Section 3

Fisheries Monitoring Report for
Rush, Lee Vining, Parker, and Walker Creeks
2006

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Date: May 8, 2007

Table of Contents

List of Tables

List of Figures

Executive Summary

This report presents the results of the tenth year of fish population monitoring for Rush, Lee Vining, Parker, and Walker creeks pursuant to State Water Resources Control Board (SWRCB) Decision #1631 and the eighth year following SWRCB Orders #98-05 and #98-07. Pilot studies were conducted in 1997 and 1998 to determine appropriate methods for generating statistically valid population estimates with 1999 being the first year estimates were generated for all study sections.

The 2006 electro-fishing sampling occurred between September 3rd and 15th. Mark-recapture electro-fishing techniques were utilized to estimate trout populations in four sections of Rush Creek, including the Mono Gate One Return Ditch (MGORD) which was last sampled in 2004. Due to high flows and unsafe wading conditions, the two normally-sampled mainstem sections of Lee Vining Creek were not sampled in 2006. Fish population estimates for two Lee Vining Creek side-channels and Parker and Walker creeks were made using electrofishing depletion methods. The radio telemetry-movement study of brown trout in Rush Creek initiated in 2005 was also continued with an additional 29 tags deployed in 2006.

Density Estimates for Age-1 and older Brown Trout

Estimated densities (number per hectare) of age-1 and older brown trout in Rush for 2006 increased in two sections (County Road and MGORD) and decreased slightly in the other two sections. Between 2004 and 2006, in the MGORD Rush Section the estimated density of age-1 and older brown more than doubled from 270.9 fish/ha to 660.3 fish/ha. This increase suggests that trout densities have recovered following their decline due to the re-construction of the MGORD's right-bank levee in 2002-03.

Estimated densities of age-1 and older brown trout decreased by 2006 in both side-channel sections of Lee Vining Creek, by 77% in the Lower side-channel and by 48% in the Upper side-channel. As previously reported, high flows prevented sampling in the main-channel sections of Lee Vining Creek.

Densities of age-1 and older brown trout in Parker Creek decreased by 50% between 2005 and 2006 after experiencing an increase of 45% between 2004 and 2005. In Walker Creek the 2006 density estimate was nearly 30% less than the 2005 estimate. This was the second straight year of declining densities of age-1 and older brown trout in Walker Creek.

Density Estimates for Age-0 Brown Trout

Estimated densities of age-0 brown trout were much higher in 2006 than densities estimated in 2005 for all (five) sample sections of Rush, Parker, and Walker creeks. The 2005 densities were the lowest ever recorded at four of these five sections.

Estimated densities of age-0 brown trout in the two side channels of Lee Vining Creek were relatively low, when compared to years 2000 through 2004 when it was possible to make estimates. However, in 2005 it was not possible to make estimates in these side channels due to a combination of low flow and very few age-0 brown trout.

Density Estimates for Age-1 and older Rainbow Trout

In Rush Creek, estimated density of age-1 and older rainbow trout increased in the Upper Section. For a fourth straight year, estimated densities of age-1 and older rainbow trout remained low in the sections of Lee Vining Creek sampled in 2006. These low numbers and continued decline were not surprising considering the poor recruitment of age-0 rainbow trout in Lee Vining Creek in 2002 - 2004. No rainbow trout were sampled in Parker or Walker creeks.

Density Estimates for Age-0 Rainbow Trout

On Rush Creek, only five age-0 rainbows were captured in the Upper Section, along with six age-0 rainbows in the Lower Section and none in the County Road Section. With the exception of the Lee Vining Lower Side-channel Section, densities of age-0 rainbow trout densities remained low in all study sections for 2006. Only two age-0 rainbow trout were captured in the Lee Vining upper Side-channel Section in 2006. No rainbow trout were sampled in Parker or Walker creeks.

Standing Crop Estimates of Brown Trout

Estimated standing crops of brown trout increased from 2005 to 2006 in all study sections of Rush Creek. For the Upper Section this was the second consecutive increase in standing crop after four years of steady declines between 2000 and 2004. The MGORD Section of Rush Creek recorded a dramatic increase of more than 700% between the 2004 and 2006 standing crop estimates, an indication of population recovery following construction activities.

Estimated brown trout standing crops (kg/ha) in the Lee Vining Lower Side-channel Section decreased by 18.5% from 2005 to 2006. Unfortunately no year-to-year comparisons were possible for the other three Lee Vining Creek sections because an estimate was not generated for the Upper side-channel in 2005 because too few fish were sampled and the Main-channel sections were not sampled in 2006 due to high flows.

The 2006 standing crop estimate in Walker Creek increased by nearly 90% after two consecutive seasons of declines (2004 and 2005); with the largest decrease (49.7%) occurring between 2004 and 2005. In Parker Creek, the estimated standing crop increased slightly (3.6%) between 2005 and 2006.

Relative Weight and Condition Factor of Brown Trout > 150 mm in Length

Relative conditions of brown trout captured during 2006 were similar to those found in 2001-05 in Upper and Lower Rush Creek sections. Brown trout condition in the County Road section in 2006 dropped to 1.00 from 1.08 in 2005, the highest ever computed for this section. The MGORD condition value of 1.12 was the highest for all study sections in 2006 and was a marked improvement from the 0.99 value in 2004.

Condition factors for brown trout in both Lee Vining Creek side-channel sections were slightly higher than the previous five years. Over all eight years of sampling, the body-condition for brown trout in Lee Vining Creek was highest in 2000.

In Parker Creek, the condition factor for brown trout in 2006 dropped slightly for the third consecutive year. In Walker Creek, the condition factor for brown trout dropped to 0.99 in 2006 from the 2005 value of 1.21, the highest value computed for this section for eight seasons of data collection.

Radio Telemetry-Movement Study

As of April of 2007 the movement study is still on-going, with the final manual relocations scheduled for May of 2007. Complete results will be reported in May of 2008.

Relative Stock Densities

Relative stock densities (RSD) are numerical descriptors of length-frequency data and were proposed as a new termination criterion in March of 2007. RSD values will simply be reported as the proportions (percentage x 100) of the total number of brown trout over 150 mm (6”) in length that in turn are greater than 225 mm or 9” (RSD-225), 300 mm or 12” (RSD-300) and 375 mm or 15” (RSD-375) in length, or:

RSD-225 = # of fish greater than 225 mm ÷ # of fish greater than 150 mm x 100
RSD-300 = # of fish greater than 300 mm ÷ # of fish greater than 150 mm x 100
RSD-375 = # of fish greater than 375 mm ÷ # of fish greater than 150 mm x 100

RSD-225 values on Rush Creek have increased from 2000 through 2006. This was especially evident in the Upper and Lower study sections. RSD-225 values ranged from 30-44 (except during 2005 at Lower Rush) in 2004-2006, which were years with relatively high stream runoff volumes. In contrast, from 2000-2003, which were much lower runoff years, RSD-225 values were less than 20 and as low as 5 for Lower Rush in 2001.

The highest RSD-300 values that have been measured thus far on Upper and Lower Rush Creek have been 4 and 3, respectively during 2006. RSD-300 and RSD-375 values for the MGORD were calculated to reflect the potential of this reach of Rush Creek to produce larger brown trout. A preliminary comparison to other eastern Sierra streams has shown that the MGORD section of Rush Creek is capable of supporting a catch-and-release fishery for trophy-sized wild brown trout on par with the Upper Owens River and Hot Creek.

There is no obvious trend in RSD-225 values for either Main-channel Section of Lee Vining Creek between 2000 and 2005. Lee Vining Creek is subjected to wider variations in runoff rates and volumes than Rush Creek, and this may be reflected in the up-and-down fluctuations of RSD-225 values.

RSD values were not calculated for Parker and Walker creeks because these sections are not included in termination criteria analyses.

Termination Criteria

In March of 2007, Chris Hunter (the Mono Basin Court-Appointed Fisheries Scientist) submitted a document to the Water Board that proposed new fisheries termination criteria on Rush and Lee Vining creeks as specified in State Water Resources Control Board Orders WR98-05 and WR98-07. The rationale for replacing the current termination criteria was to evaluate brown trout populations in a more quantifiable and relevant fashion. As stated in our eight annual reports no data were available that provided a scientifically quantitative picture of trout populations that these streams supported on a self-sustaining basis prior to 1941 (Hunter et al. 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006). In our earlier reports we also recommended that at least six to 10 years of annual data be collected to objectively evaluate the current termination criteria, as well as assess potential relationships between fish populations and physical habitat components, such as flows, physical habitat parameters, and water temperatures.

Mr. Hunter, with the assistance of his sub-consultants, proposed employing four repeatable and quantifiable metrics as termination criteria to evaluate the brown trout populations in the Upper, Lower, and County Road study sections of Rush Creek and both study sections on Lee Vining Creek – biomass, density, condition, and relative stock density (RSD) of catchable trout ≥225 mm (≥9”) fish in the population. A fifth metric for the Rush Creek sections only was the proportion of brown trout ≥300 mm (≥12”).

Finally, Mr. Hunter proposed that three termination criteria metrics of RSD were applied to the Rush Creek Mono Gate One Return Ditch (MGORD) only – the RSD of brown trout ≥225 mm, ≥300 mm, and ≥375 mm (≥15”).

Introduction

This report presents the results of the tenth year of fish population monitoring for Rush, Lee Vining, Parker, and Walker creeks pursuant to State Water Resources Control Board (SWRCB) Decision #1631 and the eighth year following SWRCB Orders #98-05 and #98-07. As required, fish population monitoring will continue until the streams have met termination criteria included in the Settlement Agreement. These termination criteria describe the presumed pre-project conditions for fish population structure:

1. Lee Vining Creek sustained catchable brown trout averaging 8-10 inches in length. Some trout reached 13 to 15 inches.
2. Rush Creek fairly consistently produced brown trout weighing ¾ to 2 pounds. Trout averaging 13 to 14 inches were also regularly observed.

In addition to these criteria, Order 98-07 states the monitoring team will develop and implement a means for counting or evaluating the number, weights, lengths and ages of fish present in various reaches of Rush Creek, Lee Vining Creek, Parker Creek and Walker Creek. No termination criteria were set forth for Parker and Walker Creeks, tributaries to Rush Creek.

The Settlement Agreement states that the monitoring team will consider young-of-year (age-0) production, survival rates between age classes, growth rates, total fish per mile and any other quantified forms as possible termination criteria, although the Settlement Agreement does not compel the choice of any one form.

This report provides fish population data mandated by the Orders and the Settlement Agreement. Fish length data is reported in millimeters (mm) in this report. For those not used to working in the metric system, an easy numerical reference point is 200 mm which is approximately eight inches. An eight-inch trout is often referred to as the minimum size of a “catchable” trout.

Study Area

The same three population estimate sample sections in Rush Creek (County Road, Lower, and Upper), two of the four Lee Vining Creek sections (B1 and A4 side-channels), and the Walker and Parker Creek sections sampled in previous years were again sampled between September 3rd and 15th of 2006 (Figure 1). Due to high flows that made sampling unsafe, the two normally-sampled mainstem sections of Lee Vining Creek were not sampled in 2006. The MGORD was sampled in 2006 for two purposes: to collect additional brown trout for the movement study and to generate a population estimate. While we expressed previous concerns about the dynamic nature of the stream channels (particularly in Rush Creek) making sample sections subject to change (Hunter et al. 2001) , it was agreed we would maintain existing sample sections after a site visit with representatives from Los Angeles Department of Water and Power (LADWP) in 2001.

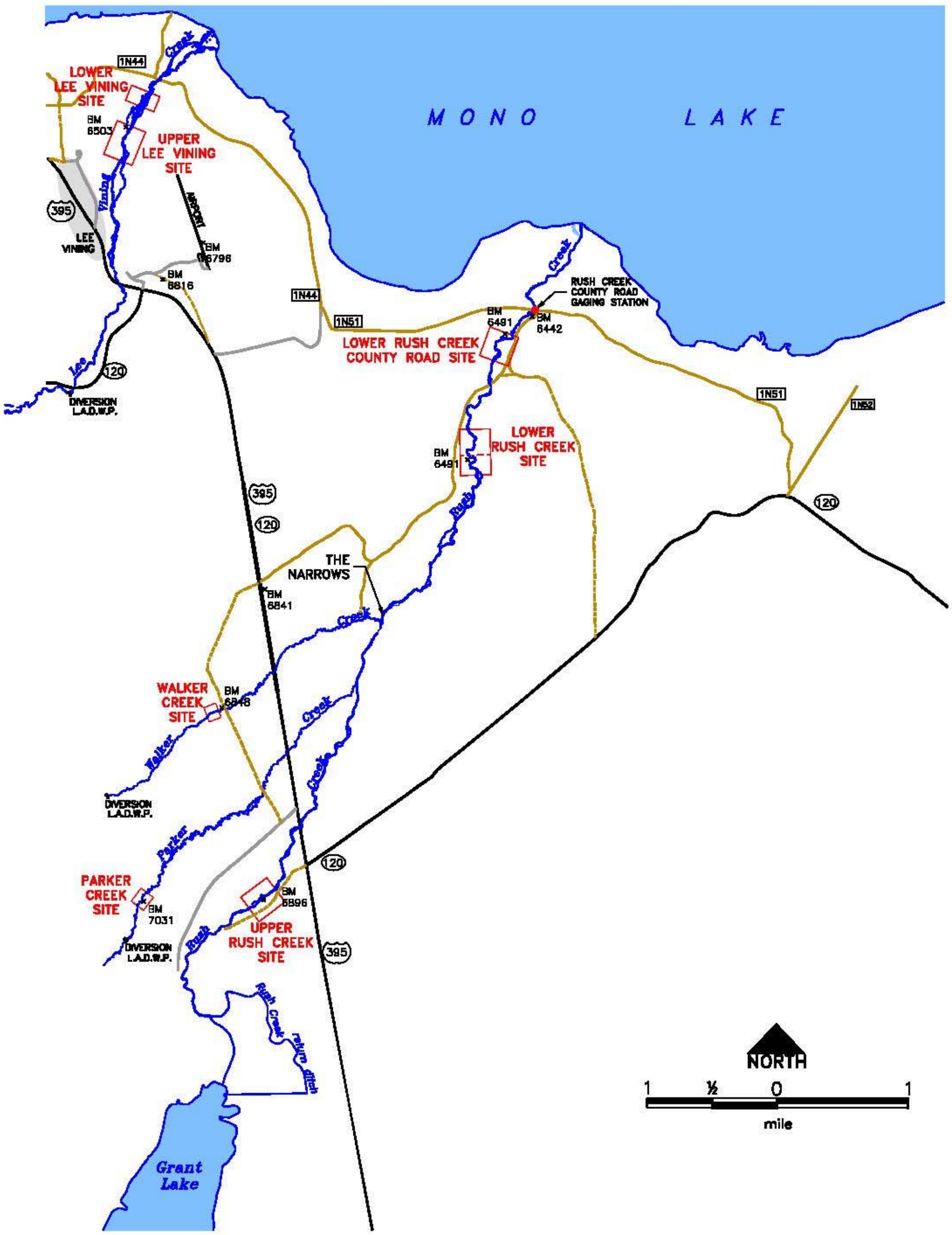


Figure 1. Map of Mono Basin study area with fish sampling sites displayed (modified from McBain and Trush 2000).

Most sample sections experienced a narrowing of channel widths from 2005 to 2006. In Rush Creek, the County Road Section was 0.7 meters narrower in 2006 than in 2005, the Lower Section was 0.3 meters narrower and the Upper Section was about 0.4 meters narrower (Table 1). These changes may be the result of where the channel widths were randomly measured and how many widths were measured.

Table 1. Total length (m), average wetted width (m), and total surface area (m^2) of sample sections in Rush, Lee Vining, Parker, and Walker creeks sampled between September 3rd and 15th, 2005. Values for 2005 provided for comparisons. **Bold font** designates noticeable changes in average channel widths between 2005 and 2006.

Section	Length (m) - 2005	Width (m) - 2005	Area (m^2) - 2005	Length (m) - 2006	Width (m) – 2006	Area (m^2) - 2006
Rush – County Road	813	**8.4**	6,829.2	813	**7.7**	6,260.1
Rush - Lower	405	6.9	2,794.5	405	**6.6**	2,673.0
Rush – Upper	430	**8.6**	3,698.0	430	**8.2**	3,526.0
Rush - MGORD	2,230	12.0	26,760.0	2,230	12.0	26,760.0
Lee Vining – Lower main	155	5.2	806.0	N/A	N/A	N/A
Lee Vining - Lower-B1	195	4.6	897.0	195	**3.9**	760.5
Lee Vining – Upper main	330	7.4	2,442.0	N/A	N/A	N/A
Lee Vining - Upper-A4	201	N/A	N/A	191	3.8	725.8
Parker	98	2.2	215.6	98	2.2	215.6
Walker	100	1.8	180.0	100	1.8	180.0

For the second year in a row, Rush Creek experienced an above average runoff (Figure 2). Due to the deep snow pack and late-spring accumulations, stream flow exceeded 200 c.f.s for 71 days between May 23rd and August 1st. Flow in Rush Creek below the Narrows (including Parker and Walker accretions) peaked at 584 c.f.s. on June 8th. The drop in the hydrograph from 68 to 41 c.f.s. between September 4th and 16th was done in order to make the fisheries sampling possible.

Stream flows in Lee Vining Creek below the intake were also a function of the deep snow pack and extended run-off (Figure 3). Lee Vining Creek experienced several distinct peaks during the snowmelt and spring run-off as a function of snowmelt occurring at distinct breaks in elevation. Stream flow in Lee Vining Creek exceeded 200 c.f.s. for 70 days between May 13th and July 24th. The largest peak discharge was 457 c.f.s. on June 7th. The valley between the latest two peak discharges was a period when air temperatures dropped and the snow-melt process was interrupted (Hanna, pers. comm.).

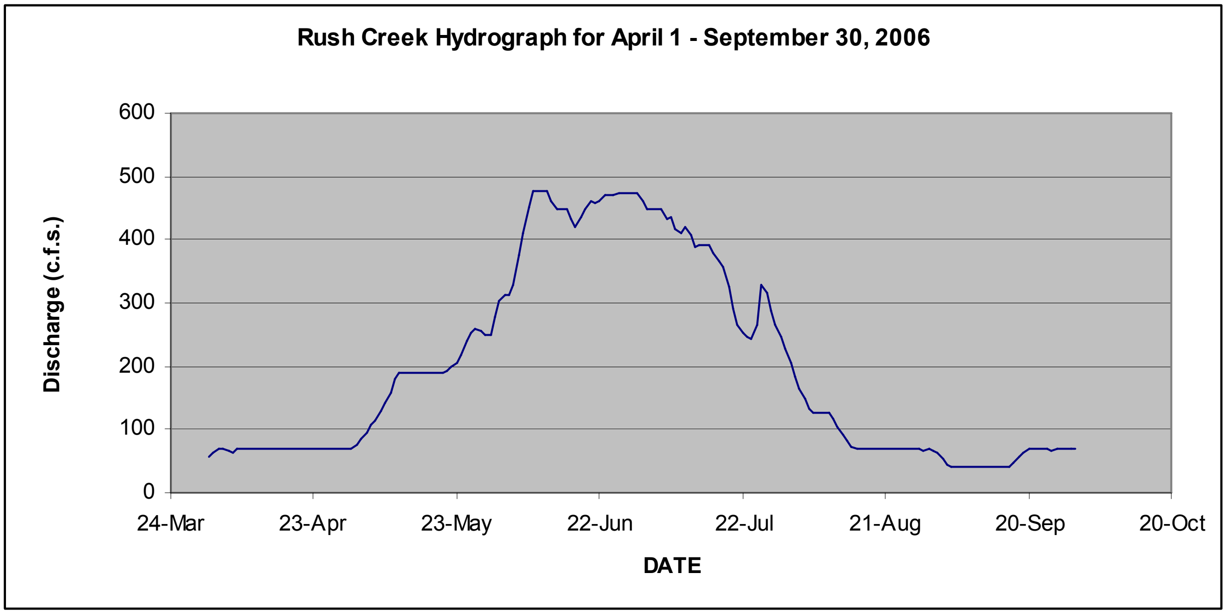


Figure 2. Daily stream flows (cubic feet per second; c.f.s) in Rush Creek above the Narrows between April and October 2006. Data were provided by LADWP.

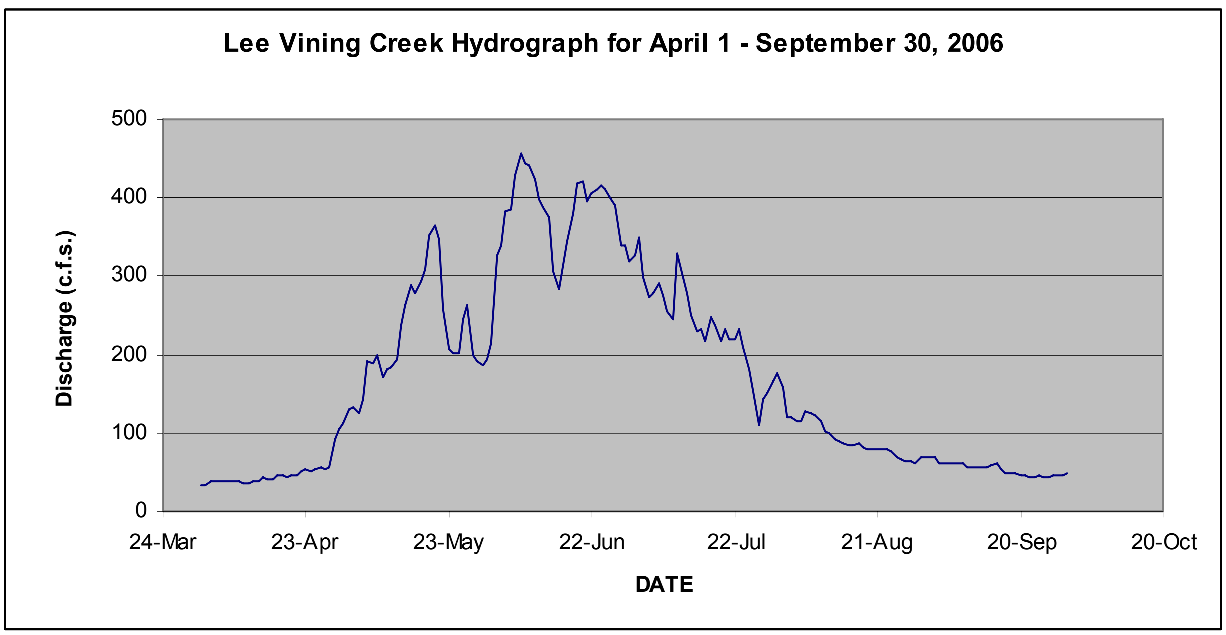


Figure 3. Daily stream flows (c.f.s) in Lee Vining Creek below the diversion between April and October 2006. Data were provided by LADWP.

Methods

Fish Population Estimates

Sampling for generating fish population estimates occurred during the late summer between September 3rd and 15th, 2006. Mark-recapture estimates were made in the MGORD, County Road, Lower, and Upper sections of Rush Creek. During all mark-recapture estimates in Rush Creek, fish were captured using a Smith-Root® 2.5 GPP electro-fishing system that consisted of a Honda® generator powering a variable voltage pulsator (VVP) that had a rated maximum output of 2,500 watts.

During mark-recapture electro-fishing an insulated cooler with several battery-powered aerators was carried in the barge to transport captured fish. A person operating an anode and a dip netter fished each half of the stream in a downstream direction (total of two electro-fisher operators and two dip netters). The fifth crew member walked the barge downstream and monitored the condition of captured fish in the live-well. All netted fish were placed in the insulated cooler within the barge shortly after capture.

A drift boat was utilized to capture fish in the MGORD and required a five-person crew to operate (Figure 4). The electrofishing barge was tied-off to the starboard side of the drift boat and two persons walked the drift boat downstream with the boat perpendicular to the channel with the port side of the drift boat facing downstream (Figure 4). An anode was thrown back and forth across the width of MGORD by a crewmember in the drift boat. Another crewmember netted stunned fish from the drift boat. A third person sat in the stern of the drift boat, monitored the electrofishing equipment and was responsible for the safety of other crew members. An attempt was made to drive the fish downstream with the electrical field and then stun them as they tried to move back upstream past the drift boat. Another group of crewmembers blocked fish from moving downstream by using a backpack shocker and one or two netters at shallower portions of the MGORD (Figure 5). Many fish were often sampled when the drift boat converged with the downstream blocking crew. Due to the high numbers of age-1 and older fish encountered in the MGORD, no attempt was made to capture enough age-0 trout to derive a reliable estimate for this age group. Rather, the focus of capture efforts was on age-1 and older fish.

Due to relatively high flows (approximately 60 c.f.s.) and unsafe wading conditions, we were unable to sample the main channel portions of Upper and Lower Lee Vining Creek sections in 2006. Depletion estimates were made in one sample section within each of Parker Creek and Walker Creek and in the two side-channels of Lee Vining Creek associated with the Lower and Upper main channel sections. For all depletion estimates Smith-Root® BP backpack electro-fishers (Models 12B and LR-24) were used to capture fish.

Figure 4. Drift boat electrofishing set-up on the Rush Creek MGORD.

Figure 5. Downstream blockers on the Rush Creek MGORD.

Two backpack electro-fishers were used when sampling the Lee Vining Creek side-channel sections, whereas a single backpack electro-fisher was used in each of the Walker Creek and Parker Creek sections. At least one dip-netter per electro-fisher netted fish stunned by that electro-fisher. An extra crew member served as a backup dip-netter and carried a five-gallon live bucket equipped with an aerator in which all captured fish were placed immediately after capture.

To meet the assumption of closed populations for sampling purposes, all sample sections, except the MGORD and County Road section, were blocked at both ends prior to sampling. Block fences were not placed at the boundaries of the MGORD and County Road sections; however these sections were long enough (2,230 m and 813 m, respectively) that effects of movements at the ends of the sample section should have been low in proportion to the number of fish in the entire section. In the Upper and Lower Rush Creek sections 12 mm mesh hardware cloth fences were installed at the upper and lower boundaries of the sections. These hardware cloth fences were installed by driving fence posts (metal t-posts) at approximately two-meter intervals through the bottom portion of the hardware cloth approximately 15 cm from its bottom edge. Rocks were hand-placed along the bottom edge of the hardware cloth to prevent fish from passing underneath the block fence. Rope was then strung across the top of each fence post and anchored to fence posts or trees on each bank. The hardware cloth was held vertically by wiring the top of the cloth to this rope with baling wire. These fences were installed prior to the marking run and maintained in place until after the recapture effort was completed. Fences were cleaned and checked at least once daily, and usually twice daily, to ensure they remained in place and for enumerating any dead fish between mark and recapture sampling.

Block fences were maintained for the duration of time (seven days) between the marking and recapture electro-fishing runs because a single field technician was employed specifically to maintain these fences. For the side-channel portions of the Upper and Lower Lee Vining Creek sections and the sample sections in Parker and Walker creeks 12 mm mesh block seines were placed at sample section boundaries during depletion efforts.

All captured fish were anesthetized, measured to the nearest mm (total length), and most were weighed to the nearest gram. Data were entered onto both data sheets and into a hand-held personal computer (Compaq iPAC®) in the field. Scale samples were taken from a sub-sample of fish (see "Age-Growth Estimates" section below) for age determinations.

All fish captured in the study sections employing the mark-recapture estimator methodology were given a clip for identification during the recapture electro-fishing run. The lower caudal fin was clipped to mark fish in the County Road section of Rush Creek and the Upper Lee Vining Creek main channel section. The upper caudal fin was clipped to mark fish in the Upper Rush Creek section. The anal fin was clipped to mark fish in the Lower Rush Creek section and the Lower Lee Vining Creek section. When clipping a fin, scissors were used to make a straight vertical cut from the top, or bottom, of the fin approximately 1-3 mm deep at a location about 1-3 mm from the posterior edge of the fin.

During September 2002, we tagged 101 brown trout longer than 225 mm with individually numbered Floy® anchor tags within our sample sections in the Rush Creek drainage. We recorded the identification numbers for any tag-recaptures we found during 2006 sampling.

Population and biomass estimates were made for all mark-recapture estimates using an updated version of Montana Fish, Wildlife and Parks' Fisheries Plus analysis package (version 1.10). All estimates were generated using this program and employed the modified Peterson estimator (Chapman 1951, as cited in Ricker 1975).

Length-Weight Regression

Length-weight regressions (Cone 1989) were calculated for brown trout in each section of Rush Creek by year to assess differences in length-weight relationships between sections and years. Log_{10} transformations were made on both length and weight prior to running regressions. Methods for calculating relative condition factors were consistent with those initially developed by Le Cren (1951) and expanded by Swingle (1965) and Swingle and Shell (1971).

Due to the difficulty of accurately sexing most of the brown trout captured during our annual sampling, no attempt has been made to determine separate condition factors for male and female fish. However our sampling occurs at the same time each year (early to mid-September), thus any changes in condition factor would not be due to seasonal differences.

Fin Clips and Growth Estimates

For generating future growth estimates, all age-0 brown trout (<125 mm) had their adipose fins clipped as a permanent mark to identify them as age-0 fish in 2006. Empirical growth will be tracked by subsequently recapturing these marked fish to estimate annual growth and verify our scale aging and back-calculations of annual growth.

All captured fish were carefully examined to see if they had previously had their adipose fin clipped (identifying them as an age-0 fish in 2003 and age-3 fish in 2006), if their left pelvic was clipped (identifying them as age-0 fish in 2004 and age-2 fish in 2006) or if their right pelvic was clipped (identifying them as age-0 fish in 2005 and age-1 fish in 2006). All recaptured clipped (adipose or left/right pelvic) fish were noted on data sheets, a scale sample was taken for aging, and their lengths and weights were averaged by stream and sample section to derive empirical growth rates.

Proportional and Relative Stock Density Calculations

Proportional stock density (PSD) and relative stock density (RSD) are numerical descriptors of length-frequency data (Anderson and Gutreuter 1983). Given representative samples of a population, stock density indices are easily calculated and can provide insight or predictive ability about population dynamics. Typically, a fish population with high stock indices consists mainly of larger individuals, whereas as a population with low stock indices consists of mostly smaller individuals. When comparing stock-indices on the same stream over consecutive years or between streams within a region, one must be aware that values are often affected by sampling technique and seasonal timing (Anderson and Neumann 1996).

The term PSD was initially defined by Anderson (1976) and represented the percentage of stock-length fish that are also of a minimum quality length. The PSD concept was further expanded to examine a range of size categories and was defined as RSD (Reynolds and Babb 1978; Gabelhouse 1984). RSD analyses were originally developed for warm-water fisheries within impoundments; however the concepts have been successfully adapted to both lake-dwelling and stream-dwelling brown trout populations (Boltz et al. 1993; Milewiski and Brown 1994).

RSD is the percentage of fish of any designated length-group in a sample and is calculated by (Wege and Anderson 1978):

RSD = # of fish ≥ specified length ÷ # of fish ≥ minimum stock length x 100.

RSD values can range from 0 to 100 and should be rounded to the nearest whole number. The use of decimals represents unfounded accuracy (Anderson and Neumann 1996).

Total lengths of lotic brown trout for RSD analyses were proposed by Milewski and Brown (1994) after examining nearly 11,000 fish from 51 distinct populations (Table 2).

Table 2. Total lengths (metric and English units) of lotic brown trout proposed by Milewski and Brown (1994) for RSD analyses.

Length Category	Metric Value (mm)	English Value (inches)
Stock	150	6
Quality	230	9
Preferred	300	12
Memorable	380	15
Trophy	460	18

Relevance of RSD's as Termination Criteria for Mono Basin Streams

Numerous streams along the eastern Sierras from the Carson River south to the Owens River have a long history of providing high-quality recreational fishing experiences. A large focus of the restoration effort within the Mono Basin has been to restore the quality of the trout fishery that Rush and Lee Vining creeks historically provided.

The metrics of biomass, density, and condition factor have utility to the scientist in assessing the biological health of a fishery, yet may have little bearing to the recreational fisherman. Thus, we proposed using RSD-225 and RSD-300 as new termination criteria to track the proportion of larger brown trout within Rush Creek and RSD-225 in Lee Vining Creek. These size categories correspond well to the proportion of the brown trout populations of interest to most stream fishermen. RSD-375 will also be employed as a new termination criterion to the MGORD section of Rush Creek to assess the proportion of trophy-sized brown trout that frequent this section.

Calculating RSD Values for Mono Basin Streams and Regional Comparisons

In order to compare our Rush and Lee Vining creek data with the regional data collected by CDFG for termination criteria purposes, the size categories proposed by Milewski and Brown (1994) were slightly modified into 25 mm increments, as follows: 225-299 mm; 300-374 mm; ≥375 mm. The terms "stock", "quality", "preferred", "memorable", and "trophy" were replaced with the actual length categories to hopefully reduce any confusion these terms may cause to reviewers.

Thus, RSD values will simply be reported as the proportions (percentage x 100) of the total number of brown trout over 150 mm (6") in length that in turn are greater than 225 mm or 9" (RSD-225), 300 mm or 12" (RSD-300) and 375 mm or 15" (RSD-375) in length, or:

RSD-225 = # of fish greater than 225 mm ÷ # of fish greater than 150 mm x 100
RSD-300 = # of fish greater than 300 mm ÷ # of fish greater than 150 mm x 100
RSD-375 = # of fish greater than 375 mm ÷ # of fish greater than 150 mm x 100

Radio Telemetry-Movement Study in Rush Creek

In 2005 a movement study of brown trout in Rush Creek was initiated. The purpose of this study was to document the seasonal movement patterns and corresponding habitat occupied by brown trout in the Rush Creek system between Grant Reservoir and Mono Lake. This movement and habitat data will be used to expand and refine the habitat suitability/stream discharge relationships being developed for Rush Creek. The data will also add to the information base necessary to establish realistic and sustainable termination criteria for Rush Creek. The goals of the study were:

GOAL (A): Document movement patterns of -

(1) Adult brown trout (age 3+ and >640 g in weight) implanted with radio transmitters in the MGORD during September 2005 to determine if these fish seasonally utilize other reaches of Rush Creek.

(2) Adult brown trout (age 2+ and between 180 - 225 g) and juveniles (Age 1+/2 between 85 - 105 g) implanted with radio transmitters in sections of Rush Creek during September 2005 to determine if these fish make seasonal migrations or move up into the MGORD.

GOAL (B): Document habitat occupied by radio-implanted adult and juvenile brown trout in Rush Creek -

(1) During all seasons and hydrologic periods, determine how (or if) habitat occupied by the tagged fish changes throughout the year. Particular emphasis was placed on documenting the habitat and survival of juvenile brown trout before, during and after winter (ice) conditions as well as before, during and after the spring runoff (high stream discharge) period.

(2) During brown trout spawning in October – December, determine the locations and habitat characteristics of the most heavily-used spawning areas.

The methodologies employed for operating the fixed receiving station and conducting manual relocations were fully described in the 2005 annual monitoring report (Hunter et al. 2006). The movement study was continued through 2006, including the deployment of additional radio tags in September. The final budgeted relocations will occur in May of 2007.

Results

Fish Population Abundance

Rush Creek

County Road Section

In 2006 a majority (69%) of the 906 brown trout captured in the County Road Section of Rush Creek were young-of-the year fish between 50 and 124 mm and the longest brown trout captured was 297 mm (Figure 6). This section supported an estimated 2,054 age-0 and 571 age-1 and older brown trout in 2006 (Table 3). Estimates of brown trout were relatively precise with standard errors ranging from 11.6 to 16.4% of the estimates. For rainbow trout, only four fish (175, 182, 185, and 193 mm in length) were sampled in 2006 (Figure 9).

Lower Section

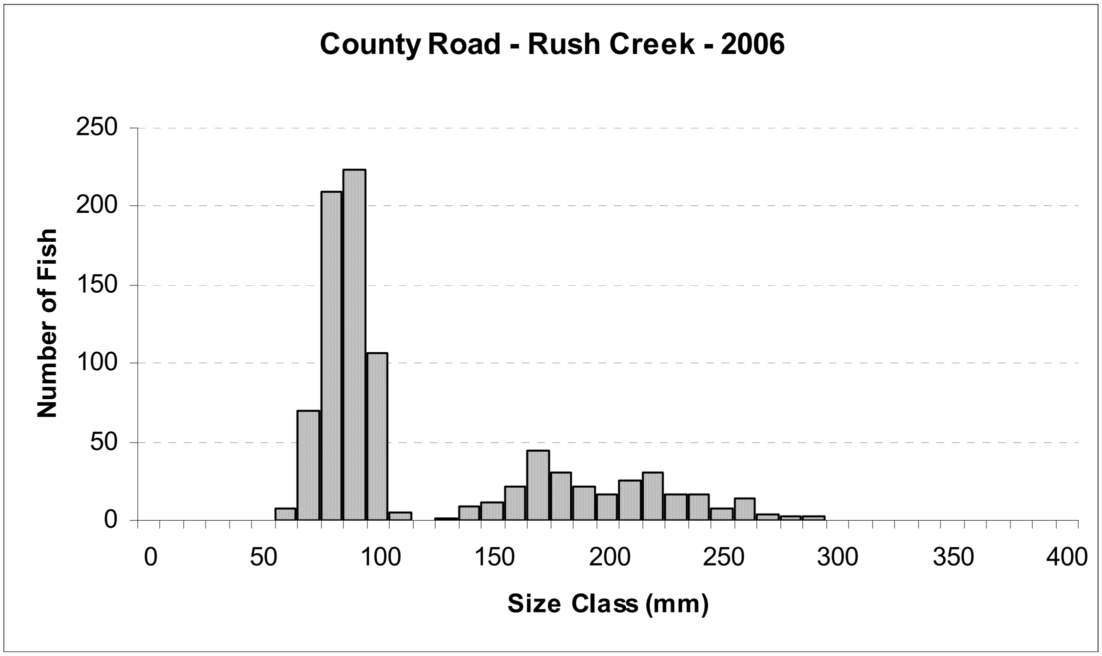
A majority (70%) of the 507 brown trout captured in the Lower Section of Rush Creek were young-of-the year fish between 50 and 124 mm (Figure 6). Four brown trout greater than 300 mm were sampled and the longest was 312 mm. This section supported an estimated 825 age-0 and 257 age-1 and older brown trout in 2006 (Table 3). Estimates of all size classes of brown trout were relatively precise with standard errors ranging from 11.6 to 17.9% of the estimates. Only 13 rainbow trout were sampled in 2006 and no estimates were generated (Figure 8).

Upper Section

A majority (71%) of the 830 brown trout captured in the Upper Section were young-of-the year fish between 50 and 124 mm (Figure 7). Ten brown trout greater than 300 mm were sampled and the longest was 351 mm in length. The Upper Section of Rush Creek supported an estimated 2,912 age-0 and 470 age-1 and older brown trout in 2006 (Table 3). Estimates of all size classes of brown trout were relatively precise with standard errors ranging from 10.1 to 15.7% of the estimates. A total of 24 rainbow trout were captured in 2006 (Figure 9). An estimate for rainbow trout ≥200 mm was 16 fish; however this estimate may be biased because only six marked fish were sampled on the capture-run (Table 3). Fifteen tui chub (*Gila bicolor*) were also sampled in the Upper Section and an estimate of 16 tui chub ≥200 mm was generated (Table 3). The tui chub were most likely flushed-out of Grant Reservoir when water was flowing over the spillway at >100 c.f.s. for 45 straight days (of which 15 days were >200 c.f.s.).

MGORD Section

A majority (71%) of the 632 brown trout captured in the MGORD Section were greater than 200 mm in length and no estimate was possible for brown under 200 mm (Figure 7). Four brown trout greater than 500 mm were sampled and the longest was 559 mm in length. In 2006 the MGORD supported an estimated 1,766 brown trout ≥200 mm in length (Table 3). This estimate of brown trout ≥200 mm was relatively precise with a standard error of 11.5%. A total of 19 rainbow trout were captured in 2006 (Figure 9). Twenty-four tui chub were also sampled in the MGORD, but no estimate was generated (Table 3).



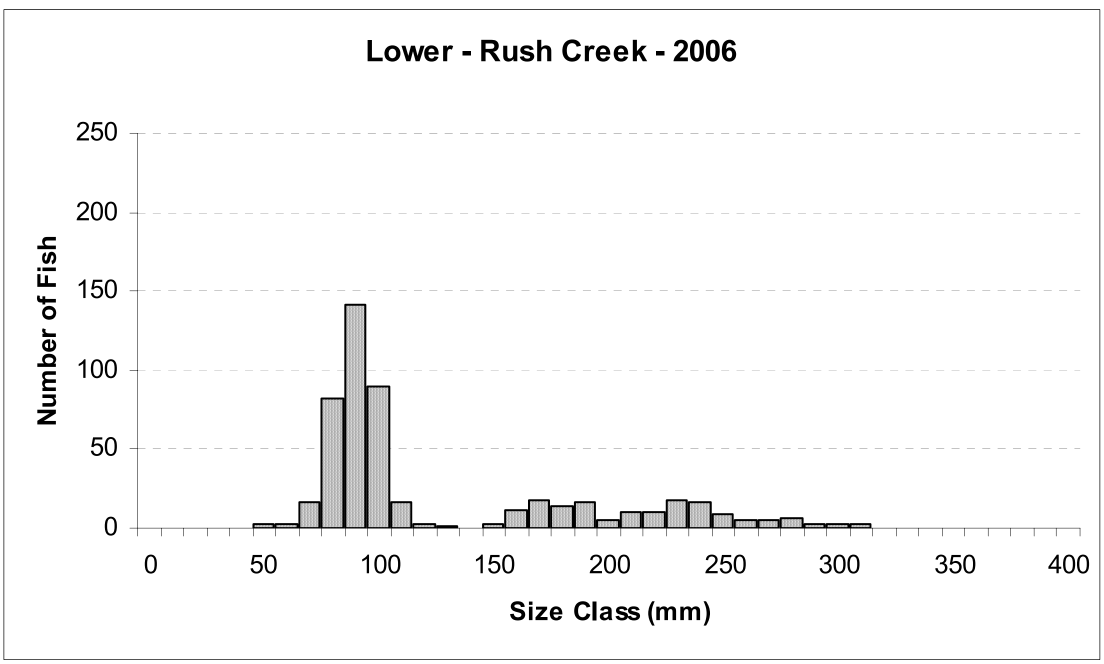
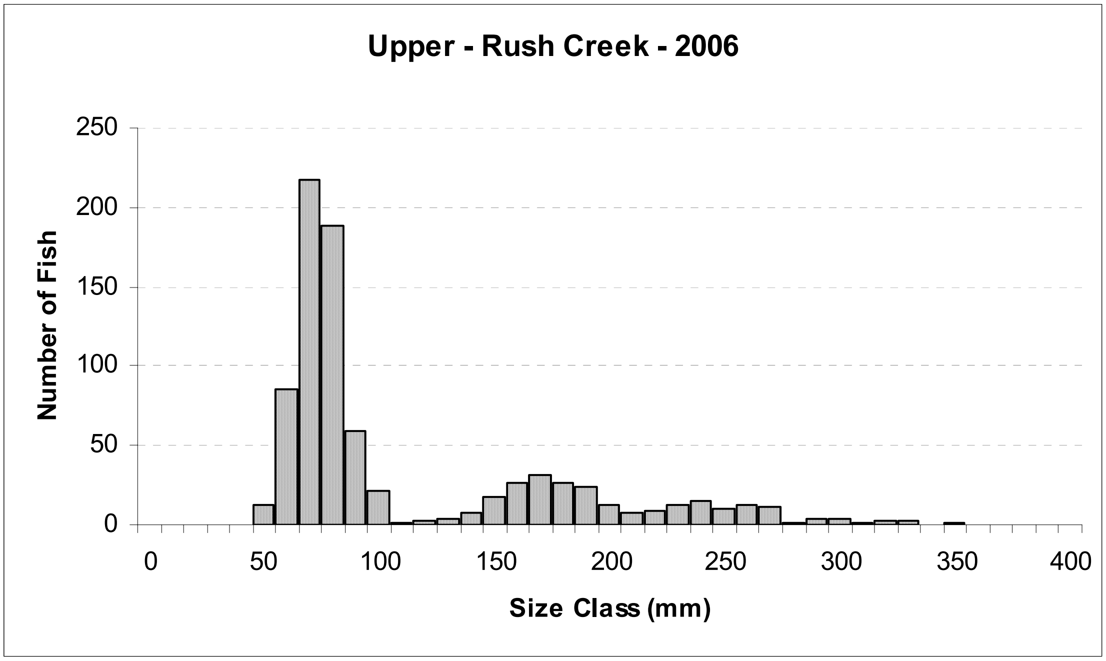


Figure 6. Length frequency histograms of brown trout captured in the County Road (top) and Lower (bottom) sections of Rush Creek between September 3rd and September 15th, 2006.



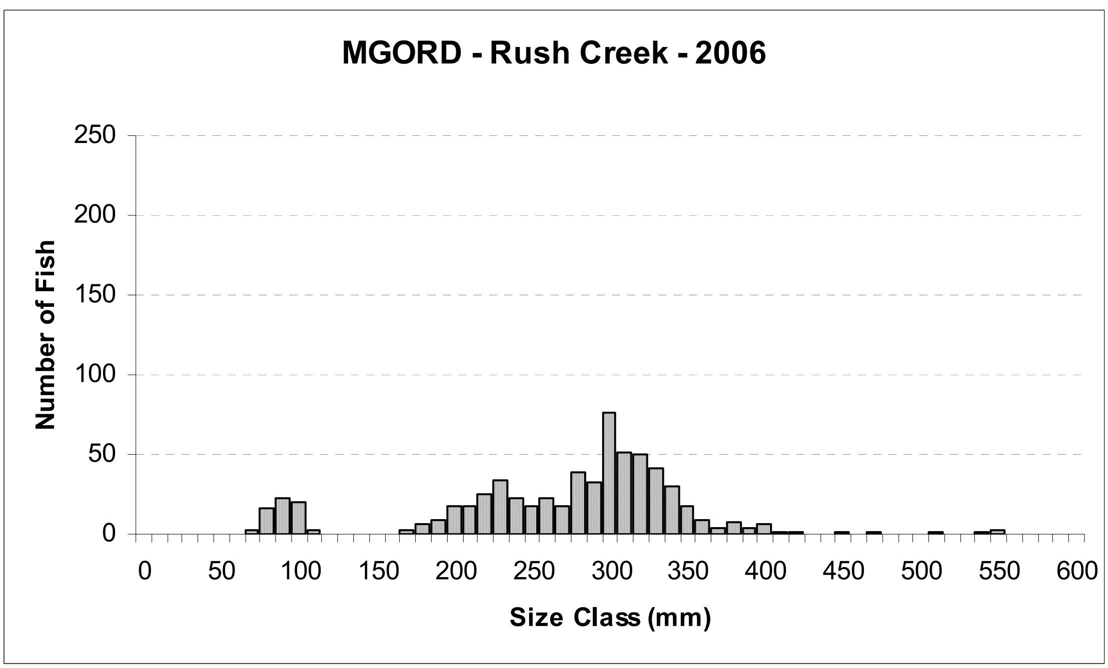
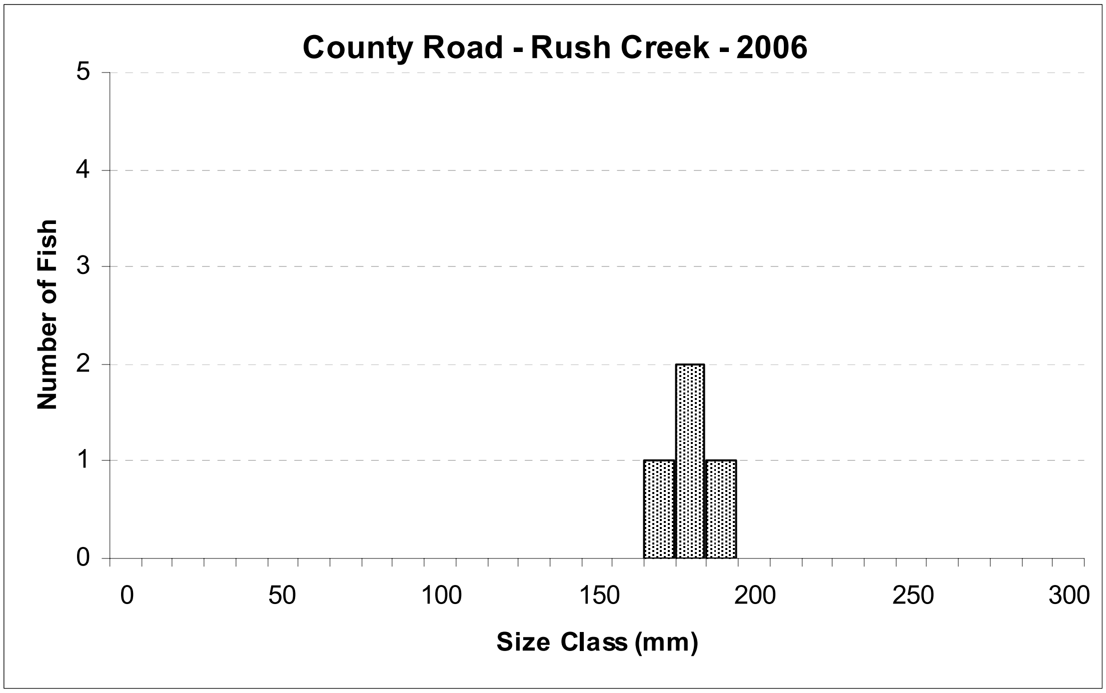


Figure 7. Length frequency histograms of brown trout captured in the Upper (top) and MGORD (bottom) sections of Rush Creek between September 3rd and September 15th, 2006.



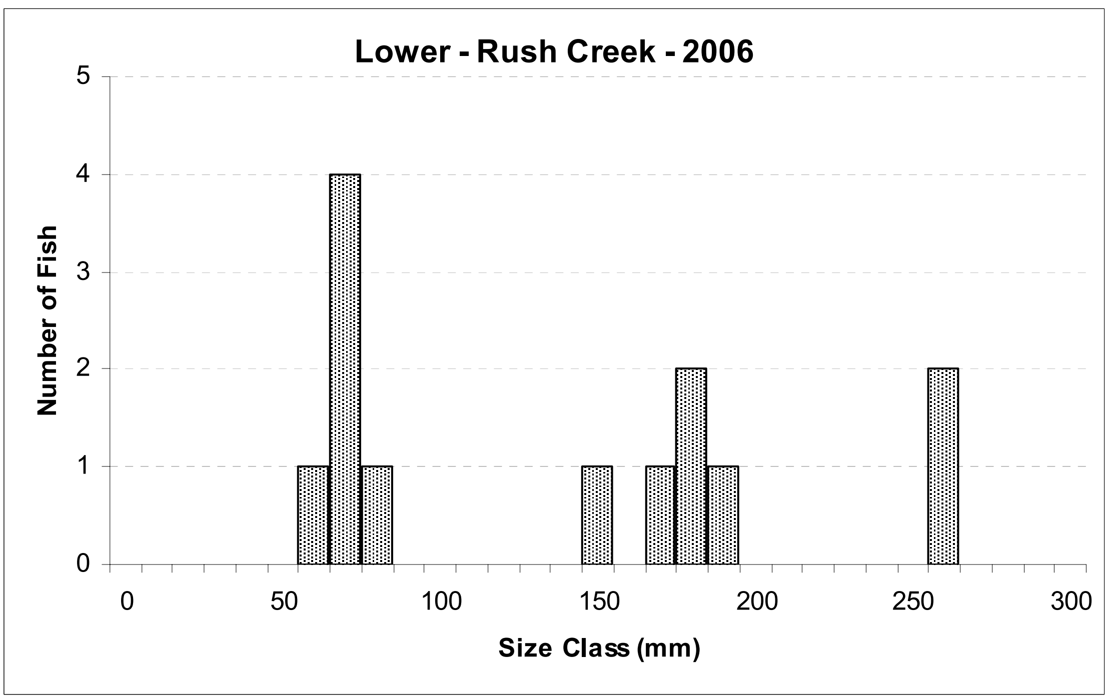
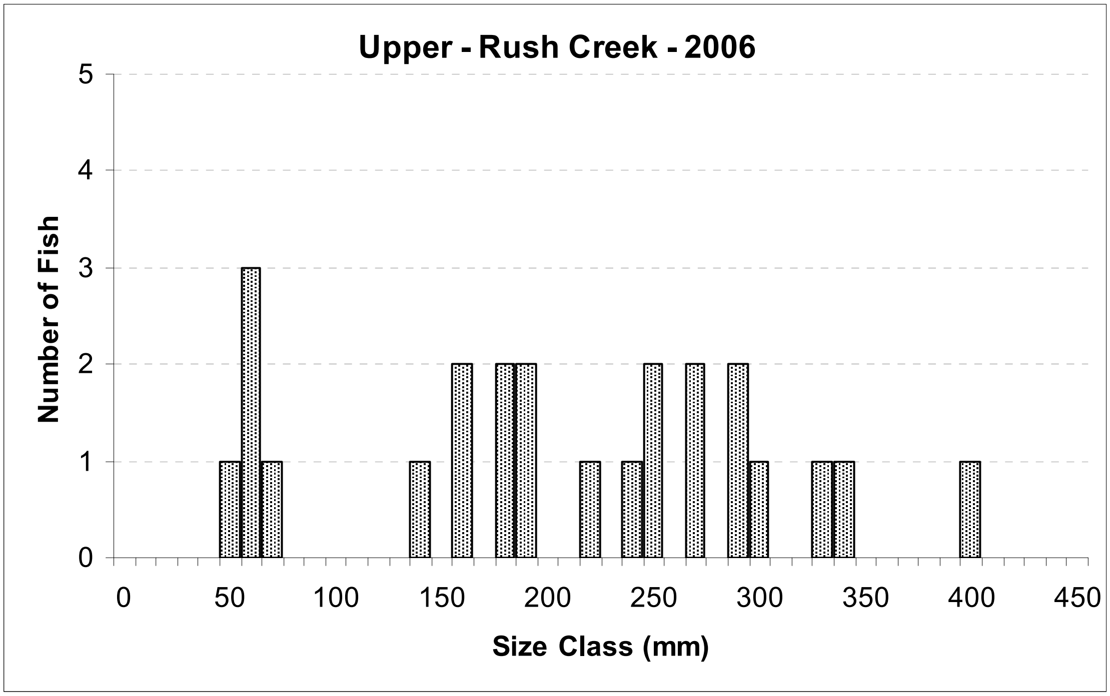


Figure 8. Length frequency histograms for rainbow trout captured in the County Road (top) and Lower (bottom) sections of Rush Creek between September 3rd and September 15th, 2006.



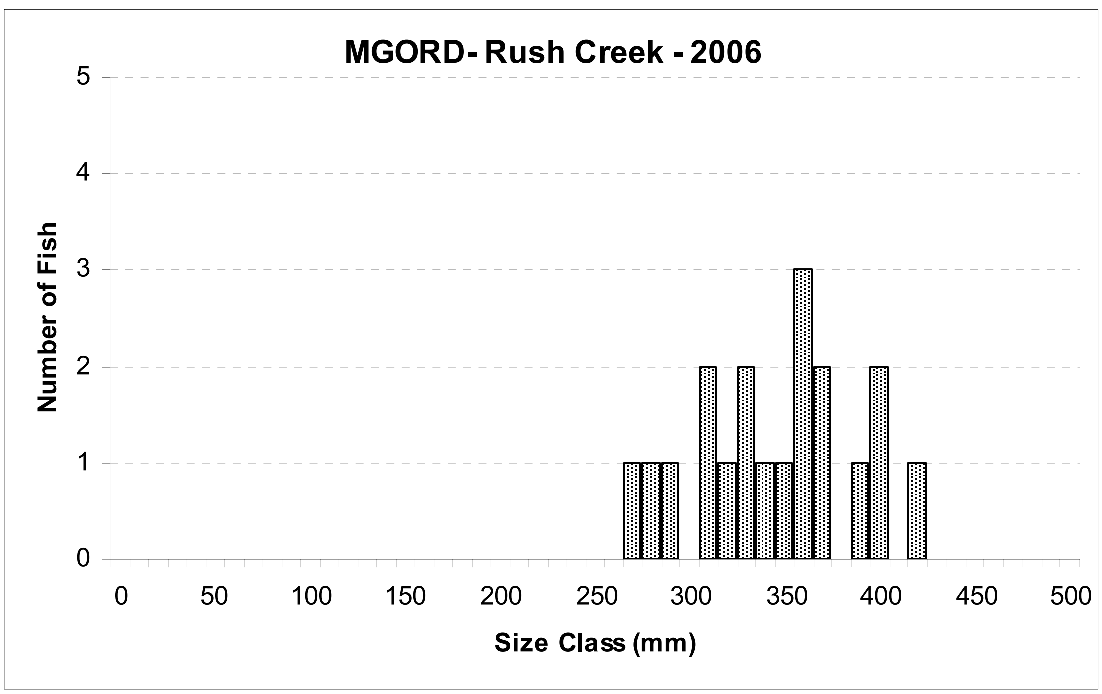


Figure 9. Length frequency histograms for rainbow trout captured in the Upper (top) and MGORD (bottom) sections of Rush Creek between September 3rd and September 15th, 2006.

Table 3. Rush Creek mark-recapture estimates for 2006 showing total number of fish marked (M), total number captured on the recapture run (C), number recaptured on the recapture run (R), and total estimated number and its associated standard error (S.E.) by stream, section, date, species, and size class. Mortalities (Morts) are those fish that were captured during the mark run, but died prior to the recapture run. Mortalities were not included in mark-recapture estimate and should be added to the estimate for an accurate total estimate. NP = estimate not possible

Stream / Section / Date / **Species**	Size Class (mm)	Mark - recapture estimate parameter values: M	C	R	Morts	**Estimate**	S.E.
Rush Creek							
County Road							
09/06/2006							
Brown Trout							
	0 - 124 mm	259	402	50	11	**2054**	238.7
	125 - 199 mm	78	81	19	0	**323**	53.1
	200 + mm	76	83	25	0	**248**	32.4
Rainbow Trout							
	0 – 124 mm	0	0	0	0	**0**	
	125 – 199 mm	2	3	1	0	**NP**[a/]	
	200 + mm	0	0	0	0	**0**	
Lower Rush							
09/04/2006							
Brown Trout							
	0 - 124 mm	134	256	41	4	**825**	95.6
	125 - 199 mm	37	38	12	1	**113**	20.2
	200 + mm	59	52	21	0	**144**	18.3
Rainbow Trout							
	0 – 124 mm	2	4	0	0	**0**	
	125 – 199 mm	2	4	1	0	**NP**[a/]	
	200 + mm	2	1	1	0	**NP**[a/]	

Table 3 (continued). Rush Creek mark-recapture estimates for 2006.

Stream / Section / Date / **Species**	Size Class (mm)	M	C	R	Morts	**Estimate**	S.E.
		Mark - recapture estimate parameter values					
MGORD							
09/05/2006							
Brown Trout							
	0 - 124 mm	9	63	0	0	**NP**[a/]	
	125 – 199 mm	4	9	0	0	**NP**[a/]	
	200 + mm	261	343	50	1	**1766**	203.0
Rainbow Trout							
	0 - 124 mm	0	0	0	0	**0**	
	125 – 199 mm	0	0	0	0	**0**	
	200 + mm	9	11	1	0	**NP**[a/]	
Tui Chub							
	0 - 124 mm	0	0	0	0	**0**	
	125 – 199 mm	2	0	0	0	**NP**[a/]	
	200 + mm	8	16	2	0	**NP**[a/]	
Upper Rush							
09/03/2006							
Brown Trout							
	0 - 124 mm	336	267	30	14	**2912**	461.5
	125 - 199 mm	82	71	18	3	**314**	53.0
	200 + mm	75	61	29	0	**156**	15.8
Rainbow Trout							
	0 - 124 mm	2	3	0	0	**NP**[a/]	
	125 - 199 mm	5	3	1	1	**NP**[a/]	
	200 + mm	9	6	3	0	**16**[b/]	4.0
Tui Chub							
	0 - 124 mm	0	1	0	0	**NP**[a/]	
	125 - 199 mm	0	0	0	0	**0**	
	200 + mm	10	10	6	0	**16**[b/]	2.0

[a/] "NP" indicates an estimate was not possible.

[b/] These estimates have fewer than 7 recaptures, so might be biased and the estimate with less than 3 recaptures is likely very biased.

Lee Vining Creek

As previously stated in the Methods section, both the Upper and Lower main-channel sampling sections of Lee Vining Creek were not sampled due to high flow in September of 2006. The flow measured at the Lee Vining Creek gauge was 61 c.f.s. on September 6th and was quite swift and deep in numerous locations throughout the main-channel. The previous year we sampled Lee Vining Creek at 50 c.f.s. and felt the conditions were marginal for safely wading and electro-fishing.

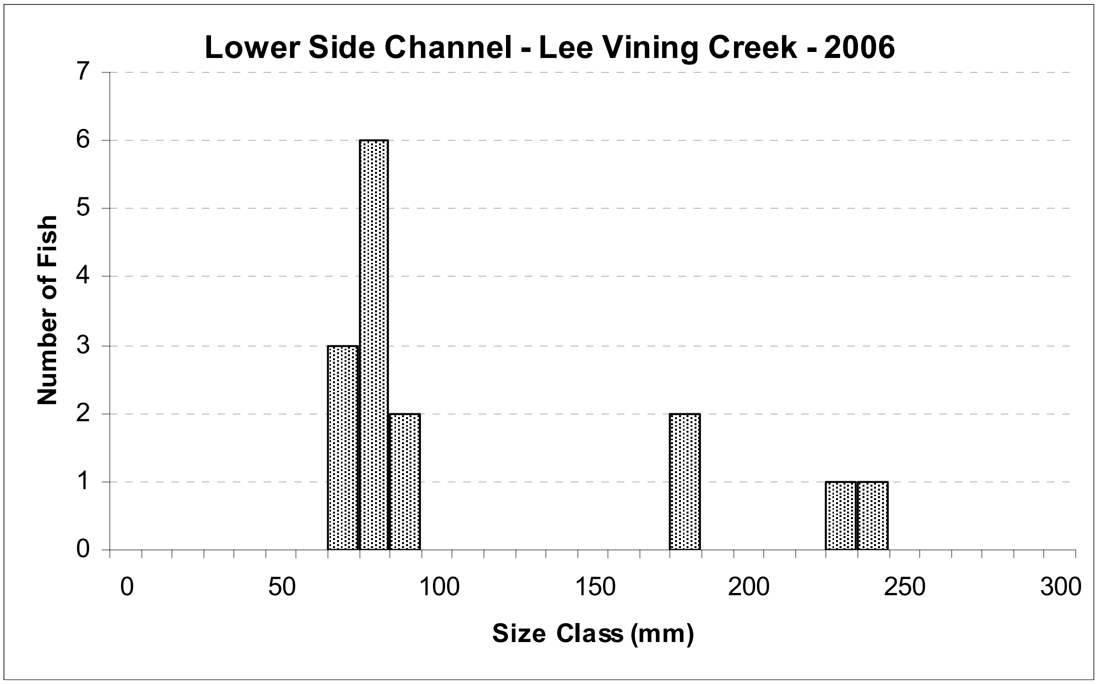
Lower Section Side-Channel

Only 15 brown trout were captured in the Lower side-channel and 11 of these were age-0 fish (Figure 10). The Lower side-channel section supported an estimated 11 age-0 brown trout and four age-1 and older brown trout in 2006 (Table 4).

Rainbow trout were more abundant than brown trout in the Lower side-channel sample section with a total of 77 fish captured, of which 72 were age-0 (Figure 11). The Lower side-channel supported an estimated 100 age-0 rainbow trout and an estimated five fish ≥125 mm (Table 4).

Upper Section Side-Channel

Twenty-one brown trout were captured in the Upper side-channel and 16 of these were age-0 fish (Figure 10). The Upper side-channel section supported an estimated 16 age-0 brown trout and five age-1 and older brown trout in 2006 (Table 4). A single 262 mm rainbow trout was sampled in the Upper Lee Vining side-channel in 2006. (Figure 11 and Table 4).



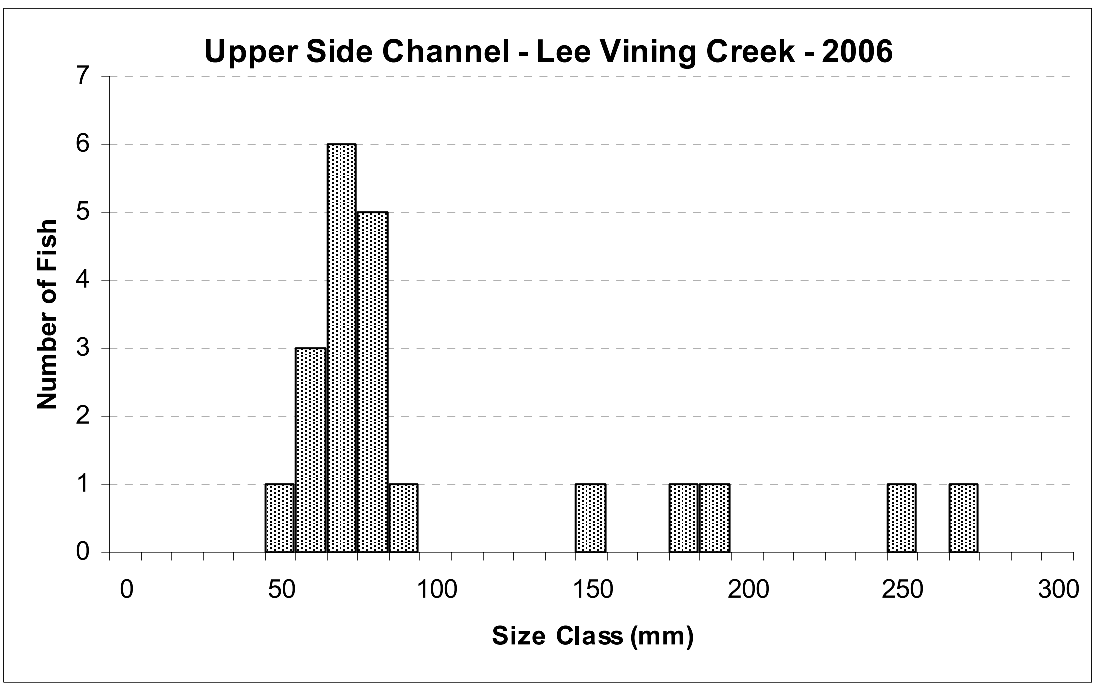
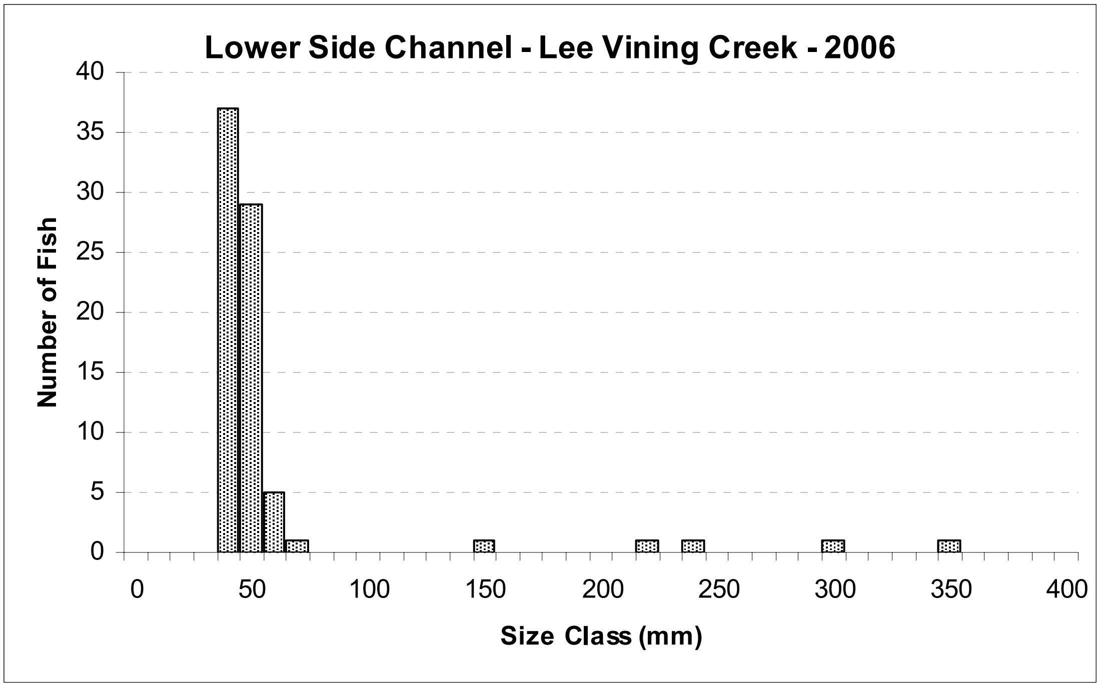


Figure 10. Length frequency histograms for brown trout captured in the Lower (top) and Upper (bottom) side-channel sections of Lee Vining Creek during September 2006.



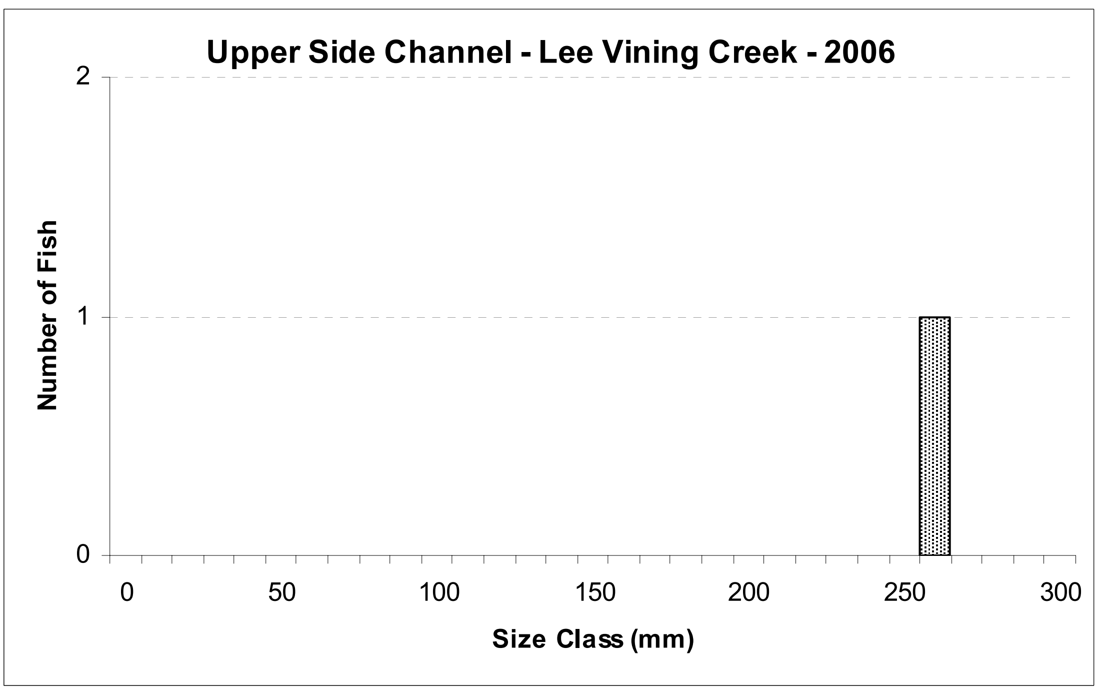


Figure 11. Length frequency histograms for rainbow trout captured in the Lower (top) and Upper (bottom) side-channel sections of Lee Vining Creek during September 2006. Note difference in y-axis values.

Table 4. Depletion population estimates made in the side channel portions of the Lower and Upper sections of Lee Vining Creek and in Parker and Walker creeks during September 2006 showing number of fish captured on each pass, estimated number, and standard deviation (S.D.) by species and length group.

Stream - Section				Removal by pass				
	Species	Size Class (mm)	Removals	1	2	3	Estimate	S.E.
Lee Vining Creek - Lower Side Channel (B1 Channel)								
	Brown Trout							
		0 - 124 mm	2	9	2	-	**11**	0.7
		125 - 199 mm	2	2	0	-	**2**	0.0
		200 + mm	2	2	0	-	**2**	0.0
	Rainbow Trout							
		0 - 124 mm	2	46	26	-	**100**	20.6
		125 - 199 mm	2	1	0	-	**1**	0.0
		200 + mm	2	4	0	-	**4**	0.0
Lee Vining Creek - Upper Side Channel (A2 Channel)								
	Brown Trout							
		0 - 124 mm	2	12	4	-	**16**	1.2
		125 - 199 mm	2	3	0	-	**3**	0.0
		200 + mm	2	2	0	-	**2**	0.0
	Rainbow Trout							
		0 - 124 mm	2	0	0	-	**0**	0.0
		125 - 199 mm	2	0	0	-	**0**	0.0
		200 + mm	2	1	0	-	**1**	0.0
Parker Creek								
	Brown Trout							
		0 - 124 mm	3	43	19	13	**86**	7.2
		125 - 199 mm	3	0	0	0	**0**	0.0
		200 + mm	3	6	4	1	**11**	1.0
Walker Creek								
	Brown Trout							
		0 - 129 mm[a/]	3	50	24	6	**84**	3.2
		130 - 199 mm	3	1	0	0	**1**	0.0
		200 + mm	3	26	4	1	**31**	0.4

[a/] One brown trout 126 mm was captured that was probably age-0, so this length group was adjusted upward to include this fish.

NOTE: one brook trout was captured in the Walker Creek section, but no estimate was made for this brook trout. It was captured on the first pass.

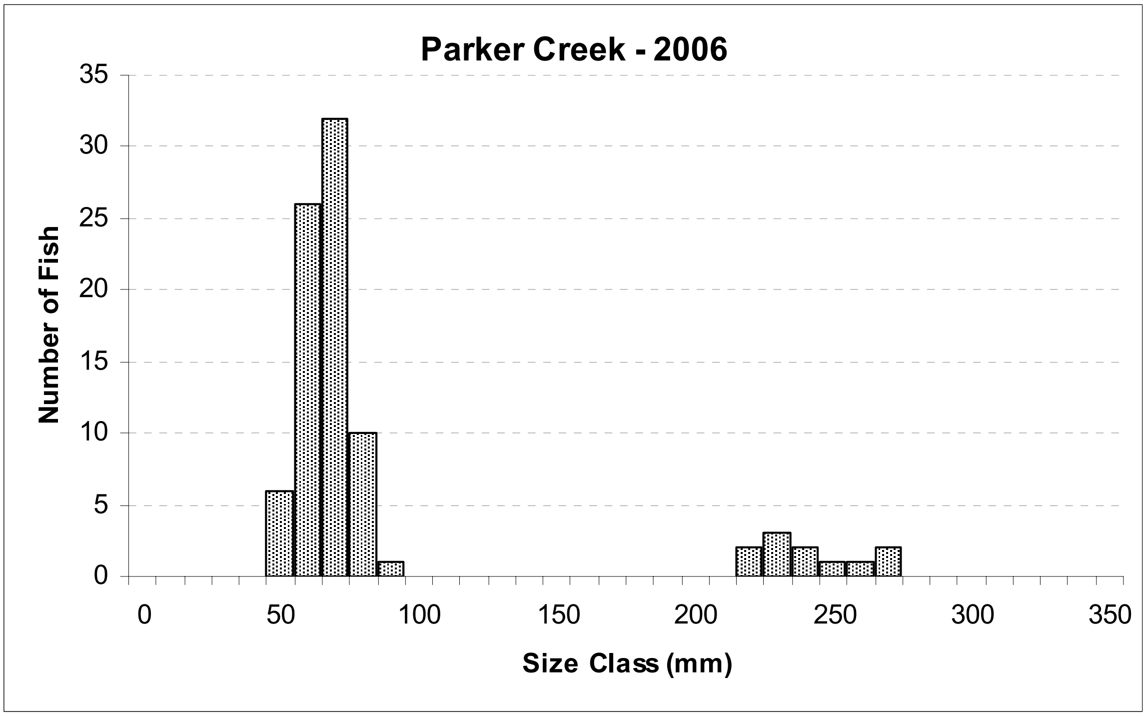
Parker Creek

As in past years, only brown trout were captured in Parker Creek (Figure 12). A total of 86 brown trout were captured in three electro-fishing passes in 2006 (up from a total of 31 fish in 2005 and 53 fish in 2004). In 2006, Parker Creek supported an estimated 86 age-0 and 11 age-1 and older brown trout (Table 4).

Walker Creek

In 2006, a fish species other than brown trout was sampled in Walker Creek for the first time in eight years of our annual sampling. A 91 mm brook trout (*Salvelinus fontlnalis*) was captured on the 1st depletion pass. Brook trout are currently present in Walker Lake and comprised a significant portion of the creek fishery between Walker Lake and LADWP's diversion when sampled by CDFG in 1987 (Deinstadt et al. 1997).

In 2006, 112 brown trout were captured in Walker Creek and 80 of these were age-0 fish (Figure 12). For the past three years, age-0 brown trout numbers have fluctuated widely in Walker Creek. For comparison, in 2005 only four age-0 brown trout were captured and in 2004 203 age-0 brown trout were sampled. In 2006, Walker Creek supported an estimated 84 age-0 and 32 age-1 and older brown trout (Table 4). Fifteen brown trout >250 mm (approximately 10") in length were captured in Walker Creek in 2006, and two of these fish were >300 mm (12") in length (Figure 12).



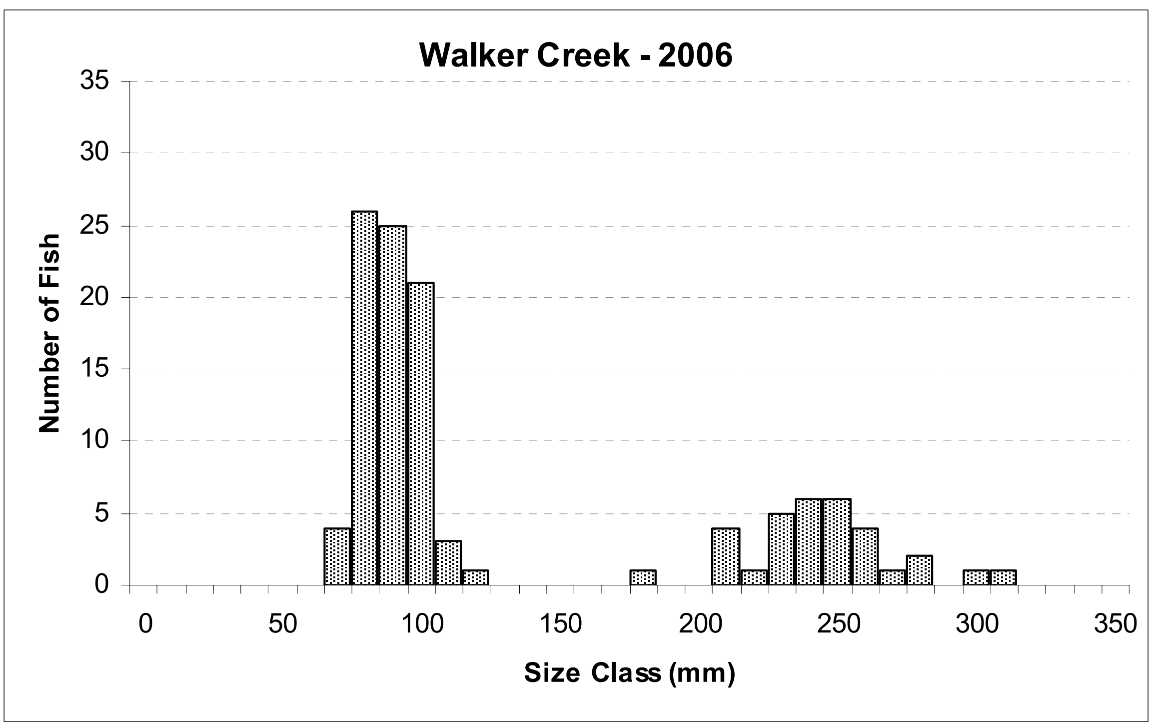


Figure 12. Length frequency histograms for brown trout captured in Parker (upper) and Walker (lower) creeks during September 2006.

Relative Condition of Brown Trout

Log_{10} transformed length-weight regressions for captured brown trout 100 mm and longer had R^2-values over 0.98 for almost all sample events, indicating that weight was strongly correlated to length (Table 6). A condition factor of 1.00 is considered average and most computed condition factors were close to 1.00 in 2006, indicating brown trout condition was about average when compared to other waters. Regression data for 2006 indicated that condition was similar among the three Rush Creek sample sections (Table 5).

Relative conditions of brown trout captured during 2006 were similar to those found in 2001-05 in Upper and Lower Rush Creek sections (Figure 13). Brown trout condition in the County Road section in 2006 dropped to 1.00 from 1.08 in 2005, the highest ever computed for this section (Figure 13). The MGORD condition value of 1.12 was the highest for all study sections in 2006 and was a marked improvement from the 0.99 value in 2004 (Figure 13).

Condition factors for brown trout in both Lee Vining Creek side-channel sections were slightly higher than the previous five seasons (Figure 14). Over all eight years of sampling, the body-condition of brown trout in Lee Vining Creek were still highest back in 2000 (Figure 14).

In Parker Creek, the condition factor for brown trout (150 to 250 mm in total length) in 2006 dropped slightly for the third consecutive year (Figure 13). In Walker Creek, the condition factor for brown trout (150 to 250 mm in total length) dropped to 0.99 in 2006 from the 2005 value of 1.21, the highest value computed for this section for eight seasons of data collection (Figure 13).

Table 5. Regression statistics for $\log_{10}$ transformed length (L) to weight (WT) for brown trout 100 mm and longer captured in Rush Creek by sample section and year. The 2006 regression equations are in **bold** type.

Section	Year	N	Equation	R^2	P
County Road	2000	412	$Log_{10}(WT) = 2.94*Log_{10}(L) – 4.83$	0.99	< 0.01
	2001	552	$Log_{10}(WT) = 2.91*Log_{10}(L) – 4.81$	0.98	< 0.01
	2002	476	$Log_{10}(WT) = 2.95*Log_{10}(L) – 4.88$	0.99	< 0.01
	2003	933	$Log_{10}(WT) = 3.00*Log_{10}(L) – 5.01$	0.99	<0.01
	2004	655	$Log_{10}(WT) = 2.97*Log_{10}(L) – 4.94$	0.99	<0.01
	2005	257	$Log_{10}(WT) = 2.97*Log_{10}(L) – 4.90$	0.98	<0.01
	2006	**373**	$\mathbf{Log_{10}(WT) = 3.000*Log_{10}(L) – 5.00}$	**0.99**	**<0.01**
Lower	1999	314	$Log_{10}(WT) = 3.03*Log_{10}(L) – 5.08$	0.99	< 0.01
	2000	230	$Log_{10}(WT) = 2.97*Log_{10}(L) – 4.90$	0.98	< 0.01
	2001	350	$Log_{10}(WT) = 2.97*Log_{10}(L) – 4.94$	0.99	< 0.01
	2002	250	$Log_{10}(WT) = 2.91*Log_{10}(L) – 4.78$	0.99	< 0.01
	2003	348	$Log_{10}(WT) = 3.00*Log_{10}(L) – 5.02$	0.99	<0.01
	2004	215	$Log_{10}(WT) = 2.93*Log_{10}(L) – 4.84$	0.99	<0.01
	2005	189	$Log_{10}(WT) = 3.06*Log_{10}(L) – 5.14$	0.99	<0.01
	2006	**271**	$\mathbf{Log_{10}(WT) = 3.00*Log_{10}(L) – 4.99}$	**0.99**	**<0.01**
Upper	1999	317	$Log_{10}(WT) = 2.93*Log_{10}(L) – 4.84$	0.98	< 0.01
	2000	309	$Log_{10}(WT) = 3.00*Log_{10}(L) – 4.96$	0.98	< 0.01
	2001	335	$Log_{10}(WT) = 2.99*Log_{10}(L) – 4.96$	0.99	< 0.01
	2002	373	$Log_{10}(WT) = 2.94*Log_{10}(L) – 4.86$	0.99	< 0.01
	2003	569	$Log_{10}(WT) = 2.96*Log_{10}(L) – 4.89$	0.99	<0.01
	2004	400	$Log_{10}(WT) = 2.97*Log_{10}(L) – 4.94$	0.99	<0.01
	2005	261	$Log_{10}(WT) = 3.02*Log_{10}(L) – 5.02$	0.99	<0.01
	2006	**485**	$\mathbf{Log_{10}(WT) = 2.99*Log_{10}(L) – 4.98}$	**0.99**	**<0.01**

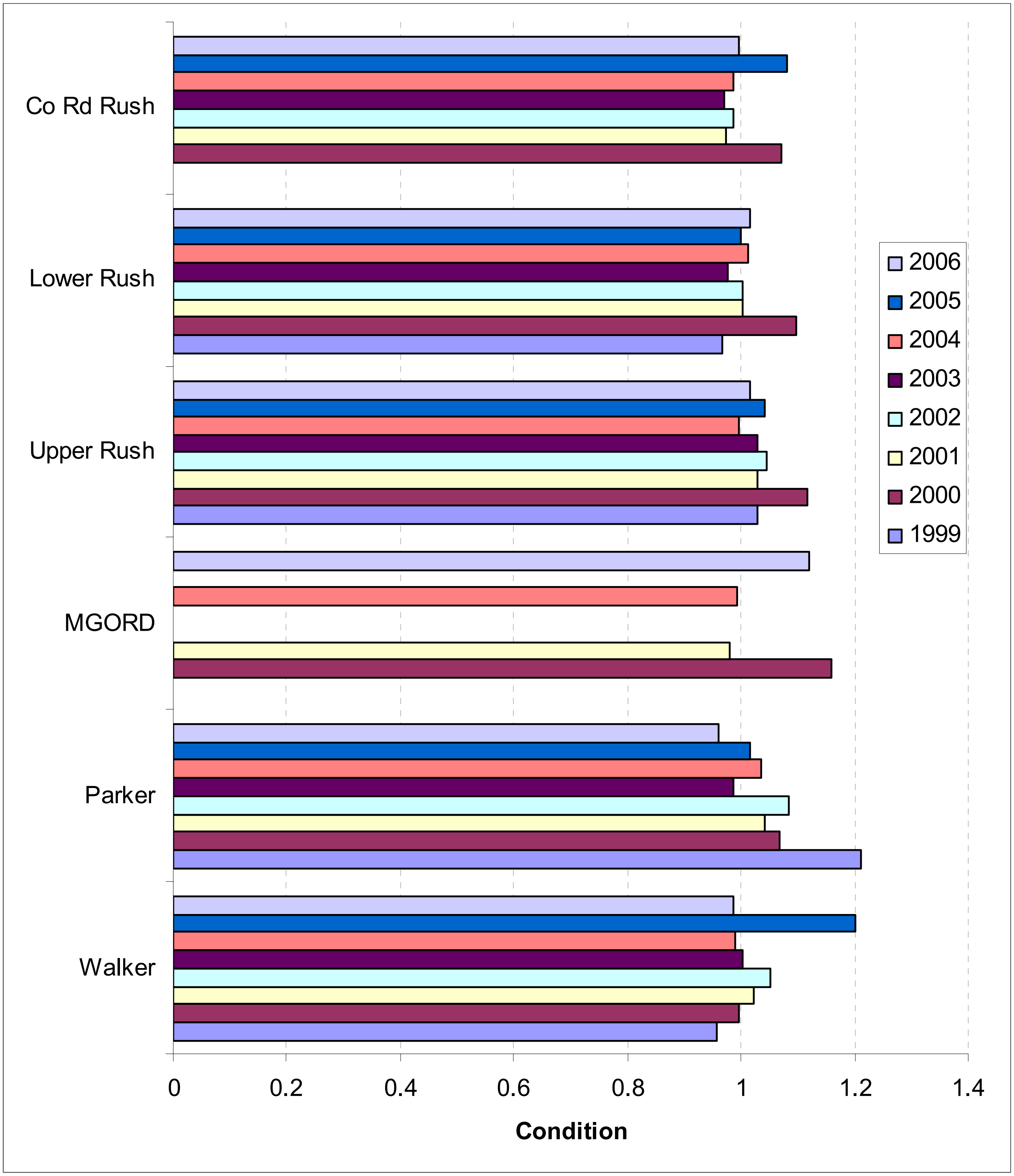


Figure 13. Condition factors for brown trout 150 to 250 mm long in Rush Creek and its tributaries (Parker and Walker creeks) from 1999 to 2006.

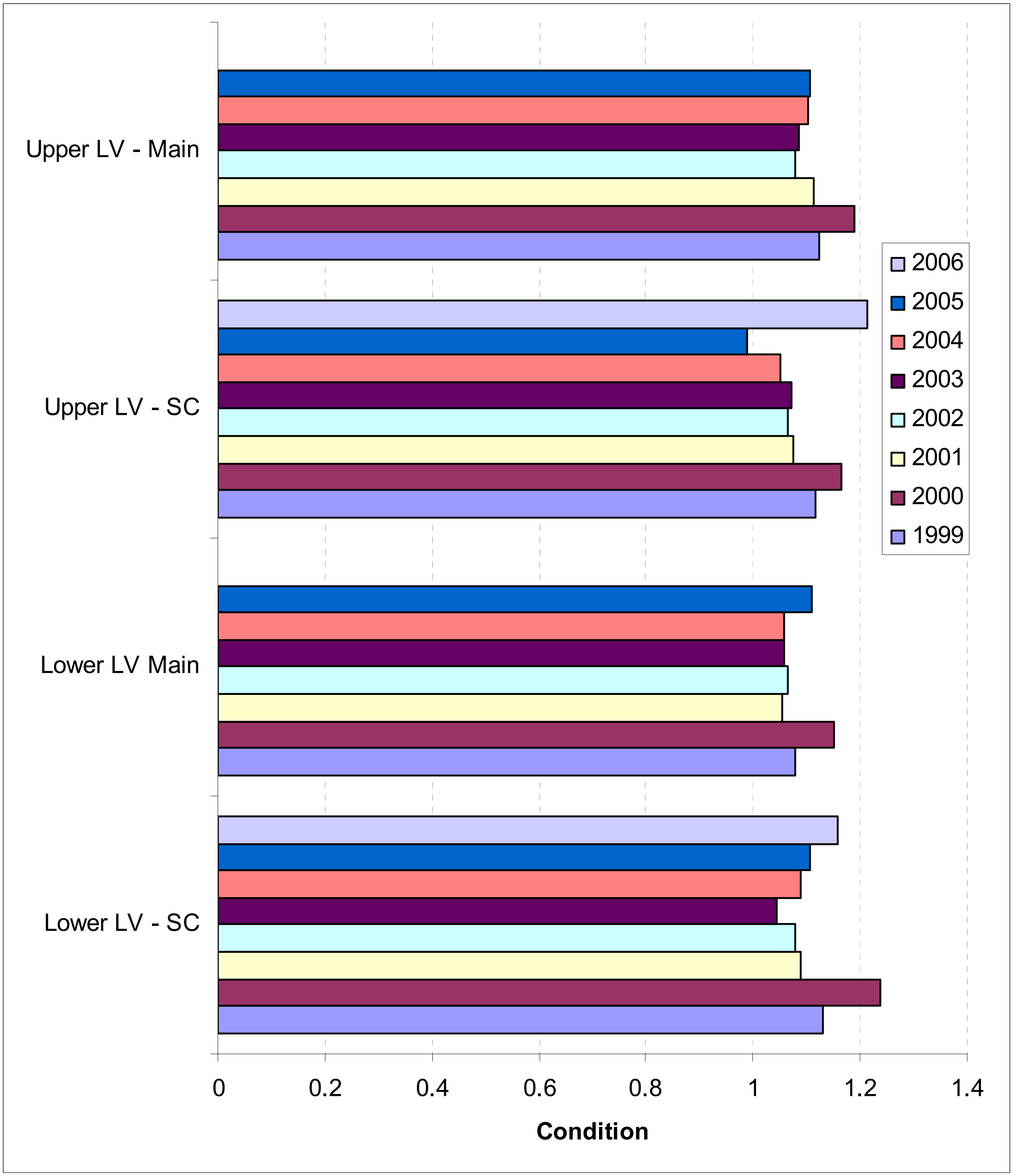


Figure 14. Condition factors for brown trout 150 to 250 mm long in Lee Vining Creek study sections from 1999 to 2006.

Fin Clips and Growth Estimates of Brown Trout

During the 2003 sampling season 2,823 age-0 brown trout had their adipose fin removed so that survival and growth of this cohort of fish could be tracked in subsequent years (Table 6). In 2006, 10 of these adipose fin-clipped brown trout were re-captured, down from 45 clipped fish recaptured in 2005 (Table 7). Growth of adipose-clipped brown trout from age-0 to age-3 ranged from 126 to 218 mm and from 85 to 335 grams (Table 7). By section, the three-year (2003 to 2006) recapture rate of adipose fin-clipped fish was variable and ranged from a low of 0.0% in the Upper Lee Vining Side-channel to a high of 1.5% in the Lower Lee Vining Side-channel (Table 7).

For computing survival and growth rates of recaptured fin-clipped fish in the MGORD we have assumed these six fish were from the group of 547 fish clipped in the Upper Rush Creek Section because no age-0 fish were clipped in the MGORD Section. Also, preliminary movement study results indicate a high degree of brown trout movement between the MGORD and Upper Rush Creek sections and no movement of brown trout from the Rush Creek Lower Section upstream through the Narrows.

During the 2004 sampling season 2,586 age-0 brown trout and 115 age-0 rainbow trout (<125 mm) had a segment of their left pelvic fins clipped off as a permanent mark so that survival and growth of this cohort of fish could be tracked in subsequent years. During the 2005 sampling season 607 age-0 brown trout and six age-0 rainbow trout (<125 mm) had a segment of their right pelvic fins clipped off as a permanent mark so that survival and growth of this cohort of fish could be tracked in subsequent years.

Since 2004 we have determined that the pelvic clips are unsuitable for tracking future growth and survival due to the propensity of these fins to regenerate to the point where future detection is difficult and unreliable. For example, only five fish with left or right pelvic fin clips were detected in 2006.

During the 2006 sampling season 1,406 age-0 brown trout and 75 age-0 rainbow trout had their adipose fin removed so that survival and growth of this cohort of fish could be tracked in subsequent years (Table 8). Note that the number of age-0 trout clipped in 2006 (1,481 fish) was a 58% increase compared to the number of age-0 trout clipped in 2005.

Table 6. Age-0 brown trout that received **adipose** fin-clips during the 2003 sampling season, by stream reach.

Collection Location	Number Of Fish Clipped	Average Total Length (mm)	Minimum Total Length (mm)	Maximum Total Length (mm)	Average Weight (g)
Rush – Co Road	983	87	61	111	7
Rush Ck– Lower	738	92	69	120	8
Rush Ck – Upper	547	104	73	125	12
Lee Vining – Upper Side	123	97	75	118	9
Lee Vining – Lower Side	66	98	76	116	10
Lee Vining – Upper Main	72	97	67	123	10
Lee Vining – Lower Main	83	97	77	119	9
Parker Creek	76	81	66	99	5
Walker Creek	135	88	66	102	8

Table 7. Age-3 brown trout captured in 2006 with **adipose** fin-clips administered during the 2003 sampling season, by stream reach.

Collection Location	Number of Fish Recap	Ave. Total Length (mm)	Min. Total Length (mm)	Max. Total Length (mm)	Average Weight (g)	Percent Recap.	Growth – Average Length (mm)	Growth – Average Weight (g)
Rush – Co Road	1	213	213	213	92	0.10%	126	85
Rush – Lower	1	275	275	275	206	0.14%	183	198
Rush – Upper	1	295	295	295	258	0.18%	191	273
Rush – MGORD	6	322	284	340	347.2	1.1%	218	335
Lee Vining – Upper Side	0	-	-	-	-	-	-	-
Lee Vining – Lower Side	1	253	253	253	183	1.5%	155	174
Lee Vining – Upper Main	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lee Vining – Lower Main	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 8. Total number of age-0 trout that received **adipose** fin-clips during the 2006 sampling season, by stream reach. Number in (#) denotes rainbow trout.

Collection Location	Number Of Fish Clipped	Average Total Length (mm)	Minimum Total Length (mm)	Maximum Total Length (mm)	Average Weight (g)
Rush – Co Road	604	91	65	119	8.1
Rush Ck– Lower	345(6)	95(74)	56(63)	121(84)	9.2(4.2)
Rush Ck – Upper	224(3)	82(61)	56(58)	124(65)	5.7(2)
Rush Ck – MGORD	54	96	76	112	9.3
Lee Vining – Upper Side	16	77	57	92	4.6
Lee Vining – Lower Side	11(66)	86(52)	78(43)	99(70)	1.5
Lee Vining – Upper Main	N/A	N/A	N/A	N/A	N/A
Lee Vining – Lower Main	N/A	N/A	N/A	N/A	N/A
Parker Creek	75	72	54	94	3.8
Walker Creek	77	95	72	115	8.9

Estimated Trout Density Comparisons

Trout populations were dominated by brown trout in all sample sections during 2006, similar to past years (Figure 15; Hunter et al. 2000; 2001; 2002; 2003; 2004; 2005; 2006). The high proportion of brown trout to rainbow trout in both Rush Creek and Lee Vining Creek is typical of most trout streams in the Mono Basin and the Owens River watershed. Studies by the California Department of Fish and Game documented brown trout as the dominant trout species in all 130 electro-fishing reaches sampled within 52 different Mono Basin streams and Owens River tributaries (Deinstadt et al. 1985, 1986, 1997).

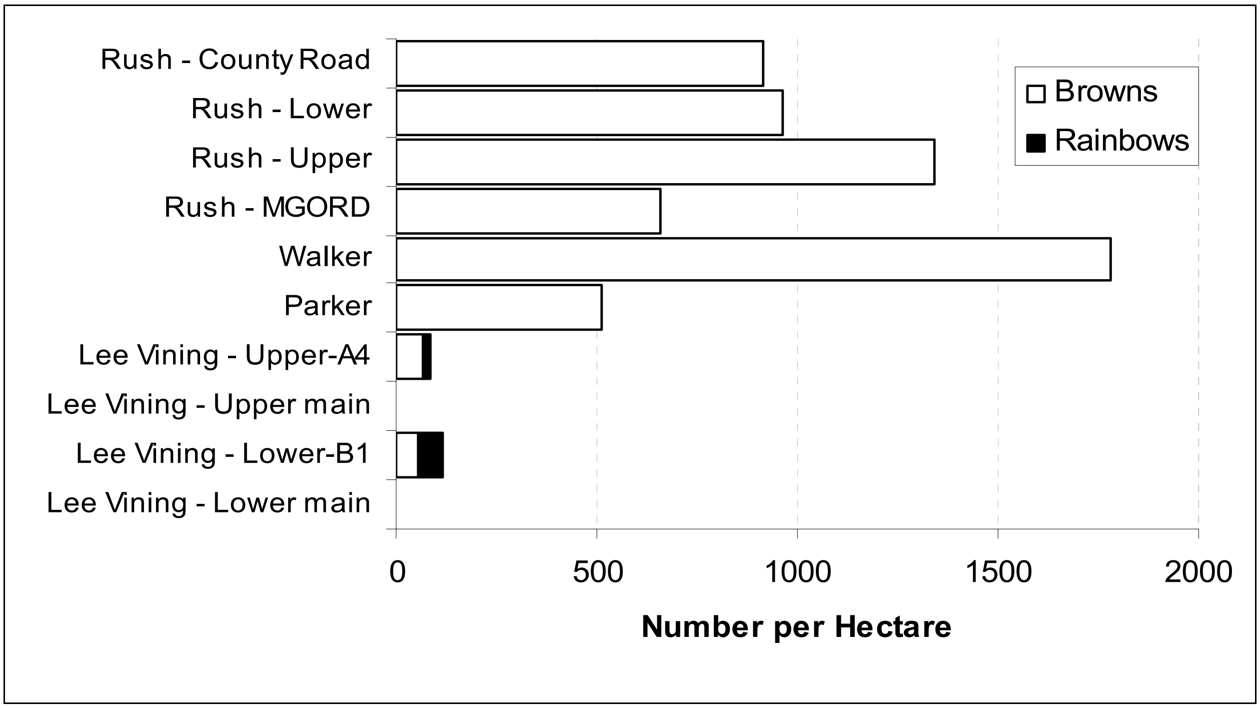


Figure 15. Densities (number/hectare) of age-1 and older brown and rainbow trout in selected Mono Lake tributaries in 2006. Due to high flows in Lee Vining Creek no density estimates were generated for main-channel sections.

Estimated densities (number per hectare) of age-1 and older brown trout in Rush for 2006 increased in two sections (County Road and MGORD) and decreased slightly in the other two sections (Figure 16). Between 2004 and 2006, in the MGORD Rush section the estimated density of age-1 and older brown more than doubled from 270.9 fish/ha to 660.3 fish/ha (Figure 16).

Densities of age-1 and older brown trout in Parker Creek decreased by 50% between 2005 and 2006, after experiencing an increase of 45% between 2004 and 2005 (Figure 16). In Walker Creek the 2006 density estimate was nearly 30% less than the 2005 estimate (Figure 16). This was the second straight year of declining densities of age-1 and older brown trout in Walker Creek (Figure 16).

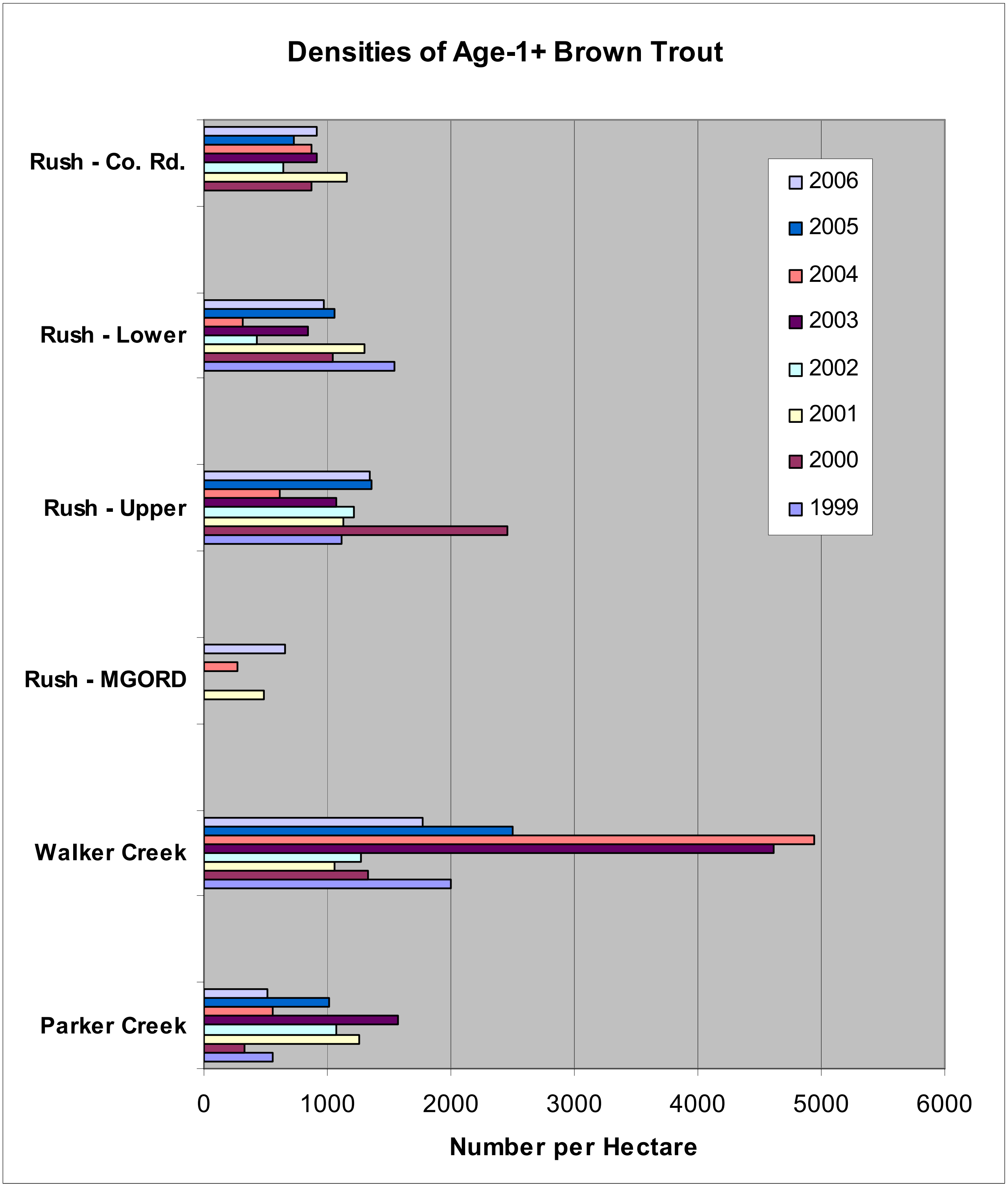


Figure 16. Estimated number of age-1 and older brown trout per hectare in sections of Rush Creek during September from 1999 to 2006.

Estimated densities (number per hectare) of age-1 and older brown trout decreased in 2006 in both side-channel sections of Lee Vining Creek (Figure 17). As previously reported, high flows prevented sampling in the main-channel sections of Lee Vining Creek.

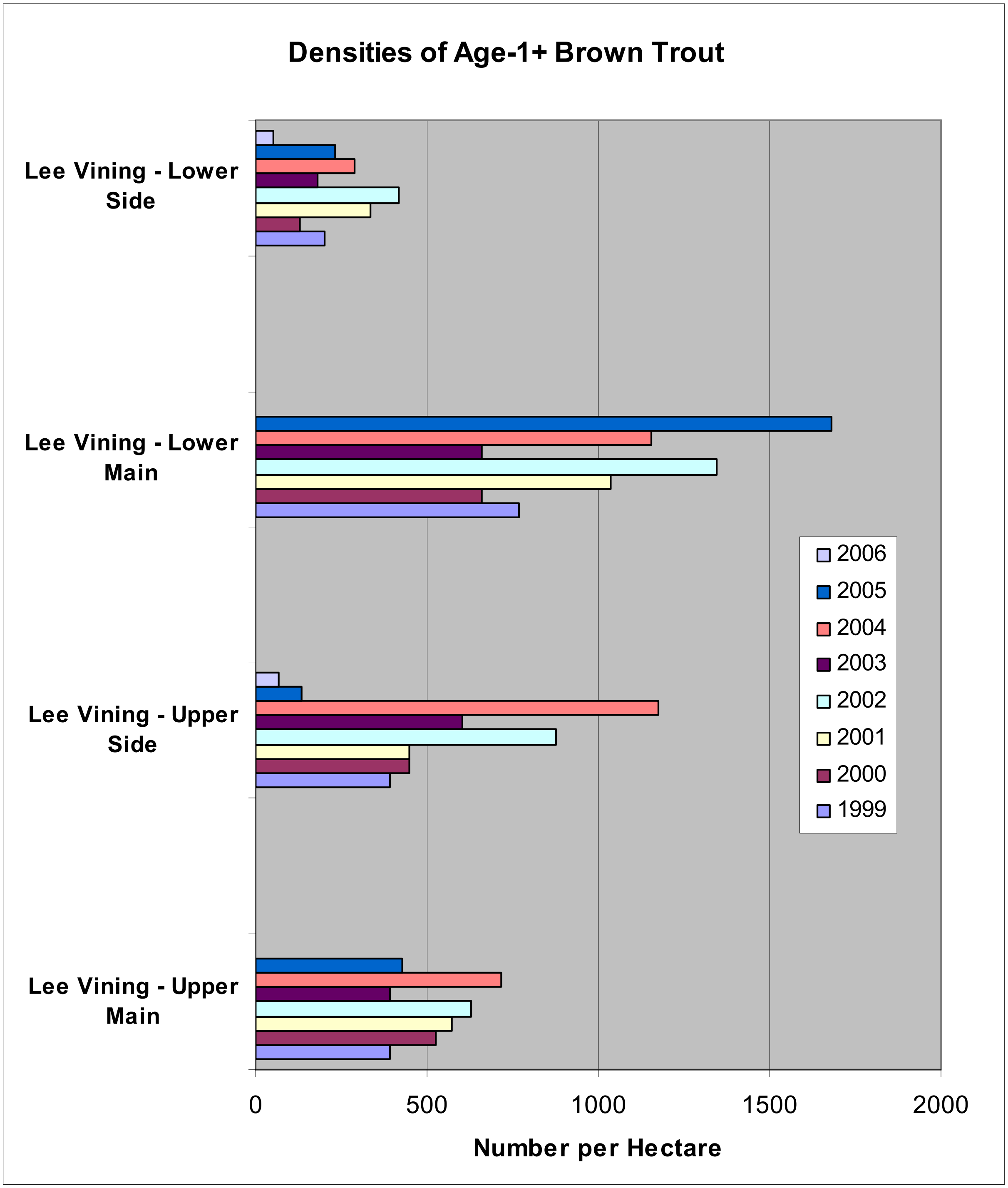


Figure 17. Estimated number of age-1 and older brown trout per hectare in sections of Lee Vining Creek during September from 1999 to 2006.

In Rush Creek, the estimated density of age-1 and older rainbow trout increased in the Upper section (Figure 18). For a fourth straight year, the estimated densities of age-1 and older rainbow trout remained low in sections of Lee Vining Creek sampled in 2006 (Figure 18). These low numbers and continued decline were not surprising considering the poor recruitment of age-0 rainbow trout in Lee Vining Creek in 2002 - 2004.

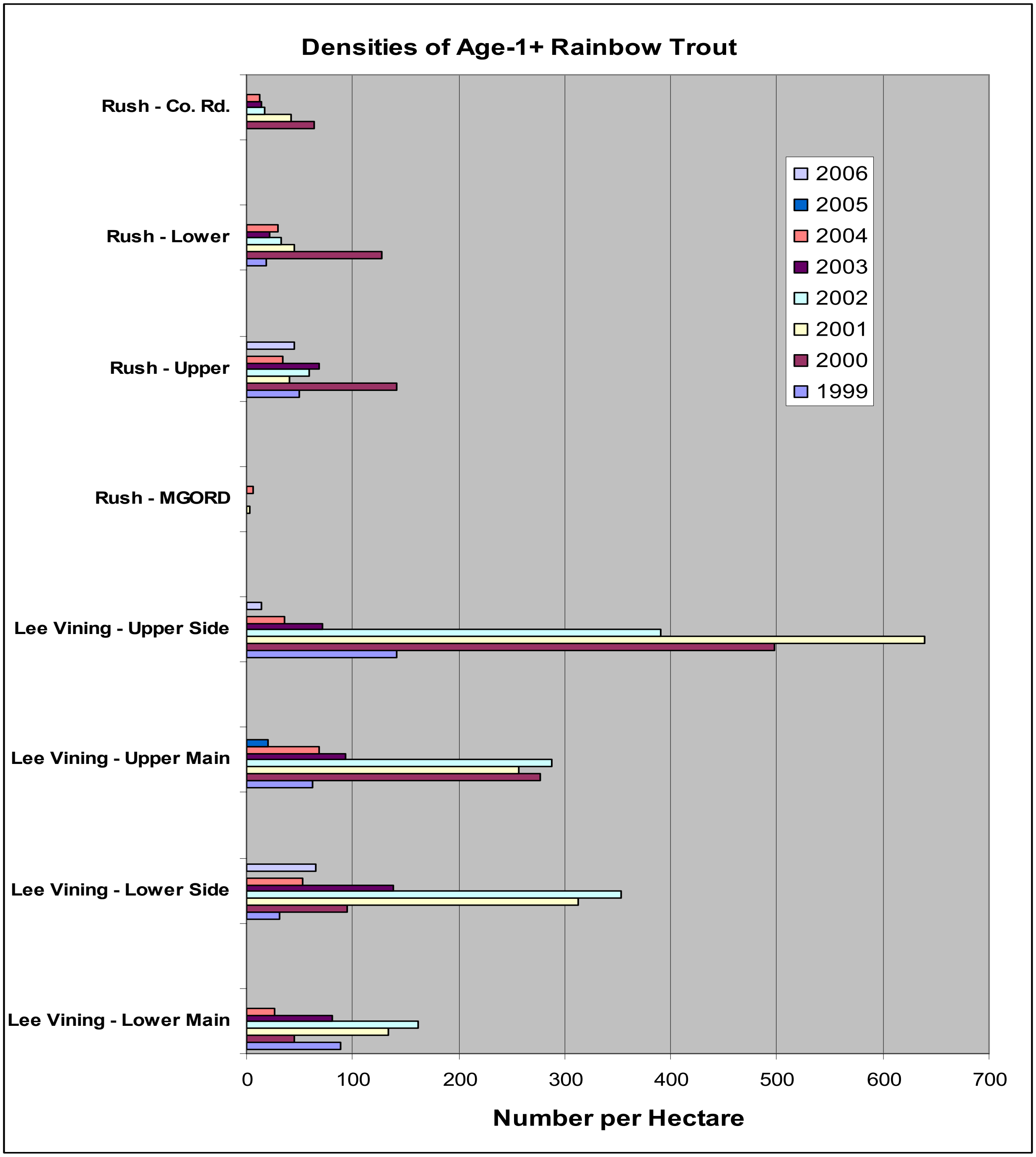


Figure 18. Estimated densities (number per hectare) of age-1 and older rainbow trout in sample sections of Lee Vining and Rush creeks, 1999 to 2006.

In 2006, age-0 brown trout populations in all sample sections of Rush, Parker, and Walker creeks experienced large increases compared to the 2005 density estimates (Figure 19). The 2005 densities were the lowest ever recorded at four of these five sections (Figure 19).

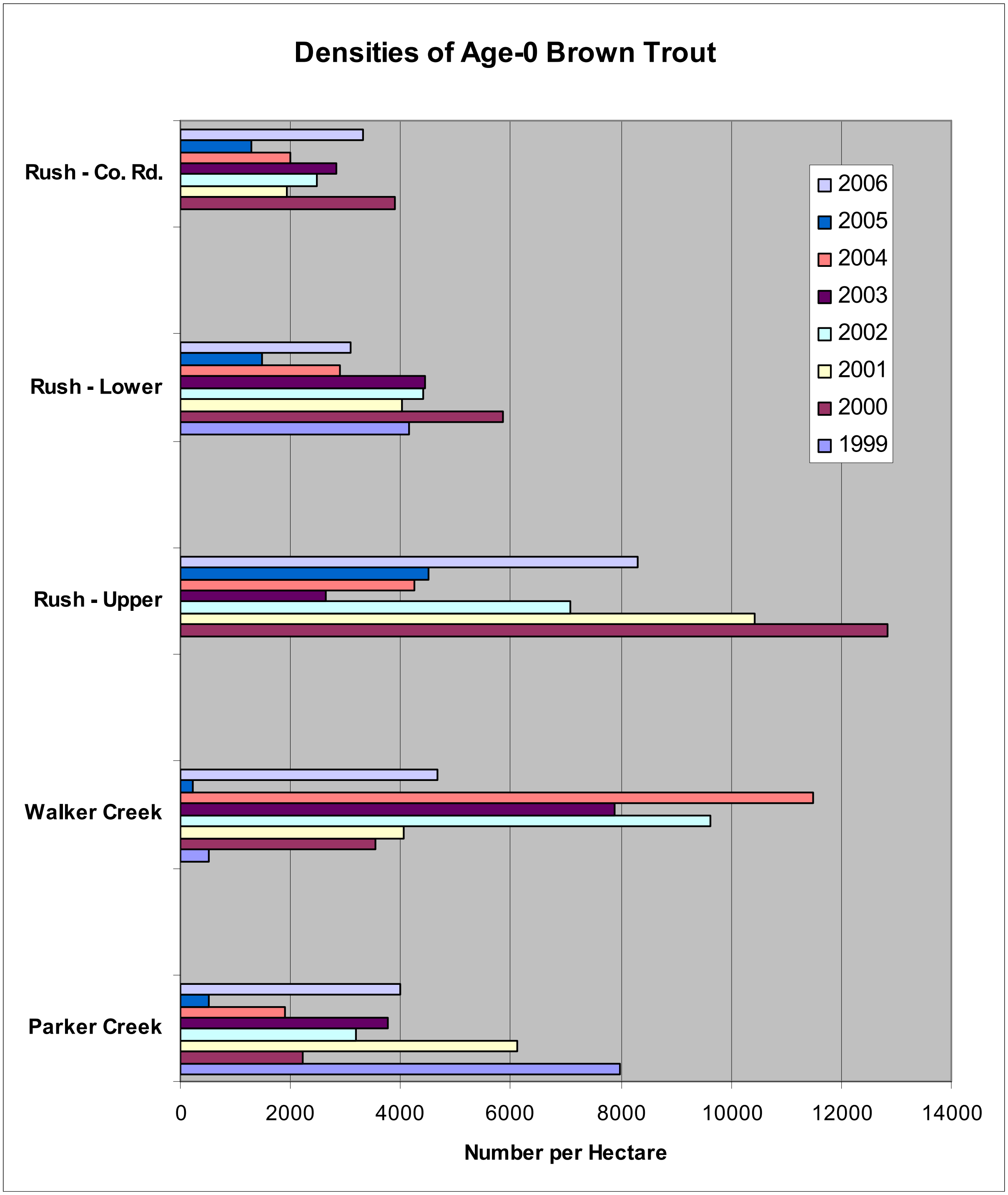


Figure 19. Estimated number of age-0 brown trout per hectare in sections of Rush Walker and Parker creeks during September from 1999 to 2006.

Estimated densities of age-0 brown trout increased in 2006 from no estimates in 2005 for both side-channel sections of Lee Vining Creek (Figure 20). The 2006 estimates were still relatively low when compared to sample years 2000 – 2004 (Figure 20).

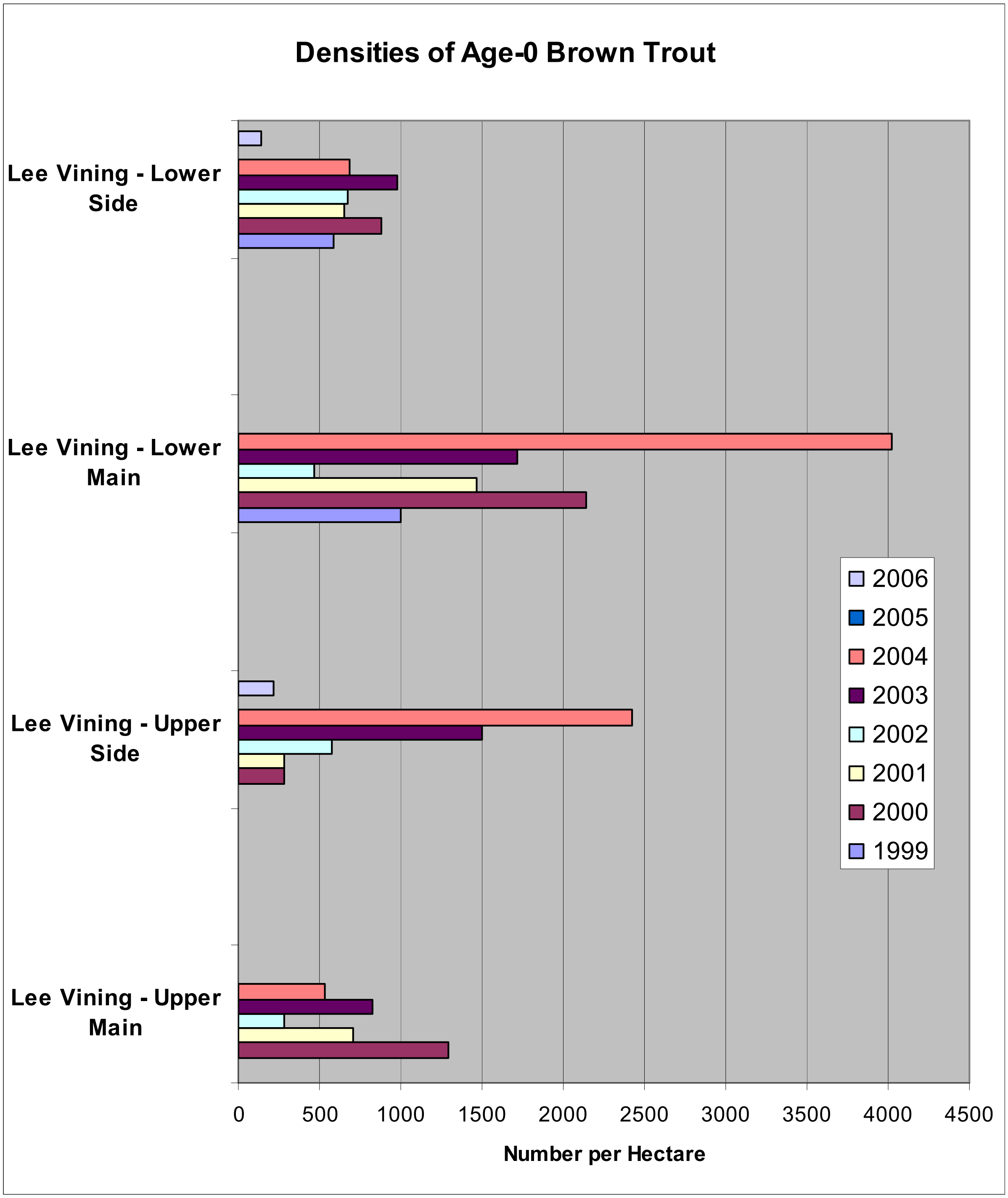


Figure 20. Estimated number of age-0 brown trout per hectare in sections of Lee Vining Creek during September from 1999 to 2006.

Densities (catch per hectare) of age-0 rainbow trout at the Rush Creek and Lee Vining Creek electrofishing sections are shown on Figure 21. Catch (M + C – R) data are presented rather than Peterson population estimates because less than seven marked fish (the minimum number required for a non-biased estimate) were recaptured during most of the sampling periods on this figure. As with age-1+ rainbow trout, age-0 densities of this species have also been very low in Rush Creek throughout the study period. During every year, densities of age-0 rainbow trout declined in a downstream direction. As well, these densities were considerably higher at all of the sections from 2000-2003 (low runoff years) compared to 2004-2006 (higher runoff years). In fact, only one age-0 rainbow trout was captured at the County Road section from 2003 through 2006.

Densities of age-0 rainbow trout have dramatically fluctuated from year-to-year within all Lee Vining Creek sections. These densities have ranged from a low of zero (0 fish/ha) at all four of the Lee Vining study sections in both 2003 and 2005 to the highest densities of 1197 fish/ha at the Lower Lee Vining side channel in 2004, followed by a value of 947 fish/ha at this same section in 2006. The latter densities are roughly ten times higher than any ever found at the Rush Creek sections from 2000-2006 (Figure 21).

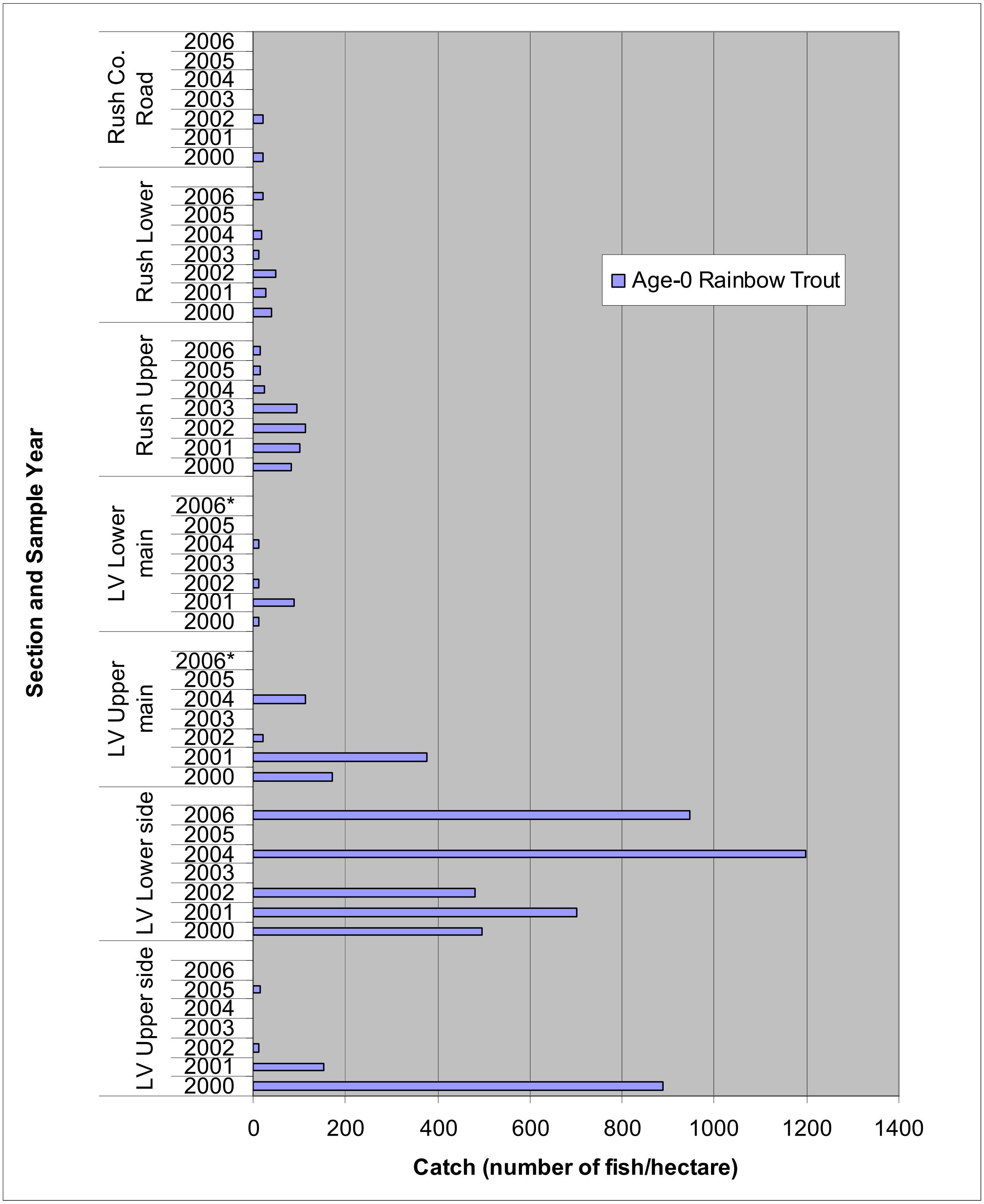


Figure 21. Densities (catch per hectare) of age-0 rainbow trout in sample sections of Rush and Lee Vining creeks, 1999 to 2006. *Due to high flow no estimates made in 2006 for the Lee Vining Creek main-channel sections.

Estimated Trout Standing Crop Comparisons

In Rush Creek brown trout standing crops estimates increased from 2005 to 2006 in all study sections (Table 9). For the Upper section this was the second consecutive increase in standing crop after four years of steady declines between 2000 and 2004 (Figure 22). The MGORD section of Rush Creek recorded a dramatic increase of more than 700% between the 2004 and 2006 standing crops estimates due most likely to the recovery of this channel reach from the construction project that occurred in 2002 and 2003 (Table 9).

Estimated brown trout standing crops (kg/ha) in the Lee Vining Lower side-channel section decreased by 18.5% from 2005 to 2006 (Table 9). Unfortunately no annual comparisons were possible for the other three Lee Vining Creek sections because an estimate was not generated for the Upper side-channel in 2005 because this channel was nearly dry and the main-channel sections were not sampled in 2006 due to high flows and unsafe wading conditions (Table 9).

The 2006 standing crop estimate in Walker Creek increased by nearly 90% after two consecutive seasons of declines (2004 and 2005); with the largest decrease (49.7%) occurring between 2004 and 2005 (Table 9). In Parker Creek, the estimated standing crop increased slightly (3.6%) between 2005 and 2006 (Table 9).

Total trout standing crops (all age classes and species combined) have been estimated since 1999 to determine potential trends (Figure 22). Total standing crop takes into account the total biomass of fish per unit area, not necessarily the age-class structure of the trout populations. In Rush Creek, where brown trout have dominated the fish community, the County Road section's standing crop has remained fairly constant, while standing crops at the Upper and Lower Rush Creek sections have generally declined until the 2005 and 2006 sampling seasons. Standing crop estimates for the brown trout populations on Parker and Walker creeks have demonstrated an overall upward trend between 1999 and 2003, followed by drops between 2003 and 2005 and finally increases in 2006 (Figure 22). Variability in naturally reproducing trout populations is common. During an 18 year-long study of an unexploited brown trout population in a relatively pristine Pennsylvania watershed, Carline (2006) found that numbers of brown trout 150-225 mm in length, as well as those greater than 225 mm in length, varied about five-fold, primarily due to differences in annual stream discharge rates and patterns, along with other natural (non-human influenced) variables.

Between 1984 and 1991, the California Department of Fish and Game (CDFG) conducted extensive electro-fishing surveys of eastern Sierra streams in the Mono Lake basin and in the Owens River watershed as part of their wild-trout management program (Deinstadt et al. 1985; 1986; 1997). Although the CDFG surveys typically sampled much shorter stream sections (240 to 380 foot long sections) than we are currently sampling, some comparisons can be made, especially for the sections of Rush Creek that overlap. The recent (2004-06) standing crops estimates are fairly similar to CDFG's estimates (Table 10). During the initial CDFG surveys (conducted in November

1984 and June 1985) no age-0 brown trout (<125 mm) were captured in any of the Rush Creek sections.

Table 9. Comparison of 2005 and 2006 brown trout standing crop (kg/ha) estimates in Mono Lake tributaries. NP stands for "not possible" and NA stands for "not available".

Collection Location	2005 Total Standing Crop (kg/ha)	2006 Total Standing Crop (kg/ha)	Percent Change Between 2005 and 2006 – total standing crops
Rush Creek - County Road	66.8	106.7	+59.7%
Rush Creek - Lower Section	94.1	138.4	+4.1%
Rush Creek - Upper Section	174.0	181.1	+38.8%
Rush Creek - MGORD Section	25.8*	208.0	+706%
Lee Vining Creek - Upper Side	**NP**	12.7	**N/A**
Lee Vining Creek - Lower Side	30.3	24.7	-18.5%
Lee Vining Creek - Upper Main	55.0	**NP**	**N/A**
Lee Vining Creek - Lower Main	173.7	**NP**	**N/A**
Walker Creek	176.3	331.0	+87.8%
Parker Creek	91.6	94.9	+3.6%

*2004 standing crop estimate.

Table 10. Comparisons of LADWP and CDFG's brown trout standing crop (kg/ha) estimates in three similar sections of Rush Creek.

Collection Locations Similar to both Studies	2004 Total Standing Crop	2005 Total Standing Crop	2006 Total Standing Crop	CDFG 1984/85 Total Standing Crop	CDFG 1986 Total Standing Crop	CDFG 1991 Total Standing Crop
Rush Creek - Co. Road	75.9	66.8	106.7	88.6	54.2	131.5
Rush Creek - Lower	55.8	94.1	138.4	152.0	99.3	72.1
Rush Creek - Upper	106.5	174.0	181.1	95.8	131.3	91.1

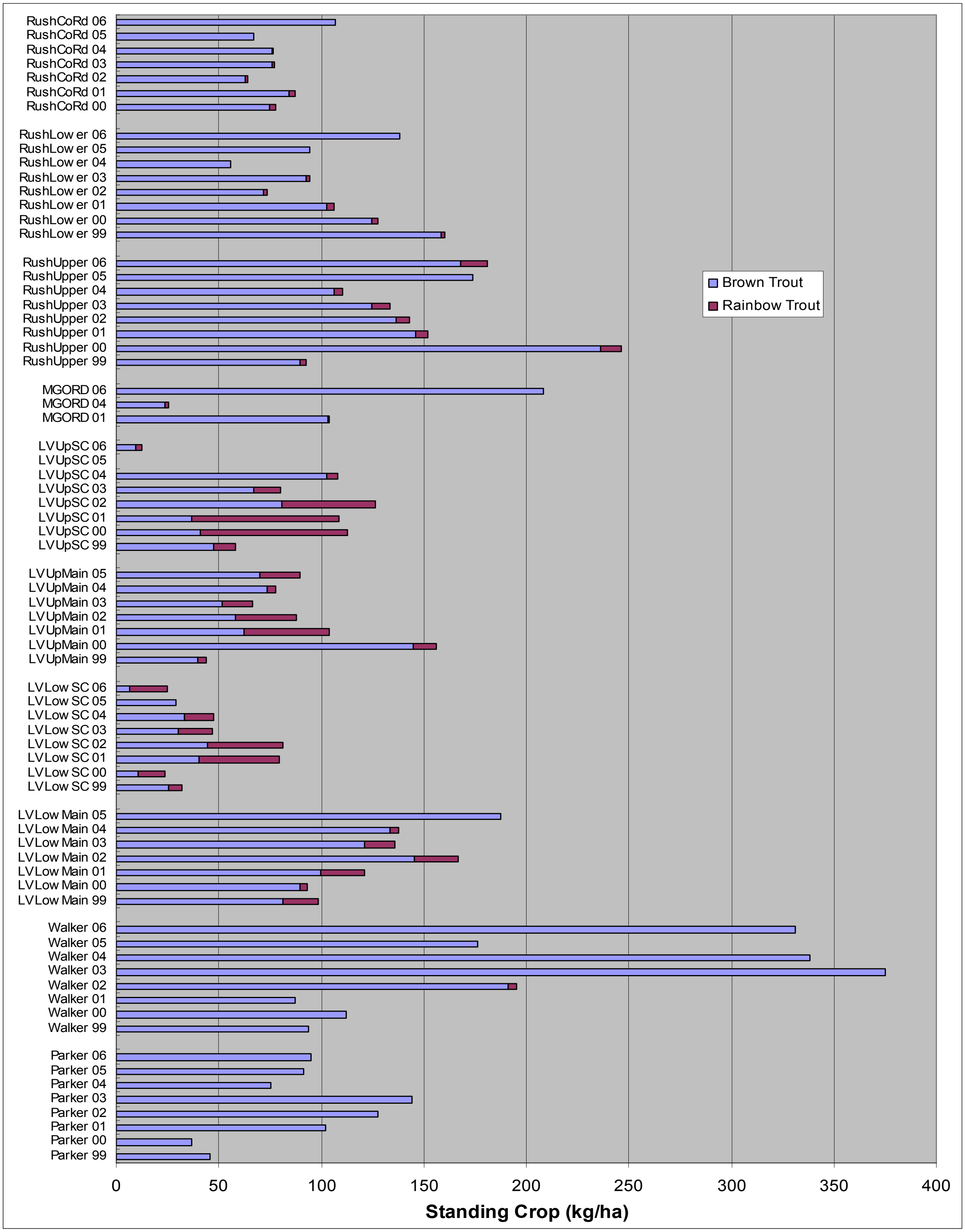


Figure 22. Estimated total standing crop (kilograms per hectare) of brown trout and rainbow trout in all sample sections, 1999 - 2006.

Relative Stock Density (RSD) Results for Rush and Lee Vining Creeks

RSD-225 values on Rush Creek have increased from 2000 through 2006, especially in the Upper and Lower study sections (Table 11). RSD-225 values ranged from 30-44 (except during 2005 at Lower Rush) in 2004-2006, which were years with relatively high stream runoff volumes. In contrast, from 2000-2003, which were much lower runoff years, RSD-225 values were less than 20 and as low as 5 for Lower Rush in 2001 (Table 11).

Fluctuations in the numbers of larger brown trout (and thus, the RSD values) on Rush Creek could at least partially be influenced by the magnitude and duration of runoff year. The high runoff flows of 2005 and 2006 likely created additional large pool (and thus large fish) habitat that was not present from 2000-2003, which should help RSD values steadily increase on Rush Creek in the future.

The highest RSD-300 values that have been measured thus far on Upper and Lower Rush Creek have been 4 and 3, respectively during 2006 (Table 11). RSD-300 and RSD-375 values for the MGORD were calculated to reflect the potential of this reach of Rush Creek to produce larger brown trout (Table 11). A preliminary comparison to other eastern Sierra streams has shown that the MGORD section of Rush Creek is capable of supporting a catch-and-release fishery for trophy-sized wild brown trout on par with the Upper Owens River and Hot Creek (Hunter 2007).

There is no obvious trend in RSD-225 values for either main-channel section of Lee Vining Creek between 2000 and 2005 (Table 12). Lee Vining Creek is subjected to wider variations in runoff rates and volumes than Rush Creek, and this may be reflected in the fluctuations of RSD-225 values.

Table 11. RSD values for Rush Creek study sections, ordered chronologically by sample year.

Sampling Location	Collection Date	Number of Fish ≥150 mm	Number of Fish 150-224 mm	Number of Fish 225-299 mm	Number of Fish 300-374 mm	Number of Fish ≥375 mm	RSD-225	RSD-300	RSD-375
Rush Ck - MGORD	9/2006	567	77	186	279	25	86	54	4
Rush Ck - MGORD	9/2004	424	144	184	65	31	66	23	7
Rush Ck - MGORD	9/2001	744	374	202	126	99	55	30	13
Rush Ck – Upper	9/2006	231	154	67	10	0	33	4	0
Rush Ck – Upper	9/2005	202	141	54	5	2	30	3	1
Rush Ck – Upper	9/2004	179	115	57	2	1	34	2	1
Rush Ck – Upper	9/2003	263	217	44	2	0	17	1	0
Rush Ck - Upper	9/2002	217	176	37	2	2	19	2	1
Rush Ck – Upper	9/2001	221	188	27	6	0	15	3	0
Rush Ck – Upper	9/2000	178	156	20	2	0	12	1	0
Rush Ck – Lower	9/2006	152	85	63	4	0	44	3	0
Rush Ck – Lower	9/2005	140	123	17	0	0	12	0	0
Rush Ck – Lower	9/2004	79	54	24	1	0	32	1	0
Rush Ck – Lower	9/2003	209	185	24	0	0	11	0	0
Rush Ck - Lower	9/2002	107	87	20	0	0	19	0	0
Rush Ck – Lower	9/2001	199	189	10	0	0	5	0	0
Rush Ck – Lower	9/2000	165	147	18	0	0	11	0	0
Rush Ck – Co Rd	9/2006	264	189	75	0	0	28	0	0
Rush Ck – Co Rd	9/2005	206	175	29	0	0	14	0	0
Rush Ck – Co Rd	9/2004	407	358	49	0	0	12	0	0
Rush Ck – Co Rd	9/2003	447	383	63	1	0	14	0	0
Rush Ck – Co Rd	9/2002	302	269	32	1	0	11	0	0
Rush Ck – Co Rd	9/2001	421	380	38	3	0	10	1	0
Rush Ck – Co Rd	9/2000	319	276	43	0	0	13	0	0

Table 12. RSD values for Lee Vining Creek study sections (main and side channel sections combined), ordered chronologically by sample year.

Sampling Location	Collection Date	Number of Fish ≥150mm	Number of Fish 150-224 mm	Number of Fish 225-299 mm	Number of Fish 300-374 mm	Number of Fish ≥375mm	RSD-225	RSD-300	RSD-375
Lee Vining Ck – Upper	9/2005	81	42	39	0	0	48	0	0
Lee Vining Ck – Upper	9/2004	193	157	35	1	0	19	1	0
Lee Vining Ck – Upper	9/2003	110	76	34	0	0	31	0	0
Lee Vining Ck – Upper	9/2002	224	167	57	0	0	25	0	0
Lee Vining Ck – Upper	9/2001	117	97	19	1	0	17	1	0
Lee Vining Ck – Upper	9/2000	86	59	27	0	0	31	0	0
Lee Vining Ck – Lower	9/2005	74	46	27	1	0	38	1	0
Lee Vining Ck – Lower	9/2004	95	84	9	2	0	12	2	0
Lee Vining Ck – Lower	9/2003	60	34	25	1	0	43	2	0
Lee Vining Ck – Lower	9/2002	167	126	38	3	0	25	2	0
Lee Vining Ck – Lower	9/2001	109	90	16	3	0	17	3	0
Lee Vining Ck – Lower	9/2000	55	35	19	1	0	36	2	0

Radio Telemetry-Movement Study in Rush Creek

In September of 2005, radio tags were implanted in a total of 54 brown trout (Table 13). Fourteen tags (model MCFT-3A) were deployed in larger brown trout captured in the MGORD on September 9th. Fifteen tags (one MCFT-3A, seven NTC-6-2's and seven NTC-4-2L's) were deployed in the Upper Rush section on September 13th. Eleven tags (five NTC-6-2's and six NTC-4-2L's) were deployed in the County Road Rush section on September 14th. Thirteen tags (eight NTC-6-2's and five NTC-4-2L's) were deployed in the Lower Rush section on September 15th. The final tag deployed (model MCFT-3A) was on September 16th in a large male brown trout captured between the County Road and Lower Rush sections. Immediate post-surgery mortality occurred on one fish that was found dead the day after surgery (Code 17).

In September of 2006, radio tags were implanted in a total of 29 brown trout (Table 14). Twenty-seven of these tags were implanted in fish captured in the MGORD and two tags were implanted in large brown trout captured just upstream of the ford (upper boundary of the County Road study section).

Table 13. Specifications of 54 Lotek Wireless Inc. tags deployed in September 2005 for the Rush Creek brown trout movement study.

LOTEK Tag Model	Air Weight (grams)	Duty Cycle (hours)	Signal Burst Interval (seconds)	Operational Life (days)	Minimum Weight Range of Fish (g)
MCFT-3A	16.0	24	5	761	640-800
NTC-6-2	4.5	12	5	416	180-225
NTC-4-2L	2.1	12	10	299	85-105

Table 14. Specifications of 29 Lotek Wireless Inc. tags deployed in September 2006 for the Rush Creek brown trout movement study.

LOTEK Tag Model	Air Weight (grams)	Duty Cycle (hours)	Signal Burst Interval (seconds)	Operational Life (days)	Minimum Weight Range of Fish (g)
MCFT-3A	16.0	24	5	761	640-800
NTC-6-2	4.5	12	5	416	180-225

As of April of 2007 the movement study is still on-going, with the final manual relocations scheduled for May of 2007. Thus, we are proposing to produce a separate progress report of the movement study by the fall of 2007. However, the following is a summary of preliminary results:

<u>Fixed Station Results (September 2005 – September 2006):</u>

- Fourteen tags were implanted in MGORD brown trout on 9/09/05 and one post-surgery mortality occurred

- Six of the 13 tagged fish migrated downstream out of the MGORD in October – November 2005.

- The length of time spent downstream of MGORD by these six fish ranged from seven days to 6.5+ months.

- The distance traveled downstream from MGORD by these six fish ranged from 4,600 feet to 17,400 feet.

- Two confirmed angling mortalities occurred which comprised 16% of our sample. Rush Creek downstream of Grant Reservoir is catch-and-release only.

- Five radio-tagged fish were recaptured during the September 2006 sampling efforts. All were longer and heavier. The range of length gain was five to 23 mm and the range weight gain was 12 to 445 g (see below).

- Code 27, a male fish, stayed in the MGORD during the fall and winter of 2005-06 and exhibited the greatest growth of the five recaptured MGORD fish. When tagged in September of 2005 it was 522 mm in length, weighed 1,575 g and had a condition factor of 1.11. In September of 2006 in was 545 mm in length, weighed 2,020 g and had a condition factor of 1.25.

<u>Manual Receiver Tracking Results (September 2005 – September 2006):</u>

- Preferred habitat during winter and spring for most fish was low velocity areas within pools such as undercut banks, bubble curtain, and submerged vegetation.

- Most measured observations of occupied velocities were less than 0.5 ft/sec (Figure 23).

- Survival rates were estimated by number of fish confirmed as alive during May-06 relocations and/or captured in Sept-06.

- Upper Rush Creek: Age ≥2+ = 57% Age 1+ = 14%
- Lower Rush Creek: Age ≥2+ = 75% Age 1+ = 20%
- County Road Section: Age ≥2+ = 0% Age 1+ = 17%
- Five radio-tagged fish were recaptured during September 2006 sampling. Three fish had lost weight (average loss = 25g) and two fish had gained weight (average gain = 13g)

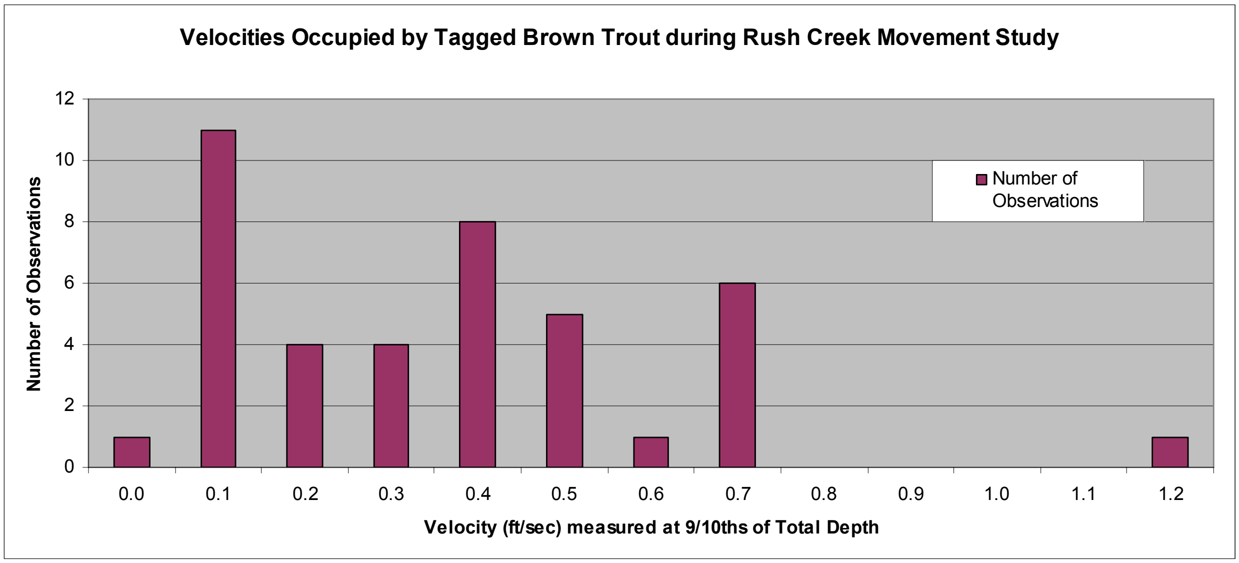


Figure 23. Occupied velocities of radio-tagged brown trout in Rush Creek measured in 2005 and 2006.

Discussion

Methods Evaluation

Mark-recapture electro-fishing has provided relatively reliable estimates and having a field technician dedicated to maintaining block fences reduced the frequency of block net failures in 2003–2006 (no failures in 2006) compared to previous years, and is probably providing better estimates. New block fence hardware cloth was purchased in 2006 and fence integrity was improved because this new material did not tear. We recommend purchasing new hardware cloth every three years.

While there were no major changes to the stream channel within the annual sample sections as a result of the large 2006 run-off and we have observed subtle changes in lower Rush Creek, particularly through the County Road section and at the upper end of the Lower Rush section. While these channel changes were expected because of the changes in the flow regime and Mono Lake levels, they make sampling challenging and we may need to consider replacing or reducing the number of sample sites in Rush Creek (downstream of the Narrows) and Lee Vining Creek. The continued channel changes make it imperative that channel lengths and wetted widths are re-measured annually to accurately compute density and standing crop estimates. All parties must recognize that documenting both the changing channel configuration and fish population response through time is an integral part of this monitoring effort.

The changing channel configurations within sample sections could change the amount of habitat sampled, especially if the creek were to abandon its current main channel and occupy a completely new channel. While the recent changes have probably not yet been significant enough to render annual comparisons invalid, it is possible that future channel changes following major high-flow events may be significant enough to make annual comparisons difficult. The upstream and downstream boundaries of all sample sections have been permanently marked. Regardless of noticeable change in the channel, channel lengths and wetted widths are re-measured annually. We have sketched rough field maps of each sample section. We will re-map these sections if we notice any significant channel change to ensure documentation of significant channel changes within the sample sections.

For the 2007 sampling we plan to install a block fence across the lower boundary of the Rush Creek County Road section due to a gradual deepening over the past two years of this once shallow riffle crest. We feel there is a high likelihood that we've been pushing fish out of the section on our final electrofishing run and potentially affecting the population estimate for this section. We've noticed that our percentage of marked fish captured during our recapture efforts for this sub-section of the County Road reach were consistently lower than the other five sub-sections located upstream.

The clipping of age-0 trout for tracking empirical growth has provided data by recapturing marked fish to estimate annual growth. However, altering the methods for marking age-0 fish should be considered. In 2003 the adipose fin was removed on all age-0 fish and these complete clips have been easy to visually identify, even in 2006 three years after the clips were administered. The adipose fin is much less likely to regenerate following removal than other fins (Elrod and Schneider 1986; Thompson and Blankenship 1997). In 2004 the left pelvic fins were clipped on all age-0 fish and depending on how much of this fin was removed some degree of regeneration occurred, making these clips much more difficult to identify on age-1 fish in 2005. We suspect that an unknown number of these clips were not noticed while handling age-1 fish in 2005. Similar problems arose during the 2006 field season in which it was difficult to identify age-2 fish with left pelvic clips and age-1 fish with right pelvic clips.

In 2006 we again utilized an adipose fin clip, but should consider another means to mark fish in subsequent years, such as a visible implant elastomer that injects a permanent dye underneath the skin that is externally visible. The use of passive integrated transponders (PIT tags) in conjunction with adipose fin clips would be another means to track growth. The advantage of injecting PIT tags into fish would be that when these fish were re-captured, individuals could be identified and the growth for specific fish determined. PIT tags also have infinite life, are relatively inexpensive, are easily applied, are well retained, and can be implanted in juvenile salmonids as small as 60 mm in length (Gries and Letcher 2002; Zydlewski et al. 2003). PIT tagged fish would also provide additional information on movement, depending on location of re-capture, as well as allow the opportunity of installing receiving stations at critical locations along Rush Creek (i.e. lower end of the MGORD).

The above-average snow-pack and extended run-off during 2006 created problems in safely sampling Rush and Lee Vining creeks. LADWP was able to reduce the flow in Rush Creek to allow us to sample our sections in September; however flows were not dropped in Lee Vining Creek which prevented us from sampling the main-channel sections. We recommend that maximum flow criteria are set for both creeks to ensure that sampling is safe and efficient. We recommend that flows in both creeks should not exceed 40 c.f.s (± 5 c.f.s.) during our annual sampling period (first two weeks of September). In 2005 we found Lee Vining Creek main-channel difficult to safely wade at 50 c.f.s and in 2006 we considered the same reach unsafe at 60 c.f.s.

Termination Criteria

The agreed upon termination criterion for Lee Vining Creek is to sustain a fishery for naturally-produced brown trout that average eight to 10 inches in length with some trout reaching 13 to 15 inches. The agreed upon termination criterion for Rush Creek states that Rush Creek fairly consistently produced brown trout weighing 0.75 to two pounds. Trout averaging 13 to 14 inches (330 to 355 mm) were also allegedly observed on a regular basis prior to the 1941 diversion of this stream.

However; no hard data were submitted during Water Board hearings to support the contention that a significant proportion of brown trout caught in lower Rush Creek ever attained the larger sizes alluded to in the historic interviews. This lack of quantifiable data is mentioned repeatedly in Decision 1631 and in the Mono Basin EIR, including the following sentence from the introduction of Mono Basin EIR-Chapter 3-D Fishery Resources:

"Published and unpublished scientific information is scarce, and definitive information is unavailable to quantitatively describe historic pre-diversion fish habitats or populations".

Recommended Termination Criteria

In March of 2007, Chris Hunter (the Mono Basin Court-Appointed Fisheries Scientist) submitted a document to the Water Board that proposed new fisheries termination criteria on Rush and Lee Vining creeks as specified in State Water Resources Control Board's Orders WR98-05 and WR98-07. The rationale for replacing the current termination criteria is to evaluate brown trout populations in a more quantifiable and relevant fashion. As stated in our eight annual reports no data were available that provided a scientifically quantitative picture of trout populations that these streams supported on a self-sustaining basis prior to 1941 (Hunter et al. 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006). In our earlier reports we also recommended that at least six to 10 years of annual data be collected to objectively evaluate the current termination criteria, as well as assess potential relationships between fish populations and physical habitat components, such as flows, physical habitat parameters, and water temperatures.

Mr. Hunter, with the assistance of his sub-consultants, proposed employing four repeatable and quantifiable metrics as termination criteria to evaluate the brown trout populations in the Upper, Lower, and County Road study sections of Rush Creek and both study sections on Lee Vining Creek – biomass, density, condition, and relative stock density (RSD) of catchable trout ≥225 mm (≥9") fish in the population. A fifth metric for the Rush Creek sections only was the proportion of brown trout ≥300 mm (≥12").

Finally, Mr. Hunter proposed that three termination criteria metrics of RSD are applied to the Rush Creek MGORD only – the RSD of brown trout ≥225 mm, ≥300 mm, and ≥375 mm (≥15”).

Rush Creek Termination Criteria for Upper, Lower and County Road Study Sections

Termination Criterion #1 - Biomass: Total brown trout standing crop estimates based on kilograms per hectare of biomass. Total standing crop estimates will also be reported to reflect contribution by age-class (young-of-year and ≥age-1). Termination criteria biomass estimate will be **≥ 175 kg/ha**. Assess trends in brown trout standing crop data with three-year moving averages by computing the average of the three most-current years of data and that average should meet the termination criteria of at least **175 kg/ha**.

Termination Criterion #2 - Density: Total number of trout per unit length (km) of stream channel. Termination criteria for total number of trout per kilometer will be **≥3,000 trout per kilometer**. Assess trends in total trout/km data with three-year moving averages by computing the average of the three most-current years of data and that average should meet the termination criteria of at least **3,000 trout/km**.

Termination Criterion #3 – Condition: Condition factor of trout ≥age-1+ will be computed and should not drop below **1.0**. Values below 1.0 should be of concern to managers. When standing crop values drop, fishery would be considered in “good condition” if condition factors remain stable or increase. It is possible that higher densities (#/ha) will result in lower condition factors for individual groups of fish due to density dependent competition.

Assess trends in condition factor with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria of condition factor **≥ 1.0**.

Termination Criterion #4 – Relative Stock Density (RSD) of Brown Trout ≥225 mm:

Relative Stock Density (RSD) values are numerical expressions of the length-frequency distribution of the larger fish (those greater than 150mm or 6”) in any sampled population. For this specific termination criterion, the values are simply the proportions (percentage x 100) of the total number of brown trout over 150 mm in length that in turn are greater than 225 mm (9”) in length.

The RSD-225 values of brown trout in all Rush Creek study sections will be computed and should not drop below **35**.

Assess trends in RSD-225 with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria RSD-225 value of **35**.

Termination Criterion #5 – Relative Stock Density (RSD) of Brown Trout ≥300 mm:

The RSD-300 is the proportion (percentage x 100) of the total number of brown trout over 150 mm in length that are greater than 300 mm (12") in length.

The RSD-300 values of brown trout in all Rush Creek study sections will be computed and should not drop below **5**.

Assess trends in RSD-300 with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria RSD-300 value of **5**.

Rush Creek Termination Criteria for the MGORD Study Section

For the Rush Creek Mono Gate One Return Ditch (MGORD) study section we propose that three termination criteria metrics of RSD are applied - the RSD of brown trout ≥225 mm (≥9"), ≥300 mm (≥12"), and ≥375 mm (≥15").

The RSD-225 values of brown trout in the MGORD will be computed and should not drop below **60**.
The RSD-300 values of brown trout in the MGORD will be computed and should not drop below **30**.

The RSD-375 values of brown trout in the MGORD will be computed and should not drop below **5**.

Assess trends in RSD-225, RSD-300, and RSD-375 with three-year moving averages by computing the average of the three most-current years of data. The averages should meet the termination criteria of **60**, **30**, and **5**, respectively.

The rationale for assessing these "large trout" metrics specifically for the MGORD is that this human-constructed section below Grant Reservoir has unique spring creek-like characteristics that support the growth of large brown trout similar to the pre-1941 productivity of the human-influenced springs below the Rush Creek Narrows. Two years of movement study data have demonstrated that approximately 40 to 50% of the large (>300 mm) radio-tagged brown trout migrated between the MGORD and lower reaches of Rush Creek, especially during autumn and winter. To most accurately evaluate the status of large brown trout in the Rush Creek system immediately downstream of Grant Reservoir, data for computing the RSD values in the MGORD should be collected in September, prior to the onset of the annual spawning migration.

Lee Vining Creek Termination Criteria

Termination Criterion #1 - Biomass: Total trout (brown and wild rainbow) standing crop estimates based on kilograms per hectare of biomass. Total standing crop estimates should also be reported to reflect contribution by age-class (young-of-year and ≥age-1) and species. Termination criteria for total biomass estimate should be **≥ 150 kg/ha**.

Assess trends in total trout standing crop data with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria of at least **150 kg/ha**.

Termination Criterion #2 - Density: Total number of trout per unit length (km) of stream channel. Termination criteria for total number of trout per kilometer should be **≥1,400 trout per kilometer**.

Assess trends in total trout/km data with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria of at least **1,400 trout/km**.

Termination Criterion #3 - Condition: Condition factor of trout will be computed and should not drop below **1.0**. Assess trends in condition factor with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria of condition factor **≥1.0**.

Termination Criterion #4 – Relative Stock Density (RSD) of Brown Trout ≥225 mm:

The RSD-225 values of brown trout in both Lee Vining Creek study sections will be computed and should not drop below **30**.

Assess trends in RSD-225 with three-year moving averages by computing the average of the three most-current years of data. That average should meet the termination criteria RSD-225 value of **30**.

Mr. Hunter's proposal of new fisheries monitoring termination criteria has undergone an extensive evolution prior to the point of formal submission to the Board. The topic of termination criteria was discussed at several Mono Basin semi-annual restoration meetings from 2004 to 2006 and at an all-day meeting in Lee Vining on June 1, 2006 devoted primarily to termination criteria issues. At this meeting the first draft of the fisheries termination criteria was distributed to stakeholders for review. A second draft of the fisheries termination criteria was distributed in November of 2006 and was reviewed by the Mono Lake Committee's fishery scientist, CalTrout and a California Department of Fish and Game (CDFG) wild trout biologist. Significant changes to the final criteria were made based on recommendations provided by CDFG.

Using the Recommended Termination Criteria – Examples with Current Data Sets

This section provides examples on how we recommend the termination criteria be utilized. The following steps should be followed:

1. With the most-current data set, calculate the biomass, density, condition factor, and RSD for each section of Rush Creek and Lee Vining Creek. Calculate the RSD-300 values for the Rush Creek sections only. We considered averaging sections for an overall Rush Creek value and an overall Lee Vining Creek value, but decided that examining each creek section-by-section was more appropriate because this strategy would better indicate which reaches were recovering.

2. For Upper and Lower Lee Vining Creek, the biomass estimates from the main and side channels were combined for a total value. For densities and condition factors, the values from the main and side channels were averaged.

3. For the current year and the two previous years, calculate the three-year running averages of biomass, density, condition factor, and RSD-225 for each section of Rush Creek and Lee Vining Creek. Calculate the three-year running averages of RSD-300 for Rush Creek sections only. Five years of data are necessary to compute a complete set of three-year running averages.

4. To determine the For the Upper, Lower, and County Road Rush Creek study sections, a section would be considered “recovered” if it met four of the five termination criteria for three consecutive years that the three-year running averages were calculated. The rationale is that in years of high young-of-year recruitment, densities will be high with fairly low biomass estimates. Conversely, in years of relatively low young-of-year recruitment densities will probably drop, but biomass of older trout should increase.

5. The Rush Creek MGORD study section would be considered “recovered” if it met the three RSD termination criteria for three consecutive years that the three-year running averages were calculated.

6. For Lee Vining Creek, a section would be considered “recovered” if it met three of the four termination criteria for three consecutive years that the three-year running averages were calculated.

Upper Rush Creek Example:

Termination Criteria	2006-2004 Average	2005-2003 Average	2004-2002 Average	2003-2001 Average
Biomass (≥175 kg/ha)	149.4	135.1	122.6	135.8
Density (≥3,000 fish/km)	5,606.0	3,884.3	4,252.7	5,807.0
Condition Factor (≥1.0)	1.02	1.02	1.03	1.04
RSD-225 (≥ 35)	32	27	23	17
RSD-300 (≥ 5)	2	2	2	2
Conclusion	**Meets 2 of 5 TC**	**Meets 2 of 5 TC**	**Meets 2 of 5 TC**	**Meets 2 of 5 TC**

Lower Rush Creek Example:

Termination Criteria	2006-2004 Average	2005-2003 Average	2004-2002 Average	2003-2001 Average
Biomass (≥175 kg/ha)	96.1	80.9	73.4	88.4
Density (≥3,000 fish/km)	2,199.0	2,314.3	3,057.3	3,289.0
Condition Factor (≥1.0)	1.01	1.00	1.00	0.99
RSD-225 (≥ 35)	29	18	21	12
RSD-300 (≥ 5)	1	0	0	0
Conclusion	**Meets 1 of 5 TC**	**Fails to meet TC**	**Meets 1 of 5 TC**	**Meets 1 of 5 TC**

County Road Rush Creek Example:

Termination Criteria	2006-2004 Average	2005-2003 Average	2004-2002 Average	2003-2001 Average
Biomass (≥175 kg/ha)	83.1	74.1	73.8	76.5
Density (≥3,000 fish/km)	2,349.7	2,314.3	2,617.0	2,741.0
Condition Factor (≥1.0)	1.02	1.01	0.98	0.98
RSD-225 (≥ 35)	18	13	12	12
RSD-300 (≥ 5)	0	0	0	0
Conclusion	**Meets 1 of 5 TC**	**Meets 1 of 5 TC**	**Fails to meet TC**	**Fails to meet TC**

Upper Lee Vining Creek Example (main and side channel combined):

NOTE: No 2006 values were generated for the main channel sections due to high flow.

Termination Criteria	2005-2003 Average	2004-2002 Average	2003-2001 Average
Biomass (≥150 kg/ha)	144.7	144.7	119.1
Density (≥1,400 fish/km)	701.3	829.0	631.7
Condition Factor (≥1.0)	1.07	1.08	1.08
RSD-225 (≥ 30)	33	25	24
Conclusion	**Meets 2 of 4 TC**	**Meets 2 of 4 TC**	**Meets 1 of 4 TC**

Lower Lee Vining Creek Example (main and side channel combined):

Termination Criteria	2005-2003 Average	2004-2002 Average	2003-2001 Average
Biomass (≥150 kg/ha)	173.9	169.2	160.3
Density (≥1,400 fish/km)	939.0	1,008.0	798.7
Condition Factor (≥1.0)	1.08	1.07	1.06
RSD-225 (≥ 30)	31	33	28
Conclusion	**Meets 3 of 4 TC**	**Meets 3 of 4 TC**	**Meets 2 of 4 TC**

Acknowledgements

We would like to thank Los Angeles Department of Water and Power for their continued support of this project, especially Mark Hanna and Dave Martin. In 2006, Chris Katopothis provided his first year of field assistance with block net set-up and maintenance, fish sampling, and block net break-down and storage. In 2006, Kirk Akin provided his second year of high-quality fisheries sampling assistance with a lightning-quick net, a gentle touch in handling fish and calm demeanor. Thanks to Kevin Peterson and Gary Hooper of the Eastside Guide Service for their services in sampling the MGORD and allowing us to trash their drift boat. The Mono Lake Committee has assisted with copying field data sheets and allowing us to use their Internet computer terminals. McBain and Trush Consultants provided maps, water temperature information, and completed physical surveys of sample sites. The owners and staff of the Latte Da and Mobile Station in Lee Vining, and Boulder Lake Lodge at June Lake have consistently provided good lodging, excellent food and beverages, and lively conversation.

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Appendix A. Sample Section Dimensions for 2000 – 2006

Stream Section	2000 Length (m)	2000 Width (m)	2000 Area(m^2)	2001 Length (m)	2001 Width (m)	2001 Area(m^2)	2002 Length (m)	2002 Width (m)	2002 Area (m^2)
Rush - County Road	813	8	6504	813	8	6504	813	8.4	6829.2
Rush - Lower	405	5.4	2187	405	6.9	2794.5	405	6.9	2794.5
Rush - Upper	430	7.4	3182	430	7.4	3182	430	7.4	3182
MGORD	Not measured	Not measured	N/A	2230	12	26760	Not measured	Not measured	N/A
Lee Vining - Lower	187	4.8	897.6	187	4.8	897.6	155	4.8	744
Lee Vining - Lower-B1	189	5	945	262	5	1310	195	4.8	936
Lee Vining - Upper-main	330	5.8	1914	330	5.8	1914	330	5.8	1914
Lee Vining - Upper-A4	201	4.2	844.2	201	4.2	844.2	201	4.2	844.2
Parker	98	2.2	215.6	98	2.2	215.6	98	2.2	215.6
Walker	100	1.8	180	100	1.8	180	100	1.8	180

Appendix A. Sample Section Dimensions for 2000 – 2006

Stream Section	2003 Length (m)	2003 Width (m)	2003 Area(m^2)	2004 Length (m)	2004 Width (m)	2004 Area(m^2)	2005 Length (m)	2005 Width (m)	2005 Area (m^2)
Rush - County Road	813	8.4	6829.2	813	7.3	5934.9	813	8.4	6829.2
Rush - Lower	405	6.7	2713.5	405	6.8	2754	405	6.8	2754
Rush - Upper	430	7.4	3182	430	7.99	3435.7	430	8.6	3698
MGORD	Not measured	Not measured	N/A	2230	12	26760	2230	12	26760
Lee Vining - Lower	155	4.8	744	155	4.8	744	155	5.2	806
Lee Vining - Lower-B1	195	4.8	936	195	4.8	936	195	4.6	897
Lee Vining - Upper-main	330	7	2310	330	5.8	1914	330	7.4	2442
Lee Vining - Upper-A4	201	4.4	884.4	201	4.2	844.2	Not measured	Not measured	N/A
Parker	98	2.2	215.6	98	2.2	215.6	98	2.2	215.6
Walker	100	1.8	180	100	1.8	180	100	1.8	180