INVENTORY AND SURVEY OF FISHERIES IN LOWLAND LAKES AND RESERVOIRS OF THE RED ROCK, RUBY, BEAVERHEAD, AND BIG HOLE RIVER DRAINAGES OF SOUTHWEST MONTANA, 2002 - 2004

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June 2004
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ABSTRACT

Fisheries data trends are updated for the 2002 - 200 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, 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 low storage pool affects on fisheries is presented and discussed. Evaluation of stocks of McBride Yellowstone strain cutthroat trout and westslope 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. Attempts to sample the native lake trout population of Twin Lakes with fyke nets are described with results presented for native burbot and other species which occupy the lake.

ACKNOWLEDGEMENTS

The author would like to acknowledge the able assistance of numerous individuals in the collection and preparation of data presented in this report. Valuable assistance in the collection of field data and analysis of those data sets was provided by Scott Lula. The list is composed of the following individuals. Able assistance in the field was provided by Tim Mosolf, Jon Hoerning, and Peter LaMothe of Montana Fish, Wildlife and Parks. Dan Downing of the Beaverhead National Forest assisted in data collection on Twin Lakes. Volunteer assistance was also provided by Dave Browning, Ethan Lula and Nathan Oswald. The author would also like to acknowledge the valuable assistance of Mary Burnham Curtis of the USGS Great Lakes Science Center in the genetic analysis of native lake trout samples and the assistance of George Holton in locating valuable historic lake trout literature references.

TABLE OF CONTENTS

INTRODUCTION

Southwest Montana provides a diverse angling experience 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 pressure. 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. 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, a monitoring program must be adhered to in order 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 most often 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. 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 - 55,000 angler-days of recreation per year although recent trends have demonstrated a marked decrease due to record low storage pools associated with severe drought. Dynamics of the trout populations of Clark Canyon were last reported by Oswald (2002). 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 traditionally 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). 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) initially 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. Recent management direction has emphasized a native species assemblage which resulted in a shift from Yellowstone to the native westslope cutthroat trout plants in 2002. 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 (2002). Hidden Lake is the uppermost of a chain of lakes located 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 (2002).

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.

Fyke nets were employed in an attempt reduce mortality associated with lake trout sampling in Twin Lakes. In order to affectively use fyke net sampling methods in shallow waters, the sampling was conducted in October at suspected lake trout spawning habitats and in May, immediately following an early ice - out. Three different fyke nets were employed in the sampling with little differentiation in sample results despite differences in net size and configuration. The largest net had a 4 foot by 6 foot box with a 100 foot by 4 foot center lead and a detachable wing of the same dimension. The intermediate net had a 4 foot by 5 foot box with a 50 foot by 4 foot center lead and two 25 foot wing leads. The small fyke had a 4 foot by 3.5 foot box with a single 30 foot by 3.5 foot center lead. All fyke net sets were fished overnight or for an approximate 15 to 18 hour period.

All game fish 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.

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 1987-2003 period. Ample reservoir storage over the five year period 1995 - 1999, often exceeding 140,000 acre feet. This relatively wet climatic period was quickly followed by a rapid decline to consecutive record low minimum pools associated with severe drought conditions over the 2001 - 2003 water years. Record low inflows from the Clark Canyon Reservoir tributaries culminated in a record low minimum pool of 9,660 acre feet in September of 2003. 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 approximating 10,000 acre feet have reduced the reservoir surface substantially, approaching 1,000 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). Over the past decade, plants have averaged 207,438 fish per year. 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 a rapidly declining minimum pool and resulted in poor survival (0swald 2002). The 2002 young of the year plant also met with poor survival leading to the suspension of these plants in 2003 and 2004 under continued low storage conditions. The typical young of the year plants will resume when storage conditions improve in the reservoir. The young of the year plants were replaced by plants of overwintered yearling Eagle Lake rainbow over the past two year period. The management decision to include yearlings into the planting strategy was adopted in response to increasing angling pressure on the reservoir and increased survival pressure in populations marked by high percentages of older, larger fish (Oswald 2000 a). Since 2002, these plants have become the primary management tool rather than a supplemental component, due to continued low storage pools. This strategy was employed under the assumption that older, larger fish at lower stock density would have a survival advantage under the current reservoir storage conditions. The recent yearling plants totaled 79,689 in 2002 and 87,007 in 2003.

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	2002	235,461

Rainbow trout population trends from 1980 through 2001 are depicted in Figure 2. Oswald (2002) described the recovery of the rainbow trout population of the reservoir under improving storage conditions between 1992 and 1998 but noted a declining trend with reduced storage pools over the 1999 - 2001 period. Sample numbers of rainbow trout remained relatively high through 2001, maintaining an average of 11.4 per net. Record low storage pools in 2002 and 2003 have resulted in an accelerated decline in sample numbers for rainbow trout. The 2003 sample density of 4.6 per net is comparable to populations of the early 1980's under the Arlee strain rainbow management and approached the drought related population low of 1991. Recent sample densities could also be influenced by increased net efficiency at extremely low fall storage pools. 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, 2001 and 2003 samples continued this declining trend in plant survival as reservoir storage pools declined markedly. The 2002 yearling sample of 4.6 per net is reflective of the superior survival of the overwintered yearlings that were added to that year's plant. Survival of the 2002 young of the year plant was only 0.2 per net, reflective of very poor survival conditions in the reservoir. Despite the fact that yearling Eagle Lake rainbow composed the entire 2003 plant, no survivors were collected in the fall net sample. The subsequent winter angler creel census also revealed few survivors of the 2003 plant. Rainbow trout plant survival and recruitment over the 2000 - 2003 period was similar to observed lows recorded in 1991 and 1994 under low reservoir storage pools.

Rainbow trout condition factor (K) is presented in Figure 4 for the 1998 - 2003 sample period. Trends in condition remained high or increased with relatively abundant storage pools but went into decline as storage pools declined between 2000 and 2003. While the decline in condition was most consistently linear for the Age II and older fish and the overall rainbow population average, a somewhat surprising decline was observed for the yearling rainbow in 2002. Oswald (1993) exhibited relationships demonstrating substantial declines in the condition of Age III and older rainbow and brown trout in Clark Canyon Reservoir under drought reduced storage pools in the 1988 - 1990 period.

Wild strain rainbow trout spawning migrations from Clark Canyon Reservoir have been monitored by multiple electrofishing sampling runs in the Red Rock River since 1986 and were last described by Oswald (2002). In addition to population monitoring data, the sampling program also yielded approximately 500,000 fertilized Eagle Lake rainbow trout eggs to the Montana hatchery system. Due to record low flows in the Red Rock River over the 2002 - 2004 period, no attempts were made to sample the spawning population. Observations over the period revealed that stream flows were too low to even sustain a spawning migration and that fish generally assembled in the extreme lower reaches of the reservoir - river confluence and attempted to spawn in a limited fluvial reach. Monitoring of future spawning runs will continue when river flows return to normal ranges.

Brown Trout

Wild brown trout population trends over the 1980-2003 period are depicted in Figure 5. The recent trend has been reflective of high wild brown trout populations from 1995 through 2003. Oswald (2000 a) observed that 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 since 2000 have resulted in a declining trend in brown trout numbers. Oswald (2002) linked the declining trend in brown trout numbers to declines in the recruitment of Age I fish. Despite the recent declining trend, brown trout sample numbers have remained relatively high when compared with samples of the 1980's and early 1990's. As was the case for rainbow trout, high brown trout numbers might be influenced by increased netting efficiency at low fall storage pools.

Angler Use Trends

Trends in angling pressure on Clark Canyon Reservoir are presented in Figures 6 and 7. Recent pressure estimates depict a substantial decrease in angler days from the 1999 sample. Low angler participation in 2001 and 2003 is reflective of low storage pools and is comparable to prior lows in pressure observed in 1991 under similar conditions. The 2003 pressure estimate of 14,583 represents an observed low for Clark Canyon Reservoir and represents a substantial deviation from pressure estimates averaging nearly 50,000 angler days per year over the 1993 - 1999 sample period. Nonresident angling pressure had been increasing at a higher rate than resident use (Figure 7) attaining its highest recorded level with the 1997 sample demonstrating virtually equal participation between resident and nonresident anglers. The 2001 sample exhibited a decline in nonresident use to 39.3% while the nonresident component in 2003 declined further to 23.8 % of the total at an observed low of 3,472 angler days.

Winter creel catch rates for rainbow trout from 1989 through 2003 are depicted in Figure 8. Very low catch rates, averaging 0.165 fish per hour over the 2000 - 2003 period, were associated with low storage pools and declining populations of rainbow trout. Similar low catch rates were also recorded in the drought affected years of 1989 and 1990. The 2003 - 2004 rainbow trout catch rate did improve slightly to 0.21 fish per hour. In most years, rainbow trout catch rates vary between 0.2 to 0.3 fish per hour , averaging 0.216 fish per hour over the past 15 winters of record. Rainbow trout catch rates, however, often appear to be independent of rainbow trout density (Oswald 2002).

Winter creel catch rates for the wild brown trout (Figure 9) 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 largely independent of brown trout density although recent high catch rates can be associated with highs in brown trout sample density and low reservoir storage pools.

RUBY RESERVOIR

Reservoir Storage Trends

Minimum storage pool in Ruby Reservoir, as determined from end of irrigation season storage, is presented in Figure 10. 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 since 2000 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 but recovered slightly to approximate the minimum fisheries target pool in 2002. Continued severe drought in 2003 resulted in a storage decline to the defined minimum pool of 2,600 acre feet by September 11. This represented the first time that the reservoir was dropped to the defined minimum since the Ruby river Task Force was established in 1995.

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 2003, Ruby Reservoir has been stocked with the wild Eagle Lake strain of rainbow trout. Plants average about 50,000 fish per year and 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 2003 plant was increased in an attempt to mitigate recruitment loss and low rainbow trout numbers revealed in the 2002 net samples. The recent stocking history of Ruby Reservoir is presented in Table 2.

Trends in the abundance of rainbow trout in Ruby Reservoir are presented in Figure 11 for the 1979-2004 period. Rainbow trout densities over the 1979-2000 period were discussed by Oswald (2002). Ample reservoir storage pools following the 1994 dewatering event allowed the complete recovery of rainbow trout populations at high sample density. Rainbow trout populations have since declined with reduced storage pools. The 2000 - 2004 collections are indicative of a declining trend in rainbow trout density associated with declining reservoir storage pools. The 2003 collection density of 13.8 fish per net was the lowest observed since 1996 when only one post dewatering plant age class was present in the reservoir. The 2003 collection also fell below the long term average of 22.3 fish per net for the period of record and fell markedly below the post dewatering event mean of 37.0 fish per net. Sample numbers in 2004 recovered slightly

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	1999	49,507
1994	50,358	2000	35,106
1995	45,347	2001	50,000
1996	51,668	2002	50,000
1997	58,359	2003	65,051
1998	49,725	MEAN	50,475

to 23.8 per net despite the record low storage pool encountered in September of 2003. The majority (67.2%) of the sample recovery, however, was due to a relatively successful recruitment of Age I fish (Figure 11) from the increased 2003 plant (Table 2). Survival of planted rainbow trout to Age I is depicted in Figure 12 for the 1994 - 2004 period. Oswald (2002) discussed the extremely high survival of planted fish to Age I which was observed in 1998 followed by strong recruitment success in 1999 and 2000. The rapid decline in rainbow trout numbers in the 2001-2003 period was associated with an even greater decline in yearling survival. Oswald (2002) noted that, 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 was not proportional to the deviation from the mean plant. High survival of Age I rainbow trout in 2004, however, appeared to be the direct result of increased plant numbers in combination with low stock densities of competing fish in the reservoir.

Oswald (2002) noted that length range and mean length of rainbow trout in Ruby Reservoir (Figure 13) had 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. During the 1996 -1999 period, maximum size range increased markedly and remained high under ample storage regimes. In the recent 2001- 2003 samples, length range was attenuated with the loss of larger fish in the population while the mean length tended to increase markedly with weal recruitment. This trend was reversed in the 2004 sample with the previously discussed improved recruitment of Age I fish. Mean rainbow trout Condition Factor (K) is presented in Figure 14 for the Age I, Age II and older, and sample mean components. As expected, mean condition was maximized and varied least among the juvenile fish. Trends in condition for the sample population mean and the Age II and older fish were similar, depicting a declining trend as reservoir pools were reduced over the 2000 - 2002 period. Condition improved somewhat in 2003 as minimum storage pools remained near the minimum fisheries target pool. Condition continued to increase in 2004 despite poor storage pools but this increase could be attributed to the dominance of the sample by Age I fish. The 2004 Condition factor for the Age II and older fish declined. Length frequency analyses are provided for the 2000 - 2004 period in Figures 15 - 19. The 2000 relationship (Figure 15) was still typical of the balanced age distribution and ultimate size that typified that ample storage pools of the late 1990's. The 2001 - 2003 distributions (Figures 16, 17, 18) however, exhibit the poor recruitment associated with the declining storage pools. These relationships were dominated by older, larger fish reflective of the increased mean lengths exhibited in Figure 13. The 2004 sample (Figure 19) exhibits the dominance of the strong recruitment from the expanded 2003 plant.

Brown Trout

Population trends for wild brown trout in Ruby Reservoir are presented in Figure 20 for the 1979-2004 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, brown trout numbers have remained low with moderate peaks expressed in 1998 and 2004. While the 1998 brown trout increase was associated with strong juvenile recruitment, the 2004 peak was associated with exceptionally large fish, many of which exceeded 20 inches in length and 3.0 pounds in weight.

Angler Use Trends

The estimated angling pressure for Ruby Reservoir is presented in Figure 21 for the 1984-2003 period. Oswald (2002) discussed the substantial increase in angler use of Ruby Reservoir concomitant with the renewal of the rainbow trout population in the late 1990's. The 2001 pressure estimate exhibited a steep decline in use and was similar to drought driven declines in most of the major fisheries of southwest Montana. The 2003 pressure estimate showed a strong recovery to 12,435 angler days despite low reservoir storage pools and declining rainbow trout populations.

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 22) steadily increased from 1997 through 1999 but declined markedly in 2001 with declines in the rainbow trout population and the recruitment of juvenile catchable fish into the population. Catch rates since the 2001 - 2002 season have recovered fully to approximate a very consistent 1.0 fish per hour over the 2002 - 2004 sample period. Ruby Reservoir winter catch rates have been very high when compared with other southwest Montana reservoirs. Despite consistently high winter catch rates, the average size of the rainbow trout harvested has declined (Figure 23) and stabilized at about 13.5 inches. This decline . 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 the 2000 - 2003 samples were associated with diminishing densities and reduced reservoir storage pools.

ELK LAKE

Yellowstone and Westslope 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. In 2002, the Yellowstone plants were replaced with plants of overwintered yearling westslope cutthroat trout for evaluation. The westslope strain of cutthroat trout is the native variation of the species for the upper Missouri River drainage. It is hoped that conversion to westslope cutthroat plants will better compliment a native species assemblage in Elk Lake. Recent Elk Lake cutthroat trout plants are summarized in Table 3.

Table 3. Recent plants of McBride Lake Yellowstone (YCT) and westslope (WCT) cutthroat trout in Elk Lake.

YEAR	YEARLING NUMBER	YOY NUMBER
1993 - YCT		250,000
1994 - YCT	9,867	
1995 - YCT	10,125	251,512
1996 - YCT	10,100	
1997 - YCT	12,699	
1998 - YCT	16,333	
1999 - YCT	15,753	
2000 - YCT	17,100	
2001 - YCT	22,560	
2002 - WCT	11,450	
2003 - WCT	14,998	

Numbers of Yellowstone and westslope cutthroat trout collected in gill nets over the 1991-2004 period are presented in Figure 24. Oswald (1993, 2000a) discussed trends associated with the failure of recruitment of YOY plants as opposed to the success of overwintered yearling plants in Elk Lake. The recent trend since overwintered yearlings were used on an annual basis has been an increase in number per net. While 1985-1994 samples averaged 14.4 fish per net, the 1995-2001 samples yielded a mean of 21.5 fish per net (Oswald 2002). The missing age classes which typified the Elk Lake cutthroat trout populations through 1995 (Figure 25) have since been filled by consecutive plants of a survivable age and size. The numbers of Age IV and older fish captured in the 2000 - 2002 samples exceeded those of all of the other sample years from 1981 to the present. The 2003 and 2004 samples exhibited the entry of the first westslope cutthroat trout into the population (Figure 24). These samples exhibited some of the higher per net yields of the sample period based largely on strong survival of the westslope cutthroat yearling plants. The 2004 sample density of 45.8 per net was the second highest observed collection density in the sampling history of Elk Lake. The entry of Age II westslope cutthroat in 2003 and the predominance of two age classes of these fish in 2004 (Figure 25) demonstrates the survivability of the westslope cutthroat plants in Elk Lake. Length frequency distributions of the 2003 and 2004 samples (Figures 26 and 27) revealed superior growth for the westslope cutthroat which overlapped into the next Yellowstone cutthroat age class despite similar size at the time of planting. The length frequency relationships further exhibit the dominance of the recent samples by the westslope strain. Additional evaluation of the westslope cutthroat trout plants is presented in Table 4 below. The comparative data clearly suggest that the initial westslope plants have outperformed the most recent Yellowstone cutthroat plant. Both of the westslope plants exhibited

Table 4. Comparative evaluation of the 2001 Yellowstone cutthroat trout (YCT) plant with the 2002 and 2003 westslope cutthroat trout (WCT) plants at Ages II and III in Elk Lake.

Sample	Strain	Sample Density	Mean Length and Wt.	Mean Condition (K)
May 2002	Age II YCT	9.0 / Net	11.9 in. 0.61 lb.	34.22
May 2003	Age II WCT	13.7 / Net	12.7 in. 0.81 lb.	39.49
May 2004	Age II WCT	30.0 / Net	12.0 in. 0.68 lb.	39.27
May 2003	Age III YCT	5.0 / Net	15.5 in. 1.32 lb.	35.51
May 2004	Age III WCT	10.0 / Net	15.8 in. 1.59 lb.	39.89

higher survival rates through Ages II and III despite far lower initial stock densities. The westslope plants also demonstrated faster growth and length at age than the Yellowstone plant. The greatest difference between the two strains, however, was demonstrated through Condition Factor which was substantially higher for both plants of the westslope cutthroat trout at Ages II and III.

Lake Trout

Lake trout sample trends are depicted in Figure 28. The status of the Elk Lake native lake trout population was last reported by Oswald (2002) who described a relatively stable population of low density. Lake trout numbers have exhibited a relatively high degree of consistency, 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. Recent samples, however, have exhibited a declining trend in number which has been accompanied by an increased mean length (Figure 29) and attenuated length range. The composite length frequency distribution for lake trout over the sample period is presented in Figure 30. Length frequency analysis demonstrates that the majority of lake trout sampled range between 16.5 and 19.5 inches in length.

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 last described by Oswald (2002). Collection trends for Elk Lake burbot are presented in Figure 31. Collection rates have varied between 5.5 and 23.0 per net with little evidence of any long term 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. The 2001 - 2003 period was also marked by an apparent population decline but burbot numbers increased substantially in the 2004 sample. Both increasing and decreasing population trends appeared to be driven by recruitment success or lack thereof. Peaks in burbot abundance in 1993, 1998, and 2004 have all been marked by substantial declines in mean length (Figure 32) indicative of strong recruitment into the population. Conversely, population declines have all been marked by increasing trends in mean length and maximum length range.

The length range and mean length for burbot in Elk Lake (Figure 32) suggest a relatively slow rate of growth and limited ultimate size for the species. A composite length frequency analysis (Figure 33) indicates a pronounced age structure within the population which has not apparent in the lower density lake trout. Strong modal separation of apparent age classes occurs at approximately 8.0, 11.0, and 14.0 inches.

White Sucker and Utah Chub

Implementation of sinking gill nets into the Elk Lake sampling regime resulted in a more consistent method of collection of white sucker and Utah chub. The white sucker is a native nongame species which occupies the deep lake bottom habitats often utilized by the native burbot and lake trout. The Utah chub is a nonnative minnow which first appeared in Elk Lake samples in 1986, the likely result of an illegal introduction. Collection densities of white sucker are presented in Figure 34 for the 1989 - 2004 period. Numbers of white suckers in the net samples appear to vary in short term increasing or decreasing trends over time. The 1989 - 1992 period exhibited collection densities averaging 33.9 white sucker per net which subsequently declined to an average of 6.6 per net over the 1993 - 1997 period. The most recent trend over the 1998 - 2004 sample period exhibited an increase to an average of 27.0 per net with a relatively high degree of year to year stability. The most recent 2003 and 2004 samples appear to be indicative of a continuing increase in white sucker populations. Analysis of length data should be incorporated into the sampling program to better understand white sucker population dynamics.

Utah chub collection densities are depicted in Figure 35 for the 1989 - 2004 period of record. Utah chub numbers have remained relatively stable over the sample period. Sample numbers appeared to represent an increasing trend over the 1991 - 1994 period, attaining a maximum of 12.6 per net in 1993. Sample numbers have since declined, generally ranging between 2.0 and 5.0 per net and sometimes declining to less than 1.0 per net as was the case in the 2004 sample.

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 (2002). Recent trends in Hidden Lake rainbow trout populations (Figure 36) reflect slightly decreasing rainbow trout numbers from a relatively strong and stable population base. Most often, Hidden Lake rainbow trout sample densities range between 25 and 30 fish per net and averaged 28.5 fish per net over the sample period. Length range and mean length of the rainbow trout collected (Figure 37) and mean Condition Factor analysis (Figure 38) are indicative of a highly stable population structure throughout the sample period. Mean length of fish in the sample tend to approximate 13.0 inches while the mean spring Condition Factor tends to approximate a value of 36.00. Length frequency analysis (Figure 39) 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 (Figure 40) and 2002 - 2003 (Figure 41) samples are indicative of improving recruitment of Age II fish into the population over the 2000 - 2002. This is also apparent in the declining mean length and downward expansion of the length range of the sample population (Figure 37) over the same period. The 2003 sample exhibited an upward shift in both mean length and maximum length range (Figure 37) as the strong recruitment of the prior two years resulted in relatively high numbers of Age III and IV fish (Figure 41).

TWIN LAKES

The fish populations of Twin Lakes have been sampled sporadically since 1964 and were last reported in detail by Oswald (2002). 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).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 disparate size classes indicative of sporadic success in lake trout recruitment was also observed in the 1964 and 1986 samples.

In the interest of reducing sample mortality while continuing research on the apparently low density population of native lake trout and sympatric species, a series of 10 fyke or trap net samples was endeavored near potential lake trout spawning habitats in October of 2003. Potential lake trout spawning habitats were selected for sampling based on criteria described in Evans et al. (1991) and Sly and Evans (1996). The selected habitats were shallow enough for effective sampling with fyke nets and sampling was conducted as water temperatures declined from 52 to 44 degrees Fahrenheit (11.0 - 5.7 degrees C.) until ice covered the surface of the lake on October 30, 2003. The species composition exhibited by the October fyke samples is given in Figure 42. No lake trout were captured in the sample series. The fall samples were clearly dominated by burbot, followed by brook trout. This order differed substantially from the 1998 series of gill net samples in which brook trout represented 56.4% of the sample followed by burbot at 22.6% (Oswald and Roberts 1998). This reversal in order was probably due to the timing of the samples which apparently coincided with the brook trout spawning migration into Big Lake Creek. Westslope cutthroat trout and longnose sucker were the next most abundant sample species. Oswald (2000a) described the apparent October migration of the longnose sucker through the lake. Rainbow and rainbow trout hybrids representative of past stocking of the lake (Oswald and Roberts 1998) represented a minor component of the samples. Capture rates for the fall fyke nets area presented in Figure 43. The mean capture rate for burbot far exceeded that observed in gill net samples in 1998 as well as any other year in the sampling history of Twin Lakes while the brook trout capture rate was comparatively low (Oswald and Roberts (1998). Pelvic fin clips on all fish captured resulted in the recapture of numerous burbot over the month of October. Recaptured burbot appeared to exhibit a trap site fidelity, particularly at the narrows between the two lake basins. Recapture rates ranged between .033 and .080 and averaged .053 over the sample period. Capture rates for westslope cutthroat and rainbow trout and longnose sucker approximated or slightly exceeded those observed in the 1998 gill net series. The length frequency distribution of the burbot captured in the fall fyke nets is presented in Figure 44. The distribution was skewed toward older, larger fish than that observed in the prior gill net samples with a dominant modal peak exhibited for the 13.5 - 14.9 inch fish. Some of the upward shift was due to the later seasonal focus of the October sampling and some was probably due to a comparative sampling bias between the two netting methods.

A similar set of 10 fyke net samples were collected immediately after ice out throughout the latter half of May 2004. The series was collected in the hope that lake trout would be drawn to shallow water habitats under early spring thermal regimes. As was the case in the October samples, no lake trout were captured in the May fyke samples. The species composition of the spring net samples (Figure 45) differed substantially from the fall samples although burbot again dominated the catch. Brook trout and longnose sucker provided the remainder of the catch at low percentages. The May sample was the first recorded capture of longnose sucker outside of the month of October and could be representative of a spring migration through the lake or could indicate that the lake provides winter habitat for the species. Collection densities of the three sample species are presented in Figure 46. Again, burbot sample densities remained very high, exceeding the prior high observed in the October 2003 fyke nets. Marked burbot from the fall 2003 samples were captured in the first series of May samples resulting in a recapture rate of 0.54, virtually identical to the average recapture rate for October 2003. Subsequent May sample recapture rates averaged slightly below that observed for the prior fall samples at 0.47 and, again exhibited a strong site fidelity. All of the May burbot recaptures occurred at the narrows between the lake basins or an underwater dome - like structure in the southwest portion of the lake that had been sampled regularly in the October of 2004. The length frequency distribution of burbot in the spring samples (Figure 47) again exhibited a shift toward older, larger fish than that observed in prior gill nets samples (Oswald and Roberts 1998) and exhibited a strong mode at 12.5 to 15.0 inches.

DISCUSSION

CLARK CANYON RESERVOIR

Minimum storage pools in Clark Canyon Reservoir have declined markedly under severe drought conditions which have dominated the climate of southwest Montana in recent years. Minimum storage pools in 2001, 2002, and 2003 resulted in consecutive record lows since the reservoir was completed in 1965. These low storage pools have resulted in the reduction of productive lake surface acreage to minima approaching 1,000 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. The recent low storage pools were associated with dramatic declines in plant survival similar to those observed in 1991 and 1994. As a result, young of the year Eagle Lake rainbow trout plants have been suspended in the reservoir in favor of smaller plants of overwintered yearling fish. The yearling rainbow have exhibited a distinct survival advantage under the current stressful conditions. This management strategy will likely be maintained until reservoir storage returns to within the normal operating range.

Total rainbow trout numbers and plant survival have declined under the recent drought condition. These declines, however, have not been as steep or of the magnitude of those observed over the 1988 - 1991 period during the prior significant drought episode. Possible explanations for the recent mitigation might include the conversion to yearling rainbow plants, emergency drought driven bag limit reductions concomitant with substantial reductions in angling pressure, and drought driven emergency angling closures in the Red Rock River. Apparent mitigation in population decline might also be an artifact of increased net sampling efficiency under reduced fall storage pools. Recent data also exhibit a decline in rainbow trout condition factor under the reduced storage pools. A similar reduction in condition was reported by Oswald (1993) concomitant with the prior significant drought episode.

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 while Oswald (2002) most recently described expanding Eagle Lake rainbow trout spawning migrations and successful egg collections under conditions of ample stream flow and ample reservoir storage. The spawning run of 2002 was attenuated abruptly as flow decreased markedly in the Red Rock River and fertilized egg production and viability declined markedly. The springs of 2003 and 2004 did not result in spawning migrations in the Red Rock River as March and April flows declined to consecutive record lows (U.S. Bureau of Reclamation flow data). The suspension of spawning migrations from Clark Canyon Reservoir has resulted in an annual loss of 300,000 to 500,000 fertilized Eagle Lake rainbow trout eggs to the Montana hatchery system in the past two years.

Oswald (2002) described abundant populations of wild brown trout exceeding former collection highs observed shortly after Clark Canyon was impounded in 1964. Relatively high numbers of brown trout have been maintained through 2003 despite declining reservoir storage pools. The brown trout populations have exhibited a declining trend since the peak densities of 1999, however, as recruitment has shown a substantial decline in recent years. Similar to the observations for rainbow trout, declines in brown trout numbers have not been as substantial as those observed over the 1988 - 1994 drought influenced period.

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). Subsequent declines in rainbow trout populations began in 2000 as minimum reservoir storage pools began to decline below minimum target pools. These population declines were associated with declining recruitment success and major shifts in length frequency distribution within the populations (Oswald 2002). The slight upward shift in the 2004 sample population was a direct result of increased survival of yearling rainbow trout from the increased 2003 plant. Oswald (1993) presented data suggesting that yearling rainbow trout survival on Clark Canyon Reservoir was linked to minimum reservoir storage pool rather than stock density of young of the year rainbow trout plants. The relatively successful 2003 Ruby Reservoir plant survival at very low storage conditions was also associated with a very low density of older fish in the population which probably reduced competition for limited resources. Additional evidence of stress to the rainbow trout populations under reduced storage conditions include a reduction in mean Condition Factor and reduction in the mean length and weight in harvested fish during recent winter creel census. Oswald (1993) observed declines in rainbow trout condition factor under reduced storage pools in Clark Canyon Reservoir.

Wild brown trout populations in Ruby Reservoir have varied at relatively low density since the dewatering event of 1994. While some evidence of recovery has been noted (Oswald 2002) brown trout numbers have probably been influenced by recent low reservoir storage pools and, possibly, competitive pressure associated with relatively high standing crops of rainbow trout.

Due to the popularity of the recently reestablished rainbow trout populations, angler use of Ruby Reservoir has increased dramatically. While angling pressure has decreased on many area waters associated with drought conditions, angling pressure has remained relatively stable on Ruby Reservoir. This is probably due to the high catch rates supported by the reservoir. Mean winter 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 with declining minimum storage pools. Oswald (2002) noted that average plants of about 50,000 young of the year Eagle Lake rainbow trout appear to be adequate to maintain a productive fishery under normal reservoir storage ranges.

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. In 2002, the traditional plants of McBride Yellowstone cutthroat trout were replaced with the native strain of westslope cutthroat trout. This management decision was made to provide a better sympatric species in a native post glacial mixture including the lake trout, Arctic grayling, burbot, white sucker, and mottled sculpin. Preliminary data suggest that the initial two westslope cutthroat trout plants have performed as well as prior Yellowstone cutthroat trout plants and exceeded those Yellowstone strain plants through Ages II and III in several parameters. To date, westslope cutthroat trout plants have exceeded the most recent Yellowstone plants in survival to Age II, maximum and mean length at age, and, most significantly, mean condition factor. Recent samples have reflected relatively high sample densities based largely on the contribution of the westslope strain.

Oswald (2002) concluded that the Arctic grayling population of Elk Lake had undergone extinction due to lack of spawning flows in extremely limited spawning habitats over a prolonged period of drought. Flow shortages in Narrows Creek continue annually under the current severe drought condition that has dominated the climate of southwest Montana. 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 as a source to refound an Elk Lake arctic grayling population and return this glacial relict species to the fishery.

Oswald (2002) described the native post glacial relict status of the lake trout population of Elk Lake. Examination of the literature (Vincent 1963), the morphologic and meristic qualities of the fish (Khan and Quadri 1971), and the genetic status (Wilson and Hebert 1998) lend credence to this assumption. Wilson and Hebert (1998) concluded 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. The most recent lake trout samples continue to be reflective of a low density population and might even represent a declining trend. Factors contributing to the loss or decline of native lake trout are discussed in detail by Evans et al. (1991), Evans and Wilcox (1991), and Evans and Olver (1995). In addition to over exploitation and habitat loss or degradation, these authors define complex relationships among native and nonnative species which have had detrimental affects on native lake trout populations. Evans and Olver (1995) describe complex relationships between lake trout and other native species where the same species can coexist with lake in relatively benign sympatry or compete adversely with the lake trout depending on timing and competitive circumstance. Often, the demise of lake trout populations can be attributed directly to the planting of non-native stocks or strains of lake trout (Evans and Wilcox 1991). The lake trout of Elk and twin Lakes both coexist with native and non-native species in systems which have been altered by the stocking of salmonid species. Due to low population densities indicated by net samples, the species was placed under restrictive of catch and release regulations in 2000. More intensive research should be directed at this unique species in the immediate future.

Oswald (2002) described the burbot population of Elk Lake. The burbot of Elk Lake represent another unique native species of glacial origin occupying a habitat niche somewhat similar to the lake trout. 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. No reason for these differing success rates in recruitment and subsequent population trends is readily apparent. Taylor and McPhail (2000) concluded that temperature at the time of spawning directly affected burbot recruitment success but these studies were undertaken in lotic environments. Length frequency analysis are indicative of a relatively slow growth rate for the species compared with lower elevation reservoirs in southwest Montana. Katzman and Zale (2000) observed very rapid growth rates in nearby Upper Red Rock Lake that far exceeded those suggested by length frequency distribution in Elk Lake. Upper Red Rock Lake, however, is a very shallow body of water which would not be comparable to Elk Lake despite its proximity. 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. Burbot biology is largely poorly understood and direct management of the species is often lacking throughout most of North America (McPhail and Paragamian 2000).

After the discovery of Utah chubs in the 1986 net samples from Elk lake, it was feared that the illegal introduction would negatively affect other species in a relatively low productivity environment. Analysis of Utah chub numbers in net samples over the 1989 - 2004 period suggest that the species has not flourished in the lake. It is possible that the habitat niches of Elk Lake are not favorable for the species or that intense predation from piscivores like lake trout and burbot have stifled expansion of the chub population.

HIDDEN LAKE

Oswald (2000a and 2002) reported on the extremely stable nature of the wild Hidden Lake rainbow trout population. Sampling conducted from 1985-2003 has revealed a continuation of this stability with ample numbers of mature, larger fish dominating populations and consistent recruitment. 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 28.5 per net over the period of record.

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 (2002) 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. Oswald (2002) cited literature sources and meristic and genetic analysis which 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.

Extremely sporadic recruitment of lake trout into the Twin Lakes population led to an attempt to trap spawning lake trout in fyke nets during October 2003. Potential spawning habitat was located visually in accordance with characteristics described by Sly and Evans (1996). Basically, this limited sample sites to two primary areas and one secondary area where appropriate sized gravels could be observed at depths of 1.0 to 1.5 meters. No lake trout were captured in 10 fyke sets which were fished through an appropriate temperature range for lake trout spawning activity. A spring series of fyke nets was also fished post ice out in the same habitats in May 2004 with the same result. The lack of lake trout in the samples could be related to the presence of deeper spawning habitats in the lake, lack of spawning adults in the population, extremely low lake trout population density or other factors not currently understood. The potential spawning habitats that were sampled in October 2003 appeared to be too shallow to withstand ice cover at the elevation and current depth of Twin Lakes. Sly and Evans (1996) discussed temporary loss of shallow spawning habitats associated with low lake levels and mentioned other factors which can temporarily render shallow spawning habitats unusable by lake trout. The sporadic recruitment success obvious in the Twin Lakes lake trout population strongly suggests that acceptable spawning habitat has not been consistently available. Low lake trout densities in Twin Lakes could also be related to other complex factors including habitat alteration, over exploitation, and competition from other native species or introduced native or non-native species as discussed by Evans et al. (1991), Evans and Wilcox (1991), and Evans and Olver (1995). Complex competitive relationships between lake trout and other species, such as the introduced brook trout or the native burbot in Twin lakes, can vary over time to the detriment or demise of the lake trout population Evans and Olver (1995).

Fyke net samples in October 2003 and May 2004 yielded more information about the native burbot population of Twin Lakes. The population appears to be relatively stable and abundant. Relatively high recapture rates appeared to be indicative of site fidelity and led to the possibility that a population estimate of the species might be possible in Twin Lakes. More study would be required to determine if the abundant burbot represent a negative competitive factor for lake trout in Twin Lakes. McPhail and Paragamian (2000) noted that the biology of burbot is poorly understood in most North American fisheries.

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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-2, R-3, and R-4

Montana Fish, Wildlife & Parks Project Number 3320

APPENDIX OF FIGURES

Figure 1. End of irrigation season (fall) storage in Clark Canyon Reservoir, 1987 - 2003.

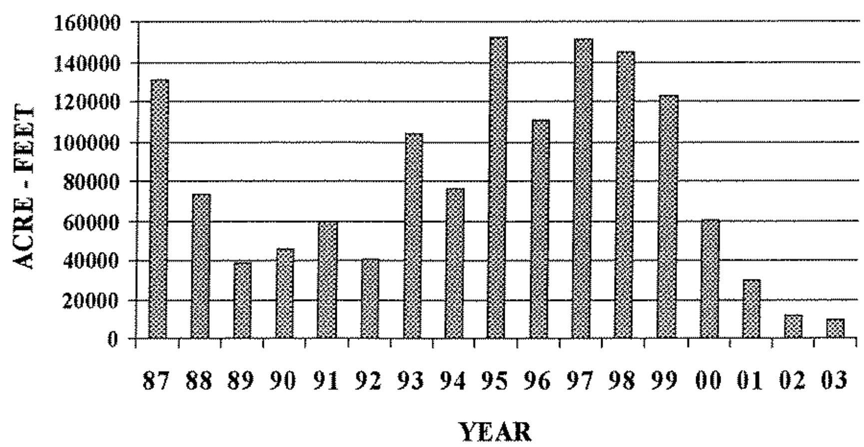


Figure 2. Mean number of rainbow trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2003.

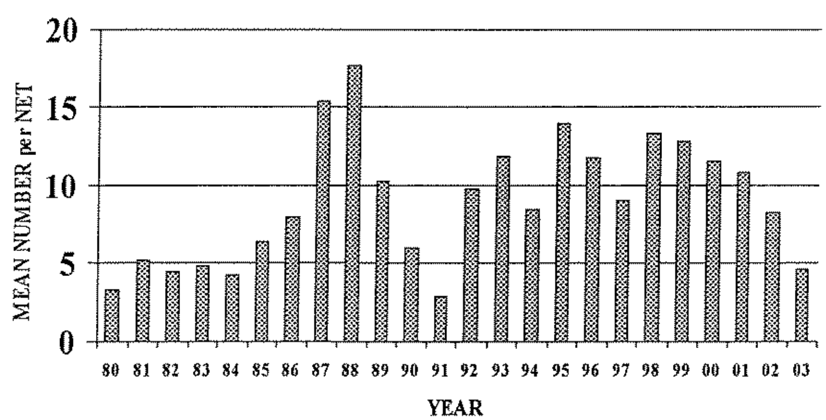


Figure 3. Mean number of Age I rainbow trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2003.

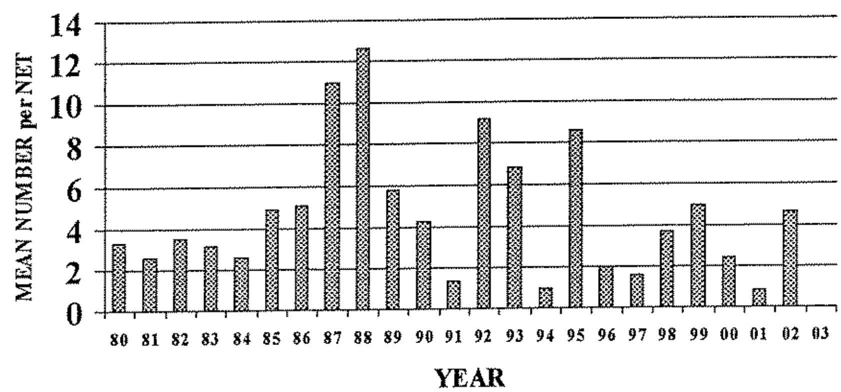


Figure 4. Mean fall Condition Factor (K) for discreet age classes of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Clark canyon Reservoir, 1998 - 2003.

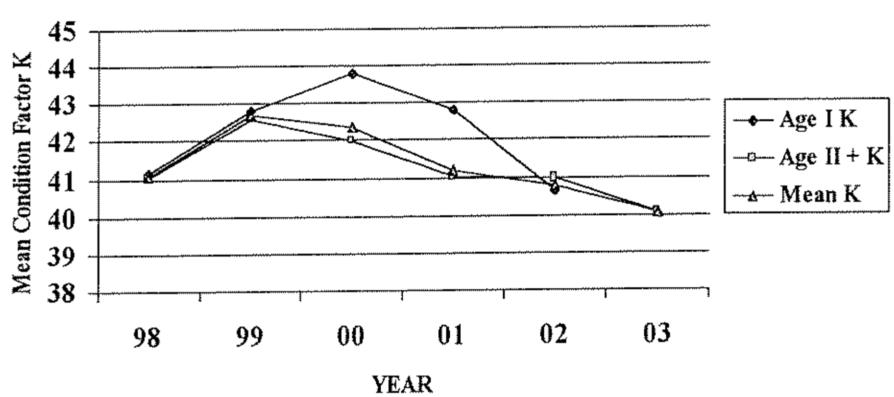


Figure 5. Mean number of brown trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2003.

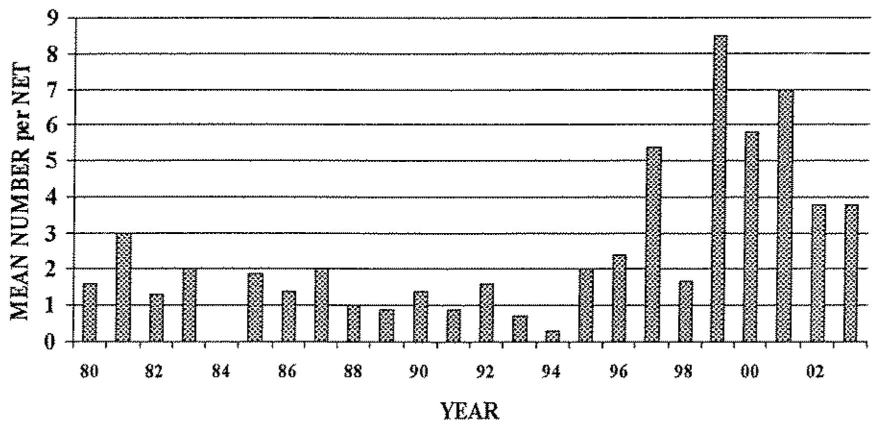


Figure 6. Estimated angling pressure (Angler - Days per Year) for Clark Canyon Reservoir 1983 - 2003.

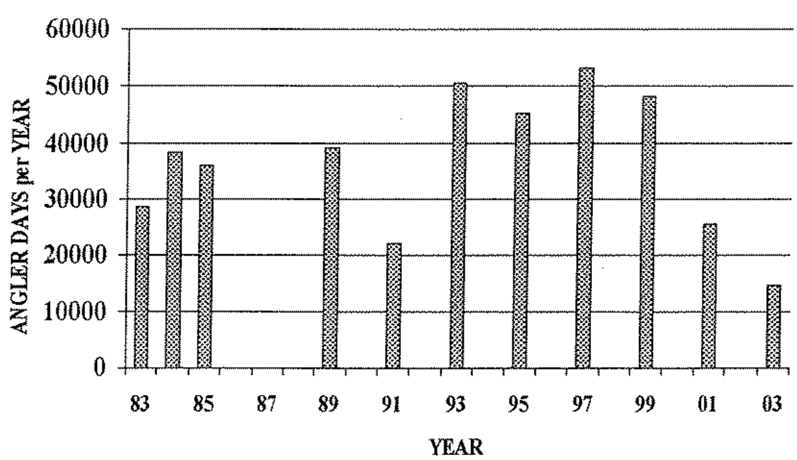


Figure 7. Estimated resident and nonresident angling pressure (Angler - Days per Year) for Clark Canyon Reservoir, 1983 - 2003.

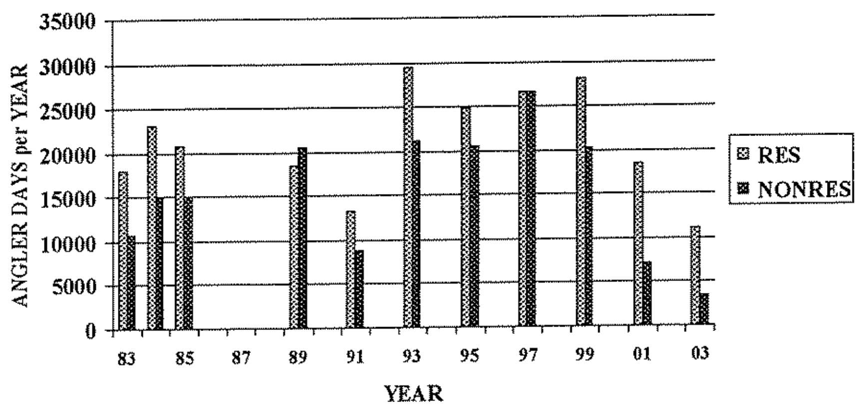


Figure 8. Winter creel catch rates for rainbow trout in Clark Canyon Reservoir, 1989 - 2003.

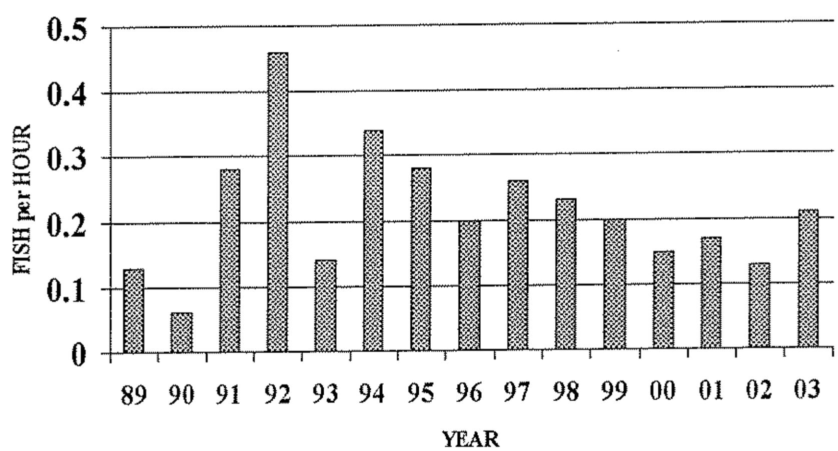


Figure 9. Winter creel catch rates for brown trout in Clark Canyon Reservoir, 1989 - 2003.

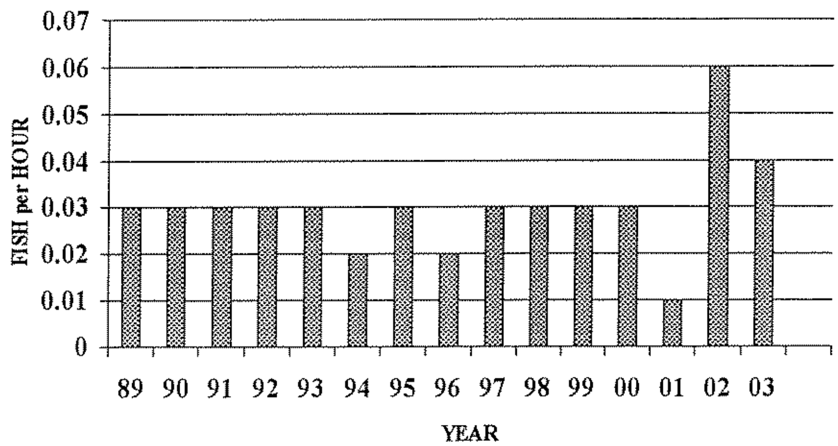


Figure 10. End of irrigation season (fall) storage in Ruby Reservoir, 1986 - 2003.

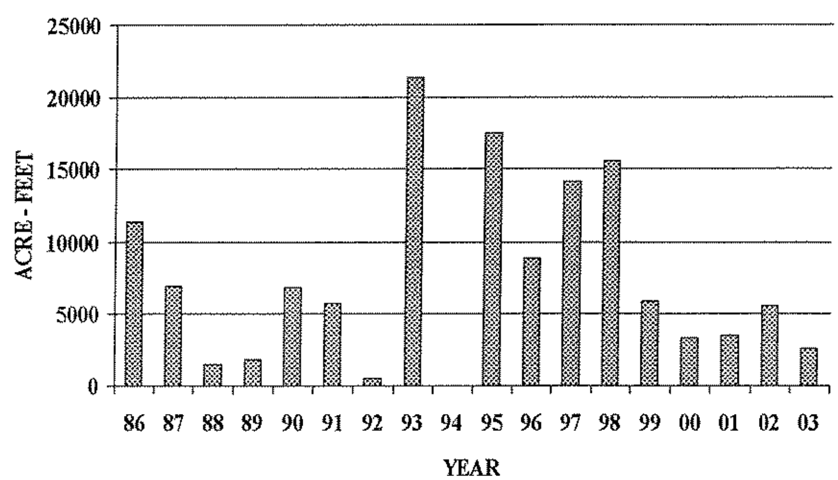


Figure 11. Mean number of Eagle Lake rainbow trout collected per floating experimental gill net set overnight in Ruby Reservoir 1995 - 2004.

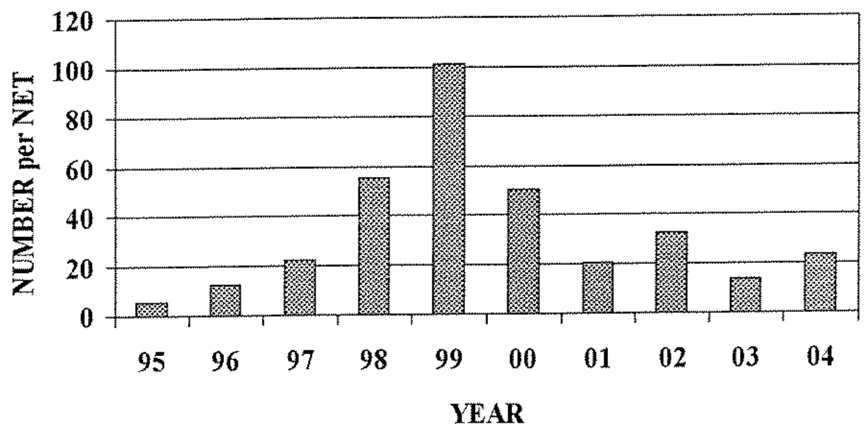


Figure 12. Mean number of Age I Eagle Lake rainbow trout collected per experimental gill net set in Ruby Reservoir 1995 - 2004.

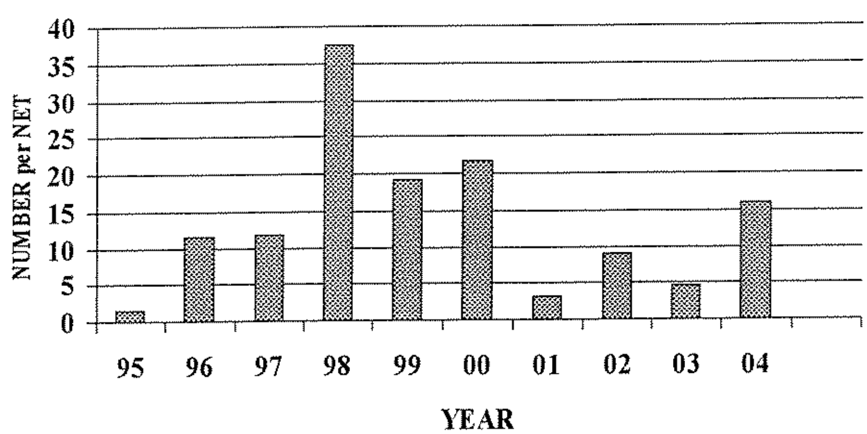


Figure 13. Length range and mean length of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1990 - 2004.

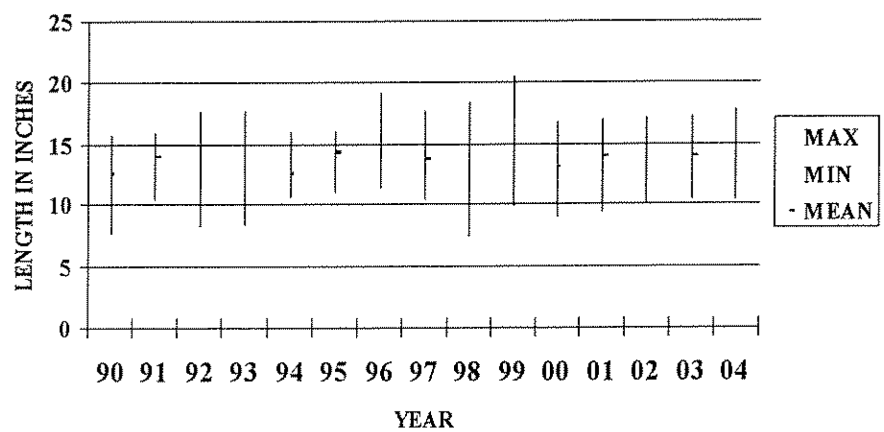


Figure 14. Mean Condition Factor (K) for rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1996 - 2004.

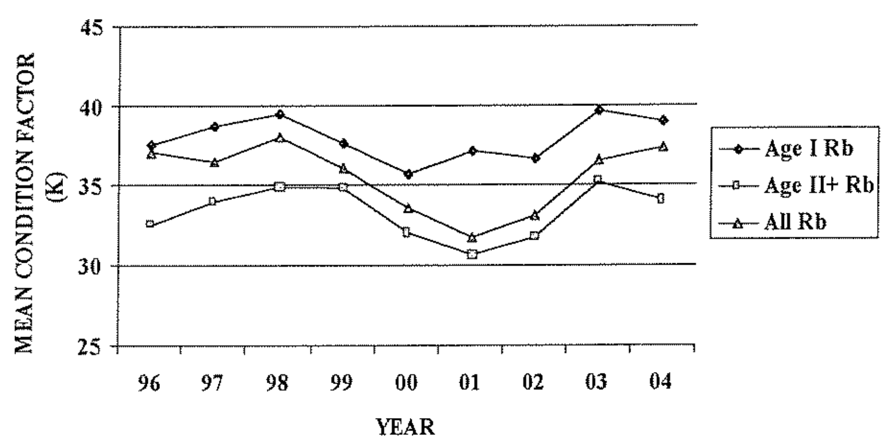


Figure 15. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 2000. (N=251)

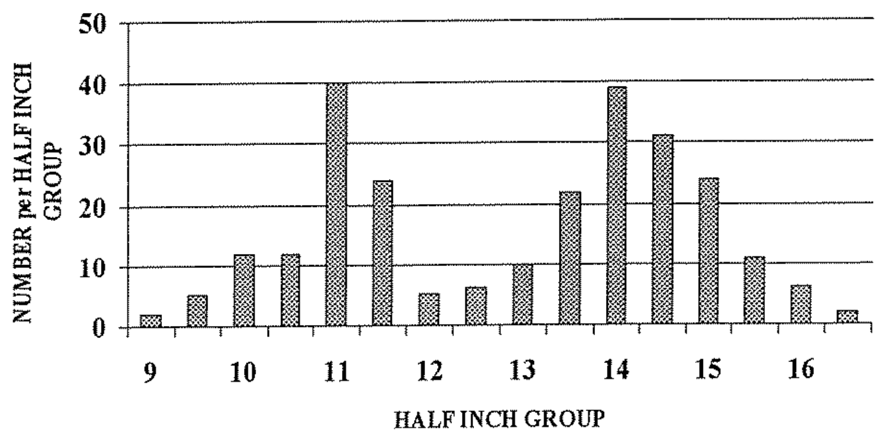


Figure 16. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 2001. (N=103)

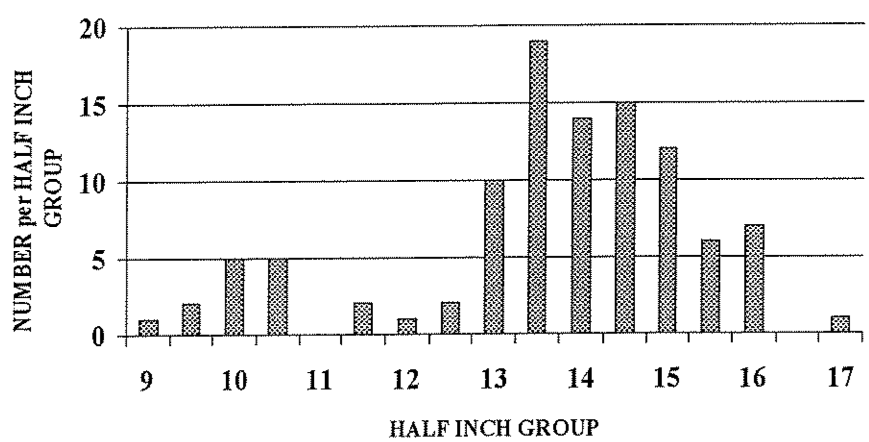


Figure 17. Length frequency distribution of rainbow trout collected in experimental floating gill nets set overnight in Ruby Reservoir, 2002 (N = 164).

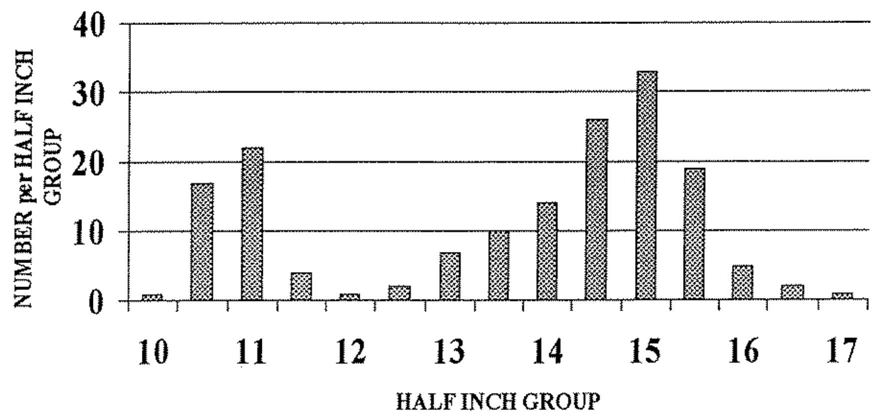


Figure 18. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 2003 (N = 69).

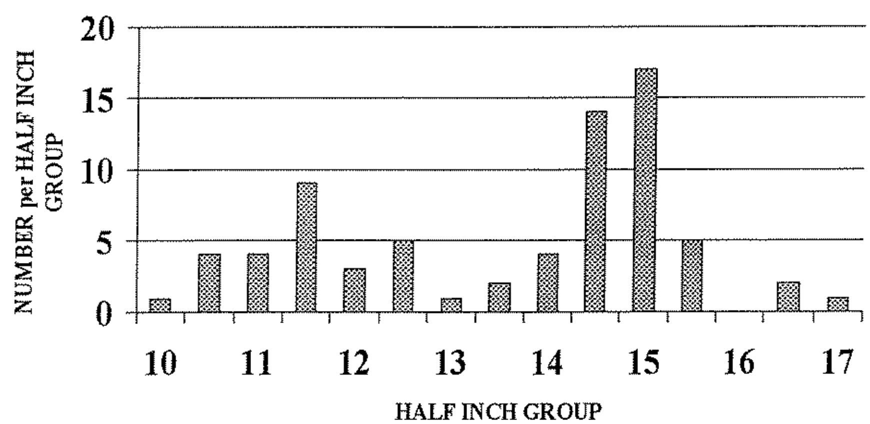


Figure 19. Length frequency distribution of rainbow trout collected in floating experimental gill nets set overnight in Ruby reservoir, 2004 (N = 119).

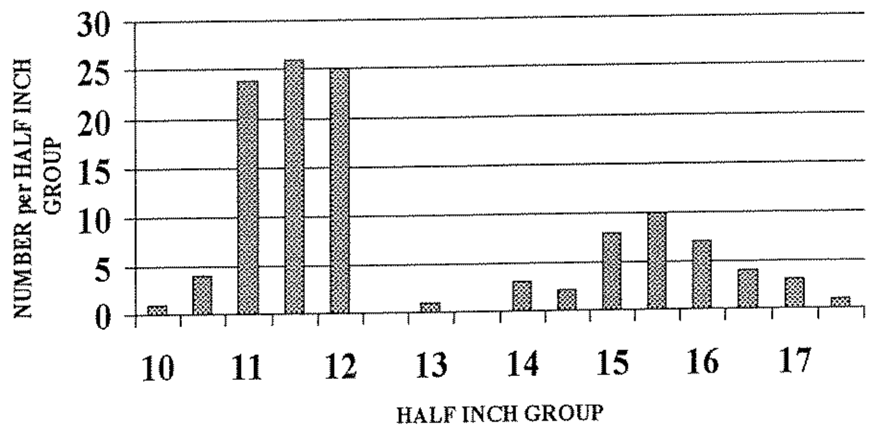
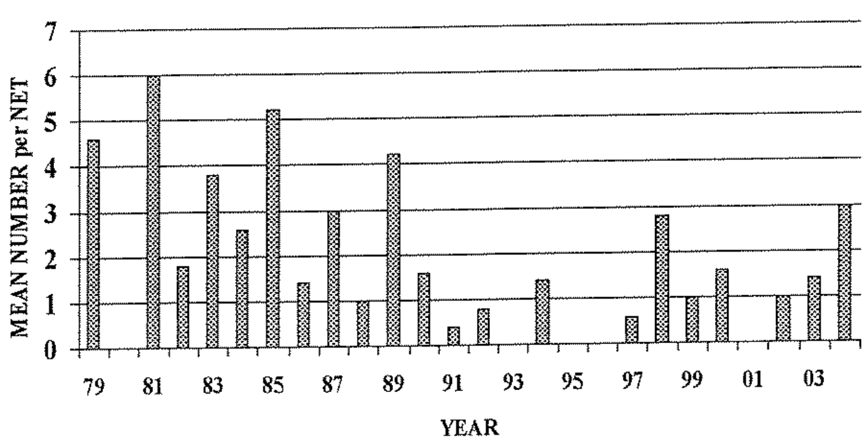


Figure 20. Mean number of brown trout collected per floating experimental gill net set overnight in Ruby Reservoir, 1979 - 2004.



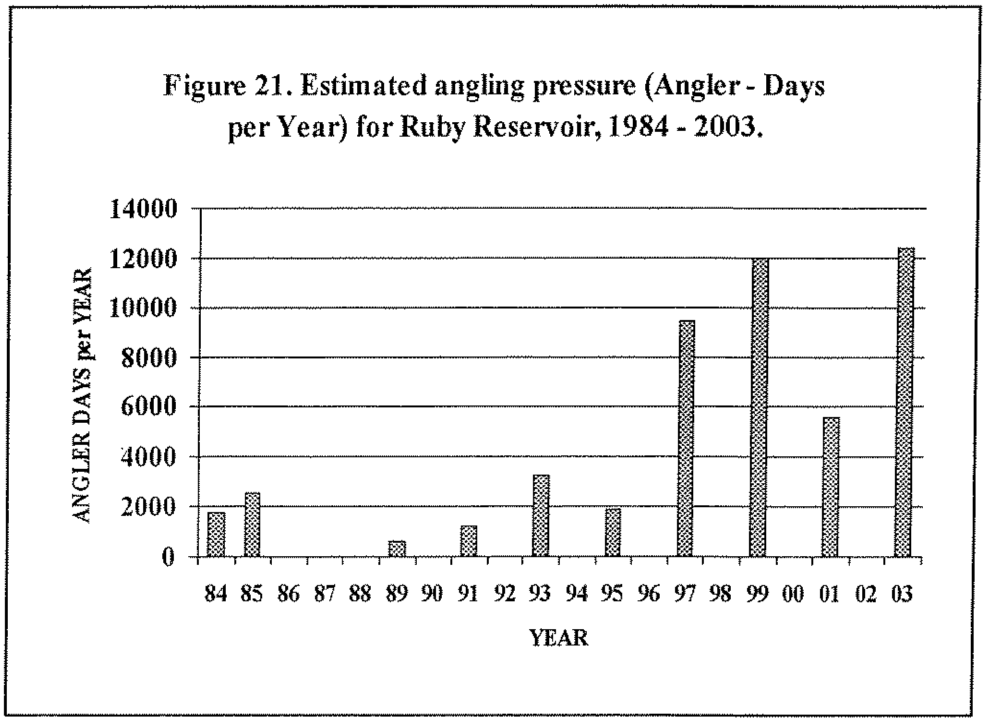


Figure 21. Estimated angling pressure (Angler - Days per Year) for Ruby Reservoir, 1984 - 2003.
ANGLER DAYS per YEAR
14000
12000
10000
8000
6000
4000
2000
0
84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03
YEAR

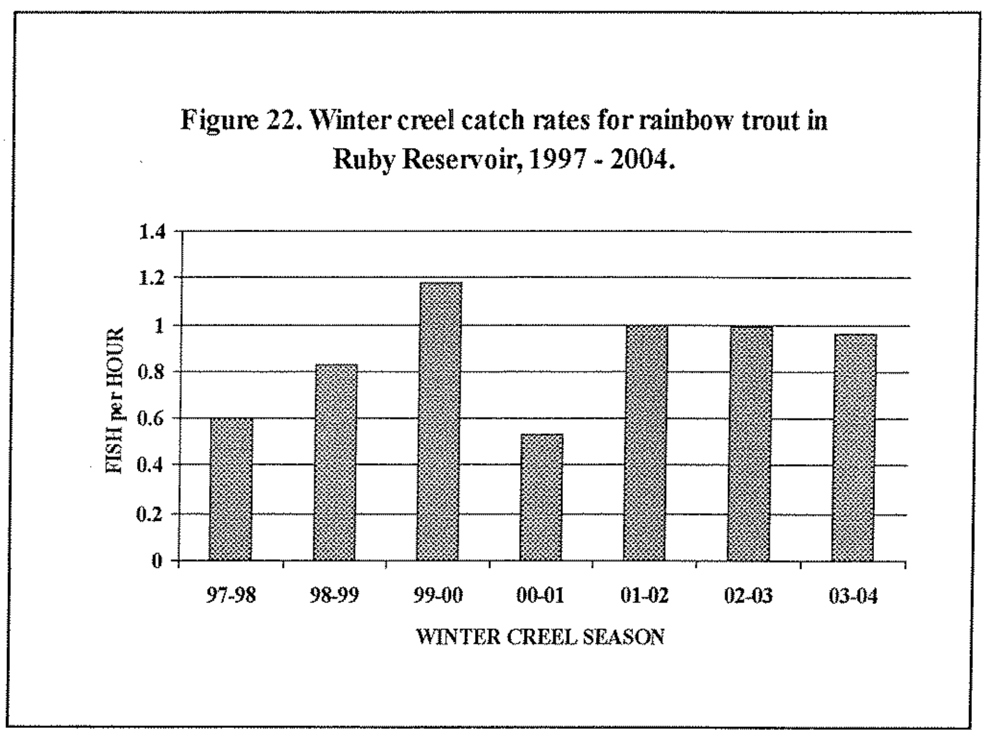


Figure 22. Winter creel catch rates for rainbow trout in Ruby Reservoir, 1997 - 2004.
FISH per HOUR
1.4
1.2
1
0.8
0.6
0.4
0.2
0
97-98
98-99
99-00
00-01
01-02
02-03
03-04
WINTER CREEL SEASON

Figure 23. Mean length (inches) of rainbow trout harvested by ice fishermen during winter creel census of Ruby Reservoir, 1997 - 2004.

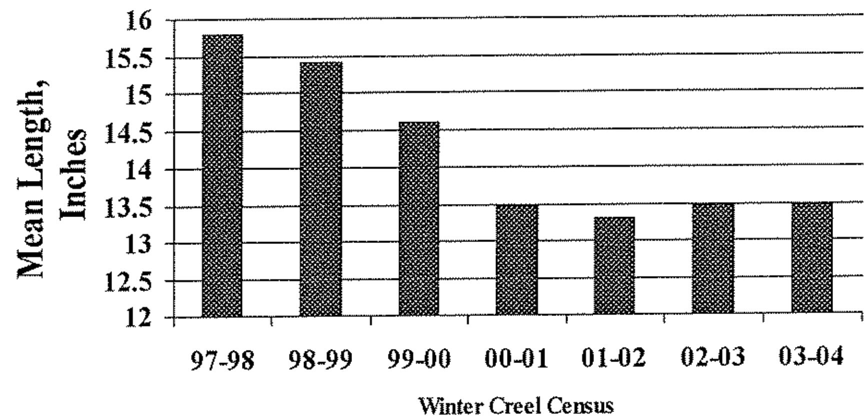


Figure 24. Mean number of Yellowstone cutthroat trout (YCT) and westslope cutthroat trout (WCT) collected per floating experiemntal gill net set overnight in Elk Lake (1991 - 2004).

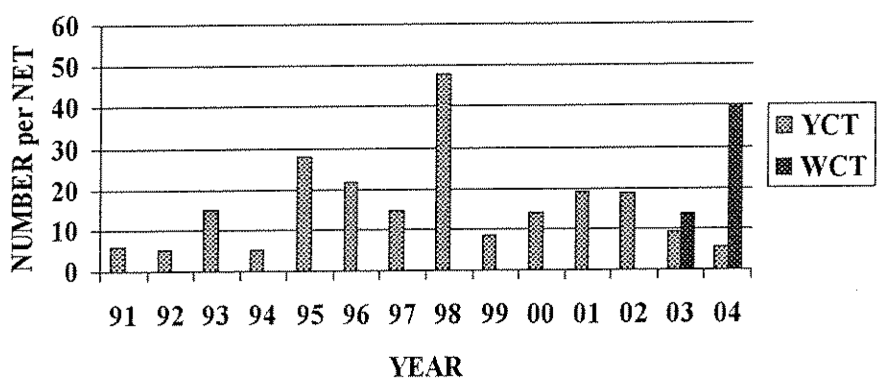


Figure 25. Age distribution of Yellowstone (YCT) and westslope (WCT) cutthroat trout collected in floating experimental gill nets set overnight in Elk Lake, 1991 - 2004.

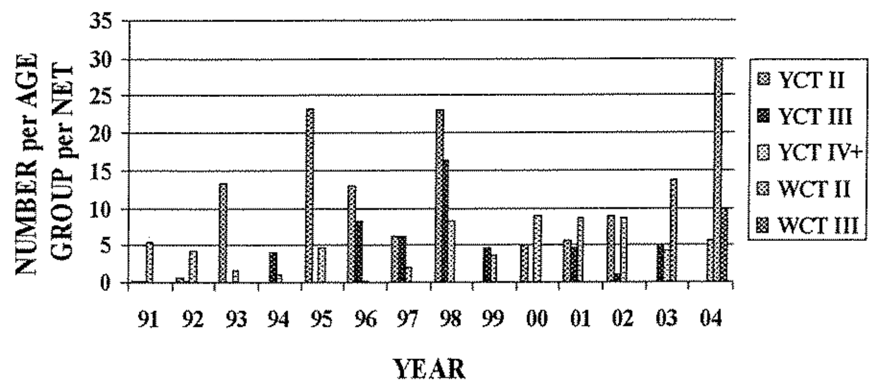


Figure 26. Length frequency distribution of Yellowstone (YCT) and westslope (WCT) cutthroat trout collected in floating experimental gill nets set overnight in Elk Lake, 2003 (N = 69).

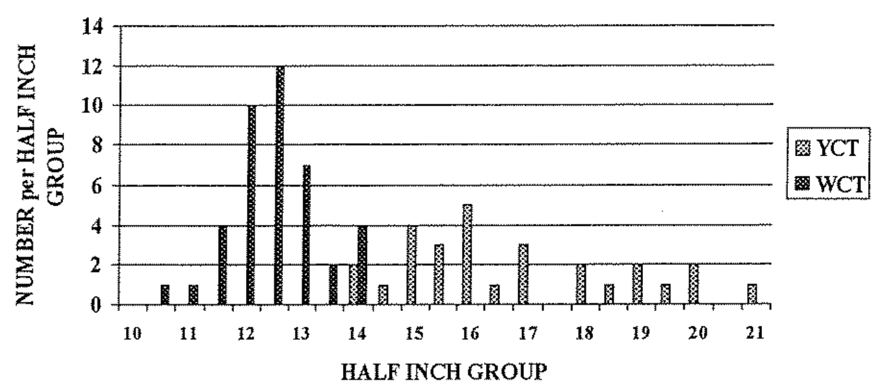


Figure 27. Length frequency distribution of Yellowstone (YCT) and westslope (WCT) cutthroat trout collected in floating experimental gill nets in Elk Lake, 2004 (N = 137).

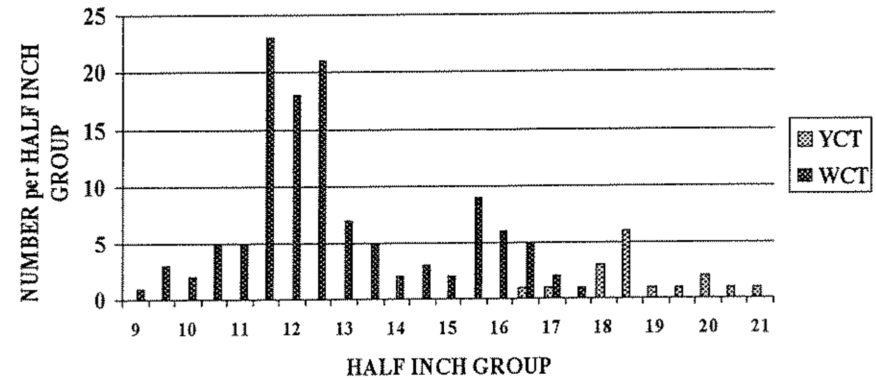


Figure 28. Mean number of lake trout collected per floating and sinking experimental gill net set overnight in Elk Lake 1981 - 2004.

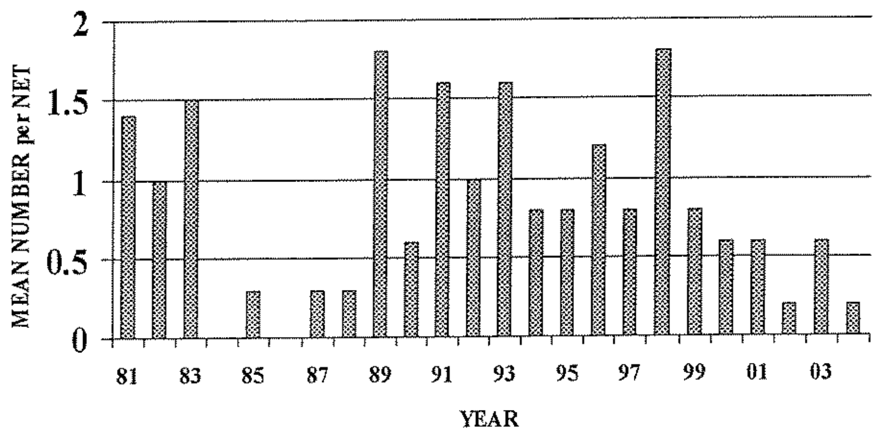


Figure 29. Length range and mean length of lake trout collected in floating and sinking experimental gill nets set overnight in Elk Lake 1991 - 2004.

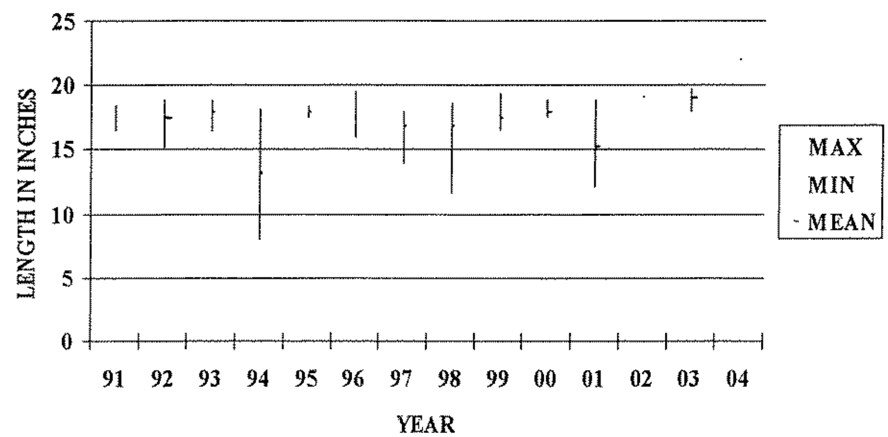


Figure 30. Composite length frequency distribution of lake trout collected in floating and sinking experimental gill nets set in Elk Lake 1993 - 2004. (N=77).

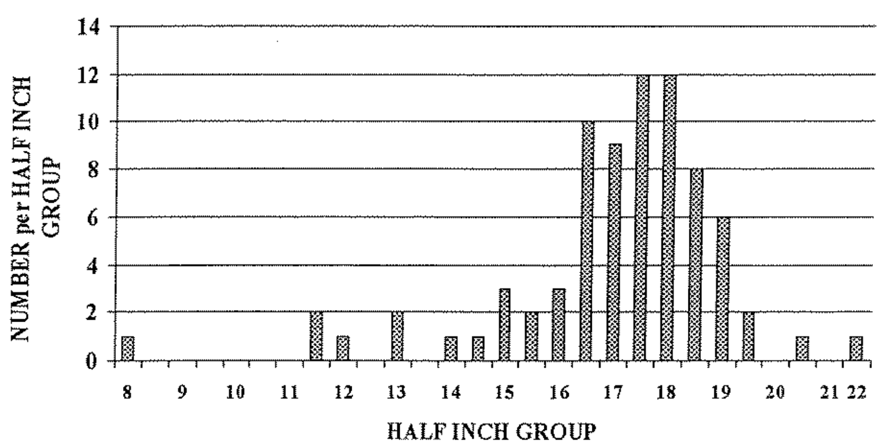


Figure 31. Mean number of burbot collected per sinking experimental gill net set overnight in Elk Lake, 1991 - 2004.

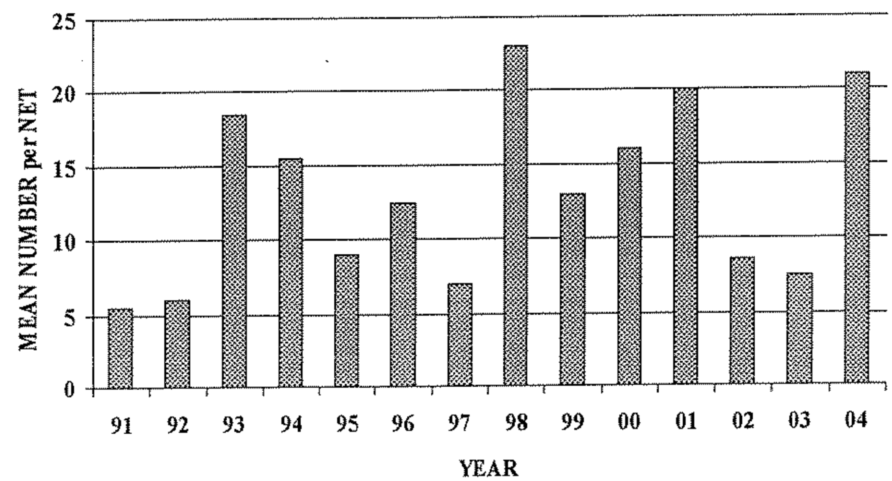


Figure 32. Length range and mean length of burbot collected in sinking experimental gill nets set overnight in Elk Lake, 1991 - 2004.

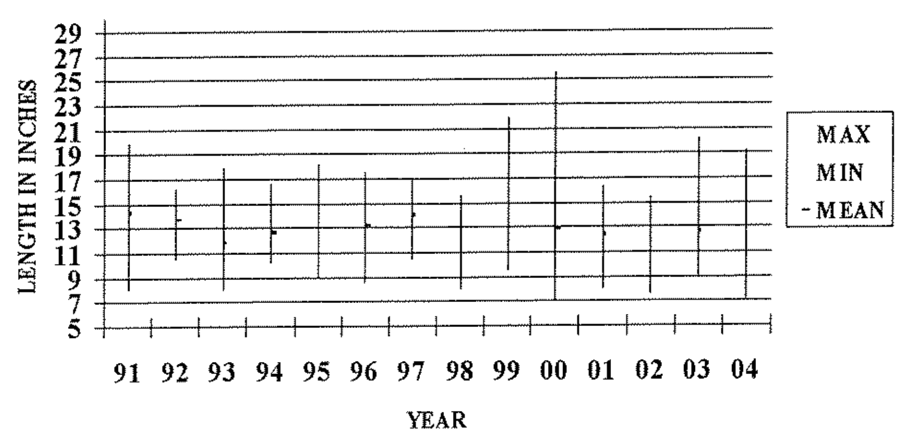


Figure 33. Composite length frequency distribution of burbot collected in sinking experimental gill nets set overnight in Elk Lake, 1991 - 2004. (N = 519).

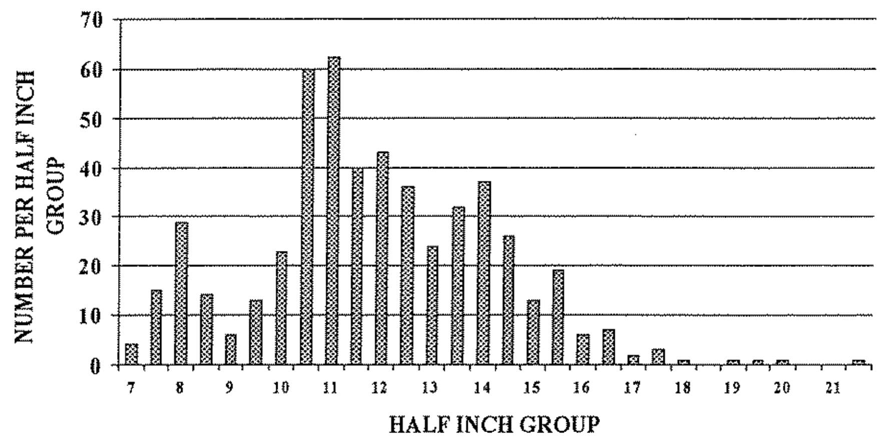


Figure 34. Mean number of white sucker collected per sinking experimental gill net set overnight in Elk Lake, 1989 - 2004.

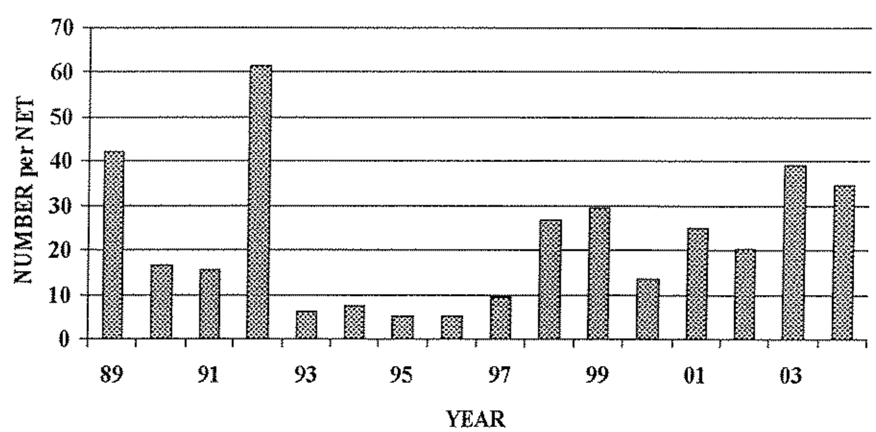


Figure 35. Mean number of Utah chub collected per experimental gill net set overnight in Elk Lake, 1989 - 2004.

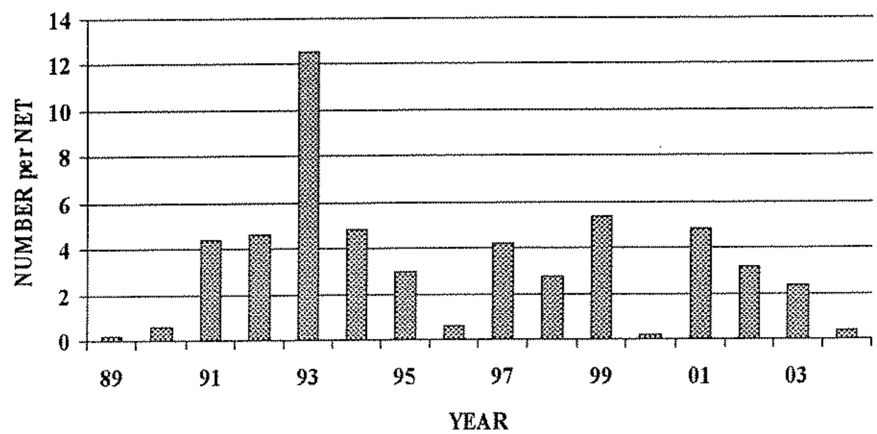


Figure 36. Mean number of rainbow trout collected per sinking experimental gill net set overnight in Hidden Lake, 1985 - 2003.

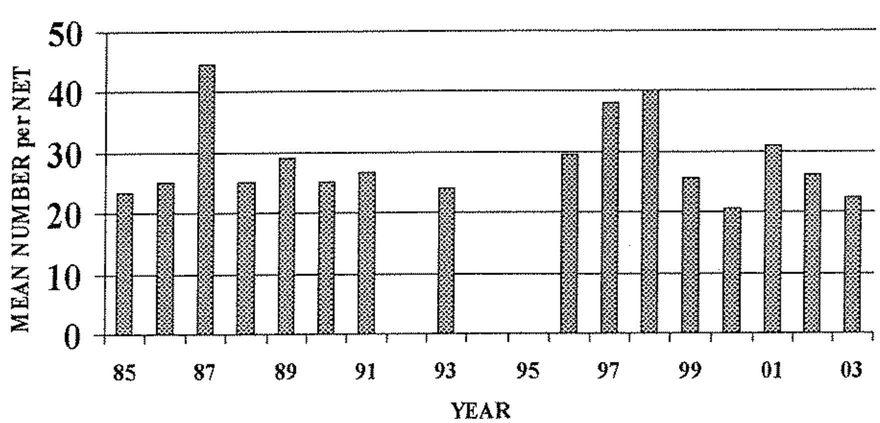


Figure 37. Length range and mean length of rainbow trout collected in sinking experimental gill nets set overnight in Hidden Lake, 1985 -2003.

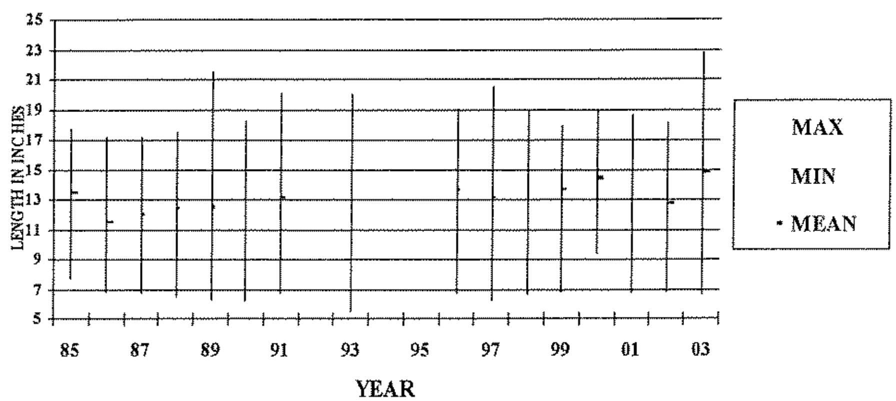


Figure 38. Mean Condition Factor (K) for rainbow trout collected in experimental gill nets set overnigh in Hidden Lake 1996 - 2003.

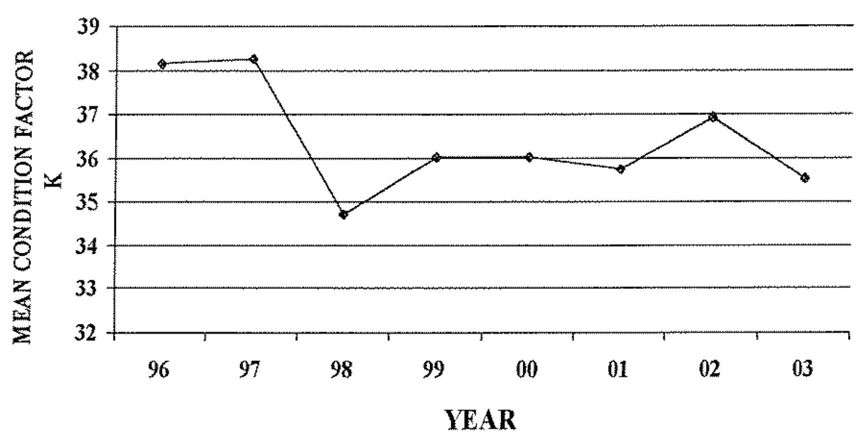


Figure 39. Composite length frequency distribution of rainbow trout collected in sinking experimental gill nets set overnight in Hidden Lake, 1993 - 2003. (N=508).

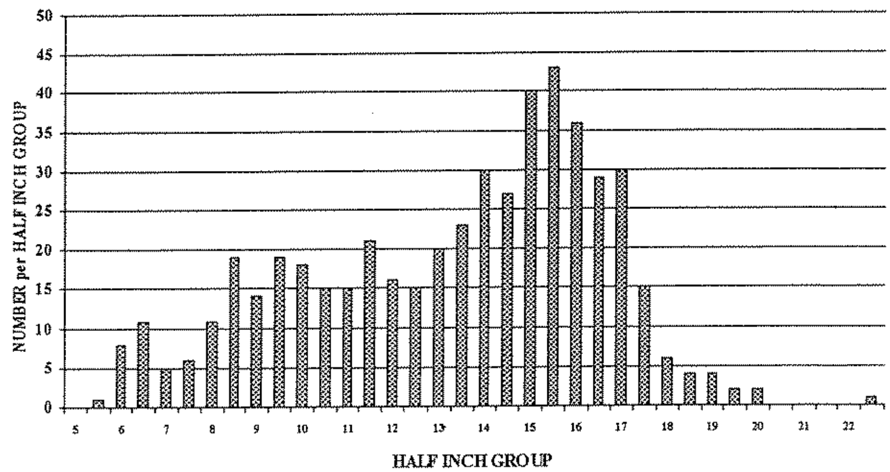


Figure 40. Length frequency distribution of rainbow trout collected in experimental gill nets set overnight in Hidden Lake in 2000 (N = 41) and 2001 (N = 60).

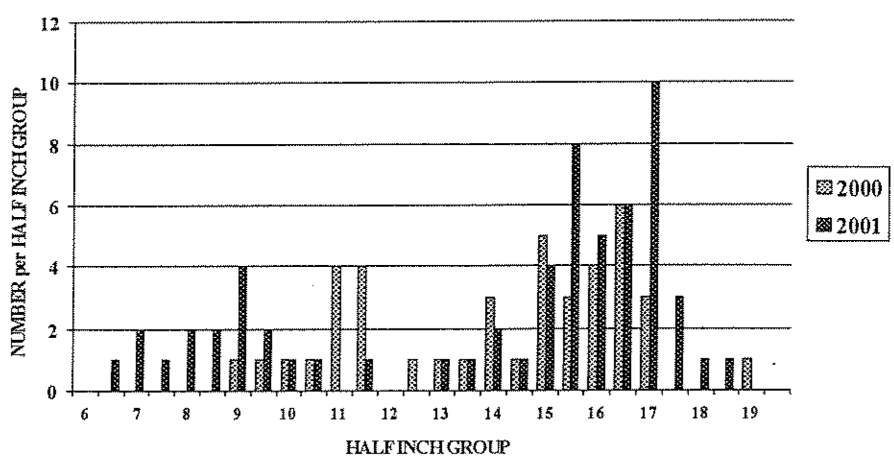


Figure 41. Length frequency distribution of rainbow trout collected in experimental gill nets set overnight in Hidden Lake in 2002 (N = 52) and 2003 (N = 45).

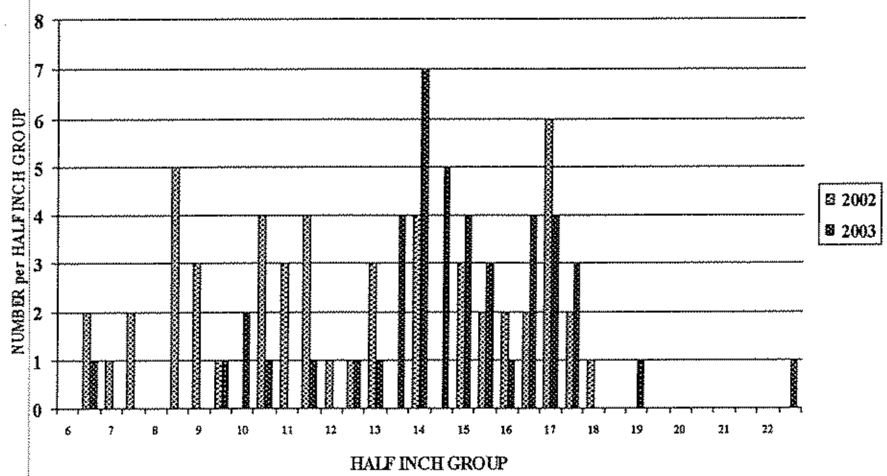


Figure 42. Species composition of fish sampled in fyke nets set overnight in Twin Lakes, October 2003.

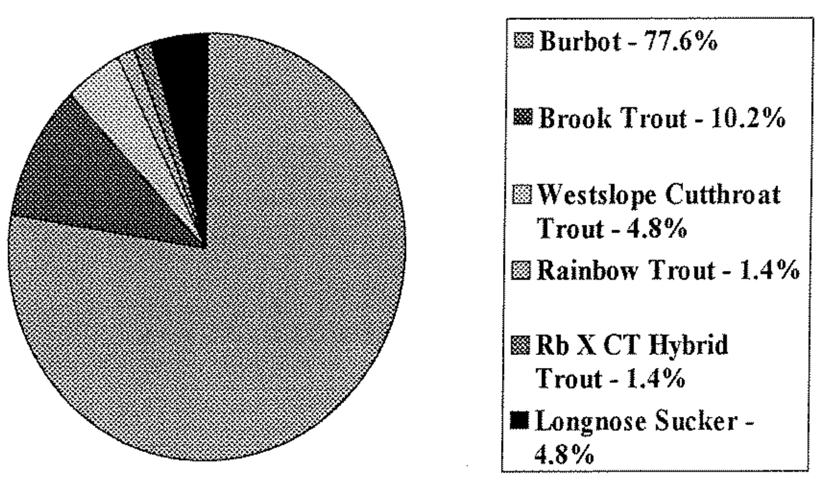


Figure 43. Mean number of the various species of fish captured per fyke net set overnight in Twin Lakes, October 2003.

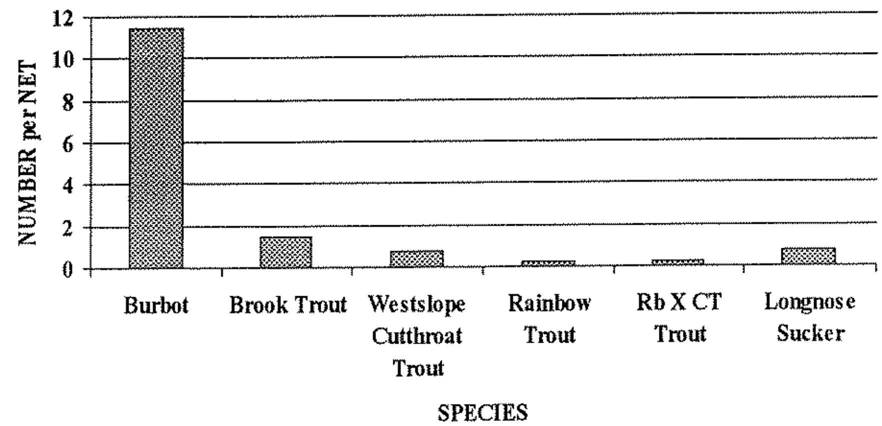


Figure 44 . Length frequency distribution of burbot captured in fyke nets set overnight in Twin Lakes, October 2003 (N = 114).

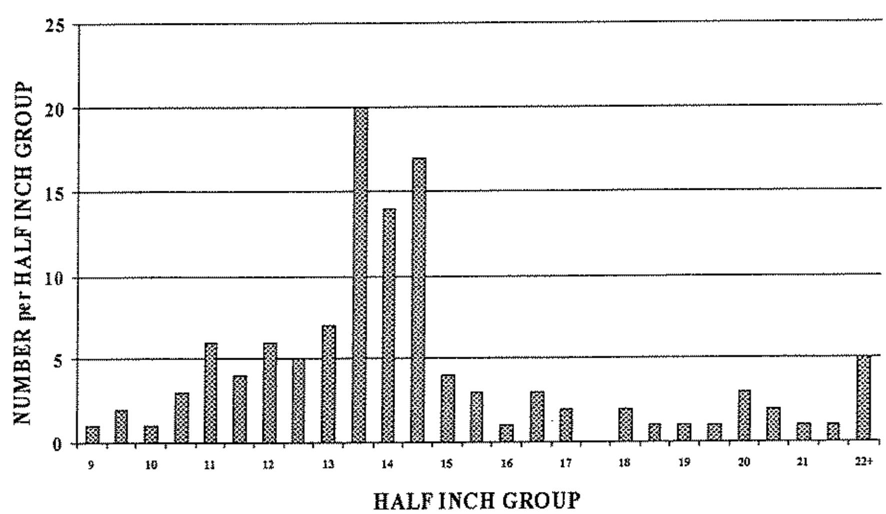


Figure 45. Species Composition of fish sampled in fyke nets set overnight in Twin Lakes, May 2004.

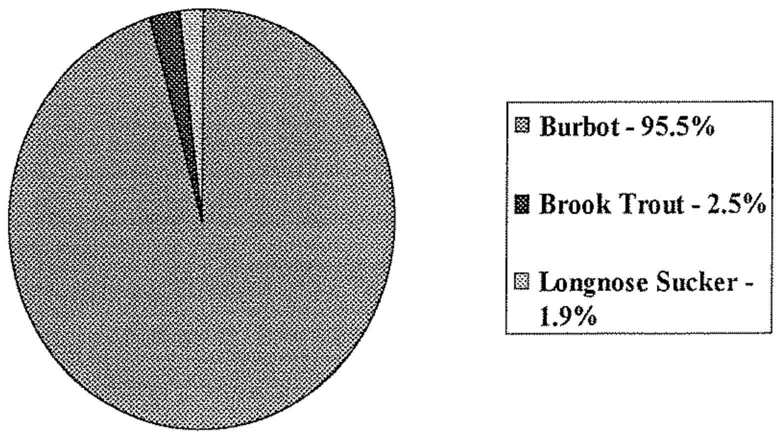


Figure 46. Mean number of the various species of fish captured in fyke nets set overnight in Twin Lakes, May 2004.

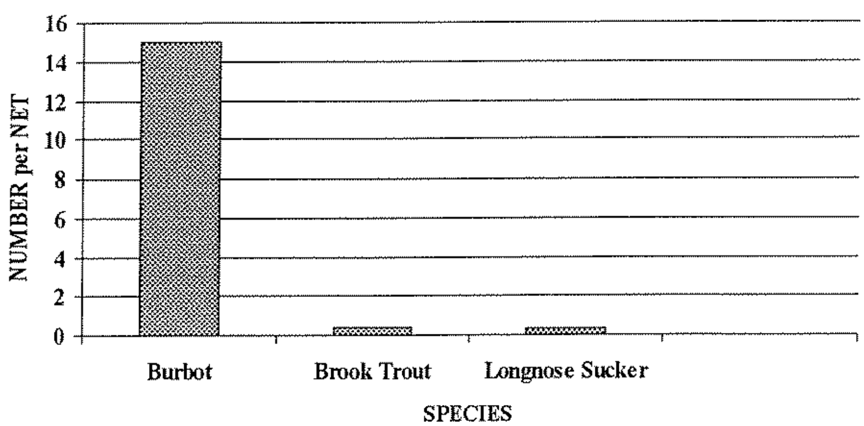


Figure 47 . Length frequency distribution of burbot captured in fyke nets set overnight in Twin Lakes, May 2004 (N = 150).