INVENTORY AND SURVEY OF THE SPORT FISHERIES OF CLARK CANYON AND RUBY RIVER RESERVOIRS IN SOUTHWEST MONTANA, 2004 - 2007

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ABSTRACT

Fisheries data trends are updated for the 2004 - 2007 study period for Clark Canyon and Ruby River Reservoirs in southwest Montana. Fisheries and storage data trends were gathered and analyzed for Clark Canyon Reservoir. Reservoir storage underwent an improving trend over the 2005-2007 irrigation seasons and stocked rainbow trout populations responded markedly with much improved survival of stocked cohorts of young of the year fish. Accompanying analyses of plant success for wild strain rainbow trout, wild brown trout population trends, rainbow trout condition, length frequency status for both species, and angler use trends are presented. Initial findings on the status of the wild burbot population of Clark Canyon Reservoir are presented for the first time since the reservoir was built in 1964. Preliminary data include trapping methods, length frequency and age length relationships, and a preliminary estimate of the adult spawning population. Reservoir storage trends, rainbow trout abundance and stock survival success, wild brown trout population trends, and angler use information are presented for Ruby Reservoir. Plants of Eagle Lake strain rainbow trout have responded to recent improvement in reservoir storage pools although the 2007 pool experienced a substantial reduction. Populations of wild brown trout exhibited improved sample density and a large size component when compared with past populations and demonstrated a very rapid and unanticipated expansion in the 2007 sample. Condition trends and length frequency analyses are also presented for rainbow and brown trout samples over the study period.

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INTRODUCTION

Southwest Montana provides an abundant angling experience in lacustrine environments formed via the construction of reservoirs on mainstem rivers and larger tributary streams. While a wide variety of lentic fisheries are sustained in natural alpine and valley lakes and natural and man made ponds, a substantial percentage of “flat water” angling opportunity is provided by public reservoirs which are readily accessed by vehicle. Concomitant with their accessibility, most of these public reservoirs are provided with ample developed campground and boat launch facilities that also tend to increase angler use. Because of their accessibility, developed infrastructure, and relatively large size, these waters tend to support relatively heavy angling pressure. Additionally, many of these lowland reservoirs are noted for their productivity, trophy fisheries, unique species composition, scenic qualities, or some combination of these factors. These characteristics, when coupled with the aforementioned attributes, can result in heavy angling pressure and high angler expectations. Most of these waters are stocked regularly 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. Both of these waters provide exceptional public fisheries resources and 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 Reservoir is managed by the Bureau of Reclamation and two private 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 (2004) while preliminary data on burbot populations were reported by Hochalter and Oswald (2007). Ruby Reservoir is managed by the Montana Department of Natural Resources and the private 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 into the 10,000 to 12,000 angler-days per year range. The trout populations of Ruby Reservoir were last described by

Oswald (2004). Federal and state land management agencies provide ample campground and boat launch facilities on both reservoirs.

METHODS

Sampling of salmonid fish populations in both reservoirs 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 temporal and spatial variation. 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.

Efforts to gain insight on the burbot population of Clark Canyon Reservoir included spawning site identification surveys, winter creel surveys, spring trap-netting at selected spawning sites, and fall trap-netting throughout the reservoir. Spawning site identification was accomplished through the use of underwater cameras and night surveys using spotlights. Fyke nets were employed to sample the spawning and post-spawning individuals in shallow environs whereas baited cod traps were used to sample burbot populations from deeper habitats in the fall as described by Bernard et al (1991). 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 approximately 15 to 18 hours.

Cod traps were approximately 3.5 feet tall with a bottom diameter of 4.0 feet and a top diameter of 3.0 feet, and were constructed of 1.0 inch mesh nylon netting. All captured burbot were tagged (numbered Floy T-bar) and released as part of a mark-recapture study to learn more about the population size, harvest, age structure, and growth rates. Cod traps were generally fished at depths of 35 to 40 feet in order to adequately sample the mature segment of the burbot population (Hofmann and Fischer 2002). The effects of decompression trauma associated with raising cod trap-captured burbot from depths greater than 33 feet were minimized using techniques modified from those described in Neufeld and Spence (2004). Fish were raised to a depth that was approximately one-half the atmospheric pressure than the original deployment depth for 15 to 30 minutes before handling. Upon completion of measuring and tagging, fish were allowed to recover in an open bottom cod pot lowered to 15 feet for approximately 15 to 30 minutes. Any fish that continued to be affected by decompression after this technique had its swim bladder deflated by inserting a hollow needle slightly below the lateral line into the body cavity (Bruesewitz et al. 1993). Despite efforts to mitigate these effects, sagittal otoliths were collected from any fish that expired as a result of handling or decompression trauma. Otoliths will be used for ageing techniques in subsequent months.

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 salmonid fish within the sample, mounted on acetate slides, and examined on a microfiche viewer to determine age. Otoliths were collected from all burbot mortalities sustained in gill net and trap net efforts as well as those collected from angler harvest during creel census. Extracted burbot otoliths were then polished and/or sectioned, and examined under a dissecting microscope to ascertain age.

Photographs were also sent to reputable biologists experienced with reading otoliths for tentative age verification.

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 harvest statistics and could not be used to estimate total pressure or harvest. Winter creel surveys on Clark Canyon Reservoir also allowed for the collection of otoliths from angler-caught burbot for age-length regression analysis. All pressure estimates used in this report were generated from the MDFWP statewide mail creel census that is conducted on a regular basis, generally during alternate, odd years.

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 Montana DNRC and 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 1987-2007 period. Ample reservoir storage over the five year period 1995 - 1999, often exceeded 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. Minimum pools in 2004 and 2005 improved slightly to approximate 20,000 and 40,000 acre feet and improved markedly in 2006 and 2007 to approximate 60,000 acre feet. Relationships depicted by Oswald (1993) showed that reservoir surface was reduced to 2,000 acres at storages approximating 40,000 acre feet 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. Recent minimal pools in 2002 and 2003 reduced the reservoir surface substantially, to surface minima approaching 1,000 acres while the current pools in 2006 and 2007 rebounded significantly to approximate 3,000 surface 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 fifteen years, young of the year rainbow plants have averaged 213,472 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 (Berg 1974). Stocked fish are usually 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 very poor survival (Oswald 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. Beginning in 2002, a 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). Initial results of the 2002 yearling plant were favorable. Thus, the yearling plants became the primary management tool rather than a supplemental component, in the absence of YOY plants in 2003 and 2004. 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 yearling plants have remained a management component through 2007 averaging 70,753 fish per year. The initial yearling plant provided for fish release as late as early June but subsequent yearling plants have been made in April to maximize hatchery space and conserve hatchery resources. The yearling plants have not been dispersed by boat. In 2005, improving conditions in reservoir storage merited a return to a limited YOY rainbow plant and further improved conditions in 2006 resulted in a modern record high YOY plant of 323,745 fish in concert with a full spring yearling plant component. The high 2006 stock densities were planned in anticipation of a minimum storage pool that would approximate 3,000 surface acres and a rainbow trout population status marked by minimal numbers of older, more competitive fish. In 2007, storage conditions similar to those observed in 2006 merited full plants of both YOY and yearling rainbow trout, however, the YOY fish were not dispersed by boat due to a shortage of assistance at the critical time.

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

YEAR	NUMBER	YEAR	NUMBER
1993	202,164	2001	248,428
1994	197,616	2002	235,461 (79,689)
1995	200,703	2003	0 (87,007)
1996	209,848	2004	0 (72,461)
1997	186,718	2005	155,000 (42,218)
1998	200,368	2006	323,745 (70,643)
1999	193,074	2007	222,042* (72,500)
2000	200,000	MEAN	213,472 (70,753)

* 2007 YOY total contains 19,747 Arlee strain rainbow trout stocked in error.

Rainbow trout population trends from 1980 through 2007 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. Despite declining densities, rainbow trout sample numbers remained relatively high through 2001, maintaining an average of 11.4 per net. Oswald (2004) noted that record low storage pools in 2002 and 2003 resulted in an accelerated decline in sample numbers for rainbow trout. The 2004 sample density of 1.2 per net established a record low rainbow trout catch since modern stocking practices were established in 1979 and exceeded the previous drought related population low observed in 1991. The 2004 minimum represented the culmination of a three year decline similar to that observed in the 1989 – 1991 period of low reservoir pools, although not quite as precipitous. Improving storage pools over the 2005 – 2007 period were accompanied by rapidly increasing rainbow trout sample catches to result in record high samples of 18.8 per net in 2006 followed by a new high of 23.3 per net in 2007. Improved rainbow trout population density was closely correlated to improved plant survival under an improving reservoir storage trend in 2005 and 2006 (Figure 3). Yearling rainbow survival also benefited from extremely low densities of adult rainbow trout and an abnormally high plant density in 2006 in anticipation of improved minimum storage pool. Juvenile survival in 2003 and 2004 was virtually nonexistent despite plants of the larger overwintered yearling fish. Relatively weak plant survival in 2007 might have been related to extremely high stock densities of older larger fish from the 2006 plant but was also associated with a plant that was not distributed by boat, as is the normal protocol at Clark Canyon Reservoir. The 2002 yearling sample of 4.6 per net was reflective of the superior survival of the overwintered yearlings that were added to that year’s plant. Oswald (2004) noted that survival of subsequent yearling plants in 2003 and 2004 was extremely poor. This trend has continued through 2007 despite improved reservoir storage conditions. Improved survival to yearling status in 2005 and 2006 was clearly associated with increased survival of the YOY plants of those years.

Rainbow trout condition factor (K) is presented in Figure 4 for the 1998 - 2007 sample period. Oswald (2004) noted that trends in condition remained high or increased with relatively abundant storage pools but went into decline as storage pools declined between 2000 and 2003. Extremely low rainbow trout sample density in 2004 resulted in a temporary spike in condition for the Age II and older component but the sample size was also exceptionally low. Despite improved storage in the reservoir, improving sample densities, particularly the record high densities of 2006 and 2007, were marked by a continued decline in rainbow trout condition. 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.

Length frequency analyses of the rainbow trout samples are depicted in Figures 5 through 8 for the 2004 – 2007 sample period. The very low sample density of 2004 (N = 6) is reflective of extremely poor plant survival in 2003 and 2004 and a population dominated by older, larger fish. The 2005 sample exhibited strong survival of the YOY plant, despite relatively low numbers of fish in the plant, and again, exhibited low numbers of older fish. The 2005 sample was also indicative of very poor survival of the spring yearling plant, which should have exhibited a mode at about 14 inches. The 2006 and 2007 analyses reflect the extremely strong survival of the 2006 YOY plant through their first two growing seasons as incipient Age I and Age II components of the population. The 2006 sample also exhibits a relatively small contribution from the 2006 spring yearling plant. The 2007 sample, however, continued to reflect a dominance by the 2006 YOY plant while a relatively strong modal presence of the 2005 YOY plant as incipient Age II fish in 2006 was almost absent in 2007.

Brown Trout

Wild brown trout population trends over the 1980-2007 period are depicted in Figure 9. The recent trend has been reflective of relatively high wild brown trout populations from 1995 through 2007. Brown trout sample density over the 15 year period from 1980 through 1994 averaged 1.3 fish per net while the mean over the more recent 13 year period, 1995 through 2007, was 4.3 fish per net. 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 resulted in a declining trend in brown trout numbers culminating in an observed minimum of 1.8 fish per net in the 2004 sample. The declining trend was similar to that observed for rainbow trout over the same period and the low was coincident with the minimal rainbow trout sample density observed in the same year. Oswald (2002) linked the declining trend in brown trout numbers to declines in the recruitment of Age I fish. A composite length frequency relationship for fall sampled brown trout is presented in Figure 10 followed by length frequency relations for the 2004 – 2007 brown trout samples in Figures 11 through 14. The 2004 and 2005 brown trout samples exhibited little indication of successful recruitment and were dominated by older, larger fish. The recent improvements in brown trout density in the 2006 and 2007 samples clearly exhibit strong modal contributions by juvenile fish in the population during both years. Oswald (2006) noted improved resident brown trout populations concommitent with markedly improved brown trout recruitment and markedly improved flow regimes in the Red Rock River over the 2005 – 2006 sample seasons.

Angler Use Trends

Winter creel catch rates for rainbow trout from 1989 through 2003 are depicted in Figure 15. Very low catch rates, averaging 0.15 fish per hour over the 2000 - 2004 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 but declined again to the second lowest observed catch rate for the sample period of 0.09 fish per hour in 2004 – 2005 following minimal rainbow trout sample densities that fall. With improving rainbow trout densities observed in the 2005 and 2006 samples, catch rates improved markedly to attain an observed high for the sample period of 0.73 fish per hour in 2006 –2007. In most years, rainbow trout catch rates vary between 0.2 to 0.3 fish per hour, averaging 0.24 fish per hour over the past 18 winters of record. While the recent high catch rate was associated with high numbers of juvenile rainbow trout in the population, rainbow trout catch rates often appear to be independent of rainbow trout density (Oswald 2002).

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. The brown trout catch rates generally approximate one-tenth those observed for rainbow trout and are probably associated with differential vulnerability to angling, as well as differential density, between the two species. This consistency in brown trout catch rate appears to be largely independent of brown trout density and recent elevated catch rates in 2003 – 2004 and 2004 – 2005 were not associated with elevated brown trout sample density or strong juvenile recruitment.

Trends in angling pressure on Clark Canyon Reservoir are presented in Figures 17 and 18. Recent pressure estimates depict a substantial decrease in angler days from the 1999 sample. Low angler participation in 2001, 2003, and 2005 is reflective of low storage pools and declining trout populations and is comparable to prior lows in pressure observed in 1991 under similar conditions. The 2003 pressure estimate of 14,583 angler days 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 18), attaining its highest recorded level with the 1997 sample and demonstrating virtually equal participation between resident and nonresident anglers. The 2003 sample exhibited a substantial decline in nonresident use to 23.8% while the nonresident component in 2005 declined further to 6.6 % of the total despite an increase in resident use. The 2005 nonresident use represented an observed low for the period of survey of only 1,265 angler days.

Burbot

Preliminary, descriptive data for the native burbot population of Clark Canyon Reservoir were initially described by Hochhalter and Oswald (2007). Relatively low trap net capture rates (CPUE = 0.6 fish/net) in spring 2006 prompted the need for increased and more diversified sampling efforts in 2007. Springtime spawning site identification surveys were conducted immediately following ice break up in select littoral areas, and were effective in locating several active spawning sites. Spawning sites were identified by visual observation of definitive burbot spawning balls comprised of approximately 20-30 individuals exhibiting typical spawning behavior (physical contact among all individuals with individuals writhing in and out of the conglomerate). Spawning balls were typically located in less than four feet of water, and were situated above a substrate composed of yellow sweet clover (*Melilotis officinalis*), organic debris, gravel, and sand. Identification of three spawning balls allowed for fyke nets to be deployed in the immediate vicinity, and led to the capture and subsequent tagging of 1,100 burbot. These fish ranged in length from 12 to 31 inches, with a modal length of 25 inches (Figures 19 and 20). Preliminary ageing results from winter creel collected burbot otoliths spanned age groups 2 through 13 (Figure 21) and revealed that fish 25 inches and greater were typically age three and older, thus comprising the spawning population. However the relationship between age and length appears to vary widely between male and female burbot, with 25-inch burbot ranging from four to nine years in age (Figures 22 and 23).

The use of baited cod traps in sampling the spring (post-spawning) and fall (reservoir-wide) burbot populations resulted in the capture of an additional 188 burbot with three recaptures from those individuals tagged during the spawning period. Overall capture rates for baited cod traps ranged from 0.2 to 10.4 fish/net with a mean CPUE of 4.7 ± 1.2 SE. Capture rates increased with declining temperatures from late September until mid November when efforts had to be suspended due to incipient ice cover. Capture rates also increased over the fall sample season as trapping efforts were concentrated in locations that proved successful in capturing burbot. Based on the limited recaptures, a population estimate (modified Petersen) was calculated at 52,021 ± 22,976 SD. However, length frequency histograms for the cod trap-captured burbot (Figure 24) show a modal length of 19.5 inches, suggesting that fall efforts did not proportionately sample the older, larger, spawning individuals as marked in the spring. As a result, population size may be larger than estimated.

RUBY RESERVOIR

Reservoir Storage Trends

Minimum storage pool in Ruby Reservoir, as determined from end of irrigation season storage, is presented in Figure 25. 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 from 2000 through 2003 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 culminating in a storage decline to the defined minimum pool of 2,600 acre feet by September 11, 2003. This represented the first time that the reservoir was dropped to the defined minimum since the Ruby River Task Force was established in 1995 (Oswald 2004). Improving flow conditions in the upper Ruby River drainage over the 2004 – 2006 period exhibited marked improvement in reservoir storage resulting in minimum pools ranging between 6,200 and 15,000 acre feet. Extremely low winter snowpack and summer precipitation in 2007,however, resulted in a marked decline in minimum storage to 3,266 acre feet.

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 53,000 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. Larger plants in the 60,000 to 66,500 fish range were also utilized over the 2005 – 2007 management period. 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	2001	50,000
1994	50,358	2002	50,000
1995	45,347	2003	65,051
1996	51,668	2004	52,207
1997	58,359	2005	66,533
1998	49,725	2006	60,141
1999	49,507	2007	66,134
2000	35,106	MEAN	53,349

Trends in the abundance of rainbow trout in Ruby Reservoir are presented in Figure 27 for the 1979-2007 period of study. Rainbow trout sample 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 density. The 2000 - 2005 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 (Oswald 2004). The 2005 sample exhibited a further decline to only 7.8 fish per net and also fell below the long term average of 21.9 fish per net for the period of record and fell markedly below the post - dewatering event mean of 32.3 fish per net. Sample numbers in 2004 recovered slightly 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 28) from the increased 2003 plant (Table 2). Relatively strong survival of planted rainbow trout to Age I also continued into the 2006 and 2007 samples under conditions of relatively ample stock density and reservoir storage and resultant recovering trend in rainbow trout sample density in the reservoir.

Mean rainbow trout Condition Factor (K) is presented in Figure 29 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 increases in 2004 and 2006 were associated with large numbers of Age I fish in the samples while a general condition decline in 2005 mimicked a dominance of the sample by Age II and older fish despite different storage pools among the respective sample years. Condition factor for the Age II and older fish exhibited a slight declining trend over the 2003 – 2007 period but remained above low values observed over the 2000 - 2002 period. Length frequency analyses are provided for the 2004 - 2007 period in Figures 30 - 33. The 2004, 2006, and 2007 relationships (Figures 30, 32, and 33) clearly exhibit the previously discussed strong modal contribution of yearling fish from the prior year's plant. These plants were associated with abundant stock density and improving storage pools. The 2005 relationship, however, exhibits dominance by the Age II and older component and relatively poor survival of Age I fish. The resultant sample distribution in 2006 thus exhibited poor densities of Age II fish with a relatively wide length spread of older individuals in the sample. The 2007 sample was indicative of both strong recruitment of Age I fish and strong survival of high numbers of fish to Age II under two consecutive years of improved storage pools.

Brown Trout

Population trends for wild brown trout in Ruby Reservoir are presented for the 1979-2007 study period (Figure 34). 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. Oswald (2004) described relatively low modern brown trout populations following the 1994 dewatering event and described exceptionally large fish, many of which exceeded 20 inches in length and 3.0 pounds in weight at low sample density. The 2004 – 2006 samples exhibited a relatively constant and improved brown trout sample density approximating three fish per net. The 2007 sample indicated an extreme and rapid increase in brown trout density to a record high of 10.3 fish per net. Composite length frequency analyses for brown trout collected over the relatively high density pre –1994 period and lower density post – 1994 sample period are compared in Figures 35 and 36. The 1979 – 1985 relationship exhibits only two pronounced modes at 13 and 15 inches with little contribution from larger fish in excess of 18 inches in length. The 2000 – 2007 relationship, however, exhibits numerous modes extended to the 22 inch group and exhibits a slight upward shift in modal length expression. This is indicative of the presence of an expanded brown trout age structure in the samples, an abundance of older, larger fish in the population, and, possibly, slightly improved brown trout growth rate under management changes since the 1994 dewatering event. Length frequency relationships for brown trout are also presented in Figures 37 – 40 for the 2004 – 2007 samples. The relatively low sample contributions of the 2004 – 2006 length frequency relationships reflect a relatively even distribution across all ages and sizes of brown trout and reinforce the abundance of older, larger fish within the populations. The relatively high catch of the 2007 sample exhibited strong modal contribution of Age II, III and IV fish but did not reflect a modal dominance predicted in any of the prior three year's samples.

Angler Use Trends

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 are presented for rainbow trout for the 1997 – 2007 period of survey (Figure 41). Oswald (2004) described rainbow trout catch rates that steadily increased from 1997 through 1999 but declined markedly in 2001 with declines in the rainbow trout population and the recruitment of catchable – sized juvenile fish into the population. Oswald also described a full recovery in rainbow trout catch rate to approximate a very consistent 1.0 fish per hour over the 2002 - 2004 sample period. The 2004 – 2005 creel exhibited a markedly reduced catch rate under low numbers of rainbow trout and low numbers of juvenile fish observed in the spring 2005 samples. However, the 2005 – 2006 creel showed an increase in catch rate under improving rainbow trout populations. The 2006 – 2007 census exhibited the highest winter catch rates observed through the period of study at 1.33 fish per hour under continued improvement in rainbow trout numbers and a second consecutive year of relatively strong juvenile recruitment into the population. 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 varied widely over the period of creel census (Figure 42). Oswald (2004) described a marked decline in the length of rainbow trout in the harvest to about 13.5 inches mean length over the 2000 – 2004 period and associated the decline, in part, to reduced reservoir pools as well as rainbow trout densities and the abundance of juvenile fish in the population. A rapid increase n the size of the fish in the harvest in 2004 – 2005 was associated with very low densities of rainbow trout and high numbers of older fish relative to poor recruitment of Age I fish in the population. The following decline in the 2005 – 2006 creel was associated with diminished numbers of older fish and relatively strong yearling recruitment while a marked improvement in mean length in the 2006 – 2007 creel resulted from strong modal improvement in the Age II and older segment of the population.

The estimated angling pressure for Ruby Reservoir is presented in Figure 43 for the 1984-2005 period of survey. 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 observed in most of the major fisheries of southwest Montana. However, the 2003 pressure estimate showed a strong recovery to 12,435 angler days despite relatively low reservoir storage pools and declining rainbow trout populations (Oswald 2004). The trend of relatively heavy angler use was continued in the 2005 pressure estimate under much improved reservoir storage but also, in association with a markedly reduced rainbow trout population and relatively low winter catch rates. Angler use trends at Ruby Reservoir appeared far less affected by recent minimal storage pools and rainbow trout population fluctuations than those observed at Clark Canyon Reservoir over the most recent period of survey.

DISCUSSION

CLARK CANYON RESERVOIR

Minimum storage pools in Clark Canyon Reservoir have often declined markedly under severe drought conditions that have dominated the climate of southwest Montana the three recent decades. Relatively brief periods of abundant precipitation and reservoir storage in the early 1980’s and late 1990’s were both followed by extended periods of exceptional drought conditions. Minimum storage pools over the 2001 – 2004 period represented 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 in 2001, 2003, and 2004 were associated with dramatic declines in plant survival exceeding those observed in 1991 and 1994. As a result, young of the year Eagle Lake rainbow trout plants were suspended in the reservoir in 2003 and 2004 in favor of smaller plants of overwintered yearling fish. Improving storage pools in 2005 resulted in a resumption of a limited young of the year rainbow plant that met with relatively strong survival. While the 2005 minimum pool declined to about 2,000 surface acres, delayed spring irrigation releases maintained a surface area at or above 3,000 acres through most of the productive spring – early summer period past the middle of July. Minimum pools approximating 3,000 surface acres marked both 2006 and 2007, resulting in the resumption of an above average plant density in 2006 and slightly above average density in 2007. The increase in minimum pool was also associated with excellent survival of rainbow trout plant cohorts and record highs in rainbow trout sample density.

Total rainbow trout numbers and plant survival have continued to decline under persistent reduced storage pools and surface acreage in the reservoir. Oswald (2004) noted that the recent rainbow trout declines were not as steep and linear, or of the magnitude of those observed over the 1988 - 1991 period, and suggested possible mitigative factors might include the conversion to yearling rainbow trout plants, emergency bag limit reductions concomitant with substantial reductions in angling pressure, and drought driven emergency angling closures in the Red Rock River. A fourth consecutive year of minimum pools significantly below the recommended fisheries minimum of 60,000 acre feet, however, drove the 2004 sample to a record low for the modern era of rainbow trout stocking management. This low also accompanied two consecutive record lows for plant survival despite the use of overwintered yearling stock. Early success using the yearling plant in 2002 lead to hope that the plants of larger fish represented a viable strategy for mitigation of reduced reservoir storage (Oswald 2004). Subsequent plants of yearlings at earlier spring dates, however, have not exhibited similar success in survival at continued low reservoir pools. Contrary to early speculation, the yearling rainbow trout failed to demonstrate a distinct survival advantage under continued stressful conditions in the reservoir. The differential response following the initial yearling plant was associated with earlier stocking dates closely following ice out. More favorable thermal and productive conditions later in the summer (Berg 1974) could potentially result in improved yearling plant survival, however, limitations in space and timing within the hatchery system could preclude that option. While improved storage conditions in 2005 and 2006 resulted in markedly improved plant survival, similar storage in 2007 resulted in a dramatic reduction in plant survival. This decline might have been the result of increased competitive and predative factors associated with record high numbers of rainbow trout and ample numbers of brown trout in the reservoir, but might also have been influenced by stocking method. Due to personnel limitations and timing restrictions, the 2007 young of the year plant was stocked directly into the reservoir via discharge from the hatchery trucks rather than dispersal around the reservoir via boat as is the normal protocol. Similarly, Yearling plants made in April have not been dispersed by boat and were all jettisoned directly from hatchery trucks into the reservoir at fixed points of release. Concentration of the plants at limited points of discharge could have enhanced competition and predation on a localized basis resulting in the substantially reduced survival. The data suggest that dispersal of plants by boat increases the probability of plant survival to yearling status across a broad range of conditions and should be maintained as standard stocking protocol in Clark Canyon Reservoir. The maintenance of minimal pools approximating 3,000 acres in 2006 and 2007 resulted in consecutive record high captures of rainbow trout. Oswald (1993, 2002, and 2004) discussed the influence of minimum pool on recruitment and abundance of rainbow trout in the reservoir. While improved reservoir pools over the 2005 – 2007 period resulted in improved rainbow trout densities, the majority of that improvement remained in the juvenile age classes of fish. Three strong cohorts of juveniles in the 2006 sample did not result in a strong cohort of Age II fish in the 2007 sample suggesting that angler harvest strongly influenced the abundance of the cohort despite reduced bag limits. This conclusion was strongly supported by record high angler catch rates observed during the 2006-2007 winter creel census. Oswald (1993 and 2004) correlated low reservoir storage pools with declines in rainbow trout condition factor. This trend was not maintained over the 2004 – 2007 period as minimal densities of rainbow trout in 2004 exhibited an extremely high condition and burgeoning densities of rainbow trout under improving storage in 2005 – 2007 exhibited declining condition. This decline was most clearly manifest in the Age I cohorts, which, as the dominant component, influenced the overall condition of the population at large. The data suggest that storage pools of about 3,000 surface acres might not be sufficient to maintain normal condition factors under extremely high densities of juvenile rainbow trout, which tend to focus on a relatively limited range of the forage species available in the reservoir.

Oswald (2002) described abundant populations of wild brown trout exceeding former collection highs observed shortly after Clark Canyon was impounded in 1964. Oswald (2004) described a declining trend in brown trout numbers with declining reservoir pools but, similar to the observations for rainbow trout, declines in brown trout numbers were not as substantial as those observed over the 1988 - 1994 drought influenced period. Recent improvements in storage pool over the 2005 – 2007 period were accompanied by substantial improvement in brown trout numbers. Similar to the rainbow trout, this improvement, particularly that observed in 2006 and 2007, was a direct result of improved brown trout recruitment into the population. The wild brown trout population of Clark Canyon Reservoir is dependant upon spawning habitats in the Red Rock River, and, to a lesser extent, Horse Prairie Creek and some localized spring environments for stock recruitment. Oswald (2006) described markedly improved flow regimes in the Red Rock River accompanying improved resident brown trout population density and improved brown trout recruitment over the 2005 – 2006 samples.

Burbot biology is largely poorly understood and direct management of the species is often lacking throughout most of North America (McPhail and Paragamian 2000). Hochalter and Oswald (2007) presented some initial findings descriptive of the burbot population of Clark Canyon Reservoir. Initial data suggest that burbot populations in Clark Canyon Reservoir appear relatively robust despite the recent drought. While managers can mitigate for productivity and habitat deficiencies within the reservoir by altering rainbow trout stocking programs, and brown trout can likely find refuge within the lotic environs of the Red Rock River and Horse Prairie Creek, burbot are a species obligate to the reservoir and may exhibit population level responses more indicative of the annual, physical variability within the reservoir. This is exemplified by an apparent preliminary relationship between spring changes (end of February to end of June) in reservoir elevations and cohort strength. This relationship suggests that spring reductions in reservoir forebay elevation greater than five feet may limit recruitment by dewatering developing eggs and/or larvae. The shallow depths (~ 4.0 feet) of spawning balls observed during this year’s spawning site identification surveys lend credence to this relationship. Taylor and McPhail (2002) concluded that temperature at the time of spawning was also a major factor in determining burbot recruitment success but their studies were conducted in lotic environments that would tend to exhibit a wider variation than that typical of a large reservoir or lake.

The life history of the burbot may allow for its ability to persist through prolonged periods of drought or other stochastic events (McPhail and Paragamian 2000). High fecundity combined with the long life expectancy of burbot (13+ years in Clark Canyon Reservoir) suggests that populations may be able to persist through several years of unfavorable recruitment conditions. Early data also suggest that recruitment to maturity and, subsequently, to the fishery occurs during even the most severe of drought years. Although this report represents the initial stages of investigation, annual analysis of catch rates and age structure will allow investigators to better discern this relationship. An initial and very preliminary estimate of the adult population was attempted by marking 1,100 fish with floy tags during the trap netting efforts on the spring 2007 spawn. Subsequent recapture efforts using baited hoop traps and cod traps began after post-spawn dispersal and continued again as water temperatures cooled in late September. Fall trapping efforts used baited cod traps exclusively and persisted until ice cover began to form in mid November 2007. A crude population estimate of 52,021 adult burbot was generated from a minimal number of three recaptures resulting in a relatively high standard deviation of 22,976 (P=.05). While efforts using cod traps proved successful, low CPUE's and limited fall trapping opportunity resulted in a capture total far below the mark total. Moreover, modal length of burbot captured in the fall effort was 19.5 inches while the modal length of the highly concentrated spring spawning sample was 25 inches, skewing the recapture effort toward younger, smaller fish. While the recapture total of three fish was minimal to initiate the calculation of an estimate, the recaptured fish spanned the length of the reservoir from southwest to northeast with one recapture in mid reservoir. This suggests wide post – spawn dispersal of the marked adults and a relatively even, if not random distribution in the reservoir. Oswald (2004) and Hochhalter and Oswald (2007) described very high rates of burbot recapture in shoreline fyke net sets in Twin Lakes and an apparently high site affinity in fall samples. Similarly, McPhail and Paragamiam (2000) documented high site fidelity and restricted home ranges for mature lentic and lotic burbot. High trap net success for mature burbot in Twin, Miner, and Mussigbrod Lakes in southwest Montana, however, is probably more related to limited surface acreages and relatively shallow depths when compared to the abundant benthipelagic habitats available in Clark Canyon Reservoir and Elk Lake where capture efficiencies are far lower (Hochhalter and Oswald 2007).

The combination of a popular ice-fishing fishery coupled with poor recruitment during periods of drought could potentially lead to exploitation of the Clark Canyon Reservoir burbot population. Comparative data indicate a relatively rapid growth rate and large ultimate size compared to most other southwest Montana lakes (Oswald 2004). Katzman and Zale (2000) reported similar rapid growth rates and ultimate size comparable to that observed for Clark Canyon Reservoir in nearby Upper Red Rock Lake. Upper Red Rock Lake, however, is a very shallow, productive lake that is located on a federal wildlife refuge and is unexploited by anglers. Burbot catch data, measured from the creel, revealed that Clark Canyon anglers were harvesting larger individuals (>20 inches), and that many of these fish were typically age-8 and older. Overharvest of these larger fish could have long-lasting consequences that may not be immediately realized during years of poor recruitment. Future changes in fishing regulations will limit the harvest of these larger, older fish, by allowing anglers to keep only one fish over 28 inches in length. Protection of the adult component would promote or enhance the rate of burbot population recovery under improved reservoir storage pools.

Reduced storage pools in Clark Canyon Reservoir have been accompanied by substantial reductions in fish populations, angler catch rates, bag limits, access to campground facilities and boat ramps, and angler participation. The 2005 pressure estimate recorded the lowest participation by nonresident anglers since regular surveys began on the reservoir. While resident use improved slightly in the 2005 survey, improving storage pools and markedly improved angler catch rates will likely substantially expand this trend in the 2007 estimate. The rainbow trout catch rates improved slightly to get back over 0.20 fish per hour in the 2005-2006 winter creel but improved substantially to establish a record high in excess of 0.70 fish per hour in 2006 – 2007 as strong cohorts of juvenile rainbow trout entered the fishery. Oswald (2004) reported a mean winter catch rate of 0.216 fish per hour for rainbow trout over 15 winters of record for Clark Canyon 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 (5,000 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, declining rainbow trout Condition Factor, and major shifts in length frequency distribution within the populations (Oswald 2002 and 2004). Improvement in minimum storage pools over the 2004 - 2006 period was accompanied by increasing rainbow trout sample density, plant survival, and higher modal lengths in surviving older fish. Improved rainbow trout populations have resulted in an increasing trend in winter catch rates and in mean lengths of fish in the winter harvest.

Wild brown trout populations in Ruby Reservoir have varied at relatively low density since the dewatering event of 1994. Recent brown trout populations have exhibited an increasing trend while the 2007 sample represented a record high for the entire period of study. The high CPUE in the 2007 sample was unanticipated and remains unexplained as no evidence of significant recruitment modes could be detected in the prior three years of sampling. The 2007 sample exhibited modes depicting a wide range of age classes and fish sizes throughout the abundant sample. Recent samples have revealed a relative abundance of larger fish in excess of 20 inches in length, and comparative length frequency analyses prior to and following the 1994 dewatering event confirm an upward size shift for Ruby Reservoir brown trout.

Oswald (2004) discussed the establishment of a popular resident based fishery in Ruby Reservoir following management changes in the aftermath of the 1994 dewatering event. Relatively high rainbow trout catch rates and a commitment to manage reservoir pools at higher levels than those preceding 1994 are probably significant factors in determining the increased pressure. Oswald (2004) discussed the high rates of angling success at Ruby Reservoir when compared with other southwest Montana public reservoirs. Site accessibility, reservoir size, and local climate are probably also determinants in the elevation in use. While some fluctuation in Ruby Reservoir storage pools and fisheries composition obviously occurs, fluctuations in angler use are not as extreme as those observed for Clark Canyon Reservoir under similar climatic conditions.

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December 2007

All Work Included in this Report in Conjunction with Federal Aid in Fish and Wildlife Restoration Acts:
Project Numbers: F-113-R-4, F-113-R-5, F-113-R-6, and F-113-R-7

Montana Fish, Wildlife & Parks Project Numbers 3320 and 3323

APPENDIX OF FIGURES

Figure 1. End of irrigation season (fall) storage in Clark Canyon Reservoir, Water Years 1987 - 2007.

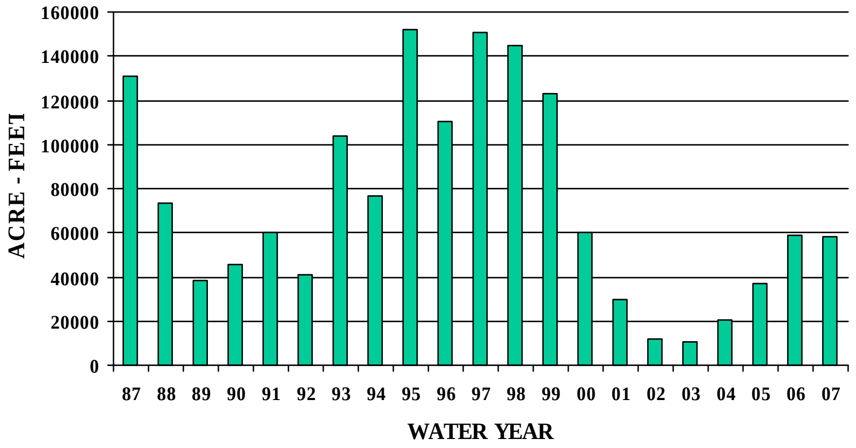


Figure 2. Mean number of rainbow trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2007.

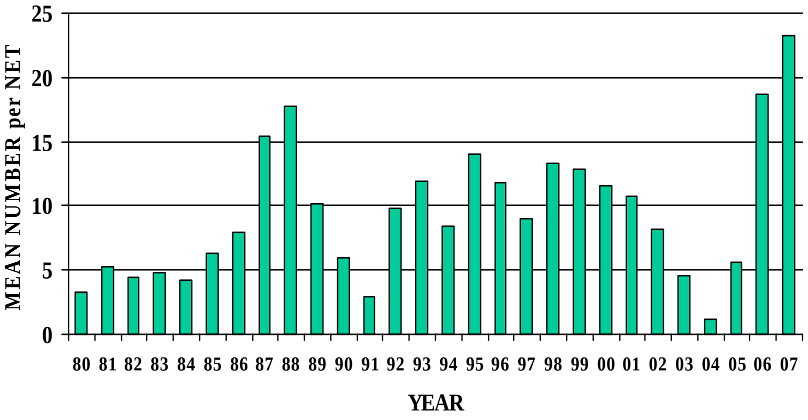


Figure 3. Mean number of Age I rainbow trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2007.

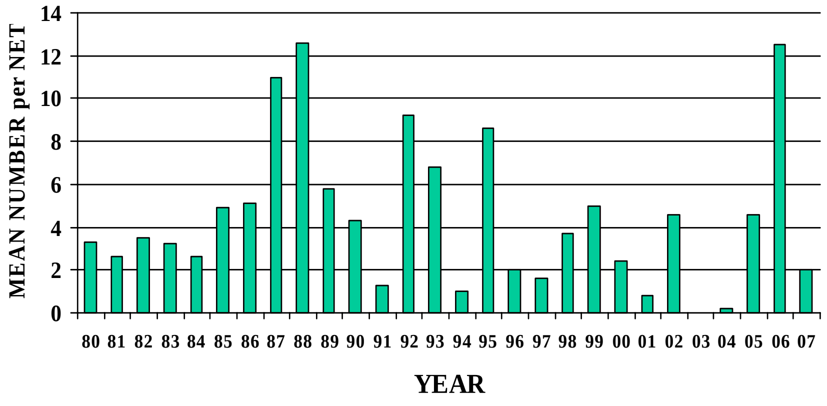


Figure 4. Mean fall Condition Factor (K) for discreet age classes of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir, 1998 - 2007.

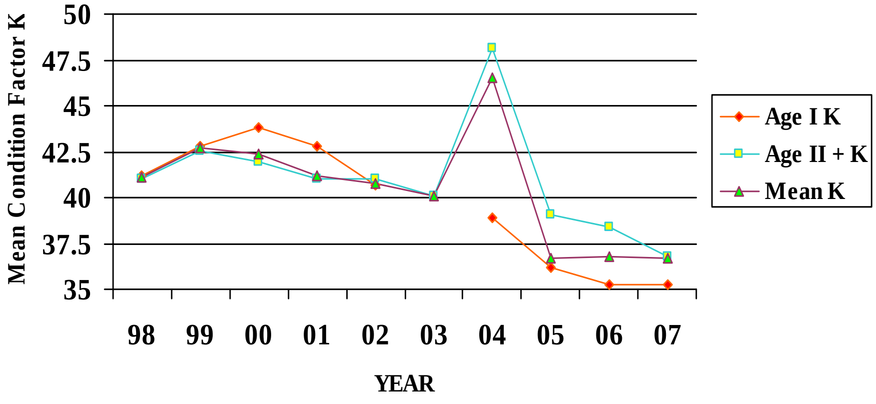


Figure 5. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2004 (N = 6).

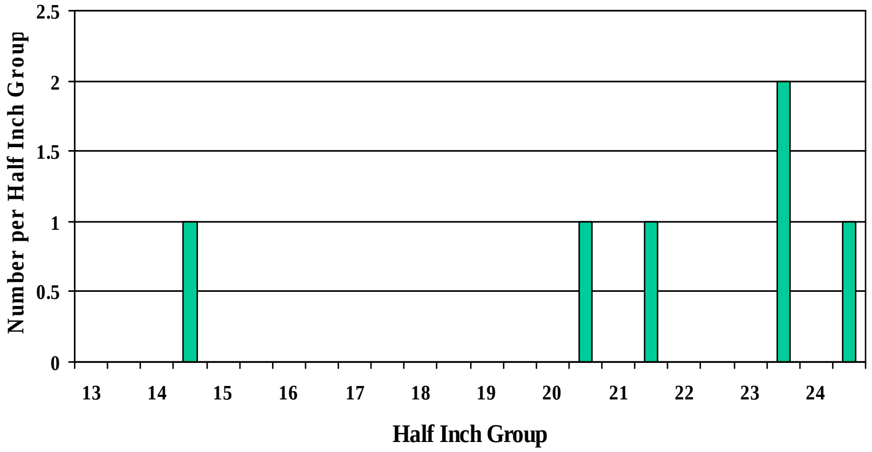


Figure 6. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2005 (N = 28).

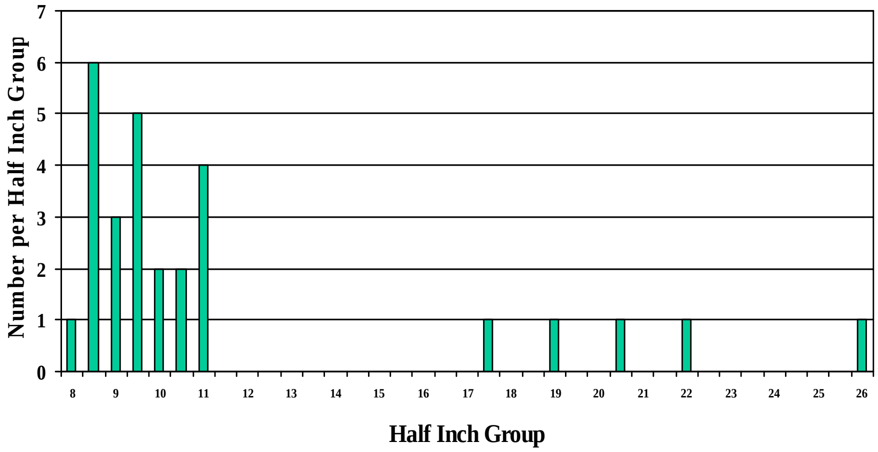


Figure 7. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2006 (N = 112).

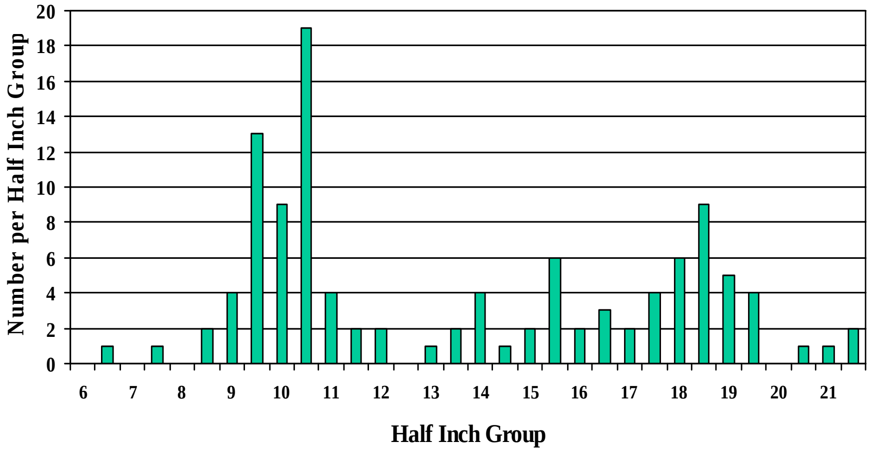


Figure 8. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2007 (N = 140).

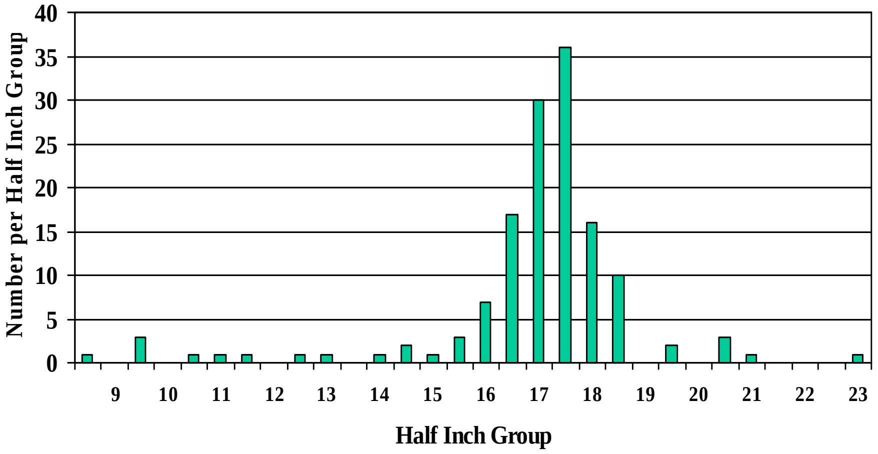


Figure 9. Mean number of brown trout collected per floating experimental gill net set overnight in Clark Canyon Reservoir, 1980 - 2007.

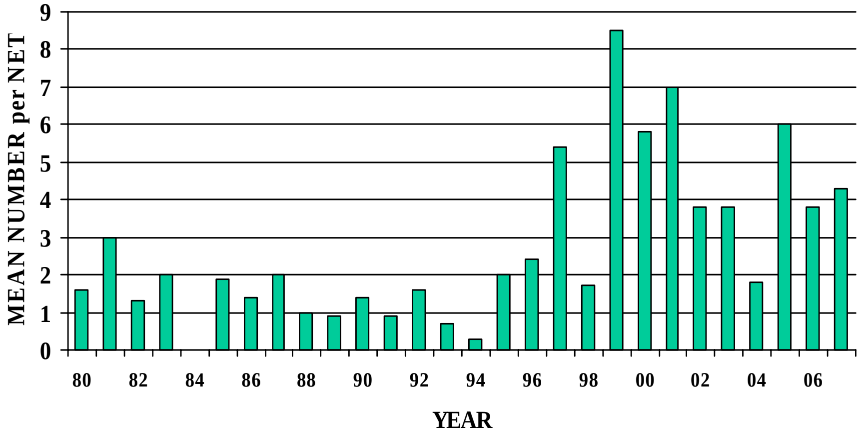


Figure 10. Composite length - frequency relationship for brown trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 1998 - 2007 (N = 221).

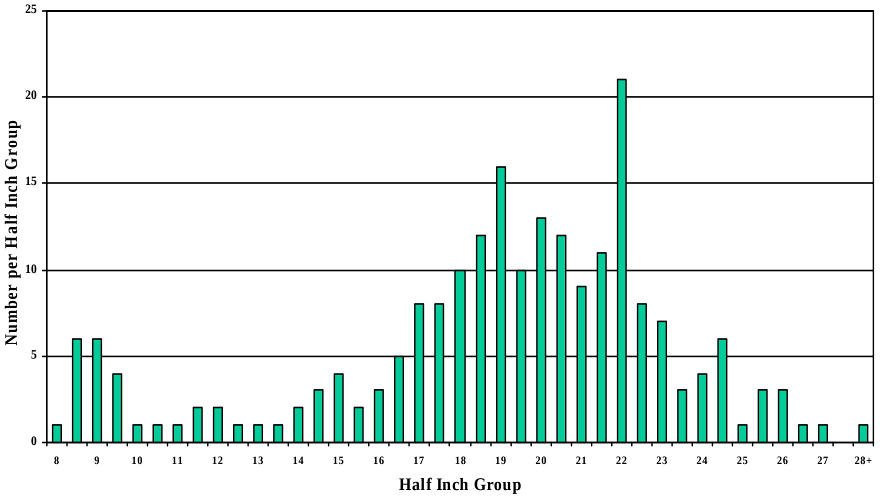


Figure 11. Length frequency distribution of wild brown trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2004 (N = 9).

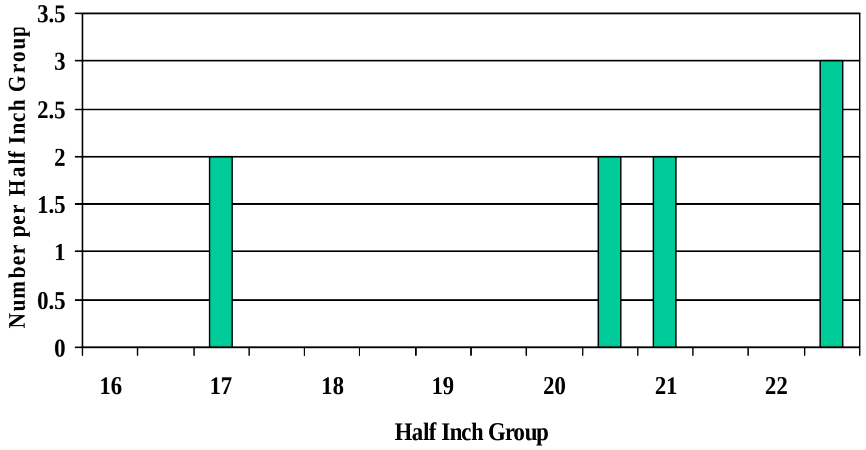


Figure 12. Length frequency distribution of wild brown trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2005 (N = 30).

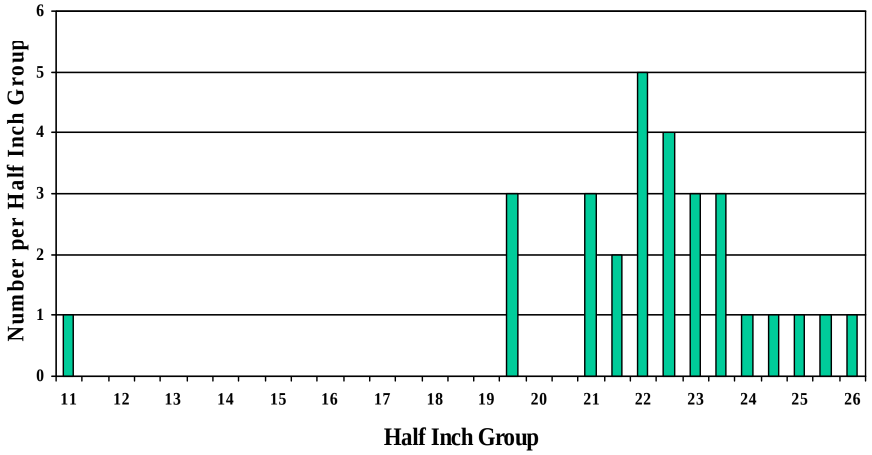


Figure 13. Length frequency distribution of wild brown trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2006 (N = 23).

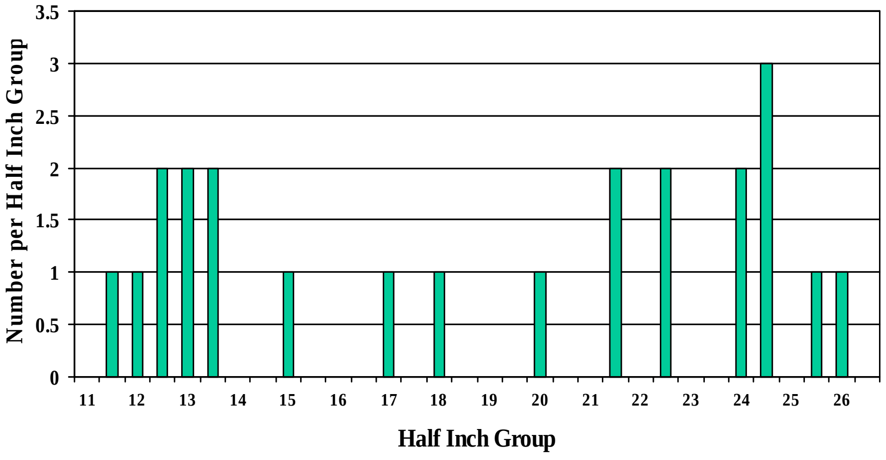


Figure 14. Length frequency distribution of wild brown trout collected in floating experimental gill nets set overnight in Clark Canyon Reservoir; Fall 2007 (N = 27).

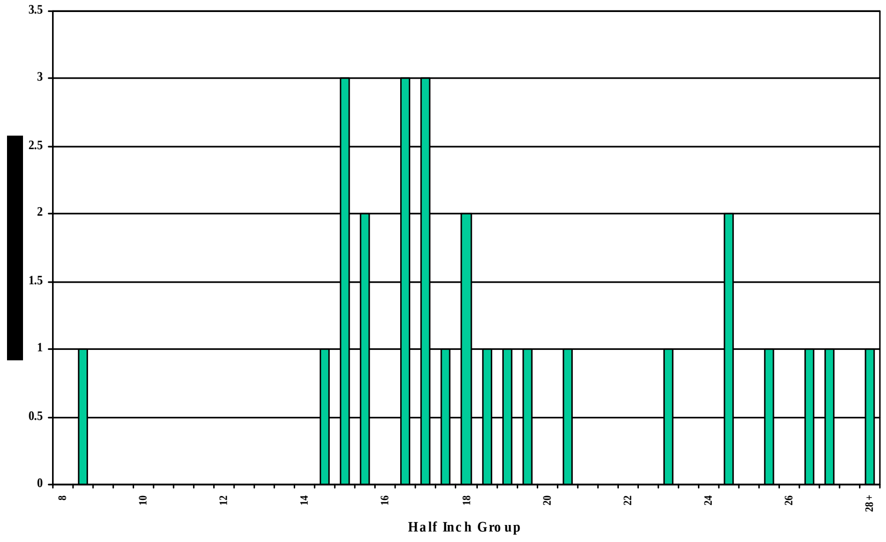


Figure 15. Winter creel catch rates for rainbow trout in Clark Canyon Reservoir, 1989 - 2006.

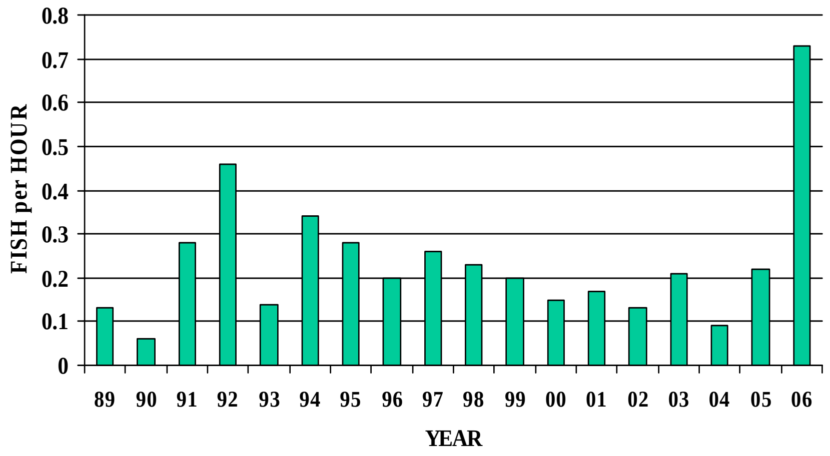


Figure 16. Winter creel catch rates for brown trout in Clark Canyon Reservoir, 1989 - 2006.

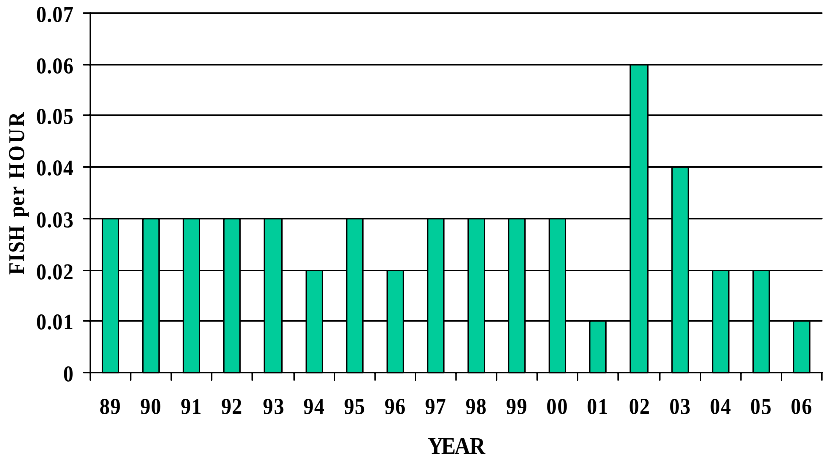


Figure 17. Estimated angling pressure (Angler - Days per Year) for Clark Canyon Reservoir 1983 - 2005.

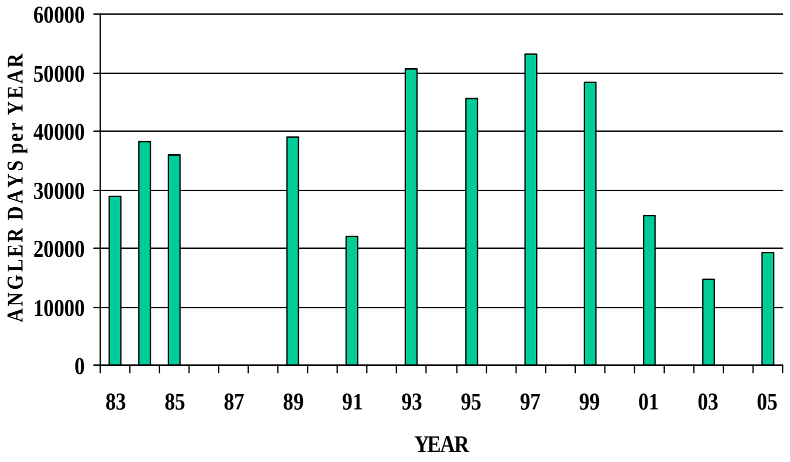


Figure 18. Estimated resident and nonresident angling pressure (Angler - Days per Year) for Clark Canyon Reservoir, 1983 - 2005.

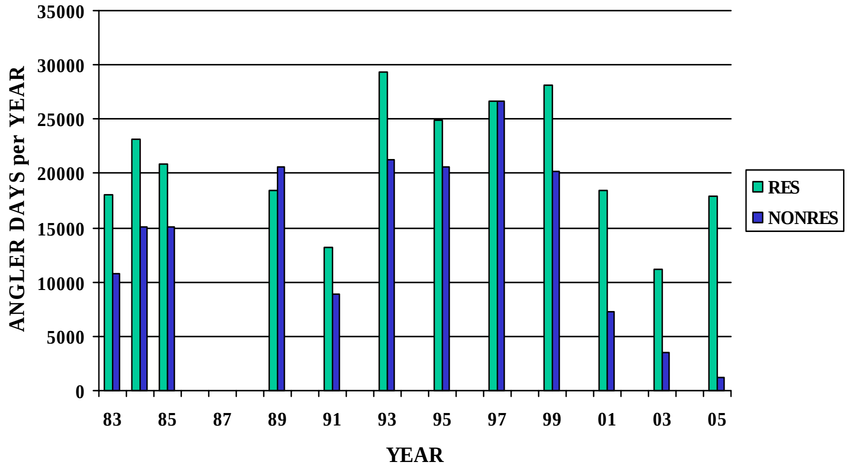


Figure 19. Length frequency distribution of spawning and post-spawn burbot in Clark Canyon Reservoir, Spring 2007 (n=1100).

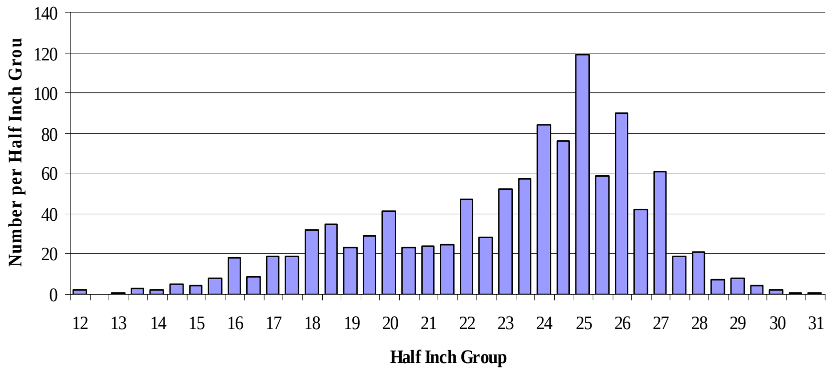


Figure 20. Length frequency distribution of sexed spawning burbot in Clark Canyon Reservoir, Spring 2007 (n=247)

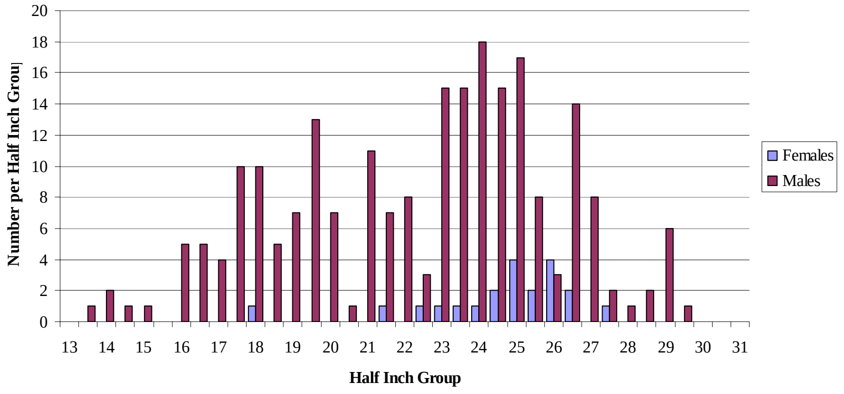


Figure 21. Age frequency distribution of angler caught burbot in Clark Canyon Reservoir, January and February 2007 (n=41).

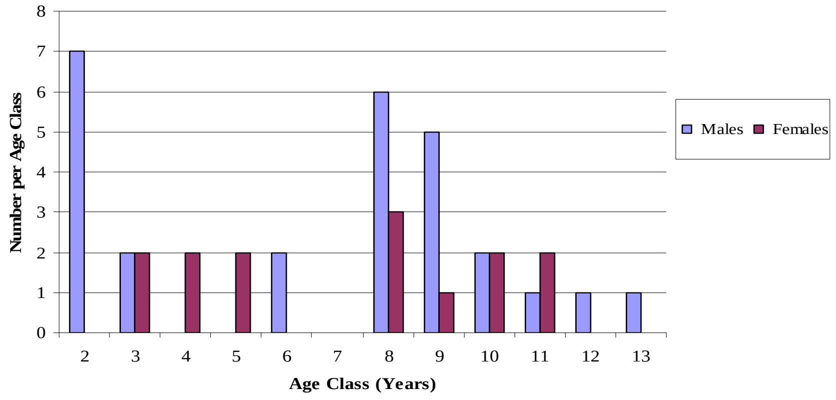


Figure 22. Age - Length of angler caught female burbot in Clark Canyon Reservoir, Jan. and Feb. 2007 (n= 13)

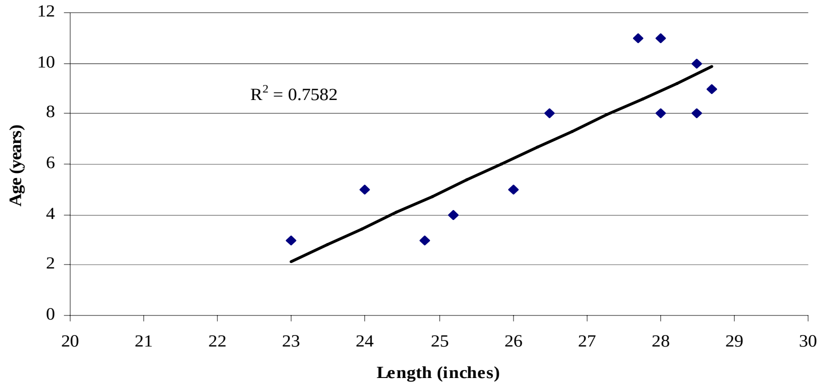


Figure 23. Age - Length of angler caught male burbot in Clark Canyon Reservoir, Jan. and Feb. 2007 (n=27)

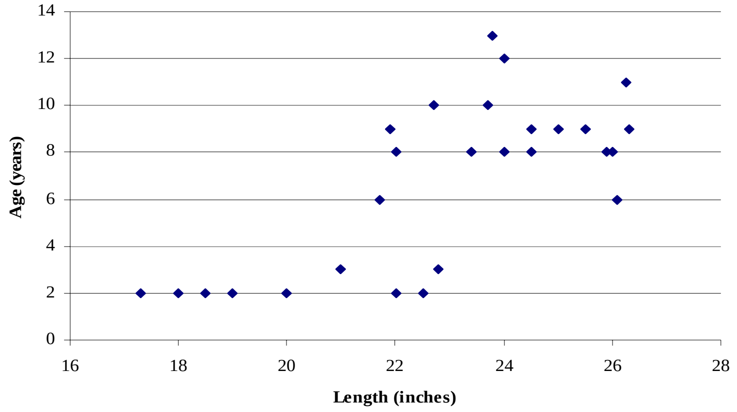
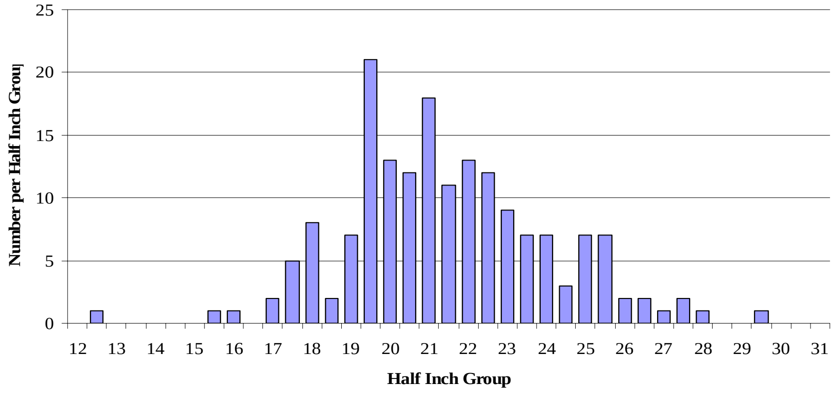


Figure 24. Length frequency distribution for burbot captured in baited "cod pot" traps set in Clark Canyon Reservoir, Fall 2007 (n=176).



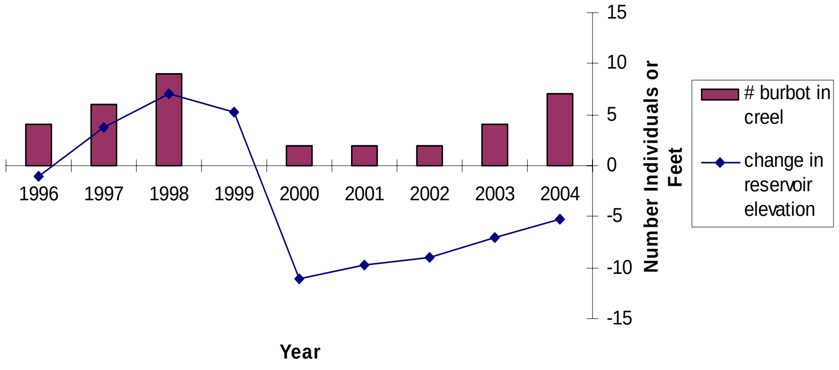


Figure 25. Clark Canyon Reservoir burbot cohort strength in angler harvest related to February-June change in reservoir forebay elevation; 1996 - 2004.

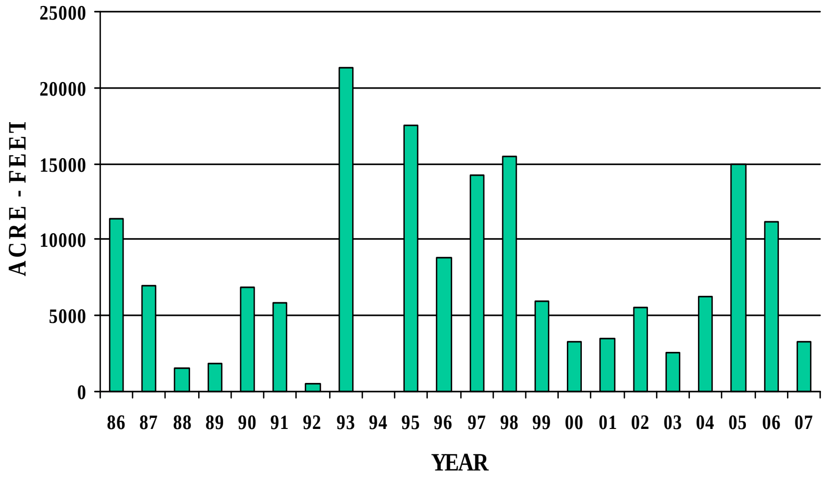


Figure 26. End of irrigation season (fall) storage in Ruby Reservoir, 1986 - 2007.

Figure 27. Mean number of Eagle Lake rainbow trout collected per floating experimental gill net set overnight in Ruby Reservoir 1995 - 2007.

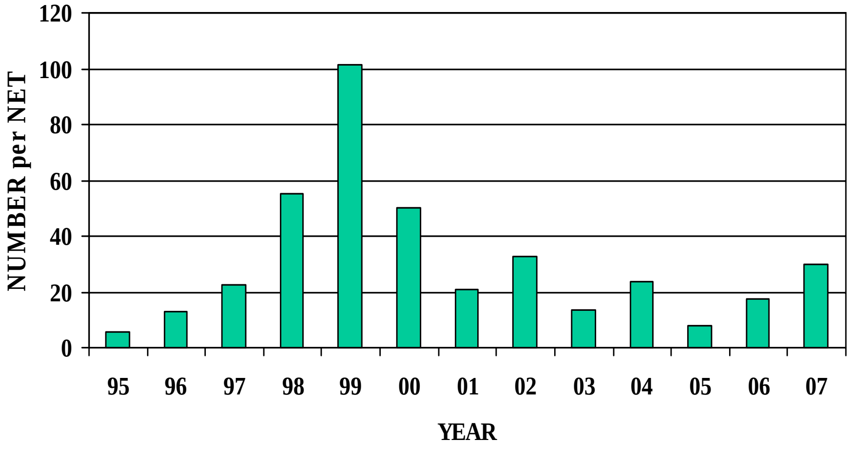


Figure 28. Mean number of Age I Eagle Lake rainbow trout collected per experimental gill net set overnight in Ruby Reservoir; Spring 1995 - 2007.

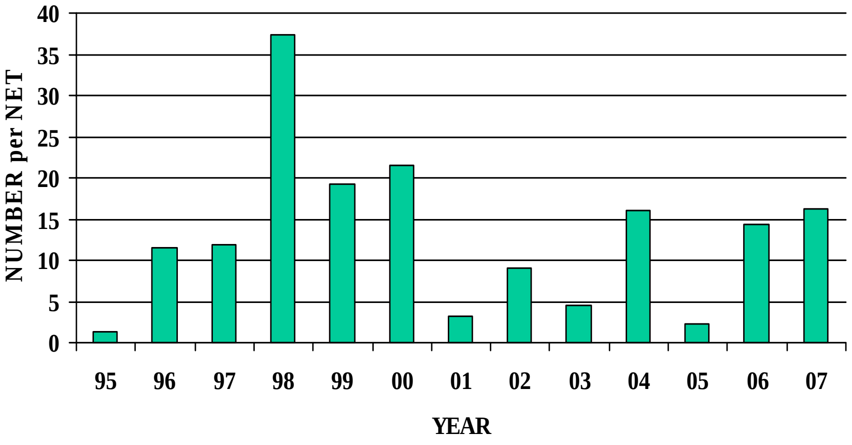


Figure 29. Mean Condition Factor (K) for rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 1996 - 2007.

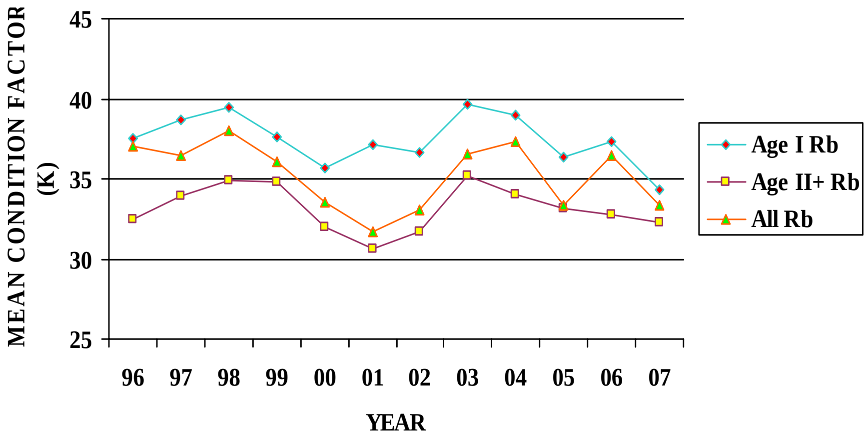


Figure 30. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, 2004 (N = 119).

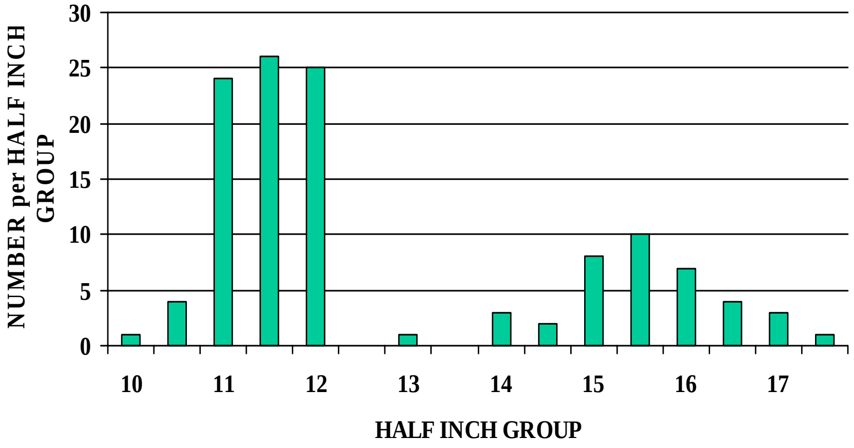


Figure 31. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, Spring 2005 (N = 39).

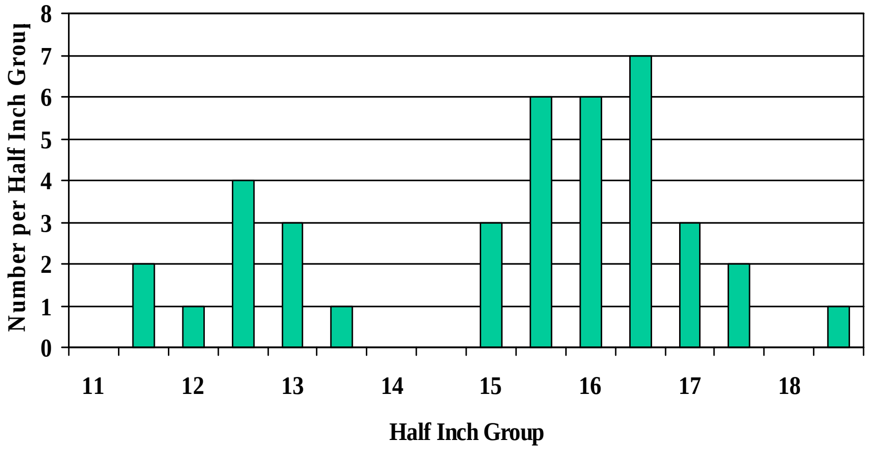


Figure 32. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir, Spring 2006 (N = 87).

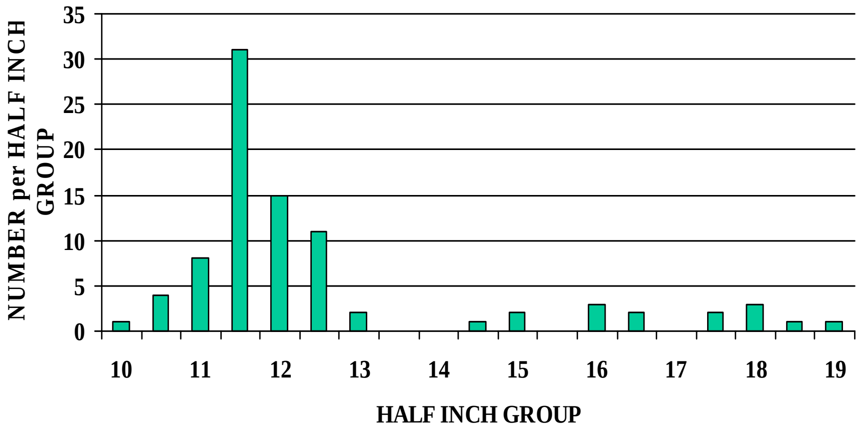


Figure 33. Length frequency distribution of Eagle Lake rainbow trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 2007 (N = 119).

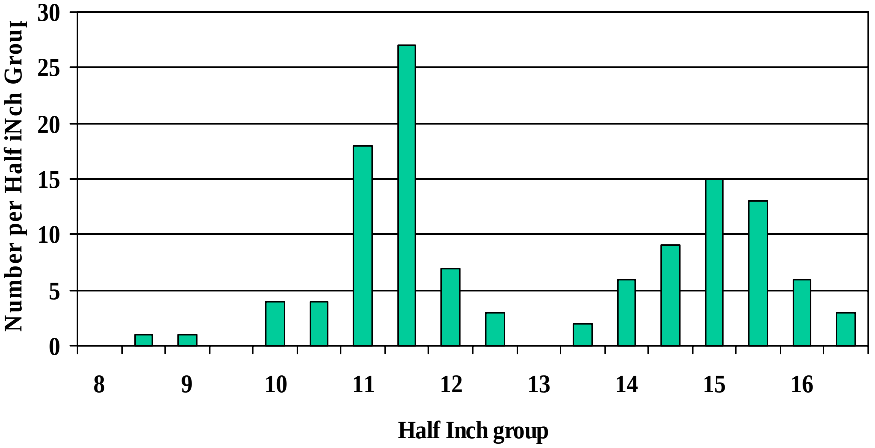


Figure 34. Mean number of brown trout collected per floating experimental gill net set overnight in Ruby Reservoir, 1979 - 2007.

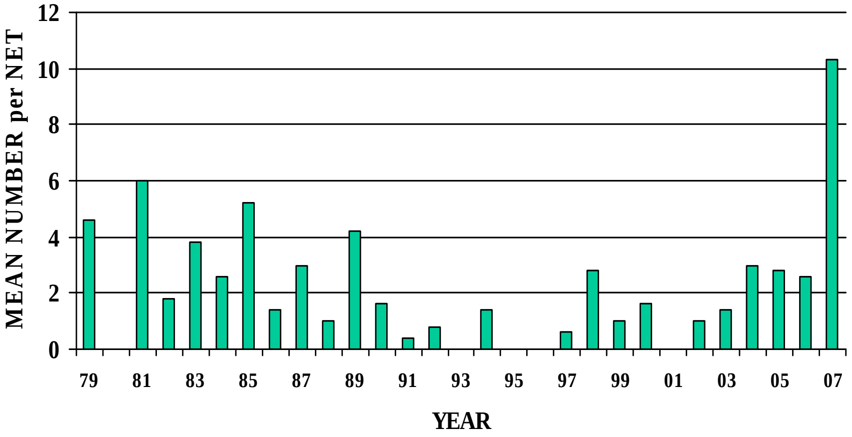


Figure 35. Composite length frequency relationship for brown trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 1979 - 1985 (N = 120).

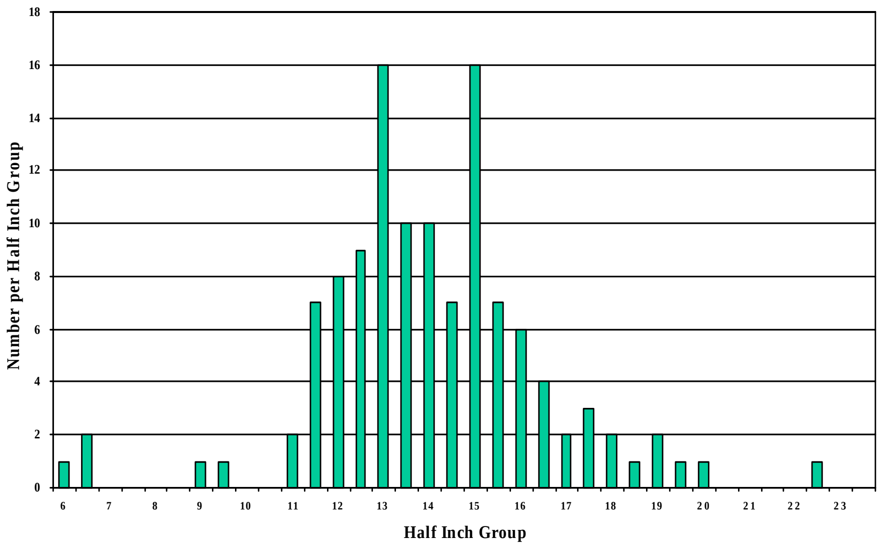


Figure 36. Composite length frequency relationship for brown trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 2000 - 2007 (N = 103).

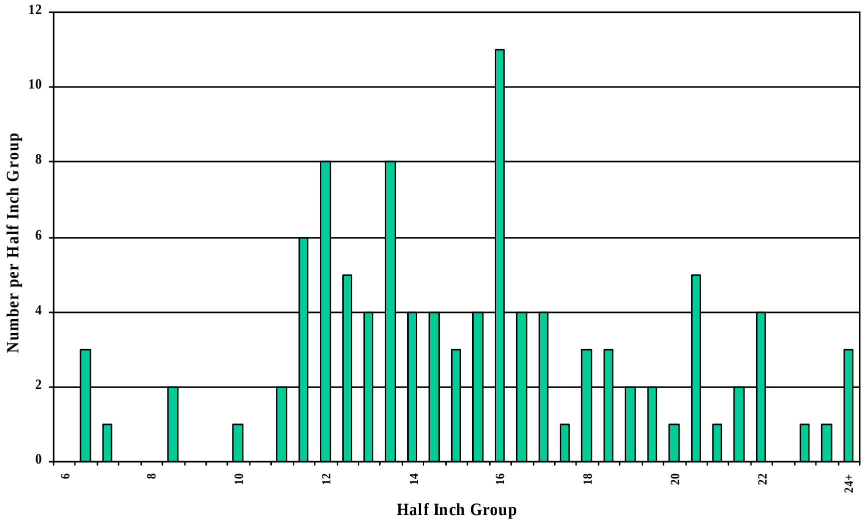


Figure 37. Length frequency distribution of brown trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 2004 (N = 15).

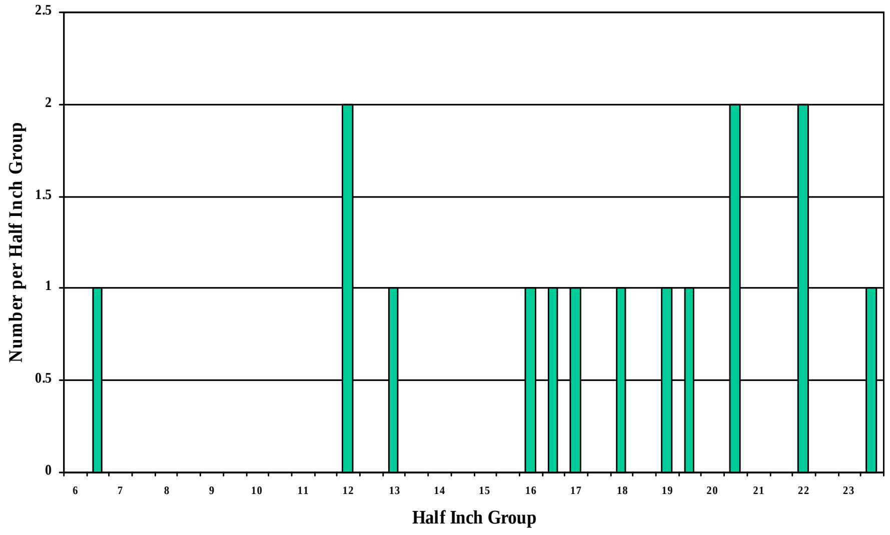


Figure 38. Length frequency distribution of brown trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 2005 (N = 14).

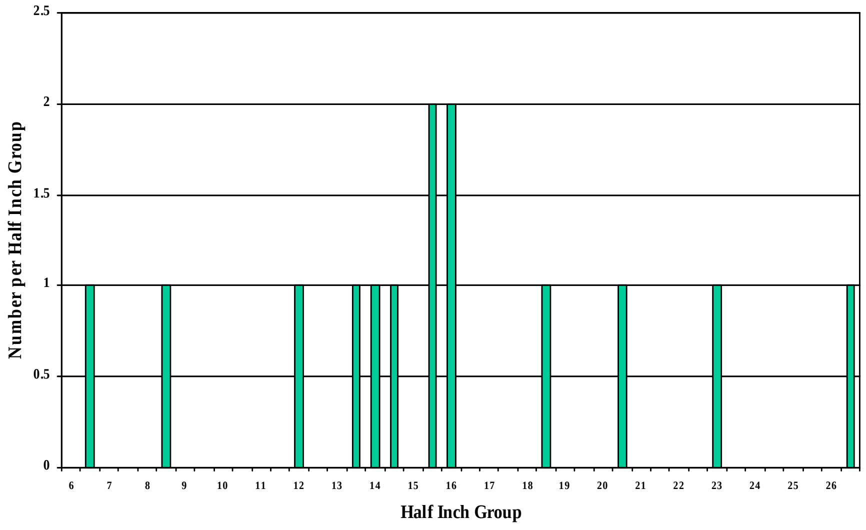


Figure 39. Length frequency distribution of brown trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 2006; (N = 13).

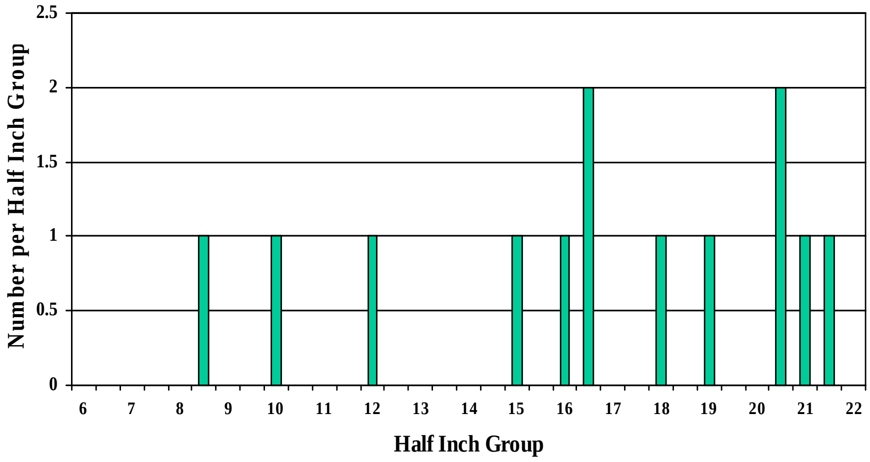


Figure 40. Length frquency distribution of brown trout collected in floating experimental gill nets set overnight in Ruby Reservoir; Spring 2007 (N = 41).

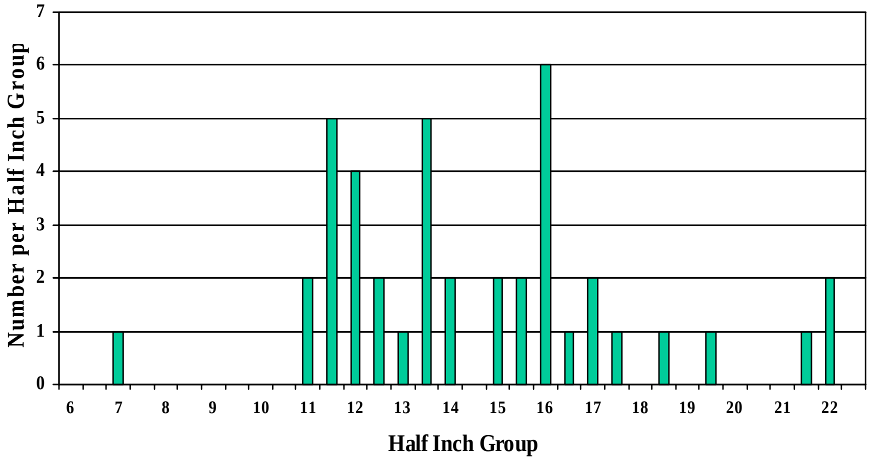


Figure 41. Winter creel catch rates for rainbow trout in Ruby Reservoir, 1997 - 2007.

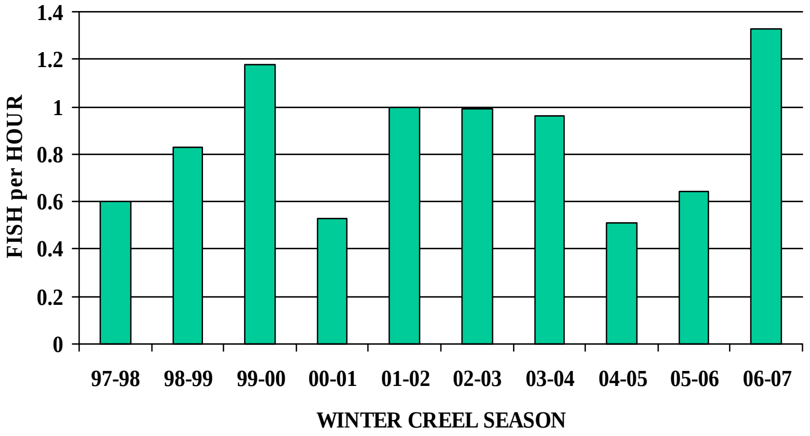


Figure 42. Mean length (inches) of rainbow trout harvested by ice fishermen during winter creel census of Ruby Reservoir, 1997 - 2007.

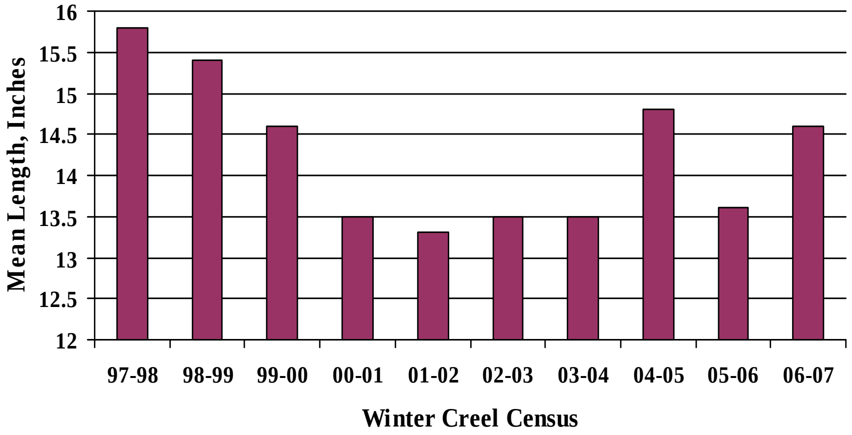


Figure 43. Estimated angling pressure (Angler - Days per Year) for Ruby Reservoir, 1984 - 2005.