Southwest Montana Native Species Research & Conservation

MONTANA FISH, WILDLIFE & PARKS
STATE WILDLIFE GRANT
PROJECT PERFORMANCE REPORT

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Location

This report represents a continuation and the completion of efforts initiated in 2004 under a Southwest Montana Native Fish Research and Conservation Grant. The 2004 work was reported and discussed in detail by Oswald et al 2005. Projects completed in 2005 were summarized by Oswald et al 2006 and 2006 efforts were described by Hochhalter and Oswald 2007. This summarization compiles efforts completed in 2007, the final year of funding under the current grant. Other recent native fish species research efforts dealing with waters and species treated in this report are presented and discussed in substantial detail in Oswald 1981, Oswald and Roberts 1998, Oswald 1999, 2000a, 2000b, 2002, 2003, 2004a and 2004b, and 2006 and Oswald and Rosenthal 2007.

Trap nets and baited cod and hoop traps were set in Clark Canyon Reservoir in order to develop a sampling program to better determine the status and composition of the native burbot population. A winter creel census and passive sampling station deployment effort was also directed at trying to determine the composition and age of burbot in the angler harvest. Clark Canyon Reservoir is a Bureau of Reclamation irrigation and flood control project on the Beaverhead River approximately 20 miles south of the City of Dillon, Montana. Trap net and gill net sampling for native Arctic grayling, lake trout, burbot, and white and longnose sucker populations was conducted on Elk Lake, Twin Lakes, Miner lake, Mussigbrod Lake, and Pintler Lake, all located in Beaverhead County, Montana. Elk Lake is located near the Red Rock Lakes National Wildlife Refuge and the town of Lakeview, MT in the Centennial Valley of the Red Rock River drainage. Radio telemetry was also employed on native lake trout in Elk Lake in order to determine habitat selection and define the location of critical spawning habitats. Twin, Miner, Mussigbrod, and Pintler Lakes are located in the Beaverhead Mountains of the upper Big Hole River drainage near the towns of Jackson and Wisdom, Montana. Sampling of the native adfluvial Arctic grayling population of the Red Rock Lakes was conducted via the use of electrofishing techniques. This sampling was conducted in Red Rock Creek in the Alaska Basin area of the upper Centennial Valley near the Red Rock Lakes National Wildlife Refuge. Efforts to reintroduce native fluvial Arctic grayling were initiated in 1998 in the upper Ruby River. The upper Ruby is the river reach located upstream from Ruby River Reservoir and is tributary to the Beaverhead River with a confluence near Twin Bridges, Montana. The monitoring of the grayling reintroduction effort was concentrated in the Three Forks Study Section which was initiated in 1987 and is located at the confluence of the three headwater forks of the Ruby River. Stone and Dyce Creeks continued to be analyzed as a potential westslope cutthroat trout brood source in 2007. Dyce Creek is located along the south slopes of the Pioneer Mountains in the Grasshopper Creek drainage, a tributary to the Beaverhead River. Stone Creek is located in the Ruby Mountains and is also tributary to the Beaverhead River. Continued efforts to expand the distribution of native westslope cutthroat trout were pursued in Alkalai Creek in 2007. Alkalai Creek was formerly analyzed as a potential reintroduction habitat until a pure population of native westslope cutthroat trout was discovered and in a very limited headwaters reach. Alkalai Creek is a tributary of the East Fork of Blacktail Deer Creek located along the west slopes of the Snowcrest Mountains. The lower Beaverhead River was sampled for native mountain whitefish population density and dynamics in one study section located between Dillon, Montana and the mouth of the Ruby River. The Beaverhead River joins the Big Hole River near Twin Bridges Montana to form the Jefferson River, one of the three headwater forks of the Missouri River. Finally, the project included analysis of the performance of westslope cutthroat trout in mountain lake sport fisheries that had formerly been stocked with the nonnative Yellowstone strain of cutthroat trout. This analysis was continued in 2007 in Elk Lake that was described above.

Objective

The project is intended to be ongoing, on an annual basis, with research or tasks directed toward accomplishing the conservation of native fish species in southwest Montana. Because the project seeks to address multiple goals for multiple species in diverse locations, the following describes general objectives for the species of concern. The objective of the project as pertains to westslope cutthroat trout (*Oncorhynchus clarki lewisi)* is to conserve and expand existing populations and gene pools. The objective as pertains to lake trout (*Salvelinus namaycush)* and burbot *(Lota lota)* is to gain an understanding of habitat requirements, limiting factors, and population dynamics in order to reverse trends of poor recruitment and low stock density. Sampling of populations of white sucker (*Catostomus commersoni)* and longnose sucker *(Catostomus catostomus)* represents companion native species population study to better understand intractions with burbot and lake trout. The objective as pertains to adfluvial Arctic grayling (*Thymallus* arcticus) is to form a dependable brood stock to provide progeny for stocking into suitable habitats within their native range. Adfluvial Arctic grayling spawning samples also represent efforts to monitor the adult reproductive segment of the native populations. Sampling of native mountain whitefish (*Prosopium williamsoni)* populations in the lower Beaverhead River represents an effort to study the effects of artificial flow manipulation from Clark Canyon dam on native species as companion to fluvial Arctic grayling reintroduction efforts.

Accomplishments

Lake Trout The objectives were met and work was completed as proposed. Spring gill net sampling was continued in Elk Lake as the established method for monitoring population trends through 2006. A total of 2 sinking sets, were fished overnight for native lake trout resulting in a CPUE of 1.0 fish per net. Gill net sampling trends for lake trout CPUE are presented in Figure 1. As is generally typical of Elk Lake gill net samples, the individuals captured were relatively large fish (Figure 2) and representative of the older, fully mature segment of the population. The 2006 and 2007 samples incorporated trap or fyke net and trammel net sampling in an endeavor to sample smaller individuals in the population and facilitate the healthy release of floy or radio tagged individuals. The 2006 effort deployed a total of 18 overnight trap nets between May 16 and May 26 resulting in the capture of 4 15.5 to 18.8 inch lake trout and a CPUE of 0.2 fish per net. Two of those individuals were surgically implanted with radio transmitters. In 2007, two sinking trammel net sets and 4 trap nets fished overnight in mid-May failed to capture any lake trout. Five baited cod traps (Oswald and Rosenthal 2007), however, captured two lake trout of 19.5 and 21.5 inches in length for a CPUE of 0.2 per net.

Trap net and angling techniques were added to the Elk Lake lake trout sampling program over the 2005 – 2007 sampling seasons to facilitate radio telemetry studies. Trap nets and angling methods were utilized to reduce stress and improve survival of fish prior to surgical implantation of radio transmitters and subsequent release. These efforts resulted in a maximum of 11 adult individuals surgically implanted with radio transmitters. Mortalities and subsequent recovery of some of the transmitters provided for reuse in additional individuals. Radio relocations in 2006 revealed a strong positive response of lake trout to depth and cold water temperatures throughout the summer months and suggested fall movements to spawning habitats in the lower (south) lake basin in October (Hochhalter and Oswald 2007). These radio relocations also confirmed active movement of individuals between the two lake basins throughout the summer. The same summer and fall patterns were strongly exhibited in 2007 with multiple relocations of 7 different adult individuals throughout the spring – summer seasons and multiple locations of 3 different adults confirming distinct spawning habitats along the west shore of the lower basin in October (Map Figure 1). Relocated adult lake trout were found grouped in two distinct locations where course angular gravels and cobble substrates were coupled with depths of 1 to 4 meters. These locations were also associated with steep basin morphometry below basalt rock cliffs along the access road cut along the lake shore. The clusters were located at a small gravel point immediately north of the USFS campground at the lake narrows and directly below the north end of a large basalt cliff above the road (Map Figures 2,3 and 4). Radio relocations also led to the visual observation of individuals at 1 to 2 meter depths on October 11, 2007 (Map Figure 4). More detailed discussion of these data will be presented in a subsequent report.

Efforts to successfully trap and radio tag adult native lake trout in Twin Lakes were continued in 2007. Gill net efforts in 2006 had revealed the presence of a relatively strong cohort of juvenile lake trout (Age I – II) and low numbers of individuals in the next older (Age II – III) cohort as well as a single very large adult individual for a relatively high CPUE of 0.55 fish per net for the lake (Hochhalter and Oswald (2007). This effort again confirmed the effectiveness of sinking monofilament gill nets as a means of capturing lake trout in Twin Lakes but failed to result in the capture of any adult individuals suitable for surgical implant of a radio transmitter. The series of gill net samples also confirmed the sporadic recruitment and wide separation of cohorts that has marked Twin Lakes lake trout sampling efforts (Oswald and Roberts 1998, Oswald 2004a). Trap net, cod trap, and angling efforts were again deployed in 2007 in an effort to capture adult individuals under conditions of minimal stress. These efforts again failed to capture any lake trout while successfully capturing all other species of fish known to occupy the lake. In addition to the effort to capture lake trout, a series of physical measurements was gathered in the two suspected lake trout spawning habitats in the lake. Transects measuring depth, length, water surface elevation and GPS location resulted in measurements that will facilitate development of a three dimensional descriptive mapping of these suspected spawning habitats. The 2008 sampling season could result in the capture of individuals large enough for surgical implantation of radio transmitters as the relatively large cohort of juveniles present in 2006 gains larger size at Age III – IV. A more detailed analysis of the 2007 Twin lakes data will be presented in a subsequent report.

Burbot The objectives were met and the work was completed as proposed. Trap or fyke net sampling was expanded in 2006 and 2007 as a non-lethal method of sampling native burbot in Elk and Twin Lakes while new sampling series were added in Miner, Mussigbrod, and Pintler Lakes in the upper Big Hole River drainage and the popular sport fishery of Clark Canyon Reservoir in the Beaverhead River drainage. The trap nets proved to be an efficient method of sampling native burbot when the selected habitats were shallow enough for effective deployment. This usually was associated with cold water temperatures at high elevation, samples immediately following ice out, or samples associated with spawning concentrations. Sampling of benthipelagic environs was most effectively completed with sinking gill nets or baited traps. Baited traps consisted of framed cod traps or sunken hoop traps (Bernard et al 1991). Hoop traps were made by merely detaching the box and lead portion from a standard fyke net and by using parallel lengths of plastic pipe for stabilization. Cod traps were approximately 3.5 feet tall with a bottom diameter of 4.0 feet and a top diameter of 3.0 feet, and were constructed of 1.0 inch mesh nylon netting. Cod traps were generally fished at depths of 35 to 40 feet in order to adequately sample the mature segment of the burbot population (Hofmann and Fischer 2002). The effects of decompression trauma associated with raising cod trap-captured burbot from depths greater than 33 feet were minimized using techniques modified from those described in Neufeld and Spence (2004). Fish were raised to a depth that was approximately one-half the atmospheric pressure than the original deployment depth for 15 to 30 minutes before handling. Upon completion of measuring and tagging, fish were allowed to recover in an open bottom cod pot lowered to 15 feet for approximately 15 to 30 minutes. Any fish that continued to be affected by decompression after this technique had its swim bladder deflated by inserting a hollow needle slightly below the lateral line into the body cavity (Bruesewitz et al. 1993).

Preliminary descriptive data for the native burbot population of Clark Canyon Reservoir were initially presented by Hochhalter and Oswald (2007). Relatively low trap net capture rates

(CPUE = 0.6 fish/net) in spring 2006 prompted the need for increased and more diversified sampling efforts in 2007. Springtime spawning site identification surveys were conducted immediately following ice break up in select littoral areas, and were effective in locating several active spawning sites. Spawning sites were identified by visual observation of definitive burbot spawning balls comprised of approximately 20-30 individuals exhibiting typical spawning behavior (physical contact among all individuals with individuals writhing in and out of the conglomerate). Spawning balls were typically located in less than four feet of water, and were situated above a substrate composed of yellow sweet clover (*Melilotis officinalis*), organic debris, gravel, and sand. Identification of three spawning balls allowed for fyke nets to be deployed in the immediate vicinity, and led to the capture and subsequent tagging of 1,100 burbot. These fish ranged in length from 12 to 31 inches, with a modal length of 25 inches (Figures 4 and 5). Preliminary ageing results from winter creel collected burbot otoliths spanned age groups 2 through 13 (Figure 6) and revealed that fish 25 inches and greater were typically age three and older, thus comprising the spawning population. However the relationship between age and length appears to vary widely between male and female burbot, with 25-inch burbot ranging from four to nine years in age (Figures 7 and 8). The use of baited cod traps in sampling the spring (post-spawning) and fall (reservoir-wide) burbot populations resulted in the capture of an additional 188 burbot with three recaptures from those individuals tagged during the spawning period. Overall capture rates for baited cod traps ranged from 0.2 to 10.4 fish/net with a mean CPUE of 4.7 ± 1.2 SE. Capture rates increased with declining temperatures from late September until mid November when efforts had to be suspended due to incipient ice cover. Capture rates also increased over the fall sample season as trapping efforts were concentrated in locations that proved successful in capturing burbot. Based on the limited recaptures, a population estimate (modified Petersen) was calculated at 52,021 ± 22,976 SD. However, length frequency histograms for the cod trap-captured burbot (Figure 9) show a modal length of 19.5 inches, suggesting that fall efforts did not proportionately sample the older, larger, spawning individuals as marked in the spring. As a result, population size may be larger than estimated. Preliminary analysis (Figure 10) suggests that vertical variation in reservoir elevation during the critical spring spawning and incubating period could influence the strength of burbot cohorts in the reservoir.

Deployment of trap nets in Elk Lake in 2006 proved a successful means of nonlethal sampling of the native burbot population. Trap nets set on contoured drop-offs throughout the latter half of May exhibited a CPUE of 13.9 fish per net with a recapture return of 7.0% (Hochhalter and Oswald 2007). This compared to a CPUE of 33.5 burbot per net in the more lethal and stressful sinking monofilament gill nets. The gill net CPUE for 2006, however, was the highest recorded capture rate for the lake and represented a 48% increase over the most recent sample in 2005. Because of this success, the 2007 sampling effort utilized four overnight sets of trap nets, two overnight sets of sinking trammel nets, and five 48 hour sets of baited cod traps. These sets resulted in the capture of 208 burbot ranging in length from 8 to 21 inches. The effectiveness of the three methods was ordered as CPUE of 76.5 for the trammel nets, CPUE of 10.5 for the trap nets, and CPUE of 3.2 for the cod traps. The trammel nets proved even more effective than monofilament gill nets for capturing burbot, however, the incidence of mortality and high levels of physical stress was unacceptable and similar to gill nets. The trap net CPUE was relatively close to that observed in 2006 while cod trap CPUE was relatively low. Comparative sampling from Clark Canyon Reservoir suggests that cod trap sampling efficiency increases substantially over time with sets of 72 to 96 hours duration. All burbot captured and released from the trap nets and cod traps were marked with individually numbered Floy T Tags for future recapture and identification. White sucker, captured in association with the burbot sampling effort, exhibited very similar CPUE between the trammel nets (74 per net) and the trap nets (71 per net). A more detailed analysis of the 2006 and 2007 Elk Lake burbot data will be presented in a subsequent FWP Completion Report.

Burbot sampling and tagging continued in Twin Lakes in association with attempts to trap live lake trout. Hochhalter and Oswald (2007) discussed the effectiveness of shoreline set trap nets in capturing burbot and the high rates of recapture in Twin Lakes. Sampling in 2007 began with a series of baited cod traps fished in 48 hour sets in late May immediately after ice out. These cod traps resulted in a CPUE of 9.6 burbot per net ranging in length from 10.5 to 26.7 inches. All burbot captured in this effort were marked with numbered Floy T Tags. A second trapping and tagging effort was completed in August and early September with Trap nets resulting in the capture of 196 burbot for a CPUE of 19.6 per net with a recapture rate of 7.6%. These data were consistent with prior fall burbot trap net sampling efforts in Twin Lakes (Oswald 2004a, Hochhalter and Oswald 2007) and should provide more information as tagged fish are returned to future samples over time. Additional analysis will be presented and discussed in a subsequent FWP Completion Report.

In 2006, efforts were initiated by the U. S. Fish and Wildlife Service (USFWS) to better understand the genetic composition of lacustrine Arctic grayling populations in lakes within the Big Hole River drainage. Efforts were concentrated on populations suspected to be of native origin and resulted in genetic collections of Arctic grayling specimens from Miner, Mussigbrod, and Pintler Lakes (Hochhalter and Oswald 2007). As a result of these efforts, companion research on the composition of the native fish communities of the lakes, including the burbot populations, began in 2006 and was continued into 2007. The three lakes were sampled with sinking monofilament gill nets and trap nets in the early summer of 2006 and Miner and Mussigbrod Lakes were sampled with trap nets in late summer, 2007. Because all three of the lakes had been sampled at least once in the past, a comparative view of net CPUE over time for burbot is presented in Figure 11. The data suggest that the native burbot populations for all three lakes have either remained relatively static or expanded somewhat over the past 4 decades. Similarly, the native Arctic grayling and longnose sucker (Figures 12 and 20) have remained relatively static or increased while nonnative brook trout have declined or remained relatively static over the same period. An apparent slight declining trend in both burbot and longnose sucker CPUE in Miner Lake might be associated with a relatively large size distribution of burbot in excess of 30 inches in length or could merely be an artifact of sample variability. The 2007 samples from Miner and Mussigbrod Lakes were collected in late summer and were limited to trap nets so were not directly comparable to the 2006 and prior sample efforts. The 2007 effort yielded CPUE's of 12.8 burbot per net in Miner Lake and 4.3 burbot per net in Mussigbrod Lake. The Miner Lake catch represented a dramatic increase in CPUE over prior efforts and yielded burbot ranging between 11.7 and 32.0 inches in length with a very strong contribution of adult fish in excess of 30 inches in length. Burbot collected in the 2007 sample from Mussigbrod Lake ranged between 10.6 and 22.0 inches in length. Burbot data from these efforts will be combined with age data from collected otoliths and presented in a subsequent FWP Completion Report.

Adfluvial Arctic Grayling The objectives were met and the work was completed as proposed. The 2006 and 2007 adfluvial Arctic grayling spawning migration was sampled in the Corral Study Section of Red Rock Creek. Relatively strong runoff flows coupled with a favorable temperature regime resulted in a relatively strong and coordinated spawning events in 2005 and

2006, however, 2007 flows declined precipitously and were far below average for the months of May and June (Figures 13 and 14). May flow regimes are critical to the initiation of spawning triggers and to facilitate grayling migration to critical spawning habitats while ample June flows are critical to the survival of the juvenile fish. While May flows in 2005 and 2006 were relatively strong in peak and duration, both years were marked by an earlier than normal peak and declining flows before the end of the month. June flows in 2005 maintained in a near normal pattern while the 2006 runoff declined early and maintained at discharges well below average. Both May and June flow regimes in 2007 were far below average. Comparative CPUE's for Arctic grayling spawning migrations are presented in Figure 15 for the 1985 – 2007 period. The recent trend, including the 2006 and 2007 samples, has been toward a marked decline in the adult Red Rock spawning population. This trend is supported by an obvious downward shift in the length frequency distribution of the spawning population since the late 1980's and a markedly higher participation of juvenile fish in the more recent spawning migrations (Figures 16 and 17). Somewhat more surprising has been an obvious decline in the mean Condition Factor Factor (K) of the spawning Red Rock grayling in the 2005 – 2007 samples (Figure 18). This decline in Condition has been most markedly manifest in the female segment of the population and likely has resulted in a significant decline in mean fecundity. The Red Rock Creek grayling spawning should continue to be monitored in order to better determine if apparent declines in the population are a result of drought conditions and resultant low flow regimes that have dominated southwest Montana since the mid-1980's or if they are symptomatic of a general population decline associated with other variables.

An interest in the genetic status of the adfluvial Arctic grayling populations of upper Big Hole River drainage lakes that continue to support native fish populations lead to the formation of a native species research strategy for Miner, Mussigbrod, and Pintler Lakes, commencing in 2006 (Hochhalter and Oswald 2007). All three lakes are located in the foothills of the Bitterroot Range on the west slope of the upper Big Hole valley and continue to support native assemblages including Arctic grayling, burbot, longnose sucker, longnose dace, and mottled sculpin. All three lakes also support populations of white sucker although their density appears to be markedly subordinate to those exhibited by the longnose sucker. All three lakes are also located on relatively large Big Hole tributaries, although downstream reaches can be severely dewatered by summer irrigation withdrawal. Mountain Lakes of the Bitterroot Range of the upper Big Hole are generally quite limited in productivity due to very limited concentrations of dissolved chemical constituents and relatively short summer growing season (Wells 1981, Oswald 1983). Arctic grayling CPUE for the 2006 June net samples are presented in Figure 19. The highest observed densities were captured in Mussigbrod Lake with Pintler Lake yielding the lowest. All three lakes exhibited relatively strong Arctic grayling populations compared with the native burbot and, especially, when compared with the nonnative brook trout. Long term trends (Figure 20) were positive for Arctic grayling and negative or static for brook trout when compared with limited net samples over the past four decades. Length frequency distributions for the three lakes (Figure 21) were indicative of greater length at age and larger ultimate size in the low density Pintler Lake population but intermediate values for the highest density Mussigbrod population. Modal length exhibited within the Mussigbrod sample was a full inch longer than that of the Miner Lake sample. The Mussigbrod length distribution was unimodal, typical of a high density population, while the Miner and Pintler Lake samples exhibited a range of separate modes. Age data from scale analysis of the 1990 Miner lake sample indicate that the 8 – 9 inch modes are representative of Age II, the 10 inch modes representative of Age III, and the 11 – 12 inch modes representative of Age IV and older fish. Mean Condition Factor (K) varied only slightly among the three lakes, however, the order was the same as that exhibited by length at age and ultimate length (Figure 22). Mean Condition, ordered by inch group for the three lakes (Figure 23), again demonstrated the same order with the highest K values at length in the Pintler sample and lowest in the Miner Lake sample although K values for 11.0 inch and larger fish were virtually identical between Miner and Mussigbrod Lakes and are probably reflective of length of reproductive maturity.

The Turner Red Rock River Ranch Reservoir was abandoned as a brood pond for the Red Rock adfluvial grayling stock with the dissolution of the MOA between FWP and Turner Ranch Resources in 2007. The pond was abandoned as a result of confirmation of repeated poor survival of grayling plants and the domination of the pond's standing crop by large numbers of white sucker and lower numbers of very large brown trout (*Salmo trutta*) that had inadvertently invaded the pond from the Red Rock River (Oswald et al 2006). While the pond will be treated to remove brown trout and white suckers, no assurance could be made that continued diversion of inflow water from the Red Rock River would not result in continued invasion by brown trout and suckers. A large egg take in 2007 at the Rogers Lake brood provided 170,000 swim up fry for the start of the reintroduction effort in Elk Lake, however, the inadvertent clogging of screens at the FWP Somers Hatchery resulted in the loss of the 2007 plant. The effort to reintroduce Arctic grayling into the native species mix of Elk Lake will be continued in 2008.

Fluvial Arctic Grayling Reintroductions The objectives were met and the work was completed as proposed. While Arctic grayling reintroductions via the stocking of overwintered yearling fish into the lower Beaverhead River have been temporarily suspended due to persistent drought conditions, spring fish population monitoring has continued in one or two study sections. This sampling has been focused on the response of the nonnative brown trout population and the native mountain whitefish population to low flows and high summer water temperatures and should provide information useful for future Arctic grayling restoration efforts. The 2006 sampling in the Anderson Study Section yielded a single adult male grayling 15.5 inches in total length and 1.13 pounds. The fish was presumed to be wild progeny from the first plant of yearling grayling. While representing a very limited data point, the fish was suggestive that Arctic grayling can successfully reproduce and survive to maturity in the lower Beaverhead River. Companion to future introduction efforts, three valley floor spring sloughs were investigated for habitat improvement and future use as sites for Remote Site Incubators (RSI's) for fertilized Arctic grayling eggs. The use of RSI's has been proven effective as an alternative to stocking for Arctic grayling introduction efforts in the upper Ruby River. In 2007, Spring and California Creeks were investigated and recommended for habitat improvement projects. In addition, major habitat improvement has already been completed on the Danziger Slough. In 2006, experimental cages of swim up fry rainbow trout were incubated in two locations and used to test for the presence and severity of potential whirling disease infection. Test results from both locations were negative. In 2007, two thermal loggers were placed in Danziger Slough and currently remain in place to gain an understanding of the annual thermal regime of the creek. Emphasis will be placed on summer temperatures as a potential thermal refuge and spring temperature regimes for spawning and rearing.

Limited monitoring of Arctic grayling introduction efforts in the upper Ruby River has been conducted via fall population monitoring in the Three Forks Study Section. The study section is located at the confluence of the three major headwater forks and supports native populations of mountain whitefish, longnose and white sucker, and mottled sculpin. The section also supports a hybrid swarm of native westslope cutthroat trout and introduced rainbow trout as well as rare and infrequent nonnative brown trout. Because the grayling introduction effort began in 1998 as flow regimes declined from a period of abundance into a persistent drought mode, summer base flow minima are presented relative to the Wetted Perimeter Minimum Instream Flow in Figure 24. Monitoring of flow regimes and their affect on habitat is also relevant because the annual introduction of a large biomass of hatchery grayling represented a potential to affect populations of wild fish already occupying upper Ruby reaches. Estimated fall density and standing crop of introduced Arctic grayling are presented in Figure 25 to include the 2007 sample. Peaks in 1998 and 2003 followed by steep linear declines are reflective of the intensity of hatchery plants into the system. Yearling plants declined to only about 1,200 fish for the entire upper Ruby in 2001 and were eliminated entirely in 2002 before resuming again in 2003. The last limited yearling grayling plant into the upper Ruby River occurred in 2005, while the first limited use of RSI's was initiated in 2003. While Arctic grayling density has declined markedly following reduction or elimination of hatchery plants, the fish have persisted and exhibited evidence of recruitment. Length frequency analysis of the 2004 – 2007 samples (Figure 26) clearly demonstrate the presence of juvenile recruits beginning in the 2004 sample and persisting through 2007 at modes below 9.0 inches. Conversely, wild recruitment was documented via length frequency analysis in 2000 (Figure 27) following the initial series of yearling plants but failed to persist in the absence of stocking in a manner similar to that observed over the 2005 –2007 period. This apparent lapse in recruitment could have been a product of extremely low flow regimes experienced in the 2000 and 2001 water years, however. While there is no definitive way to differentiate wild progeny from those generated from RSI's, the production of survivable recruits is encouraging for reintroduction efforts. The Three Forks Study Section was initiated in 1987 in order to monitor potential affects of habitat change on the wild populations of westslope cutthroat and rainbow trout and their hybrids. The data strongly suggest that trout densities and standing crops (Figure 28) respond most directly to habitat availability as related to flow regime and have not been diminished as a result of grayling introduction. This is further suggested by observing similar patterns in trout Condition Factor (Figure 29) which also appeared to follow trends in flow regime rather than maxima or minima in the standing crop of Arctic grayling in the study section.

Potential Westslope Cutthroat Trout Reintroduction Streams The objectives were met and the work was completed as proposed. Analysis of five streams as potential reintroduction sites for westslope cutthroat trout was concluded in 2007. Multiple electrofishing and herpetology surveys and macroinvertebrate collections were concluded on all reaches to determine the present biota while flow, temperature, and descriptive habitat parameters were used to describe the physical environment (Hochhalter and Oswald 2007). As a result of these endeavors, Tex (Big Sheep Creek drainage) and Curry (Red Rock River drainage) Creeks have been recommended for proceeding with initial Environmental Analysis to propose the introduction of westslope cutthroat trout from acceptable brood sources. Alkalai Creek (Blacktail Deer Creek drainage) has been recommended for direct transfer of juvenile westslope cutthroat trout from headwater reaches into downstream reaches below a decadent beaver colony and below a long high gradient slide reach, both of which are believed to serve as barriers to fish migration. Shenon Creek (Horse Prairie Creek drainage) has been recommended for Environmental Analysis to propose barrier installation, removal of nonnative brook trout, and reintroduction of westslope cutthroat trout from an appropriate brood source. Harrison Canyon Creek (Grasshopper Creek drainage) was eliminated from consideration due to limited habitat availability and diversity and extremely low summer thermal regimes. Additional detailed future consideration should be given Divide Creek in the Sage Creek basin of the Red Rock River drainage and Maurer Canyon Creek in the Red Rock River drainage, both of which were subjected to initial stages of investigation in 2007. Both streams provide relatively ample habitat availability and currently support relatively robust populations of hybridized and nonnative cutthroat trout. Both streams should be investigated further as potential sites for removal of nonnative cutthroat populations, barrier installation, and reintroduction with native westslope cutthroat trout stocks.

Potential Westslope Cutthroat Trout Brood Source Streams The objectives were met and the work was completed as proposed. Stone Creek, a Ruby Mountain tributary to the Beaverhead River, has been closely examined as a potential wild brood source due to ease of access and high densities and standing crops of westslope cutthroat trout recorded under optimum flow regimes (Oswald 1999 and 2000). In 2005, 60 fish were collected from 5 reaches within the mainstem and both major forks of the stream via electrofishing for more detailed genetic analysis and disease testing. The expanded genetic testing utilized whole fish allozyme methods on 30 fish representative of a subsample of 6 fish from each of the 5 sample reaches. This expanded genetic analysis confirmed the continued persistence of a pure population of native westslope cutthroat trout in Stone Creek exhibiting a regional polymorphism or shared variant with the Yellowstone strain. The 2005 disease testing component of the Stone Creek brood confirmation utilized all 60 fish in the sample and subjected the specimens to a broad spectrum of standard fish health tests. The 2005 fish health testing revealed a positive indication of the potential presence of Bacterial Kidney Disease via the confirmed presence of *Renibacterium salmoninarum.* The presence of the bacterium was believed associated with stress resulting from low flow conditions and drought influenced habitat reduction in the drainage (Oswald et al 2005). The genetic samples continued to indicate that Stone Creek represents a strong potential westslope cutthroat trout brood source while the positive test for Bacterial Kidney Disease precluded the use of the stream as a source of gametes or fry in 2005. Population estimates in three study sections in the mainstem and Left Fork of Stone Creek in June 2007 revealed a continuation of populations depressed by low flow regimes and likely under continued resultant physical stress. Thus, potential use of the population as a brood source donor will be deferred and continued monitoring recommended. Population data will be analyzed and presented in a subsequent Completion Report.

Nonnative Brook Trout Removal Project The objectives were met and the work was completed as proposed. An endeavor to remove competing introduced brook trout from a population of native westslope cutthroat trout was initiated in Dyce Creek following the installation of fish barrier below the confluence of the West and East Forks in 2004 (Hutchinson and Shepard 2004, Oswald et al 2006). In conjunction with westslope cutthroat trout population sampling, genetic samples were collected to confirm the purity of the population as a potential brood source. Analysis of a pooled 25 fish genetic sample revealed the presence of hybridization with rainbow trout in the population although it was not known if the hybridized fish had originated from East or West Forks or the mainstem of Dyce Creek. In 2005, a genetic sample from 25 fish from old mine tailings ponds in the West Fork was collected via angling methods. This sample confirmed that introgression with rainbow trout was present in fish from the ponds. Efforts to remove hybridized cutthroat and nonnative brook trout from the ponds were initiated in 2006 and were continued in 2007. These efforts included isolation and trapping of the pond inlets by BLM personnel and use of gill nets in the ponds by FWP. In 2007, multiple sets of 2 trammel nets were deployed over a two week period until a series of sets failed to result in the capture of more fish. This effort will be continued into the future until the ponds can be permanently isolated or reclaimed.

Westslope Cutthroat Trout Performance Evaluation in Stocked Mountain Lakes The objectives were met and the work was completed as proposed. The stocking maintenance of sport fisheries in mountain lakes has largely involved the use of McBride Yellowstone cutthroat trout in waters within the native range of westslope cutthroat trout within the upper Missouri River drainage. The McBride Yellowstone strain was preferred due to its adaptation to and resultant performance in alpine lake environments. Recent concern for the potential to increase hybridization among native westslope cutthroat trout populations and concern over potential adverse competitive scenarios with sympatric native species has led to the examination of traditional stocking programs in many mountain lakes. As a result of this scrutiny, a need has risen to evaluate the performance of the westslope cutthroat trout as a sport fish as well as a safer native species alternative for stocking management. In 2002, a management decision to convert the stocking of Elk Lake to westslope cutthroat trout was implemented. This was followed by a 2004 decision to convert the stocking of all mountain lakes in the Beaverhead and Big Hole River drainages to westslope cutthroat trout plants beginning in 2006. In 2004, another lake in the Tendoy Mountain Range was added to the stocking management program as a sport fishery based on regular plants of westslope cutthroat trout. These actions triggered the implementation of a new program to evaluate the performance of the native westslope strain in these stocked sport fisheries. Oswald et al (2005) reported on the collection of comparative data for Yellowstone and westslope cutthroat trout stocked into Elk Lake and baseline data collected on McBride Yellowstone cutthroat trout that had been stocked into Morrison Lake. The evaluation also included the initial stocking of Poison Lake in the Tendoy Mountains with westslope cutthroat trout. Continued comparison of the performance of westslope and Yellowstone cutthroat trout in Elk Lake strongly suggest initial advantages in growth, advantage in survivability to Age IV, and substantial advantage in Condition Factor for the native westslope cutthroat trout (Oswald 2004, Hochhalter and Oswald 2007).

The evaluation of the performance of westslope and McBride Yellowstone cutthroat trout plants was continued in Elk Lake in 2007. The standard comparative method of using three floating experimental gill nets to collect salmonids was employed in May shortly after ice out was shifted to the experimental use of trap nets in 2006 and 2007. While initial results from trap nets indicated that they were an acceptable nonlethal surrogate method for floating gill net trend data collection, the 2007 sample did not appear to be consistent with prior samples. The 2007 trap net effort yielded a sample of 65 westslope and 7 Yellowstone cutthroat trout. All of the Yellowstone cutthroat were Age VII or older and ranged between 20.0 and 22.5 inches in length while the westslope cutthroat were composed of Age II through VI cohorts and ranged from 8.0 to 19.3 inches in length. As has been the case through all of the comparative samples, mean K for the westslope cutthroat trout was substantially higher than that of the Yellowstone strain although the data is not directly comparable due to the older age and larger length of the surviving Yellowstone strain fish. These data will also be analyzed in more detail and discussed in a subsequent FWP Completion Report.

Mountain Whitefish Populations The objectives were met and the work was completed as proposed. Recent proposed fluvial Arctic grayling reintroduction efforts into selected habitats have stimulated an interest in the status of other sympatric native species relative to habitat quality and densities of introduced nonnative species. In the lower Beaverhead River, this sampling has been focused on the response of the nonnative brown trout population and the native mountain whitefish population to low flows and high summer water temperatures and should provide information useful for future Arctic grayling restoration efforts**.** The lower Beaverhead reach is best described as the reach between Dillon, Montana and the mouth of the Ruby River near Twin Bridges, Montana where an inverted hydrograph results in a range of habitat deficiencies that combine to limit numbers of competing fish (Oswald 2003). Within this reach, attempts have been made to describe the fall populations of white and longnose sucker in concert with densities of introduced yearling fluvial Arctic grayling. Spring efforts to quantify and describe brown trout populations have recently been expanded to include native mountain whitefish populations. This effort was continued for the mountain whitefish population in spring 2007 in the Anderson Study Section with the collection of data relevant to population densities, standing crop, length frequency distribution and condition factor (K) as well as other summary statistics. Temperature from FWP thermal loggers and base summer flow data (Figure 30) were also analyzed from the USGS Gage Station located near Beaverhead Rock and included in the analysis. Recent trends in very low summer flow regimes have persisted continuously through the 2000 – 2006 water years. These flows have been well below the WETP Minimum Flow for the reach and have been accompanied by extremely high water temperatures during the July – August period. Recent trends in mountain whitefish density and standing crop (Figure 31) depict a strong linear decline with a very slight increase in the spring 2007 sample. Comparative length frequency analysis from 2002, 2006, and 2007 (Figures 32, 33, and 34) indicate an attenuation of the whitefish population into the older age classes in the absence of significant recruitment as the population declined from 2000 through 2006. The slight improvement in mountain whitefish density in 2007 was based solely on a relatively modest recruitment of Age II fish into the population. The data indicate that native mountain whitefish populations have been reduced in a manner more severe than brown trout populations under low summer flow and high summer temperature regimes. These data will continue to be collected and analyzed for more detailed discussion in subsequent FWP Completion Reports.

DISCUSSION and RECOMMENDATIONS

Oswald (2002) described the native post - glacial relict status of the lake trout populations of Elk and Twin Lakes. Examination of the literature (Vincent 1963), the morphologic and meristic qualities of the fish (Khan and Quadri 1971), and the genetic status (Wilson and Hebert 1998) lend credence to this assumption. Wilson and Hebert (1998) concluded that the fish were of a distinct haplotype and represent a glacial relict native population. This C3 haplotype originated in northernmost Alaska and Canada and is currently distributed in western Montana and southern Alberta. More recent genetic examination of 14 fish from Elk Lake and 14 fish from Twin Lakes led to agreement with Wilson and Hebert's findings and the conclusion that the lake trout populations of both lakes represent native populations of the same glacial origin (M. B. Curtis, USGS, Personal Communication 2000). This expanded examination also eliminated the possibility that the native Twin Lakes and, particularly, Elk Lake stock due to its proximity, had been contaminated by introduced lake trout of Great Lakes origin that were stocked in Yellowstone National Park in 1890. Examinations of mitochondrial DNA by Curtis also suggest that low variation is associated with a genetic "bottleneck" caused and maintained by low populations of breeding individuals in both lakes. This is certainly substantiated by lake trout collection densities in Elk and Twin Lakes and also by age and size structure of the sample population. The most recent lake trout samples continue to be reflective of a low density population and might even represent a declining trend. Factors contributing to the loss or decline

of native lake trout are discussed in detail by Evans et al. (1991), Evans and Wilcox (1991), and Evans and Oliver (1995). In addition to over exploitation and habitat loss or degradation, these authors define complex relationships among native and nonnative species that have resulted in detrimental affects on native lake trout populations. Evans and Oliver (1995) describe complex relationships between lake trout and other native species under which the same species can coexist with lake trout in relatively benign sympatry or compete adversely with the lake trout depending on timing and competitive circumstance. Often, the demise of lake trout populations can be attributed directly to the planting of non-native stocks or strains of lake trout (Evans and Wilcox 1991). The lake trout of Elk and Twin Lakes both coexist with native and non-native species in systems that have been altered by the stocking of salmonid species. Complex competitive relationships between lake trout and other species, such as the introduced brook trout or the native burbot in Twin lakes, can vary over time to the detriment or demise of the lake trout population (Evans and Oliver 1995). Due to low population densities indicated by net samples, the species was placed under restrictive catch and release regulations in 2000. More intensive research should be directed at this unique species in the immediate future. Much of this research will be focused on spawning and rearing habitats and involve the use of radio telemetry, acoustics and underwater cameras. Due to low population densities, sampling methods should focus on nonlethal means of capture. Work in Twin Lakes should focus on spawning habitat location and description and other factors limiting recruitment. The highest priority must be directed at surgically implanting radio transmitters into adult lake trout to identify the spawning habitats. This is particularly critical in light of recent proposals to place a dam at the outlet of the lake to store water to augment streamflows in the upper Big Hole River. The proposed operation would result in an annual vertical drafting of the reservoir that could potentially exacerbate limitations on critical spawning habitats. Conversely, identification and description of critical spawning habitat could potentially lead to habitat improvement projects directed at improving access to and the quality of spawning habitat composition. While the lake trout population of Elk Lake appears to be more stable and secure than that of Twin Lakes, continued monitoring should be maintained to help secure their persistence in a dynamic native species based sport fishery.
Burbot biology is largely poorly understood and direct management of the species is often lacking throughout most of North America (McPhail and Paragamian 2000). Oswald and Roberts (1998) and Oswald (2002) also described the burbot populations of Elk and Twin Lakes as a unique native species of glacial origin occupying a habitat niche somewhat similar to the lake trout. Collection densities of burbot far exceed those observed for lake trout, the other deepwater native piscivore in both systems, and appear to trend upward or downward with the strength of recruitment classes. More recently, Oswald et al 2006, Hochhalter and Oswald 2007, and Oswald and Rosenthal 2007 have markedly expanded burbot research to include native populations in Miner, Mussigbrod, and Pintler Lakes in the upper Big Hole River drainage, and the popular sport fishery of Clark Canyon Reservoir on the Beaverhead River. Recent research efforts have focused on nonlethal means of capture such as trap nets, baited hoop nets and baited cod traps and have permitted mark and recapture and tagging efforts to better understand burbot biology. A program to gain more insight into age and growth relationships through the use of otoliths has also been undertaken in all six fisheries under study. There is little known at this time to fully explain apparent differences among or fluctuations within the burbot populations of the 6 lakes at this time. Hochhalter and Oswald (2007) noted an apparent preliminary inverse relationship between white sucker and burbot density in Elk Lake. Taylor and McPhail (2002) concluded that temperature at the time of spawning was a major factor in determining burbot recruitment success but their studies were conducted in lotic environments that would tend to exhibit a wider variation than that typical of a large reservoir or lake. Oswald and Rosenthal

(2007) noted an apparent preliminary relationship between spring changes (end of February to end of June) in reservoir elevations and cohort strength. This relationship suggests that spring reductions in reservoir forebay elevation greater than five feet may limit recruitment by dewatering developing eggs and/or larvae. The shallow depths (~ 4.0 feet) of spawning balls observed during this year's spawning site identification surveys lend credence to this relationship The life history of the burbot may allow for its ability to persist through prolonged periods of drought or other stochastic events (McPhail and Paragamian 2000). High fecundity combined with the long life expectancy of burbot suggests that populations may be able to persist through several years of unfavorable recruitment conditions. Length frequency analyses are indicative of a relatively slow growth rate for the species in the higher elevation lakes under study. Limits on ultimate size of the burbot in Elk, Mussigbrod, and Pintler Lakes probably limit the value of the species in the sport fishery. The burbot populations of Twin and Miner Lakes, and, particularly, Clark Canyon Reservoir however, produce large fish that have attracted significant sport fishery interest. Preliminary age data suggest a relatively rapid growth rate for burbot in Clark Canyon Reservoir, however, harvestable sized fish in Twin and Miner Lakes are generally much older. Thus, the burbot populations of Twin and Miner Lakes could be more easily and rapidly skewed toward a much smaller and less fecund fishery through overharvest of large individuals. A single 26.7 inch male from Miner Lake was aged at 27 years compared with male fish of that length from Clark Canyon Reservoir averaging 8 to 9 years and females averaging 5 to 6 years of age. Katzman and Zale (2000) observed very rapid growth rates in nearby Upper Red Rock Lake that far exceeded those suggested by length frequency distribution in Elk, Twin, Miner, Mussigbrod, or Pintler Lakes. Upper Red Rock Lake, however, is a very shallow body of water that would not be comparable to either Elk Lake or Clark Canyon Reservoir despite its proximity to both. The current burbot research program should be continued and expanded. Complex relationships between burbot and other native species, particularly lake trout, Arctic grayling, and long nose sucker should be clarified to better understand management of the species complex. Complex storage to surface acre and depth relationships in Clark Canyon Reservoir should be better described to facilitate burbot management. Finally, an improved understanding of potential affects of angler harvest of burbot on age and size structure and recruitment in Miner and Twin Lakes, and, particularly, Clark Canyon Reservoir could provide for improved species management via the adoption of appropriate harvest regulations.

The status of the adfluvial Arctic grayling brood pond in the lower Red Rock River drainage has been compromised by the discovery of extremely high densities of white sucker and the presence of large brown trout and was officially abandoned in 2007. It is recommended that the brood be continued at Rogers Lake and that regular infusions of gametes from collections in Red Rock Creek be added regularly to introduce a higher genetic variability into the brood and provide a more recent link to the natal population in the Red Rock River drainage. The 2005 - 2007 adfluvial grayling spawning runs in Red Rock Creek were marked by declining numbers, age structure, length, and condition factor. These declines probably have probably been accompanied by a substantial decline in fecundity and are a matter of concern for the persistence of the population. Research in the areas of limiting factors and habitat quality should be expanded in the immediate future and other sources for the fish developed. Plans to reintroduce the Red Rock grayling back into Elk Lake should proceed rapidly, particularly in light of improving snowpacks and potentially improving flows in Narrows Creek. Investigation into the status of the adfluvial Arctic grayling populations of Miner, Mussigbrod, and Pintler lakes should also continue and be expanded to determine how the populations relate to the overall grayling population of the upper Big Hole River drainage.

Fishless streams or streams bearing no salmonid fish populations represent potential reintroduction habitats to expand the current distribution of westslope cutthroat trout populations. Detailed examination of several of these resulted in recommendation of some of them for reintroduction project development. Immediate plans should be made to develop the required Environmental Assessments to begin the reintroduction of westslope cutthroat trout into Tex and Curry Creeks. The introduction efforts could utilize juvenile fish as well as eyed eggs placed in RSI's. Similarly, an Environmental Assessment to place a permanent barrier, remove nonnative brook trout and reintroduce westslope cutthroat trout should be developed for Shenon Creek. Shenon Creek represents the obvious advantage of a stream that supported westslope cutthroat trout as recently as the early 1980's. An internal movement of native westslope cutthroat trout into currently unoccupied stream reaches should also be prioritized for Alakalai Creek. This effort should proceed as soon as stock densities of juvenile (Age I) fish appear abundant enough for transfer without compromising the extant population. Another alternative approach for consideration might be the use of RSI's with eyed eggs if the natal population density remains too low for depletion of recruits. Finally, two additional streams, Divide and Maurer Canyon Creeks were preliminarily investigated as potential sites for renovation with westslope cutthroat trout. Both streams have high potential and should be investigated thoroughly as habitats where nonnative forms of cutthroat trout have thrived for extended periods of time.

Streams with suitable characteristics should be investigated as potential brood sources for westslope cutthroat trout. These characteristics, in addition to genetic purity, should include accessibility, relatively long reaches of secure habitat and occupation, high population density, relatively large fish with high fecundity, and a lack of significant disease presence. Whole fish allozyme analysis confirmed the genetic purity of the Stone Creek brood, however, positive tests for the potential presence of Bacterial Kidney Disease prevented the collection of gametes from the brood in 2005. Population estimates from discreet sections in 2006 and 2007 continued to describe a population depleted and probably under continued stress from low flow regimes. Population estimates should be continued in order to determine when population density returns to desirable densities for use as a brood source. Additional fish health samples must be collected prior to the use of this population as a source of fertilized gametes or fry for stocking elsewhere.

The management of stocked sport fisheries in mountain lakes has often been associated with the introduction of hybridization into westslope cutthroat trout populations from nonnative strains of cutthroat trout and rainbow trout. The popularity of rainbow trout as a sport fish and the successful performance of the McBride Lake Yellowstone cutthroat trout in alpine lake habitats have often been cited as the driving reasons to continue the proliferation of these plants to the present. The use of westslope cutthroat trout from hatchery sources represents a safer sport alternative in drainages currently supporting pure populations of native cutthroat trout or can represent a method of providing a sport fishery without continuing a source of hybridization in drainages where it has already occurred. Comparative data for Yellowstone and westslope cutthroat trout plants in Elk Lake have already shown certain performance advantages for the westslope strain (Oswald 2004, Hochhalter and Oswald 2007). These included survivability and growth rate through Age IV and Condition at all ages through V. Baseline data gathered on Yellowstone and westslope cutthroat in Morrison and Poison Lakes will provide a basis for future study while the future inclusion of age and growth data from the 2006 alpine lake plant of westslope cutthroat should be added to the comparative study. Lakes with relatively easy access and varying levels of productivity should be prioritized, however, a relatively large data base for

Yellowstone cutthroat trout performance has already been established for a number of less accessible southwest Montana alpine lakes (Wells 1981, Oswald 1983, Brammer et al 2006). Alpine lakes suspected of supporting or having the potential to support native populations of westslope cutthroat trout in lieu of evidence of any continuous documented stocking program should also be investigated (Oswald et al 2006). Recent genetic samples in 2005 and 2006 revealed the presence of hybridization in the Cherry Lake population but also confirmed the presence of a relatively abundant pure westslope cutthroat component in the fishery. Further genetic investigation should continue to be focused on Trapper Lake and adjacent Trapper Creek tributaries in the East Pioneer Mountains.

The mountain whitefish population of the lower Beaverhead River has suffered more dramatically than the nonnative brown trout under recent drought induced low flow and high summer temperature regimes. This population should continue to be studied as an indicator of future opportunity to resume introduction of Arctic grayling into the system. The native whitefish should also represent a strong indicator of habitat improvement in the lower Beaverhead as future projects are endeavored to improve spring runoff and base summer flow regimes. Valley floor tributaries should also continue to be analyzed for potential habitat improvement projects focused at spawning, rearing, and thermal components.

Variances

None

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Expenditure Recap:

	(75%)	(25%)	(100%)
Direct costs	$26,500.00	$ 8,833.33	$35,333.33
Plus indirect costs at est. rate of 22%	$32,330.00	$10,776.67	$43,106.67

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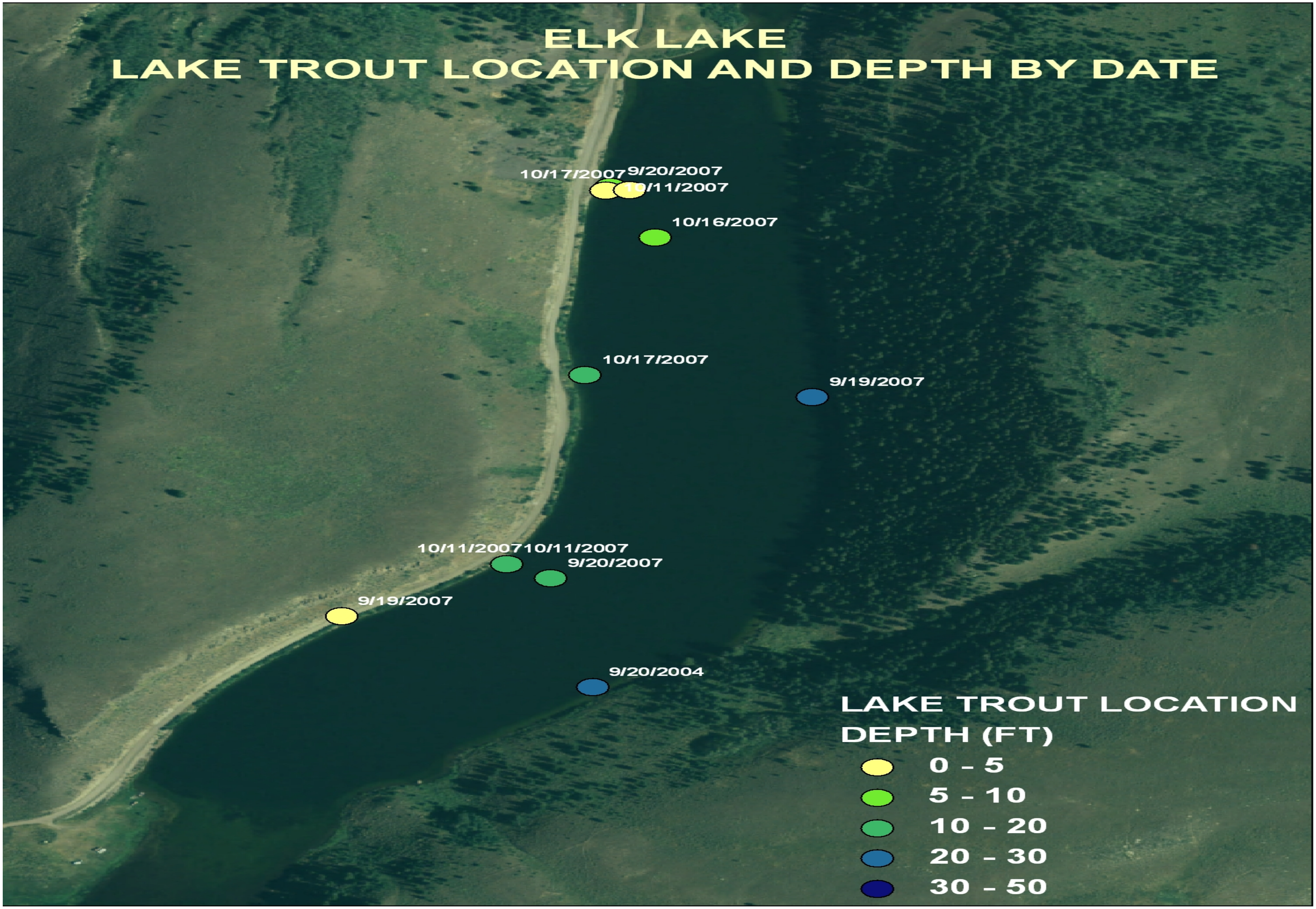
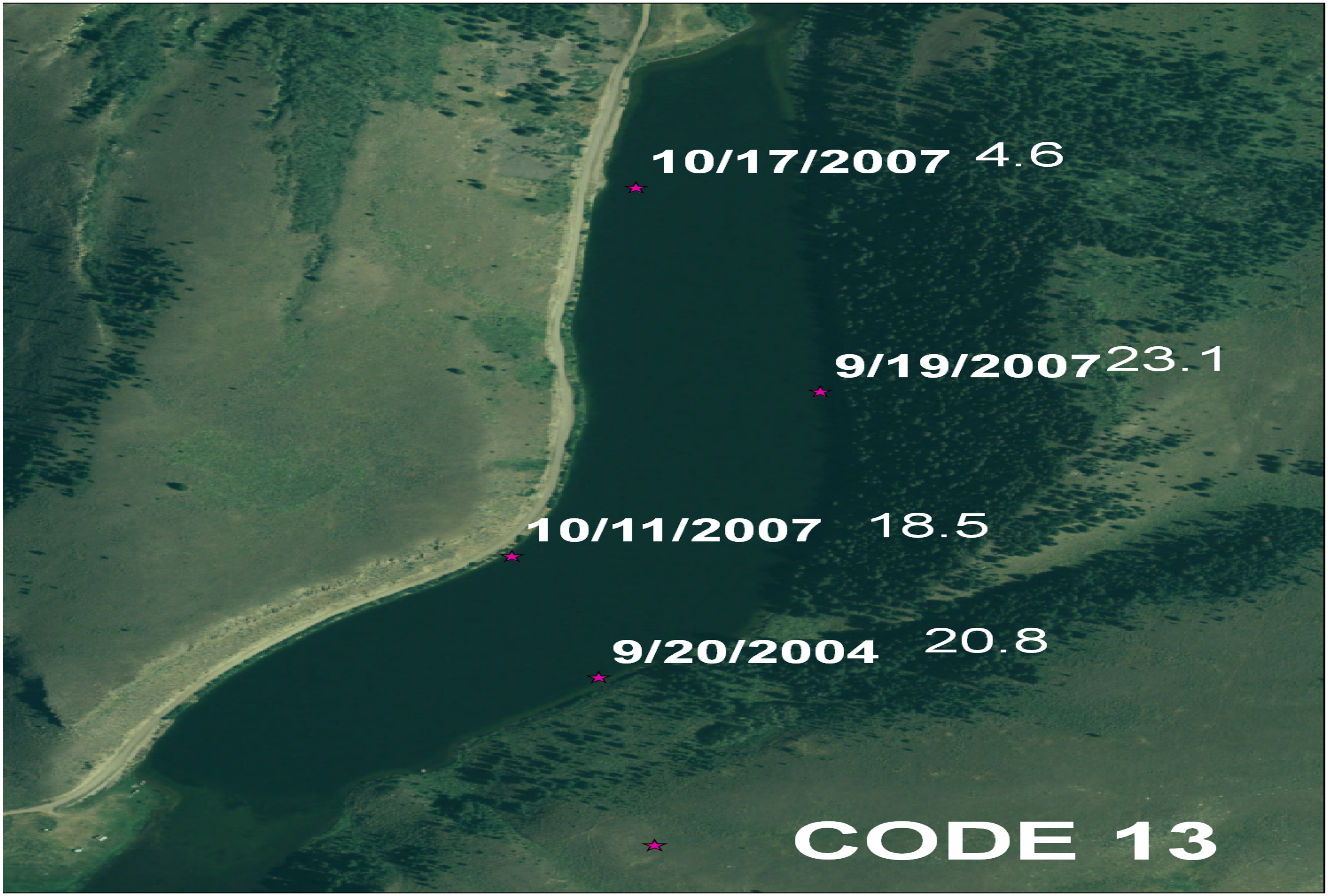
Appendix A

Map Figures

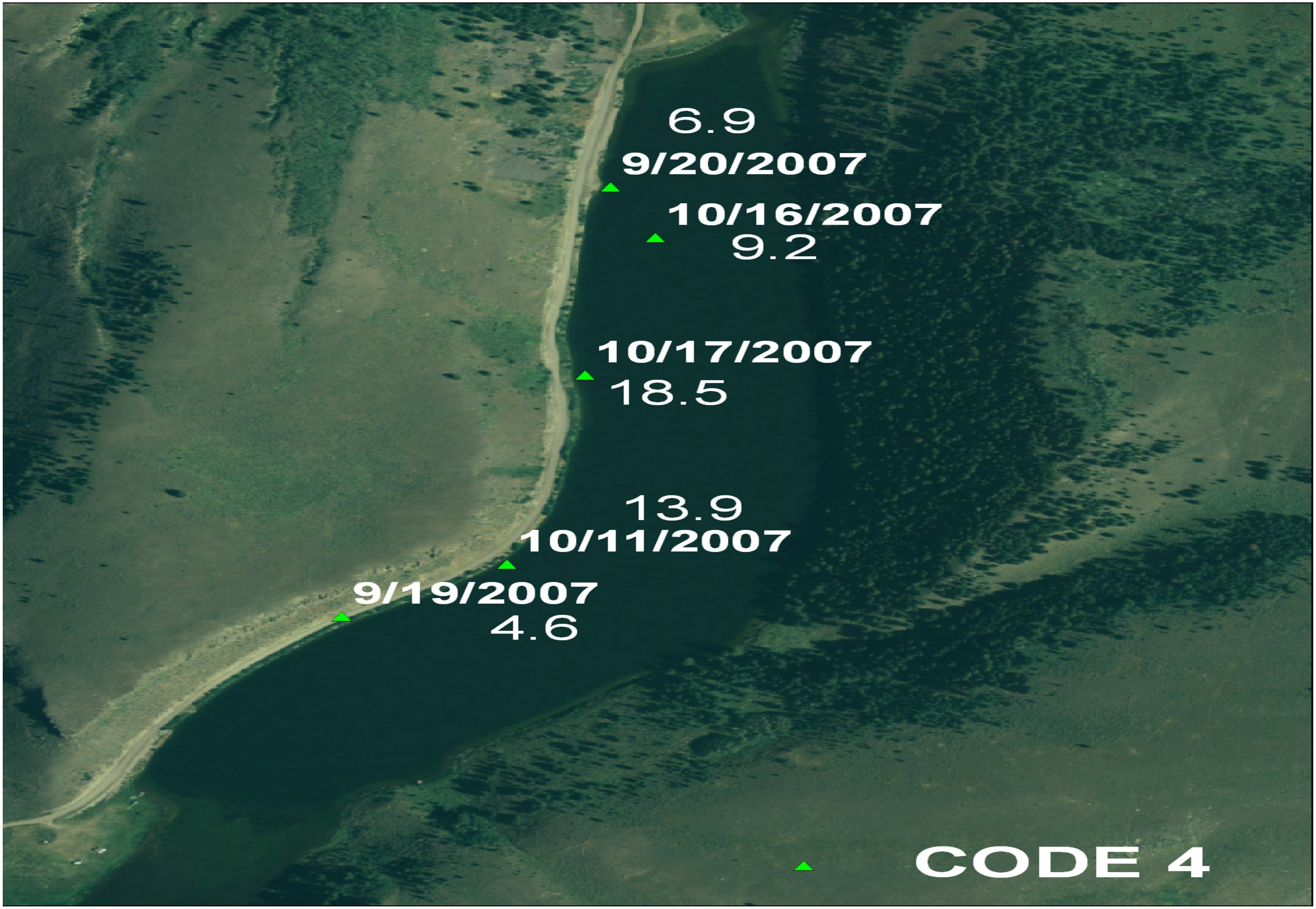
Map Figure 1. Fall lake trout radio locations by depth and date, Elk Lake 2007.



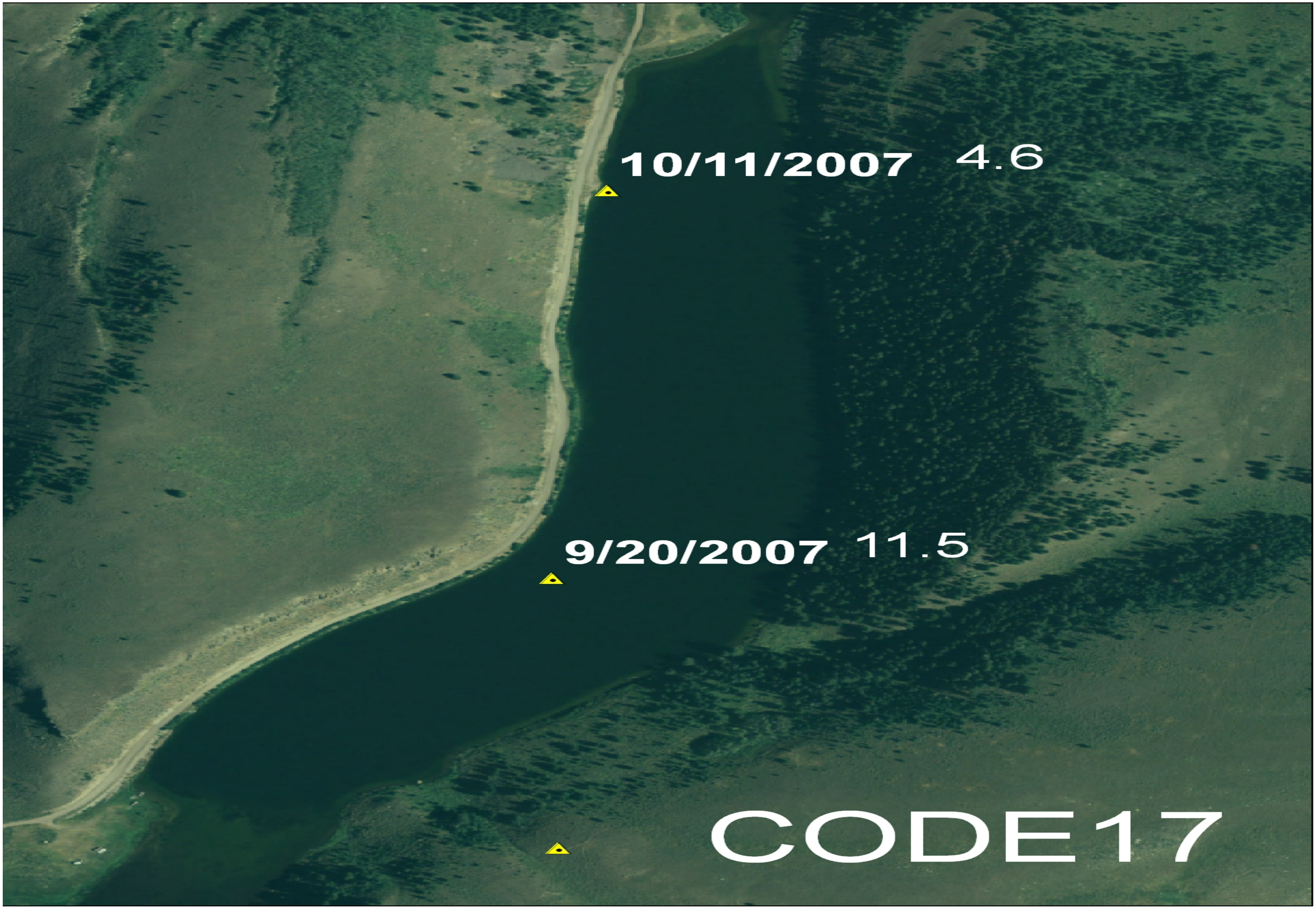
Map Figure 2. Fall lake trout radio relocation and depth, Fish 13, Elk Lake, 2007.



Map Figure 3. Fall lake trout radio relocation and depth, Fish 4, Elk Lake 2007.



Map Figure 4. Fall lake trout radio relocation and depth, Fish 17, Elk Lake 2007.



Appendix B

Graphic Figures

Figure 1. Mean number of lake trout collected per floating and sinking experimental gill net set overnight in Elk Lake 1981 - 2006.

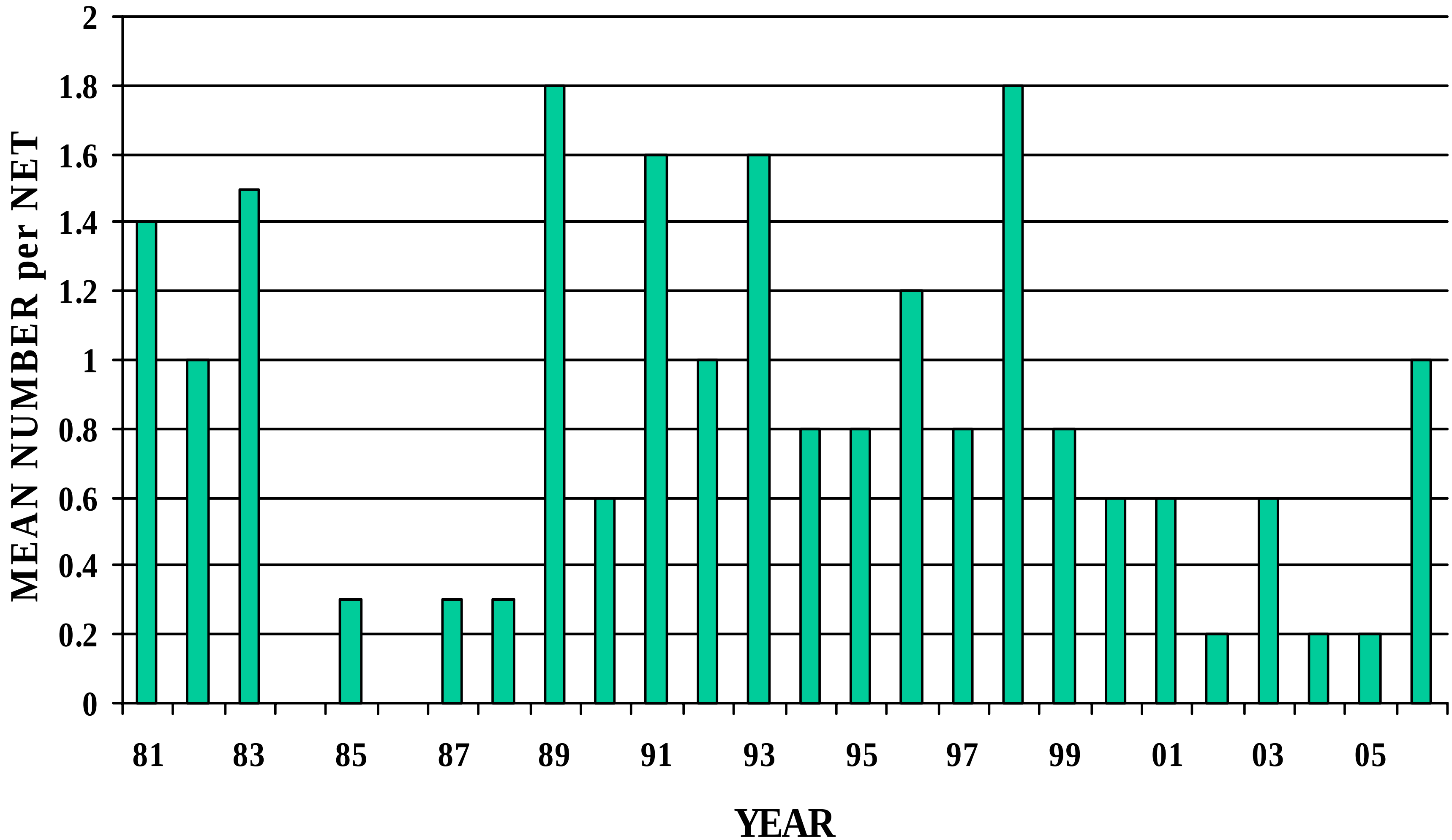


Figure 2. Length range and mean length of lake trout collected in floating and sinking experimental gill nets set overnight in Elk Lake 1991 - 2006.

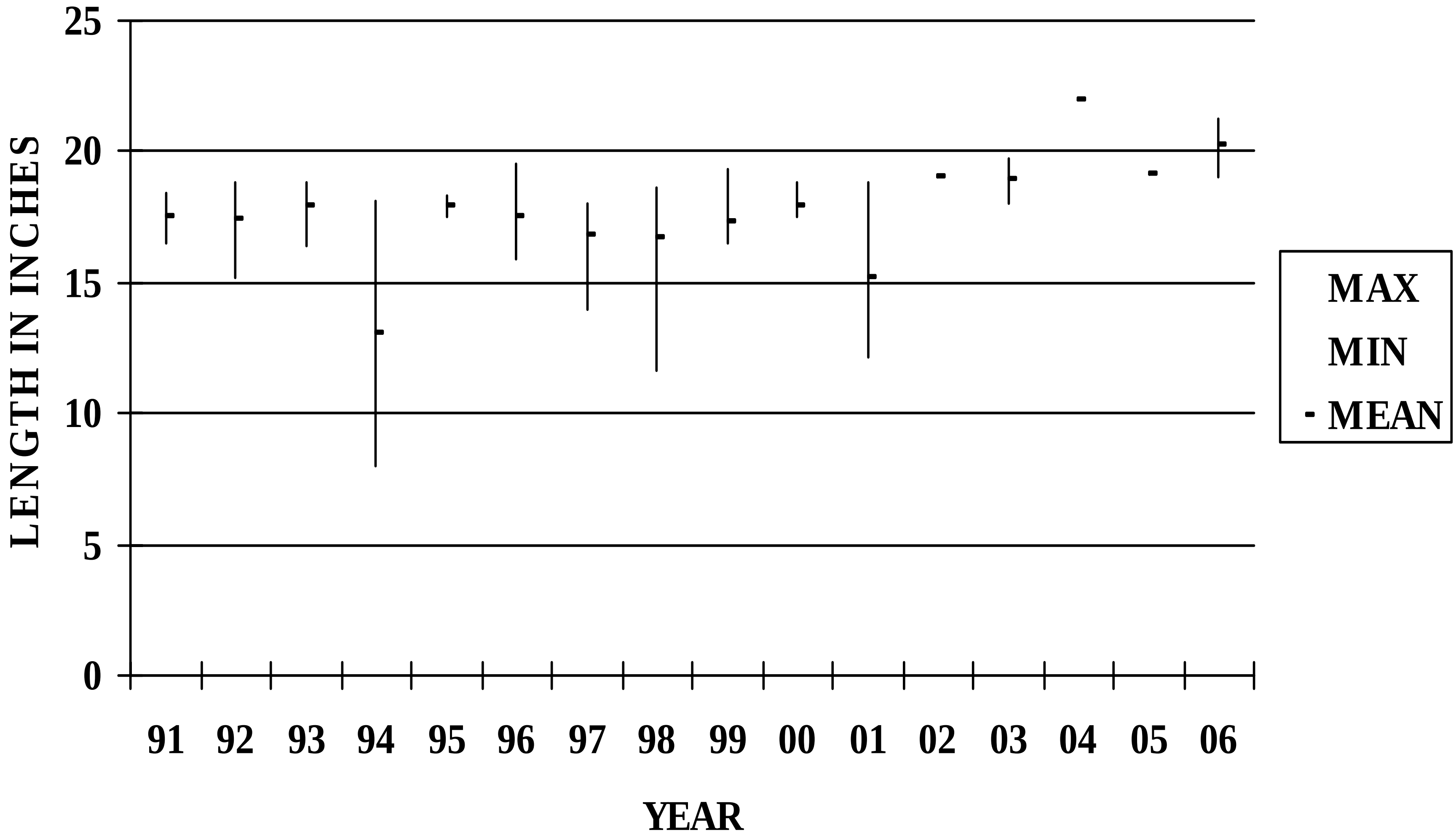


Figure 3. Composite length frequency distribution of lake trout collected in floating and sinking experimental gill nets set in Elk Lake 1993 - 2006. (N=80).

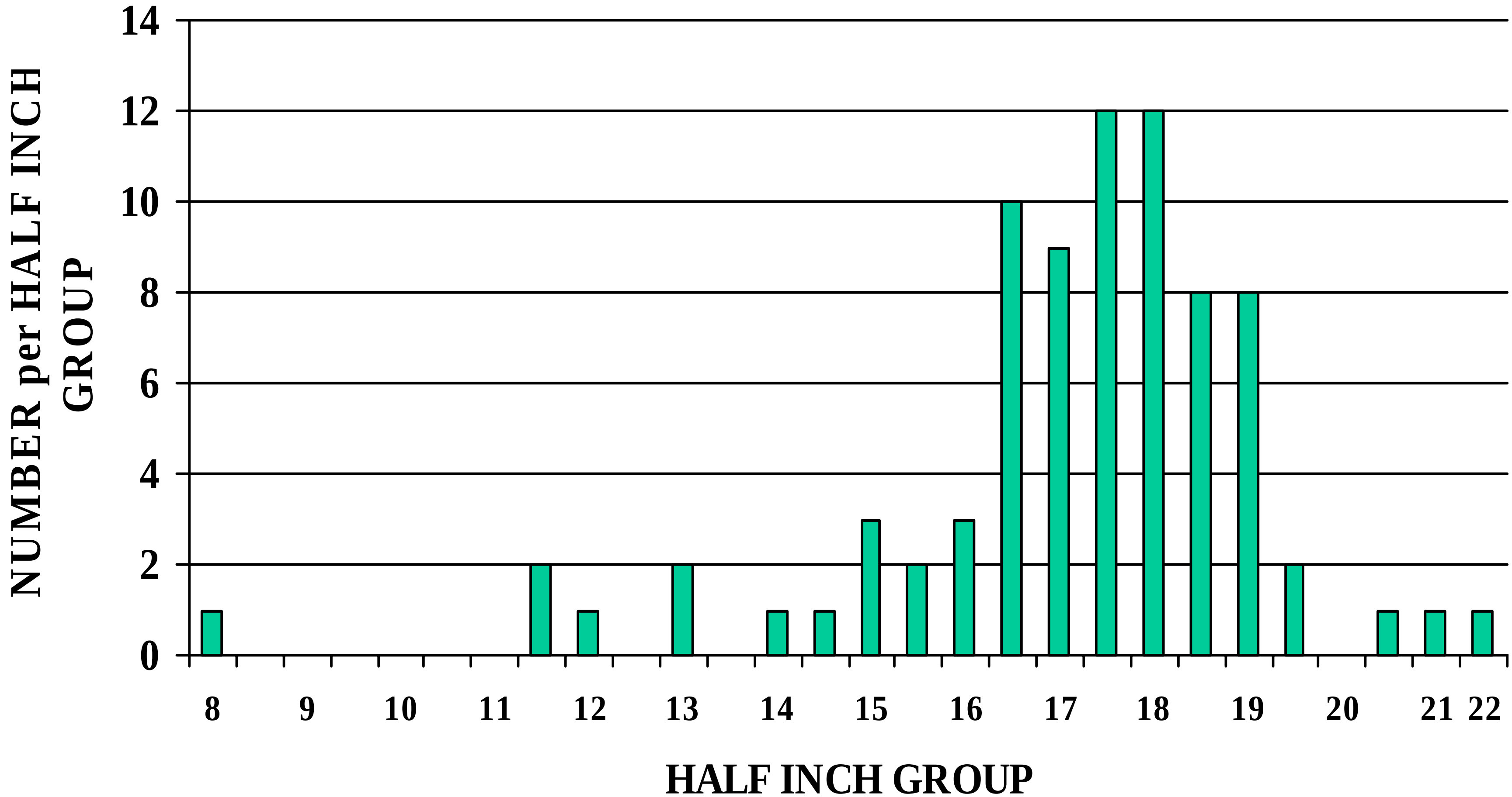


Figure 4. Length frequency distribution of spawning and post-spawn burbot in Clark Canyon Reservoir, Spring 2007 (n=1100).

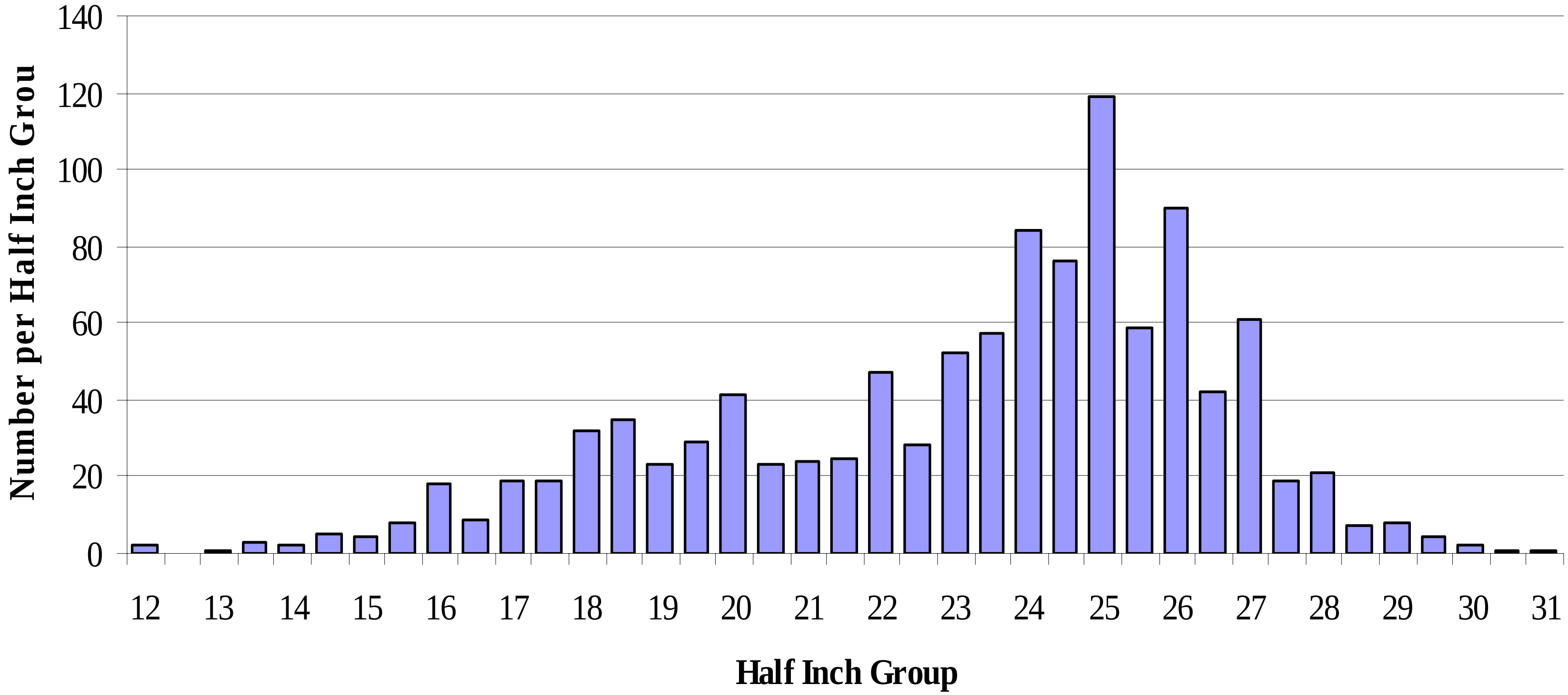


Figure 5. Length frequency distribution of sexed spawning burbot in Clark Canyon Reservoir, Spring 2007 (n=247)

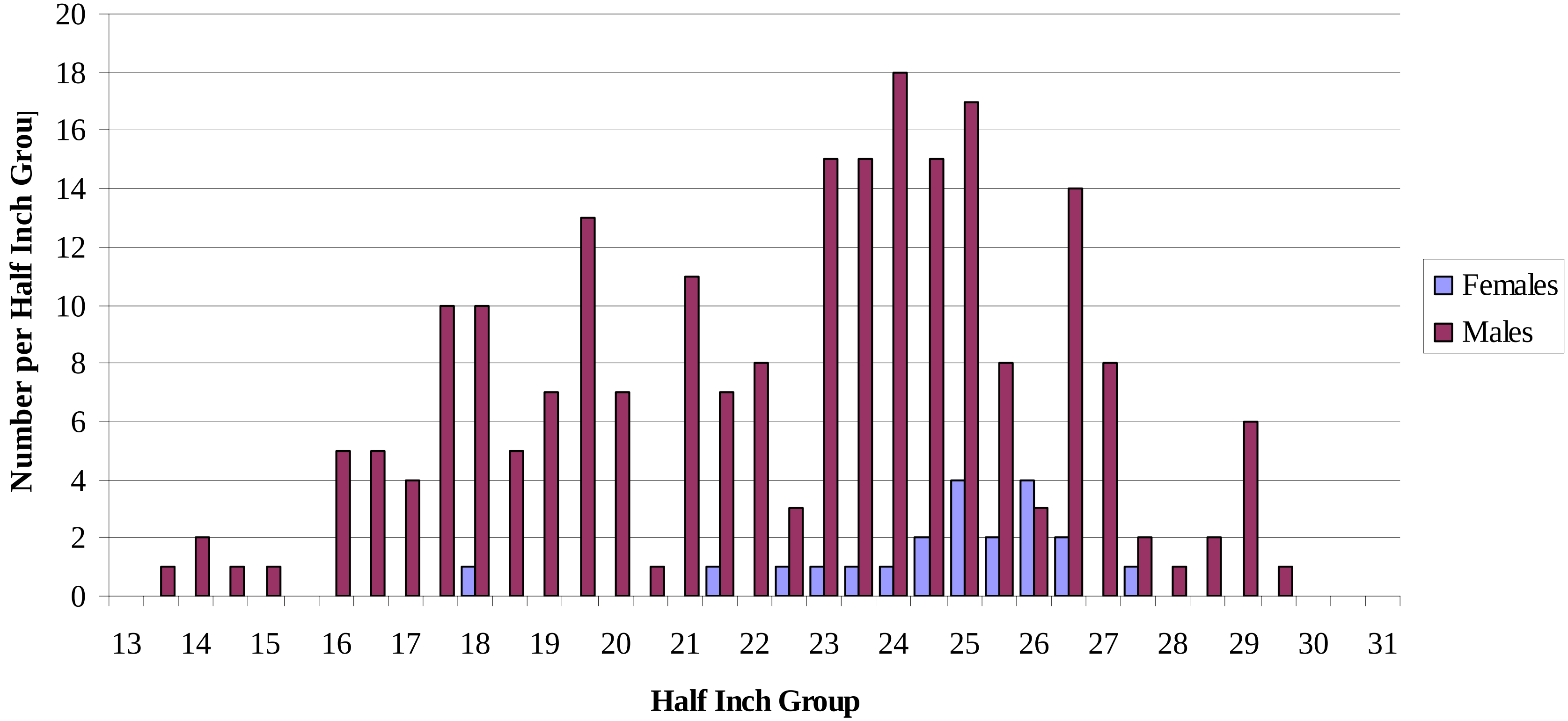


Figure 6. Age frequency distribution of angler caught burbot in Clark Canyon Reservoir, January and February 2007 (n=41).

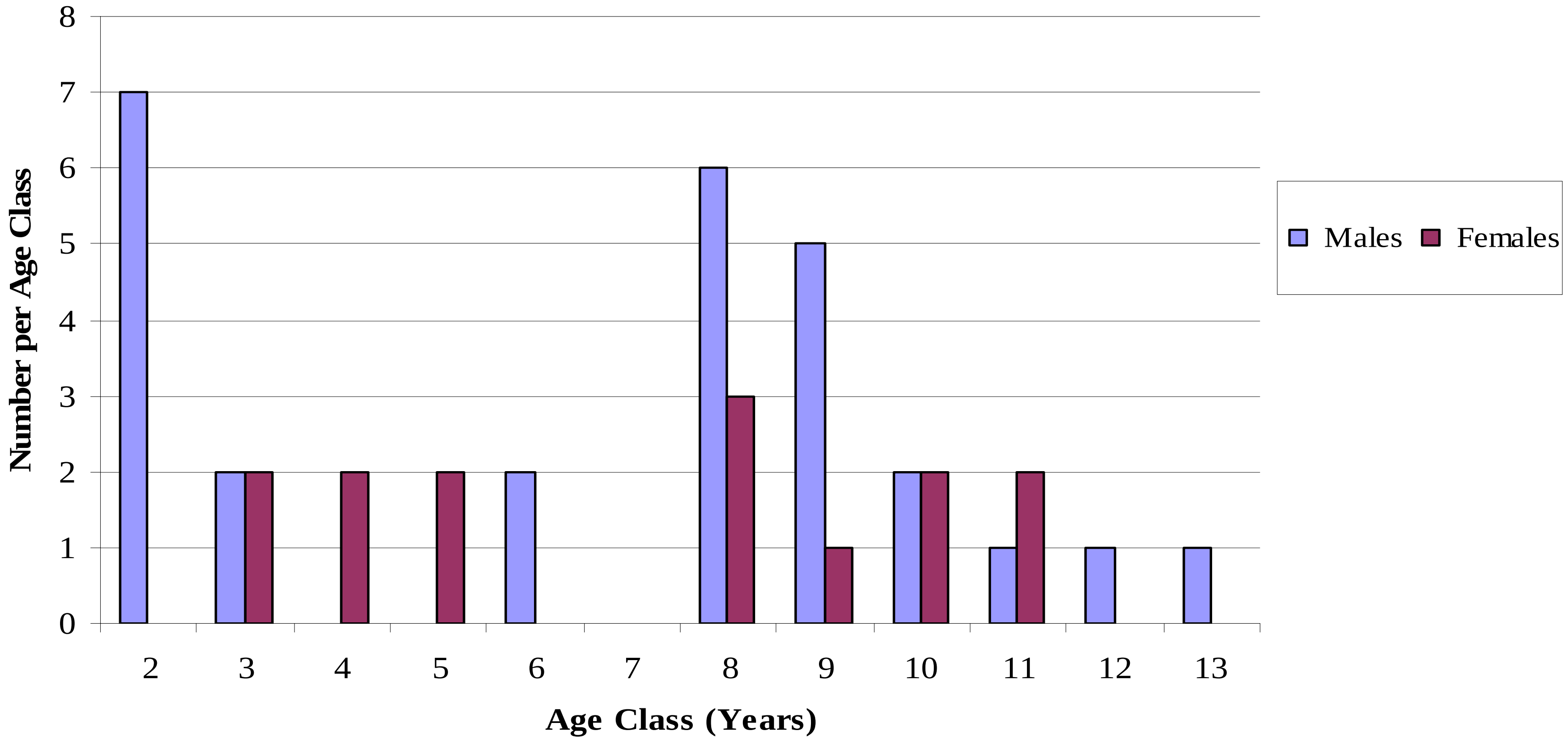


Figure 7. Age - Length of angler caught female burbot in Clark Canyon Reservoir, Jan. and Feb. 2007 (n= 13)

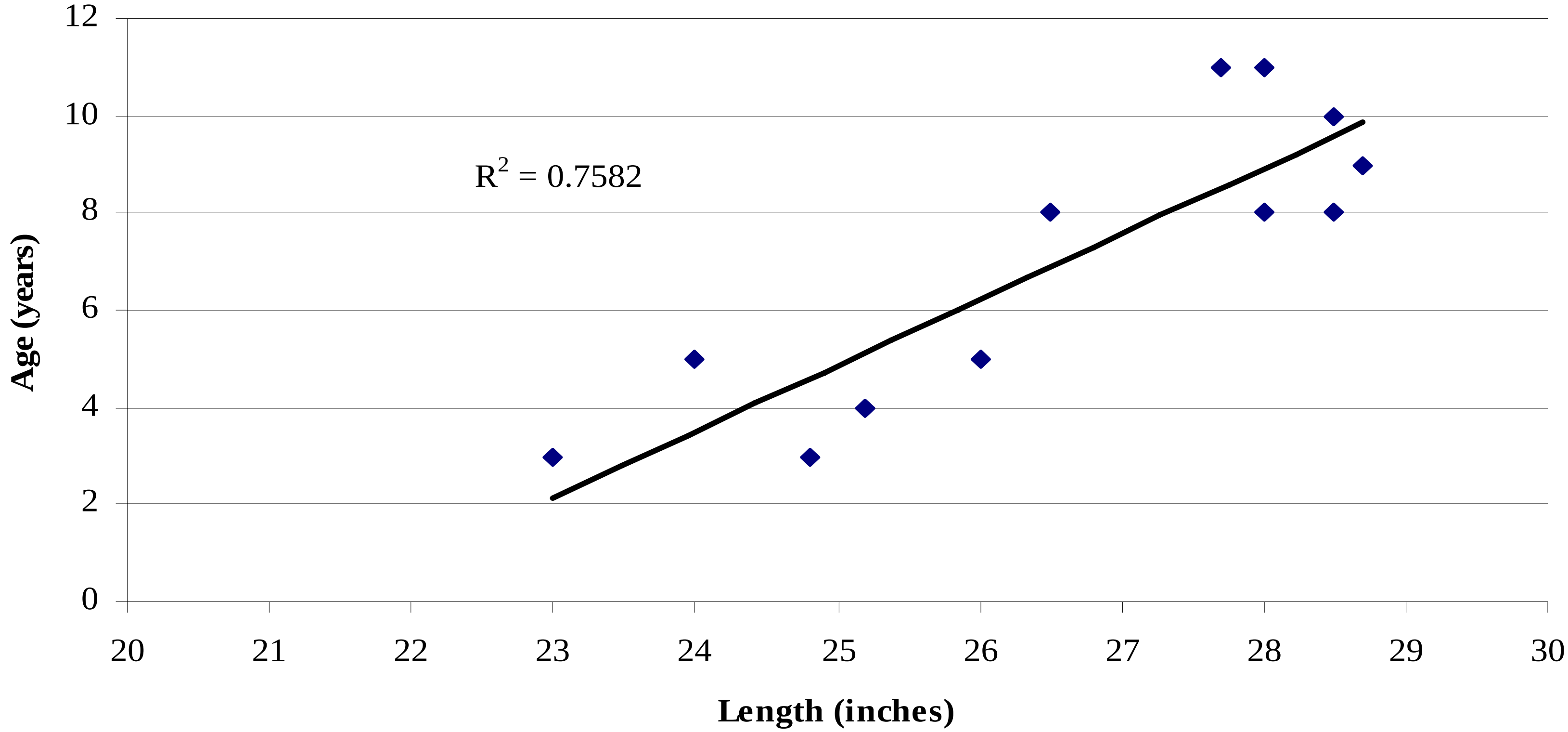


Figure 8. Age - Length of angler caught male burbot in Clark Canyon Reservoir, Jan. and Feb. 2007 (n=27)

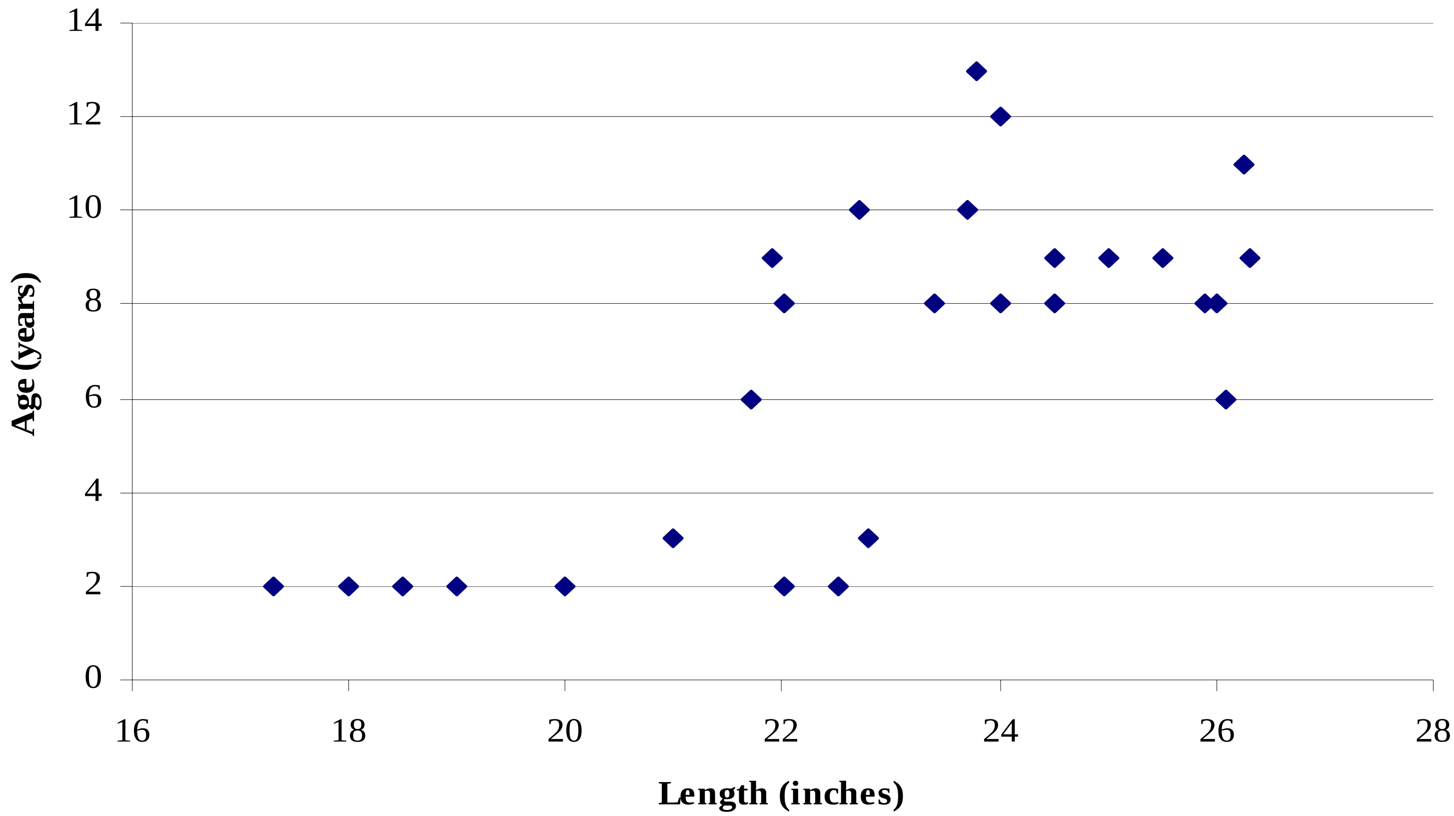


Figure 9. Length frequency distribution for burbot captured in baited "cod pot" traps set in Clark Canyon Reservoir, Fall 2007 (n=176).

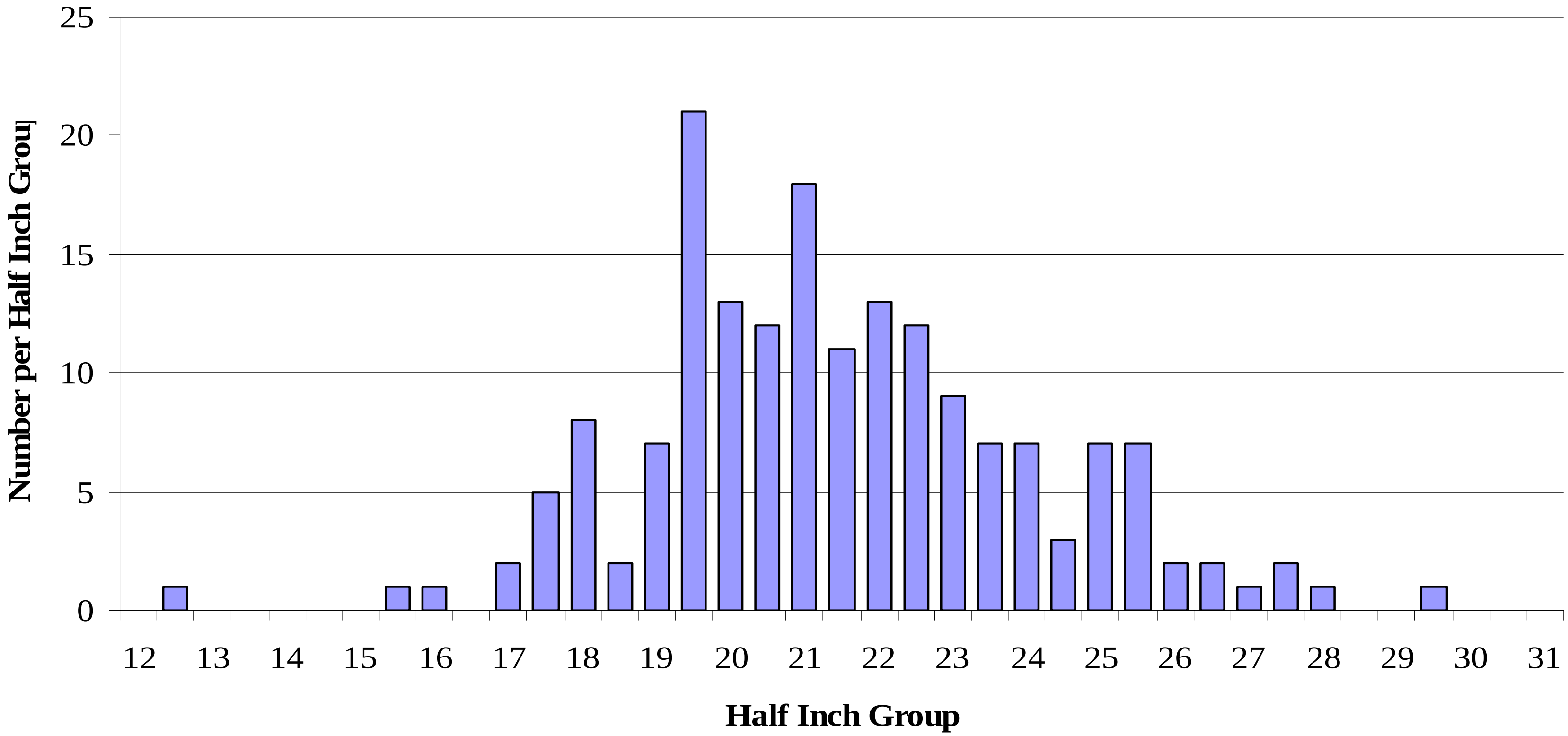


Figure 10. Clark Canyon Reservoir burbot cohort strength in angler harvest related to February-June change in reservoir forebay elevation; 1996 - 2004.

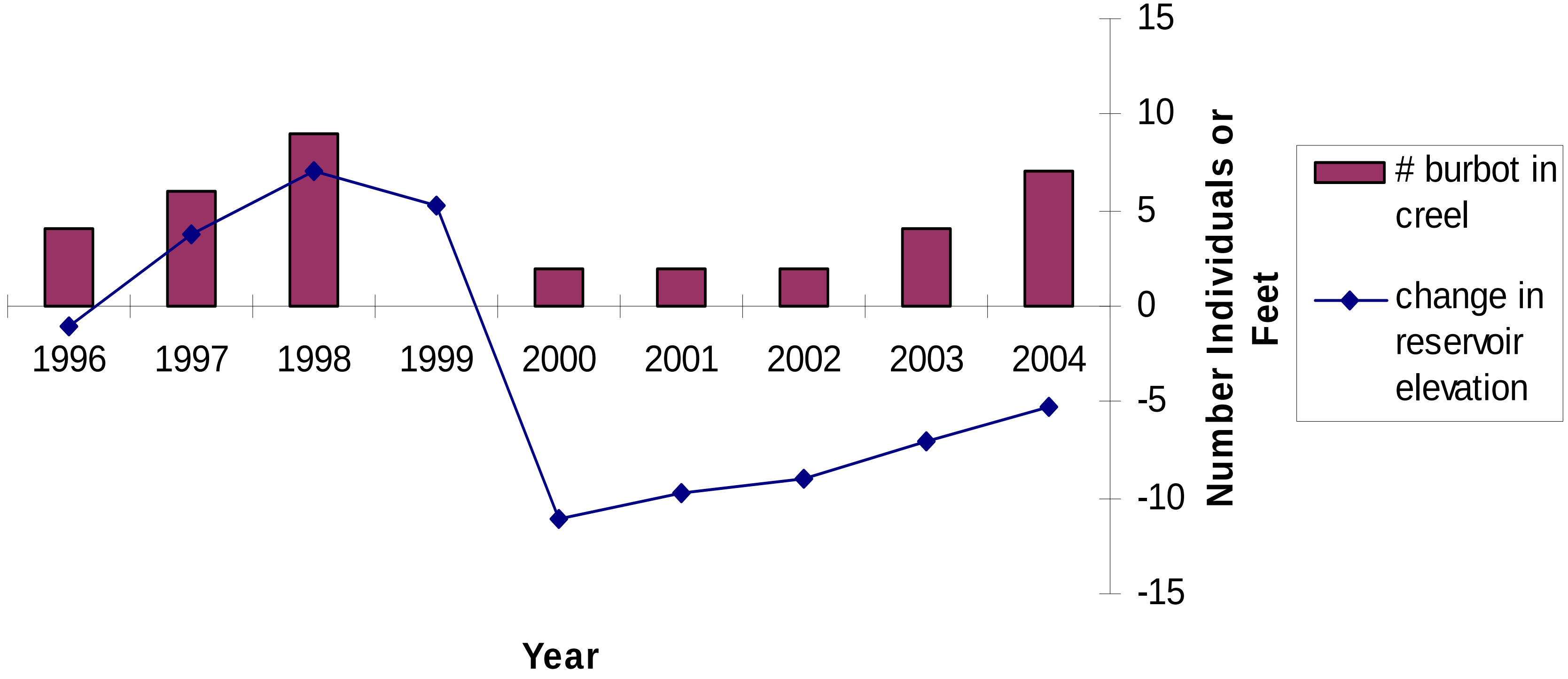


Figure 11. Comparative CPUE, over time, for burbot captured in overnight sets of sinking gill nets and trap nets in June in Miner, Mussigbrod, and Pintler Lakes in the upper Big Hole River drainage.

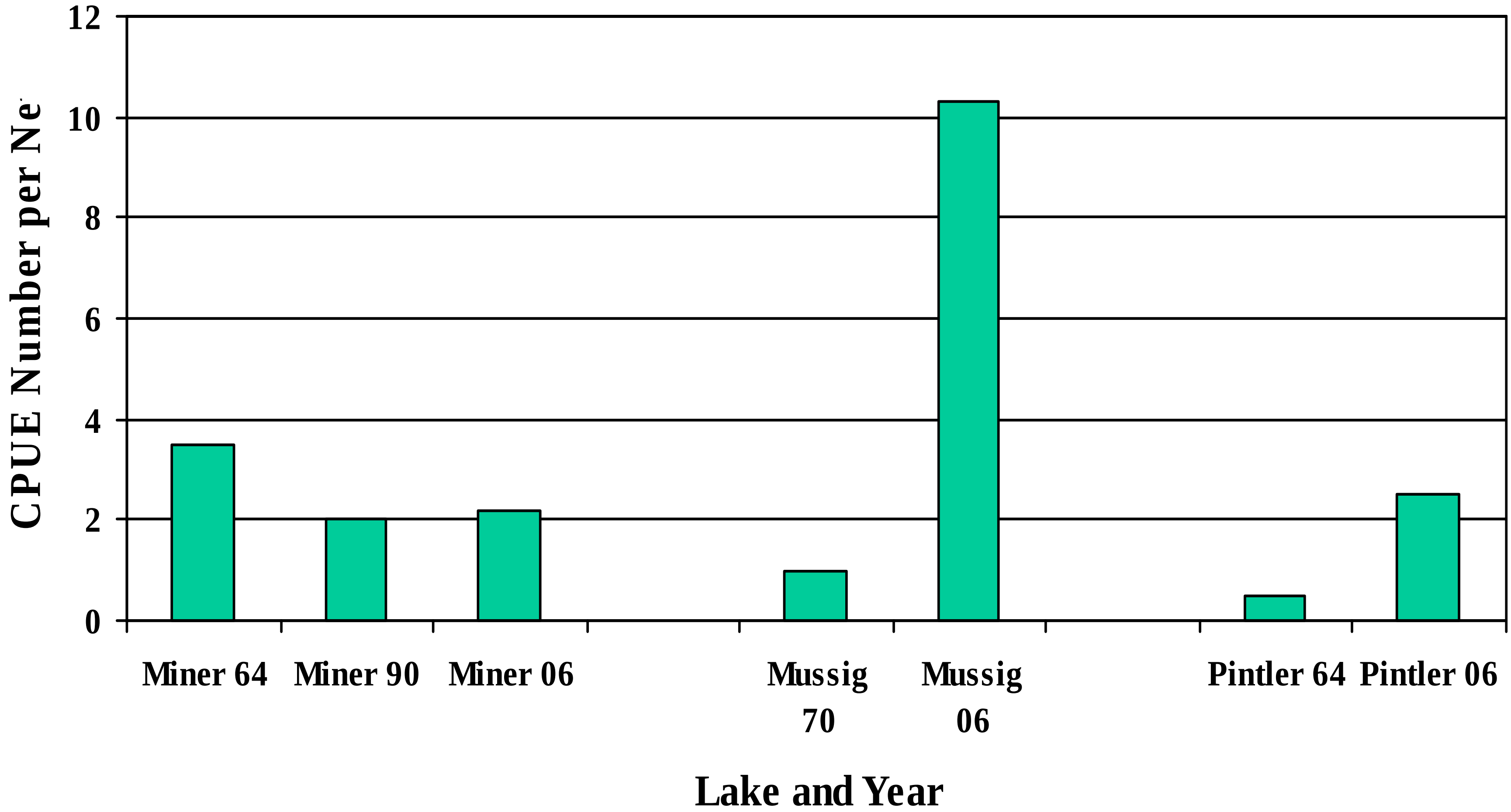


Figure 12. Comparative CPUE, over time, for longnose sucker captured in June overnight sets of sinking gill and trap nets in Miner, Mussigbrod, and Pintler Lakes in the upper Big Hole River drainage.

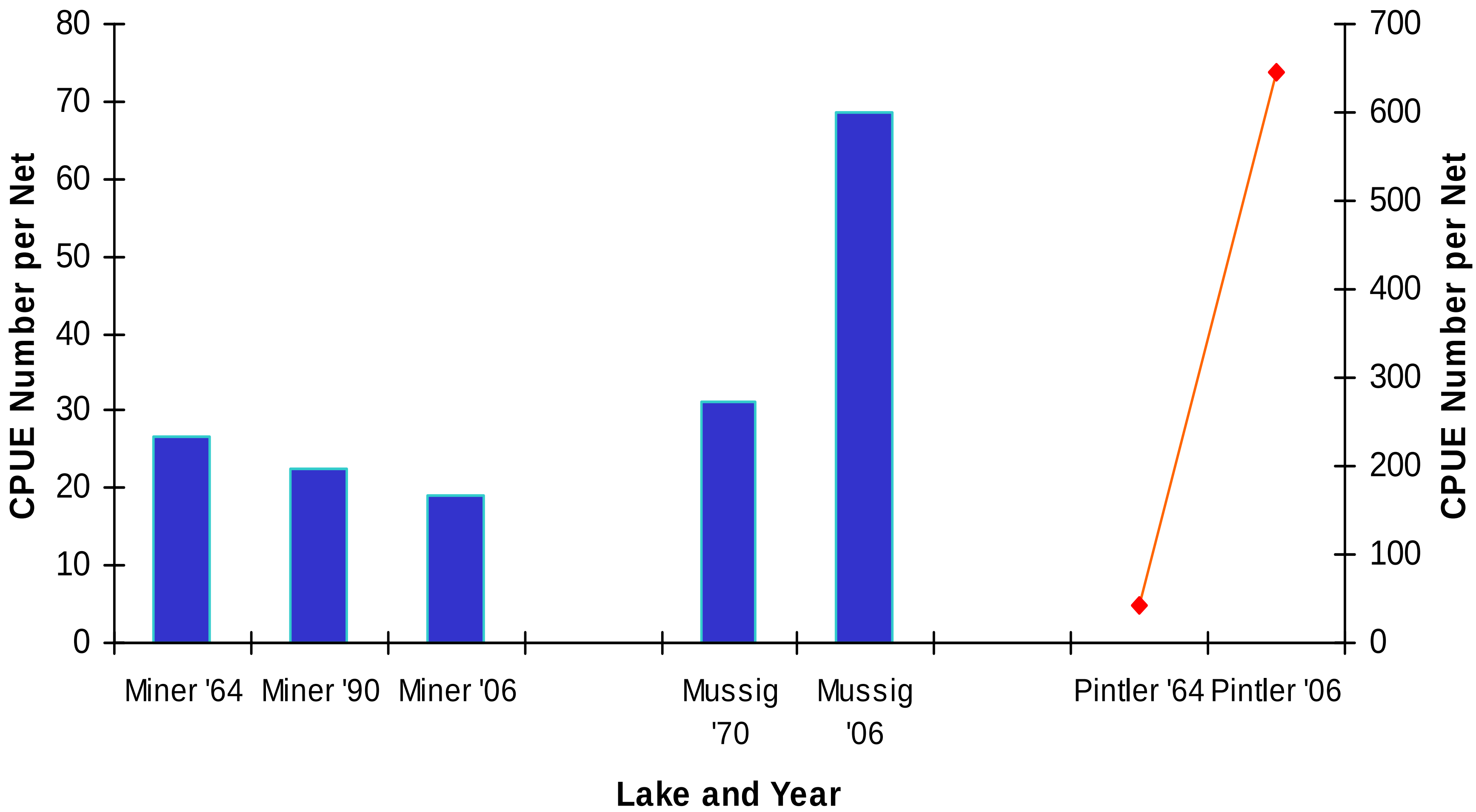


Figure 13. Compressed flow regimes and peak ADF's for May 2005 - 2007 at the USGS Red Rock Creek Gage.

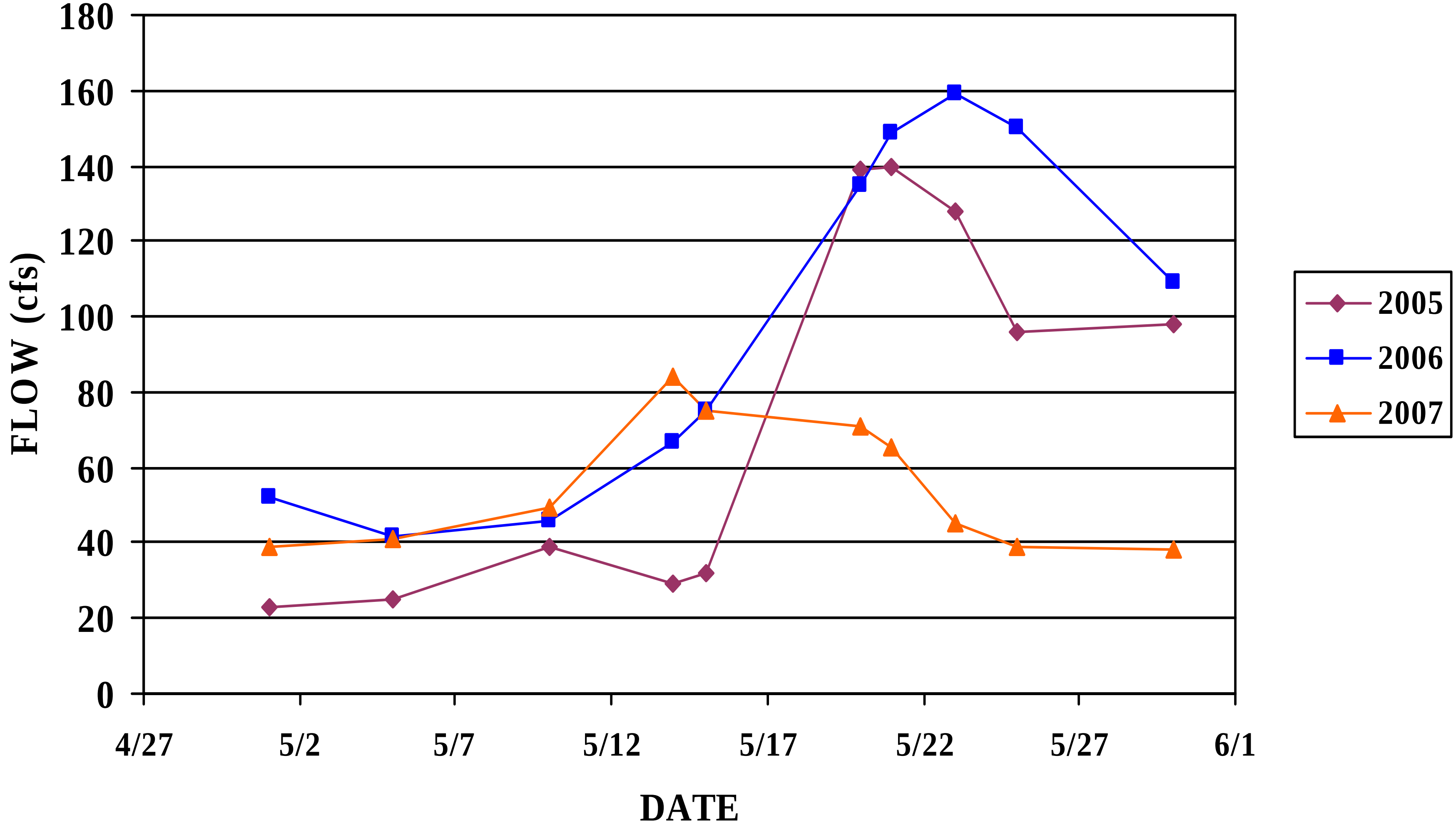


Figure 14. Compressed flow regimes for June 2005 - 2007 at the USGS Red Rock Creek Gage.

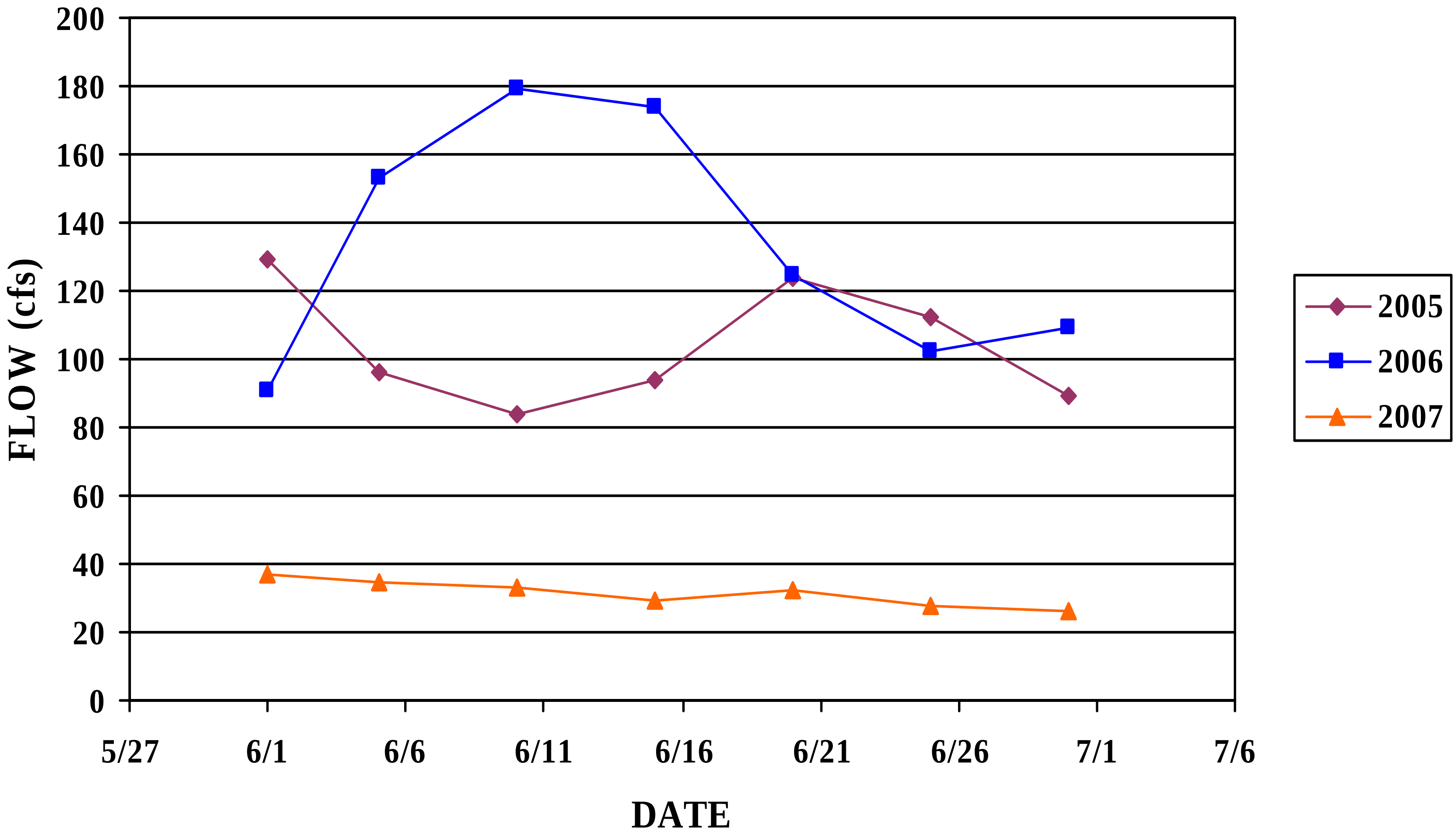


Figure 15. Catch per Unit Effort for Adfluvial Arctic Grayling collected in electrofishing samples during spring spawning migrations in the Corral Section of Red Rock Creek, for select time periods, May 1982 - 2007.

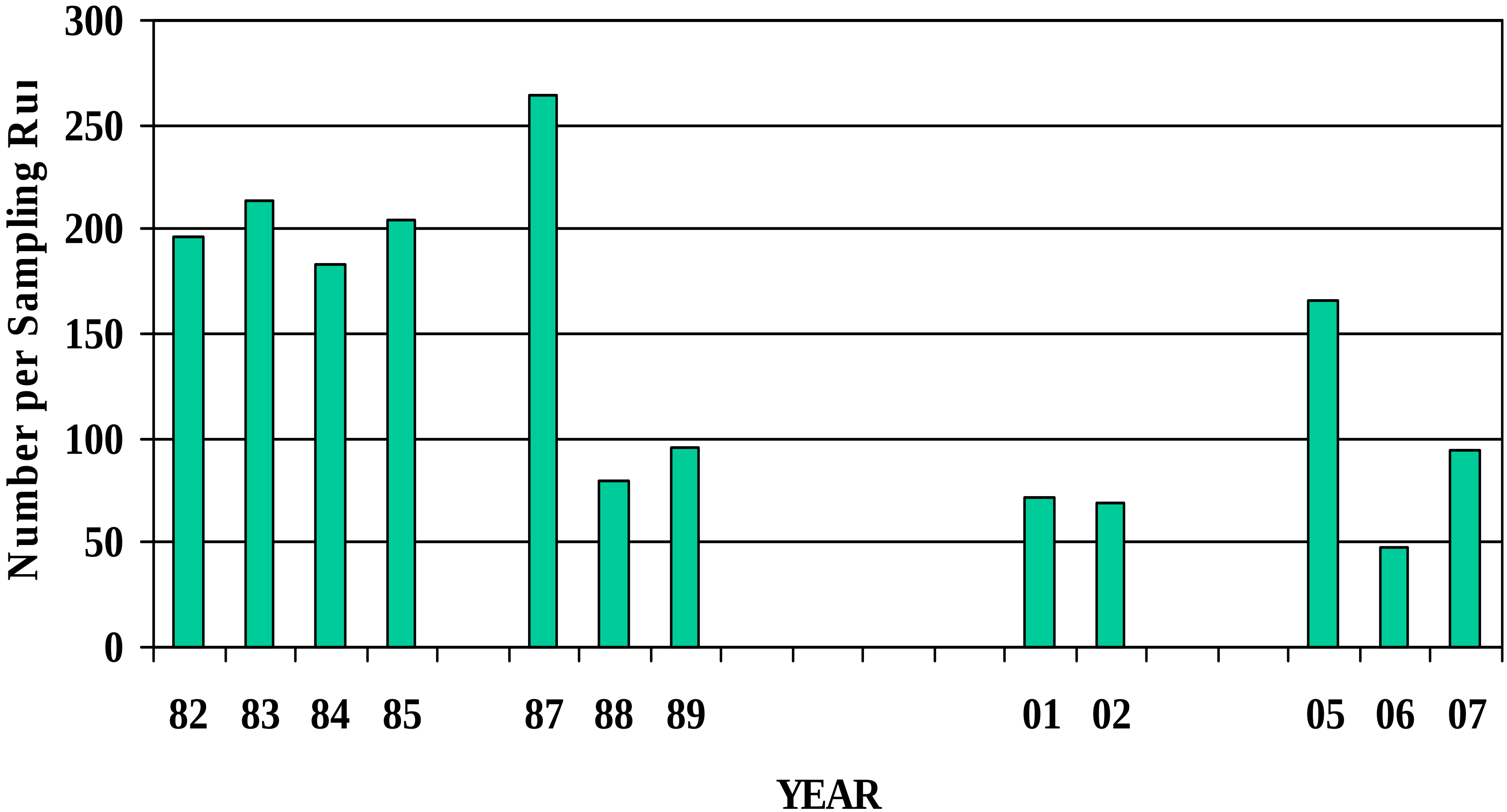


Figure 16. Length - Frequency Distribution of Arctic Grayling collected in the 1985 (N=205) and 1987 (N=360) spawning migrations in the Corral Section of Red Rock Creek.

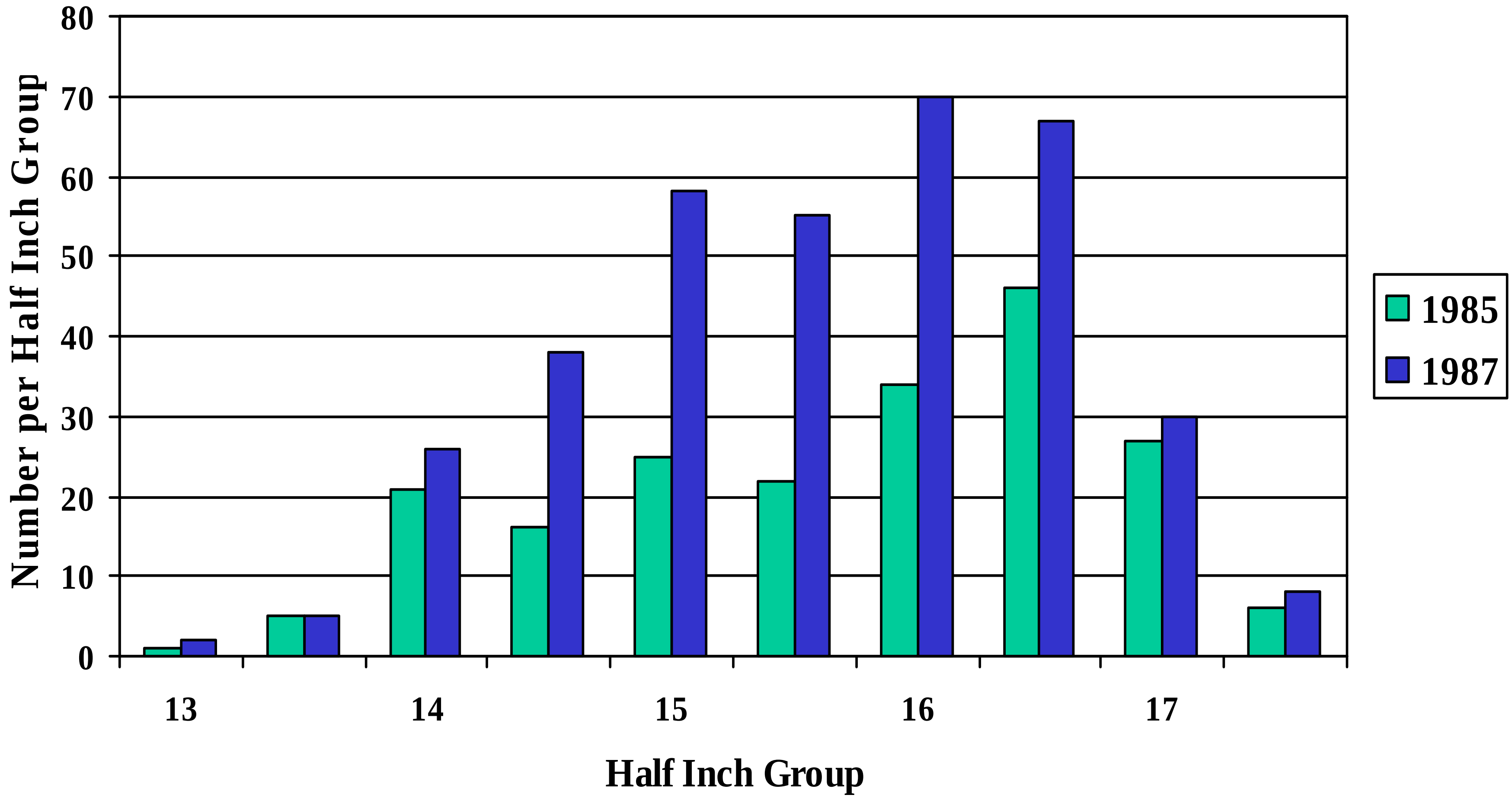


Figure 17. Length - Frequency Distribution of Arctic Grayling captured during the 2005 (N=166), 2006 (N=64), and 2007 (N=94) spawning migrations in the Corral Section of Red Rock Creek.

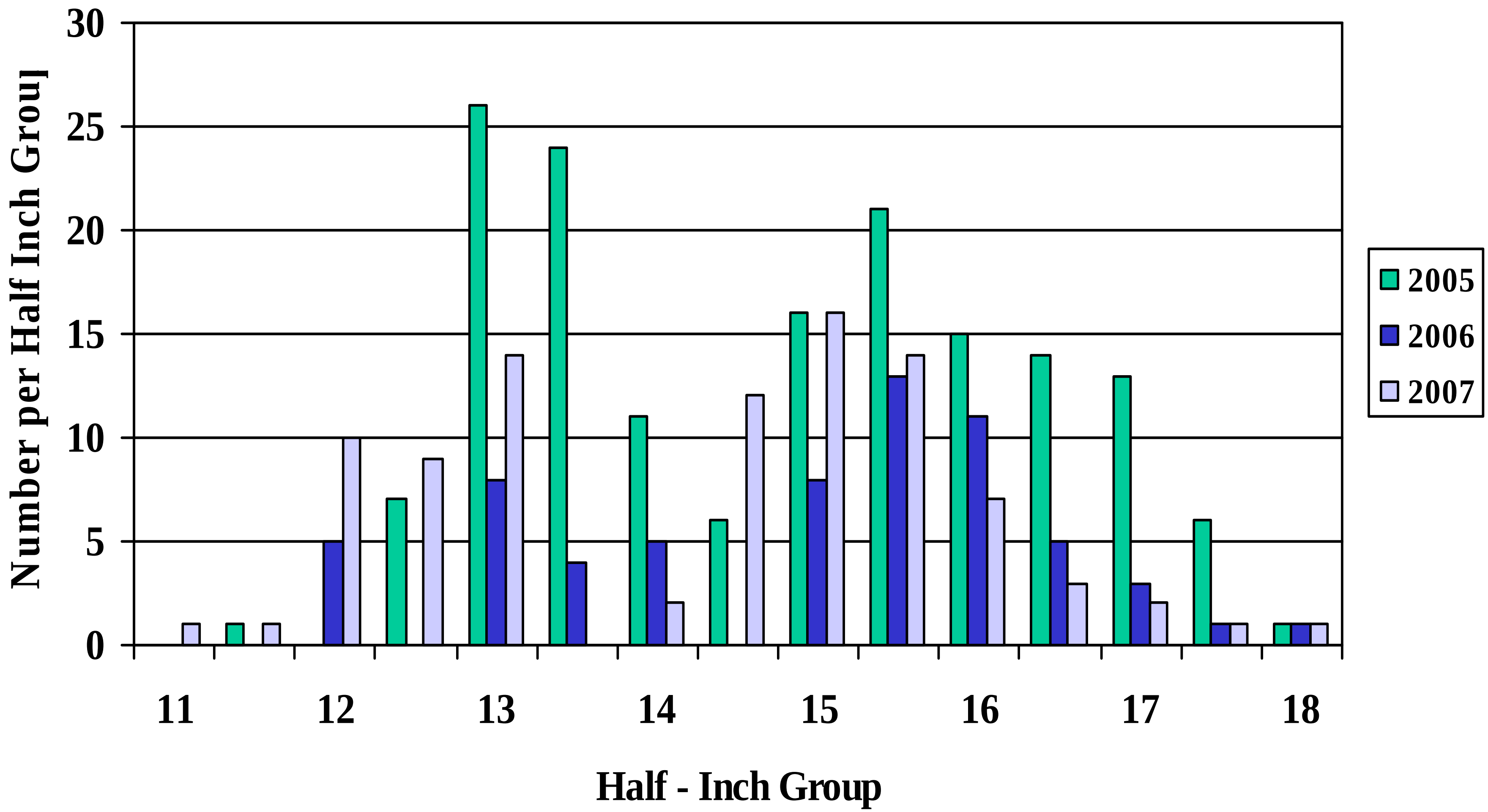


Figure 18. Mean Condition Factor (K) of spawning Arctic grayling captured in the Corral Section of Red Rock Creek; May 1985 - 1987 vs. May 2005 - 2007.

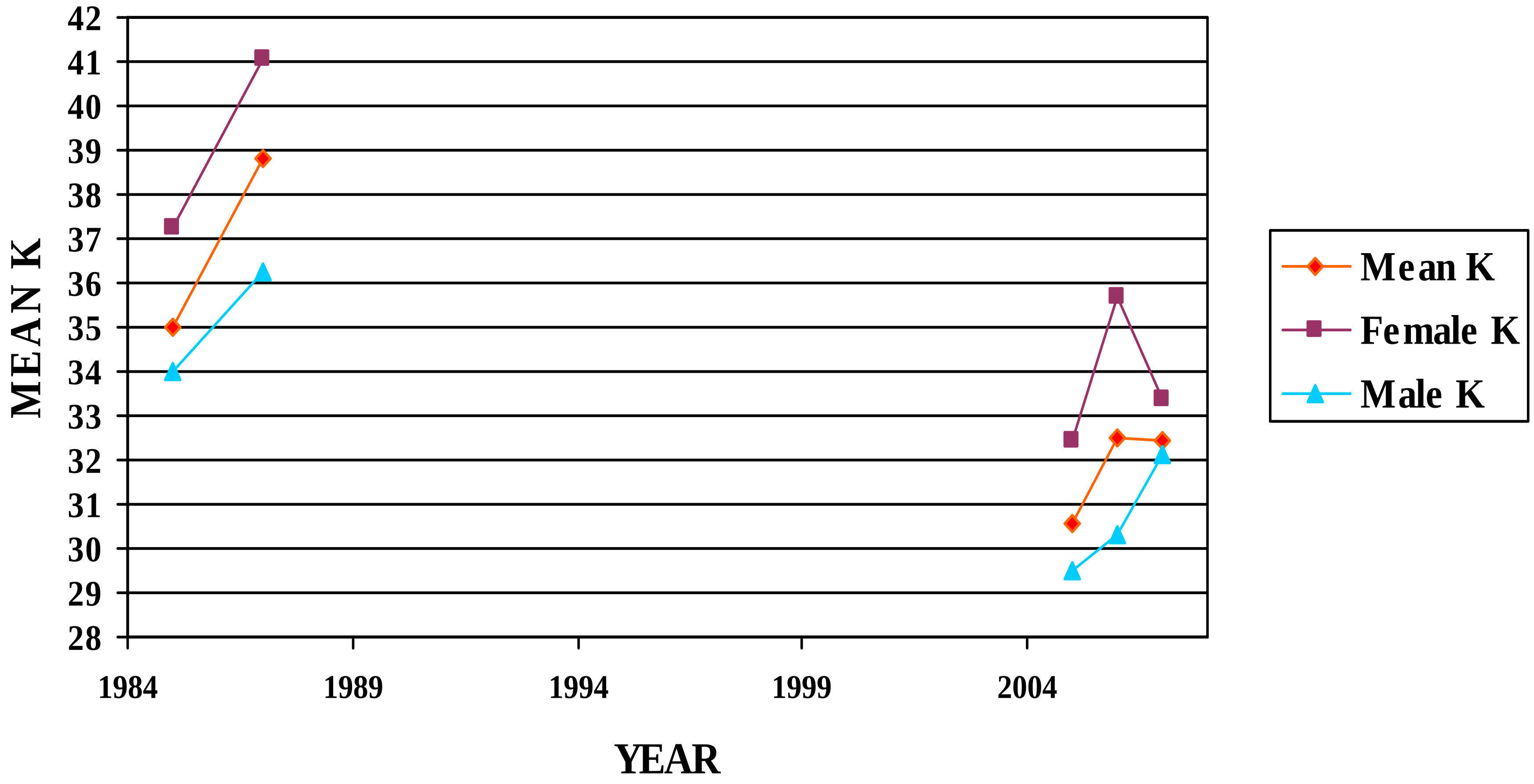


Figure 19. Catch per Unit Effort for native Arctic grayling and burbot and introduced brook trout in experimental gill and trap nets set overnight in Miner, Mussigbrod, and Pintler Lakes in the Upper Big Hole drainage; 2006.

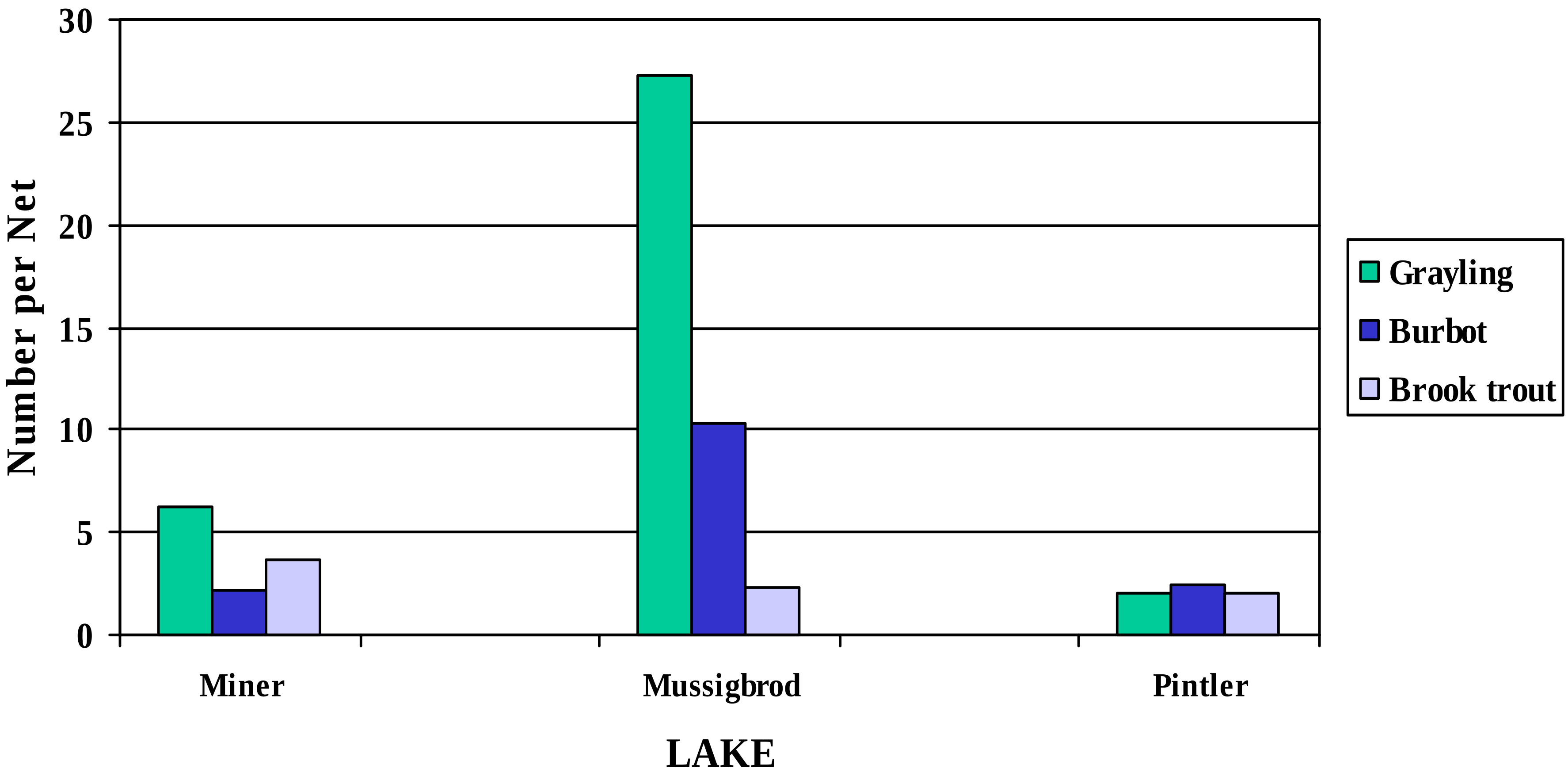


Figure 20. Comparative capture of native Arctic grayling versus introduced brook trout over time in June net samples from Miner, Mussigbrod, and Pintler Lakes in the upper Big Hole River drainage.

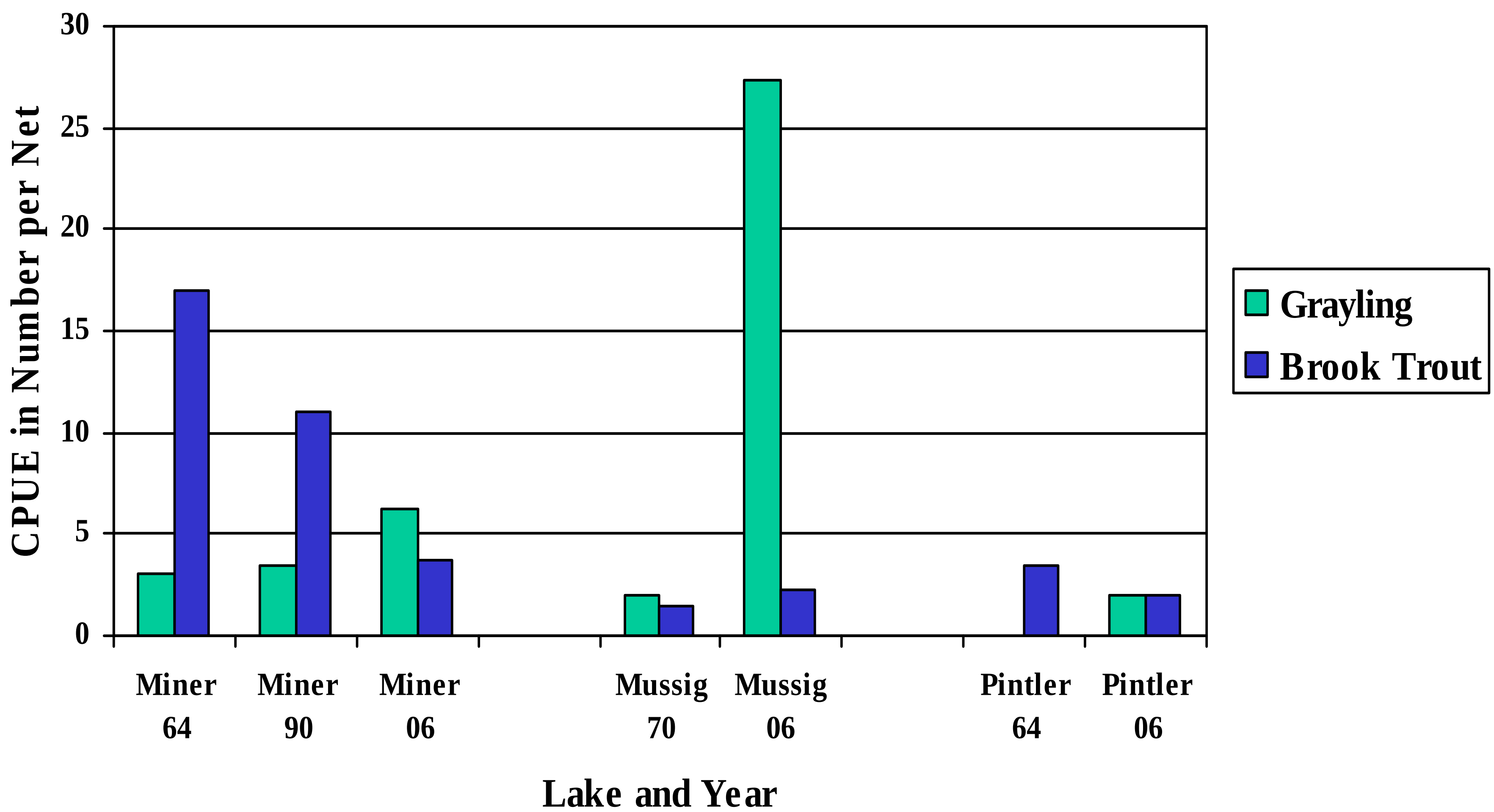


Figure 21. Length Frequency Distribution of Arctic grayling captured in experimental gill and fyke nets set overnight in Miner (N=56), Mussigbrod (N=83), and Pintler Lakes (N=13) in the Upper Big Hole; June 2006.

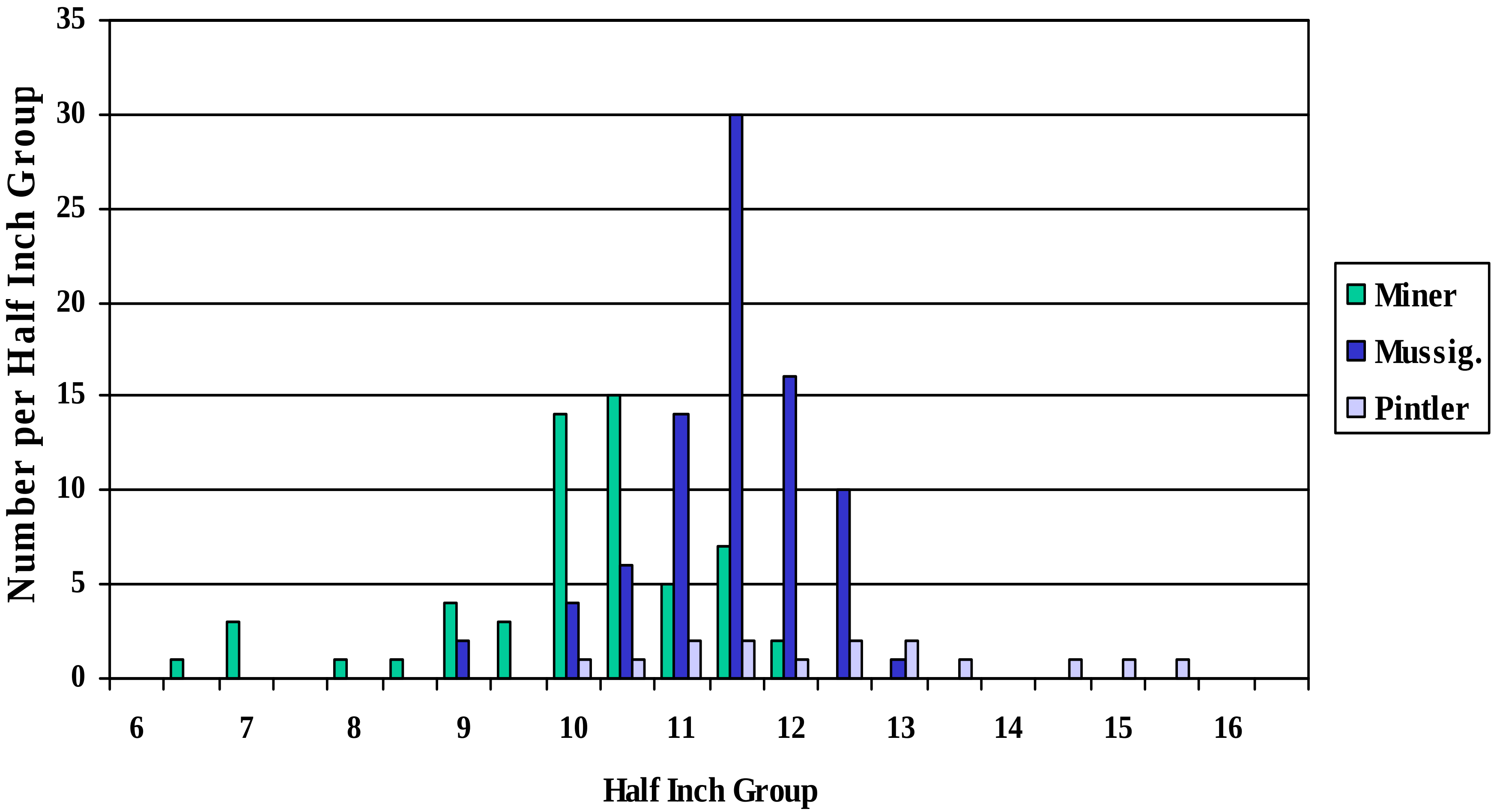


Figure 22. Mean Condition Factor (K) for Arctic grayling captured in experimental gill and fyke nets set overnight in Miner, Mussigbrod, and Pintler Lakes, June 2006.

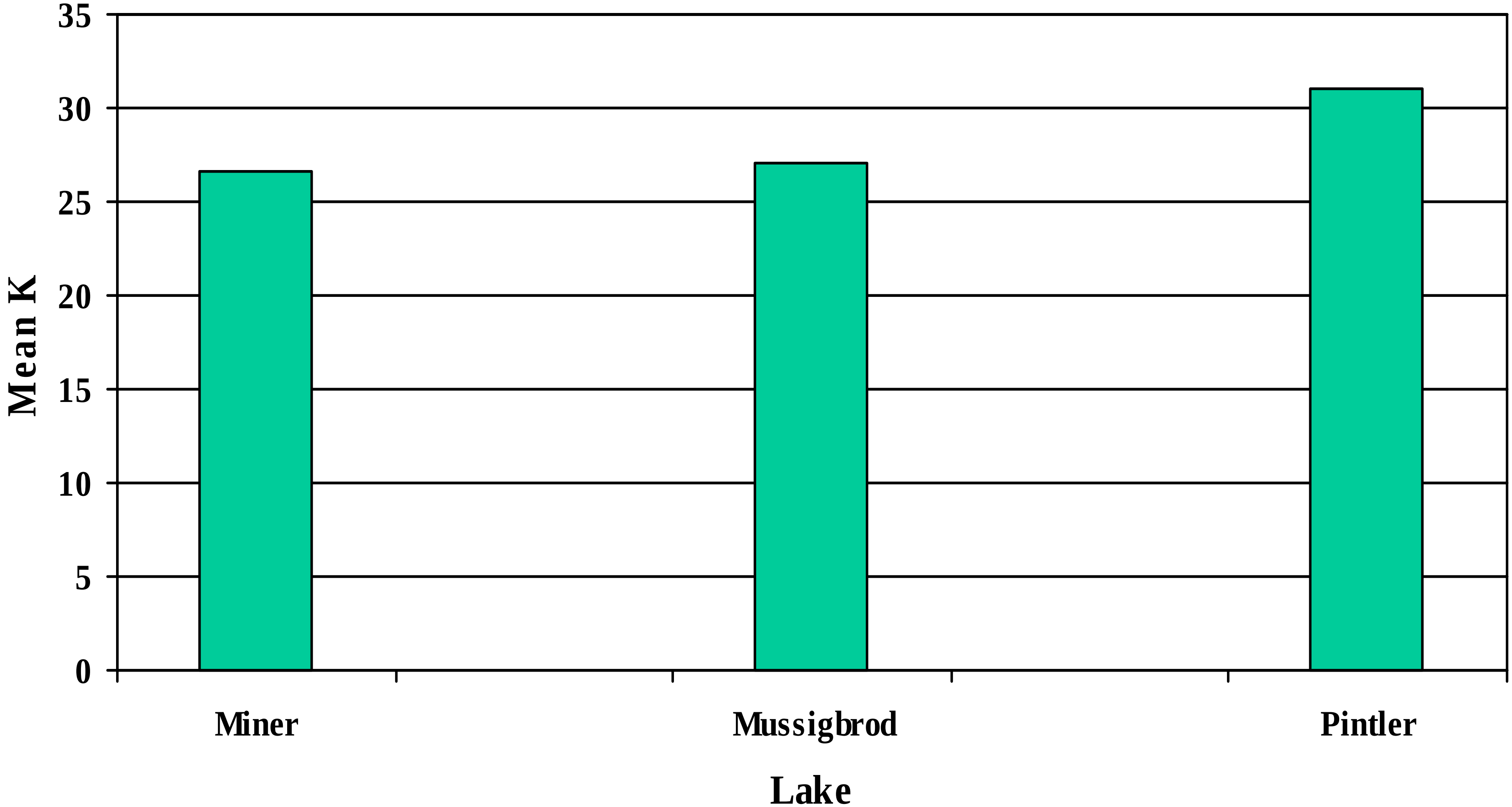


Figure 23. Mean Condition Factor (K) per Inch Group for Arctic grayling captured in experimental gill and fyke nets set overnight in Miner, Mussigbrod, and Pintler Lakes; June 2006.

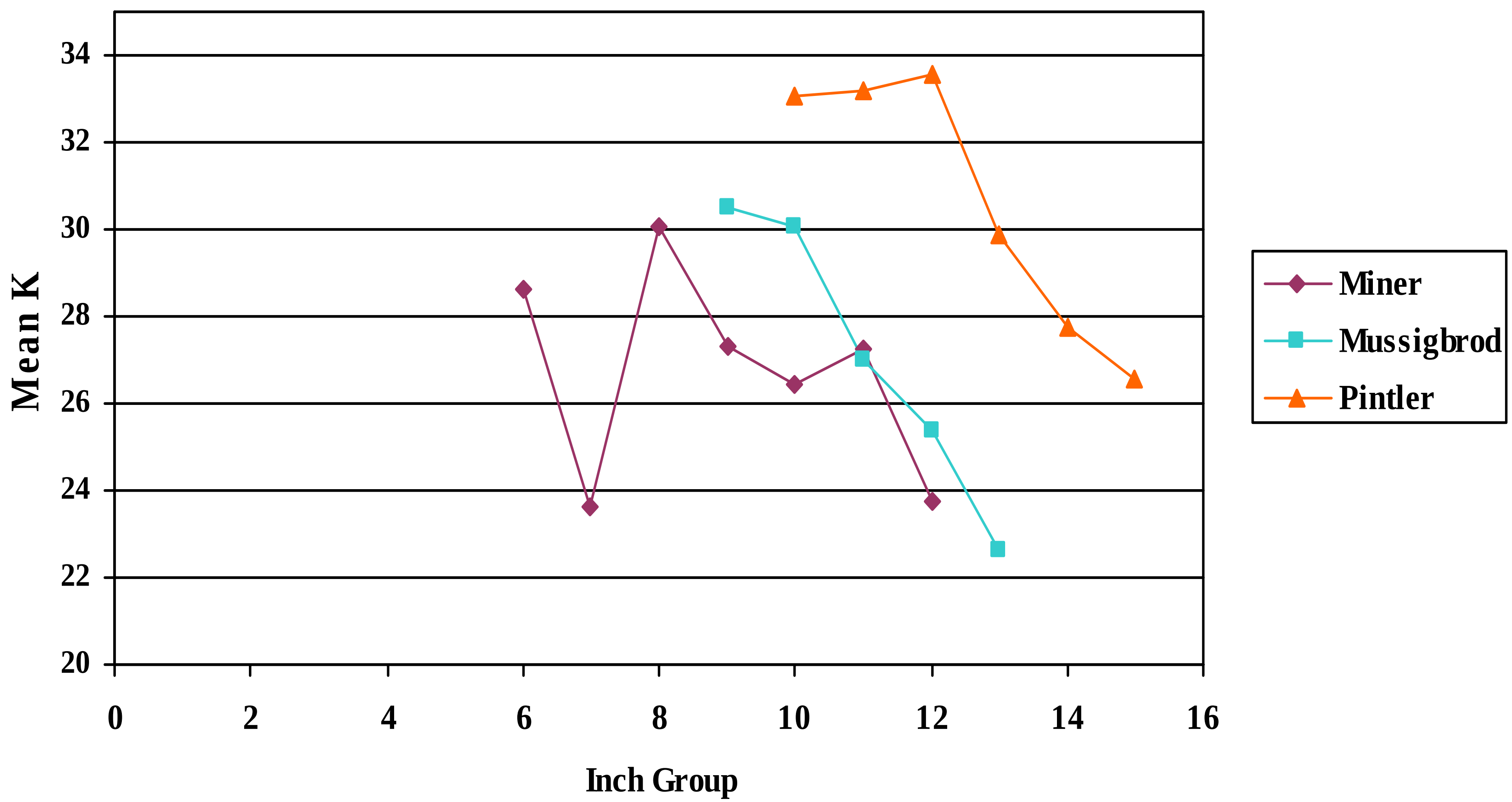


Figure 24. Mean August Flow (cfs) compared with the Minimum Recommended Flow (WETP Method) for the Upper Ruby River Measured at the USGS Gage Site 1986 - 2007.

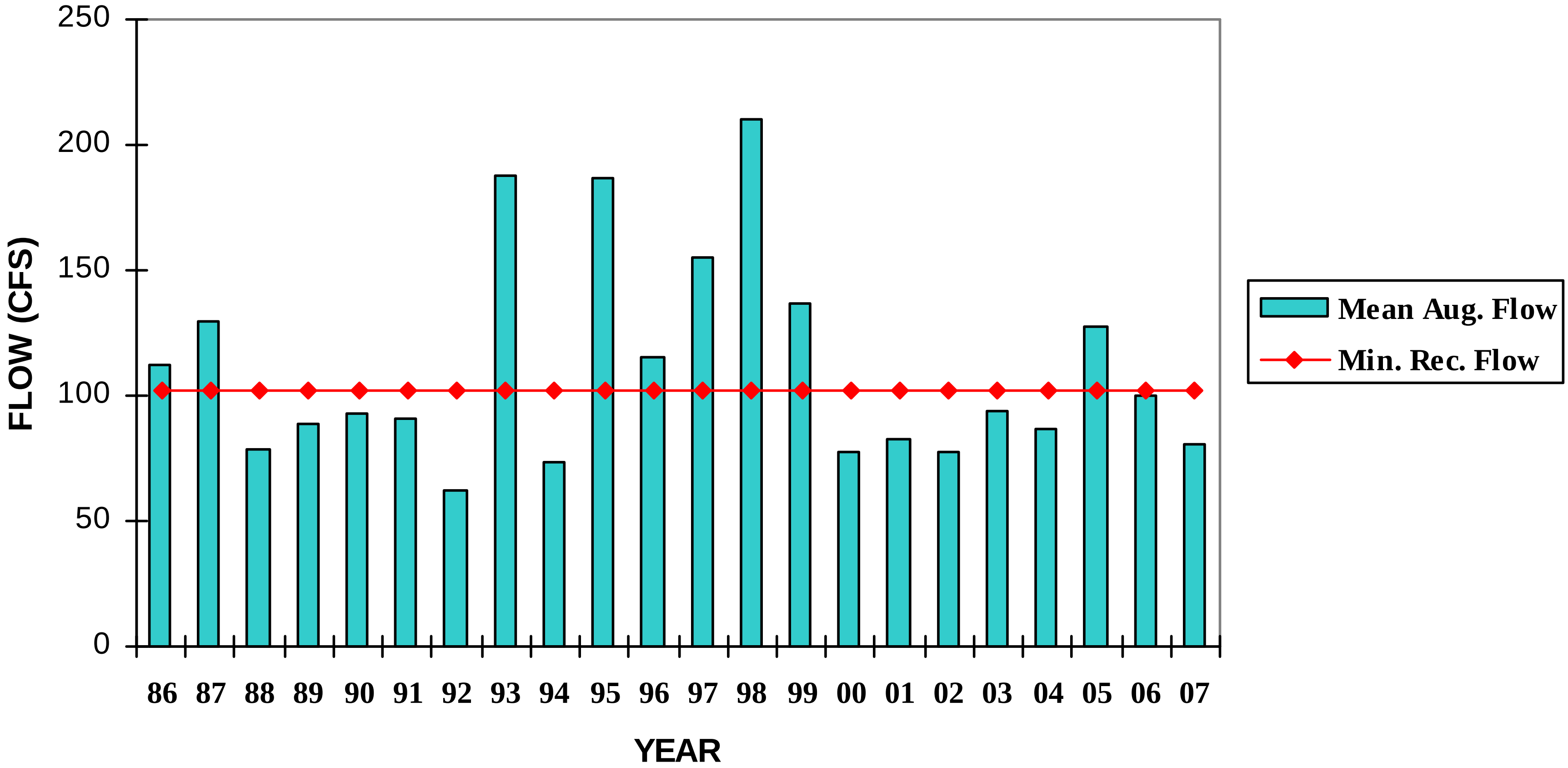


Figure 25. Estimated fall density and standing crop for Age I and older Arctic grayling in the Three Forks Section of the Ruby River 1998 - 2007.

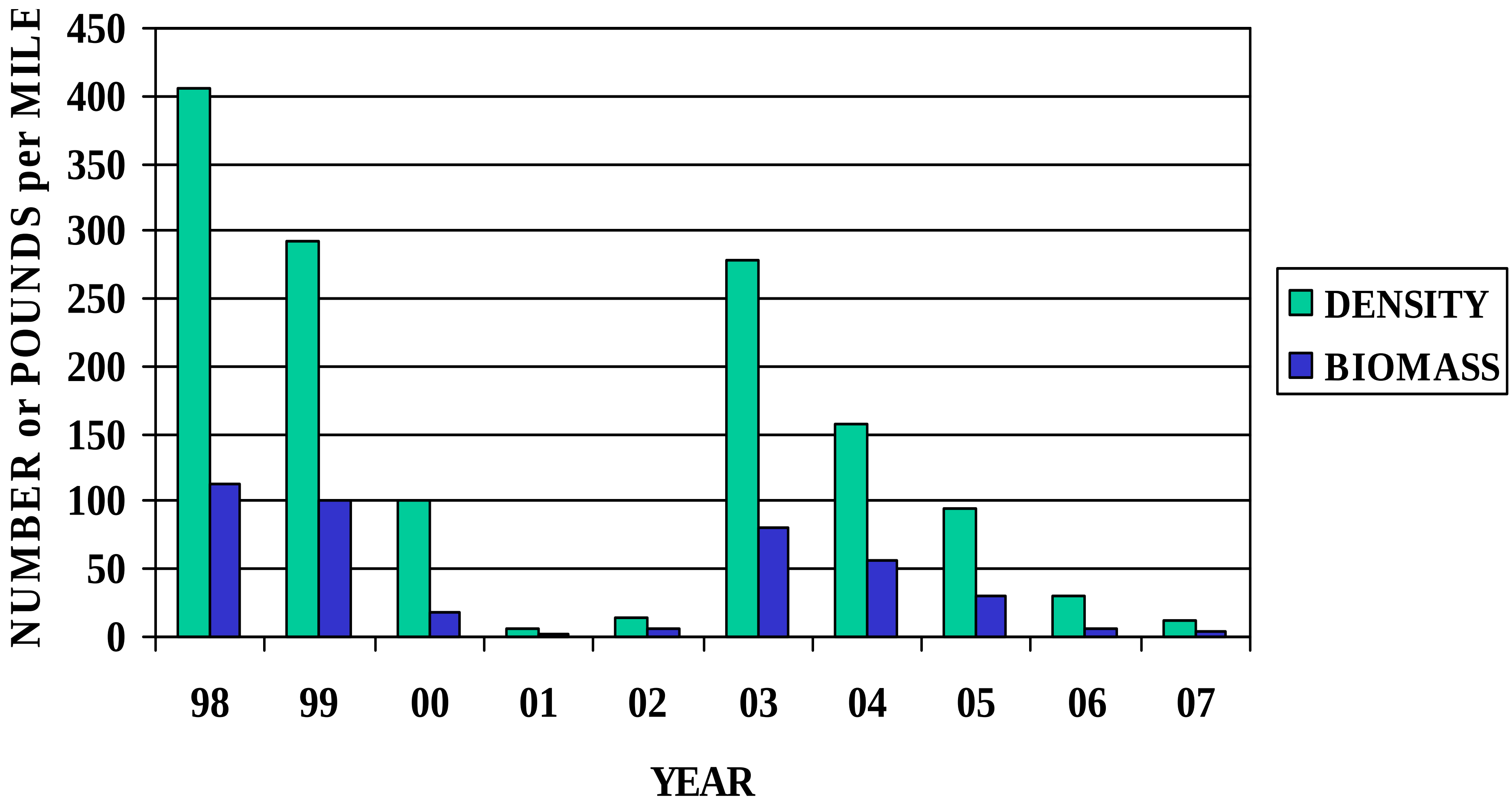


Figure 26. Length Frequency Distribution of Arctic grayling captured via electrofishing in the Three Forks Section of the upper Ruby River; Fall 2004 (N=168), 2005 (N=108), 2006 (N=31), and 2007 (N=17).

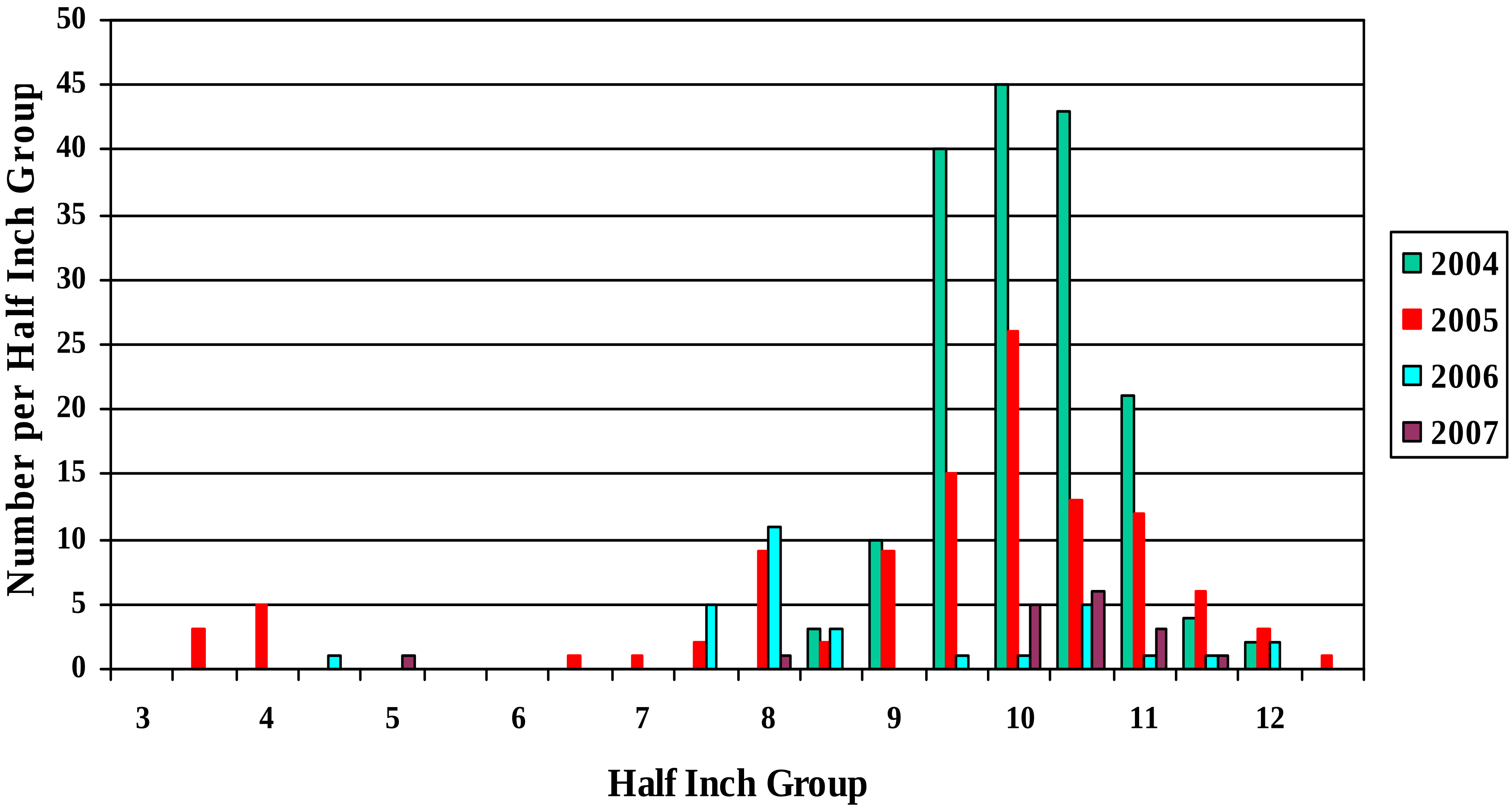


Figure 27. Length frequency distribution of Arctic grayling captured via electrofishing in the Three Forks Section of the Ruby River; Fall 2000 (N = 91), Fall 2001 (N = 8), and Fall 2002 (N = 18).

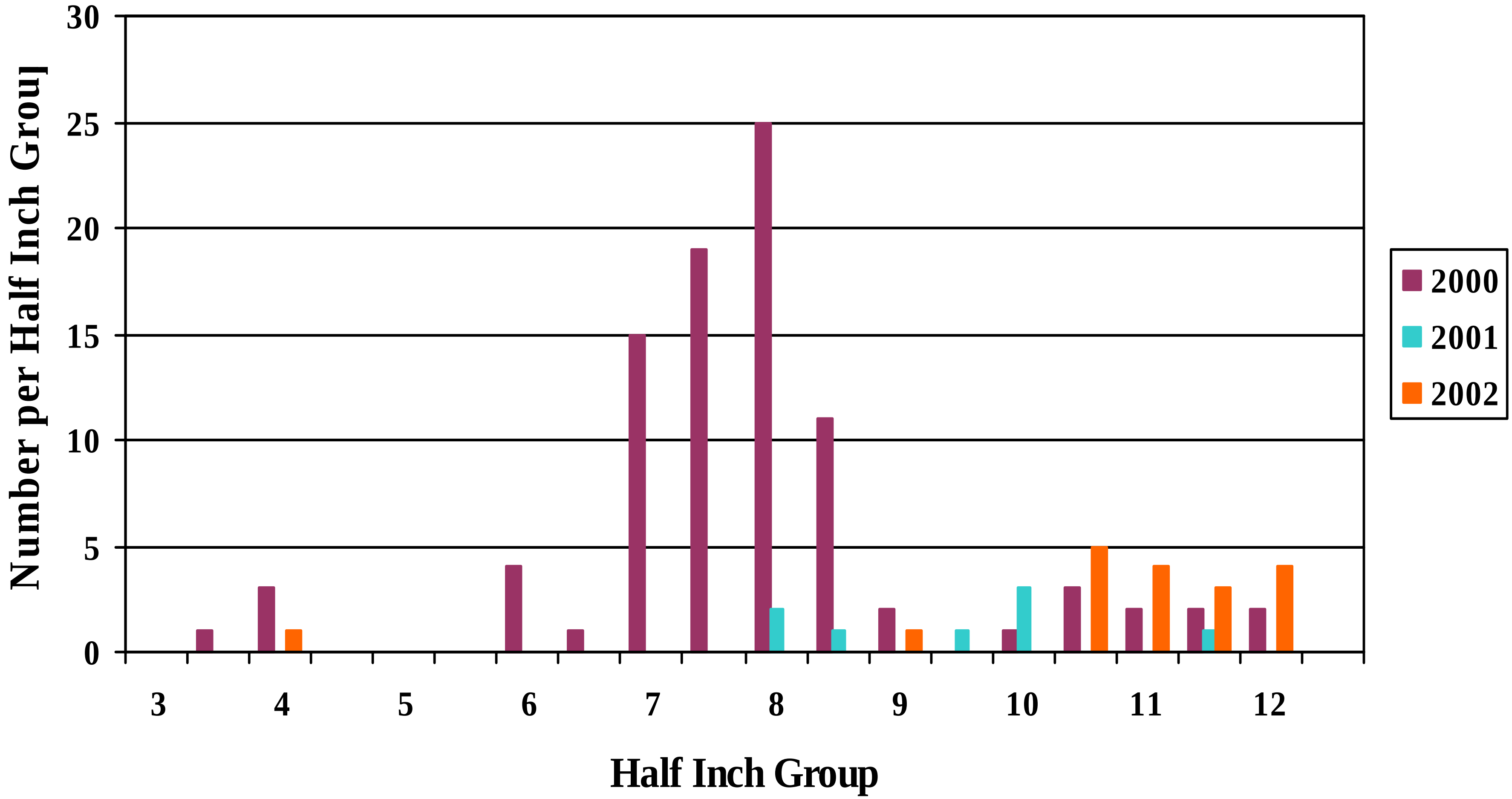


Figure 28. Estimated fall density and standing crop of the hybrid swarm of Age I and older westslope cutthroat and rainbow trout in the Three Forks Section of the Ruby River, 1987 - 2007.

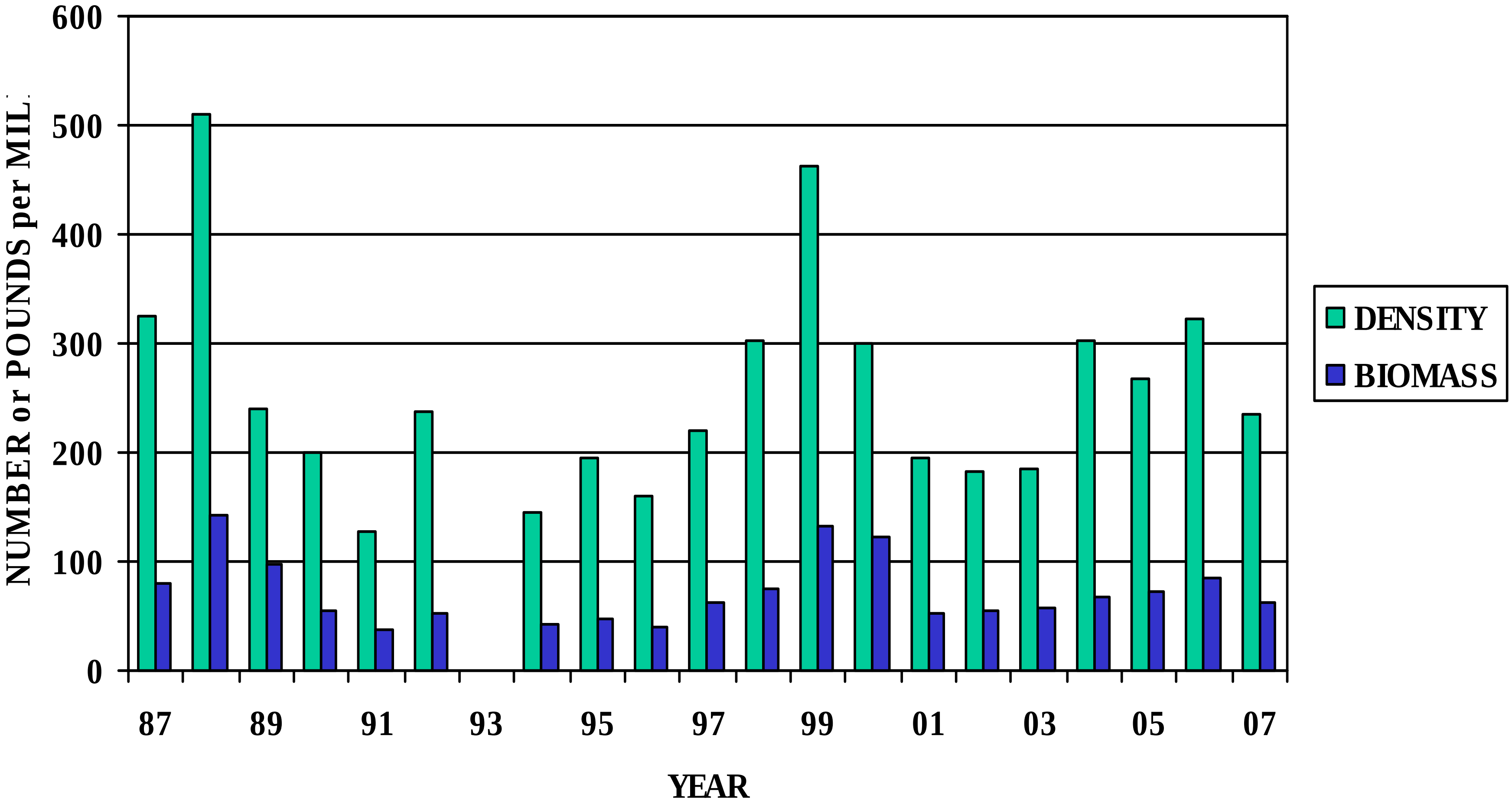


Figure 29. Mean fall Condition Factor (K) for the hybrid swarm of Age I and older rwestslope cutthroat and rainbow trout in the Three Forks Section of the Ruby River, 1987 - 2007.

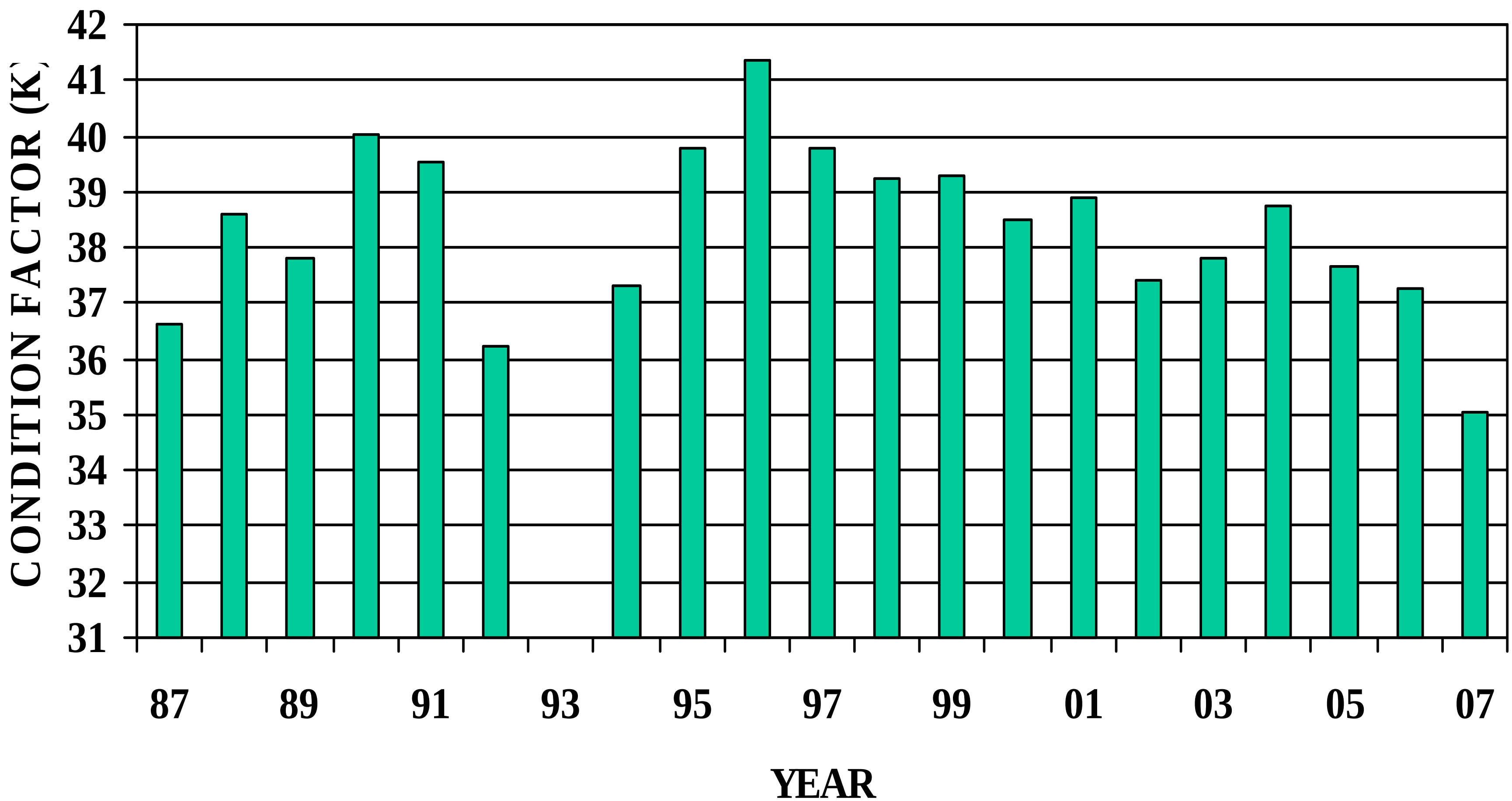


Figure 30. Mean July and August flows (cfs) and Minimum Recommended Flow (WETP Method) for the lower Beaverhead River measured at the USGS Twin Bridges Gage, 1988 - 2006.

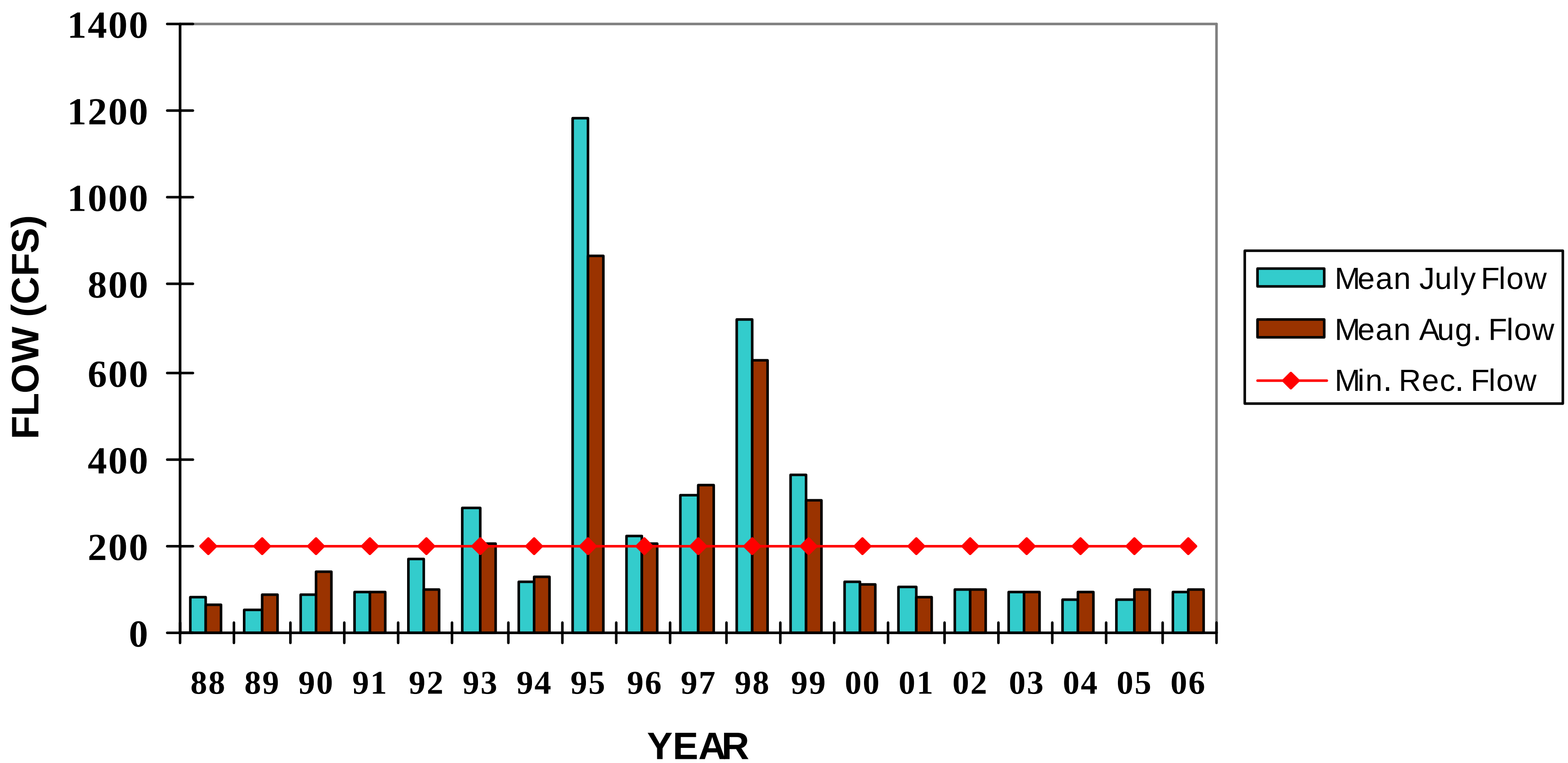


Figure 31. Estimated spring density and standing crop of Age II and older mountain whitefish in the Anderson Study Section of the Beaverhead River, 2002 - 2007.

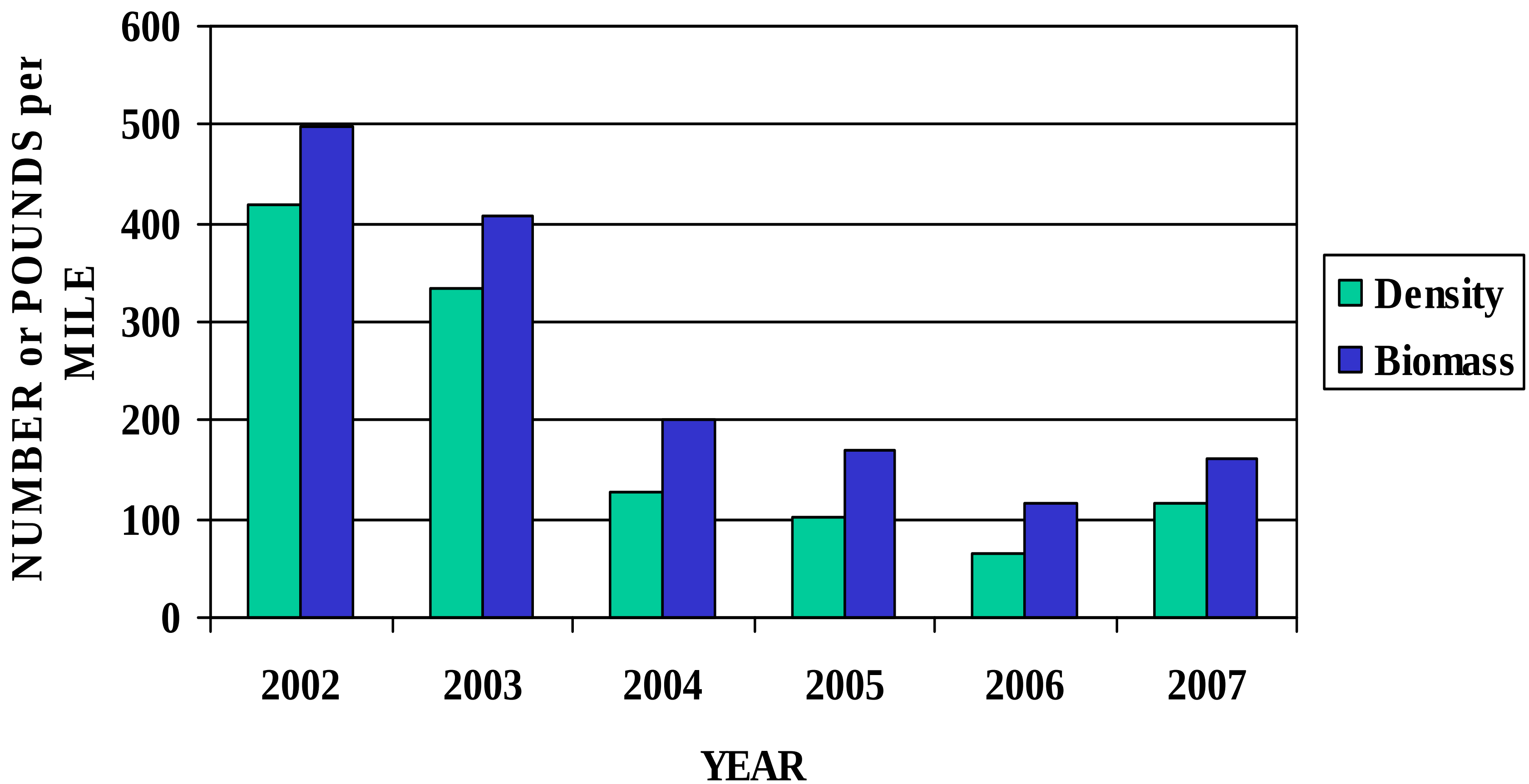


Figure 32. Length - frequency distribution of Age II and older mountain whitefish collected in the Anderson Study Section of the Beaverhead River, Spring 2002 (N=597).

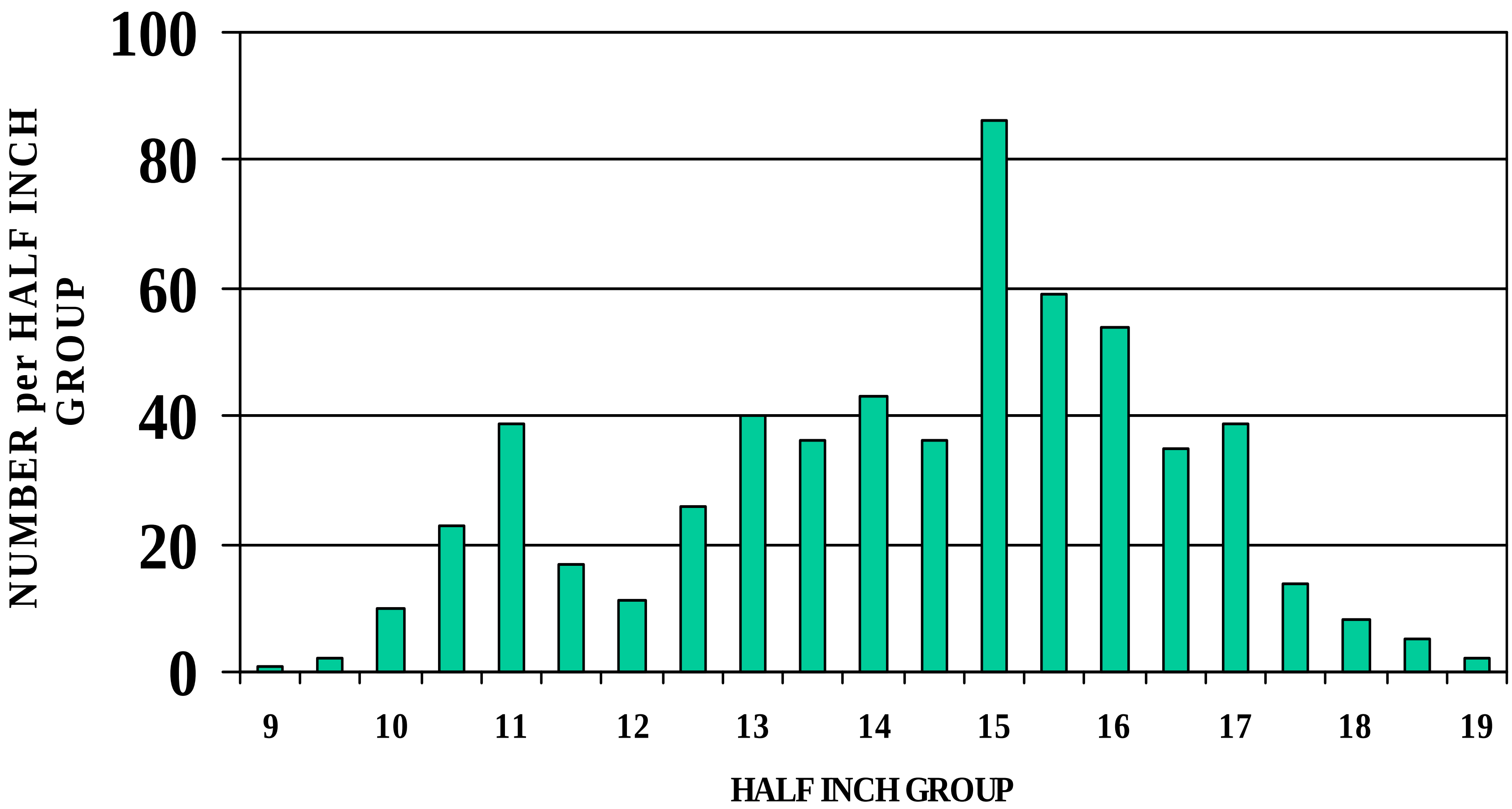


Figure 33. Length - frequency distribution of Age II and older mountain whitefish from spring samples collected in the Anderson Section of the Beaverhead River, Spring 2006 (N=198).

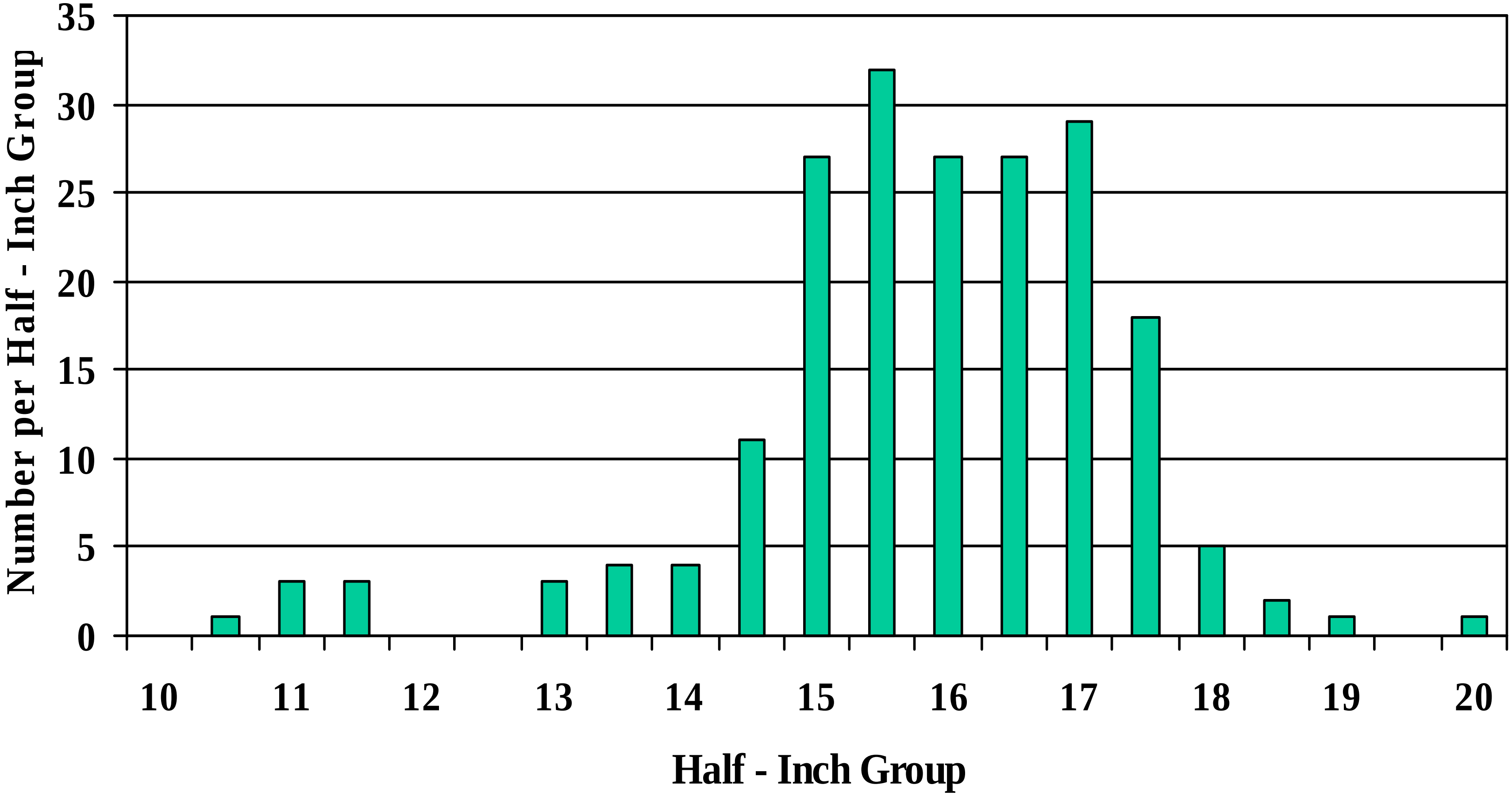


Figure 34. Length frequency distribution of Age II and older mountain whitefish captured by electrofishing in the Anderson Section of the Beaverhead River; Spring 2007 (N=137).