Population Trend Analysis and Executive Summary for Selected Stream Fisheries of the Big Hole, Red Rock, Ruby, and Beaverhead Rivers of Southwest Montana; 2006 - 2008

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May 2009
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ABSTRACT

Fish population statistics for study sections on the Big Hole, Red Rock, Ruby, and Beaverhead Rivers are updated and summarized in graphic form for the 2006 – 2008 period of study. Trends in select habitat features, primarily flow and thermal regimes are also analyzed and presented. Salmonid population dynamics are analyzed and discussed relative to long-term trends and recent sample results in a relatively brief summary fashion. Brown trout population dynamics are analyzed for the Melrose and Hog Back Study Sections of the Big Hole River and correlated with flow and thermal data. Trends in native adfluvial Arctic grayling spawning population composition are presented for the Red Rock Lake population. Recent responses of wild brown trout populations to improving flow regimes in the Red Rock River are presented and discussed for the Martinell Study Section. Data describing native fluvial Arctic grayling reintroduction efforts as well as recent trends for populations of wild brown, rainbow, and hybridized westslope cutthroat trout are presented and discussed for two upper Ruby River study sections. Lower Ruby River brown trout populations are described and discussed relative to flow regimes in the Maloney Section of the tailwater reach and the Silver Spring Section of the mid river reach. Finally, wild rainbow and brown trout and mountain whitefish population trends are presented and discussed for four study sections spanning tailwater, mid-river, and lower river environs in the Beaverhead River and a significant tributary fishery.

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation of those who assisted him during the course of the study. Scott Lula provided valuable and competent assistance in the field, in data management, and in the calculation of population estimates. Tim Mosolf, John Hoerning, Sam Hochhalter, Lucas Bateman, and Leo Rosenthal provided especially dedicated and highly competent assistance in the field. Others who made valued contributions in the field include Chris Brozell, Tracy Elam, Jim Magee, and Austin McCullough. Bob McFarland, Tracy Simonson, and Jenny Dykstra provided valuable assistance in data entry and statistical analysis. Nancy Podolinsky provided assistance in the layout and formatting of the document.

INTRODUCTION and STUDY AREA

This report is intended to provide a ready reference to the current state of salmonid population trends in the major headwater rivers of the Jefferson River drainage of southwest Montana through the 2008 sampling seasons. Graphic presentations of select population dynamics are presented in the appendices specific to each river, accompanied by brief discussions of some of the major results. For a more thorough scientific discussion of recent population trends, habitat features, and limiting factors, the reader is encouraged to obtain other recent reports referenced in this document.

This report presents recent data from study sections in the Big Hole, Beaverhead, Red Rock, and Ruby Rivers. These streams constitute the major headwater tributaries of the Jefferson River, one of the three forks of origin of the Missouri River named by Lewis and Clark Corps of Discovery. They constitute high quality and internationally recognized sport fisheries and also support relict populations of relatively rare native aquatic species of concern. Most of the modern day sport fisheries of these drainages are composed of populations of nonnative brown, rainbow, and brook trout. Native aquatic species of concern include westslope cutthroat and lake trout, Arctic grayling, and western pearlshell mussel. Other native fish species that provide locally popular, but generally under-utilized sport fisheries include the burbot and mountain whitefish. Other species occurring in these waters include the native mountain, white and longnose sucker, longnose dace, and mottled sculpin and the nonnative redside shiner and common carp. Recent references treating some of these native species, small stream habitats and lacustrine environments within the study area include Oswald (2004), Oswald et al (2005), Hocchalter and Oswald 2007, Oswald and Rosenthal (2007), Oswald et al (2008), and Oswald et al (2009).

The Big Hole River is a relatively large free flowing stream system that confluences with the Beaverhead River to form the Jefferson River near Twin Bridges, Montana. The popular sport fishery of the river is dominated by brown and rainbow trout with the brown trout representing the dominant species from approximately the town of Melrose, MT downstream to the mouth. Brown trout data from the Melrose and Hog back Study Sections are summarized through the 2007 spring study season in this report. The Melrose Study Section is located between the Montana Fish, Wildlife and Parks (FWP) Salmon Fly and Brownes Bridge Fishing Access Sites. The Hog Back Study Section is located between the FWP Glen and Notch Bottom Fishing Access Sites. In 2007 the Big Hole River supported an estimated 52,599 angler days of fishing pressure with 54% of that pressure exerted within the river reach treated in this report (McFarland 2008). Fish population data for Big Hole River sport fisheries were last reported by Oswald (2005).

The Red Rock River includes the ultimate headwater tributary of the Missouri River drainage and originates in the Centennial Valley of southwest Montana. The river drainage is roughly bisected by Lima Reservoir, a shallow irrigation storage impoundment located near the town of Lima, MT. The extreme upper reach of the system, including Upper Red Rock Lake and Red Rock Creek, supports one of the two native Arctic grayling populations south of Canada. The river reach downstream from Lima Reservoir is dominated by wild populations of brown trout and also supports a limited population of rainbow trout. This reach also provides spawning and rearing habitat for adfluvial populations of brown and rainbow trout from Clark Canyon

Reservoir, the modern day terminus of the Red Rock and origin of the Beaverhead River. The Red Rock River supports limited angler use due to limited opportunity for public access. The 2007 pressure estimate for the Red Rock River was 1,014 angler days (McFarland 2008). The Arctic grayling spawning migration is monitored in the Corral Study Section of Red Rock Creek. The Corral Section is located between the mouth of Corral Creek and the Pond Access Road on the Red Rock Lakes National Wildlife Refuge in the Alaska Basin of the upper Centennial Valley. Resident brown trout populations have been monitored, most recently, in the Martinell Study Section located near Dell, MT. The Martinell Section is located on the Martinell family ranch and originates near the mouth of Big Sheep terminating at the major channel bifurcation near the Sage Creek County Road. Resident brown trout population data from the Red Rock River were last discussed by Oswald (2006).

The Ruby River is a Beaverhead River tributary that originates in the Gravelly and Snowcrest Mountain ranges and flows to its confluence near Twin Bridges, MT. The drainage is roughly bisected by Ruby River Reservoir, an irrigation impoundment that also provides a popular sport fishery. The upper Ruby River provides a mixed fishing opportunity for brown and rainbow trout in lower reaches, largely downstream from Warm Springs Creek and westslope cutthroat trout and recently reintroduced Arctic grayling in the upper reaches and tributaries. Public access is readily available on the Beaverhead – Deerlodge National Forest in upstream reaches while the downstream segment of the upper Ruby flows largely through private lands. The lower Ruby River exhibits a relatively short but productive tailwater fishery between the reservoir dam and the town of Alder, MT but quickly adapts to ambient conditions to represent an abundant fishery for mid – sized brown trout. Despite its abundant public access in the upper reaches, the upper Ruby River supported a relatively modest angler use of 1,543 angler days in 2007, a total well within the normal range for the fishery (McFarland 2008). By contrast, the lower Ruby River supported an estimated 14,936 angler days in 2007, 60% of which were accounted for by nonresident angler use. Public access to the lower Ruby River is provided by FWP fishing access sites on six reaches of stream between the reservoir dam and a property downstream from the confluence of Silver Spring near the town of Sheridan, MT. The upper Ruby River fishery is monitored with two fall study sections. The Three Forks Section, located immediately downstream from the confluence of the three forks of the Ruby River, is used to monitor a hybrid swarm of westslope cutthroat and rainbow trout and help monitor the success of the Arctic grayling reintroduction effort. The Greenhorn Section, located between the mouths of Ledford and Robb Creeks, is used to monitor the sport fishery composed of brown and rainbow trout. The lower Ruby River reach is monitored via spring sampling in the Maloney and Silver Spring Study Sections. The Maloney Section, located on the FWP Vigilante fishing access site, is sampled to monitor the affects of over-winter flow regimes and sport fishing access on the productive tailwater fishery. The Silver Spring Section is used to monitor brown trout populations in mid river reach near the town of Sheridan and in close proximity to another FWP public fishing access. Trout population trends for the Ruby River study sections were last presented by Oswald (2006).

The modern day origin of the Beaverhead River is impounded by Clark Canyon Reservoir at the confluence of the Red Rock River and Horse Prairie Creek. The reservoir produces a tailwater sport fishery in the upper Beaverhead River that can be highly productive under ample flow regimes but can also suffer severe reductions as over-winter flow regimes fall below the recommended minimum. These fluctuations in flow regime and their affects on wild brown trout populations within the tailwater reach are discussed in detail by Oswald (2009). The sport fisheries of the tailwater reach are monitored in the Hildreth and Pipe Organ Study Sections. The Hildreth Section is located in the extremely productive upper reach of the tailwater approximately two miles downstream from the dam while the Pipe Organ Section is used to monitor declining productivity and habitat conditions in mid- tailwater, about 8 miles downstream. Oswald (2009) provides a more detailed description of both study sections. The tailwater fishery persists for approximately 12 to 16 miles downstream from the outlet of Clark Canyon Dam where dilution from Grasshopper Creek and major canal diversions impress more ambient conditions on the reach. Within this reach, summer irrigation flow delivery to the West Canal at the City of Dillon, MT generally maintains ample habitat while restricted winter flow releases from the dam can result in flow regimes below recommended minima. Brown trout populations for the reach are monitored in the Fish and Game Study Section, located between the Highway 91 South Bridge and the mouth of Poindexter Slough. The lower Beaverhead River generally represents a reach where summer flows regimes are often highly restricted by irrigation withdrawal, dominant channel forming discharges are absent or infrequent, and winter flow regimes usually increase with accretions from irrigation return to the upper aquifer. This condition can be described as an inverted hydrograph that can be accompanied by high summer water temperatures, channel sedimentation, poor riparian development and other characteristics of degraded aquatic habitats. The Anderson Section, located between the Anderson Lane County Road bridge and the mouth of Stone Creek has most recently been monitored as the study section to provide data for wild brown trout and mountain whitefish populations of the lower river reach. The Beaverhead River supported an estimated 28,005 angler days of use in 2007 (McFarland 2008), the vast majority of which was expended in the upper river reach. Both the total pressure and nonresident participation at 48.7% were well below average for the system in association with chronic low flow release regimes and declining trout populations. Poindexter Slough, a popular spring creek fishery tributary to the Beaverhead River, has also been regularly monitored as an important component of the area’s sport fishery. The majority of the fishable reach of Poindexter Slough is located on a FWP public fishing access and flows into the Beaverhead River at the downstream terminus of the Fish and Game Section about three river miles south of Dillon. While Poindexter Slough is classified as a spring creek, flows are augmented via diversion from the Beaverhead River to supply the Dillon Canal Diversion on the FWP fishing access site. The popular fishery often supports in excess of 3,000 angler days per year, however, angling use in 2007 dwindled to only 610 angler days (McFarland 2008) under restricted flow regimes and a chronic annual increase in sediment deposition . The trout populations of the Beaverhead River and Poindexter Slough were last described by Oswald (2006).

METHODS

Trout populations in rivers and large streams were sampled through the use of electrofishing techniques based on mark-recapture methodologies described by Vincent (1971). Electrofishing was conducted via boat mounted, mobile anode techniques which utilize a 3500 watt generator and Leach type rectifying box. A straight or continuous wave DC current was used at 1,000 to 1,800 watts. Fish captured within the field were drawn to the boat, netted, and deposited into a live car. Boats consisted of a modified Clackacraft drift boat or modified Coleman Crawdad boat depending upon stream size. Individual fish captured were anesthetized, segregated by species, measured for length and weight, marked with a small identifying fin clip, and released. Scale samples for age determination were collected from a representative subsample by length. A single Marking run was made through each study section followed by a single Recapture run approximately 12 to 14 days later on Red Rock, Beaverhead, and Ruby River Study Sections. Big Hole River Study Sections required multiple Mark and Recapture runs with the capture and recapture pools treated with replacement.

Trout population statistics were analyzed under a log-likelihood methodology developed and described by Montana Fish, Wildlife and Parks (1994) under guidelines presented by Brittain, Lere, and McFarland (1997). All population and standing crop estimates as well as population statistics such as condition factor, relative weight, and mean weight and length were analyzed by inch group with standard deviations assigned at the 95% confidence interval. Population estimates were largely calculated for brown trout from March and April samples collected from the study sections while rainbow trout, cutthroat trout, and Arctic grayling population estimates were calculated from September and October samples. The seasonal segregation by species was applied to avoid population estimate bias due to spawning movements and migrations.

Measurements of stream discharge and water temperature were obtained from USGS Gage Stations or USBOR Reservoir Operations Statistics, or measured directly by FWP staff. Direct measurement of instantaneous discharge was made with a Marsh McBirney Flo-Mate Model 2000 current meter.

RESULTS and DISCUSSION

Big Hole River

Updated graphic representations of trends in brown trout populations for 2006 and 2007 are presented in Appendix A for the Melrose and Hog Back Study Sections. Population data for these two study sections were most recently presented and discussed by Oswald (2005) through the 2004 sample season. Since that time, continued drought conditions have continued to influence flow and summer water temperatures in the Big Hole River. While annual flows in the river (Figure BH-1) remained below average, the 2005 – 2007 period exhibited a slightly improving trend and better flows than those observed in 2000, 2001, and 2004. Spring runoff peaks (Figures BH-2 - BH-4) also exhibited a slight trend toward increase but were also marked by relatively early and multiple events that resulted from rapidly reduced snowpack reserves. As a result, base summer flow regimes (Figures BH-5 and BH-6) remained below average and below WETP recommended instream flows for productive aquatic habitats. Concomitant with low summer flow regimes, July water temperatures trended upward (Figure BH-7) resulting in high totals of days in which maximum water temperatures exceeded 70 degrees F (Figure BH-8), particularly in 2006 and 2007. The summation of July and August thermal maxima in excess of 70 degrees F, exhibited a markedly increased trend over the 2003 – 2007 period. The trend for increased thermal regimes to accompany decreased summer flow regimes was analyzed (Figure BH-9) via correlation and linear regression. The relationship between summer base flow and maximum temperature regime was moderately correlated in a highly significant manner ($r = 0.71$, $P<.01$) and exhibited an R^2 of 0.51 for the linear regression equation.

Figure BH-1. Annual Water Yield (Acre Feet) for the Big Hole River at the USGS Melrose Gage 1982 - 2007.

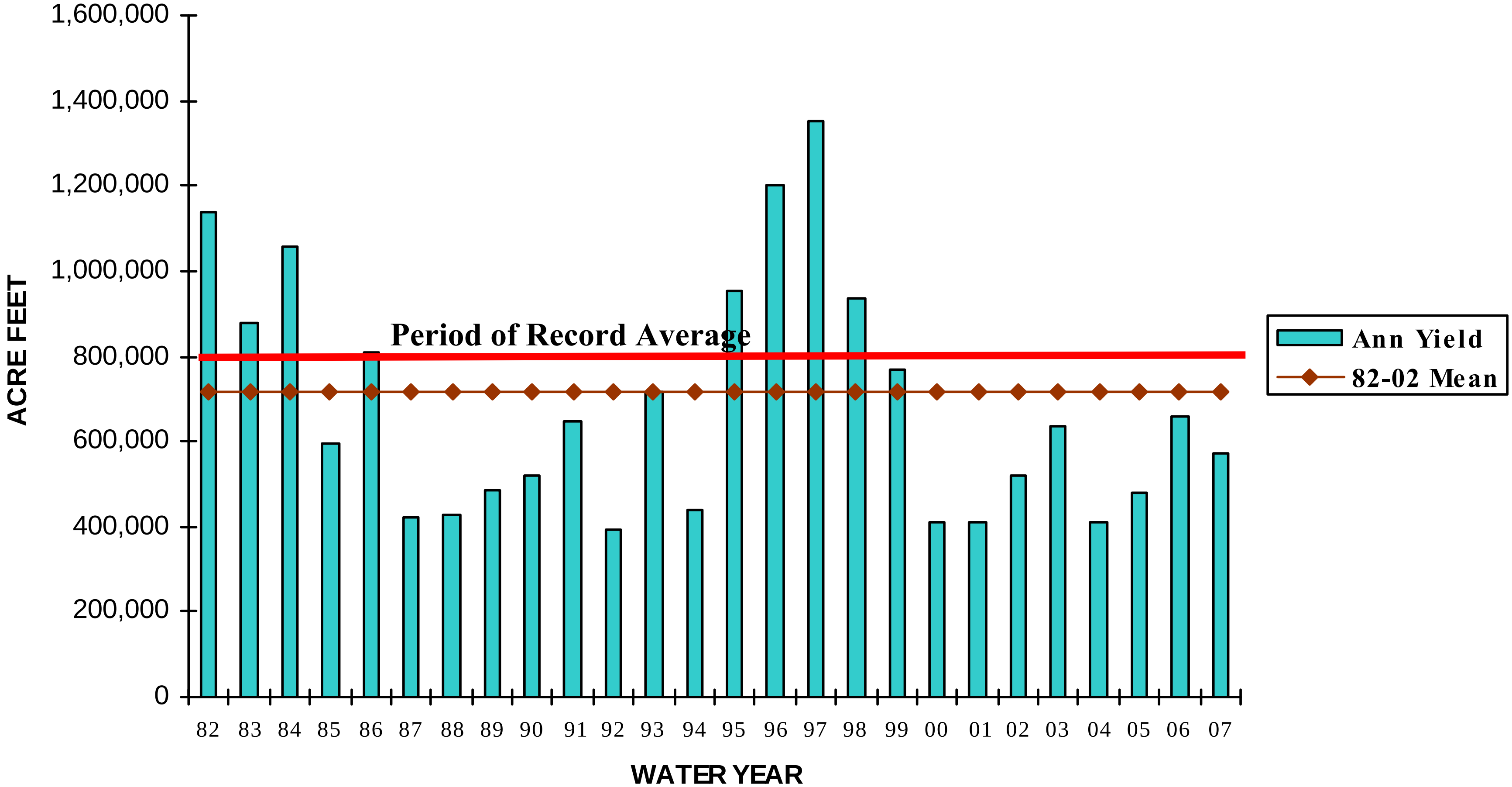


Figure BH-2. Peak spring runoff flows measured at the USGS Melrose Gage for the 1982 - 2007 period of record on the Big Hole River.

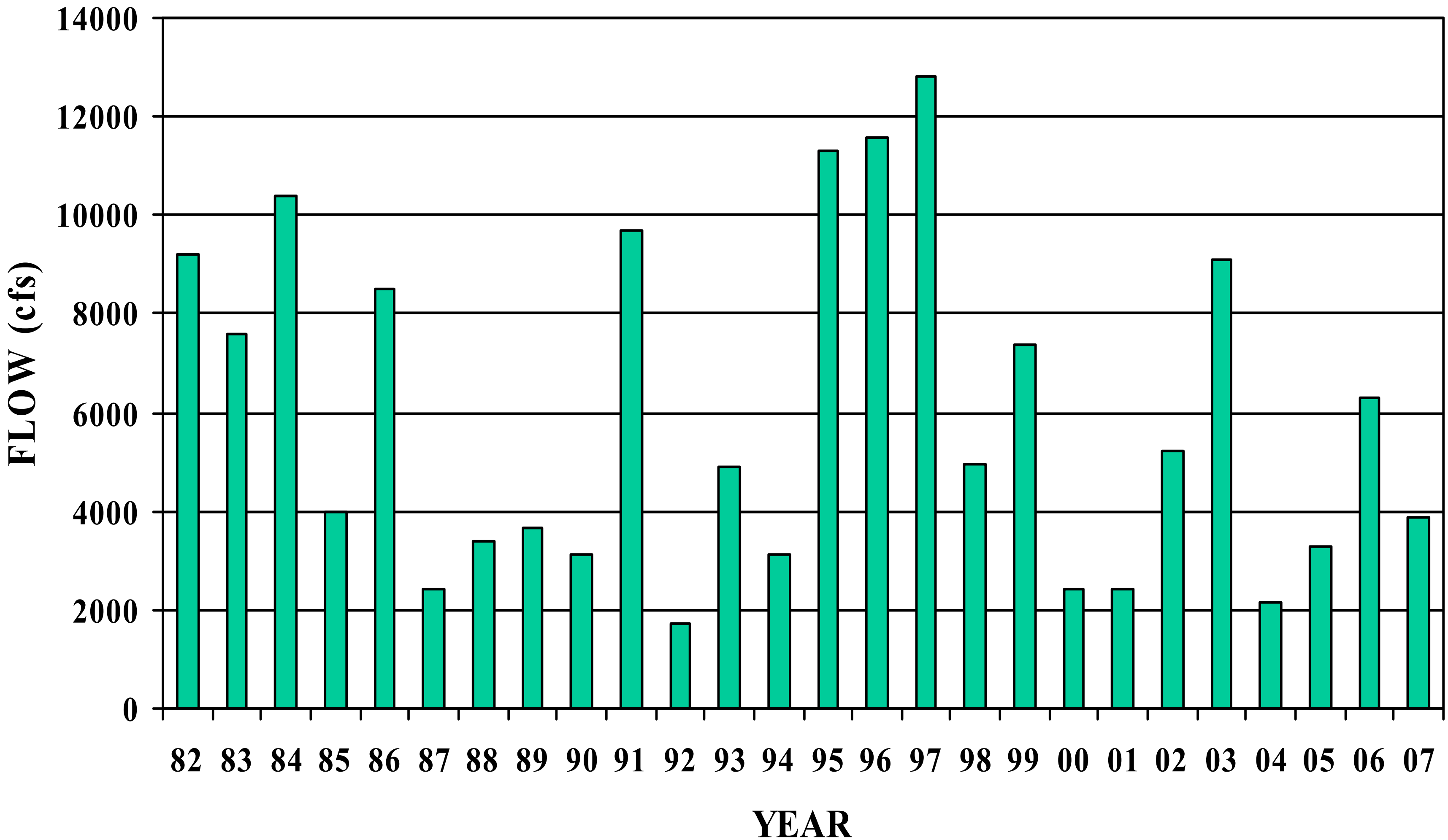


Figure BH-3. Compressed runoff regime for the spring of 2006 at the USGS Melrose Gage on the Big Hole River; April 1 - June 30.

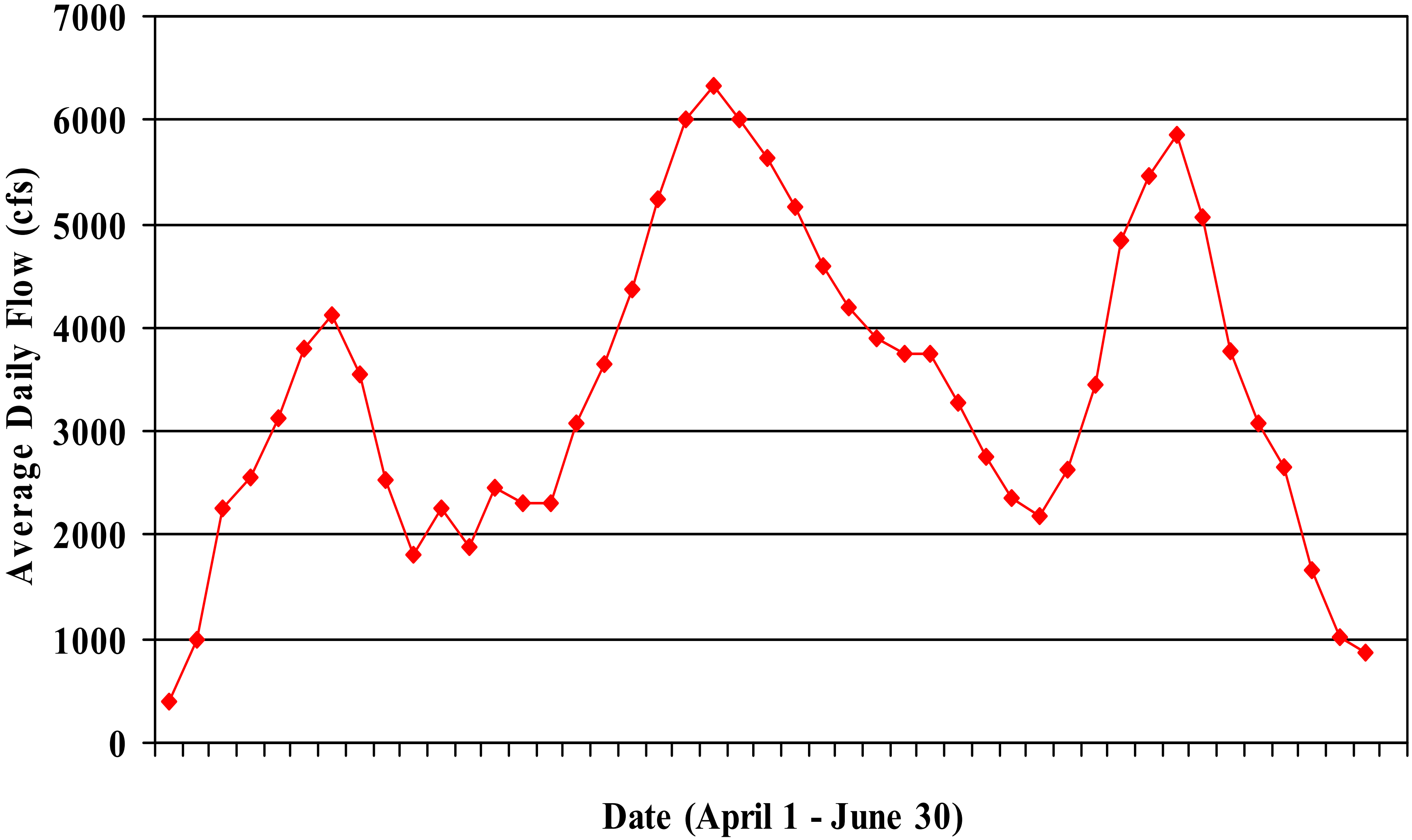


Figure BH-4. Compressed runoff regime for the spring of 2007 at the USGS Melrose Gage on the Big Hole River; March 10 - June 30.

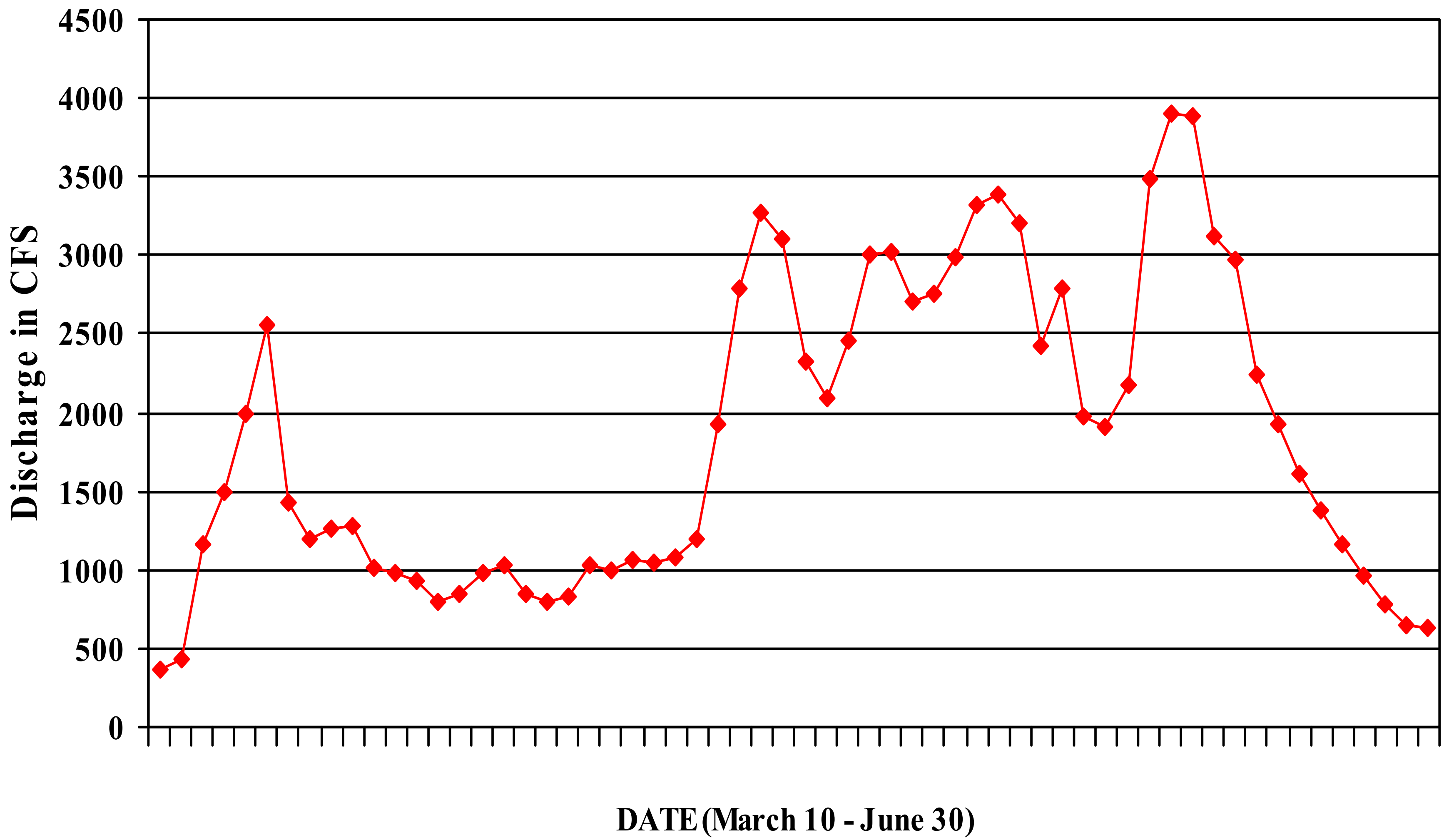


Figure BH-5. Mean August flow as compared with the FWP recommended optimum and minimum instream flow at the USGS Melrose Gage on the Big Hole River; 1982 - 2007.

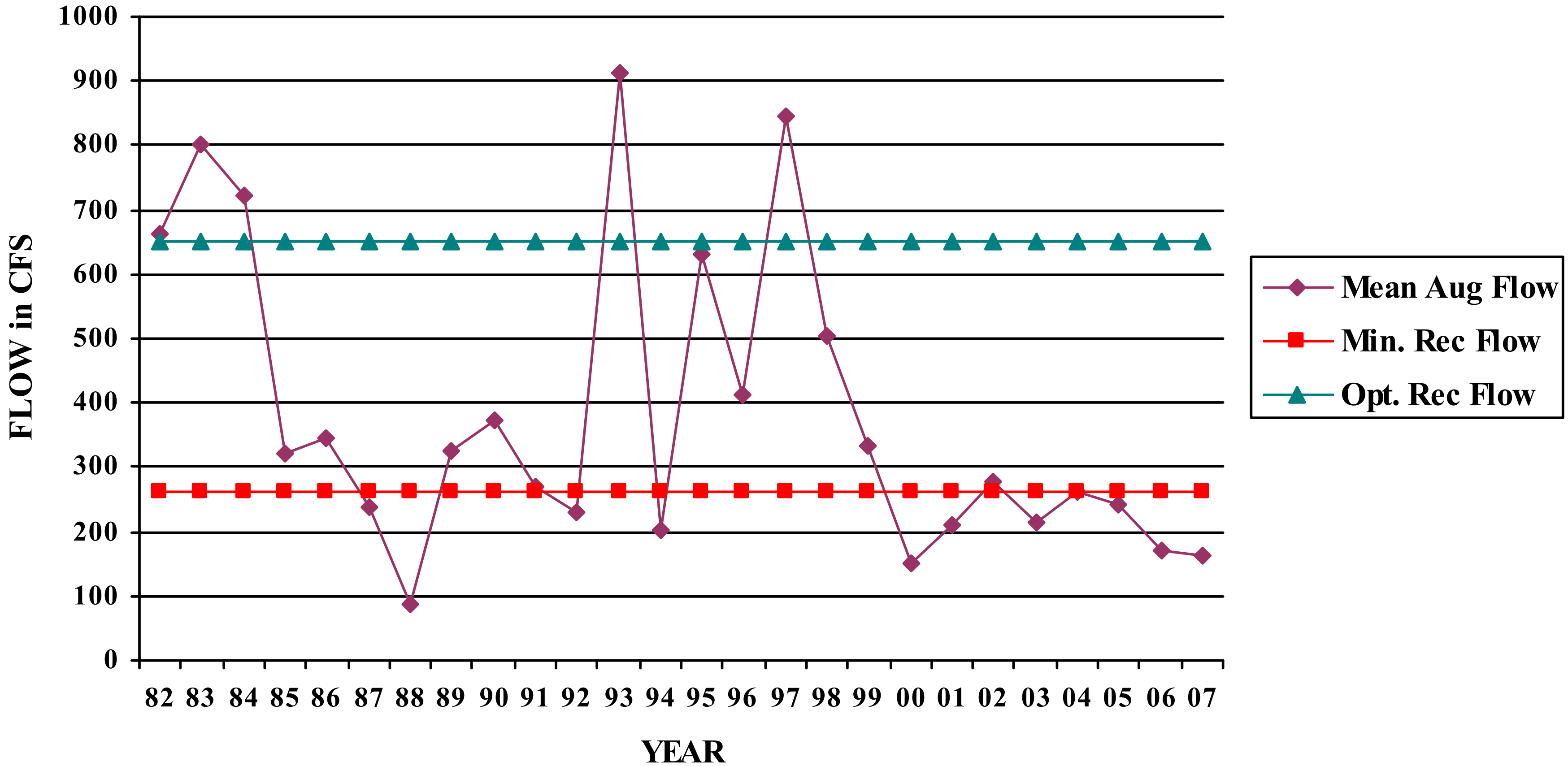


Figure BH-6. Minimum August flows (ADF) measured at the USGS Melrose Gage for the 1982 - 2007 period of record on the Big Hole River.

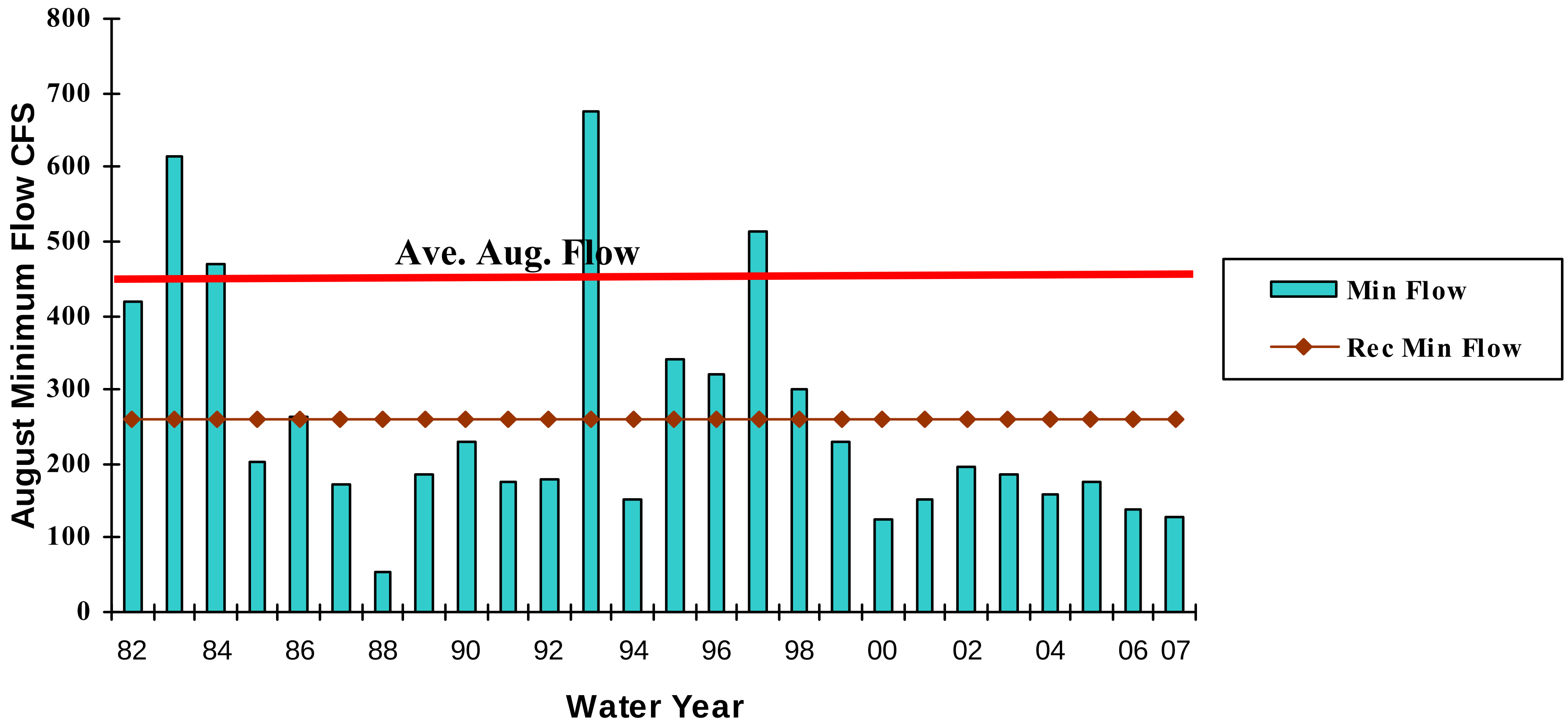


Figure BH-7. Maximum, Mean, and Minimum July temperatures recorded at the USGS Melrose Gage for the 1987 - 2007 period of record on the Big Hole River.

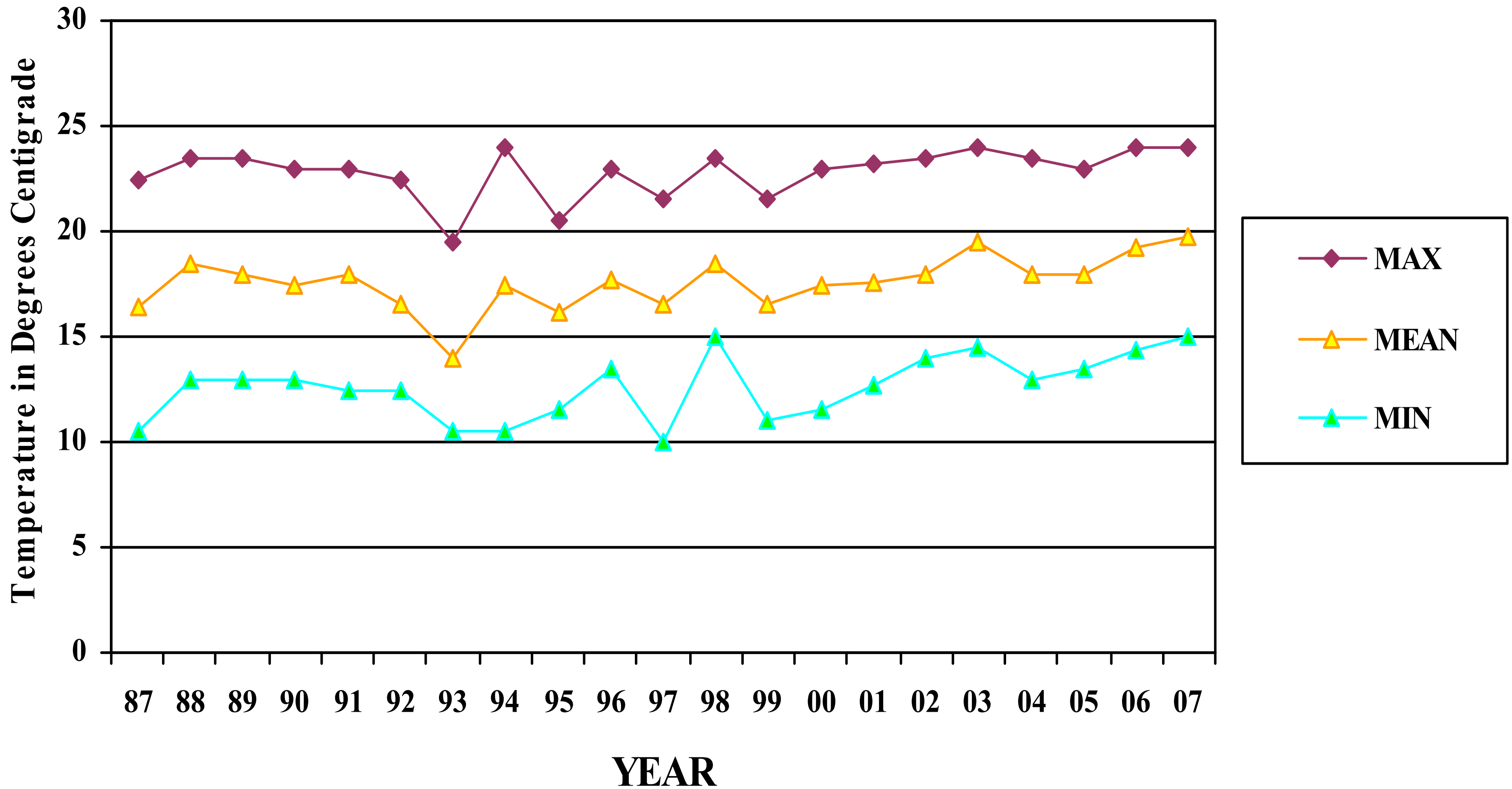


Figure BH-8. The number of days on which maximum water temperatures equaled or exceeded 70 degrees F (21.1 C) during the months of July and August at the USGS Melrose Gage for the 1987 - 2007 period of record on the Big Hole River.

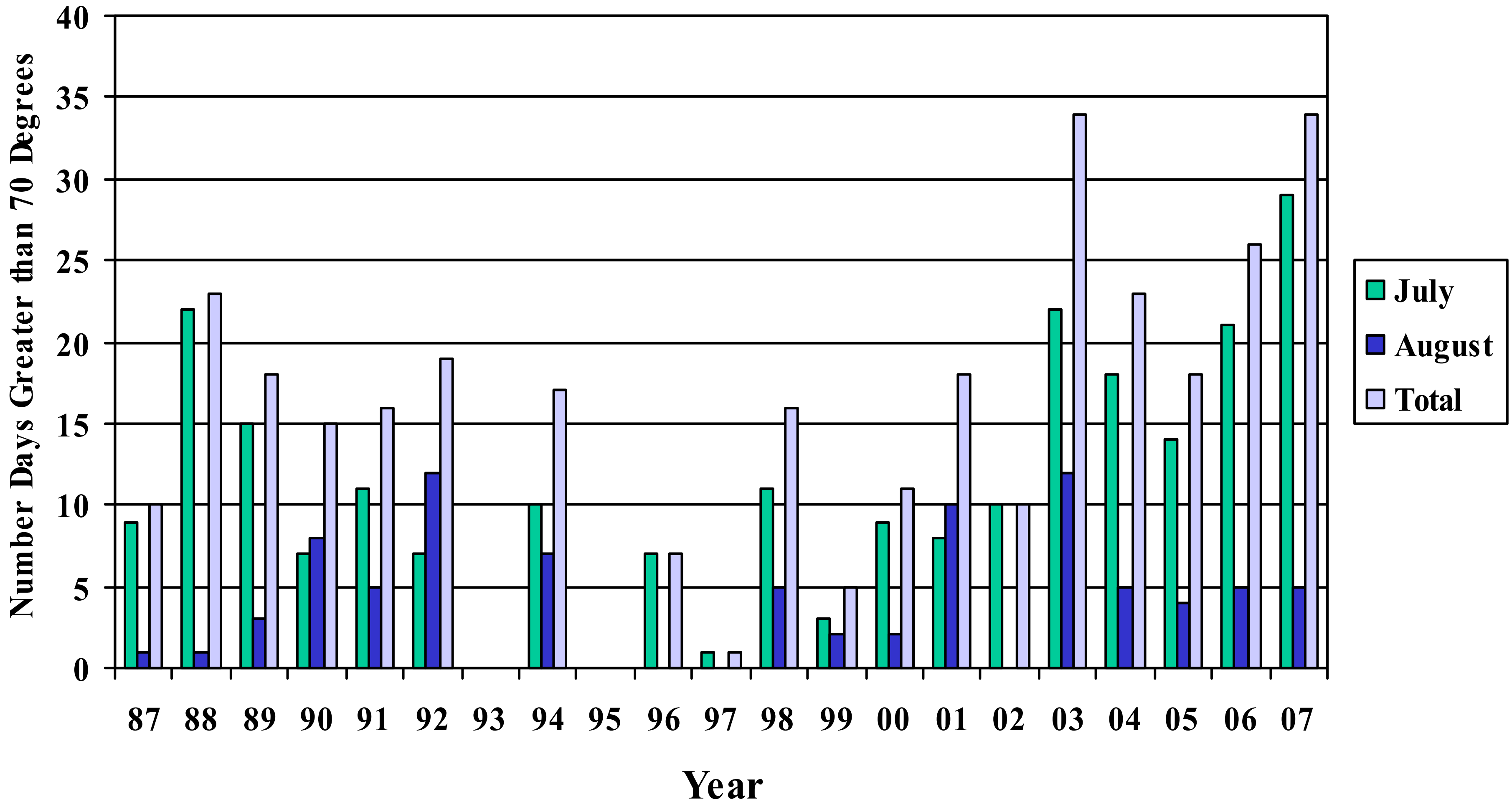
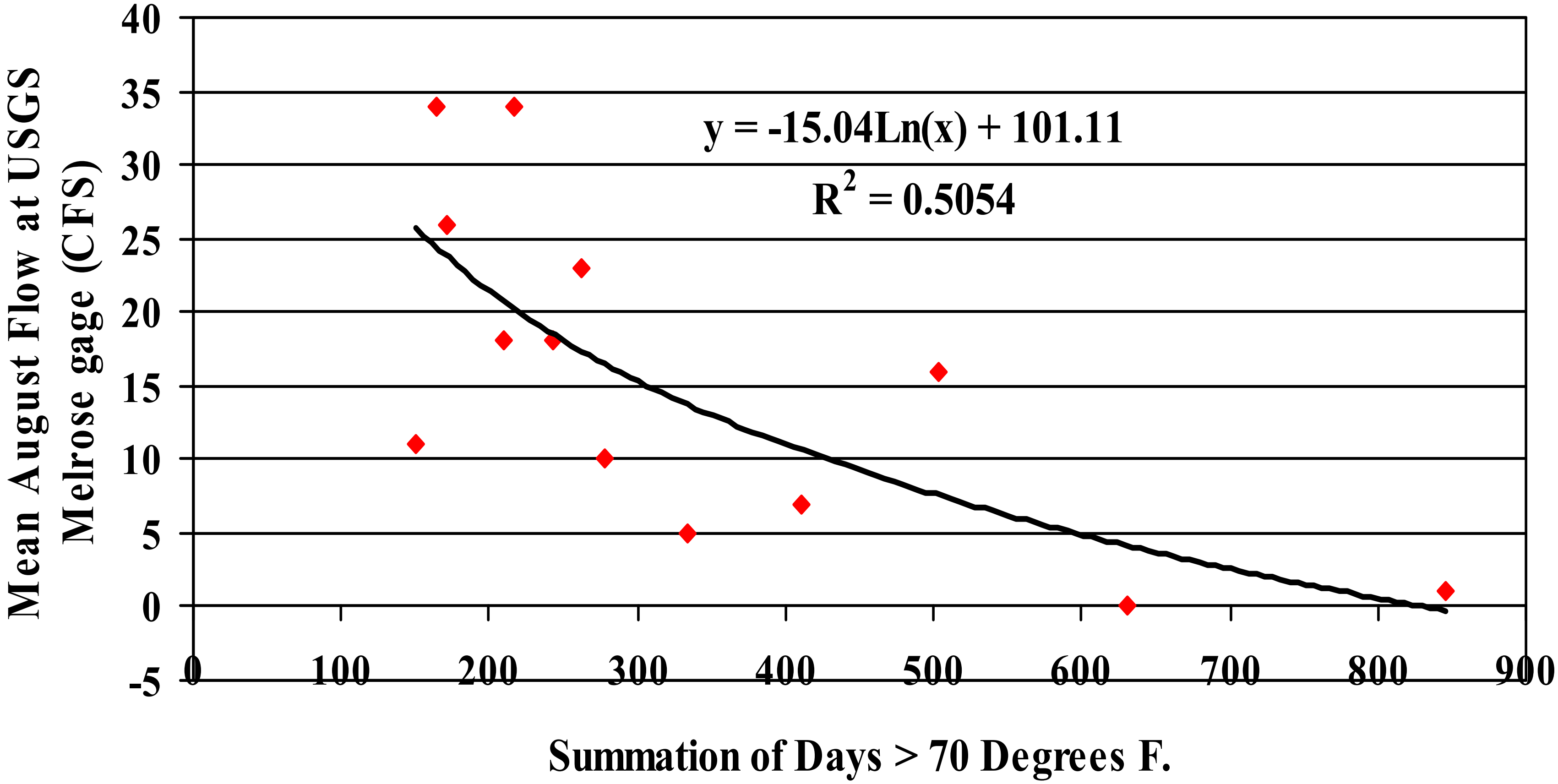


Figure BH-9. Logarithmic regression of the total number of days that water temperatures exceeded 70 degrees F. in July and August as a function of mean August flow regime at the USGS Melrose gage on the Big Hole River; 1995 - 2007.



Brown trout populations in the Melrose Section generally remained below average in response to continuing drought conditions. Brown trout standing crop and density (Figure BH-10), however, exhibited marked increases in response to a strong recruitment cohort of Age II fish in 2007. The strength of the Age II cohort is clearly exhibited in Figures BH-11 and BH-12, through its estimated density and modal strength in the length frequency distribution of the sample. Very slight increasing trends in densities of 13 inch and larger (Age III+) and 18 inch and larger (Age V+) brown trout over the 2005 – 2007 period were associated with slight increases in annual flow regimes (Figures BH-13 and BH-14). Spring brown trout condition factors (Figure BH-15) rose substantially in 2005 at low population density and standing crop, low densities of Age III+ and Age V+ fish in the population, and record warm January and February temperatures (NWS Data Files, Great Falls) but declined markedly for Age IV+ and Age V+ fish in 2006 and 2007.

Brown trout populations in the Hog Back Section exhibited similar trends for density, standing crop (Figure BH-16), and the influence of the strong recruitment cohort of Age II fish in the 2007 sample (Figures BH-17 and BH-18) as those observed in the Melrose Section. Densities of 13 inch and larger (Age III+) fish in the Hog Back Section population, however, remained static at very low density over the 2005 – 2007 study period (Figure BH-19) while the 18 inch and larger (Age V+) component (Figure BH-20) exhibited a steadily rising trend over the 2003 – 2006 period followed by a decline in 2007 despite low flow regimes. The opportunistic pattern of one to two peaks in brown trout recruitment as densities of the largest sized component of Age V and older fish in the population decline (Figure BH-21) has been observed in Big Hole, Beaverhead, and Ruby River study sections (Oswald 2006), often in association with declining flow regimes. As is demonstrated in Figure BH-22, however, this pattern can appear as a somewhat cyclic pattern of brown trout population dynamics, not necessarily tied to low flow regimes, when viewed over an extended window of time. The same patterns of response and recent declines in brown condition factor observed for the Melrose Section were also observed in the Hog Back Section (Figure BH-23) in conjunction with similar population trends.

The 1995 – 2007 period of study in the Hog Back Section provided a unique opportunity to observe an extended period of time in which ample flow regimes were followed by an extended period of sub-average flows (Figure BH-1) and brown trout populations exhibited observed maxima followed by substantial declines for density and standing crop (Figure BH-16). Because of the apparent similarity in the trends between brown trout standing crop and flow regime, the two parameters were tested for a functional relationship via correlation and regression analysis. Hog Back Section brown trout standing crop data for 1995 – 2007 period of study exhibited highly significant correlations with total annual discharge ($r = 0.79$, $P<.01$), minimum August flow ($r = 0.70$, $P<.01$), and a significant correlation ($r = 0.63$, $P<.05$) with mean August flow. This same relationship and ordination is expressed via linear regression in Figures BH-24, BH-25 and BH-26. The coefficients of determination (R^2) suggest that a maximum of 63% of the variation in brown trout standing crop could be attributed to variation in annual flow regime while only 40% could be attributed to base summer flow regime in the form of mean August flow. The data strongly suggest that the annual flow regime is more important in determining potential brown trout standing crop than base summer flow characteristics. As an additional form of analysis, brown trout standing crop was analyzed as a function of summer temperature regime in the form of the number of days in which temperatures exceeded 70 degrees during July and

Figure BH-10. Estimated spring density and standing crop of Age II and older brown trout in the Melrose Section of the Big Hole River, 1981 - 2007.

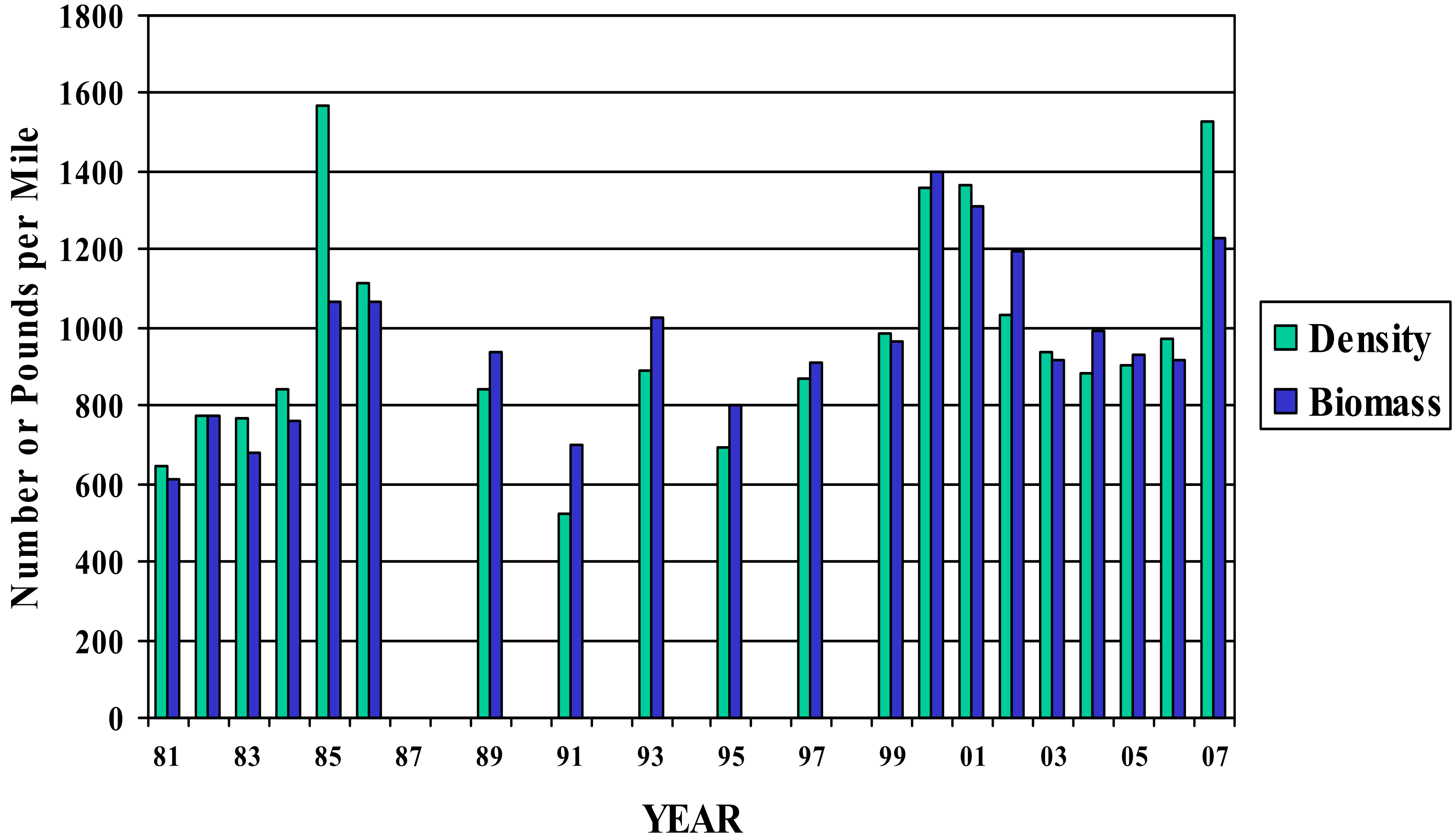


Figure BH-11. Estimated spring density of Age II brown trout in the Melrose Section of the Big Hole River 1981 - 2007.

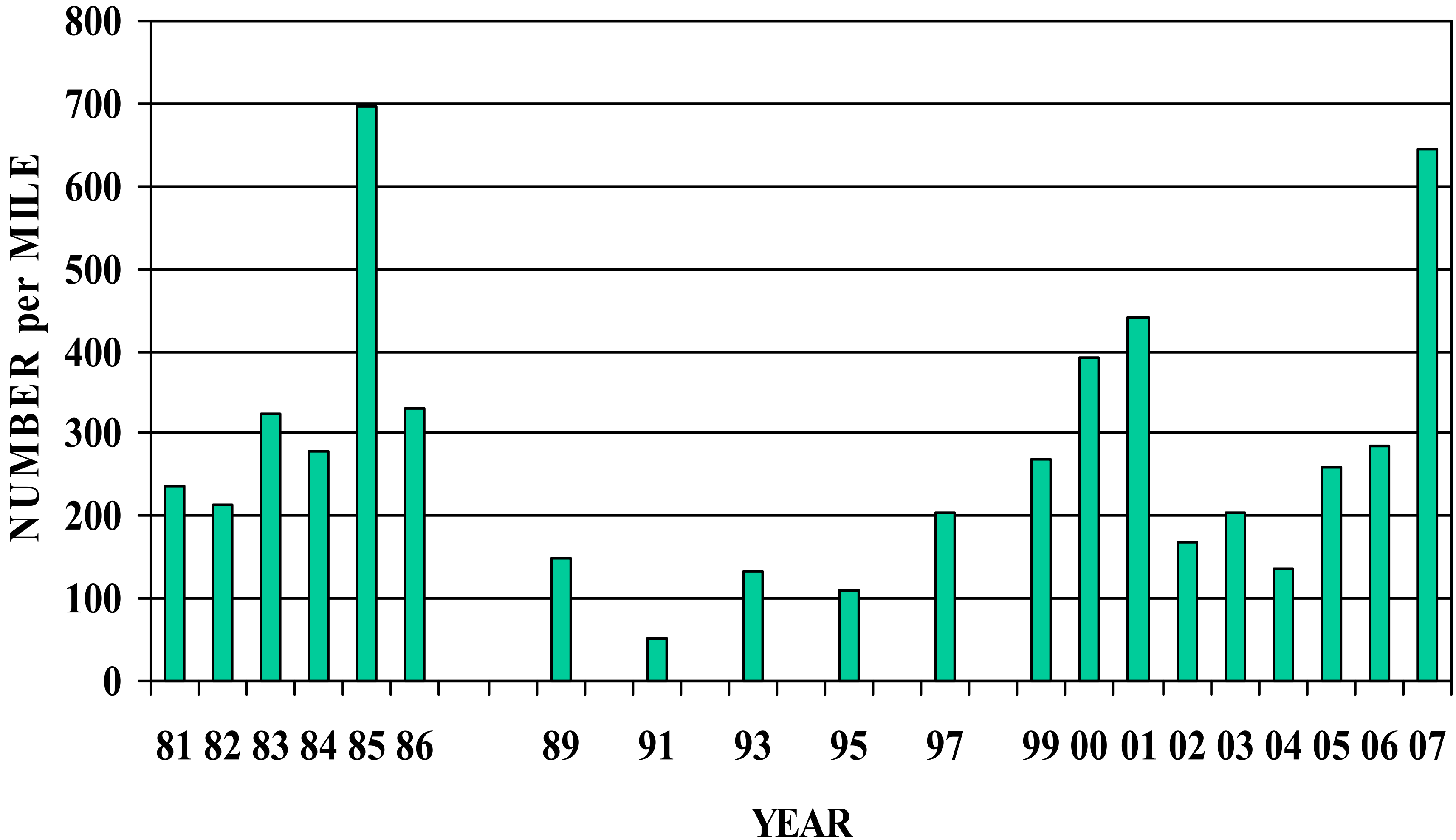


Figure BH-12. Length frequency distribution of Age II and older brown trout captured in the Melrose Section of the Big Hole River; Spring 2007 (N = 976).

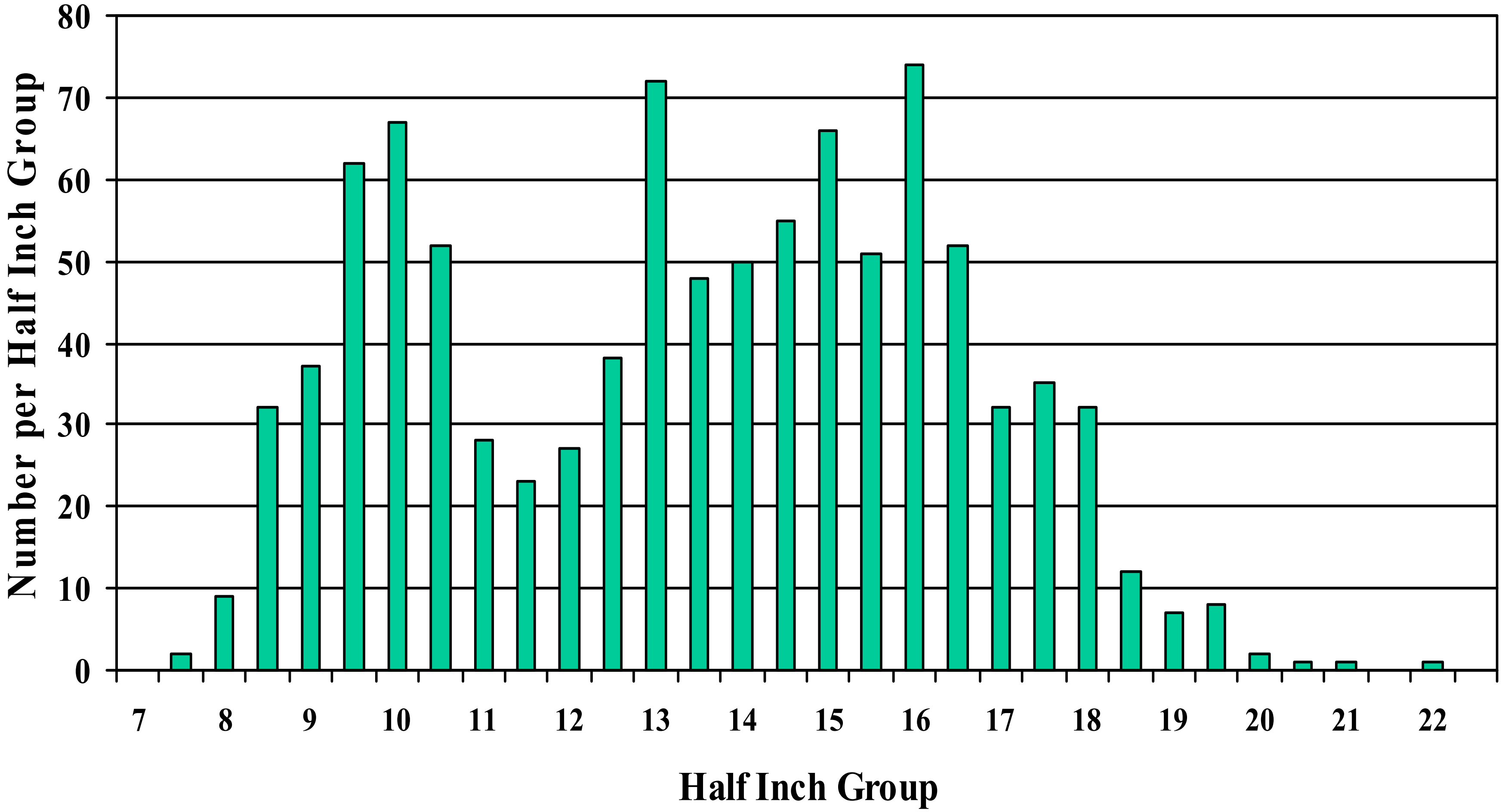


Figure BH-13. Estimated spring density of 13 inch and larger (Age III+) brown trout in the Melrose Section of the Big Hole River 1981 - 2007.

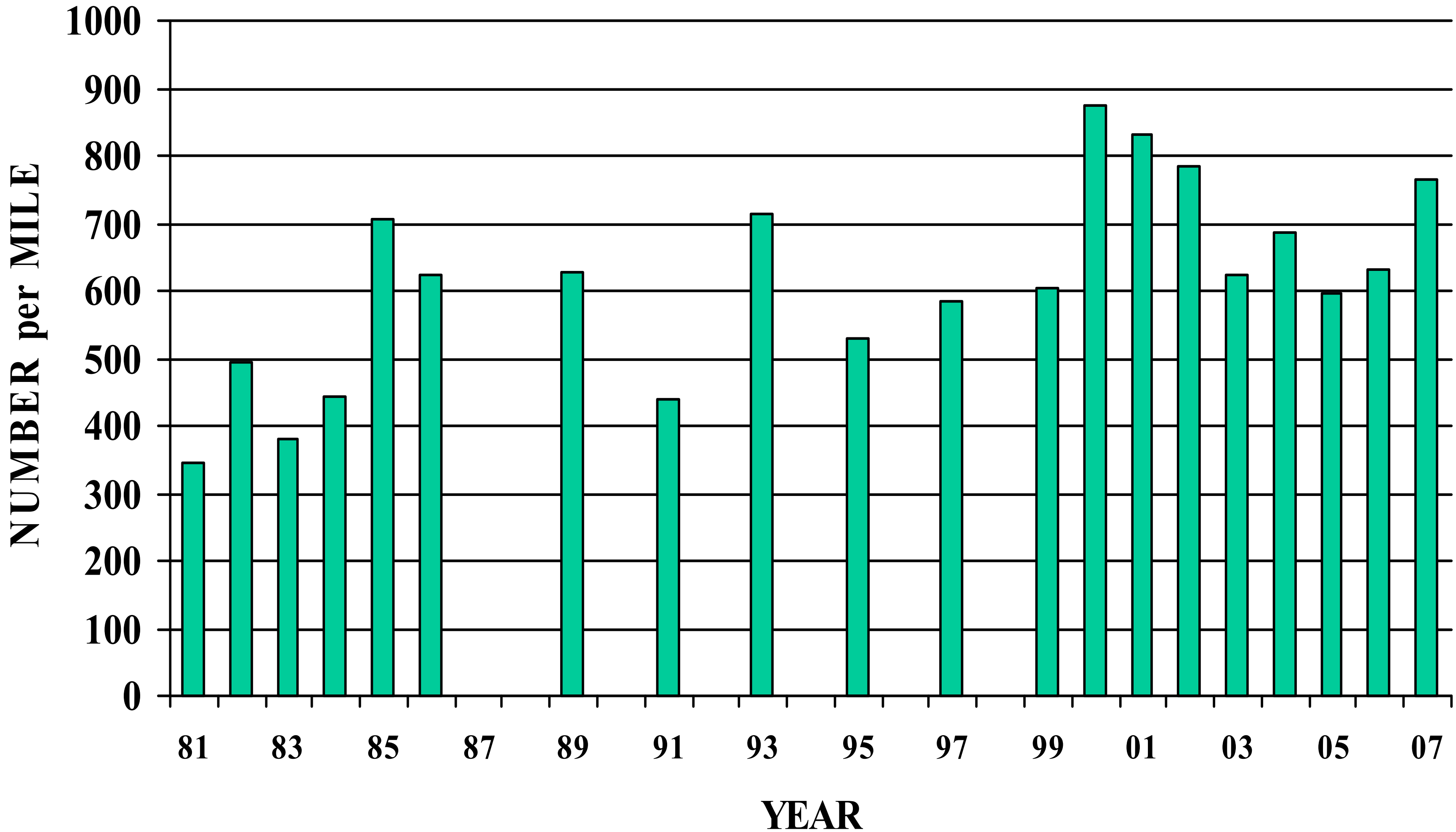


Figure BH-14. Estimated spring density of 18 inch and larger (Age V+) brown trout in the Melrose Section of the Big Hole River, 1981 - 2007.

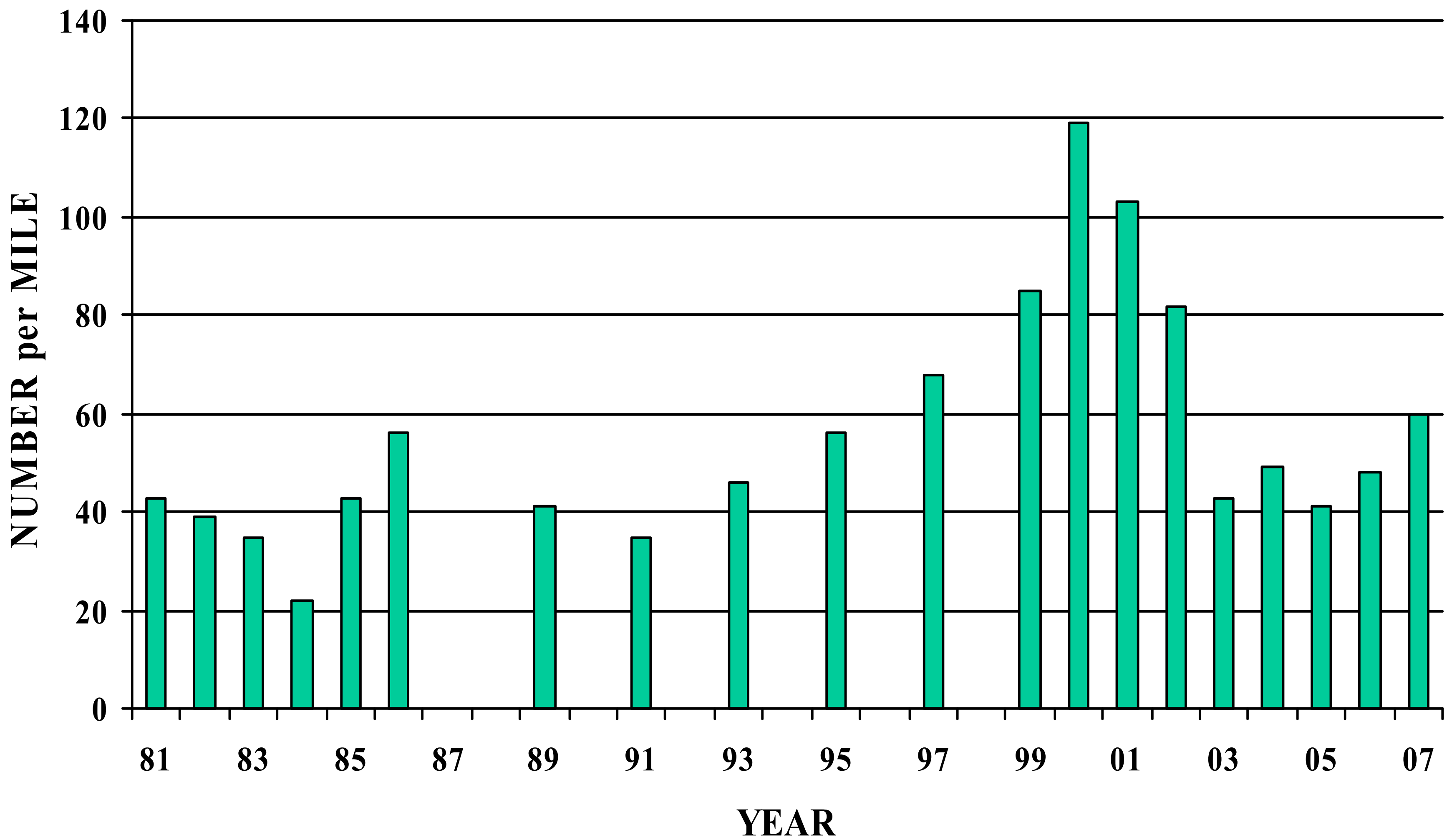


Figure BH-15. Mean spring Condition Factor (K) for total brown trout, 15.0 to 17.9 inch brown trout (Age IV+), and 18.0 inch and larger brown trout (Age V+) collected in the Melrose Section of the Big Hole River 1993 - 1997 vs. 2001 - 2003 and 2005 - 2007.

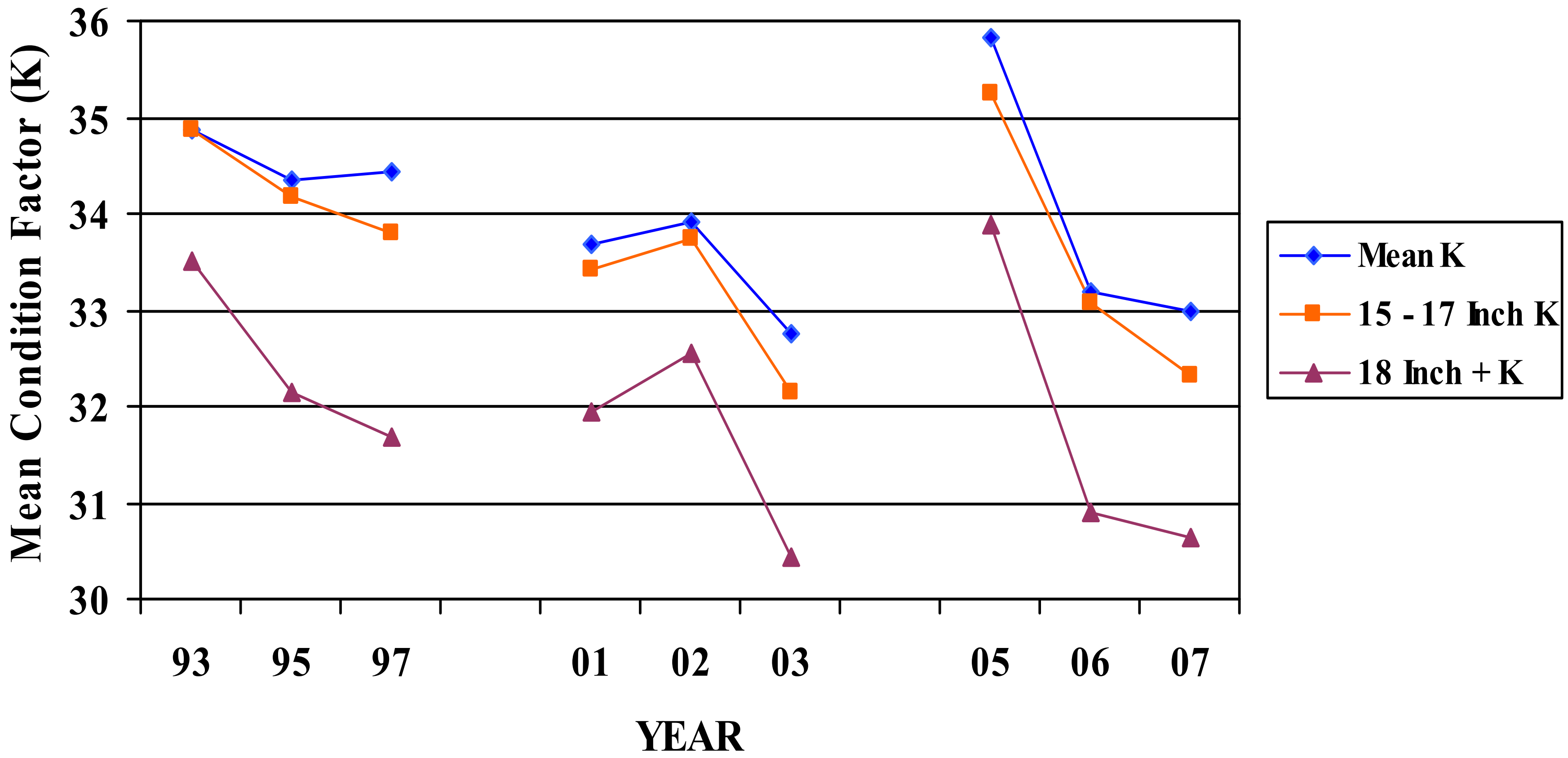


Figure BH-16. Estimated spring density and standing crop of Age II and older brown trout in the Hog Back Section of the Big Hole River, 1987 - 2007.

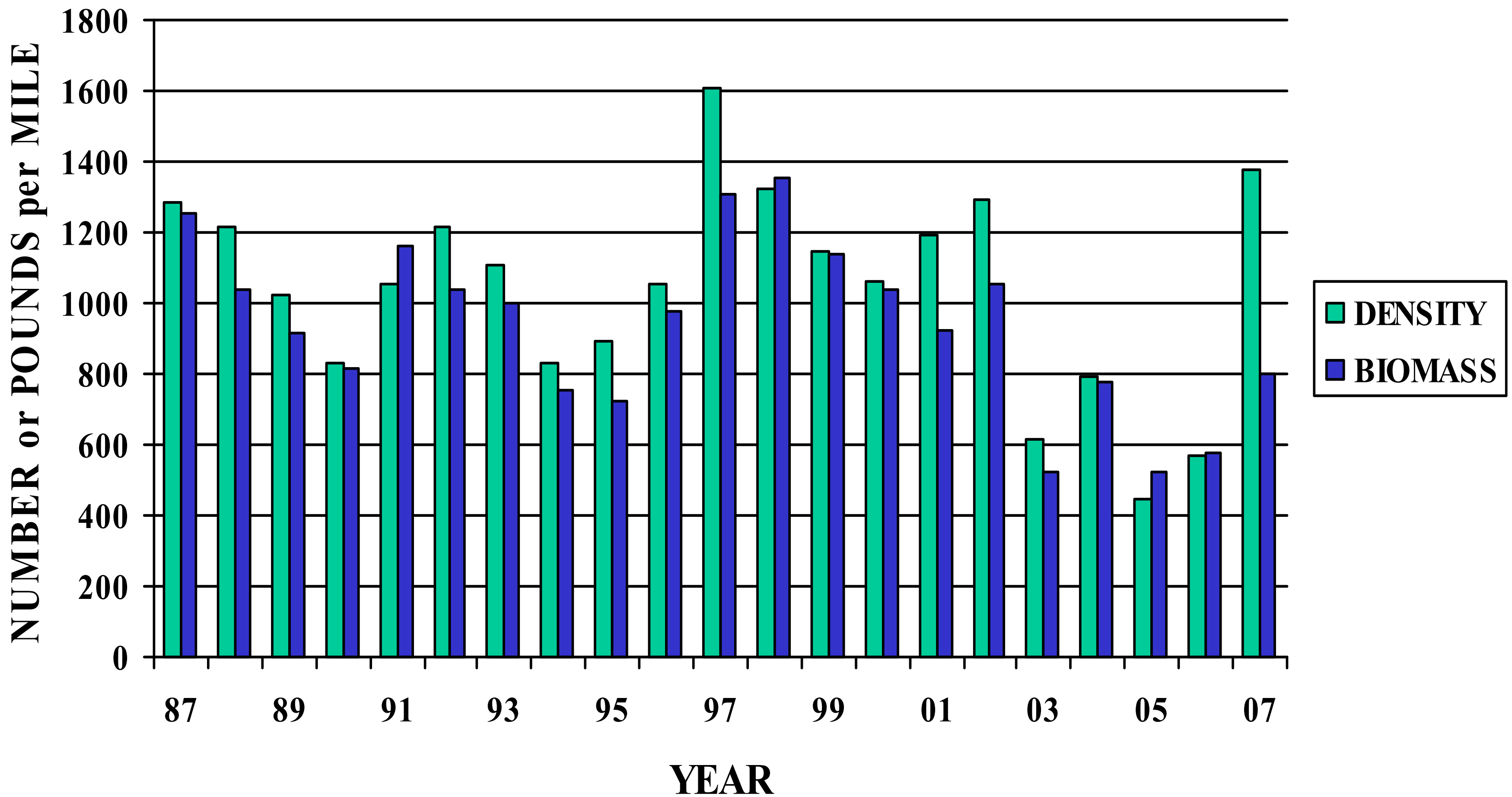


Figure BH-17. Estimated spring density of Age II brown trout in the Hog Back Section of the Big Hole River 1987 - 2007.

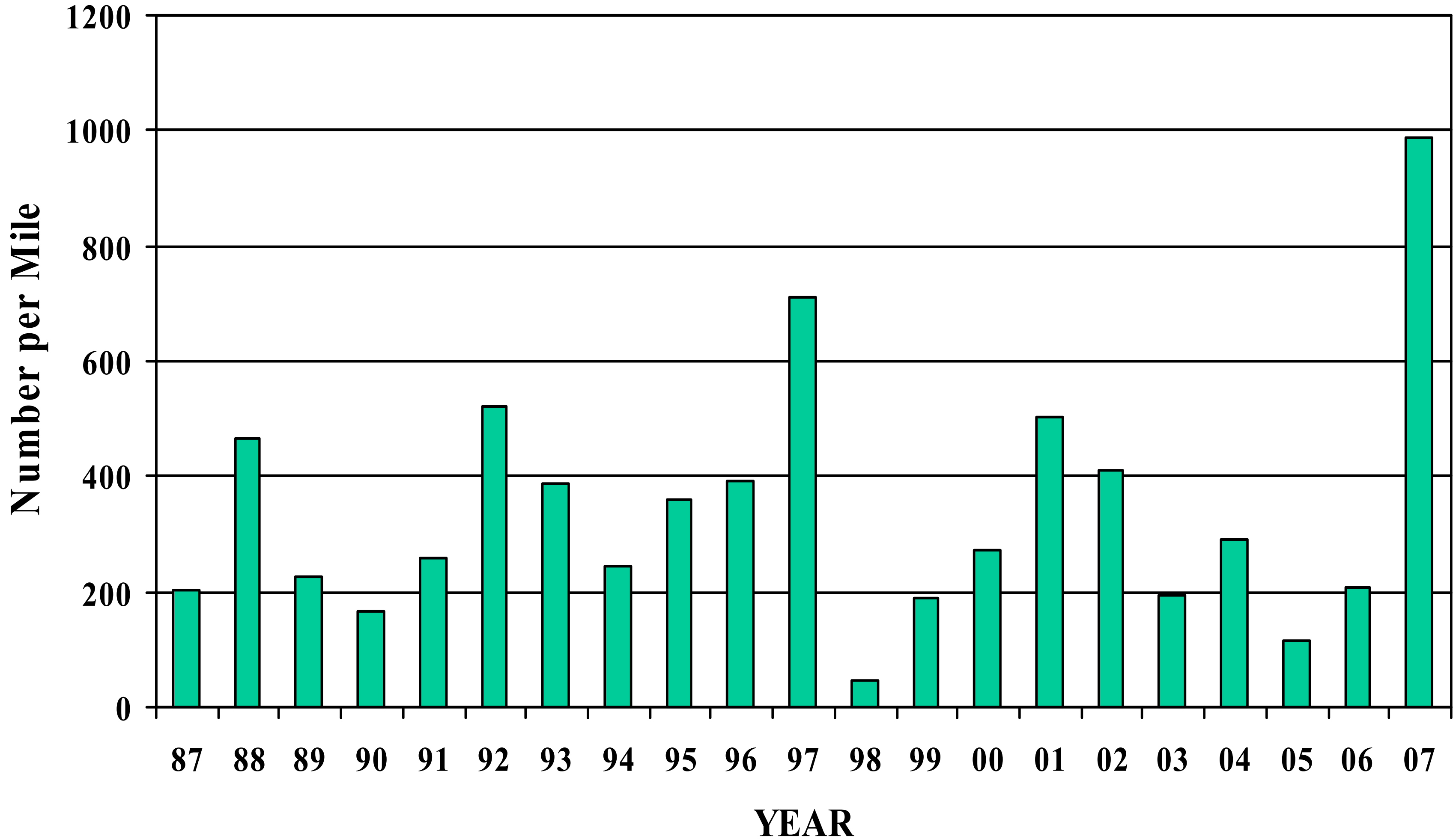


Figure BH-18. Length frequency distribution of Age II and older brown trout captured in the Hog Back Section of the Big Hole River; Spring 2007 (N = 1563).

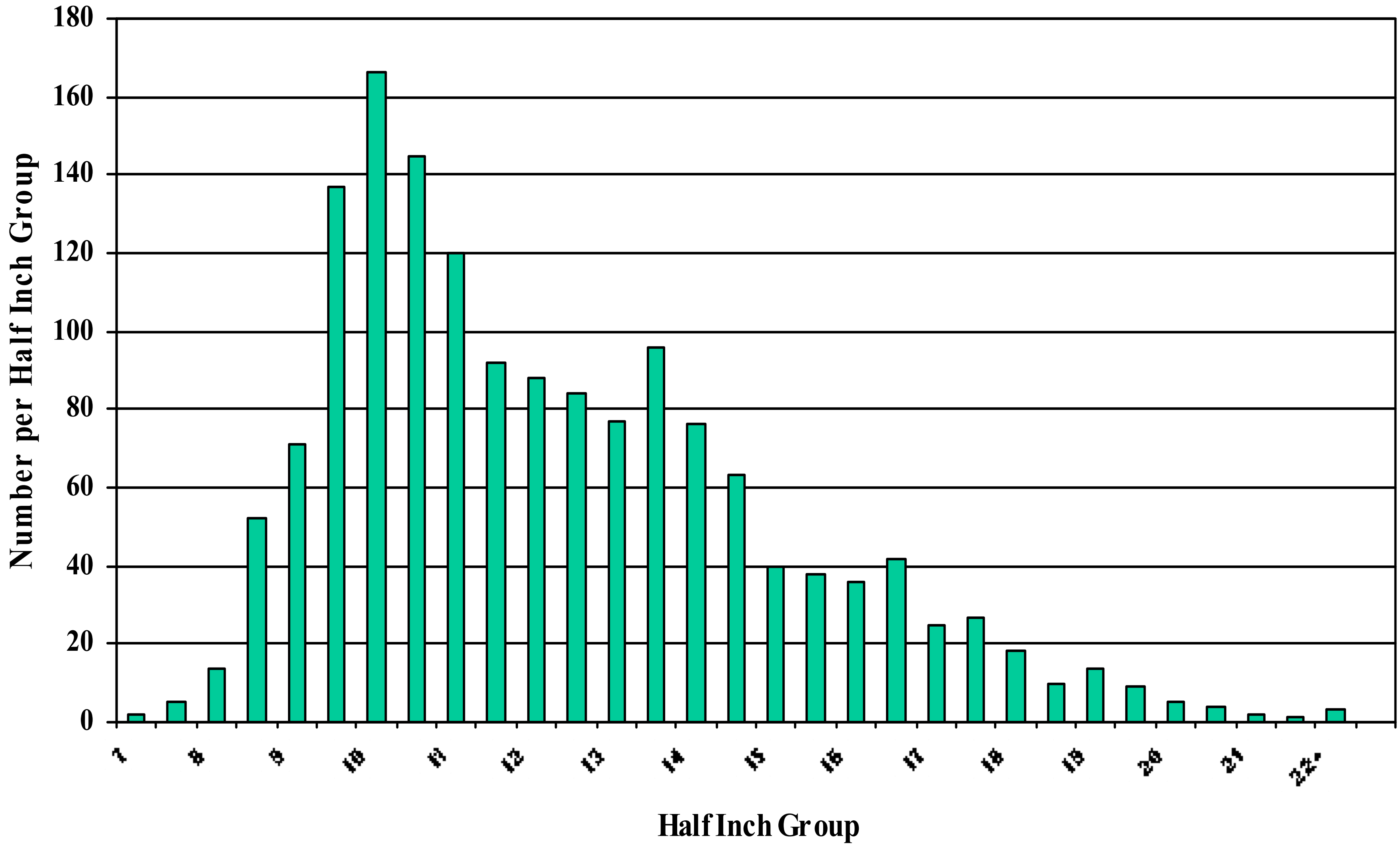


Figure BH-19. Estimated spring density of 13 inch and larger (Age III+) brown trout in the Hog Back Section of the Big Hole River, 1987 - 2007.

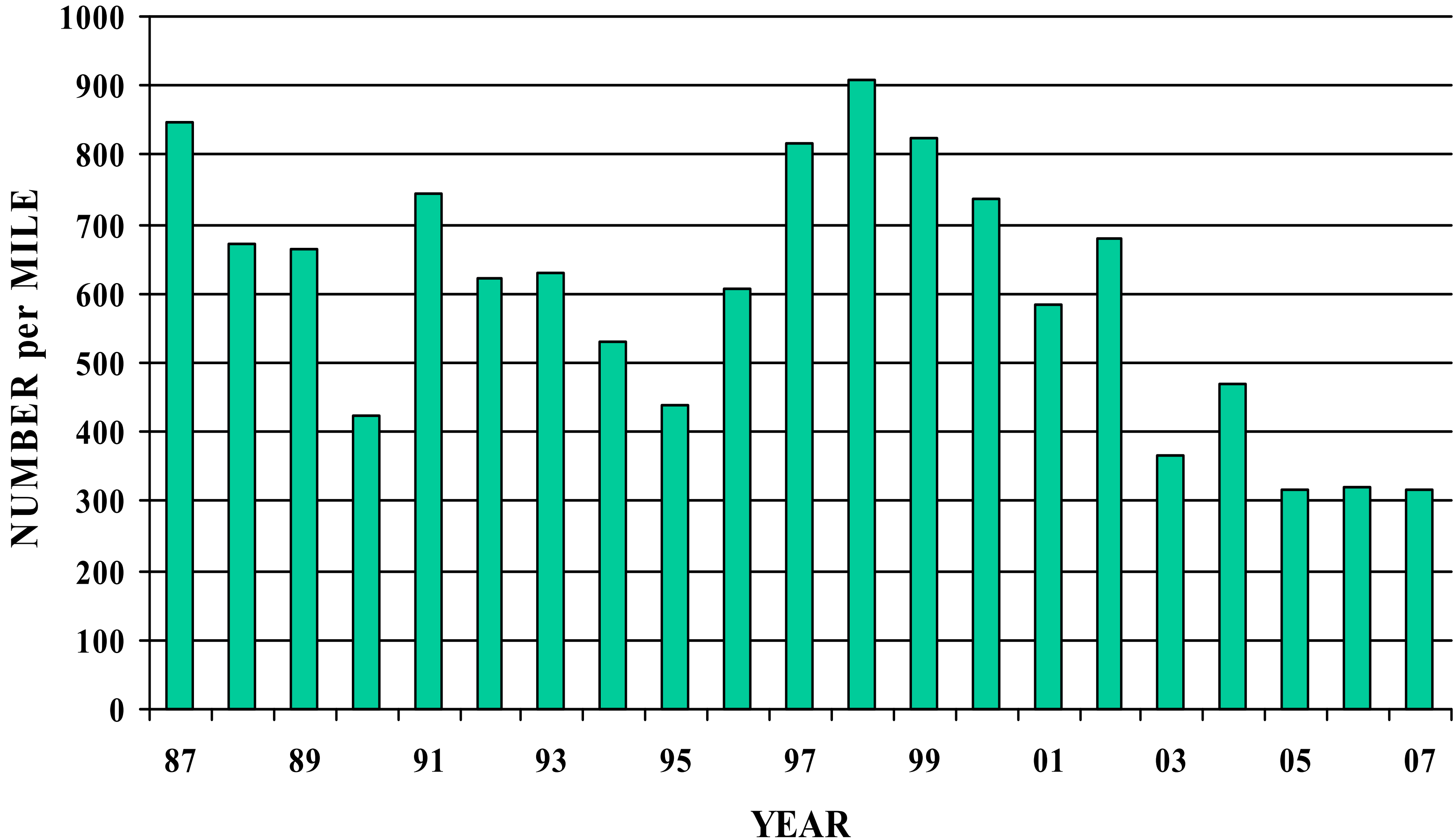


Figure BH-20. Estimated spring density of 18 inch and larger (Age V+) brown trout in the Hog Back Section of the Big Hole River, 1987 - 2007.

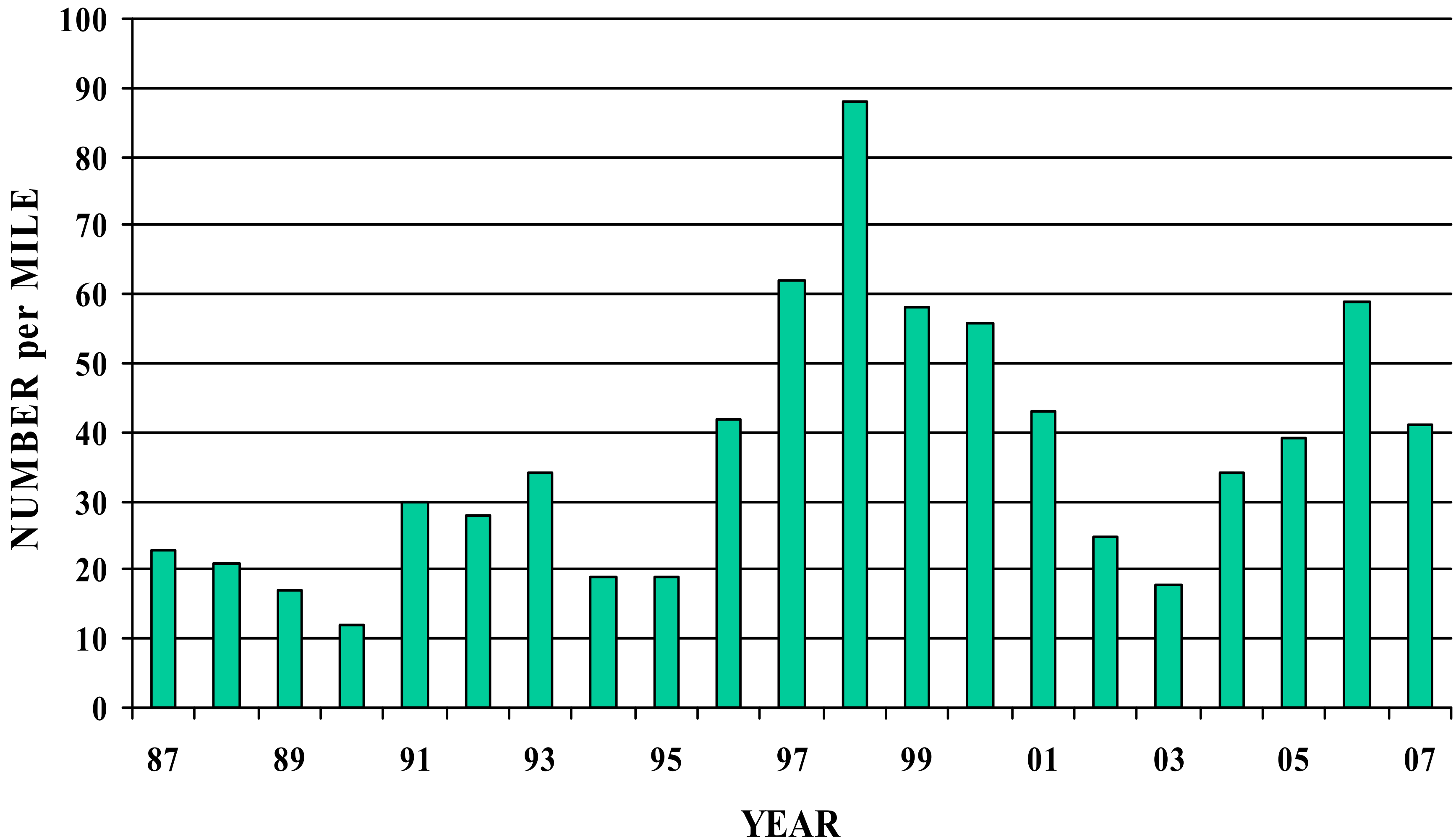


Figure BH-21. Density of Age II versus Age V and older (18 inch plus) brown trout in the Hog Back Study Section of the Big Hole River, 1998 - 2003.

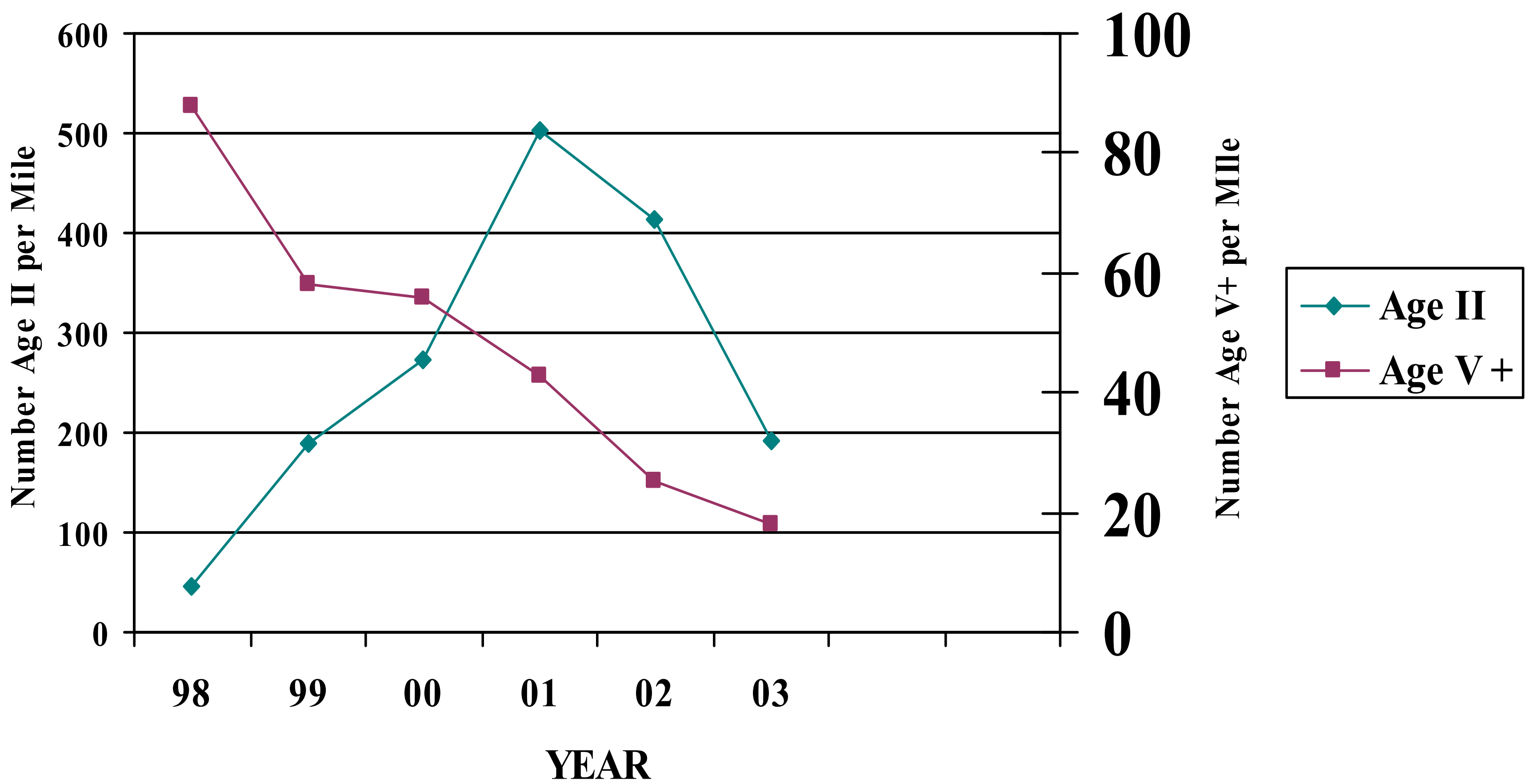


Figure BH-22. Density of Age II versus Age V and older (18 inch plus) brown trout in the Hog Back Study Section of the Big Hole River, 1987 - 2007.

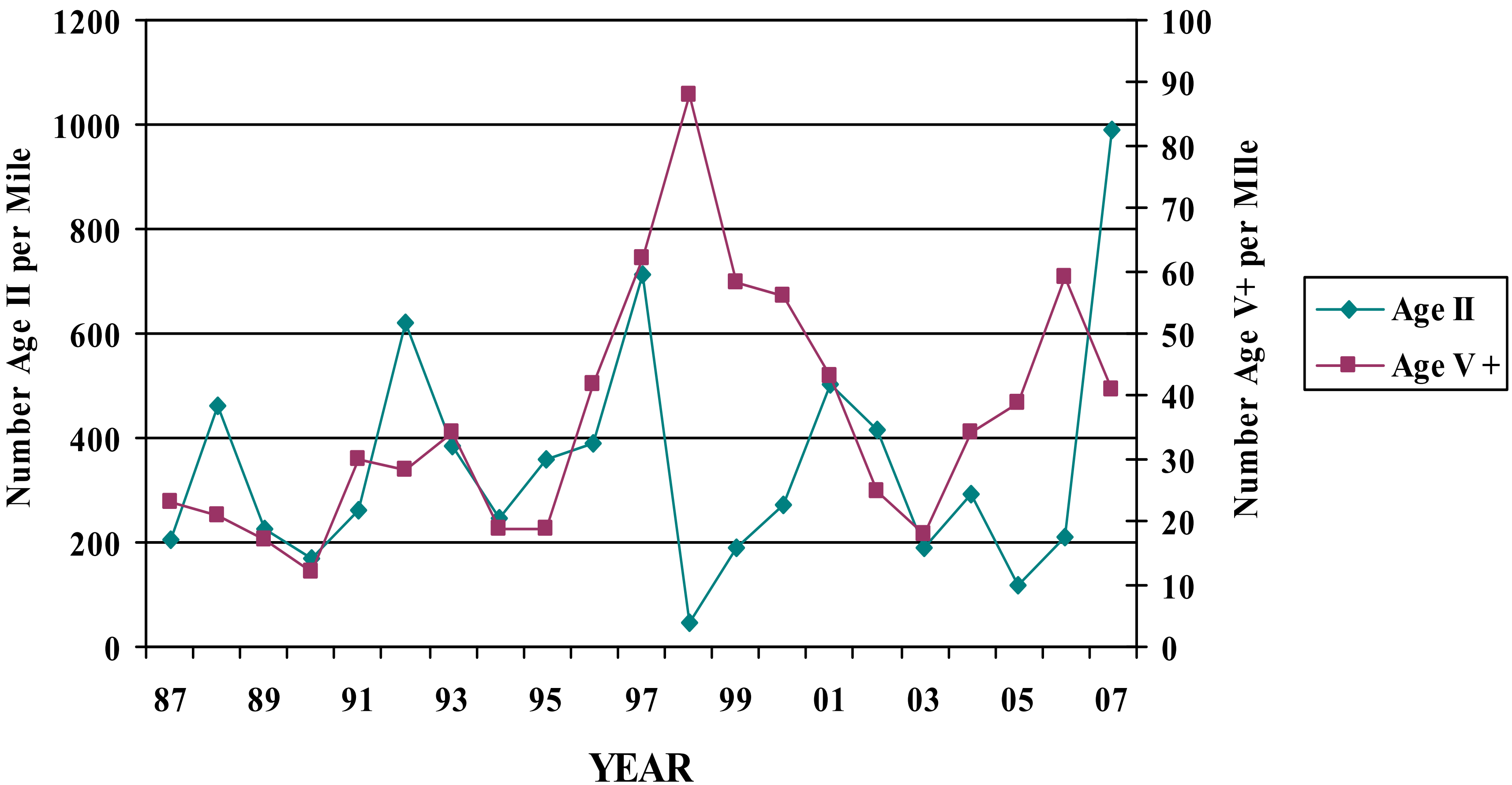


Figure BH-23. Mean spring Condition Factor (K) for total brown trout, 15.0 to 17.9 inch brown trout (Age IV+), and 18.0 inch and larger brown trout (Age V+) collected in the Hog Back Section of the Big Hole River 1995 - 1998 vs. 2000 - 2003 and 2005 - 2007.

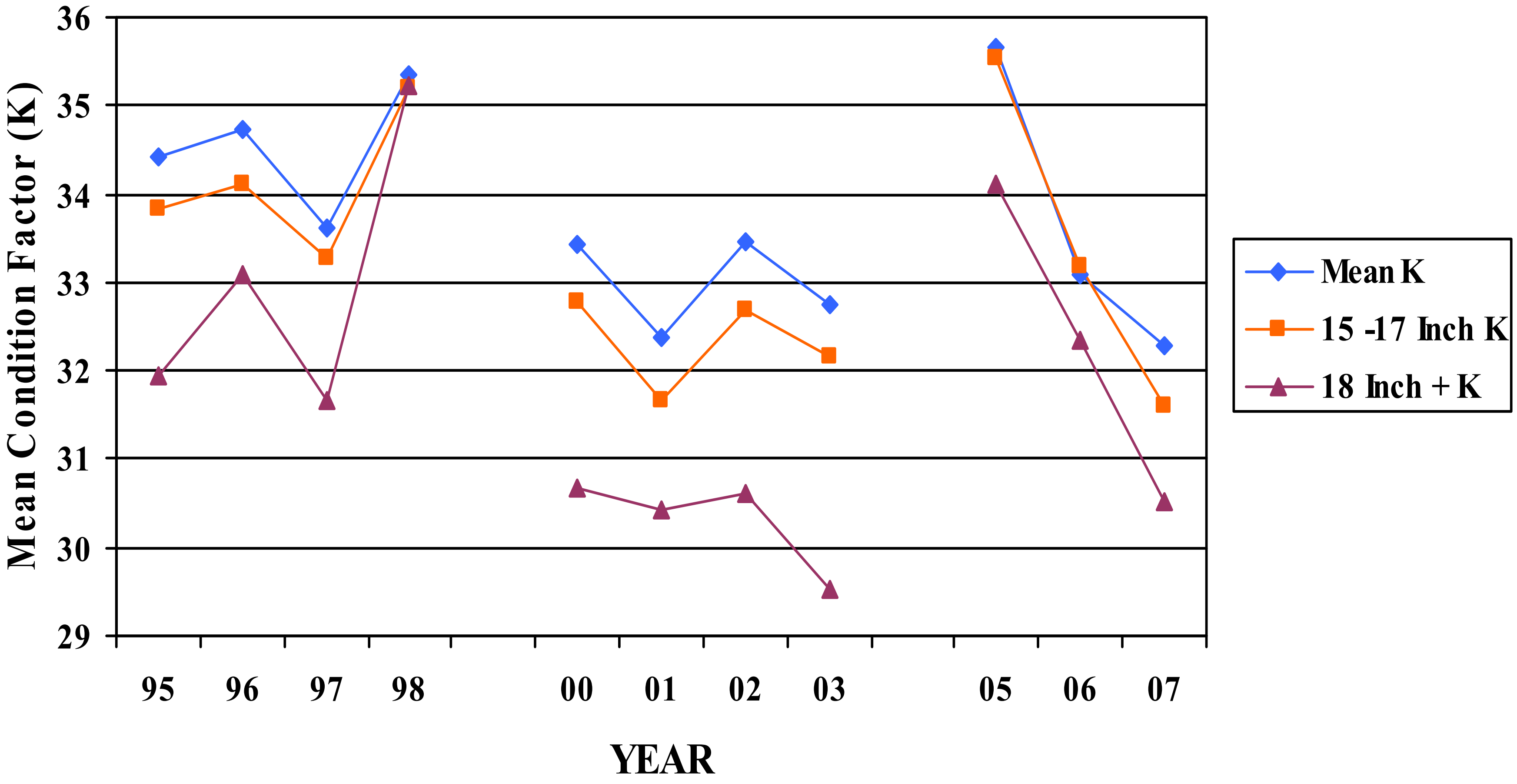


Figure BH-24. Linear regression of the estimated spring standing crop of Age II and older brown trout in the Hog Back Section as a function of the prior year's annual water yield at the USGS Melrose Gage; 1995 - 2007.

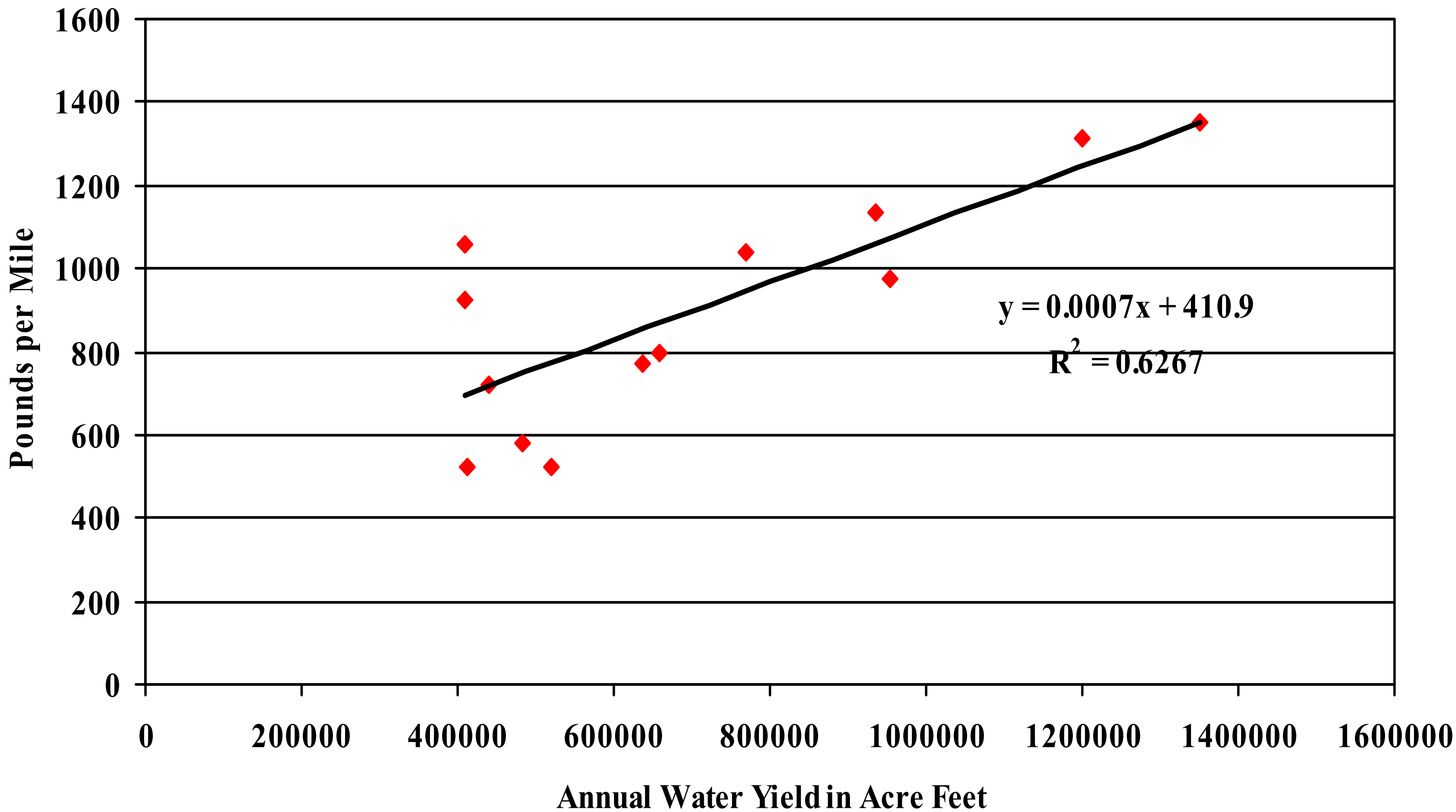


Figure BH-25. Linear regression of the estimated spring brown trout standing crop (Age II+) as a function of the prior year's minimum August flow in the Hog Back Section; 1995 - 2007.

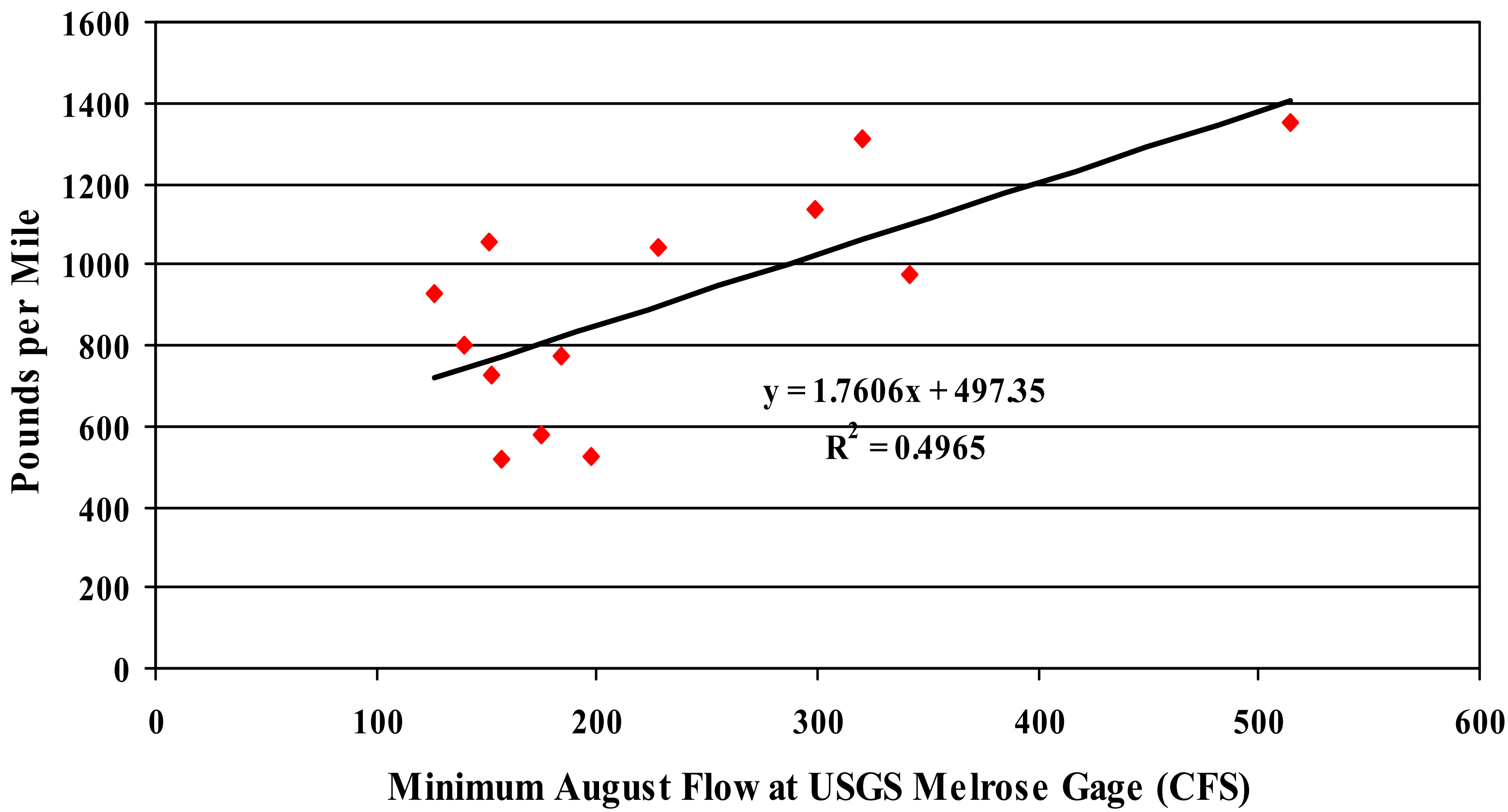
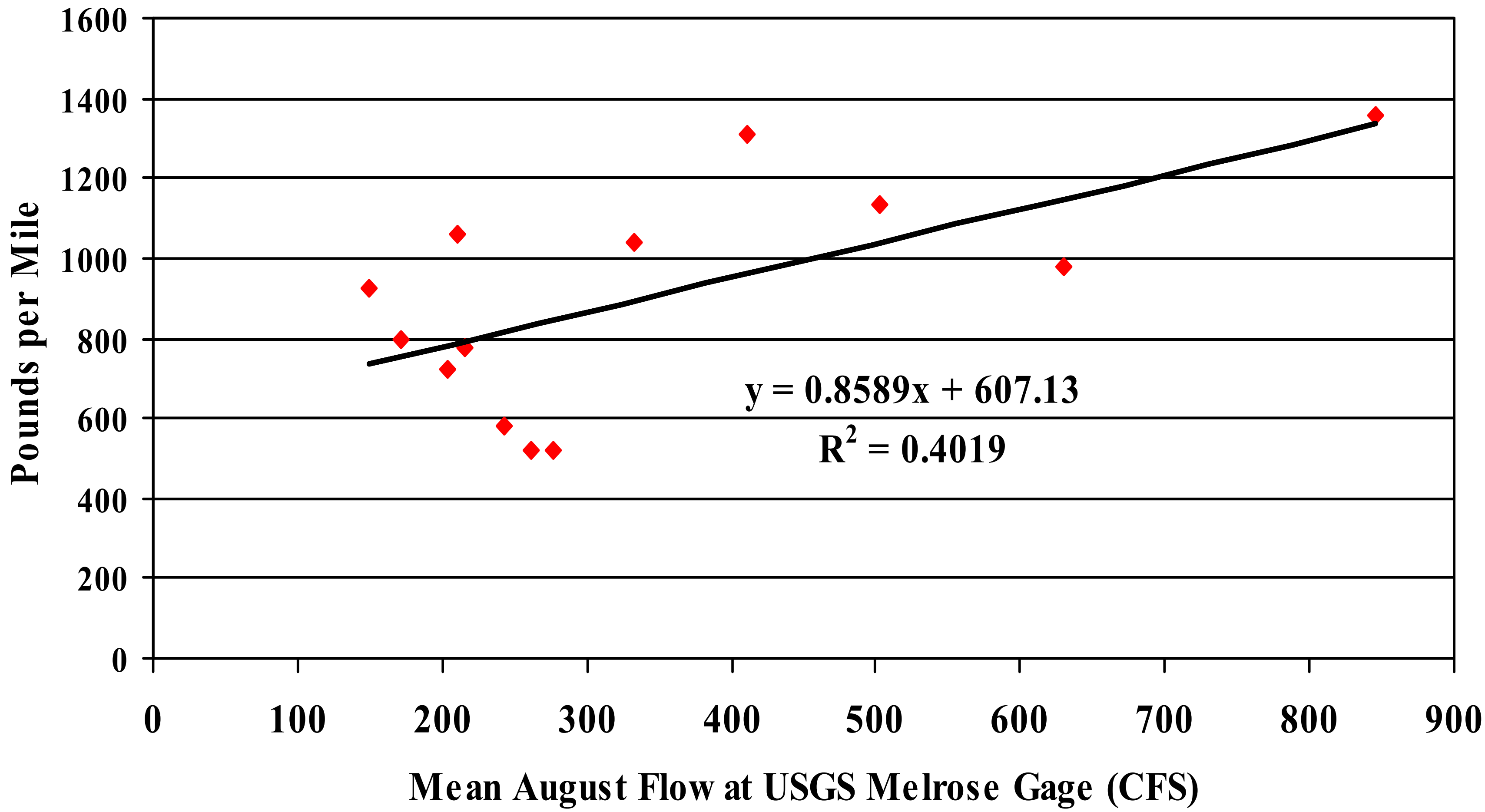


Figure BH-26. Linear regression of the estimated spring brown trout standing crop (Age II+) as a function of the prior year's mean August flow for the Hog Back Section of the Big Hole River; 1995 - 2007



August. This analysis failed to yield a significant correlation ($P<.05$) or meaningful regression. Oswald (2009) presented highly significant correlations between brown trout standing crop and over-winter flow regimes in the Beaverhead River tailwater reach.

Correlation and linear regression analyses were also applied to the relationship between densities of 18 inch and larger brown trout and flow regimes in the Hog back Section over the 1995 – 2003 period. The correlations between the densities of these older, larger fish and flow were stronger than those observed for standing crop. Densities of 18 inch and larger brown trout exhibited highly significant correlations with total annual discharge ($r = 0.87$, $P<.01$), minimum August flow ($r = 0.82$, $P<.01$), and a significant correlation ($r = 0.76$, $P<.05$) with mean August flow. Similarly, R^2 values were more robust than those observed for standing crop Figures BH-27, BH-28, and BH-29 attributing 76% of the variation in density of 18 inch and larger fish to variation in total annual discharge. Again, the analysis of the density of 18 inch and larger brown trout as a function of maximum July – August thermal regime failed to yield a significant correlation. Oswald (2009) presented relatively robust correlations between densities of older, larger brown trout as a function of over-winter flow regimes in the Beaverhead River tailwater and noted that Age V and older fish yielded more powerful relationships than those observed for the Age IV and older component.

Linear regressions established for brown trout standing crop and densities of older, larger fish within the populations provide a means of analyzing or predicting brown trout population response to a wide range of flow regimes. The ordination of correlation coefficients provides an emphasis for the importance of ample flow regimes and productive habitats at all seasons of the year.

Red Rock River

Updated graphic representations of trends in Arctic grayling spawning migrations for 2006 - 2008 are presented in Appendix B for the Corral Study Section of Red Rock Creek. Trend data for this study section was most recently presented and discussed by Oswald et al (2008) through the 2007 spawning season. Climatic conditions have interjected a large range of variation in spring flow regimes in Red Rock Creek in recent years. May flow regimes (Figure RR-1), which conservatively bracket the Arctic grayling spawning period, exhibited relatively short duration peaks in the latter half of the month in 2005 and 2006 while lacking any substantial runoff trigger in 2007. Similarly, June flows (Figure RR-2), which conservatively bracket the incubation and emergence period, exhibited a strong runoff and ample flow in 2006, intermediate and relatively stable flows in 2005, and extremely low flows in 2007.

Arctic grayling CPUE's over the 2005 – 2008 period (Figure RR-3) suggest that Arctic grayling populations have declined markedly from those observed over the 1980 – 1987 period but exhibited a slight improvement over the 2006 – 2008 sample years. Comparative data (Figures RR-4 and RR-5) also suggest that the age and size structure of recent spawning populations has declined markedly from spawning populations of the 1980's. Finally, mean condition factors of recent spawning populations (Figure RR-6) exhibited a marked decrease compared with those of the 1980's despite apparent shifts toward shorter, younger fish. The apparent declines in length

Figure BH-27. Linear regression of the estimated spring density of 18 inch and larger (Age V+) brown trout in the Hog Back Section of the Big Hole River as a function of the prior year's annual water yield at the USGS Melrose Gage; 1995 - 2003.

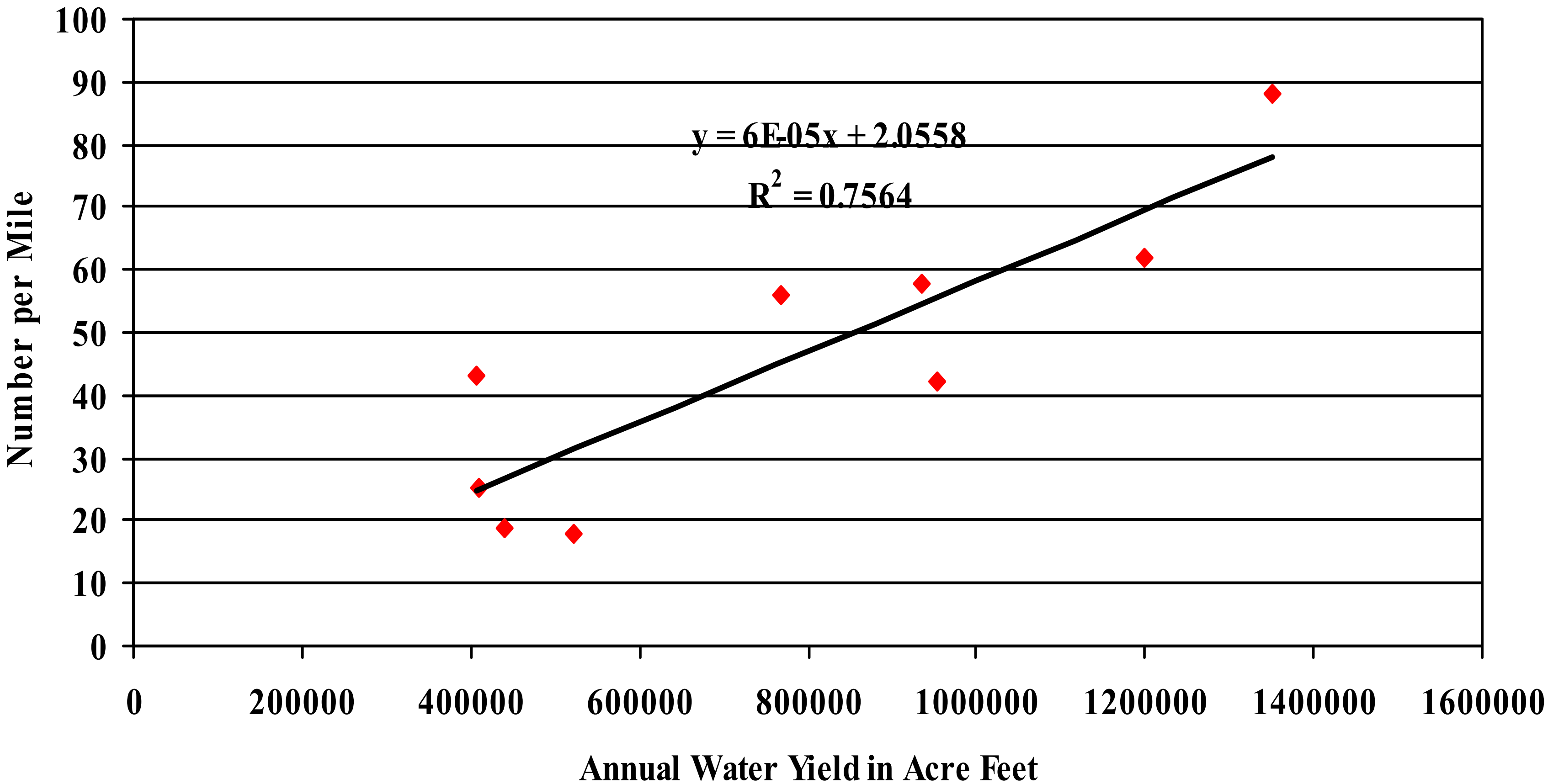


Figure BH-28. Linear regression of the estimated spring density of 18 inch and larger (AgeV+) brown trout as a function of the prior year's minimum August flow in the Hog Back Section of the Big Hole River 1995 - 2003.

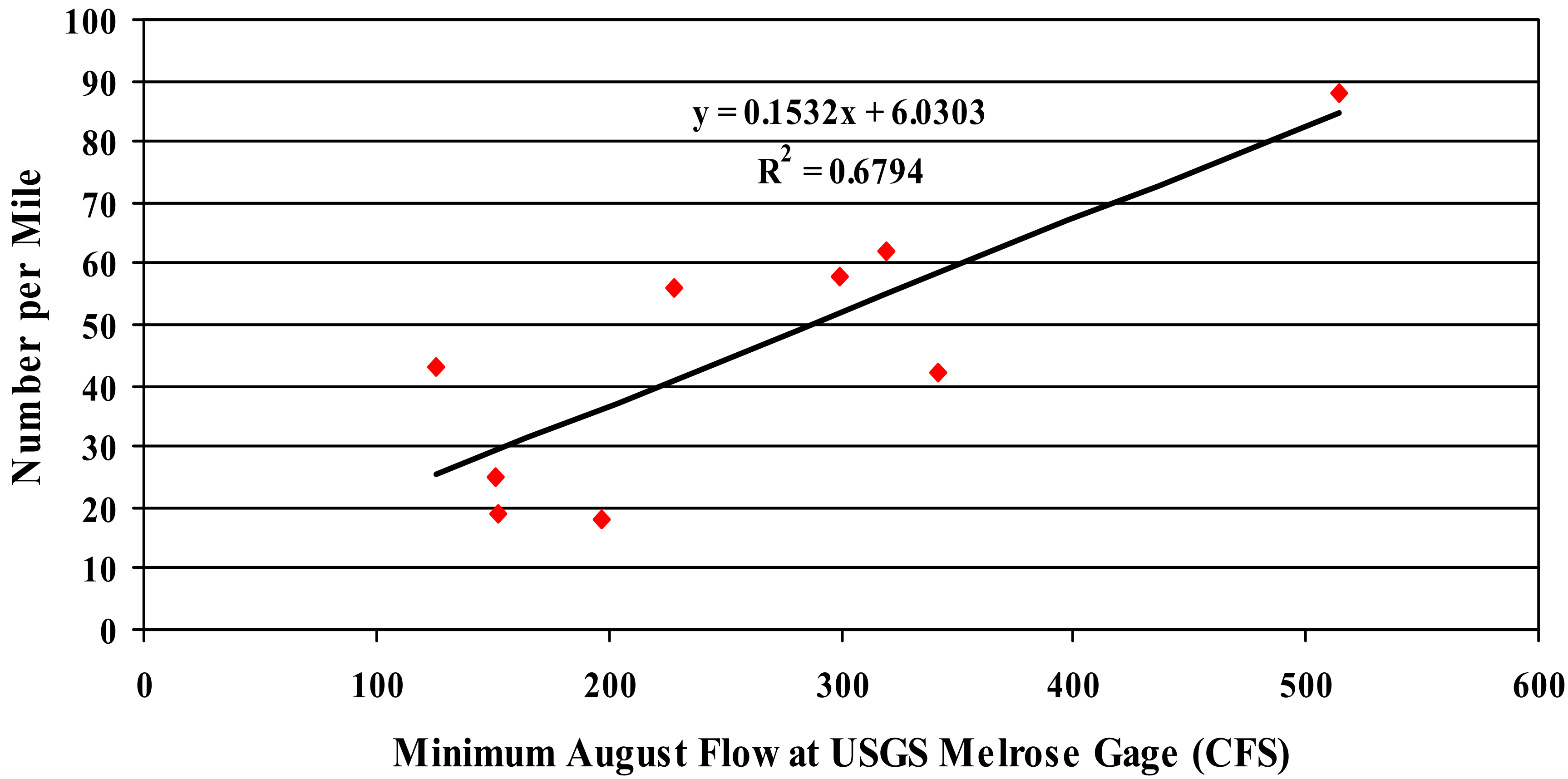


Figure BH-29. Linear regression of the estimated spring density of 18 inch and larger (Age V+) brown trout as a function of the prior year's mean August flow for the Hog Back Section of the Big Hole River; 1995 - 2003

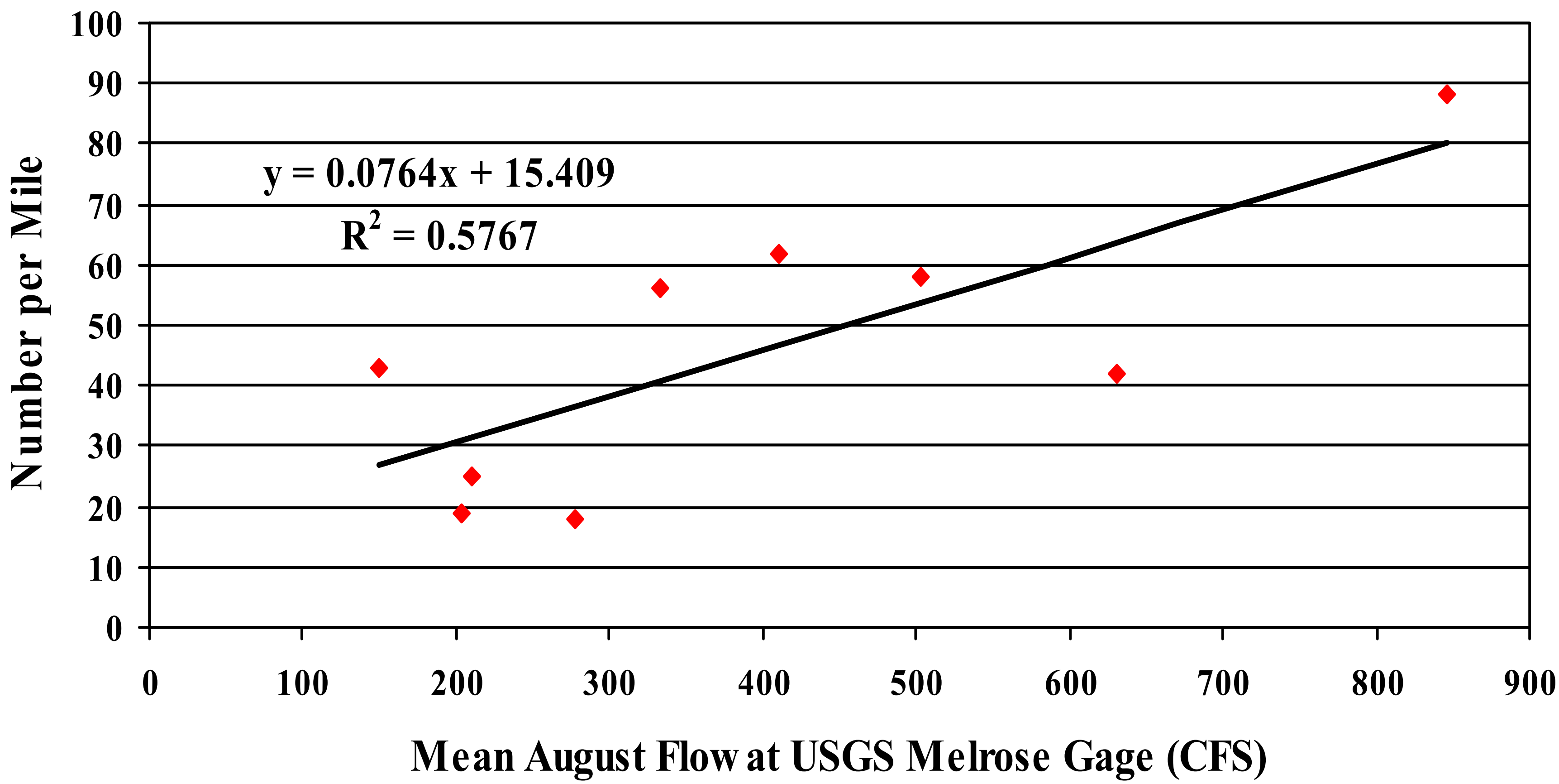


Figure RR-1. Compressed flow regimes and peak Average Daily Flows for May 2005 - 2007 at the USGS Red Rock Creek Gage.

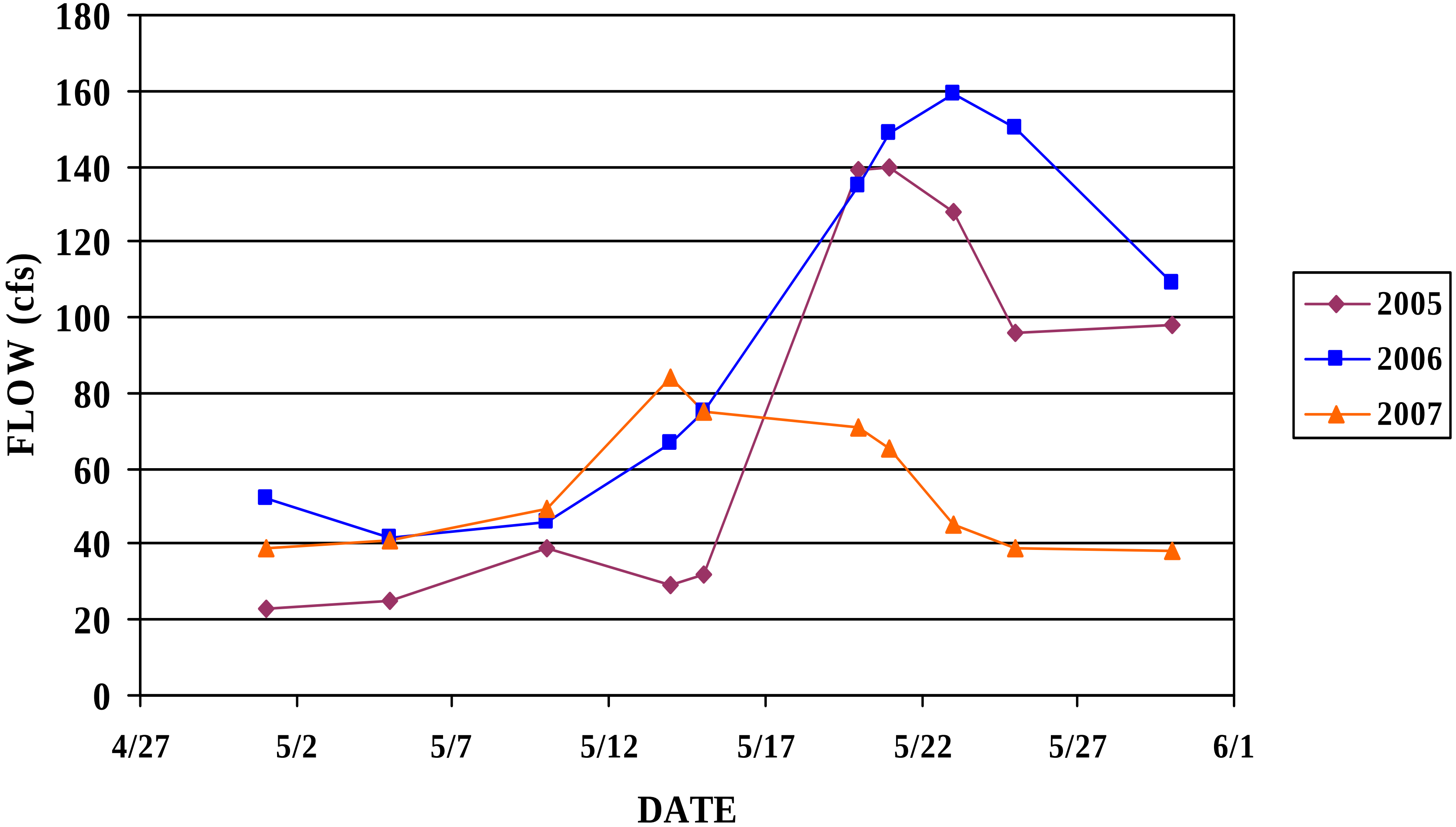


Figure RR-2. Compressed flow regimes for June 2005 - 2007 at the USGS Red Rock Creek Gage.

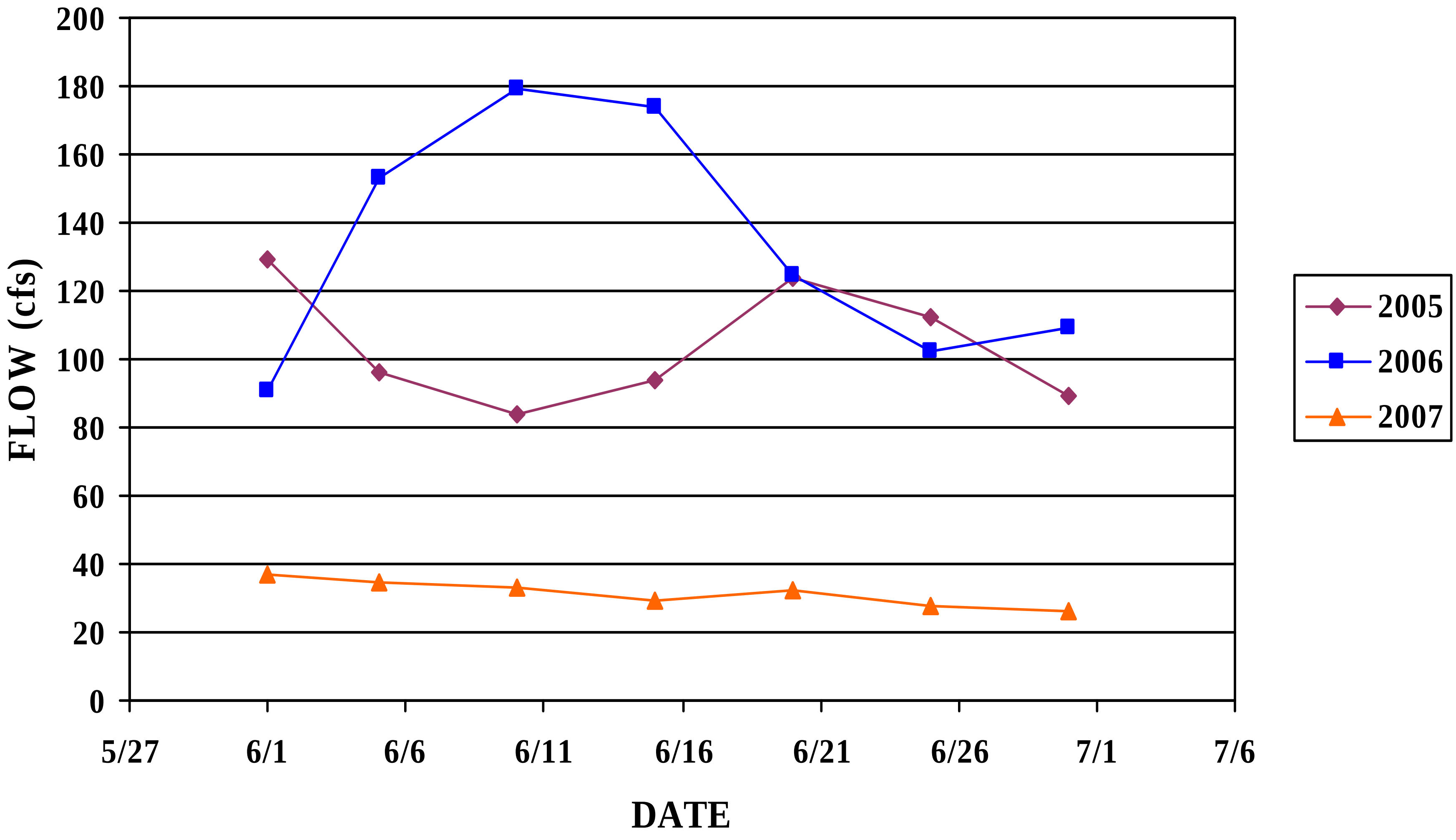


Figure RR-3. Catch per Unit Effort for Adfluvial Arctic Grayling collected in electrofishing samples during spring spawning migrations in the Corral Section of Red Rock Creek, for select time periods, May 1982 - 2008.

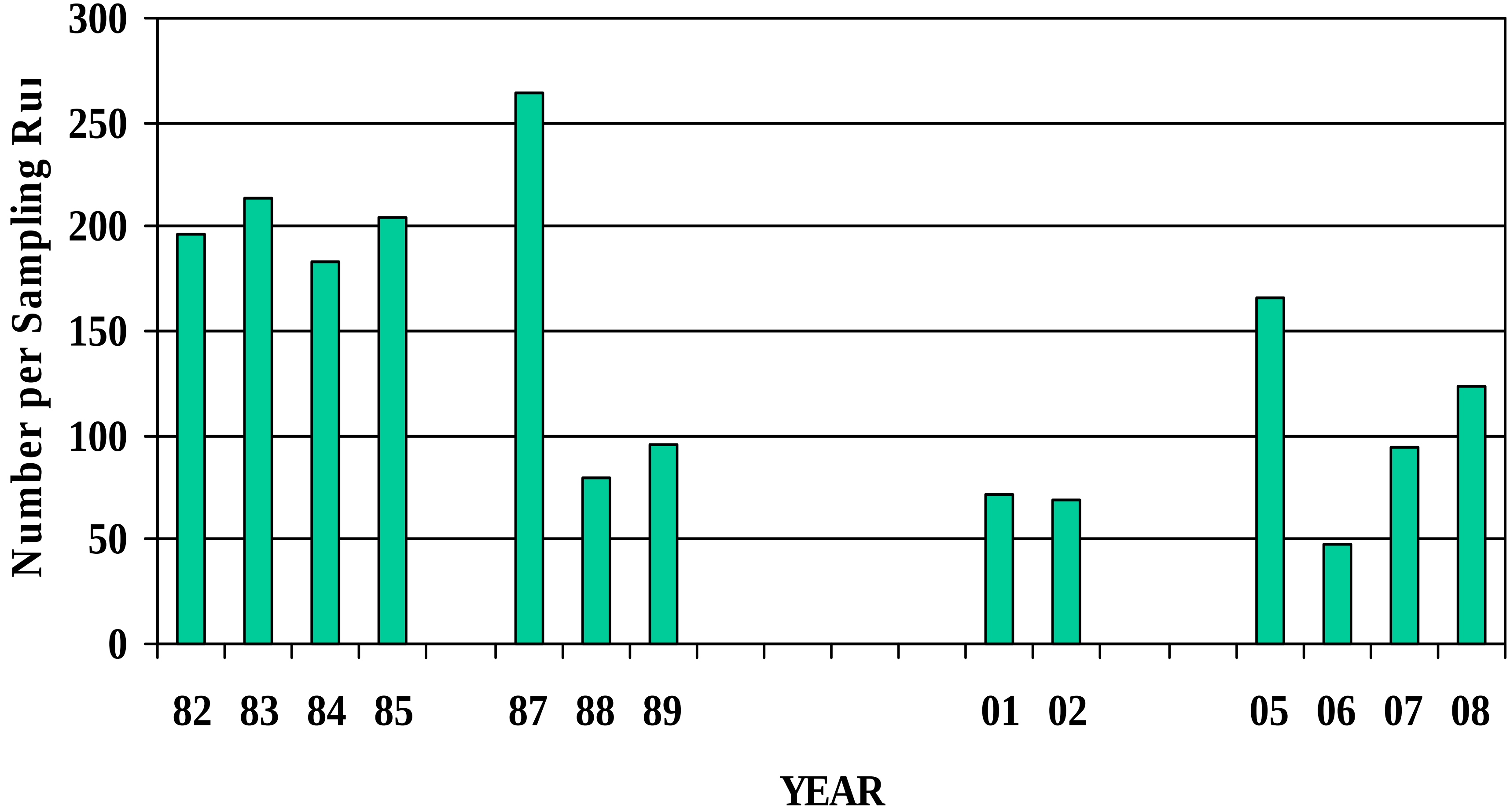


Figure RR-4. Length - Frequency Distribution of Arctic Grayling collected in the 1985 (N=205) and 1987 (N=360) spawning migrations in the Corral Section of Red Rock Creek.

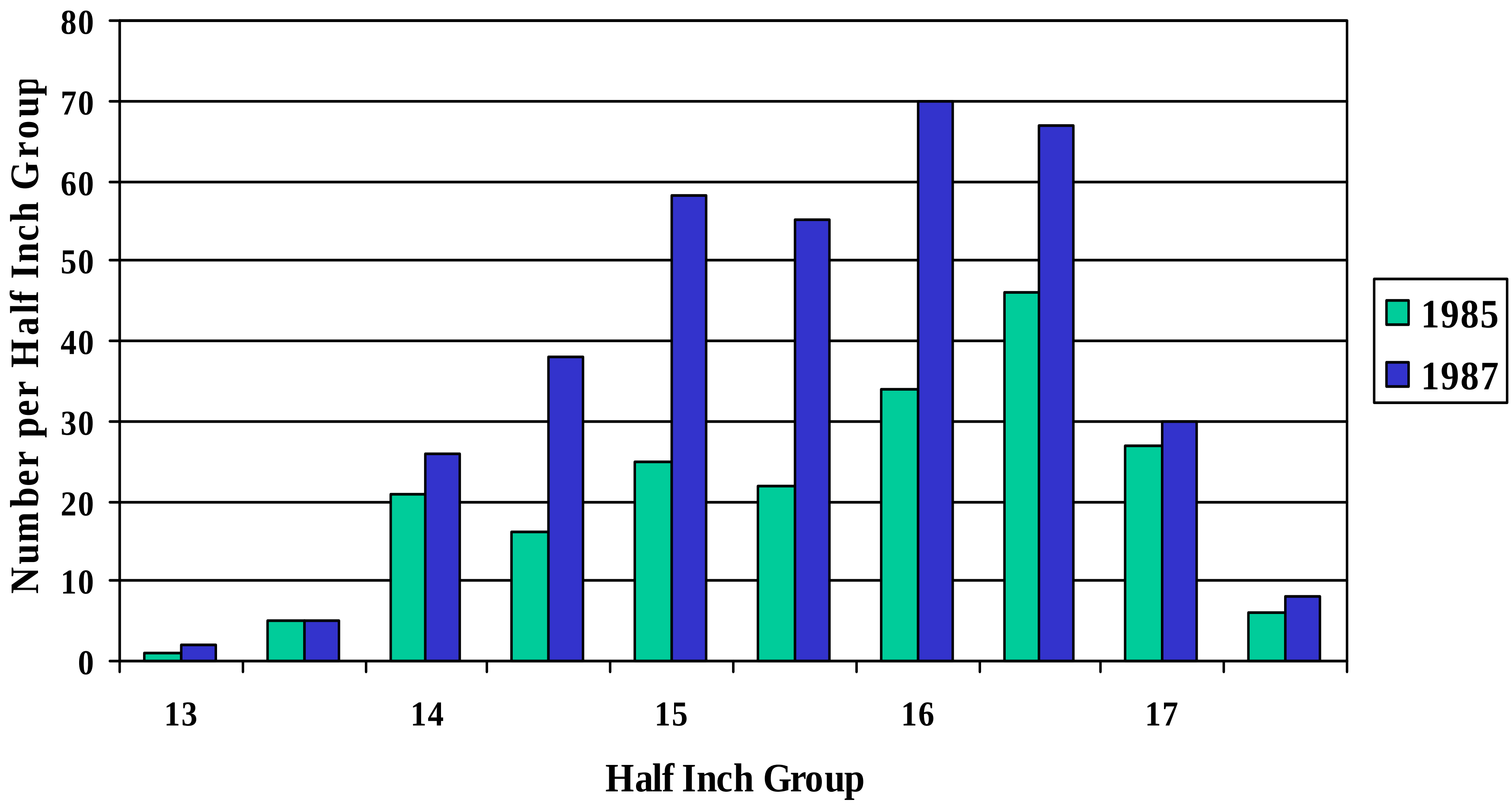


Figure RR-5. Length - Frequency Distribution of Arctic Grayling captured during the 2005 (N=166), 2006 (N=64), 2007 (N=94), and 2008 (N=150) spawning migrations in the Corral Section of Red Rock Creek.

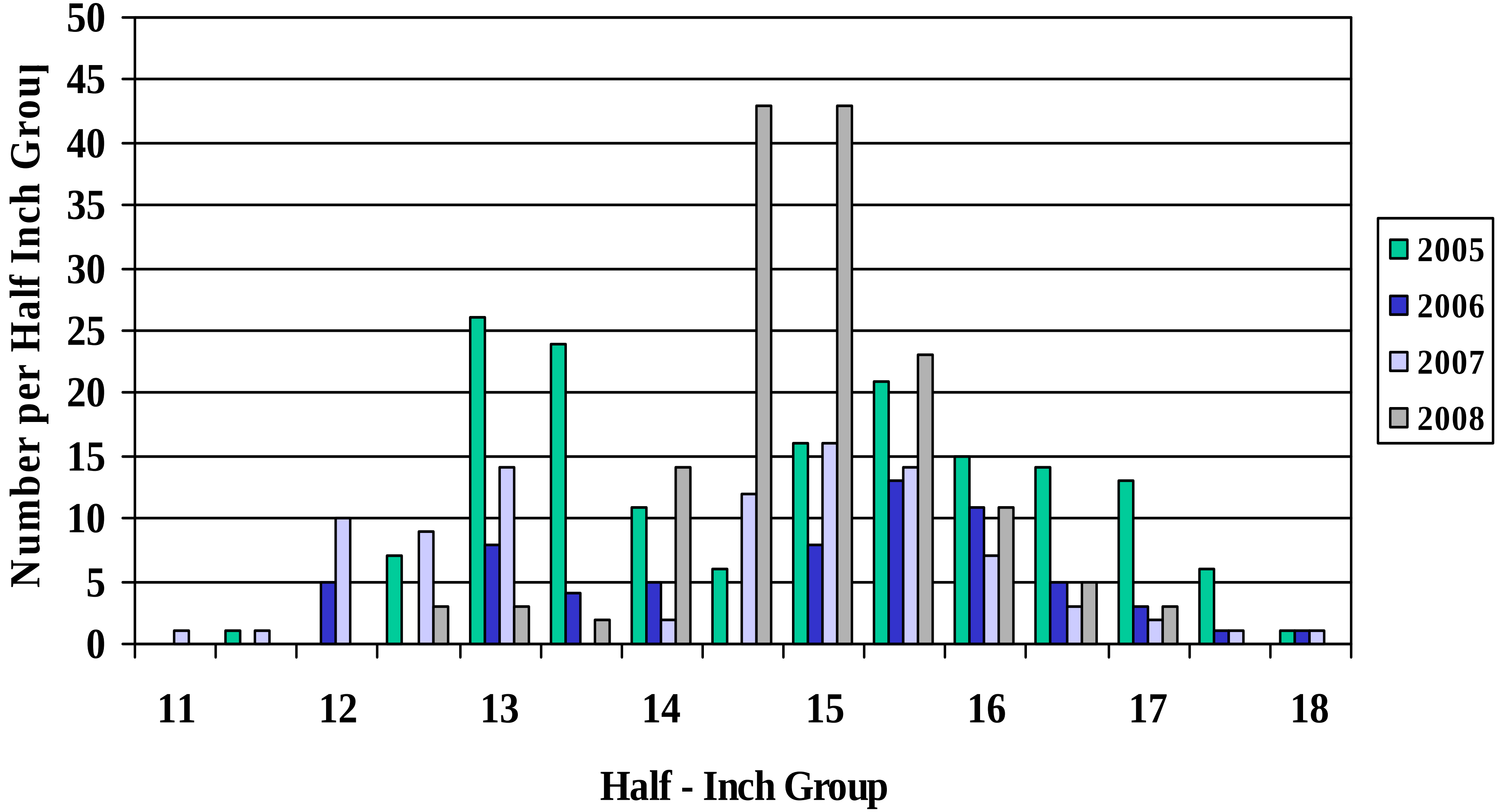
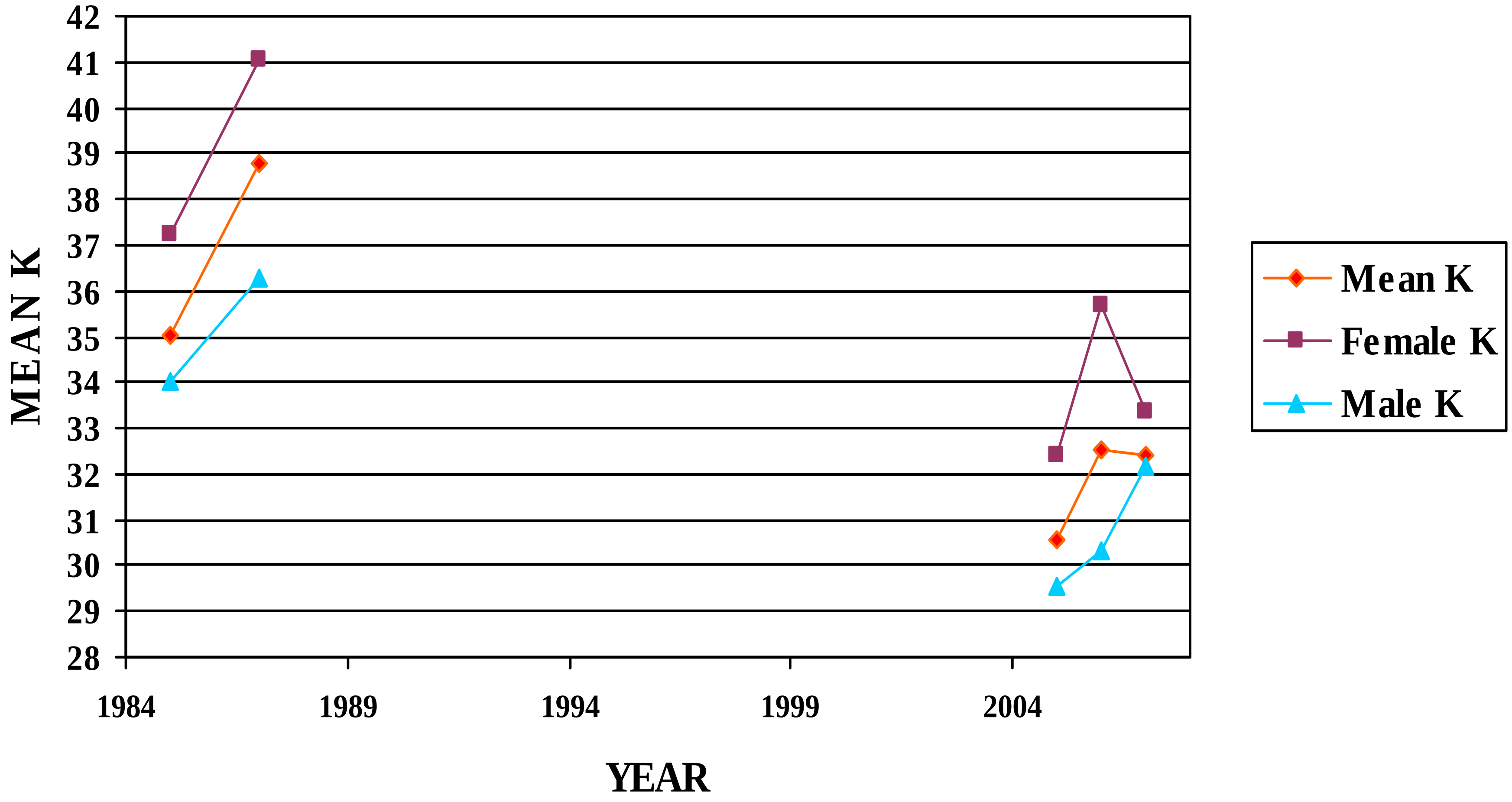


Figure RR-6. Mean Condition Factor (K) of spawning Arctic grayling captured in the Corral Section of Red Rock Creek; May 1985 - 1987 vs. May 2005 - 2007.



and condition, particularly those of the adult females, could adversely affect fecundity and future recruitment into already reduced populations of native Arctic grayling in the Red Rock River.

Appendix B also contains graphic presentations of wild brown trout population trends for the Martinell Study Section of the lower Red Rock River. The brown trout populations of the Martinell Section were most recently described and discussed through the 2006 sample season by Oswald (2006). Improving flow regimes in the Red Rock River (Figures RR-7 and RR-8), particularly the base late summer flows, generally exceeded the upper inflection point for defined minima by substantial amounts over the 2005 – 2008 water years. Nonirrigation flow release regimes from Lima Dam, however, (Figure RR-7) lagged behind irrigation releases relative to average conditions and were reduced to zero in April of 2008 concomitant with a prolonged winter climate.

Improving flow conditions were accompanied by expanding Age II and older brown trout populations (Figure RR-9) over the 2005 – 2008 period. The expanding trend of the brown trout population was most markedly manifested as substantive gains in standing crop in 2007 and 2008. Both brown trout density and standing crop exhibited a large increase in 2008 as a direct result of the successful recruitment of an exceptional cohort of Age II fish. This cohort was detectable as a large recruitment of Age I fish in 2007 (Figure RR-10) that demonstrated excellent survival to Age II in 2008.

Improving trends in brown trout density were manifest as a marked expansion in the density of 13 inch and larger fish in the 2008 sample (Figure RR-11). This expansion probably exerted the most significant influence on the markedly improved standing crop observed in the 2008 sample. Estimated densities of 16 inch and larger fish did not exhibit any detectable improvement in the 2008 sample but should expand markedly in 2009 under average flow management. Densities of the oldest, largest fish in the population (Figure RR-12) trended upward through 2007 and exhibited a slight downturn in the 2008 sample. It is probable that these 18 inch and larger (Age V+) fish improved from relatively low densities of surviving Age III and Age IV fish as flow regimes improved over the 2005 – 2007 period and began a decline with age related attrition in 2008. Continued productive flow regimes could result in substantial improvements in the densities of these older, larger fish as the strong recruitment cohorts observed in 2007 and 2008 attain Age V and older status in two to three years. Improvements in spring brown trout density and standing crop, particularly, the marked improvements in 2008, were accompanied by declining trends in spring brown trout condition factor (Figure RR-13) across the estimated population. As has been the observed case in prior studies (Oswald 2005, 2006 and 2009b), the declines in condition were most markedly manifested among the older, larger components of the population. High densities and standing crops of brown trout under conditions of rapidly expanding recruitment have been accompanied by substantial declines in condition factor under sub-minimum over-winter flow regimes in Beaverhead and Ruby River tailwater study sections.

Long term comparisons with other Red Rock River study sections (Figures RR-14, RR-15, and RR-16) suggest marked improvement in brown trout populations under improving base summer flow regimes, particularly in the 2008 samples. Marked improvements in brown trout population density, standing crop, and densities of 13 inch and larger fish approached or exceeded maximum observed totals for the expanded river reach. Estimated densities of the oldest, largest

Figure RR-7. Mean non-irrigation season flows (April and October) compared with the minimum and optimum recommended base instream flows at the USGS Monida Gage on the Red Rock River; Water Years 1986 - 2008.

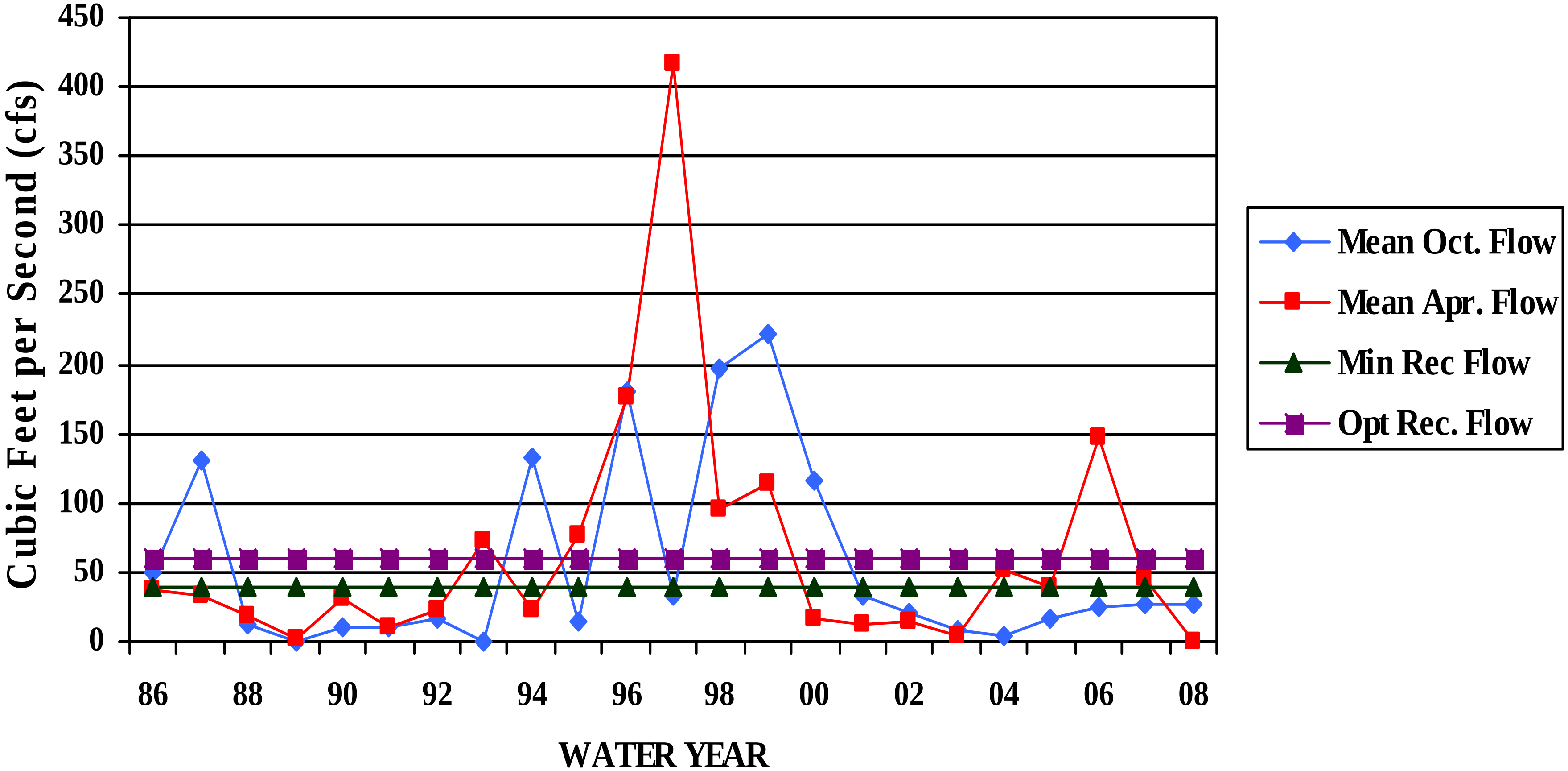


Figure RR-8. Mean August flow (cfs) compared with the minimum and optimum recommended base stream flow at the USGS Monida Gage on the Red Rock River; 1986 - 2008.

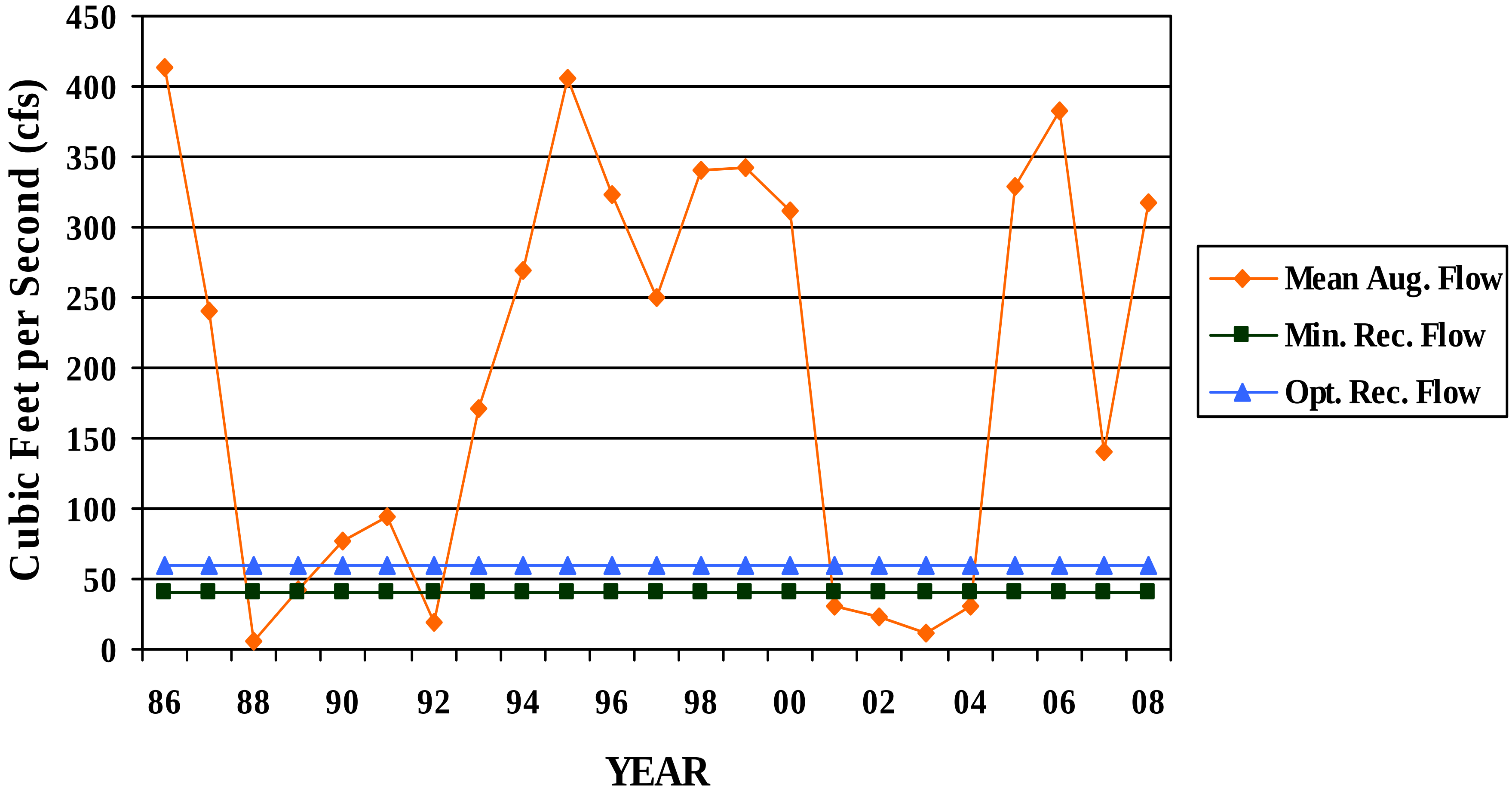


Figure RR-9. Estimated spring density and standing crop of Age II and older brown trout in the Martinell Section of the Red Rock River; 2005 - 2008.

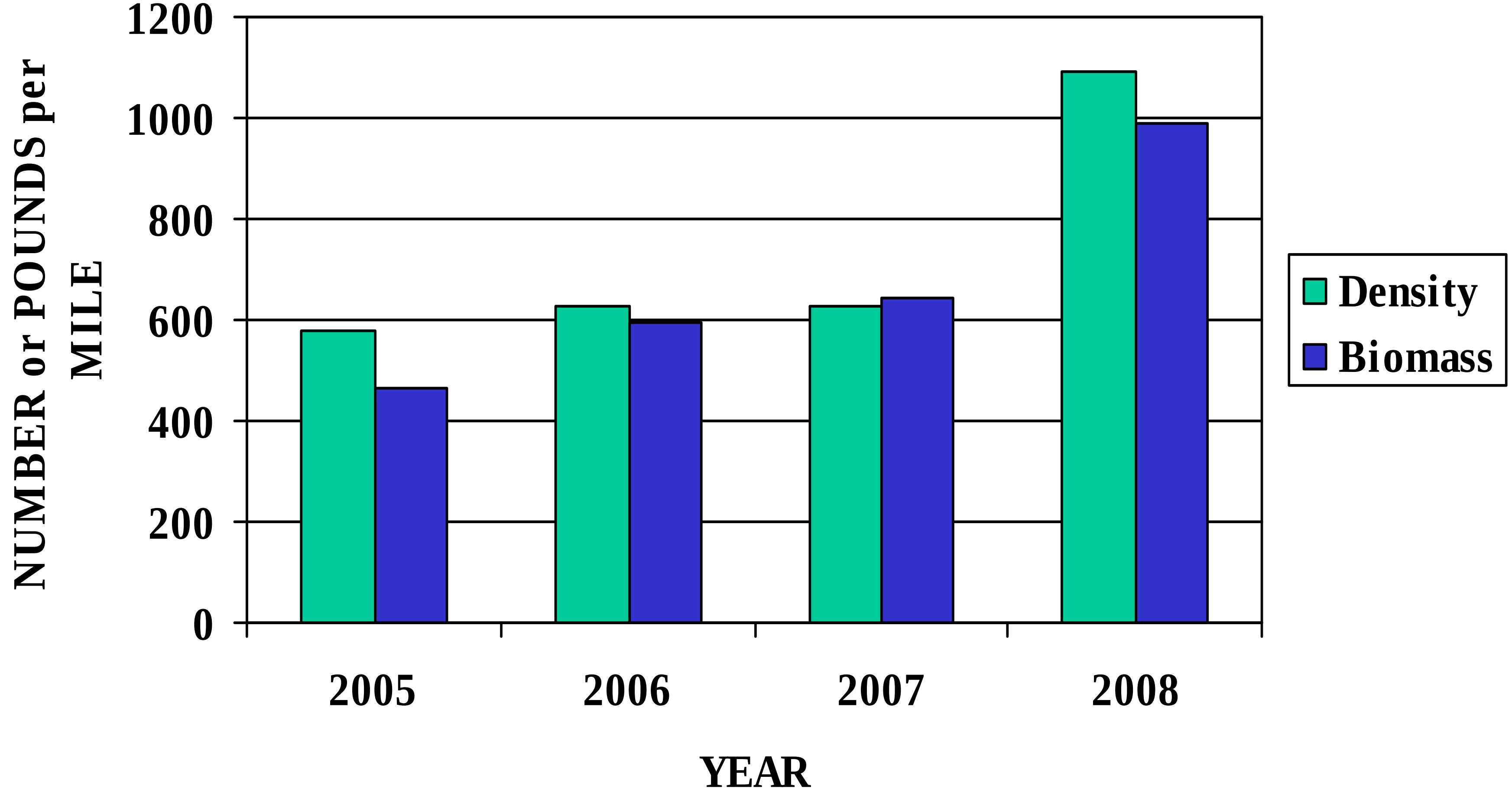


Figure RR-10. Estimated spring densities of Age I and Age II brown trout in the Martinell Section of the Red Rock River; 2005 - 2008.

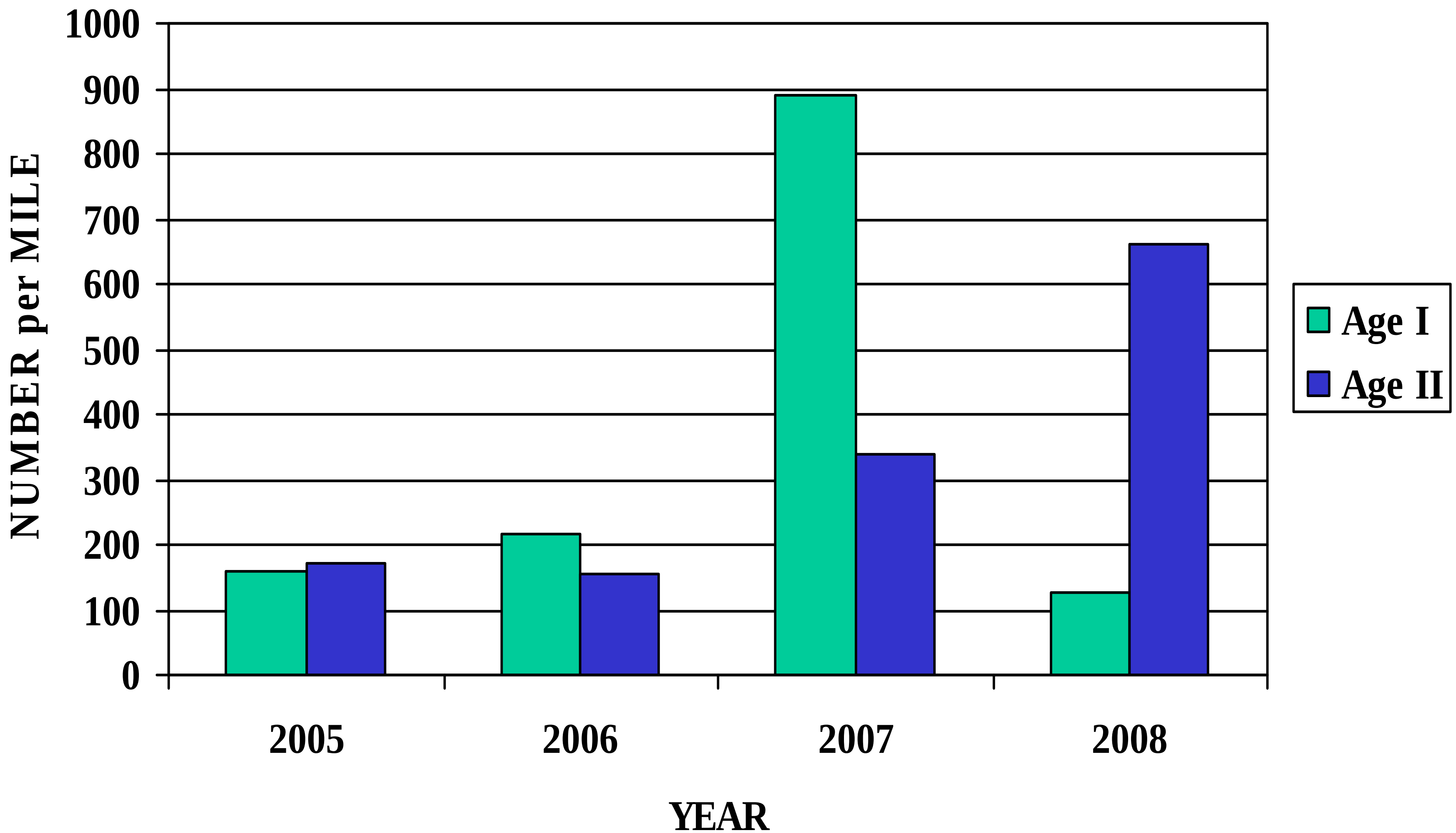


Figure RR-11. Estimated spring density of 13 inch and 16 inch and larger brown trout in the Martinell Section of the Red Rock River; 2005 - 2008.

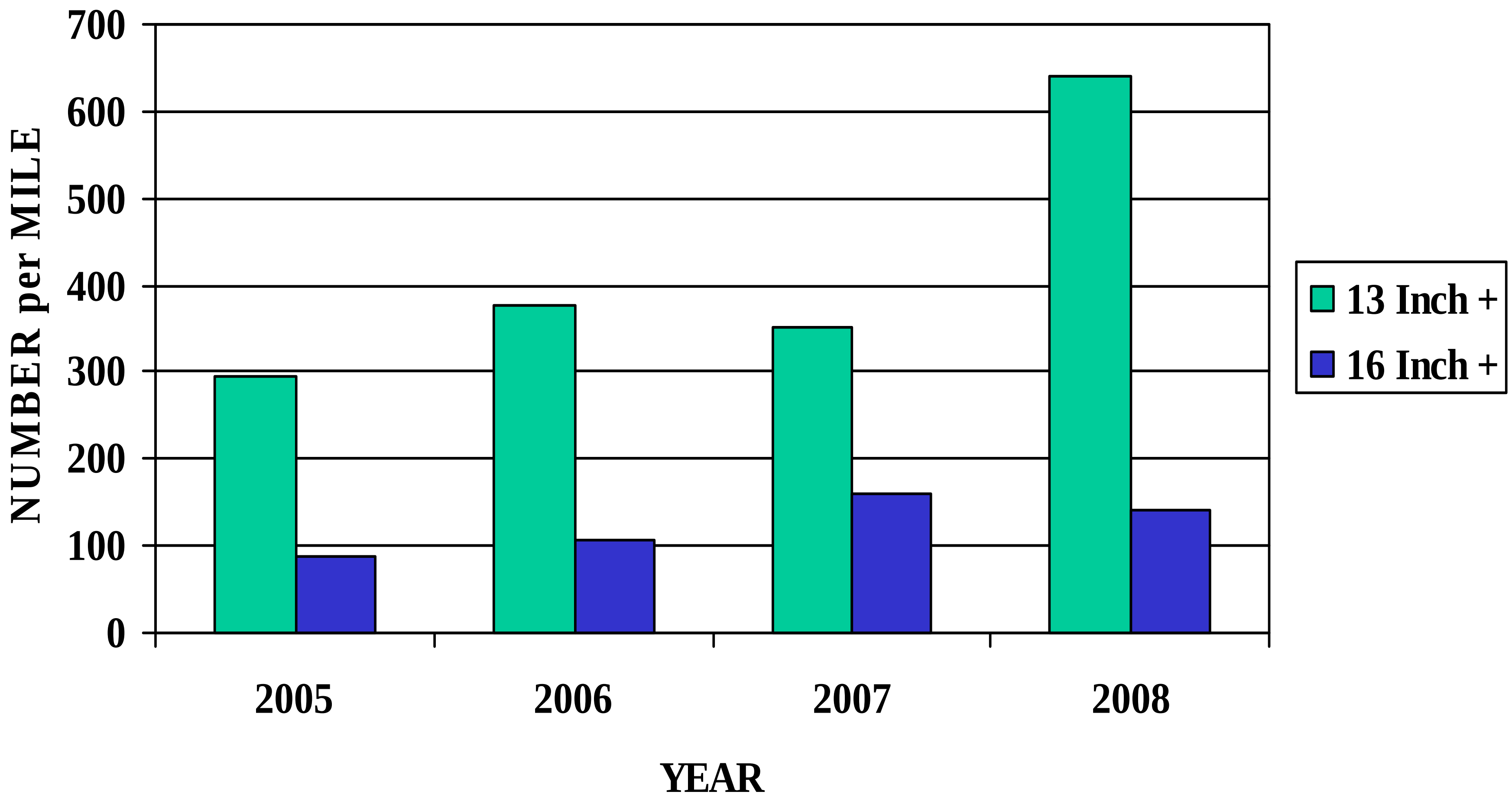


Figure RR-12. Estimated spring density of 18 inch and larger brown trout in the Martinell Section of the Red Rock River, 2005 -2008.

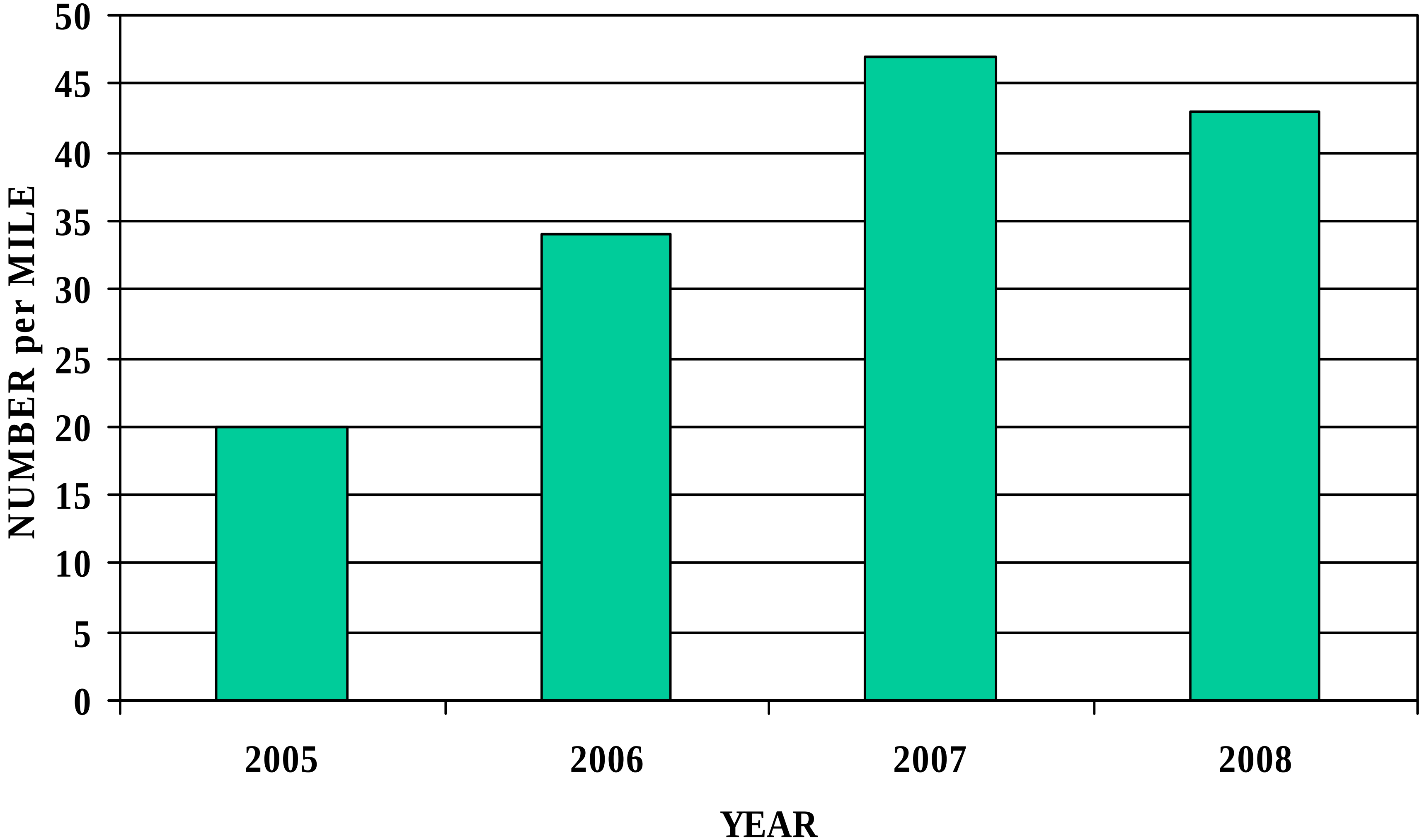


Figure RR-13. Mean spring Condition Factor (K) for brown trout and for 15.0 - 17.9 inch and 18.0 inch and larger brown trout in the Martinell Section of the Red Rock River; 2005 - 2008.

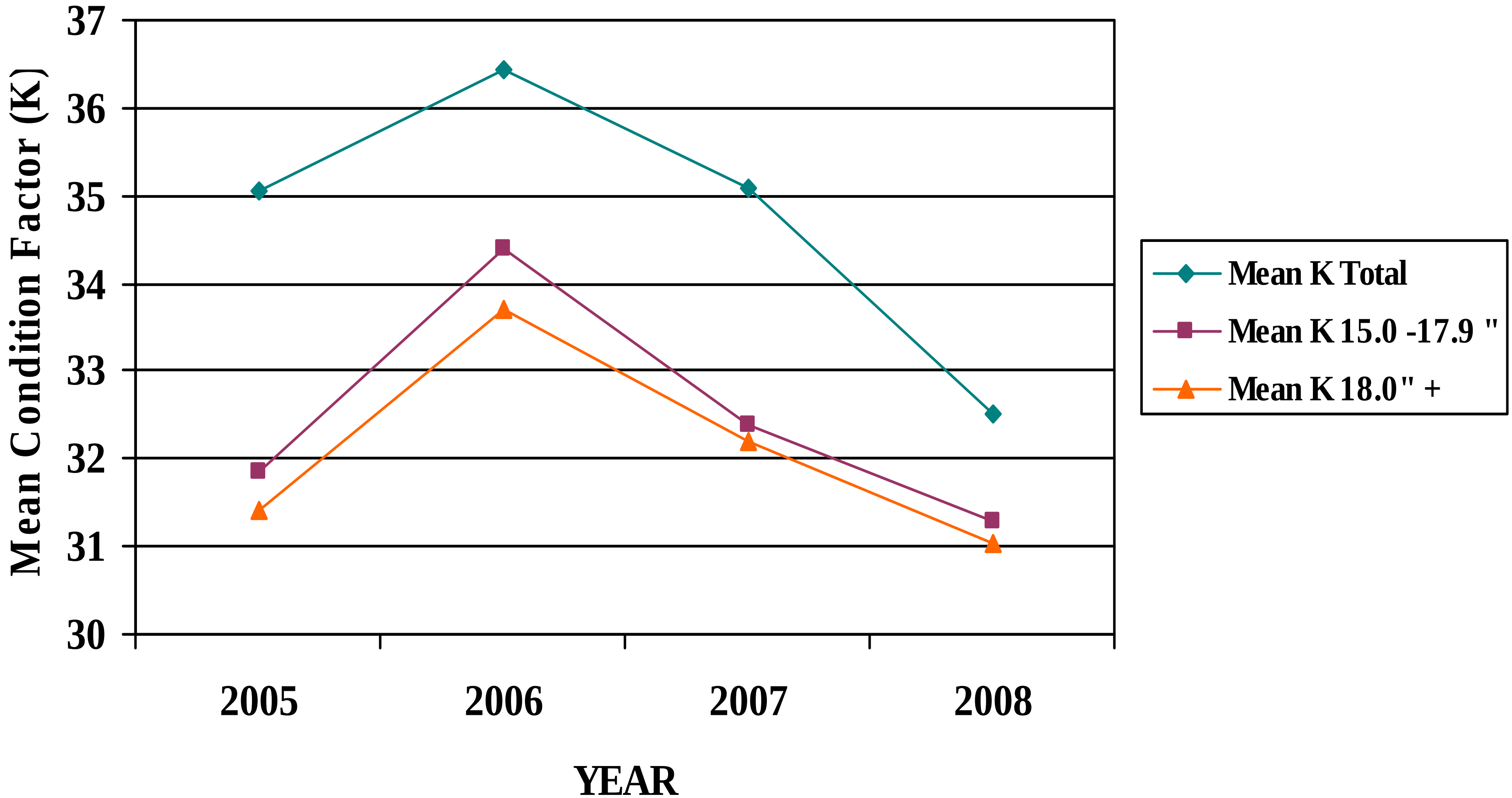


Figure RR-14. Comparative estimated population density and standing crop for brown trout from fall (Age I +) and spring (Age II +) samples in the Wellborn (Well), Dell, and Martinell (Mart) Sections of the Red Rock River; 1987 - 2008.

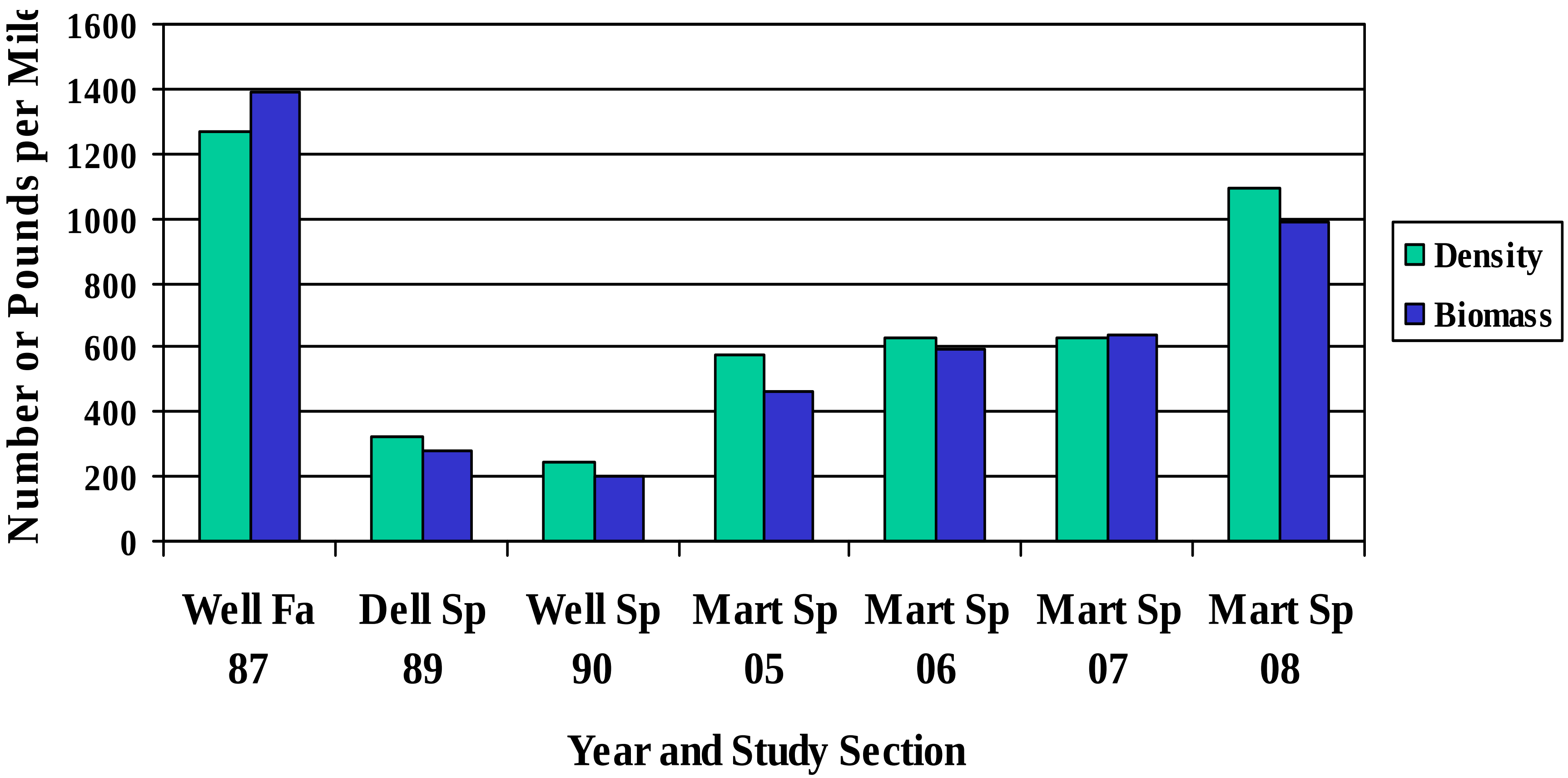


Figure RR-15. Comparative estimated spring or fall density of 13 inch and larger brown trout in the Wellborn (Well), Dell, and Martinell (Mart) Sections of the Red Rock River; 1987 - 2008.

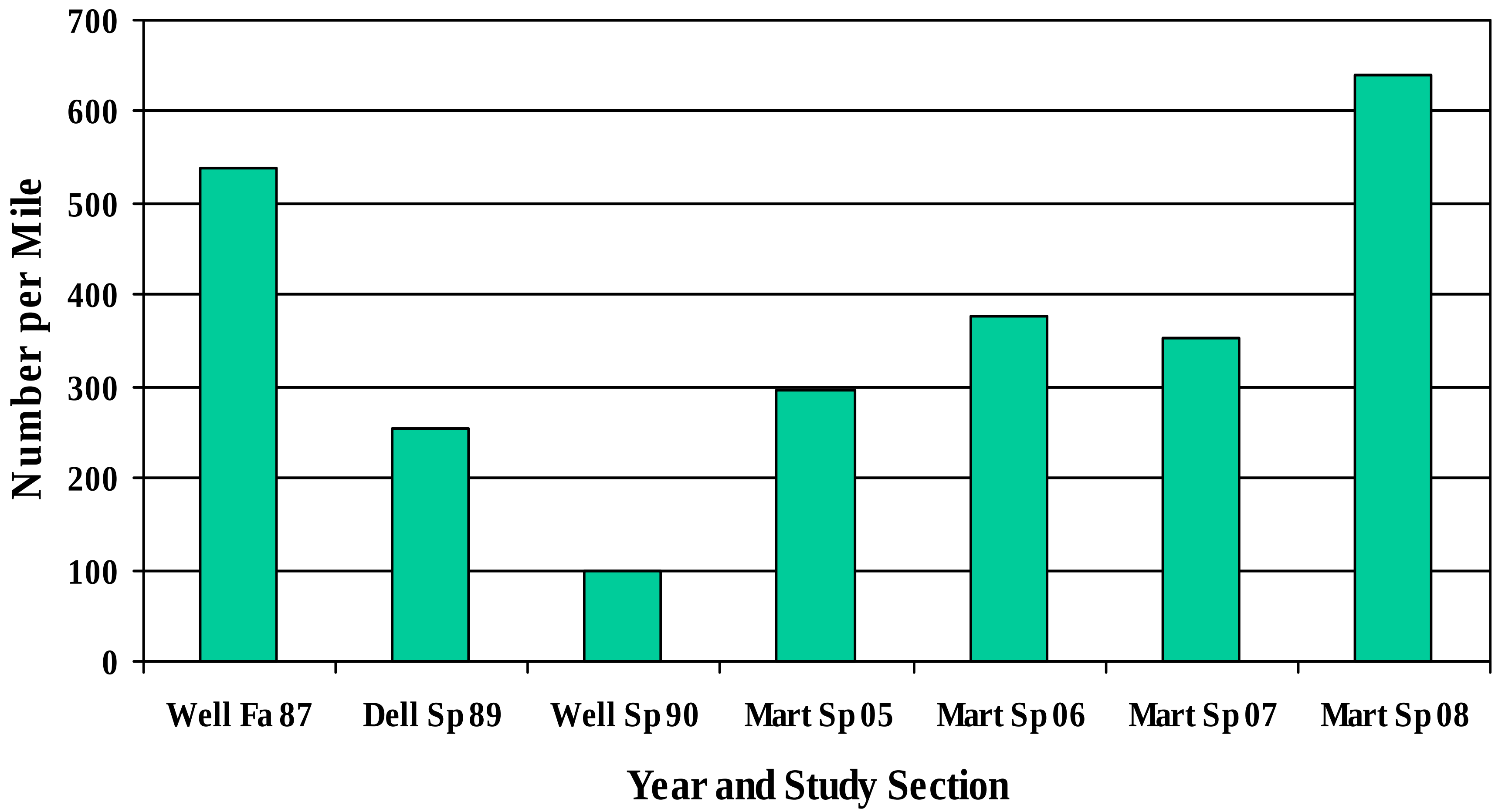
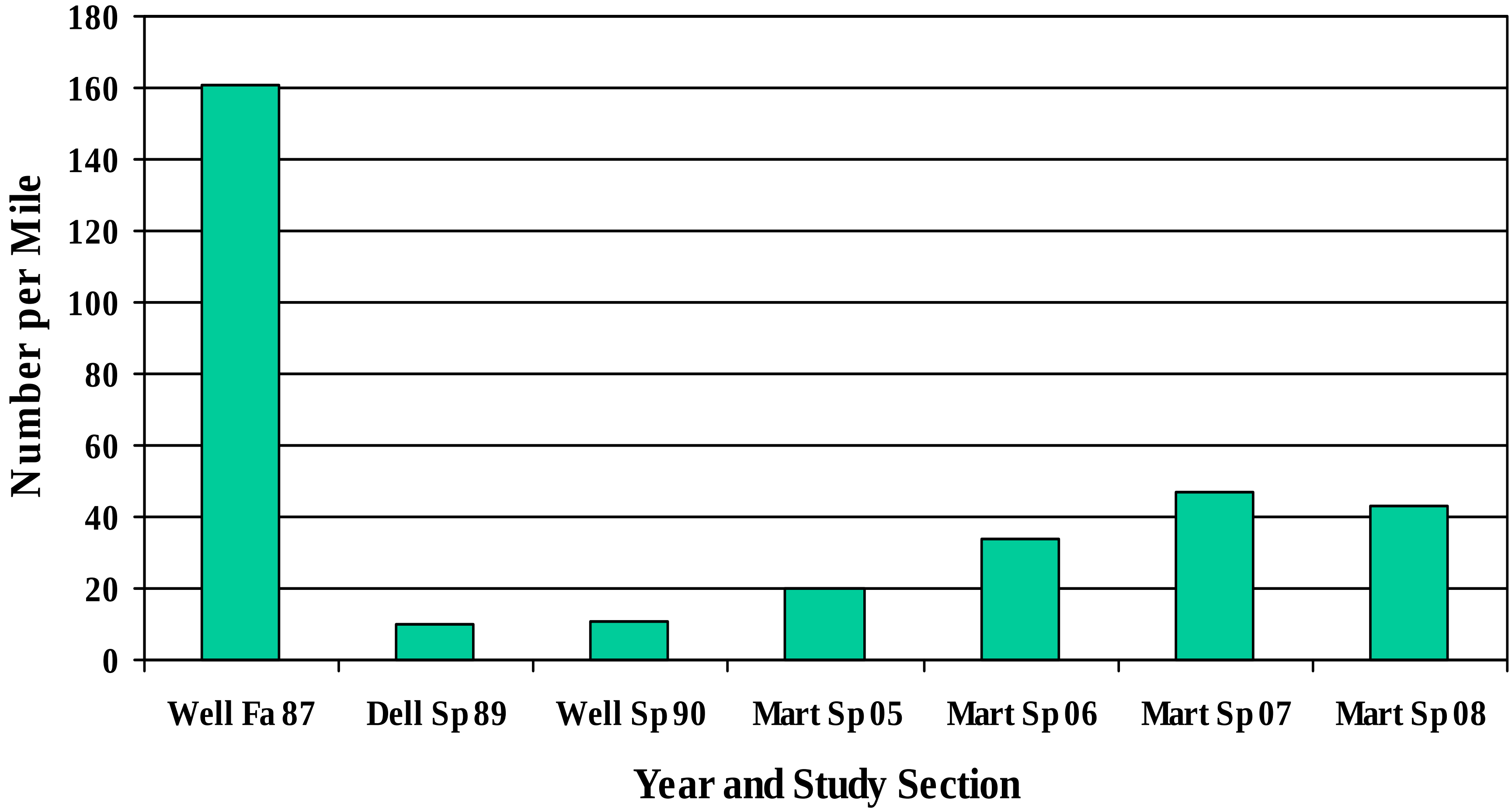


Figure RR-16. Comparative estimated fall or spring density of 18 inch and larger brown trout for the Wellborn (Well), Dell, and Martinell (Mart) Sections of the Red Rock River; 1987 - 2008.



fish in the population, however, lagged far below the observed maximum resulting from a sustained period of relatively ample flow regimes in the early to mid 1980's.

Ruby River

Updated flow and population graphics for the 2006 – 2008 period of study on the Ruby River are presented in Appendix C. Data contained in the figures were collected from the Three Forks and Greenhorn Study Sections of the upper river reach and from the Maloney and Silver Spring Study Sections, in the lower reach downstream from the reservoir. Fish population data, through the fall of 2005 and spring of 2006, were most recently summarized by Oswald (2006) and Oswald et al (2008).

Recent base summer flow regimes in the upper Ruby (Figure R-1) have shown some improvement over the 2000 – 2004 period that was marked by chronic sub-minimum August discharges. August flows were virtually at or above the recommended instream minimum of 102 cfs in 3 of the past 4 years, exhibiting a marked increase in 2008.

The improved flow regimes of 2008 were accompanied by a substantial increase in the density and standing crop of the westslope cutthroat – rainbow trout population in the Three Forks Section (Figure R-2). The rapid increase in population was largely due to major increases in the survival of Age I and Age II cohorts (Figure R-3) and was also accompanied by a large increase in condition factor (Figure R-4).

Recent trends in the reintroduction of fluvial Arctic grayling into the upper Ruby River are depicted in Figure R-5. While cessation of stocking programs clearly resulted in declines in grayling density and standing crop, Figures R-6 and R-7 clearly demonstrate evidence of consistent recruitment of juvenile grayling into the population from remote site incubators or wild spawning efforts. Future sampling will demonstrate if current levels of recruitment or current population densities are sufficient to repopulate the upper Ruby River with wild fluvial Arctic grayling.

The Greenhorn Study Section was not sampled in 2007 due to staff limitations but sampling was continued in the fall of 2008. Rainbow trout population density and standing crop (Figure R-8) exhibited small increases over recent prior years. These increases were the first observed for rainbow trout since 1998 and since whirling disease affects were manifest as substantial reductions in rainbow trout recruitment in the upper Ruby (Oswald 2006). Size distribution within the rainbow trout population (Figure R-9) was suggestive of slightly improved recruitment and survival of Age II and III fish, possible resulting from the slightly improved flow regimes of the 2005 – 2008 period. Brown trout populations (Figure R-10) remained at relatively high density accompanied by a relatively moderate standing crop in the 2008 sample. The population abundance observed in 2008 appeared to be a direct result of extremely high recruitment of Age I fish in 2006 (Figure R-11), and possibly in 2007, and was manifest as high densities of 11.0 – 15.9 inch, Age II and Age III fish. Continued favorable flow regimes should result in improving densities of Age IV and older, 16 inch and larger fish in the 2009 sample.

Figure R-1. Mean August Flow (cfs) compared with the Minimum Recommended Flow (WETP Method) for the Upper Ruby River Measured at the USGS Gage Site 1986 - 2008.

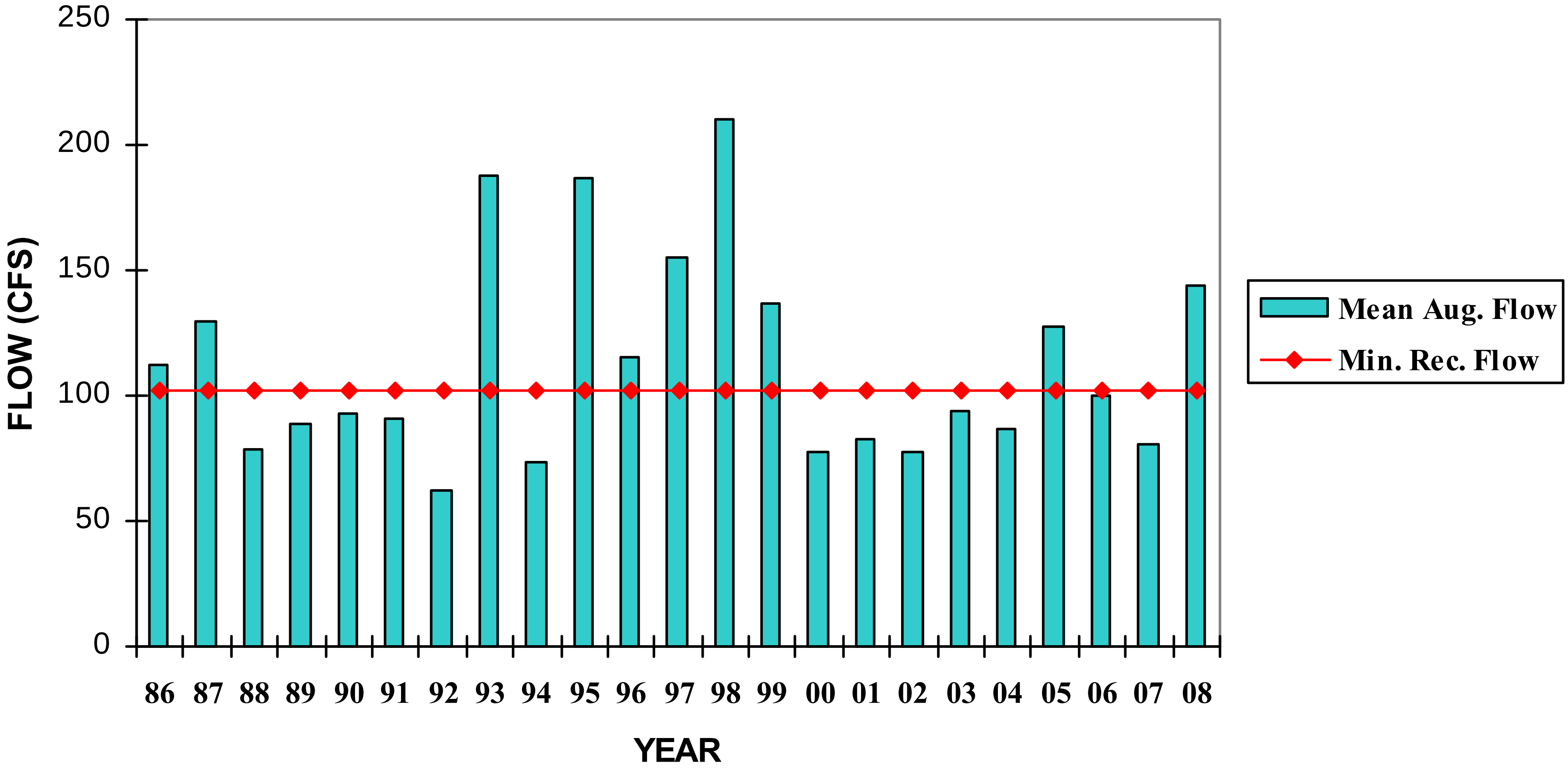


Figure R-2. Estimated fall density and standing crop of Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2008.

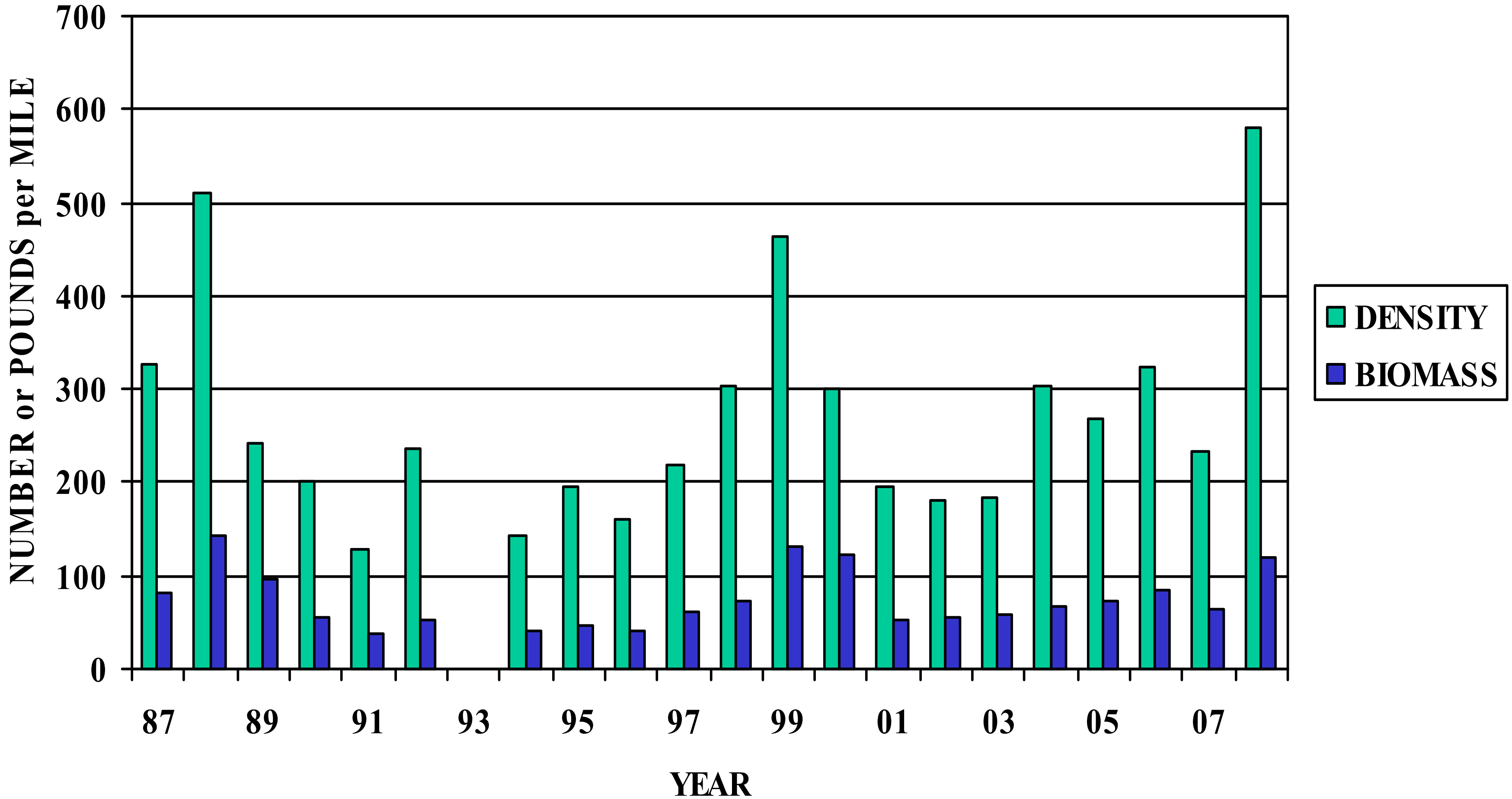


Figure R-3. Estimated fall densities, by length group, of Age I and older rainbow x westslope cutthroat hybrid trout in the Three Forks Study Section of the Ruby River, 1987 - 2008.

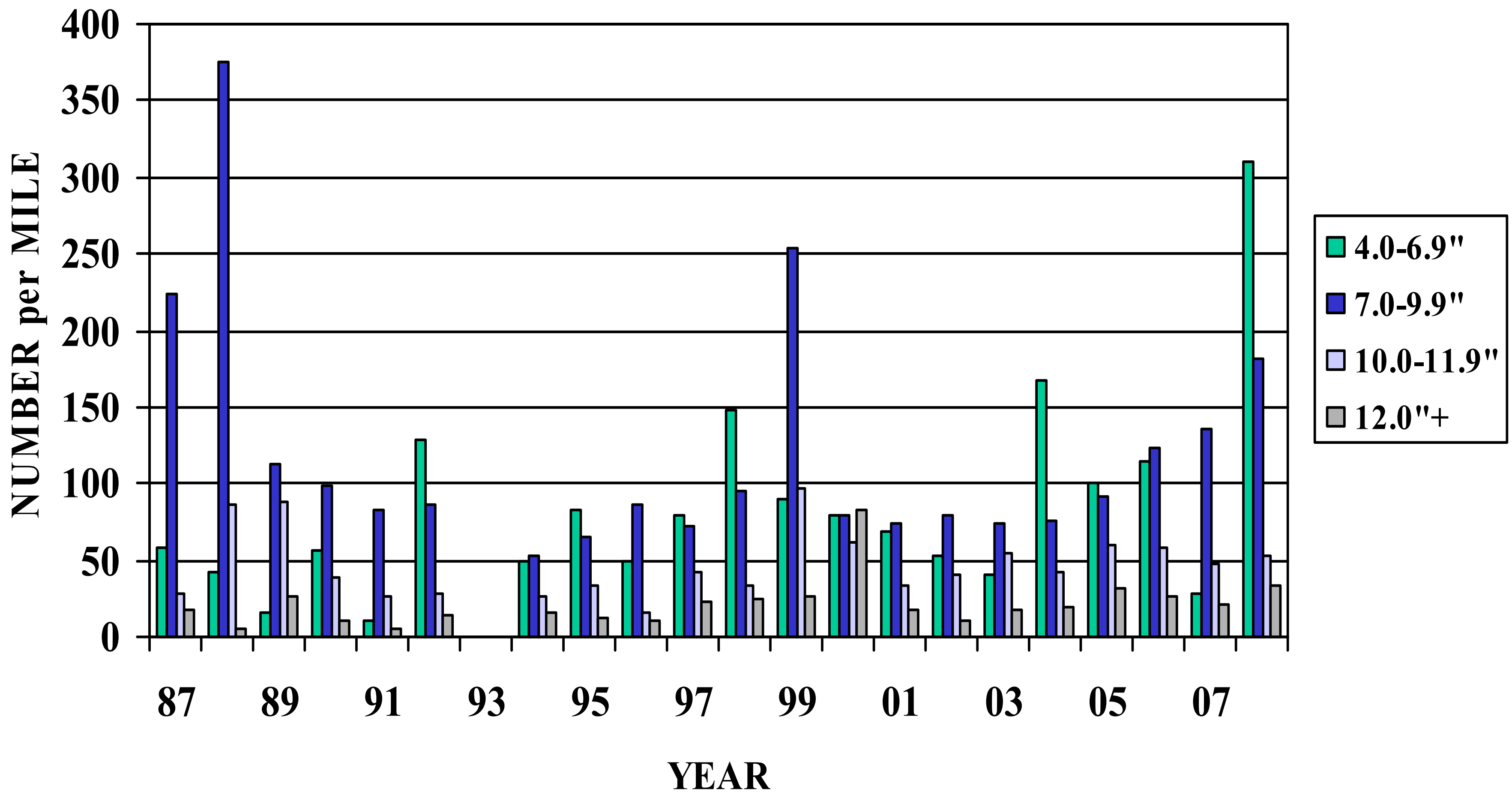


Figure R-4. Mean fall Condition Factor (K) for Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2008.

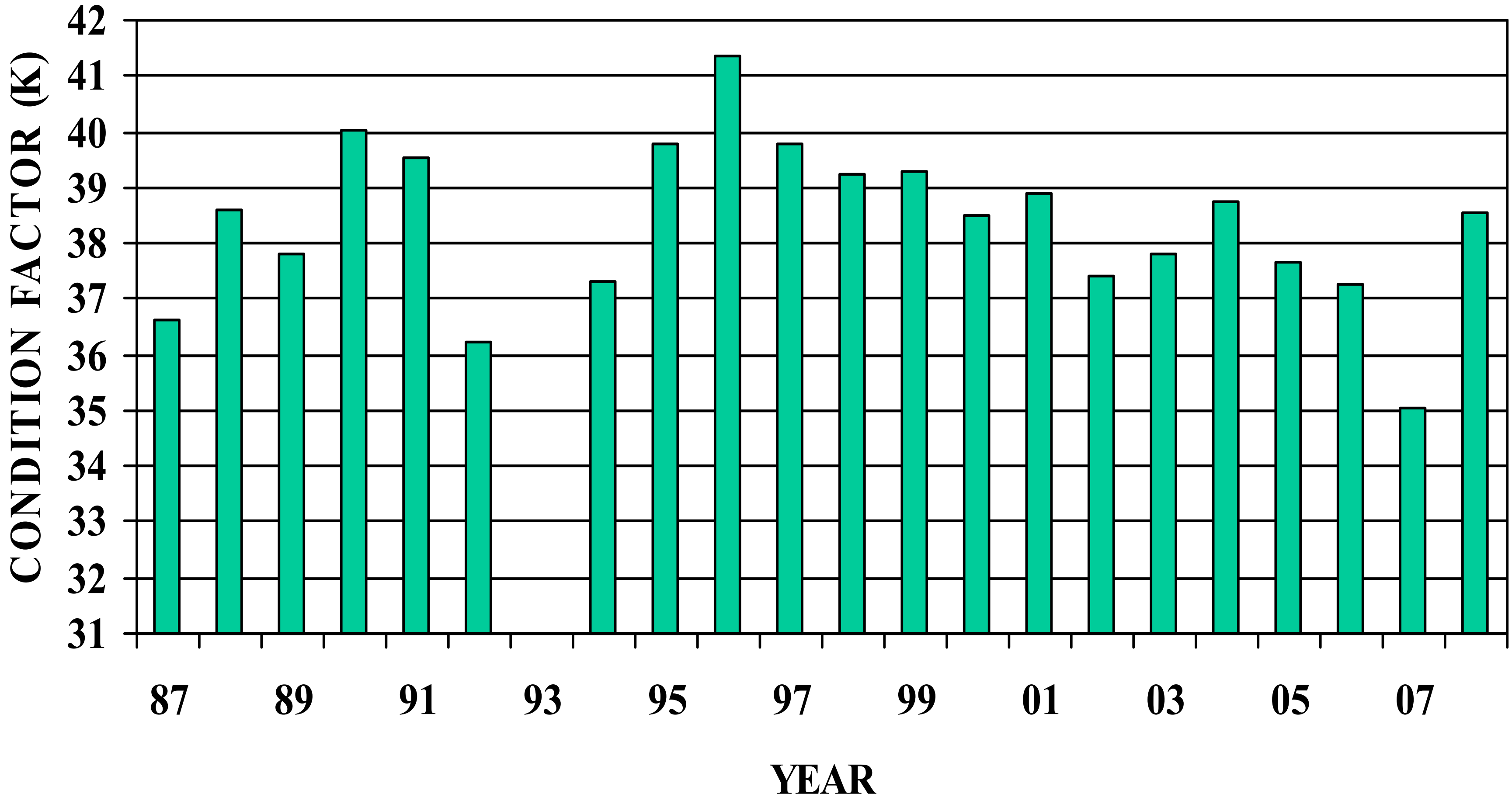


Figure R-5. Estimated fall density and standing crop for Age I and older Arctic grayling in the Three Forks Section of the Ruby River 1998 - 2007.

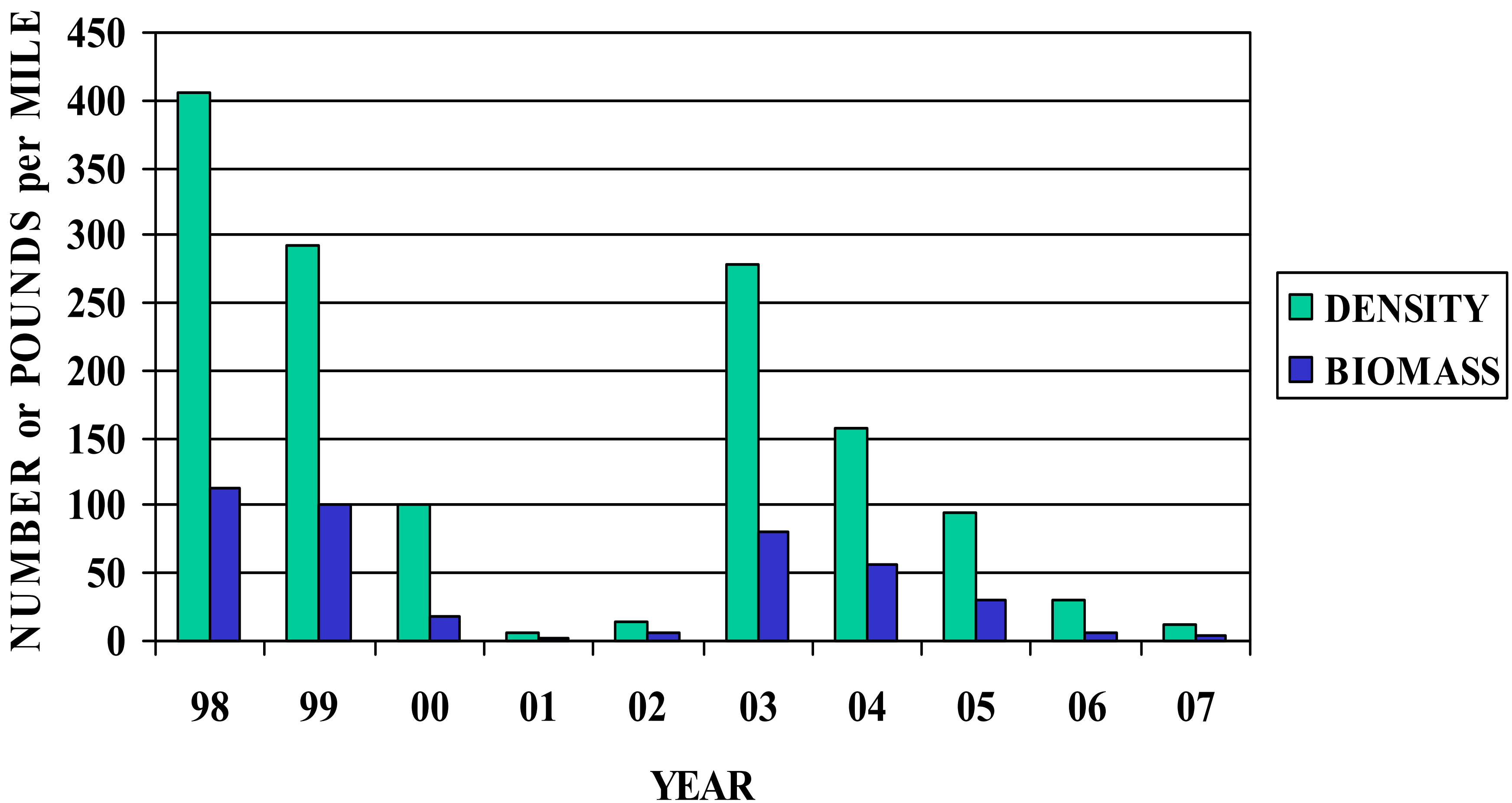


Figure R-6. Length frequency distribution of Arctic grayling captured via electrofishing in the Three Forks Section of the Ruby River; Fall 2000 (N = 91), 2001 (N = 8), 2002 (N = 18), 2004 (N=168), and 2005 (N=108).

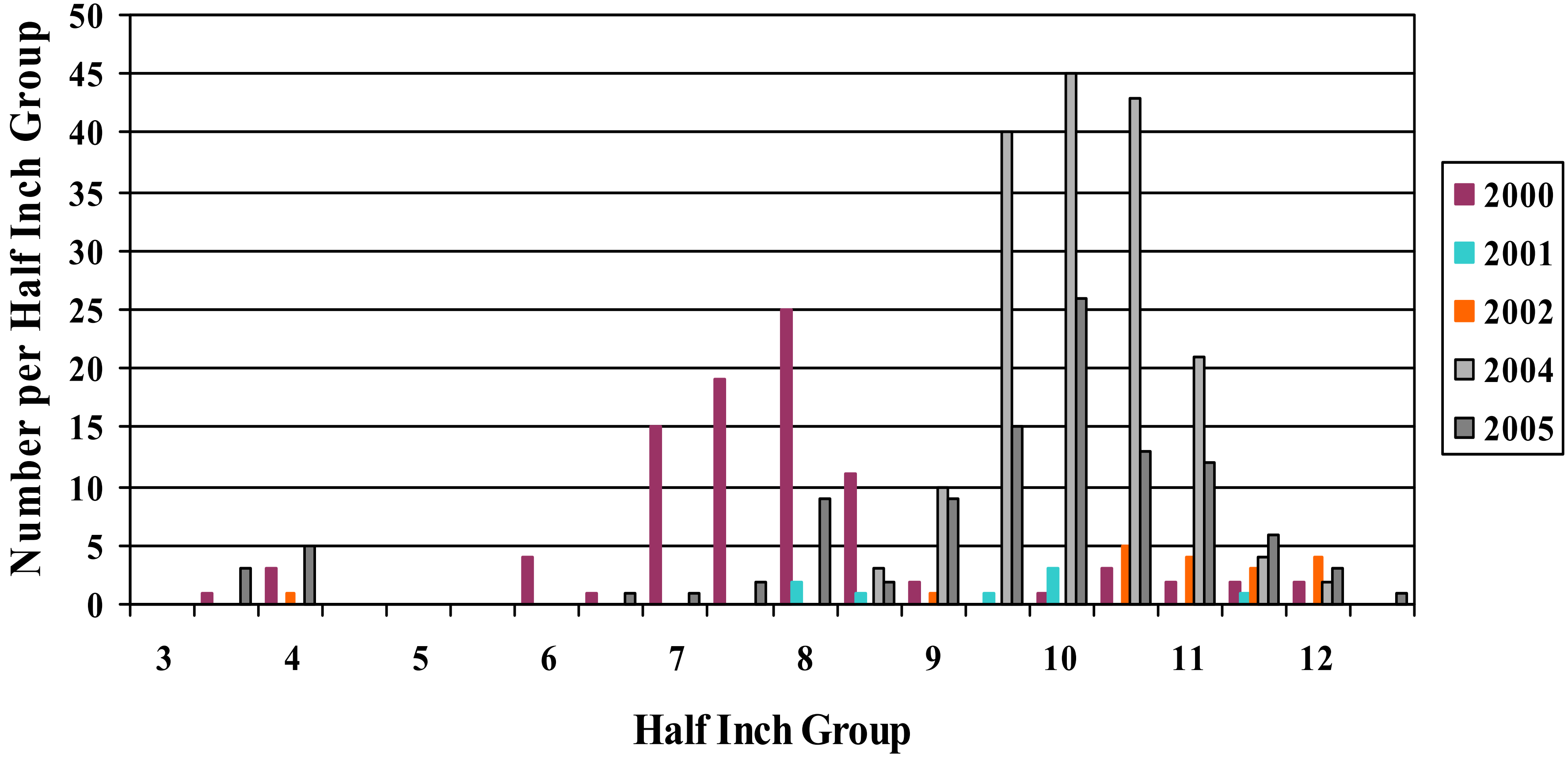


Figure R-7. Length Frequency Distribution of Arctic grayling captured via electrofishing in the Three Forks Section of the upper Ruby River; Fall 2006 (N=31), 2007 (N=17) and 2008 (N=21).

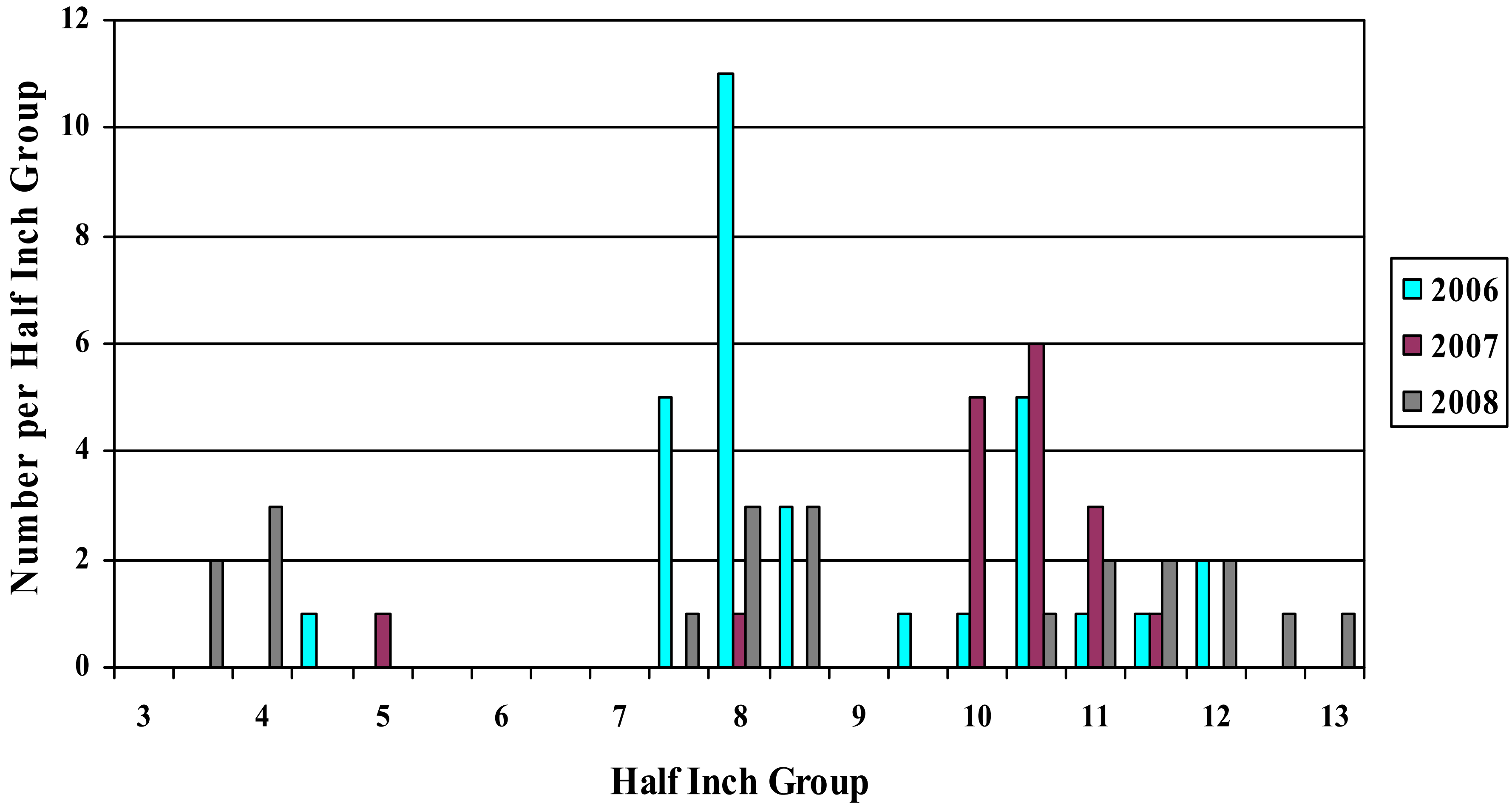


Figure R-8. Estimated fall density and standing crop of Age I and older rainbow trout in the Greenhorn Section of the Ruby River, 1990 - 2008 (*2004 estimate generated based on only 2 recaptures).

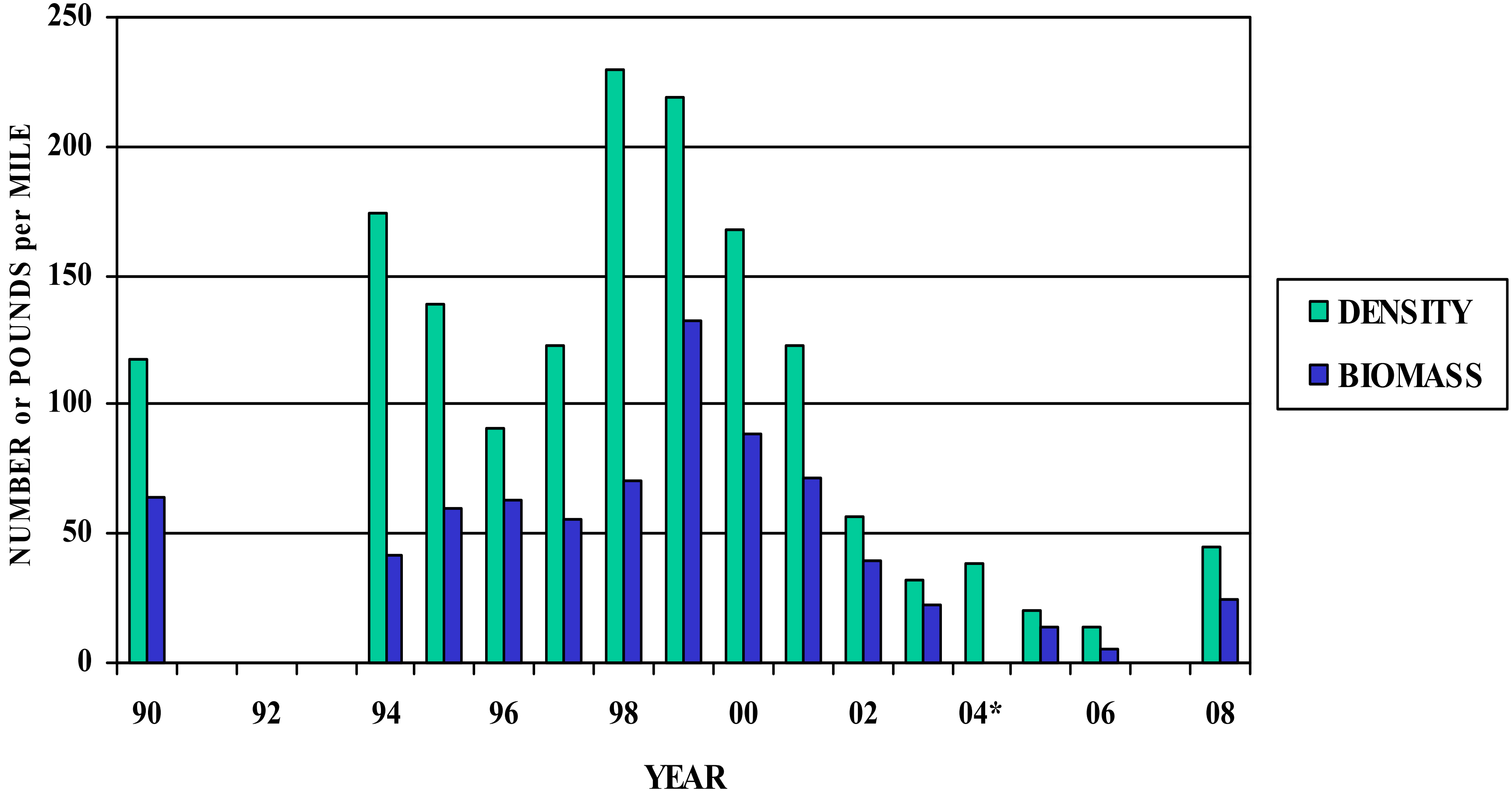


Figure R-9. Estimated fall densities, by length group, of Age I and older rainbow trout in the Greenhorn Section of the Ruby River 1990 -2008 (2004 estimate based on only 2 Recaptures).

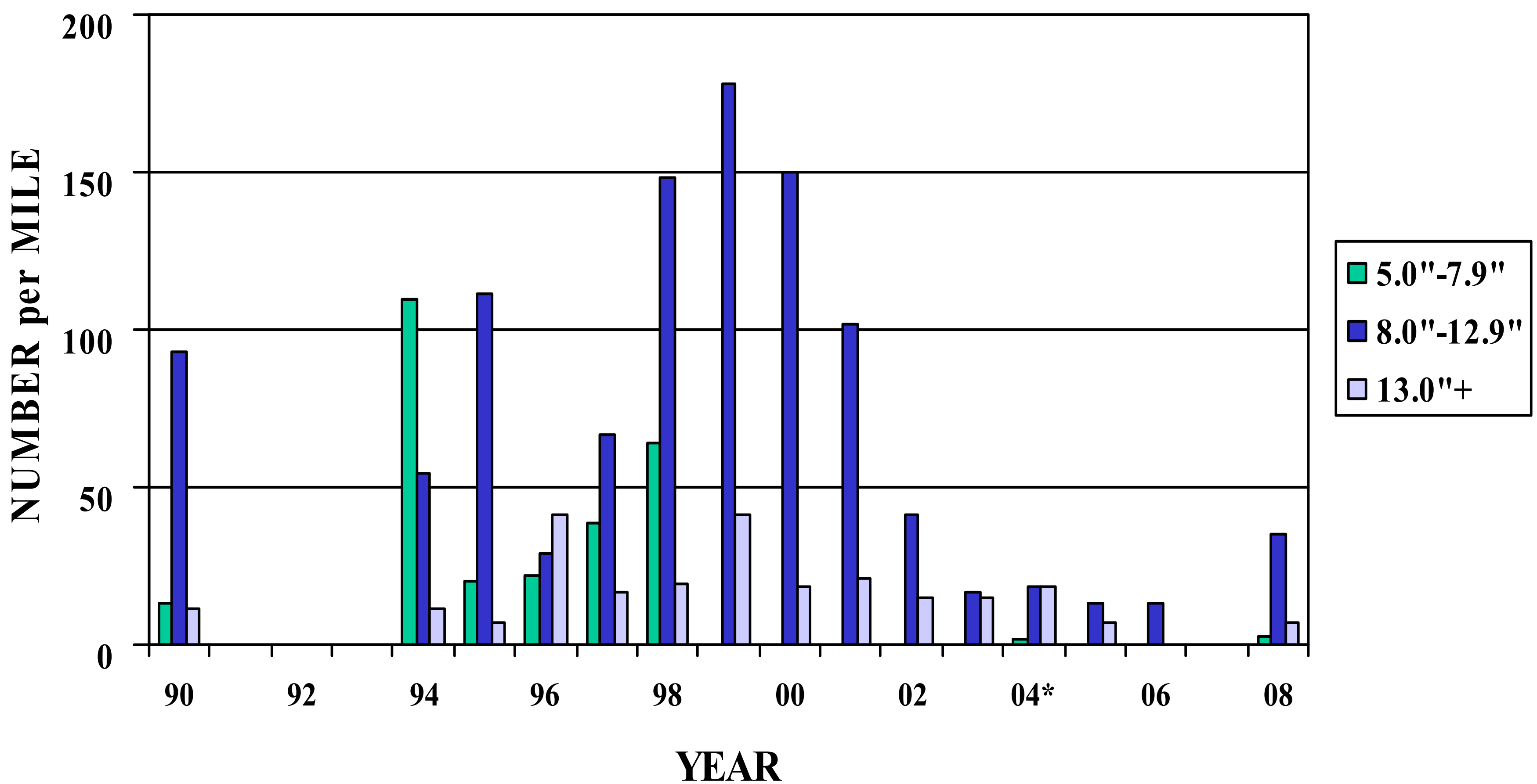


Figure R-10. Estimated fall density and standing crop of Age I and older brown trout in the Greenhorn Section of the Ruby River, 1990 - 2008.

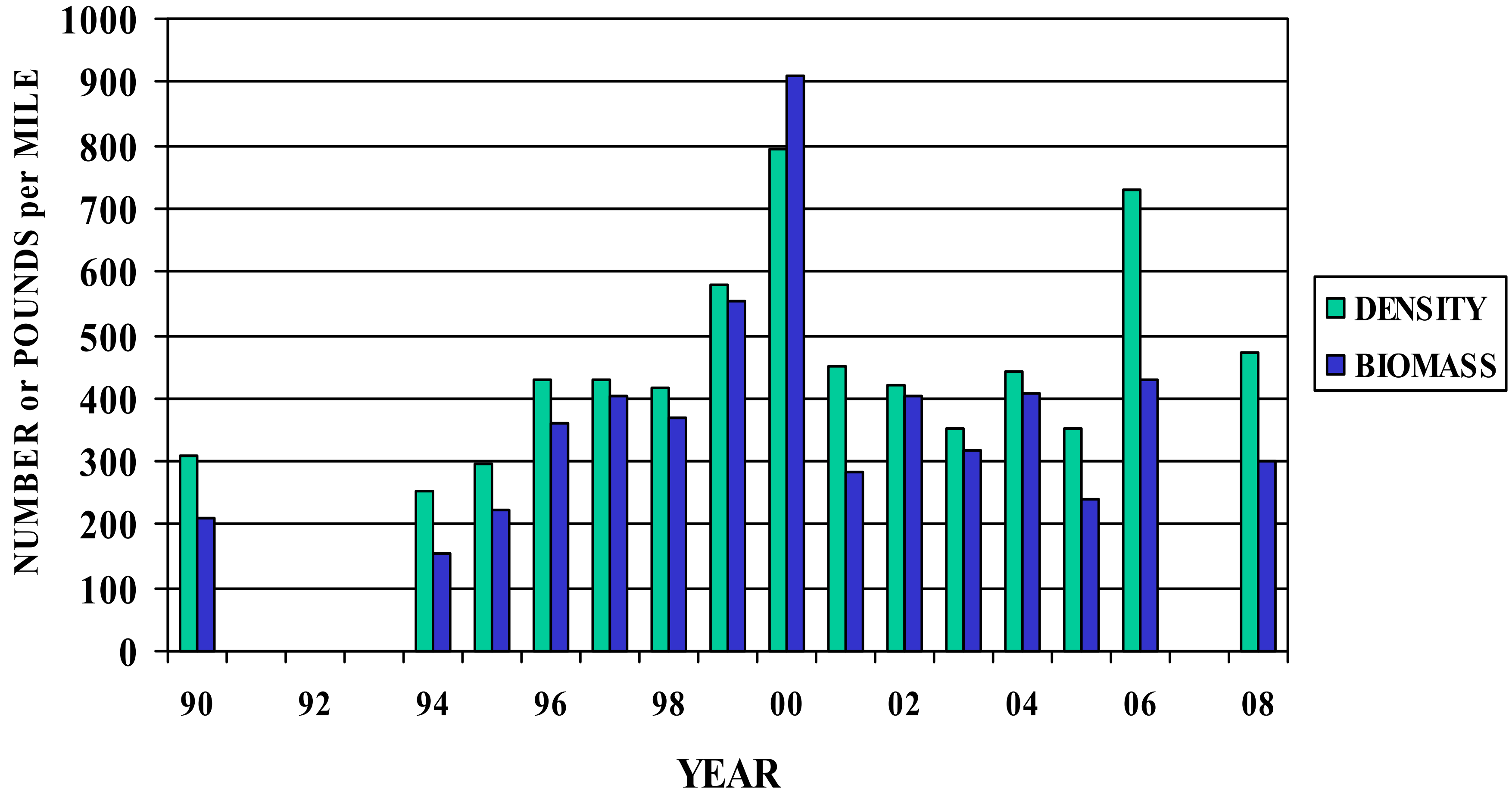
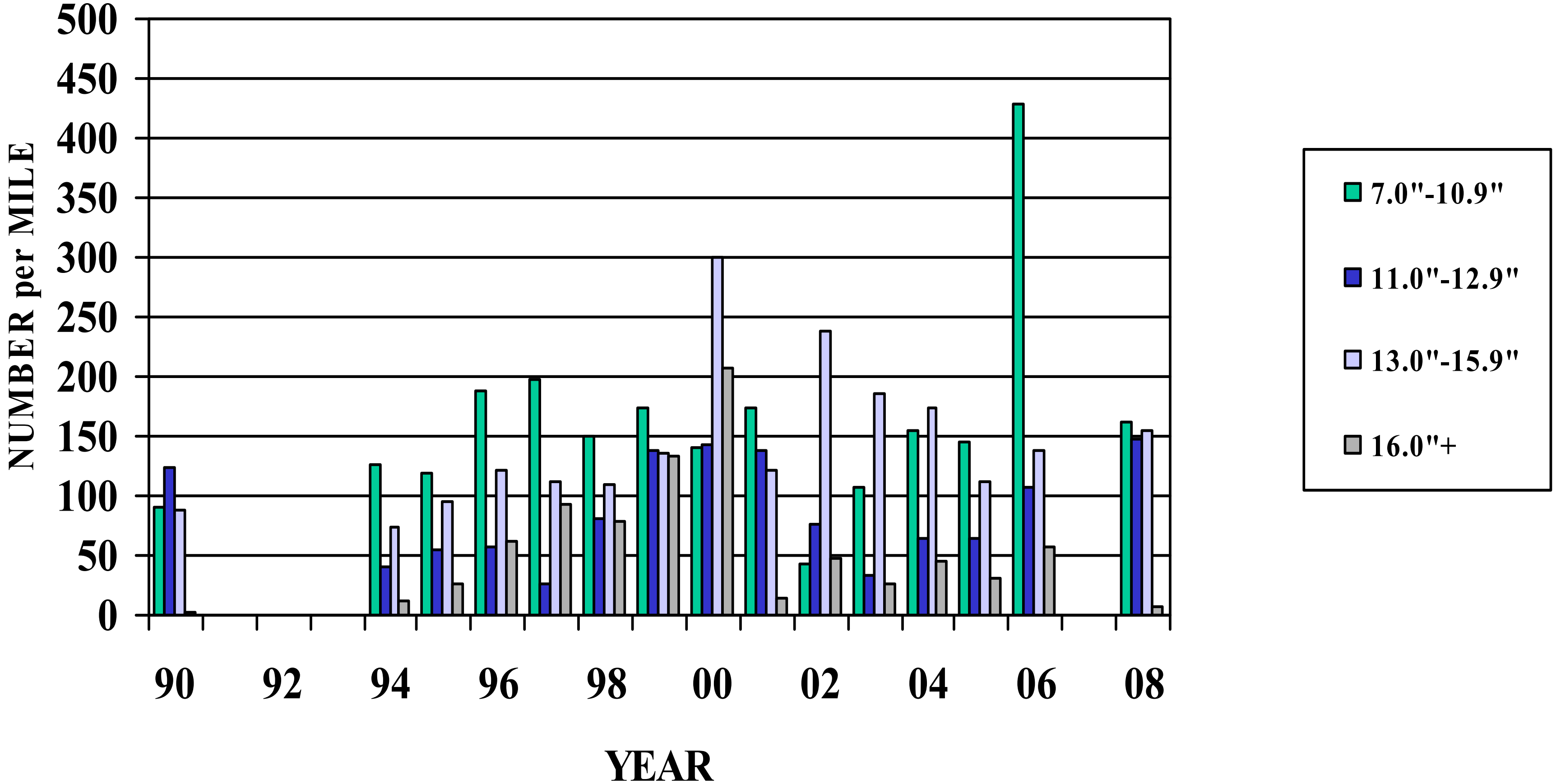


Figure R-11. Estimated fall densities, by length group, of Age I and older brown trout in the Greenhorn Section of the Ruby River, 1990 - 2008.



Over-winter flow release regimes into the tailwater fishery of the lower Ruby River from Ruby Reservoir (Figure R-12) improved markedly in 2006 and 2007 but declined substantially again in 2008. The improved flow regimes of 2006 and 2007 were accompanied by increasing trends in brown trout population density and, most markedly, in brown trout standing crop (Figure R-13) in the Maloney Study Section. These population surges were a direct result of substantial increases in the recruitment of consecutive cohorts of Age II fish (Figure R-14) into the population. While recruitment of Age II fish remained strong on an annual basis over the 2005 – 2008 period of study, densities of 13 inch and larger brown trout (Figure R-15) and densities of 18 inch and larger brown trout (Figure R-16) suffered substantial declines, in association with sub-minimum over-winter flow regime, in the 2008 sample. Recruitment of the 2005 through 2007 Age II cohorts should have been manifest as strong and improving numbers of 13 inch and larger (Age III+) fish in the 2008 sample. Similarly, successful recruitment of the Age II cohort of 2005 should have been manifest as improving, rather than declining densities of 18 inch and larger (Age V+) fish in the 2008 sample under ample flows and productive habitat conditions similar to the 1996 – 2000 and 2006- 2007 Water Years. Statistical examination of the relationship between the estimated density of 18 inch and larger brown trout as a function of over-winter flow regime yielded a highly significant ($P<.01$) correlation ($r = 0.84$) for the 1997 – 2005 period of flow analysis. This correlation between flow and the abundance of the older, larger component of the brown trout population is expressed as a logarithmic regression (Figure R-17) that can be used to predict one of the potential responses of the brown trout population of the Ruby River tailwater to over-winter flow management. The relationship depicted in Figure R-17 also exhibited a relatively robust R^2 value suggesting that 71% of the variation in the density of 18 inch and larger brown trout in the Ruby River tailwater could be attributed to the variation in over-winter flow regime. Oswald (2009) presented highly significant ($P<.01$) correlations between the densities of 18 inch and larger and 20 inch and larger brown trout and over-winter flow regimes, as well as the affects of cumulative years of sub-minimum over-winter flow regimes in the Beaverhead River tailwater fishery.

The immediate affect of declining over-winter flows on burgeoning brown trout populations in the Maloney Section was also evident in length frequency distribution analysis of the samples. The length frequency distribution of the 2006 sample (Figure R-18), under an ample flow regime, depicts a strong cohort of Age II fish entering the population, a relatively strong cohort of Age III fish at the 14.0 inch mode and an extremely strong cohort of Age IV fish at the 16.0 inch mode. The subsequent samples of 2007 and 2008 at declining and sub-minimum overwinter flows (Figure R-19) depict continued strong recruitment of an Age II cohort in 2007 but at a markedly reduced length mode, a stagnation of the Age IV and older component, and no visible length advancement of the Age V and older component. This was immediately followed by a marked attenuation in length for the Age III modes, erosion in the length distribution of the Age IV modal distribution, and a loss, rather than the anticipated gain, in the18 inch and larger component of the Age V and older groups. The loss in potential growth and ultimate size in the population was further demonstrated by continuous declines in brown trout condition factor (Figure R-20) over the 2006 – 2008 period. The combination of burgeoning recruitment of Age II fish in the absence of average densities of fully mature 18 inch and larger fish and declining over-winter flow regimes ultimately resulted in a form of stunted growth, condition, and ultimate size potential in the Maloney Section brown trout population in 2008.

Figure R-12. Mean nonirrigation season (November - March) flow (cfs) in the lower Ruby River below Ruby Reservoir Dam measured at the USGS Gage compared with the Minimum Recommended Flow (WETP Method); Water Years 1995 - 2008.

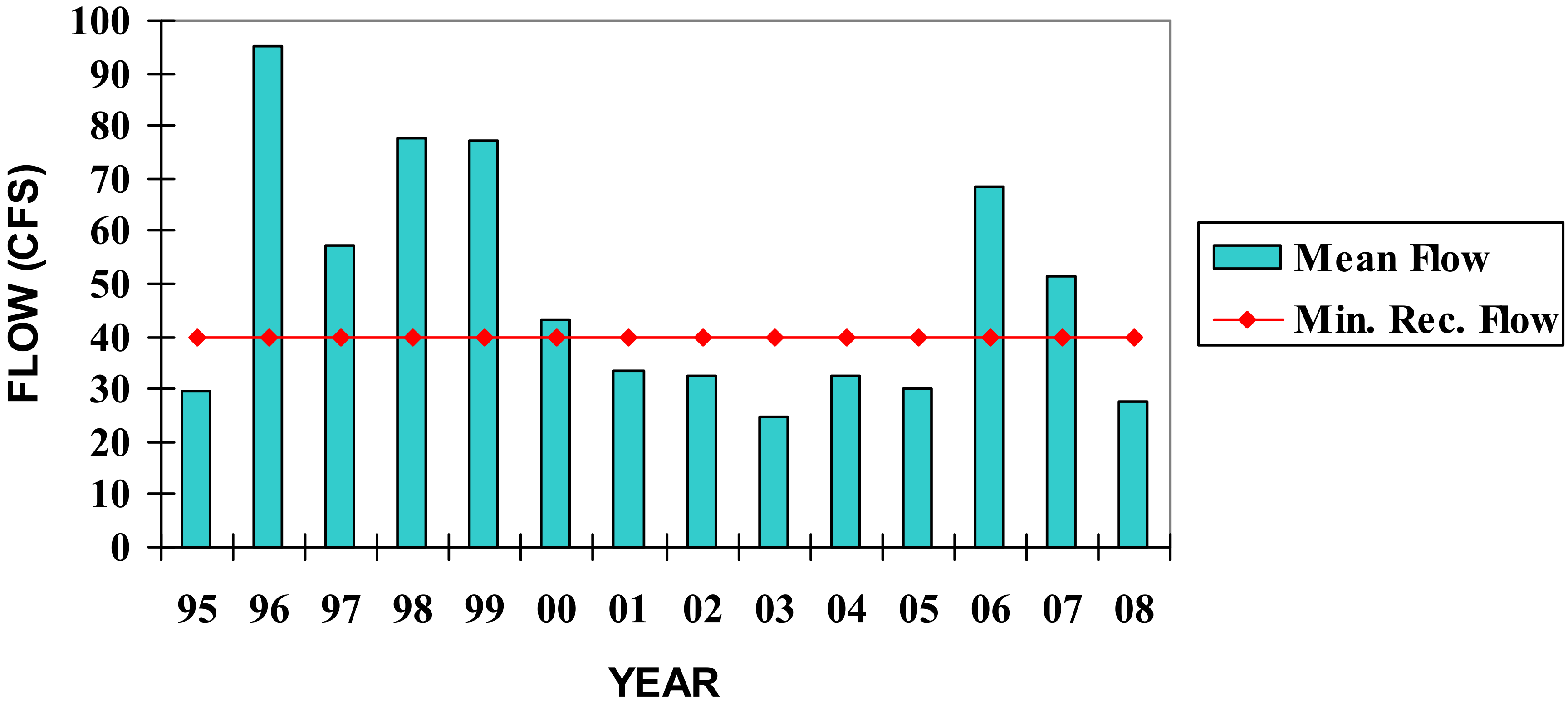


Figure R-13. Estimated density and standing crop of fall Age I and older brown trout in the Passamari (P) Section (1994 - 1997) and spring Age II and older brown trout in the Maloney (M) Section (1998 - 2008) of the Ruby River.

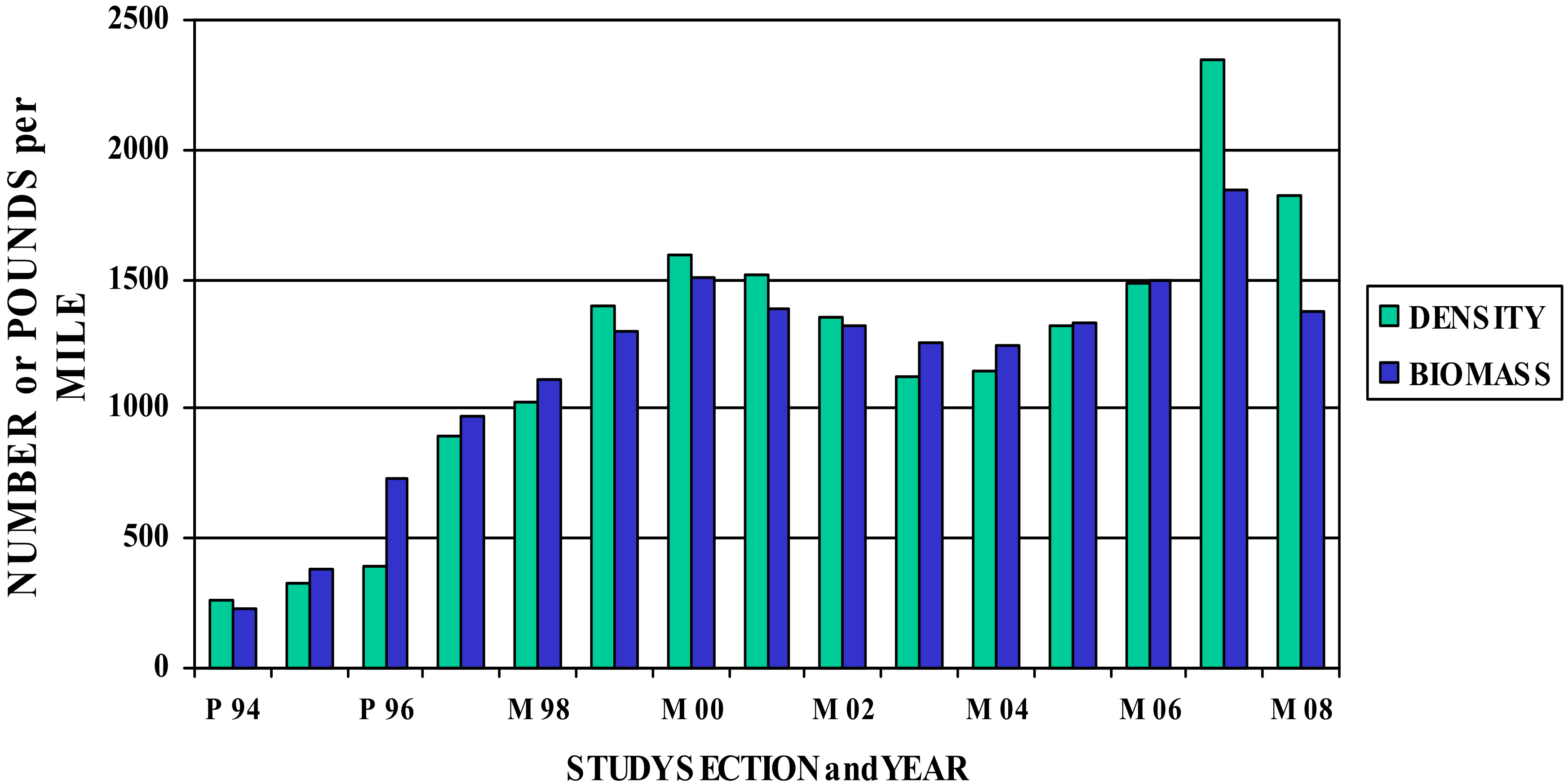


Figure R-14. Estimated densities of juvenile brown trout from fall samples of Age I fish in the Passamari (PASS) Section and spring samples of Age II fish in the Maloney (MAL) Section of the Ruby River, 1994 - 2008.

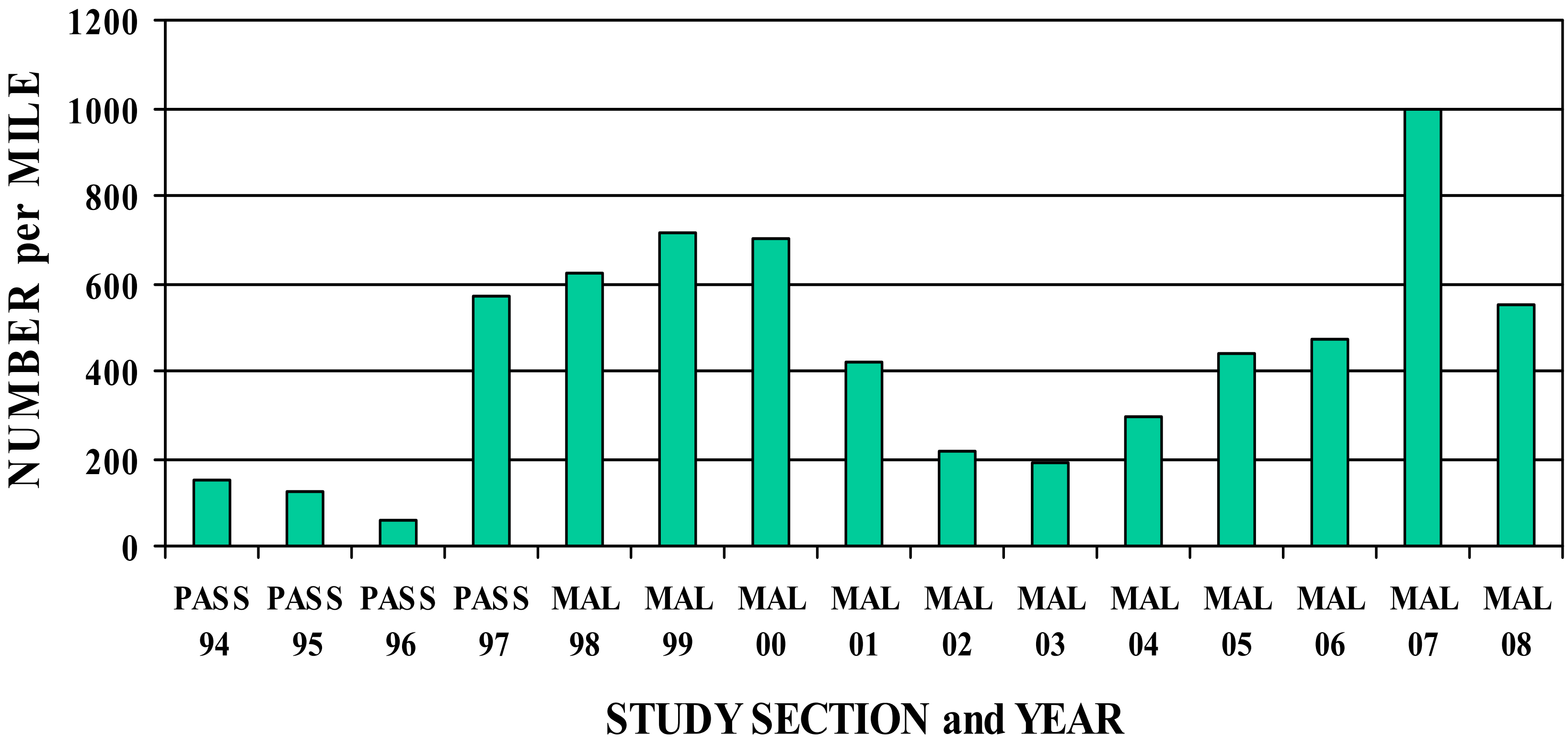


Figure R-15. Estimated densities of 13 inch and larger brown trout from fall samples in the Passamari (PASS) Section and spring samples in the Maloney (MAL) Section of the Ruby River, 1994 - 2008.

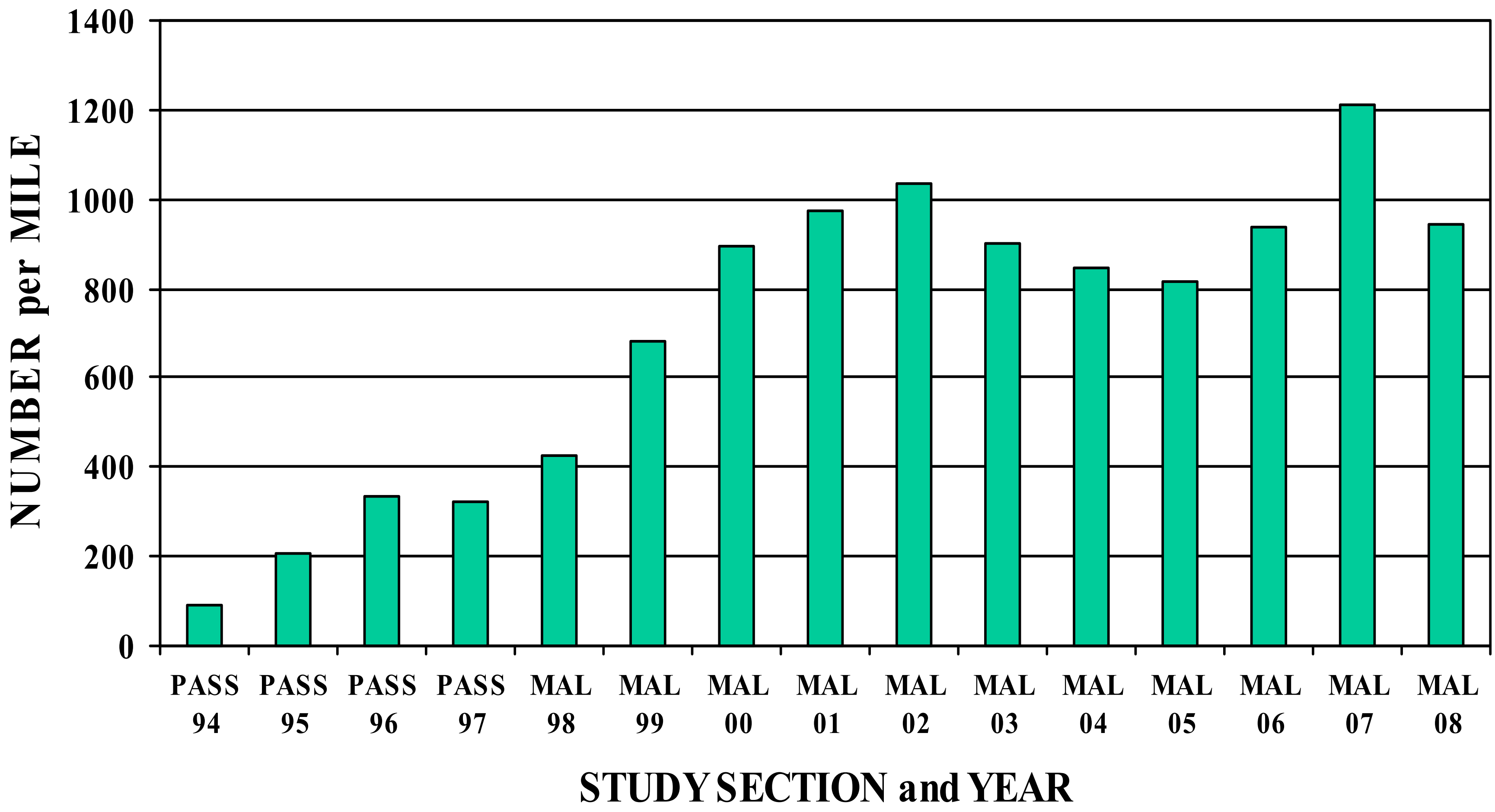


Figure R-16. Estimated densities of 18 inch and larger brown trout from fall samples in the Passamari (PASS) Section and spring samples in the Maloney (MAL) Section of the Ruby River, 1994 - 2008.

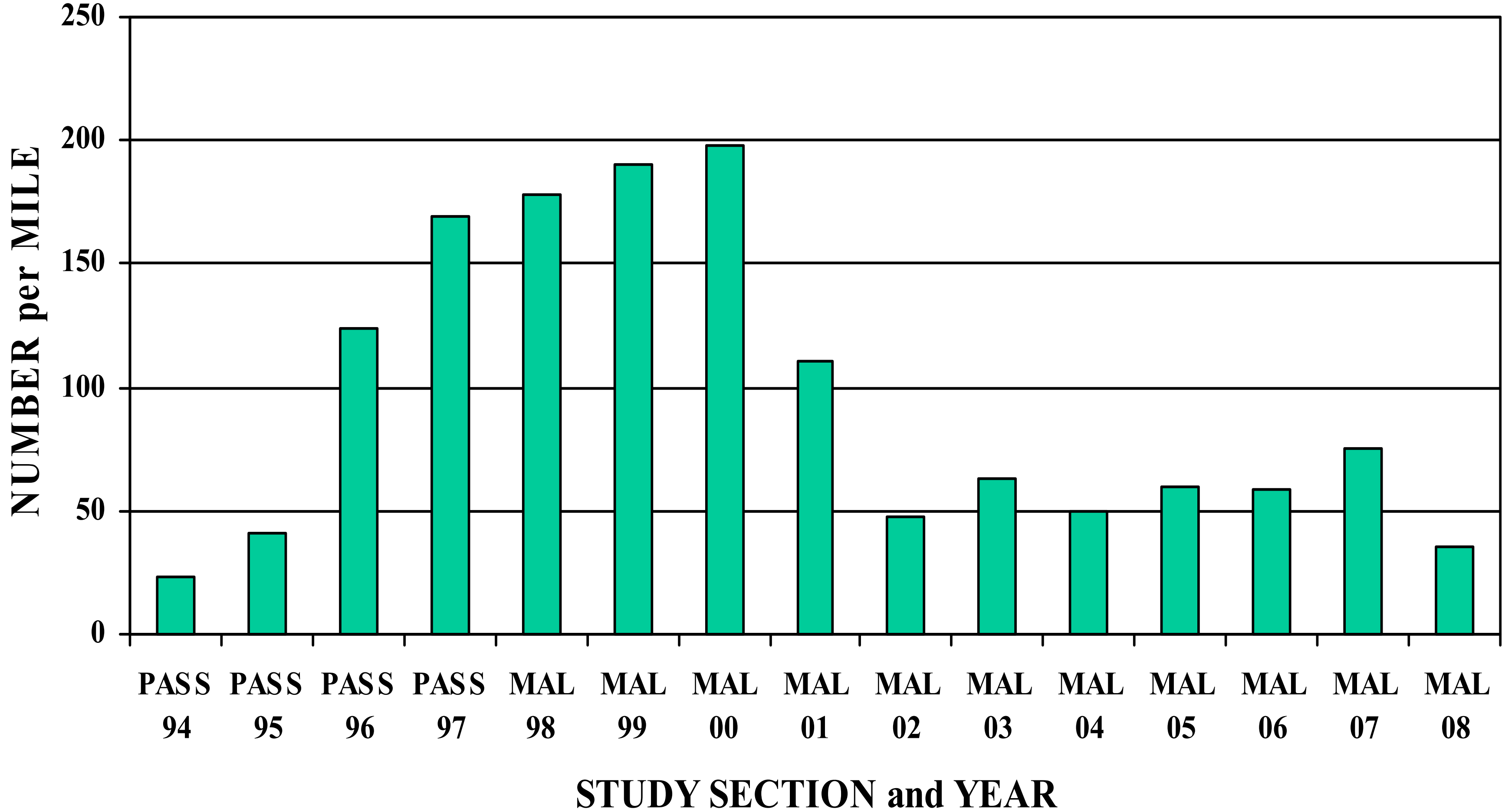


Figure R-17. Logarithmic regression of the estimated spring density of 18 inch and larger (Age V+) brown trout as a function of the mean overwinter flow regime from Ruby Reservoir Dam in the Maloney Section of the Ruby River; 1997 - 2005.

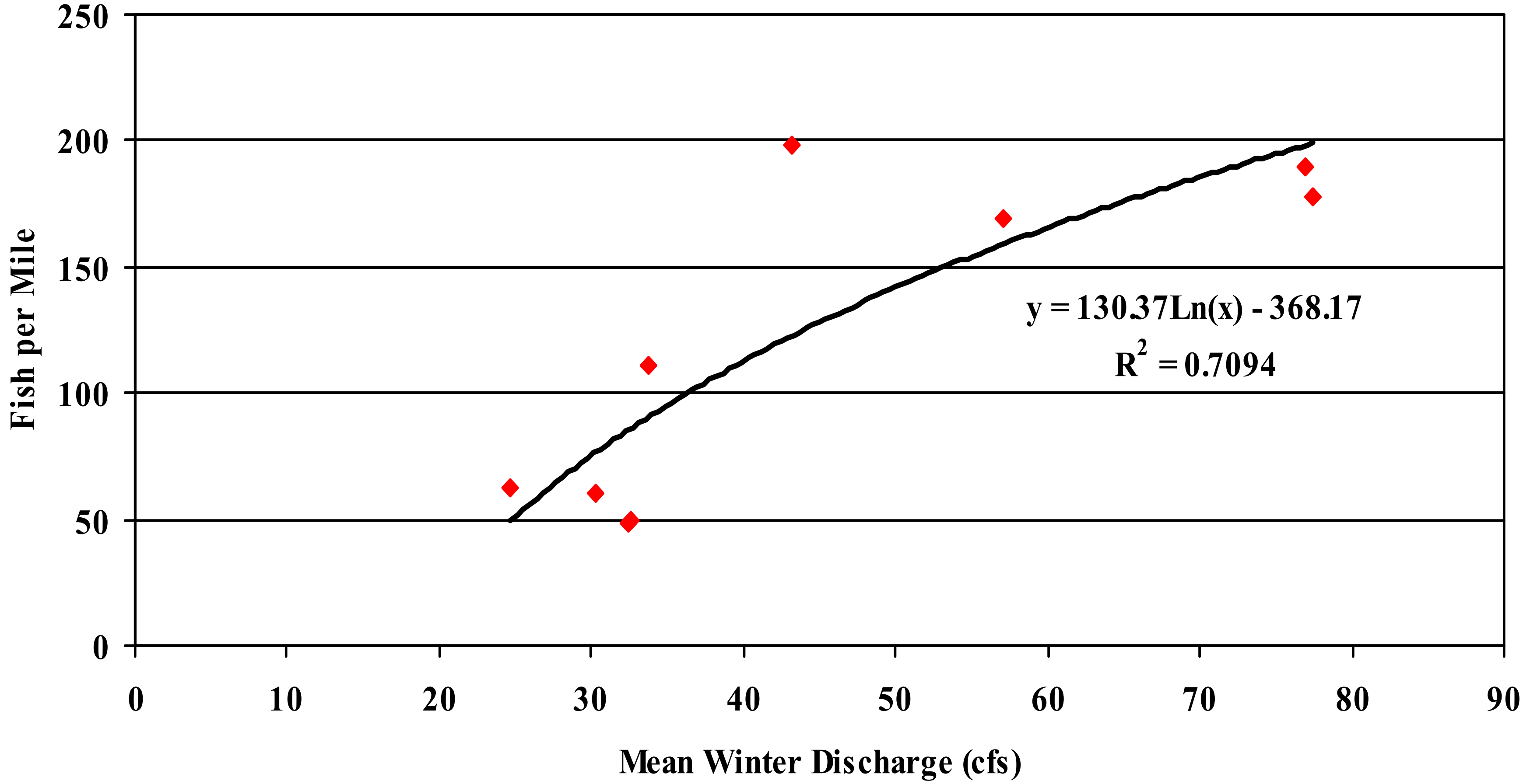


Figure R-18. Length frequency distribution of Age II and older brown trout collected in the Maloney Section of the Ruby River, Spring 2006 (N = 972).

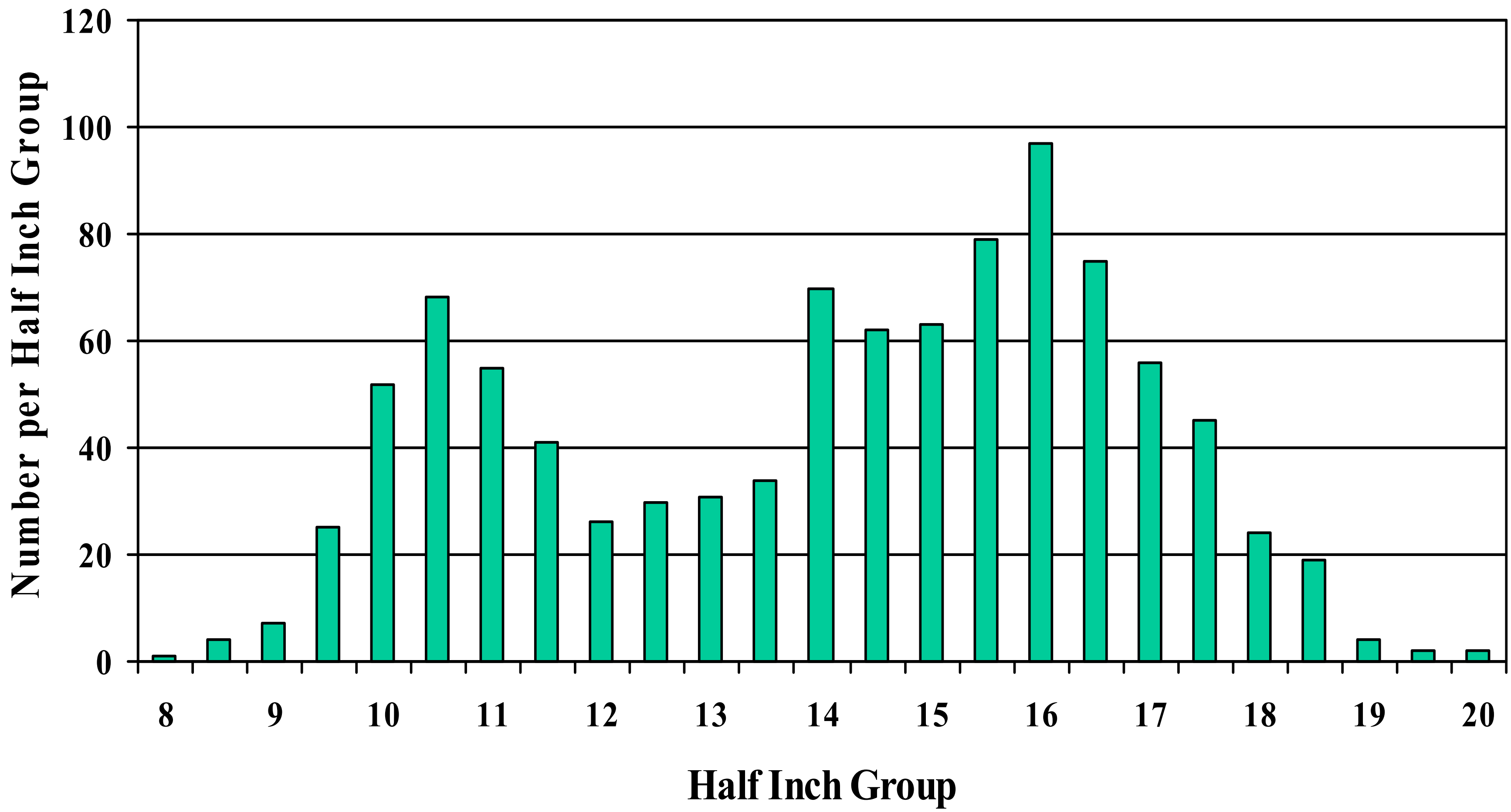


Figure R-19. length frequency distribution of Age II and older brown trout in the Maloney Section of the Ruby River; Spring 2007 (N = 1486) and 2008 (N = 1261).

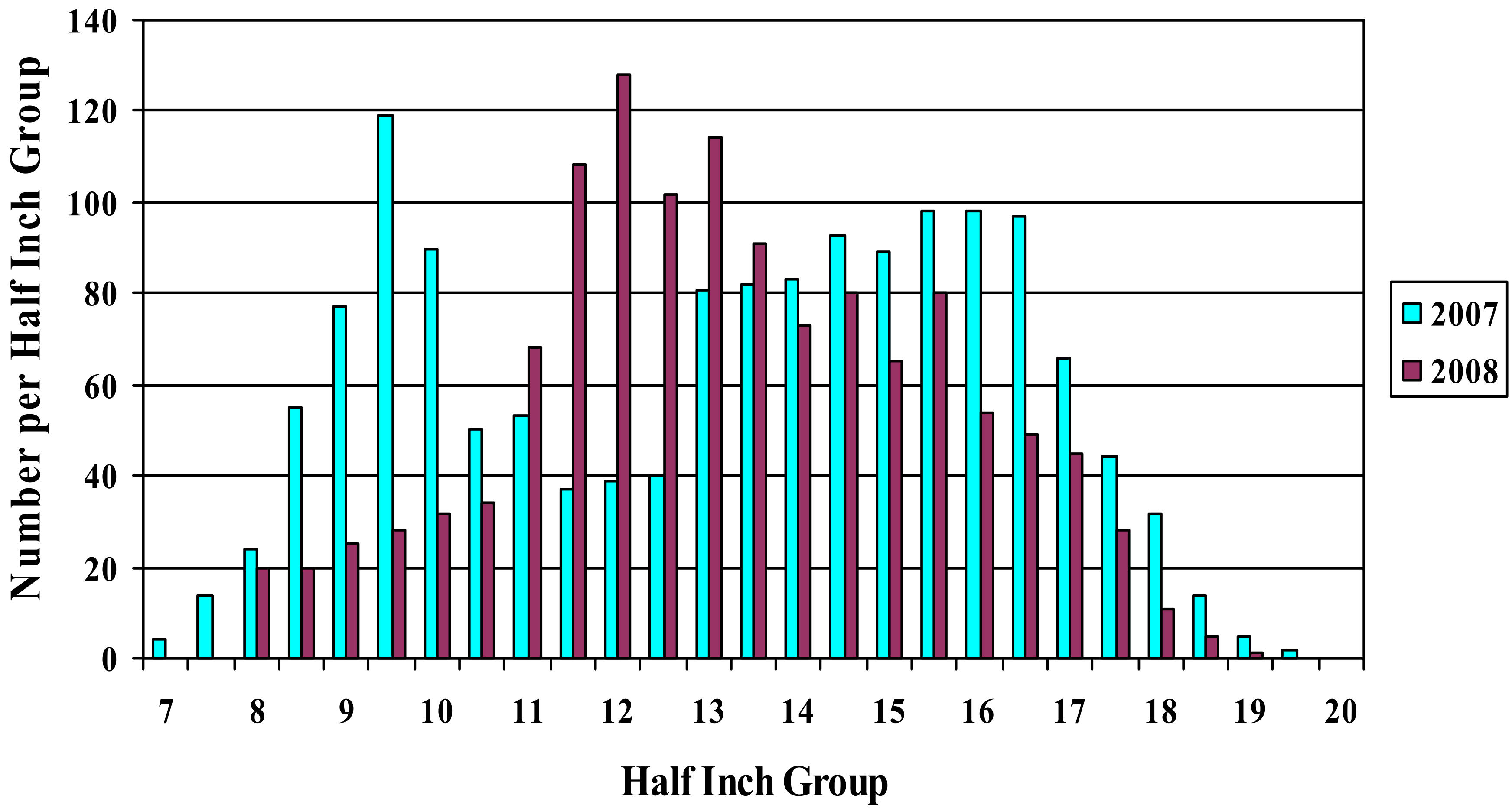
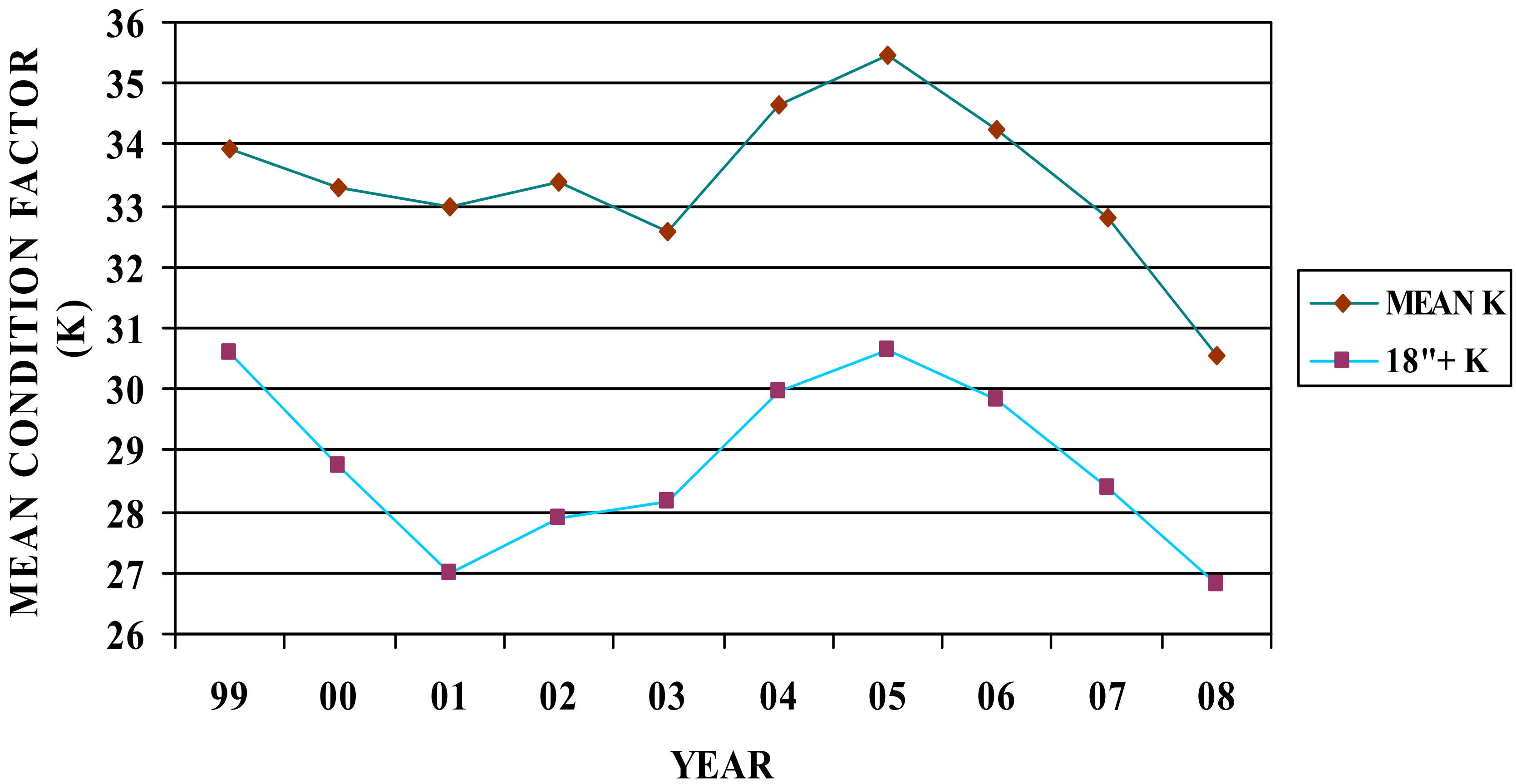


Figure R-20. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Maloney Study Section of the Ruby River 1999 - 2008.



The Silver Spring Study Section is located near the middle of the lower Ruby River Reach. It is typified by relatively stable flow regimes resulting from tributary inflow, particularly that of Silver Spring, and accretions from other groundwater sources including irrigation return flow. The estimated spring densities and standing crops of brown trout populations in the Silver Spring Section are depicted in Figure R-21 through the 2008 sample. Brown trout density and standing crop have exhibited a declining trend since observed maxima were recorded in 2000 and have maintained at relatively low levels over the 2004 – 2008 period of study. Strong recruitment cohorts (Figure R-22) of Age I fish were observed in the 2006 and 2008 samples, however the 2006 cohort failed to survive to Age II in significant density in the 2007 sample. Record high densities and standing crops observed for the study section in 1999 and 2000 resulted directly from strong cohorts of Age I fish surviving to Age II over the 1998 – 2000 period. Length frequency analysis of the 2007 and 2008 samples (Figure R-23) depicts populations marked by weak cohorts of Age II and Age III fish and a very stable sample population mode at 13.0 – 14.5 inches. While this dominant population mode was descriptive of age and length distribution within the population, densities of 13 inch and larger fish (Figure R-24) exhibited the same trend of decline that marked population density over the 2000 – 2008 period and remained stable at low density in the 2007 and 2008 samples. Densities of older, larger fish within the population, however, (Figure R-25) maintained at relatively high levels in the 2007 and 2008 samples representing a 4 year trend that began in 2005. Densities of these 16 inch and larger fish appeared to be a response to overall reduced population density, rather than strong recruitment cohorts or exceptional habitat quality, and might, in combination with the population skew toward larger fish, be responsible for the observed poor survival of Age I fish.

Beaverhead River

The highly productive tailwater reach of the upper Beaverhead River extends about 16 miles from Clark Canyon Dam to Barretts Diversion. By Barretts, ground water accretions, large canal withdrawals, and the confluence of Grasshopper Creek modify reservoir releases substantially enough to largely return the river to a more ambient condition for the locale. Flows within the tailwater reach are largely determined by storage in Clark Canyon Reservoir, summer irrigation demand, and over-winter replenishment of storage pools. Recent storage patterns in Clark Canyon Reservoir (Figure BVHD-1) have exhibited modest improvement at a relatively consistent minimum pool. This improvement, however, has not been manifest as improved over-winter flow releases into the Beaverhead River (Figure BVHD-2). Over-winter flow regimes remained far below the FWP Minimum Reservation of 200 cfs for the eighth consecutive year through the 2008 Water Year. Over the 2001 – 2008 period, sub minimum over-winter flows exhibited a highly attenuated range of 27 – 53 cfs and a mean of 34.8 cfs or 17.4% of the recommended minimum. These chronically reduced flow regimes have exerted a profound influence on tailwater brown trout populations in the Beaverhead River. The influence of flow on brown trout population dynamics was manifest as wide fluctuations in standing crop, condition factor and, most markedly, densities of older, larger fish within the population. A highly detailed statistical analysis and discussion of brown trout population dynamics as a function of over-winter flow regimes in the Beaverhead River tailwater is presented by Oswald (2009).

Recent trends in brown trout population density and standing crop in the Hildreth Section (Figure BVHD-3) reflected a dramatic increase in the 2007 – 2008 samples following minimum

Figure R-21. Estimated spring density and standing crop of Age II and older brown trout in the Silver Spring Section of the Ruby River, 1989 - 2008.

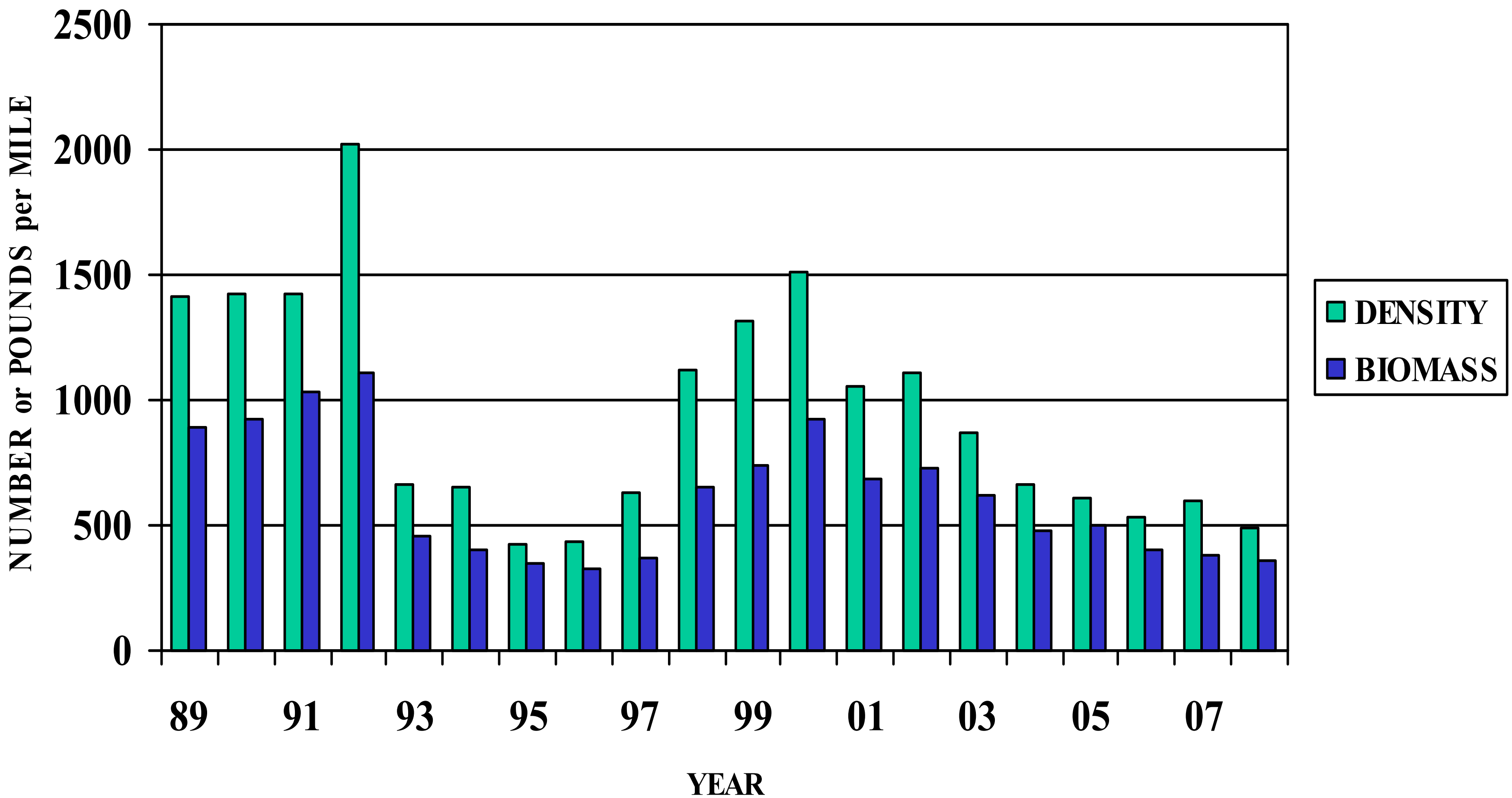


Figure R-22. Estimated spring densities of juvenile (Age I and Age II) brown trout in the Silver Spring Section of the Ruby River, 1989 - 2008.

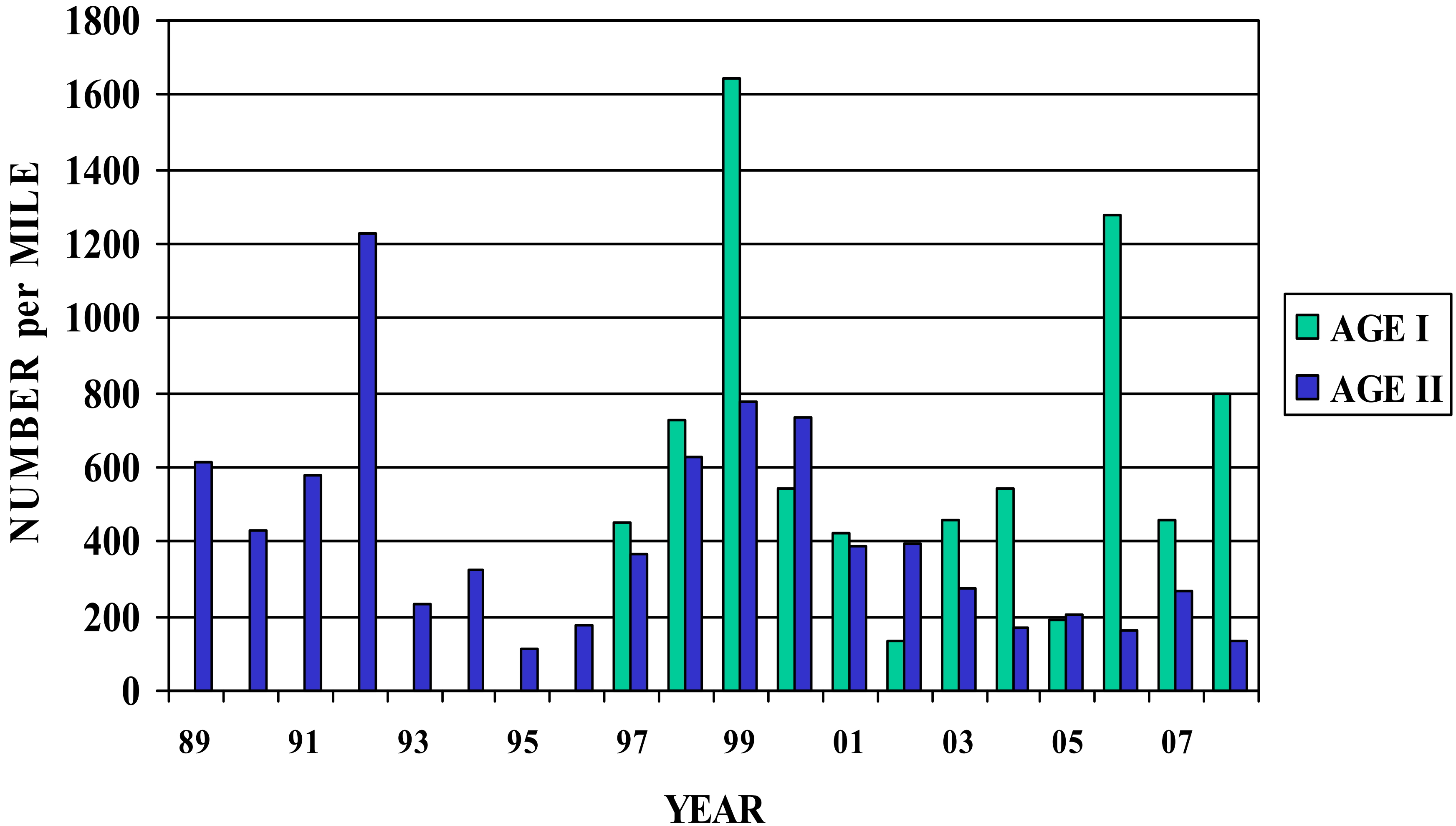


Figure R-23. Length frequency distribution of Age I and older brown trout in the Silver Spring Section of the Ruby River; Spring 2007 (N = 744) and 2008 (N = 528).

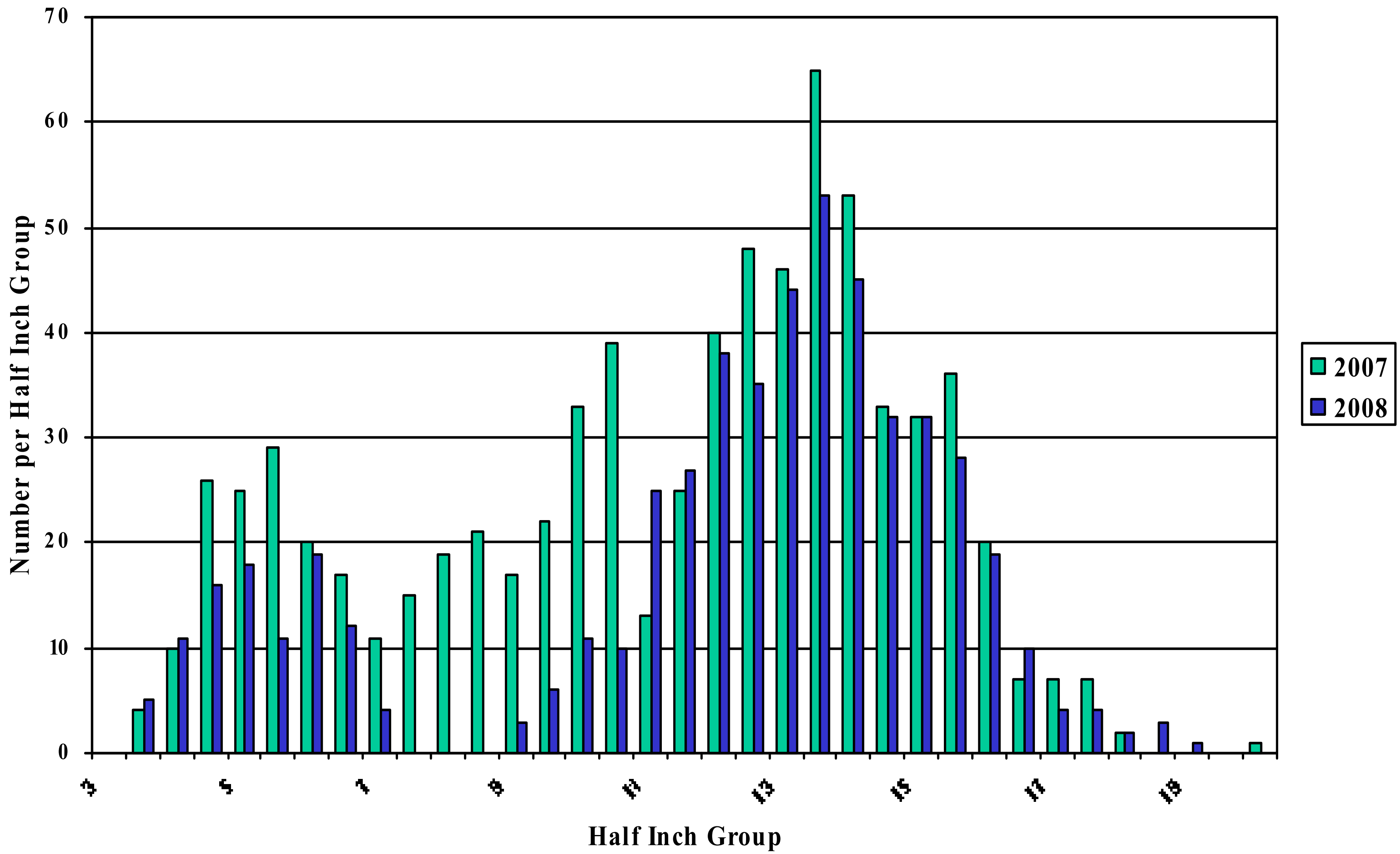


Figure R-24. Estimated spring density of 13 inch and larger brown trout in the Silver Spring Section of the Ruby River, 1989 - 2008.

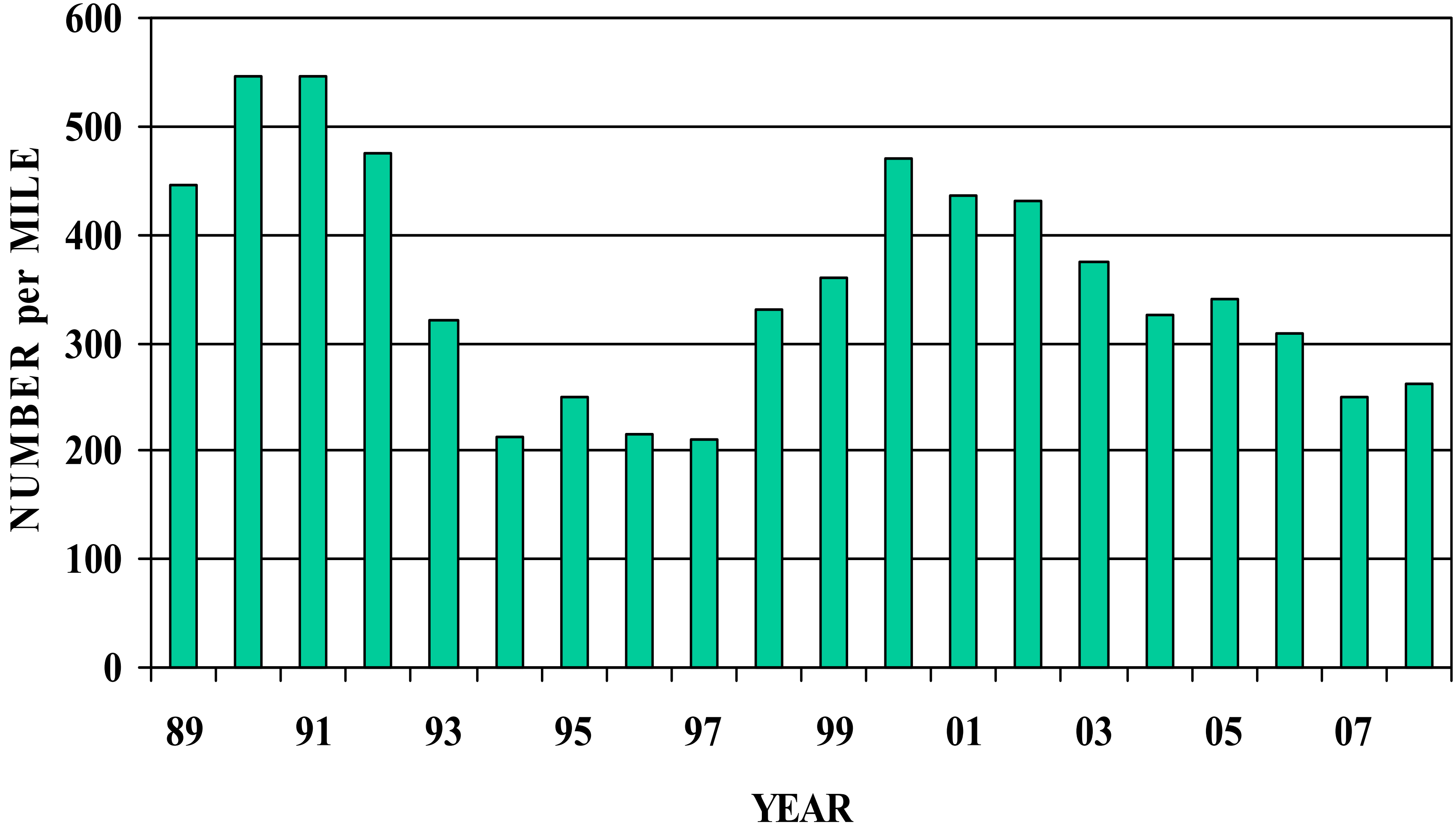


Figure R-25. Estimated spring density of 16 inch and larger brown trout in the Silver Spring Section of the Ruby River, 1989 - 2008.

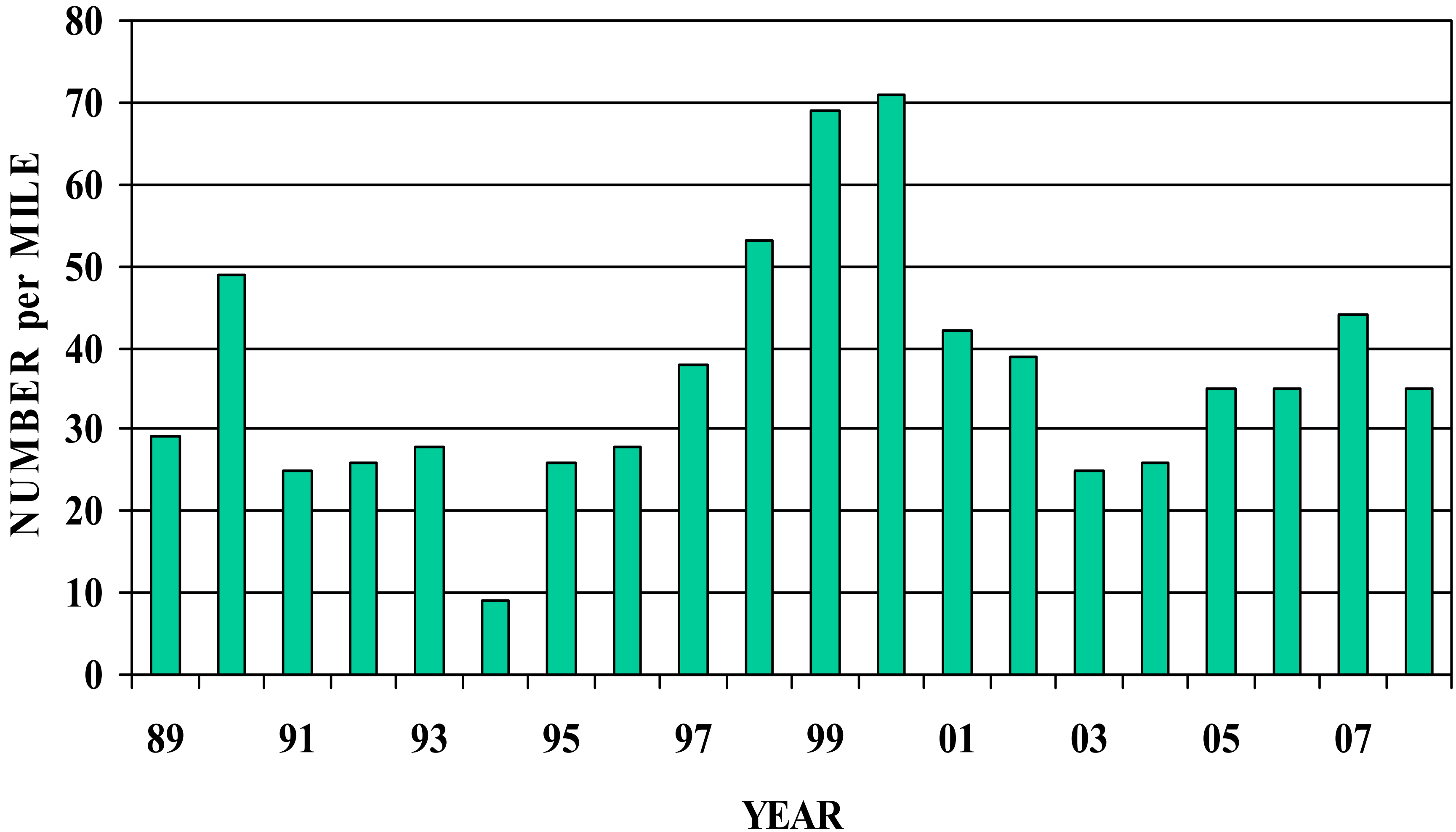


Figure BVHD-1. End of irrigation season (fall) storage in Clark Canyon Reservoir, Water Years 1987 - 2008.

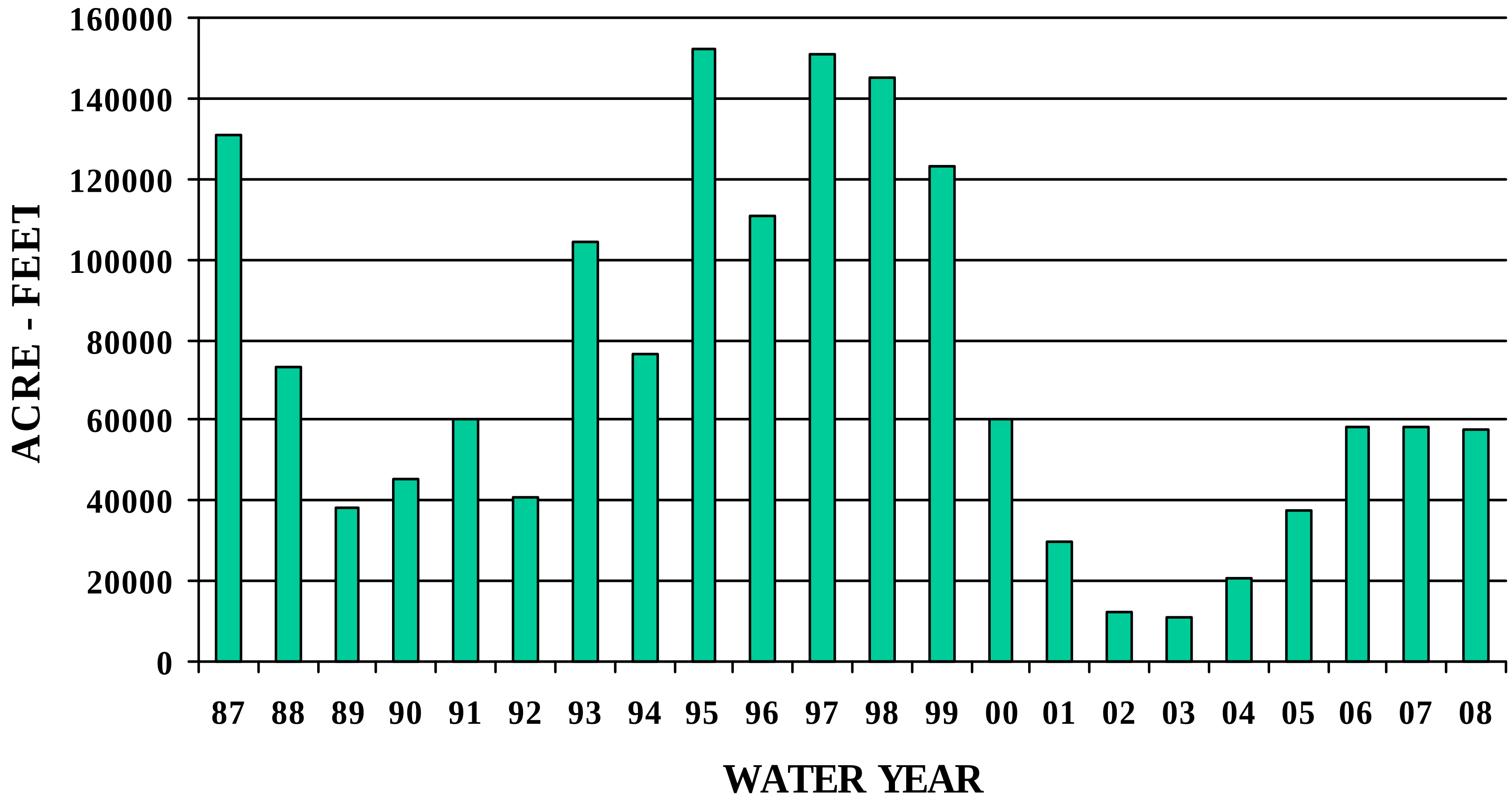


Figure BVHD-2. Mean nonirrigation season (October through March) flow release into the Beaverhead River from Clark Canyon Dam over the 1982 - 2008 Water Years.

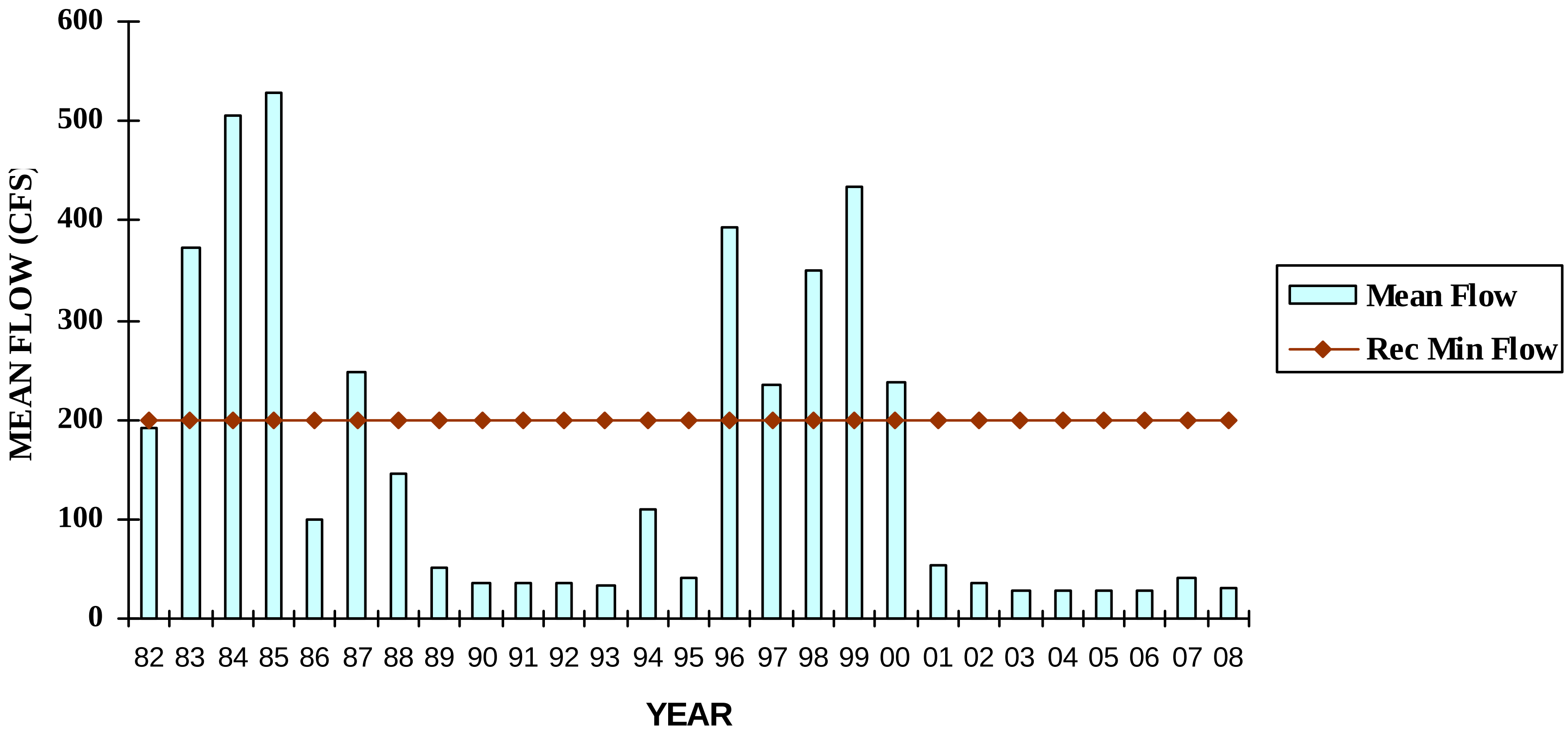
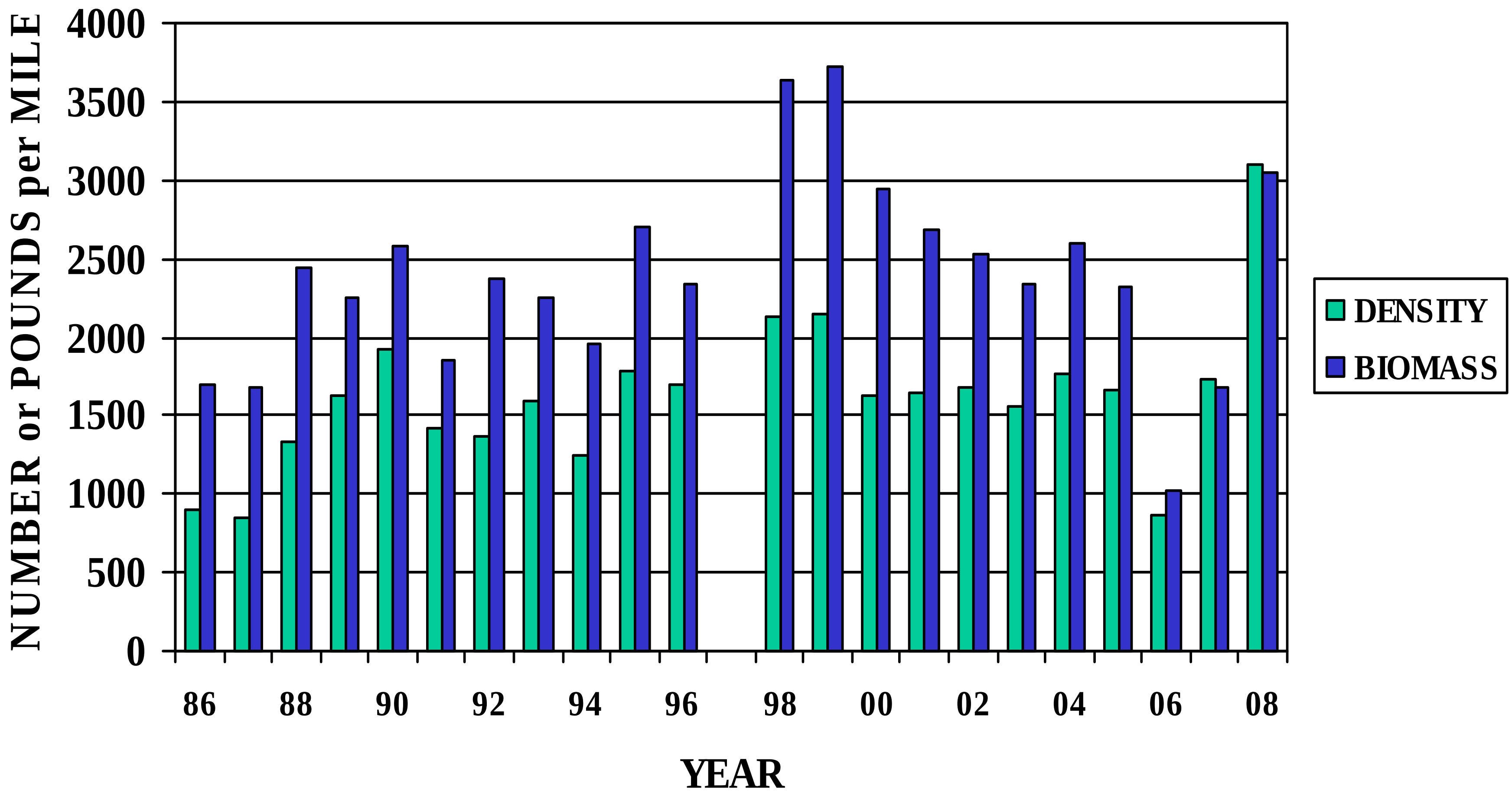


Figure BVHD-3. Estimated spring density and standing crop of brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2008.



observed levels for both parameters in 2006. The rapid expansion of the brown trout population occurred despite relatively static conditions in over-winter flow patterns and was the direct result of substantial recruitment of Age II fish (Figure BVHD-4) in both years. This opportunistic survival of juvenile fish followed the minimum standing crop of 2006 and was probably a direct result of markedly reduced competition and predation within the brown trout population. A more typical length frequency distribution for the Hildreth Section brown trout population is presented in Figure BVHD-5 and can be contrasted with the distributions that marked the 2007 – 2008 samples. By comparison, the 2007 and 2008 samples exhibited a population skewed dramatically toward younger, smaller fish and also suggest a marked attenuation of growth rate for the study section. This condition appears similar to that observed in the Ruby River Maloney Section under burgeoning recruitment of Age II fish and declining or sub-minimum flows. Densities of older, larger brown trout in the Hildreth Section (Figures BVHD-6 and BVHD-8) remained stagnated at markedly reduced and atypical levels and continued to represent a much reduced and atypical contribution to the population (Figure BVHD-7). Very large, or trophy, brown trout (Figure BVHD-9) that have typified the upper Beaverhead River tailwater fishery in the past remained virtually nonexistent in the Hildreth Section population for the third consecutive year. Brown trout condition factor (Figure BVHD-10) exhibited an upward surge in the 2007 sample at relatively low population density and a dominance by juvenile fish but markedly turned downward in 2008 as brown trout density and standing crop surged upward, a large cohort advanced to Age III, and over-winter flow did not improve. Again, the observations were similar to those made in the lower Ruby River tailwater over the 2007 – 2008 period of study.

Rainbow trout populations have been sporadically monitored in fall samples from the Hildreth Section in recent years due to the extremely low flow regimes and relatively high water temperatures that have typified the recent study period. Despite these limitations, fall rainbow trout populations were estimated in 2006 and 2008 in the study section. Age I and older rainbow trout density and standing crop (Figure BVHD-11) exhibited markedly different patterns than those observed for brown trout over the 2006 – 2008 period of study. Rainbow trout density remained very stable at near average levels while standing crop advanced markedly but remained substantially below average between the two samples. Similar to the brown trout, the Hildreth Section rainbow trout population exhibited opportunistic recruitment of Age I fish in 2006 and 2007 (Figure BVHD-12), however, did not appear to suffer any attenuation of growth or ultimate length at age as the cohorts advanced to Age III. Densities of older, larger fish within the rainbow trout population (Figure BVHD-13) remained markedly below average but exhibited a slight improvement at the lower end as substantial numbers of fish entered the Age III cohort.

The brown trout population of the mid-tailwater reach was monitored via spring population estimates in the Pipe Organ in 2007 and 2008. Brown trout population trends in the Pipe Organ Section were extremely similar to those observed for the Hildreth Section. Brown trout density and standing crop (Figure BVHD-14) expanded markedly upward with the opportunistic recruitment of highly successful Age II cohorts (Figure BVHD-15) in 2007 and 2008. Densities of older, larger fish (Figure BVHD-16) in the population remained extremely depressed at a very constant low level and condition factor (Figure BVHD-17) declined markedly from 2007 to 2008 under burgeoning population density and standing crop as over-winter flows remained chronically low.

Figure BVHD-4. Length frequency distribution of Age II and older brown trout captured by electrofishing in the Hildreth Section of the Beaverhead River; Spring 2007 (N=1,278) and 2008 (N=1,601).

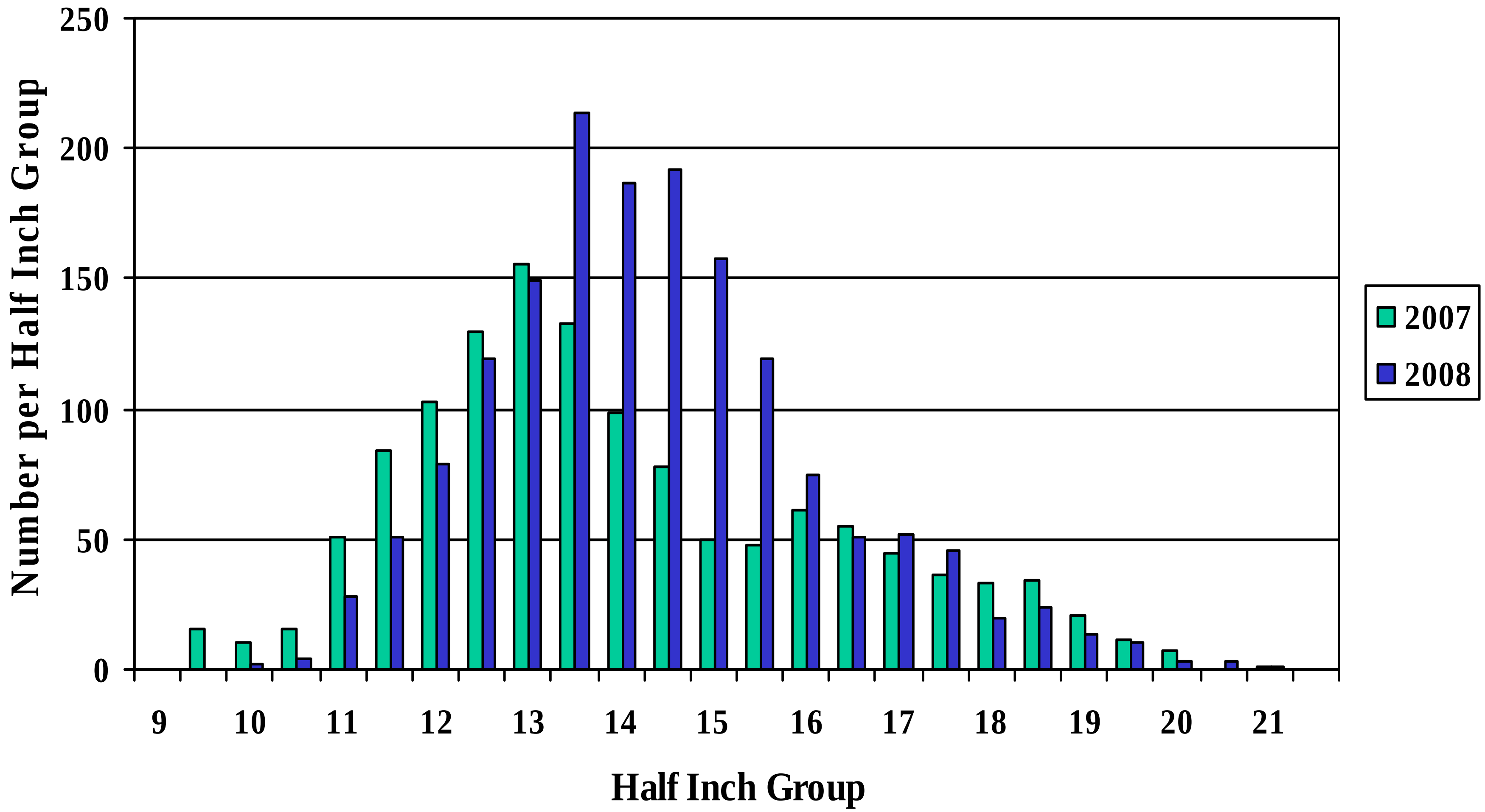


Figure BVHD-5. Length frequency distribution of Age II and older brown trout captured by electrofishing in the Hildreth Section of the Beaverhead River; Spring 1999 (N=1,206).

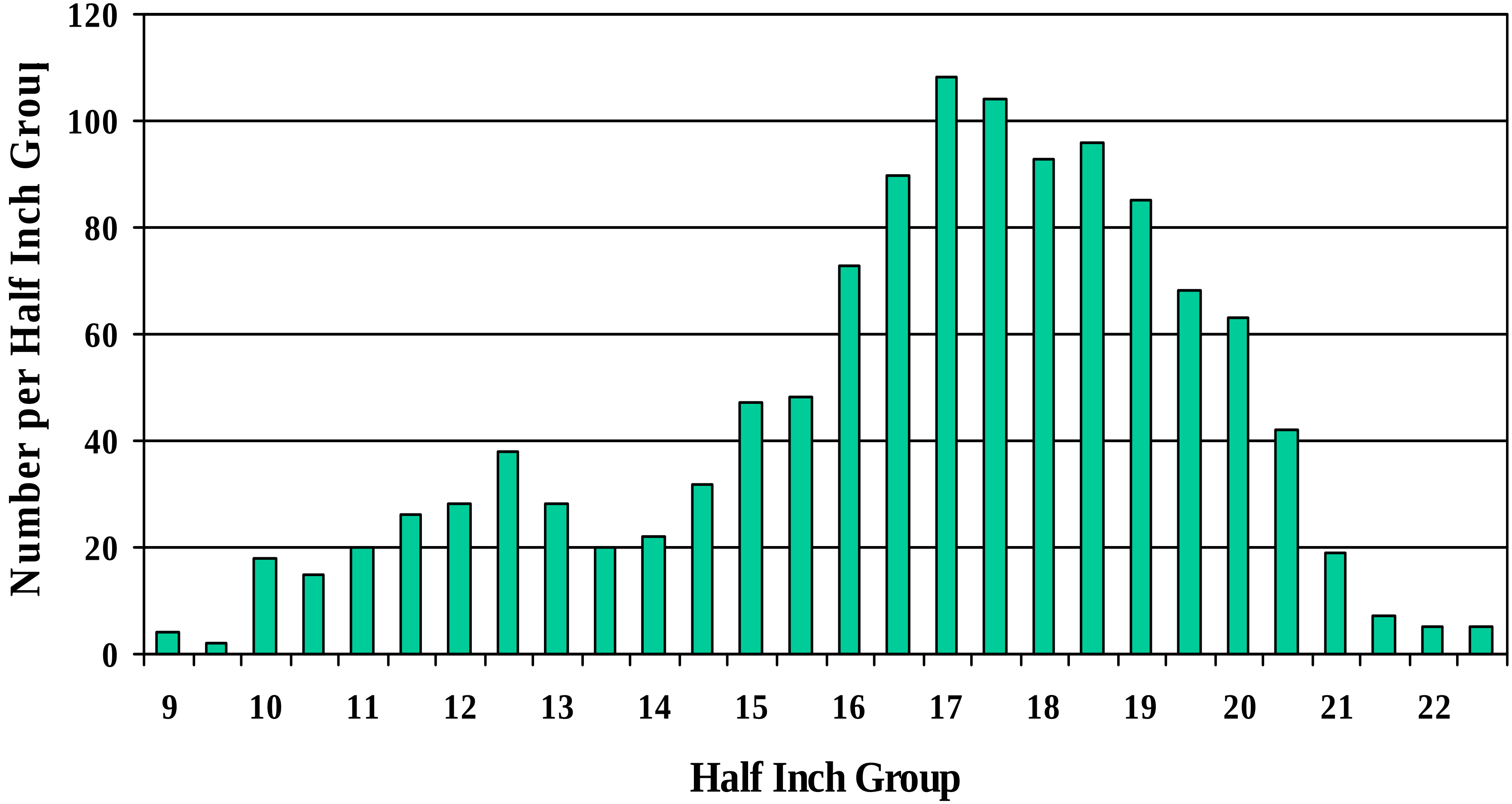


Figure BVHD-6. Estimated spring density of 18 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2008.

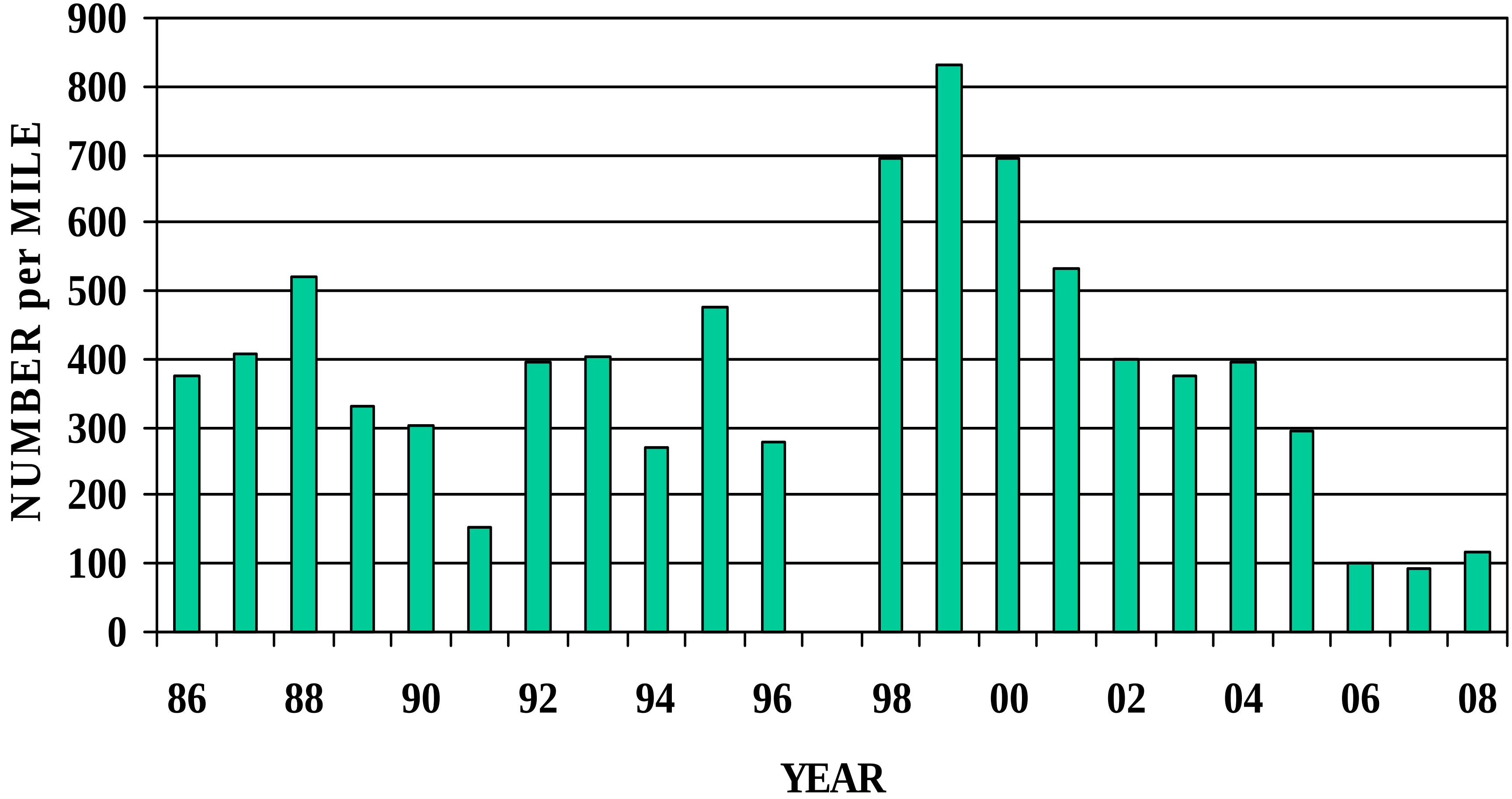


Figure BVHD-7. Density of 18 inch and larger brown trout as a percentage of the total spring brown trout population in the Hildreth Section of the Beaverhead River; 1986 - 2008.

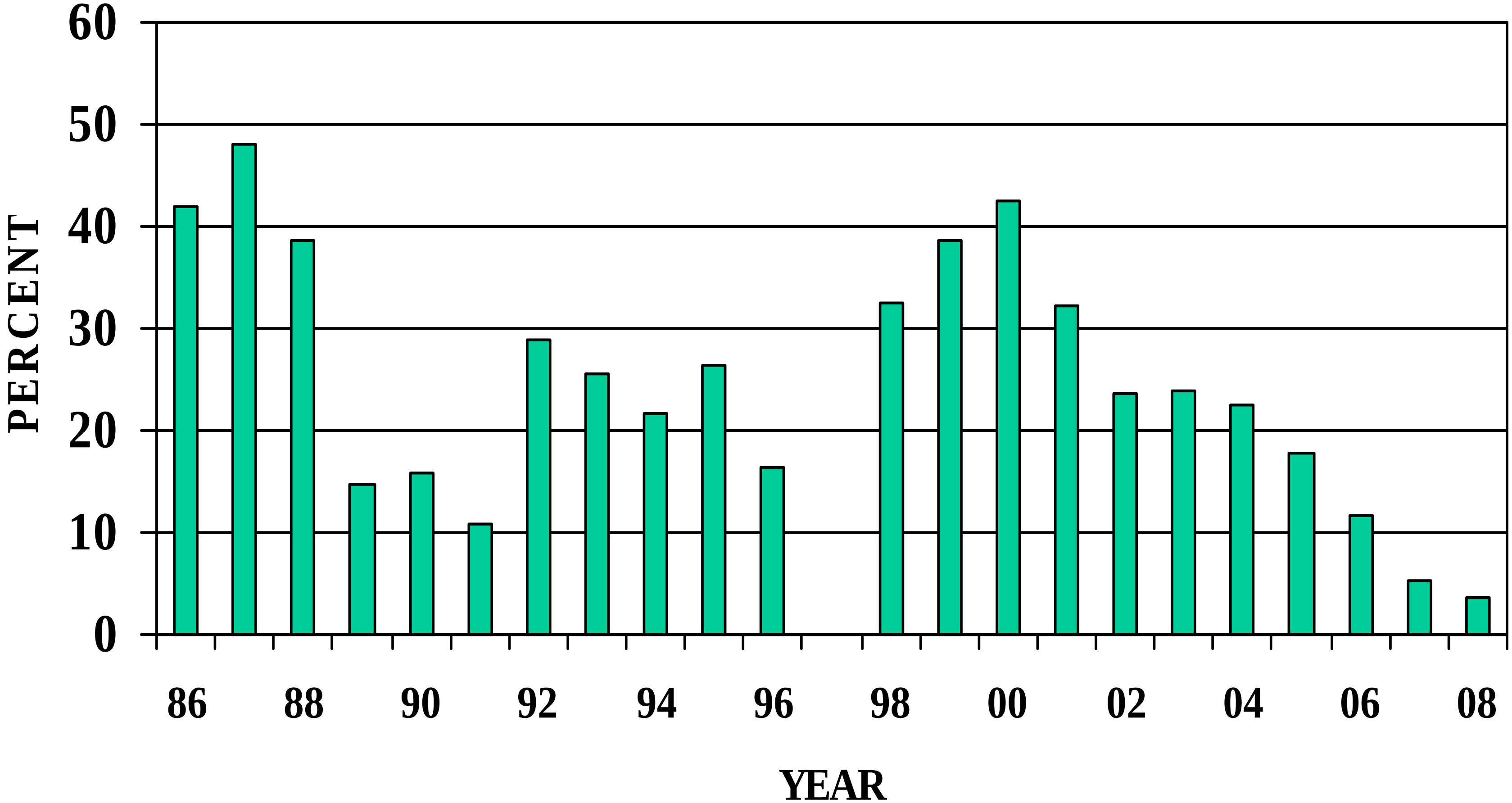


Figure BVHD-8. Estimated spring density of 20 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2008.

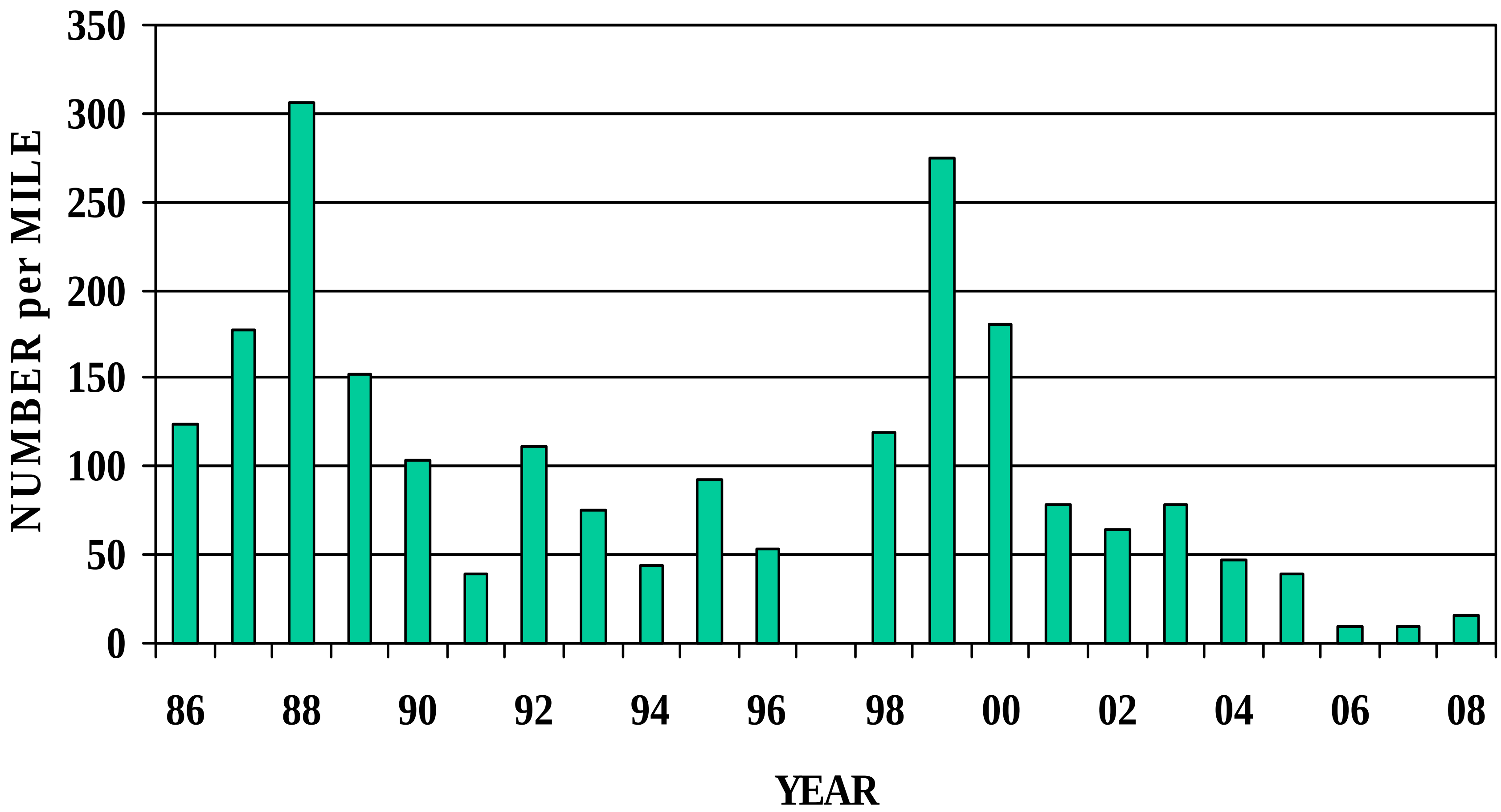


Figure BVHD-9. Estimated spring density of 22 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2008.

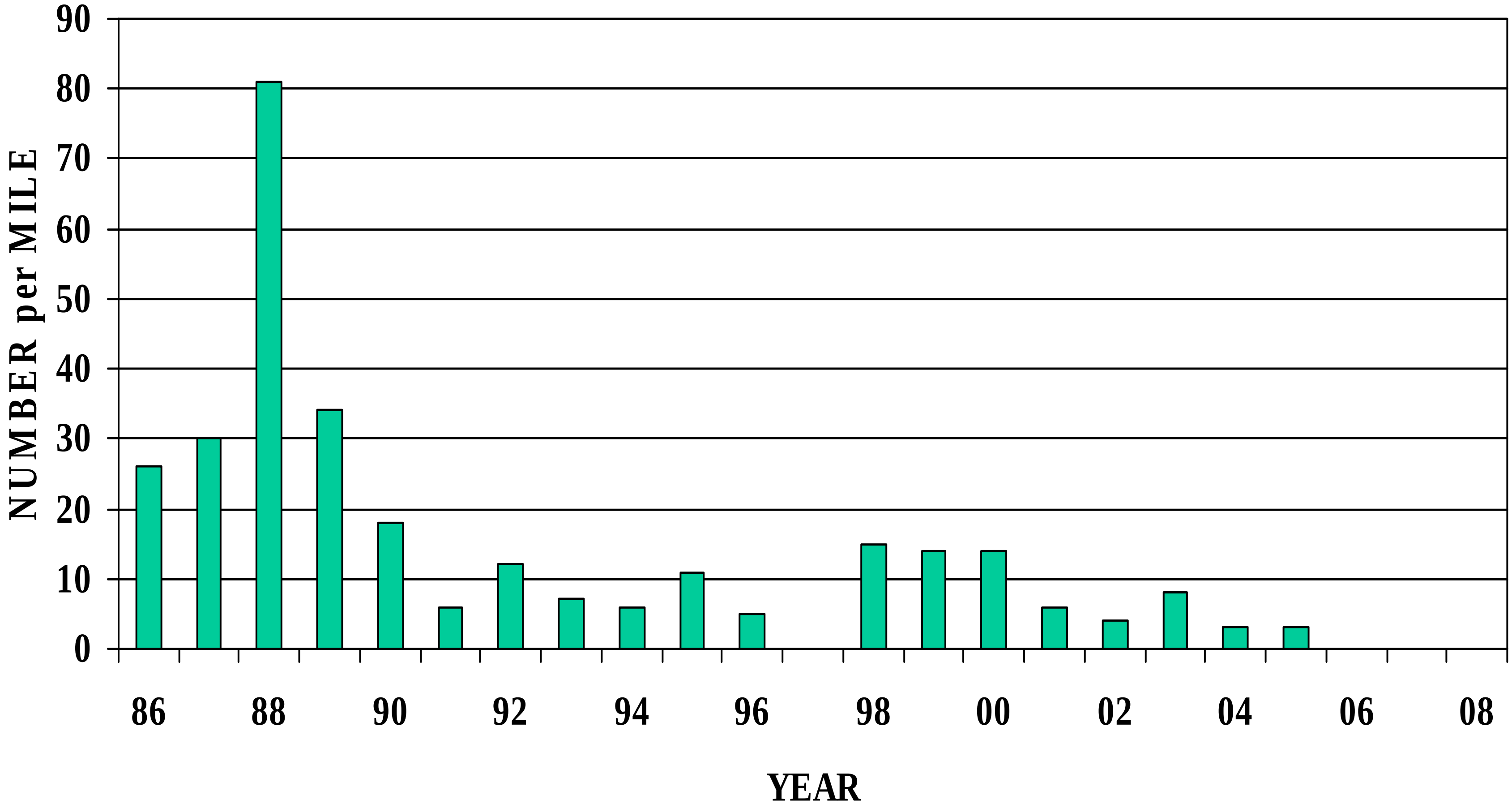


Figure BVHD-10. Mean spring Condition Factor (K) for Age II and older brown trout and the 18 inch and 20 inch and larger length groups of brown trout collected in the Hildreth Section of the Beaverhead River, 1999 - 2008.

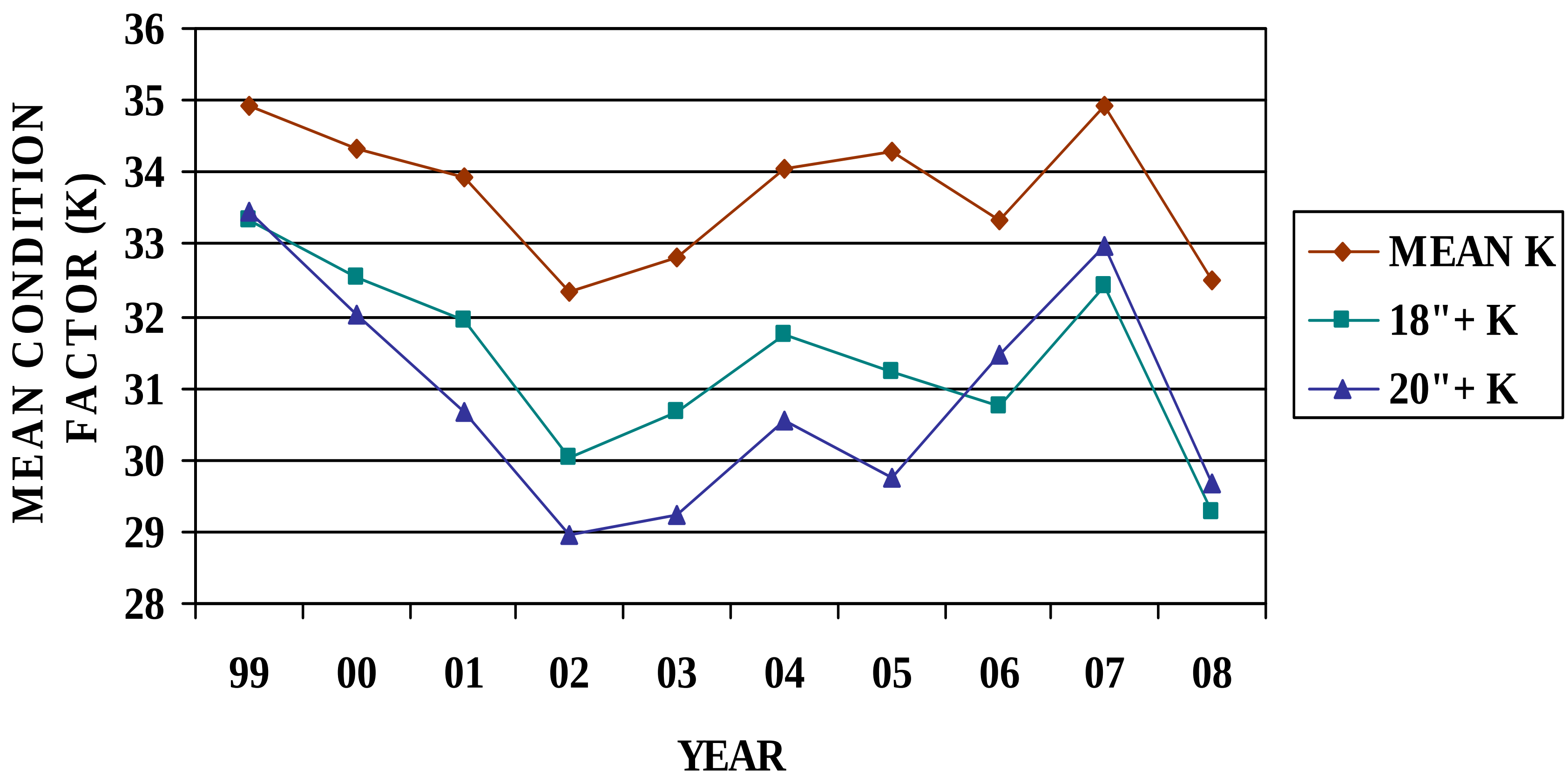


Figure BVHD-11. Estimated fall density and standing crop of Age I and older rainbow trout in the Hildreth Section of the Beaverhead River 1986 - 2008.

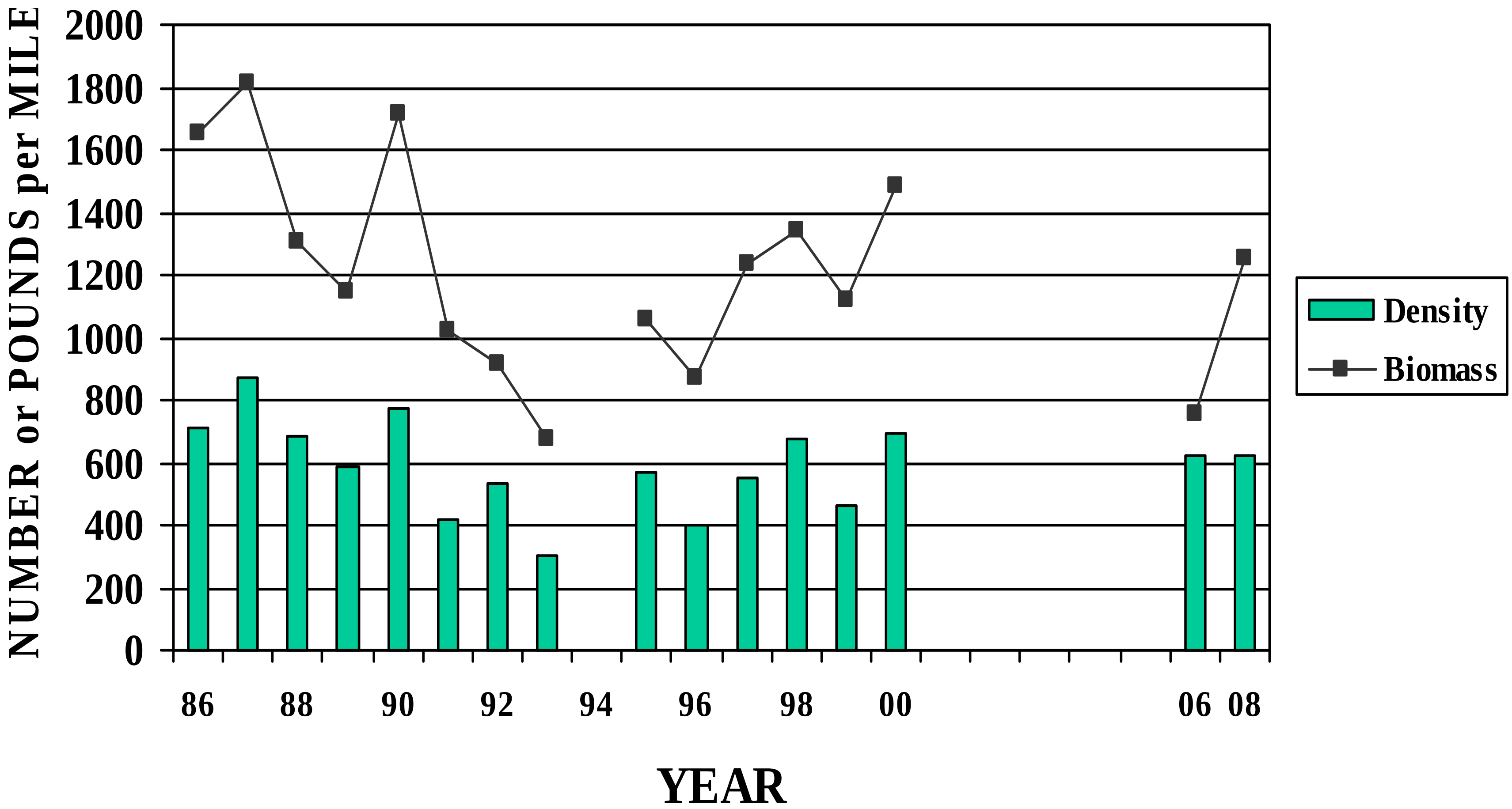


Figure BVHD-12. Length frequency distribution of Age I and older rainbow trout collected in fall samples in the Hildreth Section of the Beaverhead River; 2006 (N = 373) and 2008 (N = 412).

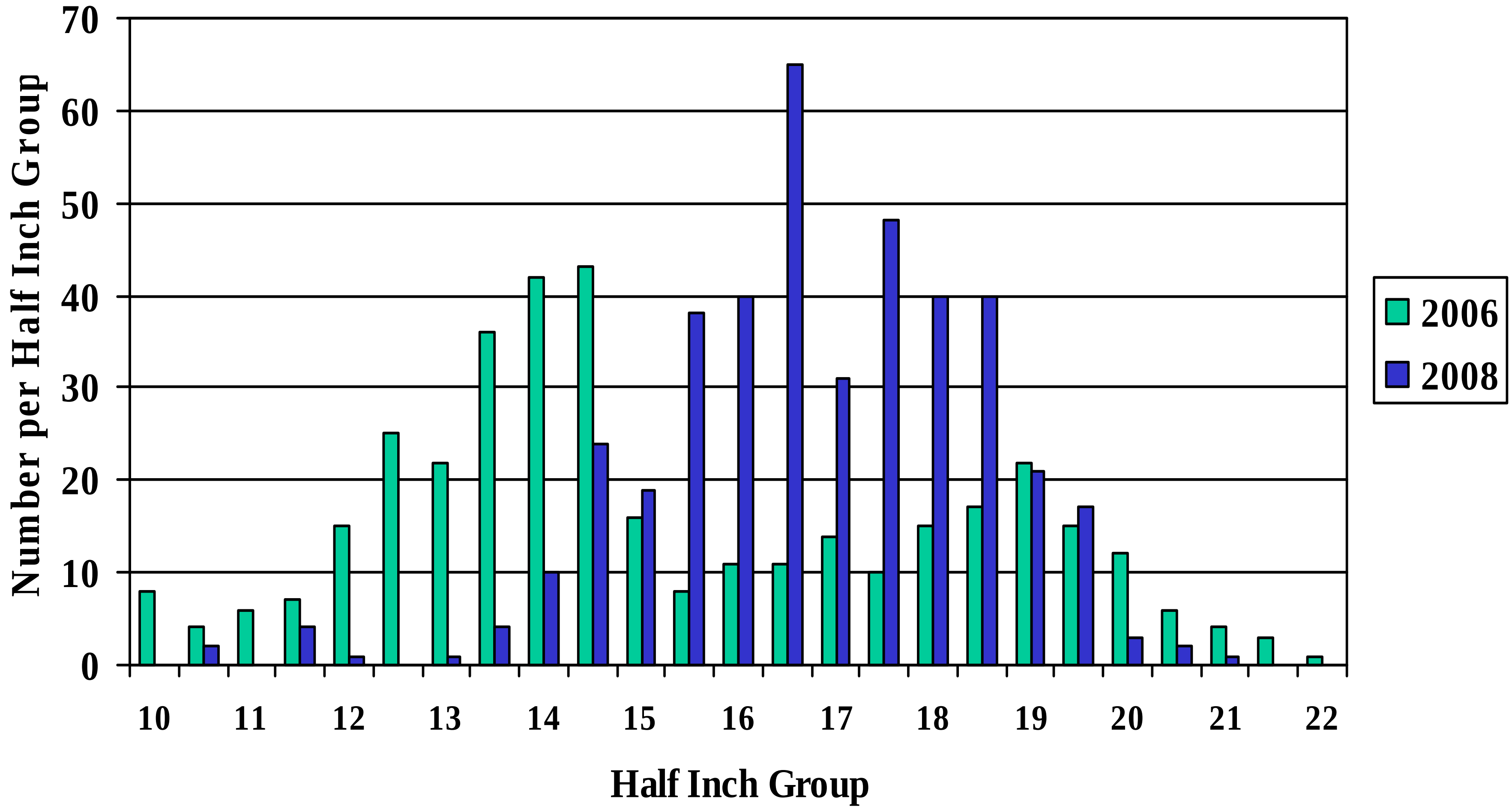


Figure BVHD-13. Estimated fall density of 18 inch and larger and 20 inch and larger rainbow trout in the Hildreth Section of the Beaverhead River, 1986 - 2008.

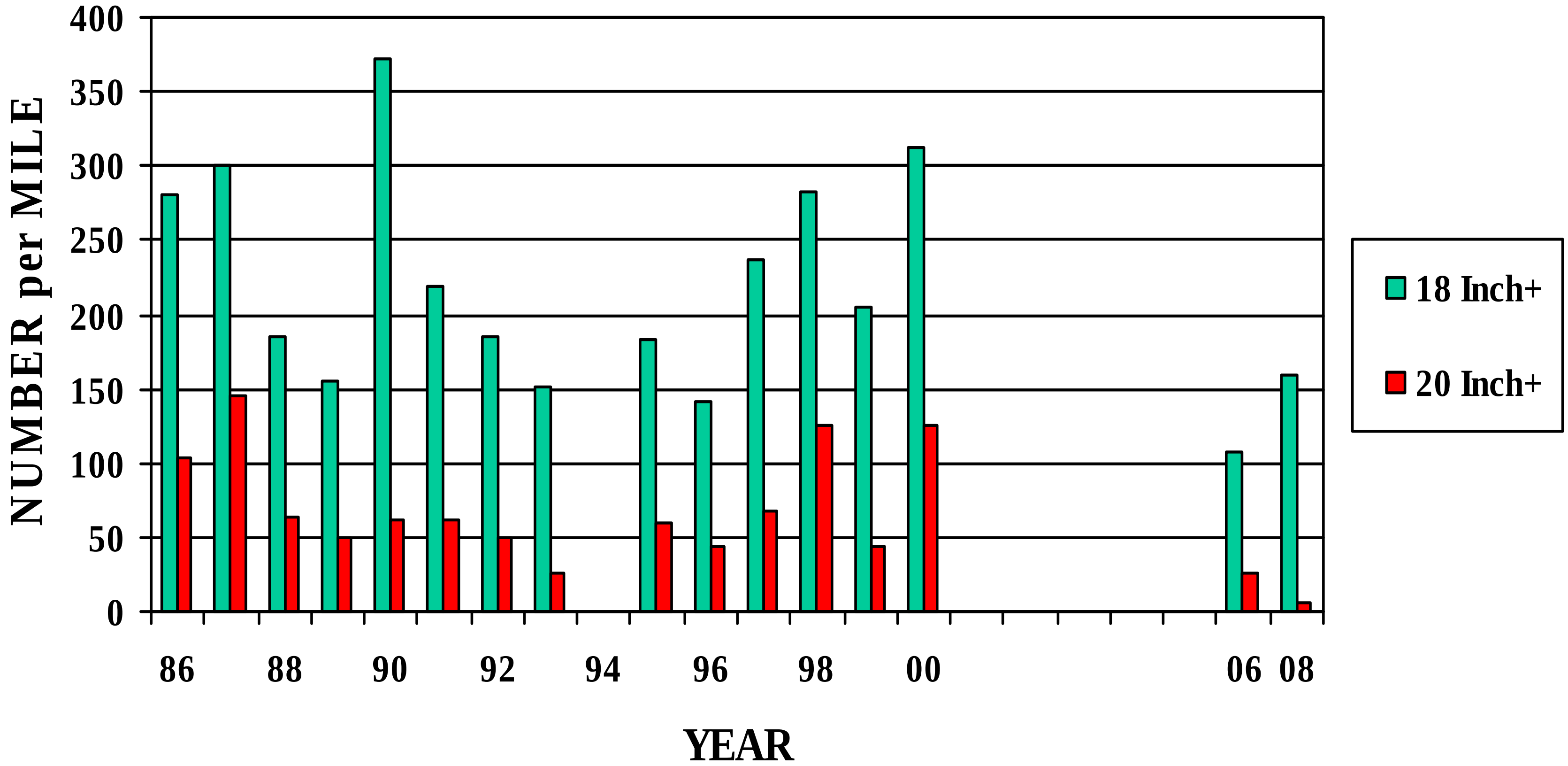


Figure BVHD-14. Estimated spring density and standing crop of Age II and older brown trout in the Pipe Organ Section of the Beaverhead River, 1986 - 2008.

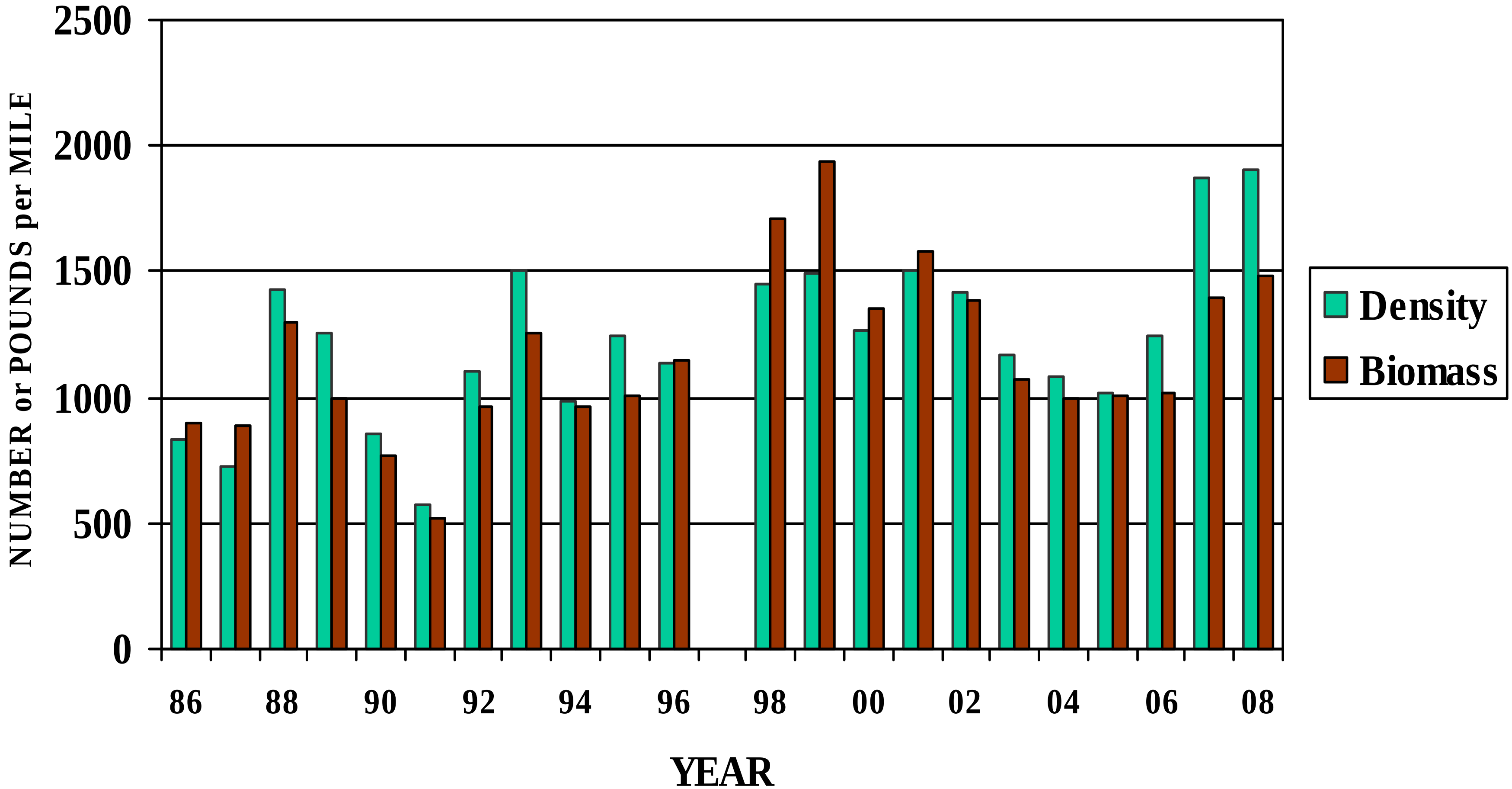


Figure BVHD-15. Length frequency distribution of Age II and older brown trout captured by electrofishing the Pipe Organ Section of the Beaverhead River; Spring 2007 (N=1,376) and 2008 (N=1,310).

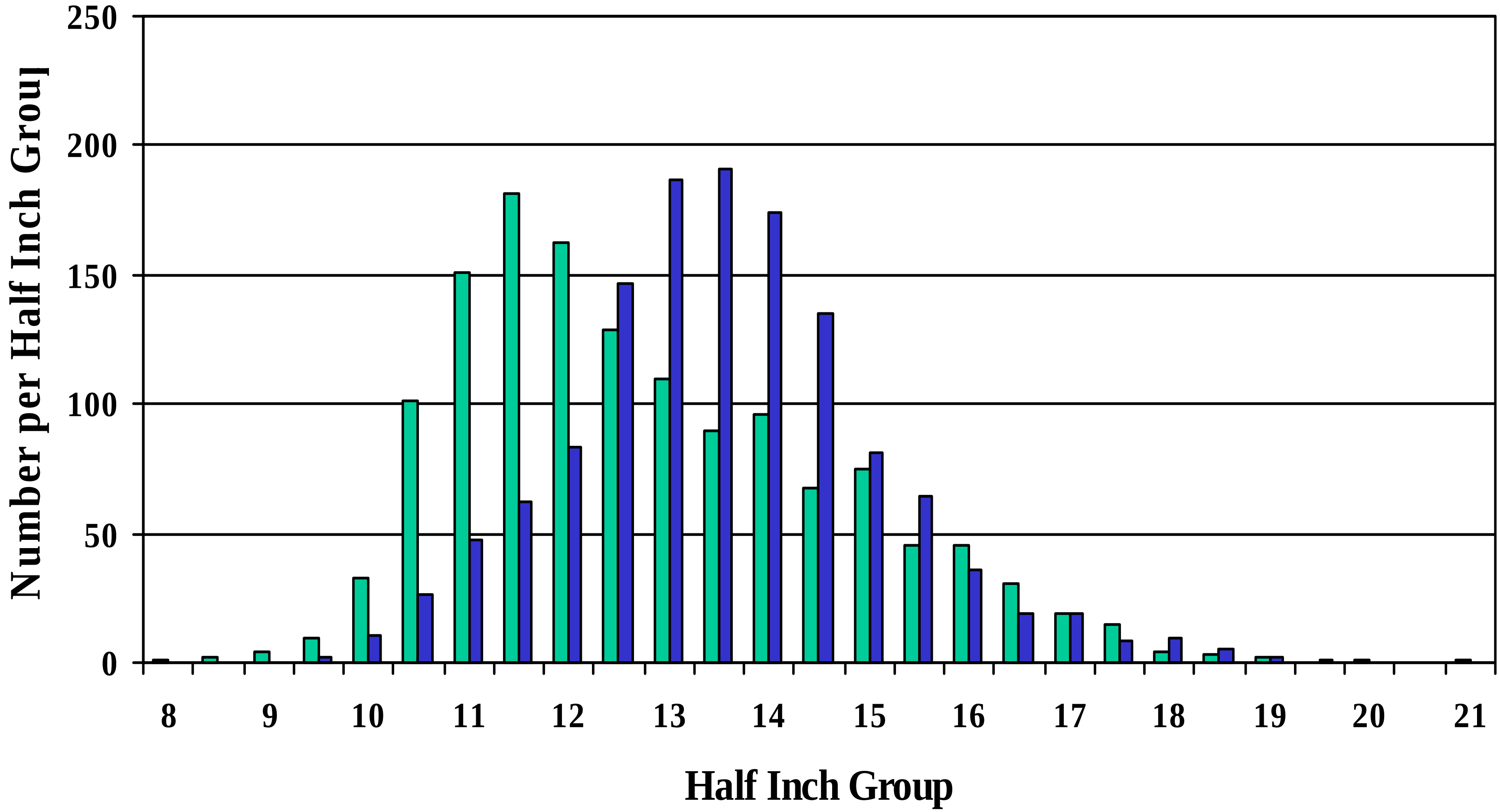


Figure BVHD-16. Estimated spring density of 18 inch and larger brown trout in the Pipe Organ Section of the Beaverhead River, 1986 - 2008.

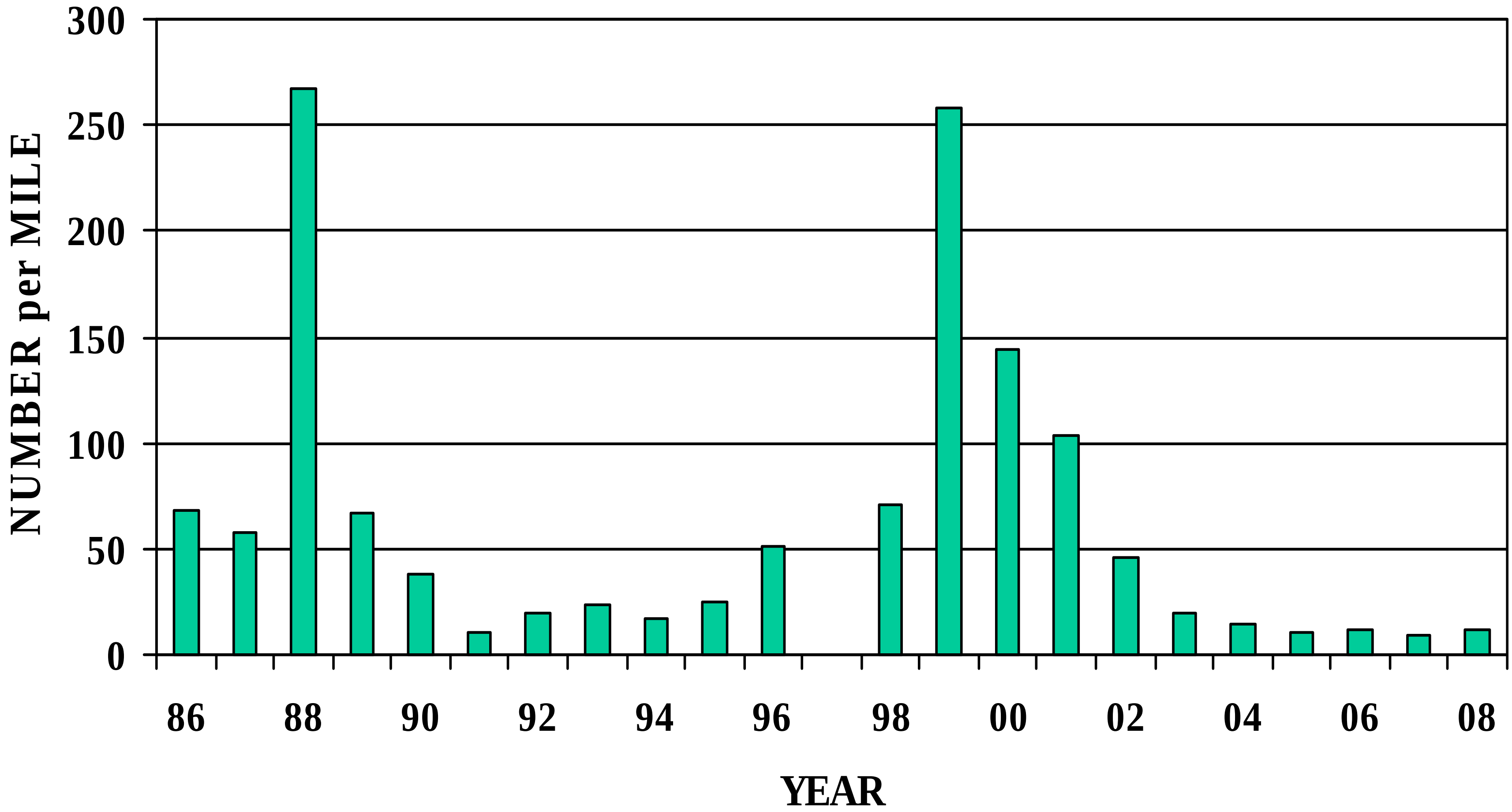
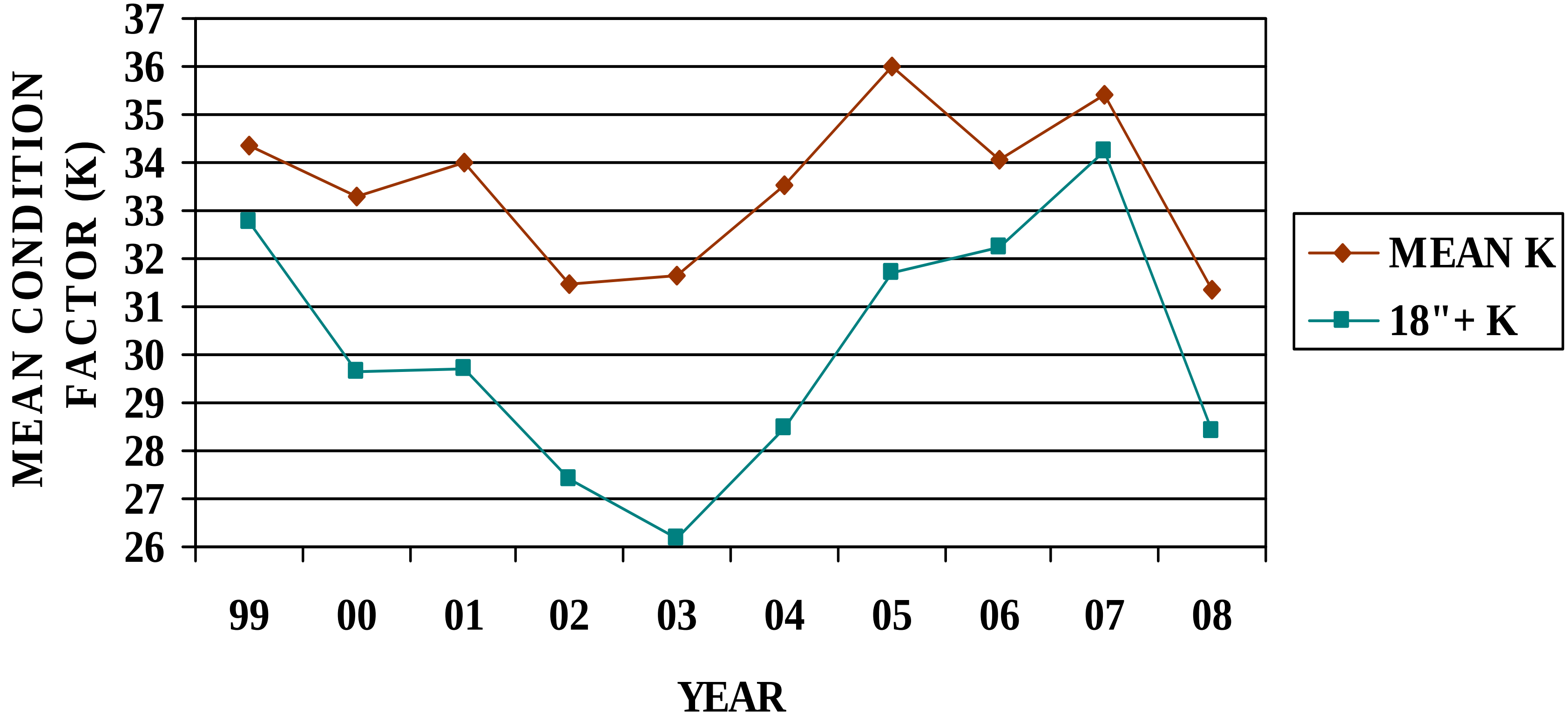


Figure BVHD-17. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Pipe Organ Section of the Beaverhead River, 1999 - 2008.



The brown trout population of the mid-river reach was monitored in the Fish and Game Section, approximately 22.5 miles downstream from Clark Canyon Dam and about 5.0 miles south of the City of Dillon. While the study section is located downstream from the immediate influence of the tailwater, fall flows as low as 40 – 45 cfs have been measured at the head of the section as over-winter release regimes were reduced and set at the Clark Canyon Dam outlet. Another characteristic unique to the Fish and Game Section study reach is the reduction of angling pressure accomplished under the Beaverhead River Recreation Rules that limit the availability of the reach to commercial float fishing trips. Brown trout densities and standing crops in the Fish and Game Section (Figure BVHD-18) have remained relatively stable at low levels over the recent study period. This pattern differed markedly from those observed in the upstream study sections despite a similar strong recruitment cohort of Age II fish in 2007 (Figure BVHD-19) that was not repeated in 2008. Growth, ultimate length at age, and distribution of fish throughout the normal age – length analysis increments (Figure BVHD-20) appeared far less influenced by drought based flow limitations than the upstream brown trout populations. The presence of older, larger fish within the Fish and Game Section (Figure BVHD-21) exhibited a declining trend and low densities of the Age IV (16" – 17") component but also exhibited relatively robust contributions to the population by the larger Age V and older fish. Brown trout condition factor (Figure BVHD-22) exhibited a temporary improvement in 2007 with the addition of a relatively substantial cohort of Age II fish but continued a decline in 2008 as the cohort advanced to Age III. The older larger fish in the population, however, exhibited substantial declines in condition over the 2007 – 2008 samples. The response in condition demonstrates a level of stress exerted on the population similar to that observed in the upstream tailwater study sections. The data suggest that some form of compensatory mechanism has allowed the brown trout population of the Fish and Game Section to better adapt to reduced habitat conditions via reduced density and standing crop. This apparent ability to support balanced densities of older, larger fish within the population under reduced flow regimes has not been observed in the more productive tailwater sections of the Beaverhead or Ruby Rivers.

The lower Beaverhead River is generally defined as the river reach between the City of Dillon and the confluence with the Big Hole River near the town of Twin Bridges. Major irrigation supply delivery is often attenuated at the West Canal at Dillon as accretions and tributaries provide the majority of water supply to lower river reaches. This often results in a lack of channel forming discharge events, low summer flows coupled with high summer water temperatures, and an increasing limb of the hydrograph through the winter months. This condition is sometimes described as an inverted hydrograph and has been associated with numerous aquatic habitat problems in the lower Beaverhead River. Recent base summer flow regimes in the lower river (Figure BVHD-23) have remained far below average and far below the FWP Minimum Flow Reservation of 200 cfs for the reach. Chronic low flows have also been accompanied by extemely high thermal regimes, particularly during July when recorded maxima have often entered the upper 70 degree range. Base summer flows have maintained below recommended minima for nine consecutive years in the lower Beaverhead.

Brown trout populations in the Anderson Section of the lower Beaverhead River (Figure BVHD-24) remain chronically depressed when compared with densities and standing crops observed in other southwest Montana rivers. Recent trends exhibit a steady population increase, aided by the relatively successful recruitment of Age II fish into the population in 2007 and 2008 (Figure

Figure BVHD-18. Estimated spring density and standing crop of Age II and older brown trout in the Fish and Game Section of the Beaverhead River, 1988 - 2008.

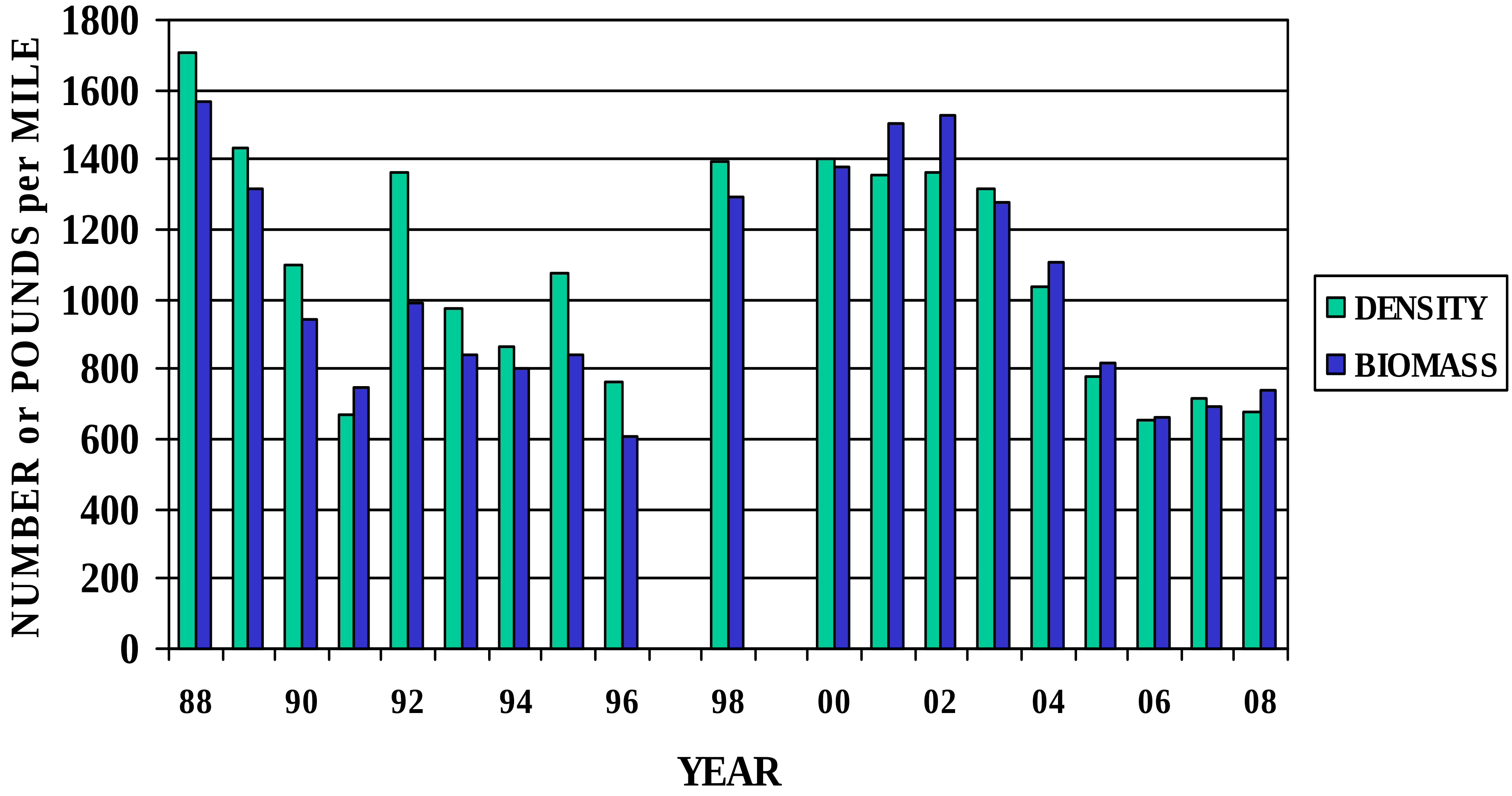


Figure BVHD-19. Length frequency distribution of Age II and older brown trout captured by electrofishing the Fish and Game Section of the Beaverhead River; Spring 2007 (N=844) and 2008 (N=879).

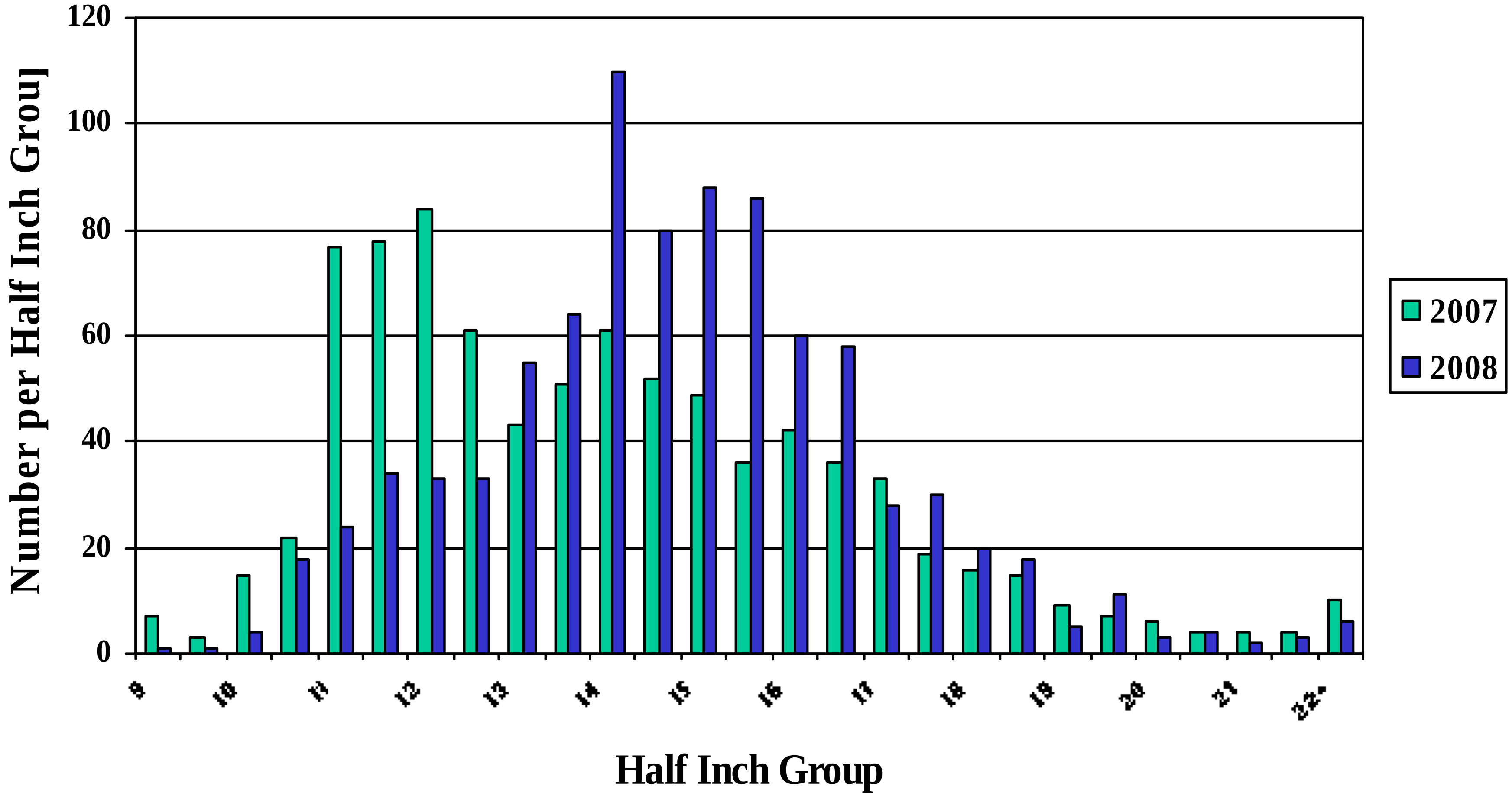


Figure BVHD-20. Estimated spring densities, by length group, of Age II and older brown trout in the Fish and Game Section of the Beaverhead River, 1988 - 2008.

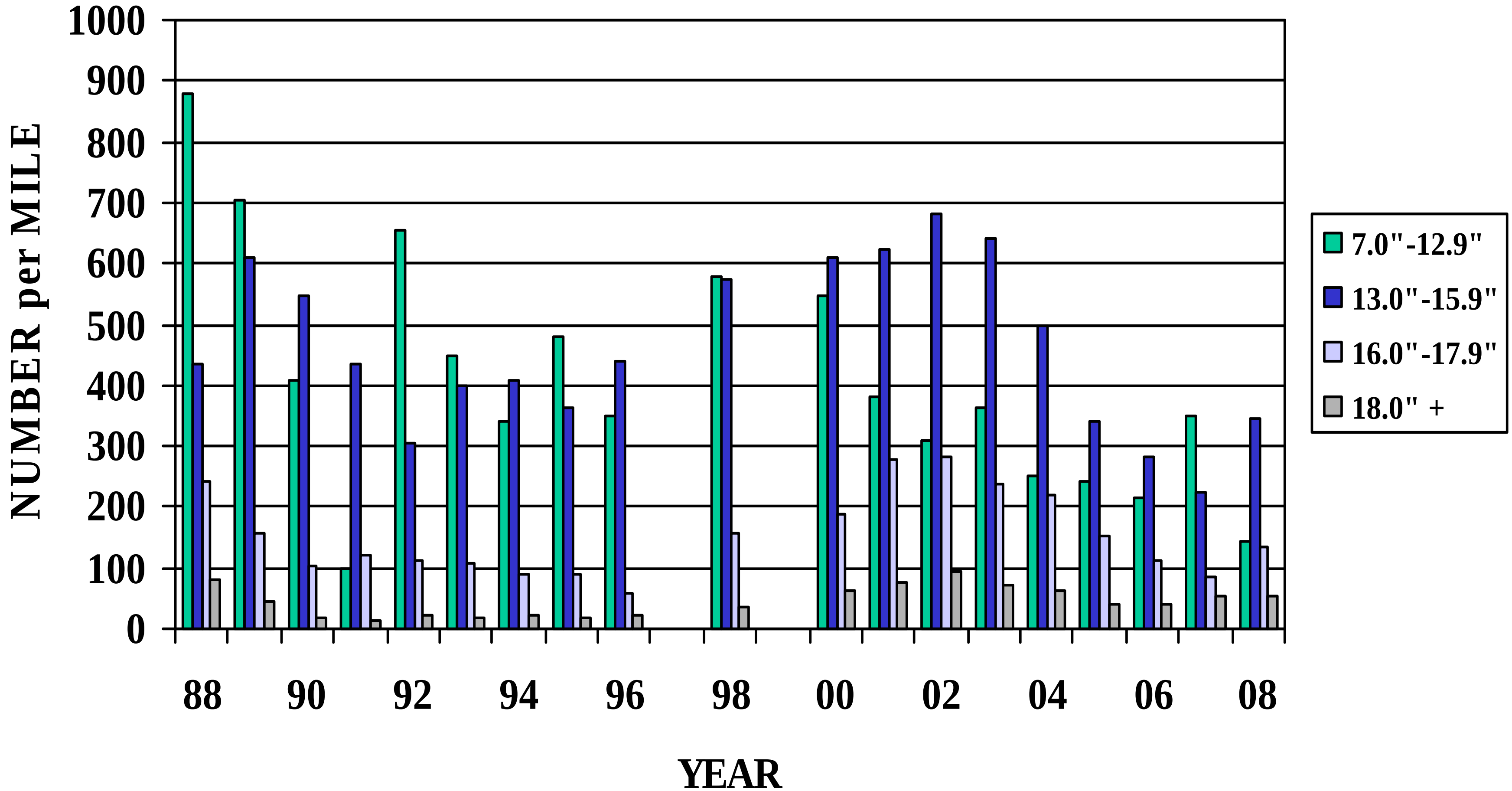


Figure BVHD-21. Estimated spring densites of Age IV and older brown trout, by discreet length group, for the Fish and Game Section of the Beaverhead River; 1996 - 2008.

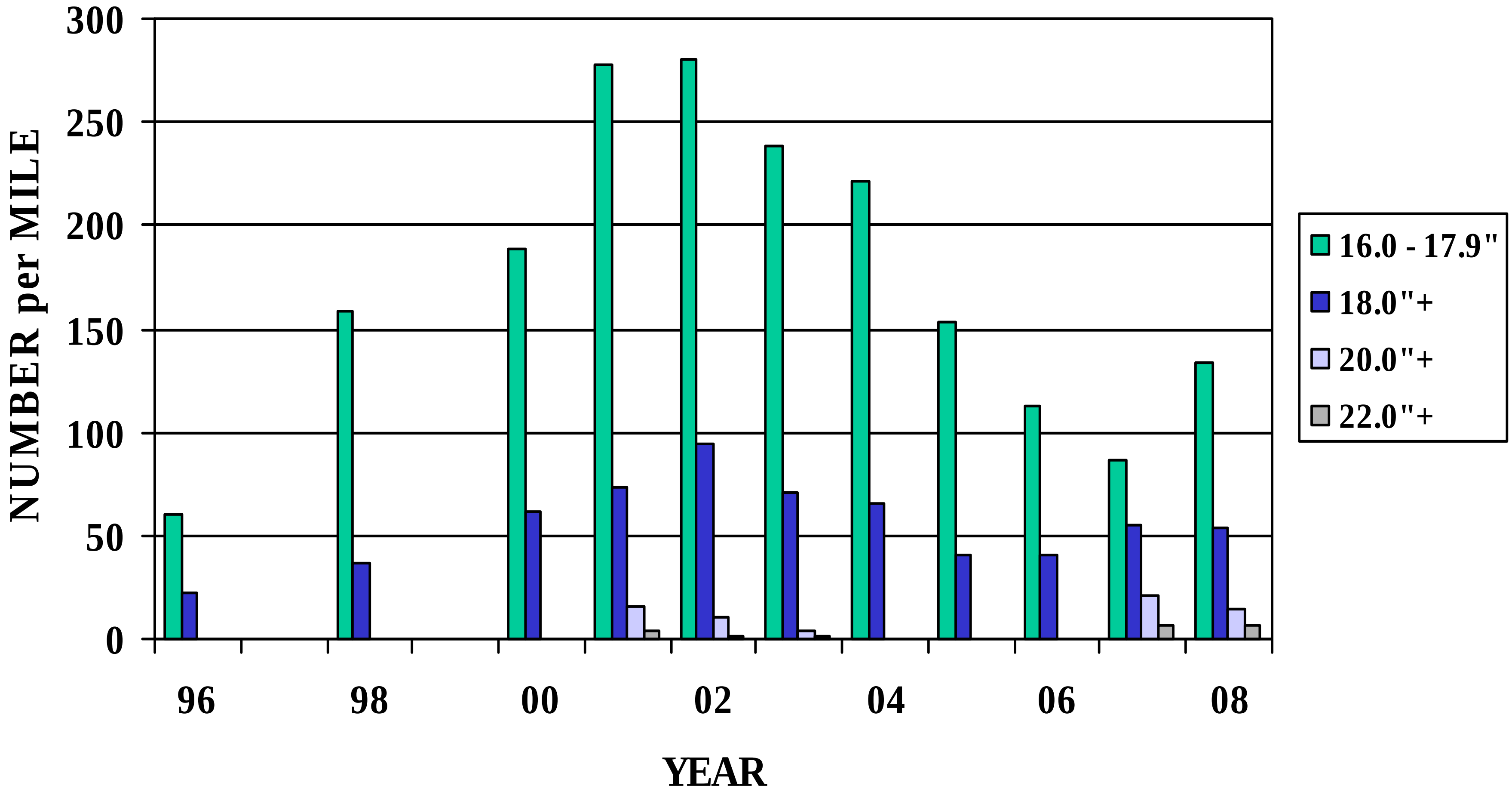


Figure BVHD-22. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Fish and Game Section of the Beaverhead River 1998 - 2008.

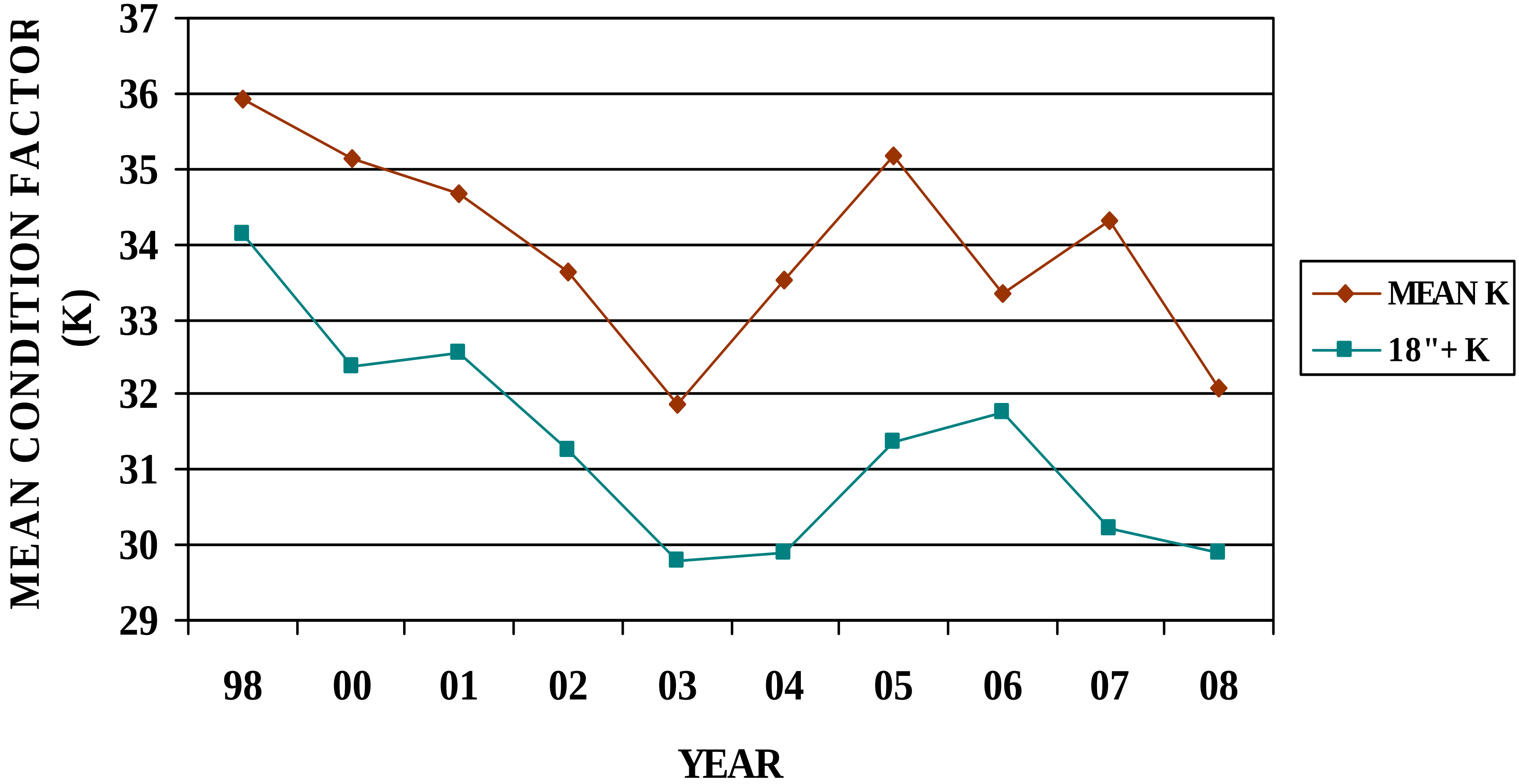


Figure BVHD-23. Mean July and August flows (cfs) and Minimum Recommended Flow (WETP Method) for the lower Beaverhead River measured at the USGS Twin Bridges Gage, 1988 - 2007.

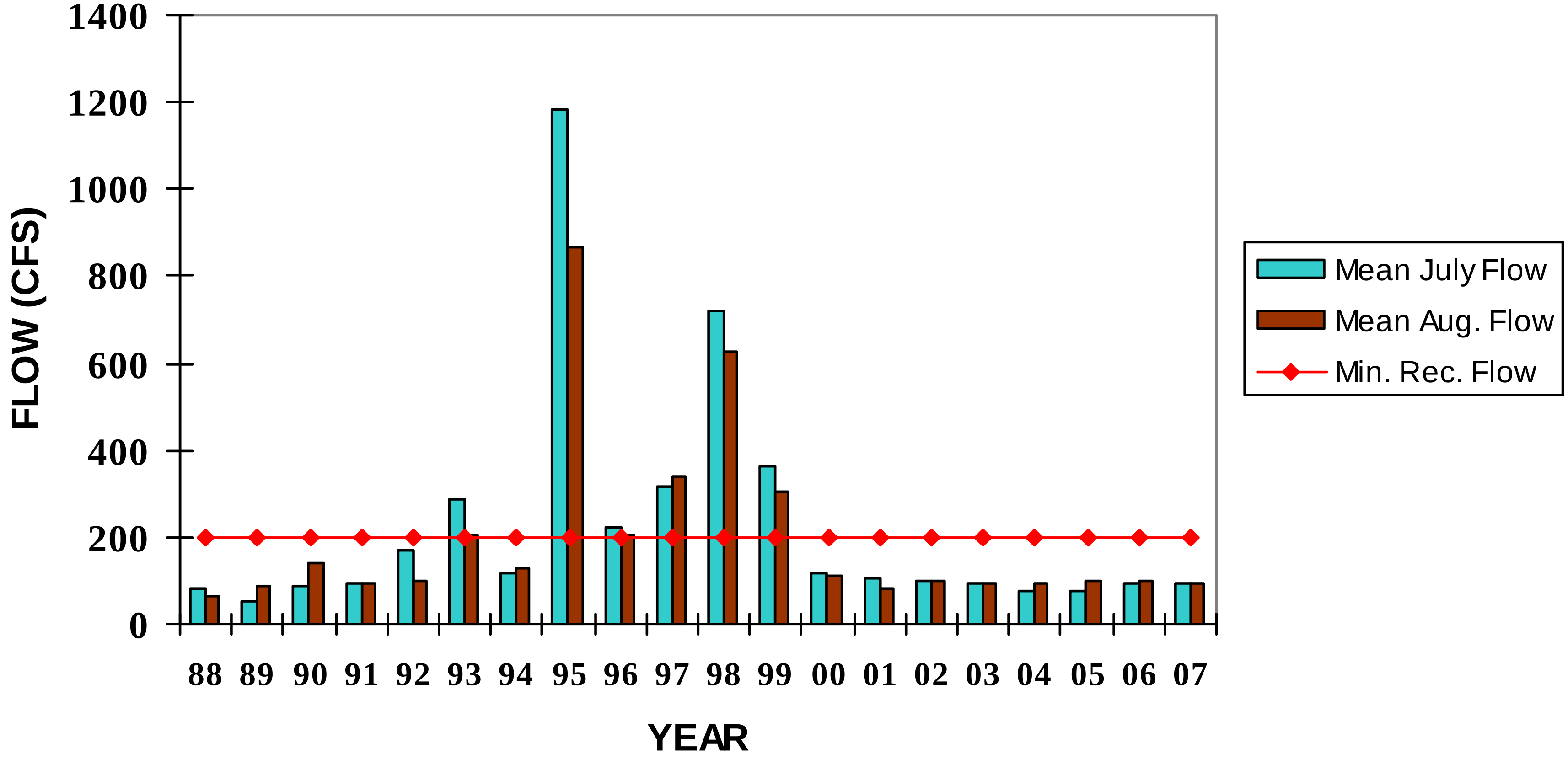
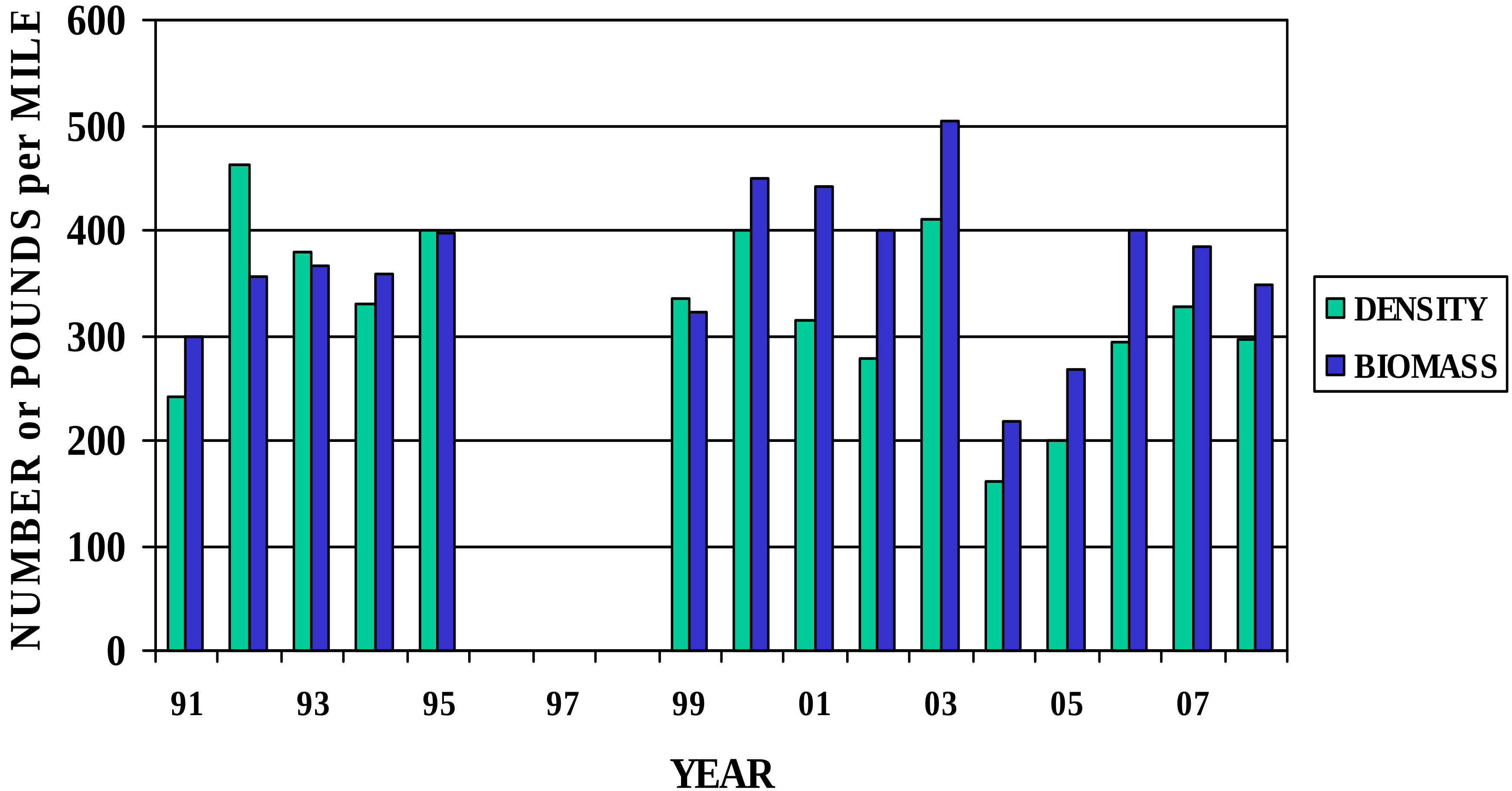


Figure BVHD-24. Estimated spring density and standing crop of Age II and older brown trout in the Anderson Section of the Beaverhead River, 1991 - 2008.



BVHD-25). Chronic low densities in the lower river are often accompanied by a relatively high percent composition of large fish accompanied by robust condition factors. The 18 inch and larger component of the population (Figure BVHD-25) had undergone a declining trend over the 2006 – 2008 sample period, however, increasing numbers of Age III and Age IV fish in 2008 should lead to improving densities of larger fish in the near future.

Mountain whitefish population densities and standing crops in the Anderson Section (Figure BVHD-26) have undergone substantial declines under chronic low summer flow regimes over the 2002 – 2008 period of study. Both population parameters were strongly correlated with cumulative years of sub-minimum summer flow regimes in a highly significant manner ($P<.01$) with density exhibiting $r = 0.94$ and standing crop exhibiting $r = 0.96$ over the period. Mountain whitefish density and standing crop also yielded relatively tight logarithmic regressions (Figure BH-27) as a function of the cumulative years of sub-minimum flow regimes suggesting that 92% of the variation in standing crop and 88% of the variation in density could be explained by the accumulation of years of low flow regimes in the lower river. Length frequency analyses of mountain whitefish sample populations (Figures BVHD-28, BVHD-29, and BVHD-30) suggest that the declines in density and standing crop have largely resulted from poor survival and poor recruitment of juvenile cohorts resulting in compositions skewed toward older, larger fish.

Poindexter Slough provides one of the few public opportunities to access a valley floor spring creek fishery in southwest Montana. Flow in Poindexter Slough is also augmented, via diversion from the Beaverhead River, to supply irrigation demand, primarily in the Dillon Canal. Recent restrictions applied by irrigation boards at the point of diversion, have resulted in flow regimes far below the FWP minimum and reservation of 57.9 cfs in Poindexter Slough. These sub-minimum flow regimes have been most markedly manifest in the reach downstream from the Dillon Canal Diversion. The low flow regimes have been accompanied by large-scale sedimentation in the absence of meaningful flushing flows. The sediment deposition appeared to be largely autochthonous and of an organic composition resulting in a visible loss in habitat niche diversity and thalweg depth. Recent trends in brown trout density and standing crop have been indicative of a slow and steady decline since the 2000 sample (Figure BVHD-31). While the 2005 and 2006 samples exhibited improvements in population density, these gains were short lived and were not accompanied by increases in standing crop. The increased densities were associated with relatively substantial recruitment cohorts of Age I fish (Figure BVHD-32) that did not contribute substantially to the brown trout biomass. Densities of 13 inch and larger fish (Figure BVHD-33) also exhibited a steady declining trend from 2000 – 2007 but increased markedly in 2008. This increase might have been the result of relatively good survival of the 2005 and 2006 cohorts of Age I fish. The densities of 15 inch and larger fish also exhibited a declining trend in recent samples through 2007 and exhibited a similar marked increase in the 2008 sample. This rapid increase could not be explained by juvenile recruitment trends or prior years' densities of 13 inch and larger fish. The rapid increase in these older, larger fish might have been a growth rate response to low densities and standing crops but this appeared doubtful in the absence of prior increases in the 13 inch and larger component. The increase might also have been due to an in-migration of larger fish to take advantage of deep water habitats behind a large beaver dam complex in the study section or an unmeasured improvement in the prior year's flow regime.

Figure BVHD-25. Estimated spring densities, by length group, of Age II and older brown trout in the Anderson Section of the Beaverhead River, 1991 - 2008.

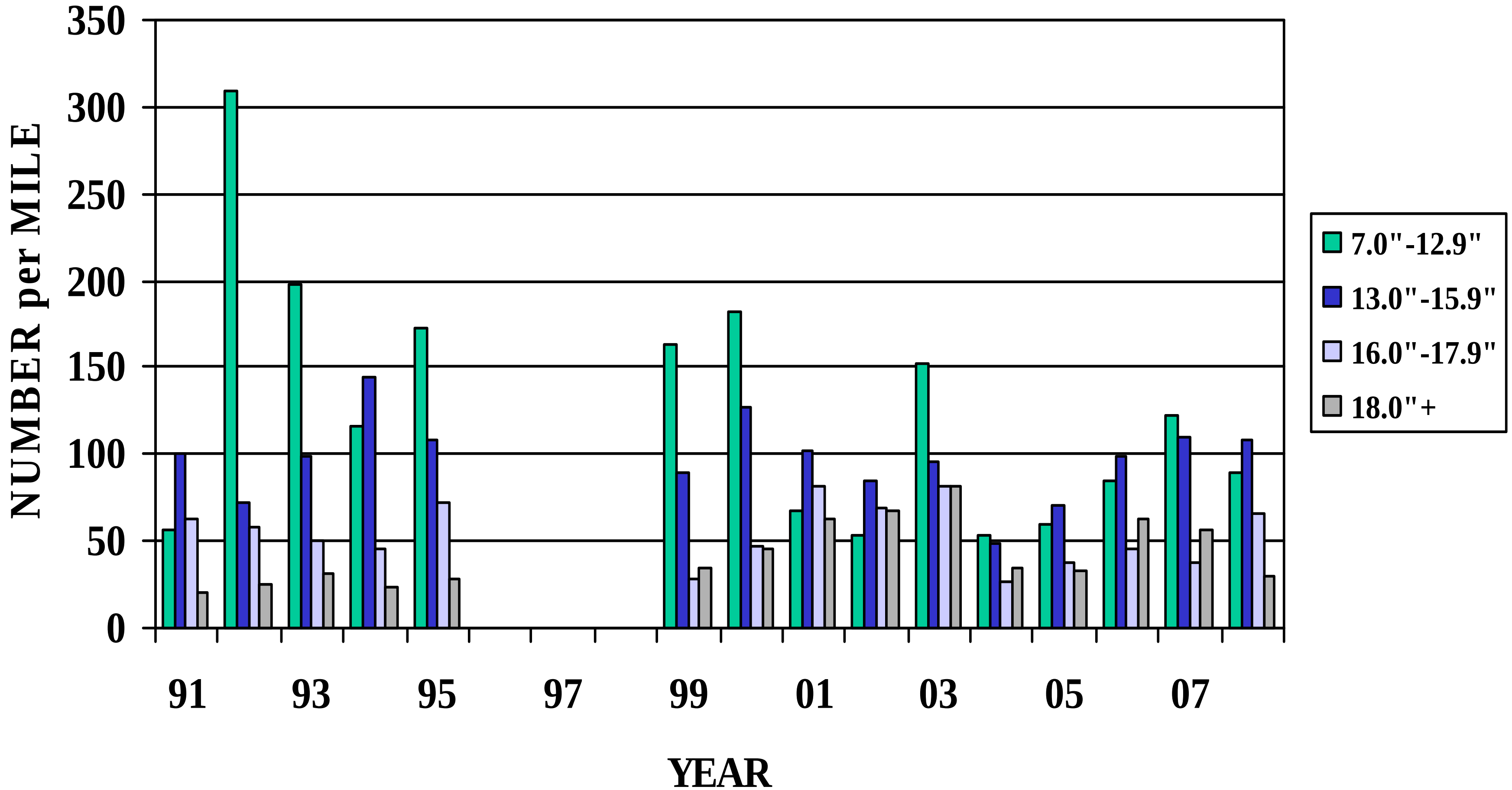


Figure BVHD-26. Estimated spring density and standing crop of Age II and older mountain whitefish in the Anderson Study Section of the Beaverhead River, 2002 - 2008.

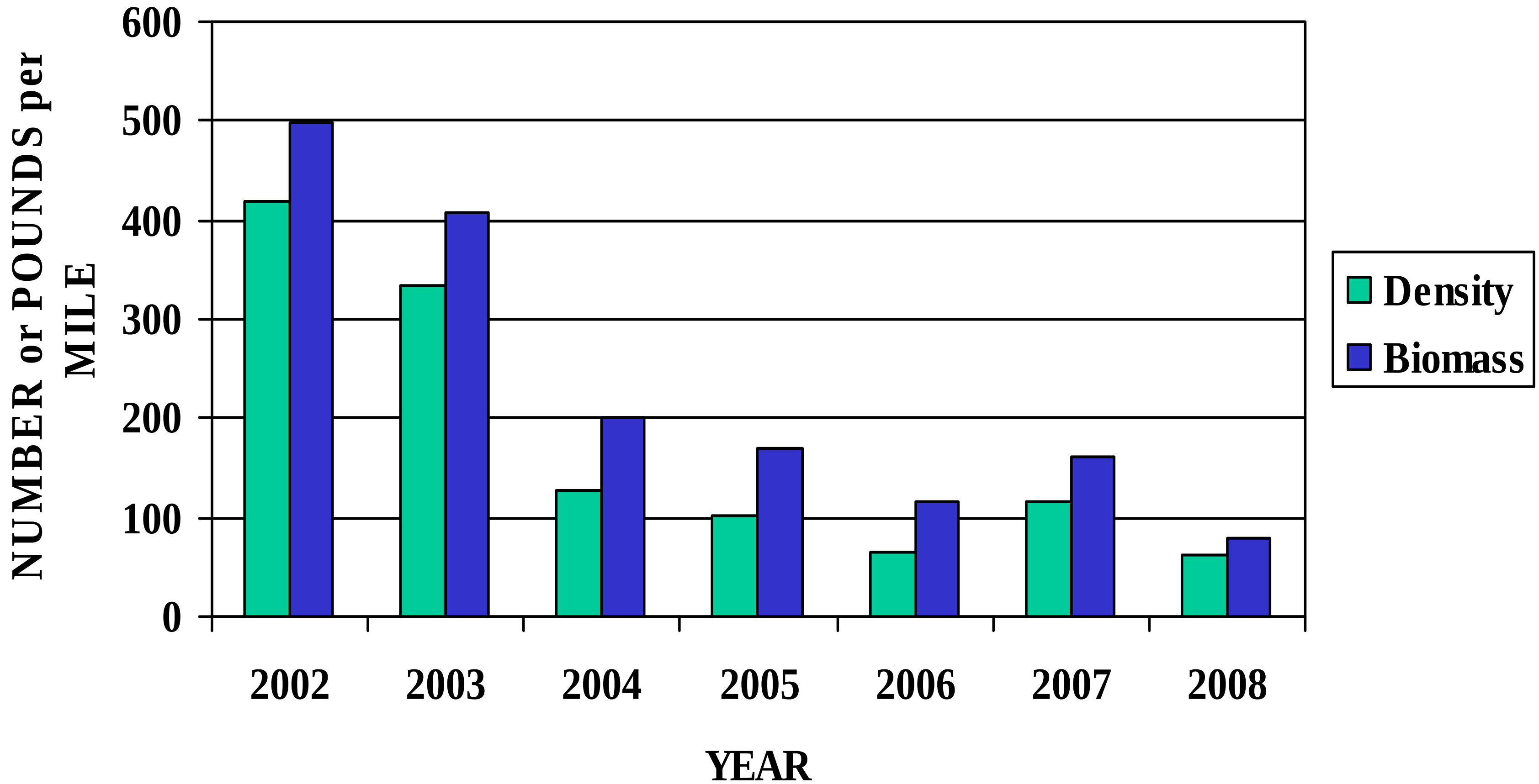


Figure BVHD-27. Logarithmic regression of estimated Age II & older mountain whitefish density and standing crop as a function of cumulative years of base summer (July-August) flow regimes in the Anderson Section of the lower Beaverhead River; 2001 - 2008.

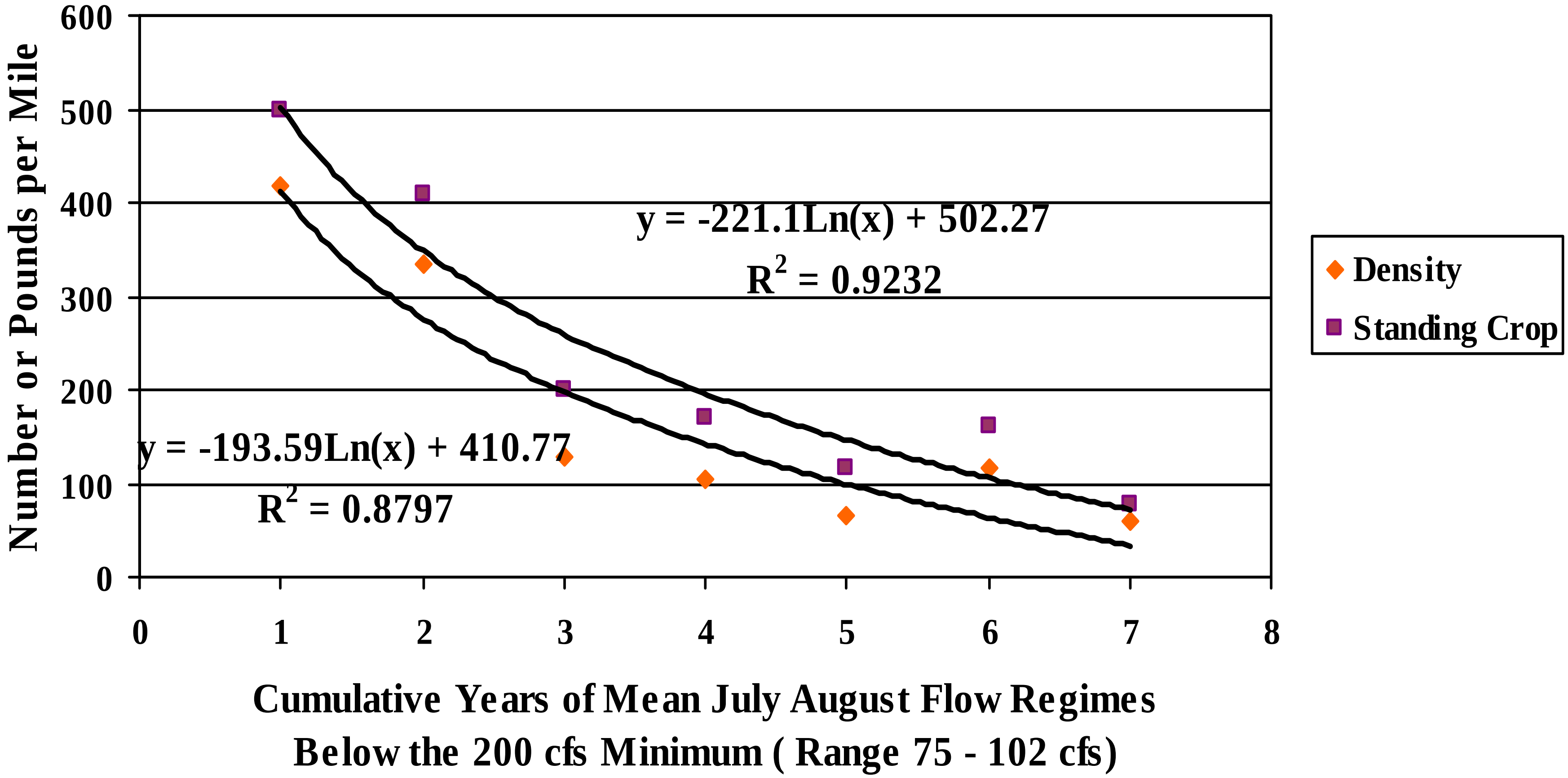


Figure BVHD-28. Length - frequency distribution of Age II and older mountain whitefish collected in the Anderson Study Section of the Beaverhead River, spring 2002 (N=597).

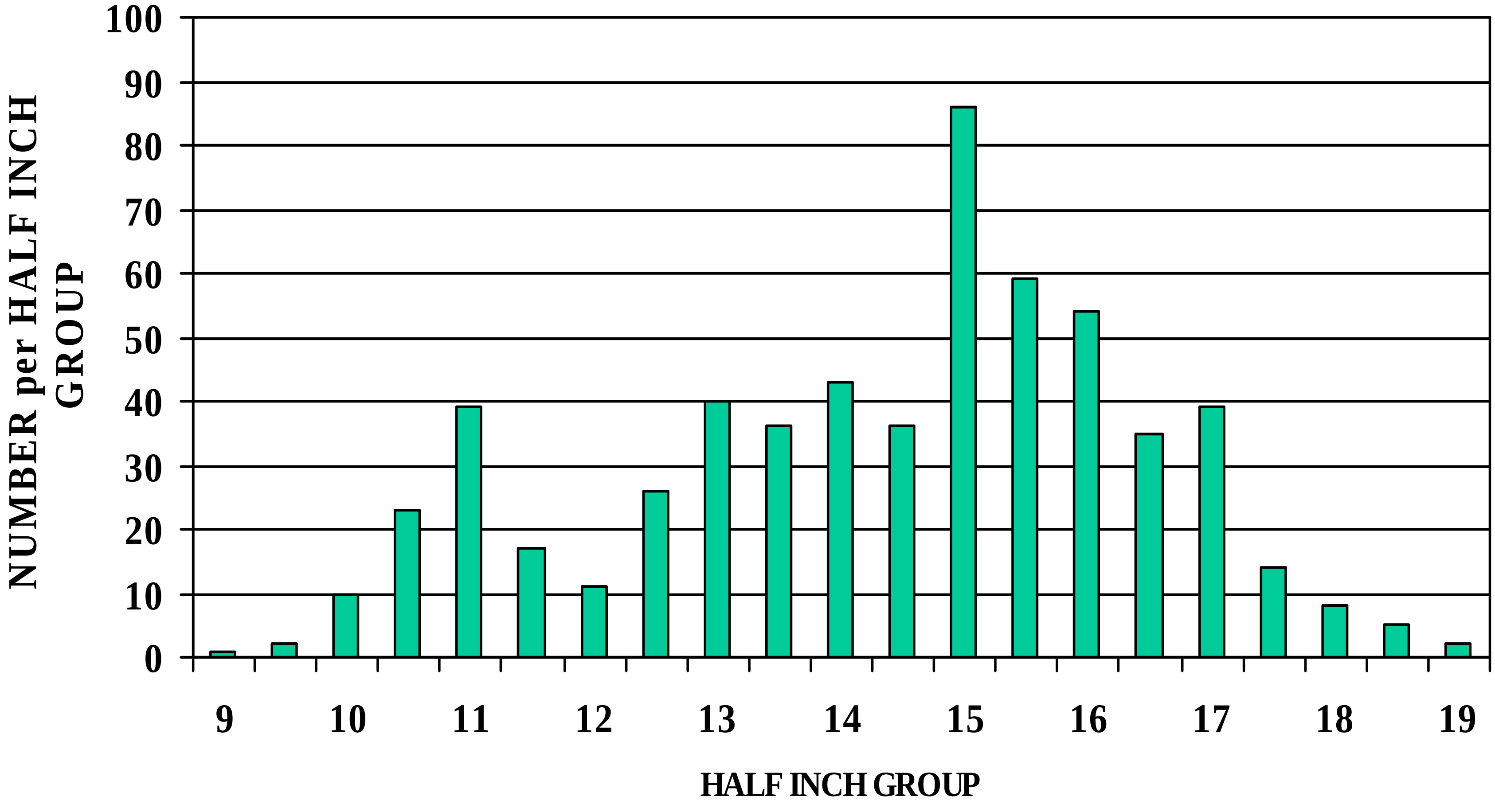


Figure BVHD-29. Length - frequency distribution of Age II and older mountain whitefish from spring samples collected in the Anderson Section of the Beaverhead River, 2006 (N=198).

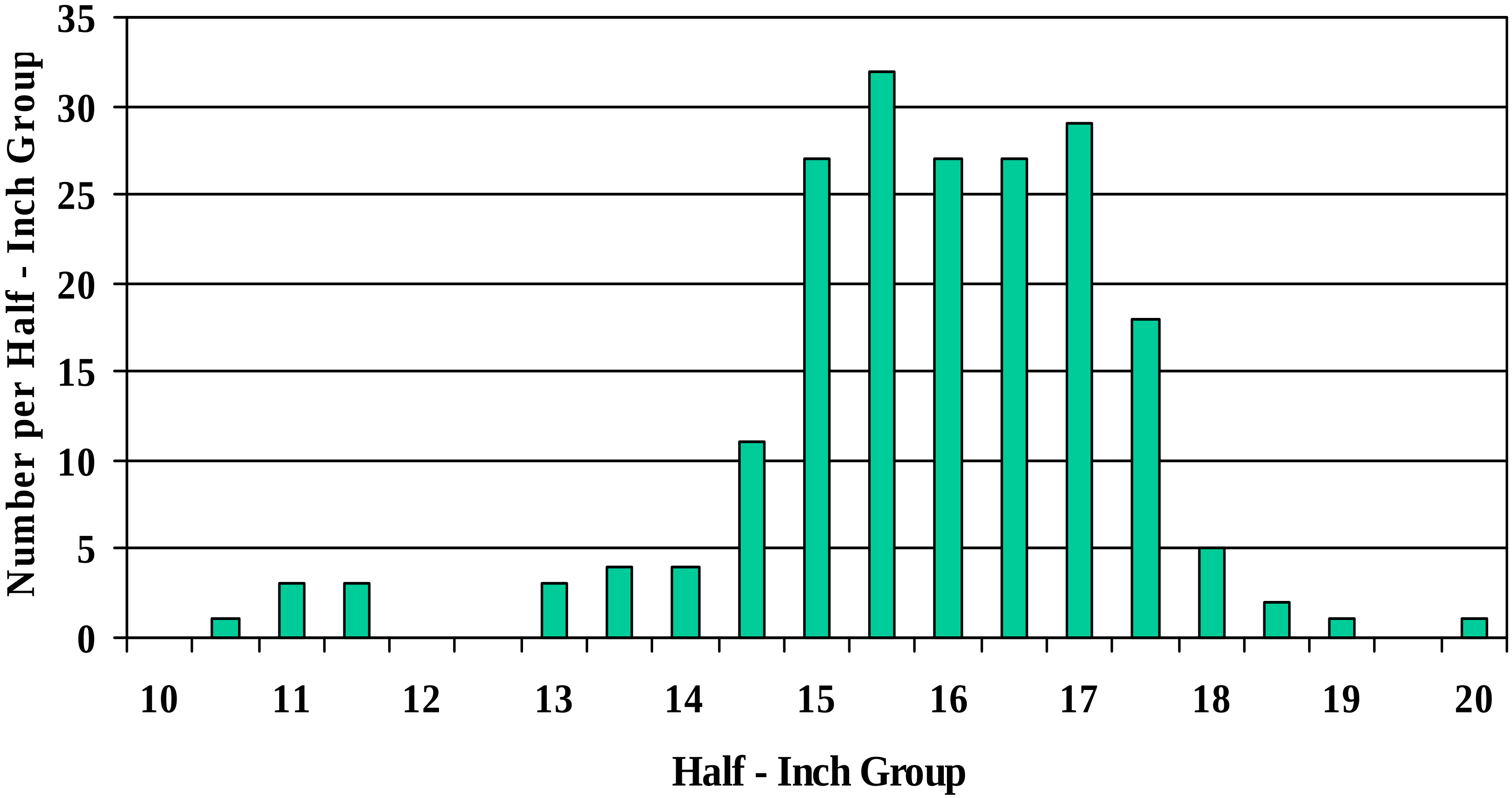


Figure BVHD-30. Length frequency distribution of Age II and older mountain whitefish captured by electrofishing in the Anderson Section of the Beaverhead River; Spring 2007 (N=137) and 2008 (N=131).

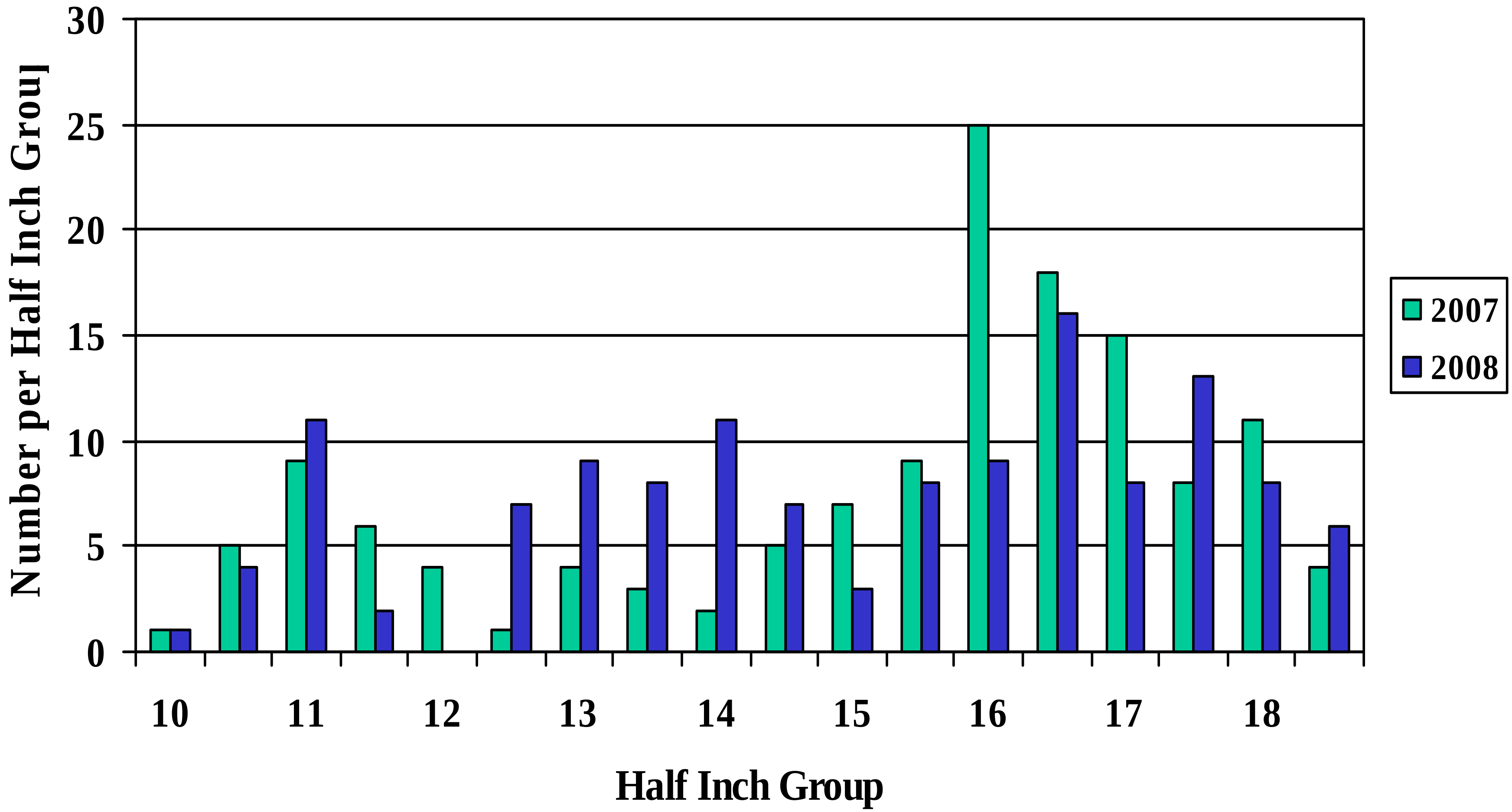


Figure BVHD-31. Estimated spring density and standing crop of Age I and older brown trout in Section Three of Poindexter Slough; 1989 - 2008.

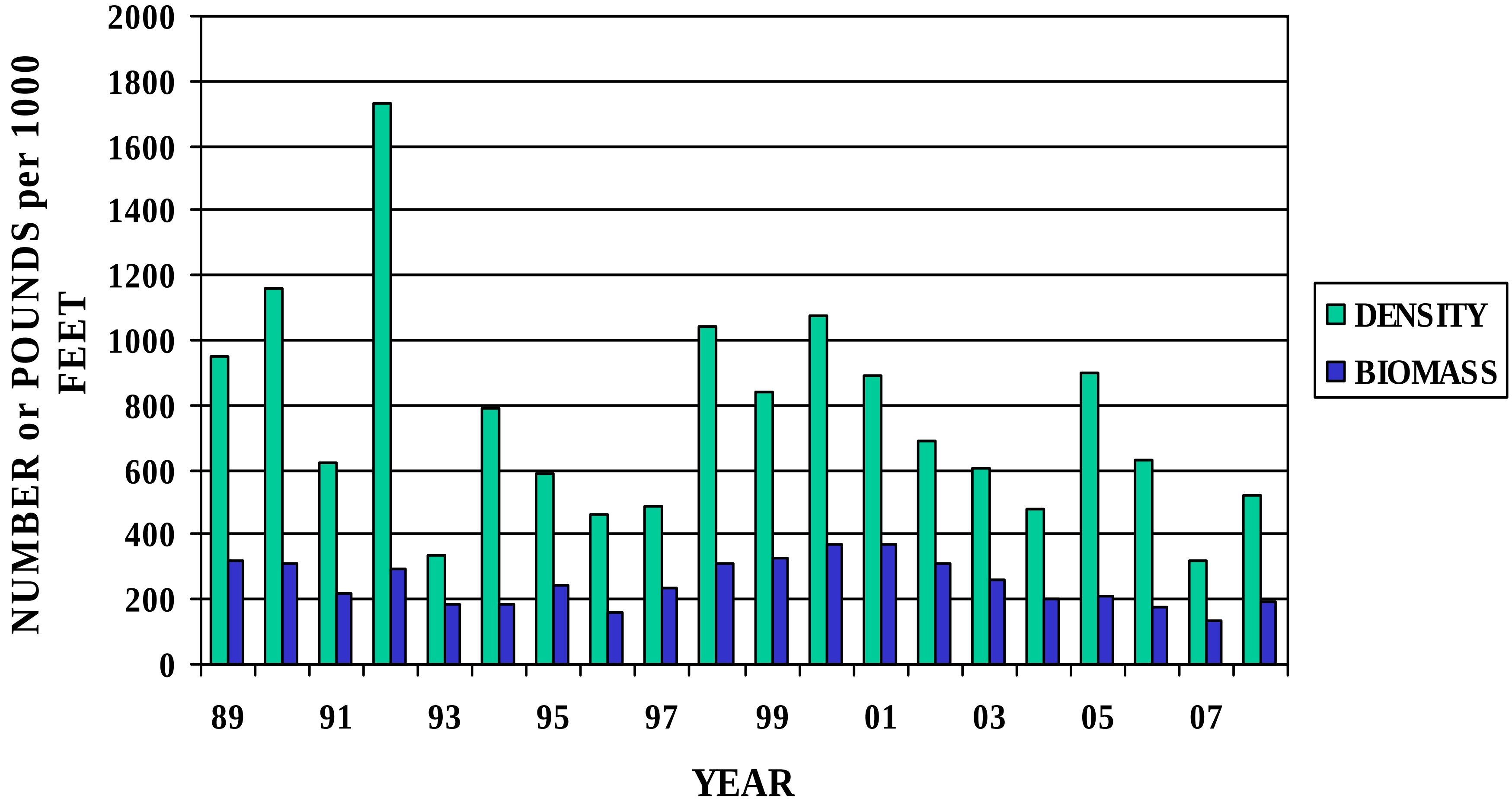


Figure BVHD-32. Estimated spring density of Age I brown trout in Section Three of Poindexter Slough, 1989 - 2008.

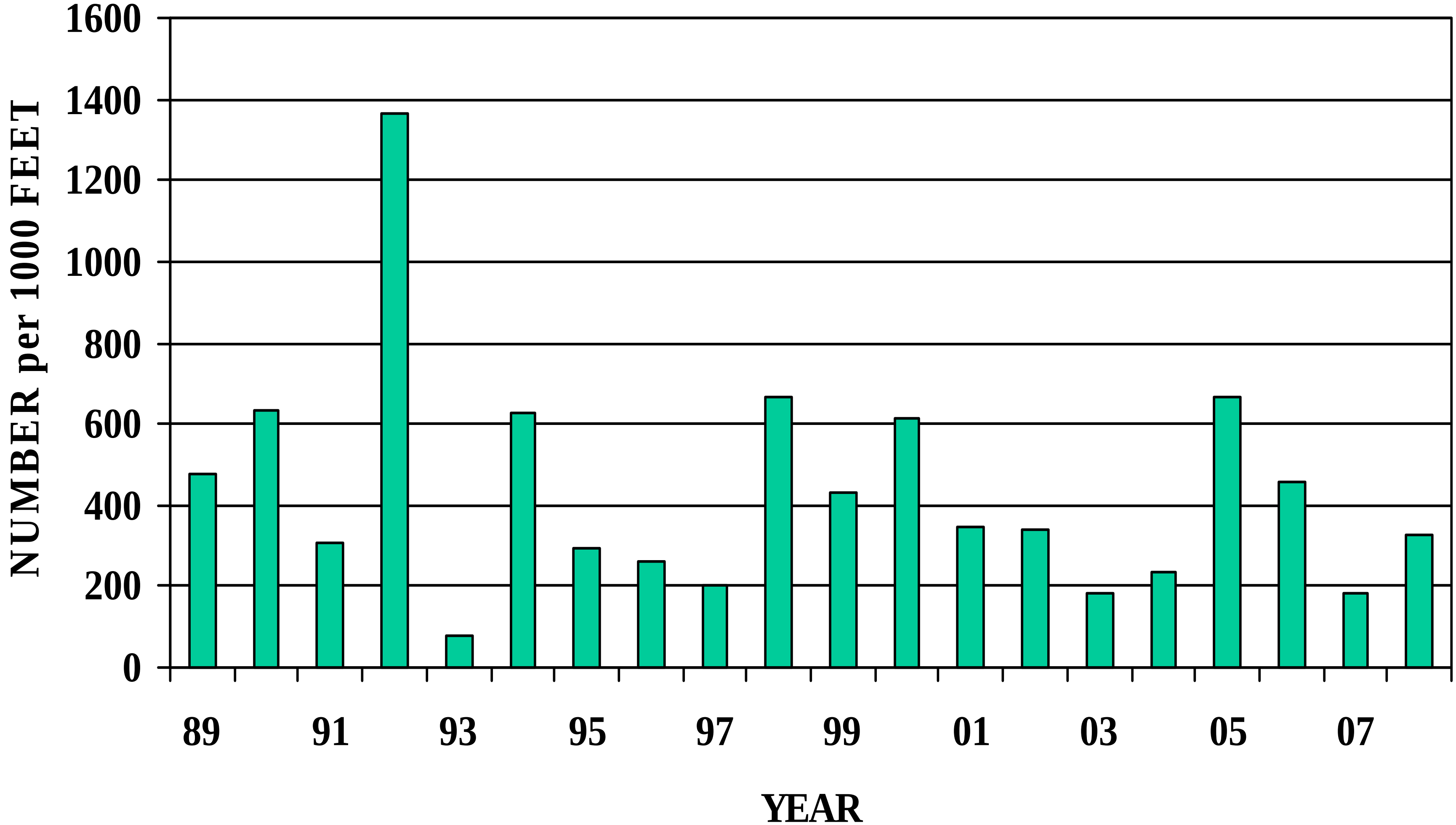


Figure BVHD-33. Estimated spring density of 13 inch and larger brown trout in Section Three of Poindexter Slough, 1989 - 2008.

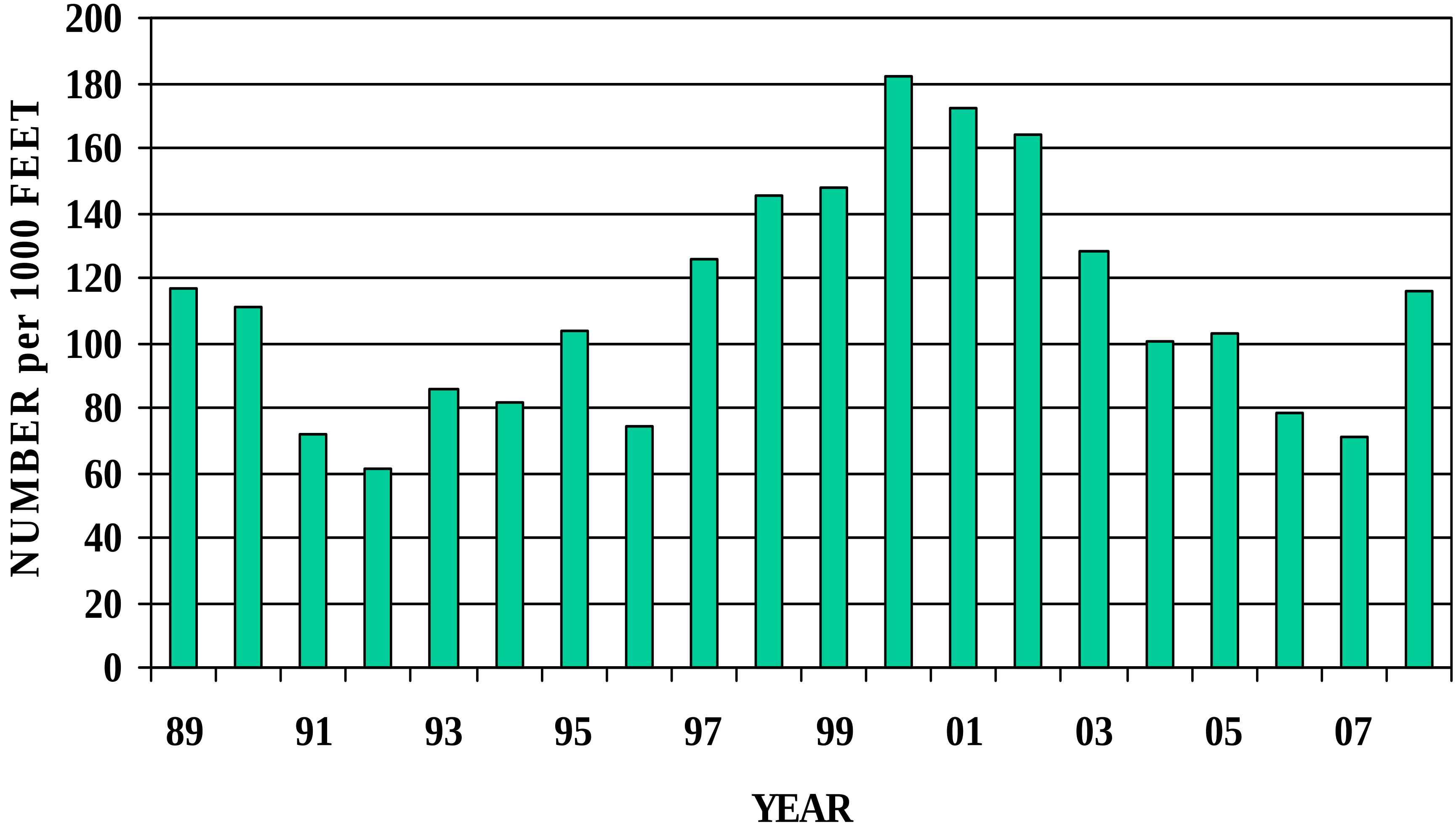
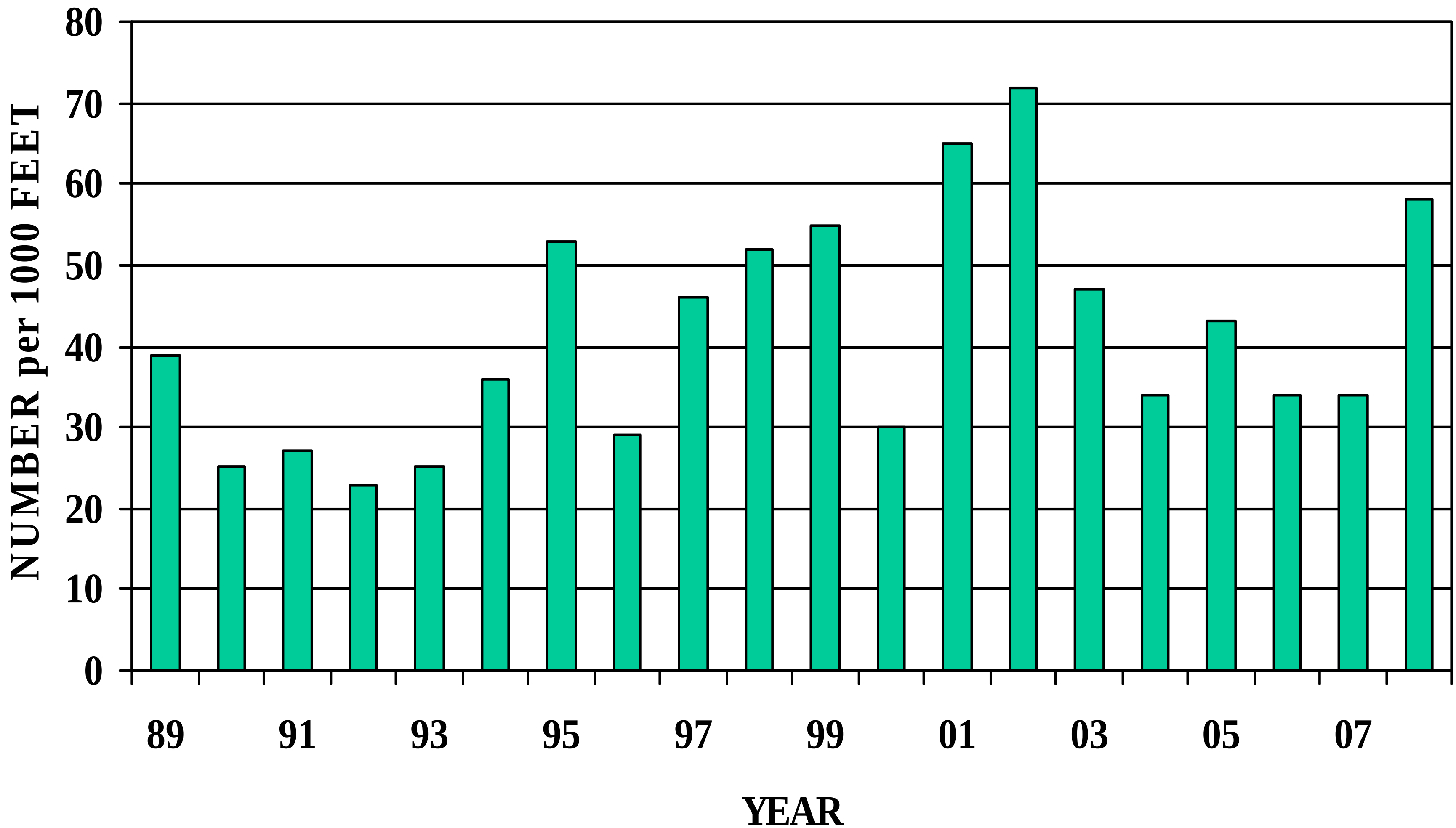


Figure BVHD-34. Estimated spring density of 15 inch and larger brown trout in Section Three of Poindexter Slough, 1989 - 2008.



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May 2009

All work included in this report in conjunction with Federal Aid in Fish and Wildlife Restoration Acts:
Project Numbers: F-113-R-6, R-7, and R-8
Montana FWP Project Number 3320