MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION

JOB PROGRESS REPORT

State: Montana

Project Number: F-46-R-3
Job Number: I-f

Project Title: Statewide Fisheries Investigations
Study Title: Survey and Inventory of Cold Water Streams
Job Title: Southwest Montana Major River Fisheries Investigation

Period Covered: July 1, 1989 through June 30, 1990

OBJECTIVES

Madison River

1. Maintain a minimum flow ≥700 cfs at the Kirby gage below Quake Lake and ≥1100 cfs downstream from Ennis Dam.

Worked with the Montana Power Company using SCS snow survey information to insure stream flows at both gage sites remain at or above the 700 and 1100 cfs levels, respectively.

2. Maintain wild trout population ≥3000 age II and older trout/mile below Ennis Dam and determine effects of water temperatures on catch rates.

Spring wild trout population estimate was made in the Norris section to be compared with previous population estimates. Water temperature data was gathered using a thermograph. Data will be analyzed at a later date.

3. Maintain channel and streambanks in present or improved conditions.

Data included in this report.

4. Maintain aesthetic quality of upper Madison River fishing experience (State Project).

No work was done on this objective at this time as the Scenic Easement Committee was not reactivated.

5. Maintain densities of wild trout ≥13 inches at 1200/mile between Quake Lake and McAtee Bridge (catch-and-release section).

Wild trout population estimates were made for the Pine Butte and Snoball sections for the fall, 1988 and spring 1989 period. Data included in future report.

6. Maintain densities of wild trout ≥13 inches at 1200/mile between Varney Bridge and Ennis Lake with the opportunity of catching large size (≥18+ inches) brown trout.

Fall fish population was made with data included in this report.

7. Attempt to disperse angler use in the Quake Lake to Ennis Lake reach. Continue to provide spatial segregation for bank and boat anglers, where possible (State Project).

No work was done on this objective at this time, as special angling regulations were enacted in 1988 to divide the river between Ennis Lake and Quake Lake into areas of wade only fishing and areas which fishing from boat was allowed to disperse the two use types to minimize social interaction

Yellowstone River

1. Reduce magnitude of irrigation season dewatering in spring tributaries during cutthroat trout spawning and incubation periods.

Graduate student study was set up to determine cutthroat trout spawning and recruitment requirements in the various spawning tributaries.

2. Maintain channel and streambanks in present or improved condition.

Data included in this report.

3. Maintain water quality and aesthetics of river.

A cooperative study with Yellowstone National Park was initiated to determine the location and causes of sediment input into the Yellowstone River during summer rain events.

4. Maintain a catch rate of 0.5 fish/hour with trout population densities ≥1000 fish greater than 9 inches/mile and 50 cutthroat trout over 12 inches/miles.

Four wild trout population sections were electrofished during

1987-88 period. Data will be included in a future report.
5. Increase cutthroat trout numbers in Yellowstone River.

A catch and release angling regulation was adopted for the Yellowstone River to reduce the annual mortality of cutthroat. Cutthroat trout eggs were placed in some of the spawning tributaries to determine if numbers in the river could be increased.

6. Provide increased opportunity to catch large trout in a reach of the Yellowstone River.

A special angling regulation was installed on the section of the river between the Emigrant Bridge and the Pine Creek Bridge (5 trout of which four can be below 13 inches and only one can exceed 22 inches) to provide more large trout.

7. Acquire a suitable fishing access site between Highway 89 and Springdale (State Project).

Attempted to purchase a parcel of land in this area, but failed. Have contacted the Montana Dept of Highways and obtained a site near the Highway 89 bridge.

Big Hole River

1. Insure, within hydrologic constraints, that flow do not fall below minimum of 300 cfs in reach 1, 200 cfs in reach 2 and 100 cfs in reach 3 of the Big Hole River.

Instream flows reservations filings are being prepared for future filing.

2. Maintain channel and streambanks of the Big Hole River in present or improved state of stability.

Data included in future report.

3. Maintain instream sediment levels and flow regime at average current levels.

Reviewed those U.S.Forest Service timber sale and road plans which affected flows and water quality.

4. Maintain fluvial grayling populations at a minimum of 40 age II and older fish per mile upstream from Pintlar Creek.

Electrofished the Big Hole River between Wisdom and Wise River to define characteristics of Grayling spawning run and to determine the amount of Grayling habitat which presently exists. Work with the Grayling study committee to formulate a

Grayling recovery plan. Data to be included in future report.

5. Maintain brown trout populations in lower river (Glen Access to mouth) at densities ≥1000 age II and older fish/mile with limited numbers of rainbow trout.

Data was collected and will be included in a future report.

6. Maintain brown trout population in lower, mid-river (Divide to Glen Access) at densities ≥750 age II and older fish/mile and rainbow trout densities ≥1000 I and older fish/mile.

Spring and fall brown and rainbow trout population estimates were made in the Maiden Rock section to determine their densities with data to be included in a future report.

7. Maintain rainbow trout populations in upper mid-river (Pintlar Creek to Divide) at densities ≥1300 age I and older fish/mile and brown trout densities at ≥200 age II and older fish/mile with limited numbers of fluvial grayling and brook trout.

Fall population estimates were made on the Jerry Creek study section in 1988 and 1989 with data to be included in a future report.

8. Maintain native, fluvial grayling populations at a minimum of 40 age II and older/mile in upper river (Headwaters to Pintlar Creek) and densities of age II and older brook trout at ≥400 per mile.

Data will be included in a future report.

9. Maintain numbers of larger, brown trout (≥18 inches) at densities ≥100/mile and large rainbow trout (≥15") at densities ≥100/mile in special regulation section (Divide to Melrose).

Special angling regulations which allows only a 5 trout limit of which only one can exceed 22 inches and catch and release only fishing for trout between 13 inches and 22 inches was evaluated using spring and fall population estimates from the Maiden Rock study section. Data will be included in a future report.

10. Collect information on fishing pressure, harvest, catch rates, angler attitudes and preferences to assist in responsible management.

No work was accomplished on this objective.

11. Provide increase user access to Big Hole River between the

notch and Pennington Bridge (State Project).

Final plans for the development of the Notch Access has been approved with negotiations being made for an additional access site at Pennington Bridge.

12. Provide increased acreage of public land in Big Hole River Corridor.

Continued discussion with the BLM to locate additional public river frontage.

13. Keep Big Hole River management current with angler needs and expanding recreational demand.

The development of the Big Hole River management plan was completed.

14. Mitigate or eliminate deleterious effects of planned developments in the fishery of the Big Hole River including water quality and quantity and aesthetic values.

Was involved in various USFS and BLM planning processes.

Beaverhead River

1. Within hydrologic constraints, seek to obtain minimum non-irrigation season releases of 250 cfs from Clark Canyon Dam and maintain minimum flows of 150 cfs in the river downstream from Barretts. Maintain stable, spawning season flow releases.

Worked with the U.S. Bureau of Reclamation to insure the best possible flows from Clark Canyon Dam for sections of the river above and below Barretts Diversion.

2. Eliminate gas bubble trauma in Beaverhead River trout population.

Trout populations were sampled to determine number, species and sizes having gas bubble trauma. Percent gas saturation was also measured. Data will be analyzed at a future date.

3. Insure that operation of proposed hydroelectric generator does not alter flow regimes or temperatures of discharges and utilize hydro generation to eliminate gas supersaturation problems.

Reviewed plans for proposed hydroelectric generator and made comments necessary to insure adequate protection to fisheries resource in river.

4. Maintain densities of ≥250 brown trout 18" and larger/mile and ≥150 rainbow trout 18" and larger/mile above Henneberry. Maintain densities of ≥1000 age II and older brown trout and ≥600 age I and older rainbow trout per mile above Henneberry.

Spring and fall population estimates were made for the Hildreth and Pipe Organ sections of the river above Barretts Diversion for the spring and fall of 1989. Data will be included in this report.

5. Collect population information for lower Beaverhead River (downstream from Barretts) to assist in management decisions (State Project).

Spring brown trout estimates were made for the Fish and Game, Low Flow, and Twin Bridges study sections. Data will be included in this report.

6. Maintain or increase numbers of rainbow trout in river upstream from Barretts.

Spring and fall rainbow population estimates were made for two sections of the river above Barretts Diversion with rainbow trout numbers being estimated. Data will be included in this report.

7. Collect information on fishing pressure, harvest, catch rates, angler preferences and attitudes to assist in managing for high quality angling experiences (1991).

Creel census and angler survey was initiated in spring 1989 with data to be included in a future report.

8. Increase angler use of Beaverhead River downstream from Barretts in an effort to decrease use of upper river (State Project).

No work done on this objective at this time.

9. Keep Beaverhead River management current with angler needs and expanding recreational demand.

No work on this objective at this time.

10. Maintain channel and streambanks in present or improved state of stability.

Data to be included in this report.

Gallatin River

1. Maintain channel and streambanks in present or improved stability.

Data to be included in this report.

2. Mitigate and reduce irrigation season dewatering in Gallatin River.

Actively promoted the irrigators to petition a ditch rider to be appointed by the water judge to insure water reaching all portions of the river.

3. Decrease magnitude of sediment and turbidity from Taylor Fork and Sage Creek.

Worked with the Gallatin Forest to promote better land use practices in these drainages.

4. Maintain wild trout populations of ≥2500 age II and older fish per mile upstream from Gallatin Gateway.

Data to be included in a future report.

5. Determine potential of establishing large trout management area between mouth of canyon and Gallatin Gateway (State Project).

Electrofishing data will be included in a future report.

Jefferson River

1. Insure, within hydrologic constraints, that flows do not drop below 550 cfs at the Three Forks gage.

Instream flow reservations filings are being prepared for future filing.

2. Maintain channel and streambanks in present improved state of stability.

Data will be included in this report.

3. Increase numbers of rainbow trout to ≥200 age I and older/mile.

Special angler regulations were installed on the Jefferson River allowing only catch and release fishing for rainbow trout. The Hell's Canyon Creek rainbow trout spawning run was electrofished obtaining rainbow eggs to hatch and stock in a spring creek to imprint a possible new rainbow spawning run for the river.

4. Maintain densities of ≥450 age II and older brown trout/mile from mouth to Boulder River and ≥600 age II and older brown trout/mile between the Boulder river and the head of the river.

Brown trout population estimates were made on two sections of the river to determine the number of brown trout per mile. Data will be included in a future report.

5. Increase recreational use of Jefferson River (State Project).

No work done on this objective.

6. Acquire additional access sites at Kountz bridge and Waterloo bridge.

Both locations were initiated and the Kountz Bridge site was acquired.

7. Elevate public awareness of values of fishery (State Project).

No work was done on this objective.

Missouri River

1. Insure, within hydrologic constraints, that flows do not fall below 1500 cfs above Canyon Ferry Reservoir.

Instream flow reservations filings are being prepared for future filing.

2. Maintain channel and streambanks of the Missouri River in present or improved state of stability.

Data will be included in this report.

3. Restore the fall run of rainbow trout out of Canyon Ferry Reservoir to 1978 levels and provide 12,000 hours of use with a harvest of ≥8000 rainbow trout.

No work was done on this objective be cause of lack of time.

4. Increase reproduction of brown and rainbow trout (State Project).

Preliminary work was initiated.

PROCEDURES

Fish Populations in the Jefferson, Missouri and Yellowstone River were sampled with an 18-foot aluminum boat powered by a 90 horsepower outboard motor with a jet unit. The boat was equipped with a double boom system. A mobile positive electrode boat electrofishing system was used to electrofish the Beaverhead, Big Hole, Gallatin and Madison Rivers.

Population estimates of trout were made using the Peterson type mark and recapture system described by Vincent (1971). Multiple mark and recapture runs were made where either sample size or efficiency was low. All movement studies were based on fish marked with individually numbered Floy FD-68B anchor tags.

Streambanks and channels were protected from poorly designed projects through FWP participation in administration of the Stream Protection Act and Natural Land and Streambank Protection Act of 1975 (SB 310). Water discharge permits issued by EPA and the Montana WQB will be reviewed and comments offered. A hand held current meter was used to make flow measurements.

Mark-recapture population estimates were made each fall from 1967-1989 during the month of September. Methods were described by Vincent (1987). During most years a total of 3 marking runs and 2 or 3 recapture runs were required to obtain valid estimates. Average recapture efficiencies were generally 10-15%.

FINDINGS

BEAVERHEAD RIVER

Fish Populations. Fish population data for study sections on the Beaverhead River were last presented in 1986 (Oswald 1986). Since that time, new study sections have been added to typify Beaverhead River trout populations under different flow and habitat conditions throughout the length of the system. The Twin Bridges Section was initiated in 1987 and sampled for three successive spring seasons. This section originates at the mouth of the Ruby River (T3S, R6W, SE1/4, NE1/4 Sec. 33) and continues downstream for a distance of 2.50 miles to the Highway 41 bridge at Twin Bridges (T3S, R6W, SW1/4, SW1/4 Sec. 27). This reach of the Beaverhead River had not been sampled previously and was used to describe existing trout populations under conditions of varying flow regime, poor riparian development, unstable streambanks with frequent artificial manipulation and heavy sediment loading. The Mule Shoe section was initiated in the spring of 1990. This Section originates at the Highway 41 bridge at Beaverhead Rock (T5S, R7W, NW1/4, SE1/4 Sec. 22) and proceeds 3.14 miles downstream to the diversion of the Island Ditch (T5S, R7W, NW1/4, NE1/4 Sec. 14). This Section approximates the location of the old Blaine study Section which was sampled during the 1971-75 period. The Mule Shoe Section was initiated to monitor changes from the 1970's and typify brown trout populations in a mid-lower river habitat subject to low summer flow regimes, sediment loading, variable riparian development, and numerous areas of bank and channel instability. The Low Flow Section was initiated in 1987 in order to typify brown trout populations under good habitat conditions and limited flow regimes. This section is located in the reach of river commonly managed by releases from Clark Canyon Dam as the low flow point in the Beaverhead River irrigation system. The Low Flow Section originates at a small diversion immediately downstream from the Selway Bridge on the north side of the City of Dillon, Montana (T7S, R8W, SE1/4, SE1/4, Sec. 7. The section continues downstream for a distance of 2.50 miles to the Hayden Ditch diversion (T6S, R8W, SE1/4, SW1/4, Sec. 33). This section approximates the old Sportsman's Park Section that was sampled in 1967 and 1968. The Fish and Game Section which was sampled in 1980 and 1981 was resampled 1988-90 to provide a basis for comparison with the Low Flow Section. Summer streamflow in the river reach containing the Fish and Game Section is much more stable and abundant than flows in the Low Flow Section. The Fish and Game Section was shortened slightly from its original length to 1.70 miles and presently ends at the mouth of Poindexter Slough. In addition to these new and reinstated study sections, data were collected in the Pipe Organ (2.49 mi.), Henneberry (1.50 mi.), and Hildreth (1.18 mi.) Sections since data were last reported for 1984 (Oswald 1986).

Because a large number of study sections were sampled in a relatively proximal time period, a comparison of the brown trout populations of reaches spanning the length of the Beaverhead River can be presented. Recent drought conditions and drastically reduced storage pools in Clark Canyon Reservoir have resulted in lower than average streamflows in all reaches of the river in 1989 and 1990. The low flow regimes have been most pronounced in the non-irrigation season in the upper tailwater reach and most effective during the irrigation season in the lower reaches of the river. For this reason, 1988 was chosen for the year to compare brown trout populations within the Beaverhead mainstem. Data for 1987 was used for the Henneberry Section because that was its last sample date while 1990 data was the only sample available for the Mule Shoe Section. Comparative data for brown trout density and standing crop within the mainstem Beaverhead River are presented in Figure 1. The data presented clearly demonstrate different trends in brown trout density and standing crop in a downstream progression. Density of Age II and older brown trout increases in a downstream progression to the Dillon vicinity; then drops off dramatically in poorer habitats in the lower reaches. Standing crop, however, attains its maximum levels in upper reaches of the tailwater, drops in the lower portion of the tailwater, rises again in the reach upstream from Dillon and drops rapidly downstream from Dillon with declining quality of flow regime and habitat. It is interesting to note that standing crops far exceed density in the productive Hildreth and Henneberry sections and largely drop below the density line downstream. The only exception to this trend is the Mule Shoe Section where both density and standing crop decline to the observed minima in the Beaverhead system. A comparison between the Fish and Game and Low Flow Sections reveals similar densities but a significant difference in standing crops. The lower biomass of the Low Flow Section is reflective of restricted growth and ultimate size under low summer flow regimes.

Hildreth Section

Brown trout densities and standing crops are exhibited in Figure 2 for the 1985-90 sample period. Estimates presented are from spring samples to minimize brown trout movement and include Age II and older fish. The data shows a maturation of the strong recruitment of year classes from the 1980 and 1981 spawning seasons (Oswald 1984 and 1986). This is evidenced as a trend of increasing difference between density and standing crop over the 1983-88 period. In 1988, brown trout biomass reached a recorded high in the sampling history of the section while density was virtually at the mean population value of the past 15 years. On September 1, 1988, storage in Clark Canyon Reservoir dropped to 73,300 acre feet as a result of severe drought conditions and reduced inflow from the Red Rock River. A decision was made to reduce non-irrigation flow releases from the dam to 50 cfs over the 1988-89 winter period. In 1989, reservoir storage was further reduced to about 40,000 acre feet representing about 30% of average pool on September first. Flow releases from the dam for over - winter habitat in 1989-90 were further reduced to 35 cfs to combine with spring inflow to result in a river discharge of 50 cfs at the stream gauge station downstream from the dam. These non-irrigation flow releases were approximately one-third of the minimum flows observed through the remainder of the 1980's and represented a severe reduction in brown trout habitat when standing crop of brown trout was at high levels. Thus the 1989 standing crop underwent a reduction although numbers increased substantially. Despite severe flow reductions, brown trout density increased to record high levels in 1989 and 1990 samples. High standing crops were concomitant with the high densities but the difference between density and standing crop was much lower than normal for the Hildreth Section.

Analysis of the length composition of the 1985-90 brown trout populations of the Hildreth Section is presented in Figure 2. The data depict the maturation of the 1980-81 year classes as numbers of large fish increased to the observed maximum in 1988. The 1988 sample data depict a population in which 23% of the estimated population was greater than 20 inches in length. These larger fish accounted for 43% of the standing crop in the sample thus explaining the reason for the large difference between density and biomass. A strong recruitment of younger brown trout in 1988, 89 and 90 from the spawning seasons of 1985-87. The 1989 and 1990 samples show increasing percentages of the population accounted for by fish in the 14.0 - 17.9 inch range as numbers of large fish rapidly declined. In 1989, numbers of 20 inch and larger brown trout declined by 50% to account for 9% of the population and 19% of the biomass. By 1990, numbers of these larger fish had further declined by 66% from 1988 levels to account for 5% of the population and 11% of the biomass.

Because the upper Beaverhead River is a renowned trophy fishery, an analysis of the decline of the density and standing crop of larger brown trout is presented in Figures 4 and 5. These figures depict a rapid decline in the numbers and biomass of large brown trout at all size categories greater than 18 inches. The decline was most pronounced between 1988 and 1989, the first winter of severe streamflow reductions, and continued to a lesser degree between 1989 and 1990. The decline in standing crop of these large brown trout was of a greater amplitude than density despite the maintenance of high total population biomass due to increased numbers of smaller fish. The rapid erosion of the population of large brown trout suggests that the population suffered severe stress due to low flow regimes and further suggests that the entirety of the decline would not result from the over maturation of a population dominated by two year classes of old fish. Data presented in Figure 6 indicate symptoms of the stress applied to the brown trout population of the Hildreth Section by the low non-irrigation flow regimes. Data in Figure 6 show declines in average spring brown trout condition between 1988 and 1990. Observed brown trout condition in 1988 was approximately average for the Hildreth Section. Mean condition for the brown trout population declined 7.6% between 1988 and 1990. The majority of the decline occurred between 1988 and 1989. Mean condition of the 13.0-17.9 inch segment of the population was higher than the population mean but also declined 7.6% from 1988 to 1989 exhibiting the same trend over the 1988-90 period as the overall population. Larger brown trout (18 and 20 inch +) underwent a severe decline in condition resulting in a decline of 14.2% for 18 inch plus fish and 19.7% for 20 inch plus fish between 1988 and 1990. For these larger fish, condition continued to decline between 1989 and 1990 at an annual rate of 5.2% for 18 inch plus fish and 4.8% for 20 inch plus fish.

The data indicate that severe reductions in overwinter streamflow resulted in rapid and substantial declines in the population of large brown trout in the upper Beaverhead River. The stressful habitat conditions were compounded by high densities and extremely high standing crops of the mature fish. The situation may have been further compounded by the recruitment of large numbers of smaller fish, which, due to their lower demands for food and habitat, may have been stronger competitors under the reduced flow conditions. It is also possible, however, that declines in the density and standing crop of the larger trout provided an opening of habitat niches to the younger trout that were not available under the domination of the large brown trout. Future sampling will be required to determine the fate of the large numbers of younger brown trout in the Hildreth Section under continuing low winter flow regimes.

Population estimate data for rainbow trout were collected in the Hildreth Section over the 1985-89 period. Rainbow trout data were collected in fall sample seasons in order to avoid estimate inflation do to spawning movements. Estimated densities and standing crops of rainbow trout are presented in Figure 7 for the Hildreth Section. As in the case of the brown trout, rainbow trout biomass is widely separated from and much higher than density. This is indicative of a population in a productive environment with rapid growth and large ultimate size. Both density and standing crop remained high in the 1985-87 period but underwent a decline in 1988 and 1989. The difference between biomass and density decreased with declining populations in 1988 and 1989 indicative of a decrease in average size of the rainbow trout. Rainbow trout densities in 1985 and 1987 were the fifth and sixth highest observed over the past 16 years while standing crops observed in those years were the second and third highest in the period. Conversely, densities recorded in 1988 and 1989 were the lowest and third lowest observed over the 16 year period and standing crops were the lowest observed over the period in the Hildreth Section.

Analysis of the 1985-89 populations by length group (Figure 8) reveals a trend similar to that observed for brown trout. The 1985-87 period showed populations of increasing numbers of larger (18 and 20 inch plus) fish to a maximum attained in 1987. Since 1987, numbers of larger trout have declined and numbers of mid-sized (14.0 - 17.9 inch) rainbow trout have accounted for an increasing portion of the population. In contrast to the situation with the brown trout, numbers of smaller (8.0 - 13.9 inch) rainbow trout have also declined.

The data suggest that low non-irrigation season flow regimes have also resulted in declines in the rainbow trout population of the Hildreth Section. Symptoms of declining numbers of large fish as well as declining recruitment of young fish were also characteristic of rainbow trout populations under drought conditions in the Big Hole River (Oswald 1989). The domination of the rainbow trout population by mid-sized fish is similar to that of the brown trout of the Hildreth Section. The condition of the rainbow trout population could be compounded by competition from high densities of brown trout in the reach. In the 1990 fishing season, rainbow trout harvest limits were reduced to one fish. Future sampling will be required in order to determine the full affect of reduced flow regimes as well as reduced potential harvest on the rainbow trout population of the Hildreth Section.

Henneberry Section

The Henneberry Section was sampled over the 1984-87 period to establish a study section for comparison with the Pipe Organ Section under different angler use and harvest regulations. The end of the Henneberry Section and beginning of the Pipe Organ were separated by only about .15 miles. The beginning of the Pipe Organ Section is located at about the midpoint (7.3 miles below the dam) of the 14.6 mile (Dam to Barretts) tailwater. Thus the two sections are quite similar in terms of thermal regime, flow, and nutrient concentrations resulting from the tailwater of Clark Canyon Reservoir. Good to excellent channel and bank habitat is abundant in both study sections but eroded streambanks and altered reaches are much more prevalent in the Pipe Organ Section. Channel and bank alteration in the Pipe Organ Section is largely due to the proximity of the stream to a railroad embankment in downstream portions of the sample reach. Both sections experienced channel changes and meander cutoffs resulting from prolonged flooding during the summer of 1984 but these disruptions were much more significant in the Pipe Organ Section due to grazing practices and the discussed alterations. Brown trout density and standing crop is presented in Figure 9 for the 1985- 87 period in the Henneberry Section. The brown trout population of the Henneberry Section is typical of a very productive tailwater reach supporting high densities and higher standing crops. The positive difference between standing crop and density is indicative of a large average size for brown trout produced within the section. The data depict a rapid increase in both numbers and biomass in 1985 over levels observed in 1984 (Oswald 1986). Both density and standing crop declined from the 1985 peak in the two subsequent years but remained at relatively consistent levels with 1984. In 1985, brown trout biomass swelled to 3,037 lbs. per mile while it ranged between 1,771 and 1,817 lbs. per mile in the other three sample years. The trend of declining brown trout populations between 1985 and 1987 was also apparent in the Hildreth and Pipe Organ Sections (Figures 2 and 12) but 1984 populations in both of those sections were similar to those of 1985 suggesting the maturation of a strong cohort concomitant with poor recruitment of younger stocks. The inconsistency of the Henneberry data is further substantiated by a length analysis of the populations presented in Figure 10. Length distribution within the population displayed a high degree of consistency in 1984, 86 and 87 with the exception of the 8.0-13.9" group which would vary most widely dependant upon recruitment success. Examples of this consistency include the 14.0-15.9" group which varied between 397 and 423 per mile and the 20.0 inch and larger group which varied between 49 and 64 per mile. In 1985, the 14.0 - 15.9 inch group was estimated at 465 per mile and the 20.0" and larger group was 114 per mile. Examples of other exceptional length group estimates in 1985 included the 16.0-17.9 inch group which was 68% higher and the 18.0-19.9" group which was 112% higher than any other estimate in the 1984-87 period. There is no apparent basis in length group analysis for the high densities of all sizes of brown trout or the rapid increase in standing crop observed in 1985. Possible explanations for this phenomenon include a temporary concentration of fish in the section resulting from displacement during the prolonged (June - October) flood flows in 1984 and abnormally light harvest of fish because anglers could not easily access the river during the 1984 season. The data presented in Figure 10 depict a brown trout population capable of producing high numbers of large fish. Eighteen inch and larger brown trout ranged between 198 and 455 per mile and 20 inch and larger fish ranged between 49 and 114 per mile.

A comparison of the brown trout populations of the Henneberry and Pipe Organ Sections is presented in Figure 11 for the 1984-87 period in which the Henneberry Section was sampled. Total population density was consistently higher in the Henneberry Section although the difference between the two sections was lowest in 1984. With the aforementioned exception of the 1985 sample, the brown trout population of the Henneberry Section maintained a high degree of consistency throughout the sample period. The total density of brown trout demonstrated a very slight declining trend while distribution of the population by length group remained extremely stable. Populations in the Pipe Organ Section declined consistently over the period while numbers of larger fish sustained a substantial increase in 1985 and underwent decreases in 1986 and 1987. Mean percent composition of the length groups selected in Figure 11 for the sample period in the Henneberry Section were 36.5% (8.0 - 13.9"), 26.5% (14.0 - 15.9"), 21.5% (16.0 - 17.9"), and 15.5% (18.0"+). The same length groups composed 45.5%, 29.0%, 16.5%, and 9.0% of the Pipe Organ population over the sample period. Numbers of 18 inch and larger brown trout ranged between 161 and 455 per mile in the Henneberry Section and ranged from 58 to 169 per mile in the Pipe Organ Section. The high point estimates for these larger fish occurred in 1985 and the percent decline to 1987 levels was similar between the two sections. A further analysis of the numbers of larger fish between the two sections shows that numbers of 20 inch and larger brown trout ranged from 49 to 114 per mile in the Henneberry Section and from 10 to 48 per mile in the Pipe Organ Section. Again, with the exception of the 1985 point estimate, numbers of these large trout were extremely consistent within each section in the other three comparative years. The major differences in brown trout populations between the two sections appear related to an ability of the Henneberry reach to support much higher densities and percent composition of larger brown trout than the Pipe Organ Section despite similar growth rates between the two sections.

Analysis of comparative brown trout population data between the two study sections, particularly density - standing crop relationships and analysis of densities of larger trout from year to year, suggest that differences in the abundance of large brown trout cannot be solely attributed to differences in angling regulations between the two sections. Oswald (1986) suggested that increased differentiation in abundance of brown trout with increasing size between the two sections was due to size selective angler harvest on a year long basis in the Pipe Organ Section. This supposition was based on long term data for the Pipe Organ Section and a 1984 comparison with the Henneberry Section. Subsequent data collected in both sections suggest that differences between the two sections are inherent to the different habitats represented. While both sections provide reaches of excellent habitat, a much higher percentage of the Pipe Organ Section is poor habitat due to alterations by human activity or trauma resulting from the 1984 flood. Estimated lengths of poor habitat represent a minimum of 33% of the Pipe Organ Section and a maximum of 8% of the Henneberry Section. While it is probable that winter and early spring harvest of trout in the Pipe Organ Section has some affect on the comparative density difference of larger trout between the two sections, the data suggest that habitat limitations are probably the controlling factor.

Pipe Organ Section

Brown trout density and standing crop relationships for the 1985-90 period are presented in Figure 12 for the Pipe Organ Section. From 1985 through 1988 density and standing crop followed a pattern identical to that observed in the Hildreth Section with the exception that biomass dropped below the density curve in the Pipe Organ Section in 1988. This pattern was associated with the maturation of a strong cohort along with poor recruitment over the period. The biomass curve was above the density curve in 1985 - 1987 representing the only period that this occurred during the 1980's. Data summarized from the 1970,s (Oswald 1984) indicate that brown trout biomass curves exceed density curves in the Pipe Organ Section when brown trout recruitment is relatively low and survival of a cohort of older fish is relatively high. In contrast with the situation in the Hildreth Section, both numbers and standing crops of brown trout declined substantially in 1989 and 1990 in the Pipe Organ Section. This decline was concomitant with severely reduced non-irrigation season flow regimes discussed above. The rapid population increase in 1988 was due to excellent recruitment of 8.0 - 13.9 inch fish (Figure 13) similar to that observed in the Hildreth Section. This recruitment remained strong in 1989 and '90 but showed a declining trend each year. Numbers of large (18.0"+) brown trout attained relatively high density for the section in 1988 but rapidly eroded with the low overwinter streamflows. Numbers of these larger fish declined from 107 per mile in 1988 to 37 per mile in 1990. Numbers of mid-sized brown trout (14.0 - 17.9") remained relatively constant from 1988-90 ranging from 301 to 260 per mile despite strong recruitment of younger fish each year. Spring condition of the brown trout in the Pipe Organ Section over the 1988-90 period is presented in Figure 14. The data indicate a pattern of stress induced by low flow regimes similar to that observed in the Hildreth Section. The overall population and the mid-sized fish suffered declining condition between 1988 and 1989 but the decline was mitigated by declining densities between 1989 and 1990. In contrast with the Hildreth Section, condition in the total population was better than that of the mid-sized fish and actually increased slightly between 1989 and 1990 due to a high percentage of smaller fish in the population. Mean condition for 13.0-17.9 inch fish declined 11.1% over the period.Mean condition for 18 inch and 20 inch and larger brown trout, however, declined substantially through 1990 representing losses of 23.3% and 24.2% in the condition of each respective length group.

Brown trout populations in the Pipe Organ Section have suffered declines in 1989 and 1990 as a result of severely reduced overwinter flow regimes. In many ways, the declines were worse than those observed in the Hildreth Section. Examples of this include greater loss in condition in all fish in excess of 13 inches and substantial reductions in population and standing crop despite ample recruitment. Declines in the numbers of large brown trout of 65% (18.0"+) and 73% (20.0"+) between 1988 and 1990 exceeded the percent decline recorded in the Hildreth Section. The severity of the affects of low winter streamflow on the brown trout population of the Pipe Organ Section may be related to previously discussed habitat limitations in the reach. It may also be related to winter water temperature declines at low flow regimes as distance from the reservoir outlet and major springs becomes more important with reduced outlet discharge.

Rainbow trout populations were monitored in the Pipe Organ Section through fall population estimates collected in the 1985-89 period. No sample was collected in 1986. Estimated standing crops and densities of rainbow trout are presented in Figure 15. In contrast with the high density brown trout, rainbow trout biomass has consistently remained above density. The difference between the two parameters has declined rapidly in recent years however. During this period, rainbow trout have declined both in number and biomass. This trend has rapidly accelerated under recent low flow regimes with rainbow trout density declining 60% and biomass declining 70% from 1987 to 1990. Recruitment of rainbow trout into the population has been poor over the period (Figure 16) and, in contrast with the Hildreth Section, was not substantial in 1987. Numbers of all length groups of rainbow trout have declined but the 1989 data suggest that recent low flow regimes may be causing greater declines in the numbers of smaller and larger fish within the population. Future sampling will be required to fully ascertain the affects of low overwinter flows on the rainbow trout population of the Pipe Organ Section.

Fish and Game Section

Trout populations in the Fish and Game Section were first sampled in 1980 and 1981 to typify the reach of river bordering the newly acquired Poindexter Slough Fishing Access. This data was never fully analyzed other than total density and length group calculations. The section was reinstated in the sampling program in 1988 to monitor population differences, under differing flow regimes, with the Low Flow Section. Estimated brown trout densities and standing crops are presented in Figure 17 for the Fish and Game Section. Brown trout densities in the section remained quite stable at extremely high levels over much of the period ranging from about 1400 to 1700 per mile through 1989. In 1990, density declined markedly to 1077 per mile representing a declining trend from 1988 levels. Brown trout standing crops also declined over the 1988-90 period with declining density. The relationship between density and standing crop remained stable through the density decline with standing crop levels remaining slightly below the density curve. The deterioration of the tailwater affect with distance from the dam outlet and major diversions at Barretts have resulted in a loss of productivity relative to upstream sections. Excellent brown trout habitat however has resulted in high densities and high standing crops of smaller average fish size than that of sections in the upper tailwater reach. Length group analysis of the brown trout population of the Fish and Game Section (Figure 18) revealed a trend of strong and relatively consistent recruitment through 1988. The 1989-90 samples exhibited a declining trend in recruitment with the 1990 sample representing about 40% of the numbers of Age II brown trout observed in the 1980-81 and 1988 samples. Over the 1988-90 period, numbers of 13 inch and larger brown trout were much higher than those observed in 1980 81. High numbers of 16.0 - 17.9" fish and 18.0" and larger fish indicate the maturation of a strong cohort similar to conditions observed in the upstream sections. Numbers of 18.0 inch and larger fish attained an observed peak in 1988 at 81 per mile , declined to 45 per mile in 1989 and dropped to an observed low for the section of 17 per mile in 1990. This occurred despite relatively strong numbers of 16 - 17 inch fish and very high numbers of 13 to 15 inch fish in 1989. Mean condition (Figure 19) of brown trout in the section declined over the 1988-90 period. This decline was not of the magnitude observed in upstream sections and followed somewhat different patterns. Mean condition of the population underwent a 6.5% decline over the period but the decline occurred between 1988 and 1989 with condition actually increasing slightly between 1989 and 1990 as population density was markedly decreased. Condition of the 13.0-17.9" group declined 8% over the period and this decline was nearly linear over both years. The large brown trout underwent a 13% decline over the period, the majority of which was accounted for between 1989 and 1990.

Patterns of streamflow in the Fish and Game Section differ substantially from those of the upper tailwater portion. Winter or non-irrigation season flows are still heavily influenced by releases from Clark Canyon dam but additional flow is provided by inflows from Grasshopper Creek and natural and irrigation return groundwater accretions. These additional flows would tend to have a mitigative affect on critical minimum flows which was not available to sections in the upper river. It must be assumed, however, that severely reduced non-irrigation flow releases would tend to drive flows in the Fish and Game Section toward critical minima. Irrigation season flows in the Fish and Game Section are more directly controlled by releases from the dam. In years of normal reservoir storage, ample quantities of water are delivered to the West Side Canal located immediately southwest of Dillon. This major demand assures ample flow regimes in the Fish and Game Section much the same way as major demands at Barretts assure ample flows through the tailwater reach. Recent low storage pools in Clark Canyon Reservoir have called for reductions in irrigation allotments in the interest of conserving water in storage. This condition has also resulted in a water management program which varies flow regimes widely as minimal amounts of water are provided for irrigation as precipitation and demand patterns fluctuate. The Fish and Game Section was subjected to winter flow reductions described above for the 1988-89 and 1989-90 non-irrigation season. During the irrigation season in 1989, the section was subjected to major flow reductions as well as a widely fluctuating flow regime. The brown trout data suggest that these flow reductions have resulted in declines in the population. Slight declines noted between 1988 and 1989 may have been influenced by winter flow regimes. This is difficult to substantiate, however, and may have been the result of natural mortality concomitant with the maturation of a cohort. Numbers of 16.0 and 18.0 inch and larger fish were reduced over the period but were still relatively high for the section. Strong numbers of 13 to 15" and 16 to 17" fish in 1988 did not result in maintenance of the numbers of 16" and larger fish in 1989 however. Numbers of 13.0 to 15.0" fish increased substantially following strong recruitment. The drop in condition between the two years was symptomatic of stress on the population. Drastic population declines did occur between 1989 and 1990 following the low summer and winter flow period. Substantial losses were sustained in density, standing crop, and numbers of all length groups as well as a substantial decline in condition of the largest fish. The data suggest that summer flow restrictions and fluctuations coupled with intensified winter flow reductions were effective in determining losses in the brown trout population of the Fish and Game Section.

Limited information on the rainbow trout population of the Fish and Game Section was collected in spring samples. Because the sampling was conducted during the spawning period, estimates are subject to error induced by trout movement. For this reason, population data presented in Figure 20 must be viewed as trend information rather than accurate estimates. The data indicate that rainbow trout populations in the Fish and Game reach have declined substantially from the early 1980's. The same trend was apparent in Poindexter Slough, a spring creek entering the Beaverhead river at the end of the Fish and Game Section (Oswald 1990). The reason for the decline is not understood at present but centers around consistently poor recruitment into the population. The declining trend in rainbow trout may represent limitations in spawning habitat availability coupled with competitive factors with the abundant brown trout. The trend information presented in Figure 20 suggest a slight annual decline in rainbow trout numbers over the 1988-90 period. This decline is similar to that of the brown trout and may also be associated with low flow regimes although this is difficult to ascertain from the limited data.

Low Flow Section

The Low Flow Section was established in 1987 to monitor the effects of chronic low summer flow regimes in the reach. The fish population of the reach is dominated by brown trout. Low numbers of rainbow trout are also found in the section and together with the abundant mountain whitefish and infrequent burbot compose the remainder of the gamefish species present. The non-game species found in the section include longnose and white sucker, longnose dace, mottled sculpin and occasional carp. Brown trout densities and standing crops are reported in Figure 21. The data indicate a relatively productive system supporting abundant (1526 - 1790 per mile) population densities of Age II and older brown trout. This level of abundance was comparable to that of the Fish and Game Section prior to 1990. Biomass was also high and closely paralleled trends in abundance while remaining below the density curve. The difference between the density and biomass curve in the Low Flow Section was greater than that observed in the Fish and Game Section indicative of reduced growth and ultimate size potential. The Sportsman's Park Section, which closely approximated the Low Flow Section, was sampled in 1967 and 1968 (Wipperman 1968). The 1967 estimate for brown trout revealed a population of 1,088 per mile and a standing crop of 977 lbs. per mile. This was a summer estimate, however, and included Age I fish which would not appear in a spring estimate on the Beaverhead River. The 1968 estimate which was limited to Age II and older fish exhibited a density of 384 per mile. Current data indicate that populations of wild brown trout have increased markedly in the Low Flow Section since the late 1960's. Trends in the density and biomass curves indicate that a strong cohort which appeared as Age II fish in 1988 was moving toward maturation. The trend of biomass and density to increase over the 1988-90 period was in contrast with all of the upriver study sections and indicates that the Low Flow Section was not affected by recent flow reductions.

Analysis of the Low Flow Section brown trout population by length group (Figure 22) depicts a population heavily dominated by small to mid-sized brown trout. Growth and ultimate size limitations have resulted in a population in which only 8% of the brown trout exceed 16 inches in length and 18 inch and larger fish were present at densities ranging from 14 to 22 per mile. The data presented in Figure 22 are indicative of a high degree of population stability with consistent recruitment. Higher numbers of 13.0-15.9 and 16.0-17.9" fish in 1989 and 1990 were consistent with strong recruitment of Age II fish in 1988 and 1989.

In sharp contrast with upstream sections,mean brown trout condition for the Low Flow Section (Figure 23) was not indicative of flow induced stress. While mean condition of all brown trout in the Low Flow Section was somewhat lower than that observed in the Fish and Game Section prior to 1990, the trend in the Low Flow showed no significant decline. In fact, mean condition of the total brown trout population and all brown trout less than 18 inches was virtually constant over the period. Minor fluctuations in the condition of 18 inch and larger brown trout were not considered to be significant in view of a small sample size and a lack of any discernible trend.

Data comparing the Fish and Game and Low Flow Sections for the 1988-90 period are presented in Figure 24. The 1988 and 1989 data, prior to substantial flow reduction in the Fish and Game Section, clearly depict major size distribution differences between the two sections. The Fish and Game Section clearly supported higher percentages and total numbers of brown trout in excess of 16 inches than did the Low Flow Section. Differences in the numbers of 18 inch and larger brown trout were even more marked. This difference is also demonstrated in the density and standing crop relationships which indicate that the Fish and Game Section can support much higher standing crops at equivalent density than the Low Flow Section.

Brown trout populations in the Low Flow Section have apparently adapted to flow regime restrictions as a high density population with restricted growth and ultimate size. The section provides good habitat throughout most of the reach and data indicate that spawning and rearing habitat are in good supply. Because the Low Flow reach is located a sufficient distance downstream from the dam outlet, tributary inflow and groundwater accretions supply ample non-irrigation season flows. The non-irrigation season flow relief is much the same as that described for the Fish and Game Section with the substantial addition of inflow from Poindexter Slough and Blacktail Deer Creek. Thus over winter flow reductions from Clark Canyon Reservoir in 1988 and 1989 caused no discernable declines in the brown trout populations of the section. Summer irrigation season flows through the section have limited the numbers of larger fish in the section. Increases in the population of the Low Flow Section in 1989 and 1990 were possibly related to periods of ample flow in the section in recent years of dry conditions and close water management. In most years, ample flow has been delivered to the West Side Canal while lower portions of the Beaverhead rely on groundwater accretions, tributary inflow, and irrigation recharge to meet irrigation demand and minimal streamflow needs. In recent years, this system has not been adequate to sustain the flow needs thus requiring that dam releases be supplied to the lower river.

Under this flow management system, the Low Flow Section has actually received stronger summer streamflow than the 50 to 75 cfs that would normally be supplied below the West Side Canal diversion. For these reasons, it is not at all surprising that the brown trout population of the Low Flow Section would be increasing while populations in upstream reaches have declined.

While the Low Flow Section does not support an estimatable rainbow trout population, rainbow trout were collected during each sample season. Numbers of rainbow trout collected in the section have declined each year from a high of 33 in 1987 to 8 in 1990. This decline is consistent with that observed in the Fish and Game Section. In 1967 and 1968, estimated populations of rainbow trout were at levels of 174 and 106 per mile in the Sportsman's Park Section (Wipperman 1968). This data indicates that conditions have not been favorable for the maintenance of a rainbow trout population within the reach. This may merely be a function of the cessation of the stocking of hatchery rainbow trout into the Beaverhead River after 1964. It might also be indicative of a loss of rainbow trout spawning habitat or a general inability of the rainbow trout to compete with high densities of brown trout in the system.

Mule Shoe Section

Sampling in the mid-lower river was resumed in 1990 with the establishment of the Mule Shoe Section in the vicinity of Beaverhead Rock. The section corresponds quite closely to the old Blaine Section which was sampled in the 1970,s (Miller 1972 and 1975). Brown trout density and biomass for the Mule Shoe and Blaine Sections is presented in Figure 26. The data indicate that little change has occurred in the section in the past twenty year span. Numbers and standing crops of brown trout in 1990 were slightly higher than those observed in 1971 and 1975. The elevated biomass of 1990 might only be a function of relatively high numbers of 18 inch and larger brown trout which may be a temporary condition formed by the maturation of a cohort. Future sampling will be required to determine if the populations of the reach have improved slightly. Length group analysis (Figure 26) of the 1990 Mule Shoe and 1975 Blaine brown trout populations depicts a population with limited recruitment. Numbers of 16 inch and larger brown trout accounted for 22% of the 1975 population and 32% of the 1990 population. Brown trout in excess of 18 inches were estimated at a density of 40 per mile representing 14% of a relatively small total population.

The Mule Shoe Section has supported the lowest density and standing crop of any section sampled in the Beaverhead River. Moreover, comparative data from the 1970's suggest that this reach is the only sampled portion of the Beaverhead River in which brown trout populations have not substantially increased over the past 15 to 20 years. Miller (1972 and 1975) cited sediment, flow, temperature and bank habitat problems as affecting brown trout populations in the reach. Early irrigation season flow reductions and recent drought conditions have complicated the flow and temperature problem. Streambank observations have noted large amounts of streambank erosion, a scarcity of woody riparian cover, substantial areas of recent channel changes and an apparent degradation of the streambed. Heavy sediment deposition through the reach might be limiting reproductive success. Future sampling should establish a stronger base for the description of brown trout population dynamics.

Twin Bridges Section

The Twin Bridges Section was established in 1987 to describe trout populations in the lowermost reaches of the Beaverhead River. Streamflows lowered by irrigation withdrawal throughout the lower river system, receive substantial recharge from the Ruby River and several major spring sloughs including California, Owsley, Schoolhouse, and Jacobs Sloughs. Gamefish populations of the section were dominated by brown trout and mountain whitefish. Other gamefish collected in the section included occasional rainbow and brook trout, burbot, and a single arctic grayling believed to have been a migrant from the Big Hole River. Nongame species collected include longnose and white sucker, longnose dace, mottled sculpin and carp brown trout populations of the Twin Bridges Section are described in Figure 27. Brown trout density in the Twin Bridges Section was relatively low, ranging from about one half to one third of densities observed in all other sections except Mule Shoe. Populations of brown trout over the 1987-89 period were relatively stable, ranging from 580 to 676 per mile in a slightly declining trend. Brown trout standing crop ranged between 433 and 478 pounds per mile and exhibited a slightly increasing trend as density declined.

Composition of the brown trout population by length group (Figure 28) was descriptive of a population dominated by small to mid-sized fish. Strong recruitment of Age II fish in 1987 and subsequent maturation of that cohort to Age IV was responsible for declining densities and increasing standing crops over the sample period. Recruitment of Age II fish declined each year from the peak observed in 1987. Growth of brown trout in the Twin Bridges Section was the lowest observed in the Beaverhead system with average lengths at Age II of 9.0", Age III of 12.0" and Age IV+ of 15.9". Numbers of 16.0-17.9 inch fish ranged between 22 and 72 per mile while densities of 18.0 inch and larger trout were estimated at a maximum of 15 per mile which is comparable to the Low Flow Section.

Habitat in the Twin Bridges Section suffers from heavy deposition of fine sediments as was the case in the Mule Shoe reach. Streambank vegetation is sparse and areas of bank erosion are abundant as are lengths of bank which have been altered with rock or brush rip-rap. The population increases over those observed in the Mule Shoe

Section are probably due to tributary flow relief and subsequent thermal relief provided in the reach. The Twin Bridges Section supports moderate to low brown trout populations relative to upstream portions of the Beaverhead River and these populations appear to be limited in recruitment.

MADISON RIVER

Varney Section. The Varney section of the Madison River has been electrofished each fall since 1967. During that 23 year period, a considerable amount of change in the trout population has been documented. Vincent (1987) described the negative impacts of stocking catchable rainbow trout on population levels of wild trout during the late 1960s and early 1970s. All stocking was eliminated in the Varney section after 1969. Stocking continued in much of the middle Madison River through 1973. The period 1967-1972 was considered a period of stocking and transition for purposes of this analysis.

The Varney section of the Madison River is a 4.0 mile long reach of river 41 miles downstream from Quake Lake and about 4 miles upstream from the town of Ennis. This reach of river is characterized by a braided unstable channel formed primarily by extreme winter ice-gouging on an annual basis. Habitat consists of long riffles interspersion with fast runs along undercut banks and a few pools with maximum depths of about 7 feet. The average stream width is 200 feet with an average gradient of approximately 30 feet/mile. Streambed materials consist of mixed gravel and cobble. The average annual discharge at the USGS McAllister gage (about 15 miles downstream from the Varney section) was 1,768 cfs for a 50 year period of record (1939-1988).

Brown trout. Brown trout population levels during the 23 year period are presented (Table 1). In analyzing the data, it was readily apparent that there were 4 discernible population levels that corresponded quite closely to changes in stocking policy and/or regulations. The response of the population following cessation of stocking and implementation of minimum winter instream flow levels is well-documented by Vincent (1987). Numbers and biomass of wild brown trout showed 50-100% increases in the 1973-77 post-stocking era versus the 1967-72 stocking and transition era (Table 1), (Figure 29). Fishing regulations were the same during both periods.

The response of older age classes (IV+) was not as dramatic as it was for younger fish (age I-III). This led to speculation that angling mortality may be a limiting factor and, beginning with the 1978 fishing season, the regulations were changed from a straight 10 fish or 10 lbs. and 1 fish limit to a limit of 3 fish, only 1 of which could exceed 18 inches. Sculpins were also banned for bait. It was apparent that the desired results were achieved. Both numbers and biomasss of age 3 and older fish increased substantially (Table 1). This was most readily apparent in looking at the estimated numbers of fish over 13 inches (Figure 30). Numbers and mortality rates of age 1 and 2 fish were little changed between the 10-fish period (1973-77) and the 3-fish period (1978-83). The real apparent change was in numbers and mortality rates for fish age 3 and older. Age 3 and older fish increased an average of 117% in number, and the average mortality rate declined from 67.4% in the 10-fish era to 39.2% in the 3-fish era. A Kruskal-Wallis nonparametric analysis of the data indicated a highly significant difference (99% level) between the age III & mortality rate under the 10-fish, 3-fish, and 5-fish limit scenarios. The changes in age III+ mortality rates are illustrated (Figure 31).

Observation of brown trout condition factors also indicate changes during the period of the 3-fish limit. Prior to 1978 (1967-77 period), the average condition factor for 14-18" brown trout was always greater than 40.0, averaging about 41.0 during the period. From 1978-1983, condition factors ranged from 34 to 39, averaging about 36.0. To put that into perspective, a 16 inch fish with a condition factor of 41 would weigh 1.68 lbs. That same fish with a condition factor of 36 would weigh 1.48 lbs., or 0.2 lbs. less. It appears likely that high densities of age 3+ brown trout during the 3-fish limit period were adversely affecting condition factors. Since 1984, condition factors have rebounded to an average of about 39, intermediate between previous values.

This decline in growth and condition is even more readily apparent in examining the average length of age 3 brown trout in the fall population (Figure 32). Age 3 fish are chosen because most have not yet spawned and their scales can still be accurately aged. Age 3 brown trout averaged 15.5 inches during 1967-72 when population densities were low. In the period 1973-77 under the 10-fish limit, the average length was 15.1 inches. The 3-fish limit precipitated a steep decline, and during 1978-83 the average length of age 3 fish was off over 1 inch at 13.9 inches. This number has since rebounded with lower population densities to an average of 14.6 inches since 1984. Clearly, the high population density of the 3-fish limit era had an adverse impact on growth and condition of larger brown trout.

In 1984, the fishing regulations were changed to a straight 5-fish limit with only 1 over 18 inches and only 1 could be a rainbow. Analysis of data from the 1984-1989 period indicate that overall brown trout numbers and biomass have declined in all age groups. Mortality rates have increased, particularly for age 3 and older fish, averaging 39.2% under the 3-fish limit and 58.2% since the change back to 5-fish. Along with the decrease in density, there has been a rebound in growth rates and condition factor. Population parameters for age 3 and older brown trout under the current 4-fish limit are very much intermediate between low levels of the 10-fish limit period and high levels of the 3-fish period.

In summary, the evidence is very compelling that the brown trout population of the Varney section of the Madison River can be manipulated by adjustments to fishing regulations. Under a 10-fish limit, mortality of larger fish was excessive and the population did not achieve its full potential in terms of numbers and biomass. A restrictive 3-fish limit instituted in 1978 resulted in overpopulation of age 3 and older brown trout, manifested by reduced growth rate and condition factor. With the current regulations allowing 5-fish since 1984, the population levels and biomass have declined somewhat but the growth and condition factors have improved and numbers of trophy size fish (over 18 inches) have been maintained; averaging 49/mile in 1967-1972, 33/mile in 1973-1977, 59/mile in 1978-1983, and 58/mile since 1984. The present regulation for brown trout should be maintained with annual evaluation in order to make certain that increasing fishing pressure does not result in excessive mortality to age 3 and older fish. The relationship of streamflow to the brown trout population is discussed in a later section of this report.

Rainbow trout. Rainbow trout population levels also responded dramatically in the years following the cessation of stocking (Table 2). Biomass and numbers of rainbow trout age 2 and older were an average of 201% and 235% higher for the 1973-77 period versus 1967-72 (Fig. 33). This improvement is attributed primarily to the cessation of the stocking of hatchery fish (Vincent 1987). As was discussed by Vincent, the apparent negative effects of stocking of catchable rainbow trout were more pronounced on the wild rainbow than on the brown trout population.

Table 1. Fall (September) population and biomass estimates of wild brown trout from the Varney section of the Madison River during 1967-1989.

	Number per Mile					Biomass (lbs/mile)
Year	Age I	Age II	Age III	Age IV	Age V+	Age II+
			Stocking and Transition Period[1]			
1967	395	201	99	55	--	462
1968	1,060	154	95	28	10	360
1969	788	171	102	35	9	408
1970	997	231	139	46	22	616
1971	924	407	192	125	39	996
1972	753	386	189	79	16	757
Average	**820**	**258**	**136**	**61**	**19**	**600**
			10-Fish Limit			
1973	902	426	89	43	30	589
1974	1,003	542	258	51	--	897
1975	1,209	465	256	78	--	815
1976	1,969	468	254	109	--	954
1977	1,083	725	258	116	26	1,174
Average	**1,233**	**525**	**223**	**79**	**28**	**886**
			3-Fish Limit			
1978	899	646	404	97	42	1,153
1979	1,021	381	605	267	65	1,486
1980	799	543	237	179	181	1,036
1981	1,217	542	373	181	224	1,321
1982	1,557	406	325	267	229	1,401
1983	1,761	544	270	188	151	1,188
Average	**1,209**	**510**	**369**	**197**	**149**	**1,264**
			5-Fish Limit - 1 Rainbow			
1984	1,374	455	226	231	258	1,435
1985	1,004	456	183	189	99	1,086
1986	915	326	236	119	64	914
1987	968	381	164	78	46	679
1988	688	393	239	110	57	848
1989	762	205	376	138	34	966
Average	952	369	237	144	93	988

[1] This period included both stocking and the first three years no stocking.

Vincent (1987) states that the recovery rate of wild brown trout was faster than for wild rainbow in the post-stocking era. This is apparent as the populations of age 4 and older rainbow were slow to rebound (Table 2). Fishing regulations were the same (10 fish) during both the stocking period (1967-72) and post-stocking (1973-77).

Regulations became progressively more restrictive in an attempt to improve the population of older rainbow during the past 10 years. In 1978, the limit was reduced from 10 fish to 3 fish, and in 1984 it was further restricted to a species-specific regulation allowing only one rainbow trout in the creel. While the results have not been dramatic, there does seem to have been some response. The average number of fish over 13 inches has increased from 58 per mile during 1967-72 to 167 per mile during 1973-77 (10 fish limit), 199 per mile during 1978-83 (3 fish limit), and 267 per mile during 1984-89 (1 fish limit) (Figure 34). Thus, the number of 13 inch fish per mile increased 60% in going from a 10-fish limit to a 1-fish limit.

Similarity, the number of fish per mile over 18 inches has increased 50% from 8 per mile under the 10-fish limit to 12 per mile with a 1 fish limit. Rainbow trout over 18 inches would generally be at least 6 years old, and thus are a very small proportion of the population.

The apparent mechanisms by which rainbow trout populations have increased is two-fold, increasing yearling populations and reduced mortality rates in older age classes. During the period 1978-83, the average fall population of age 1 fish was 911 per mile (Table 2). This represented a 64% increase over the previous era during which the 10-fish limit was in effect. It is suspected that the increasing population of adult spawners that resulted from the cessation of stocking was responsible for the improved recruitment. As will be discussed in the next section of this report, streamflows do not seem to have been a factor. During the most recent regulation era (1984-89), the recruitment of yearlings has declined markedly to levels similar to those of the 10-fish regulation period. Since the number of adult fish have remained stable, we can only surmise that the 1987-89 drought conditions have played a role in that development.

Analysis of mortality rates do not provide as clear a relationship to population levels is they did with brown trout. Mortality rates of age 1 fish were highest (68.9%) during the 5-fish regulation period (Figure 35).

One significant linear relationship was discovered during analysis of mortality rates. A regression of age 1 fall population levels of rainbow trout versus the successive years mortality rate indicated a strong linear trend (Figure 36) which

Table 2. Fall (September) population and biomass estimates of wild rainbow trout from the Varney section of the Madison River during 1967-1989.

Year	Number of Fish per Mile Age I	Age II	Age III	Age IV	Age V+	Biomass (lbs/Mile) Age II+
Stocking and Transition Period[1]						
1967	82	30	5	--	--	29
1968	--	64	28	--	--	96
1969	175	33	10	4	--	49
1970	217	186	26	19	--	210
1971	--	184	61	36	--	296
1972	319	26	54	24	--	135
Average	**198**	**87**	**31**	**21**	**--**	**136**
10-Fish Limit						
1973	644	74	40	--	--	131
1974	622	389	25	21	--	322
1975	350	471	238	19	--	569
1976	440	198	250	127	16	714
1977	730	231	70	45	11	309
Average	**557**	**273**	**125**	**53**	**14**	**409**
3-Fish Limit						
1978	1,506	723	126	37	12	551
1979	302	159	159	59	26	324
1980	427	129	163	86	17	300
1981	1,085	255	132	132	87	440
1982	1,012	338	140	59	26	386
1983	1,136	278	262	108	57	572
Average	**911**	**314**	**164**	**80**	**38**	**429**
5-Fish Limit - 1 Rainbow						
1984	638	172	115	108	80	459
1985	387	214	97	93	58	446
1986	1,079	207	148	69	49	442
1987	127	320	131	79	68	532
1988	776	115	220	86	30	408
1989	416	204	162	206	27	640
Average	**571**	**205**	**146**	**107**	**52**	**488**

[1] This period includes both stocking and the first three years of no stocking.

explained 46% of the variation in mortality rates. High mortality rates during periods of high population level are an indication that density-dependent mortality factors are affecting population levels of age 1 rainbow trout. Angling mortality is not a likely factor in this relationship since rainbow in the Varney section average about 8 inches at age 1 in the fall and 11 inches at age 2 and thus are probably not kept by anglers. It would thus appear that recruitment to age 1 is not a limiting factor to the rainbow population.

The mortality rate of the age 2 and older population has declined with more restrictive angling regulations, resulting in variable populations of age 2+ fish. The average number of age 2+ fish per mile increased from 445 per mile (10 fish limit) to 395 per mile (3 fish limit) and then declined to 510 per mile (1 fish limit). Age 2 and older mortality rates during the same three periods declined from 55.2% to 43.7% to 37.5% (Figure 35).

The primary reason that the change to a 1 fish limit has not resulted in major shifts to larger fish in the population is that mortality rates of age 4 and older fish (generally 15 inches and longer) remain unacceptably high. The average 4+ mortality rate was 62.2% under a 10-fish limit, 52.5% under a 3-fish limit, and 67.1% under a fish limit (Figure 35). Without intensive creel census, we cannot evaluate the role that angling harvest or release mortality plays in this. Further restriction to a strict catch and release regulation for rainbow is the only other alternative, but given that population levels of larger fish are at least being maintained, it may not be warranted at this time.

The growth rate and condition factor declines earlier noted for brown trout in 1978-83 period were also manifested in the rainbow trout population. The average length of 3-year old rainbow trout declined from 14.3 inches in fall 1973-77 to 12.9 inches in 1978-83 and average condition factor for 14-inch rainbow declined from an average of about 39.3 to 35.3 (Figure 37). For a 14-inch fish this represents an average fall weight of 1.08 lbs. versus 0.97 lbs., or 10% decline. While environmental factors such as reduced streamflow have played a role, it is suspected that the competitive interaction due to high densities of adult brown trout was the major factor in the reduced growth and condition of rainbow trout. During the most recent regulation era (1984-89), the growth rates and condition of rainbow trout have rebounded to intermediate levels just as they did with brown trout. Condition factors for 14-inch fish have averaged 37.1 and the average length of 3-year old fish since 1984 has been 13.6 inches. Despite the drought conditions of 1987-89, these values have held steady.

In summary, the increasingly restrictive regulations on rainbow trout in the Varney section of the Madison River over the past decade have resulted in improved populations of larger fish (over 13 inches). Improvements, however, have been less pronounced than expected. High mortality rates of age 4 and older rainbow remain a problem, and it is uncertain whether these high mortality rates are a result of angler-induced mortality or natural factors. In the upper Madison Pine Butte section where catch and release regulations are in effect, the average mortality rate for age 4 and older rainbow during 1984-1988 was 53.4% versus 67.1% at Varney. Habitat conditions and fishing pressure are dissimilar in the two sections, so it is unlikely that a direct comparison of the two sections is meaningful.

Rainbow trout populations in the Varney section of the Madison River are subject to more annual fluctuation and variation to more annual fluctuation and variation in year class strength and mortality rates than one brown trout. This may be partly a reflection of wider confidence intervals in the two respective population estimates, but it seems that there are still unknown environmental factors which affect annual reproduction and recruitment. Annual variations in the population levels of yearling fish of nearly 1,000% have been witnessed in recent years despite comparable populations of adult spawners (Table 2). Some evaluation of spawning conditions and rainbow recruitment may be in order before recommendations could be supported to restrict angling for rainbow trout to catch and release only.

Stream flow

Variations in streamflow have the potential to alter or mask population responses to changes in external factors such as the effects of stocking or fishing regulation changes. Vincent (1987) pointed out that during the stocking period on the Varney section of the Madison River, mean winter flow levels did not show a relationship to wild trout population levels. However, following the cessation of stocking, the total trout biomass responded positively to increased winter (December-April) flows. This relationship can now be examined in more depth since we have 13 additional years of data.

During the post-stocking period (1973 to present), there are four periods of alternating dry and wet cycles on the Madison River. From 1973-76 and 1983-86 means winter flows were above average, and from 1977-82 and 1987-89 mean winter flows were below average (Figure 38). The average streamflow during the lowest month in a water year was found to provide a good indicator of relative water conditions and is used here to evaluate the impacts of streamflow on population levels. During all but four years, this month fell during late winter, between January 1 and April 30. This value is referred to as the "monthly mean low flow" (Figure 38).
Numerous attempts to correlate flow levels since 1973 with population levels of brown trout failed to demonstrate any strong linear relationships. It does appear that there is a tendency toward higher numbers of age 1 fish in years preceded by high minimum flows, but the relationship was not significant (Figure 38).

In reality, both the minimum instream flows and the yearly brown trout year class strength have been remarkably consistent for the 17 year period between 1973 and 1989. Total variation in minimum streamflows was between 964 and 1,538 cfs and age 1 population levels fluctuated between 688 and 1,969 fish per mile. The consistent winter flows are probably responsible for consistent brown trout year class strength.

The population of age II+ brown trout bears no relationship to winter flows. In fact, the four highest population density levels of age II+ fish fell during the 1977-1982 drought cycle. The current medium population densities began to decline to those levels in 1985 and 1986, two years prior to the most recent drought.

Clearly, adult brown trout population levels in the Varney section of the Madison River correspond much more clearly to changes in fishing regulations than to variations in mid winter streamflow levels.

The same statement is true for rainbow trout. A clear progression of higher population levels of adult rainbow trout has accompanied more restrictive fishing regulations (Figure 34) despite cyclic flow patterns. Rainbow year class strength at age 1 did not appear to have any significant correlation to flow levels of the preceding year nor did mortality rates.

The only significant relationship related to flow that could be discovered was a tendency for both brown and rainbow trout condition factors to correlate linearly with monthly low flow levels in the years since stocking ceased (1973-89). Essentially, this is a result of the fact that condition factors were at their lowest levels during the 1977-82 drought cycle. As was previously discussed, there is also an apparent relationship between high densities of brown trout and low condition factors (both brown and rainbow), but undoubtedly the drought cycle which reduced both habitat and food supply must also have played a role.

STREAM PROTECTION PROJECTS

There are six Soil Conservation District associated with the seven major rivers in this report. Approximately 120 "310" streambank project were inspected and 20 SPA 124 projects.

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Prepared by: E.R. Vincent, Brad Shepard, Wade Fredenberg, Richard Oswald.

Date: August 24, 1990.

Figure 1. Estimated densities and standing crops of brown trout collected in the Hildreth (HI), Henneberry (HB), Pipe Organ (PO), Fish and Game (FG), Low Flow (LF), Mule Shoe (MS) and Twin Bridges (TB) Sections of the Beaverhead River.

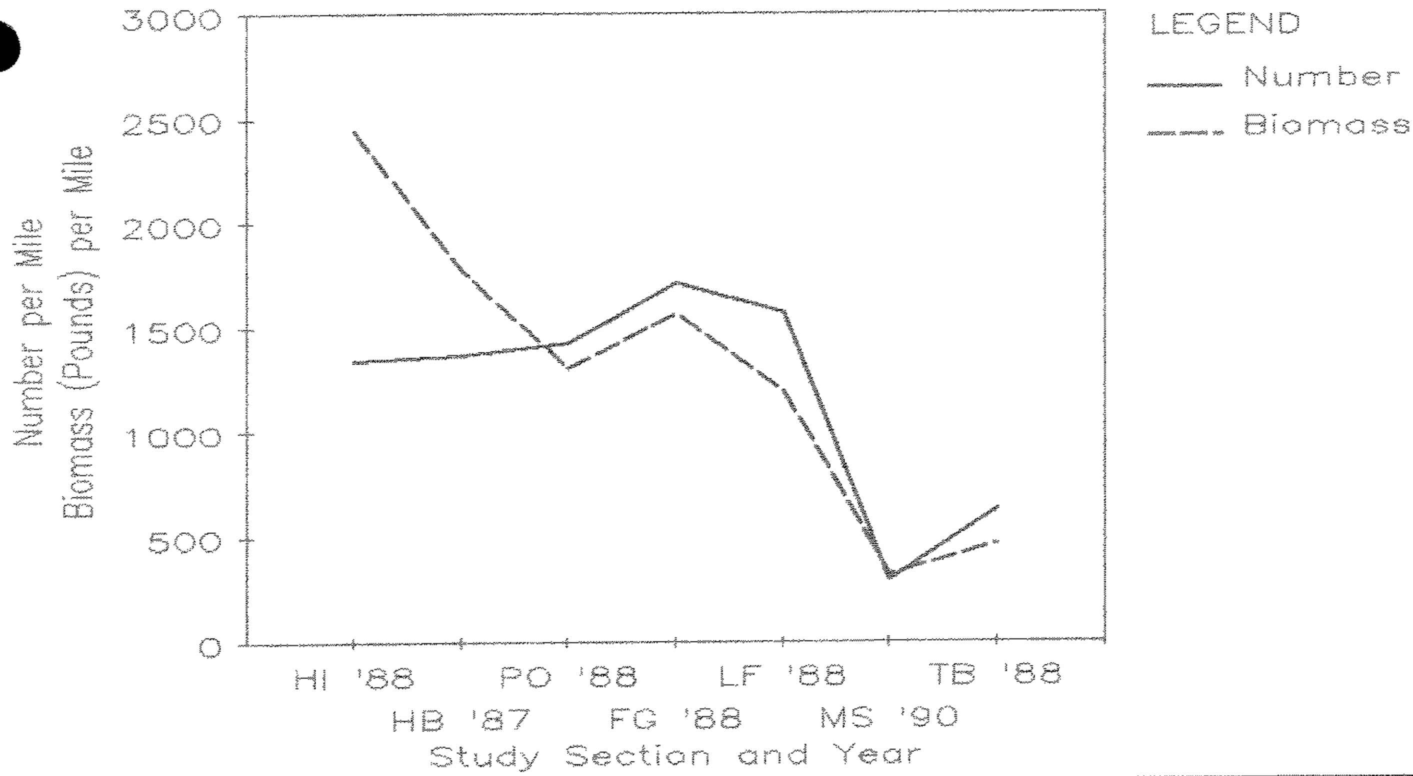


Figure 2. Estimated densities and standing crops of Age II and older brown trout from spring samples collected in the Hildreth Section (1.18 miles) of the Beaverhead River 1985 - 1990.

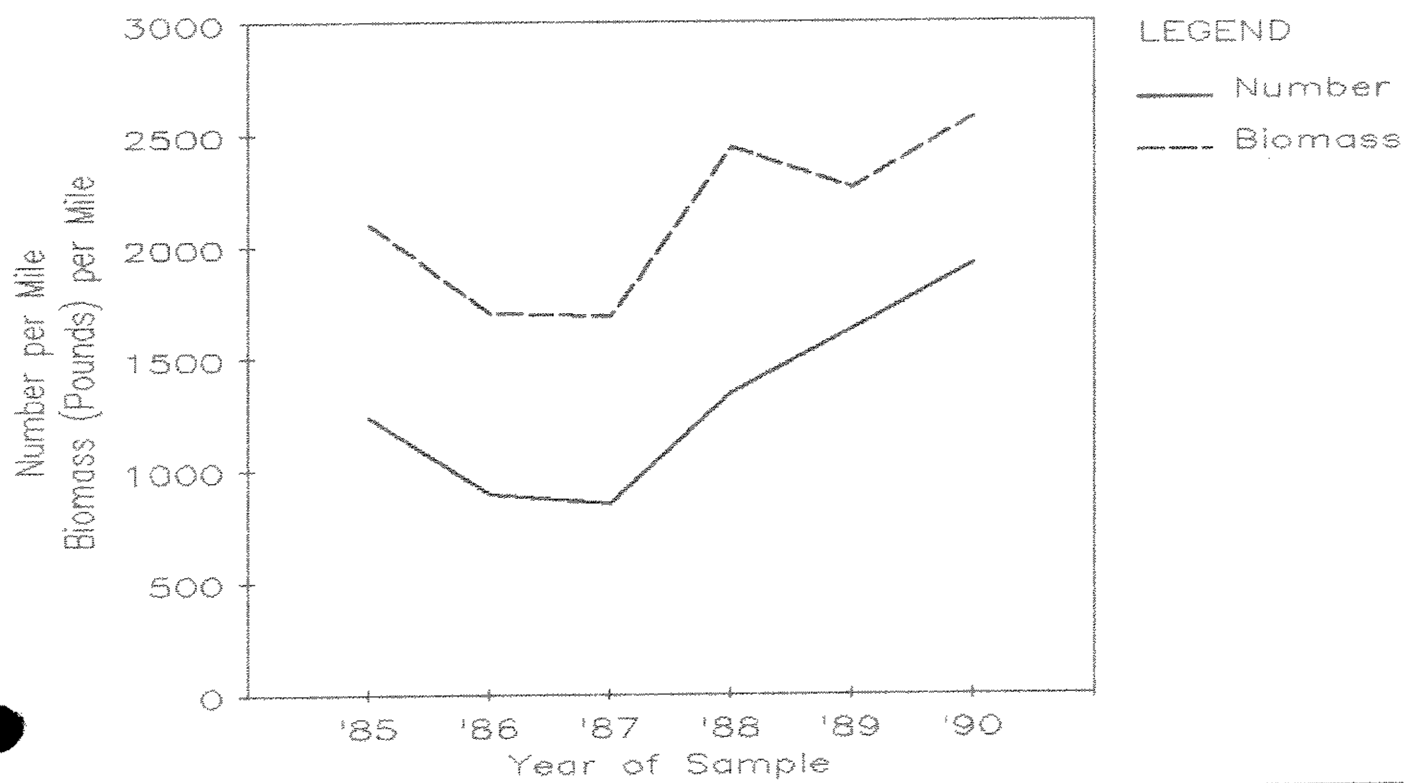


Figure 3. Estimated densities, by length group, of Age II and older brown trout from spring samples collected in the Hildreth Section of the Beaverhead River 1985 - 1990.

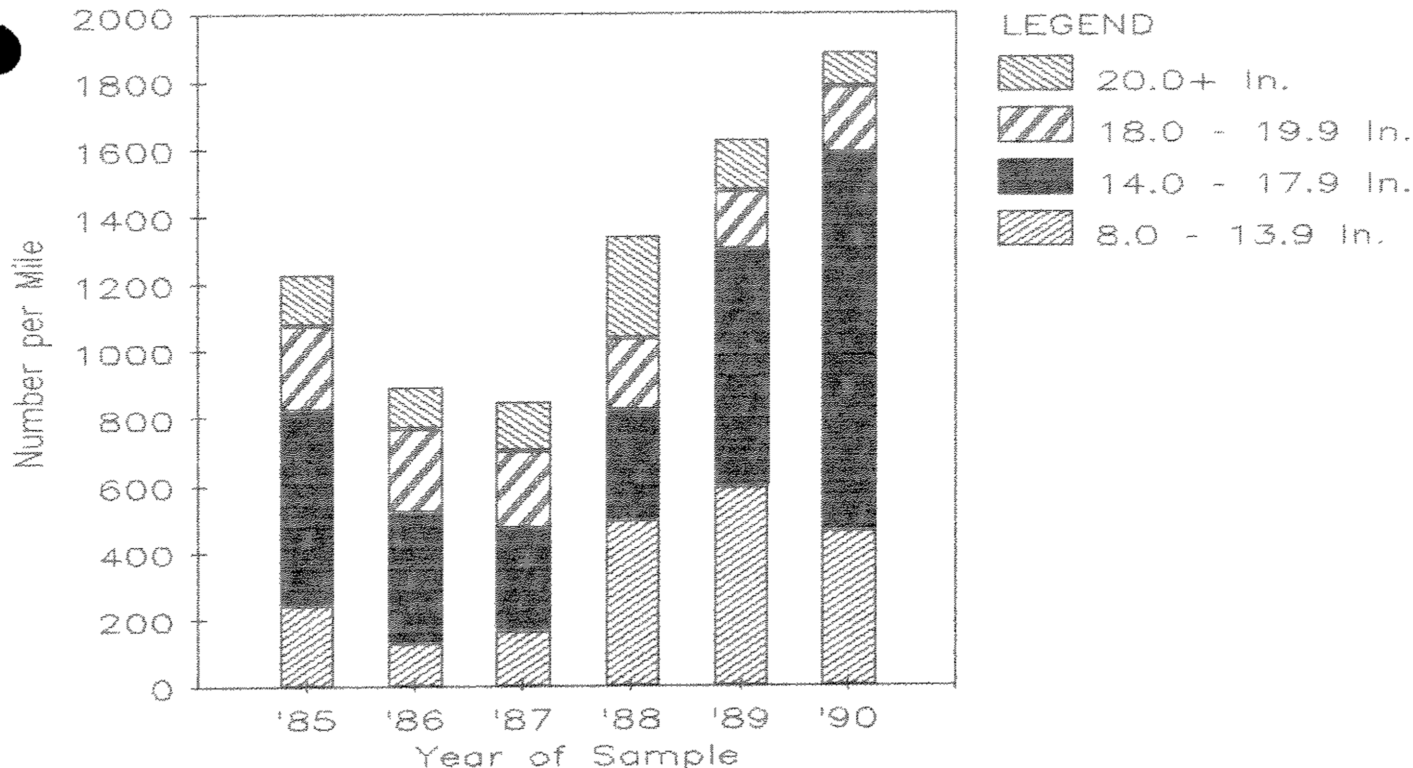


Figure 4. Estimated densities of 18 inch and larger brown trout from spring samples collected in the Hildreth Section of the Beaverhead River 1988 - 1990.

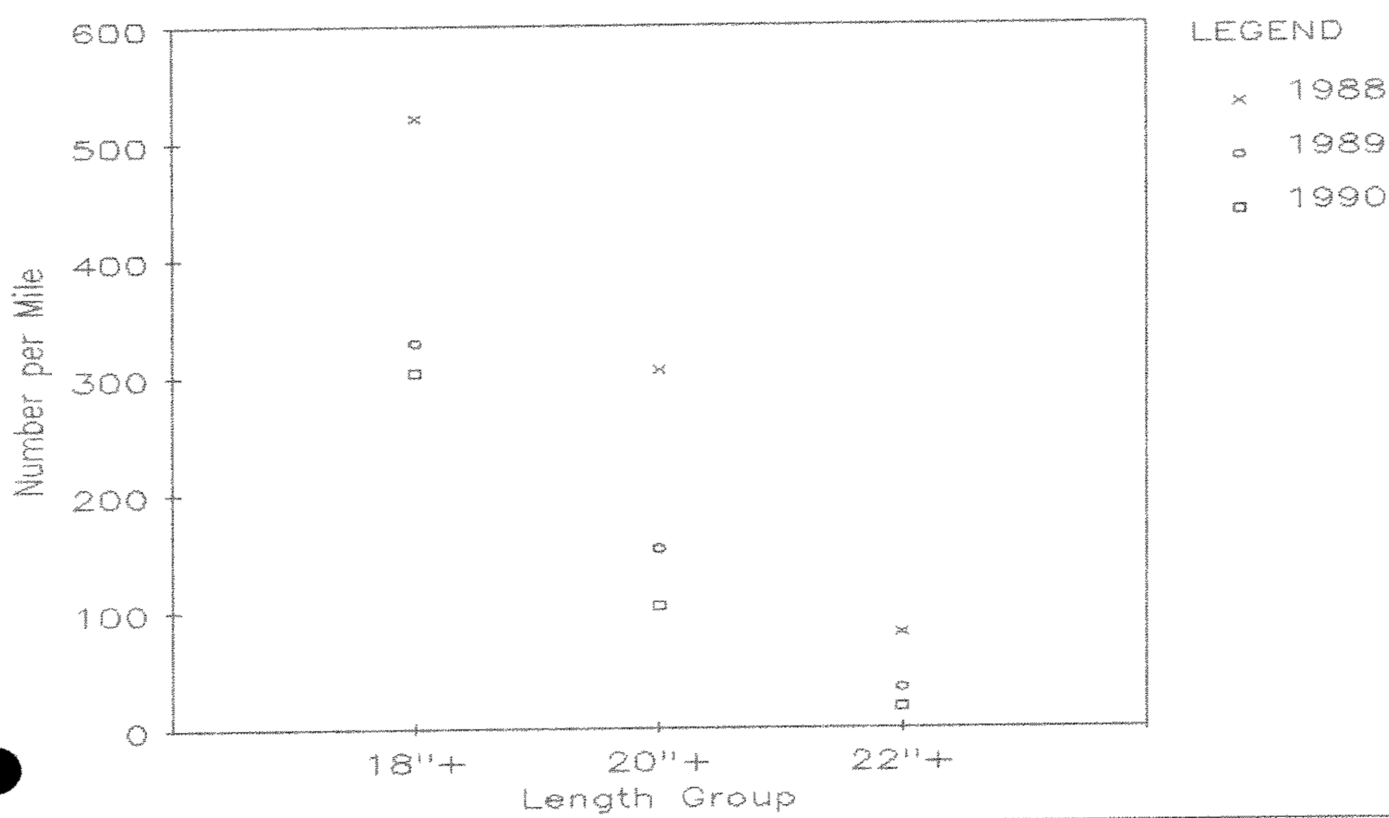


Figure 5. Estimated biomass of 18 inch and larger brown trout from spring samples collected in the Hildreth Section of the Beaverhead River 1988 - 1990.

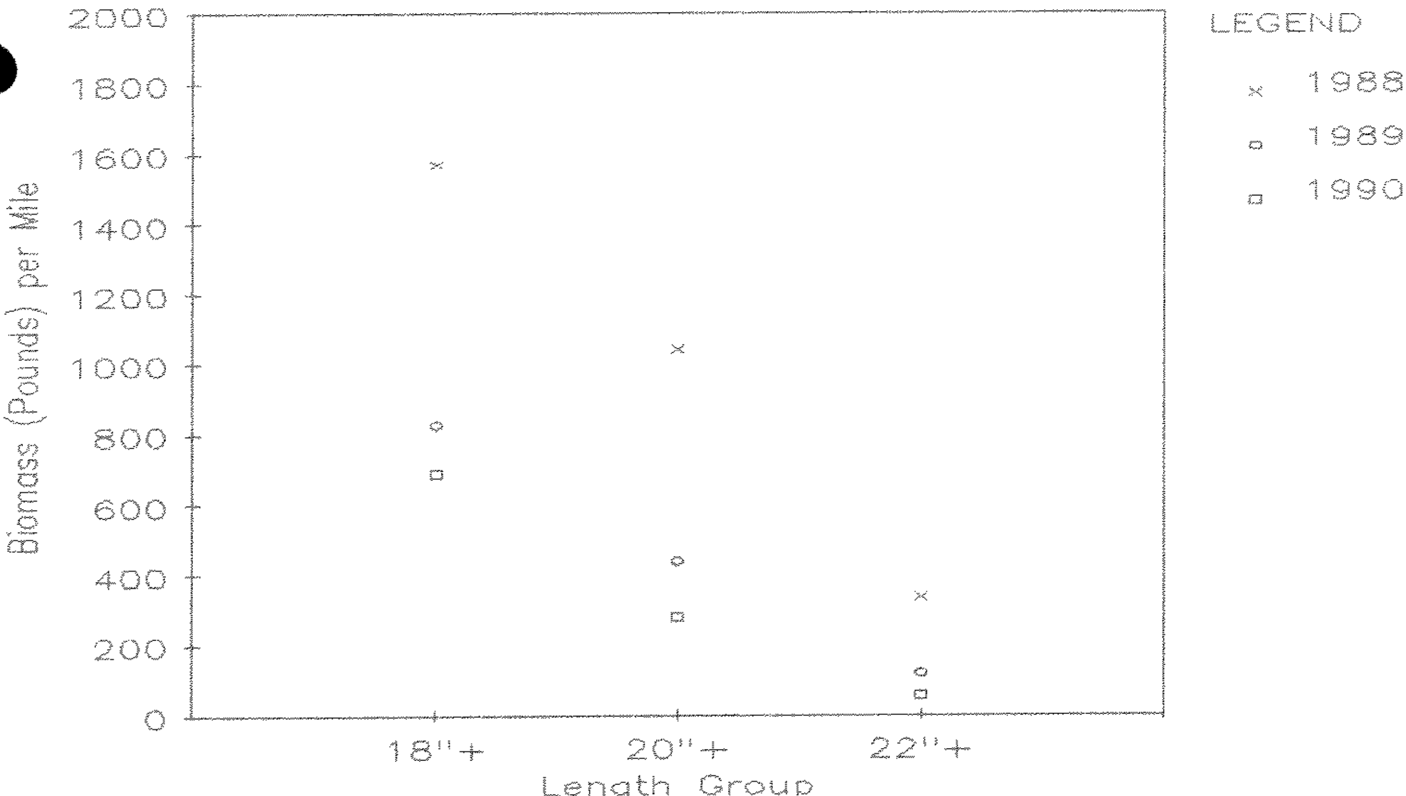


Figure 6. Mean condition factor (K) of brown trout and discreet length groupings of brown trout collected in the Hildreth Section of the Beaverhead River 1988 - 1990.

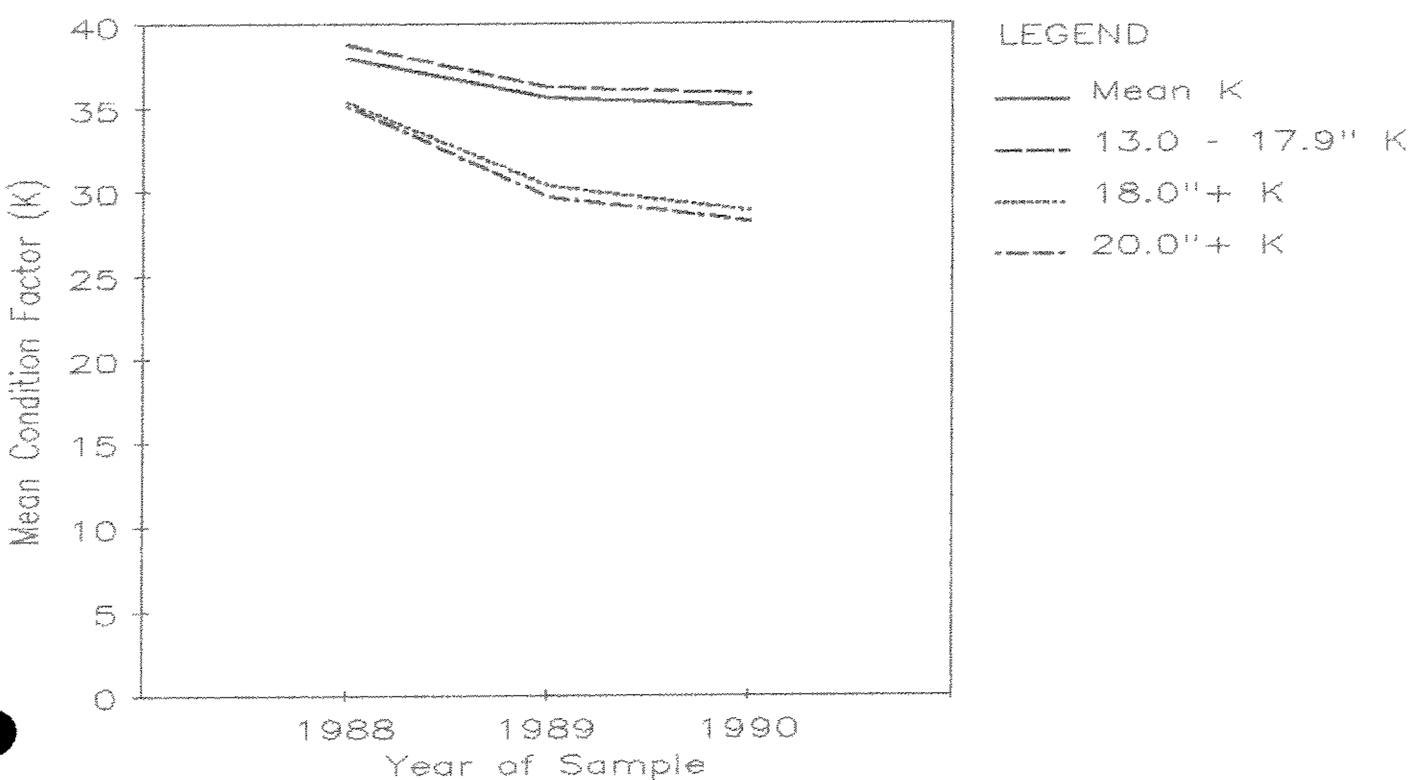


Figure 7. Estimated densities and standing crops of Age I and older rainbow trout from fall samples collected in the Hildreth Section (1.18 miles) of the Beaverhead River 1985 - 1989.

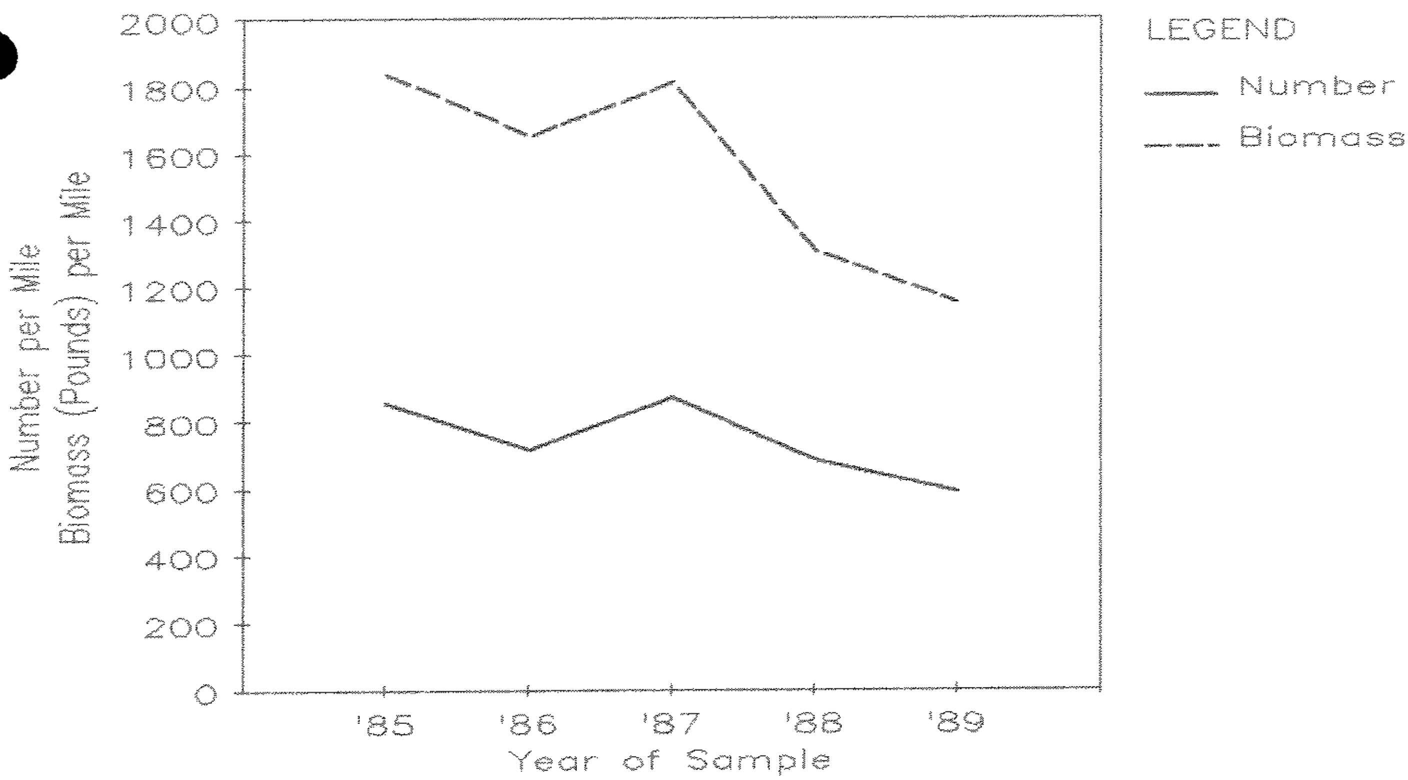


Figure 8. Estimated densities, by length group, of Age I and older rainbow trout from fall samples collected in the Hildreth Section of the Beaverhead River 1985 - 1989.

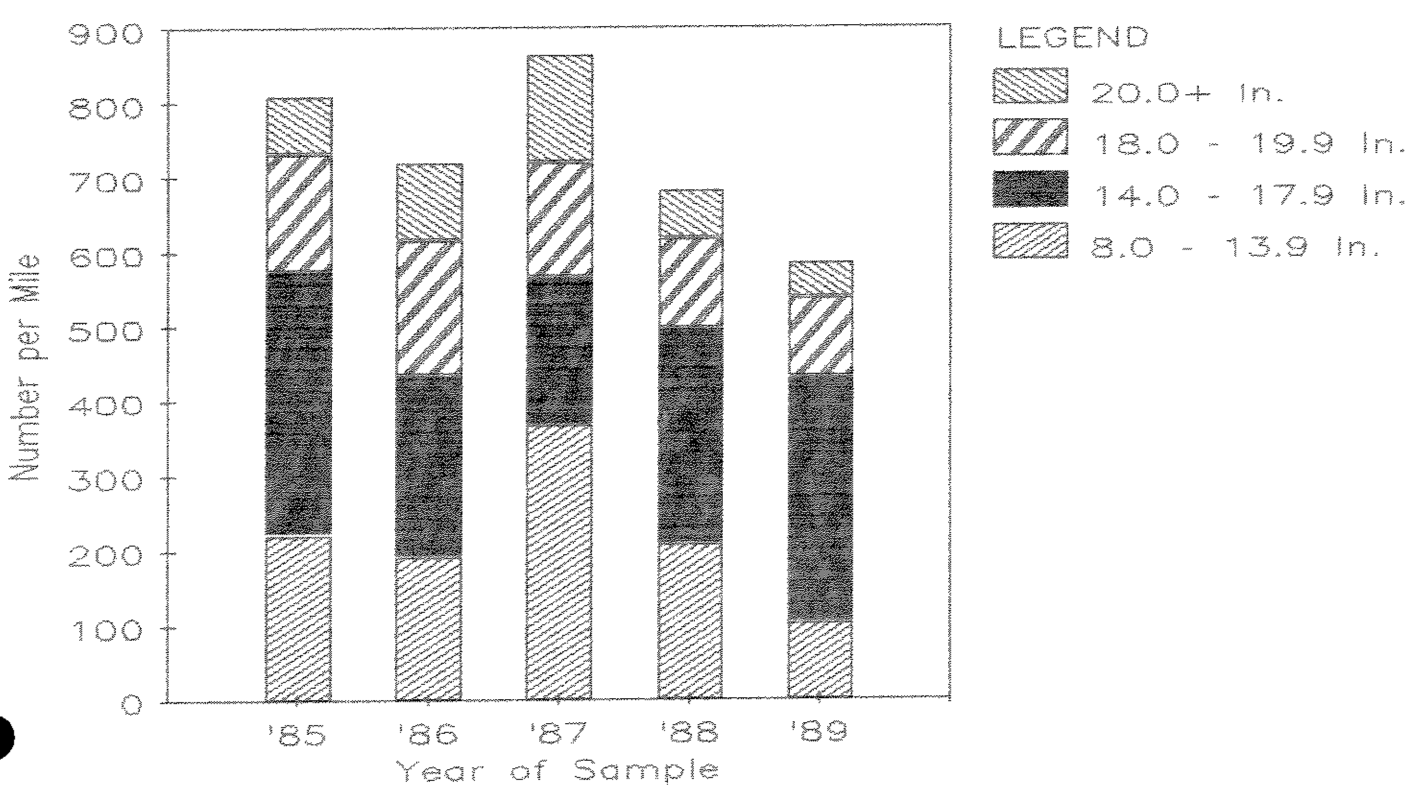


Figure 9. Estimated densities and standing crops of Age II and older brown trout from spring samples collected in the Henneberry Section (1.5 miles) of the Beaverhead River 1985 - 1987.

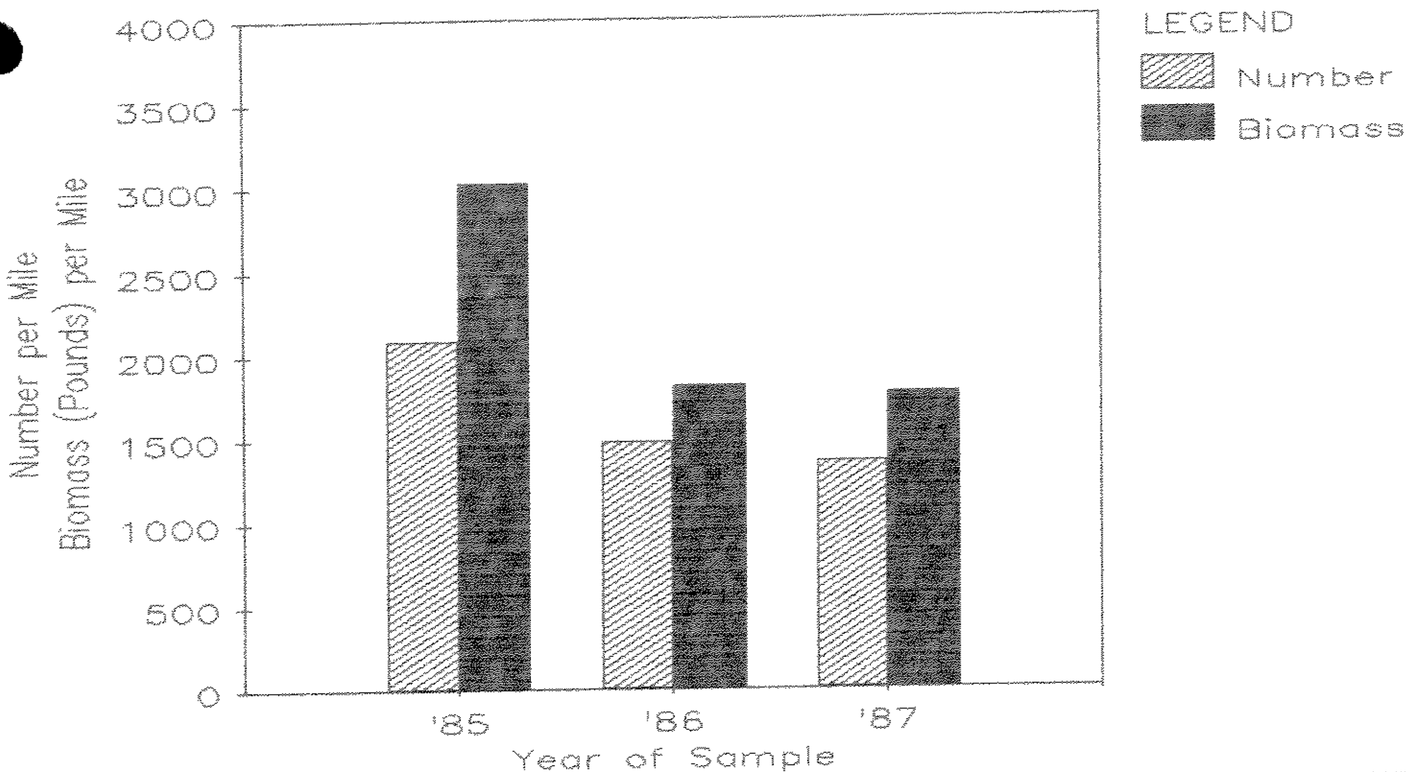


Figure 10. Estimated densities, by length group, of Age II and older brown trout in the Henneberry Section of the Beaverhead River 1985 - 1987.

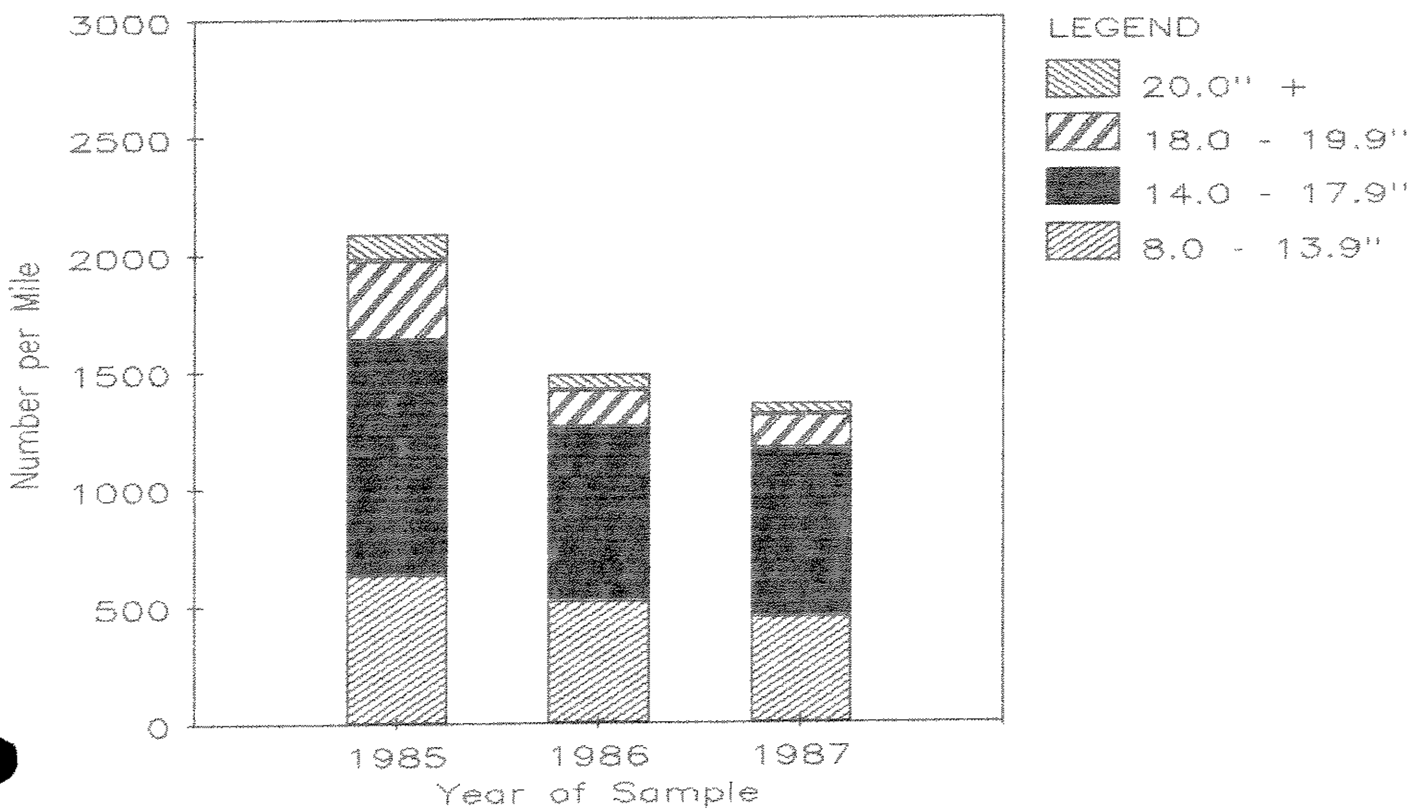


Figure 11. Estimated densities, by length group, of Age II and older brown trout in the Henneberry (HB) and Pipe Organ (PO) Sections of the Beaverhead River 1984-87.

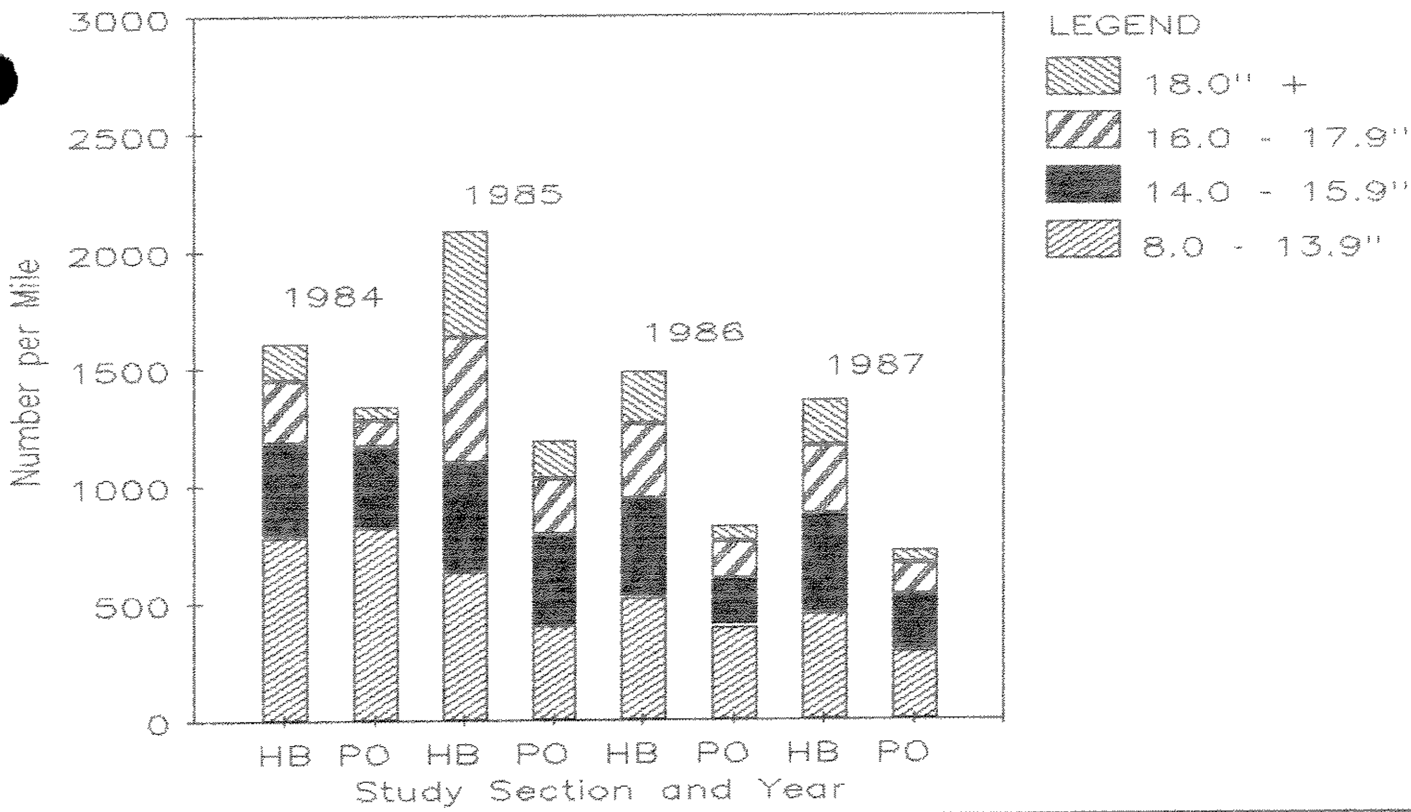


Figure 12. Estimated densities and standing crops of Age II and older brown trout from spring samples collected in the Pipe Organ Section (2.49 miles) of the Beaverhead River 1985 - 1990.

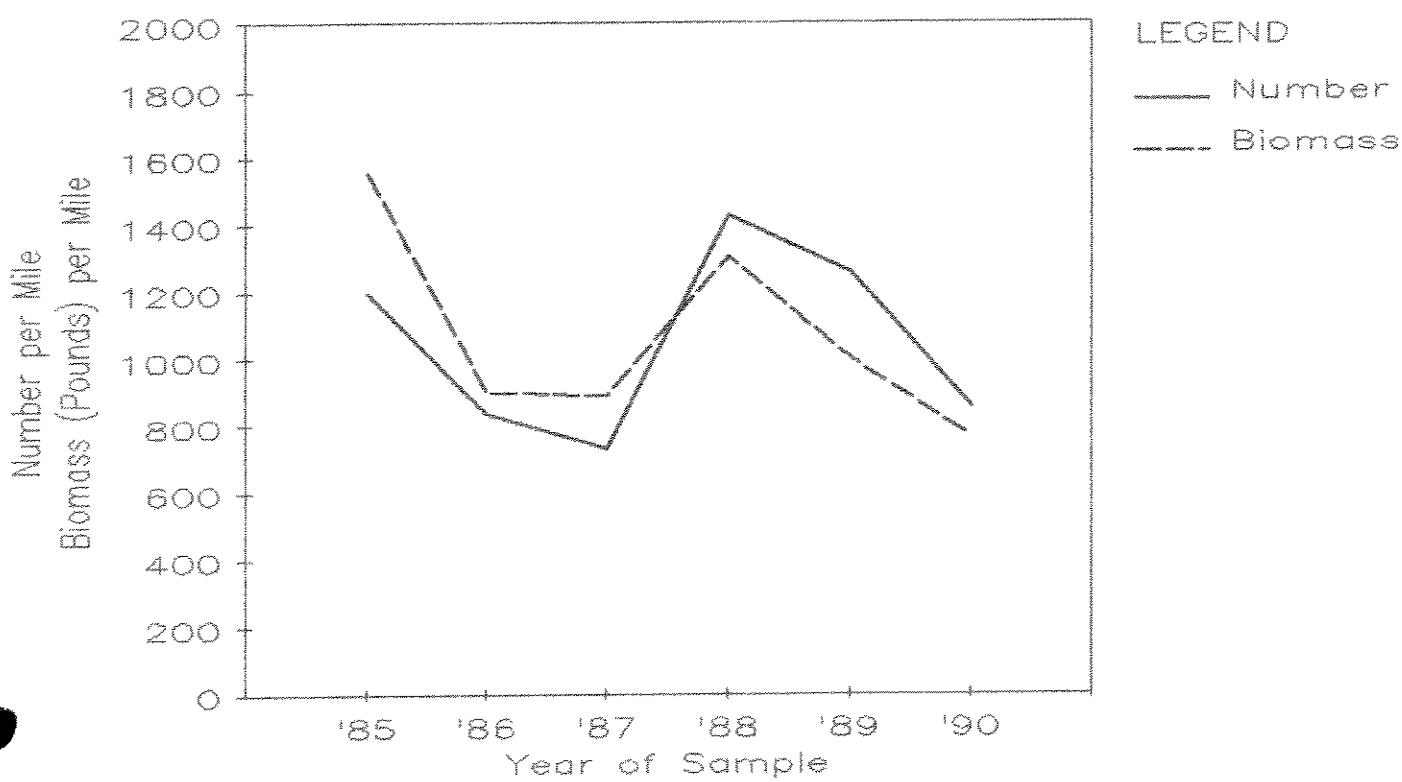


Figure 13. Estimated densities, by length group, of Age II and older brown trout in the Pipe Organ Section of the Beaverhead River 1985 - 1990.

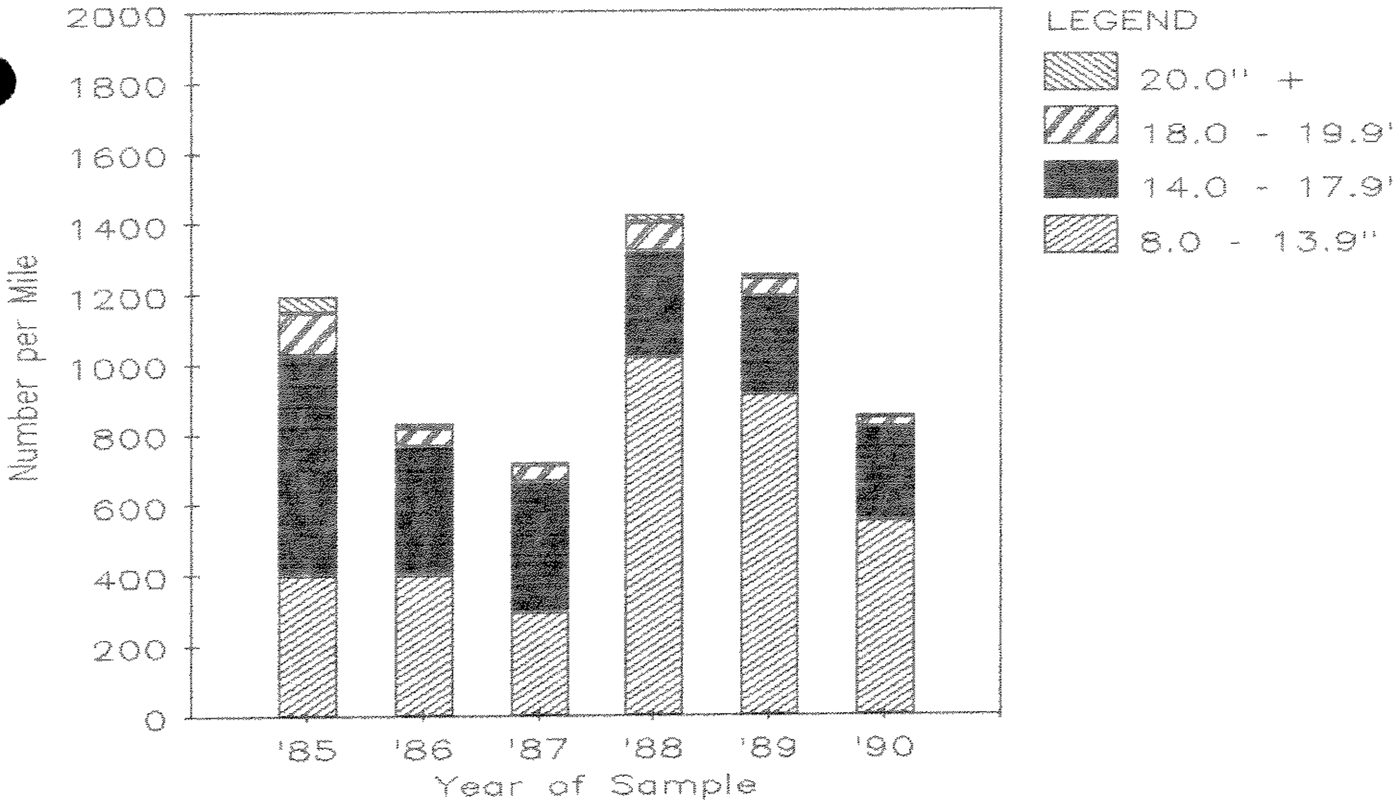


Figure 14. Mean condition factor (K) for discreet length groupings of brown trout collected in the Pipe Organ Section of the Beaverhead River in spring samples 1988 - 1990.

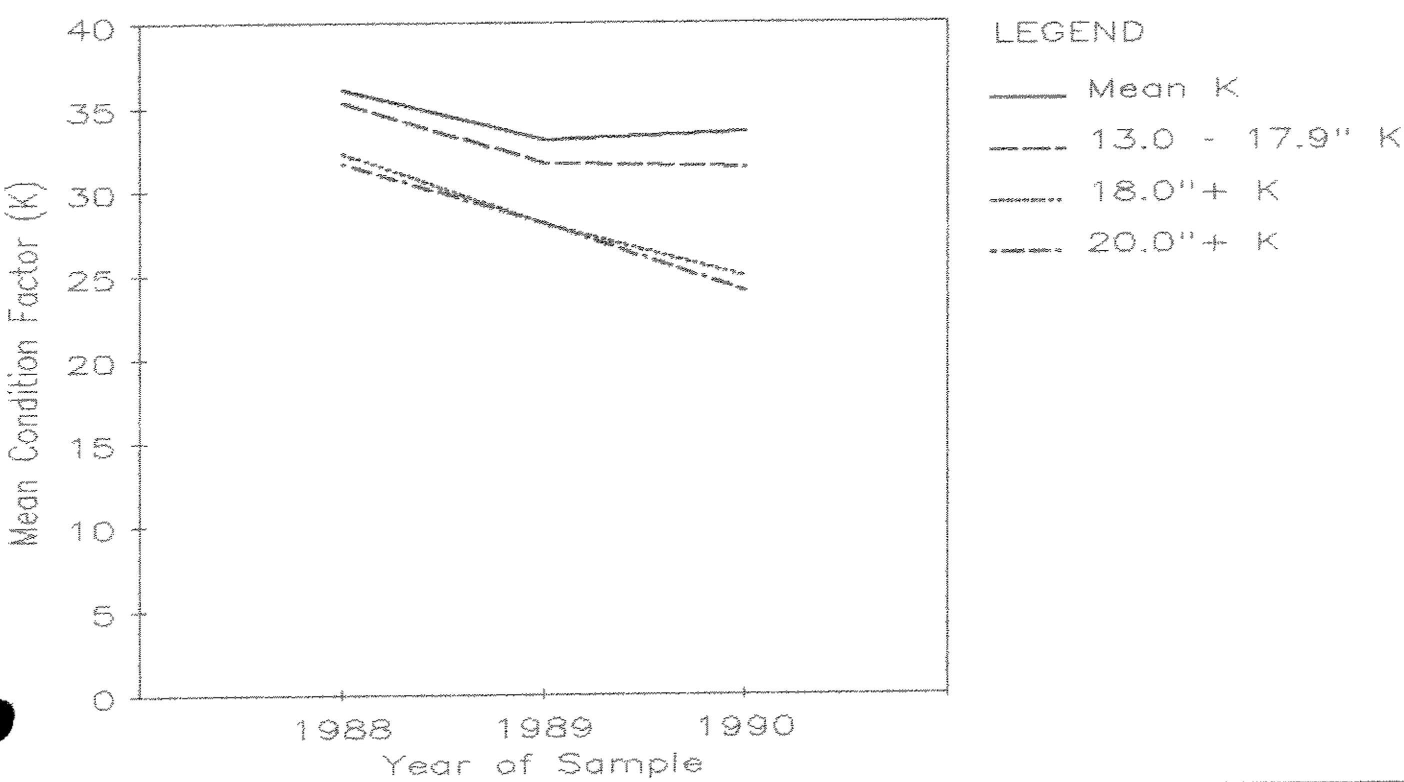


Figure 15. Estimated densities and standing crops of Age I and older rainbow trout from fall samples collected in the Pipe Organ Section (2.49 miles) of the Beaverhead River 1985 - 1989.

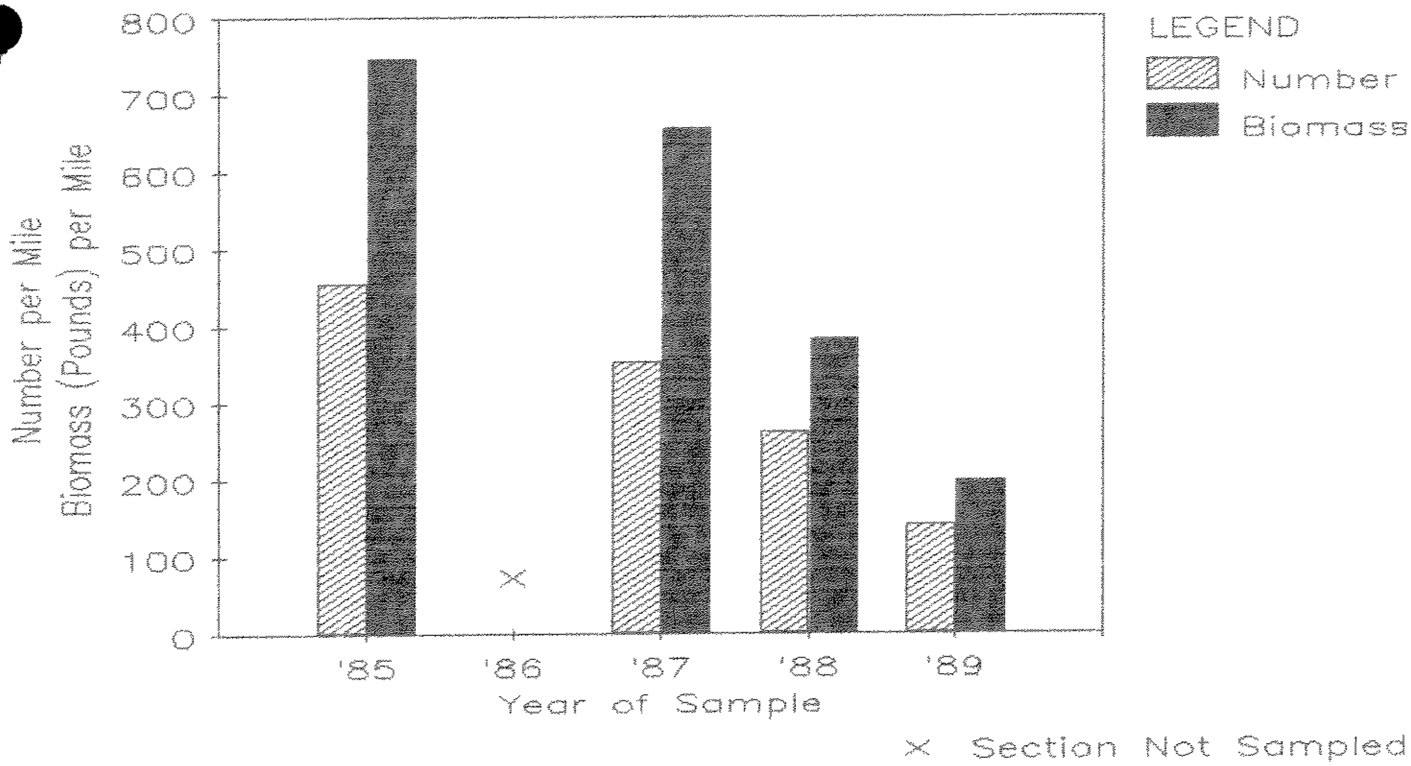


Figure 16. Estimated densities, by length group, of Age I and older rainbow trout from fall samples collected in the Pipe Organ Section of the Beaverhead River 1985 - 1989.

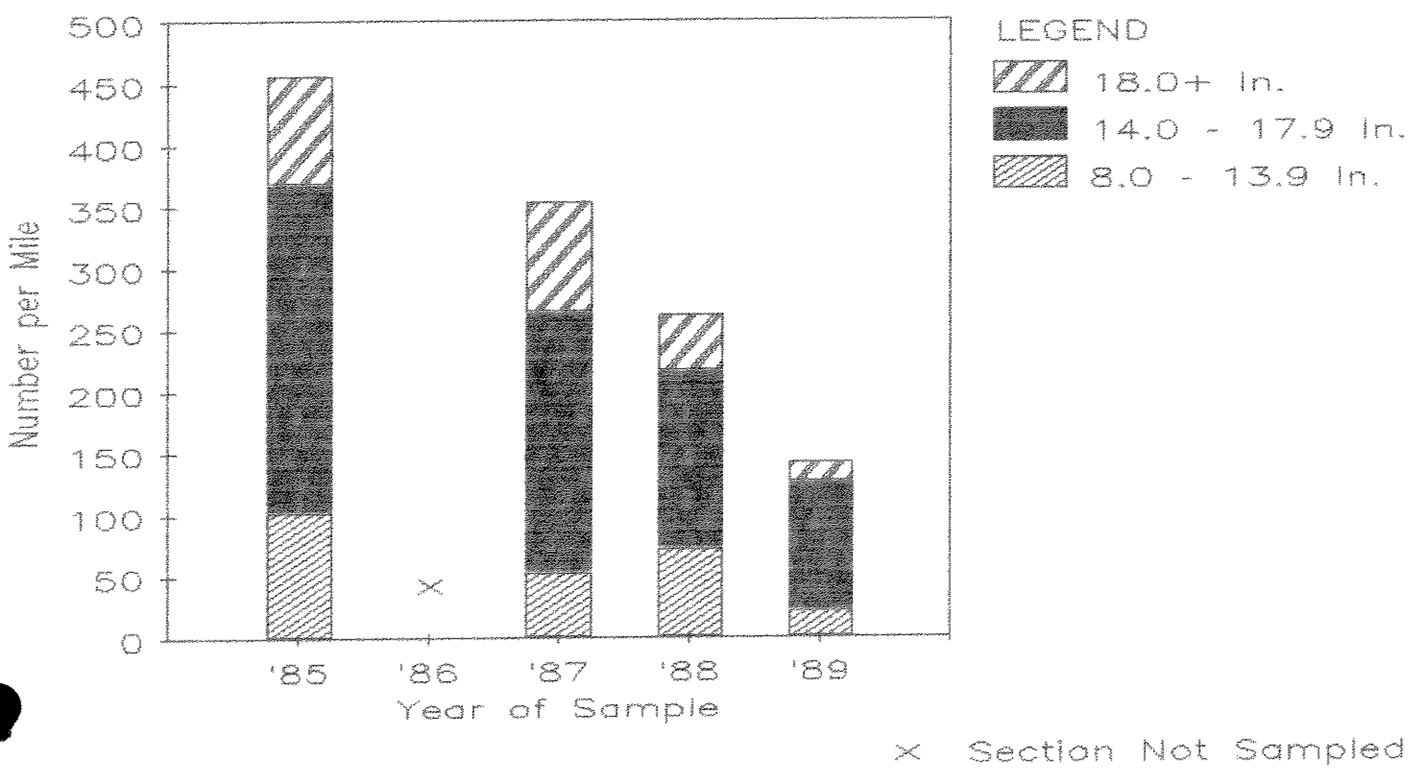


Figure 17. Estimated densities and standing crops of Age II and older brown trout from spring samples collected in the Fish and Game Section (1.70 miles) of the Beaverhead River 1980 - 1981 and 1988 - 1990.

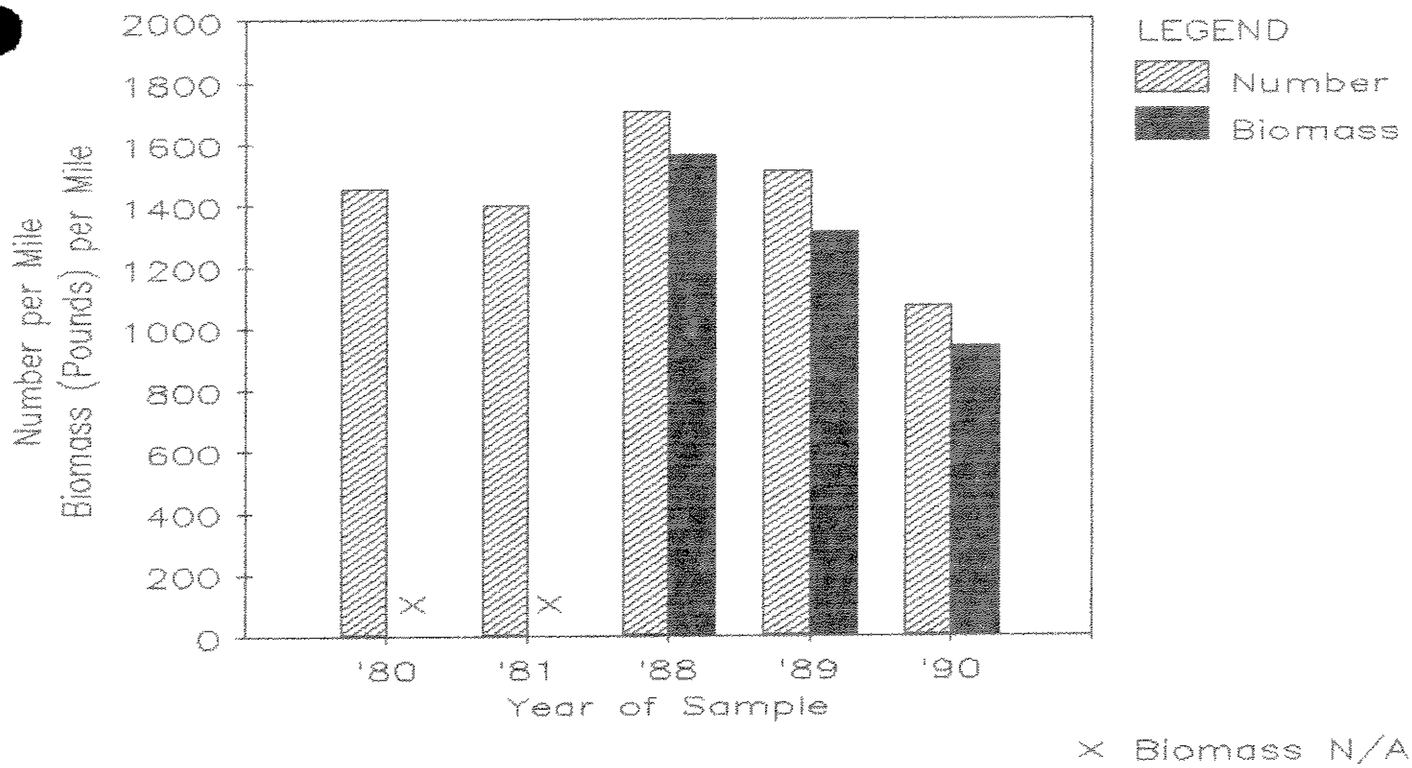


Figure 18. Estimated densities, by length group, of Age II and older brown trout from spring samples collected in the Fish and Game Section of the Beaverhead River 1980 - 1981 and 1988 - 1990.

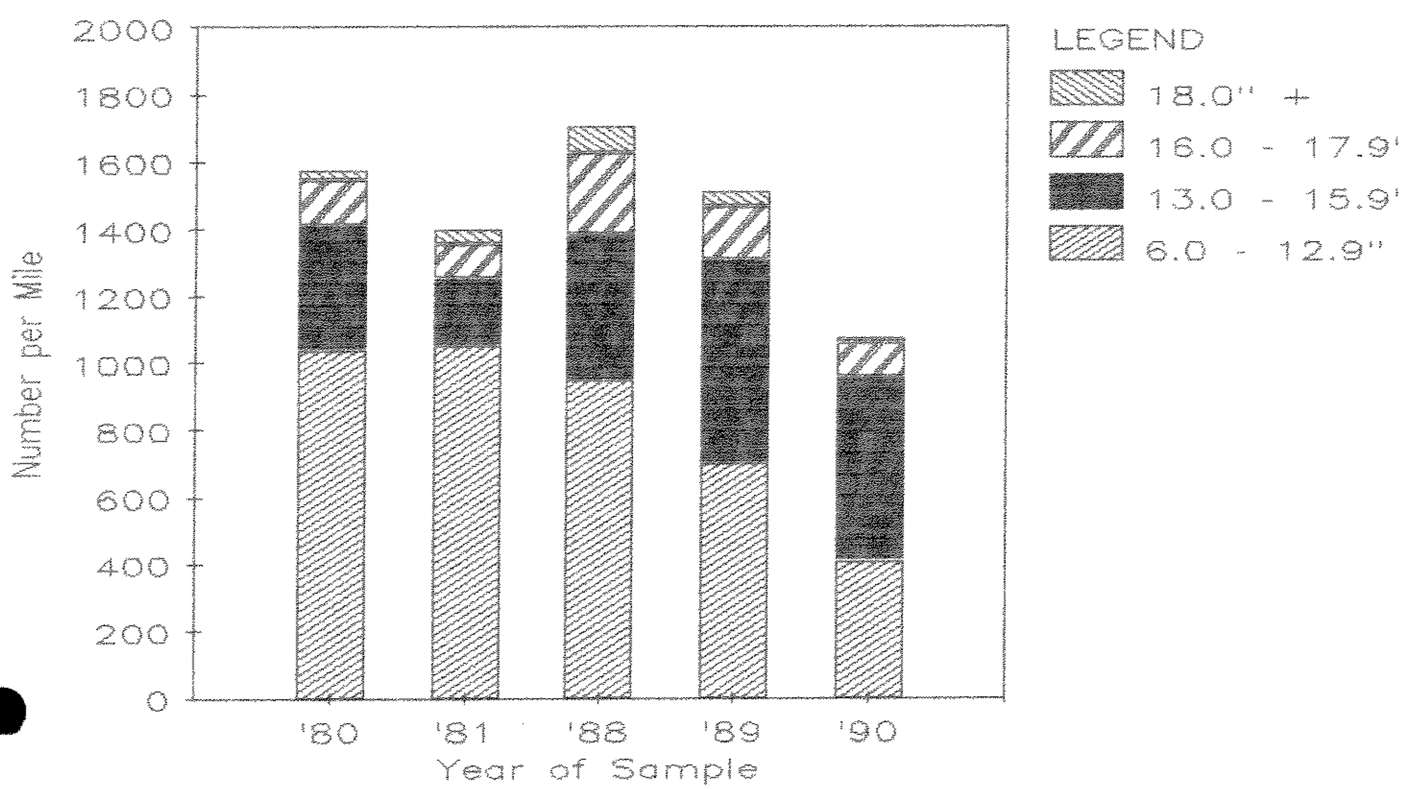


Figure 19. Mean condition factor (K) for discreet length groupings of brown trout collected in the Fish and Game Section of the Beaverhead River in spring samples 1988 - 1990.

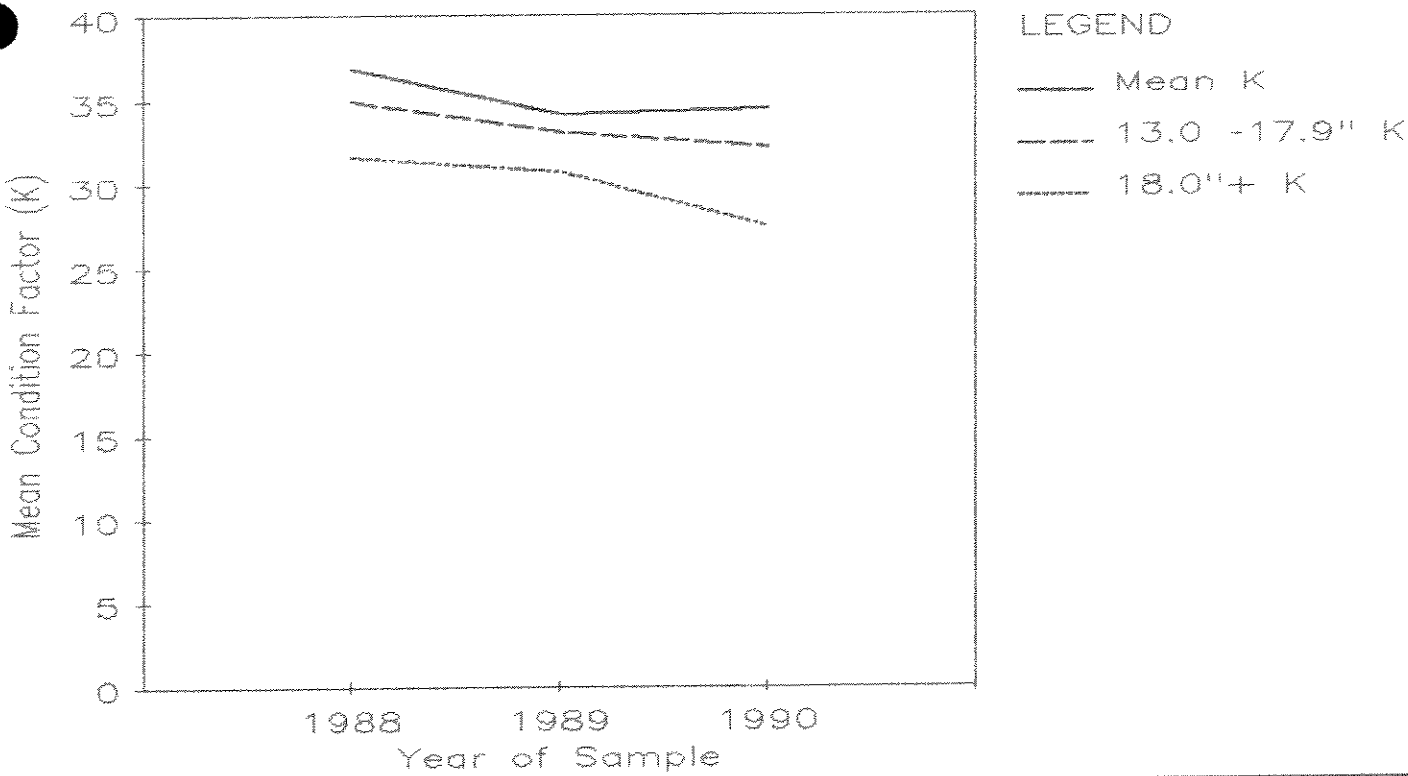


Figure 20. Estimated densities and standing crops of Age II and older rainbow trout from spring samples collected in the Fish and Game Section (1.70 miles) of the Beaverhead River 1980 - 1981 and 1988 - 1990.

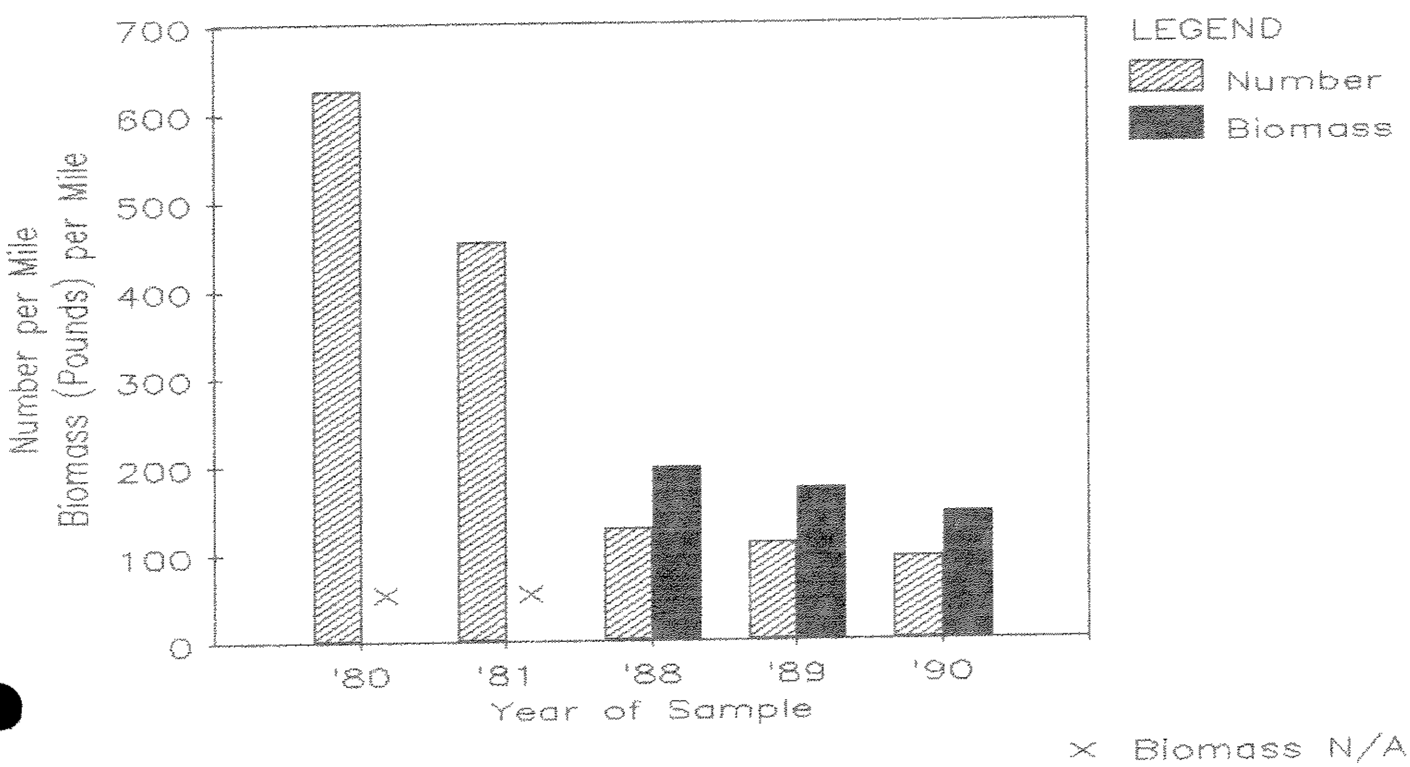


Figure 21. Estimated densities and standing crops of Age II and older brown trout from spring samples collected in the Low Flow Section (2.50 miles) of the Beaverhead River 1987 - 1990.

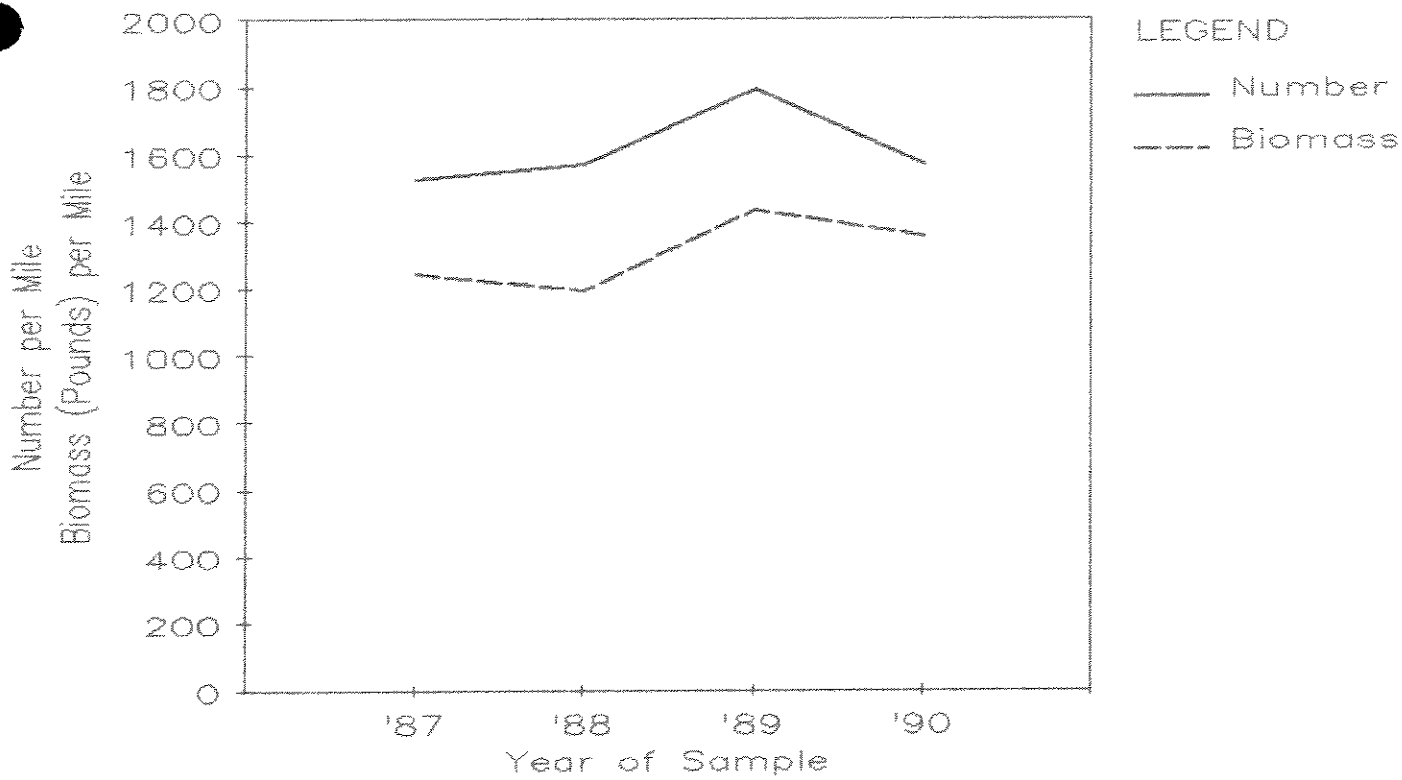


Figure 22. Estimated densities, by length group, of Age II and older brown trout from spring samples collected in the Low Flow Section of the Beaverhead River 1987 - 1990.

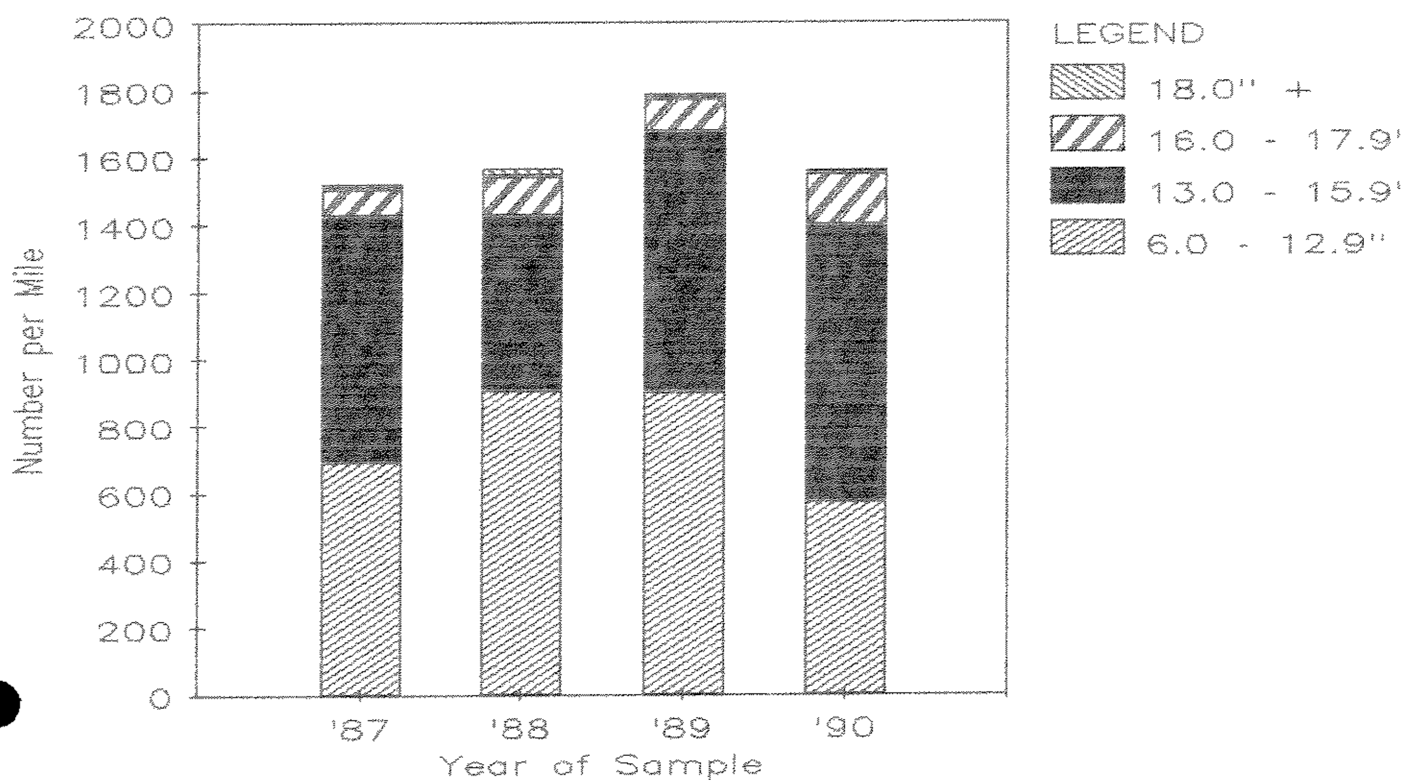


Figure 23. Mean condition factor (K) for discreet length groupings of brown trout collected in the Low Flow Section of the Beaverhead River in spring samples 1987 - 1990.

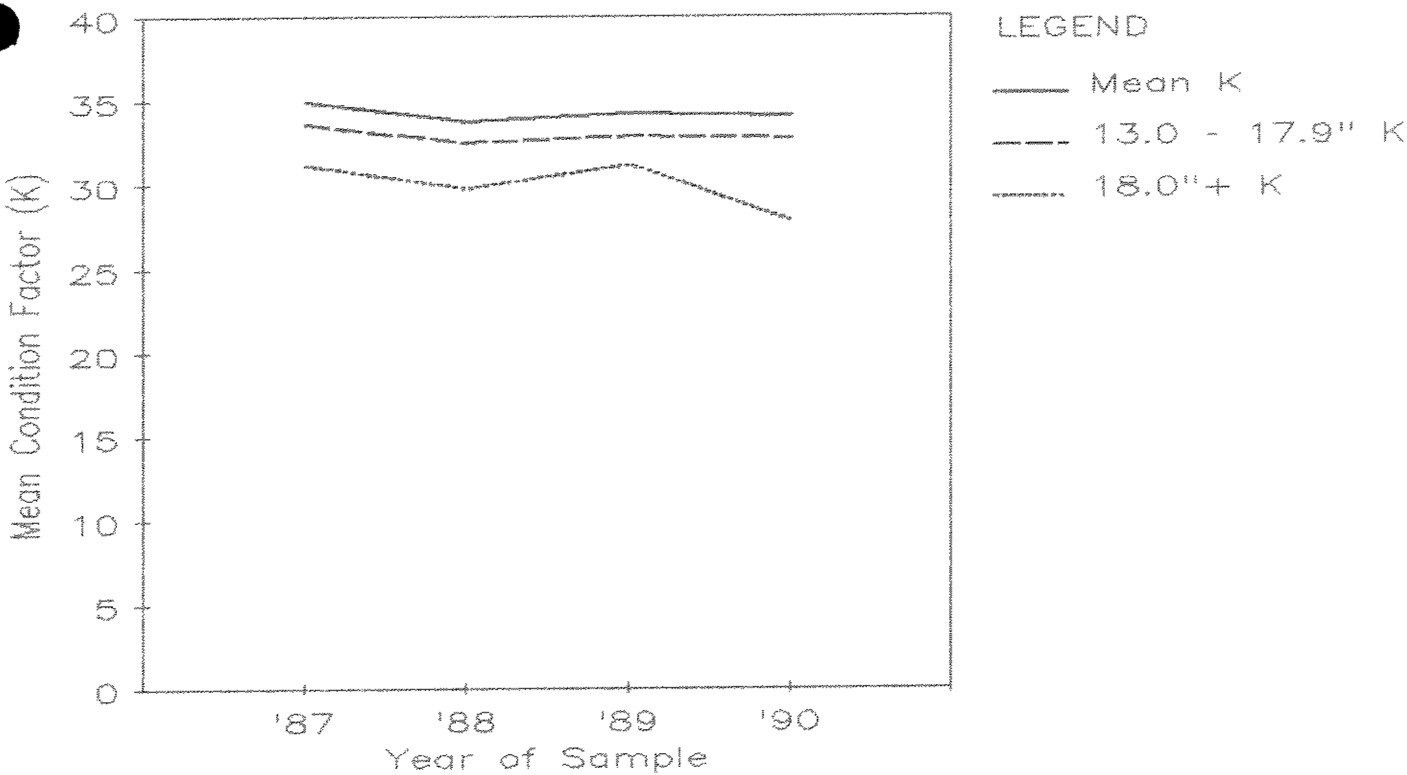


Figure 24. Estimated densities, by length group, of Age II and older brown trout in the Low Flow (LF) and Fish and Game (FG) Sections of the Beaverhead River 1988 - 1990.

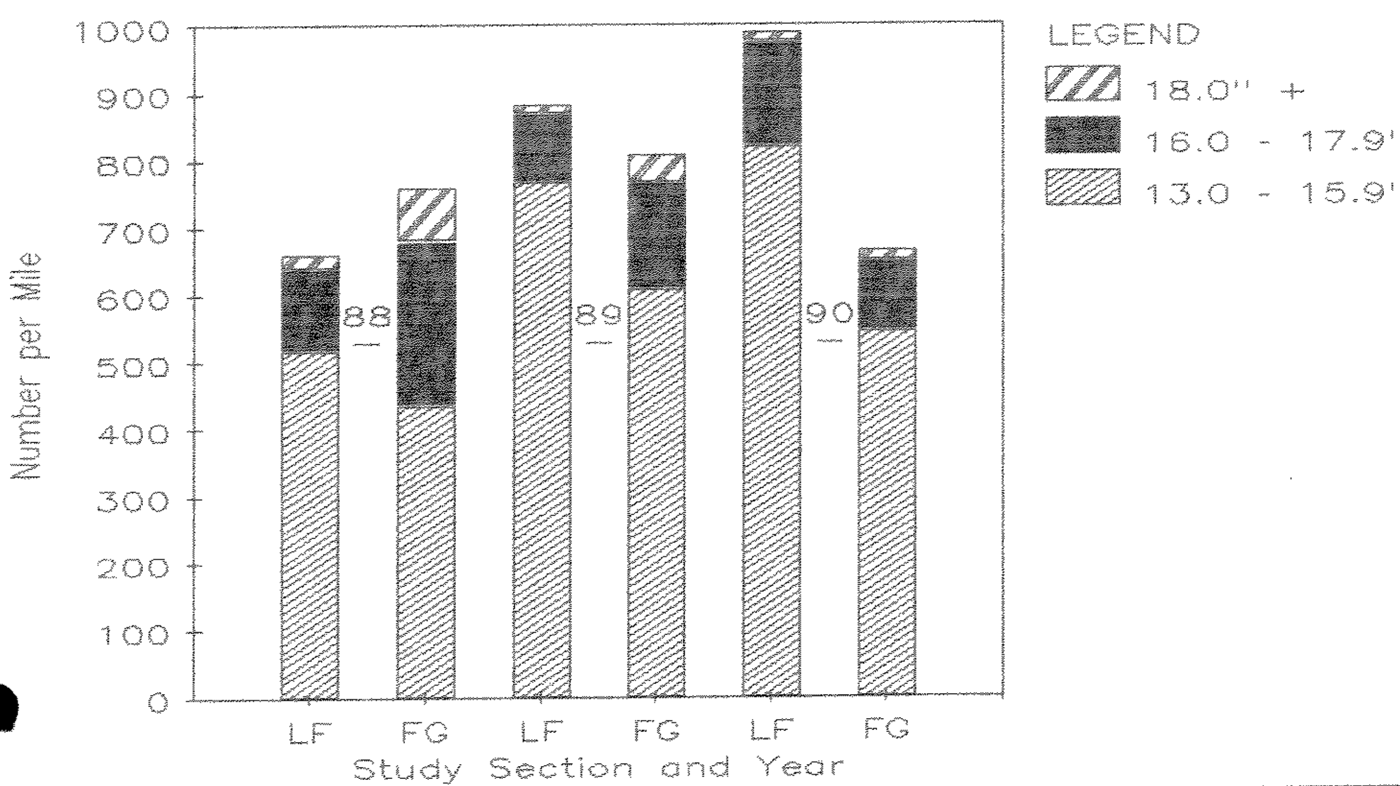


Figure 25. Estimated densities and standing crops of Age II and older brown trout from samples collected in the Blaine (3.38 mi.) and Mule Shoe (3.14 mi.) Sections of the Beaverhead River 1971, 1975, and 1990.

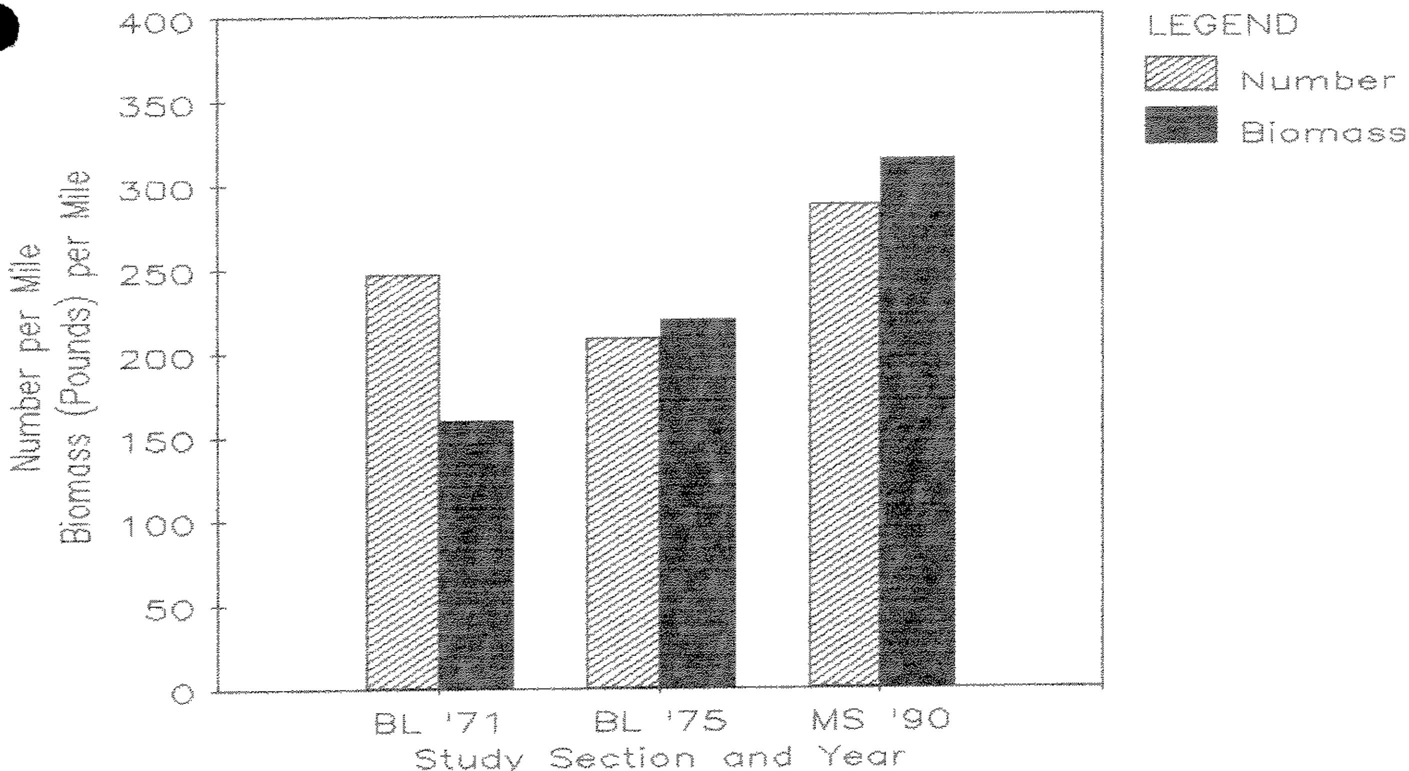


Figure 26. Estimated densities, by length group, of Age II and older brown trout from spring samples collected in the Blaine (BL) and Mule Shoe (MS) Sections of the Beaverhead River 1975 and 1990.

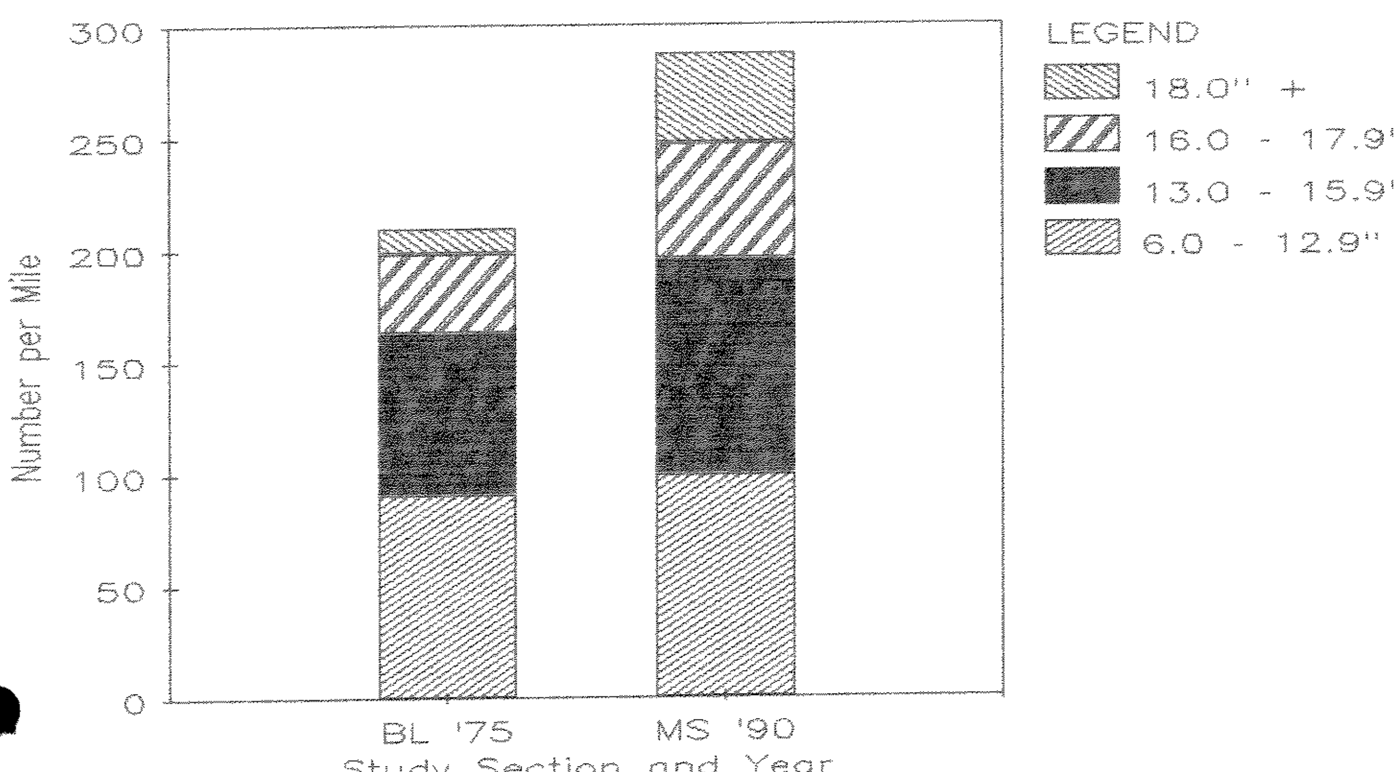


Figure 27. Estimated densities and standing crops of Age II and older brown trout from spring samples collected in the Twin Bridges Section (2.50 miles) of the Beaverhead River 1987 - 1989.

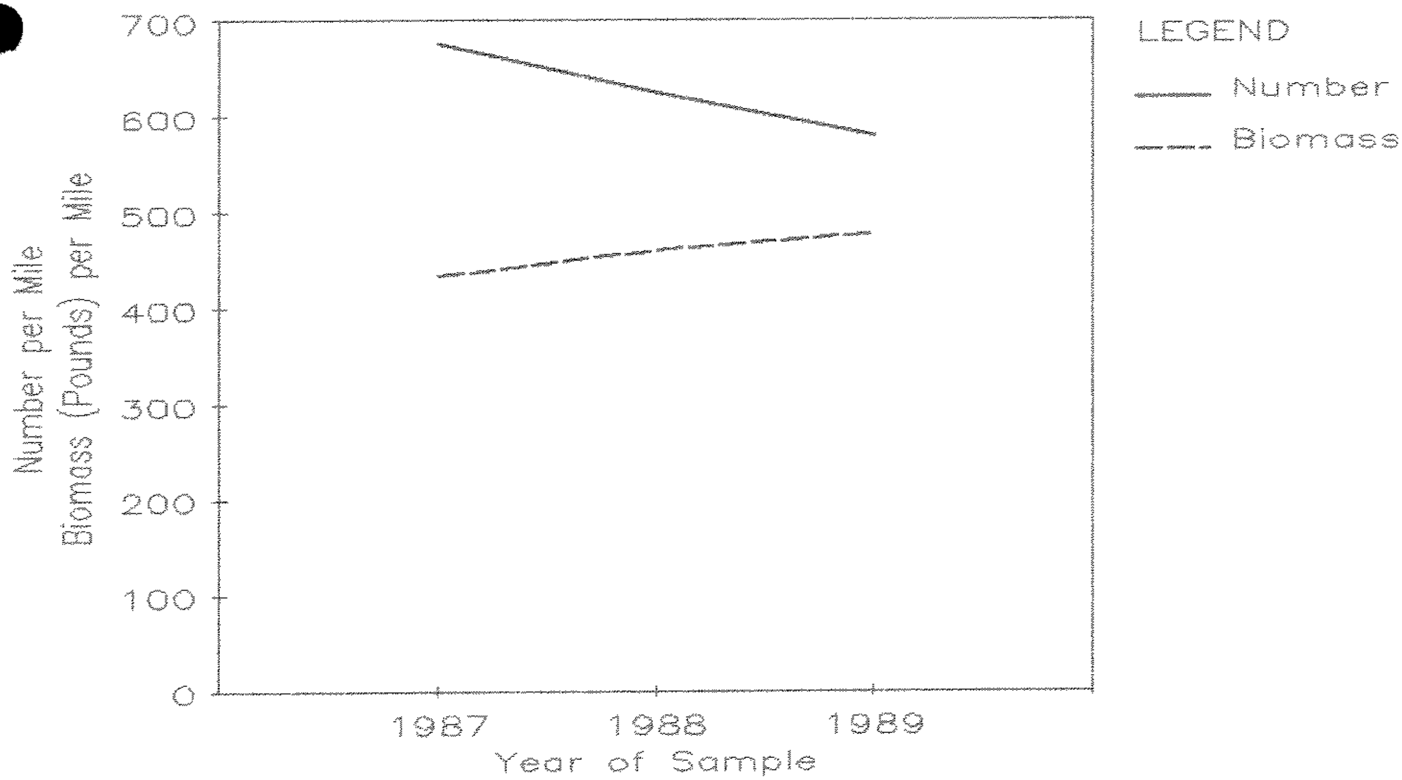
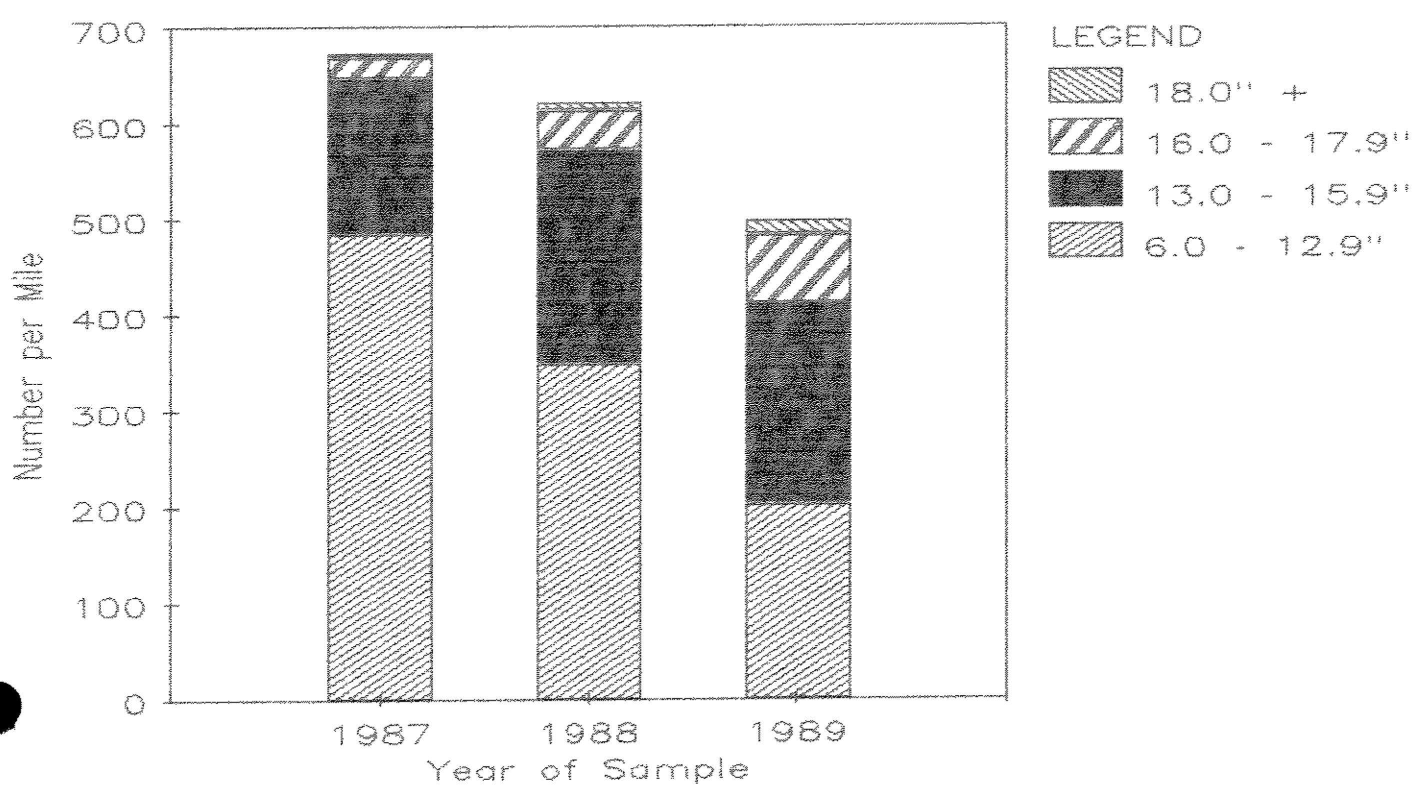


Figure 28. Estimated densities, by length group, of Age II and older brown trout from spring samples collected in the Twin Bridges Section of the Beaverhead River 1987 - 1989.



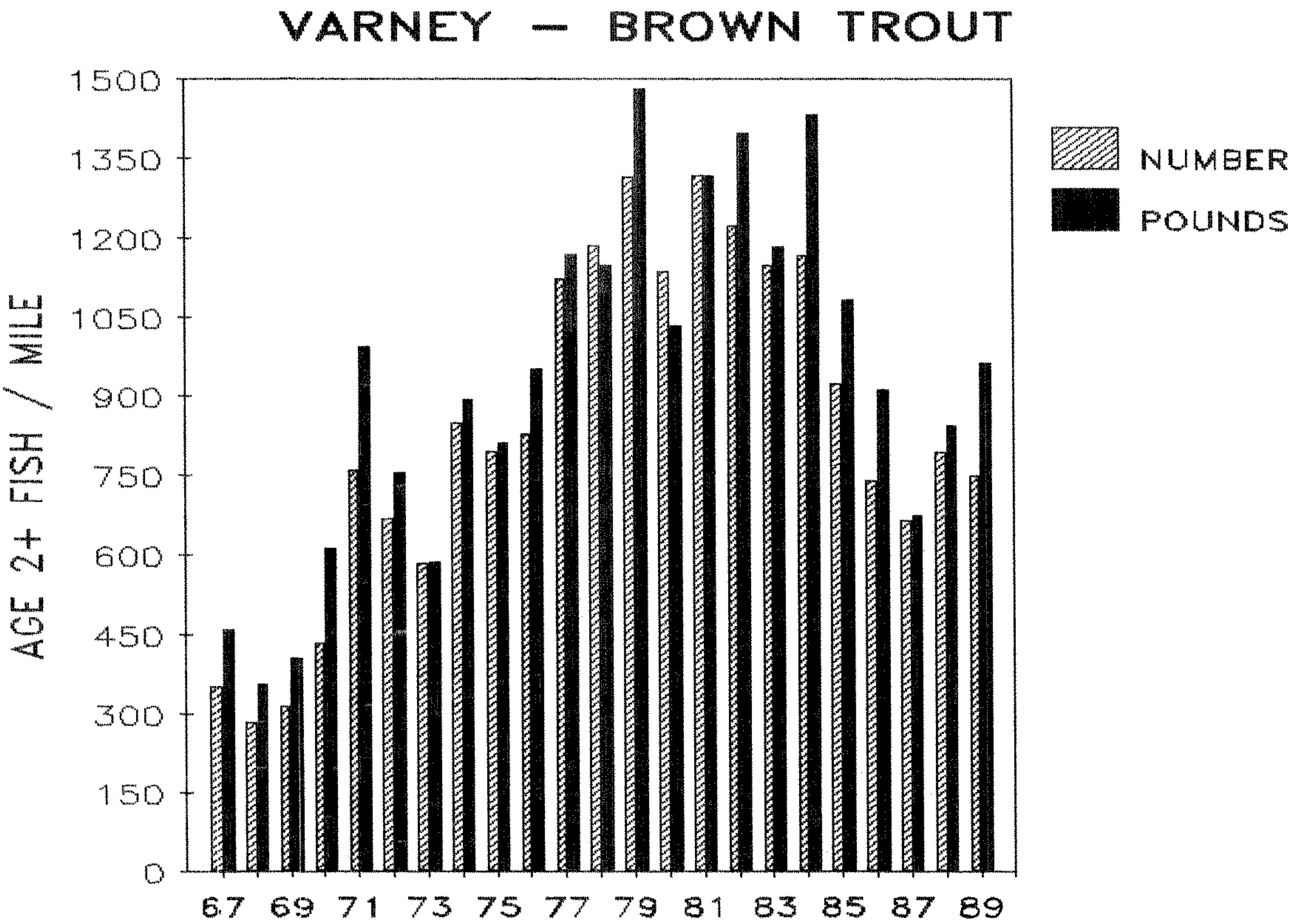


Figure 29. Fall (September) population and biomass estimates of age 2 and older brown trout from the Varney section of the Madison River during 1967-1989.

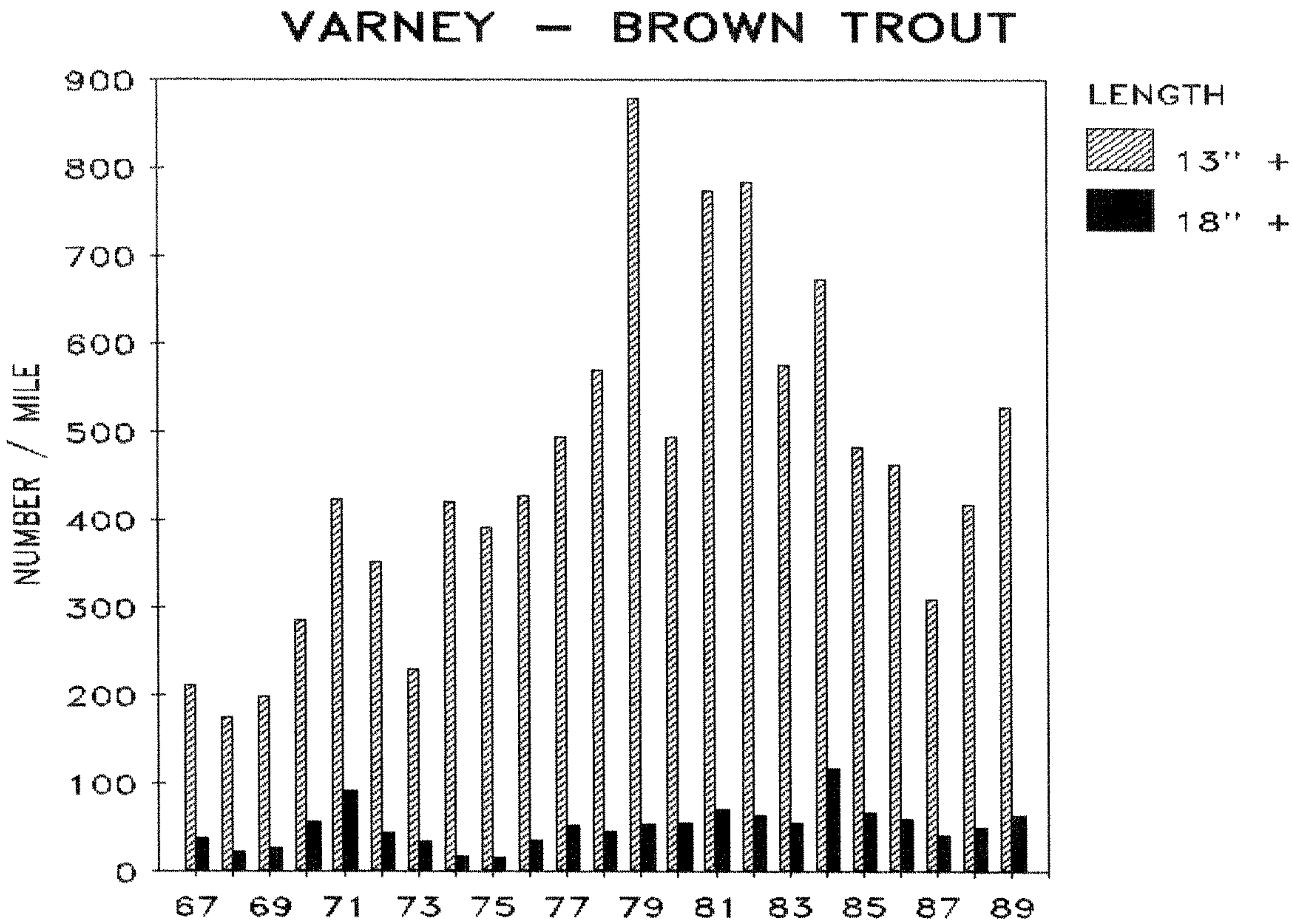


Figure 30. Fall (September) population estimates of brown trout longer than 13 and 18 inches, respectively, per mile in the Varney section of the Madison River during 1967-1989.

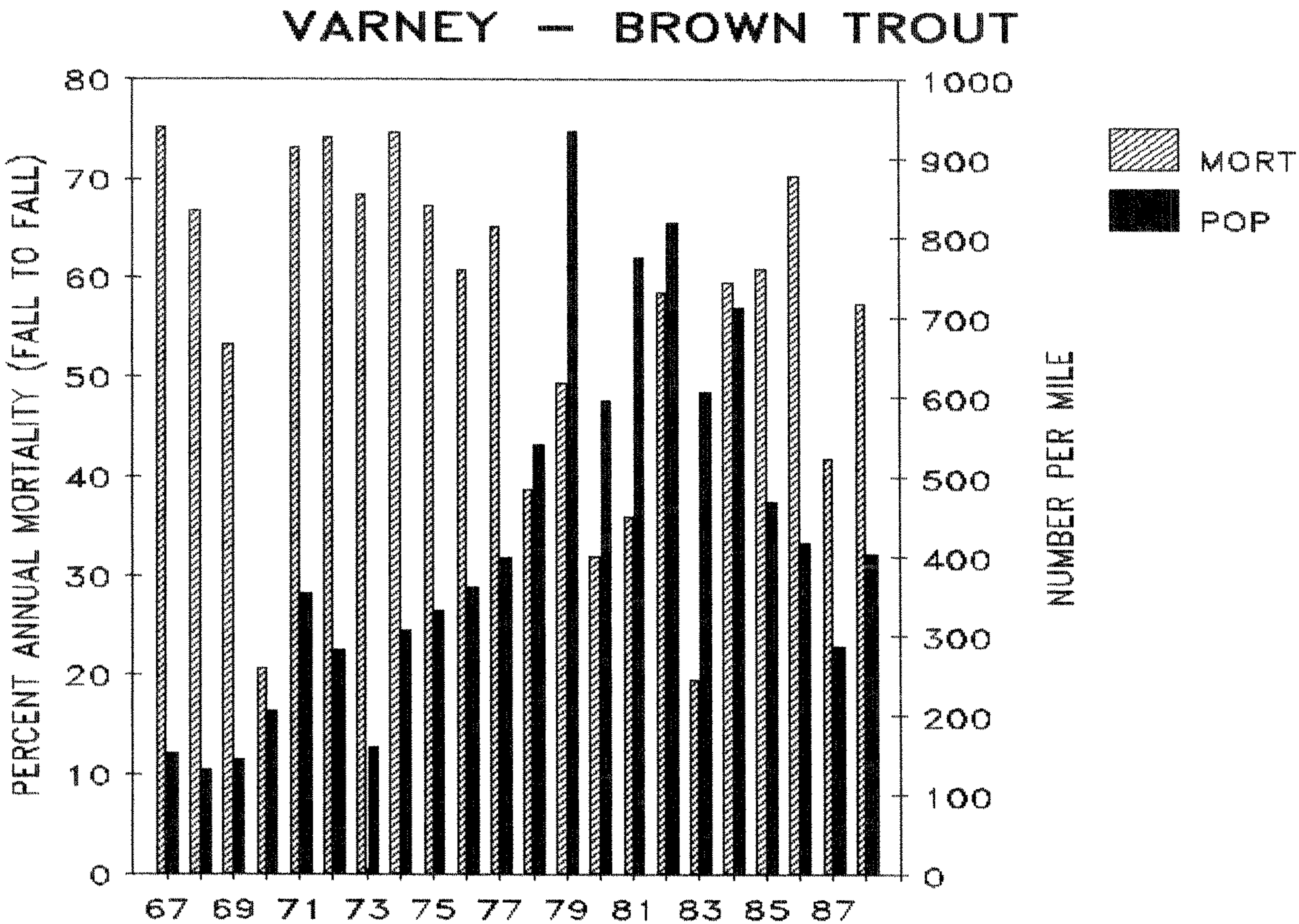


Figure 31. Fall (September) estimated population levels and subsequent annual mortality rates of age 3 and older (3+) brown trout from the Varney section of the Madison River during 1967-1988.

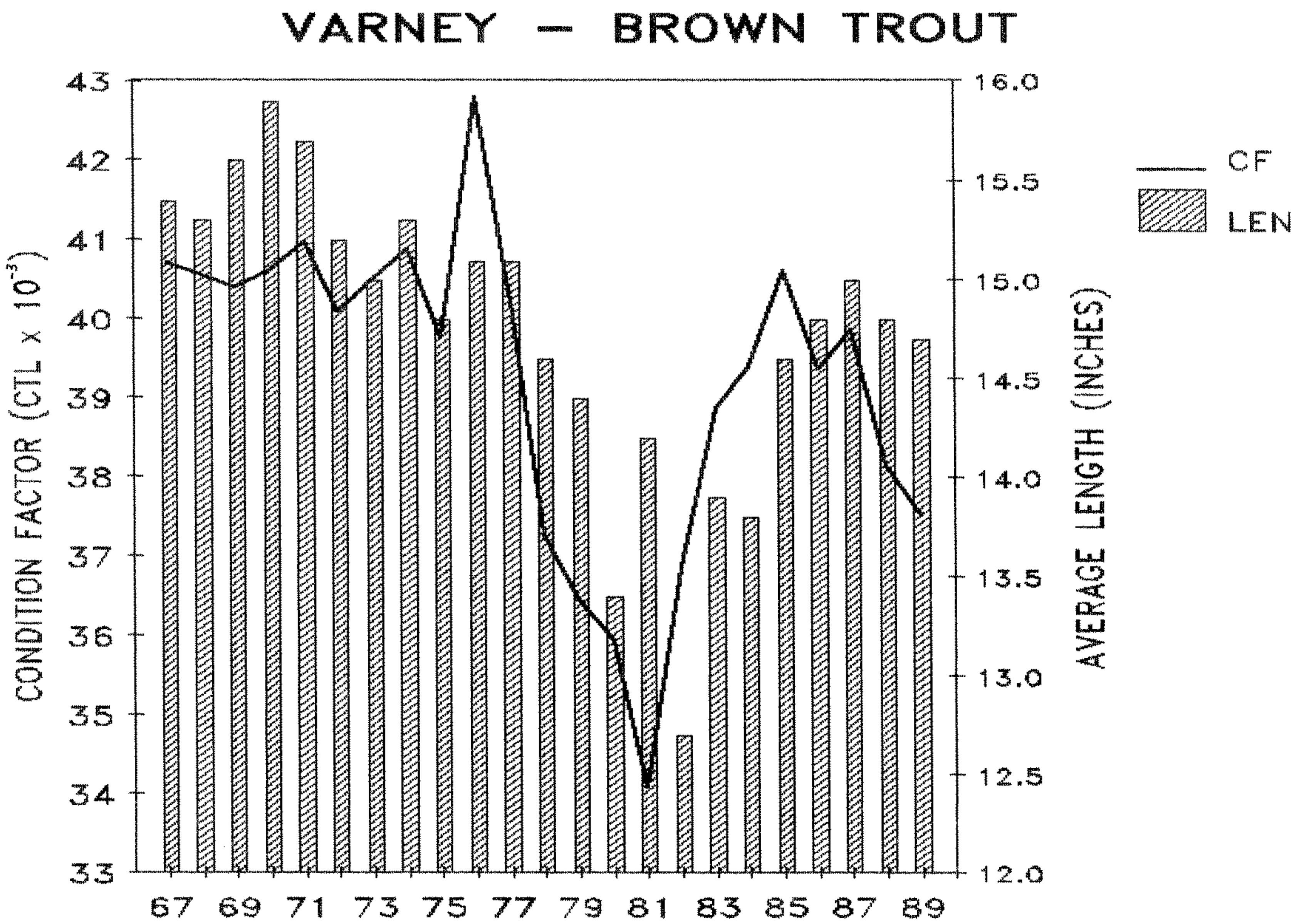


Figure 32. Fall (September) condition factors and average length of age 3 and older (3+) brown trout from the Varney section of the Madison River during 1967-1989.

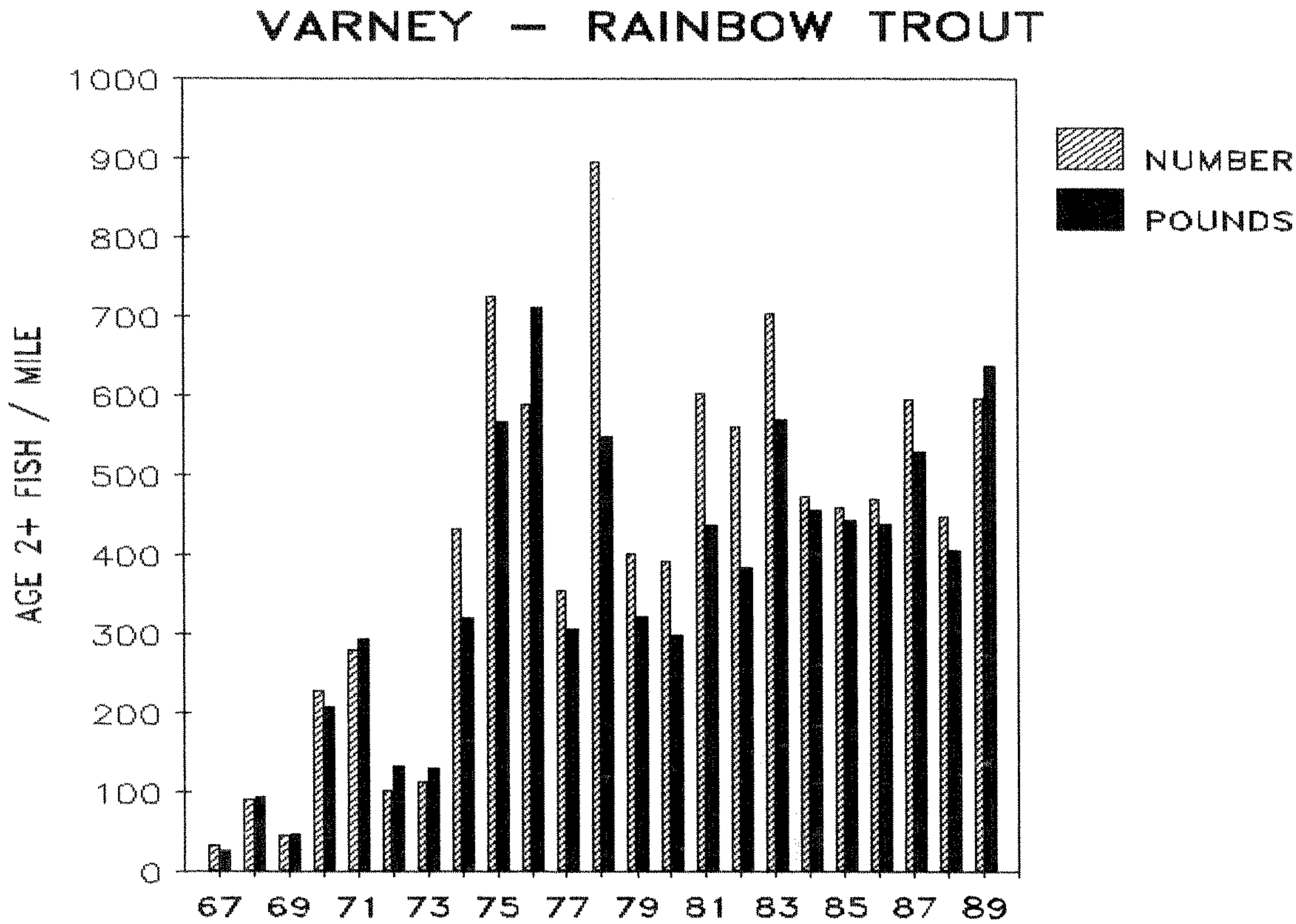


Figure 33. Fall (September) population and biomass estimates of age 2 and older rainbow trout from the Varney section of the Madison River during 1967-1989.

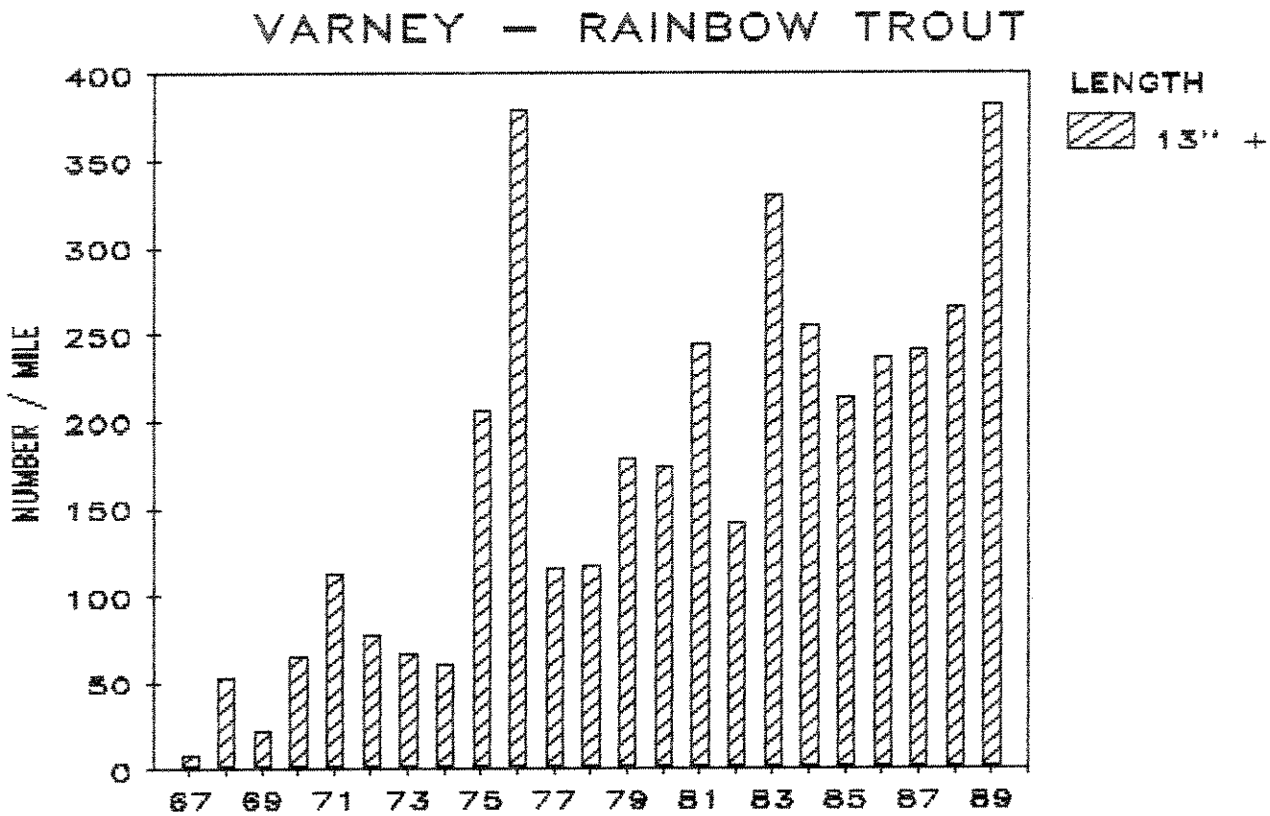


Figure 34. Fall (September) population estimates of rainbow trout longer than 13 inches in the Varney section of the Madison River during 1967-1989.

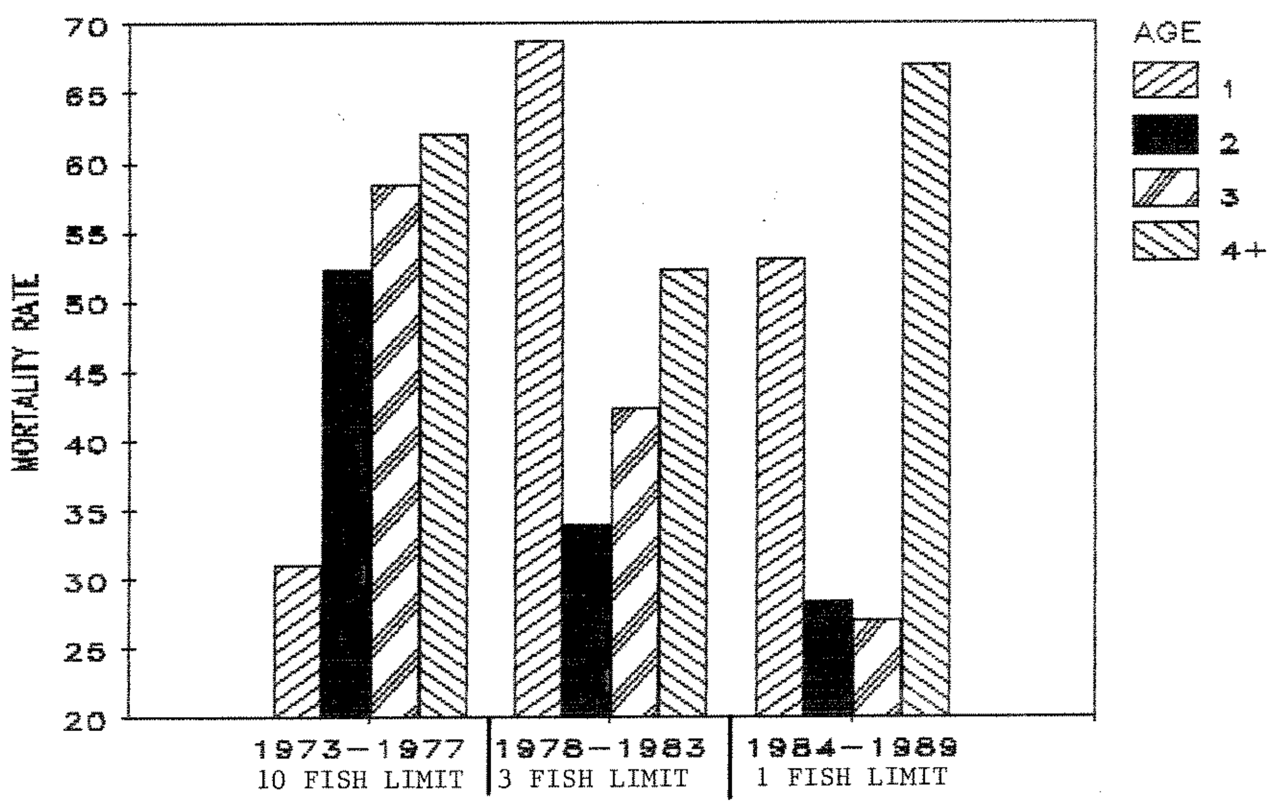


Figure 35. Comparison of average annual rainbow trout mortality rates in the Varney section of the Madison River under three different regulations.

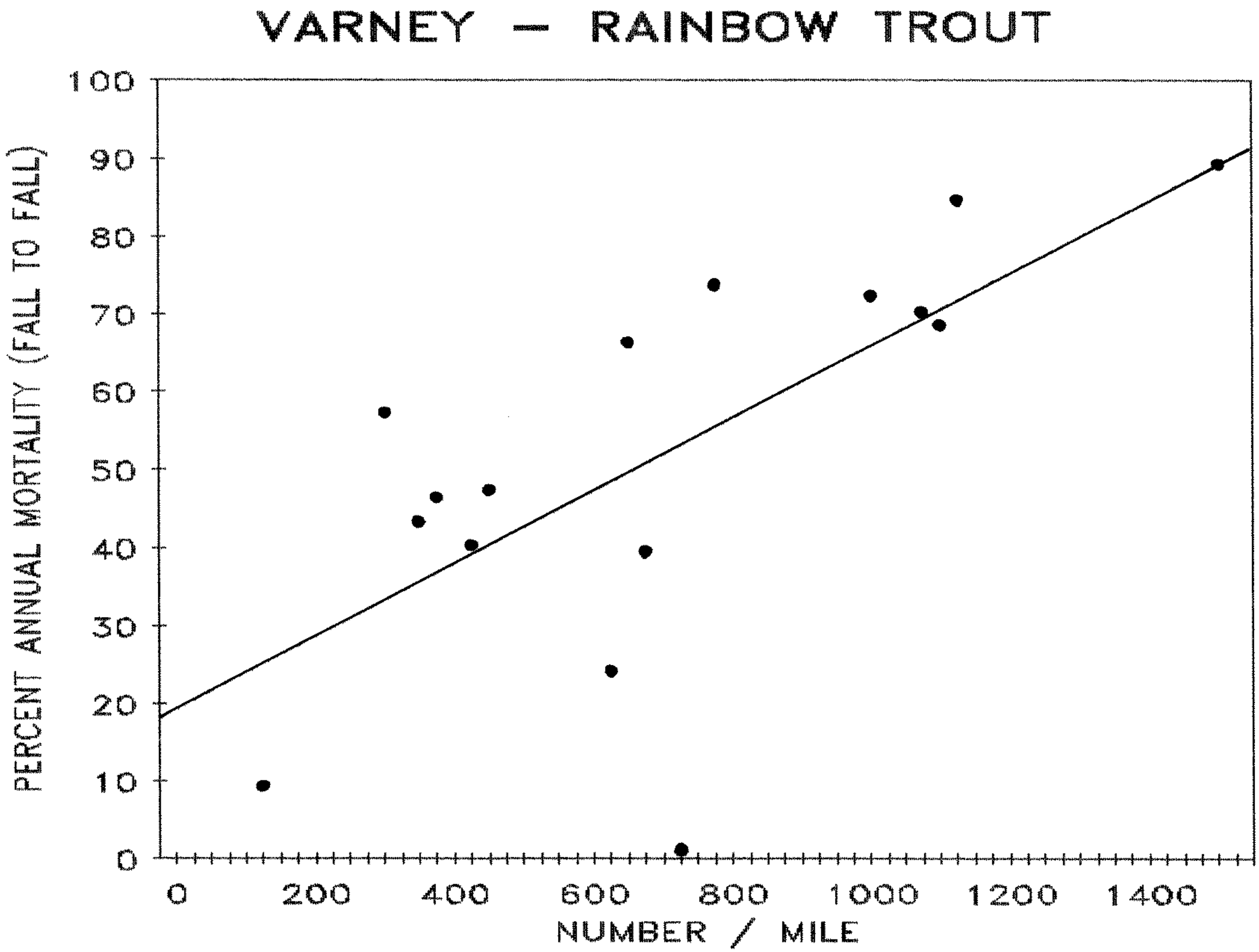


Figure 36. Regression of the estimated fall (September) population level of age 1 rainbow trout (x axis) versus the subsequent annual mortality rate (y axis) in the Varney section of the Madison River from 1973-1988.

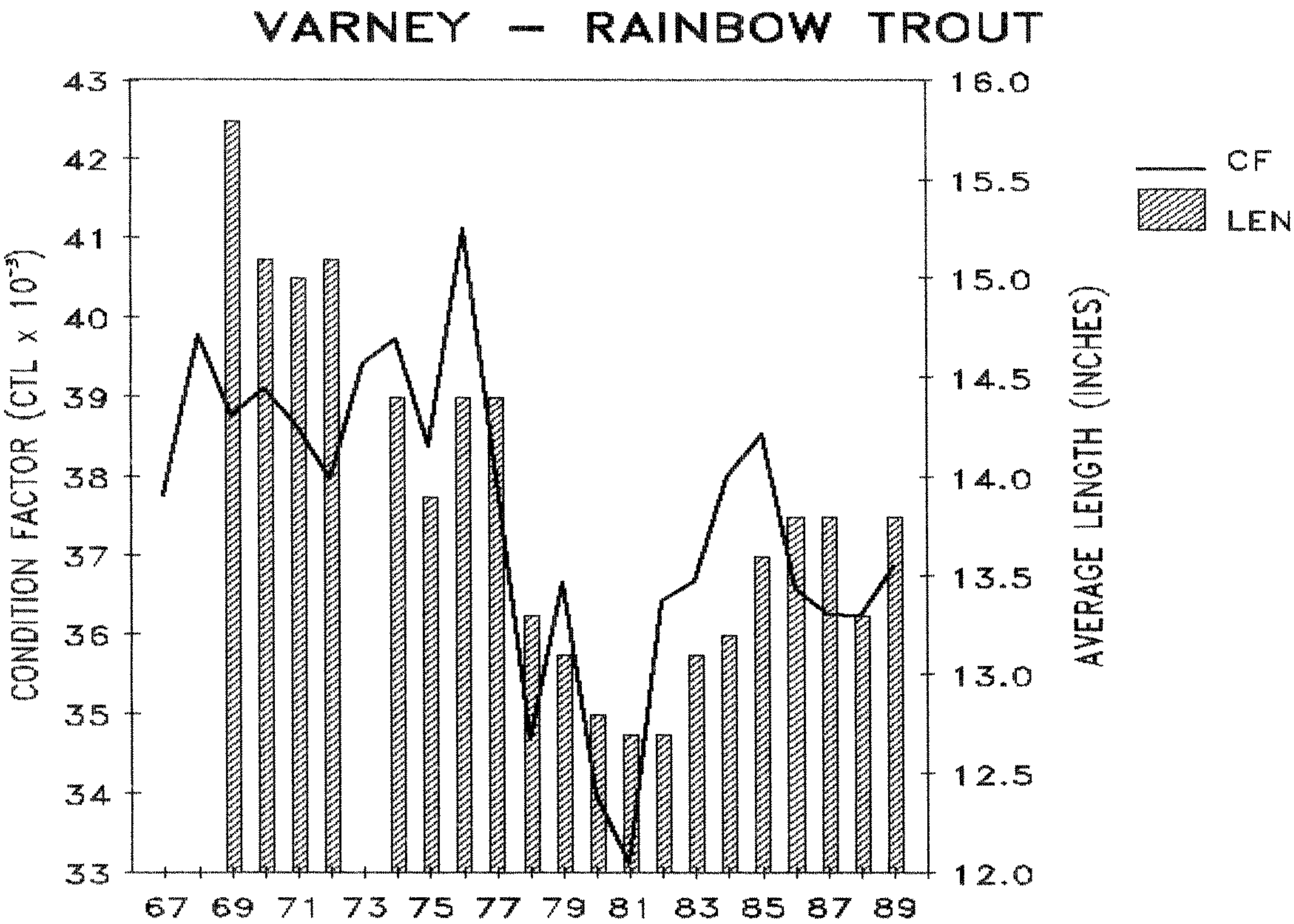


Figure 37. Fall (September) condition factors and average length of age 3 rainbow trout from the Varney section of the Madison River during 1967-1989 (no condition factors for 1967, 1968, or 1973).

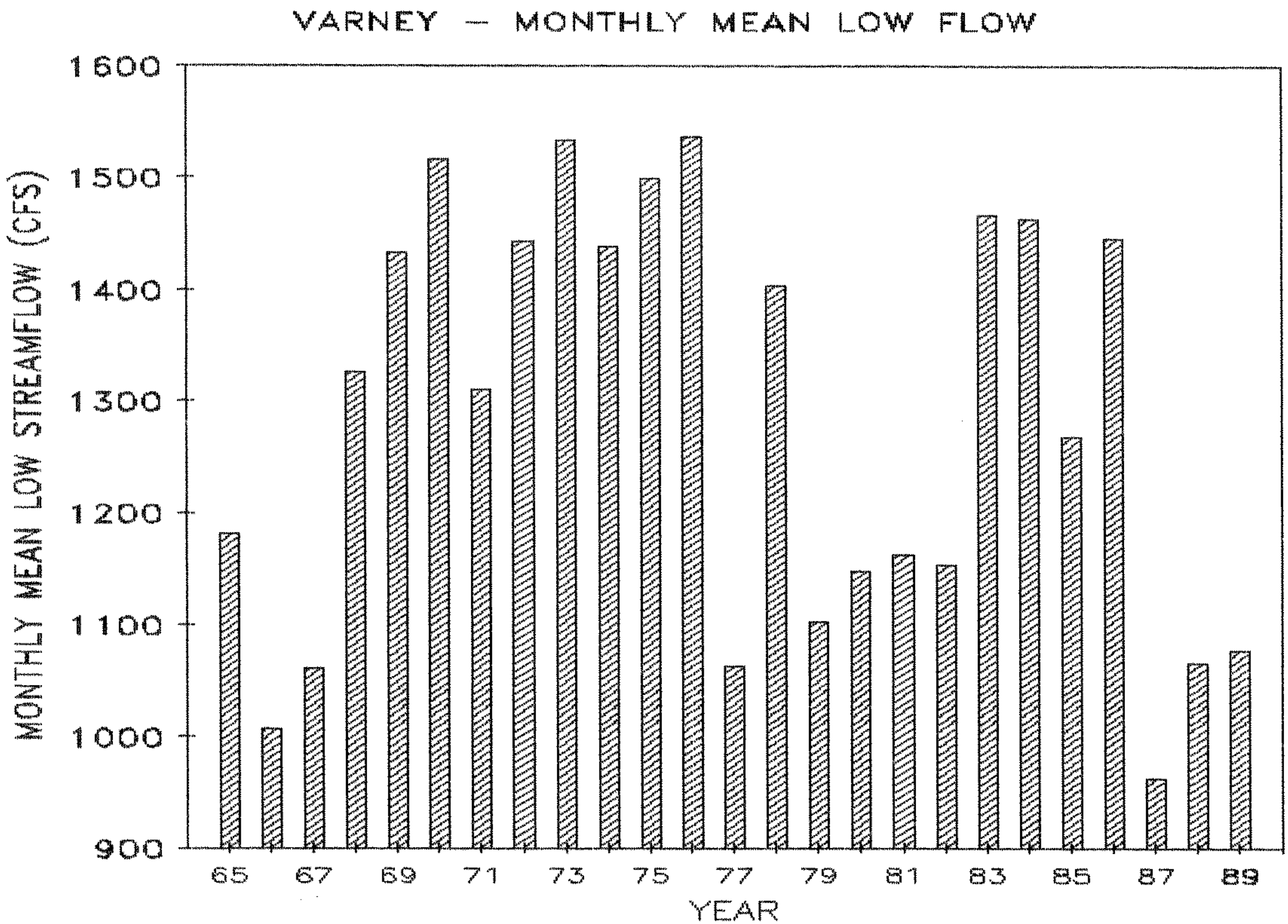


Figure 38. Monthly mean low flow levels at the McAllister gage site below Ennis Lake on the Madison River during 1965 - 1989. The monthly mean low flow is the average daily flow during the lowest calendar month of the water year (October 1 - September 30).