which still maintained high numbers of fish. Further storage decline below the Minimum Fisheries Target Pool resulted in substantial population decline.

Wild brown trout populations also began recovery under ample reservoir storage pools although the brown trout did not appear in samples until 1997 at extremely large size. The 1998 sample revealed a relatively strong recruitment of juveniles into the population, however, the 2001 sample resulted in the capture of no brown trout.

The reservoir was essentially under populated for the 1995 and 1996 plants and growth of stocked Eagle Lake Rainbow trout to Age I and Age II was exceptional. Growth in 1998 and 1999 declined somewhat under burgeoning populations and a lower storage pool in 1999. This decline continued in the 2000 and 2001 samples as both rainbow trout density and reservoir storage pools declined suggesting that reservoir storage was more important than stock density in determining rainbow trout growth and ultimate size.

Under recent high rainbow trout populations, angler use of Ruby Reservoir has increased dramatically. While angling pressure has soared, rainbow trout populations have remained very high and winter creel catch rates have been extremely high when compared with other southwest Montana reservoirs. Recent samples have shown a decline in numbers of older, larger fish and the average size of fish in the harvest has declined. This suggests that heavy angler use could have some influence on the size and age structure of the population in Ruby Reservoir. However, the data, when compared with sample length frequency distribution and length ranges strongly suggest that both stock density of rainbow trout and minimum reservoir storage pools have significantly influenced the growth and ultimate size of the fish available for harvest. Numbers of Age I and Age II fish remain high, at ample reservoir storage pool, indicating that the plant of approximately 50,000 young-of-the-year rainbow trout is sufficient to stock the reservoir and satisfy angler needs.

ELK LAKE

Oswald (1993) evaluated the use of young-of-the-year versus overwintered yearling plants of McBride Yellowstone strain cutthroat trout in Elk Lake. This evaluation showed that vastly increased numbers of young-of-the-year fish did not result in increased survival to Age II while limited numbers of yearling plants could result in high survival to Age II. Since 1994, consistent plants of overwintered yearlings has resulted in greater stability within the Elk Lake cutthroat trout fishery in terms of age and size structure (Oswald 2000 a). The 2000 and 2001 samples yielded the highest sample densities of Age IV and older fish for the period of record. Limits in size of young-of-the-year fish, productivity of the lake, and annual cycles in thermal regime and zooplankton abundance, as well as predation factors probably limit the use of young-of-the-year plants in Elk Lake. Angler use in Elk Lake has declined somewhat in the recent past. During the 1980's angler use averaged 2,468 angler days per year over four sample years from 1983-1989. During the 1990's, angler use declined to average 1,174 angler days per year over four sample years between 1991 and 1997. Oswald (2000 a) noted that the decline in use was similar to that observed on nearby Hidden Lake and could have been related to the remote location of these lakes. The 1999 angling pressure on Elk Lake, however, was estimated at 2,271 angler days, an estimate similar to those observed in the 1980's. A slight increase was also noted in the 1999 pressure estimate for Hidden Lake.

Data suggest that the Arctic grayling population of Elk Lake has undergone extinction due to lack of spawning flows in extremely limited spawning habitats over a prolonged period of drought. While the presence of native lake trout and burbot in Elk Lake and the proximity of a native adfluvial grayling population in nearby Red Rock Lake strongly suggest that grayling were native to the system, subsequent plants probably were responsible for the maintenance of the most recent grayling population. Attempts are currently being made to form a viable brood stock of adfluvial lacustrine Arctic grayling by using Red Rock Lake as the source. After the brood stock is mature, it should be used a source to refound an Elk Lake arctic grayling population and return this glacial relict species to the fishery.

The lake trout of Elk Lake have long been accepted as representing a native population. Recent examination of the literature and genetic analysis lend credence to this assumption. Vincent (1963) cited numerous authors from the late 1800's which described collections of native lake trout from Elk Lake prior to 1890 when the species was first brought to the intermountain west for introduction. He also referenced a type collection of three lake trout sent to the U.S. National Museum listing Elk Lake as the specimen locality. He concluded that the lake trout of Elk Lake were a glacial relict population and native in origin. Khan and Quadri (1971) in a meristic and morphological examination of lake trout from across its range of distribution determined that the lake trout of Elk and Twin Lakes represented a glacial refuge population in the upper Missouri River drainage. Genetic examination of a small collection of lake trout from Twin Lakes in 1994 led Wilson and Hebert (1998) to conclude that the fish were of a distinct haplotype and represent a glacial relict native population. This C3 haplotype originated in northernmost Alaska and Canada and is currently distributed in western Montana and southern Alberta. More recent genetic examination of 14 fish from Elk Lake and 14 fish from Twin Lakes led to agreement with Wilson and Hebert's findings and the conclusion that the lake trout populations of both lakes represent native populations of the same glacial origin (M. B. Curtis, USGS, Personal Communication 2000). This expanded examination also eliminated the possibility that the native Elk Lake stock had been contaminated by introduced lake trout of Great Lakes origin which were stocked in Yellowstone park in 1890. Examinations of mitochondrial DNA by Curtis also suggest that low variation is associated with a genetic "bottleneck" caused and maintained by low populations of breeding individuals in both lakes. This is certainly substantiated by lake trout collection densities in Elk Lake and also by age and size structure of the sample population. This unique native population of lake trout had been managed under a restrictive two fish bag limit but data suggested a need for increased protection, which resulted in the application of catch and release angling regulations beginning in 2000.

The burbot of Elk Lake represent another unique native species occupying a habitat niche somewhat similar to the lake trout. While sampling of burbot through the use of sinking gill nets began in 1991, data on the species had not been included in prior reports. Collection densities of burbot far exceed those observed for lake trout, the other deep water native piscivore in the system, and appear to trend upward or downward with the strength of recruitment classes. The recent trend since 1998 has been one of population increase while the prior trend between 1993 and 1997 was one of population decrease. No reason for these differing success rates in recruitment and subsequent population trends is readily apparent. Length frequency analysis are indicative of a relatively slow growth rate for the species compared with lower elevation reservoirs in southwest Montana. Limits on ultimate size of the burbot in Elk Lake probably preclude the value of the species in the sport fishery, particularly when compared with the more popular and abundant cutthroat trout.

HIDDEN LAKE

Oswald (2000 a) reported on the extremely stable nature of the wild Hidden Lake rainbow trout population. Sampling conducted from 1985-2001 has revealed a continuation of this stability with ample numbers of mature, larger fish dominating populations and sufficient recruitment maintaining an abundant population. Recent sample trends have indicated expanding populations between 1996 and 1998 followed by declining populations between 1998 and 2000. Despite these recent trends the rainbow trout population of Hidden Lake is generally maintained at a sample density between 20 and 30 per net averaging 29.1 per net over the period of record.

Oswald (1993) noted a reported decline in angling pressure on Hidden Lake in the 1989 and 1991 Pressure Estimates. This trend was continued over the 1993-1997 period with annual angling pressure averaging approximately 550 angler days per year over the period (Oswald 2000 a). The 1999 pressure estimate noted a slight increase over the long term average at 720 angler days of effort. An increase in angling pressure was also noted for nearby Elk Lake in the 1999 estimates. The data strongly suggest that declining use is not associated with the abundance of the rainbow trout population but could be associated with the remote location of the lake and the limited angling season. Under current regulations, Hidden Lake is open to fishing from the third Saturday in June through November 30 while most lakes and reservoirs are open for angling the entire year.

The rainbow trout of Hidden Lake construct redds and actively spawn along shorelines and windswept shoreline points. Spawning habitat in the small inlet stream from spring origins is extremely limited and few fish are observed using the stream for spawning. The lake also does not have an outlet stream. It therefore appears doubtful that the abundant rainbow trout population of Hidden Lake could originate from this limited stream spawning resource. The data and spawning observations suggest that the rainbow trout of Hidden Lake, and the Hidden Lake habitat represent unique resources which have resulted in a successful lacustrine rainbow trout population, that is, a population capable of spawning and reproducing in a lake. Additional research should be conducted to determine if the Hidden Lake rainbow trout do successfully spawn, incubate and hatch eggs in a lacustrine environment. This would elevate the status of the population as an important brood source for lakes with characteristics similar to Hidden Lake.

TWIN LAKES

Twin Lakes has long been managed through the stocking of salmonid species due to its accessibility, developed campgrounds and boat ramps, and scenic alpine setting. Unsuccessful plants to establish Arctic grayling were attempted between 1928 and 1939. Single plants of cutthroat trout were made in 1934, 1994, and 1998 and rainbow trout were stocked annually from 1940 through 1963 with marginal success for either species. Despite this intensive management effort, Twin lakes remains sparsely populated with six species of fish, the least abundant of which are the rainbow and cutthroat trout. Oswald and Roberts (1998) noted limits in productivity based on very low dissolved chemical components and high elevation. Oswald (2000 a) most recently described the fish populations of Twin Lakes including the wild brook trout and the native lake trout, burbot, and longnose sucker.

The lake trout of Twin Lakes have long been accepted as representing a native population. Recent examination of the literature and genetic analysis lend credence to this assumption. Vincent (1963) cited naturalist's reports from the late 1800's which described visits to Twin Lakes and reference to native lake trout prior to 1890 when the species was first brought to the intermountain west for introduction. He concluded that the lake trout of Twin Lakes were a glacial relict population and native in origin. Khan and Quadri (1971) in a meristic and morphological examination of lake trout from across its range of distribution determined that the lake trout of Elk and Twin Lakes represented a glacial refuge population in the upper Missouri River drainage. Genetic examination of lake trout collected from Twin Lakes in 1994 led Wilson and Hebert (1998) to conclude that the fish were of a distinct haplotype represent a glacial relict native population. More recent genetic examination of 14 fish from Elk Lake and 14 fish from Twin Lakes led to agreement with Wilson and Hebert's findings and the conclusion that the lake trout populations of both lakes represent native populations of the same glacial origen (M. B. Curtis, USGS, Personal Communication 2000). Examinations of mitochondrial DNA by Curtis also suggest that low variation is associated with a genetic "bottleneck" caused and maintained by low populations of breeding individuals in both lakes. This is certainly substantiated by lake trout collection densities in Twin Lakes and also by age and size structure of the sample population. Sampling data collected over the 1964-1998 period are suggestive of extremely sporadic recruitment success and limited typical lake trout spawning habitat in the form of windswept gravel or small cobble reefs at depths of one to two meters can be readily observed in the lake. Length range, mean length, and length frequency distribution of lake trout in Twin Lakes are extremely variable when compared with the Elk Lake lake trout population.

This unique native population of lake trout has been managed under a restrictive two fish bag limit but data suggested a need for increased protection. As such, the implementation of catch and release angling regulations occurred in 2000. Additional management plans under consideration for the lake include construction of a low head dam between the two lake basins to increase storage capacity of the upper lake basin. This stored water would be used to augment late summer and early fall flows in the Big Hole River to improve Arctic grayling habitat during drought conditions. The affects of artificially raising and lowering the lake pool and of fragmenting the two lake basins on the native lake trout are currently unknown and merit intensive study. Additional study of the lake trout population should also include investigations on the feasibility of improving spawning and rearing habitat and the relationships with brook trout populations.

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Report Prepared By: Richard A. Oswald, MFWP, Region 3, Bozeman June 2002

All Work Included in this Report in Conjunction with Federal Aid in Fish and Wildlife Restoration Acts:
Project Numbers: F-78-R-6 and F-113-R-1

Montana Fish, Wildlife & Parks Project Number 3320

APPENDIX OF FIGURES

Figure 1. End of irrigation season (fall) storage in Clark Canyon Reservoir, 1987 - 2001.

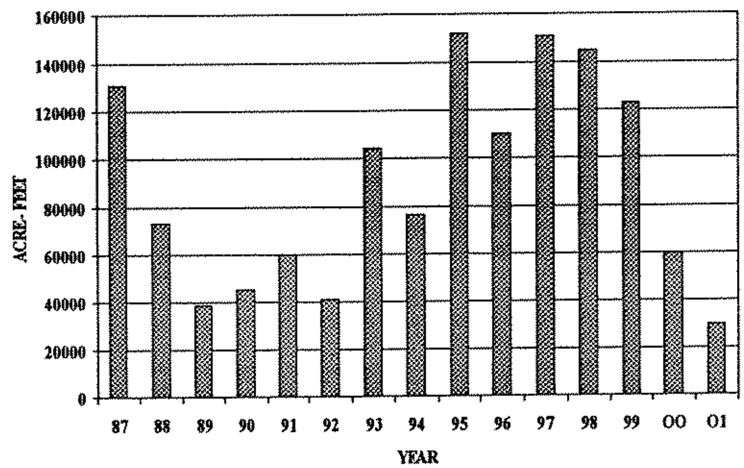


Figure 2. Mean number of rainbow trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2001.

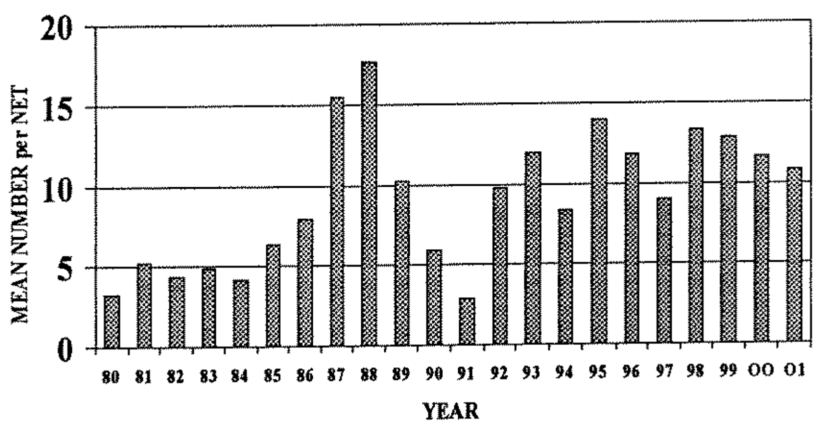


Figure 3. Mean number of Age I rainbow trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2001.

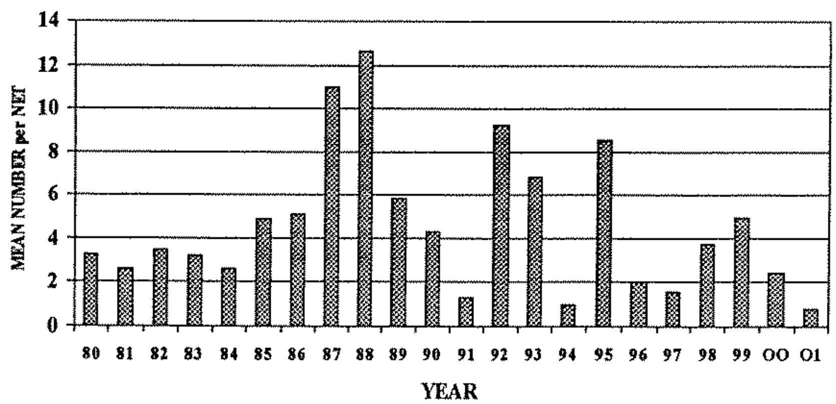
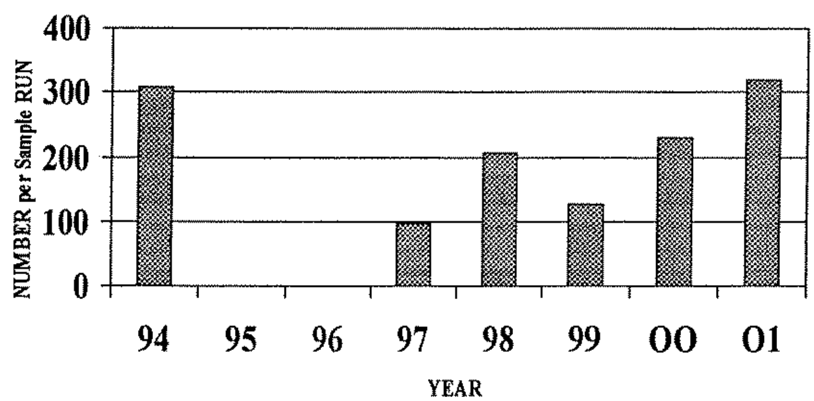


Figure 4. Mean numbers of spawning rainbow trout from Clark Canyon Reservoir captured per electrofishing run in the Roe Section of the Red Rock River, 1994 - 2001.



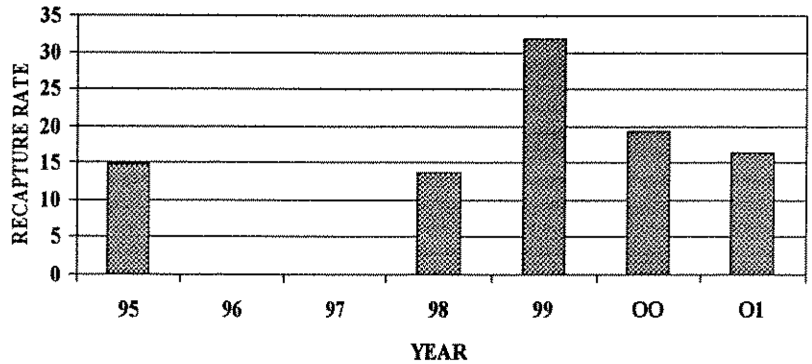


Figure 5. Mean rate of recapture (mark/capture) of spawning rainbow trout from Clark Canyon Reservoir captured in the Roe Section of the Red Rock River, 1994 - 2001.

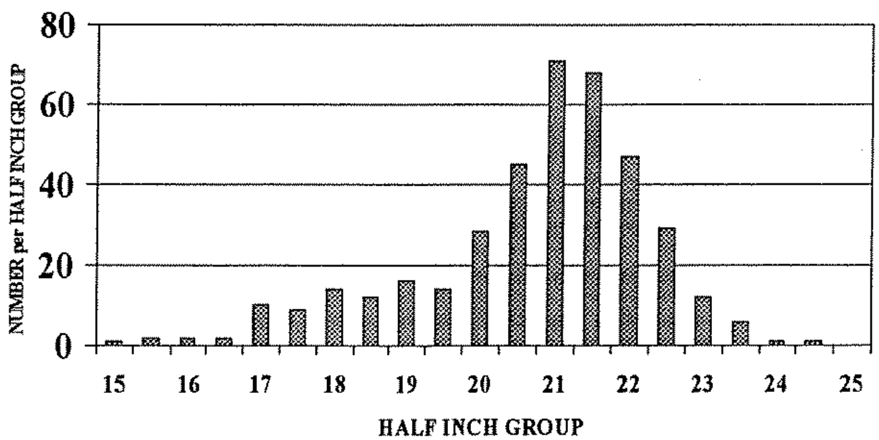


Figure 6. Length frequency distribution of spawning rainbow trout from Clark Canyon Reservoir captured in the Roe Section of the Red Rock River, 1997. (N=391)

Figure 7. Length frequency distribution of spawning rainbow trout from Clark Canyon Reservoir captured in the Roe Section of the Red Rock River, 1998. (N=444)

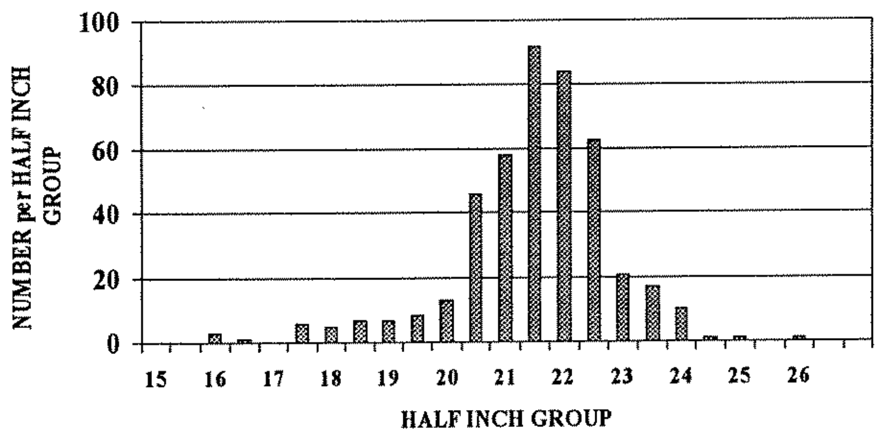


Figure 8. Length frequency distribution of spawning rainbow trout from Clark Canyon Reservoir captured in the Roe Section of the Red Rock River, 1999. (N=581)

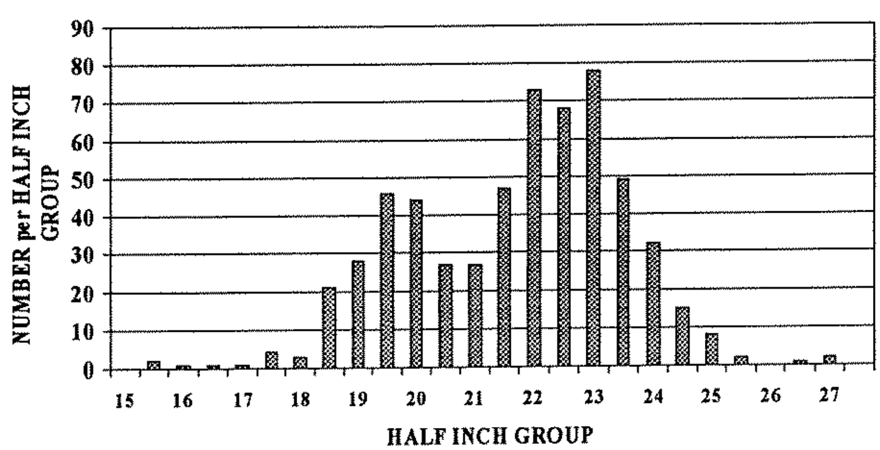


Figure 9. Length frequency distribution of spawning rainbow trout from Clark Canyon Reservoir captured in the Roe Section of the Red Rock River, 2000. (N=605)

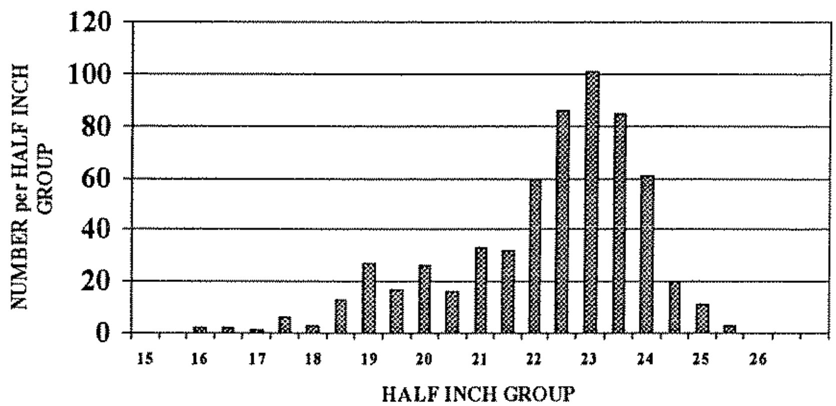


Figure 10. Length frequency distribution of spawning rainbow trout from Clark Canyon Reservoir captured in the Roe Section of the Red Rock River, 2001. (N=840)

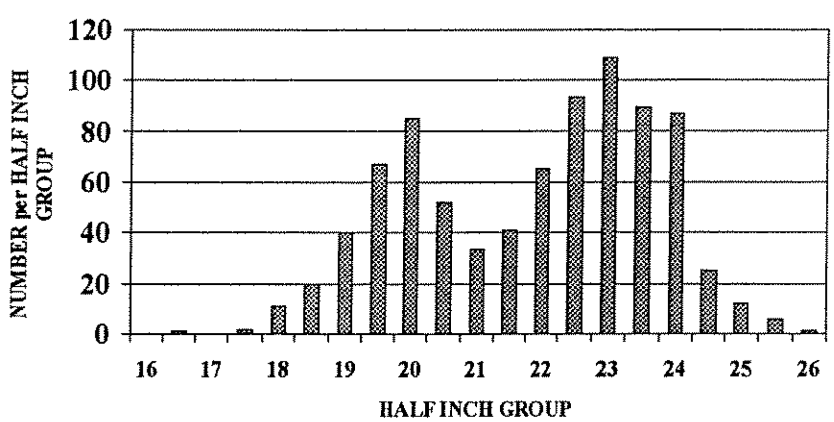


Figure 11. Weight distribution of 4.00 pound and larger spawning rainbow trout from Clark Canyon Reservoir collected in the Roe Section of the Red Rock River, 1994 - 2001.

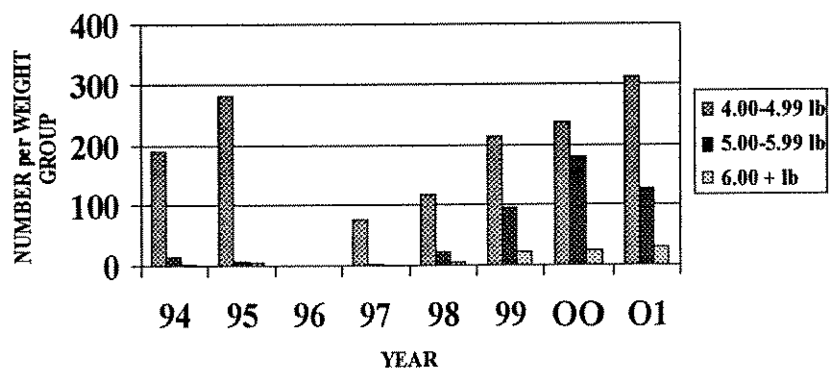


Figure 12. Mean number of brown trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2001.

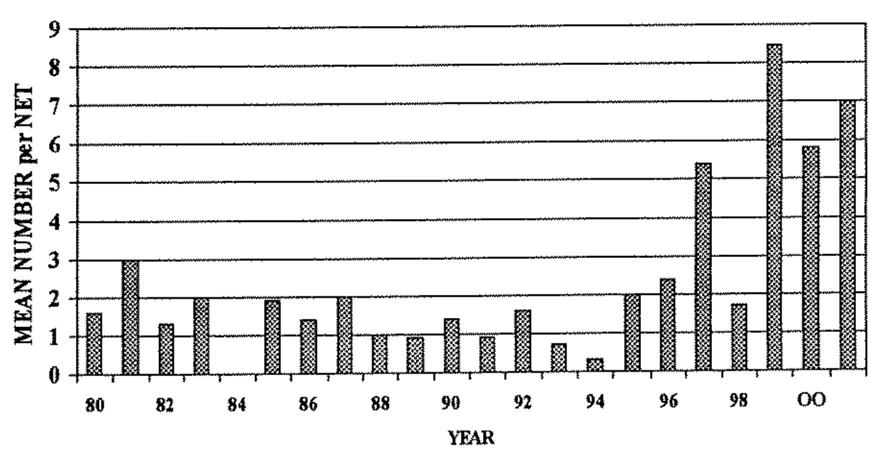


Figure 13. Estimated angling pressure (Angler - Days per Year) for Clark Canyon Reservoir 1983 - 1999.

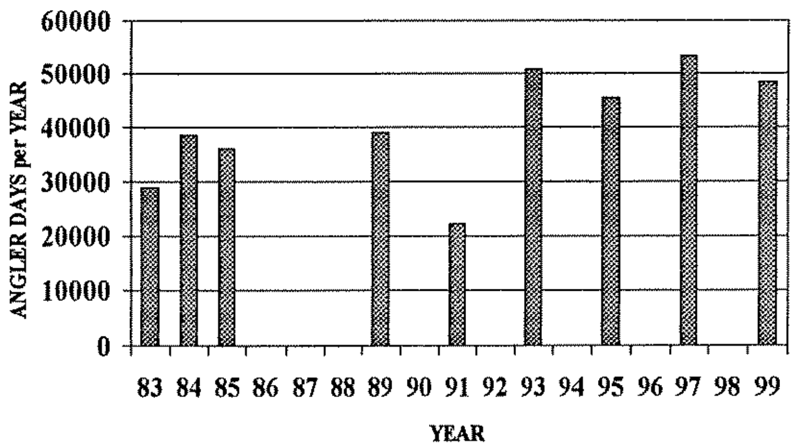


Figure 14. Estimated resident and nonresident angling pressure (Angler - Days per Year) for Clark Canyon Reservoir, 1983 - 1999.

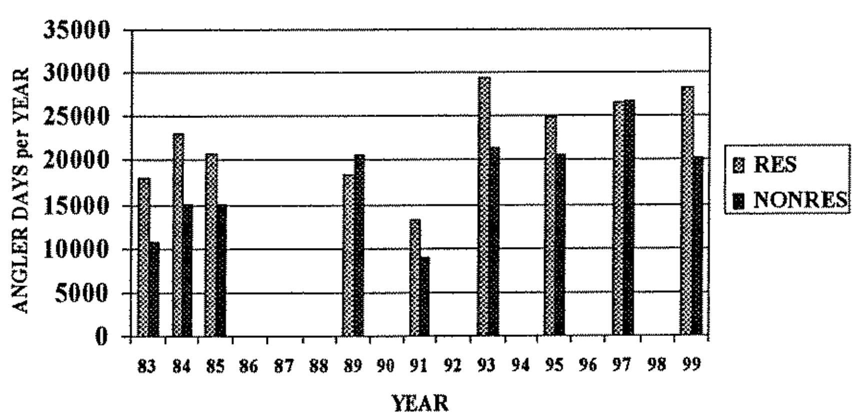


Figure 15. Winter creel catch rates for rainbow trout in Clark Canyon Reservoir, 1989 - 2001.

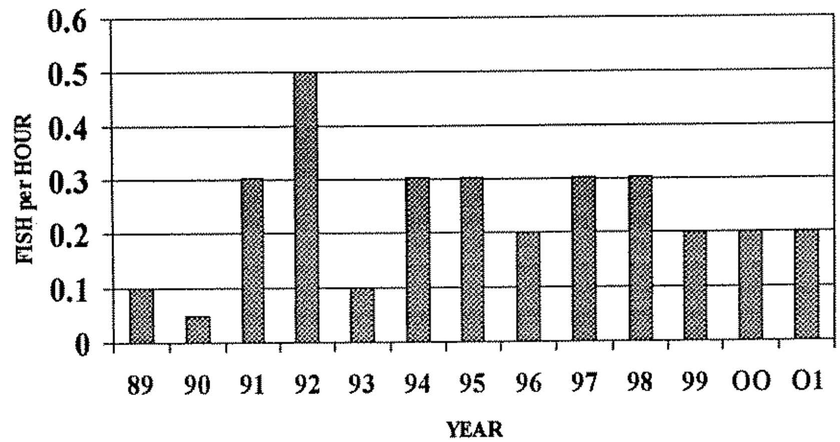


Figure 16. Winter creel catch rates for brown trout in Clark Canyon Reservoir, 1989 - 2001.

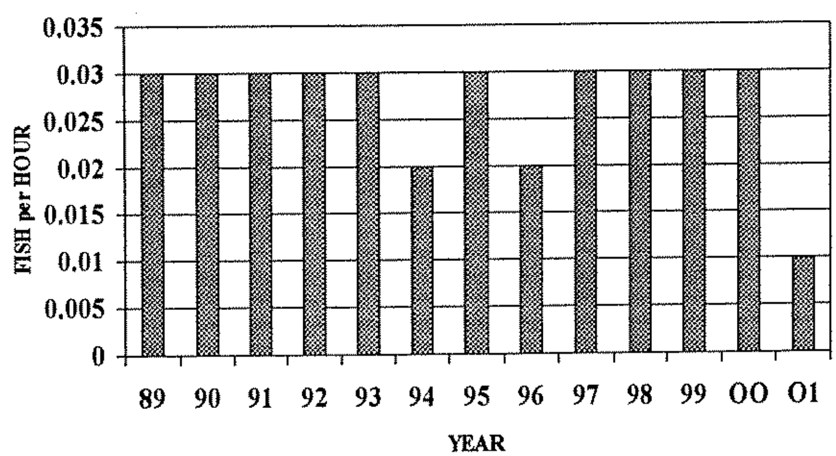


Figure 17. End of irrigation season (fall) storage in Ruby Reservoir, 1986 - 2001.

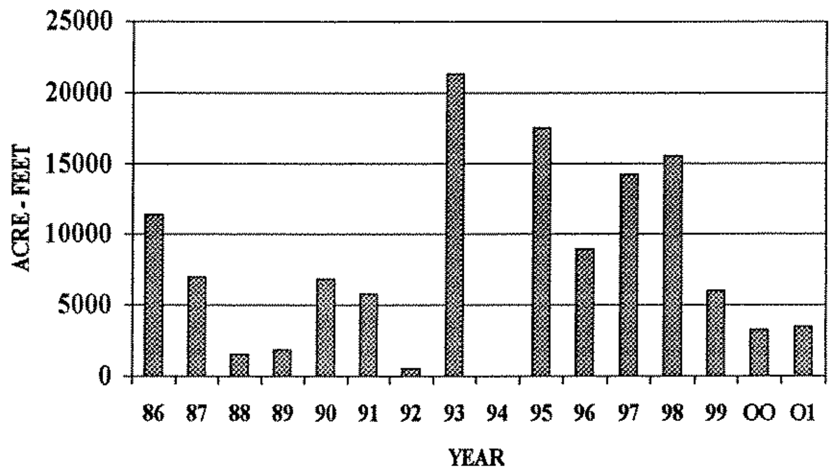


Figure 18. Mean number of rainbow trout collected per floating experimental gill net set overnight in Ruby Reservoir, 1979 - 2001.

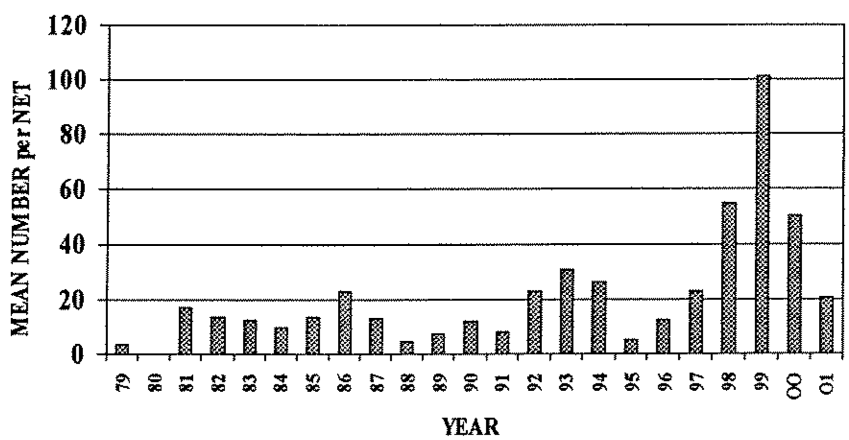


Figure 19. Mean number of Age I Eagle Lake rainbow trout collected per experimental gill net set in Ruby Reservoir 1994 - 2001.

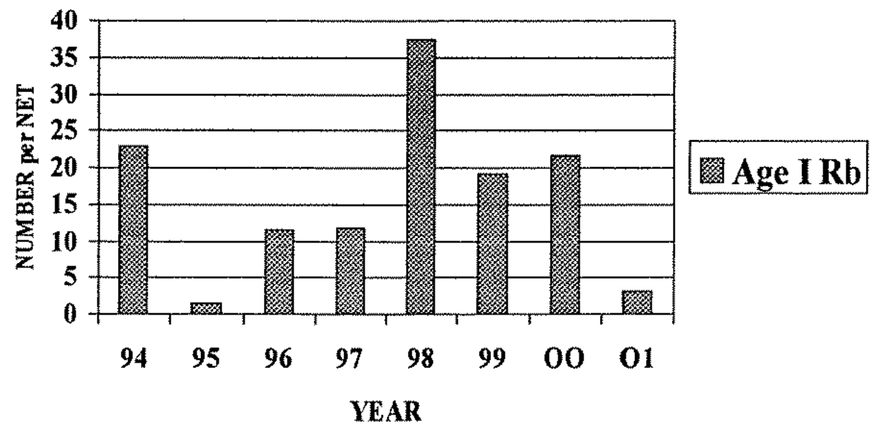


Figure 20. Length range and mean length of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1990 - 2001.

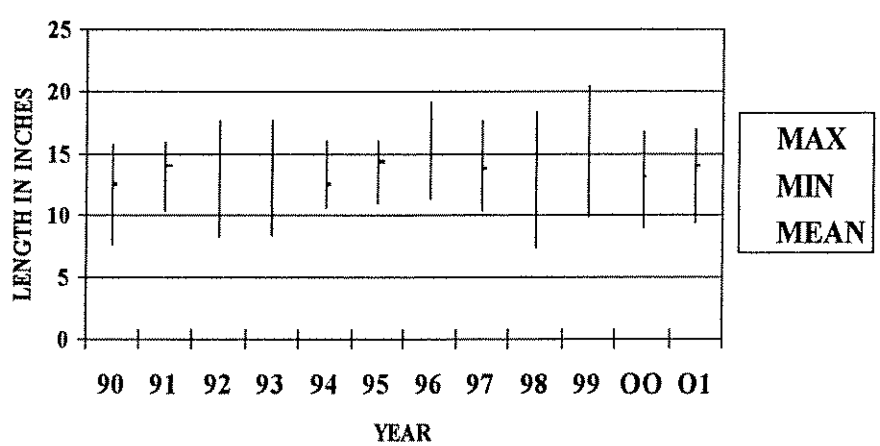


Figure 21. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1996. (N=64)

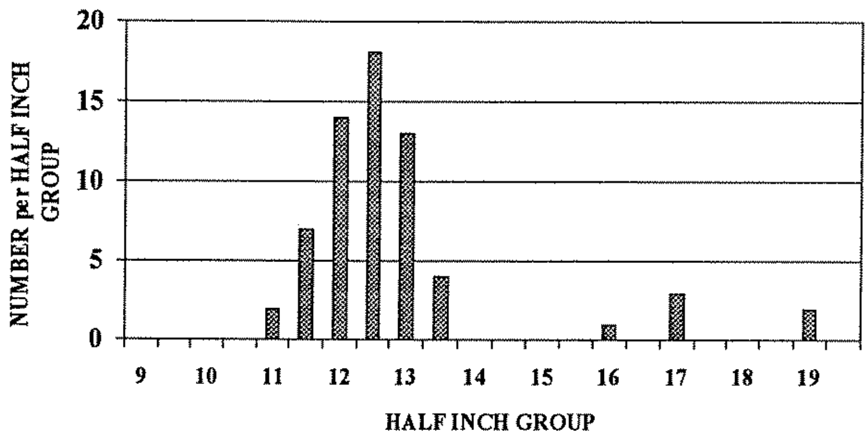


Figure 22. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1997. (N=110)

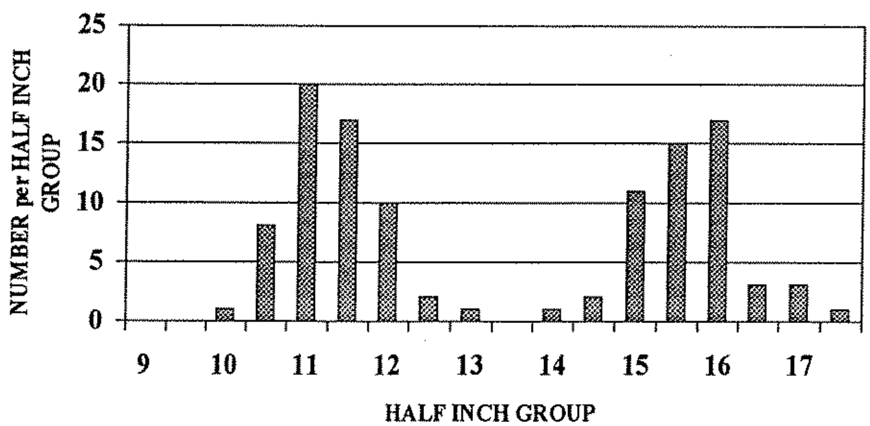


Figure 23. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir 1998. (N=275)

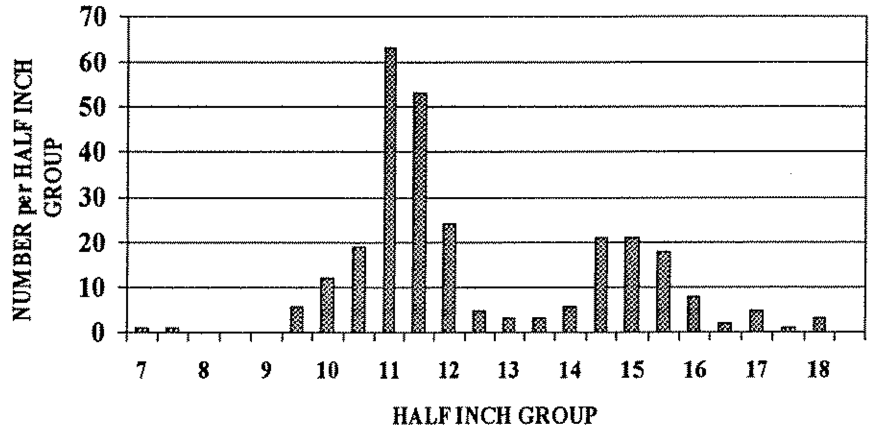


Figure 24. Length frequency distribution (fall sample) of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1999. (N=304)

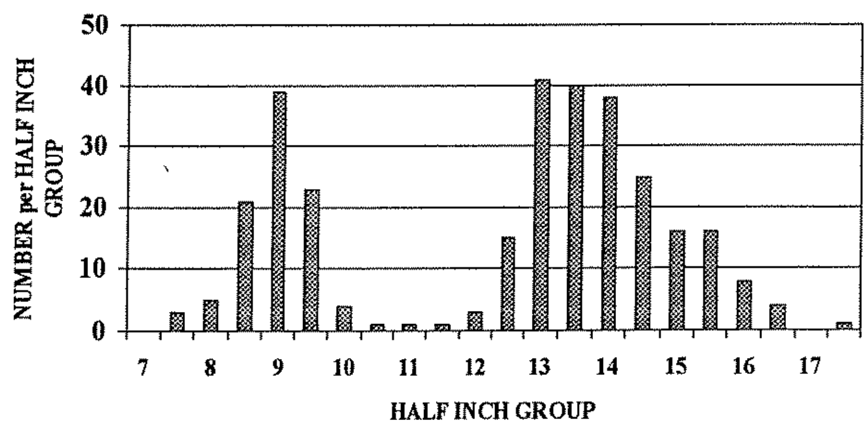


Figure 25. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 2000. (N=251)

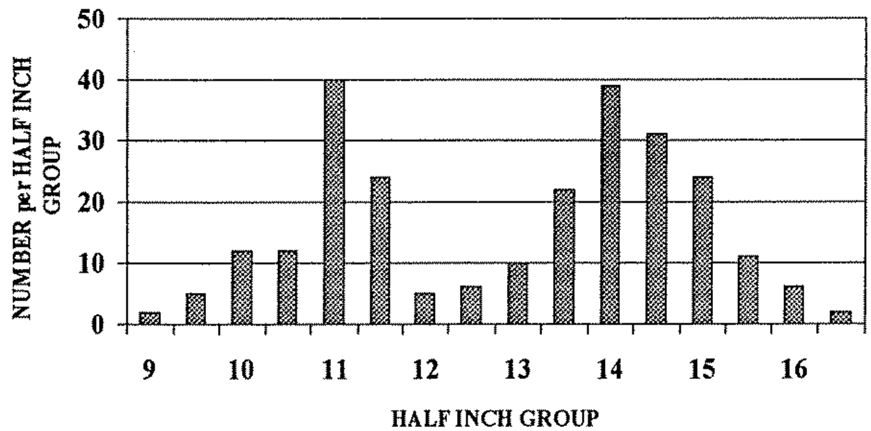


Figure 26. Length frequency distribution of rainbow trout collected in experimental floating gill nets set overnight in Ruby Reservoir, 2001. (N=103)

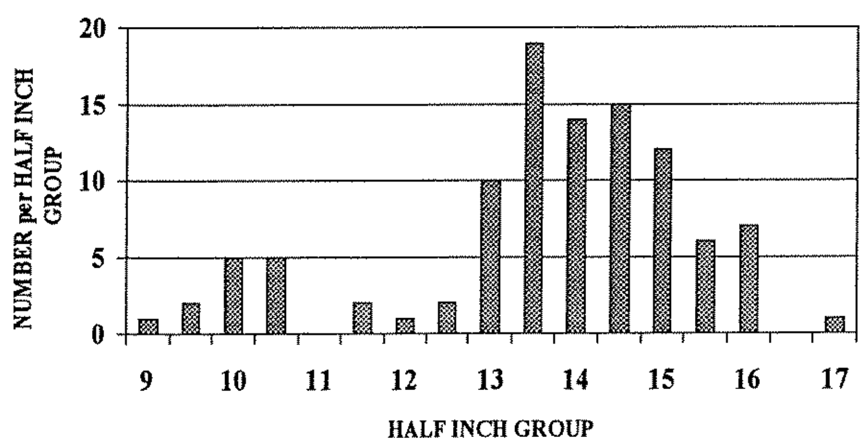


Figure 27. Mean number of brown trout collected per floating experimental gill net set overnight in Ruby Reservoir, 1979 - 2001.

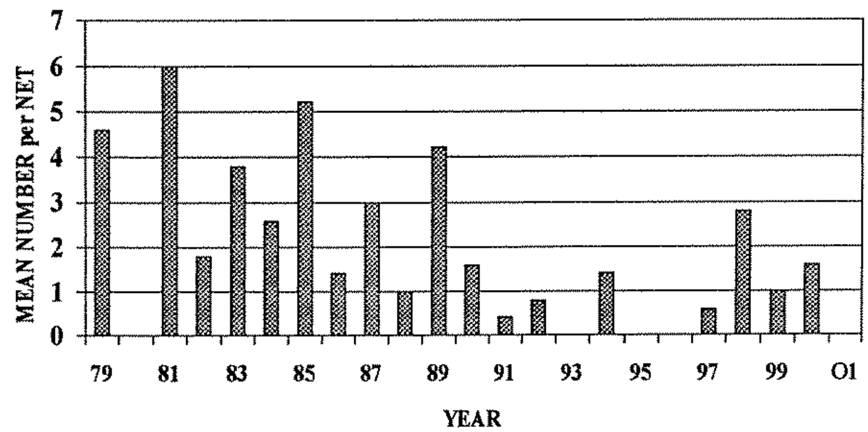


Figure 28. Estimated angling pressure (Angler - Days per Year) for Ruby Reservoir, 1984 - 1999.

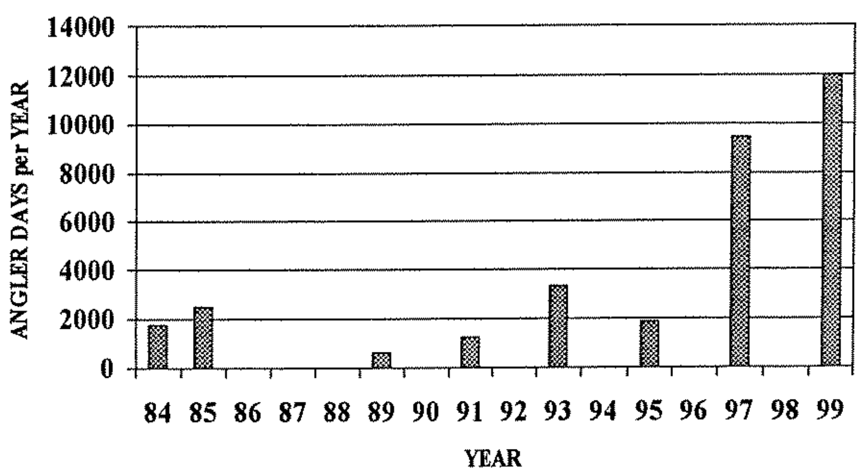


Figure 29. Winter creel catch rates for rainbow trout in Ruby Reservoir, 1997 - 2001.

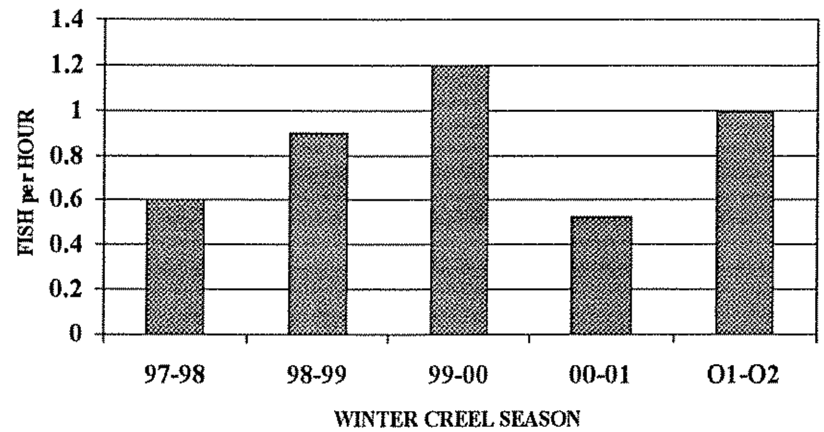


Figure 30. Mean number of McBride Yellowstone cutthroat trout collected per floating experimental gill net set overnight in Elk Lake, 1981 - 2001.

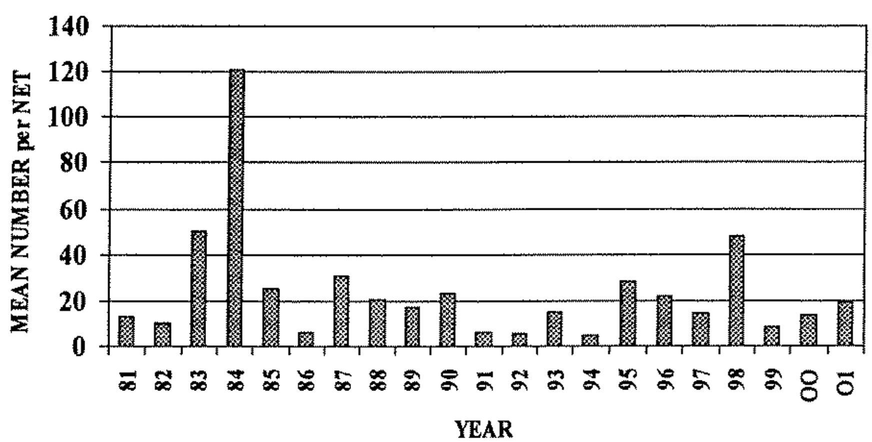


Figure 31. Age distribution of McBride Yellowstone cutthroat trout collected in floating experimental gill nets set overnight in Elk Lake, 1981 - 2001.

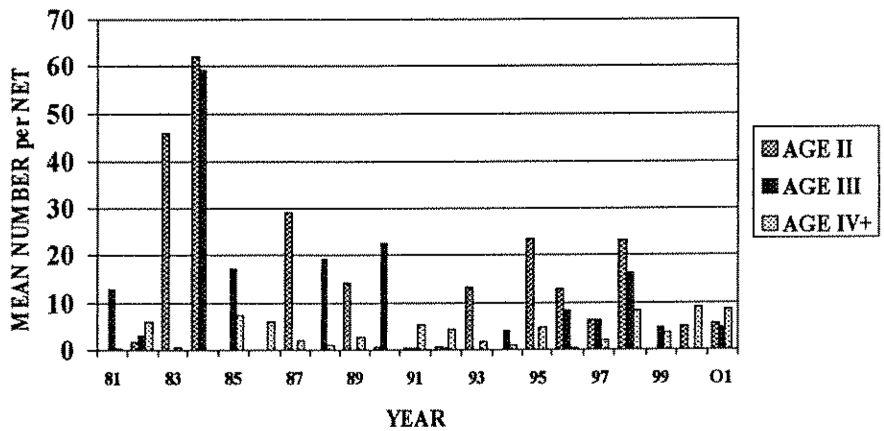


Figure 32. Mean number of arctic grayling collected per floating experimental gill net set overnight in Elk Lake 1981 - 2001.

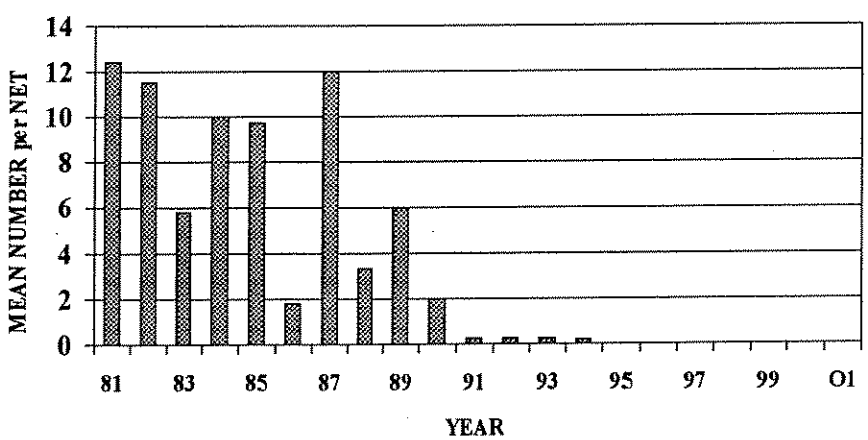


Figure 33. Mean number of lake trout collected per floating and sinking experimental gill net set overnight in Elk Lake 1981 - 2001.

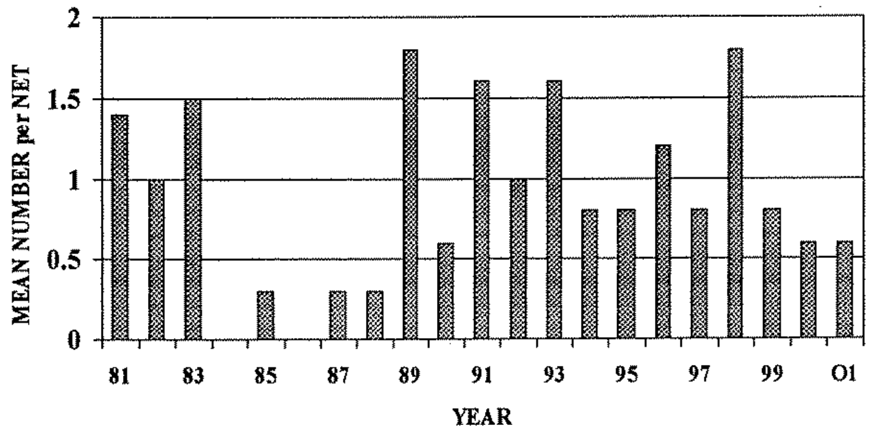


Figure 34. Length range and mean length of lake trout collected in floating and sinking experimental gill nets set overnight in Elk Lake 1991 - 2001.

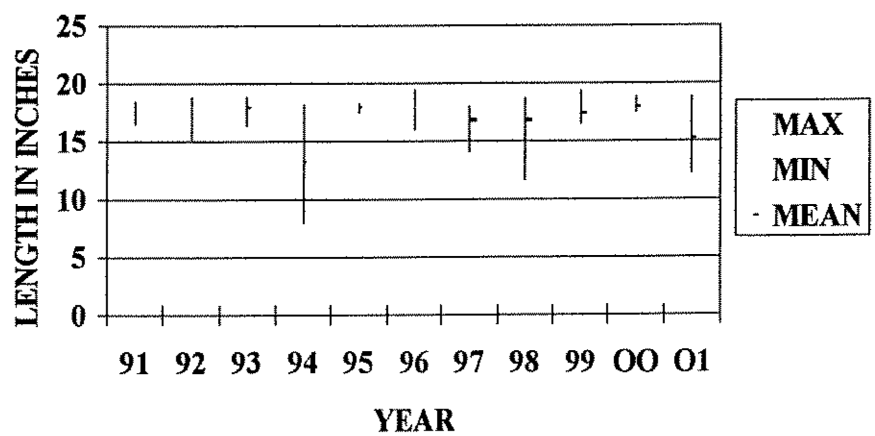


Figure 35. Composite length frequency distribution of lake trout collected in floating and sinking experimental gill nets set in Elk Lake 1993 - 2001. (N=72)

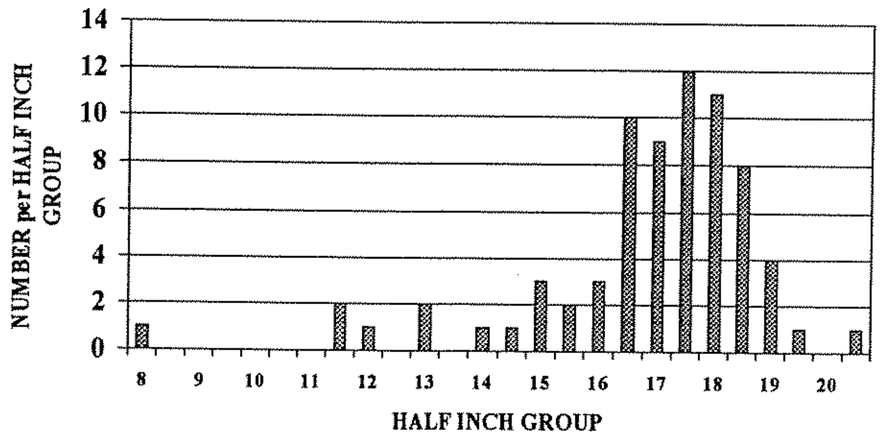


Figure 36. Mean number of burbot collected per sinking experimental gill net set overnight in Elk Lake, 1991 - 2001.

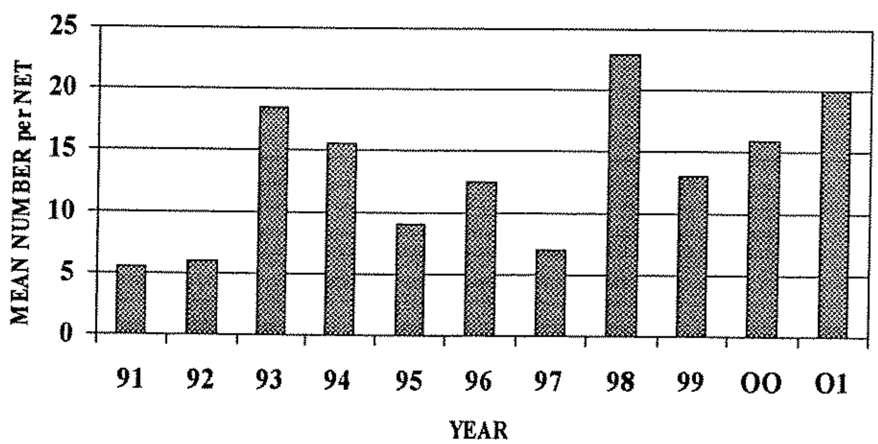


Figure 37. Length range and mean length of burbot collected in sinking experimental gill nets set overnight in Elk Lake, 1991 - 2001.

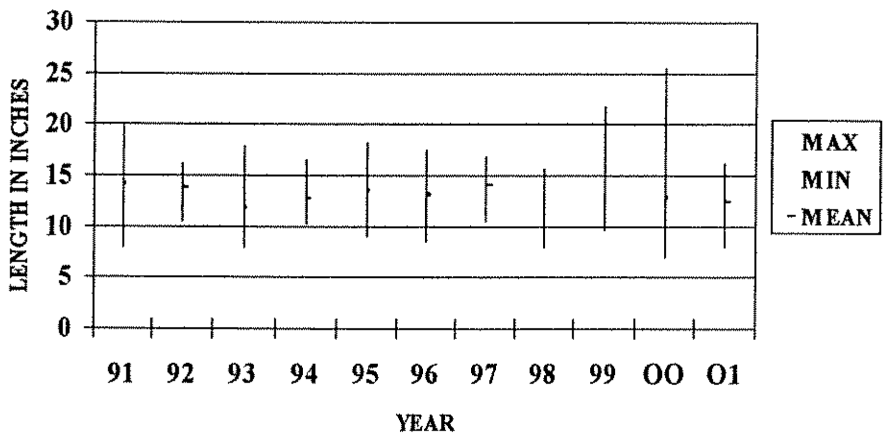


Figure 38. Composite length frequency distribution of burbot collected in sinking experimental gill nets set overnight in Elk Lake, 1991 - 2001. (N = 445)

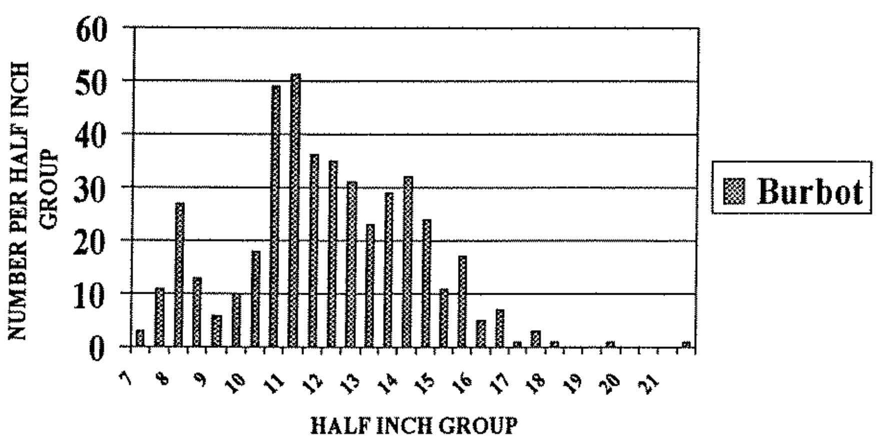


Figure 39. Mean number of rainbow trout collected per sinking experimental gill net set overnight in Hidden Lake, 1985 - 2001.

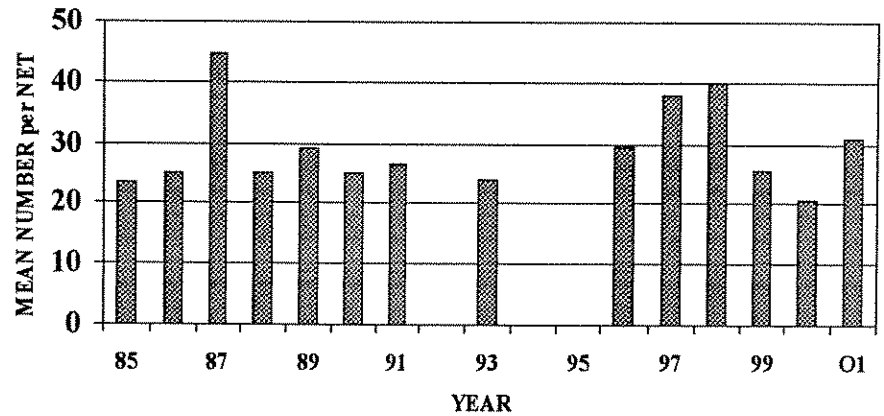


Figure 40. Length range and mean length of rainbow trout collected in sinking experimental gill nets set overnight in Hidden Lake, 1985 -2001.

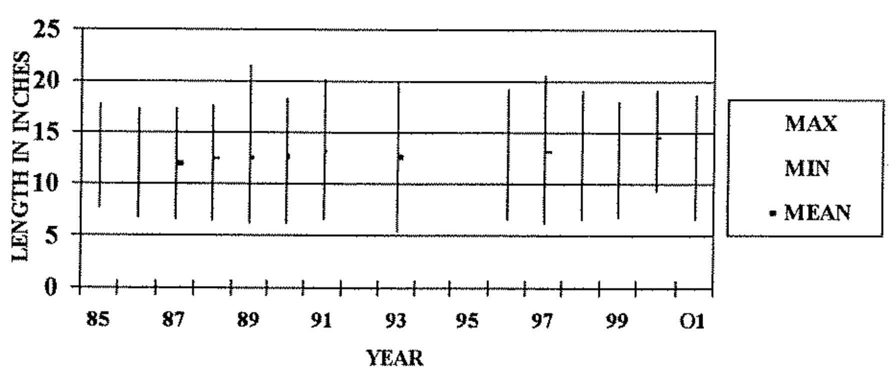


Figure 41. Composite length frequency distribution of rainbow trout collected in sinking experimental gill nets set overnight in Hidden Lake, 1993 - 2001. (N=411)

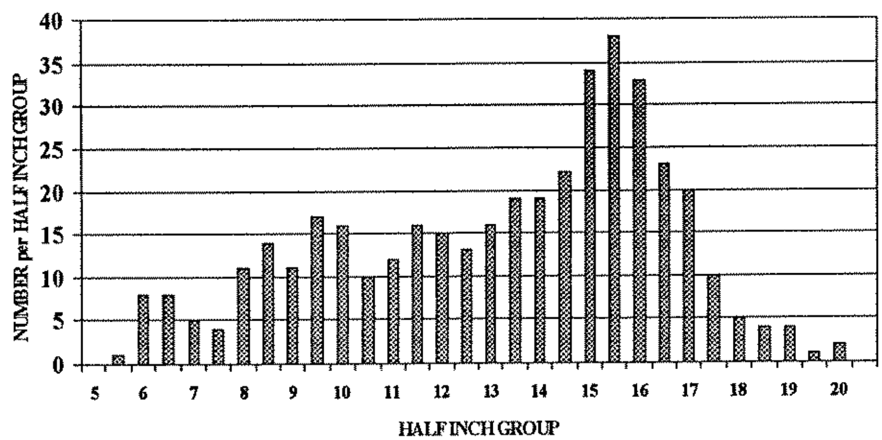


Figure 42. Length frequency distribution of rainbow trout collected in experimental gill nets set overnight in Hidden Lake in 2000 (N = 41) and 2001 (N = 60).