INVENTORY AND SURVEY OF SELECTED STREAM FISHERIES OF THE RED ROCK, RUBY, AND BEAVERHEAD RIVER DRAINAGES OF SOUTHWEST MONTANA; 2003 - 2006

By:

Richard A. Oswald

October 2006
Montana Department of Fish, Wildlife & Parks
Region Three
1400 S. 19th Avenue
Bozeman, Montana

ABSTRACT

Trout population data are presented for six study sections on the Beaverhead River. Trout populations of the upper river tailwater environment declined substantially in association with drought influenced declines in flow below the recommended minimum of 200 cfs. Brown trout populations suffered declines in density, standing crop, numbers of older, larger fish, and condition similar to those experienced in prior drought episodes of the late 1980's and early 1990's. Lower river brown trout and mountain whitefish populations also exhibited substantial declines in association with low flow regimes. Salmonid population data are presented for two study sections in the upper Ruby River. Trout populations declined substantially from drought influenced flows exhibiting reductions in density, standing crop, recruitment, and condition factor. Data are also presented describing Arctic grayling reintroduction efforts in the upper Ruby River. Trout population data are presented for two study sections sampled in the lower Ruby River system. The affects of the recent drought on brown trout populations are discussed among the various study sections over the period of record. The trout populations of Poindexter Slough are presented for the study period. Brown trout population declines and recovery are discussed in regard to flow reductions in the system. Brown trout population data for a new study section on the Red Rock River are presented and data compared with similar study sections that were sampled in the late 1980's and early 1990's.

ACKNOWLEDGMENTS

The author would like to gratefully acknowledge the able assistance of the following individuals in the collection of field data under often arduous conditions; Scott Lula, Tim Mosolf, Jon Hoerning, Tracy Elam, Sam Hochhalter, James Magee, Austin McCollough, Adam Petersen, and Emily Rens. The author would also like to thank Dick Vincent, Jim Peterson, Ken Staigmiller, Jeff Bagdanov and Jody Hupka for assistance in the analyses of Whirling Disease samples. Finally, the author would like to acknowledge the assistance of Bob McFarland, Reed Simonson, Wayne Black, and Deanna Meredith in data preparation and analysis techniques.

TABLE OF CONTENTS

INTRODUCTION

The mainstem river fisheries of the upper Missouri River drainage of southwest Montana are nationally renowned for their wild trout populations and “blue ribbon” fisheries. These river systems, first described by the Lewis and Clark expedition in the early 1800’s, also contain smaller tributary streams which provide high quality sport fisheries or support native fish populations in isolated settings. The popular sport fisheries of these drainages are based on abundant wild trout populations and support relatively high angler use, both of which have recently undergone relatively substantial declines associated with severe drought conditions (Oswald 2003, 2004, 2005). Similar declines in trout populations and angling pressure were observed in the drought episode of the late 1980's and early 1990's. More recent precipitation and snowpack conditions have resulted in improvements in soil moisture and surface water supply, warranting a drought –free classification for Beaverhead and Madison counties in 2005 (NRCS and NWS classification data 2005). Depleted aquifers and reservoir storage pools resulting from 5 to 6 years of continuous drought have maintained reduced flows in most area streams throughout the report period, however. This report details wild trout and mountain whitefish population dynamics in selected study sections of mainstem rivers and tributary streams in the Red Rock, Ruby, and Beaverhead River drainages of southwest Montana which were last described by Oswald (2003).

The streams of southwest Montana support a relatively limited diversity of native fish species to include westslope cutthroat trout; Arctic grayling; mountain whitefish; burbot; white, longnose, and mountain sucker; longnose dace, and mottled sculpin. Concern over the future of native fluvial Arctic grayling of the upper Missouri River system has led to recent grayling reintroduction projects beginning in 1997 in the upper Ruby River and in 1999 in the lower Beaverhead River (Oswald, 2000c). Concern over the future persistence of native westslope cutthroat trout has resulted in numerous studies of population genetics and hybridization, competition with introduced species, and habitat limitations. These studies have resulted in recent projects which have attempted to improve habitat quality, reduce competitive factors and expand westslope cutthroat trout distribution within the upper Missouri drainage (Oswald 1999, 2000c, and 2003). The popular sport fisheries of southwest Montana are largely based upon wild populations of introduced salmonids including the brown, rainbow, and brook trout as well as lesser tributary contributions of Yellowstone cutthroat trout or rainbow trout and their hybrids with native westslope cutthroat trout. Introduced nongame species include the red side shiner minnow and common carp which are present at low density in lower reaches of the mainstem river systems.

The Beaverhead River supports variable populations of brown and rainbow trout dependant upon dominant habitat type, regulated flow regimes, inverted lower river hydrograph, distance from the tailwater of Clark Canyon Dam, sediment loading, thermal regime, and riparian development. The Beaverhead River can be roughly bisected into upper and lower river reaches at the City of Dillon, Montana based on flow regime. The upper river reach generally depends upon irrigation and flood control releases from Clark Canyon Dam for its dominant flow regime that can result in an extremely productive “tailwater” reach between the dam and Barretts Diversion. A spring runoff component can be introduced in the reach from major tributaries such as Grasshopper and Blacktail Deer Creeks which can also augment base flow. Summer stream flows generally remain ample while winter flows can often exhibit critical low flows for the maintenance of fish habitat. The lower river reach exhibits an inverted hydrograph in which spring and summer flows are often minimal and winter months are characterized by a rising hydrograph as irrigation water drains from alluvial terrace formations surrounding the valley floor. Lower river tributaries are largely representative of valley floor spring creeks or “sloughs” and are subject to the same inverted hydrograph as the river. The sport fishery of the Beaverhead River is dominated by brown trout while limited rainbow trout populations have been supported between Clark Canyon Dam and the city of Dillon, Montana. Beginning in 1999, an attempt was made to reestablish an Arctic grayling population in the lower river between the mouth of Stodden Slough and the confluence of the Beaverhead and Big Hole Rivers. This introduction effort was postponed after the 2001 plant due to persistent low summer flows and high water temperatures associated with drought conditions and low flow release regimes from Clark Canyon Dam. Past angler use of the Beaverhead River has been concentrated in the upper tailwater portions of the system between Clark Canyon Dam and Barretts Diversion. This concentrated use pattern has persisted to the present but estimated pressure had increased from 15,093 angler days in 1991 to 39,726 angler days in 1997 and 39,622 in 1999 (MFWP 1989-2001) with nonresident angler use accounting for about 63% of the total angler user days. In 2001, the Montana Fish Wildlife and Parks Commission established a Biennial Rule regulation that restricted float fishing use by commercial outfitters and nonresident anglers. This rule was renewed by the Commission for another two year period in 2003 and extended again in 2005. Angling pressure in 2001 declined markedly to an estimated 14,574 angler days, however, the percent contribution of the nonresident angler component remained high at 62.2% of the total. The 2001 pressure was similar to that observed in the drought influenced 1991 estimate and declines were similar to those observed in other area rivers which suffered drought influenced flow regimes. Angling pressure rebounded to 26,968 angler days in 2003 despite continuing low flow conditions, however, the nonresident component increased to 70.8% of the total. Angler use in 2005 declined back to 22,069 angler days with 55% nonresident participation as low stream flows and declining fish populations persisted. Oswald (2003) last described the salmonid populations of the Beaverhead River.

The fisheries of the Ruby River can be examined as two systems also, i.e., a lower river and an upper river environment, roughly bisected by the Ruby Reservoir. The lower Ruby River supports relatively abundant populations of brown trout in habitats downstream from the Ruby Reservoir. The size composition and abundance of these populations is dependant upon distance from the reservoir tailwater, dominant habitat type and condition, and flow release regime from the dam. Oswald (2000c) presented a relatively complete picture of brown trout density and production throughout the length of the lower Ruby River. Upper Ruby River fisheries are dominated by brown and rainbow trout in relatively close proximity to the reservoir while upper reaches of the river are dominated by a hybridized swarm of rainbow trout and westslope cutthroat trout. Since 1997, attempts have been made to reintroduce a fluvial Arctic grayling population in the upper Ruby River. In 1994, a complete dewatering of Ruby Reservoir occurred (Oswald 2000a and 2000c) resulting in a significant fish kill in a limited reach of the Ruby River tailwater downstream from the dam. This event led to the formation of a Governor’s Ruby River Task Force that investigated and recommended methods to promote adequate storage in Ruby Reservoir and adequate flow regimes for irrigation and fisheries in the Ruby River. Oswald (2000c and 2003) described the response of the fisheries to abundant flow regimes of the late 1990’s followed by the reduced flows of the current drought episode. In 1995, angler frustration over decreasing access to private lands along the lower Ruby River led to the formation of a Governor’s Ruby River Fishing Access Task Force. Recommendations of this Task Force led to the formation of a Lower Ruby River Fishing Access Plan (MFWP 1996) and the ultimate acquisition of 5 public fishing access sites along the lower river corridor in 1996. Increased public access had an immediate affect on angling pressure within the lower Ruby River reach. In 1997, angling pressure on the lower Ruby was estimated at 9,458 angler days, a marked increase over the 1995 pressure estimate of 5,974 angler days (MFWP 1989-2001). Angling pressure continued to increase to an observed high of 13,996 angler days in 1999 but declined markedly to 9,162 in 2001. Similar to the Beaverhead River, nonresident anglers composed 62.6% and 64% of the 1999 and 2001 angling pressure, respectively. The 2003 and 2005 pressure estimates exhibited an increase in angler use to 11,317 and 11,356 angler days with nonresident use composing 57% and 55% of the total pressure, respectively. Angling pressure in the upper Ruby River has historically remained relatively low despite an abundance of public ownership on Beaverhead National Forest lands. Pressure estimates from 1989 through 1995 averaged 685 angler days per year with an observed maximum of 862 in 1991. Similar to trends in other area rivers, angling pressure increased sharply to 1,591 and 1,252 angler days in 1997 and 1999 but declined under the influence of drought impacted flows to 763 angler days in 2001 and rebounded markedly to 2,020 angler days in 2003. The 2003 angling use was dominated by resident fishermen at 62.7% of the use. The 2005 pressure estimate of 1,684 angler days was quite comparable to the modern pre-drought use levels of 1997 and 1999. The 2003 and 2005 pressure estimates were probably reflective of improved summer flow regimes in both of those sample years. Fish population data for both the upper and lower reaches of the Ruby River were last reported by Oswald (2003).

Poindexter Slough is a major public spring creek fisheries resource. It is tributary to the Beaverhead River and is located in close proximity to the city of Dillon, Montana. While base flows of Poindexter Slough are maintained through accretions from numerous valley floor spring sources, a significant portion of the stream’s summer flow consists of irrigation water diverted from the Beaverhead River. The fishery of Poindexter Slough is dominated by wild brown trout which attain extremely high density due to an abundance of favorable spawning and rearing habitat. Much of the productive fisheries reach of Poindexter Slough is located on public fishing access property maintained by MFWP. Recent angling pressure estimates indicate a use rate of approximately 3,000 angler days per year through 1999 (MFWP 1989 - 2001). Unlike most other area waters, Poindexter Slough has maintained a relatively stable base flow from spring sources despite severe drought conditions. As a result, angling pressure increased in 2001 to an observed high of 4,095 angler days. Recent restrictions in river water diverted into the Slough, however, have resulted in diminished flow regimes and declining angler use down to 2,757 angler days in 2003 and 1,589 angler days in 2005.The brown trout populations of Poindexter Slough were last described by Oswald (2003).

The Red Rock River is representative of another system bifurcated by an irrigation dam and reservoir. The river originates in the upper Centennial Valley of southwest Montana as the geographic origin of the Missouri River system at Hell Roaring Creek. The upper river supports sparse fisheries between Red Rock lakes and Lima Reservoir due to limited habitat niche diversity and abundance associated with relatively low gradient in a sand dune, ancient lake bed geology. The 57.4 mile lower river reach between Lima and Clark Canyon Reservoirs can support relatively abundant gamefish populations of wild brown trout and mountain whitefish as well as limited populations of rainbow trout. The lower river reach also provides important spawning habitat for adfluvial rainbow trout, brown trout, and mountain whitefish from Clark Canyon Reservoir on a seasonal basis (Oswald 2004). A new study section was initiated in the

Red Rock River near the town of Dell, Montana in 2005. The Martinell Section was selected to monitor brown trout populations in the aftermath of severe drought conditions, angling closures, and voluntary efforts by landowners to maintain minimal stream flow. The Martinell Section originates upstream from the confluence with Big Sheep Creek and terminates at the channel bifurcation upstream from the Sage Creek Road. The section is 4,518 feet in length. The resident trout populations of the Red Rock River near Dell, MT were monitored briefly during the drought episode of the late 1980's and early 1990's (Vincent et al 1990) in the aftermath of a total dewatering of the channel that persisted for 10 months between July 1988 and May 1989. These earlier efforts were concentrated in the Wellborn and Dell Study Sections located adjacent to each other immediately downstream from the current Martinell Section. Reaches up and downstream from the Martinell Section were observed as totally dewatered or carrying minimal flows of 1. 0 to 4.0 cfs at different base summer flow regimes during the current drought episode. The Martinell Section, however, maintained minimum base flows in the 25 to 30 cfs range throughout the same period. The Red Rock River usually supports a relatively low angler use due to a preponderance of private land ownership and limited opportunities for public access. From 1991 through 1999 angling pressure on the Red Rock River averaged 1,277 angler days per year, peaking, similar to other area waters, in 1997 at 2,375 angler days. Fishing pressure on the Red Rock River has been heavily dominated by nonresident use averaging 77.8% over the 1991 – 1999 survey period. Recent voluntary and mandatory drought based fishing closures placed within the system from 2000 through 2004 had severely reduced or virtually eliminated angler use within the Lima Dam to Clark Canyon Reservoir reach. The opportunity to fish the river in 2005 did not result in a return to pre-drought use levels with an estimated 514 angler days expended in the reach.

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 is 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.

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 (1998). 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.

RESULTS

UPPER BEAVERHEAD RIVER

Flow Regime

Persistent drought conditions and resultant low storage pools have dominated the past five years in Clark Canyon Reservoir (Figure 1). Storage improved slightly in 2005 but did not result in any subsequent flow improvements in the Beaverhead River and did not attain the minimum recommended storage pool for fisheries last approximated in 2000. The current storage situation is similar to that experienced during the 1989 - 1992 period which resulted in extremely low over winter flow releases into the Beaverhead River and subsequent losses in trout populations (Oswald 1990, Oswald and Brammer 1993, Oswald 2003). Figure 2 demonstrates the affects of low overwinter dam releases on flows in the upper Beaverhead River and compares those flows with the Minimum Recommended Instream Flow (MFWP 1989) for the reach. Despite the appearance of relatively ample reservoir storage over most of the period, overwinter flows in the upper Beaverhead River have dropped below the recommended minimum in 16 of the 25 years depicted. In most of those years, flow dropped substantially below the recommended minimum resulting in significantly reduced wetted perimeter and substantial reductions in fish habitat availability and niche diversity. In the 2003 through 2006 water years, flow releases averaged only 27 cfs. In each of those years, flow reductions occurred in early September and did not improve until mid to late May. Flow accretions throughout the system improved flows as distance downstream from the dam increased but were insufficient to increase flow to the recommended minimum between the dam and the City of Dillon in any year since 2002. The extremely low overwinter flow regimes have represented only about 13.5% of the recommended instream flow for fisheries and aquatic habitat maintenance and have become a chronic situation over the past six water years.

Hildreth Study Section

Brown trout population density and standing crop are presented in Figure 3 for the 1986 through 2006 period. Brown trout density and, particularly standing crop, have declined with low winter flow regimes over the 2000 - 2006 period. While brown trout population density declined from the observed highs which exceeded 2,100 Age II and older fish per mile in 1998 and 1999, it remained relatively stable in the succeeding years through 2005. Brown trout standing crop, however, has declined in a steep, linear fashion throughout the 2000 - 2006 period to an observed modern low in 2006. Brown trout density also declined to roughly equal modern observed lows in 2006. While declines in standing crop were steep and sharply defined through 2005, the 2006 estimate represented a decline in biomass of more than 2,000 pounds per mile from highs observed in 1999. The steep declines in brown trout biomass were correlated directly with substantial losses in numbers of older, larger fish. Numbers of 18 inch and larger brown trout (Figure 4) soared to 832 per mile in 1999 following ample flow regimes (Figure 2) but had declined, in a steep linear fashion, to 296 per mile by 2005 and 102 per mile in 2006. Similar observations can be made, in more dramatic fashion, for 20 inch and larger brown trout (Figure 5) which largely compose the Age V and older segment of the population. During the low winter flow regimes of the 1988 - 1991 and 1999 - 2006 periods record high numbers of these older larger fish declined markedly in a very linear fashion. Observed highs for these large fish occurred in 1988 and 1999 following periods of abundant flow. The 2006 estimate of only 9 twenty inch and larger fish per mile was the lowest density recorded in the sampling history of the study section. Densities of 22 inch and larger brown trout (Figure 6) continued to remain very low throughout the reporting period. Low numbers of larger brown trout can be correlated directly with steep declines in brown trout standing crop over the 2000 – 2006 period. Figures 7 and 8 clearly depict a situation under which the contribution of 18 inch and larger brown trout to the total Age II and older population has declined substantially to a modern low while numbers of 20 inch and larger brown trout have similarly declined as a segment of the 18 inch and larger segment of the population. Brown trout Condition Factor (K) over the recent period of declining stream flow is depicted in Figure 9. Mean population Condition for Age II and older brown trout declined in a linear fashion over the four year period through 2002 to a relatively low value of 32.35 for the upper Beaverhead River tailwater. As brown trout standing crop declined over the 2003 – 2006 period, mean brown trout condition recovered slightly but did not recover to numbers observed in 1999 or even 2000 under better flow regimes and much higher densities and standing crops. Condition for 18 inch and larger and 20 inch and larger fish declined more steeply and more severely, with increased length and age through the 2002 sample but similarly, improved through 2006 with markedly reduced density and standing crop of these larger fish. Similar to the overall population Condition Factor, recovered K values for the larger fish remained below those observed in 1999 and 2000. Similar relationships between overwinter flow and brown trout Condition Factor were depicted under the low overwinter flow regimes of the 1988 - 1990 period in the upper Beaverhead River by Oswald (1990) and Oswald and Brammer (1993), for the 1999 – 2000 period in the upper Beaverhead and Ruby Rivers (Oswald 2003) and over the 2000 – 2003 period in the Big Hole River (Oswald 2005).

Trends in rainbow trout density and standing crop were last reported for the 1986 – 2000 period by Oswald 2003. Due to extremely low fall flow release from Clark Canyon Dam, rainbow trout population estimates were not conducted over the 2001 – 2005 period. Rainbow trout population sampling will be resumed when fall flow regimes improve in a significant manner.

Pipe Organ Study Section

Brown trout population trends are presented in Figure 10 for the 1986-2006 period of study in the Pipe Organ Section. Brown trout density and standing crop declined from an observed high of 1999 with low flow regimes experienced in the 2000 - 2006 period. Unlike the situation in the Hildreth Section, the decline in standing crop has not been linear and appeared to level out at about 1,000 pounds per mile over the 2004 – 2006 period. Brown trout density had experienced a linear decline following relatively good recruitment of Age II fish in 2001 (Oswald 2003) and declined to an observed low of about 1,000 fish per mile in 2005. Brown trout density increased slightly in 2006, however most of the increase was due to a large recruitment of Age II fish which was not accompanied by any significant increase in standing crop. Numbers of Age II brown trout in 2006 were estimated at slightly more than 700 fish per mile accounting for 56.6% of the total population. Numbers of larger brown trout (Figure 11), which had declined in a steep linear fashion from 1999 to 2002 (Oswald 2003), continued to decline to minimal densities in 2005 and 2006. Numbers of these 18 inch and larger fish dropped to 10 and 12 fish per mile in 2005 and 2006 to match the prior drought influenced minimum density of 11 per mile observed in 1991. Similar to the situation in the Hildreth Section, mean brown trout Condition Factor (Figure 12) also declined at low flow over the 1999 - 2003 period and began to recover as brown trout standing crop and densities of older, larger fish declined. Overall population condition factor actually exceeded that observed at much higher density and standing crop in 1999, however, the influence of high numbers of young fish with K values of 35.00 to 36.00 and mild winter temperatures (Oswald 2005) probably influenced those high values in a positive manner. Mean Condition of the 18 inch and larger fish declined much more dramatically than that of the general population and remained below values observed in 1999 despite dramatic reductions in the density of these older fish.

Fish and Game Study Section

Fish and Game Section brown trout population trends are depicted in Figure 13 for the 1988-2006 period of study. Similar to the Hildreth and Pipe Organ Study Sections, brown trout density and standing crop peaked at high levels in 1998 following a period of abundant flow. The 2000 - 2002 trend, however differed markedly from that observed in either of the two upstream study sections with both density and standing crop maintaining stable or increasing trends despite poor flow regimes (Oswald 2003). Brown trout population density and standing crop over the 2003 – 2006 period of study, however, declined in a steep linear fashion similar to those observed in the Hildreth and Pipe Organ Study Sections. Oswald (2003) observed that the high standing crops of the 1998 - 2002 period were correlated directly with increasing numbers of 16 inch and larger fish (Figure 14). Substantial losses in standing crop from 2003 through 2006 were directly correlated with declines in numbers of these 16.0 inch and larger fish and also was accompanied by declines of 13.0 – 15.9 inch fish which were even more dramatic. Losses in brown trout density were also closely accompanied by declines in recruitment of Age II fish included in the 7.0 – 12.9 inch component at densities of about 250, or less, per mile (Figure 14) over the 2004- 2006 period of study. By 2006, brown trout density, standing crop, and size class distribution had declined to lows similar to those observed in 1991 under the prior severe drought episode. Brown trout Condition Factor declined (Figure 15) similar to the situation observed in both the Hildreth and Pipe Organ Sections over the 1998 - 2003 period and recovered slightly at declining standing crop, over the 2004 – 2006 period. While mean K values recovered somewhat since observed minima in 2003, values largely remained below those observed over the 1998 – 2001 period and far below maximum values observed in 1998. Similar to the situation in the Pipe Organ Section, the population mean K increased substantially in 2005 followed by a decline in 2006 despite decreasing densities and standing crops.

LOWER BEAVERHEAD RIVER

Flow Regime

The lower Beaverhead River can generally be classified as the reach between the City of Dillon, Montana and the mouth of the river at its confluence with the Big Hole River. The majority of the spring and summer flow released from Clark Canyon Reservoir is diverted into major irrigation canals located between the dam and Dillon, Montana. The river gage in Dillon is often managed as the low flow point in the system with valley floor springs and irrigation return flow and seepage left to provide irrigation water and instream flow throughout the remainder of the system. As such, spring and summer flow regimes are often quite low while fall and winter usually is marked by an ascending hydrograph as irrigation water drains into the valley floor. This phenomenon is often described as an inverted hydrograph. Low summer flows within the lower river reach are depicted in Figure 16. With the exception of 1993 and the 1995 - 1999 period, both very wet climatic episodes, the overall 1988 - 2005 period was marked by extremely low July and August streamflows. Base summer flows over the 2000 – 2005 period failed to meet the FWP Minimum Instream Flow of 200 cfs and largely failed to produce mean monthly flows in excess of 100 cfs over the 2003 – 2005 period. In July 2005, flows declined to a minimal range of 22 to 26 cfs for a five day period at the USGS Gage at the head of the Mule Shoe Study Section near Beaverhead Rock. The generally recognized minimum flow of 25 cfs to be maintained at the lowest point in the Beaverhead River by the Bureau of Reclamation and irrigation companies was not met on four of those five days. In association with a decrease in elevation down the gradient of the valley floor, the low flow regimes of July and August are often accompanied by high thermal regimes (USGS 1988 - 2004). The recent period of study, 2003 - 2005 exhibited extremely high water temperatures at the Beaverhead Rock USGS Gage. This was particularly the case in 2003, when July and August water temperatures often exceeded 70 degrees Fahrenheit for 15 to 18 hours per day up to an observed maximum of 19.75 hours. Maximum daily water temperatures during the period generally attained values of 77 to 80 degrees F. to a maximum of 81.1 degrees while maximum night cooling usually dropped temperatures into the 66 – 68 degree range. The extremely high temperatures were associated with diurnal flow regimes as low as 60 – 69 cfs and as high as 111 – 127 cfs. The extremely high temperatures and low flows precipitated an emergency angling closure by FWP from July 25, 2003 to September 11, 2003 in an attempt to mitigate some of the potential stress to existing fish populations, particularly mountain whitefish and brown trout.

Anderson Study Section

Brown trout population trends for the Anderson Section are presented in Figure 17 for the 1991-2006 period of study. Brown trout populations within the Anderson Section have remained at chronically low density when compared with those of the upper river reaches. Population density has varied between approximately 300 and 450 fish per mile with a standing crop of about 300 to 400 pounds per mile. The recent period of study exhibited modern lows in both brown trout density and standing crop in 2004 and 2005 following the extremely high water temperatures and low flows of the summer of 2003. Although the 2006 sample revealed an apparent increase in population despite continued low flows, these apparent increases could have been due to inflated estimates resulting from significant fish movement between mark and recapture runs. The 2006 sample was collected with a 25 day period between mark and recapture runs rather than the customary 12 to 14 days. The long period between electrofishing runs was also marked by a rather steep decline in flow of 355 cfs at the USGS Gage at Beaverhead Rock and a decline in recapture to capture efficiency from a mean of 29.6% in 2004 and 2005 to 22.6% in 2006 despite similar base flow regimes among the sample years. The 2006 sample was also marked with a disparity between the mark sample with 177 fish and the recapture run with 292 fish in the capture. Te recent declines in brown trout standing crop and density far exceeded those observed in the 1992 – 1994 period and exceeded the prior observed low for the section recorded in 1991. Length distribution within the population (Figure 18) indicated that recruitment has suffered at low flow regimes over the recent past and the brown trout population suffered from low density at all length and age groups. While the 2003 population was reflective of relatively strong recruitment of Age II fish, this cohort was not apparent in strong numbers over the following years. Similar to prior samples the 2003 – 2005 populations were reflective of relatively high percentages of larger fish at low population density. As was the case with overall brown trout population density in the 2006 sample, the length and age distribution within the population could be inflated by brown trout movement in an out of the study section between the sample runs.

Beginning in 1999, fluvial Arctic grayling were reintroduced to the lower Beaverhead River via annual plants of overwintered yearling fish (Magee 2003). These plants continued through 2002 and were temporarily discontinued for further evaluation of low flow regimes and high water temperatures beginning in 2003. Despite a lack of grayling plants since 2002 and no indication of grayling plant survival in the lower Beaverhead since 2003, a large male grayling, 15.5 inches in length, was captured in the 2006 sample. This fish bore no fin deformities consistent with the overwintered yearling hatchery grayling that had been planted in the Beaverhead River and was presumed to be a wild fish.

Spring population estimates for Age II and older mountain whitefish have been included in the Anderson Section sampling efforts since 2002 (Figure 19). The initial sample revealed a whitefish population of approximately 420 fish per mile representing a standing crop of slightly less than 500 pounds per mile. Initial observations suggested that whitefish density and standing crop had the potential to exceed maximum densities and standing crops observed for brown trout in the lower river study sections. However, steady declines under chronic low flow and high temperature regimes resulted in an estimated whitefish population of only 65 fish per mile with a standing crop of 115 pounds per mile by 2006. The whitefish population declines since 2002 have been more consistent and of greater amplitude than those observed for the brown trout over the same period. The long duration between the mark and recapture runs and variable flow regimes in the interim did not appear to inflate the 2006 whitefish population estimates in a manner similar to the brown trout. This appeared to be the case despite a 2006 recapture to capture efficiency of only 23.6% as compared with a mean efficiency of 35.5% for 2004 and 2005. This may have been associated with the extremely low whitefish density composed almost entirely of fully mature fish or might merely have been due to different responses to flow and time by the different species. A comparison of length frequency analysis between the whitefish samples of 2002 and 2006 (Figures 20 and 21) revealed a distribution among numerous age classes that was strongly skewed toward a dominance by larger, Age IV and older fish by 2006. This situation was similar to that observed for the brown trout populations of the lower river.

Mule Shoe Study Section

Brown trout population trends for the Mule Shoe Section are depicted in Figure 22 for the 1990-2006 period of study. Brown trout populations in the Mule Shoe Study Section have exhibited substantial declines in density and standing crop since 2002, declining to an observed low density of 94 Age II and older fish per mile by 2005. The trend of declining populations under low flow regimes and high summer water temperatures was similar to that observed in the Anderson Section but of greater amplitude. A similar population increase in 2006 to that observed in the Anderson Section was also unexplained by any potential improvements in recruitment or age class survival (Figure 23) and was also presumed due to estimate inflation related to fish movement in and out of the study section between mark and recapture efforts. The 2006 Mule Shoe sample was conducted with a 24 day interlude between and the mark and recapture efforts which exhibited a 377 cfs decline in flow. The normal interlude between mark and recapture is 12 to 14 days. Recapture to capture efficiency for brown trout in the 2006 Mule Shoe sample was 12.9% as opposed to a mean value of 27.7% for the 2004 and 2005 samples despite extremely low flow on the date of recapture. The size and age distribution within the brown trout population of the Mule Shoe Section (Figure 23) exhibited declines at all classifications indicative of sustained poor recruitment and survival at all age classes. Similar to observations in the Anderson Section, older, larger brown trout constituted increasing percentages of the population. Increases in all classifications in 2006 appeared associated with inflation of the estimated density of brown trout and could not be correlated with prior age class strength.

Mountain whitefish population estimates began in the 2002 spring sample (Figure 24) in the Mule Shoe Section. Mountain whitefish density and standing crop exceeded 500 fish and 500 pounds per mile which slightly exceeded observed maxima for those parameters for brown trout in the study section and exceeded the maximum estimated whitefish population in the Anderson Section. Population trends since 2002 have exhibited severe linear declines to an observed density minimum of les than 100 fish per mile in 2005. Similar to observations for the brown trout population, the 2006 estimate appeared inflated due to movement of fish into and out of the study section between mark and recapture efforts. Mean recapture to capture efficiency for 2004 and 2005 was 30.1% as compared with a reduced 2006 efficiency of 24. 2% despite low flow regimes on the date of recapture. A similar decline in mountain whitefish efficiency in the 2006 Anderson Section sample, however, did not appear to result in inflation of that population estimate. Length frequency comparison between the 2002 and 2006 samples (Figures 25 and 16) revealed a sample population similar to that observed in the Anderson Section and similarly skewed toward larger Age IV and older fish.

Silver Bow Study Section

Oswald (2003) described the location, extent, and physical habitat of the Silver Bow Study Section implemented to monitor the success of fluvial Arctic grayling introductions in downstream reaches of the lower Beaverhead River. Sampling of the section continued from fall 200 through the spring sample of 2003 and was discontinued thereafter due to extremely low summer flow regimes and a suspension of the grayling introduction effort. The brown trout population of the Silver Bow Section is depicted in Figure 27 for the 2001 - 2003 spring samples. Typical of lower Beaverhead River study sections, both density and standing crop for brown trout were relatively low. Similar to observations in the Mule Shoe Section, brown trout density and standing crop declined precipitously in the 2003 sample with density declining below 100 fish per mile. Length distribution within the Silver Bow brown trout populations is depicted in Figure 28. A relatively strong cohort of 13.0 - 15.9 inch fish in 2001 resulted in improved densities of 16 inch and larger fish in 2002 and relatively strong 18.0 inch and larger fish in 2003. This trend toward relatively high percent composition of the population by older, larger fish was similar to the trends observed in the Anderson and Mule Shoe Sections. A relatively strong cohort of Age II (7.0 - 12.9 inch) fish in 2002, however, did not result in expected high densities of Age III (13.0 – 15.9 inch) fish in 2003 although that cohort represented the modal length group in the population for that sample. Recruitment of Age II fish into the population remained chronically weak in all three sample years at less than 100 fish per mile.

Arctic grayling plants were initiated in the Silver Bow Section in 1999 with release points at the Silver Bow Lane Bridge and downstream locations on State Land (Magee 2002). Sampling for introduced Arctic grayling was begun in the Silver Bow Section in fall 2000 and continued through spring of 2003 (Figure 29). As was the case in both the Anderson and Mule Shoe Sections (Oswald 2003), Arctic grayling numbers remained low through the 2000 - 2003 period and were indicative of poor overwinter survival. Similar to the Mule Shoe Section, the fall 2002 sample yielded a valid population estimate of 14 fish per mile representing 4.9 pounds per mile standing crop. The estimate was for yearling Arctic grayling originating from the 2002 plant with a single fish in the sample representing an Age II grayling from the prior year's plant. The spring 2003 sample, however, did not result in a valid population estimate and yielded a capture total of only a single grayling in two runs through the study section. The 2003 collection rate of only 0.5 fish per sample run was the lowest observed over the study period and indicative of worsening flow and thermal conditions in the lower Beaverhead River Study Sections.

Mountain Whitefish population densities and standing crops in the Silver Bow Section in the spring 2002 and 2003 samples are depicted in Figure 30. The estimated density of mountain whitefish in the Silver Bow Section substantially exceeded those observed for both the Anderson and Mule Shoe Sections at nearly 700 fish per mile in 2002 but declined markedly to less than 400 fish per mile in the 2003 sample. Despite high whitefish density, however, standing crop was lower than that observed in either of the upstream study sections at slightly more than 100 pounds per mile. The 2003 whitefish standing crop did not decline as precipitously as density suggesting that most of the population loss between the two years was associated with recruitment losses. The two year trend for mountain whitefish in the Silver Bow Section was indicative of declining populations, similar to observations in the Anderson and Mule Shoe Sections under declining flow regimes and high summer water temperatures.

UPPER RUBY RIVER

Flow Regime

The upper Ruby River can be classified as the approximate 40 mile mainstem river reach upstream from the Ruby Reservoir. This headwater system is composed of myriad tributaries entering from the Gravelly, Snowcrest, and Ruby Mountains. Most of the upper watershed is located on National Forest Lands, and, as such, is not as affected by irrigation as much as most of the valley floor river systems of southwest Montana. Mean August streamflow for the 1986 - 2005 period is depicted in Figure 31 and compared with the Minimum Recommended Instream Flow. Despite relatively low irrigation demand upstream from Ruby Reservoir, 11 of the past 20 years have exhibited summer flow regimes that failed to meet the Minimum Instream Flow Recommendation of 102 cfs. As has been the case for other southwest Montana Rivers, drought streamflows have dominated the 1988 - 1994 period as well as the recent 2000 - 2005 period with a comparatively brief period of relatively ample flow dominating the 1995 - 1999 period. While the 2000 – 2004 base August flow regimes remained below the recommended minimum, some improvement was evident in 2003 and 2004. The upper Ruby USGS Gage consistently revealed daily flows that remained closer to long term median values than those observed at other southwest Montana gage sites on the Big Hole, Red Rock and Beaverhead Rivers. Base August flow for the 2005 water year exceeded the recommended minimum flow for the first time since 1999 posting a mean value of 128 cfs. The relatively abundant tributary system coupled with the high elevations of the upper Ruby valley generally result in cool summer temperature regimes.

Three Forks Study Section

The Three Forks Section typifies high gradient headwater environments of the upper Ruby River. The trout population of the Three Forks Section is composed of a hybrid swarm of westslope cutthroat trout, rainbow trout, and the hybridized progeny of both species. Due to the difficulty of visually separating individual fish, population data are analyzed as rainbow x cutthroat hybrid trout. Population data for the Three Forks Section are depicted in Figure 32 for the 1987-2005 period of study. Rainbow x cutthroat hybrid densities and standing crops declined dramatically over the 2000 - 2003 period from highs recorded in 1999. This pattern of population decline with declining streamflows in the recent past was remarkably similar to that observed over the 1987 - 1991 period of study in the section. Length group analysis of the population (Figure 33) revealed that high densities of older, larger fish observed in 1999 and 2000 had eroded under reduced flow regime while recruitment of juvenile fish also declined annually, in a linear fashion, through the 2003 sample. Improved flow regimes in 2004 were marked by strong recruitment of Age I (4.0 – 6.9 inch) fish in the sample. Markedly improved flows in 2005 were accompanied by another relatively strong recruitment of Age I fish and a significant survival of fish to the Age II (7.0 – 9.9 inch) cohort. This increase in population density was also accompanied by improved survival of fish into the older age classes in excess of 10.0 inches in length. Mean condition factor of rainbow x cutthroat trout in the Three Forks Section is depicted in Figure 34 for the study period. The 2000 - 2002 study period exhibited a continued decline in average Condition Factor with declining summer flow from highs observed in the 1995 - 1997 period, however, improving flow regimes in 2003 and 2004 were marked by improvement in mean condition. The decline in condition observed in 2005 was unexplained by significant flow improvements and might have been due to age distribution within the population, thermal regime, or other environmental factors.

Attempts to reintroduce fluvial Arctic grayling into the upper Ruby River were initiated in 1997 with a plant of 29,805 young of the year fish in late summer. These fish were very small and survival was documented into October 1997 with the capture of 31 2.0-3.3 inch fish in the Three Forks Section. Subsequent sampling documented low winter survival of these young of the year plants. Beginning in 1998, the upper Ruby River received annual plants of overwintered yearling grayling to increase survivability. Subsequent plants of yearling grayling were continued through 2005 and remote site incubators were added to the introduction effort in 2003. These incubators were placed in upper river tributary environments and received fertilized eggs from the FWP fluvial grayling brood stocks. The estimated density and standing crop of Arctic grayling in the Three Forks Section is depicted in Figure 35 for the 1998 - 2005 period of study. The 1998 population estimate of 406 fish per mile was composed entirely of Age I fish and exceeded the density of the wild rainbow x cutthroat trout (Figure 32) by 104 fish per mile. The vast majority of fish in 1998 appeared to originate from the 1998 yearling plant with very few individuals suspected of being survivors of the 1997 plant. The 1999 population estimate of 292 grayling per mile represented in a decline in the number of fish planted in 1999 and was dominated by yearling fish. Standing crop in both years approximated 100 pounds per mile indicative of larger sized yearling plants in 1999 and the presence of Age II fish in the population. Subsequent samples through 2002 showed a marked decrease in grayling survival with decreasing flow regime, diminished planting efforts and high overwinter mortality. Wild reproduction of grayling was documented (Oswald 2003) but observed recruitment was limited due to low survival of stocked fish to reproductive adulthood. Resumption of yearling plants in 2003 again resulted in an immediate population increase that, again, diminished over the 2003 – 2005 period. While the 2005 population density was relatively low compared with past introduction samples, the population was marked by two age classes (0 and I) of wild juvenile recruits as well as some older fish from past spawning efforts of planted fish. The oldest observed wild recruit was an Age IV male.0 Mean length, weight, and condition factor for Arctic grayling in the Three Forks Section are presented in Table 1. Mean length, weight, and condition factor varied between 1998 and 2005 dependant upon differences among plants, contribution of

Table 1. Mean length (inches), weight (pounds), and Condition Factor (K) for Arctic grayling collected in the Three Forks Section of the Ruby River 1998 - 2000.

Year	Mean Length	Mean Weight	Condition Factor (K)
1998	9.8	0.28	29.60
1999	10.5	0.35	30.06
2000	8.1	0.18	31.60
2001	9.6	0.28	31.34
2002	10.8	0.42	30.53
2003	9.8	0.29	29.37
2004	10.3	0.36	32.77
2005	8.1	0.30	32.20

wild progeny and Age II and older plant survivors, and prevailing habitat conditions. Oswald (2000c) noted increasing grayling size between 1998 and 1999 despite the high density and standing crop impressed upon the habitat via the Arctic grayling plants. Moreover, grayling size increased as rainbow x cutthroat trout density and standing crop reached very high levels for the study section (Figure 32) while maintaining a high mean condition factor (Figure 34) under ample flow regimes. Subsequent declines in average size in 2000 and increases in 2002 reflect differential plant sizes but also resulted from the inclusion of wild progeny into the population in 2000 and increased contribution of Age II and older fish in 2002. A similar situation was observed in 2004 and, especially 2005 when a low mean length due to the presence of abundant juvenile fish accompanied the second highest observed mean Condition Factor since the reintroduction effort began. Wild young of the year grayling were collected in fall samples in the Three Forks Section in 2000, 2002, 2004 and 2005 while suspected wild yearling fish were collected in the 2001, 2004, and 2005 samples.

A mountain whitefish population estimate was added into the sampling effort in 2004 (Figure 36) in order to better assess the total fish density and standing crop supported within the section. The effort revealed a population density of nearly 700 fish per mile exhibiting a relatively low standing crop of only 139 pounds per mile. The wide differential between the stock density and standing crop was accounted for by large numbers of juvenile, primarily yearling fish, in the population. Mountain whitefish composed about 65.2% of the density and 57.4% of the standing crop of native gamefish in the section in 2004. Another reason to assess the native whitefish population was to attempt to gain additional insight into the high overwinter mortality rate of stocked yearling grayling compared with other endemic native species. It had long been observed that late season sampling efforts in the high gradient headwater environment of the Three Forks Section were marked by an apparent out migration of westslope cutthroat and rainbow trout and their hybrids. It was assumed that the migration was to more favorable deep water habitats for overwintering downstream. Mountain whitefish in 2004 exhibited a Recapture to Mark (R/M) ratio of 0.133 between the two runs. This could be compared with a R/M ratio of 0.227 for the rainbow – cutthroat hybrid swarm but was contrasted markedly with an R/M ratio of 0.600 for the stocked grayling. Similarly, mountain whitefish exhibited a Recapture to Capture (R/C) ratio 0f of 0.262 compared with an R/C ratio of 0.414 for the cutthroat – rainbow trout swarm and contrasted with a R/C ratio of 0.711 for the grayling. The data strongly suggest that the wild mountain whitefish and the westslope cutthroat and rainbow trout exhibited a tendency to outmigrate from the study section as winter conditions began to be manifest while the introduced grayling exhibited little tendency to move between the two sampling runs. Mountain whitefish estimates were not included in subsequent samples due to the large number of yearling fish captured and limited capability to hold and transport captured whitefish without causing undo stress to them and other fish in the samples.

Greenhorn Study Section

The Greenhorn Section is typical of lower reach habitats of the upper Ruby River system with trout populations of the reach dominated by brown and rainbow trout. Rainbow trout density and standing crop are depicted for the Greenhorn Section in Figure 37 for the 1990-2005 period of study. The section has supported relatively low densities of Age I and older rainbow trout that peaked with strong flow regimes in 1998 - 1999. Similarly, rainbow trout standing crop in the Greenhorn Section peaked in 1999 at more than 130 pounds per mile. Since 1999, both density and standing crop have declined, in a very steep and linear fashion, to observed lows for the sampling history of the study section recorded over the 2003 – 2005 study period. The 2005 rainbow trout population exhibited new lows of only 20 fish per mile at a standing crop of only 14 pounds per mile. These figures were representative of population declines of 91.3% in density and 89.5% in standing crop since observed maxima were observed under favorable flow regimes in 1998 and 1999. In addition to the declines in rainbow trout density and standing crop, rainbow trout yearling recruitment (Figure 38) was virtually absent over the recent 2003 - 2005 period. Oswald (2000c and 2003) observed that the 1999 – 2002 rainbow trout populations also lacked any discernible yearling recruitment in the length distribution analysis.

Brown trout densities and standing crops within the Greenhorn Section are portrayed in Figure 39. Brown trout density and standing crop substantially exceeded that observed for rainbow trout in the section and attained peaks in density and standing crop exceeding 800 fish per mile and 900 pounds per mile in 2000. Oswald (2000c and 2003) suggested that brown trout populations had flourished and increased markedly under ample flow regimes since 1995. Recent samples in 2001 and 2005, however, have exhibited brown trout population declines under declining flow regimes. This declining trend was similar to that observed for rainbow trout but the amplitude of the declines was not nearly as substantial. While recent brown trout densities and standing crops were far less than the maxima observed under ample flow regimes, they did not decline to lows observed in the early 1990's under more severe flow reductions. Length analysis of the Greenhorn Section brown trout populations (Figure 40) indicated that numbers of older, larger fish that had maximized following ample flow regimes also declined markedly in 2001 and 2002 and remained at low density through the 2005 sample. Relatively ample densities of 13.0 to 16.0 inch fish in 2002, 2003, and 2004 failed to result in increases in the 16.0 inch ad larger component in any of the succeeding sample years. These declines in numbers of larger fish directly influenced the steep decline in biomass within the brown trout population. Recruitment of juvenile brown trout also benefited from the ample flow regimes of the late 1990's and remained strong through 2001 as numbers of larger fish were reduced but declined markedly in 2002 and 2003. The 2004 and 2005 samples, however, exhibited relatively strong recruitment of yearling brown trout in opposition to observations made for the rainbow trout over the same period.

Despite large plants of yearling Arctic grayling in upstream Ruby River habitats since 1998, very few grayling have been captured during fall sampling in the Greenhorn Section. Numbers of Arctic grayling captured during two (mark and recapture) electrofishing passes through the 2.2 mile section between 1998 and 2002 averaged 4.8 fish per sample year and ranged between a high of 11 fish in 2000 and a low of zero fish in 2002. In 2003, large numbers of grayling were stocked within the study section boundary resulting in the capture of 142 grayling for a mean capture rate of 71 fish per run. The large majority of the sample appeared to be stocked yearling fish from the 2003 plant ranging from 9.0 – 11.0 inches in length. The capture differential between the Mark and Recapture runs was large at 133 versus 9 fish in each run, indicative of a strong migration trend that fall. The subsequent samples in 2004 and 2005 exhibited normal prior established patterns with a capture rate of 7.0 fish in 2004 and 2.0 in 2005. These data strongly suggest that the stocked arctic grayling have functioned in locating acceptable habitat and holding their position in the upper river as opposed to out migrating in search of acceptable habitat downstream or in Ruby Reservoir. Observations of grayling movements within the upper Ruby River made by Liermann (2001) over the 1998 - 1999 introduction period and data presented by Opitz (2000) and Oswald (2000c and 2003) along with the most recent samples, continue to support this conclusion. The 2003 sample appeared to represent an anomaly resulting from the direct stocking of fish into lower reaches of the stream. This plant also resulted in the highest number of observations and reports of grayling being caught by ice fisherman in Ruby Reservoir (MFWP Winter Creel Data 2003 – 2004) since the grayling reintroduction effort began in 1998.

LOWER RUBY RIVER

Flow Regime

The lower Ruby River can be described as the reach between the Ruby Reservoir Dam and the mouth of the river at its confluence with the Beaverhead River near Twin Bridges, Montana. Oswald (2000c) described a limited tailwater reach downstream from the dam which is rapidly diminished due to a large number of major canals located between the dam and Alder, Montana. The remainder of the lower river is influenced by a few relatively minor tributaries and an inverted hydrograph similar to that described for the lower Beaverhead River. Flows in the lower Ruby River are thus controlled largely by flow releases or spring spillway overflow from Ruby Reservoir and accretions from irrigation return seepage to the valley floor. In 1994, Ruby Reservoir was completely drained resulting in a substantial fish kill in the reservoir and river tailwater (Oswald 2000a and 2000c). Mean overwinter flows in the tailwater of the dam since 1995 are presented in Figure 41 and compared with the Minimum Recommended Flow of 40 cfs for the reach. While ample storage in Ruby Reservoir between 1996 and 2000 resulted in overwinter flows that exceeded Minimum Flow Recommendations, flows in 2001 dropped below the recommended 40 cfs minimum and remained there through 2005. Mean over winter flows in 2006 rebounded substantially, exceeding the recommended minimum in a manner similar to flow regimes observed over the 1996 - 2000 period. Low minimum flows in the tailwater reach generally reflect low flow conditions throughout the system although reduced flows can be manifest in late spring and summer in downstream reaches.

Passamari and Maloney Study Sections

The Passamari and Maloney Sections typify the limited tailwater environment of the lower Ruby River immediately downstream from the Ruby Reservoir dam. The study sections were established in 1994 and 1998 (Oswald 2000c) to monitor wild brown trout recovery in the aftermath of the 1994 fish kill and to monitor the affects of public fishing access in 1998. Brown trout population trends in the Passamari and Maloney Sections are depicted in Figure 42 for the 1994-2006 period of study. In the aftermath of the 1994 event, brown trout density was reduced to 257 Age I and older fish per mile representing a standing crop of only 227 pounds per mile. Steady increases in density and standing crop under relatively ample flow regimes resulted in full population recovery by 1999 and observed maxima in density and standing crop by 2000 (Oswald 2003). The 2000 population estimate of 1,595 brown trout representing 1,508 pounds of biomass per mile was indicative of a productive tailwater environment and population expansion was not deterred by the acquisition of public fishing access in the reach in 1997. Reduced flow regimes over the 2001 - 2004 period were accompanied by declines in brown trout density and standing crop although both parameters remained at higher levels than those observed as populations recovered from the 1994 kill and prior to the acquisition of public access. Increases in population density and standing crop in 2005 and 2006 were likely associated with improved overwinter survival resulting from relatively mild winter conditions in 2005 and markedly improved flow regimes in 2006. Improved population density and standing crop were observed in 2005 in spite of a lack of improvement in overwinter flow regime. These improvements were also associated with an extremely mild winter temperature regime that resulted in markedly improved spring brown trout condition factor in the Big Hole River (Oswald 2005) and in tailwater study sections of the Beaverhead River in the current study. A similar improved spring brown trout condition (Figure 46) was noted in 2005 in the Maloney Section and could be a significant factor in improved brown trout density and standing crop in that sample. The improved brown trout density and standing crop in the 2005 and 2006 samples was not related to expanding numbers of 13 inch and larger fish (Figure 43). This segment of the population declined under reduced overwinter flows from 2003 through 2005 but rebounded strongly under improved flows in 2006. The abundance of older, larger fish in the population (Figure 44) declined substantially after 2001 and remained at minimal densities of about 50 fish per mile through the 2002 – 2006 period. While no improvement in the numbers of these Age V and older fish resulted from improved flows in 2006, numbers of 16.0 - 17.9 inch fish were much improved at 387 fish per mile. This was indicative of a strong potential for substantial improvements in numbers of Age V and older fish in 2007 if strong flow regimes can be maintained. Recruitment of juvenile brown trout (Figure 45) also declined markedly from 1997 through 2000 with ample flow and recovered numbers of large reproductive adults but declined abruptly in 2001 and 2002 with limited flow regimes. Similar to conditions observed in the tailwater reaches of the upper Beaverhead River under low flows, brown trout Condition Factor (Figure 46) declined in the Maloney Section over the 1999 - 2003 period. As was the case in the Beaverhead River study sections, the decline in Condition was manifest most severely in the older, larger fish in the population. Condition improved in 2004 and 2005 under reduced densities of older, larger fish and generally mild winter temperatures similar to observations made in Beaverhead River tailwater sections and Big Hole river study sections (Oswald 2005). Brown trout Condition Factors maintained at relatively high values in 2006 under improved flow regimes despite a substantial increase in standing crop.

Silver Spring Study Section

The brown trout populations of the Silver Spring Section were last described by Oswald (2003). Since that time, brown trout populations (Figure 47) continued to exhibit a declining trend under relatively low population densities and standing crops. The 2006 population density of 530 per mile was the lowest recorded since lows for the study section of about 430 fish per mile were observed in 1995 and 1996. Recruitment of Age II brown trout (Figure 48) declined markedly from highs observed in 1999 and 2000 and remained at very low density over the 2004 – 2006 period despite apparent improvements in recruitment of Age I fish in 2003 and 2004. The 2006 sample exhibited extremely strong recruitment of Age I fish into the population. Densities of 13 inch and larger brown trout (Figure 49) exhibited a declining trend over the 2003 – 2006 period, dropping to a low of about 300 fish per mile by 2006. Declines in this approximately Age III and older segment of the population appeared directly related to the recent chronic lows in the recruitment of Age II fish into the brown trout population. Densities of larger brown trout had improved over the 1995 - 2000 period with ample flow regimes but declined substantially as flows were reduced in 2001 - 2004. These 16 inch and larger fish (Figure 50) largely comprise the Age V and older segment of the population. Slight improvements in the density of these older, larger fish in 2005 and 2006 accompanied continued declines in brown trout density and standing crop. Oswald (2000c) had noted that densities of 16 inch and larger fish appeared to flourish with reduced recruitment and population density in the Silver Spring Study Section.

POINDEXTER SLOUGH

Section Three

The brown trout populations of Poindexter Slough were last described by Oswald (2003). Recent trends in brown trout population density and standing crop are depicted in Figure 51 for the 1989-2006 period of study. Brown trout density and standing crop exhibited declining trends under reduced streamflow over the 2000 – 2004 period. Declines in brown trout density were relatively steep and linear while declines in standing crop were more tempered. Relatively high densities observed in 2005 and 2006 were not accompanied by improvements in standing crop which continued to exhibit a declining trend. The observed improvements in brown trout density in were due largely to relatively strong recruitment of Age I fish in both years (Figure 52) and thus, did not result in any substantive improvements in biomass. Poindexter Slough has traditionally supported the highest observed brown trout densities within the study area, however, most of this elevated density has been associated with highly successful recruitment of Age I fish. Prior to the observed improvements in recruitment in the 2005 – 2006 samples, Age I densities had exhibited a declining trend from 2000 through 2004 resulting in some of the lowest juvenile densities observed in the sampling history of the section. Oswald (2000c) noted that reduced recruitment in Poindexter Slough resulted in an improved mean standing crop relative to population density. This was not the case in the recent reporting period. Numbers of 13 inch and larger fish (Figure 53) exhibited a steep, linear declining trend since observed highs recorded in 2000 and had declined to a density of less than 80 fish per thousand feet by 2006. Similarly, numbers of 15 inch and larger brown trout (Figure 54) had declined to low densities of 34 fish per thousand feet by the 2004 and 2006 samples. The declining trend of these Age IV and older fish followed an observed high density recorded in 2002, two years later than that observed for the 13 inch and larger segment of the population. On a relative basis, declines in the density of the 15 inch and larger fish were not as severe as those observed for the 13 inch and larger segment which composes the bulk of the brown trout standing crop. This might be indicative of a continued declining trend in the number of older fish under reduced flow regimes or a lower response to decreased population density than those observed in some of the past samples.

RED ROCK RIVER

Flow Regime

Recent flow regimes for the Red Rock River near Lima, Mt are depicted in Figures 55 and 56 for the 1986 – 2006 period. As has been the case in other southwest Montana streams, the late 1980’s and early 1990’s were characterized by low flow regimes followed by a relatively brief period of abundant precipitation and streamflow in the late 1990’s. The 2000 – 2005 period was, again, characterized by significant drought conditions characterized as Exceptional in southern Beaverhead County, Montana by the National Weather Service (NWS Data, Great Falls, MT). As a result of these climatic conditions, low flow regimes were again experienced in the Red Rock River. Non irrigation season or over winter flow regimes are characterized in Figure 55 and compared with upper and lower WETP Minimum Instream Flow inflection points. Because the USGS Gage below Lima is not operated throughout the winter months, the October and April flow regimes were utilized to bracket the non-irrigation period. Typical of tailwaters below irrigation storage dams, drought period low flow regimes were manifest strongly over the non-irrigation period over the 2000 – 2005 period. October flows remained below the minimum recommended flow of 40 cfs consistently over the 2001 – 2005 period. April flows also remained below the 40 cfs minimum or between the 40 and 60 cfs inflection points over the 2000 – 2005 period. Flow regimes during the current drought episode were similarly to those observed during the drought episode of the late 1980’s and early 1990’s. April flow regimes in 2006 represented the first significant departure from low non-irrigation flow regimes since 1999 and substantially exceeded minimum recommended flow requirements at 147 cfs. While irrigation storage projects generally are capable of producing ample flow regimes over a brief spring and summer growing season, the severity of the recent drought also limited late summer flow regimes as depicted in Figure 56. Mean August flow regimes over the 2000 – 2004 period failed to meet the 40 cfs minimum flow recommendation and were more chronically severe than those observed in the prior drought episode of the late 1980's and early 1990's. Improved precipitation and storage in 2005 and 2006 resulted in relatively abundant summer flows that far exceeded minimum flow requirements. While flow data at the USGS Gage adequately depict flow conditions within the Red Rock system, individual flow measurements lower in the drainage revealed far more severe flow conditions. Measurements made in reaches between Lima and Dell, MT generally revealed flows in the 1.0 to 7.0 cfs range while flow sometimes ceased at the County road downstream from Sage Creek. Maximum water temperatures often reached the 76 – 82 degree F. range under these conditions. Some of the private landowners cut back on irrigation or utilized valley floor spring flows to provide flow refugia throughout the river reach. One of these reaches near Sage Creek and another near Kidd, MT often provided 25 – 30 cfs flows that maintained maximum water temperatures in the 66 – 70 degree F. range. River reaches downstream from Kidd exhibited improved flows due to additional spring accretions and generally maintained base summer flows in the 40 – 80 cfs range. These refugia, in addition to voluntary and mandatory angling closures impressed over the 2000 – 2004 period, were expected to provide a level of protection for fisheries that was absent during the drought episode of the late 1980's and early 1990's. The Martinell Study Section was located in the flow refuge between Big Sheep Creek and the Sage Creek Road.

Martinell Study Section

The resident brown trout populations of the Red Rock River were last described by Oswald in Vincent et al. (1990) for study sections located downstream and in relatively close proximity to the modern Martinell Section. The Martinell Section was initiated to monitor the effects of flow refugia and angling closures in mitigating fish loss under severe drought conditions in the Red Rock River. Brown trout population density and standing crop is presented in Figure 57 for the 2005 and 2006 samples in the Martinell Section. The density of Age II and older brown trout was estimated at 576 fish per mile in 2005 and improved slightly to 626 per mile in 2006. Brown trout standing crop also improved from 2005 to 2006, but more substantially than density, increasing from 466 to 595 pounds per mile. Recruitment and survival of juvenile brown trout also exhibited improvements (Figure 58) between the two samples. While densities of Age I fish increased between the two samples, survival of Age I to Age II fish appeared extremely high from 2005 to 2006 with slight improvements in flow regime. Similarly, densities of 13 inch, 16 inch, and 18 inch and larger brown trout (Figures 59 and 60) also appeared to increase between the two samples. These length groupings roughly approximated the Age III, Age IV and Age V and older cohorts within the population. The most substantial increase appeared manifest in the oldest, largest fish in excess of 18.0 inches in length. Mean spring brown trout Condition Factors (Figure 61) were analyzed in order to assess the base condition of fish at various ages and sizes and to provide a base for future comparison under improving flow regimes. As has been noted in other study sections, brown trout Condition in the Martinell Section declined as fish increased in length, age, and sexual maturity. Condition Factors increased between 2005 and 2006 under slightly improved flow regimes despite increases in population density, standing crop, and numbers of older, larger fish. Condition for brown trout in the Martinell Section also tended to exceed values observed in upper Beaverhead River and Ruby River tailwater sections in the 2005 – 2006 spring samples. The current brown trout density and standing crop data from the Martinell Section can be compared with similar data collected from the Wellborn and Dell Sections before and after the extreme dewatering event of 1988 (Figure 62). While the current populations of the Martinell Section were substantially below density and biomass estimates of 1987, they far exceeded post-dewatering estimates of the 1989 and 1990 samples. Mean brown trout densities and standing crops in the Martinell Section in 2005 – 2006 exceeded those observed in the Dell and Wellborn 1989 – 1990 samples by 110% and 121%, respectively. Similar comparisons were observed among the study sections and samples for the 13 inch and larger segment (Figure 63) and, more substantially, for the 18 inch and larger segment (Figure 64) of the brown trout population.

DISCUSSION

BEAVERHEAD RIVER

Upper River Study Sections

Brown trout populations in the upper tailwater reach of the Beaverhead River declined significantly in association with drought limited non-irrigation flow regimes which dominated the winter period since the 2001 Water Year. Non-irrigation season flow regimes in the Beaverhead River failed to meet the Minimum Recommended Instream Flow (FWP 1989) of 200 cfs in fifteen of the past twenty-five Water Years over the 1982 - 2006 period of record. Mean flow releases in twelve of those fifteen years failed to average even 25% of the recommended minimum. The current spate of drought conditions has resulted in 6 consecutive years in which minimum non-irrigation season flow releases remained far below the 200 cfs minimum and 4 consecutive years in which releases of only of 25 cfs initiated the Beaverhead River flow from the dam. Flow releases of 25 cfs from Clark Canyon Dam generally result in flows of about 40 to 45 cfs at the head of the Hildreth Section, 60 – 65 cfs at the head of the Pipe Organ Section and 80 to 85 cfs at Barretts Diversion. Thus, under recent prevailing conditions, flow regimes throughout the entire tailwater and upper river reach have remained at 20% to 43 % of the recommended minimum for fisheries.

Oswald (2003) demonstrated that brown trout population parameters which had flourished and maximized in 1998 or 1999 under the ample flow regimes of the 1996 - 2000 period included density, standing crop, numbers of older, larger fish, and Condition Factor in both the Hildreth and Pipe Organ Study Sections. Frazier (2003) noted substantial declines in brown trout density in the Big Horn River tailwater as non-irrigation season flows declined below recommended minima but did not present analyses for the other parameters. In the Beaverhead River tailwater, population parameters such as standing crop and numbers of larger, older fish (18, 20, or 22 inch and larger component) probably approached or exceeded carrying capacity (Oswald 2000c) as numbers of larger fish began to represent smaller percentages of the population indicating that growth and ultimate size were compromised at maximal standing crops and increasing density. Oswald (2003) noted that declines in brown trout standing crop, numbers of 18 inch or 20 inch and larger fish and brown trout Condition Factor over the 1999 -

2002 period were steep, linear and similar to those observed in the 1988 - 1992 period (Oswald 1990, Oswald and Brammer 1993). Declines in brown trout standing crop and numbers of older larger fish have continued, under chronic low flow conditions, to approximate record low values through the 2006 samples. Frazier (2003) noted that observed declines in brown trout densities in the Big Horn River tailwater were associated with declines in recruitment due to loss of secondary channel habitats. Oswald (2000b, 2002, 2005) noted declines in brown trout standing crop, densities of older, larger brown trout, and brown trout Condition Factor in the Big Hole River over a prolonged period of drought reduced flow regimes and observed similar increases in numbers of large fish under ample flow conditions. Brown trout Condition Factor improved slightly after minimum values were observed with a declining trend through 2002 (Oswald 2003) during the 2003 – 2006 period. These improvements probably resulted from a combination of diminished standing crop, low densities of older, larger fish, and mild winter conditions. Similar observations were made for brown trout condition in Big Hole River study sections under prolonged low flow regimes (Oswald 2005). The data suggest that reduced brown trout Condition Factor is most markedly manifest as habitat reduction under low flows is initiated on relatively robust brown trout populations.

The long term data clearly demonstrate that limited non-irrigation flow releases into the Beaverhead River have resulted in chronic low flow regimes which have significantly limited brown trout populations. The data also substantially demonstrate that flow releases significantly exceeding or falling below the recommended minimum of 200 cfs maximize or minimize brown trout population parameters such as standing crop, numbers of older, larger fish in the population, and Condition Factor, especially that of the larger fish.

The Fish and Game Study Section is located downstream from the main canal diversions at Barretts and immediately upstream from the West Canal Diversion at Dillon. As such, the Fish and Game Section is representative of a substantially diminished tailwater affect but better flow and thermal regimes than those experienced in the lower river. Oswald (2003) noted that brown trout populations in the Fish and Game Section did not experience similar declines to those observed for the upper tailwater study sections under drought influenced flows in the 1999 - 2002 period of study. Despite very low winter flow regimes, brown trout density, standing crop and numbers of older, larger fish in the population remained strong although Condition Factor exhibited declines similar to those observed upriver. The brown trout population response to low flow regimes was also in complete opposition to the response noted during the prior 1988 - 1991 drought episode which exhibited severe population decline (Oswald 2000c). Oswald (2003) suggested that the improved response of the brown trout population of the Fish and Game Section to low flows was related to drought based angling closures and new river recreation rules that limited pressure within the section. It was further suggested that reduction in angling pressure could have mitigated the affects of drought on fish populations by reducing one source of stress under the chronic stress of extremely low flow regimes. Despite these mitigative measures, continued low flow stress resulted in four consecutive years of decline and eventuated in brown trout populations of minimum density and standing crop similar to those observed in upper river study sections by the 2006 sample. A similar response to mitigative angling restrictions was noted on the Big Hole River study sections as chronic low flow conditions persisted over a long period of time (Oswald 2005).

Lower River Study Sections

Oswald (2000c) noted that brown trout populations in the lower Beaverhead River have remained at low density since the 1970's with very little, if any, significant change. Oswald and Brammer (1993) listed habitat problems characteristic of the lower river including altered flow regime, heavy bedload transport associated with an inverted hydrograph, channel atrophy, high summer temperatures, and bank instability associated with poor woody riparian vegetative development. While summer flow regimes in the late 1990's were capable of matching or exceeding the recommended minimum flow of 200 cfs, recent flow regimes since 2000 have declined far below the recommended minimum. This chronic low summer flow condition has been the dominant flow regime in twelve of the past eighteen Water Years. Base summer flows in the past five have failed to average 50% of the recommended minimum instream flow of 200cfs and have been accompanied by extremely high water temperature regimes. The recent chronic low flow conditions have resulted in declining brown trout and mountain whitefish densities, standing crops and juvenile recruitment although density has declined more rapidly than standing crop as relatively high percentages of larger fish of both species marked some of the samples. This response differed from observations in upper river study sections where numbers of larger fish are dramatically reduced in more productive populations. The affect of low flow on brown trout recruitment and its affect on population density in the lower river study sections was similar to observations made in a much more productive population in the Big Horn River (Frazer 2003) but was noted as a chronic problem in the lower Beaverhead River by Oswald (2000c). Oswald (2003) suggested that differential flow and temperature regimes among the three study sections also affected brown trout populations within the chronically dewatered lower river reach. Recent data suggest that this would also apply to mountain whitefish populations. While poor quality lower Beaverhead River habitats chronically support reduced populations of brown trout and mountain whitefish under an inverted hydrograph, the recent severity and persistence of chronic low flows has resulted in the lowest populations observed in the three study sections. The 2006 population estimates appeared to be inflated in association with abnormally long interludes between mark and recapture efforts in conjunction with substantial flow reductions. Future sampling efforts should be conducted within the standard recommended 10 to 14 day interlude between sampling runs.

Due to low brown trout density, favorable length of river reach available, and active alluvial processes, the lower Beaverhead River was selected by MFWP as an Arctic grayling recovery area and received its first plants of overwintered grayling in 1999. Oswald (2000c) described preliminary observations that the stocked grayling distributed throughout the reach and that a fall migration in a downstream direction was triggered by the rising limb of the inverted hydrograph. Subsequent grayling plants over the 2000 - 2002 period fared poorly under low flow conditions. Oswald (2003) described low survival of summer plants to their first fall in the river and poor overwinter survival to Age II. These observations lead to a temporary suspension of Arctic grayling introduction efforts until more favorable flow regimes are encountered in the lower Beaverhead River. Other factors suspected of influencing grayling introductions insufficient stock density, small size of fish in the plants, and predation by large brown trout. While the 2003 Silver Bow sample revealed the last stocked grayling encountered in the lower river study sections, the 2006 Anderson Section sampled revealed a large adult male grayling of wild origin suggesting that a few Arctic grayling can reproduce and survive in the lower Beaverhead River under extremely poor habitat conditions.

UPPER RUBY RIVER

Oswald (2000c) noted that populations of rainbow x cutthroat hybrids, rainbow trout, and brown trout had all recovered from drought influenced flow regimes of the 1985-1994 period and flourished as ample flow regimes dominated the 1995 - 1999 period in the upper Ruby River. Recovery in terms of highs in density, standing crop, recruitment and condition factor were all observed in the Three Forks and Greenhorn Sections. Oswald (2003) noted that those population parameters all entered into declining trends, however, as summer flow regimes declined significantly below recommended instream flows over the 2000 - 2002 period of study. Declines in standing crop, numbers of larger fish in the population and Condition Factor for the rainbow X cutthroat trout hybrid swarm of the Three Forks Section mimic those observed in larger mainstem rivers like the Big Hole (Oswald 2002 and 2005) or Beaverhead River (Oswald 2000c and 2003) despite a lack of any major irrigation diversion or flow manipulation. Recent improvements in flow, although relatively minor until 2005, have been accompanied by some improvements in the fish populations of the upper river. Major declines in the rainbow trout population of the Greenhorn Section, however, have also been accompanied by a virtual lack of recruitment success since 1999. Additional sampling in the area has resulted in the identification of a severe whirling disease infection originating in the vicinity of Warm Springs Creek. Test cages placed in the Greenhorn Study Section revealed virtual 100% infections of juvenile rainbow trout exhibiting average histologies as high as 3.02 and 3.72, on a maximum 5.00 scale in 2002 and 2003. Test cages placed in upstream environments, to include the Three Forks Study Section have failed to reveal any infection while population data have not revealed any significant declines in rainbow or westslope cutthroat trout recruitment. The data clearly suggest that the substantial decline in rainbow trout populations in the upper Ruby River is strongly correlated with the whirling disease infection. Recent data suggest that the rainbow trout population of the greenhorn Section might have stabilized at very low density for the present.

Arctic grayling reintroduction efforts in the upper Ruby River have met with limited success to date. While stocked populations of grayling have demonstrated an affinity for the fluvial environment of the Ruby, maintained high population density throughout the stocked reach (Opitz 2000), and exhibited an ability to migrate within the system without drifting into Ruby Reservoir (Liermann 2001), winter survival has appeared to be a significant limiting factor. Recent data suggest that stocked yearling grayling might not have the natural ability to out-migrate from headwaters and summer habitats to overwinter habitats compared with other species native to the system. Perhaps the most important successful component of the reintroduction effort has been the documentation of successful reproduction over the 2000 - 2006 period (Magee 2002, Oswald 2003, Lamothe and Magee 2004). While recent samples have been indicative of declining densities as stocking has been reduced, they have contained older wild individuals as well as Age 0 and Age I recruits. Many of the juvenile recruits, however, have been the result of remote site egg incubators placed in headwater tributaries as an alternative to the yearling stocking program (Lamothe and Magee 2004). Questions still remain, however, as to whether the stock density of grayling surviving to reproductive adulthood can represent sufficient reproductive density to provide sufficient natural recruitment into a persistent population. Natural carrying capacity of habitats, particularly at low flow regimes, must certainly limit the rate at which yearling grayling can be stocked. Oswald (2003) observed that the artificial placement of a large standing crop of grayling into the apparently limited environment of the Three Forks Section did not result in deleterious affects on the wild rainbow x cutthroat hybrid population that occupied the reach upon the initiation of reintroduction efforts. Oswald further noted, however, that the density and standing crop of these wild fish remained high in spite of the high density grayling population and their mean condition factor remained high concomitant with ample habitat niche at high flow.

LOWER RUBY RIVER

The complete dewatering of the Ruby Reservoir in 1994 resulted in a substantial fish kill and heavy losses in the wild brown trout population of the river below the dam. Oswald (2000a and 2000c) described rainbow trout population recovery after 1995 in the Ruby Reservoir and full recovery of wild brown trout populations in the productive tailwater environment of the river. Actions taken via the establishment of a Governor's Ruby River Task Force in 1994 and 1995 coupled with ample storage in Ruby Reservoir and ample flow regimes in the Ruby River resulted in maximum brown trout densities and standing crops by the 2000 sample. Brown trout condition factor, juvenile recruitment, and densities of 18 inch and larger fish also peaked in 1999 or 2000 in the Maloney Section. These major brown trout population parameters peaked with abundant stream flow despite the acquisition of public fishing access through the Maloney Section Reach in 1997. Oswald (2000c) discussed concern over unrestricted public access to reaches of the lower Ruby River and the implementation of special restrictive regulations in anticipation of negative affects of angler driven mortality. The data strongly suggest that brown trout populations, including densities of large fish, were unaffected by angling pressure under the prevailing regulations (Oswald 2003). Moreover, comparative data with other lower Ruby River Study Sections strongly suggested that brown trout populations were unaffected by angling prior to the inception of the special regulations (Oswald 2000c). In an evaluation of special restrictive regulations on the Big Hole River, Oswald (Vincent et al. 1989) suggested that the restrictions had little discernible affect after eight years of implementation and further suggested (Oswald 2000b) that the prevailing voluntary angler practice of catch and release was adequate to maintain brown trout mortality within natural population rates. Oswald (2003) noted that brown trout population declines in the Maloney Section over the 2001 - 2002 period were directly attributable to diminished flow regimes and included reduced density, standing crop, recruitment, condition factor, and numbers of 18 inch and larger fish. These population declines continued, under persistent low flow regimes, through 2004 and beyond for some of the parameters. These responses were similar to those observed in the upper Beaverhead River tailwater study sections under reduced flow regimes. Relatively strong juvenile recruitment in 2005 and 2006 and relatively high numbers of surviving Age IV fish in the 2006 sample should provide for rapid brown trout population recovery under improving flows regimes.

Oswald (2000c) noted substantial declines in brown trout populations in the Silver Spring Section over the 1993-1996 period and observed, in a more limited manner, in the Sailor Section downstream. The subsequent discovery of whirling disease in the study section in 1995 triggered companion graduate research on the affects of the disease on brown trout in the lower Ruby River and Poindexter Slough. While the study could not directly confirm that whirling disease was the causative vector of declining recruitment in both streams, Opitz (1999) and Oswald

(2003) suggested that the disease could have had population level effects on a naïve population, if only for a single reproductive generation. Brown trout generally demonstrate a resistance to whirling disease although populations can be affected under favorable conditions for *Myxobolus cerebralis* (Walker and Nehring 1995. The most recent data suggest that flow regimes, rather than whirling disease, have had the most direct impact on brown trout population parameters, including recruitment, in the Silver Spring Section. While flow relationships have clearly influenced recent population trends, overall brown trout population densities, standing crops, and numbers of 13 inch and larger fish have failed to attain pre whirling disease highs for any sustained period including the abundant flow period of the late 1990's. The only population parameter that did so was the density of the 16 inch and larger fish, which flourished over the 1997 – 2002 period, as a result of relatively abundant flow regimes and lower population densities than those observed prior to whirling disease, Similar to the observed situation in the Maloney Section, the proximity of public angling access to the Silver Spring Section has had no discernible affect on brown trout populations. Oswald (2003) observed that exclusive angling access and numerous habitat improvement projects had not resulted in superior brown trout populations in the Sailor Section of the lower Ruby River. Similarly, brown trout populations of the Sailor Section had not exhibited population highs similar to those observed prior to the discovery of whirling disease in the system.

POINDEXTER SLOUGH

Poindexter Slough has generally supported extremely abundant wild brown trout populations exceeding any other water in the project area in lineal density. Most of the high population densities in Poindexter Slough have been associated with strong annual recruitment of Age I fish (Oswald 2000c). Major declines in recruitment over the 1993 - 1997 period concomitant with the discovery of whirling disease in 1995 (Oswald 2000c) elevated concern over declining brown trout density. Poindexter Slough provides excellent habitat for *Tubifex tubifex*, an intermediate host for *Myxobolus cerebralis*, and may provide for "hot spots" for the disease (Opitz 1999). Such hot spots have been identified in the upper Colorado River (Walker and Nehring 1995) in association with declines in brown trout recruitment. As was the case in the lower Ruby River, recovery in brown trout recruitment in Poindexter Slough closely mimicked the length of time required for reproductive maturation of cohorts recruited in the aftermath of the severe population declines. The extremely high densities of brown trout in Poindexter Slough have been linked closely with juvenile recruitment while standing crop has remained relatively stable. Oswald (2003) suggested that population compensation in the form of increased numbers of larger fish at reduced population density indicated that growth rates and ultimate size for individual fish in the population were improved by the decreased density and further suggested that Poindexter Slough brown trout standing crops have been maintained at, or very close to, carrying capacity. Similar observations were made for larger fish as density declined in the lower Ruby River while brown trout ultimate size has been reduced in the upper Beaverhead River under burgeoning population density and standing crop (Oswald 2000c). Although Poindexter Slough, like other southwest Montana streams has been impacted by the recent drought and somewhat reduced flows, Oswald (2003) suggested that it was difficult to attribute the slight increases or declines in brown trout population density to flow regime due to the dominant spring creek habitat. Abundant flows in the late 1990's however, provided for a high water table and the diversion of abundant irrigation water supply from the adjacent Beaverhead River through Poindexter Slough. Conversely, recent restrictions by water user boards on amounts of water diverted at river headgates has significantly limited the amount of water diverted into Poindexter Slough over the past three years. The WETP minimum recommended instream flow in Poindexter Slough is 58 cfs at the mouth with the Beaverhead River. Recent measurements collected over the 2004 – 2006 period (MFWP data files, Dillon, MT) have indicated that flows as low as 6 cfs have been measured below the Dillon Canal Diversion) at the head of Section Three resulting in flows as low as 16 cfs at the mouth of the slough. Generally, mid summer flows measured at the mouth have ranged between 26 and 30 cfs, far below the recommended minimum. Limited flow entry from the river has also eliminated any form of a spring runoff to mobilize organic sediments and scour diverse habitat niche over the recent past. As a result, a distinct pattern of decline has marked brown trout population density, standing crop, and numbers of 13 inch and larger fish since peaks observed in the 2000 sample and numbers of the Age IV and older, 15 inch and larger, component of the population since 2002. Conversely, these same population parameters had demonstrated an increasing trend during and immediately following the abundant flow regimes of the late 1990's. To this extent, recent fluctuating flow regimes, rather than a relatively constant groundwater supply, have strongly influenced the brown trout populations have Poindexter Slough and recent reductions of water supply from the Beaverhead River appear to be directly correlated with significant declines in brown trout population parameters.

RED ROCK RIVER

The Red Rock River has been subjected to chronic low flow regimes, under severe drought conditions similar to other southwest Montana streams, since approximately 2000. Typical of the situation below most irrigation reservoirs, low flows were most severely manifest during non-irrigation periods in late fall, winter, and early spring. These low overwinter flows below storage dams have substantially impacted brown trout populations in the Beaverhead and Ruby Rivers (Oswald 2003). Significantly below average storage pools in Lima Reservoir, however, also resulted in chronic low flows manifest in late summer throughout the 2000 – 2004 period. Similar drought conditions in the late 1980's and early 1990's resulted in dewatered reaches of the river that persisted for long periods of time. Oswald, in Vincent et al. (1990), described a complete dewatering of the river reach between the mouth of Sage Creek and Lima Dam for a period of about 10 months from July of 1988 to May of 1989. While the current drought episode did not result in a dewatered reach as expansive as that observed in 1988 – 1989, several shorter reaches in the Dell, Montana vicinity suffered complete dewatering or flows reduced into the 1.0 to 5.0 cfs range in the 2000 – 2004 period. Both drought episodes resulted in significant reductions in brown trout populations in the Dell, MT vicinity when compared to populations estimated in 1987 although the reductions were more marked following the 1988 dewatering event (Vincent et al. 1990). During the drought spate of the 1987 – 1994 period, the only protection afforded the brown and rainbow trout populations of the Red Rock River was an emergency daily bag and possession limit reduction from 5 to 2 trout per day. Over the 2000 – 2005 period, voluntary efforts by some of the irrigators resulted in flow refugia which often provided for flows of 25 to 30 cfs when up and downstream reaches could be nearly or completely dewatered. Fish surviving in the discreet refugia were additionally afforded protection through the implementation of voluntary, and later, mandatory summer fishing closures over the 2000 – 2004 period. The summer fishing closures were followed by mandatory angling closures over the fall spawning period in October and November and accompanied by a bag and possession limit reduction from 5 to 3 fish for brown and rainbow trout. The data strongly suggest that these additional protections resulted in brown trout populations that fared better through prolonged low flow regimes than those of the late 1908's and early 1990's. Population parameters demonstrated improved conditions include density, standing crop, recruitment, and density of older, larger fish. Initial observations suggest that brown trout populations are also recovering more rapidly as flow regimes began to improve in 2005 and 2006 than those observed in the prior drought episode. Oswald (2003 and 2005) suggested that voluntary flow relief efforts by irrigators and reduction of angling pressure reduced the rate of brown trout population decline in study sections on the Big Hole and Beaverhead Rivers. The Martinell Study Section should continue to be monitored as flow regimes in the Red Rock River continue to improve in order to better determine rates of brown trout population recovery and the roles of flow refugia and angling closures in that recovery.

LITERATURE CITED

Boltz, G. 2000. Fisheries investigations on the Red Rock Lakes National Wildlife Refuge, Montana. USFWS Progress Report, 1998-1999. Bozeman, MT 45pp.

Brittain, S., M. Lere, and B. McFarland. 1997. Mark / Recapture estimate guidelines for Montana. Fish. Inf. Services Bull., Mont. Dept. Fish, Wild & Parks, Bozeman 20pp.

Frazer, Ken. 2003. Upper Bighorn River Investigations. Job. Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts. Montana Department of Fish, Wildlife and Parks Job Progress Report F-78-R-4, R-5, and R-6; F-113-R-1, R-2, and R-3. 39pp.

Lamothe, Peter and J. Magee. 2004. Reintroducing fluvial Arctic grayling (*Thymallus arcticus*) to the upper Ruby River, MT. Montana Arctic Grayling Recovery Group, Montana Fish Wildlife and Parks, Region Three, Bozeman. 55pp.

Liermann, Bradley W. 2001. An evaluation of the reintroduction of fluvial Arctic grayling into the upper Ruby River. M.S. Thesis, Montana State University, Bozeman, 89pp.

Magee, James P. 2002. Montana fluvial Arctic grayling recovery project: monitoring report 2000 - 2001. Montana Fish, Wildlife & Parks Annual Report to Fluvial Arctic grayling workgroup. 65pp.

Montana Fish, Wildlife & Parks. 1989. Application for reservations of water in the Missouri River basin above Fort Peck dam. Vol. 2., Mont. Dept Fish, Wild. & Parks, Helena 620pp.

___. 1991 - 2001. Montana statewide angling pressure estimates. Fish. Inf. Services, Mont. Dept. Fish, Wild. & Parks, Bozeman

___. 1994. Mark / Recapture version 4.0, a software package for fishery population estimates. Fish. Inf. Services, Mont. Dept. Fish, Wild. & Parks, Bozeman 45pp.

___. 1996. Lower Ruby River fishing access plan. Mont. Fish, Wild. & Parks, Region Three,

Opitz, S.T. 1999. Effects of whirling disease on recruitment of brown trout in the Ruby River and Poindexter Slough, Montana. M.S. Thesis, Montana State Univ. Bozeman 97pp. Bozeman. 21pp.

___. 2000. Upper Ruby River Arctic grayling reintroduction annual report 1999. Fluv. Arc. Grayling Workgroup, Mont. Dept. Fish, Wild. & Parks, Bozeman. 31pp.

Oswald, R.A. 1984. Inventory and survey of the waters of the Big Hole and Ruby River drainages. Job Prog. Rpt., Fed Aid in Fish and Wild Rest. Acts. Mont. Proj. No. F-9-R-31-32, Job No. Ib, 23pp.

___. 1986a. Investigation of the influence of Clark Canyon Reservoir on the stream fishery of the Beaverhead River. Job Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts. Mont. Proj. No. F-9-R-34, Job No. IIa, 22pp.

___. 1986b. Inventory and survey of the waters of the Big Hole, Beaverhead, and Ruby River drainages. Job Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts, Mont. Proj. No. F-9-R-34, Job No. Ib, 35pp.

___. 1999. Preliminary response of a westslope cutthroat trout population to reclamation techniques applied within the Stone Creek drainage of the Ruby Mountains. Report to the Stone Cr. Watershed Committee. Mont. Fish, Wild. And Parks, Dillon. 16pp.

___. 2000a. Inventory and survey of fish populations in lowland lakes and reservoirs of the Red Rock, Ruby, Beaverhead, and Big Hole River drainages of southwest Montana. Job Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Proj. Nos. F-78-R-1,2,3,4, and 5. 50pp.

___. 2000b. Inventory and survey of the salmonid populations of the Big Hole River of southwest Montana, 1981- 1999. Job Prog. Rpt., Fed Aid in Fish and Wild. Rest. Acts. Proj. Nos. F-78-R-1,2,3,4 and 5. 32pp.

___. 2000c. Inventory and survey of selected stream fisheries of the Red Rock, Ruby, and Beaverhead River drainages of southwest Montana. Job Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts, Proj. Nos. F-78-R-1; F-78-R-2, F-78-R-3; F-78-R-4; and F-78-R-5. 75pp.

___. 2002. Inventory and survey of the salmonid populations of the Big Hole River of southwest Montana 2000 - 2001. Job Prog. Rpt., Fed Aid in Fish and Wild. Rest Acts, Proj. Nos. F-78-R-6 and F-113-R-1. 27pp.

___. 2003. Inventory and Survey of selected stream fisheries of the Red Rock, Ruby, and Beaverhead River drainages of southwest Montana; 2000- 2002. Job Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts, Proj. Nos. F-78-R-6, F-113-R-1, F-113-R-2; 71pp.

___. 2004. Inventory and survey of fisheries in lowland lakes and reservoirs of the Red Rock, Ruby, Beaverhead, and Big Hole River drainages of southwest Montana. Job Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Proj. Nos. F-78-R-6 , F-113-R-2, R-3, and R-4. 48pp.

___. 2005. Inventory and survey of the brown and rainbow trout populations of the Big Hole River of southwest Montana 2001 - 2005. Job Prog. Rpt., Fed Aid in Fish and Wild. Rest Acts, Proj. Nos. F-113-R-2, R-3, R-4, and R-5. 34pp.

Oswald, R.A. and J.A. Brammer 1993. Survey of the trout populations of the Beaverhead River and selected tributaries within its drainage. Job. Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts. Mont. Proj. No. F-46-R-6, Job Nos. Ie and If, 51pp.

USGS, 1989-2006. Water resources data for Montana, Water Years 1989 - 2006. U.S. Geological Survey, annual water resources reports for Montana.

Vincent, E.R. 1971. River electrofishing and fish population estimates. Prog. Fish Cult. 33(3):163-167.

Vincent, E.R., C. Clancy, W. Fredenberg, R. Oswald, and B. Rehwinkle. 1989. Southwest Montana major river fisheries investigations. Job Prog. Rpt., Fed Aid in Fish and Wild. Rest. Acts, Proj. No. F-46-R-2, Job No. If, 59pp.

Vincent, E.R., W. Fredenberg, R. Oswald, and B. Shepard. 1990. Southwest Montana cold water stream investigations. Job. Prog. Rpt., Fed. Aid in Fish and Wild. Rest. Acts. Mont. Proj. No. F-46-R-3, Job No. Ie. 29pp.

Walker, P.G. and R.B. Nehring. 1995. An investigation to determine the cause(s) of the disappearance of young wild rainbow trout in the upper Colorado River, in Middle Park, Colorado. Colorado Division of Wildlife.

Report Prepared By: Richard A. Oswald, MFWP, Region 3, Bozeman August 2006

All Work Included in this Report in Conjunction with Federal Aid in Fish and Wildlife Restoration Acts:
Project Numbers: F-113-R-3, F-113-R-4, F-113-R-5, and F-113-R-6

Montana Fish, Wildlife & Parks Project Number 3320

APPENDIX OF FIGURES

Figure 1. End of irrigation season (fall) storage in Clark Canyon Reservoir, 1982 - 2005.

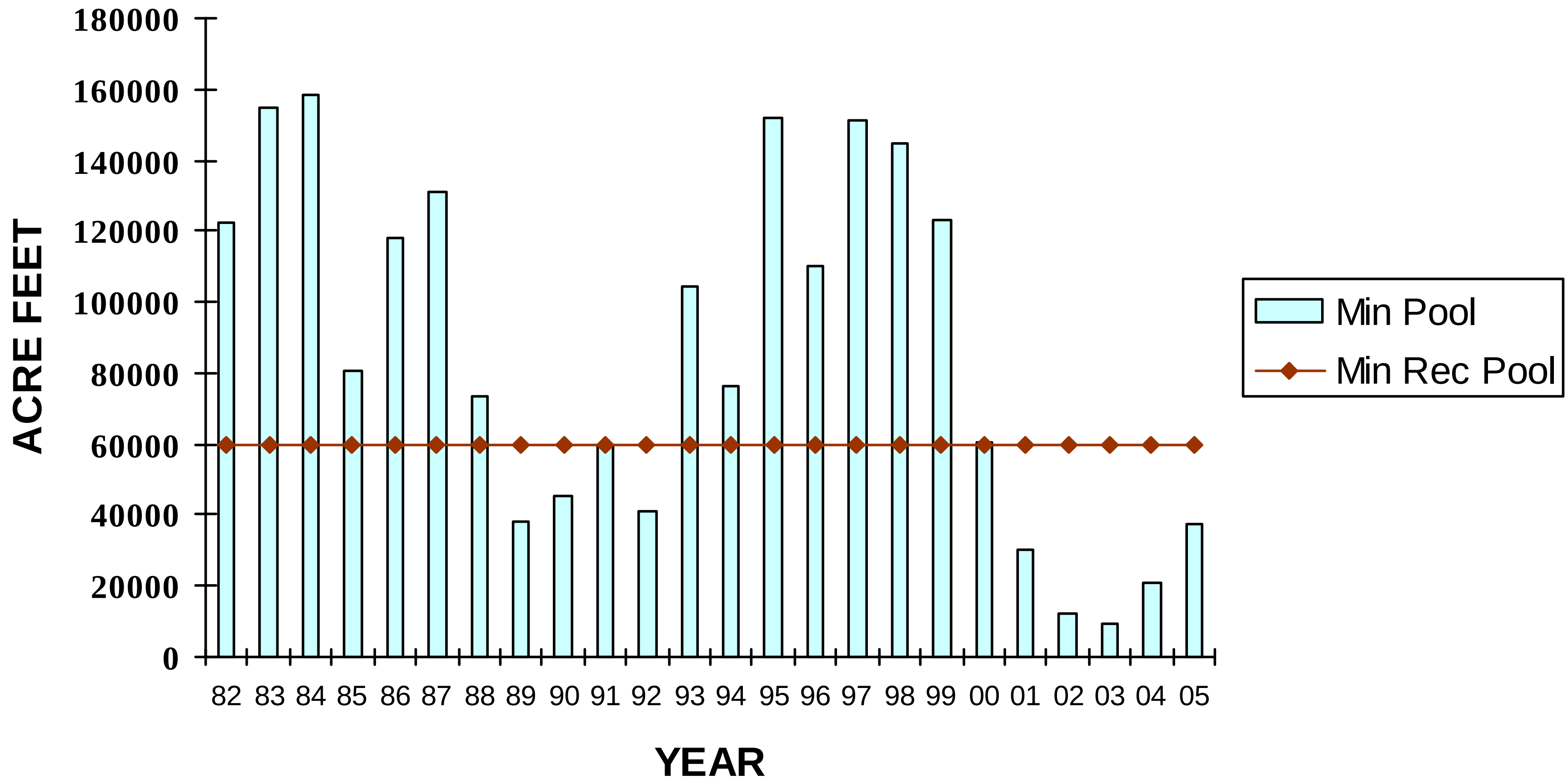

Figure 2. Mean nonirrigation season (October through March) flow release into the Beaverhead River from Clark Canyon Dam over the 1982 - 2006 Water Years.

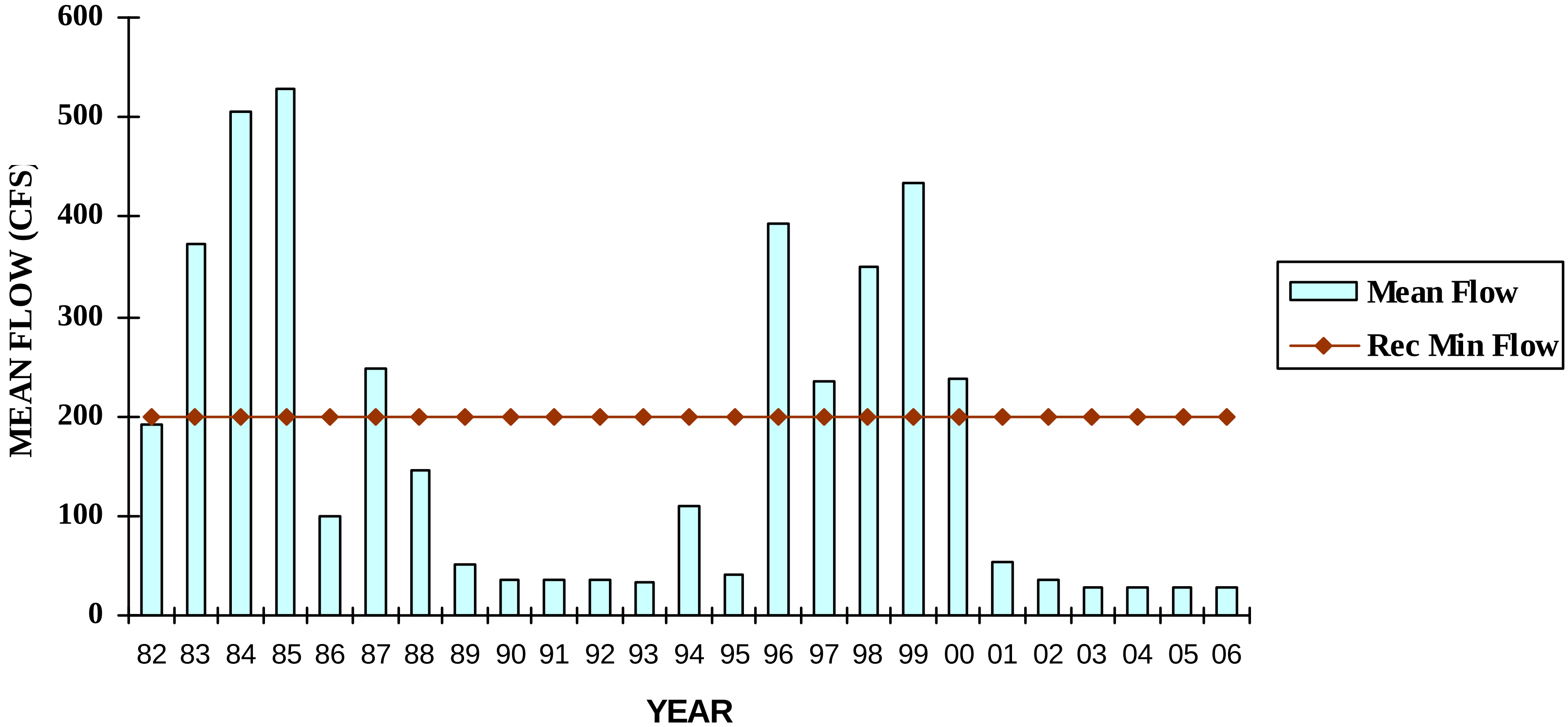

Figure 3. Estimated spring density and standing crop of brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2006.

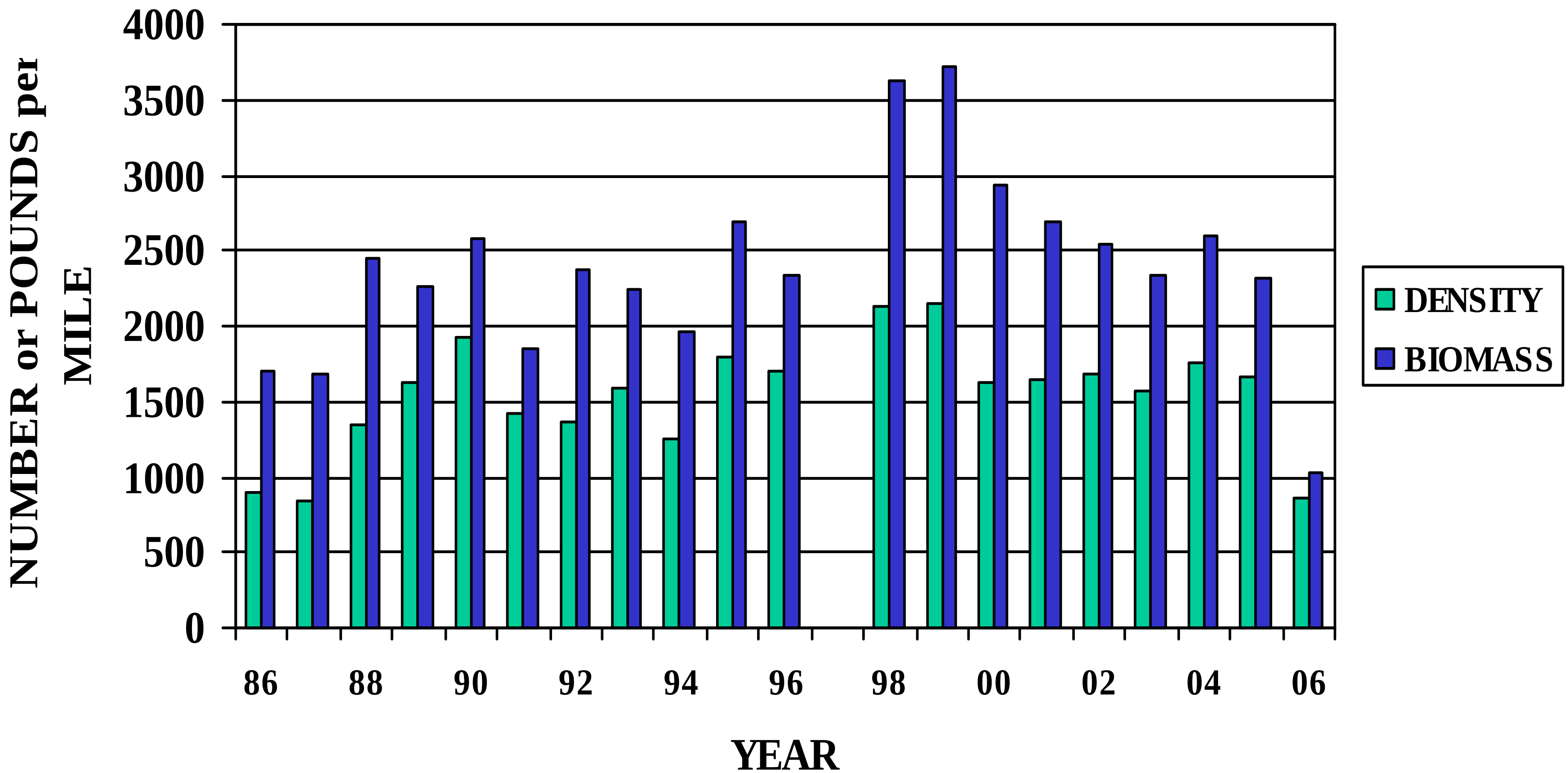

Figure 4. Estimated spring density of 18 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2006.

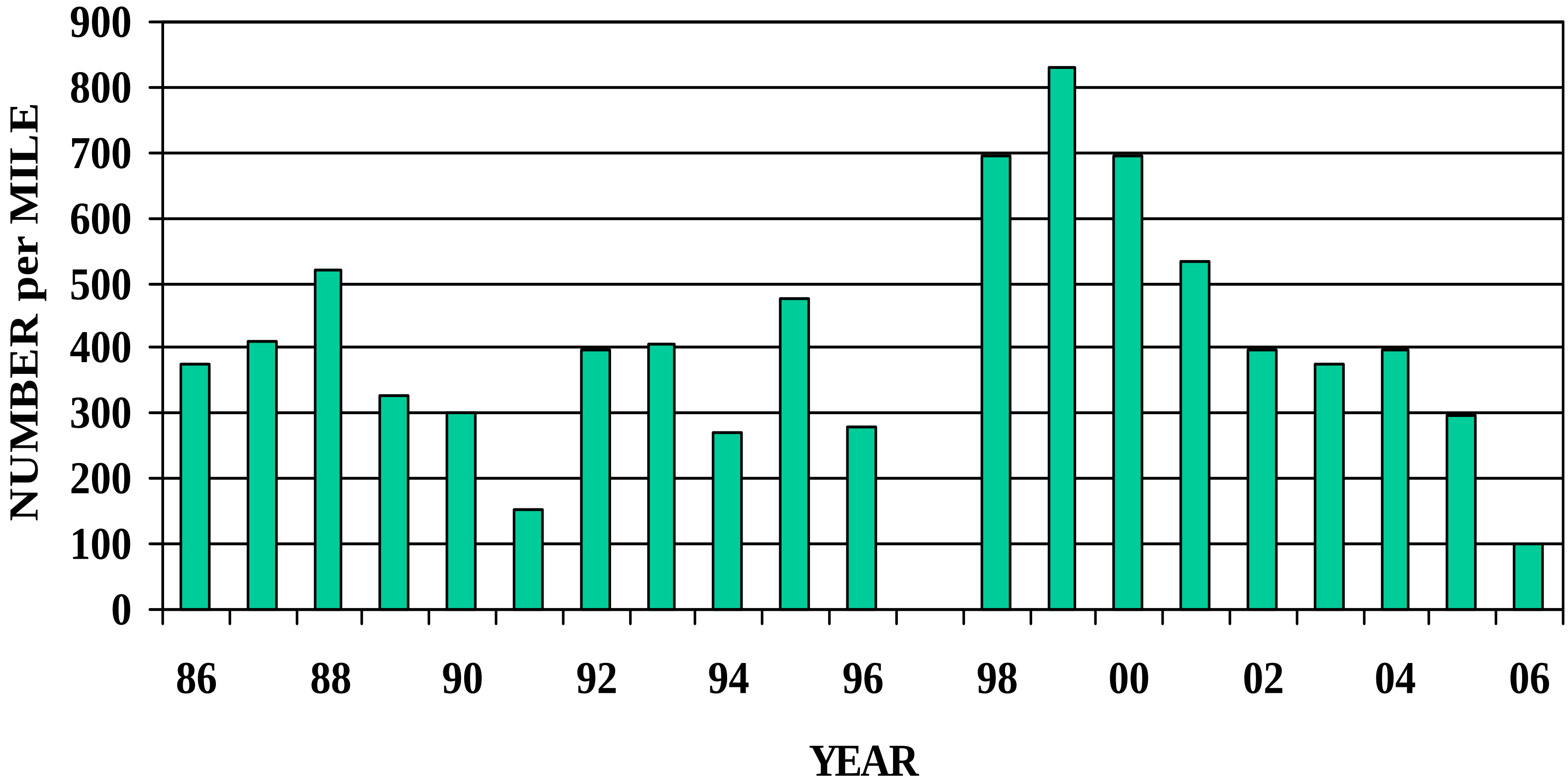

Figure 5. Estimated spring density of 20 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2006.

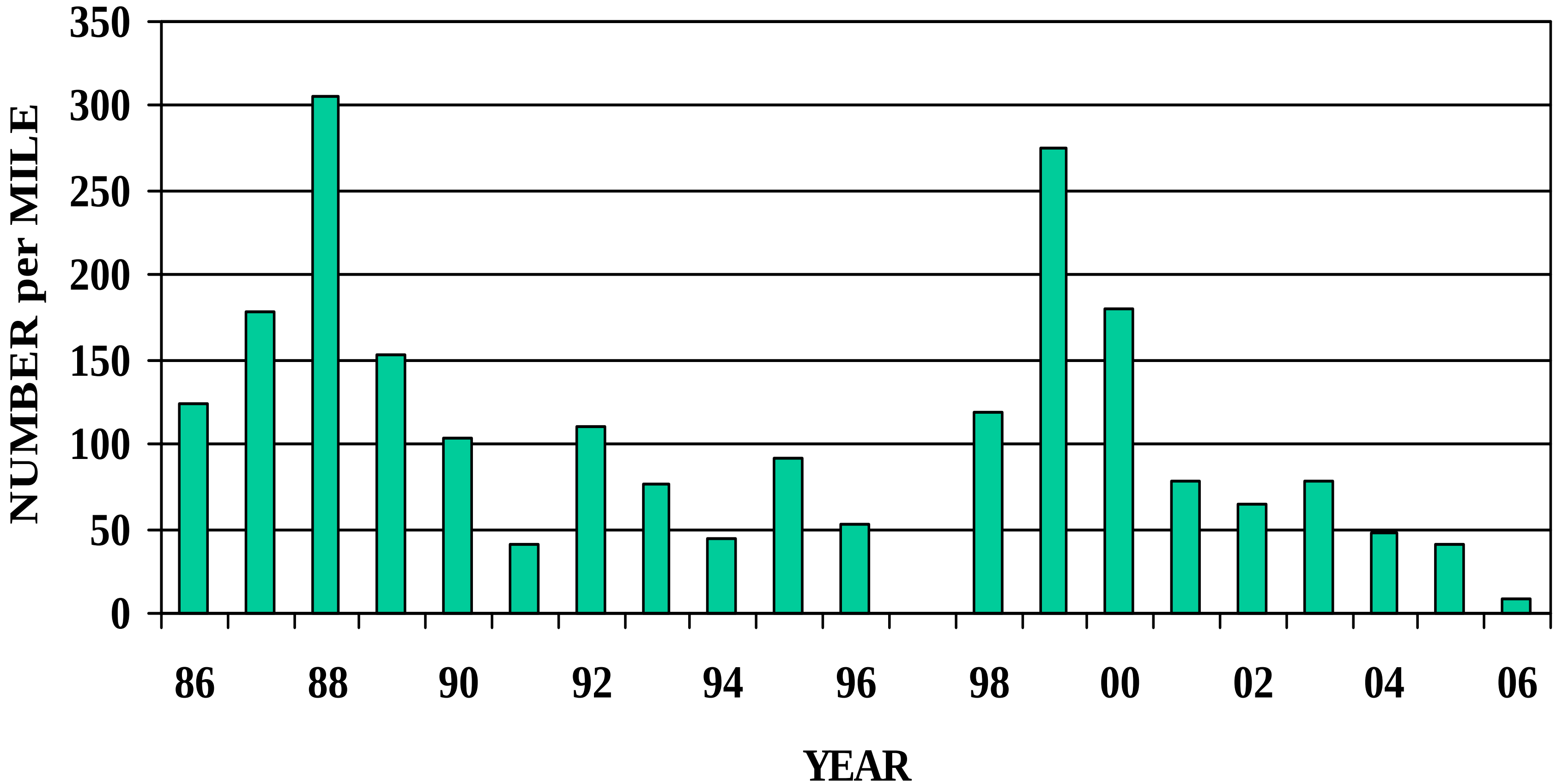

Figure 6. Estimated spring density of 22 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2006.

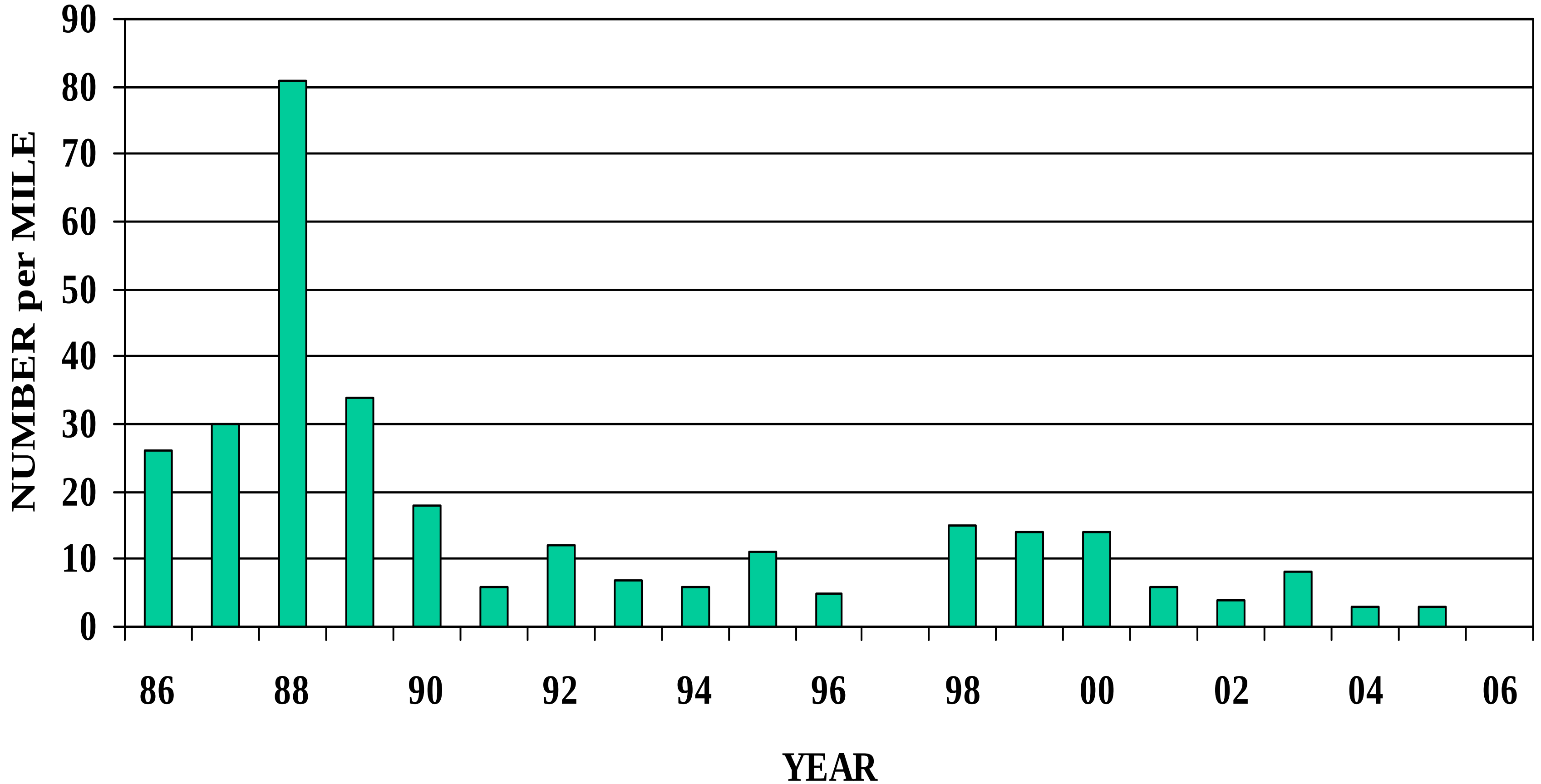

Figure 7. Density of 18 inch and larger brown trout as a percentage of the total spring brown trout population in the Hildreth Section of the Beaverhead River; 1986 - 2006.

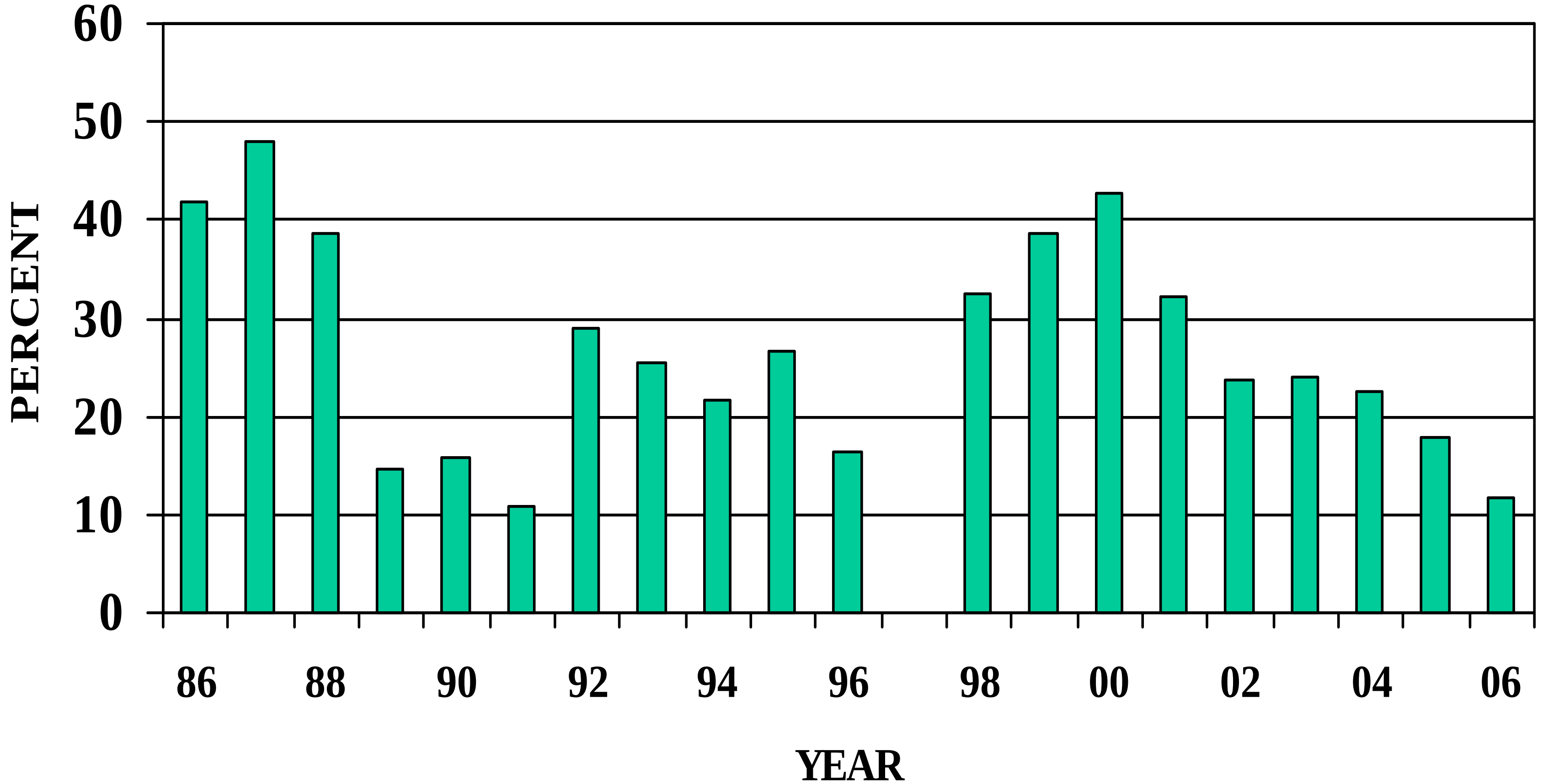

Figure 8. Density of 20 inch and larger brown trout as a percentage of the 18 inch and larger segment of the brown trout population in the Hildreth Section of the Beaverhead River, 1986-2006.

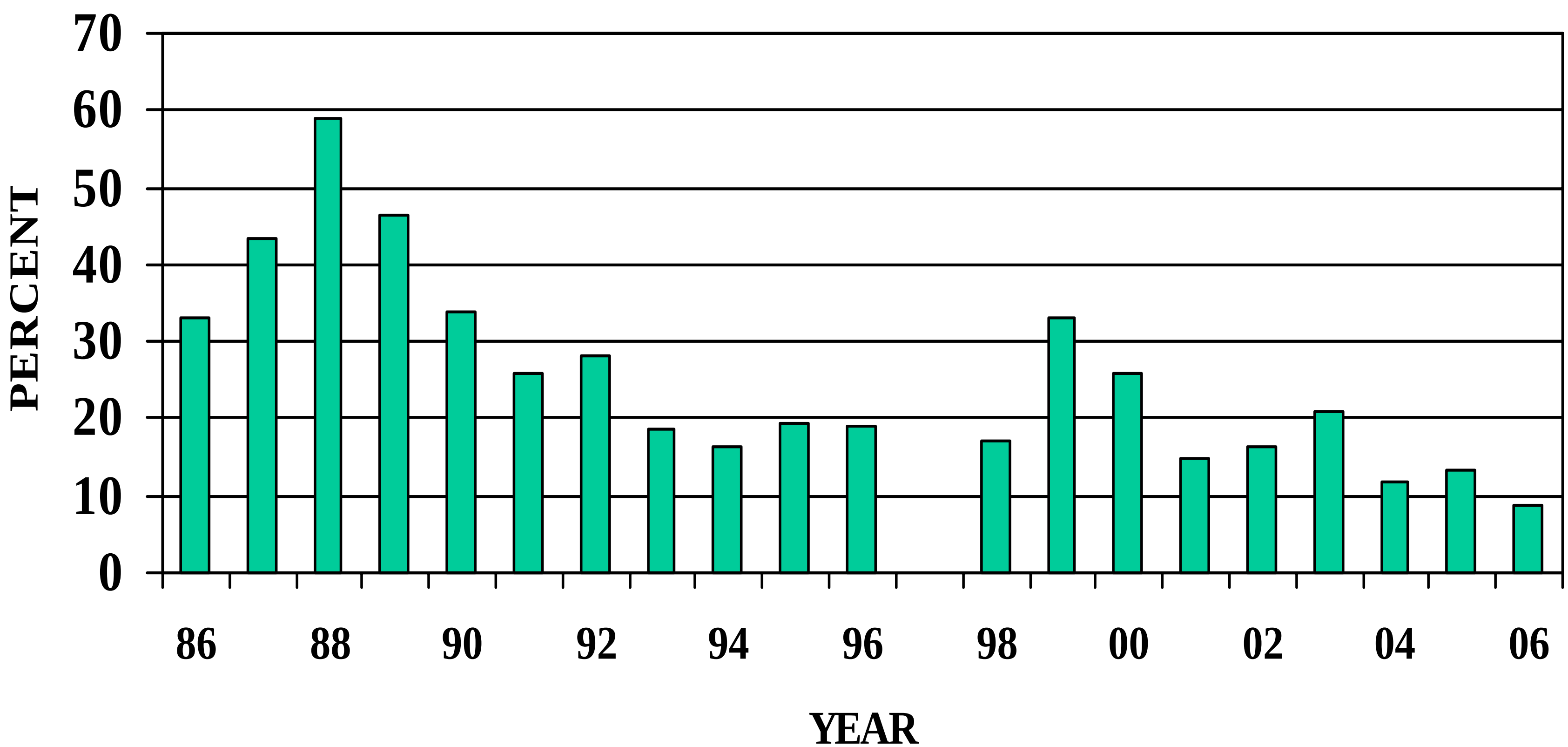

Figure 9. Mean spring Condition Factor (K) for Age II and older brown trout and the 18 inch and 20 inch and larger length groups of brown trout collected in the Hildreth Section of the Beaverhead River, 1999 - 2006.

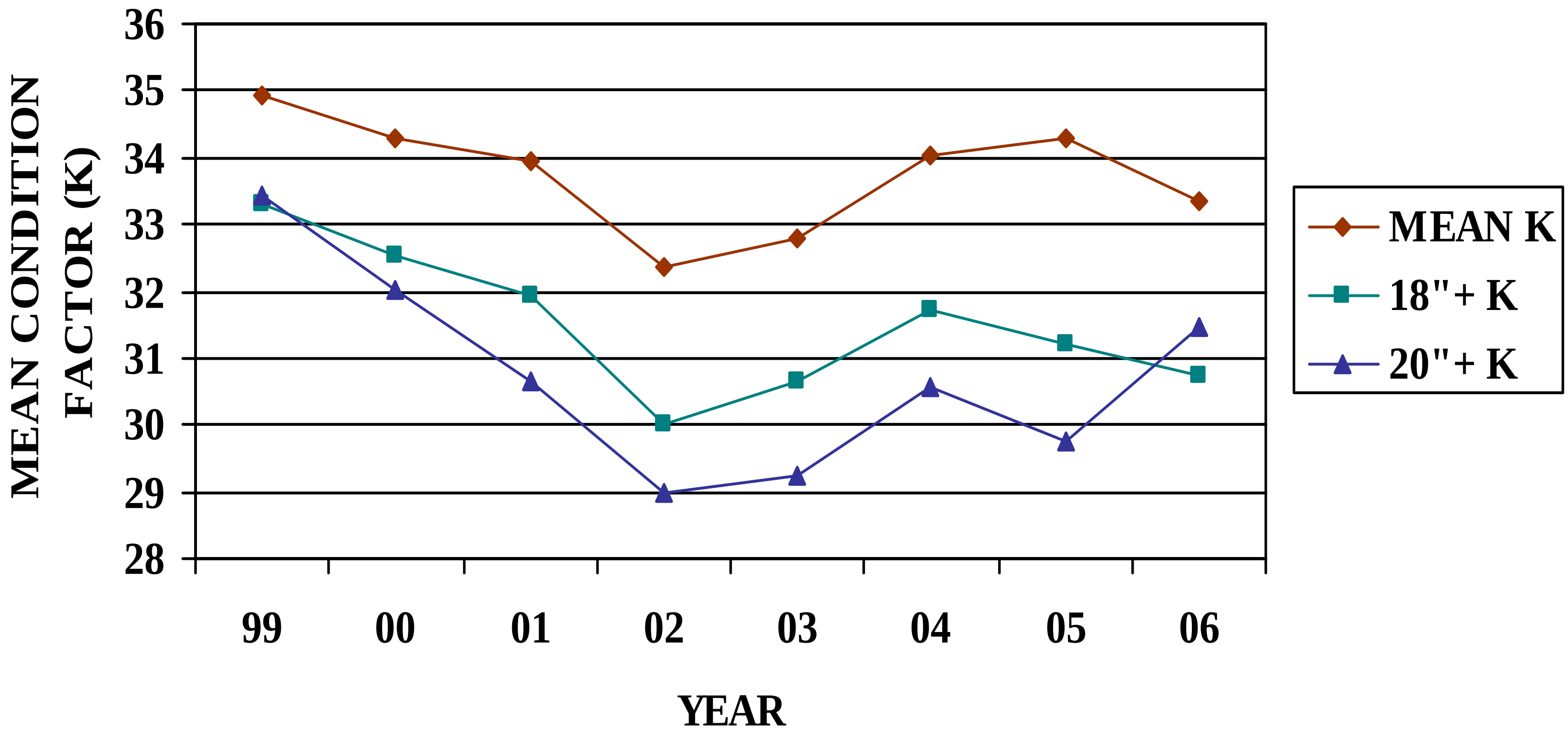

Figure 10. Estimated spring density and standing crop of Age II and older brown trout in the Pipe Organ Section of the Beaverhead River, 1986 - 2006.

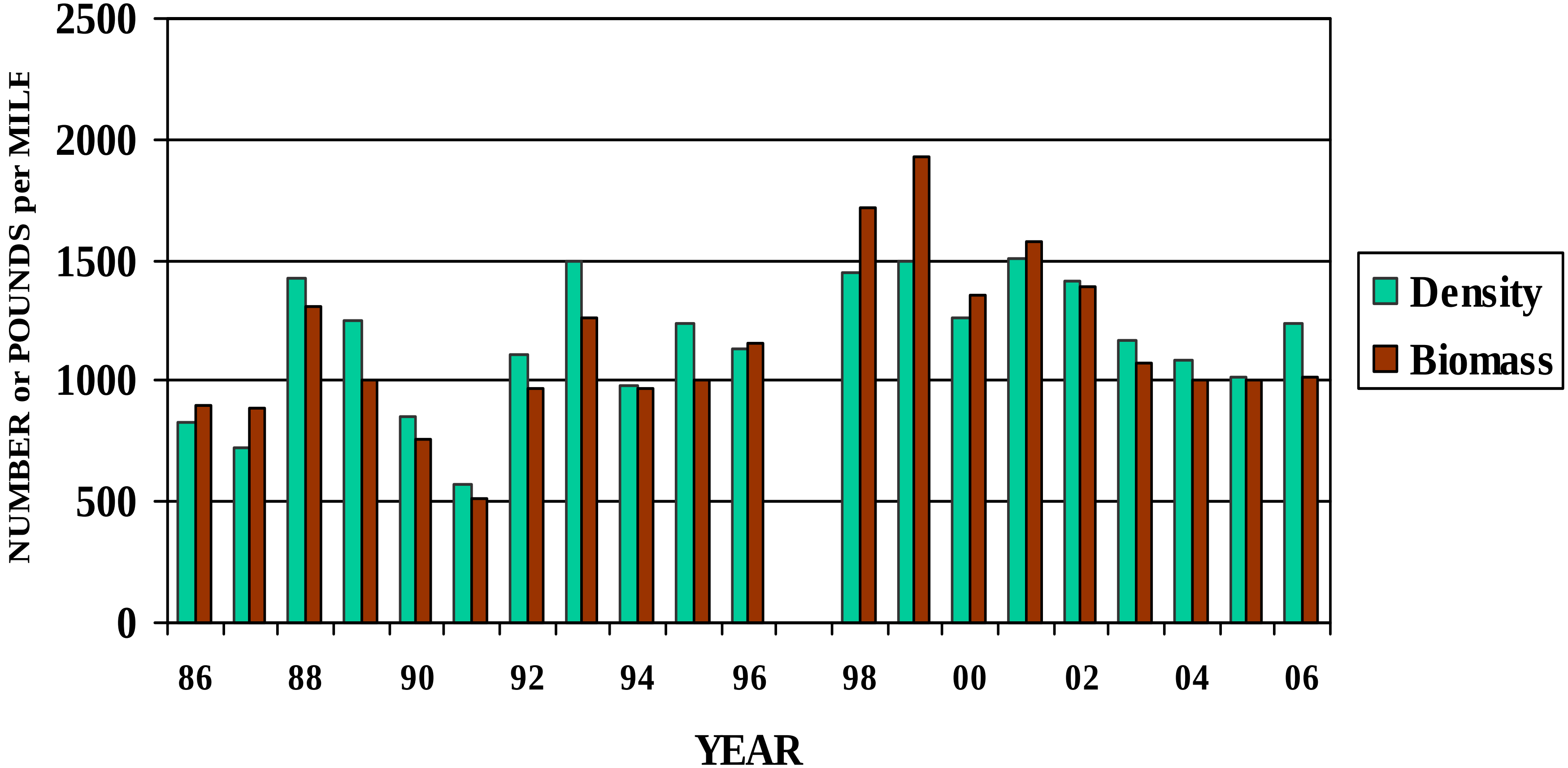

Figure 11. Estimated spring density of 18 inch and larger brown trout in the Pipe Organ Section of the Beaverhead River, 1986 - 2006.

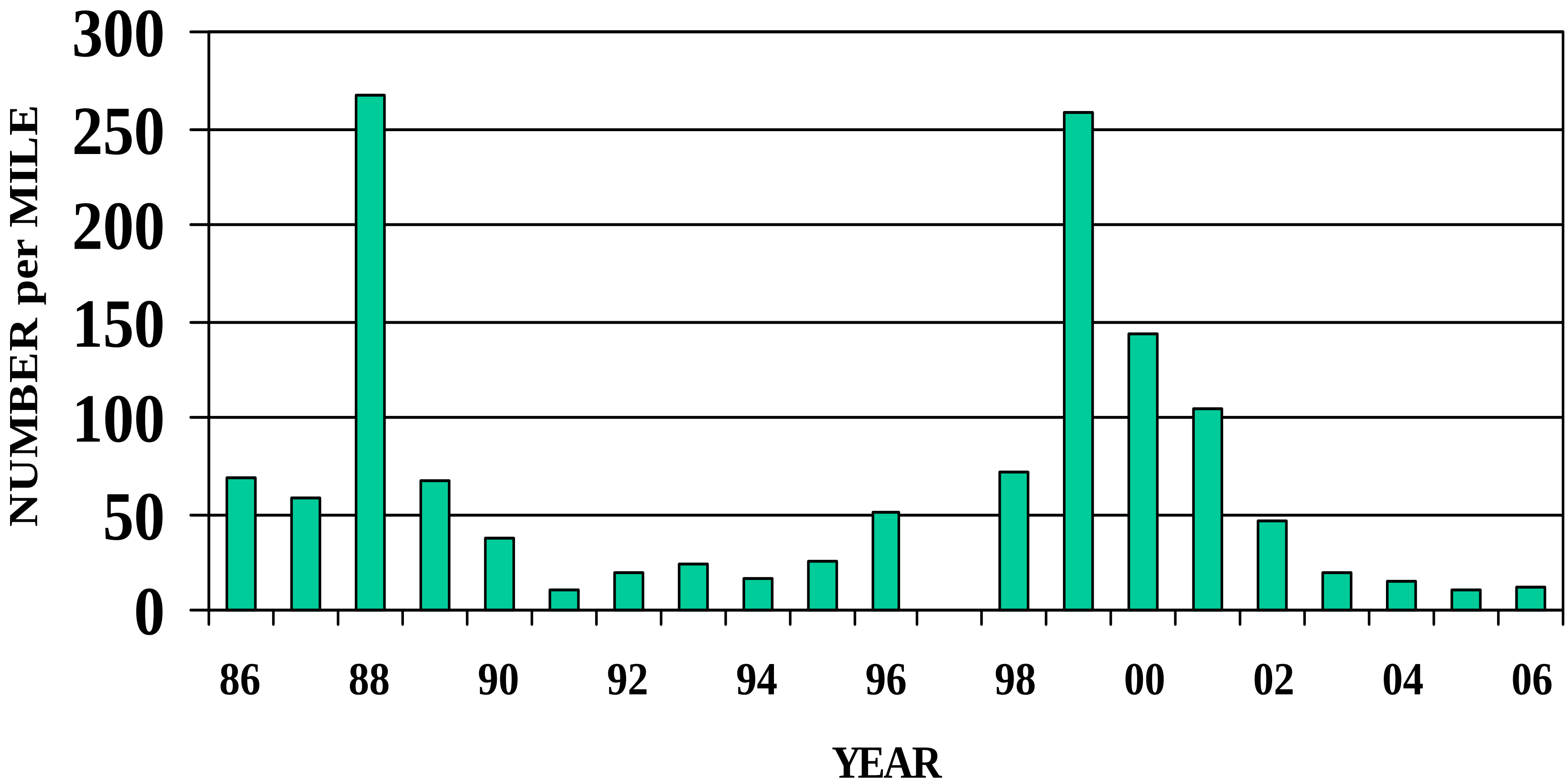

Figure 12. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Pipe Organ Section of the Beaverhead River, 1999 -2006.

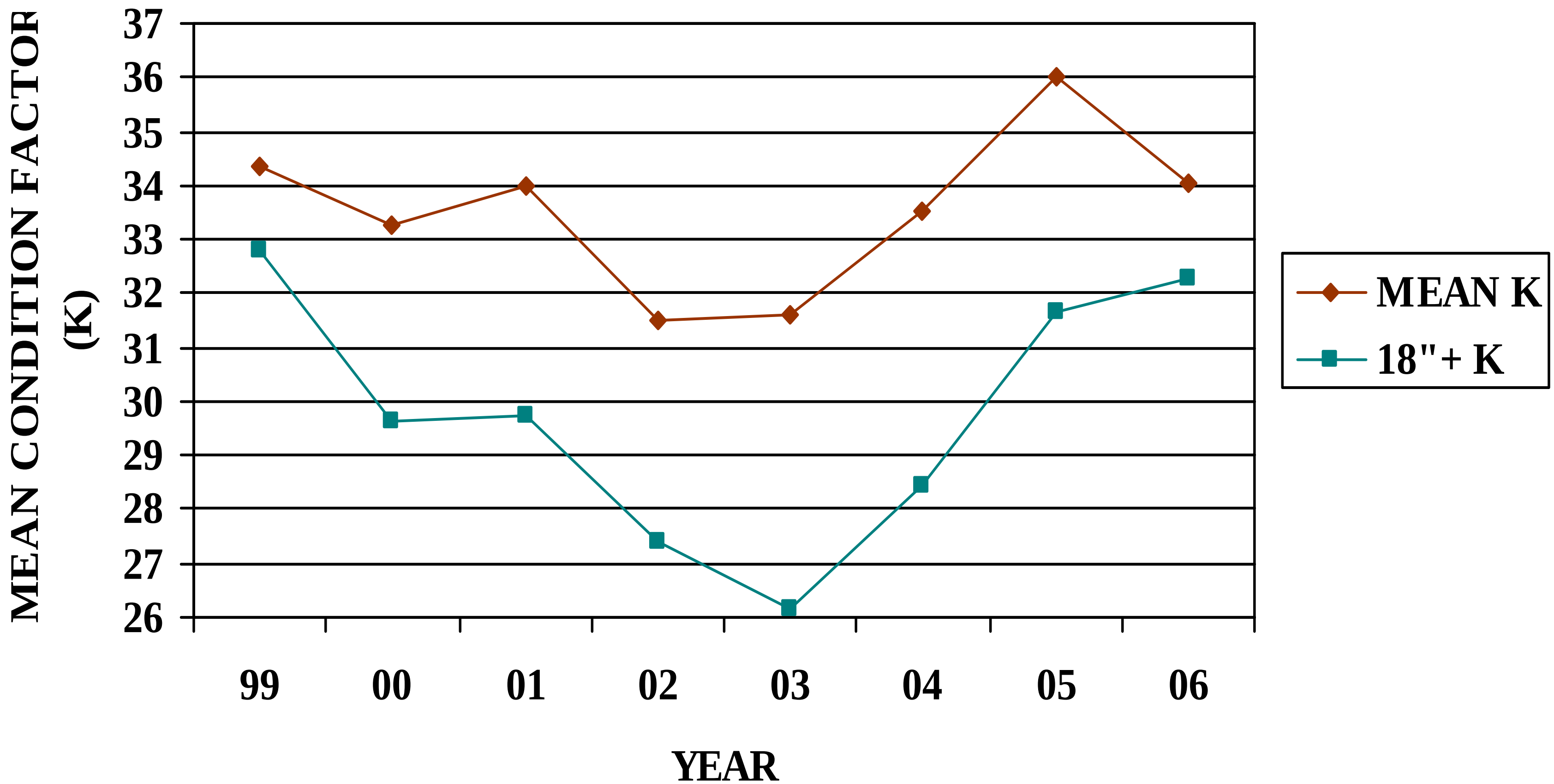

Figure 13. Estimated spring density and standing crop of Age II and older brown trout in the Fish and Game Section of the Beaverhead River, 1988 - 2006.

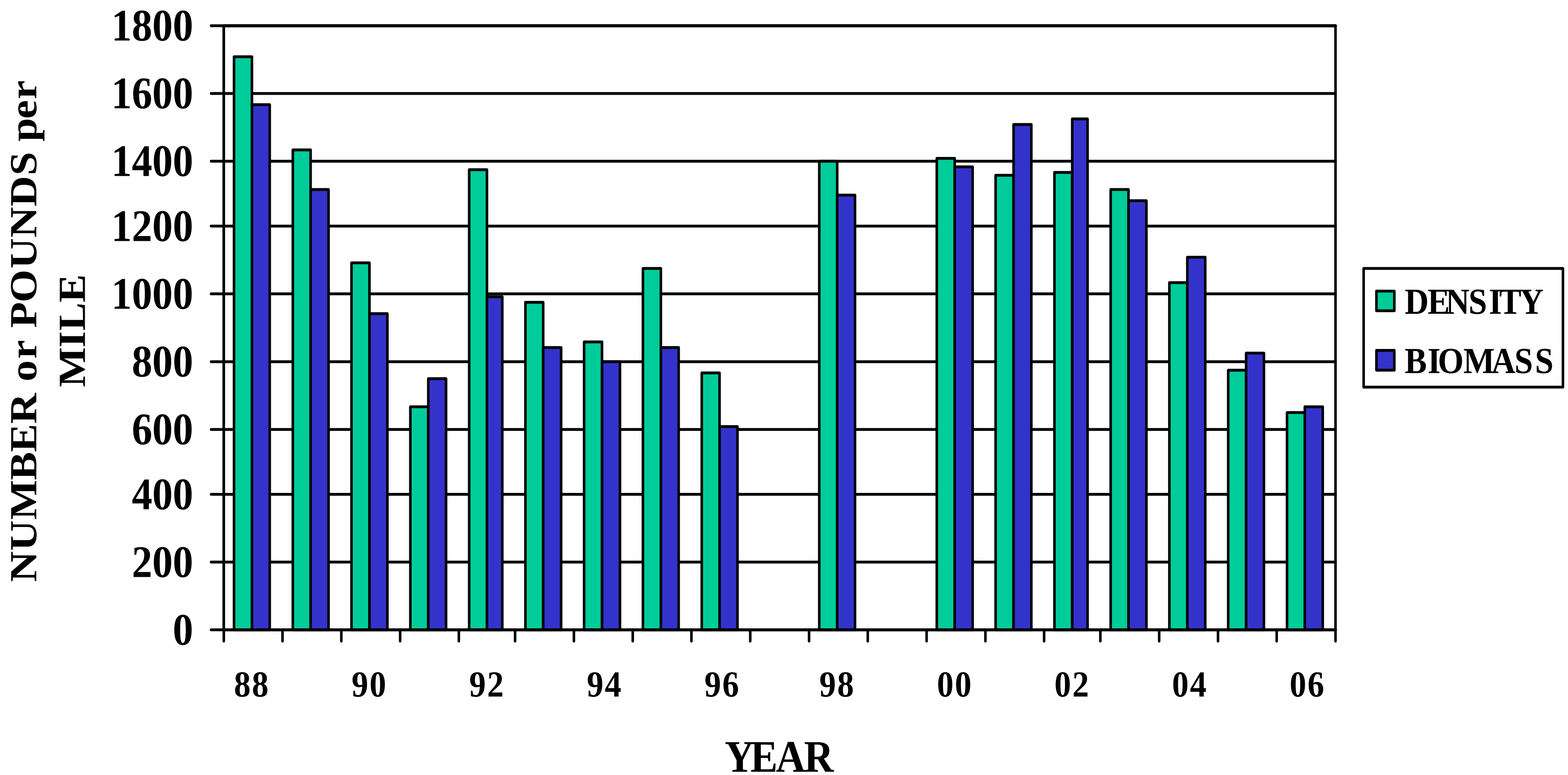

Figure 14. Estimated spring densities, by length group, of Age II and older brown trout in the Fish and Game Section of the Beaverhead River, 1988 - 2006.

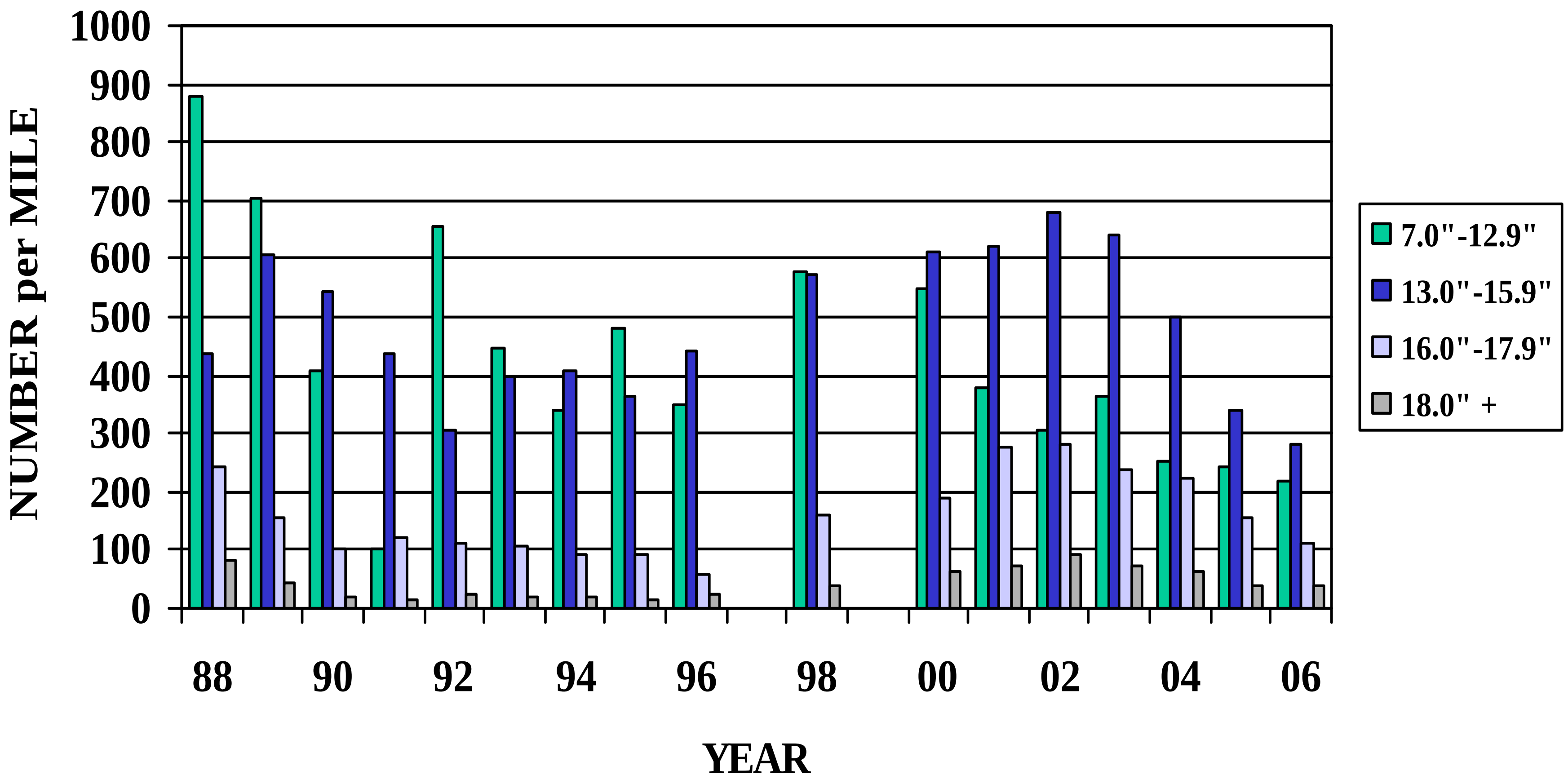

Figure 15. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Fish and Game Section of the Beaverhead River 1998 - 2006.

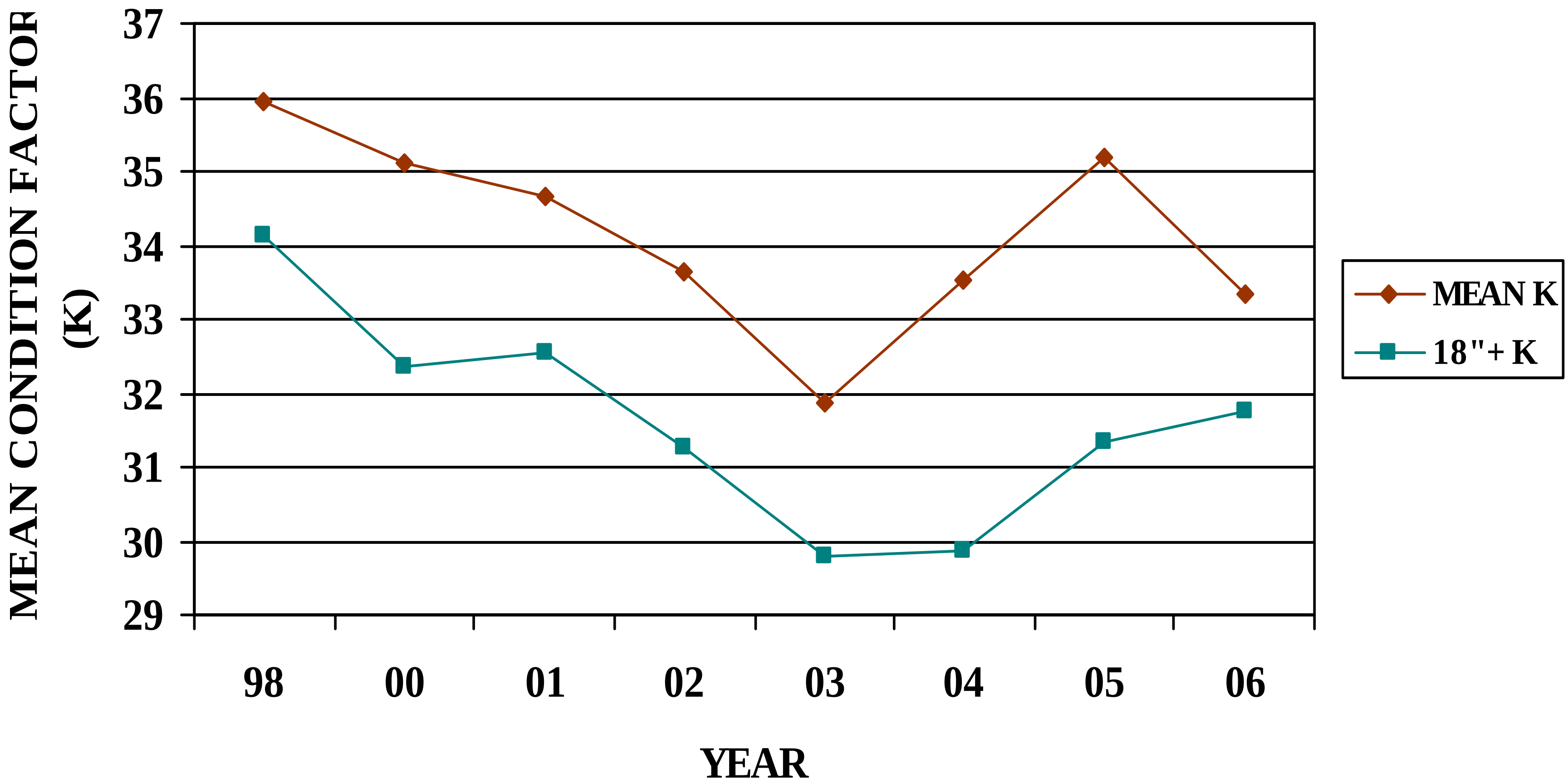

Figure 16. Mean July and August flows (cfs) and Minimum Recommended Flow (WETP Method) for the lower Beaverhead River measured at the USGS Twin Bridges Gage, 1988 - 2005.

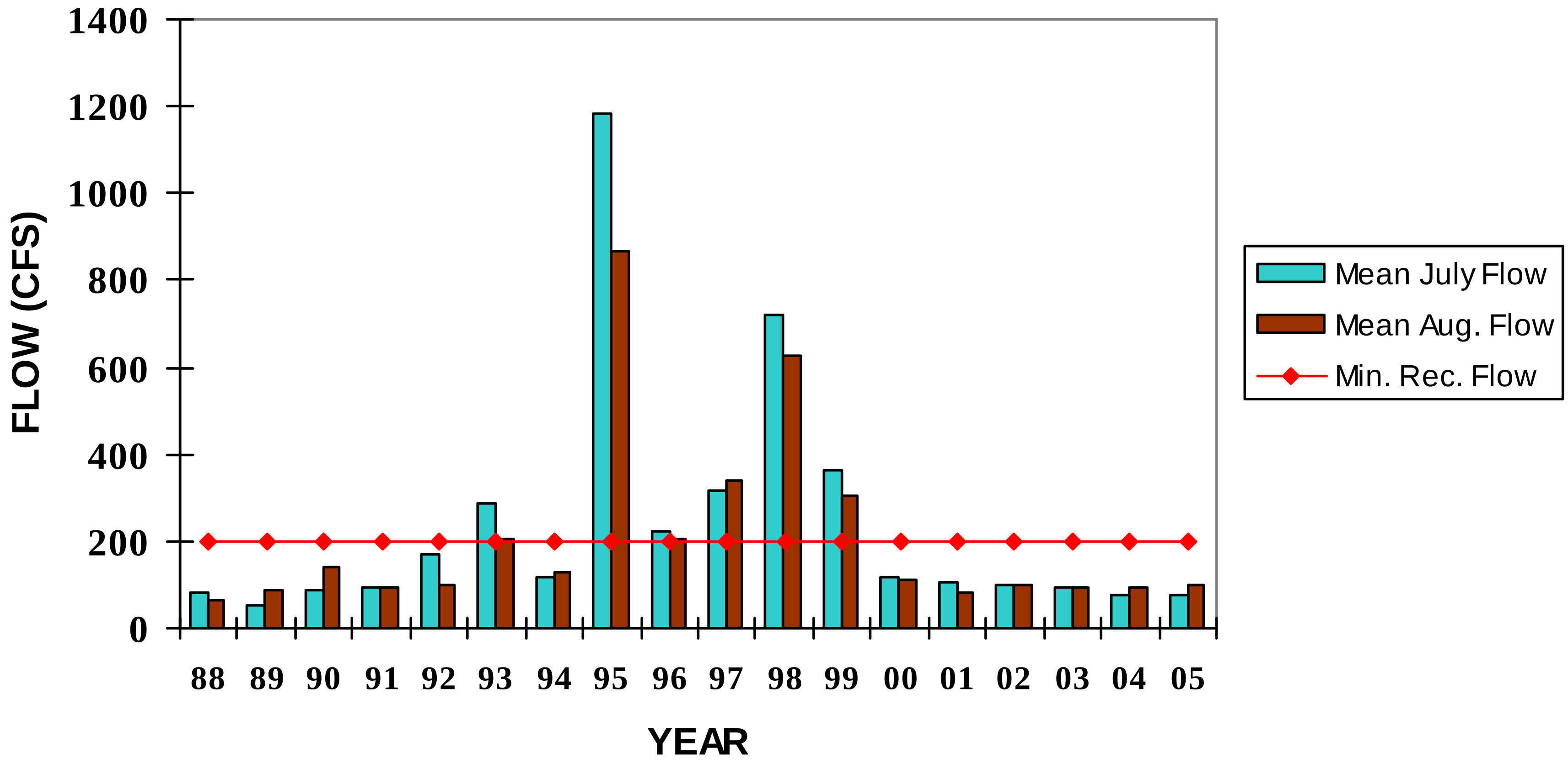

Figure 17. Estimated spring density and standing crop of Age II and older brown trout in the Anderson Section of the Beaverhead River, 1991 - 2006.

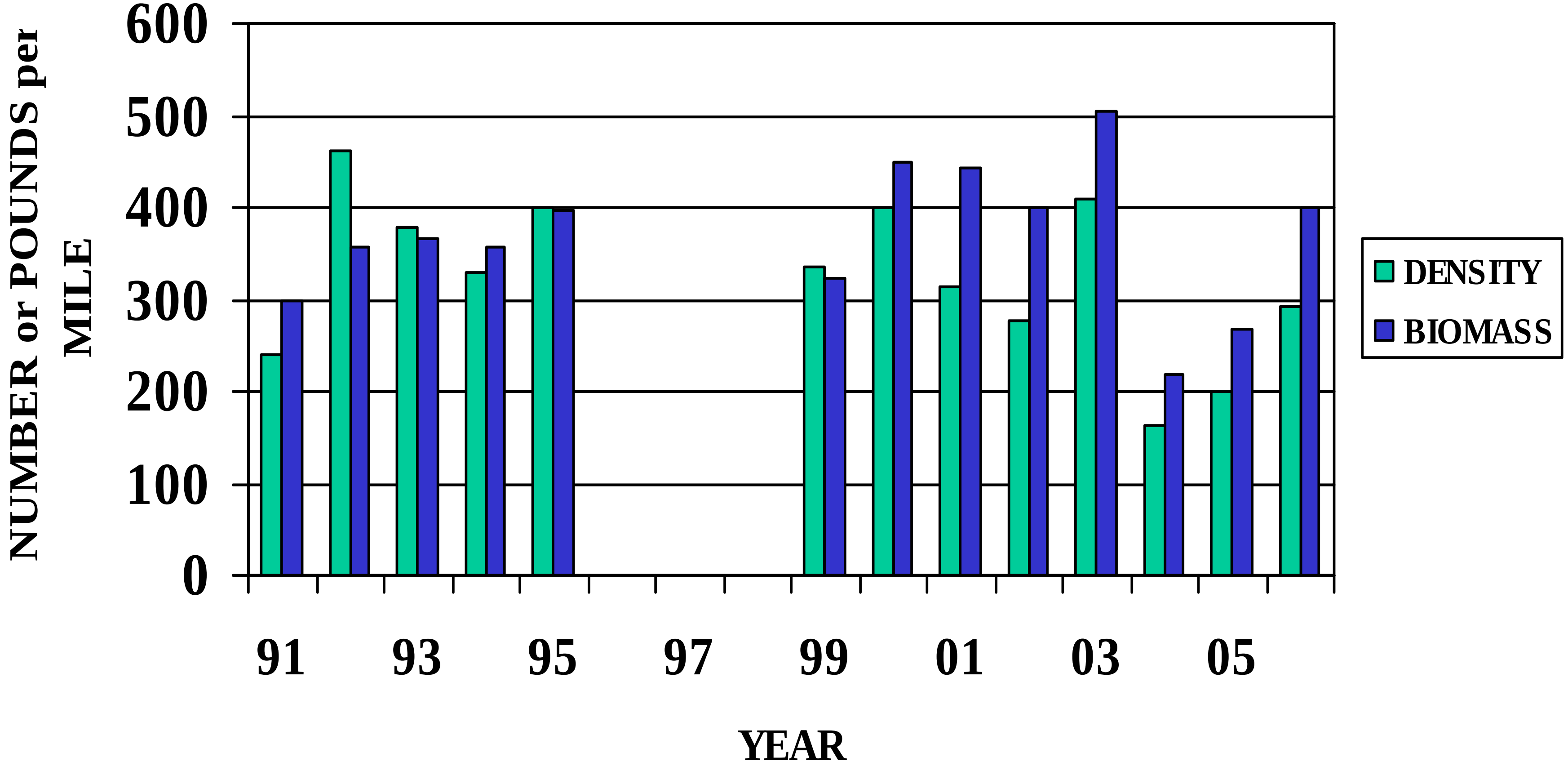

Figure 18. Estimated spring densities, by length group, of Age II and older brown trout in the Anderson Section of the Beaverhead River, 1991 - 2006.

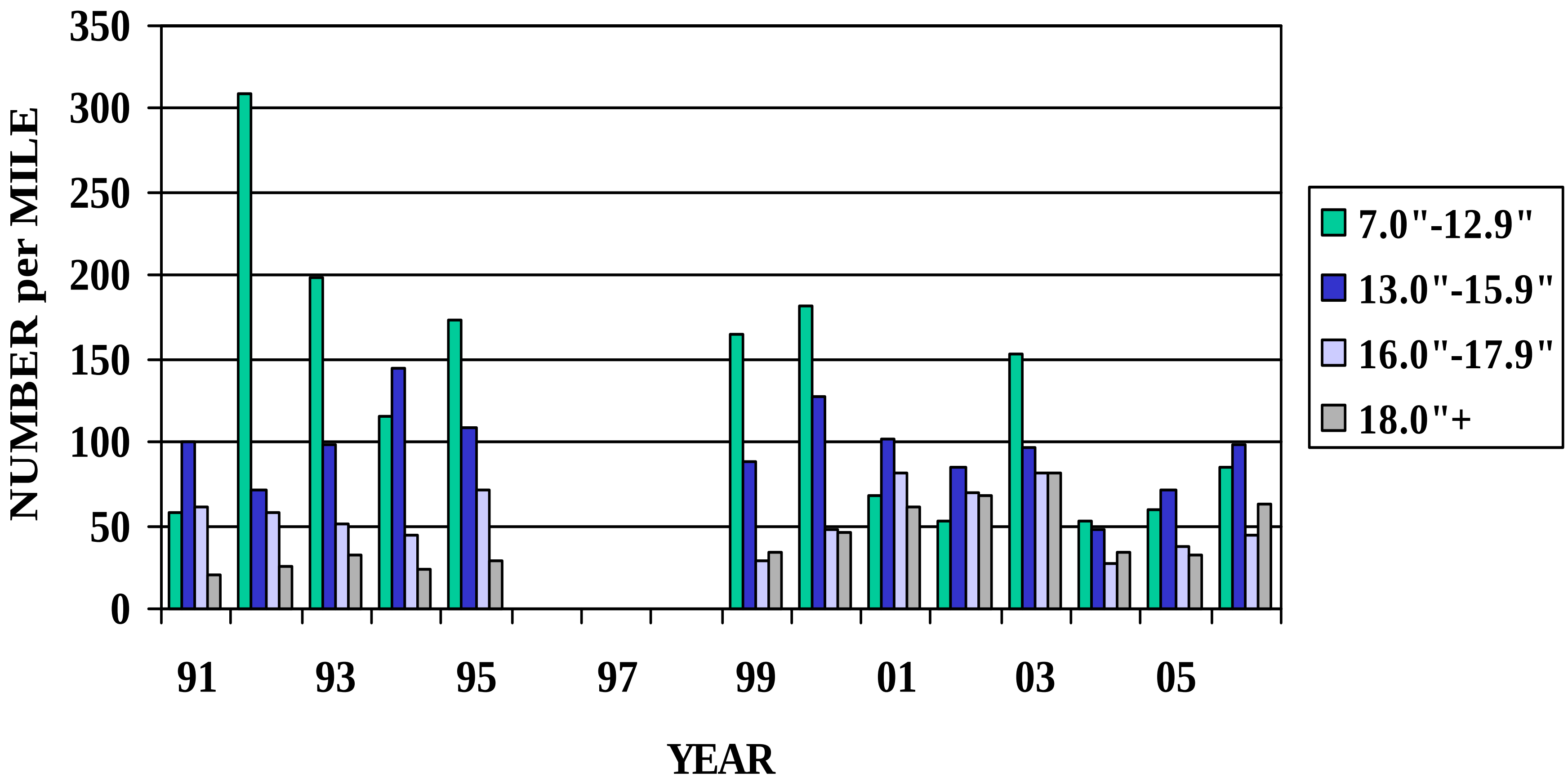

Figure 19. Estimated spring density and standing crop of Age II and older mountain whitefish in the Anderson Study Section of the Beaverhead River, 2002 - 2006.

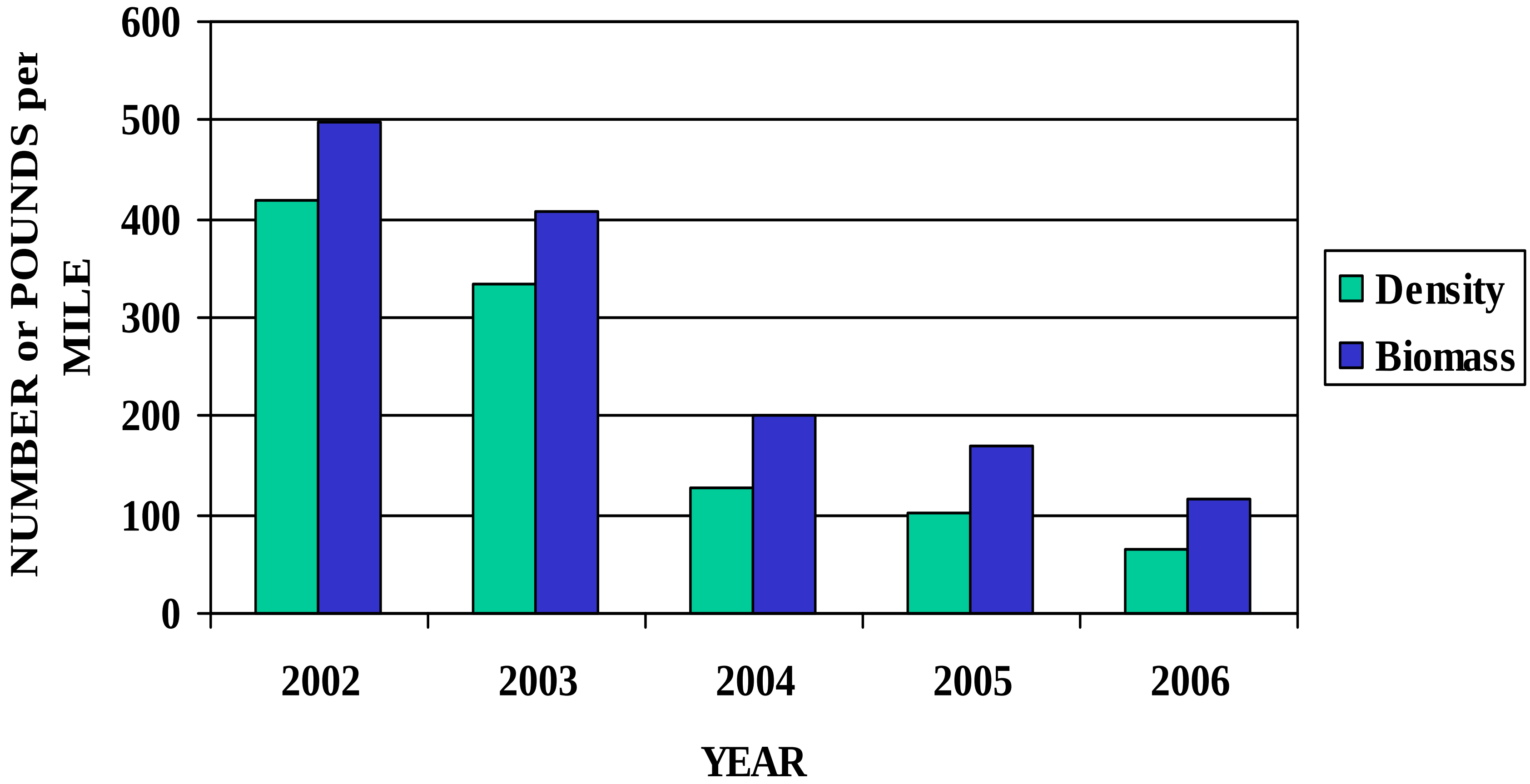

Figure 20. Length - frequency distribution of Age II and older mountain whitefish collected in the Anderson Study Section of the Beaverhead River, spring 2002 (N=597).

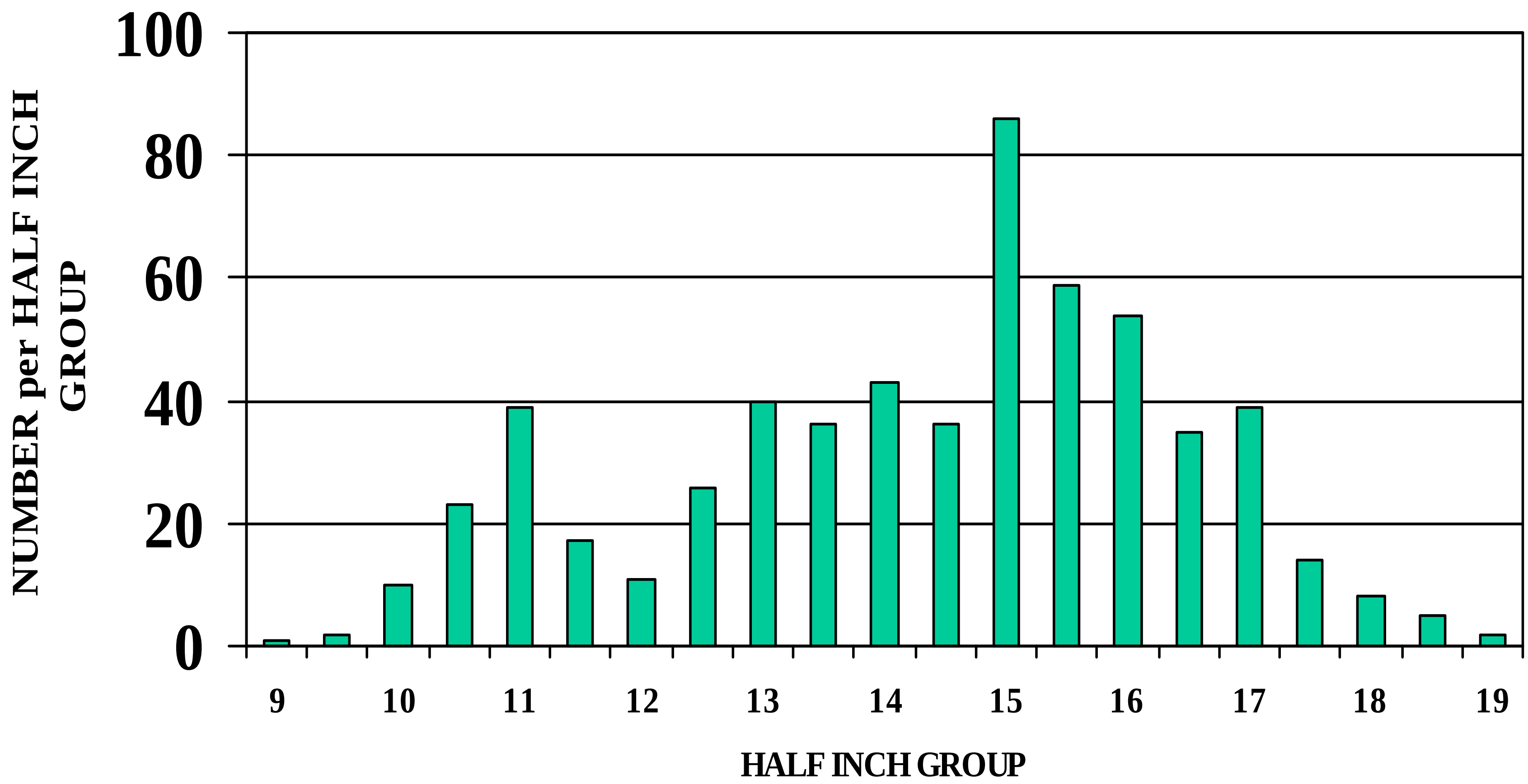

Figure 21. Length - frequency distribution of Age II and older mountain whitefish from spring samples collected in the Anderson Section of the Beaverhead River, 2006 (N=198).

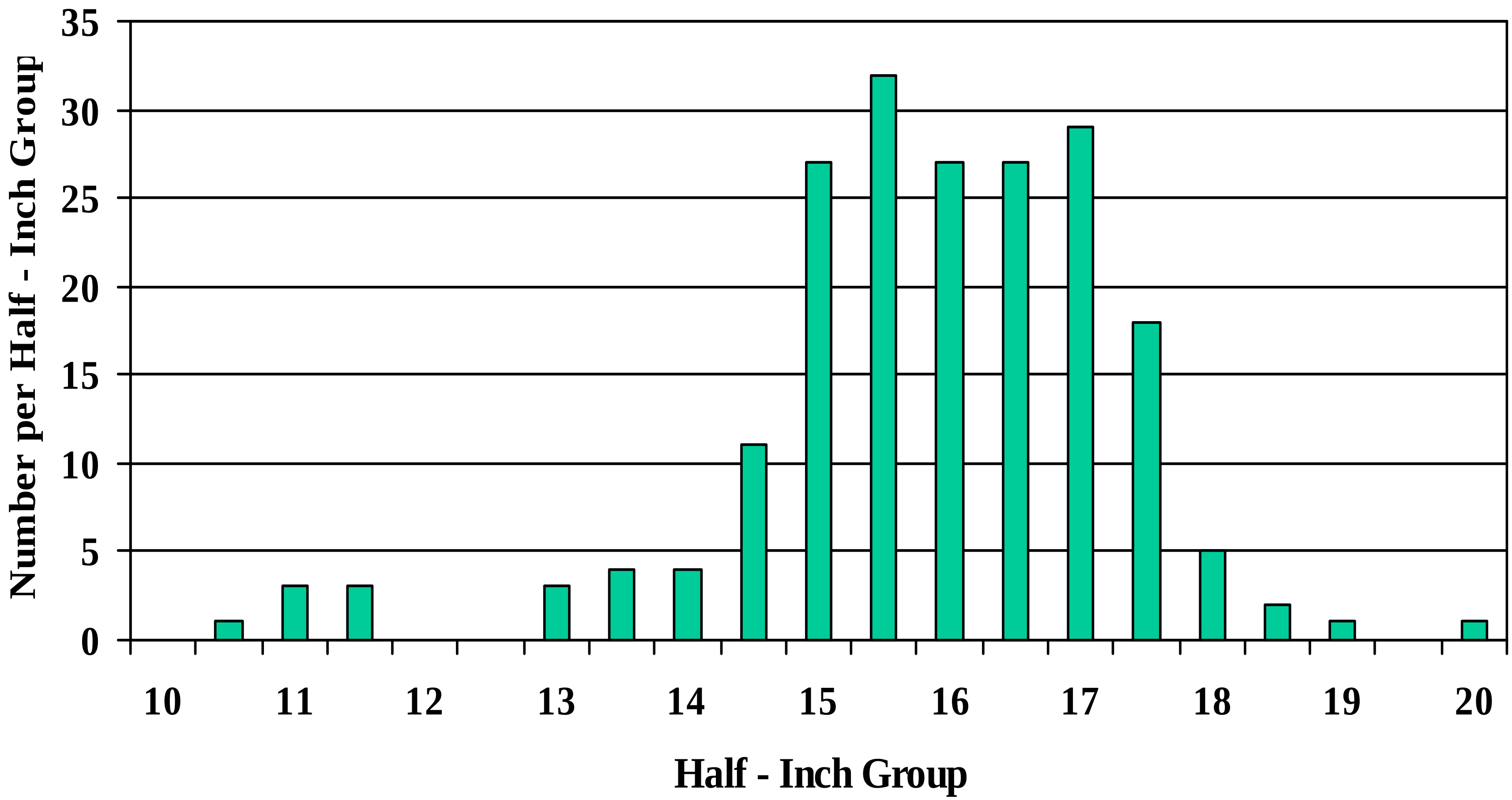

Figure 22. Estimated spring density and standing crop of Age II and older brown trout in the Mule Shoe Section of the Beaverhead River, 1990 - 2006.

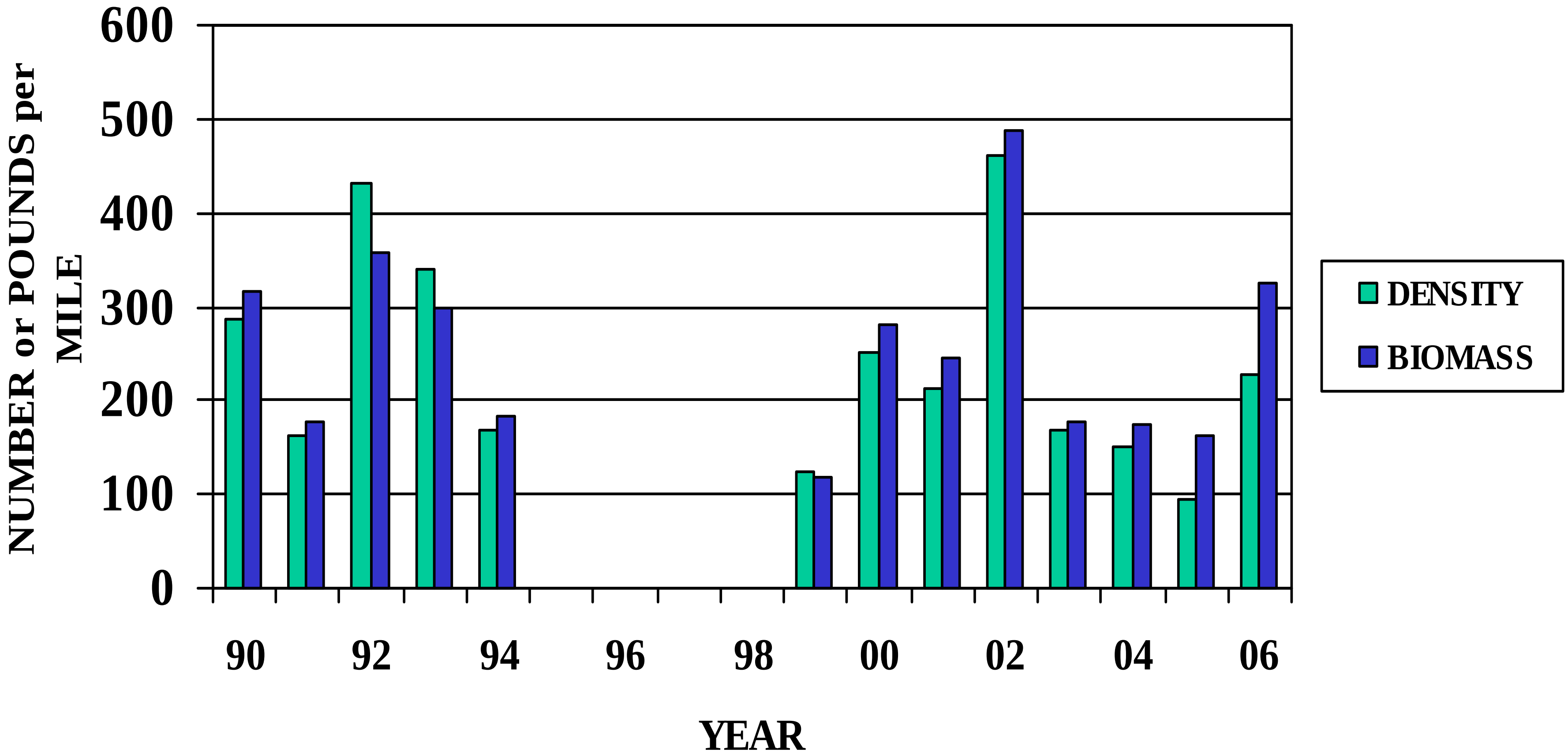

Figure 23. Estimated spring densities, by length group, of Age II and older brown trout in the Mule Shoe Section of the Beaverhead River; 1990 -2006.

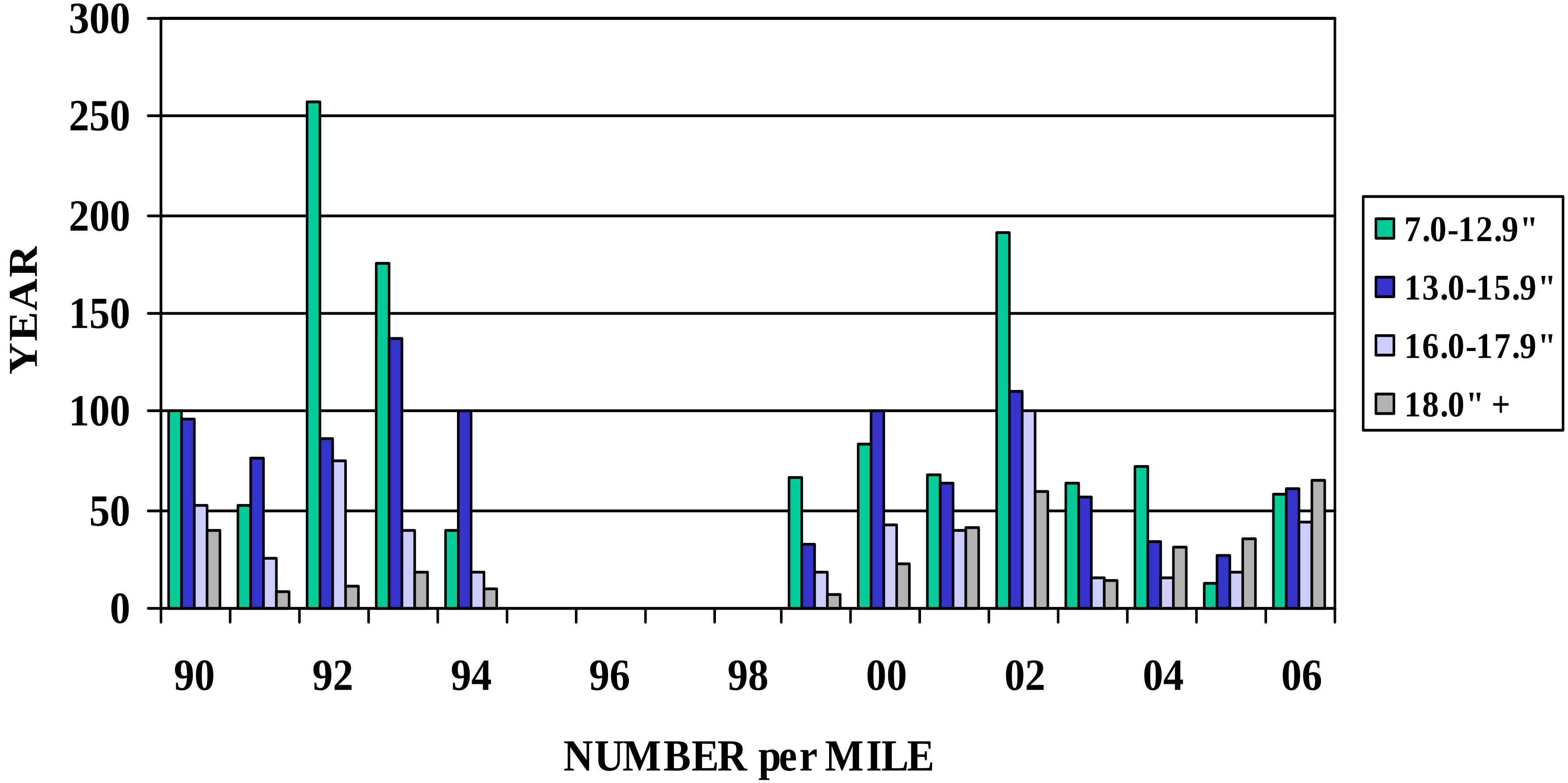

Figure 24. Estimated spring density and standing crop of mountain whitefish in the Mule Shoe Study Section of the Beaverhead River, 2002 - 2006.

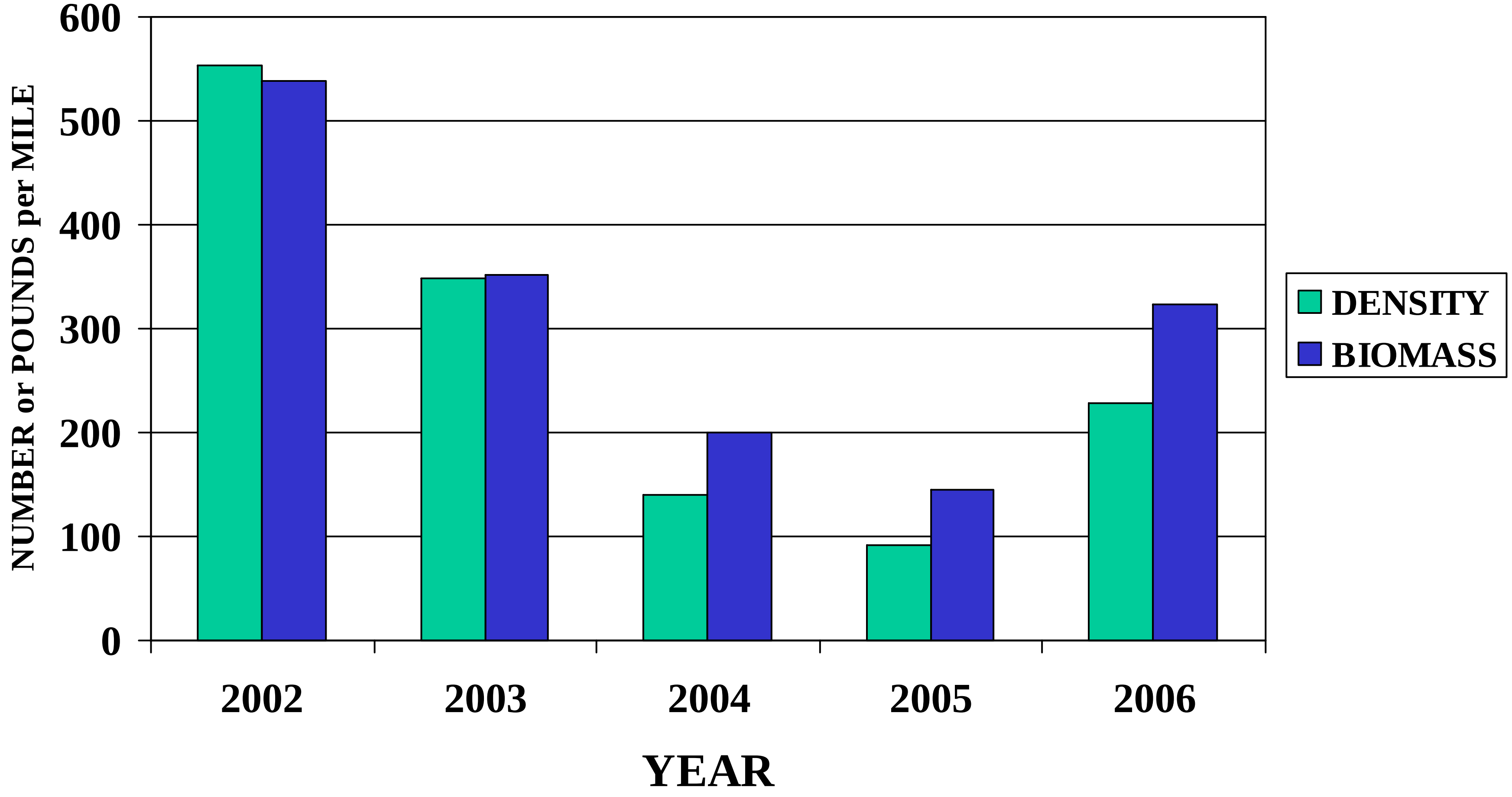

Figure 25. Length - frequency distribution of Age II and older mountain whitefish collected in spring samples from the Mule Shoe Study Section of the Beaverhead River, 2002 (N=501).

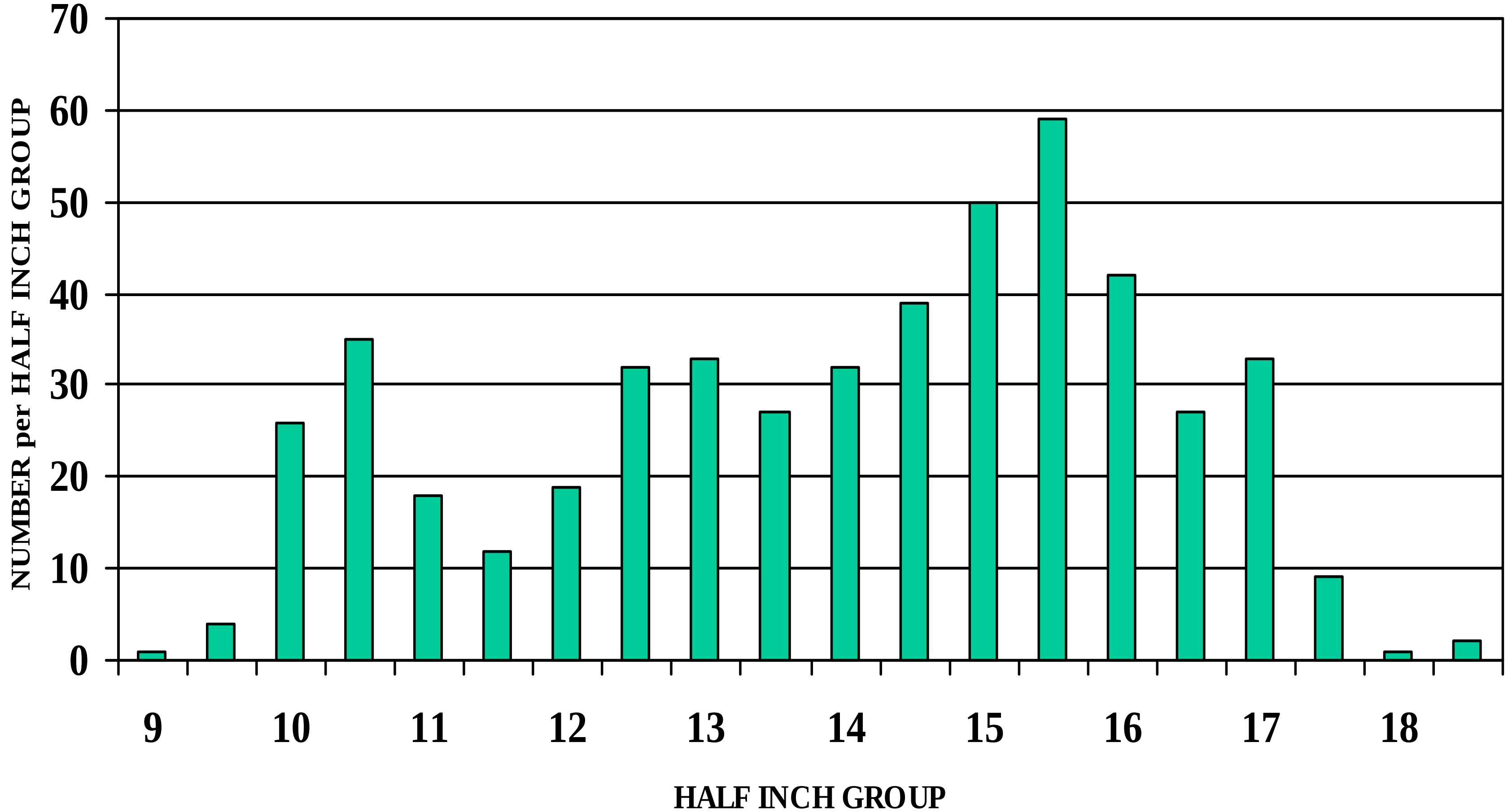

Figure 26. Length frequency distribution of Age II and older mountain whitefish from spring samples in the Mule Shoe Study Section of the Beaverhead River; 2006 (N = 119).

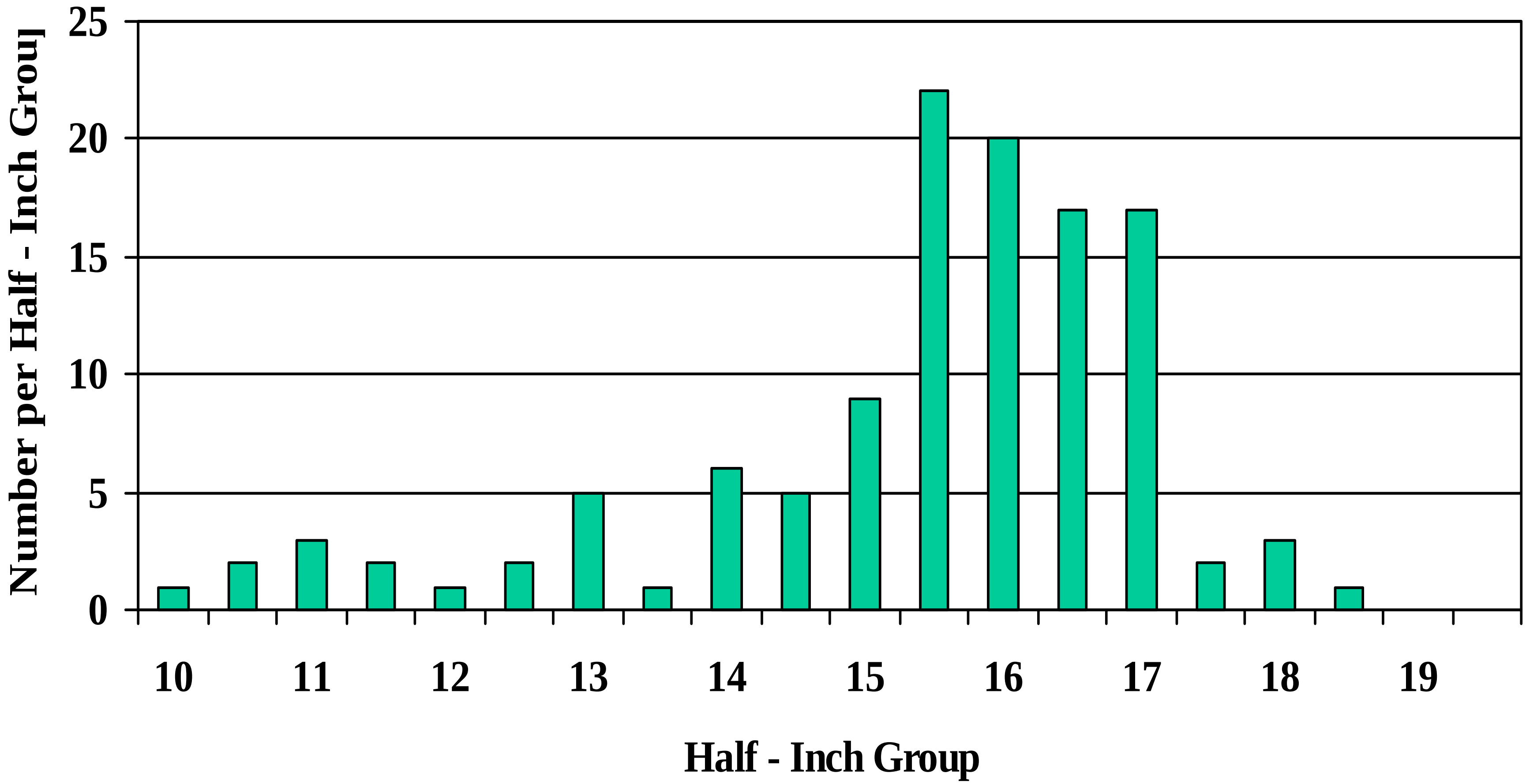

Figure 27. Estimated spring density and standing crop of Age II and older brown trout in the Silver Bow Section of the Beaverhead River, 2001 - 2003.

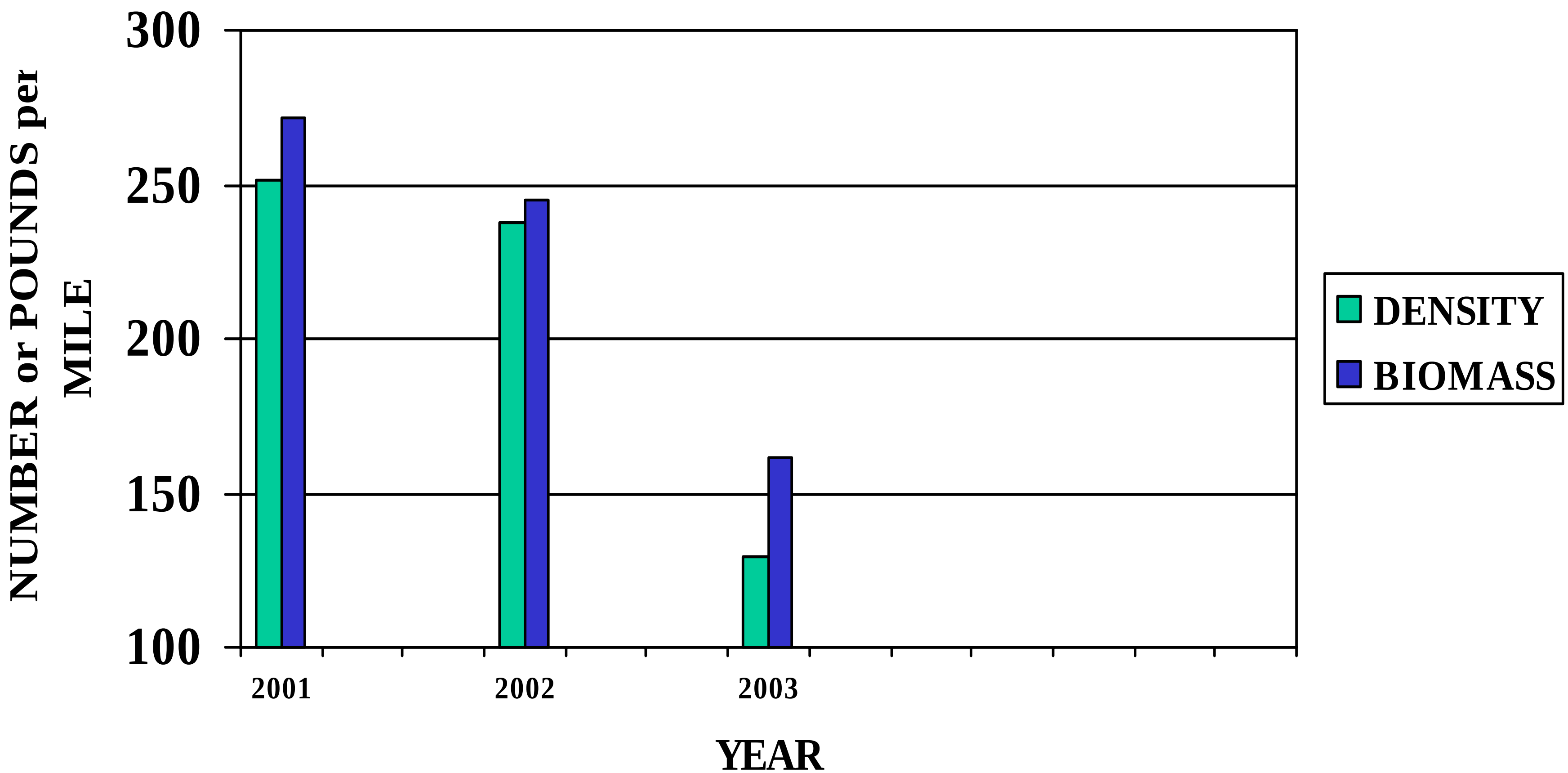

Figure 28. Estimated spring densities, by length group, of Age II and older brown trout in the Silver Bow Section of the Beaverhead River, 2001 - 2003.

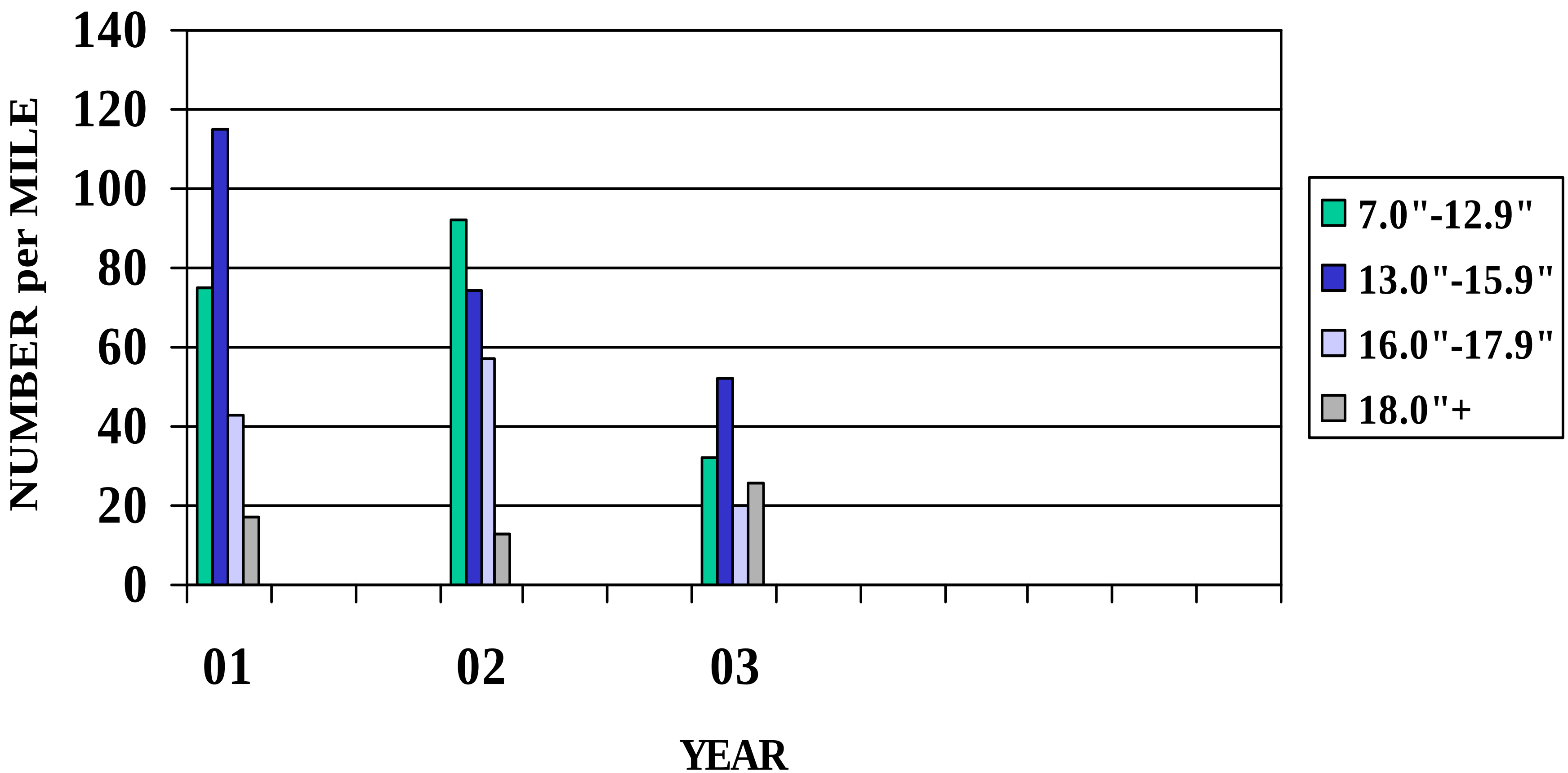

Figure 29. Spring and fall numbers of introduced Arctic Grayling captured during two electrofishing passes (mark and recapture) through the Silver Bow Study Section (2.50 miles) of the Beaverhead River; 2000 - 2003.

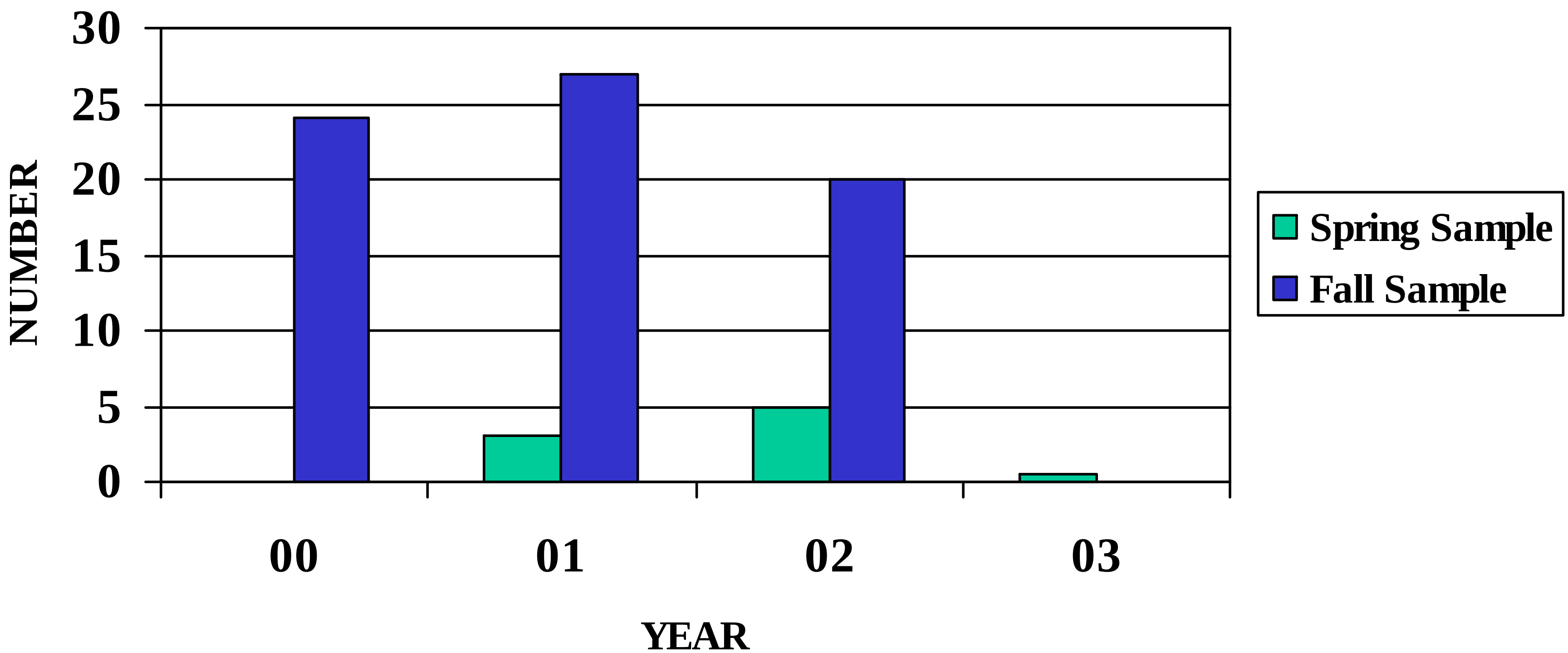

Figure 30. Estimated spring density and standing crop of Age II and older mountain whitefish in the Silverbow Study Section of the Beaverhead River, 2002 and 2003.

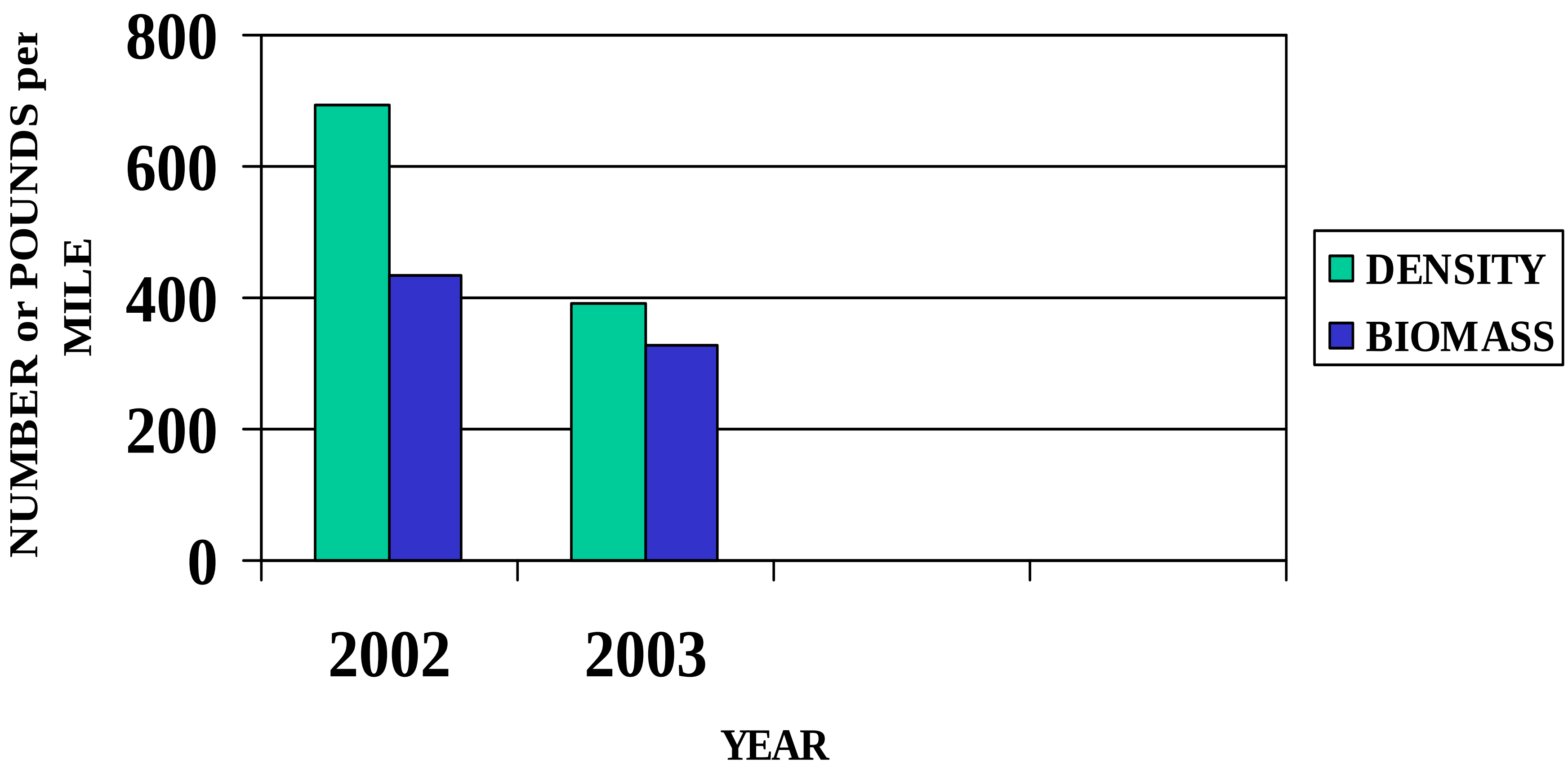

Figure 31. Mean August Flow (cfs) compared with the Minimum Recommended Flow (WETP Method) for the Upper Ruby River Measured at the USGS Gage Site 1986 - 2005.

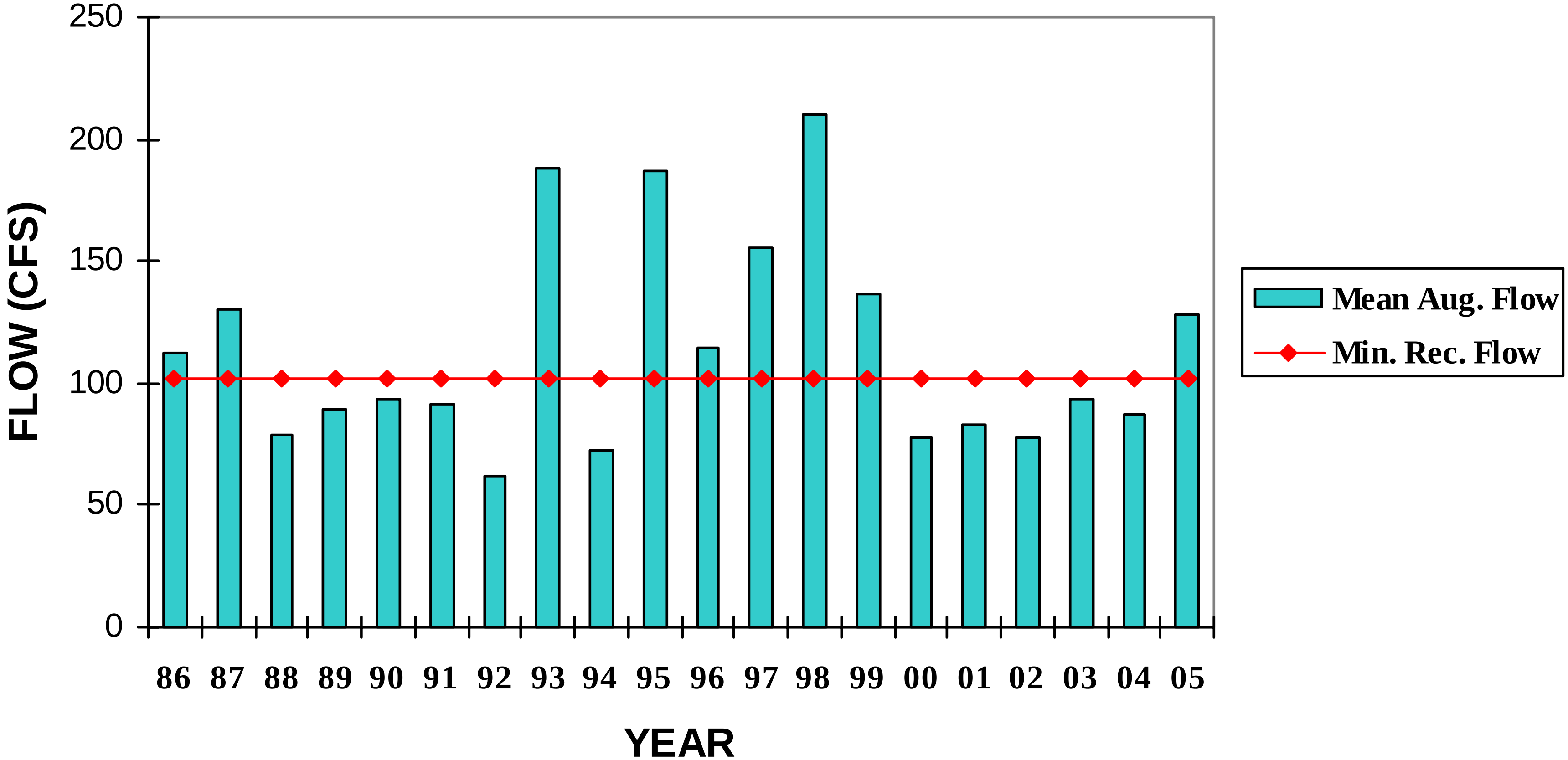

Figure 32. Estimated fall density and standing crop of Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2005.

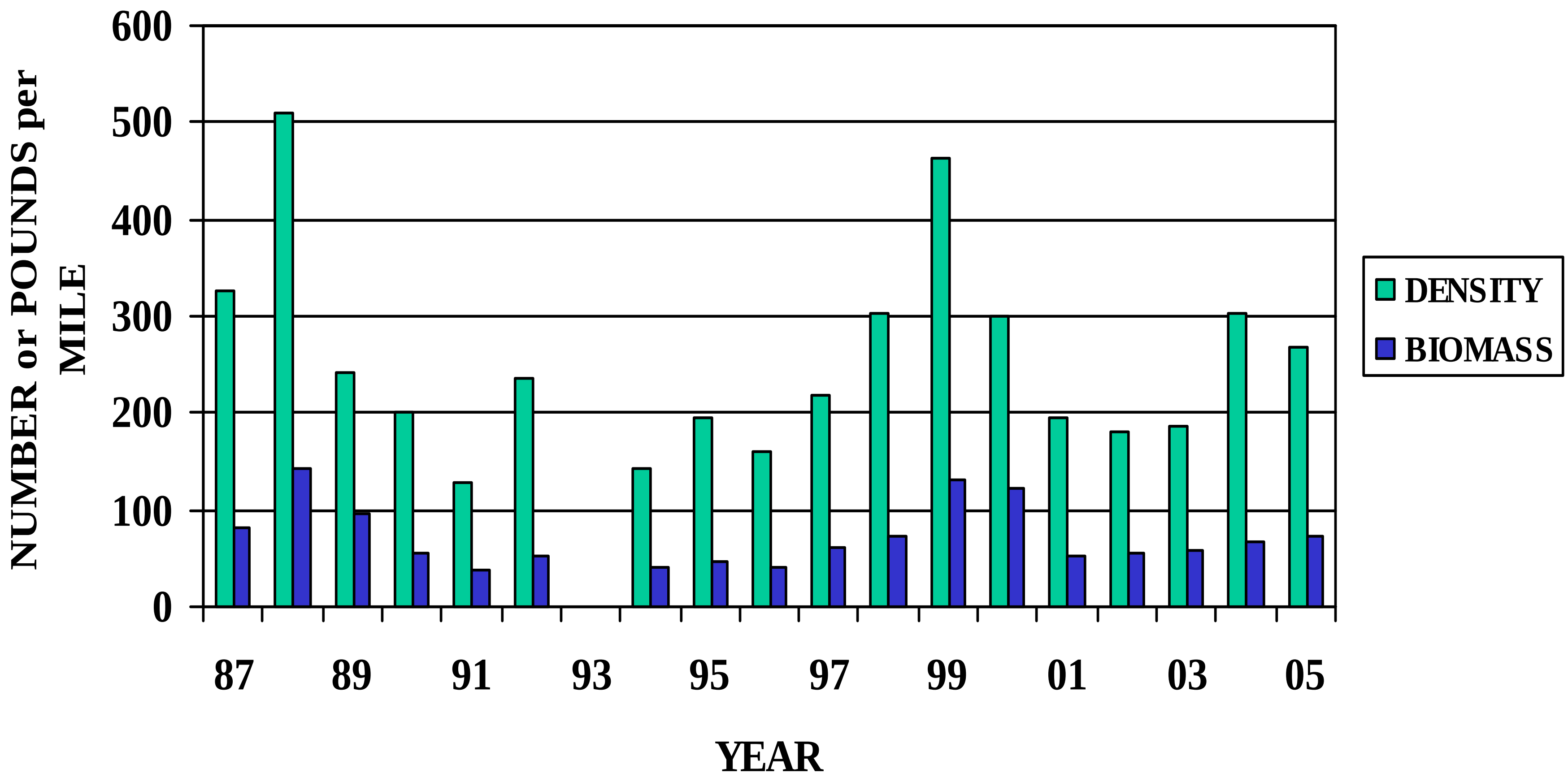

Figure 33. Estimated fall densities, by length group, of Age I and older rainbow x westslope cutthroat hybrid trout in the Three Forks Study Section of the Ruby River, 1987 - 2005.

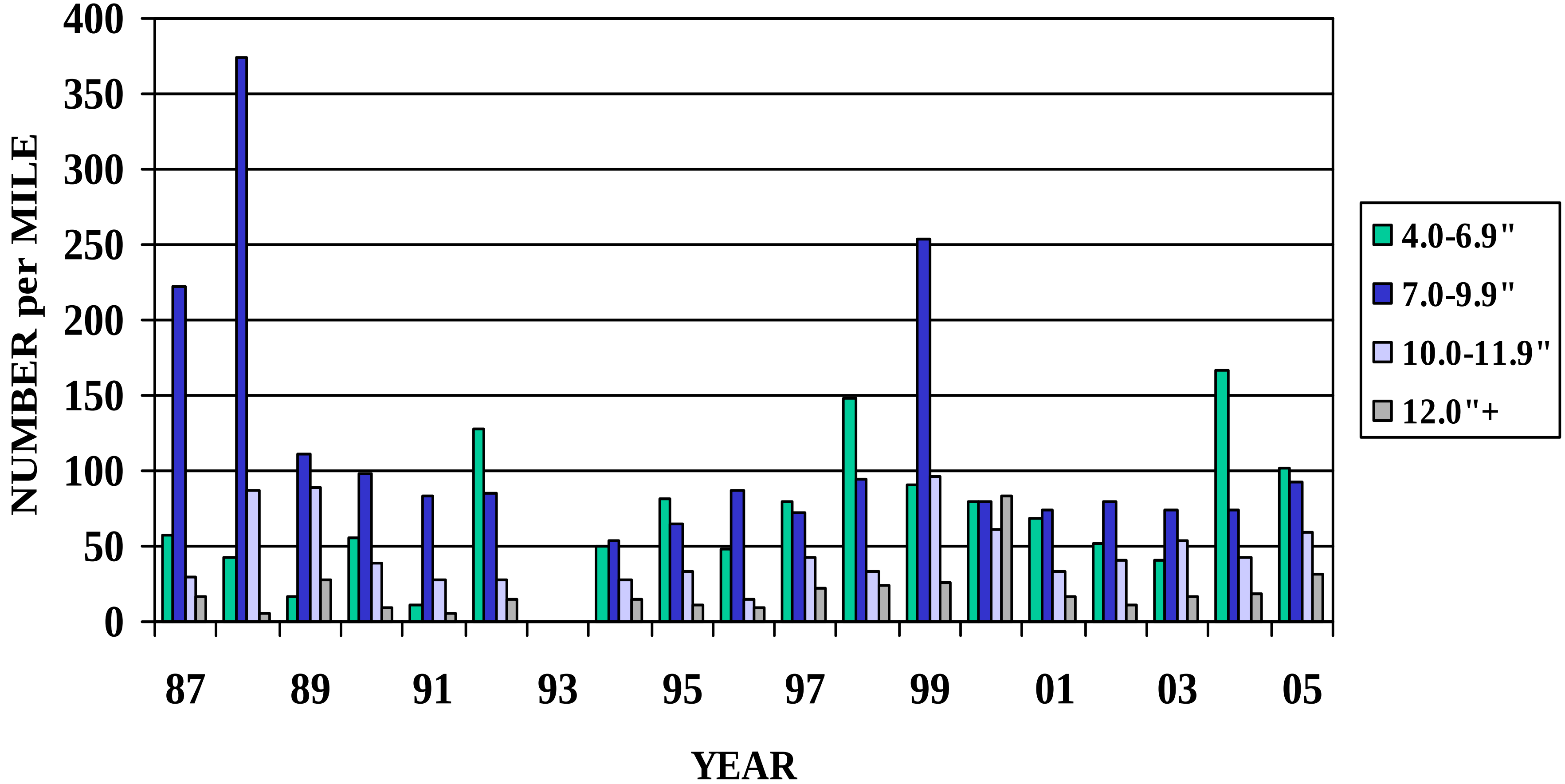

Figure 34. Mean fall Condition Factor (K) for Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2005.

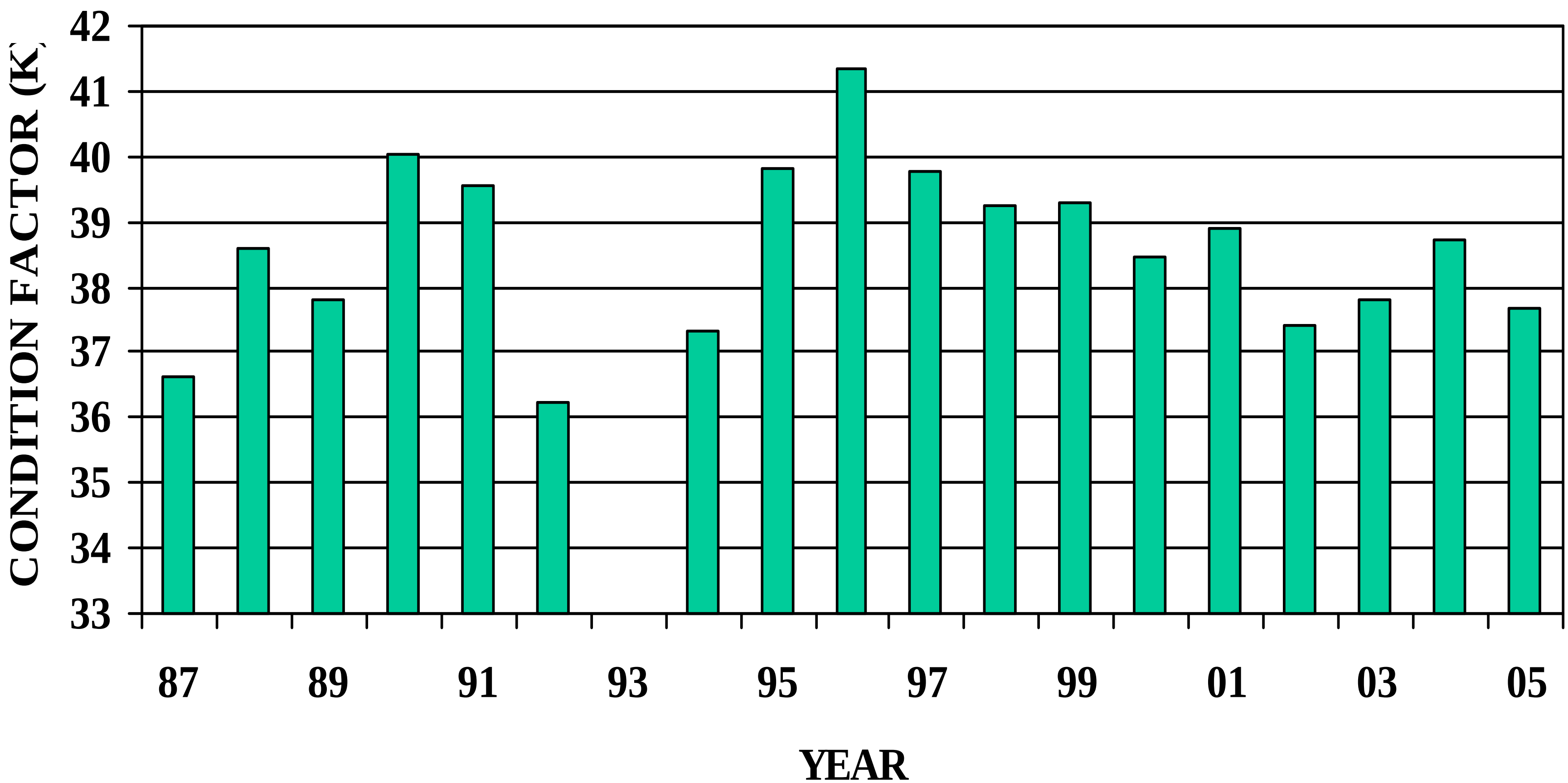

Figure 35. Estimated fall density and standing crop for Age I and older Arctic grayling in the Three Forks Section of the Ruby River 1998 - 2005.

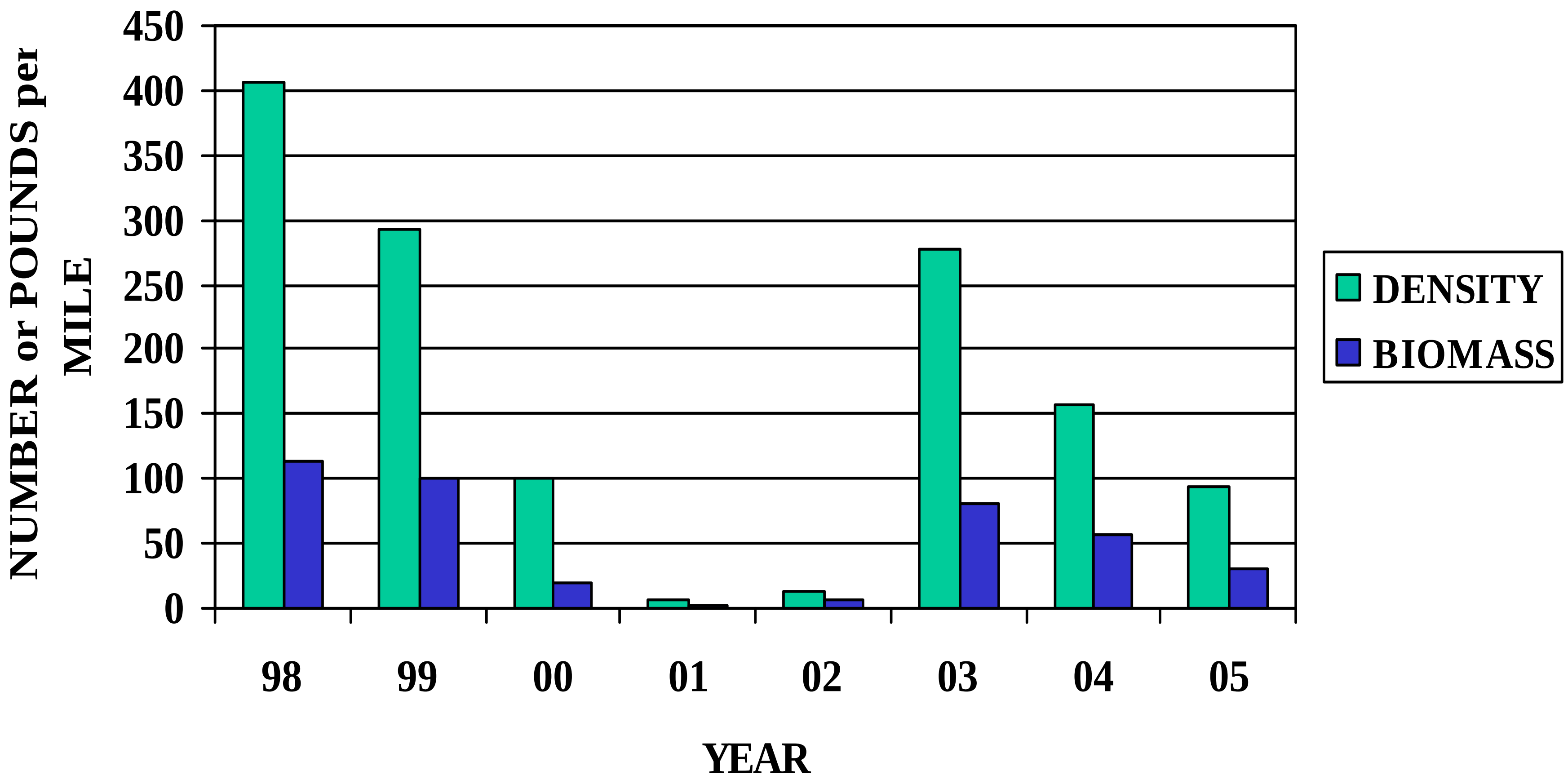

Figure 36. Estimated density and standing crop of Age I and older mountain whitefish in the Three Forks Study Section of the Ruby River; 2004.

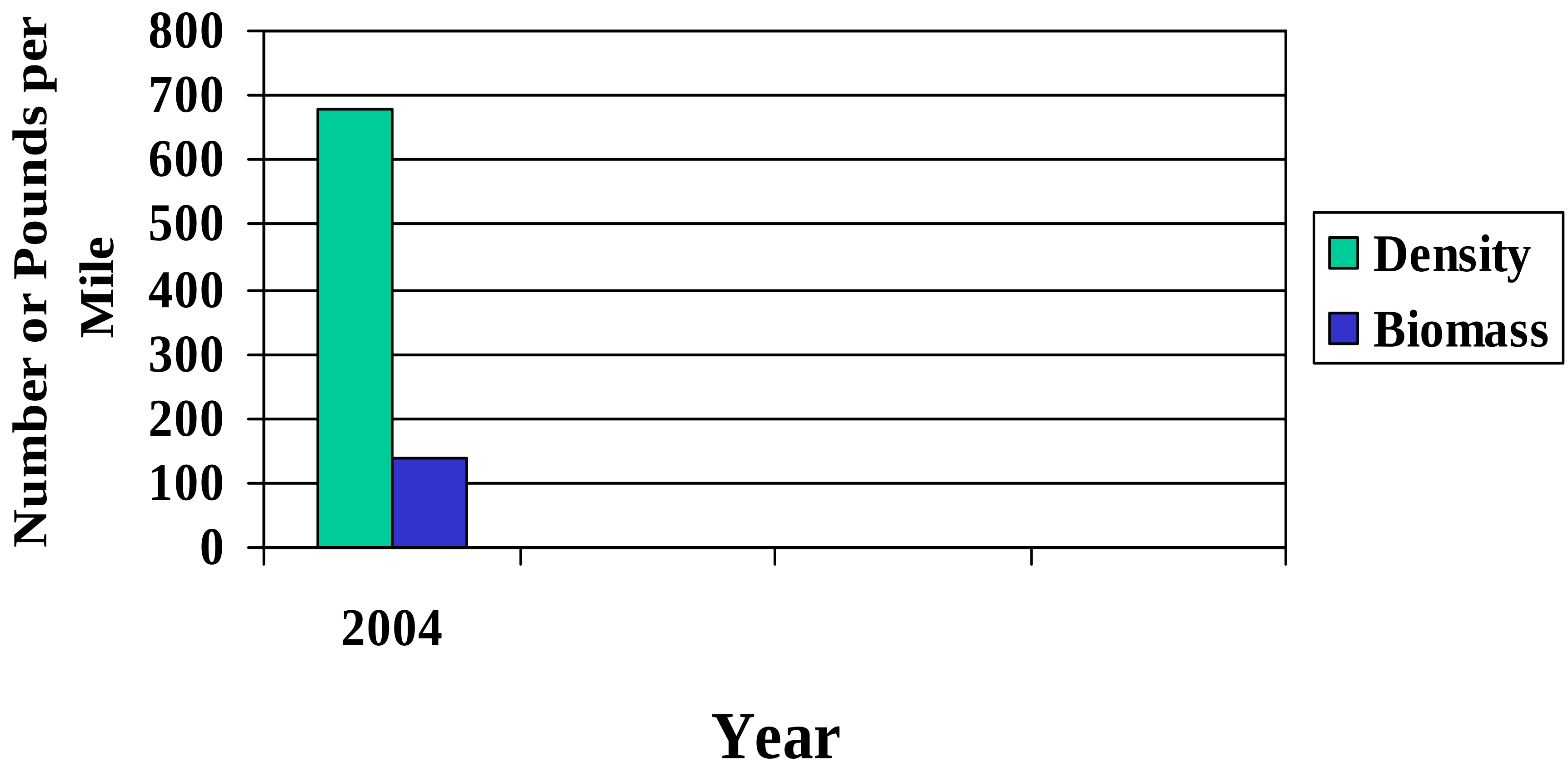

Figure 37. Estimated fall density and standing crop of Age I and older rainbow trout in the Greenhorn Section of the Ruby River, 1990 - 2005 (2004 estimate generated based on only 2 recaptures).

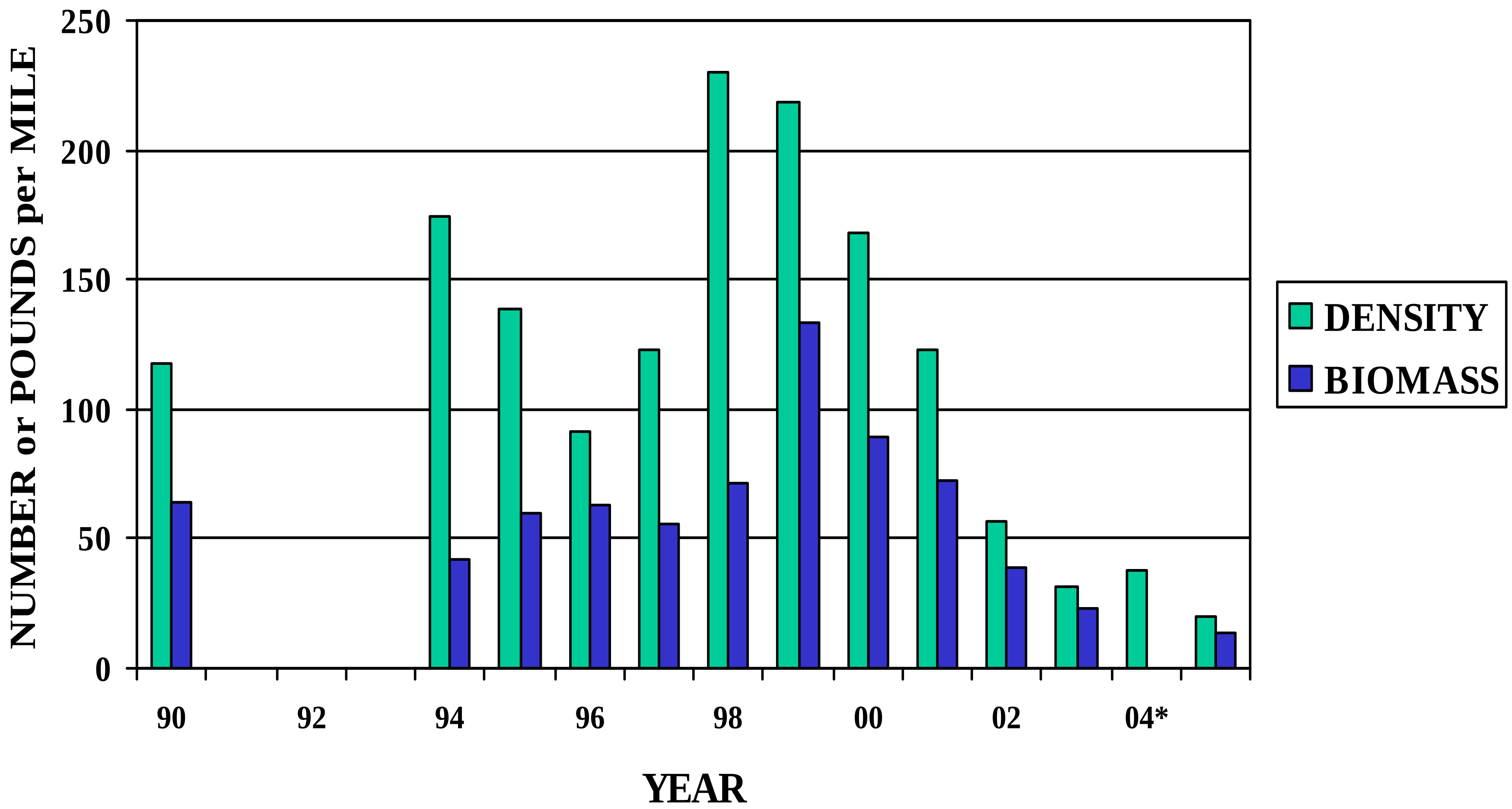

Figure 38. Estimated fall densities, by length group, of Age I and older rainbow trout in the Greenhorn Section of the Ruby River 1990 -2005 (2004 estimate based on only 2 Recaptures).

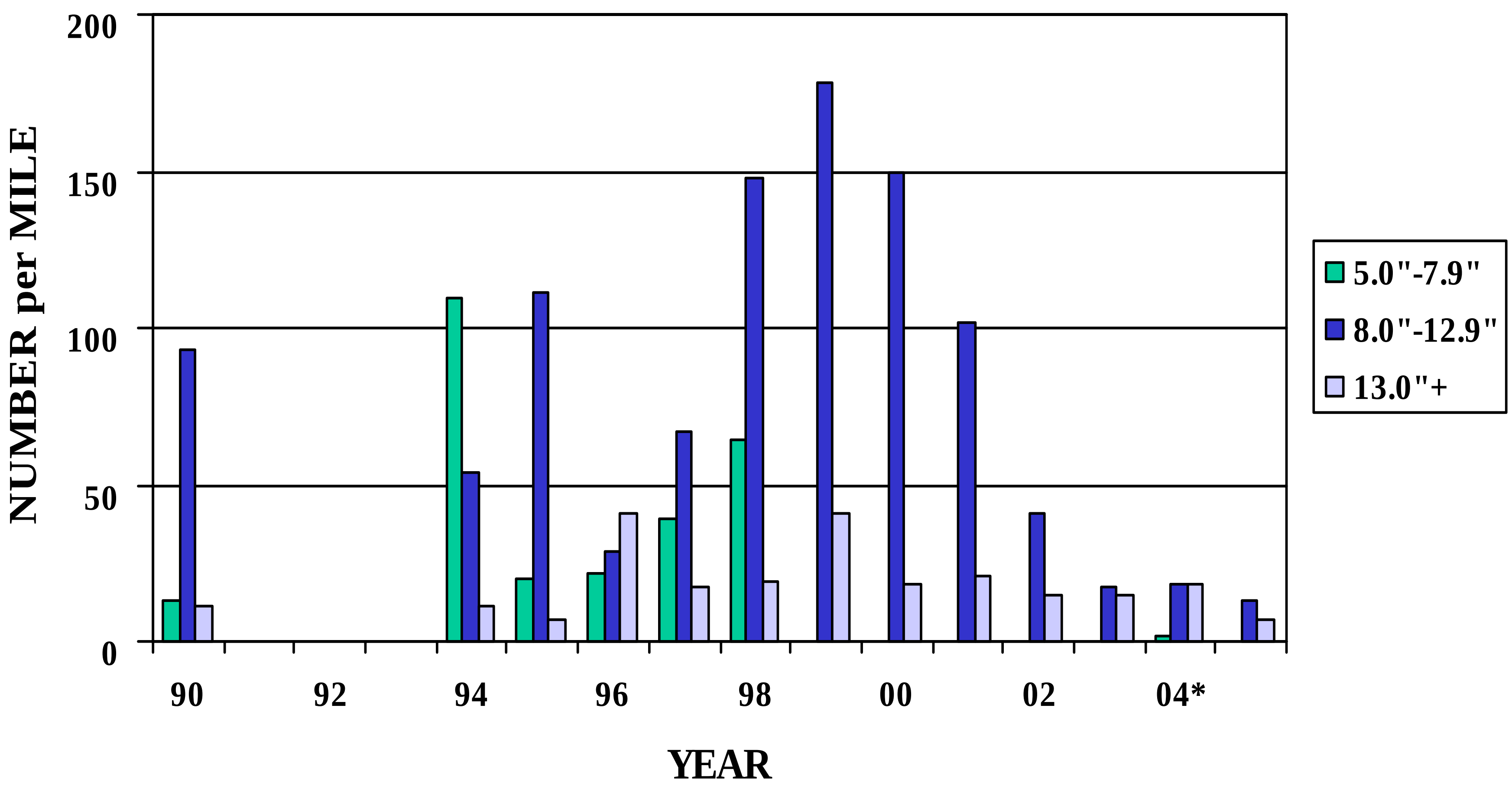

Figure 39. Estimated fall density and standing crop of Age I and older brown trout in the Greenhorn Section of the Ruby River, 1990 - 2005.

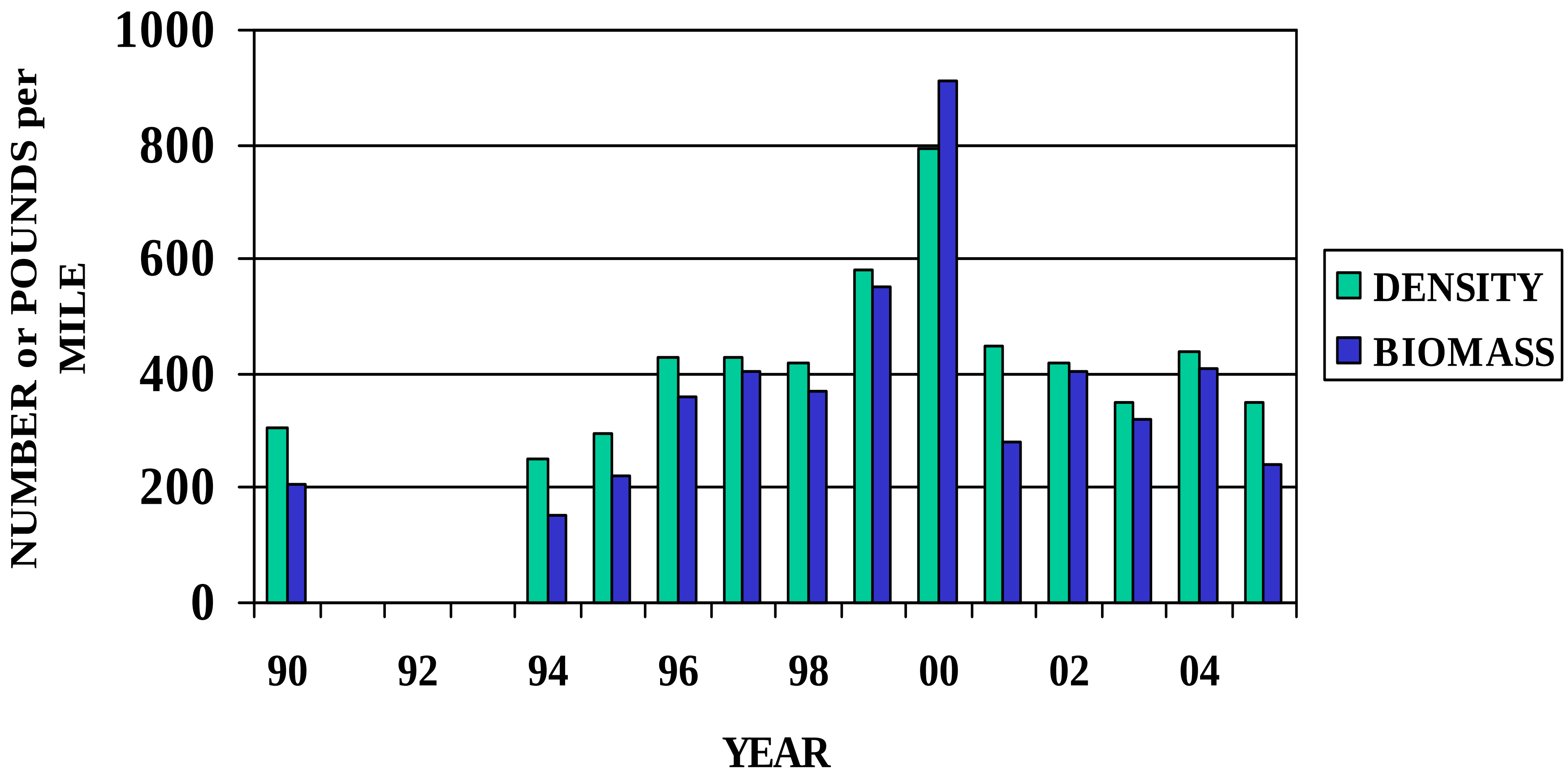

Figure 40. Estimated fall densities, by length group, of Age I and older brown trout in the Greenhorn Section of the Ruby River, 1990 - 2005.

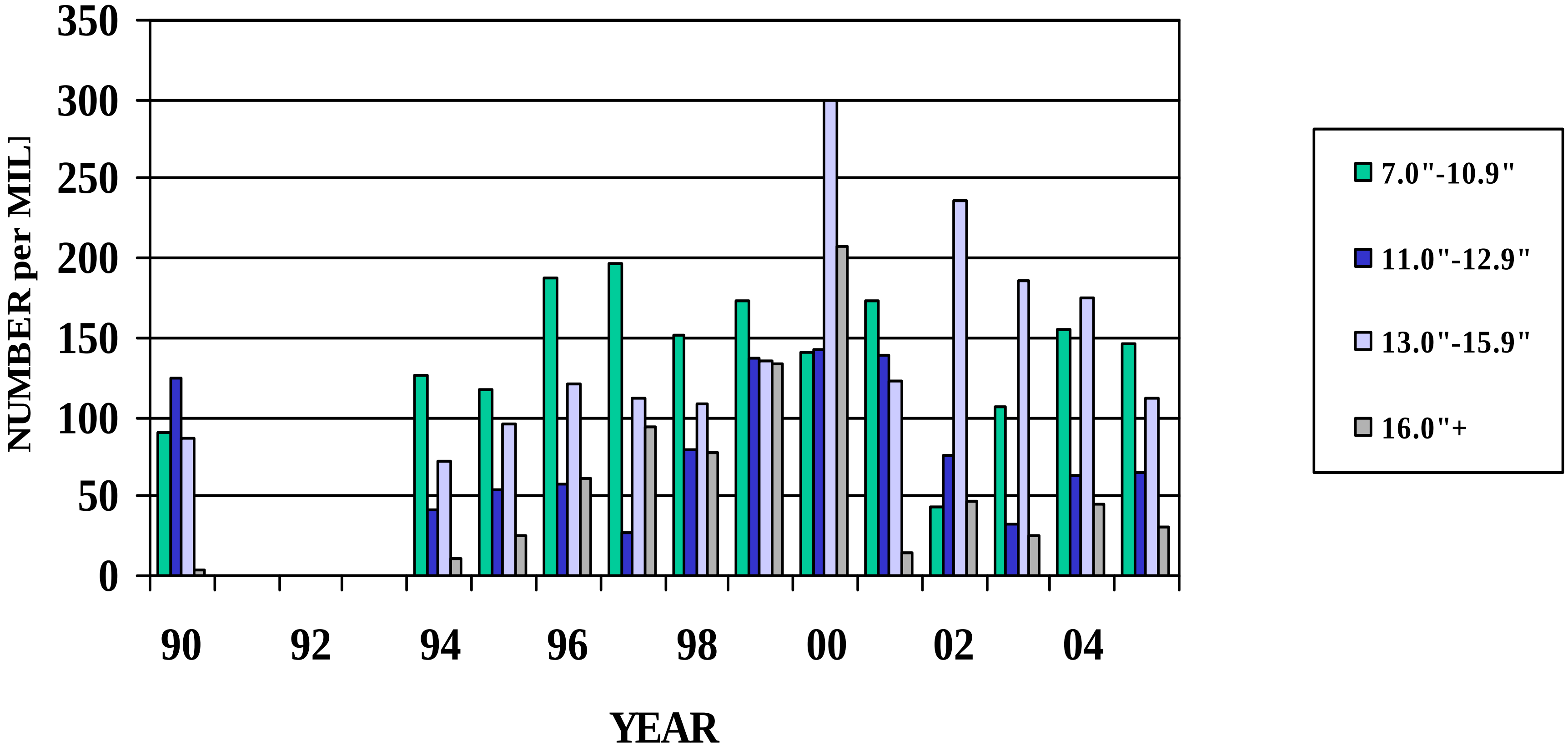

Figure 41. Mean nonirrigation season (November - March) flow (cfs) in the lower Ruby River below Ruby Reservoir Dam measured at the USGS Gage compared with the Minimum Recommended Flow (WETP Method); Water Years 1995 - 2006.

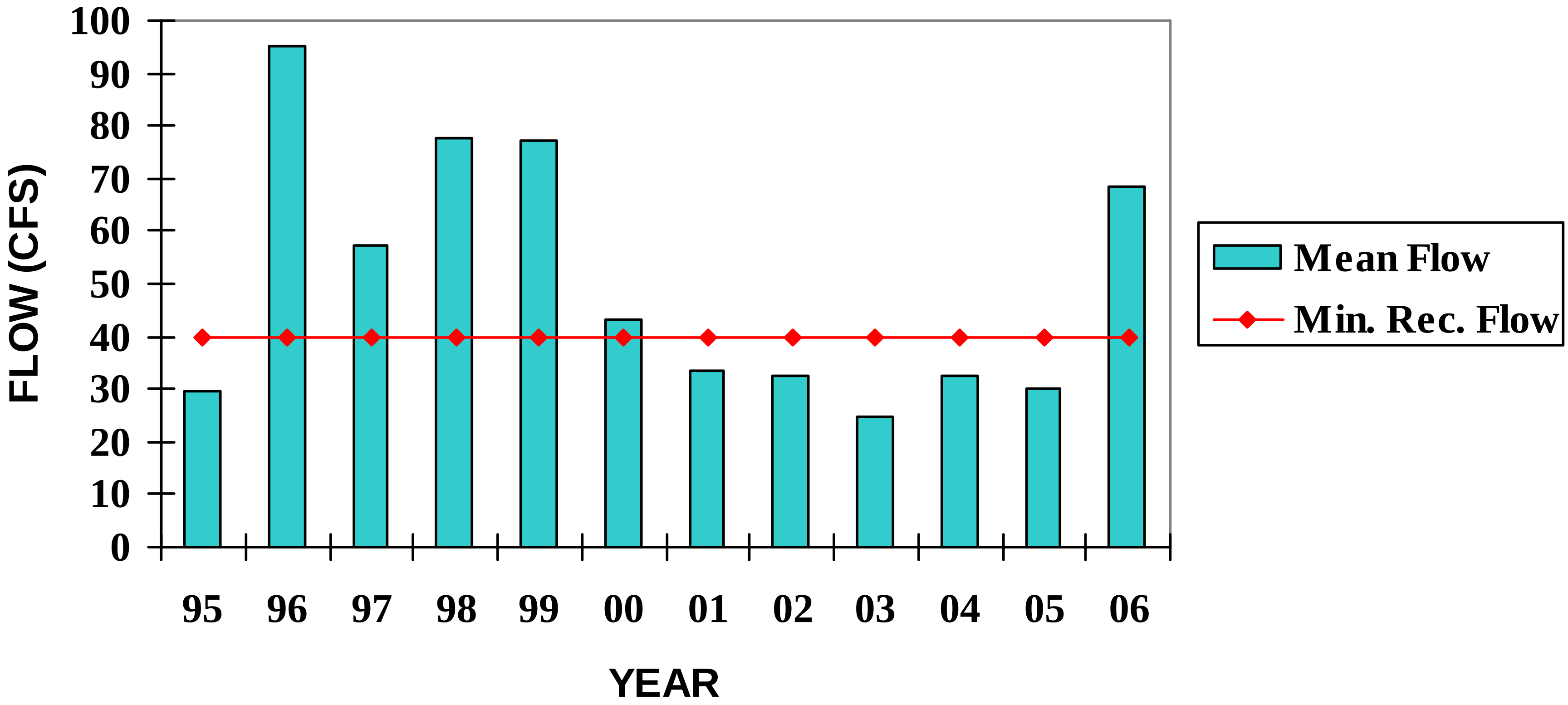

Figure 42. Estimated density and standing crop of fall Age I and older brown trout in the Passamari (PASS) Section (1994 - 1997) and spring Age II and older brown trout in the Maloney (MAL) Section (1998 - 2006) of the Ruby River.

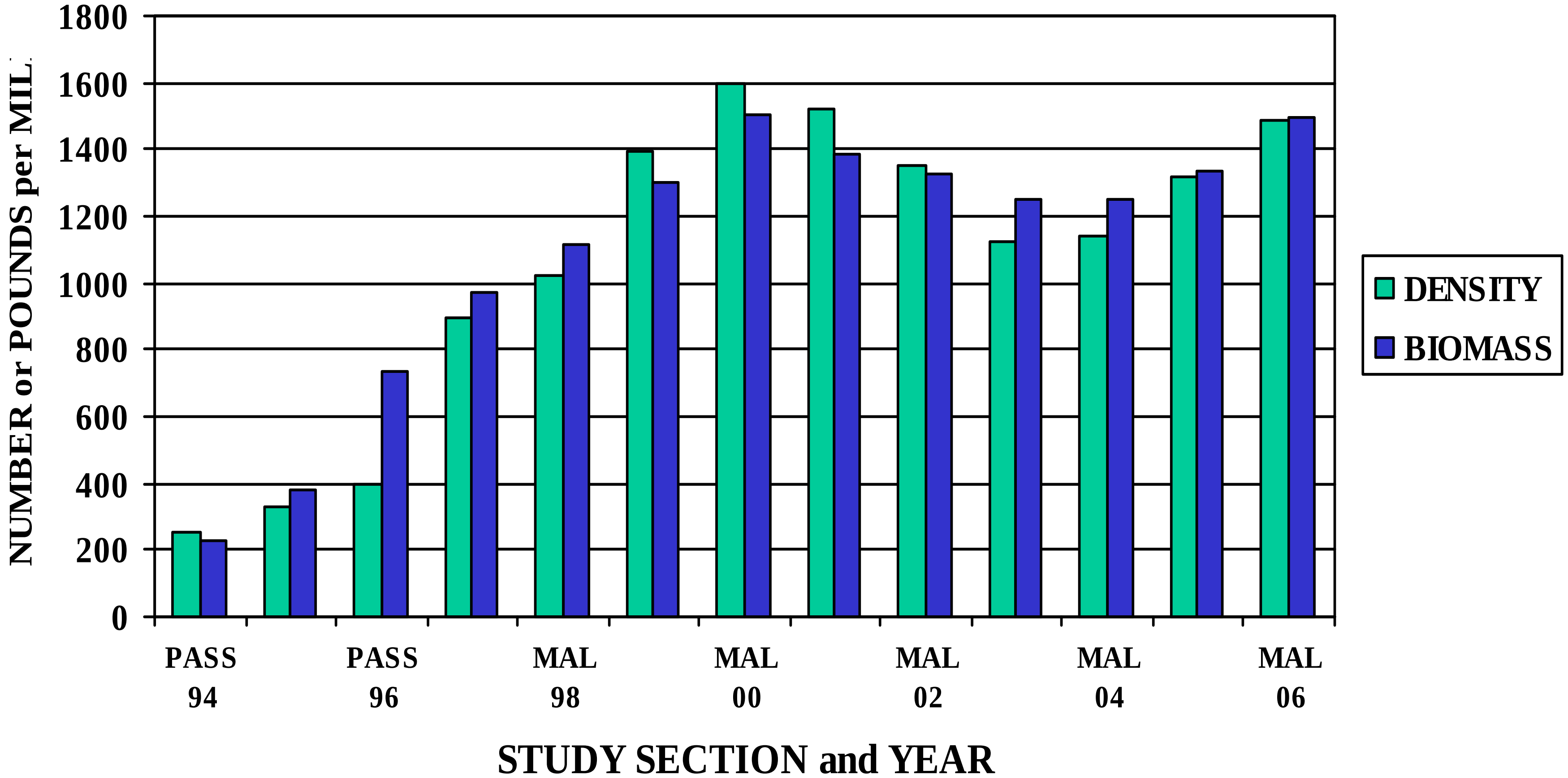

Figure 43. Estimated densities of 13 inch and larger brown trout from fall samples in the Passamari (PASS) Section and spring samples in the Maloney (MAL) Section of the Ruby River, 1994 - 2006.

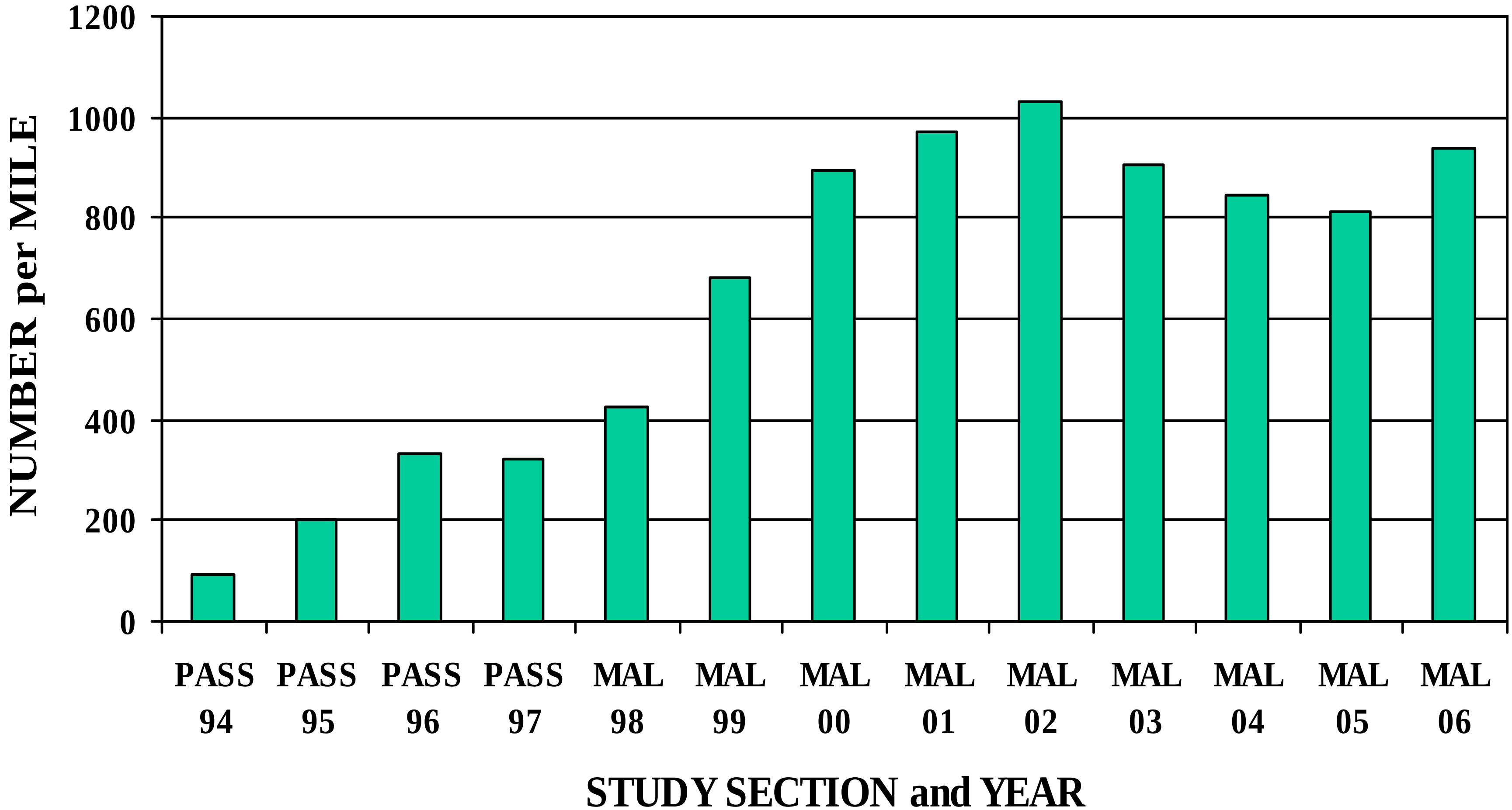

Figure 44. Estimated densities of 18 inch and larger brown trout from fall samples in the Passamari (PASS) Section and spring samples in the Maloney (MAL) Section of the Ruby River, 1994 - 2006.

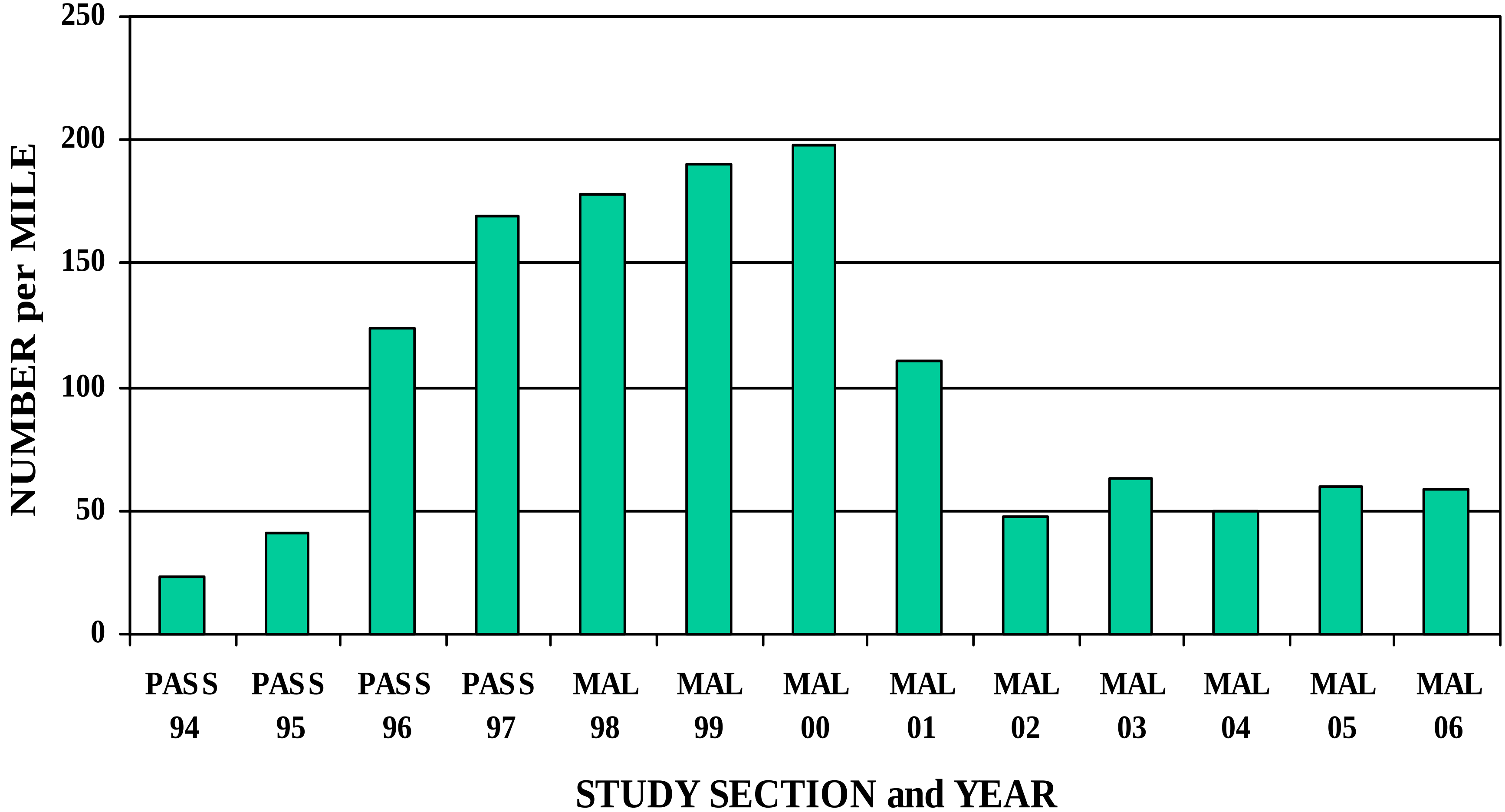

Figure 45. Estimated densities of juvenile brown trout from fall samples of Age I fish in the Passamari (PASS) Section and spring samples of Age II fish in the Maloney (MAL) Section of the Ruby River, 1994 - 2006.

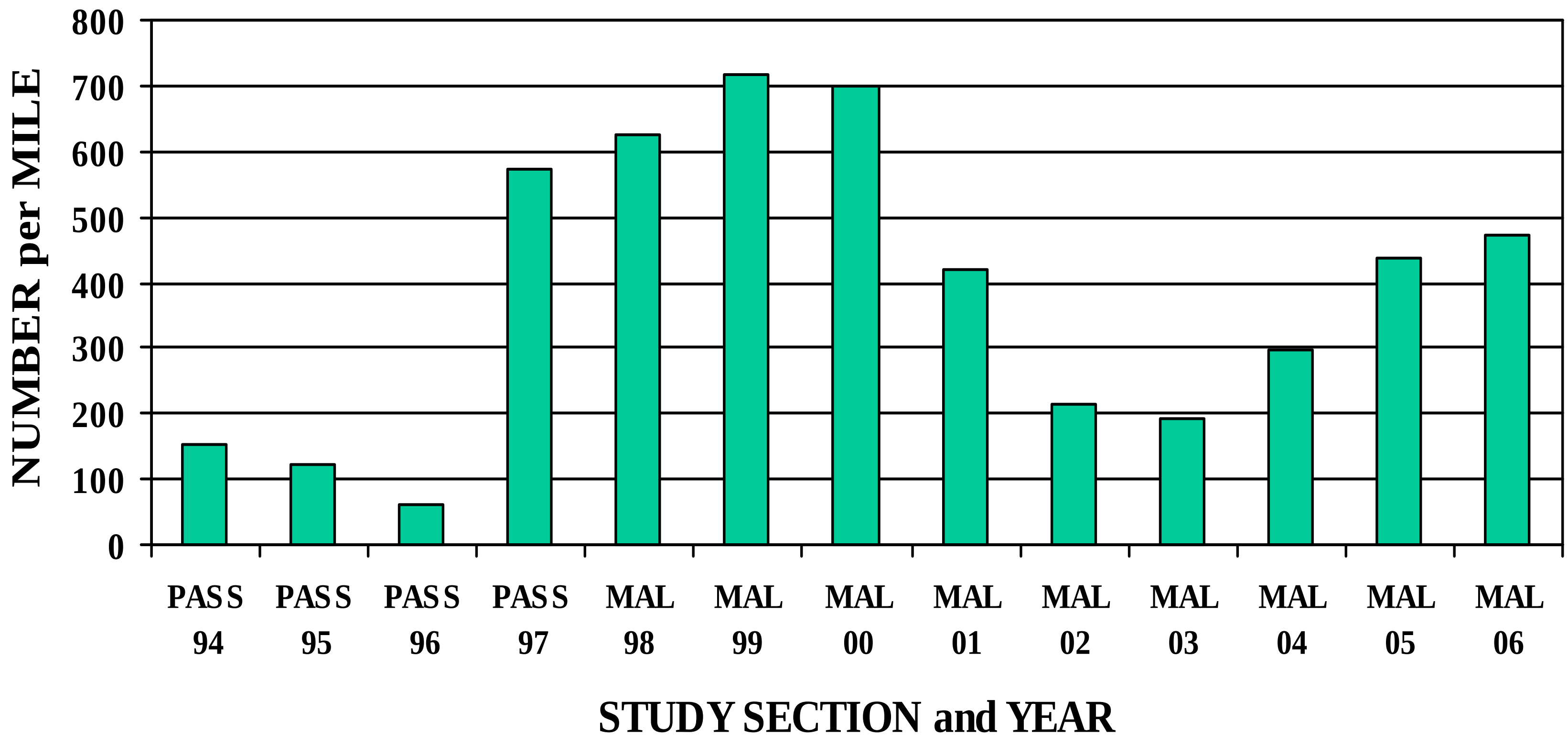

Figure 46. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Maloney Study Section of the Ruby River 1999 - 2006.

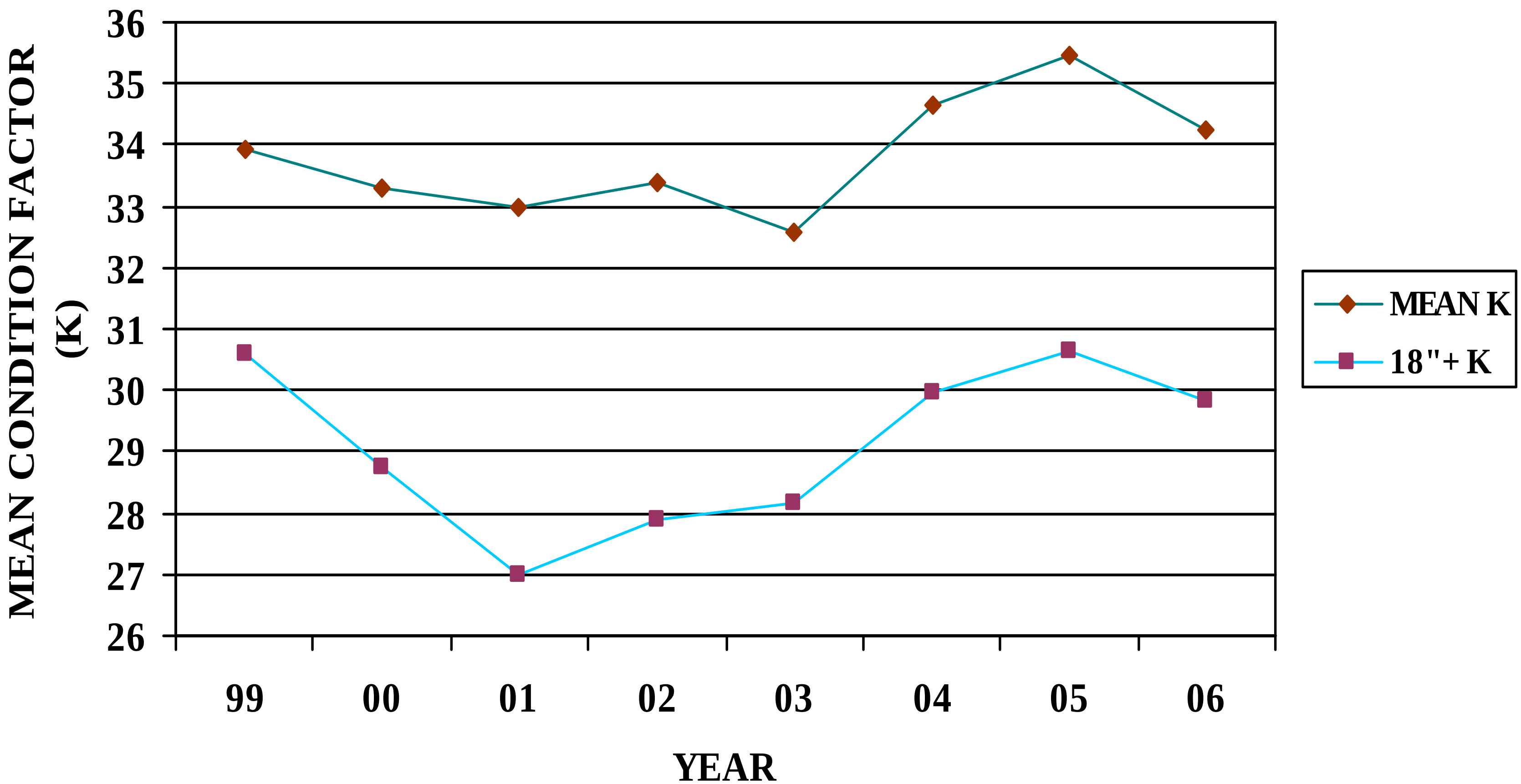

Figure 47. Estimated spring density and standing crop of Age II and older brown trout in the Silver Spring Section of the Ruby River, 1989 - 2006.

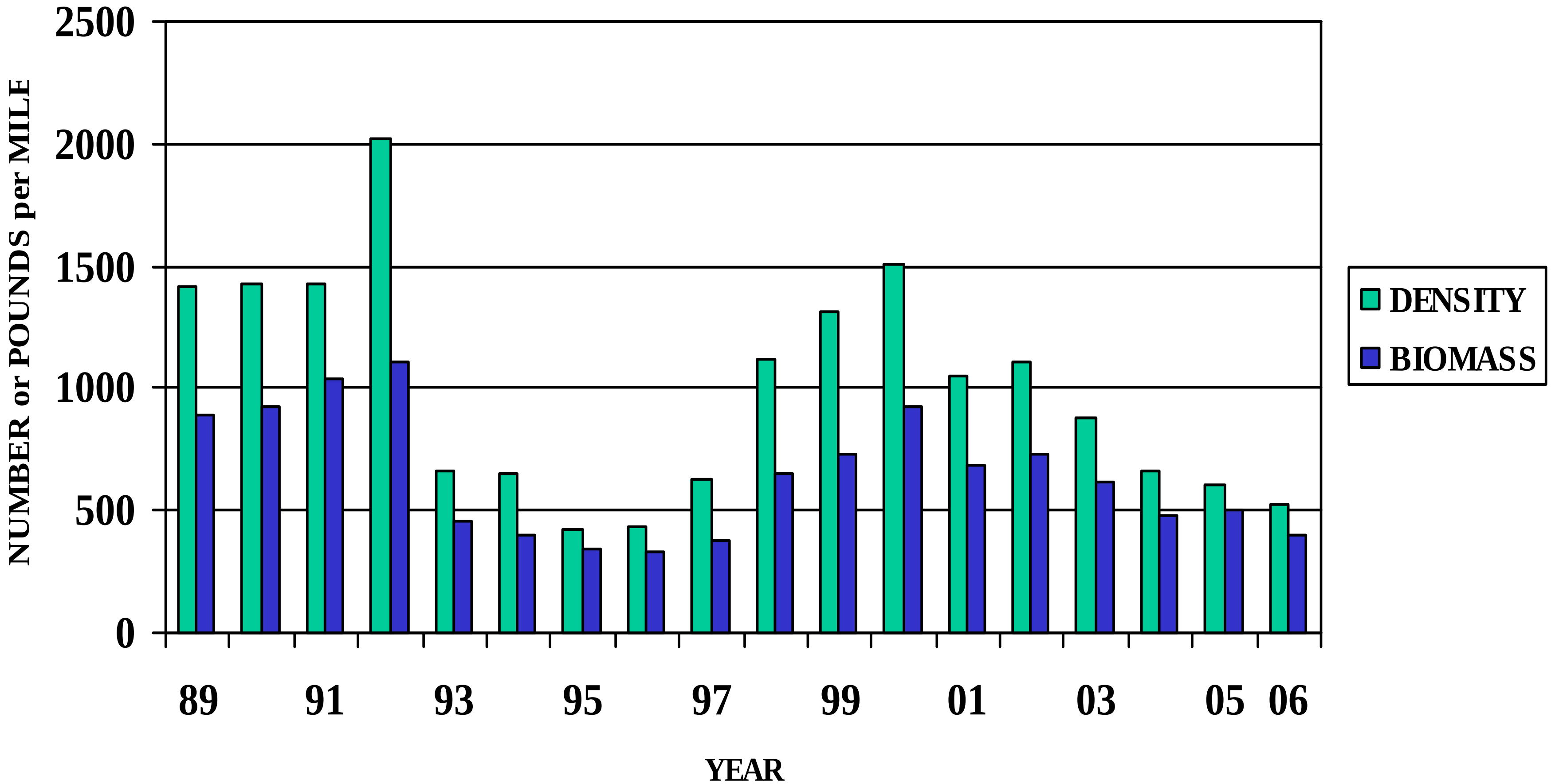

Figure 48. Estimated spring densities of juvenile (Age I and Age II) brown trout in the Silver Spring Section of the Ruby River, 1989 - 2006.

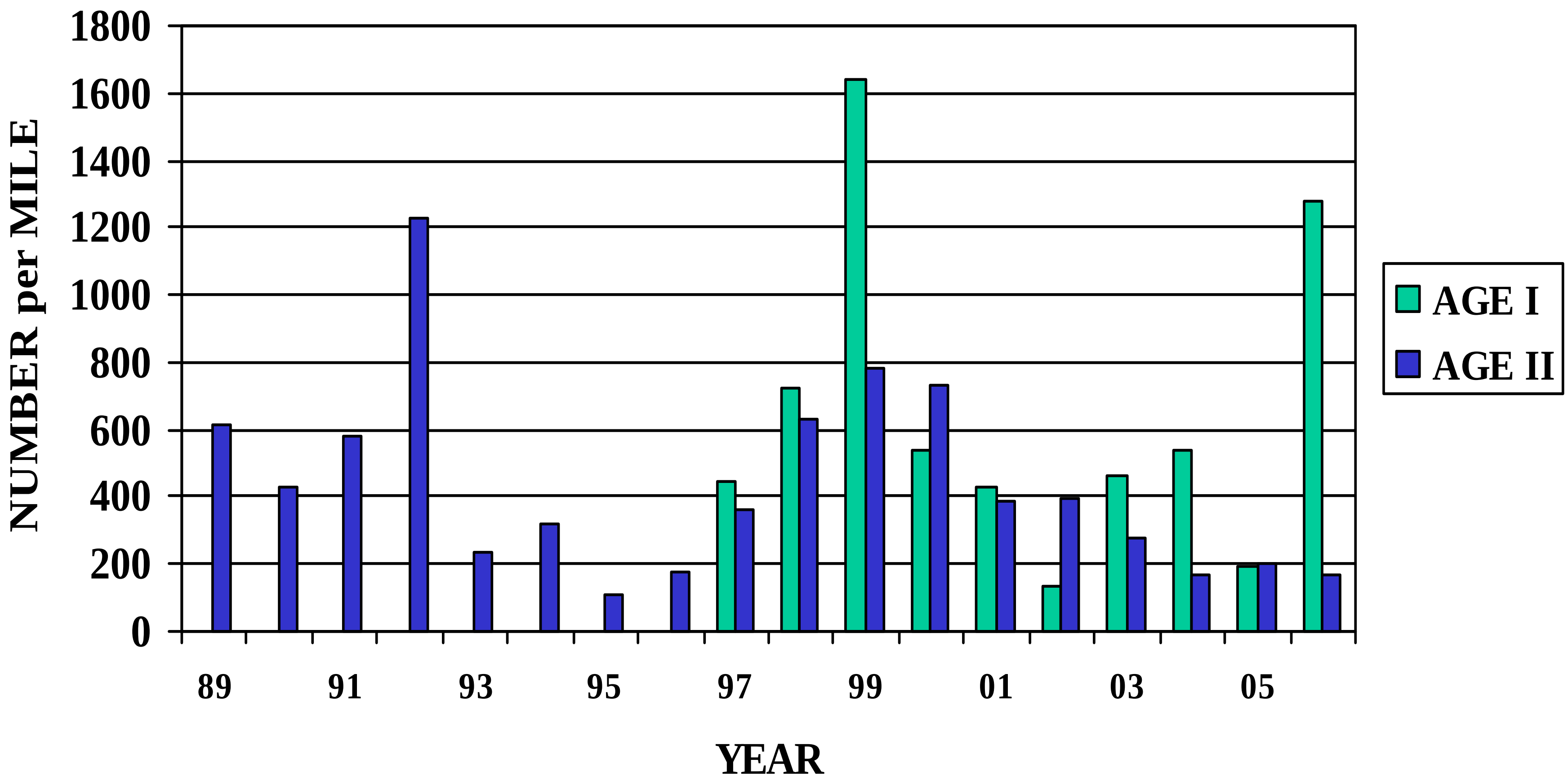

Figure 49. Estimated spring density of 13 inch and larger brown trout in the Silver Spring Section of the Ruby River, 1989 - 2006.

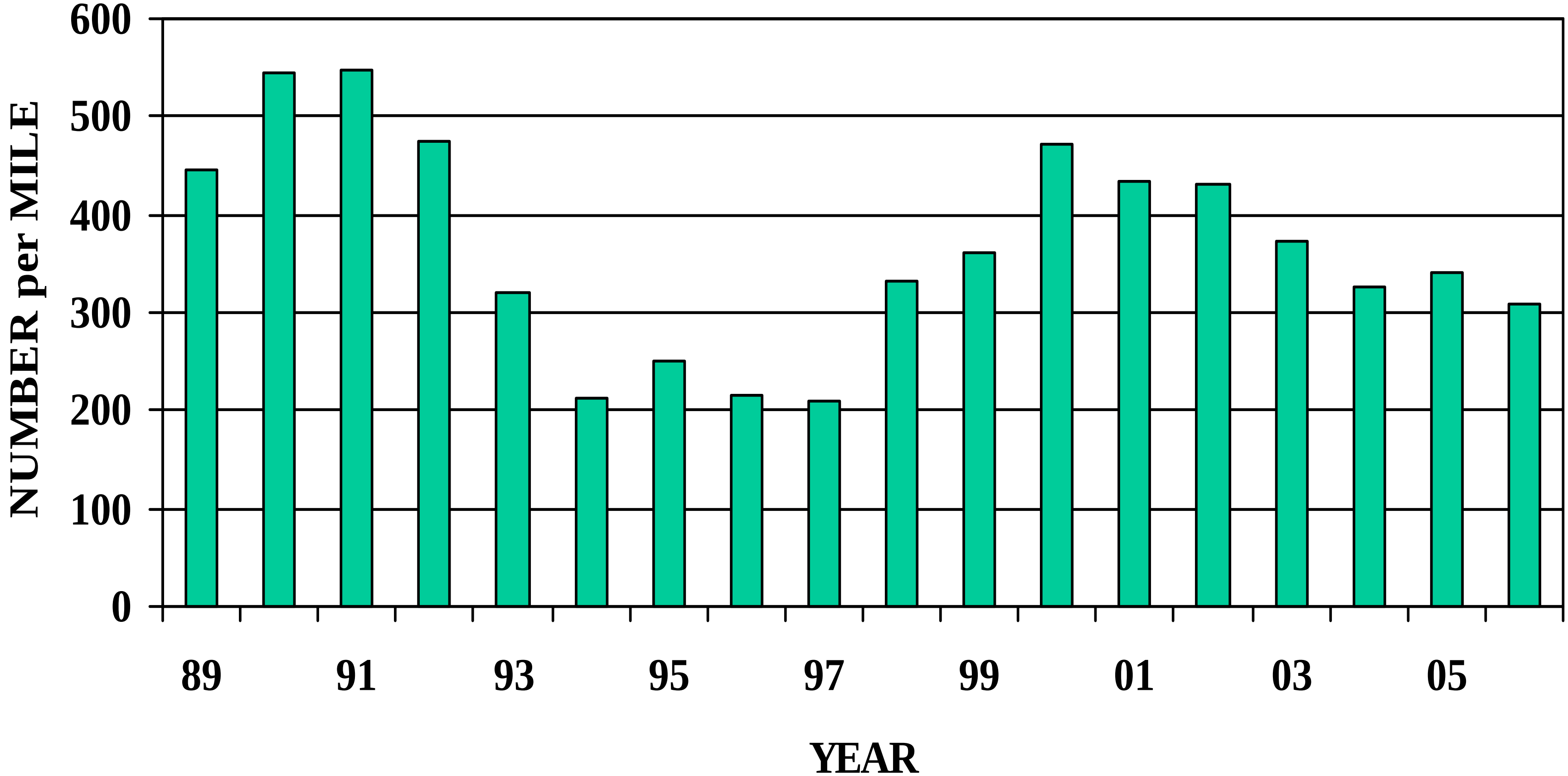

Figure 50. Estimated spring density of 16 inch and larger brown trout in the Silver Spring Section of the Ruby River, 1989 - 2006.

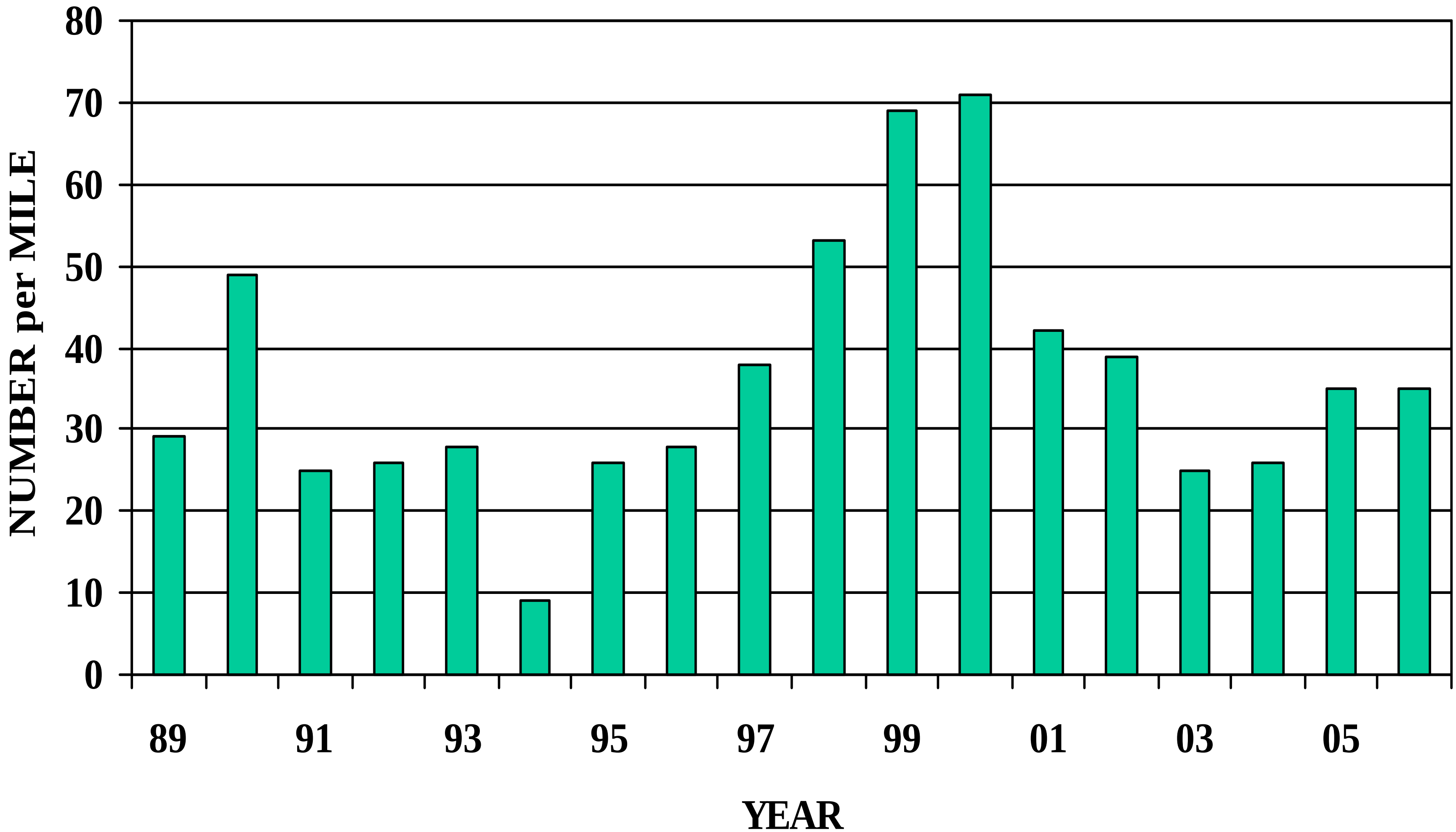

Figure 51. Estimated spring density and standing crop of Age I and older brown trout in Section Three of Poindexter Slough, 1989 - 2006.

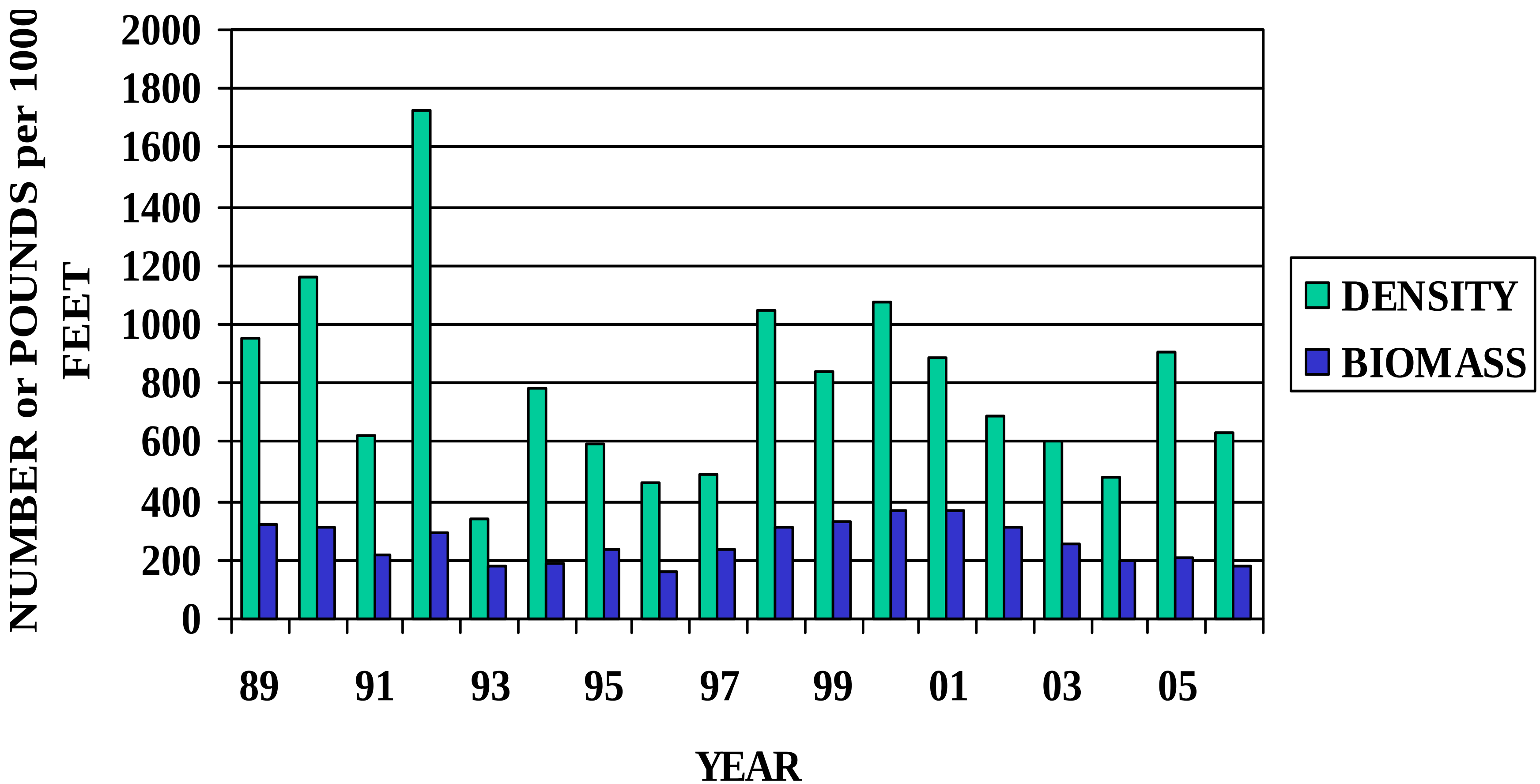

Figure 52. Estimated spring density of Age I brown trout in Section Three of Poindexter Slough, 1989 - 2006.

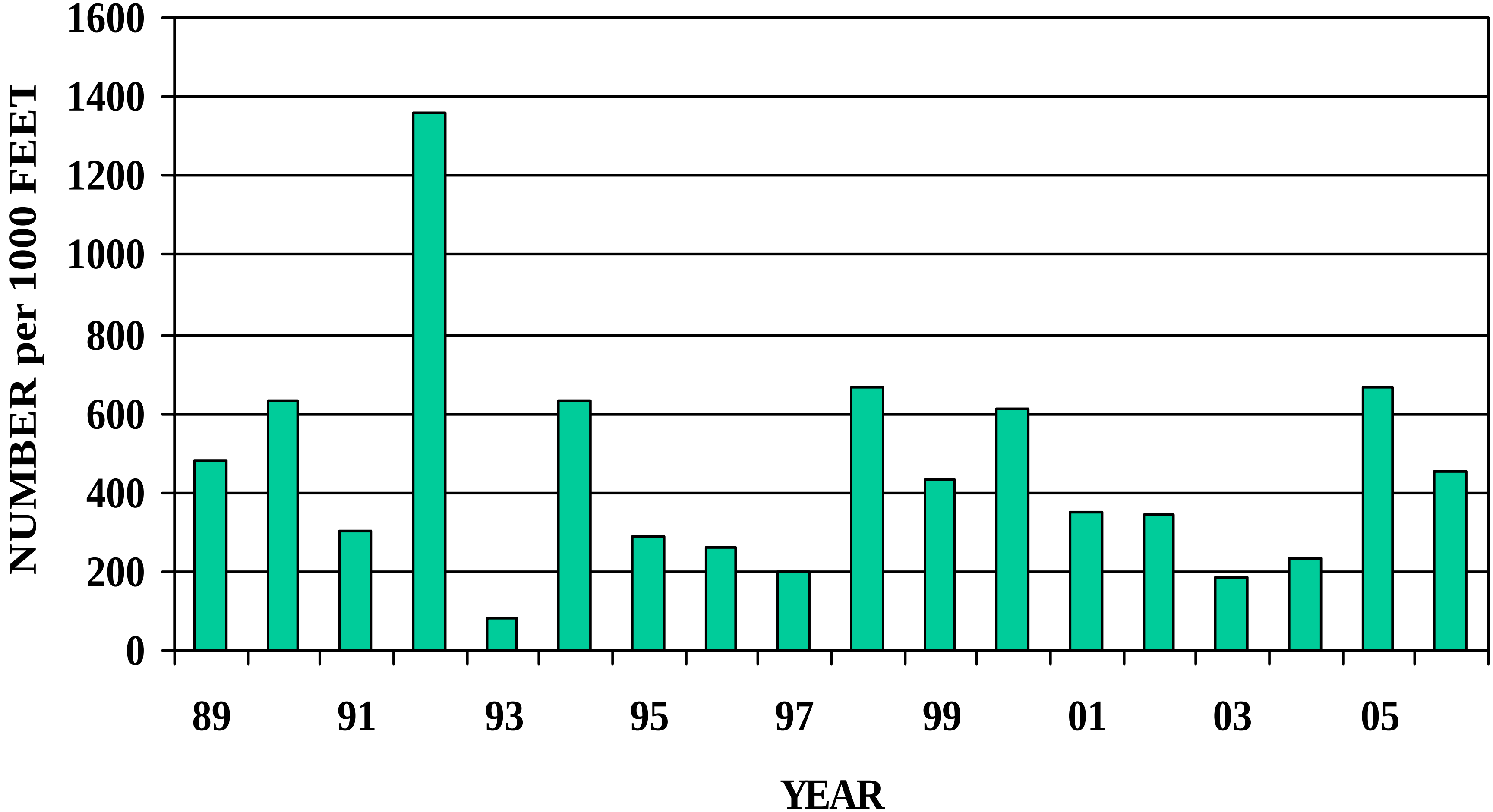

Figure 53. Estimated spring density of 13 inch and larger brown trout in Section Three of Poindexter Slough, 1989 - 2006.

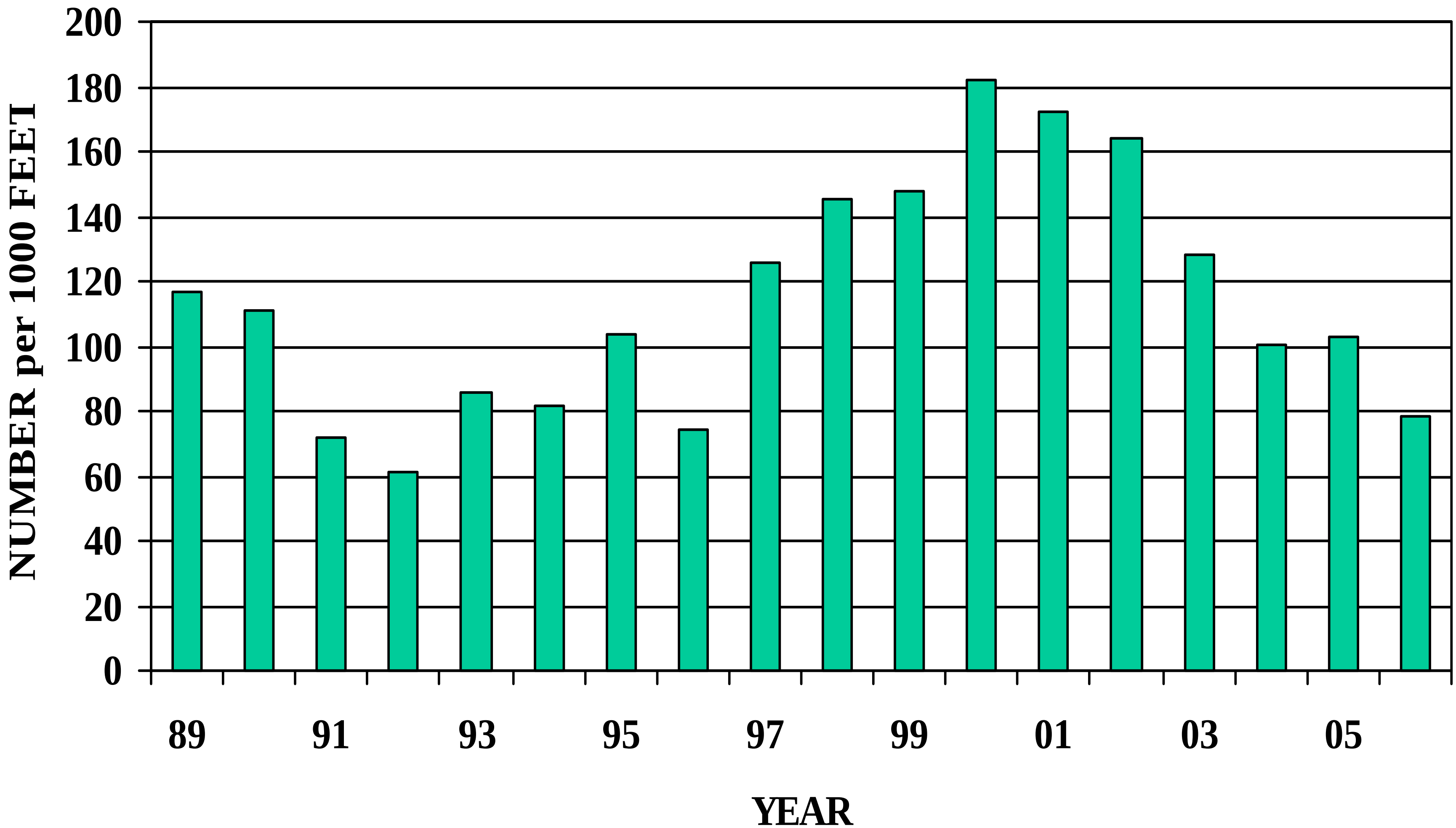

Figure 54. Estimated spring density of 15 inch and larger brown trout in Section Three of Poindexter Slough, 1989 - 2006.

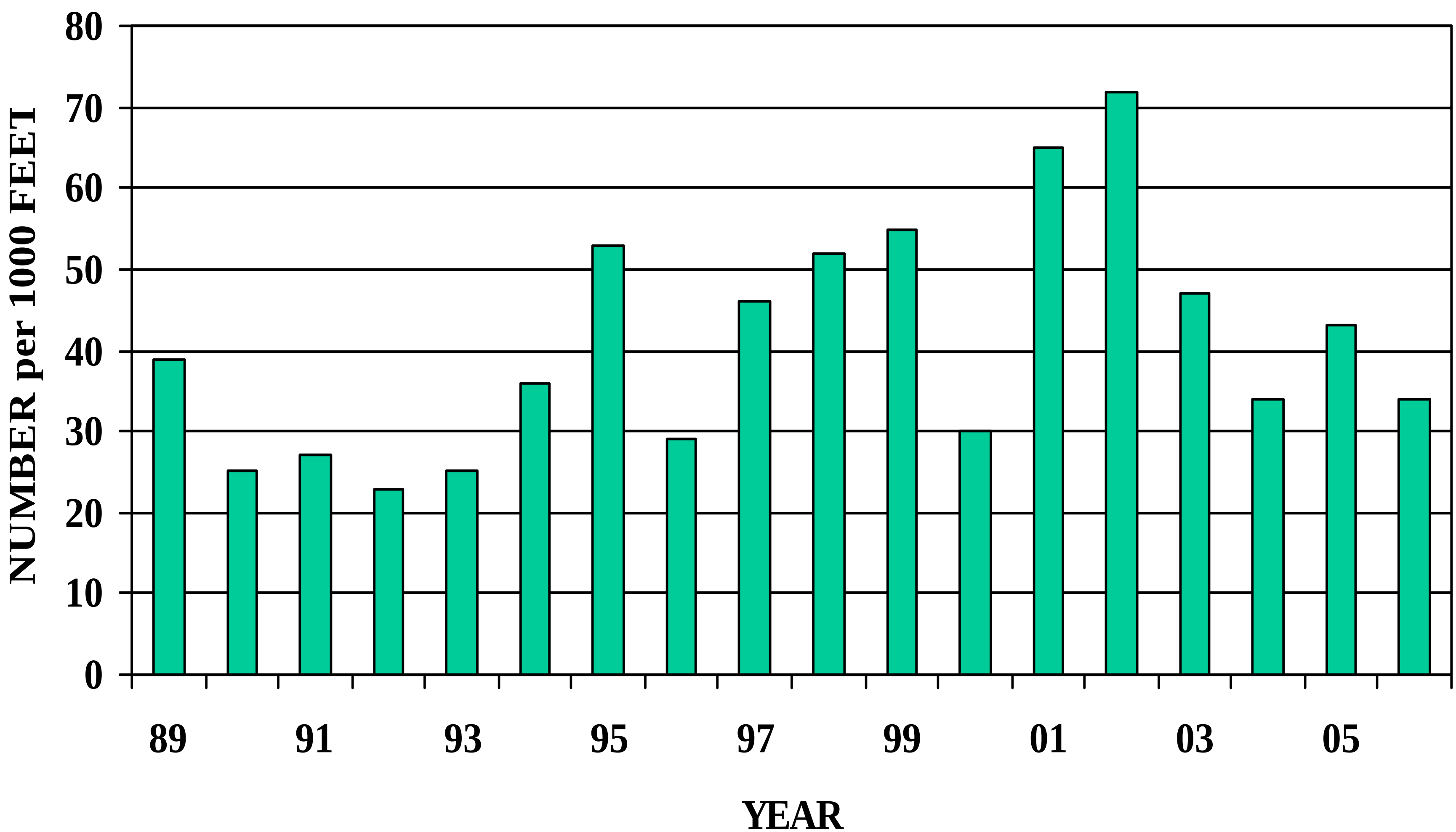

Figure 55. Mean non-irrigation season flows (April and October) compared with the minimum and optimum recommended base instream flows at the USGS Monida Gage on the Red Rock River; Water Years 1986 - 2006.

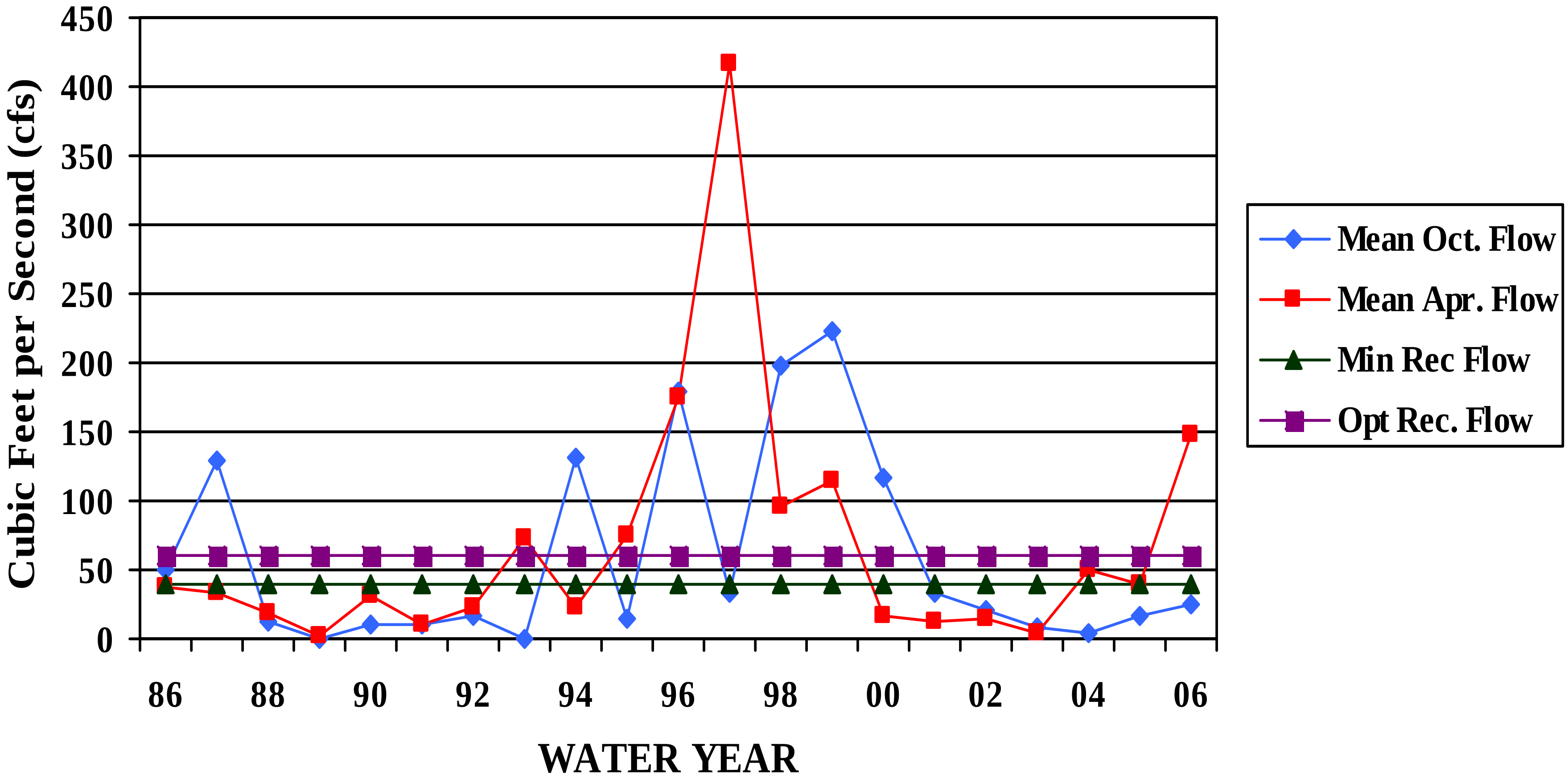

Figure 56. Mean August flow (cfs) compared with the minimum and optimum recommended base stream flow at the USGS Monida Gage on the Red Rock River; 1986 - 2006.

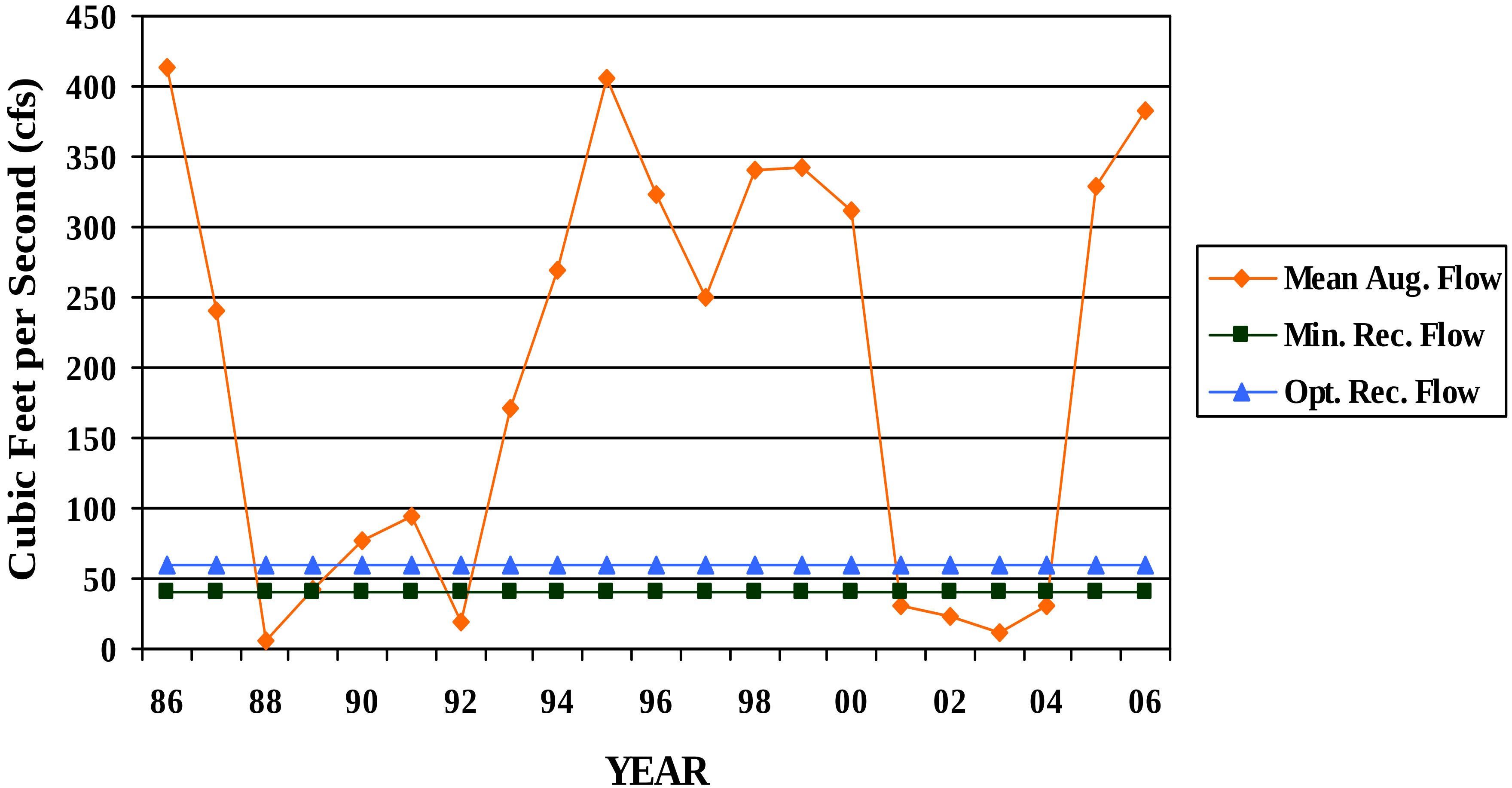

Figure 57. Estimated spring density and standing crop of Age II and older brown trout in the Martinell Section of the Red Rock River; 2005 - 2006.

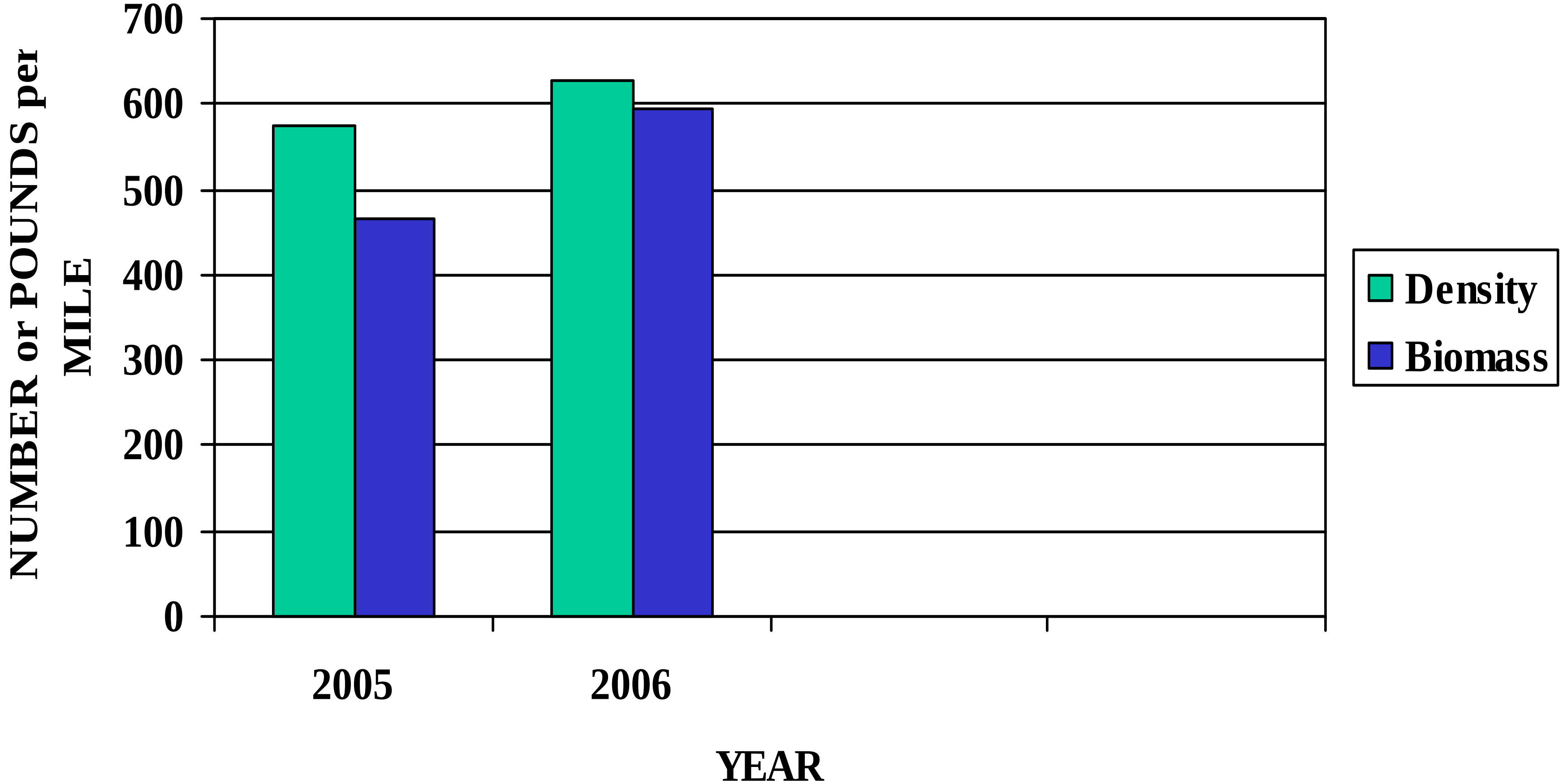

Figure 58. Estimated spring densities of Age I and Age II brown trout in the Martinell Section of the Red Rock River; 2005 - 2006.

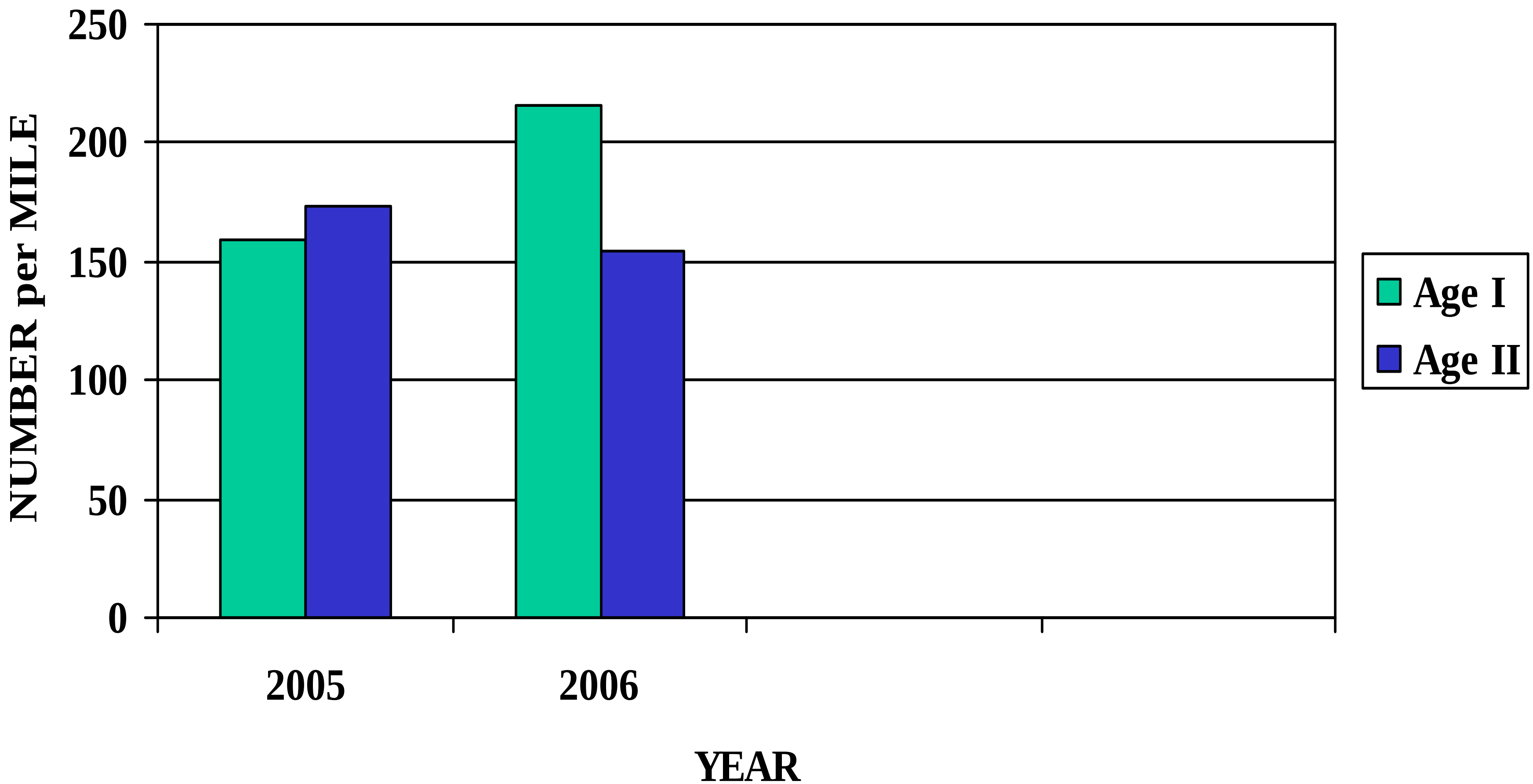

Figure 59. Estimated spring density of 13 inch and 16 inch and larger brown trout in the Martinell Section of the Red Rock River; 2005 - 2006.

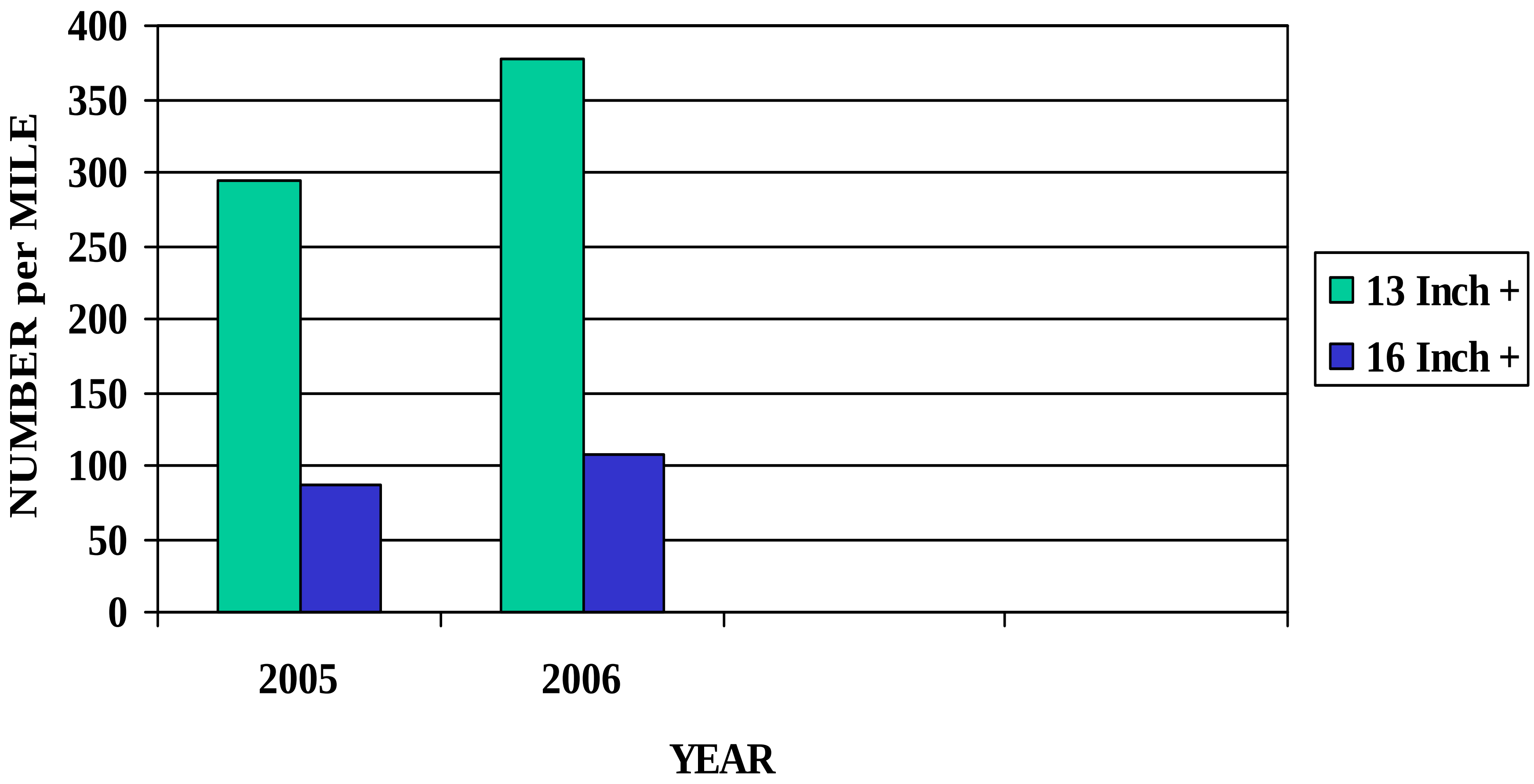

Figure 60. Estimated spring density of 18 inch and larger brown trout in the Martinell Section of the Red Rock River, 2005 -2006.

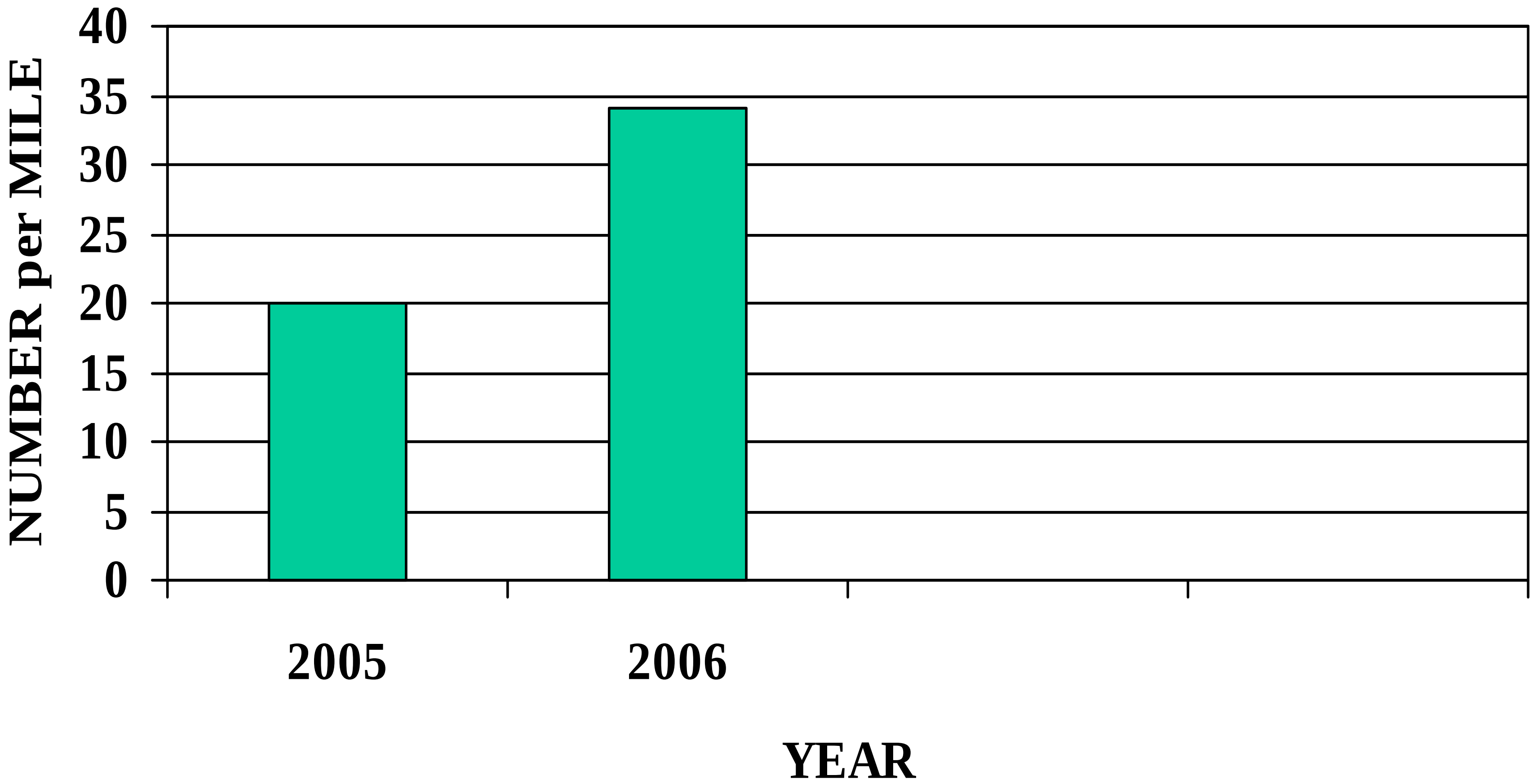

Figure 61. Mean spring Condition Factor (K) for brown trout and for 15.0 - 17.9 inch and 18.0 inch and larger brown trout in the Martinell Section of the Red Rock River; 2005 - 2006

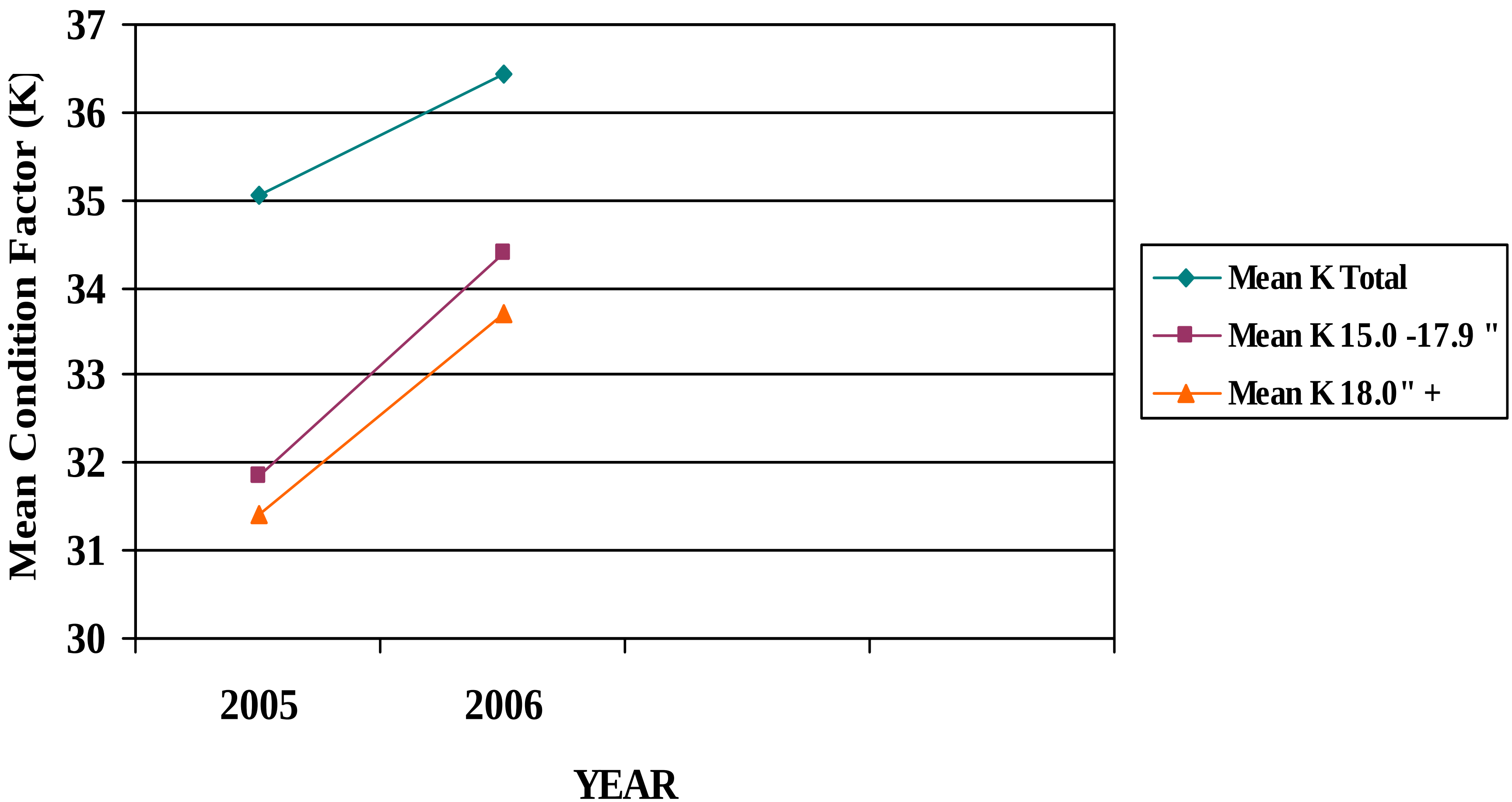

Figure 62. Comparative estimated population density and standing crop for brown trout from fall (Age I +) and spring (Age II +) samples in the Wellborn (Well), Dell, and Martinell (Mart) Sections of the Red Rock River; 1987 - 2006.

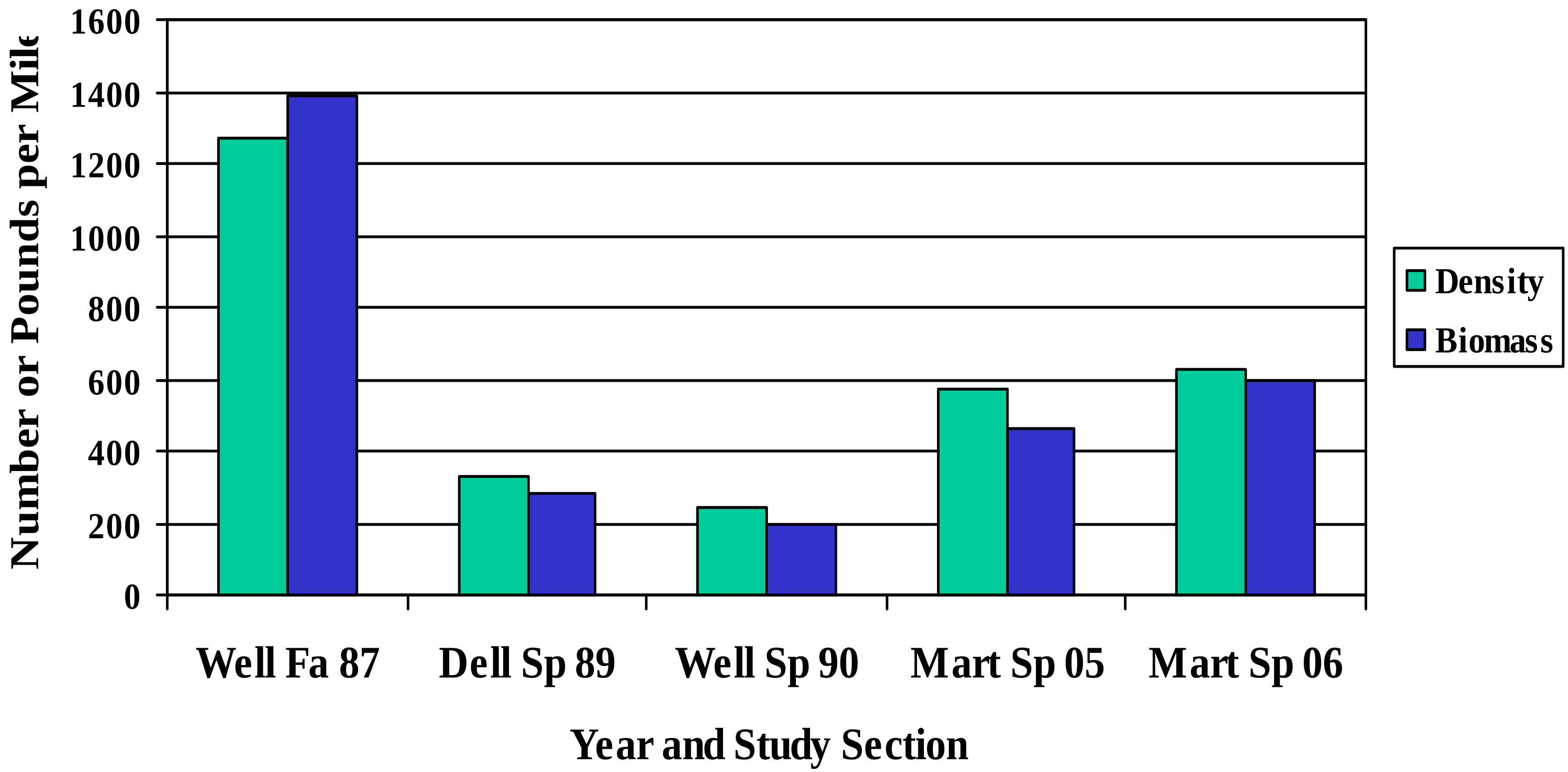

Figure 63. Comparative estimated spring or fall density of 13 inch and larger brown trout in the Wellborn (Well), Dell, and Martinell (Mart) Sections of the Red Rock River; 1987 - 2006.

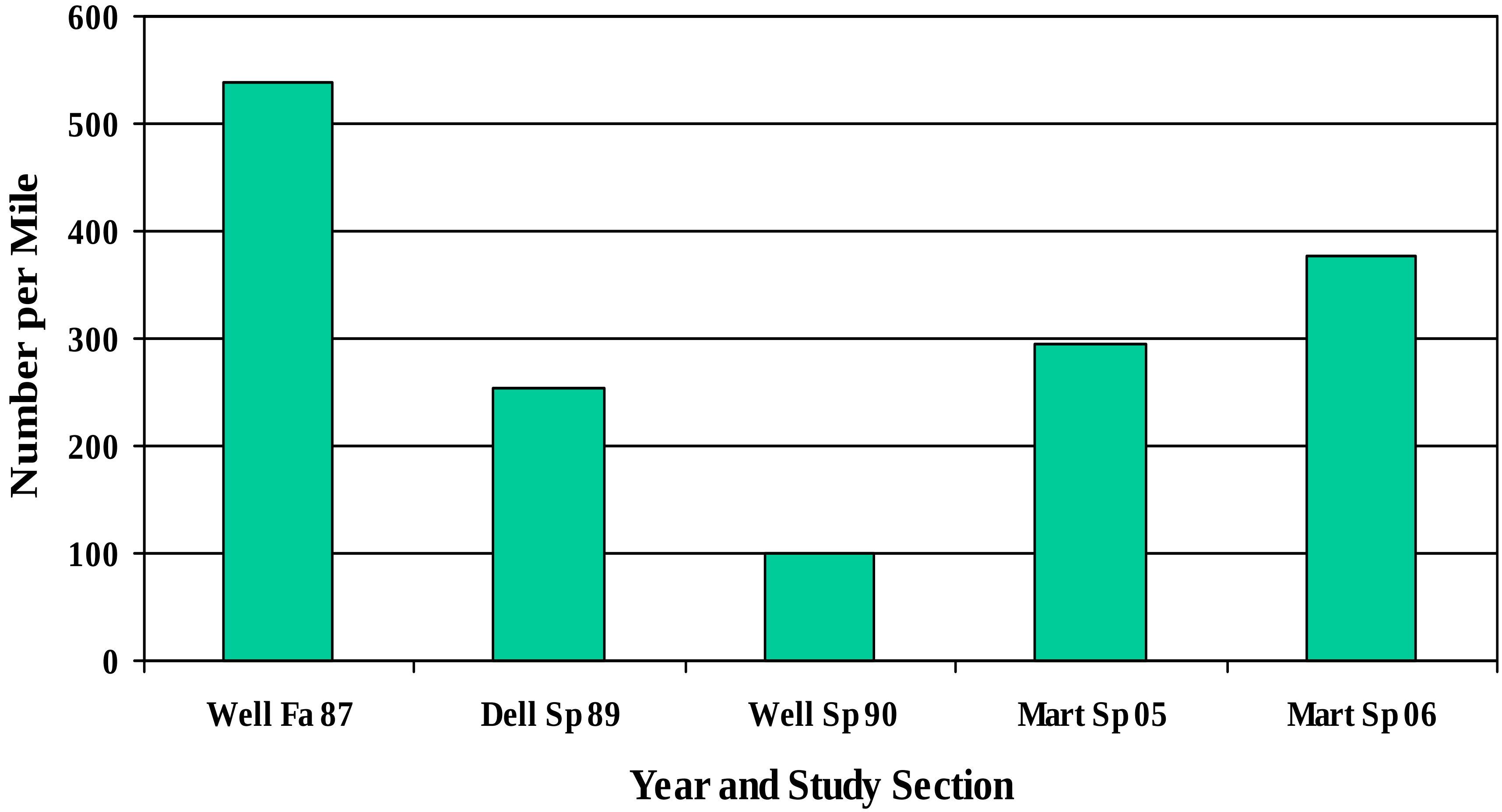

Figure 64. Comparative estimated fall or spring density of 18 inch and larger brown trout for the Wellborn (Well), Dell, and Martinell (Mart) Sections of the Red Rock River; 1987 - 2006.