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SURVEY OF SALMONID POPULATIONS IN LOWLAND LAKES WITHIN THE DRAINAGES OF THE RED ROCK, RUBY, BEAVERHEAD, AND BIG HOLE RIVERS OF SOUTHWEST MONTANA.

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ABSTRACT

Fisheries and storage trend data were gathered for Clark Canyon Reservoir in southwest Montana. The affects of annual hatchery plants of Arlee, DeSmet, and Eagle Lake strains of rainbow trout were evaluated. Survival of hatchery plants of rainbow trout was compared with reservoir storage regime, number stocked, time of plant, and angler catch rates. Long term trends in the wild brown trout population were analyzed over the life of the storage project. Rainbow and brown trout population trends in Ruby River Reservoir were compared with summer storage regimes and different stocking strategies over a thirteen year period 1980 - 1992. Cutthroat trout stocking programs in Elk Lake were evaluated to determine survival and stock densities resulting from hatchery plants of young of the year versus overwintered yearling fish. Population trend information for wild populations of arctic grayling and native lake trout in Elk Lake were also analyzed and presented. Population trend information and other descriptive statistics were presented for the wild rainbow trout fishery of Hidden Lake over a seven year sample period. Analysis of the affects of special angling regulations and pond storage regimes were continued for the wild brook trout population of Culver Pond on the Red Rock National Wildlife Refuge. Data collected on the wild rainbow trout population of McDonald Pond, also located on the Refuge, were analyzed to determine the success of population reestablishment strategies. Samples were collected in Miner Lake to determine trends in wild brook trout and arctic grayling populations after the cessation of hatchery plants after 1966. Data collected in 1990 were compared with samples collected in 1964. Trend information for wild lake and brook trout populations were analyzed over a 29 year period (1964 - 1992) for Twin Lakes after hatchery plants of rainbow trout were terminated in 1963.

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INTRODUCTION

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

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

Clark Canyon and Ruby Reservoirs are man made impoundments on the Beaverhead and Ruby Rivers. Both reservoirs were constructed to provide stored irrigation reserves and flood control. Clark Canyon is managed by the Bureau of Reclamation and two boards of water users. It provides about 257,000 acre-feet of storage and 5,900 acres of surface at the top of the flood control pool although normal operating pools result in a lake of about 4,000 to 5,000 acres. Clark Canyon provides fisheries for rainbow and brown trout, burbot and mountain whitefish. 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 supports about 40,000 angler-days of recreation per year. Dynamics of the trout populations of Clark Canyon were last reported by Oswald (1989).

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.

populations in the past and attempts have also been made to manage the reservoir as a wild self sustaining fishery. Ruby Reservoir has supported angler use of about 2,000 to 4,000 angler-days per year. The trout populations of Ruby Reservoir were last described by Oswald (1989). 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. 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 supports wild populations of arctic grayling, lake trout, and burbot. The lake trout population is considered native (Holton 1990) while the status of the grayling population is unknown due to heavy stocking of the species in the 1950's. Two national forest campgrounds are located on Elk Lake and a private lessee operates a fishing camp on national forest property. Elk Lake has supported an estimated 2,000 to 3,000 angler days of recreation per year. The trout populations of Elk Lake were last described by Oswald 1989. Hidden Lake is the uppermost of a chain of lakes which are in the Madison River drainage and occupies 149 acres. 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 1989.

Culver and McDonald Ponds are small man made impoundments located on the Red Rock Lakes National Wildlife Refuge. Both ponds are spring fed and represent very productive environments which provide trophy trout fisheries. Culver Pond supports a self sustaining population of brook trout while McDonald Pond supports a wild rainbow trout population. Both fisheries have been managed under limited special trophy regulations since 1986. Water levels in the ponds have been manipulated at various times to accommodate trumpeter swan management strategies on the refuge. The trout populations of Culver and McDonald were most recently described by Oswald (1989).

Twin and Miner Lakes are large alpine lakes located on the Beaverhead National Forest. They are situated in the Beaverhead Mountains on the west side of the upper Big Hole River Valley. Unlike most alpine lakes in the vicinity, both of these lakes are easily accessed by maintained roads and support large, developed public campgrounds. Twin Lakes is located at an elevation of 7235 feet, has a surface 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, brook trout, and burbot. The lake trout population is considered to be one of four native populations in Montana (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. Miner lake is located at an elevation of 8,180 feet, has a surface of 54 acres, and is 30 feet deep. Miner Lake was stocked with rainbow trout and arctic grayling through 1966, after which the stocking program was abandoned. Since stocking was halted, the lake has supported wild populations of brook trout and arctic grayling. The estimated pressure supported by Miner Lake has ranged between 1,000 and 2,000 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 and Twin Lakes, sinking gill nets of similar construction to the floaters were set overnight to sample lake trout populations.

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

Characteristics of spawning migrations from Clark Canyon reservoir were gained through electrofishing procedures. Sampling methods used a mobile anode and boat mounted cathode to draw fish for capture. A 2500 watt generator was employed as power source and current was rectified to continuous DC through the use of a Leach box. All trout captured were fitted with color coded individually numbered Floy type tags. Estimates of the spawning population of rainbow trout were calculated by using tagged fish under a modified Peterson mark - recapture format. Trout captured in a given spring migration provided the mark while trout captured during the subsequent year's migration provided the recapture to capture ratio. Known mortality was deleted from the mark total through tag return analysis.

A limited creel census was conducted on Clark Canyon Reservoir in 1989, 1990, 1991, and 1992. The creel census was conducted one day per week for 6 to 9 weeks per period, generally on weekend days to maximize the number of interviews. Creel census data was gathered during both summer and winter periods. 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.

Some of the Clark Canyon Reservoir rainbow trout were marked using permanent fin clips or fluorescent pigment to determine strain or year of plant. Adipose fin clips were readily observable in the field while pigment mark detection required the use of a blacklight and viewing box.

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. Pond elevational data for Culver and McDonald Ponds was provided by the U.S. Fish and Wildlife Service from Refuge data files.

RESULTS

Clark Canyon Reservoir

Rainbow Trout Stocks

Recent rainbow trout plants in Clark Canyon Reservoir are presented in Table 1. Management of Clark Canyon with the domestic Arlee strain was modified in 1982 to include stocks of the wild DeSmet strain. In 1991, plants of both the Arlee and DeSmet strains were abandoned to evaluate the performance of the wild Eagle Lake strain of rainbow trout.

Survival trends of rainbow trout are depicted in Figure 1. The first half of the 1980's were marked by stable numbers of Arlee rainbow in the 4 to 5 per net range. This stability occurred despite early May plants which ranged from 154,000 to 217,000 in number. In 1985, rainbow density began to increase with limited survival of the 1984 plant of Age 0 DeSmet entering the population. In 1987, the population expanded dramatically with the entry of Age 2 DeSmet from the 1986 yearling plant. The population continued to expand in 1988 with extremely high survival of Arlee rainbow from a June plant of young of the year fish. After 1988, the population began a rapid decline associated with low reservoir storage pools until recovering storage in 1991 resulted in high survival of Eagle Lake rainbow in 1992.

Survival of Arlee rainbow (Figure 2) approximated the survival trend for all rainbow with two major exceptions. The 1987 density of Arlee was low despite a relatively high number planted in 1986 and high survival of DeSmet rainbow from the 1986 plant; and, no Arlee rainbow contributed to the population recovery in 1992.

Trends for DeSmet strain rainbow are presented in Figure 3. DeSmet first appeared in samples in 1985 following limited survival from the 1984 plant. Numbers of that cohort increased slightly in 1986 with increased age, size and sampling efficiency. The 1987 sample revealed very successful survival of the 1986 yearling plant to Age 2. The years following 1987 showed a slow decline in the DeSmet population with advancing age of the dominant cohort. A slight upward trend in 1991 was due to limited survival of the 1990 yearling plant which did not exhibit the success of the 1986 plant.

Declining numbers of rainbow trout in Clark Canyon Reservoir during the 1989 - 1991 period were associated with declining survival of rainbow plants and record low storage pools. The relationships between reservoir storage, surface acreage, and elevation are given in Figures 4 and 5. These figures demonstrate a close linear relationship between the three parameters associated with a very graduated basin morphometry. The figures also demonstrate the short storage conditions prevalent in the 1988 - 1992 period. The survival success of rainbow trout plants over the 1985 - 1992 period varied directly with end of season storage (Figures 6 and 7) expressed as surface acres. This relationship also remained the same for reservoir volume and elevation for both fall samples of fish planted the prior spring and spring samples of fish planted the prior year. The relationship between stock survival and reservoir storage also appeared to be independent of strain planted or number of fish stocked. This concept is further demonstrated in Figure 8 which shows that number of fish planted and strain of rainbow used in the plant result in no discernible trend relationship.

The 1988 - 1992 period was also marked by low condition factors for mature rainbow trout (Figure 9) which was indicative of stress on the population. Despite declining numbers of rainbow trout (Figure 1), rainbow trout condition was very low in 1989, increased slightly with increased storage in 1990, and increased markedly in 1991 with improved storage conditions. Condition again declined with decreased storage in 1992 but was higher than in the 1988 - 1990 period.

Recent plants of the Eagle Lake strain of rainbow trout in 1991 and 1992 have yet to be fully evaluated. Growth appears similar to that of the Arlee and DeSmet strains. Young of the year fish collected in fall averaged 10.1 inches and 0.45 pounds. Spring Age 1 fish averaged 14.0 inches and 1.39 lbs. and grew to 17.7 inches and 2.23 lbs. by their second fall in the reservoir.

<u>Rainbow Trout Stock Identification</u>

In order to identify rainbow trout stocks, varied marking techniques were employed and evaluated. The 1983 and 1986 plants of DeSmet rainbow were marked with a permanent adipose fin removal of 10% and 20% of the respective plants. While these plants were Ages 2 and 3, adipose marks composed 9.3 and 19.2% of samples collected in the lake. Samples collected in the spawning run, however, varied with sex ratio. When the 1986 plant ascended the Red Rock River as Age 2 fish, the adipose clip was detected at 9.1% with a male to female sex ratio of 11.0 : 1.0. After the 1986 plant matured at Age 6 and 7, the adipose clip was detected at a rate of 12.7 and 11.8% at male to female ratios of 0.1 :1.0

in the 1991 and 1992 spawning runs. It was noted that much of the 1986 plant was marked with deformed dorsal fins due to their being held in a hatchery raceway to yearling status. This mark appeared more complete than the adipose clip and appeared at rates of 55 to 57% in 1990, '91, and '92.

Two plants were impregnated with fluorescent pigment in an attempt to gain a complete mark of each cohort that was readily detectable in the field. The 1987 plant of Age 0 DeSmet exhibited a 33% mark at Age 1 and Age 2, although samples were small due to low survival. The 1988 plant of Arlee rainbow exhibited a 37.4% mark at Age 0 and a 29.8% mark at Age 1+.

All rainbow trout captured during spawning runs in the Red Rock River were implanted with color coded, individually numbered Floy type tags for future identification. Tagged fish composed a gradually increasing percentage of the population as follows:

Year	1987	1988	1989	1990	1991	1992
% Tags	3.6	2.5	7.5	8.9	11.0	13.9

from the number of rainbow trout collected in each year's spawning migration.

<u>Rainbow Trout Spawning Stocks</u>

Spawning migrations of DeSmet rainbow were monitored in the Roe Section of the Red Rock River beginning in 1986. The number of fish captured per sampling trip is described in Figure 10 which depicts a rise and decline in the spawning population which was dominated by a single cohort from the 1986 plant. A method of estimating the spawning population was employed which used fish tagged in a given year as the marked sample and tagged fish captured in the following year as the recapture sample. This method (Figure 11) differs slightly from the trend information of Figure 10. The population estimates showed a slight increase in the spawning population after most of the fish had attained Age 4 in 1989 followed by a rapid decline in number by 1991. Because all of the fish were probably not potential spawners at Age 3, the 1988 estimate must be considered an underestimate of the total DeSmet population. Recapture to capture ratios were 6.4%, 6.6%, 8.0%, and 19.8% for the 1988 through 1991 estimates. Both methods of analysis show that the spawning population of DeSmet rainbow was dependant on the 1986 yearling plant and that recruitment into the population from either natural reproduction or survival of subsequent plants was minimal.

Length - frequency analysis of the spawning sample is depicted in Figures 12 - 14. These figures demonstrate a trend toward increased length in the population as age of the dominant year class advanced to Age 7 by 1992. Length - frequency data, when coupled with data from earlier spawning runs (Oswald 1989), also demonstrate a lack of recruitment into the spawning population as the 1986 plant matured.

The sex ratio of the dominant 1986 cohort in the spawning migration was also indicative of a population lacking recruitment. The male to female ratio declined dramatically from 0.4 : 1.0 in 1989 to 0.1 : 1.0 in 1991 and 1992. This is also indicative of a shorter life span for the male when compared to that of the female DeSmet and emphasizes the importance of balanced age distribution for successful rainbow trout recruitment.

Rainbow Trout Creel

A limited creel census was conducted on Clark Canyon Reservoir in both winter and summer seasons in order to determine rainbow trout catch rates since the winter of 1989. The data is summarized below:

	1989	1990	1991	1992
Summer	-	0.10	0.10	0.66
Winter	0.10	0.05	0.30	0.50

The numbers represent the total catch of rainbow trout per hour but do not represent harvest. The data indicate that, during the period in which stock survival was low and rainbow trout numbers were declining, catch rates were very low. As stock survival improved with the 1991 plant of Eagle Lake rainbow, catch rates improved markedly beginning with the winter of 1991 - '92. Creel data further indicated that Age 1 Eagle Lake rainbow composed 95% of the catch during the 1991-'92 winter season and continued to dominate the catch through the following summer and winter periods.

Angler tag returns allowed some assessment of the harvest of DeSmet rainbow over time. The rate of angler return of tagged fish in each year is presented as a percent of the fish tagged each year as follows:

Year	1986	1987	1988	1989	1990	1991	1992
Return	12.0%	7.4%	9.3%	5.9%	6.3%	3.9%	3.2%

The data indicate a declining trend in the percent of tagged fish harvested and a declining trend in the number of tags returned as the limited pool of DeSmet rainbow advanced in age and decreased in number. The numbers might also be influenced by a decreasing effort by anglers, particularly local fisherman, to return tags. The overall rate of return for all fish tagged over the seven year period was 6.9 percent.

Brown Trout

Numbers of brown trout collected in spring net samples are depicted in Figure 15. The data indicate a gradually decreasing population of brown trout in the reservoir over time, however, slightly lower numbers of brown trout over the 1988 - 1992 period are probably associated with drought period flow regimes in the spawning tributaries and low storage pools in the reservoir. Length analysis of the population (Figure 16) indicated strong recruitment into the population in 1990 but significant increases in net samples were not observed in subsequent years. Mean length of brown trout within the population demonstrated an increasing trend from 1979 to 1992 but did not attain levels observed in the early 1970's.

Mean brown trout condition (Figure 17) exhibited a trend similar to that of the rainbow trout during the reduced storage pool period. This occurred despite brown trout densities that are normally much lower than those for rainbow trout and is indicative of reduced food supply in the reservoir.

Results of limited creel census indicate that brown trout play a relatively minor role in the fishery compared with rainbow trout. Summer catch rates for brown trout were generally at or slightly below 0.1 fish per hour while winter catch rates were consistent at 0.03 fish per hour over the 1989 - 1992 period. While catch rates for brown trout are low, the large average size provides a trophy component and some diversity to the fishery.

Ruby River Reservoir

Rainbow Trout

Management of Ruby Reservoir has been subject to major changes over the recent past. Management of the reservoir under stocks of Arlee rainbow, McBride Yellowstone cutthroat, and wild rainbow trout populations was described by Oswald (1989). Recent management of the reservoir has returned to annual plants of rainbow trout (Table 2) composed of fish from wild strains. During this period, the reservoir has been subject to severe drawdown due to normal irrigation demand and drought conditions. Storage volumes at the end of irrigation drawdown in Ruby Reservoir are presented in Table 4. The data show that, with the exception of 1986, the reservoir was drawn down to pools of less than 8000 acre - feet over the 1985 - 1991 drought period. Storage pools of less than 2000 acre - feet were experienced in 1988 and 1989.

Despite recent low storage pools, rainbow trout populations demonstrated an increasing trend (Figure 18) to an observed maximum sample in 1992. Prior peaks in rainbow trout abundance due to successful Arlee or wild stock survival in 1981 and successful recruitment of wild stocks in 1986 were associated with or closely followed relatively ample storage regimes. The increasing trend in rainbow trout numbers since the minimal collection of 1988, however, was associated with a period of low storage pools.

The prior peaks in abundance in 1981 and 1986 were marked by strong age cohorts (Figure 19) which dominated the samples and lowered mean length while expanding length range (Figure 20) in the population. These same trends were apparent in 1992 although the 1991 collection might have been low due to sampling variation. The 1992 collection was dominated (57%) by Age 2 fish while Age 3 (17%) and Age 4+ (22%) fish contributed significantly to the sample. The contribution of stocked Hebgen Lake rainbow to the Age 2 or DeSmet rainbow to the Age 3 cohorts is unknown.

Another marked difference between the 1986 population peak and that of 1992 or 1981 was the lack of a rainbow trout planting program between 1980 and 1988. The 1992 peak followed a stocking regime of a mixture of wild strains that included DeSmet, Hebgen Lake, and McConaughy rainbow as well as the domestic Arlee rainbow in 1988. The 1981 peak followed after a program of hatchery plants of the Arlee rainbow strain.

Brown Trout

Numbers of brown trout collected in spring samples from Ruby Reservoir are depicted in Figure 21. Numbers of brown trout are much lower than those for rainbow trout and appear to be more variable although that might be a function of smaller sample size. The general trend for brown trout numbers, however, appears to be a slow decline over the sample period. Recent samples exhibited the lowest numbers of brown trout collected and may be a function of drought conditions.

Brown trout sample age composition and the mean length and length range within the sample are presented in Figures 22 and 23. Strong cohorts of Age 2 brown trout appeared in the 1981 and 1985 samples similar to the pattern exhibited in the rainbow trout population. These cohorts did not remain dominant in subsequent samples however. Recent brown trout samples demonstrated an elevation in mean length concomitant with a narrowed length range typical of poor recruitment into the population.

Elk Lake

Cutthroat Trout

Elk Lake has received annual plants of the McBride Lake strain of Yellowstone cutthroat trout since 1986 (Table 4) and received plants of overwintered yearling cutthroat in 1982, 1983, 1986, 1988, and 1992. Numbers of McBride cutthroat collected in spring net samples from Elk Lake are presented in Figure 24. Cutthroat numbers in Elk Lake have fluctuated from highs following plants of yearling fish to lows observed in the third and fourth years following the prior plant. This is further demonstrated in Figure 25 which shows high numbers of Age 2 fish following yearling plants, followed by intermediate numbers of Age 3 fish in the second year, and low numbers of Age 4 fish in the third year.

Large numbers of young of the year fish planted over the 1987 - 1991 period resulted in the capture of only two Age 2 fish in 1990, one Age 2 and one Age 3 fish in 1991, and two Age 2 and one Age 3 fish in 1992. The data strongly suggest that high numbers of cutthroat fry planted in late summer and fall result in poor survival in Elk Lake. Conversely, early summer plants of relatively low numbers of yearling cutthroat exhibit high survival.

<u>Arctic Grayling</u>

Grayling numbers in spring samples are presented in Figure 26. After exhibiting a relatively high degree of stability over the 1979 - 1987 period, the grayling population began to decline markedly from 1988 to 1992. This decline was marked by a gradual increase in mean length and a narrowed length range (Figure 27) associated with an aging population and lack of recruitment. The decline of the grayling was directly associated with nonexistent or inadequate streamflows in Narrows Creek, the major grayling spawning tributary of Elk Lake. Narrows Creek did produce a surface flow to the lake in May and June of 1991 and was ascended by a small number of spawning grayling. The 1992 sample resulted in the capture of a single Age 1 grayling indicating that some recruitment resulted from the 1991 migration. Future samples will be required to determine if the 1991 recruitment resulted in a significant cohort.

<u>Lake Trout</u>

Lake trout numbers in spring samples (Figure 28) are descriptive of a stable population present at low density as reflected in gill net catches of one to two per net. This density can be compared with wild grayling populations, prior to loss of spawning habitat, of six to twelve per net and stocked densities of yearling cutthroat trout of about 20 to 50 per net at Ages 2 and 3. Apparent low densities of lake trout over the 1984 - 1988 period are due to sampling methods that did not attempt to collect the species.

Lake trout length statistics (Figure 29) describe the average Elk Lake fish at about 15 to 16 inches, seldom exceeding 20 inches in length. The length statistics also suggest stable conditions within the lake trout population. Limited age analysis from scale samples indicated that the 1990 sample was composed of fish of Ages 3 and 4 while the 1991 sample was dominated by Age 6 and older fish. Age - growth analysis are indicative of a slow growth rate and limited ultimate size for the species when compared with other salmonids in Elk Lake.

Hidden Lake

Rainbow Trout

The rainbow trout population of Hidden Lake is wild and self - sustaining since limited plants of the species were introduced in the mid 1930's and 1940's. The population of Hidden Lake has been very stable at high density over the sample period (Figure 30), generally ranging between 25 and 30 fish per sample net. The age composition of the population (Figure 31) has also exhibited a high degree of stability. Age distribution within the samples over the seven year period has averaged as follows:

Age	I	II	III	IV	V+
% Comp	3.2	46.6	24.8	20.5	8.2

The low contribution of Age 1 fish to the population sample is due to sampling inefficiency at the small size of these fish in early spring.

Mean spring length of rainbow trout and length range within the samples (Figure 32) are also indicative of a very stable population. The average length of a fish in the population is about 12.5 inches and mature fish normally range up to about 18 inches in length. Growth, as depicted in Figure 33, is excellent with Age 3 fish averaging 13.7 inches prior to the onset of the growing season. Average length of Age 1 fish is biased upward since only the largest fish of that cohort are likely to be sampled in the gill nets.

Culver Pond

Brook Trout

Trends in the brook trout population of Culver Pond are presented in Figure 34. Low brook trout densities in the 1970's were followed by high densities in the early 1980's marked by strong recruitment. Since the mid - 1980's, the population has been relatively stable at sample densities ranging between 20 and 40 per net. Despite a dam failure in 1988, sample densities remained high in 1989 and 1988. A plant of brook trout was introduced into the pond by the U.S. Fish and Wildlife Service after dam reconstruction in 1988 but the presence of high numbers of Age 2 and older fish in the 1989 sample (Figure 35) indicated good survival of brook trout despite the breach. The 1989 - 1992 period has been marked by a steady decline of brook trout numbers in the sample. Strong numbers of Age 2 fish in 1989 and 1990 resulted in relatively high numbers of Age 3 and older fish in the 1991 sample but do not explain the complete lack of older fish in the 1992 sample. The lack of these older fish is particularly difficult to explain in light of trophy management regulations on Culver Pond which resulted in an immediate population response in 1987 following their application on strong numbers of Age 2 fish present in 1986. The 1989 - 1992 population decline was marked by low numbers of Age 1 fish in the 1990 and 1991 samples but the 1992 sample exhibited strong recruitment.

The recent population decline in Culver Pond has been marked by pond drawdowns associated with waterfowl management. Desired pond operating levels range between 2.5 and 3.5 feet as recorded at the staff gauge (USFWS data). Since 1986, pond elevations have been drawn down below the 2.0 foot level to extremes of 1.4 feet in 1989 and below 1.28 feet in 1992. The drawdowns occurred over the winter period to aid swan feeding and, most recently, to encourage swan migration. In 1990, spring - summer pond elevation was below desired levels except for a brief period between mid - August and mid - October. In 1991, the pond was drawn down to a 1.73 ft. minimum and was maintained between 2.50 and 3.07 feet from April through September. The more ample storage regime in 1991 was followed by better recruitment of Age 1 brook trout in 1992.

The mean length and length range of brook trout in the Culver Pond samples (Figure 36) are indicative of a fast growing population with trophy potential for the species. The 1992 sample exhibited the lowest mean length and narrowest length range of any sample collected in Culver Pond. Growth of brook trout in Culver Pond is exceptional with average length at age as follows:

Age	I	II	III	IV+
Ave. L. (in.)	7.7	11.9	15.6	17.1

The data indicate that a 15 inch and larger brook trout can be produced in three years which generally results in a fish in excess of two pounds due to high condition factors in the pond. The goal of the special regulation was to increase numbers of Age 3 and older fish to maximize trophy opportunity. The number of 15 inch and larger brook trout in the samples is presented in Figure 37. Numbers of these large fish recovered quickly in 1987 following the implementation of special regulations on a strong cohort of Age 2 fish from 1986. Numbers of these 15 inch plus fish have since declined despite the continuation of the special regulations and strong cohorts of Age 2 fish present in 1989 and 1990.

McDonald Pond

Rainbow Trout

Numbers of rainbow trout in McDonald Pond (Figure 38) declined dramatically in the mid 1980's as access to spawning habitat was denied by beaver dams. A program was initiated to recover the trophy wild fishery through the removal of the beaver dams, installation of a restrictive angling regulation, and the hatchery stocking of the wild Eagle Lake strain of rainbow trout. A highly successful plant of yearling Eagle Lake rainbow in 1988 resulted in very high numbers of Age 2 fish sampled in 1989. Numbers of these hatchery fish declined after 1989, but wild progeny entering the population began to rebuild a population base with numbers similar to those observed in the 1970's.

Mean length of fish in the population declined dramatically as length range expanded in 1991 and 1992 (Figure 39). This was indicative of natural recruitment from planted Eagle Lake rainbow and the subsequent establishment of natural year classes. Samples collected in 1991 contained Age 1 and 2 fish as well as survivors of the 1987 and 1988 plant. The 1992 sample contained wild progeny of Ages 1, 2, and 3 but captured no survivors from the plants. Mean spring lengths for wild fish recruited in the pond were 6.1 inches at Age 1, 13.6 inches at Age 2, and 16.0 inches at Age 3. The Age 4 and older Eagle Lake plant captured in 1991 averaged 23.4 inches in length.

Storage in McDonald Pond has been manipulated to accommodate trumpeter swan management strategies on the Refuge. The optimal operating level on the pond has been defined as surface elevations of 4.5 to 5.5 feet as measured at a permanent staff gauge. In 1990, pond elevation was drawn down to 3.90 feet in mid-April and ranged between 3.90 and 4.06 feet until June 7 to encourage macrophyte use and production. In 1992, draw down of the pond from an elevation of 5.0 feet began on October third and continued to November 3 when winter elevation was reached at 3.10 feet. This strategy was adopted to encourage swan migration. The low sample capture of 1990 (Figure 37) was probably influenced by abnormal fish distribution associated with the drawdowns. Visual observations supported such a conclusion.

Rainbow trout redd counts made in Elk Spring since 1988 have averaged 7.2 redds per year in the limited reach of spawning habitat available. A redd count made in 1987 when wild recruitment appeared absent noted 10 redds downstream from the first beaver dam in habitat that appeared unsuitable for the rearing of fry. At the time of observation, some of these redds were already covered with fine sediments.

Miner Lake

Brook Trout and Arctic Grayling

Miner Lake was routinely stocked with rainbow trout from 1933 through 1954 and was stocked with rainbow again in 1966. The lake also received plants of arctic grayling from the early 1930's through 1952. Since the cessation of hatchery stocking, the lake has supported wild populations of brook trout and arctic grayling. No record exists for the introduction of brook trout but this introduction probably occurred in the late 1930's or early 1940's.

Gill net samples collected in 1964 were compared with samples collected in 1990. Data presented (Figure 40) suggest that brook trout numbers have declined somewhat from 1964 levels of abundance while grayling populations have remained stable. Brook trout populations appeared to be relatively abundant at 12 to 18 per net while grayling populations were relatively low at about 3 per net.

Analysis of mean length and length range for both species in the samples indicate stable conditions between 1964 and 1990 (Figure 41). Growth for both species appeared somewhat limited as the average brook trout was slightly over 9.0 inches in length and the average grayling about 9.5 inches in length.

A limited creel census was conducted on Miner Lake in 1991. This survey was based on a sample of 67 interviews and indicated that arctic grayling (66.2%) and brook trout (25.8%) dominated the catch. Interestingly, rainbow and cutthroat trout were reported as minor components in the creel although none were collected in either the 1964 or 1990 samples and no record of cutthroat plants exists for the lake. Other species represented in the creel included burbot and mountain whitefish. The high proportion of grayling in the creel was indicative of a catchability far exceeding that of brook trout relative to observed sample densities. Catch rates for grayling and brook trout were calculated at 1.52 and 0.60 fish per hour, respectively. Relative to their respective sample densities, grayling appeared to be 8 times more catchable than brook trout in Miner Lake.

Twin Lakes

Lake Trout

The lake trout population of Twin Lakes is considered a native relict of post glacial dispersal. The lake was also stocked with hatchery plants of cutthroat trout (1934), arctic grayling (early 1930's), and rainbow trout (1940 - 1963). The introduction of brook trout was not documented but probably occurred in the late 1930's or early 1940's.

Sample densities of lake trout are presented in Figure 42 for sporadic samples collected between 1964 and 1992. High sample density was observed in 1964, 1988, and 1990. These samples were collected in sinking gill net sets during stable summer conditions. Low sample densities recorded in other years may be associated with unstable thermal conditions (early spring and late fall) and fall spawning concentrations and, thus, may not be reflective of population trends. High sample densities observed over a 24 to 26 year period suggest that the lake trout population of Twin Lakes has remained relatively stable unless the low sample densities are a product of fluctuating recruitment and not merely artifacts of poor sampling efficiency. High sample densities of 4.0 to 5.0 per net were approximately double those observed in Elk Lake, the other native lake trout population in the area.

Length range and mean length within the Twin Lakes samples (Figure 43) exhibit little in the way of trend although this may be reflective of the small sample sizes in 1970, 1978, and 1992. Maximum and mean lengths have decreased markedly when comparing the 1964 sample with the 1988 and 1990 samples. The 1964 sample contained an abundance of fish in excess of 22.0 inches in length and 5.00 pounds in weight. Fish of this size have not been collected since 1964. Age determination from scale analysis revealed an age composition of Age 5 to Age 10+ in the 1964 sample. The 1988 sample was dominated by a single cohort of Age 3 fish, thus explaining the narrow length range for the sample. The 1990 sample was also dominated by Age 3 fish (over 50%) but contained individuals of all other age groups from Age 2 through Age 6+. Limited age - growth analysis suggests that lake trout range from about 13.0 - 14.9 inches at Age 3, 15.0 - 15.9 inches at Age 4, and 16.0 - 16,9 inches at Age 5 in Twin Lakes. The data also indicate that a lake trout must be at least 7 years old to attain lengths in excess of 22.0 inches.

Limited creel information was collected on Twin Lakes in 1991. Lake trout composed 10% of the sampled catch representing a catch rate of .08 fish per hour. Total numbers of fish caught within the limited sample suggest that anglers are relatively successful in catching this slow growing low density species.

Brook Trout

Brook trout population trends (Figure 42) exhibited an apparent decline over the sample period. Sample densities from the 1960's and 1970's ranged between about 8 to 11 per net while sample densities in the 1980's and 1990's ranged between 2 and 4 fish per net. This decline in number was accompanied by a declining trend in mean length and ultimate length within the recent samples (Figure 43). The data suggest that angling pressure could be responsible for the change in the brook trout population.

Limited creel data collected in 1991 indicated that brook trout (80%) dominated the catch, with lesser contributions from lake trout and burbot, in Twin Lakes. The catch rate for brook trout was calculated at 0.62 fish per hour which was very similar to that observed in Miner Lake.

DISCUSSION

Clark Canyon Reservoir

Rainbow trout populations in Clark Canyon Reservoir were increased markedly due to the introduction of wild strain rainbow into the system and a shift in planting dates from early May to the late May - early June period. Survival of two plants of DeSmet strain rainbow trout provided a longer lived component into the rainbow trout population than that afforded by the short lived Arlee strain. Adjustment of planting dates to early June coincided with surface temperatures closely approximating a hatchery environment and coincided with the onset of the exponential growth period for the zooplankton community as described by Berg (1974). The exceptional survival of the 1986 plant of DeSmet rainbow was attributed to the competitive advantage afforded by increased age and size at yearling status (Oswald 1989) and probably influenced the poor survival of the 1986 Arlee plant. Exceptionally high survival of the 1987 Arlee rainbow plant coincided with the first June plant into Clark Canyon. The importance of zooplankton, particularly Daphnia spp., as a major food organism in Clark Canyon has been observed through cursory stomach analysis of rainbow trout and discussed by Berg (1974).

Declining numbers of rainbow trout over the 1989 - 1991 period were associated with poor survival of hatchery plants. Survival of fall plants of Age 0 DeSmet rainbow was poor as the DeSmet population was dominated by the 1986 yearling plant. Oswald (1989) attributed poor survival of fall plants to a variable thermal regime associated with fall turnover and an annual minimum in zooplankton abundance as described by Berg (1974). Poor survival of fall planted rainbow was also observed by Lere (1992) in Canyon Ferry Reservoir although some success of fall plants was suggested for Hebgen Reservoir by Fredenberg (1989).

Poor survival of spring plants of rainbow trout over the 1989 - 1990 period was correlated with low storage pools in the reservoir. During the period, the reservoir was drawn down to storage pools representing surface acreage at or approaching 2000 acres. Normal drawdown in the reservoir results in a final surface area of 4000 acres or more. The 1989 - 1990 period thus represented a substantial reduction in the productive capacity of the reservoir due to dewatering of large areas of littoral habitat and a substantial reduction in the acreage of euphotic zone. This downturn in production was also substantiated by a significant loss of condition in mature brown and rainbow trout indicative of a reduced forage base. Lere (1992) also suggested that poor survival of rainbow plants in Canyon Ferry Reservoir was associated with low storage pools. Intermediate survival of the 1988 and 1991 plants suggest that a drawdown storage volume representing approximately 3000 surface acres is adequate to maintain sufficient production to insure good rainbow trout survival. Survival of the 1991 Eagle Lake rainbow plant could also have been enhanced by rapidly declining stocks of older rainbow and increased productivity due to the rehydration of dried out littoral shelves.

Evaluation of the performance of the DeSmet strain of rainbow trout in Clark Canyon Reservoir was completed with the introduction of the Eagle Lake strain into the system. Establishment of a wild population of DeSmet was hampered by extremely poor survival of fall plants of young of the year fish and an apparent lack of significant natural recruitment despite strong spawning migrations and redd construction in the Red Rock River. The population of DeSmet rainbow was clearly dominated by a single cohort from the 1986 yearling plant of 103,500 fish. The spawning population, as this cohort attained sexual maturity at Age 4, was estimated at about 12,500 fish. Using this benchmark, proportional back calculation of the population from gill net trend peaks suggest that the population of the 1986 cohort was about 76,875 fish at Age 2 in the spring of 1987. This indicated an approximate 33% loss from the total planted within the first year in the reservoir. Domination of the DeSmet population by a single cohort resulted in a substantial reduction in male spawners after females attained sexual maturity. Very few males attained ages of 5 or older while significant numbers of females attained Age 7. The skewed sex ratios at age and the diminished number of mature males as the females attained full maturity suggest a need for a balanced age distribution within the population to effect successful recruitment. Poor natural recruitment also may be influenced by drought conditions in the river and reservoir as well as spawning habitat limitations in the Red Rock River.

Growth of the DeSmet rainbow in Clark Canyon Reservoir closely approximated that of the Arlee strain (Oswald 1989). Ultimate size of the DeSmet was generally much greater than that observed for the Arlee due to a much increased life expectancy for the DeSmet. By Age 7, most of the surviving DeSmet had attained lengths in excess of 22.0 inches and weights in the 5.0 to 7.5 pound range.

Attempts to mark rainbow trout plants met with limited success in Clark Canyon Reservoir. Significant adipose removals (20%) proved useful in tracking the cohort but were skewed by sex ratio in the spawning runs. Pigment spray proved detectable at a 30 - 40% retention rate but fell far short of expectations as a complete mark and use of the black box was limited in the field. The best means of separating strains appeared to be differential growth patterns associated with age and size at the time of plant. These differences could be confirmed through scale analysis.

Limited creel data showed poor angler success at low rainbow density during the 1989 - 1991 period. The same trend and very similar catch rate values were observed in summer and winter creel census on Canyon Ferry Reservoir over the period (Lere 1992). In addition to low rainbow density, catch rates were probably influenced by decreasing susceptibility of DeSmet rainbow as age increased within the population. Bureau of Reclamation creel data show summer catch rates as high as 0.3 rainbow per hour and 0.15 per hour in winter over the 1981 - 1983 period despite relatively low densities of Arlee rainbow. Low catch rates for rainbow trout resulted in declining angler use on Clark Canyon Reservoir. Pressure estimates for Clark Canyon generally average about 40,000 angler-days per year (MDFWP mail survey) and are quite stable at that number. In 1989 the pressure estimate was 39,034 but had declined to 22,096 angler-days by

1991. Some of this decline was associated with the inaccessibility of boat launch facilities under low storage conditions, however. High catch rates observed for Eagle Lake rainbow as the strain entered the fishery in the winter of 1991 - '92 were associated with strong survival from the 1991 plant and suggest a high degree of catchability for the strain.

Rainbow trout harvest could not be calculated due to the limited nature of the creel. Angler tag returns of DeSmet rainbow suggest a cumulative harvest of 6.9% over seven years, however, this method does not account for harvest that occurred in the first two years that the fish were in the reservoir when angling susceptibility is highest. Cumulative harvest through Age 5 was estimated at 22% for DeSmet and 11% for Eagle Lake rainbow for individual plants of the strains in Canyon Ferry Reservoir (Lere 1992).

Numbers of wild brown trout in Clark Canyon Reservoir have demonstrated a gradually declining trend over the 1966 - 1992 period. It is unknown, at present, if the recent decline 1988 - 1992 represents a continuation of this trend or represents a short term low due to drought conditions in the reservoir and river spawning and rearing habitats. An apparent decline in brown trout populations in the early 1980's was associated with the successful establishment of rainbow trout populations in the reservoir from hatchery plants but might also be a product of changing habitat conditions with increased reservoir age.

Ruby River Reservoir

Rainbow trout populations in Ruby Reservoir have demonstrated a periodicity marked by successful recruitment years which generally followed relatively high summer drawdown pools. Recruitment peaks of rainbow in the reservoir have followed hatchery plants, as those observed in 1981 and 1992, or have been due entirely to natural recruitment as observed in 1985 and 1986. Due to a lack of an external marking program for plants made in the reservoir and a constant use of young of the year plants, no separation of planted and wild rainbow has been possible. The failure of plants of McBride Yellowstone cutthroat and subsequent establishment of a strong wild rainbow trout population was described by Oswald (1989). The subsequent decline of this population, as well as that of the wild brown trout population, were assumed to be the result of poor storage conditions in the reservoir and drought conditions in the river. The recent 1992 population peak for rainbow trout followed slightly improved reservoir storage conditions in 1990 and 1991 and an aggressive program of hatchery plants of wild strains of rainbow trout. Because the population peak of 1992 was dominated by Age 2 fish, the major contribution of hatchery fish, if planted fish contributed, was due to survival of the Hebgen Lake strain of rainbow. The 1992 rainbow peak was not accompanied by an increase in brown trout numbers as was the case in both 1981 and 1985 suggesting that the success of the rainbow trout population was due to hatchery plants. Further analysis of the Ruby Reservoir rainbow trout populations should include some marking of hatchery plants to determine the success of the wild strain management program.

Elk Lake

The management of Elk Lake for McBride Yellowstone cutthroat has been highly successful when plants of overwintered Age 1 fish have been introduced in early summer. Late summer or fall plants of young of the year fish have consistently failed despite the stocking of vastly increased numbers of these fish. Lund (1974) made similar observations and noted the superiority of the survival of yearling plants. The data indicate that relatively strong cohorts of Age 3 cutthroat are consistently depleted in a substantial manner by Age 4, probably due to selective angler harvest of large fish. Due to limitations of hatchery space for overwintered yearlings, a constant supply of these older plants is unlikely. The best management strategy for Elk Lake cutthroat, therefore, is probably a system under which overwintered yearlings are planted every second year resulting in a population based on Age 2 and Age 4 cohorts. This strategy would lend a greater consistency to the fishery than that afforded by sporadic plants of yearlings interspersed with unsuccessful plants of young of the year fish. Department pressure estimates (MDFWP mail creel) indicate that Elk Lake generally supports about 2000 to 3000 angler-days per year. In 1989, the pressure estimate totaled 2908 angler-days as cutthroat from the last yearling plants were Ages 2 and 4. By 1991, angler use declined to 987 angler-days following 3 successive attempts to maintain the fishery with young of the year plants.

Elk Lake Grayling populations have declined dramatically since 1987 due to a lack of recruitment related to drought conditions in Narrows and Limestone Creeks. Both of these important spawning tributaries have failed to carry adequate surface flow during the grayling spawning period in most years since drought conditions began in 1985. Some limited spawning activity was observed in 1991 and a single yearling grayling captured in 1992 substantiated that some successful recruitment resulted. Lund (1974) found that Narrows Creek was the primary spawning and recruitment source for the grayling population of Elk Lake. He found that the small stream provided habitat for a spawning population of grayling in excess of 500 fish and recruited in excess of 2000 fry to the lake. If poor recruitment conditions persist in Narrows Creek, the data suggest that the grayling population of Elk Lake could be extirpated in the near future. This scenario may already have occurred if the 1991 recruitment was insufficient to resurrect an already depleted brood stock of mature fish. If drought conditions abate in the near future, it might be necessary to reestablish a population through hatchery plants of lacustrine grayling from a proximal source such as Upper Red Rock Lake.

The lake trout population of Elk Lake appears to be relatively stable at low densities over time. Low numbers observed over the 1984 - 1988 period were due to sampling method and should not be construed as indicative of a population decline. The lake trout appear to be limited in growth by the absence of a true pelagic forage species but may benefit from the illegal introduction of Utah chub (Oswald 1986) which have slowly increased in number over the recent past.

Hidden Lake

Hidden Lake has maintained a wild rainbow trout population since it received its last hatchery plant in 1947. In total, the lake only received minimal plants in four years during the 1930's and 1940's but the introduction and habitat were sufficient to establish a self - sustaining population. Studies were conducted on the rainbow population of Hidden Lake from 1985 - 1991 to determine its status and trend. All parameters examined indicate that the population of Hidden Lake exhibits a high degree of stability at relatively high density. Recruitment appeared ample to stock the lake and maintain a very high sample density. Age composition of the population is balanced and consistent. All data indicate a population in balance with its habitat, natural mortality, recruitment, and angler harvest. Angler use of Hidden Lake generally ranges between 1000 and 2000 angler-days per year (MDFWP mail creel). In 1989 pressure on Hidden Lake was estimated at 952 angler-days which declined to 741 angler-days in 1991. The decline was probably associated with declining visits to nearby Elk Lake and does not represent a decline in angler success. Because of the innate stability of the Hidden Lake rainbow population, sampling of the lake will be limited to alternate years in the immediate future.

Culver Pond

Culver Pond has long been recognized for its ability to produce trophy brook trout, sometimes exceeding 5 pounds in weight. Both arctic grayling and rainbow trout were stocked into the pond at various times but neither species was successful in establishing a population. A ditch carrying water to the pond from Red Rock Creek in 1963 introduced suckers into the system but the pond was drawn down and treated with rotenone in 1964 (Peterson 1973). The pond has since been managed for brook trout and fed only by natural springs at the upper end. A special "slot limit" regulation was put into effect in 1986 which requires the release of all brook trout between 12 and 18 inches in length and limits angler gear to artificial flies and lures. The regulation produced immediate results in 1987 with a rapid increase in the number of 15 inch and larger fish. This was due to the rapid growth rate of the species in the pond. Since 1987, it has been difficult to evaluate the success of the regulation. The dam was breached in 1988 resulting in an extreme drawdown of the pond although the data suggest that the brook trout population survived the dam failure with minor loss. Since 1989, the population has undergone a steady decline, marked by decreasing numbers of 15 inch and larger fish and poor recruitment. The recent period has also been marked by winter pond drawdown to enhance trumpeter swan feeding. Peterson (1973) suggested that winter pond drawdown for swan management would have the affect of decreasing brook trout carrying capacity. The 1992 drawdown of the pond was severe and was effected to encourage swan migration. Future samples will be required to fully evaluate the affects of pond drawdown on the brook trout population.

McDonald Pond

McDonald Pond has been noted for its ability to produce trophy sized wild rainbow trout in a spring pond environment that is accessible to the angling public. Although the pond was also planted with arctic grayling, none were collected in samples taken as early as 1971 (Peterson 1973). Oswald (1986) noted that a lack of natural recruitment had substantially reduced the wild rainbow population of the pond and embarked on a cooperative program with Refuge management to reestablish a self sustaining trophy fishery. This program called for the removal of spawning barriers in Elk Springs Creek, establishment of restrictive angling regulations (Oswald 1986, 1989), and plants of the wild Eagle Lake strain of rainbow trout.

Since plants of Eagle Lake rainbow were made in McDonald Pond in 1987 and 1988, the process of population reestablishment has evolved to a stage of successful wild recruitment. Poor survival of the 1987 plant was followed by excellent survival in 1988. Numbers of Age 2 fish collected in 1989 probably indicated a stocking rate in excess of preferred pond carrying capacity but mortality between Age 2 and Age 3 reduced this brood stock significantly. Redd counts made since the brood plant indicated good spawning activity in the limited spawning habitat provided in Elk Springs Creek. Wild recruitment in the form of Age 1 and 2 fish appeared in the 1991 samples and filled age classes 1 through 3 by 1992. Recent sample numbers are indicative of population densities similar to those observed between 1970 and 1980. Further study will be needed to determine the recruitment potential of wild progeny produced within the pond system and, after a mature component is gained from wild recruitment, the affects of the special regulation.

Refuge manipulation of storage in the pond has not been as frequent as that observed in Culver Pond. A spring drawdown in 1990 was accompanied by a severe decline in the numbers of stocked Eagle Lake rainbow but visual observations of fish concentrations suggested that low sample catch was due to abnormal distribution and limited movement of fish under low storage conditions. It is unknown if low numbers of planted Eagle Lake brood stock in subsequent samples were influenced by the 1990 drawdown or if they resulted from natural and angling mortality over time. In 1992, Refuge management implemented a significant overwinter drawdown to encourage swan migration. Future samples will be required to evaluate the affects of this drawdown on wild stocks of rainbow trout.

Miner Lake

Miner Lake has sustained wild populations of brook trout and arctic grayling since all stocking of hatchery fish ended after 1966. Despite numerous hatchery plants of rainbow trout, the species was unable to establish a self - sustaining population in the available habitat. Brook trout remain the most abundant species in the lake while grayling appeared stable at low density. Growth of both species appeared limited by the productivity of lake. Wells (1981) noted a relatively low chemical productivity for alpine lakes in the western slopes of the upper Big Hole drainage.

Because Miner Lake is accessed by developed roads and a highly developed campground, angler use is high for a small mountain lake. In the past, Miner Lake has sustained 1000 to 2000 angler-days of pressure per year (MDFWP mail creel). Recent pressure estimates in 1989 and 1991, however, indicate a substantial decline in angler use to 478 and 325 angler-days, respectively. Letters of angler complaint indicate that this decline is due to angler dissatisfaction with the fishery. It is assumed that angler dissatisfaction was linked to relatively low catch rates and small size associated with the brook trout population. For this reason, and the limited fishery provided by wild stocks of brook trout and grayling, Miner Lake was stocked with young of the year McBride Yellowstone cutthroat trout in 1992. A future sampling program will be necessary to evaluate the success of cutthroat trout management in Miner Lake.

Twin Lakes

Twin Lakes represents a situation similar to that of Miner Lake in that access and developed campgrounds result in relatively high angler use. Twin Lakes has generally provided between 500 and 1000 angler-days of recreation (MDFWP mail creel) in the past. Recent pressure estimates were calculated at 508 angler-days in 1989 and 639 angler-days in 1991. It is probable to assume that the opportunity to fish for lake trout results in a fairly stable attraction to a segment of the angling public.

The lake trout population has probably remained relatively stable in terms of numbers over the 1964 - 1992 period, although more summer samples should be collected to confirm this supposition. The data suggest, however, that a declining trend in the number of older, larger fish could be operative in the population. Limited creel census in 1991 found that anglers were relatively successful in catching lake trout which could affect the age structure and reduce the ultimate size for this slow growing, long - lived species.

Sample trends for brook trout indicate a steady population decline over the sample period. Angler catch rate for the species, however, remained similar to that observed on Miner Lake in 1991. This decline could influence lake trout growth due to a reduction in the forage species available.

The lake trout data indicate that numbers of large lake trout have declined substantially since 1964. This may be due to a combination of angler harvest and limited forage in the lake. Prior to 1964, Twin Lakes received regular plants of cutthroat and rainbow trout. These plants could have contributed to the lake trout forage base as well as providing additional angling opportunity above that currently available through wild fisheries. Resumption of a stocking program should be evaluated for Twin Lakes through the use of McBride Yellowstone cutthroat. A reduced bag limit and some form of size restriction should also be considered and evaluated for the lake trout population.

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Project No. F-46-R-5 Job No. II-c and II-d
Project No. F-46-R-6 Job No. II-c and II-d

APPENDIX

Table. 1. Recent stocking history of Arlee, DeSmet, and Eagle Lake strains of rainbow trout into Clark Canyon Reservoir.

Year	Month	Strain	Number
1979	May	Arlee	217,000
1980	May	Arlee	201,000
1981	May	Arlee	196,000
1982	May	Arlee	193,000
	Nov	DeSmet	36,000
1983	May	Arlee	154,000
	Sep	DeSmet	248,000
1984	May	Arlee	150,000
	Aug - Oct	DeSmet	254,000
1985	May	Arlee	208,000
1986	May	Arlee	212,000
	May	DeSmet*	103,500
	Aug	DeSmet	10,000
1987	Jun	Arlee	222,000
	Aug	DeSmet	102,000
1988	Jun	Arlee	201,000
1989	Jun	Arlee	157,000
1990	May	DeSmet*	91,000
1991	Jun	Eagle Lake	160,000
1992	May - Jun	Eagle Lake	247,325

* Yearling plant

Table 2. Recent stocking history of various strains of rainbow trout into Ruby River Reservoir.

Year	Month	Strain	Number	Size
1988	Jun	Arlee	25280	5.4"
1989	Aug	DeSmet	27300	3.0"
1990	Aug	Hebgen L.	157403	1.5"
1991	Aug	McConaughy	30591	4.4"
1992	Jun	Eagle L.	53000	3.5"

Table 3. End of irrigation season storage pool (acre feet) in Ruby River Reservoir 1979 - 1991.

Year	Storage	Year	Storage
1979	1000	1980	15210
1981	6500	1982	14760
1983	16640	1984	13410
1985	7960	1986	11370
1987	6970	1988	1500
1989	1840	1990	6870
1991	7360		

Table 4. Recent stocking history of McBride Lake Yellowstone cutthroat trout into Elk Lake.

Year	Month	Number	Size	Age
1982	Jun	21602	7.0"	1
1983	Jul	15019	8.0-9.0"	1
1984	-	-	-	-
1985	-	-	-	-
1986	Jun-Jul	13000	7.0-8.0"	1
1987	Oct	70000	2.5"	0
1988	Jun-Jul	17987	6.7-7.6"	1
	Sep-Oct	106908	1.6-1.9"	0
1989	Sep-Oct	342597	2.0-2.7"	0
1990	Sep	254058	1.8-2.4"	0
1991	Jul-Sep	288000	1.2-2.8"	0
1992	May-Jun	30310	4.9-7.3"	1

Figure 1. Spring numbers of rainbow trout collected per overnight gill net in Clark Canyon Reservoir 1980 - 1992.

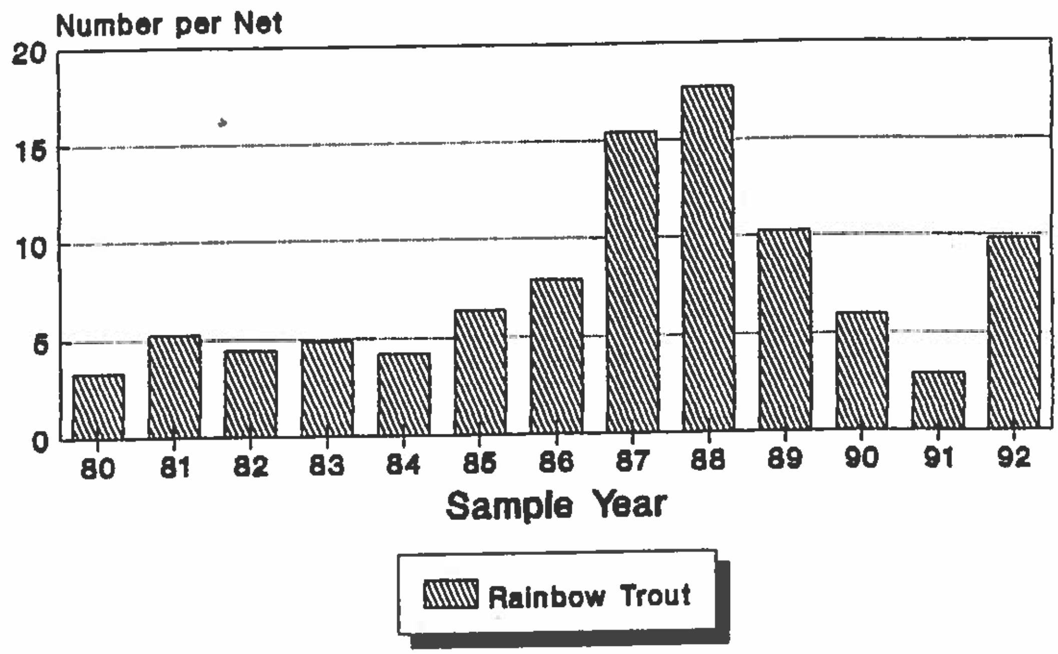


Figure 2. Spring numbers of Arlee strain rainbow trout per overnight gill net set in Clark Canyon Reservoir 1980 - 1992.

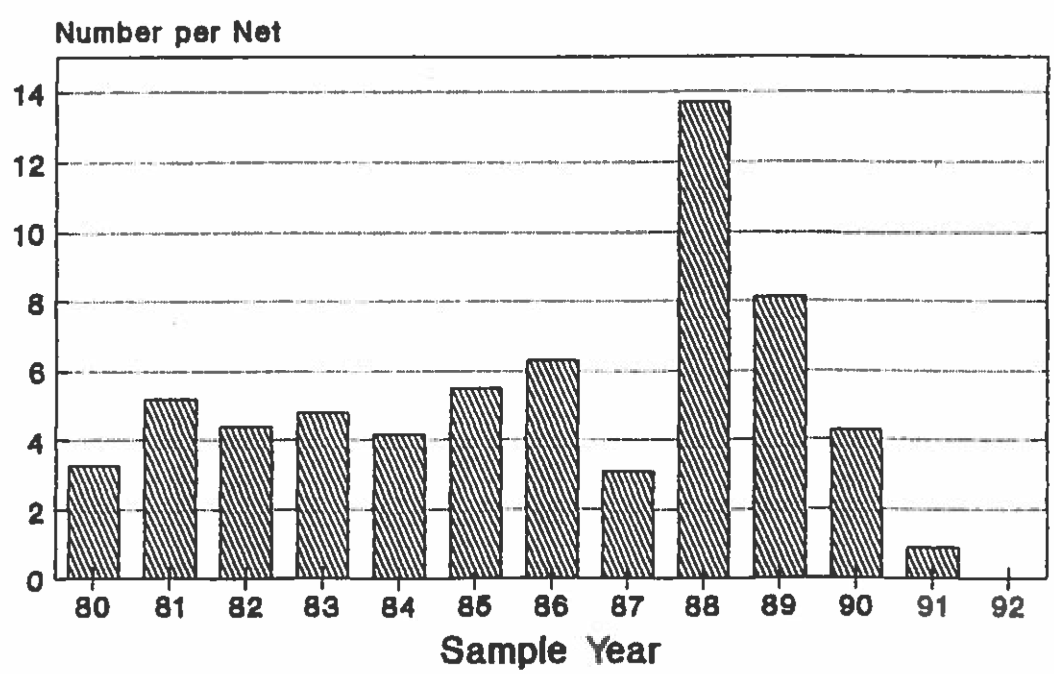


Figure 3. Spring numbers of DeSmet strain rainbow trout per overnight gill net in Clark Canyon Reservoir 1985 - 92.

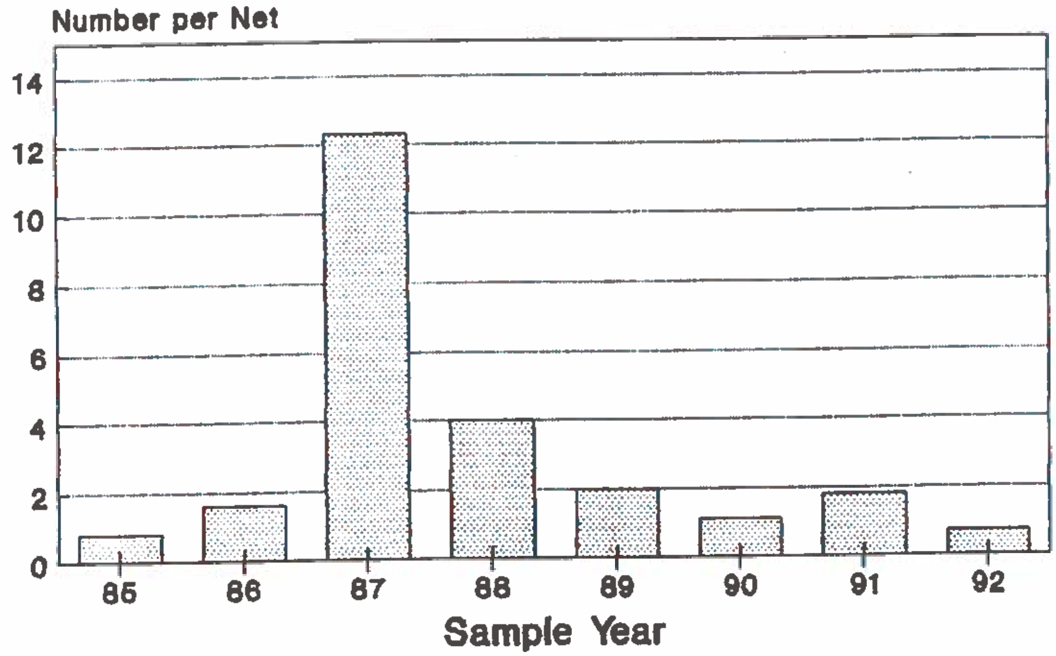
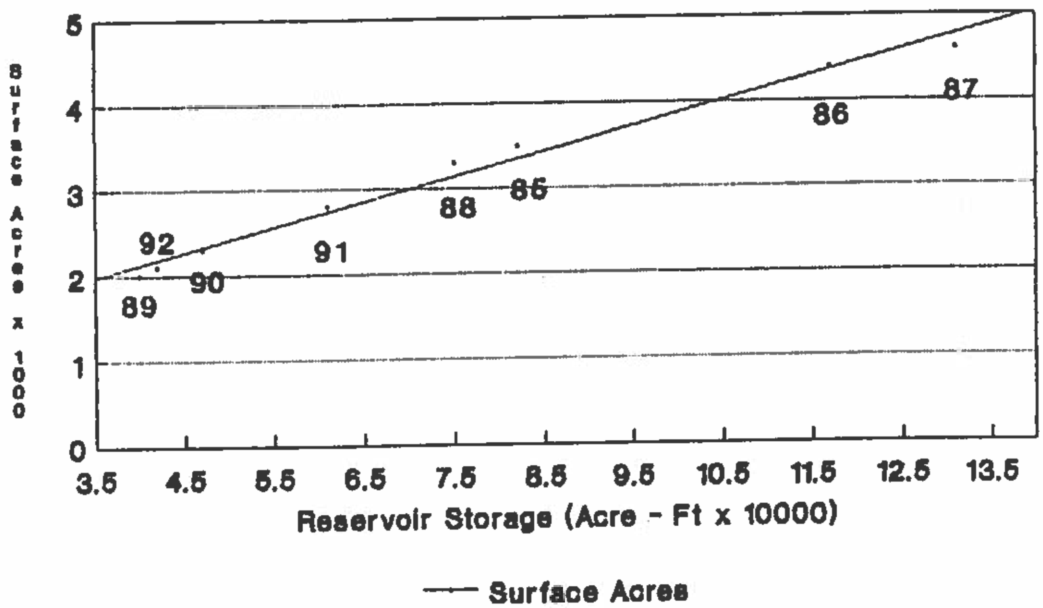
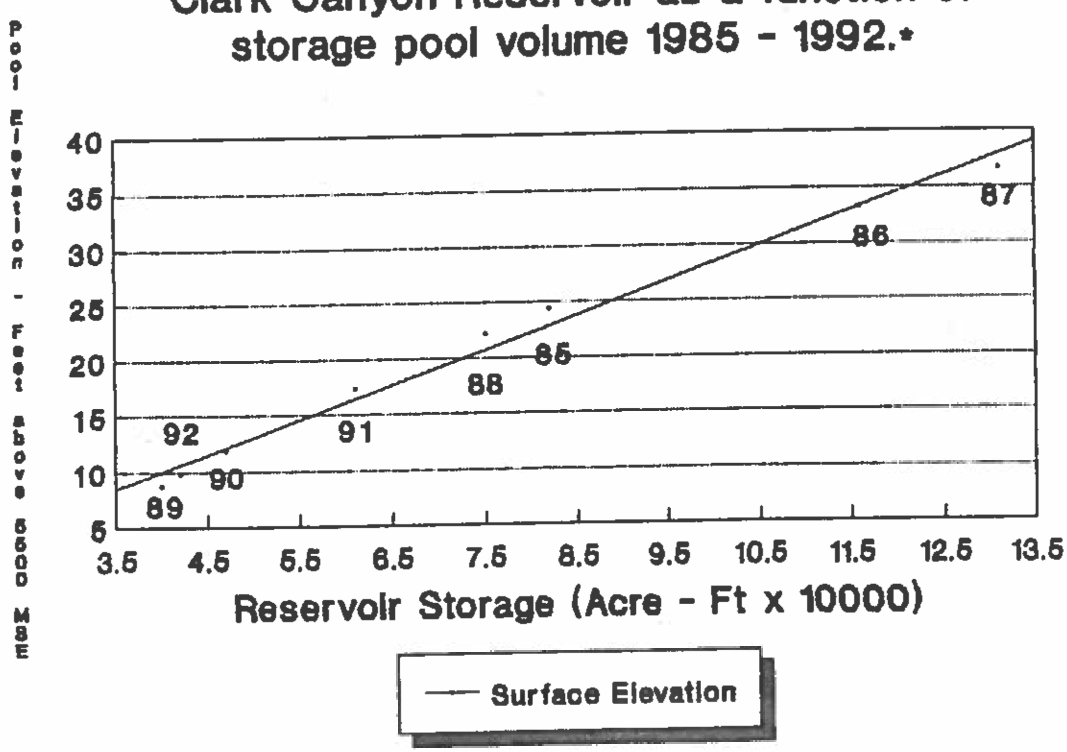


Figure 4. Surface acreage of Clark Canyon Reservoir as a function of storage pool volume 1985 - 1992.*



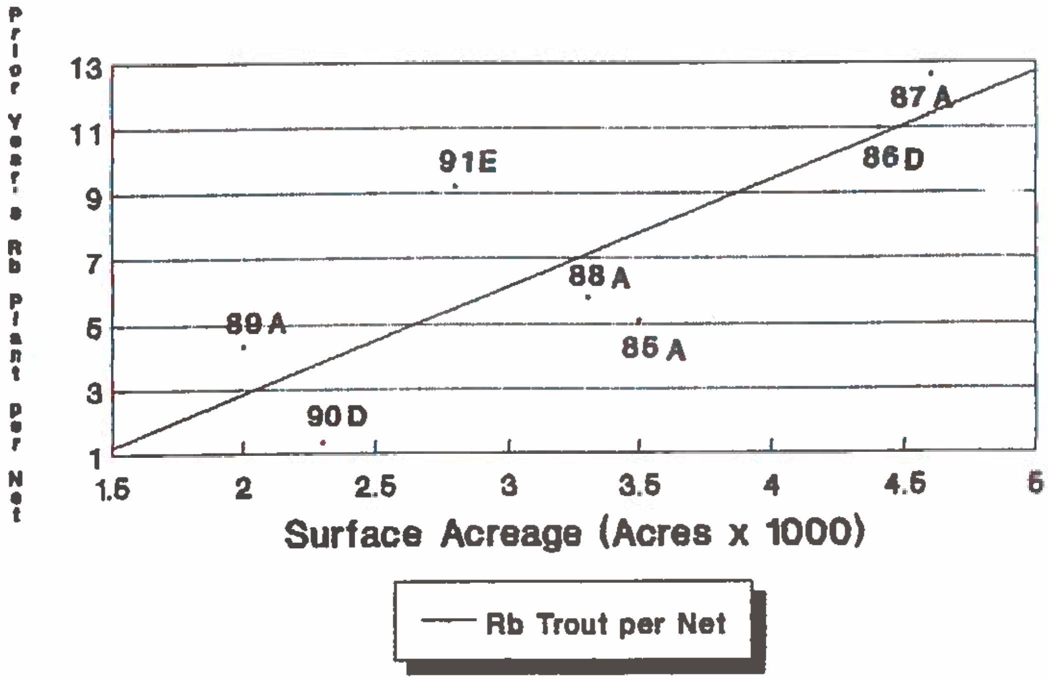
*End of irrigation season drawdown.

Figure 5. Water surface elevation of Clark Canyon Reservoir as a function of storage pool volume 1985 - 1992.*



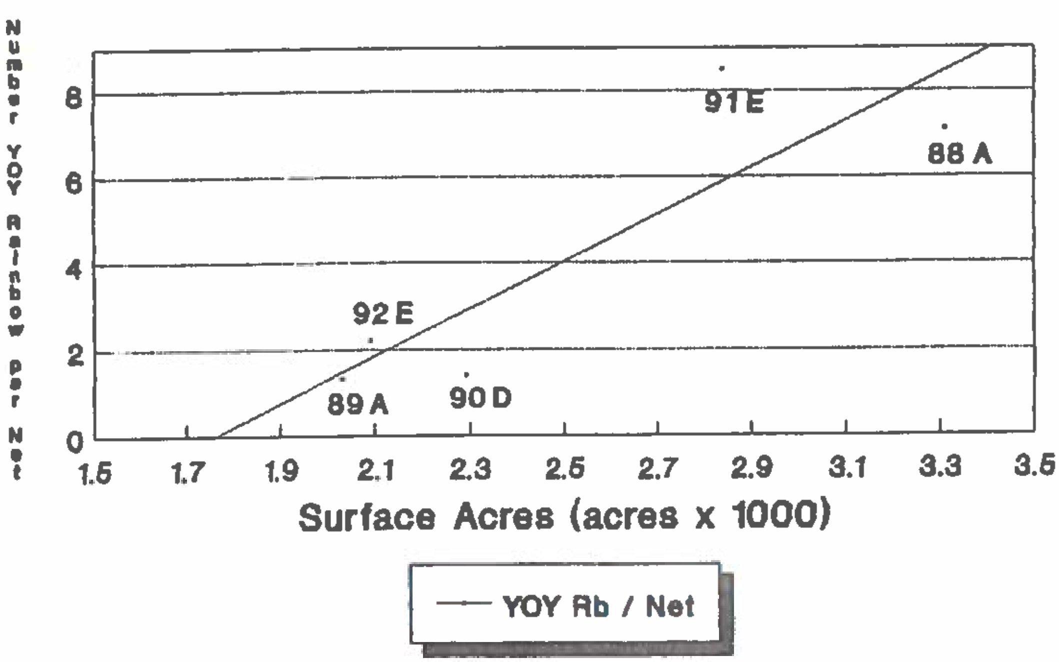
* End of irrigation season drawdown.

Figure 6. Spring samples of prior year's plant of rainbow trout vs drawdown acres in Clark Canyon Reservoir 1985 - 1991.*



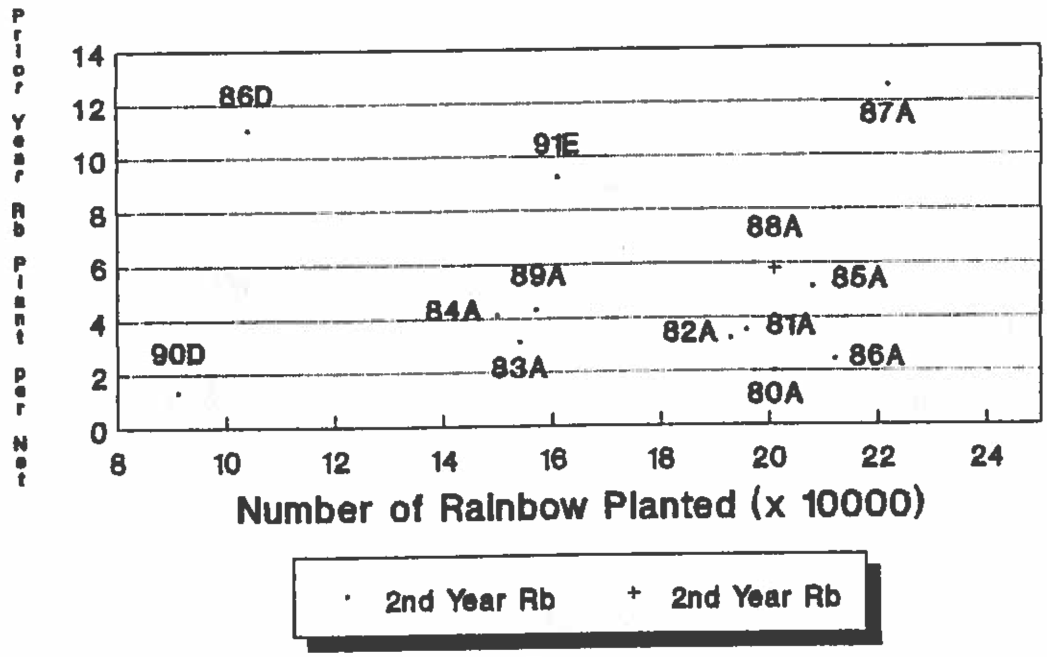
* A = Arlee, D = DeSmet, E = Eagle Lake

Figure 7. Fall gill net samples of YOY rainbow trout vs drawdown acreage in Clark Canyon Reservoir 1988 - 1992.*



* A = Arlee, D = DeSmet, E = Eagle Lake

Figure 8. Rainbow trout from prior year in spring samples vs number stocked in Clark Canyon Reservoir (1980 - 1991).*



* A = Arlee, D = DeSmet, E = Eagle Lake

Figure 9. Mean Condition Factor (K) for Age 3 and older rainbow trout in fall samples from Clark Canyon Reservoir.

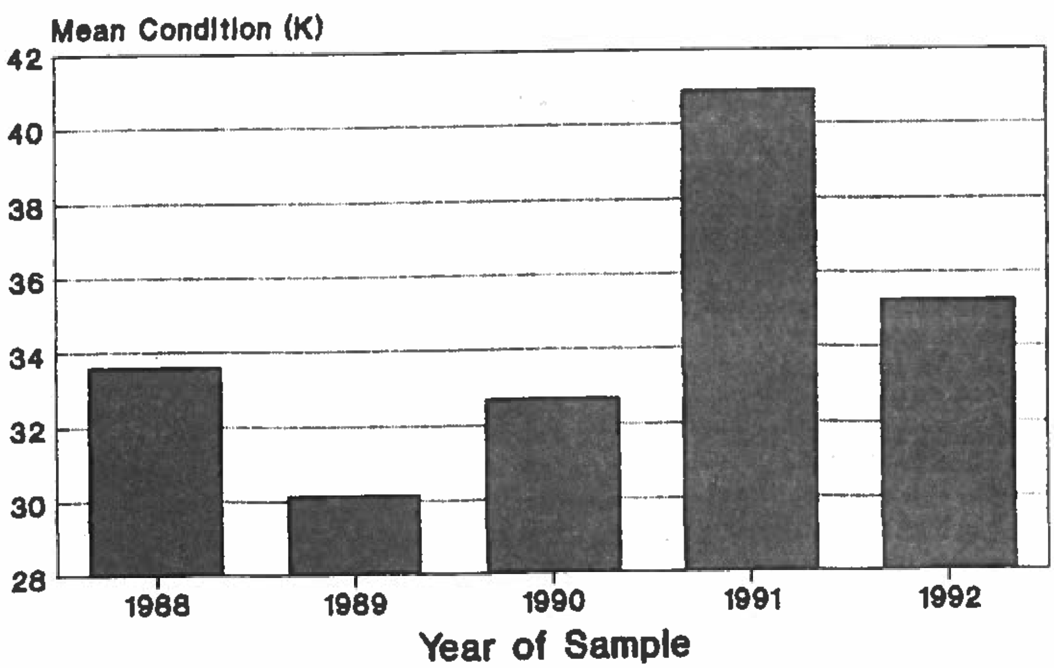
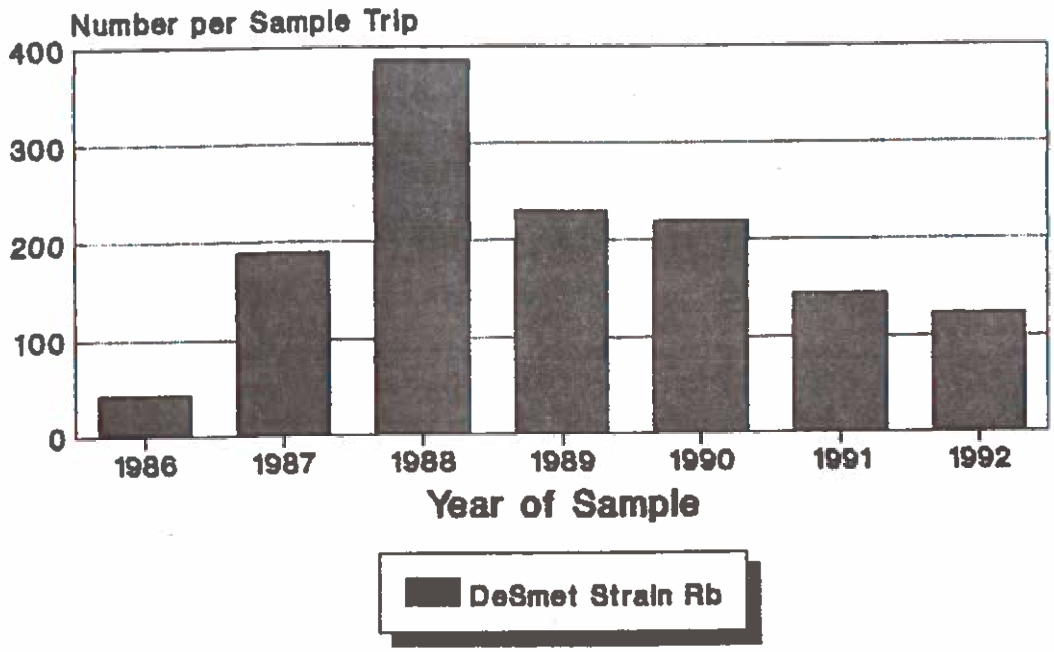
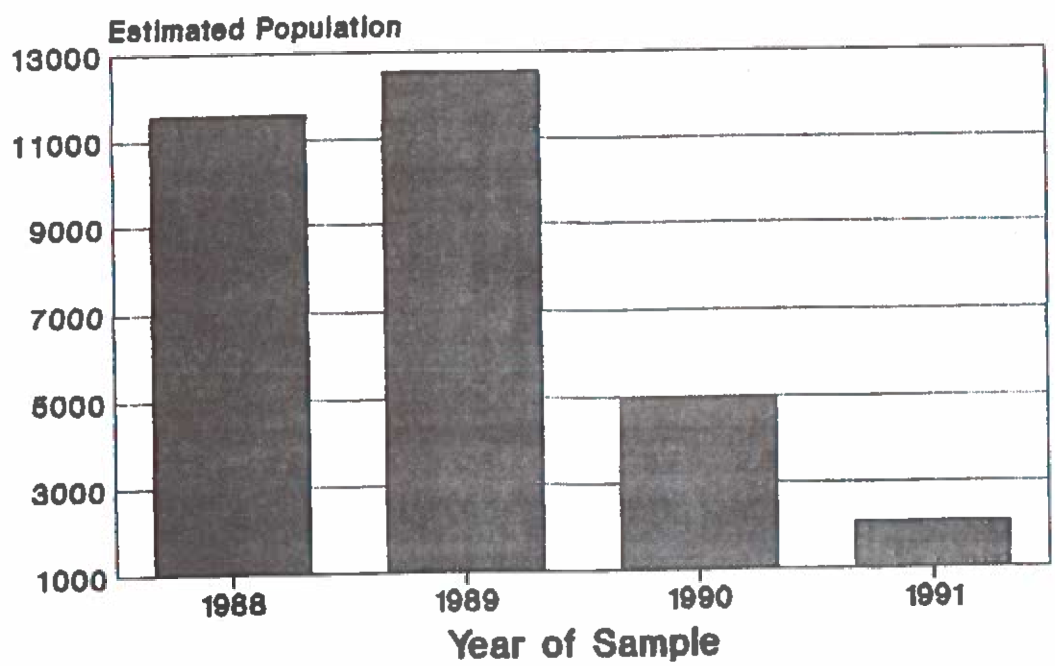


Figure 10. Numbers of spawning rainbow trout captured per electrofishing run in the Roe Section of the Red Rock River.*



* Clark Canyon Reservoir spawning run.

Figure 11. Estimated spawning population of wild strain rainbow trout in Clark Canyon Reservoir 1988 - 1991.*



* Primarily DeSmet strain rainbow trout.

Figure 12. Length - frequency of DeSmet rainbow trout captured in the Red Rock River during the 1990 spawning migration

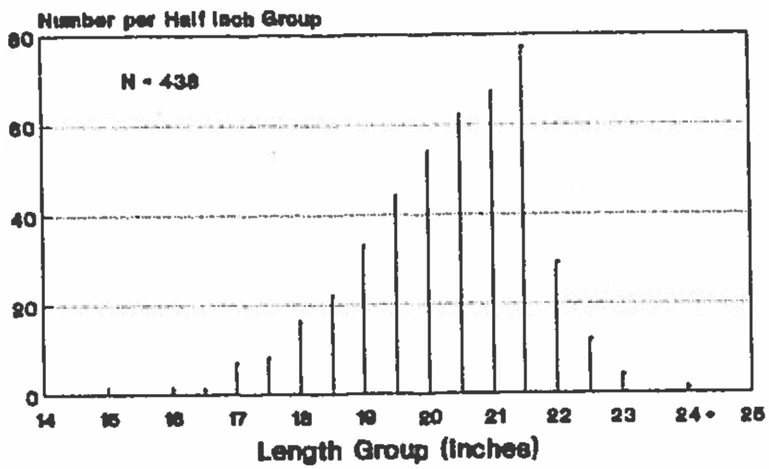


Figure 13. Length - frequency of DeSmet rainbow trout captured in the Red Rock River during the 1991 spawning migration

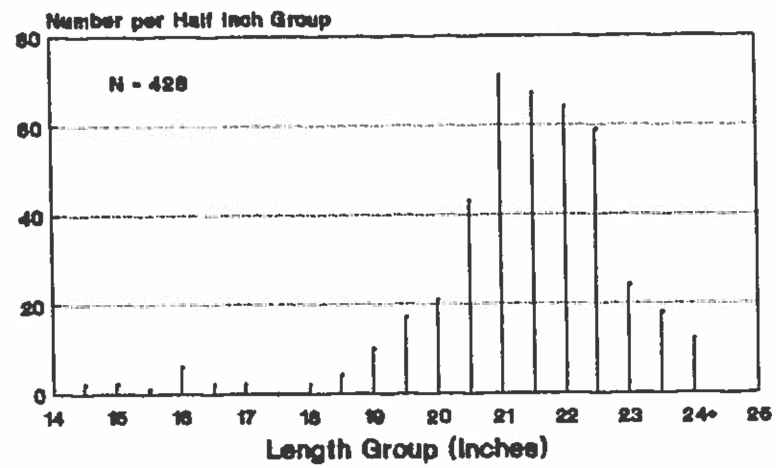


Figure 14. Length - frequency of DeSmet rainbow trout captured in the Red Rock River during the 1992 spawning migration

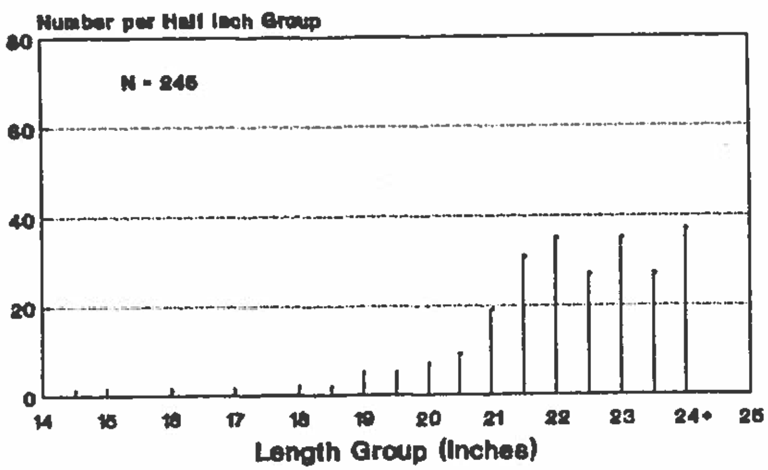


Figure 15. Spring numbers of brown trout per 125 foot experimental gill net set overnight in Clark Canyon Reservoir 1966 - 1992.

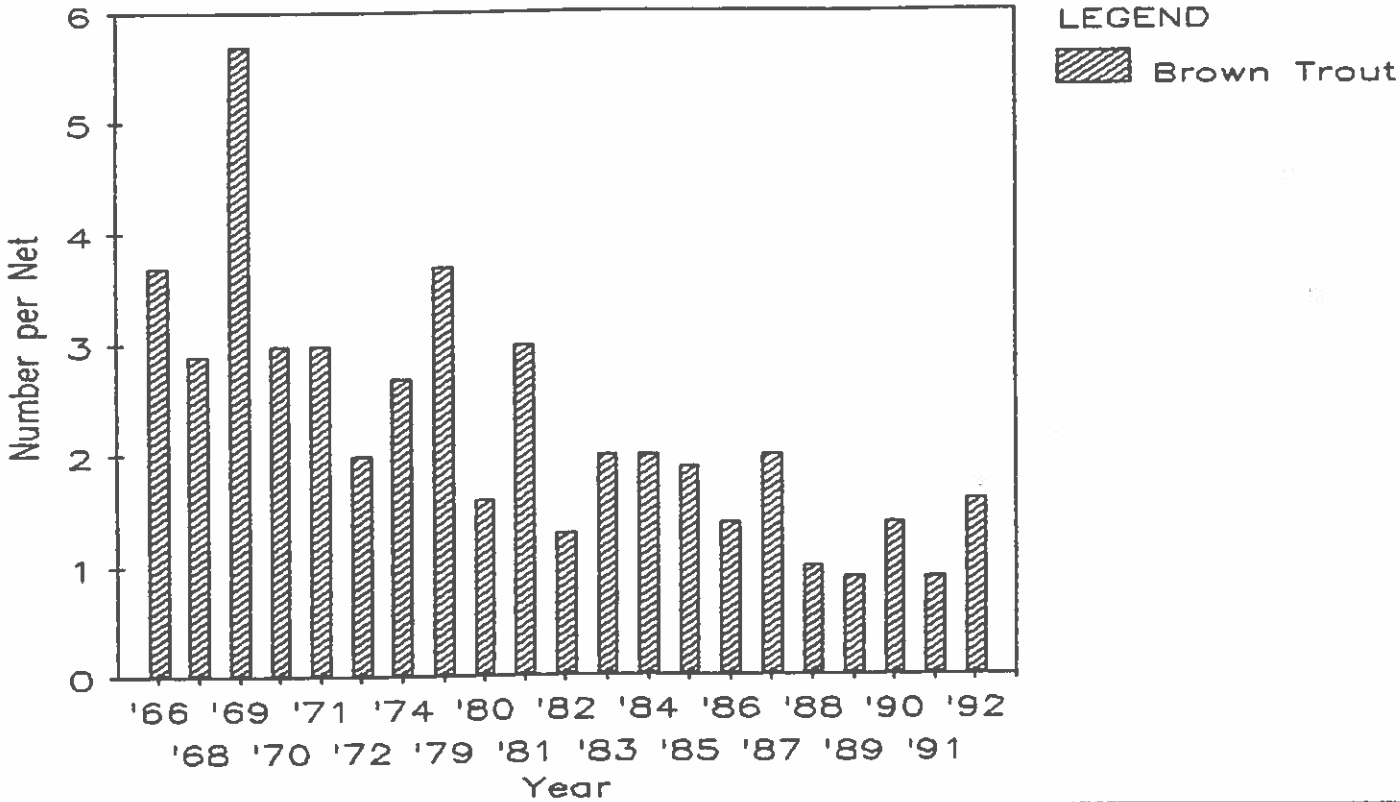


Figure 16. Length range and mean length of brown trout collected from spring samples using 125 foot experimental gill nets in Clark Canyon Reservoir 1966 - 1992.

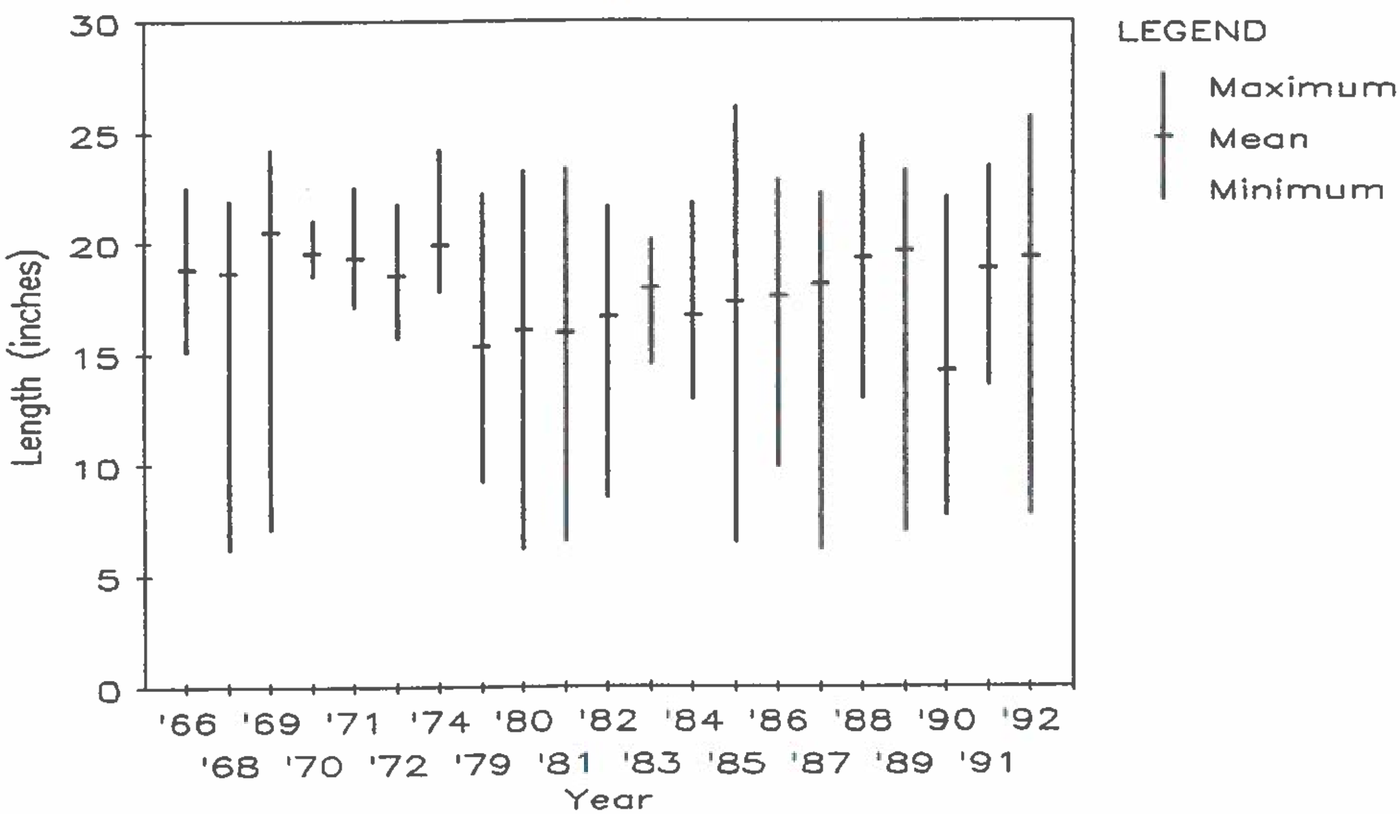


Figure 17. Mean Condition Factor (K) for Age 3 and older brown trout (20"+) in fall samples from Clark Canyon Reservoir

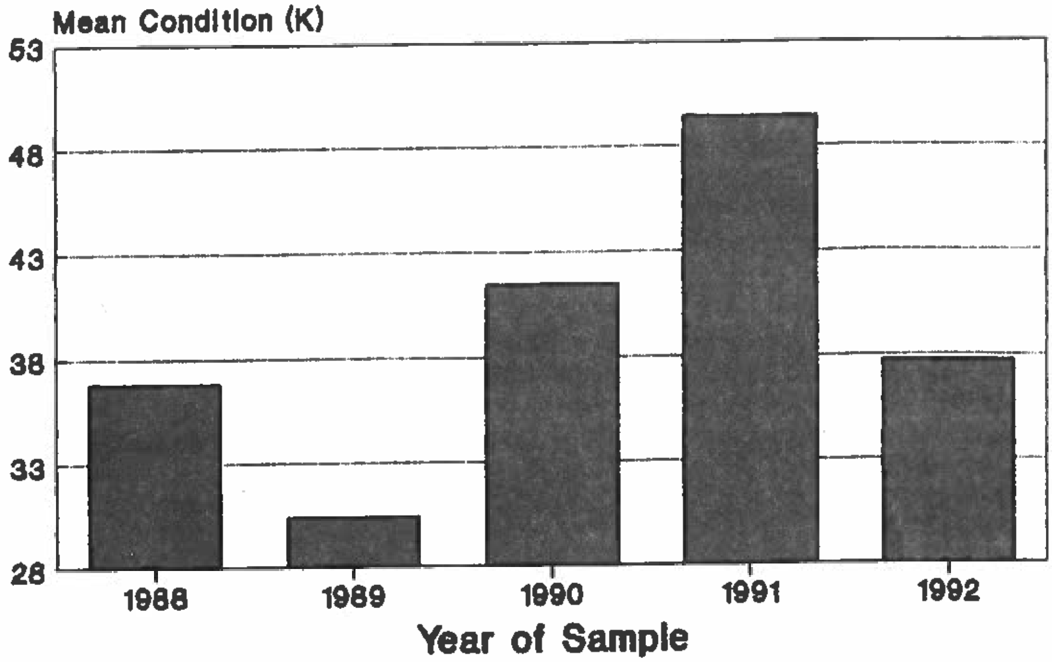


Figure 18. Rainbow trout trend information from spring samples collected in 125 foot floating experimental gill nets set overnight in Ruby River Reservoir 1979 - 1992.

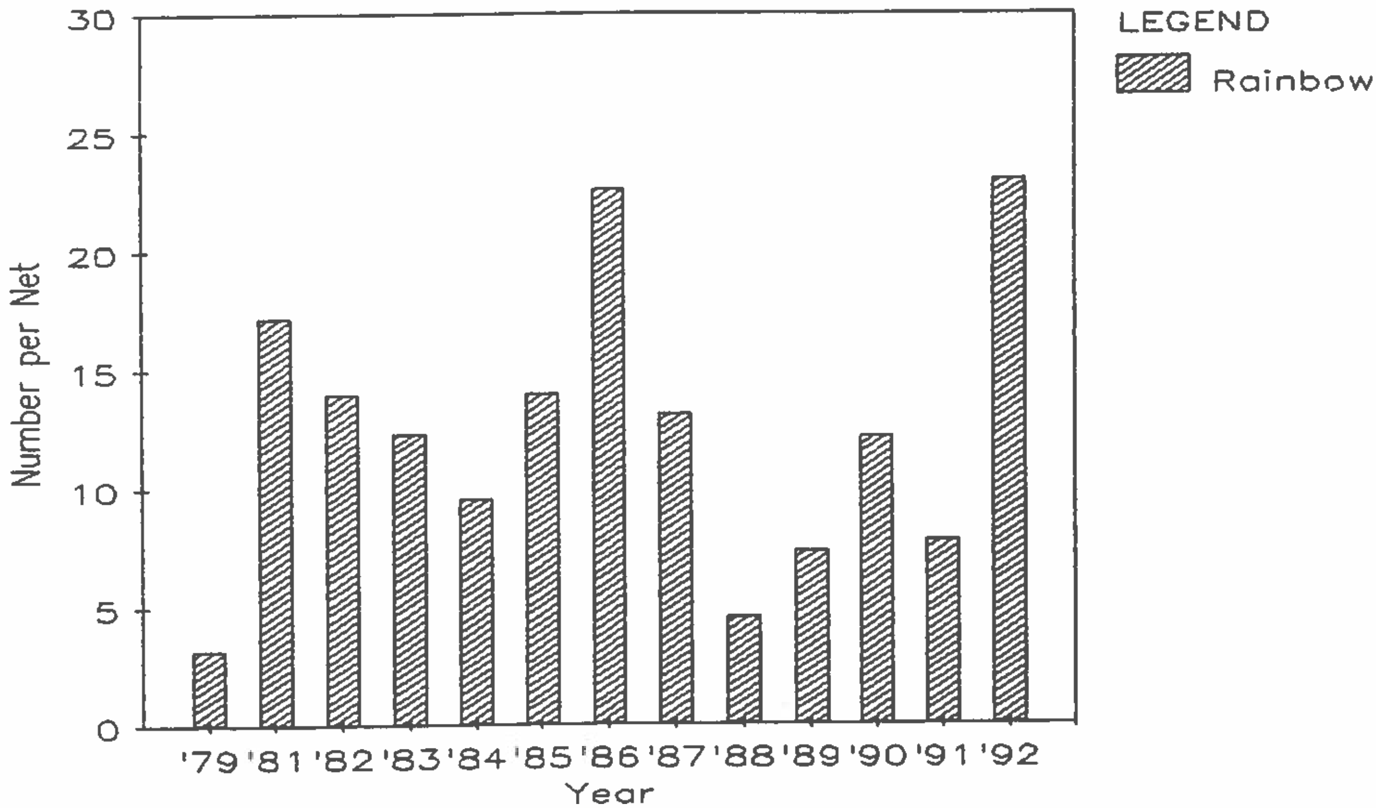


Figure 19. Rainbow trout trend information, by age class, from spring samples collected in 125 foot floating experimental gill nets set overnight in Ruby River Reservoir 1979 - 1992.

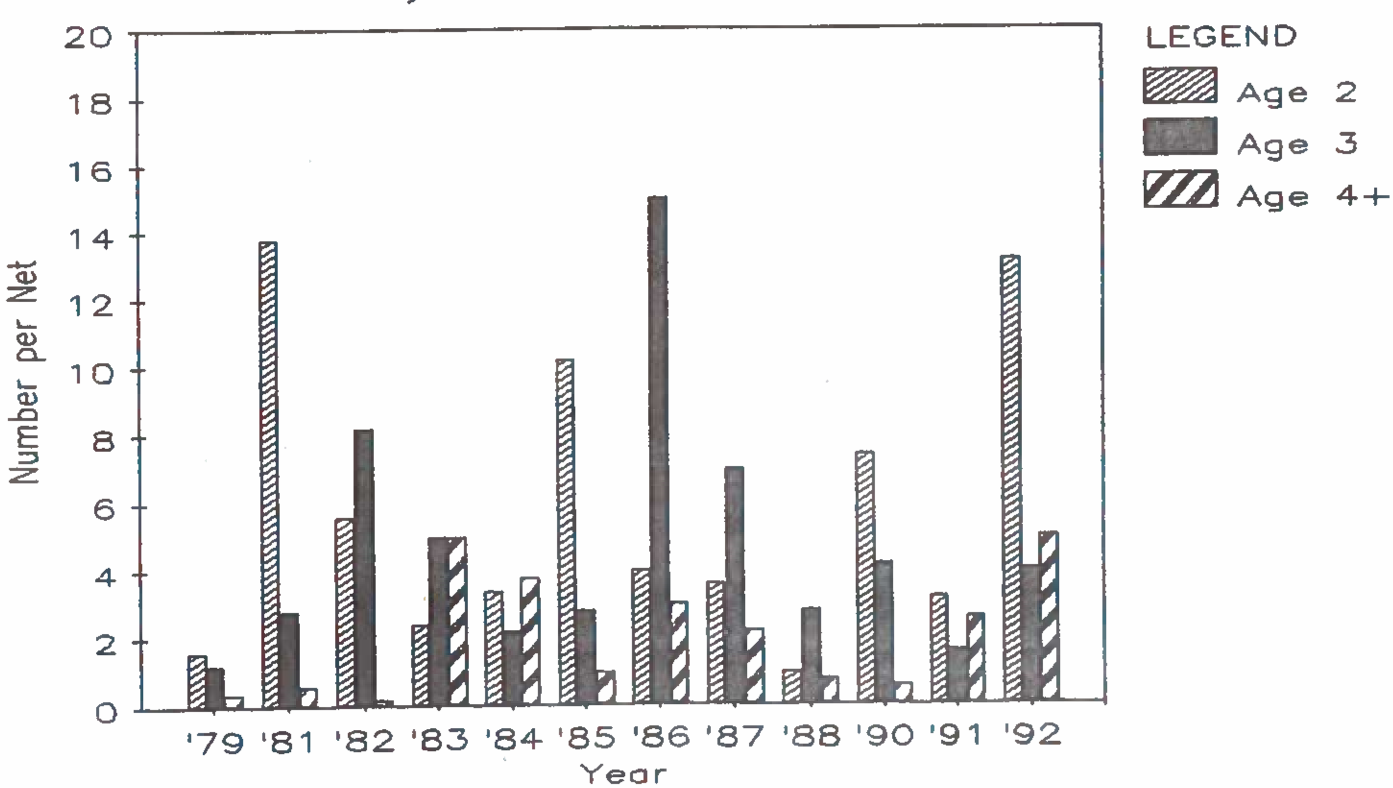


Figure 20. Length range and mean length of rainbow trout collected from spring samples using 125 foot floating experimental gill nets in Ruby River Reservoir 1979 - 1992.

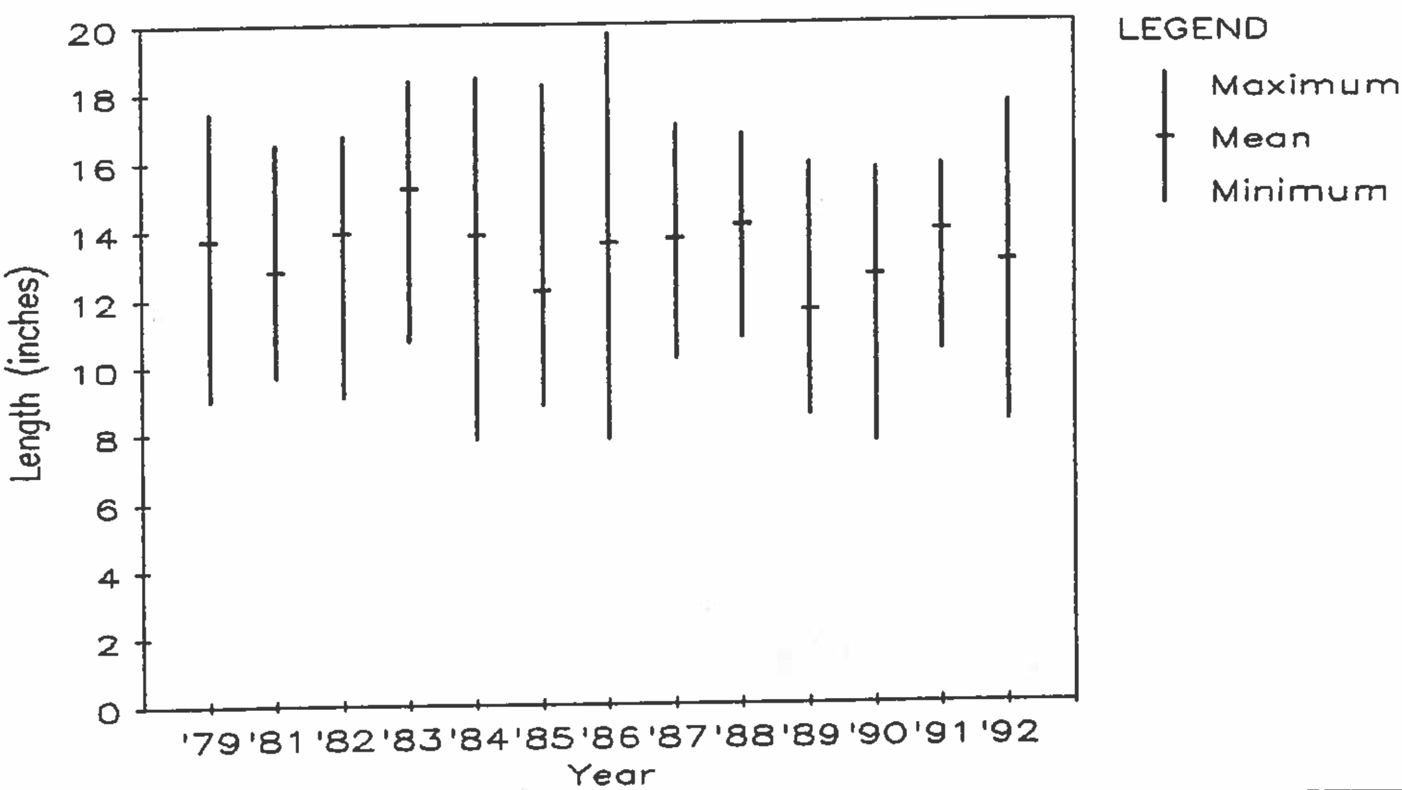


Figure 21. Brown trout trend information from spring samples collected in 125 foot floating experimental gill nets set overnight in Ruby River Reservoir 1979 - 1992.

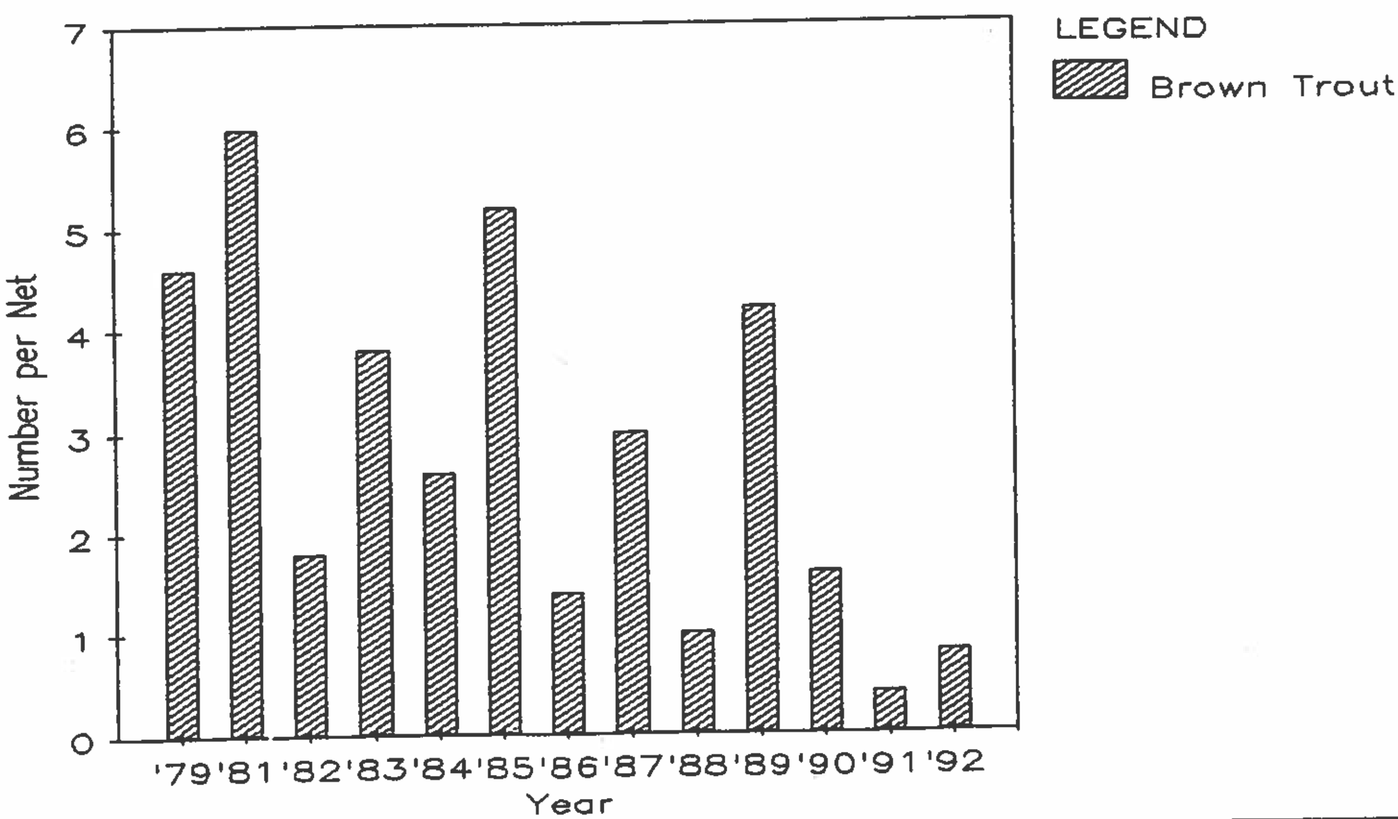


Figure 22. Brown trout trend information, by age class, from spring samples collected in 125 foot floating experimental gill nets set overnight in Ruby River Reservoir 1979 - 1991.

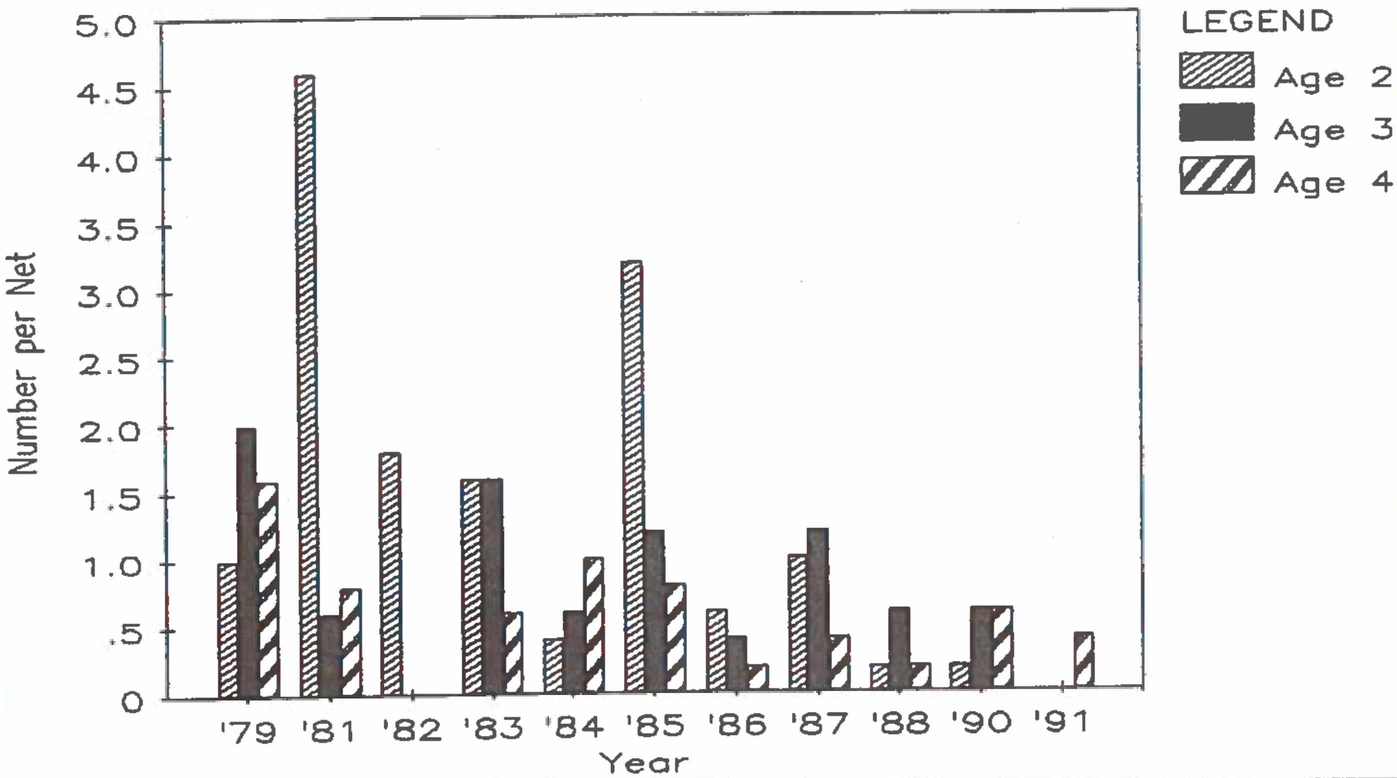


Figure 23. Length range and mean length of brown trout collected from spring samples using 125 foot floating experimental gill nets in Ruby River Reservoir 1979 - 1992.

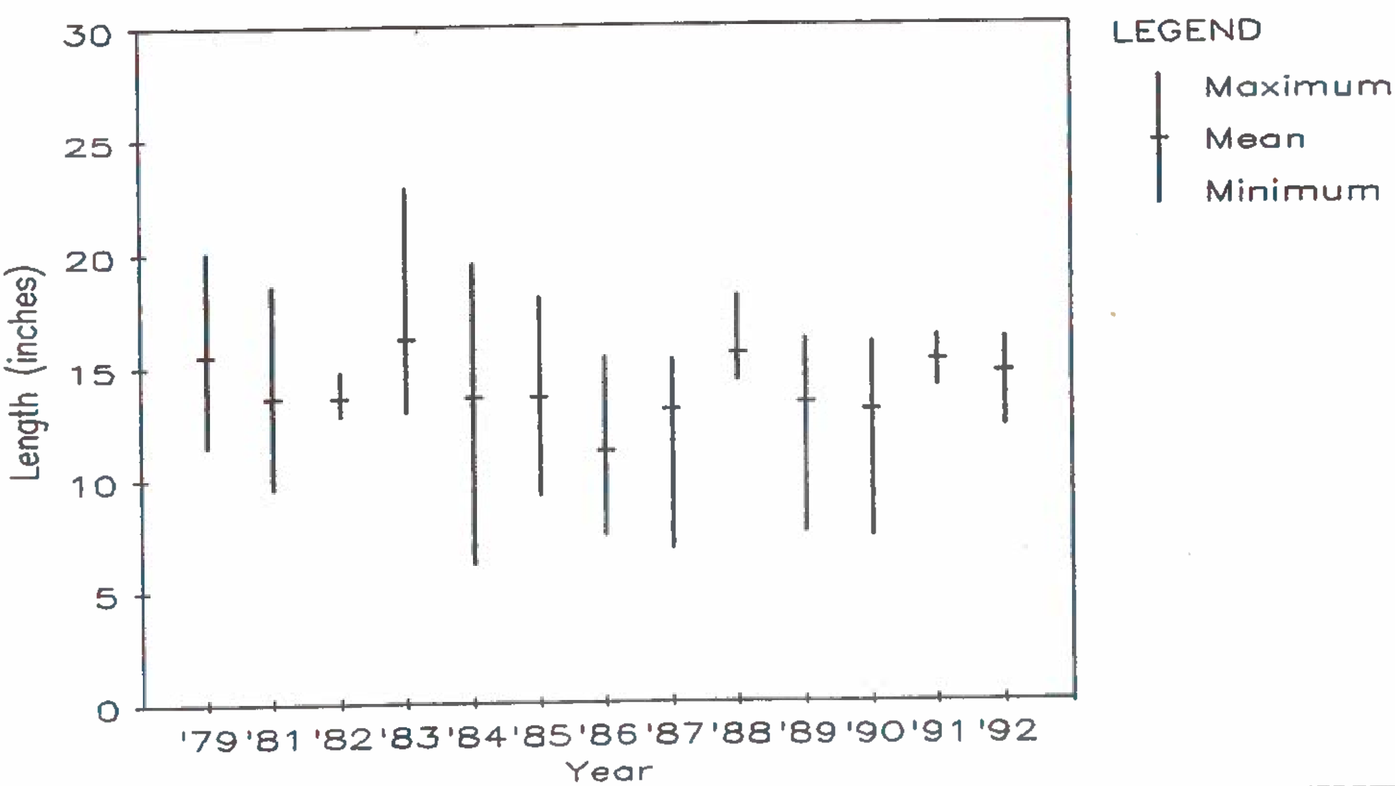


Figure 24. Spring numbers of McBride Yellowstone cutthroat trout per 125 foot floating experimental gill net sample collected from Elk Lake 1979 - 1992.

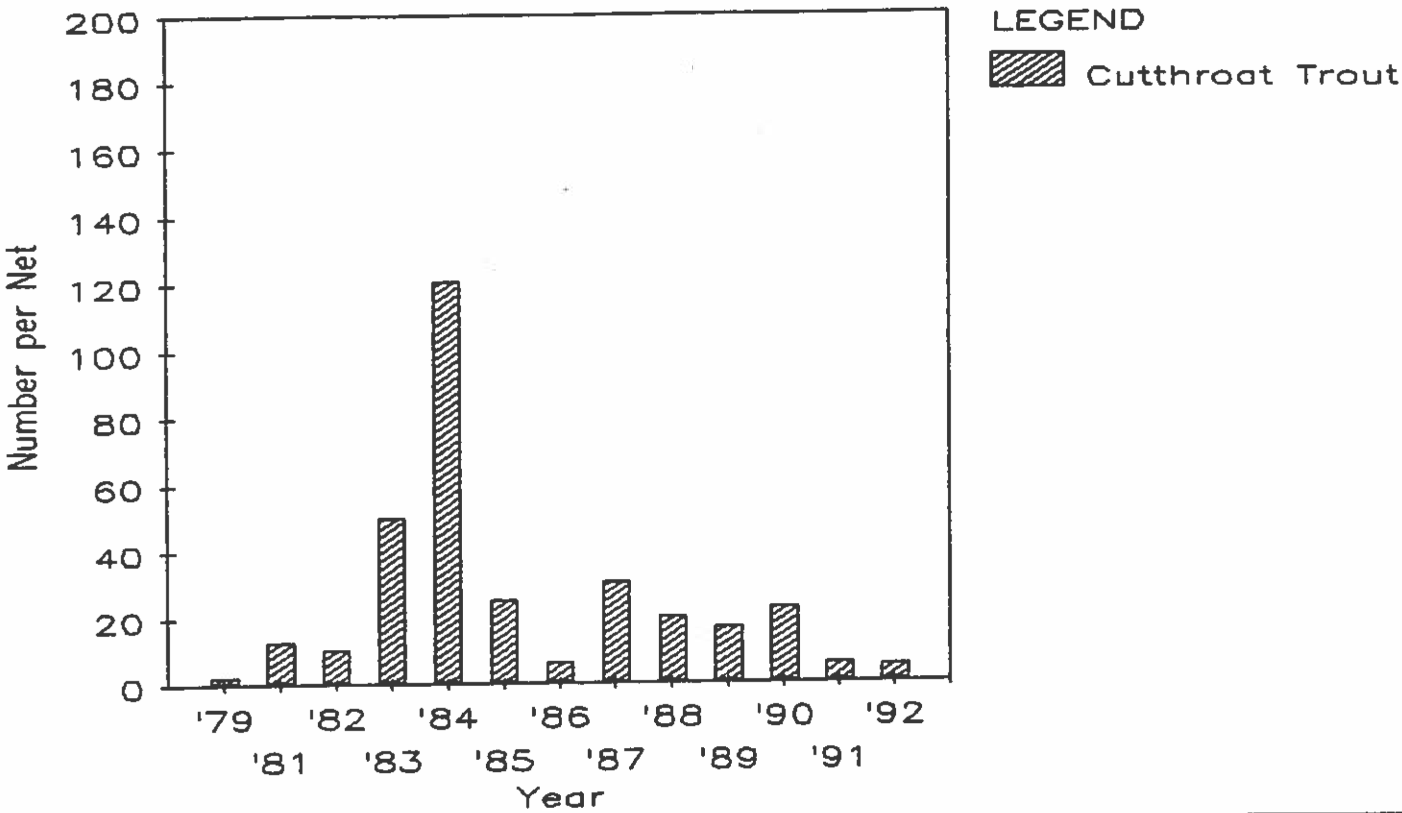


Figure 25. Spring numbers of McBride Yellowstone cutthroat trout, by age class, per 125 foot experimental floating gill net sample collected from Elk Lake 1979 - 1992.

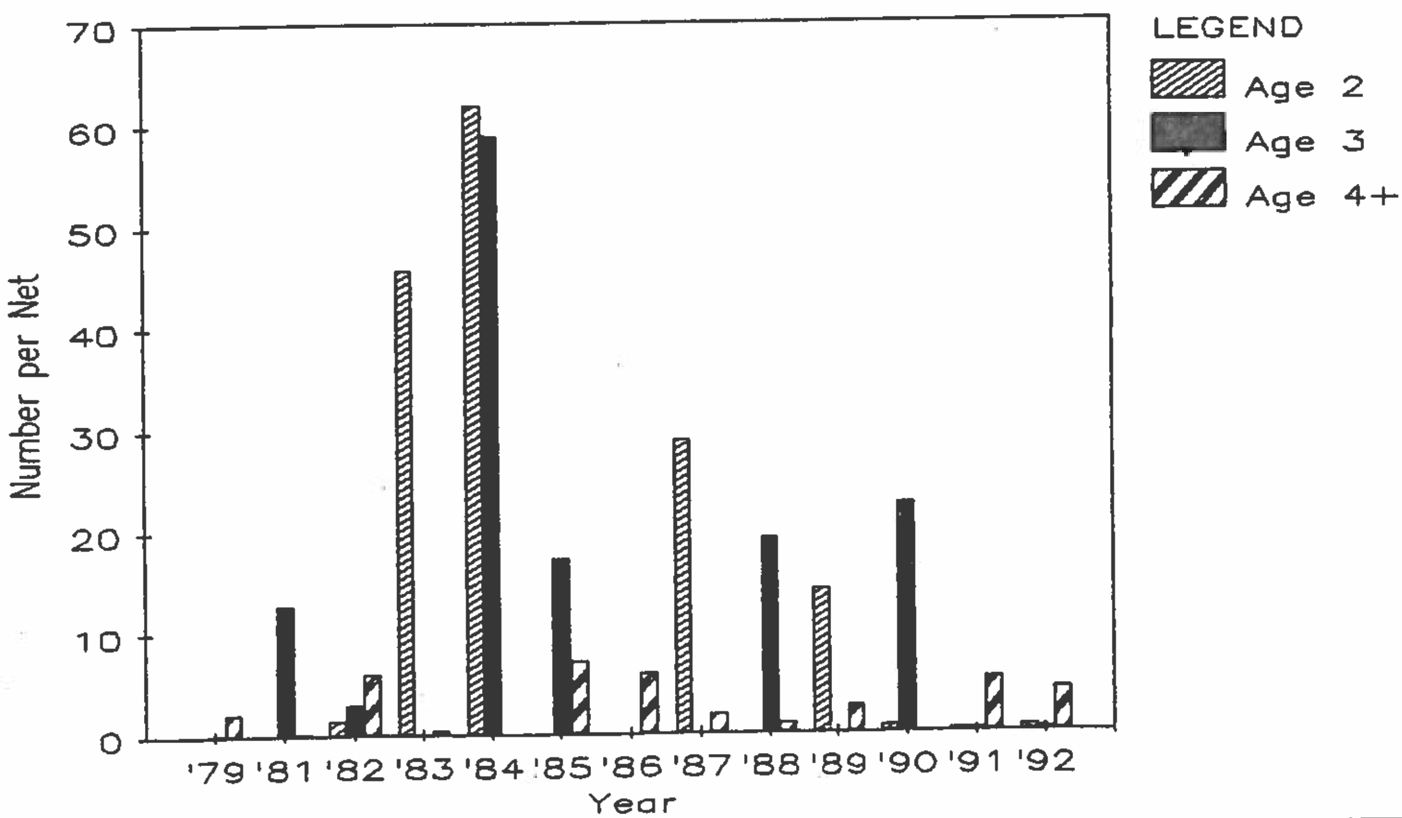


Figure 26. Spring numbers of arctic grayling per 125 foot experimental floating gill net sample collected from Elk Lake 1979 - 1992.

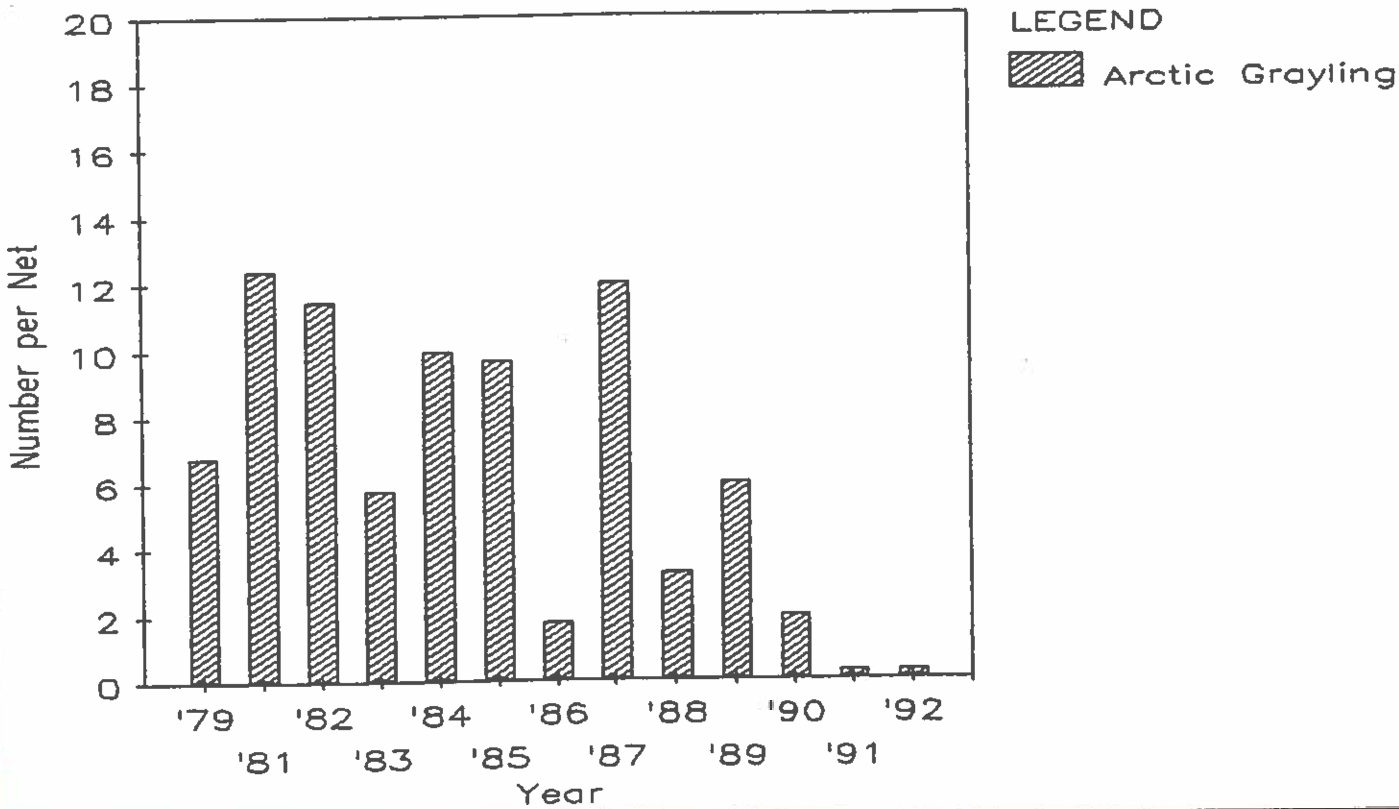


Figure 27. Length range and mean length of arctic grayling collected from spring samples using 125 foot floating experimental gill nets in Elk Lake 1979 - 1992.

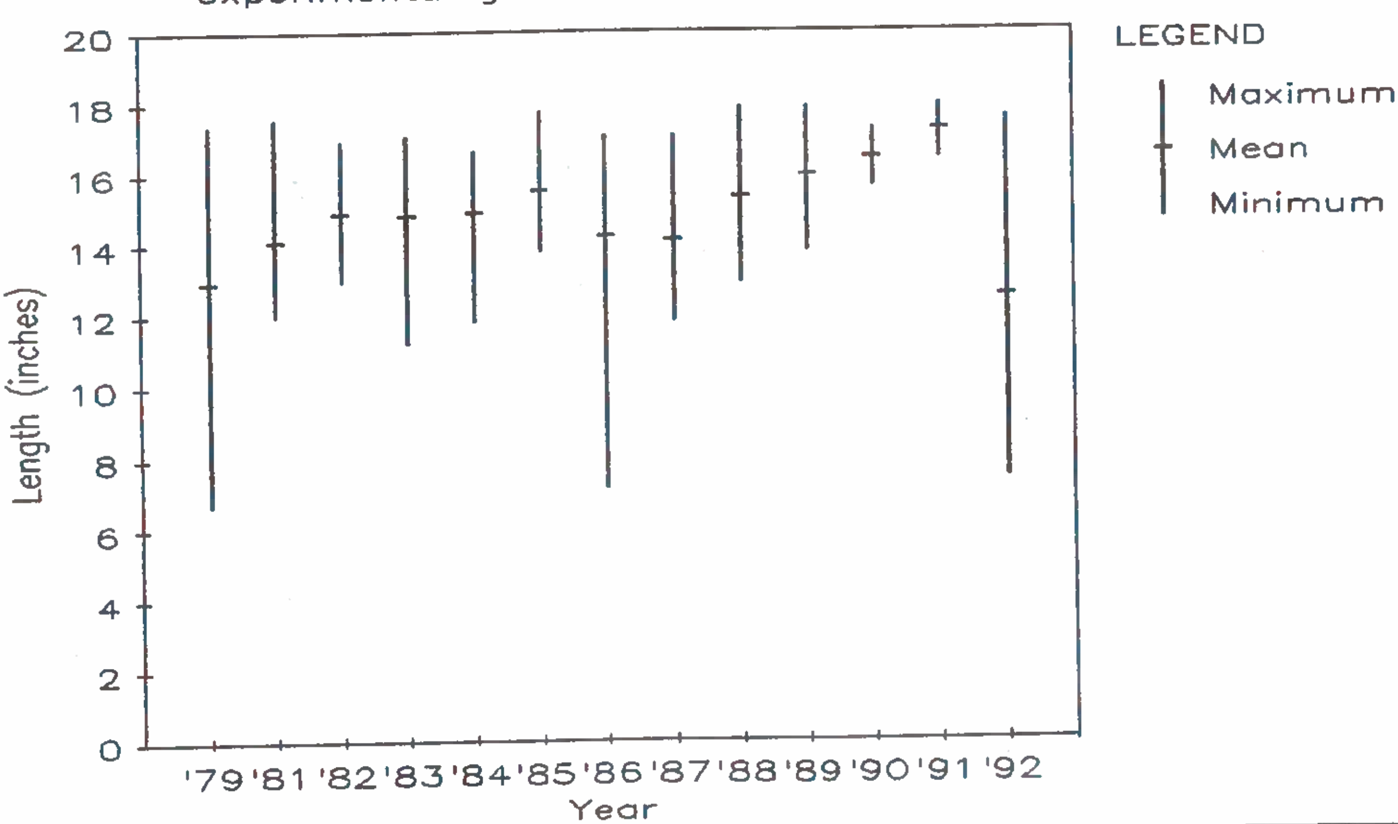


Figure 28. Spring numbers of lake trout per 125 foot experimental gill net sample collected from Elk Lake 1979 - 1992.

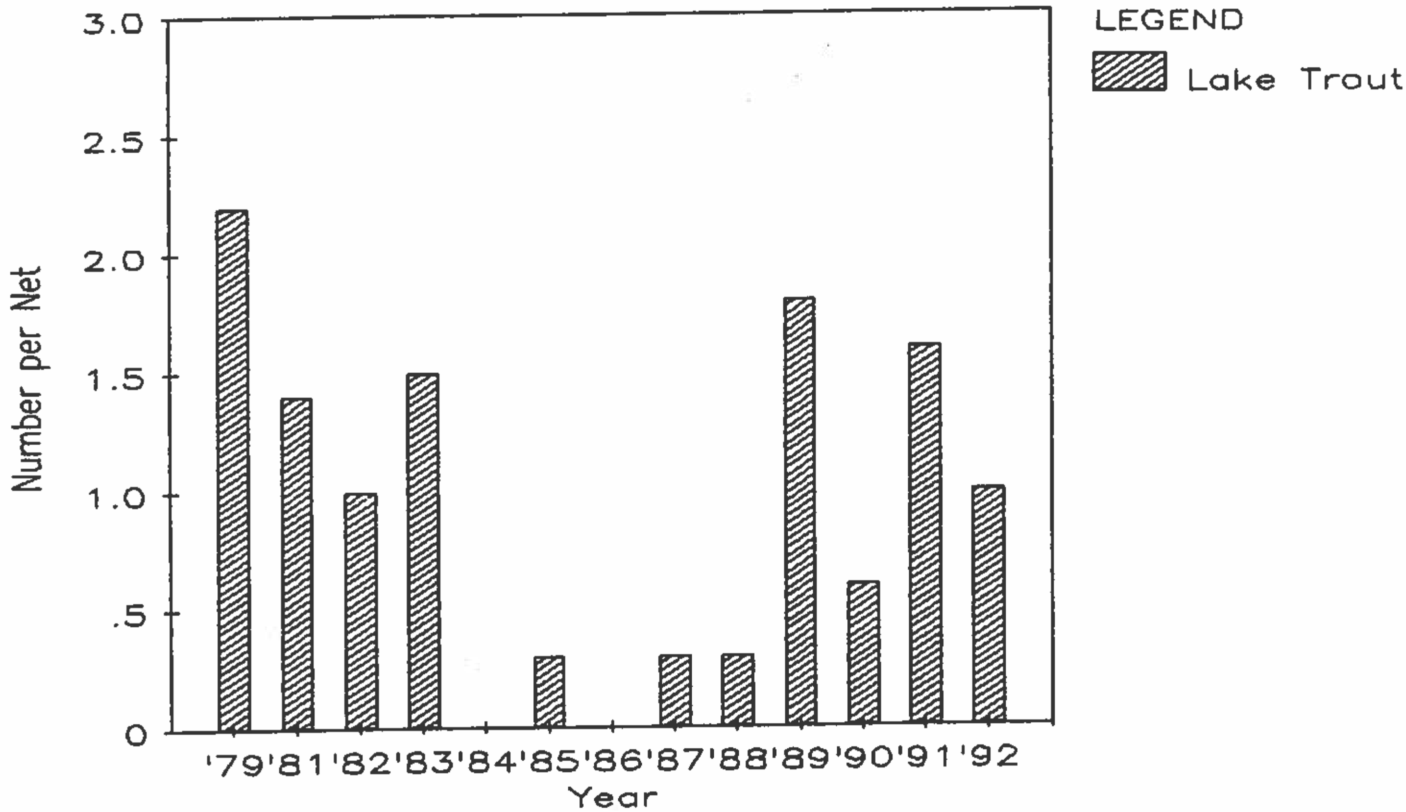
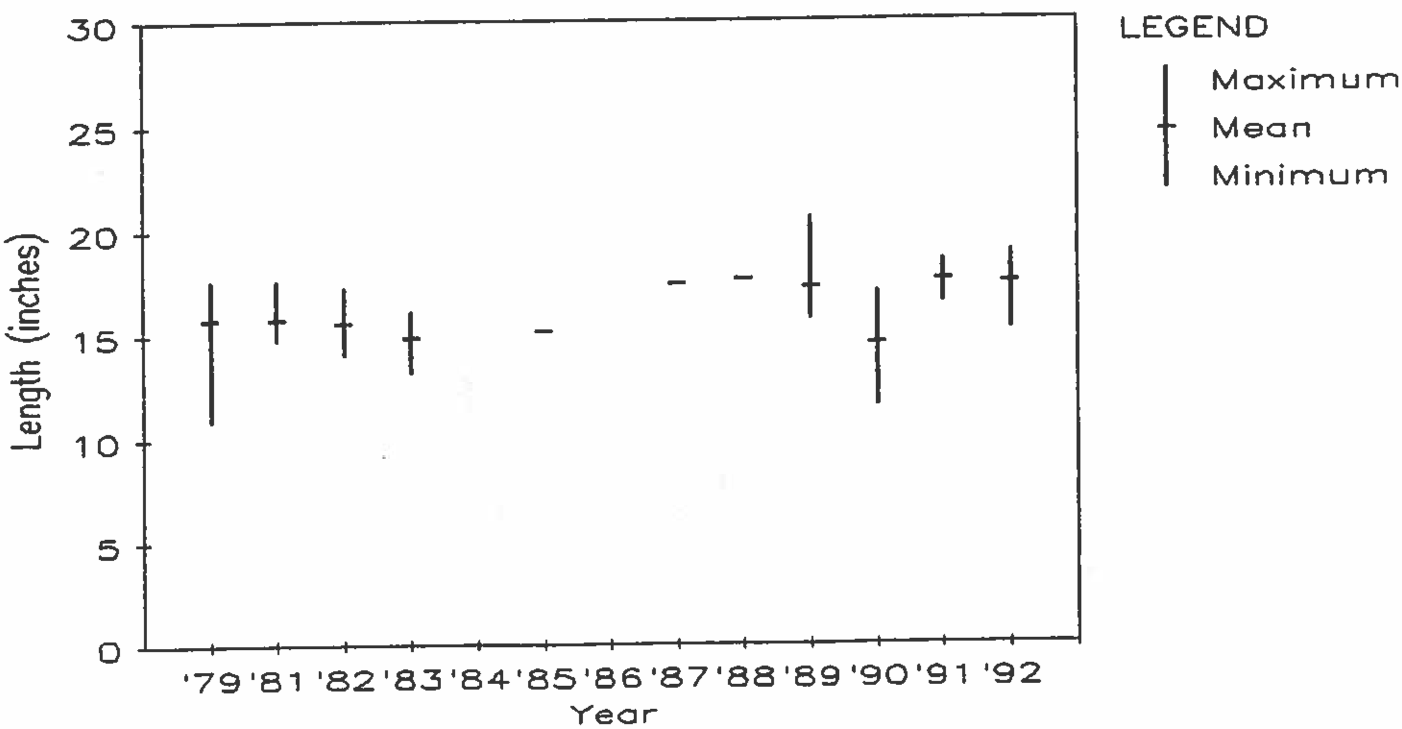


Figure 29. Length range and mean length of lake trout collected from spring samples using 125 foot floating and sinking experimental gill nets set in Elk Lake 1979 - 1992.



* Sinking Nets Used 1979, '89 - '92.

Figure 30. Spring numbers of rainbow trout per 125 foot experimental floating gill net sample collected from Hidden Lake 1985 - 1991.

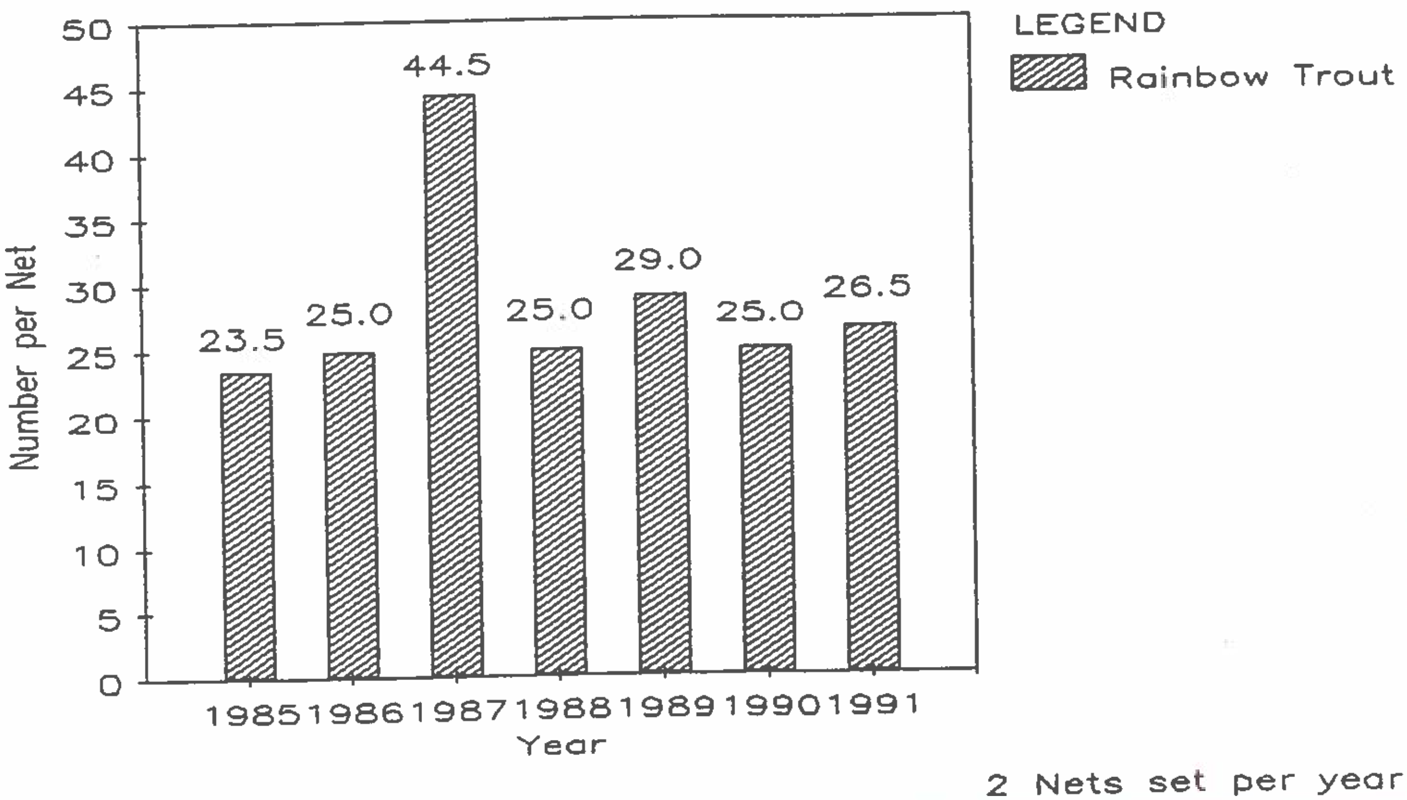


Figure 31. Age composition of spring rainbow trout samples collected in 125 foot floating experimental gill nets set in Hidden Lake 1985 - 1991.

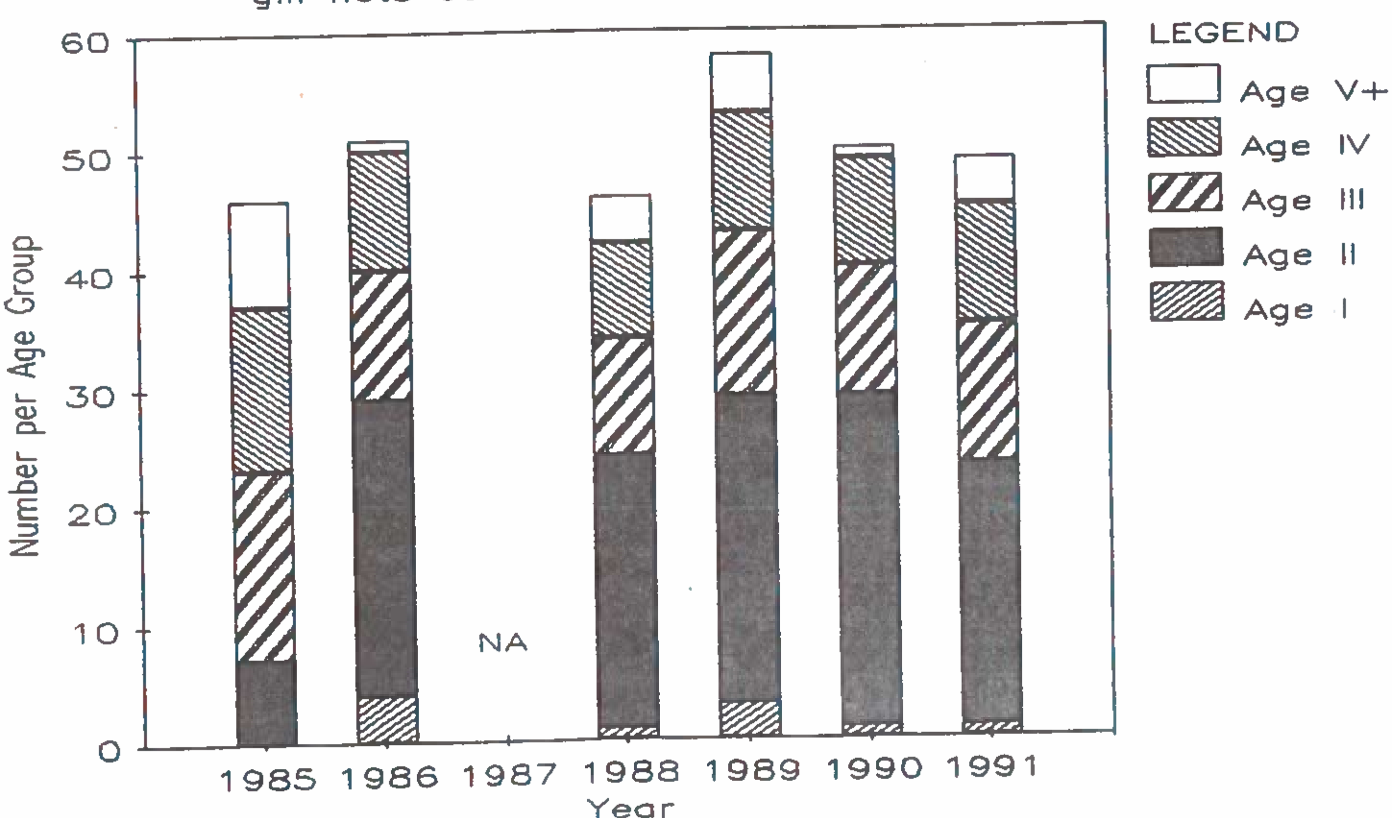


Figure 32. Length range and mean length of rainbow trout collected from spring samples using 125 foot experimental gill nets set in Hidden Lake 1985 - 1991.

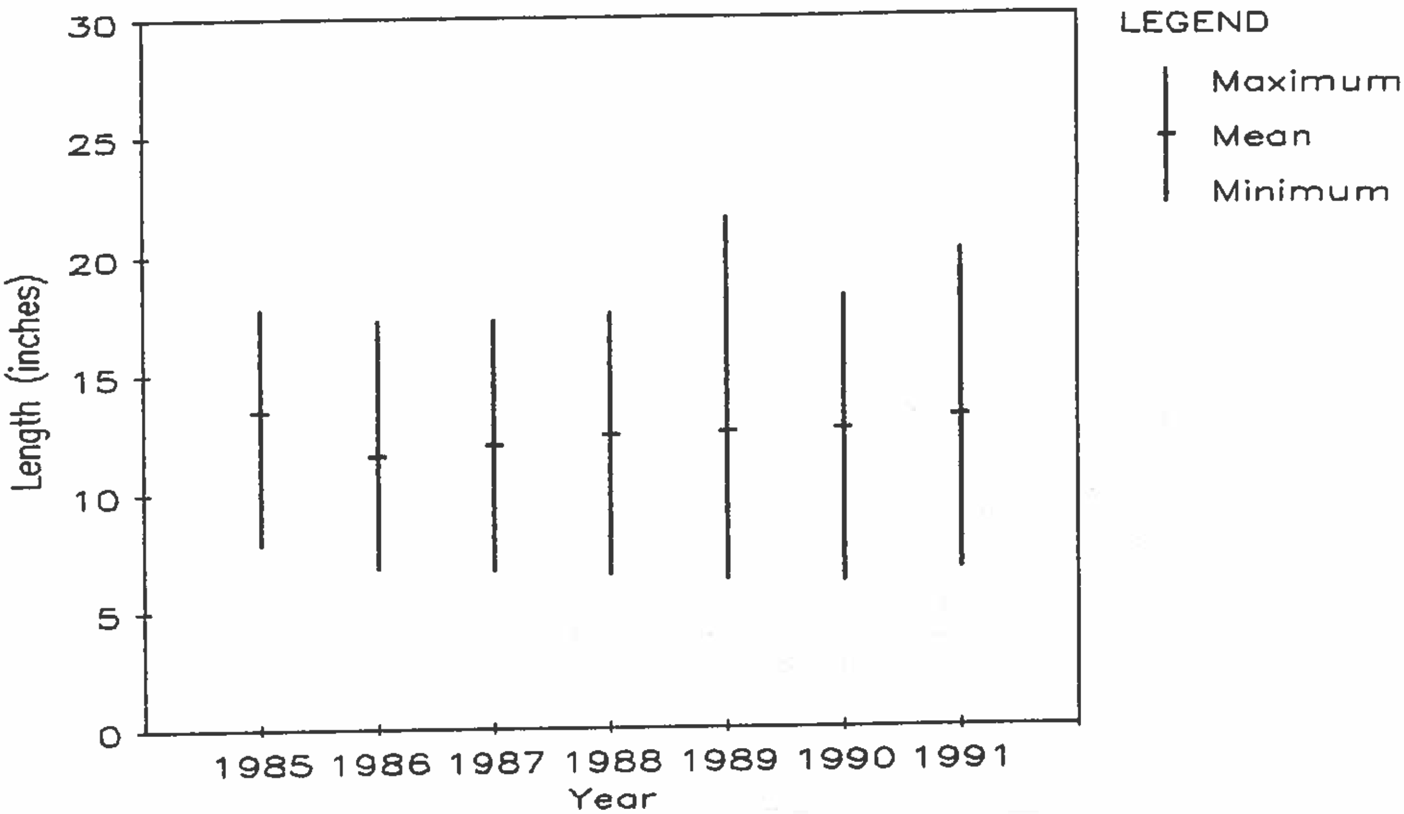


Figure 33. Mean length at age for rainbow trout collected in spring samples from Hidden Lake. Means derived from composite of samples collected in experimental gill nets over the 1985 - 1991 period.

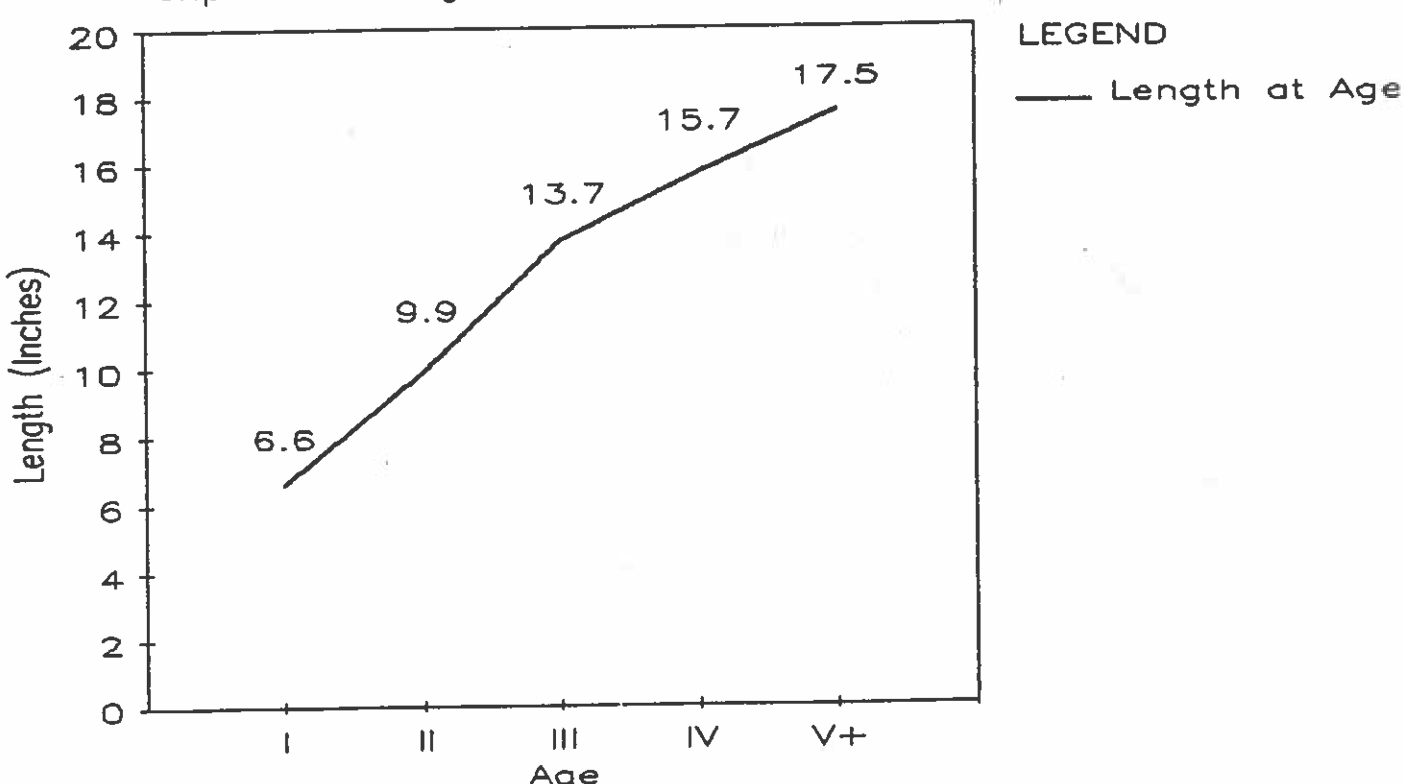


Figure 34. Spring numbers of brook trout per 125 foot experimental floating gill net sample collected from Culver Pond 1971 - 1992.

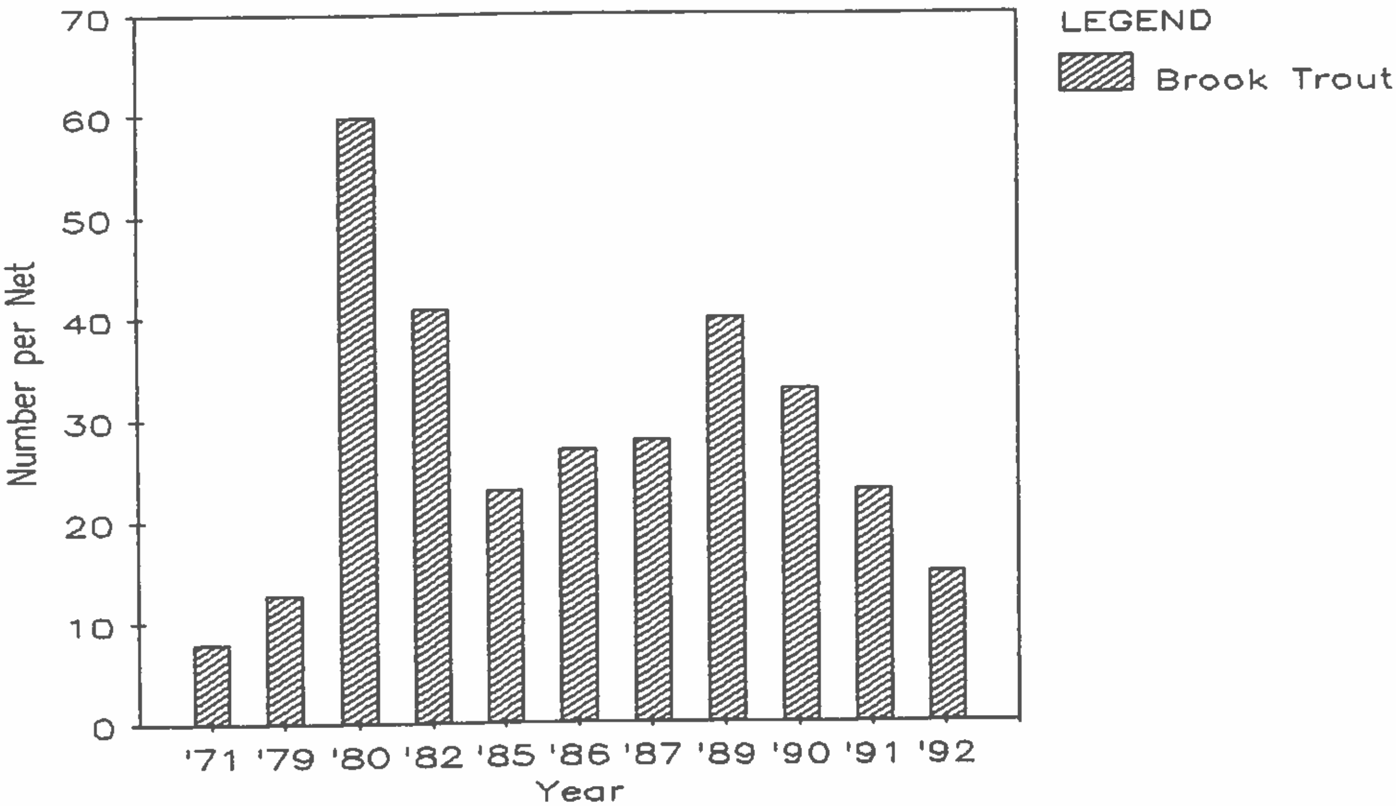


Figure 35. Age composition of spring brook trout samples collected in experimental gill nets set overnight in Culver Pond 1985 - 1992.

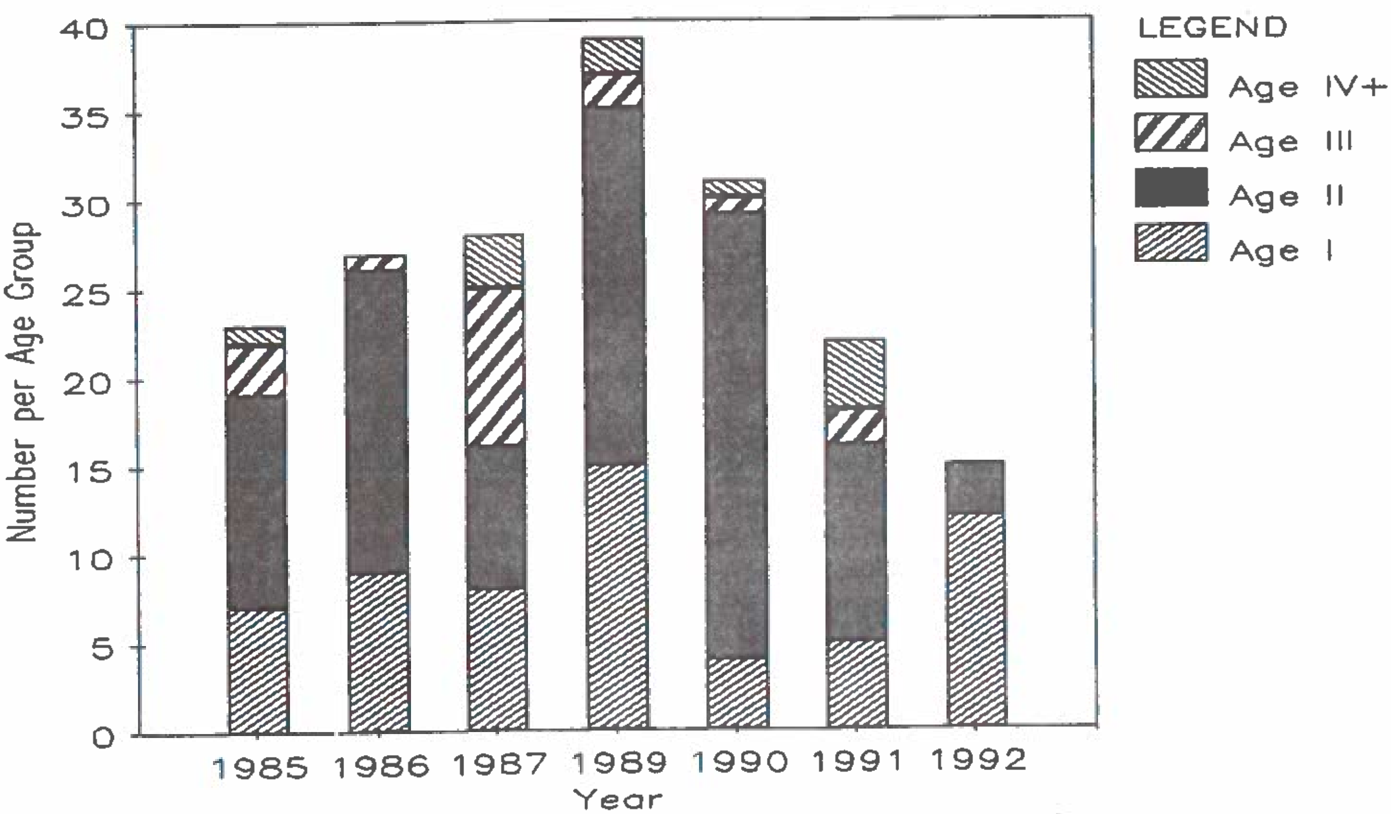


Figure 36. Length range and mean length of brook trout collected from spring samples using 125 foot experimental gill nets set in Culver Pond 1971 - 1992.

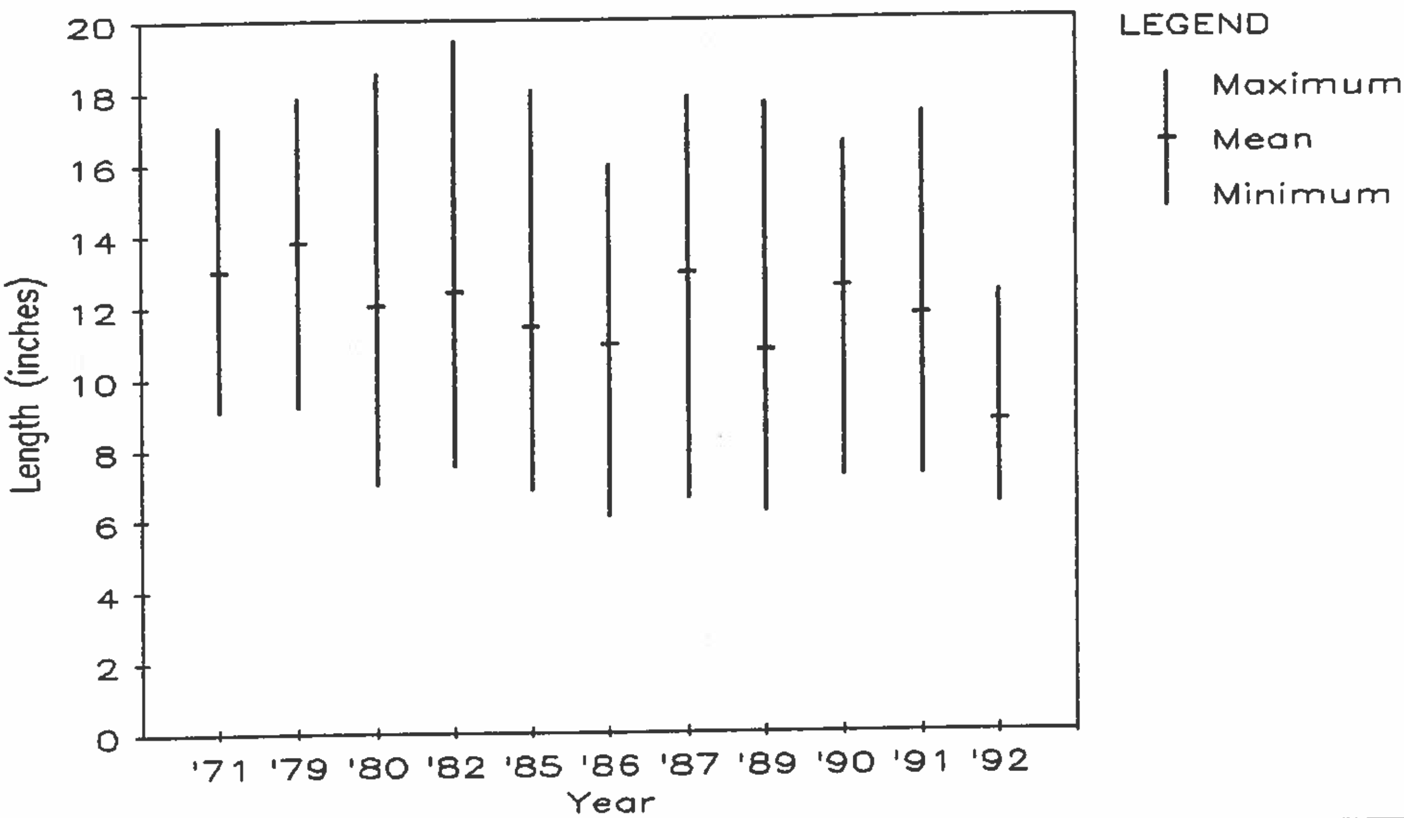


Figure 37. Spring numbers of 15 inch and larger brook trout collected per experimental gill net set in Culver Pond 1971 - 1992.

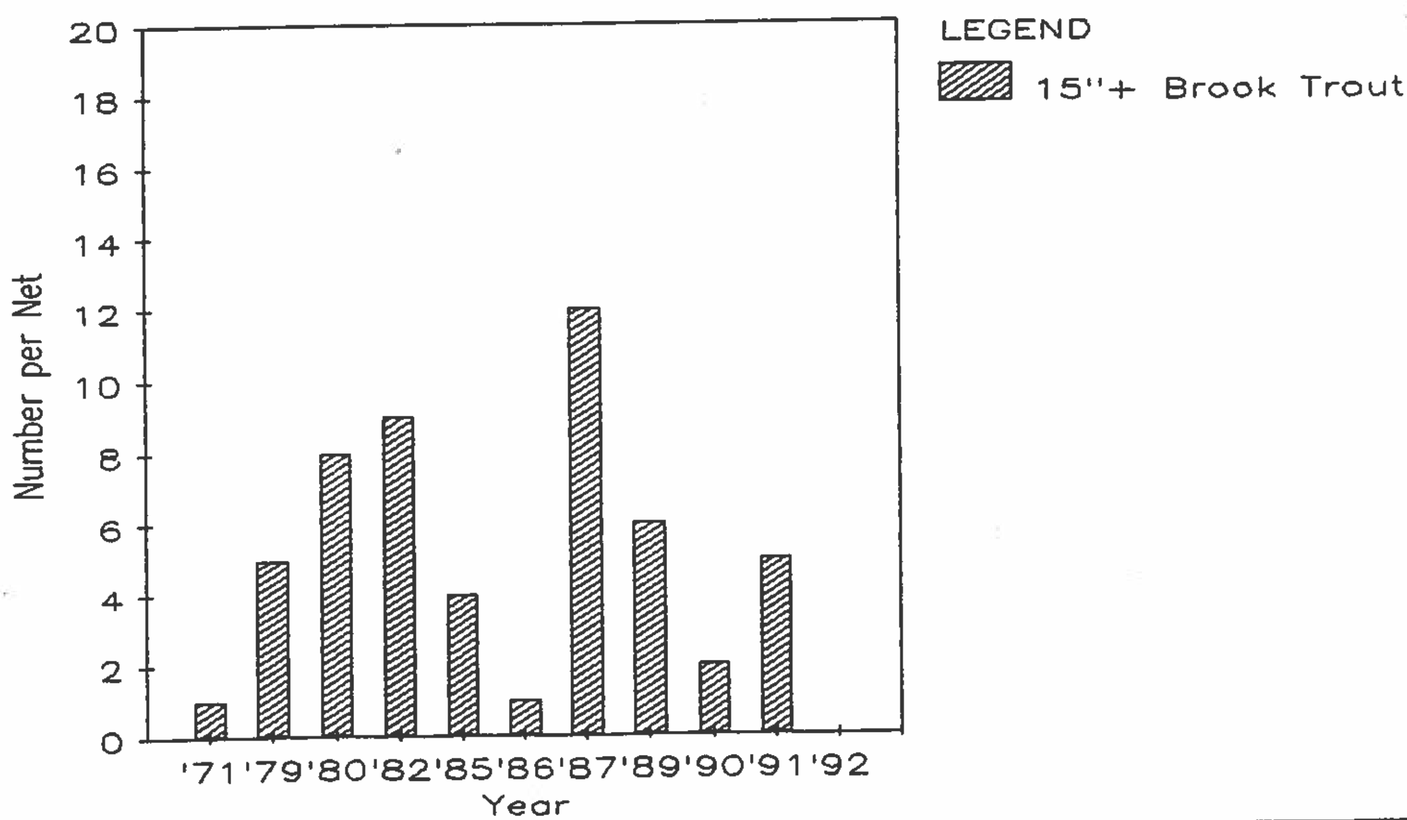


Figure 38. Spring numbers of rainbow trout per 125 foot experimental floating gill net sample collected from McDonald Pond 1971 - 1992.

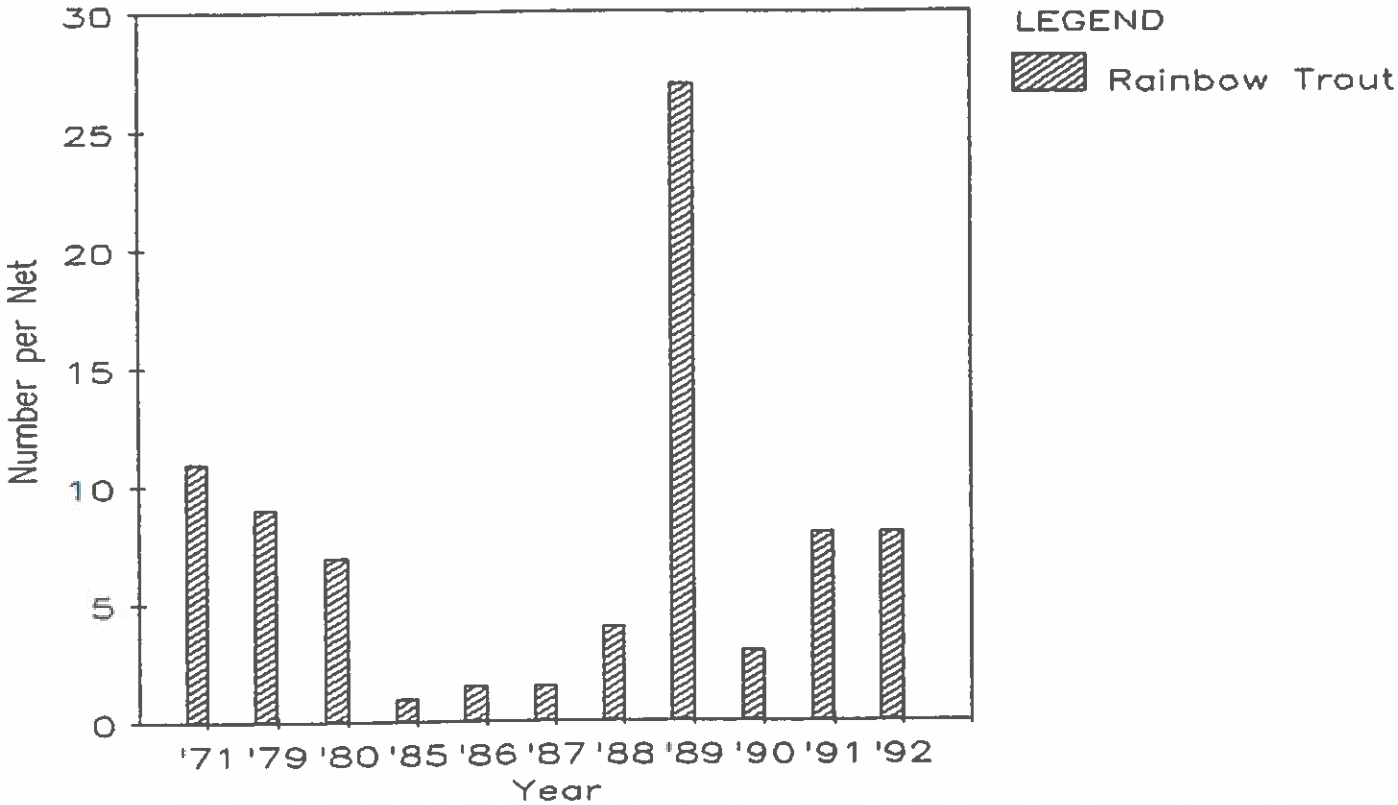


Figure 39. Length range and mean length of rainbow trout collected from spring samples using 125 foot floating experimental gill nets in McDonald Pond 1971 - 1992.

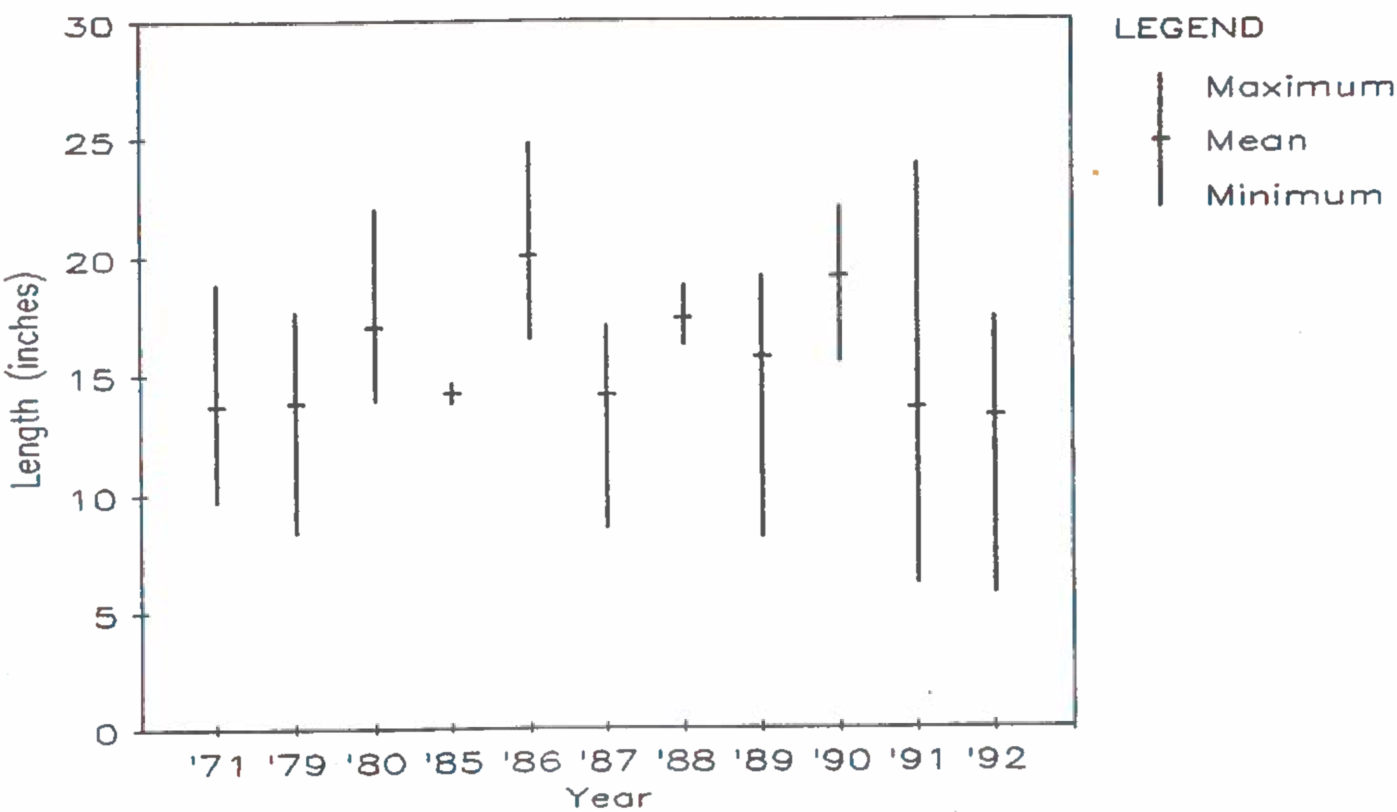


Figure 40. Summer numbers of brook trout and arctic grayling collected in 125 foot floating experimental gill nets set overnight in Miner Lake in 1964 and 1990.

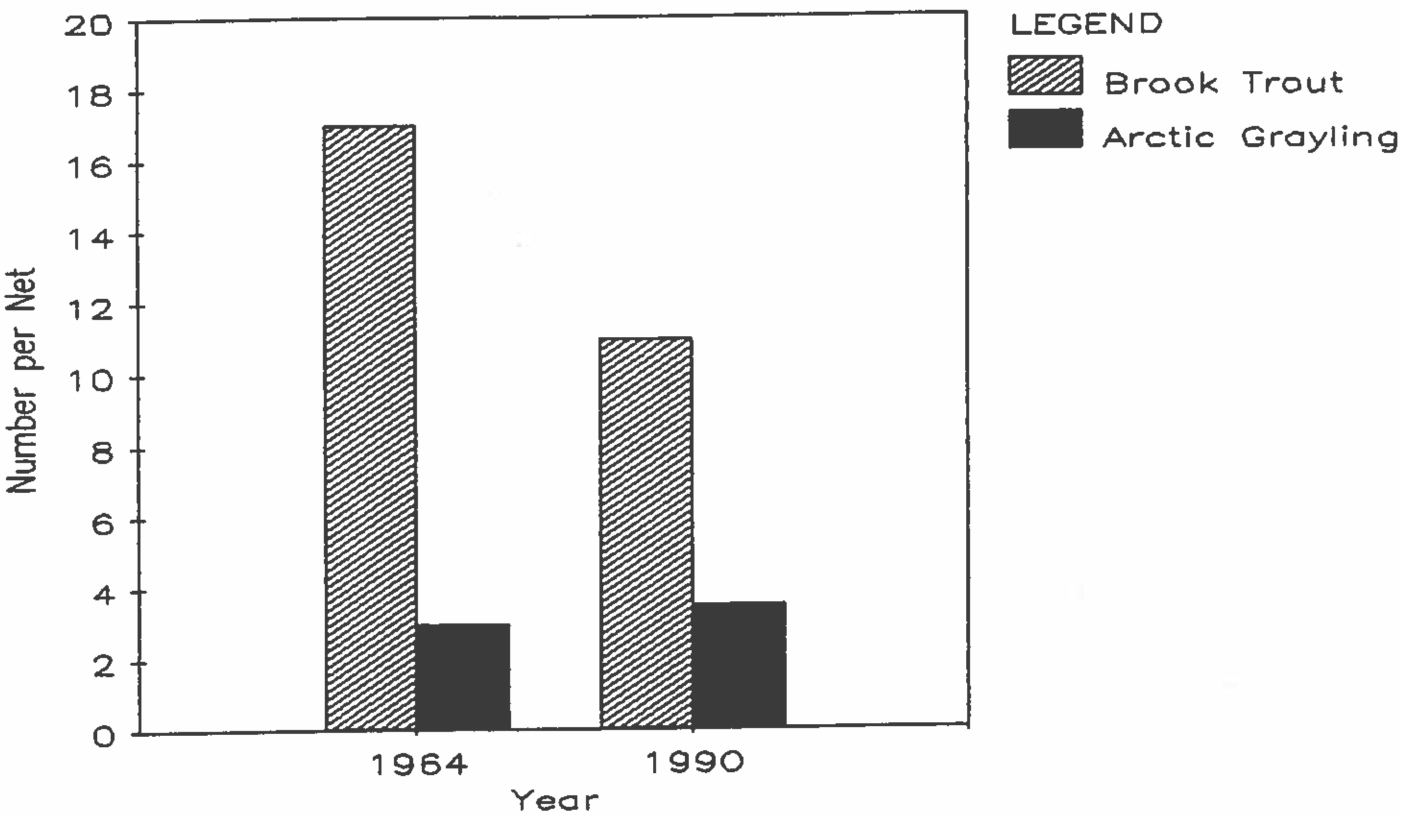


Figure 41. Mean length and length range for brook trout and arctic grayling collected in summer net samples from Miner Lake in 1964 and 1990.

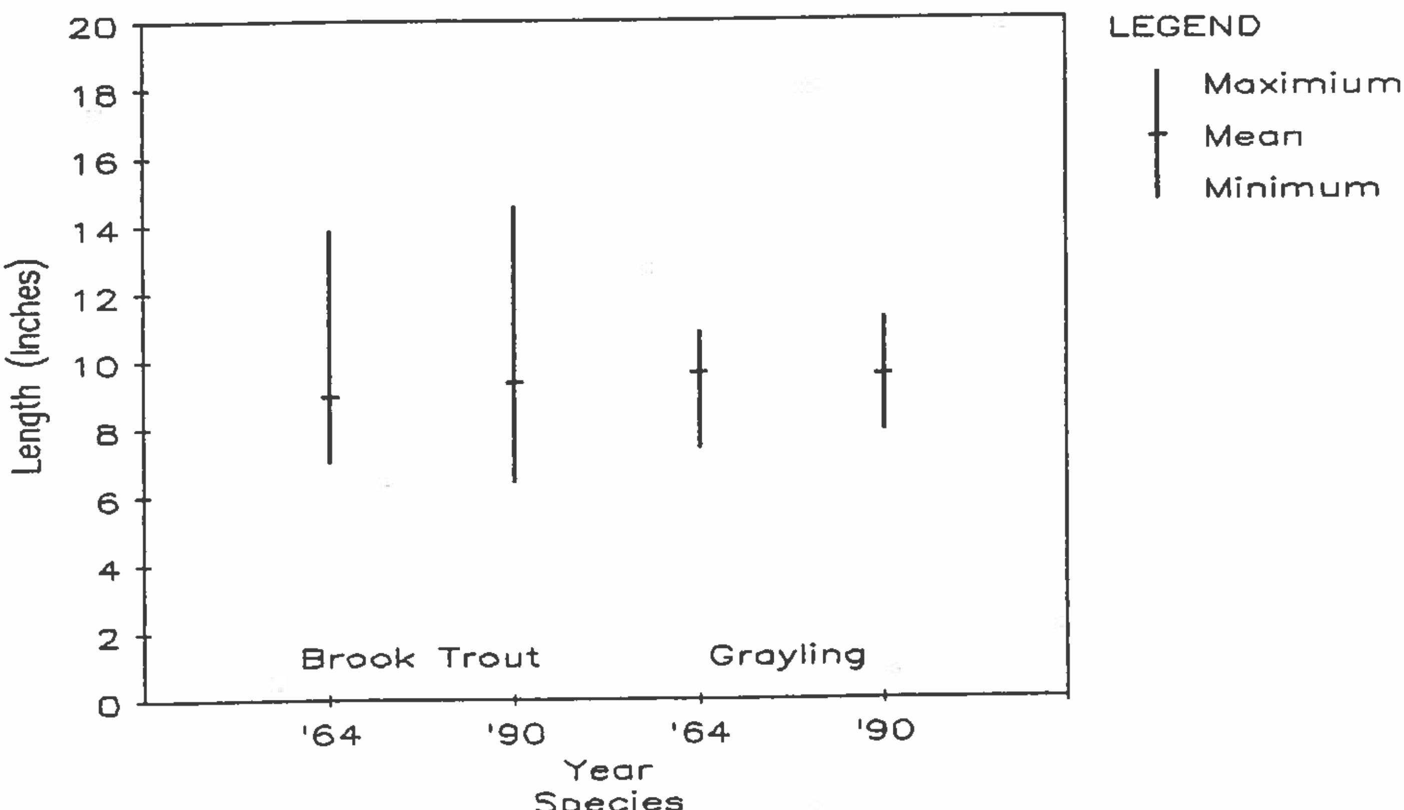


Figure 42. Numbers of lake trout and brook trout collected in floating and sinking experimental gill nets set overnight in Twin Lakes 1964 - 1992.

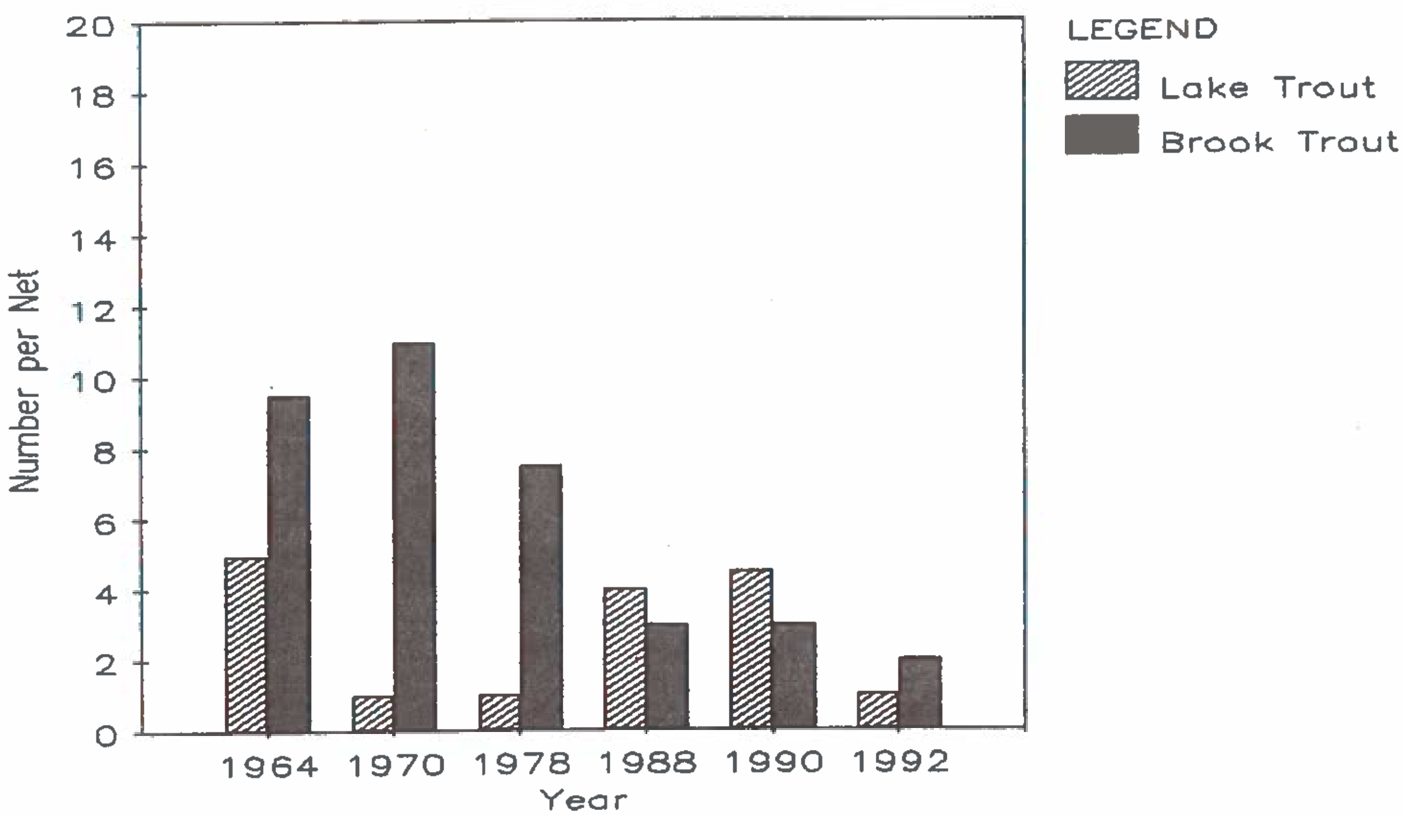


Figure 43. Mean length and length range for lake trout and brook trout collected in gill net samples from Twin Lakes 1964 - 1992.