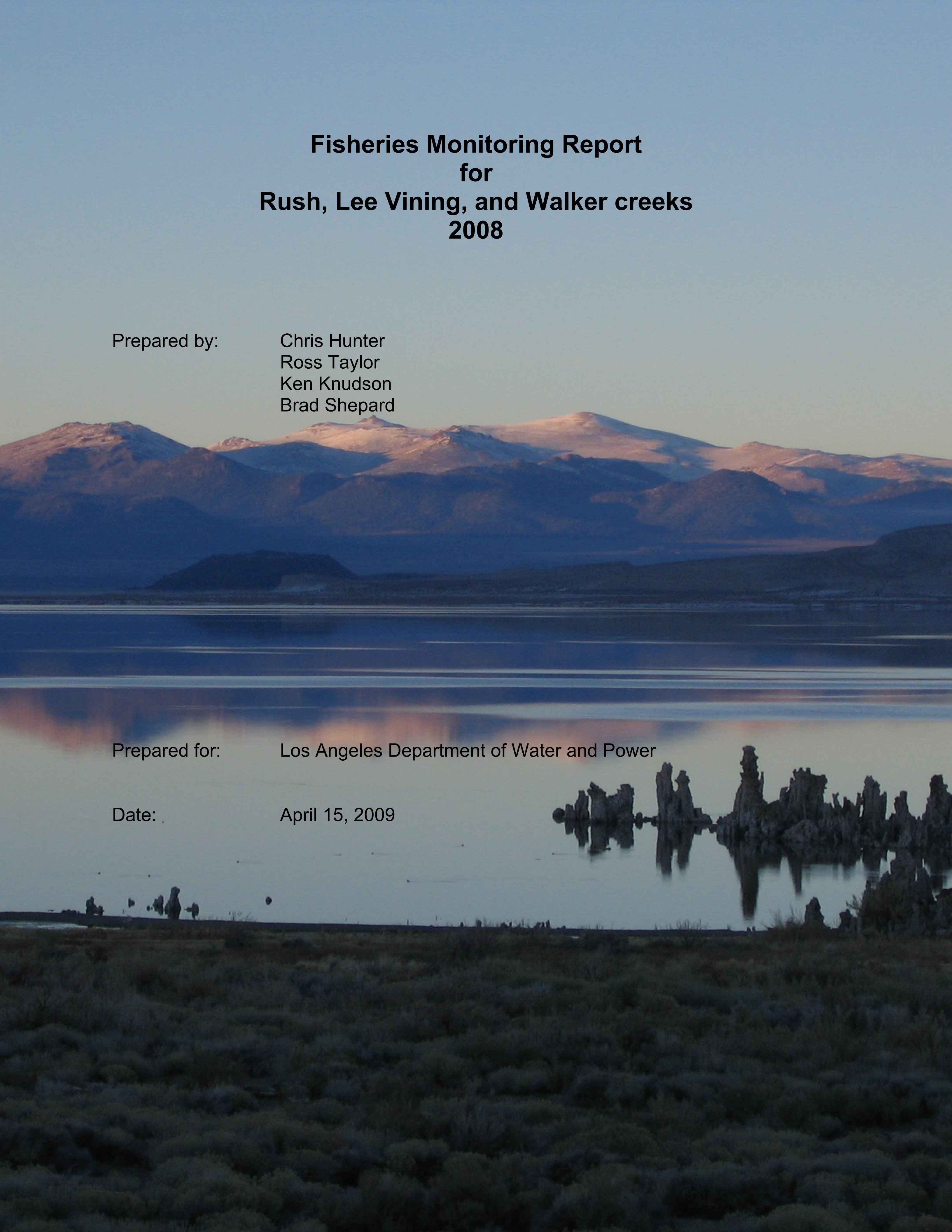
Chapter 3

Fisheries Monitoring Report for Rush, Lee Vining, Parker, and Walker Creeks 2008-09



Fisheries Monitoring Report for Rush, Lee Vining, and Walker creeks 2008

Prepared by: Chris Hunter
Ross Taylor
Ken Knudson
Brad Shepard

Prepared for: Los Angeles Department of Water and Power

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Executive Summary

This report presents the results of the twelfth 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 tenth 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.

Starting in 2008, the annual sampling sections were modified as follows. In Rush Creek the MGORD and Upper sections were maintained, the Lower section was discontinued, a new Bottomlands section was added and the County Road section was shortened. The Parker Creek section was also discontinued. In Lee Vining Creek the Upper main channel and side channel sections were dropped, the Lower main channel section was extended by approximately 100 meters and the Lower side channel section was maintained.

The 2008 electro-fishing sampling occurred between September 8th and 18th. Mark-recapture electro-fishing techniques were utilized to estimate trout populations in four sections of Rush Creek and one section of Lee Vining Creek. Fish population estimates for the Lower Lee Vining Creek side channel and Walker Creek were made using electro-fishing depletion methods. In 2008, the MGORD section of Rush Creek was sampled for the purpose of generating RSD-values, condition factors and population estimates.

Density Estimates of Age-1 and older Brown Trout

In 2008, estimated densities (number per hectare) of age-1 and older brown trout in the Upper and County Road sections of Rush Creek declined slightly from 2007 estimates. The Upper section of Rush Creek had an estimated density of 1,424 age-1 and older brown trout/ha in 2008. In the County Road section, the 2008 estimate of 1,642 age-1 and older brown trout was the second highest density estimate over the ten-year sampling period. The new Bottomlands section of Rush Creek had an estimated density of 1,834 age-1 and older brown trout/ha. Between 2006 and 2008, the MGORD section of Rush Creek experienced a 14.3% decrease in estimated density of age-1 and older brown trout/ha.

In Walker Creek the 2008 density estimate of age-1 and older brown trout was more than twice the 2007 estimate. Since 2002 Walker Creek has annually had the highest density estimates of age-1 and older brown trout for all sample sections.

In 2008, the side channel section of Lee Vining Creek had an estimated density of age-1 and older brown trout that was three times greater than the 2007 estimate. Estimated densities of age-1 and older brown trout in the main channel of Lee Vining Creek were

714% higher in 2008 than in 2007 and the 2008 density estimate was the third highest for the ten years of annual sampling

Density Estimates of Age-0 Brown Trout

In 2008, estimated densities of age-0 brown trout in the Rush Creek County Road and Upper sections were less than half those estimated in 2007. Between 2007 and 2008, the County Road section's density estimate of age-0 brown trout dropped by 54% and the Upper section's density estimate dropped by 68%. The new Rush Creek Bottomlands section had an estimated density of 2,640 age-0 brown trout/ha in 2008, which was comparable to the County Road and Upper section estimates of 2,244 and 2,629 age-0 brown trout/ha, respectively.

In Walker Creek the age-0 density estimate of brown trout decreased by 8% in 2008 from 2007, but the 2008 estimate of 18,444 age-0 brown trout/ha was still seven times greater than any other section of Rush Creek.

In 2008, age-0 brown trout density estimates (number per hectare) in the main channel section of Lee Vining Creek dropped by 23% from densities estimated in 2007. No age-0 brown trout were captured during 2008 within the Lee Vining Creek side channel.

Density Estimates of Age-1 and older Rainbow Trout

Insufficient numbers of age-1 and older rainbow trout were captured in the Rush Creek sample sections to generate population estimates, thus no densities were calculated for these sections in 2008.

In contrast, during 2008 the Lee Vining Creek main channel section supported the highest estimated density of age-1 and older rainbow trout for the ten years of annual sampling. For Lee Vining Creek main channel section, the 2008 density estimate was the first estimate generated since the 2005 sampling season; in 2007 insufficient numbers of age-1 and older rainbow trout were captured to generate an estimate and in 2006 the flow was too high to safely electro-fish the main channel.

Density Estimates of Age-0 Rainbow Trout

Insufficient numbers of age-0 rainbow trout were captured in the Rush Creek sample sections to generate population estimates, thus no densities were calculated for these sections in 2008.

In 2008, age-0 rainbow trout density estimates in the main channel section of Lee Vining Creek dropped by 65% from densities estimated in 2007. In contrast, the density estimates of age-0 rainbow trout within the Lee Vining Creek side channel increased by 42% in 2008 from the 2007 estimate.

Standing Crop Estimates of Brown Trout

In Rush Creek, brown trout standing crop estimates decreased from 2007 to 2008 in all sample sections. In the County Road section, the 2008 estimated standing crop of 85.7 kg/ha was a 29% decrease from the 2007 estimate. In the Upper Rush Creek section, the 2008 estimated standing crop of 107.2 kg/ha was a 34% decrease from the 2007 estimate. Because the MGORD section was only sampled using the mark-recapture method in even years, the comparison was between sampling years 2006 and 2008. In this two-year time period, the estimated standing crop decreased by nearly 70% in the MGORD. The new Rush Creek Bottomlands section had an estimated total standing crop of 98.2 kg/ha in 2008, which was comparable to estimates in both the County Road and Upper sections of 85.7 kg/ha and 107.2 kg/ha, respectively.

Between 2007 and 2008, Walker Creek experienced a decrease of 24% in estimated standing crops of brown trout. The 2008 estimated standing crop of 290 kg/ha was still higher than any other study section for the ten seasons of annual sampling.

In Lee Vining Creek total standing crops dropped slightly between 2007 and 2008 in the side channel area, but in the main channel total standing crops increased dramatically from 75.3 kg/ha in 2007 to 212.7 kg/ha in 2008.

Condition Factor of Brown Trout between 150 mm and 250 mm in Length

Condition factors of brown trout between 150 – 250 mm in length were less than 1.00 for all sections in Rush Creek and in Walker Creek, indicating that brown trout condition was moderately poor in these sections during 2008. Specifically, the County Road section had a condition factor of less than 0.9 and this was the lowest value documented in 10 years of annual sampling. For 2008, the Upper Rush Creek section experienced a slight increase in condition factor from the previous year; however, 2008 was the second consecutive year where the condition factor was less than 1.00. The new Bottomlands section of Rush Creek recorded a condition factor of 0.92 for the 2008 sampling season.

The mean condition factor for 150 to 250 mm brown trout in Lee Vining Creek during 2008 was over 1.00, indicating that brown trout condition was good; however, the mean condition factor in 2008 was the lowest condition factor documented since annual sampling started in 1999.

Overall, condition factors in all sections have generally decreased since the 2005 sampling season.

Relative Stock Densities (RSD's)

RSD-225 values for brown trout in all Rush Creek sample sections decreased between 2007 and 2008, ranging from a 25% drop in the County Road section to a 35% decrease in the Upper section. RSD-225 values for brown trout in all Rush Creek sample sections have now decreased for two consecutive sampling years. RSD-300 values remained low in the Upper Rush Creek section, with a drop from 3 to 4 between 2007 and 2008. The Rush Creek County Road section has had a RSD-300 value of 0 since 2002.

As with the other two Rush Creek sections, all RSD values for the MGORD have decreased for two consecutive seasons. The RSD-300 value experienced a 65% drop between 2007 and 2008. The RSD-375 value for 2008 was 3 and has been 4 or less for three consecutive sampling years.

In the Lee Vining Creek sample section, the RSD-225 value for all trout (brown and rainbow trout combined) decreased by 75% between 2007 and 2008. This large drop in RSD-225 can be attributed to the large numbers of trout that were between 150 – 224 mm in length; most likely age-1 fish. In 2008, the Lee Vining Creek section had a RSD-300 value of 0 for the second consecutive year.

Termination Criteria

In Rush Creek, neither of the annually sampled sections met the target of meeting four out of five termination criteria for the average of the three-year period of 2006-2008. The County Road and Upper sections met only one of the five the termination criteria, with estimated densities greater than 3,000 fish per kilometer.

Because the Lee Vining Creek main channel section was not sampled in 2006, the most recent three-year running average was comprised of data collected in 2008, 2007 and 2005. In Lee Vining Creek, the current sampling section failed to achieve the target of meeting three out of four termination criteria. The current sampling section met two of the four termination criteria (biomass and condition factor).

The MGORD section of Rush Creek met two of three RSD termination criteria for the average of years 2006-2008. The RSD-375 average for 2006-2008 failed to meet termination criteria due to three consecutive years where low (less than 5) values were recorded.

Introduction

This report presents the results of the twelfth 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 tenth 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. Rush Creek fairly consistently produced brown trout weighing ¾ to two pounds. Trout averaging 13 to 14 inches were also regularly observed.

2. Lee Vining Creek sustained catchable brown trout averaging eight to 10 inches in length. Some trout reached 13 to 15 inches.

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 specific 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. In 2006, a new suite of termination criteria were proposed by the Fisheries Stream Scientist in an attempt to make the calculation and interpretation of the fisheries termination criteria more quantifiable. The proposed metrics were well received; however, the proposed values assigned to signify “recovery” of the fishery were contentious. Along with population estimates; the annual fishery monitoring report will include the metrics of biomass, density, condition factor and relative stock density (RSD) because these are generally accepted by fishery professionals as repeatable and quantifiable measurements of stream-dwelling trout populations.

This report provides fish population data mandated by the Orders and the Settlement Agreement. Fish length data are 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

Starting in 2008, the annual sampling sections were modified as follows. In Rush Creek the MGORD and Upper sections were maintained, the Lower section was discontinued, a new Bottomlands section was added and the County Road section was shortened from 813 meters to 237 meters. The Parker Creek section was also discontinued, while the Walker Creek section was maintained. In Lee Vining Creek the Upper main channel and side channel sections were dropped, the Lower main channel section was extended by approximately 100 meters and the Lower side channel section was maintained.

In Rush Creek the Lower section was located immediately downstream of where the channel split into two channels. The east channel (aka the 10-channel) had been mechanically re-opened prior to 1999. In 1999, this section was originally selected as a sampling area, but we were never able to effectively sample the 10-channel because it was not yet an established channel. Instead, much of the 10-channel flowed through some old pond areas and across the floodplain in many extremely small rivulets. However, during the past ten years water flows down the 10-channel have both incised the channel and annually increased, so that less and less flow has been moving through the original Lower Rush sample section. Consequently, after the 2007 annual sampling we decided to discontinue sampling the Lower Rush section.

To aid in the transition to a "new" sample section in the lower reach of Rush Creek, annual sampling within the County Road section was conducted in 2008 and will be continued into the foreseeable future. The rationale for sampling an abbreviated reach within the County Road section was to maintain a long-term time-series of trout population data in Rush Creek downstream of the Narrows. Maintaining a long-term monitoring reach in lower Rush Creek is important because over the past ten years these data have tracked fish population responses to a wide range of run-off types, summer thermal regimes, and evolving pool habitats. The continuation of sampling within the County Road section also prevents an interruption in the termination criteria analysis of a sample section located downstream of the Narrows based on examining three-year running averages.

Comparisons of estimated standing crops were relatively consistent between the County Road and Lower sections over time from 2000 to 2007; indicating data from either section will provide the information needed to evaluate how management decisions affect fish populations within this reach (Figure 1). The newly-established Bottomlands sampling section is located between the County Road and Lower Rush Creek sections.

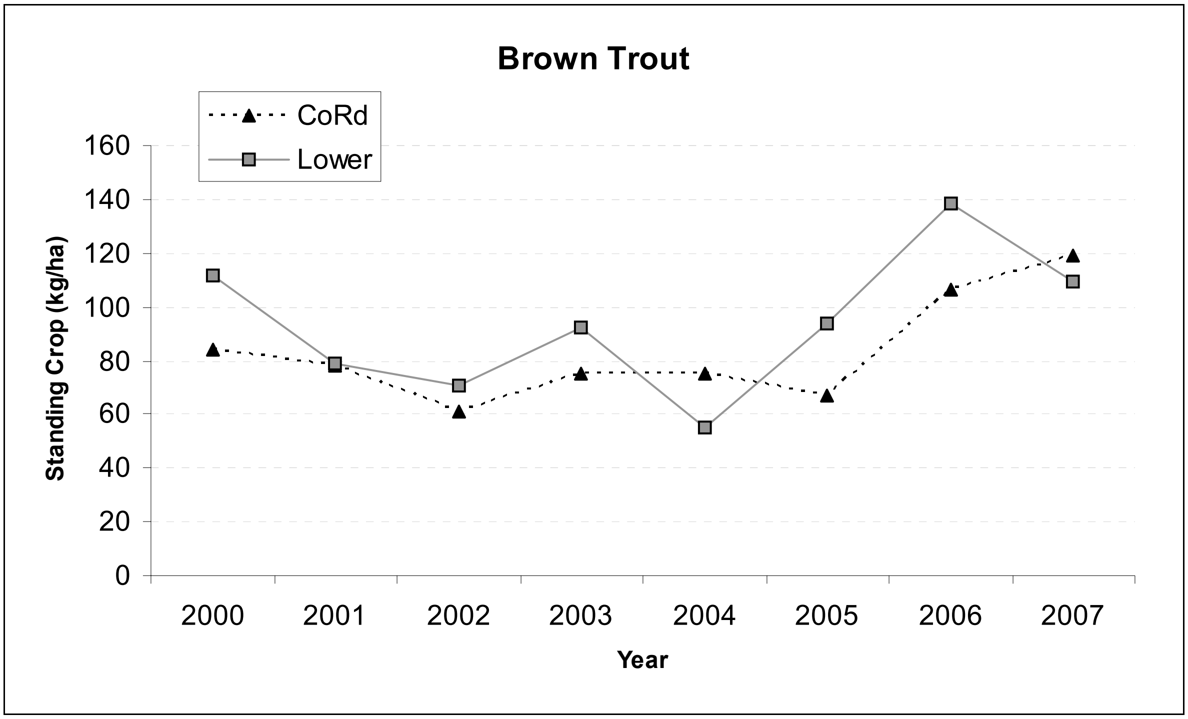
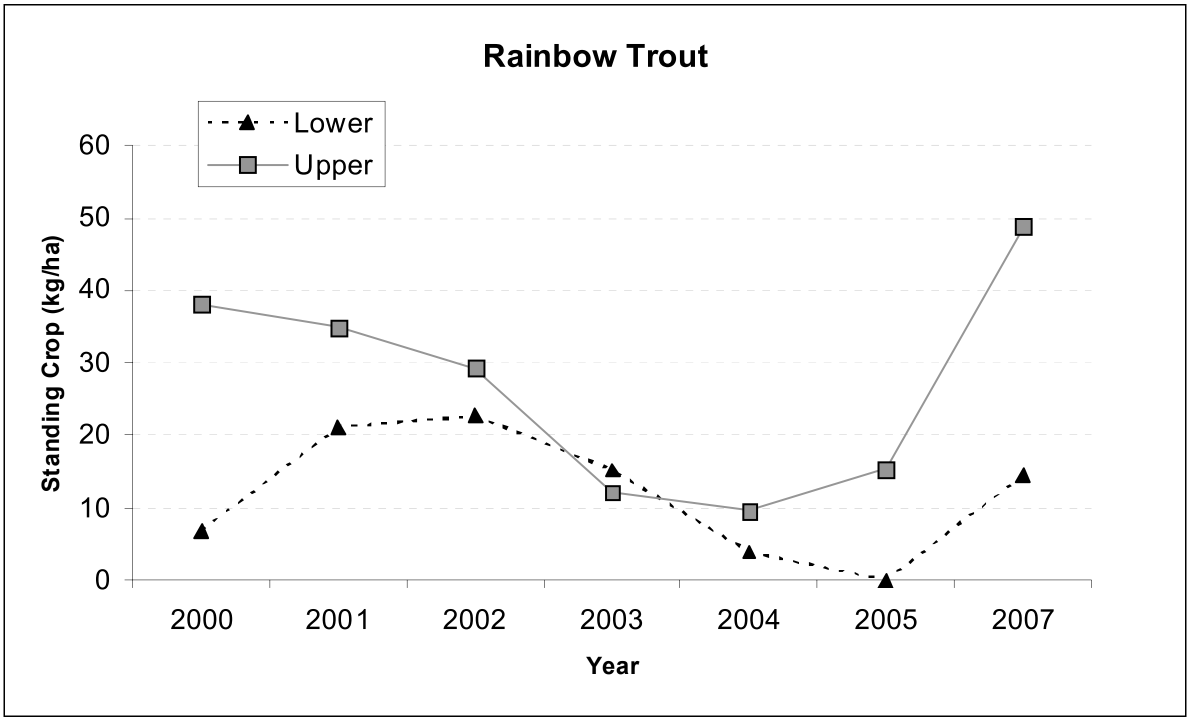


Figure 1. Standing crop estimates of age-0 and older brown trout in two sections of Rush Creek from 2000 to 2007.

The decision to select a new sample section within lower Rush Creek was made after the 2008 pool survey of the entire stream (from the bottom of the MGORD downstream to the Mono Lake delta). The approximately 1,200 meter section of Rush Creek located downstream of the 10-channel return and upstream of the County Road ford had characteristics we believe are most representative of the dynamic equilibrium that the stream is moving toward through time and where the stream was contained within a single channel. Within the 1,200-meter reach a 437-meter section was selected for annual sampling, starting in 2008. This new sample section was named the "Bottomlands" section and will eventually replace both the Lower Rush and County Road sections. Starting in 2008 the length of the County Road section was reduced by 576 meters and, as started in 2007, a block fence was used at the downstream boundary of this section.

In Lee Vining Creek both the main channel and associated side channel of the Upper section were discontinued. The Upper and Lower main channel sections of Lee Vining Creek are physically very similar, so data collected for these sections have shown similar trends of fish abundance through time (Figure 2). Flows in the side channel associated with the Upper section have declined annually until now this channel is either dry or nearly dry during September, so it cannot be sampled. The Lower Lee Vining Creek main channel section was lengthened by 100 meters, but the side channel associated with the Lower section was the same length as in previous years.



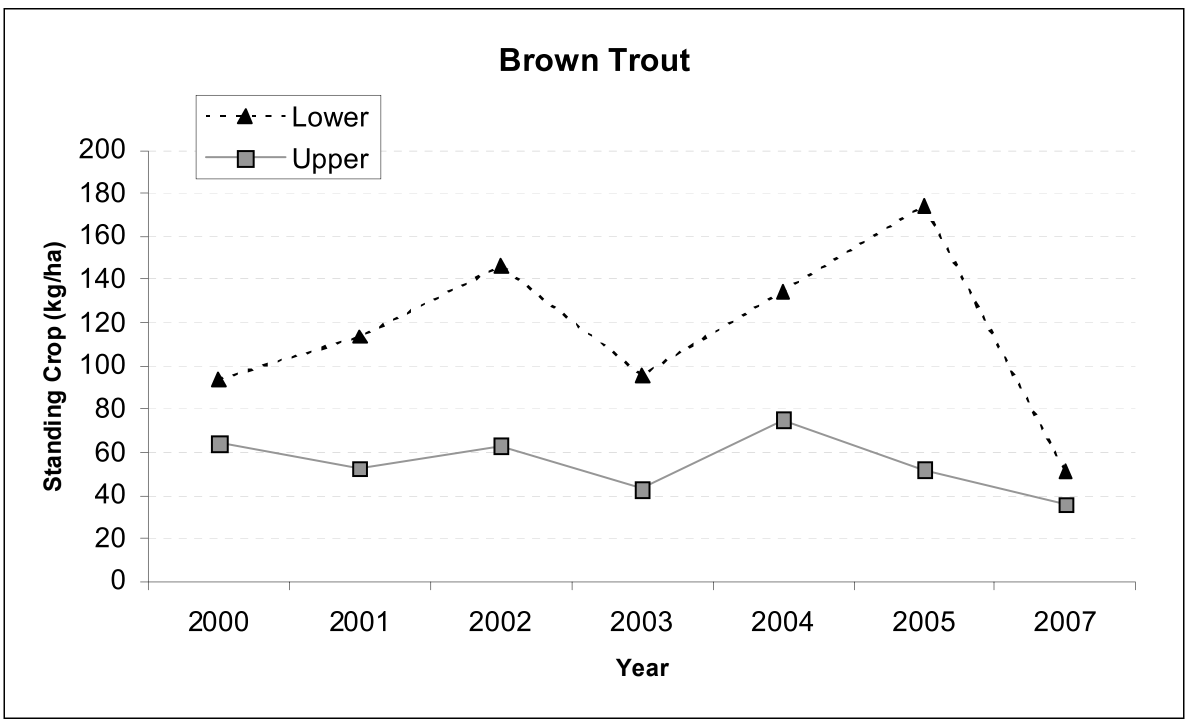


Figure 2. Standing crop estimates of age-0 and older rainbow trout (top) and brown trout (bottom) in two sections of Lee Vining Creek from 2000 to 2007.

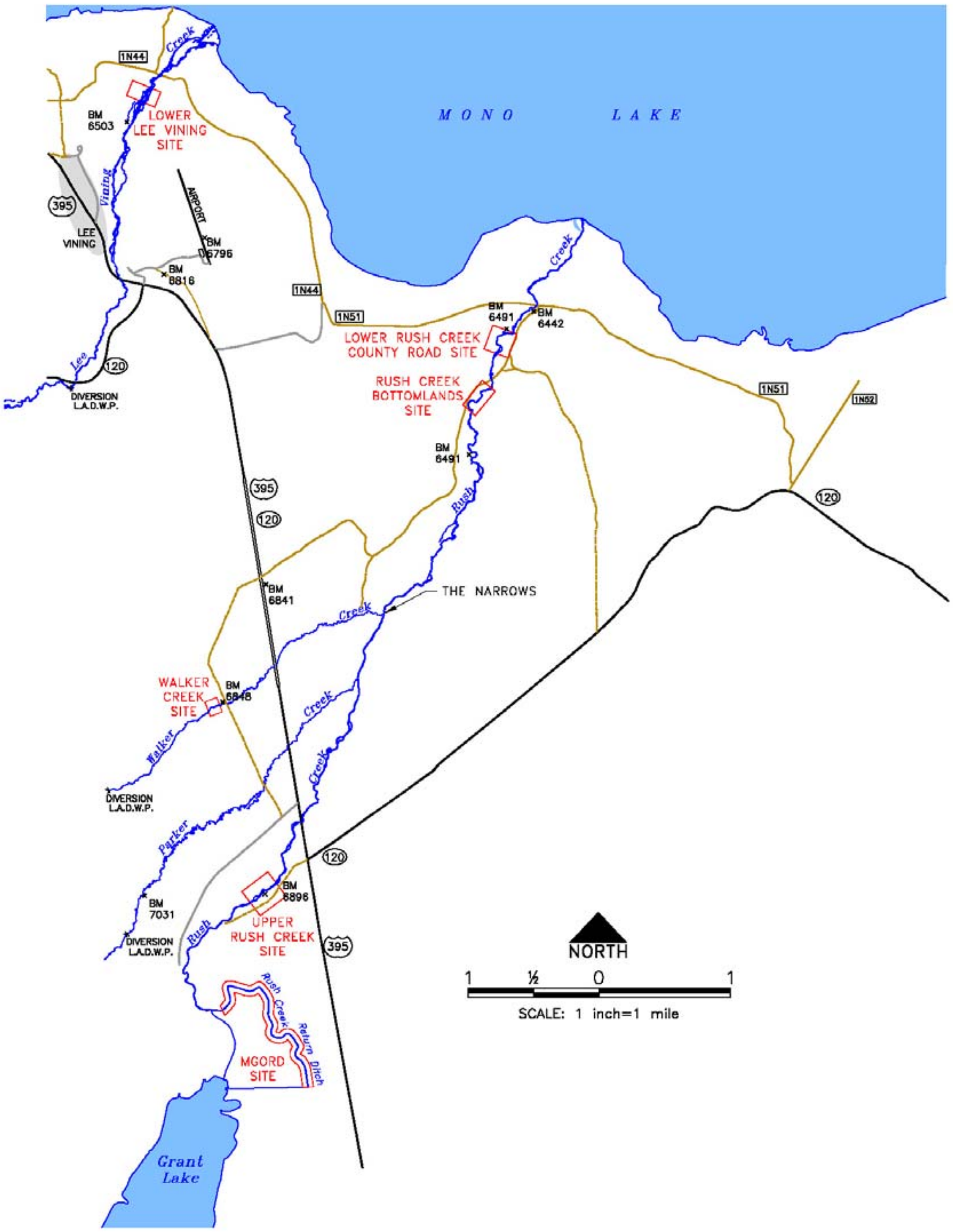


Figure 3. Map of Mono Basin study area with 2008 fish sampling sites displayed (created by McBain and Trush 2009).

The 2008 Runoff Year Forecast for the Mono basin made in April-08 was 86% and was designated a "Normal" Runoff Year. The peak flow release in Rush Creek at the bottom end of the MGORD was 387.9 c.f.s. on June 7th and included a 90.9 c.f.s. augmentation from Lee Vining Creek through the five-siphons (Figure 4). The peak flow below the Narrows was 423 c.f.s. The flow variations evident in August were the test flow releases conducted for the Rush Creek in-stream flow study (Figure 4).

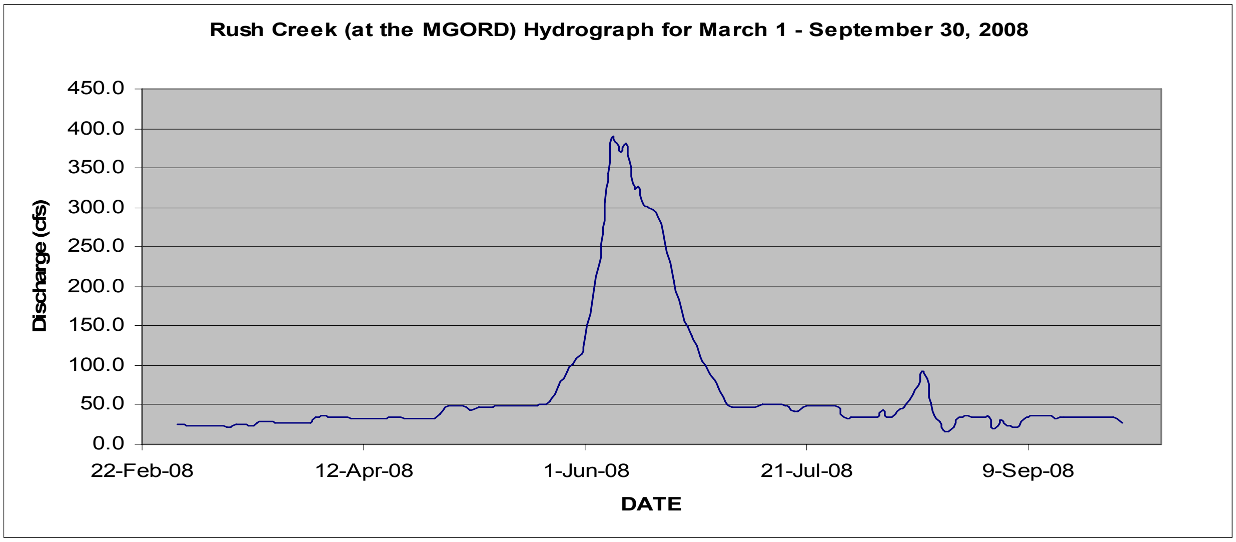


Figure 4. Daily stream flows (c.f.s.) in Rush Creek below the MGORD between March and September 2008. Data were provided by LADWP.

The peak flow in Lee Vining Creek below the LADWP diversion was 167c.f.s. and occurred on July 17th and July 22-23rd (Figure 5). As during most years, Lee Vining Creek experienced several distinct peaks in run-off due to snowmelt occurring at distinct breaks in elevation and/or the effects of cooling and warming air temperatures.

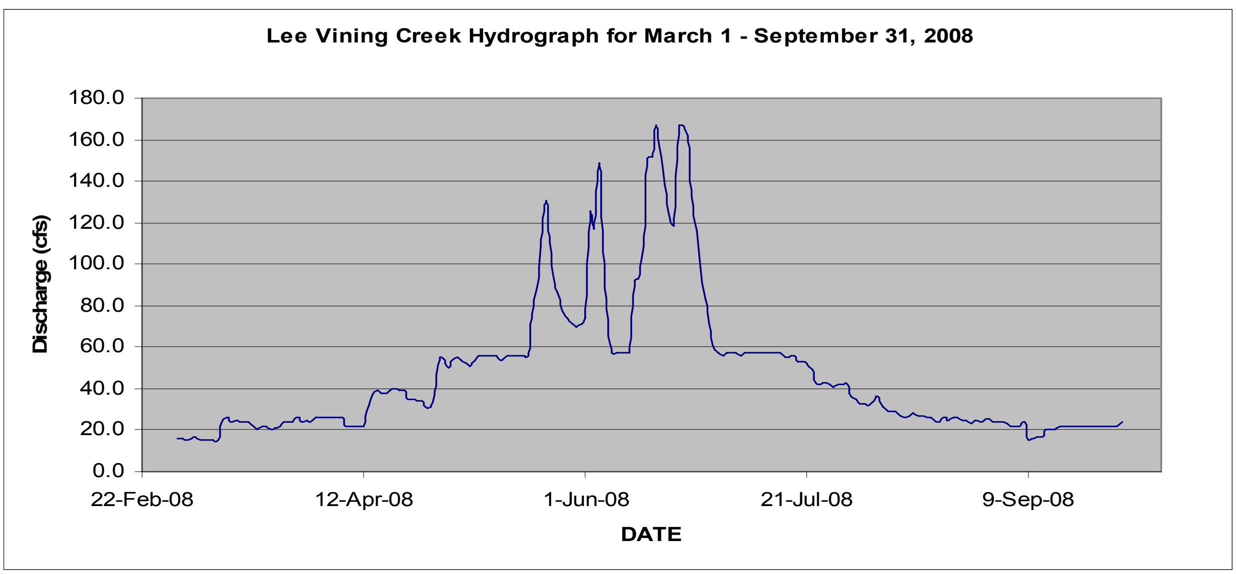


Figure 5. Daily stream flows (c.f.s.) in Lee Vining below the diversion between March and September 2008. Data were provided by LADWP.

Methods

Field sampling for generating fish population estimates occurred during the late summer between September 8th and 18th, 2008. Mark-recapture estimates were made in the new sub-section of the County Road section, the new Bottomlands section, the Upper section and the MGORD section of Rush Creek and in the Lower main channel section of Lee Vining Creek.

For all mark-recapture sampling efforts 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. This unit was contained in a six-foot long fiberglass barge that was walked down the Rush Creek channel. A sampling run consisted of a single downstream pass starting at the upper block fence and terminating at the lower block fence. During mark-recapture electro-fishing an insulated cooler with several battery-powered aerators was also carried in the barge to transport captured fish. A pair of two-person teams consisting of an anode operator and a dip netter fished each half of the channel as the barge moved in a downstream direction. The fifth crewmember skillfully maneuvered the barge downstream, monitored the condition of the captured fish in the fish cooler, and acted as the crew's safety officer. All netted fish were placed in the insulated cooler shortly after capture. In all sections of Rush Creek, frequent stops were made to work fish as the cooler became full.

A drift boat was utilized to capture fish in the MGORD and required a five-person crew to operate (Figure 6). The electro-fishing 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 facing downstream. An anode was thrown back and forth across the width of the MGORD by a crewmember in the drift boat. Another crewmember netted stunned fish from the drift boat and placed them in the insulated cooler. A third person sat in the stern of the drift boat, monitored the electro-fishing equipment and was responsible for the safety of other crewmembers. Usually no more than several hundred meters of the MGORD could be sampled before the cooler was full of fish. At these sub-stops, all captured fish were transferred to net-pens. A separate team of three people was required to process captured fish and record data.

Mark-recapture sampling on the Lower Lee Vining Creek main-channel section was accomplished with two Smith-Root® backpack electro-fishers (models12-B and SR-20). A sampling run consisted of two passes through the study section, first an upstream pass from the lower block fence to the upper block fence, immediately followed by a downstream pass back to the lower block fence. This technique also required five persons: two electro-fisher operators, two dip netters, and a bucket carrier.

Depletion estimates were made in the Walker Creek sample section and in the side-channel associated with the Lower Lee Vining Creek section (aka B-1 channel). For all depletion estimates the Smith-Root® backpack electro-fishers were used to capture fish. A single backpack electro-fisher was used when sampling the Lee Vining Creek side-channel and Walker Creek sections. One dip-netter accompanied the electro-fisher and netted fish stunned by that electro-fisher. A third 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.

Figure 6. Drift boat set-up for electro-fishing the MGORD section of Rush Creek, 2008.

To meet the assumption of a closed population for sampling purposes, all sample sections were blocked at both ends (upper and lower boundaries) prior to sampling, including both boundaries of the County Road sub-section. For all sections sampled for mark-recapture estimates 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 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 t-post and anchored to either t-posts or trees on each stream 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 twice daily to ensure they remained in place and for enumerating any dead fish caught on the fences between the mark and recapture sampling period (duration of seven days).

For the two sections (Lower Lee Vining Creek side-channel and Walker Creek) where depletion estimates were made, the upper and lower boundaries were temporarily blocked with 12 mm mesh seine nets. These nets were in place only for the duration of the multiple passes required to generate estimates, usually no more than several hours.

All captured fish were anesthetized, measured to the nearest mm (total length) and most were weighed to the nearest gram on a digital scale. Data were entered onto data sheets (hard copies) and into a hand-held personal computer (Compaq iPAC®) in the field.

All fish captured in study sections where mark-recapture estimates were made were fin-clipped during the marking electro-fishing run for later identification during the recapture electro-fishing run. The anal fin was clipped to mark fish in the MGORD and Bottomlands sections of Rush Creek and Lower Lee Vining Creek. The lower caudal fin was clipped to mark fish in the Upper Rush Creek section and the upper caudal fin was clipped to mark fish in the County Road section of Rush Creek. 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.

For calculating biomass and density estimates, channel lengths and widths were re-measured. Wetted widths were measured with a tape along the entire length of each study reach at approximately 10-meter intervals. The annual re-measurement also provided insight into potential changes in channel geometry within the study reaches.

Population and biomass estimates were made for all mark-recapture and depletion estimates using Montana Fish, Wildlife and Parks' Fisheries Analysis Plus computer package (version 1.2.7; Montana Fish, Wildlife and Parks 2004). All mark-recapture estimates employed the modified Peterson estimator within the Fisheries Analysis Plus software package (Chapman 1951, as cited in Ricker 1975).

Length-Weight Relationships

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. Only brown trout 100 mm and longer were analyzed. Fulton-type relative condition factors were also computed according to methods initially developed by LeCren (1951) and expanded by Swingle (1965) and Swingle and Shell (1971) for all brown trout 150 to 250 mm.

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

Fin Clips and Growth Estimates

During the 2008 sampling period age-0 brown trout were given permanent adipose fin clips to estimate future growth. No fin was clipped during 2007 because we determined that using an adipose clip was the only fin clip that could be reliably recognized in subsequent years (Hunter et al. 2008). All captured fish were carefully examined to see if they had been fin-clipped in the previous four years, as follows:

- Year 2003 = Adipose fin clip – identifying them as age-0 fish in 2003 and age-5 fish in 2008.
- Year 2004 = Left pelvic clip – identifying them as age-0 fish in 2004 and age-4 fish in 2008.
- Year 2005 = Right pelvic clip – identifying them as age-0 fish in 2005 and age-3 fish in 2008.
- Year 2006 = Adipose clip – identifying them as age-0 fish in 2006 and age-2 fish in 2008.

All recaptured brown trout that were clipped as age-0 fish were noted on the data sheets and their lengths and weights were averaged by stream and sample section to derive empirical growth rates.

Relative Stock Density (RSD) Calculations

Relative stock density (RSD) was introduced as a new parameter in 2006 as a quantitative termination criterion. RSD's are numerical descriptors of length-frequency data and given representative samples of a population, RSD's are easily calculated and can provide insight or predictive ability about population dynamics. Please refer to the 2006 Mono Basin Fisheries Report for a more detailed literature review regarding RSD concepts and relevance as a quantifiable form of termination criteria (Hunter et al. 2007).

RSD values are simply reported as the proportions (percentage x 100) of the total number of brown trout ≥150 mm (~6") in length that are also ≥225 mm or ~9" (RSD-225), ≥300 mm or ~12" (RSD-300) and ≥375 mm or ~15" (RSD-375). These three RSD values are calculated by the following equations:

RSD-225 = [(# of brown trout ≥225 mm) ÷ (# of brown trout ≥150 mm)] x 100
RSD-300 = [(# of brown trout ≥300 mm) ÷ (# of brown trout ≥150 mm)] x 100
RSD-375 = [(# of brown trout ≥375 mm) ÷ (# of brown trout ≥150 mm)] x 100

Termination Criteria Calculations and Analyses

In Decision-1631, the agreed upon termination criteria for Lee Vining Creek is to sustain a fishery for naturally-produced brown trout that average eight to 10 inches in length (200 to 250 mm) with some fish reaching 13 to 15 inches (330 to 375 mm). The agreed upon termination criteria for Rush Creek states that Rush Creek fairly consistently produced brown trout weighing from 0.75 to two pounds. Trout averaging 13 to 14 inches (330 to 350 mm) were also allegedly observed on a regular basis prior to the 1941 diversion of this stream.

The termination criteria provided in this report are based on the suite of termination criteria proposed by the Fisheries Stream Scientist in an attempt to make the calculation and interpretation of the fisheries termination criteria a more quantifiable exercise. The rationale for replacing the original termination criteria was to evaluate brown trout populations with metrics derived from quantifiable methodologies that are generally accepted as standards by fisheries professionals. As stated in our ten previous 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, 2007, 2008).

Four repeatable and quantifiable metrics will be employed as termination criteria to evaluate the brown trout populations in the Upper, Lower, and County sections of Rush Creek – biomass, density, condition and relative stock density (RSD) of catchable trout (≥225 mm or ≥9") in the populations. The same four criteria will be applied to all trout (brown and rainbow combined) in the Lee Vining Creek sample section. A fifth metric for Rush Creek sections only will be RSD-300 of brown trout (proportion of brown trout ≥300 mm or ≥12").

Finally, three termination criteria metrics of RSD will be applied to the Rush Creek MGORD only – the RSD of brown trout ≥225 mm (RSD-225), ≥300 mm (RSD-300) and ≥375 mm (RSD-375).

<u>Rush Creek TC for Upper, Bottomlands and County Road Sections</u>

<u>Termination Criterion #1 – Biomass:</u> 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 two age-classes (age-0 and ≥age-1). The termination criterion for biomass estimate is **≥ 175 kg/ha**. Trends in brown trout standing crop data are assessed 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 brown trout per unit length (km) of stream channel. The termination criterion for total number of trout per kilometer is **≥3,000 trout/km**. Trends in total number of trout per kilometer are assessed 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 brown trout ≥age-1+ is computed and should not drop below **1.00**. 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 (# of fish/ha) will result in lower condition factors for individual groups of trout due to density dependent competition. Trends in condition factor are assessed with three-year moving averages by computing the average of three most-current years of data. That average should meet the termination criteria of condition factor **≥1.00**.

Termination Criterion #4 – RSD-225: RSD-225 values of brown trout are computed for all sections of Rush Creek and should not drop below **35**. Trends in RSD-225 are assessed 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 at least **35**.

Termination Criterion #5 – RSD-300: RSD-300 values of brown trout are computed for all sections of Rush Creek and should not drop below **5**. Trends in RSD-300 are assessed 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 at least **5**.

Lee Vining Creek TC

Termination Criterion #1 – Biomass: Total trout (brown and wild rainbow combined) standing crop estimates based on kilograms per hectare of biomass. Total standing crop estimates will also be reported to reflect contribution by two age-classes (age-0 and ≥age-1). The termination criterion for biomass estimate is **≥ 150 kg/ha**. Trends in total trout standing crop data are assessed 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 **150 kg/ha**.

Termination Criterion #2 – Density: Total number of trout per unit length (km) of stream channel. The termination criterion for total number of trout per kilometer is **≥1,400 trout/km**. Trends in total number of trout per kilometer are assessed 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 **1,400 trout/km**.

Termination Criterion #3 – Condition: Condition factor of trout ≥age-1+ is computed and should not drop below **1.00**. Trends in condition factor are assessed with three-year moving averages by computing the average of three most-current years of data. That average should meet the termination criteria of condition factor **≥1.00**.

Termination Criterion #4 – RSD-225: RSD-225 values of all trout (brown and wild rainbow) are computed for both Lee Vining Creek study sections and should not drop below **30**. Trends in RSD-225 are assessed 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 at least **30**.

Rush Creek TC for the MGORD Section

For the Rush Creek MGORD study section three termination criteria metrics of RSD are utilized – the RSD of brown trout ≥225 mm (≥9”), ≥300 mm (≥12”) and ≥375 mm (≥15”).

RSD-225 value in the MGORD is computed and should not drop below **60**.

RSD-300 value in the MGORD is computed and should not drop below **30**.

RSD-375 value in the MGORD is computed and should not drop below **5**.

Trends in RSD-225, RSD-300 and RSD-375 were assessed 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 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 RSD values of MGORD brown trout should be collected in September, prior to the onset of the fall spawning season when migrations occur.

How to use the Quantifiable Termination Criteria

1. With the most-current data set, calculate the biomass, density, condition factor and RSD-225 values for each section of Rush Creek and Lee Vining Creek. Calculate the RSD-300 values for Rush Creek sections only.

2. For Lee Vining Creek, the biomass estimates from the main and side (if watered) channels were combined for a total value. For densities and condition factors, the values from the main and side (if watered) 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, three-year running averages.*

4. For the Upper, Bottomlands and County Road sections of Rush Creek, a section of would 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 (age-0) recruitment, densities will be high with fairly low biomass estimates. Conversely, in years of low age-0 recruitment densities will probably drop, but biomass of older trout should increase. Years of high densities may also exhibit lower condition factors due to density-dependent competition for available food and/or habitat.

5. For Lee Vining Creek, the sample 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.

Results

Channel Lengths and Widths

Due to differences in stream flows during 2008 channel widths could not be reliably compared between years; however, previous channel measurements are presented to illustrate the changes made to Lower Lee Vining Creek main channel section and the County Road section of Rush Creek, as well as the addition of the Bottomlands section (Table 1). In past reports we have expressed concerns about the dynamic nature of the stream channels (particularly in lower Rush Creek) making sample sections subject to change (Hunter et al. 2001 - 2008). Between 2007 and 2008, the continued increase of flow going down the 10-channel instead of the Lower Rush Creek section finally prompted the decision to drop the Lower sample section and establish the new Bottomlands section.

Table 1. Total length (m), average wetted width (m), and total surface area (m^2) of sample sections in Rush, Lee Vining, and Walker creeks sampled between September 8 -18, 2008. Values for 2007 provided for comparisons.

Section	Length (m) 2007	Width (m) 2007	Area (m^2) 2007	Length (m) 2008	Width (m) 2008	Area (m^2) 2008
Rush – Co. Road	813	7.4	6,016	237	8.2	1943.4
Rush - Bottomlands				437	8.0	3496
Rush – Upper	430	8.5	3,655	430	8.9	3827
Rush - MGORD	2,230	12.0	26,760	2,230	12.0	26,760
LV – Lower main	155	5.7	884	255	5.4	1377
LV - Lower-B1	195	2.5	488	195	2.5	488
Walker	100	2.1	210	100	1.8	180

Fish Population Abundance

Rush Creek – County Road Section

In 2008 about 39% of the 297 brown trout captured in the County Road section of Rush Creek were young-of-the-year (age-0) fish between 50 and 125 mm and the longest brown trout captured was 271 mm (Figure 7). This section supported an estimated 436 age-0 and 319 age-1 and older brown trout (Table 2). Estimates of brown trout were not as precise as previous years with standard errors ranging from 12% to 27% of the estimates.

Six rainbow trout were sampled in 2008 and these ranged in length from 120 to 285 mm (Figure 9). No population estimates were generated for rainbow trout due to insufficient numbers of recaptures.

Rush Creek – Bottomlands Section

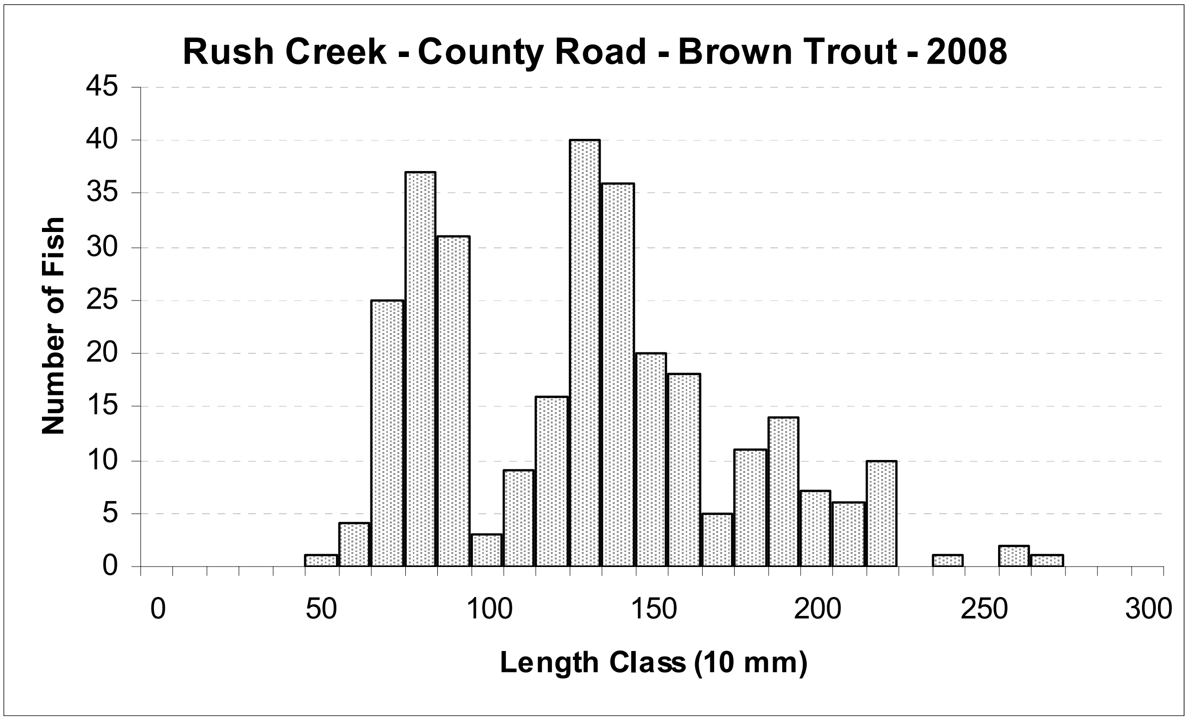
In 2008 about 50% of the 582 brown trout captured in the Bottomlands section of Rush Creek were young-of-the-year (age-0) fish between 58 and 124 mm and the longest brown trout captured was 252 mm (Figure 7). This section supported an estimated 921 age-0 and 638 age-1 and older brown trout (Table 2). Estimates of brown trout were moderately precise with standard errors ranging from 12% to 21% of the estimates.

Twelve rainbow trout from 132 to 198 mm were sampled in 2008 (Figure 9). No population estimates were generated for rainbow trout due to insufficient numbers of recaptures.

Rush Creek – Upper Section

In 2008 about 54% of the 707 brown trout captured in the Upper section of Rush Creek were young-of-the-year (age-0) fish between 58 and 124 mm and the longest brown trout captured was 390 mm (Figure 8). Seven brown trout greater than 300 mm were sampled in 2008, including one fish greater than 350 mm. This section supported an estimated 987 age-0 and 537 age-1 and older brown trout (Table 2). Estimates of brown trout in Upper Rush Creek were more precise than the County Road and Bottomlands sections' estimates with standard errors ranging from 9% to 12% of the estimates.

Sixteen rainbow trout were sampled in 2008 that ranged in length from 82 to 250 mm (Figure 10). An estimated 12 rainbow trout from 125 to 199 mm inhabited this section during 2008, but this estimate was not too reliable due to the relatively small number of recaptures (five) (Table 2). No population estimates were generated for other size groups due to insufficient numbers of recaptures.



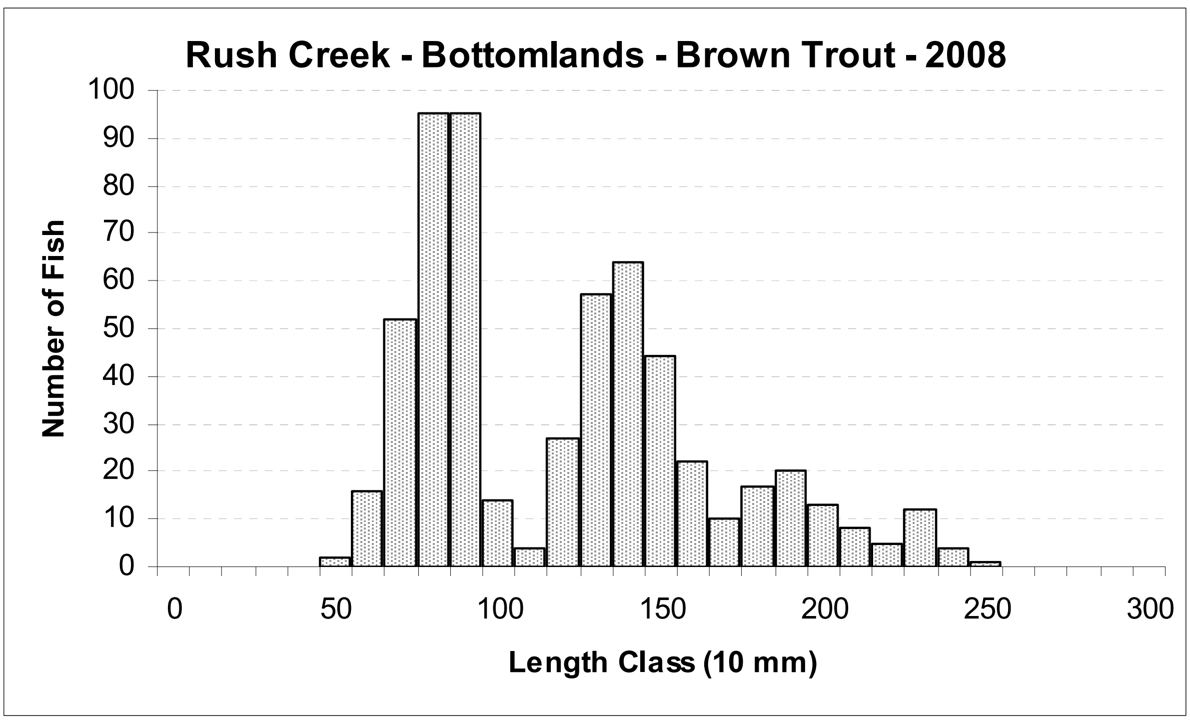
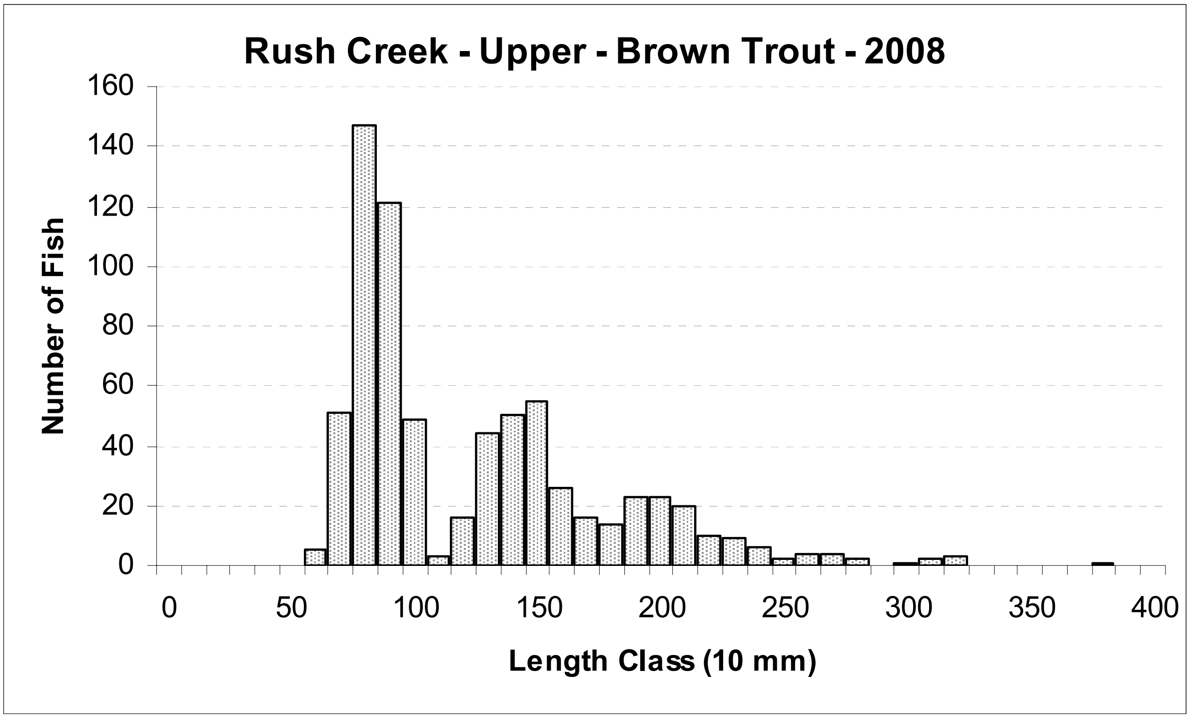


Figure 7. Length-frequency histograms of brown trout captured in the County Road (top) and Bottomlands (bottom) sections of Rush Creek between September 8th and 18th, 2008. Note different scales on the y-axes.



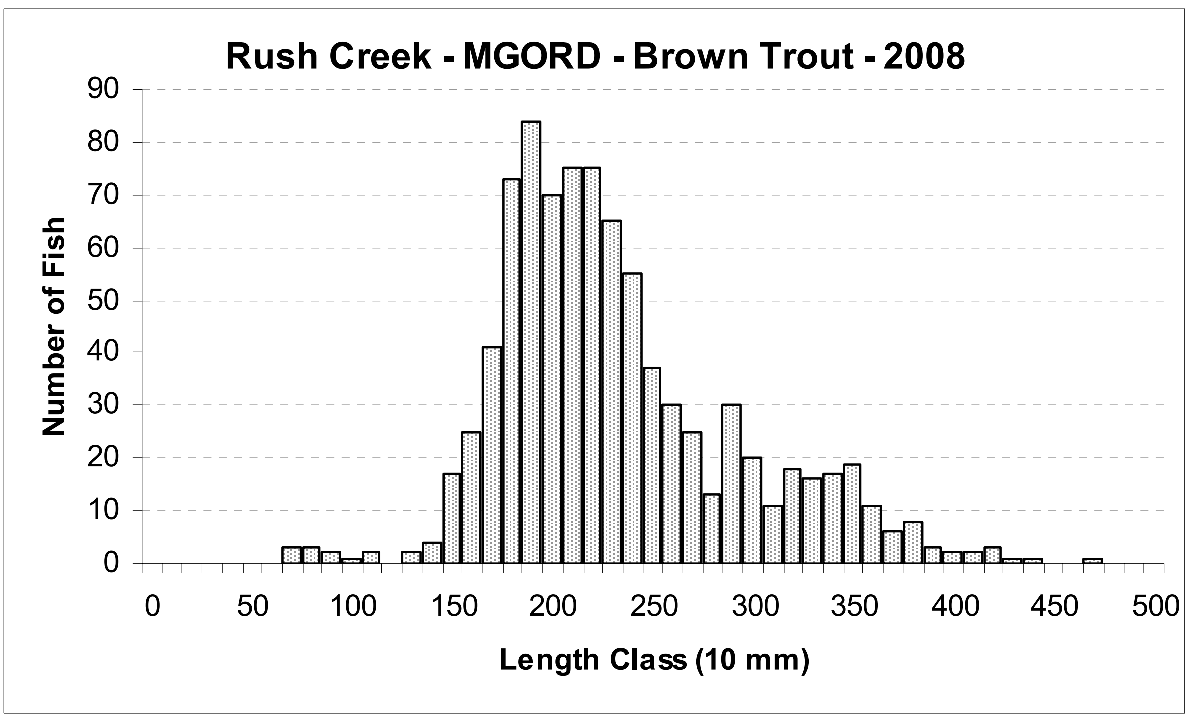
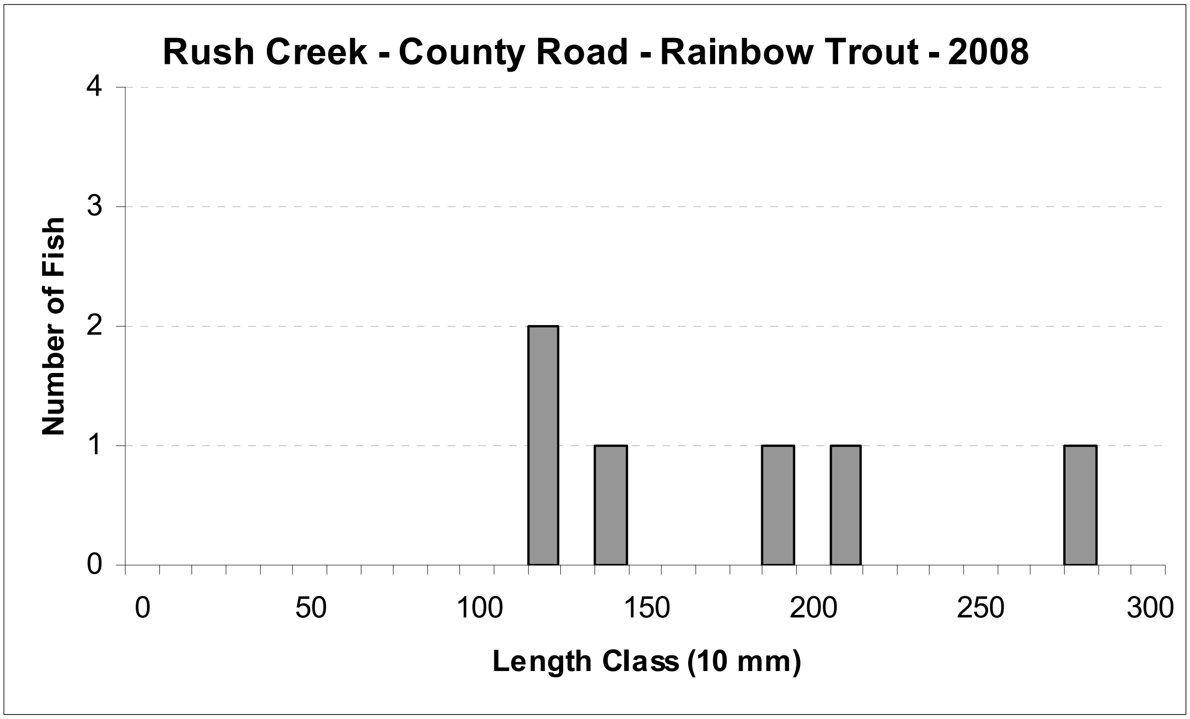


Figure 8. Length-frequency histograms of brown trout captured in the Upper (top) and MGORD (bottom) sections of Rush Creek between September 8th and 18th, 2008. Note different scales on both x-axes and y-axes.



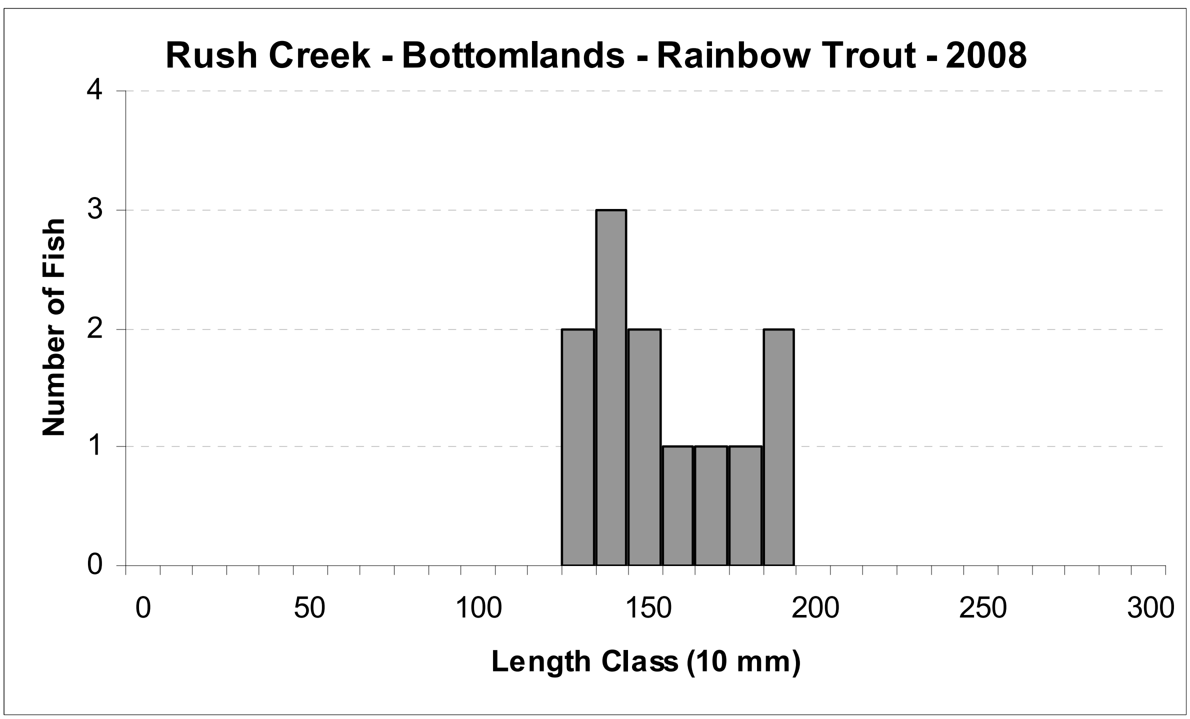
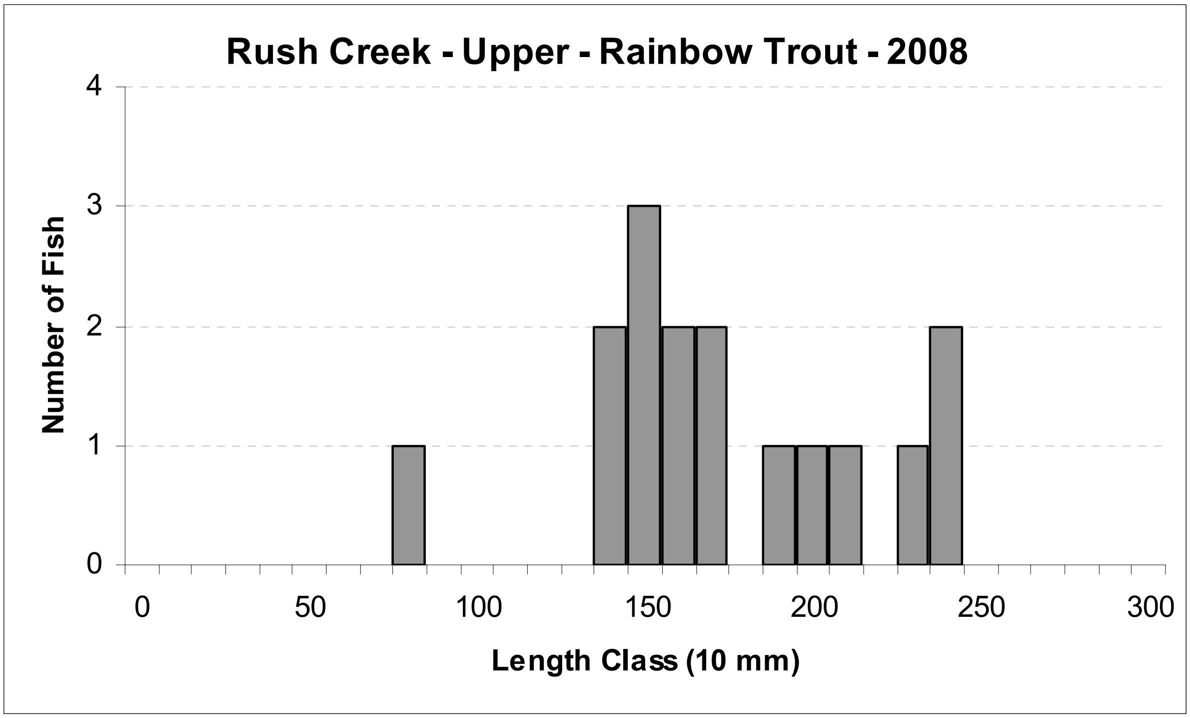


Figure 9. Length-frequency histograms of rainbow trout captured in the County Road (top) and Bottomlands (bottom) sections of Rush Creek between September 8th and 18th, 2008.



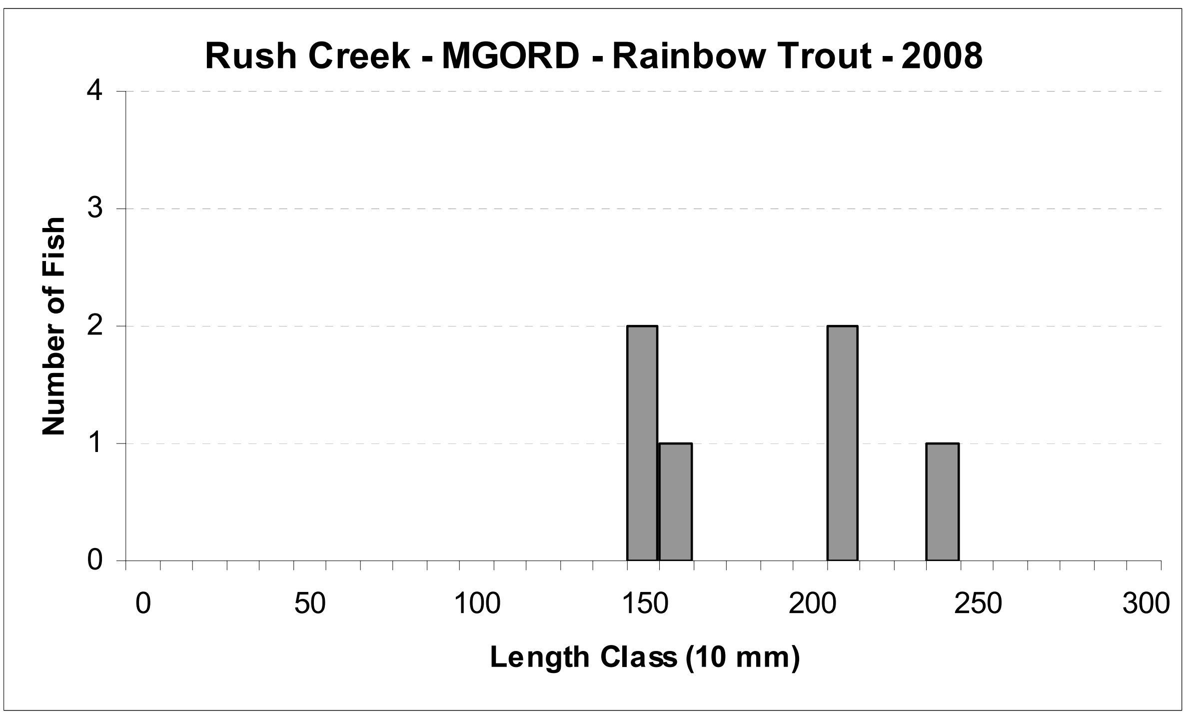


Figure 10. Length-frequency histograms of rainbow trout captured in the Upper (top) and MGORD (bottom) sections of Rush Creek between September 8th and 18th, 2008.

Table 2. Rush Creek and Lee Vining Creek mark-recapture estimates for 2008 showing total number of fish marked (M), total number captured on the recapture run (C), total 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) were those fish that were captured during the mark run, but died prior to the recapture run. Mortalities were not included in mark-recapture estimates and should be added to estimates for accurate total estimates. NP = estimate not possible.

Stream / Section / Date / **Species**	Size Class (mm)	M	C	R	Morts	**Estimate**	S.E.
		Mark - recapture estimate parameter values					
Rush Creek							
Bottomlands							
09/10/2008							
Brown Trout							
	0 - 124 mm	146	162	25	2	**921**	147.5
	125 - 199 mm	144	141	36	3	**555**	67.0
	200 - 299 mm	32	22	8	0	**83**	17.7
Rainbow Trout							
	125 - 199 mm	8	6	2	0	**NP**[a/]	
County Road							
09/10/2008							
Brown Trout							
	0 - 124 mm	68	56	8	0	**436**	118.3
	125 - 199 mm	89	94	29	0	**284**	34.6
	200 - 299 mm	19	17	9	0	**35**	5.1
Rainbow Trout							
	100 - 324 mm	3	4	1	0	**NP**[a/]	
MGORD							
09/08/2008							
Brown Trout							
	0 - 149 mm	5	10	0	0	**NP**[a/]	
	150 - 224 mm	184	290	62	3	**854**	76.8
	225 - 299 mm	157	215	71	0	**473**	33.4
	300 - 499 mm	103	83	46	0	**185**	13.2
Rainbow Trout							
	0 - 149 mm	0	0	0	0	**0**	0.0
	150 - 274 mm	1	6	1	0	**NP**[a/]	
Upper Rush							
09/09/2008							
Brown Trout							
	0 - 124 mm	179	224	40	19	**987**	121.1
	125 - 199 mm	117	155	42	7	**427**	43.8
	200 - 424 mm	60	57	31	1	**110**	8.9

Table 2 (continued). Rush Creek and Lee Vining Creek mark-recapture estimates for 2008.

Stream / Section / Date / Species	Size Class (mm)	M	C	R	Morts	Estimate	S.E.
		Mark - recapture estimate parameter values					
Rainbow Trout							
	0 - 124 mm	0	2	0	0	**NP**[a]	
	125 - 199 mm	8	8	5	0	**12**[b]	1.7
	200 - 399 mm	4	1	0	0	**NP**[a]	
Lee Vining Creek							
Main Channel							
09/11/2008							
Brown Trout							
	0 - 124 mm	74	110	34	0	**237**	24.0
	125 - 199 mm	78	87	47	0	**144**	8.7
	200 - 299 mm	23	24	16	0	**34**	2.5
Rainbow Trout							
	0 - 124 mm	17	31	9	0	**57**	9.6
	125 - 199 mm	38	34	15	0	**84**	11.7
	200 - 324 mm	33	30	22	0	**45**	2.7

[a] "NP" indicates an estimate was not possible due to too few recaptures.
[b] These estimates have fewer than 7 recaptures.

Rush Creek – MGORD Section

During 2008, only fish that were 150 mm and longer were actively captured in the MGORD, thus there was not effort focused at sampling age-0 brown trout. For example, 865 brown trout were captured that ranged in length from 72 to 474 mm, of which 850 were 150 mm or longer (Figure 8). One hundred forty brown trout longer than 300 mm were captured in 2008, including 57 fish greater than 350 mm and ten fish longer than 400 mm. This section supported an estimated 1,512 brown trout that were 150 mm and longer (Table 2). Estimates of brown trout in the MGORD section of Rush Creek were more precise than the other Rush Creek study sections with standard errors ranging from 7% to 9% of the estimates.

Six rainbow trout were sampled in 2008 that ranged in length from 159 to 245 mm (Figure 10). No population estimates were generated for rainbow trout within the MGORD due to insufficient numbers of recaptures.

Lee Vining Creek – Main Channel Section

In 2008 about half of the 299 brown trout captured in the main channel section of Lee Vining Creek were young-of-the-year (age-0) fish between 70 and 107 mm and the longest brown trout captured was 259 mm (Figure 11). This section supported an estimated 237 age-0 and 178 age-1 and older brown trout (Table 2). Estimates of brown trout were relatively precise with standard errors ranging from 6% to 10% of the estimates.

A total of 137 rainbow trout were sampled in 2008 with 39 (28%) of these fish being age-0 fish that ranged from 59 to 115 mm in length (Figure 12). This section supported an estimated 57 age-0 and 129 age-1 and older rainbow trout (Table 2). Estimates of rainbow trout were relatively precise with standard errors ranging from 6% to 17% of the estimates.

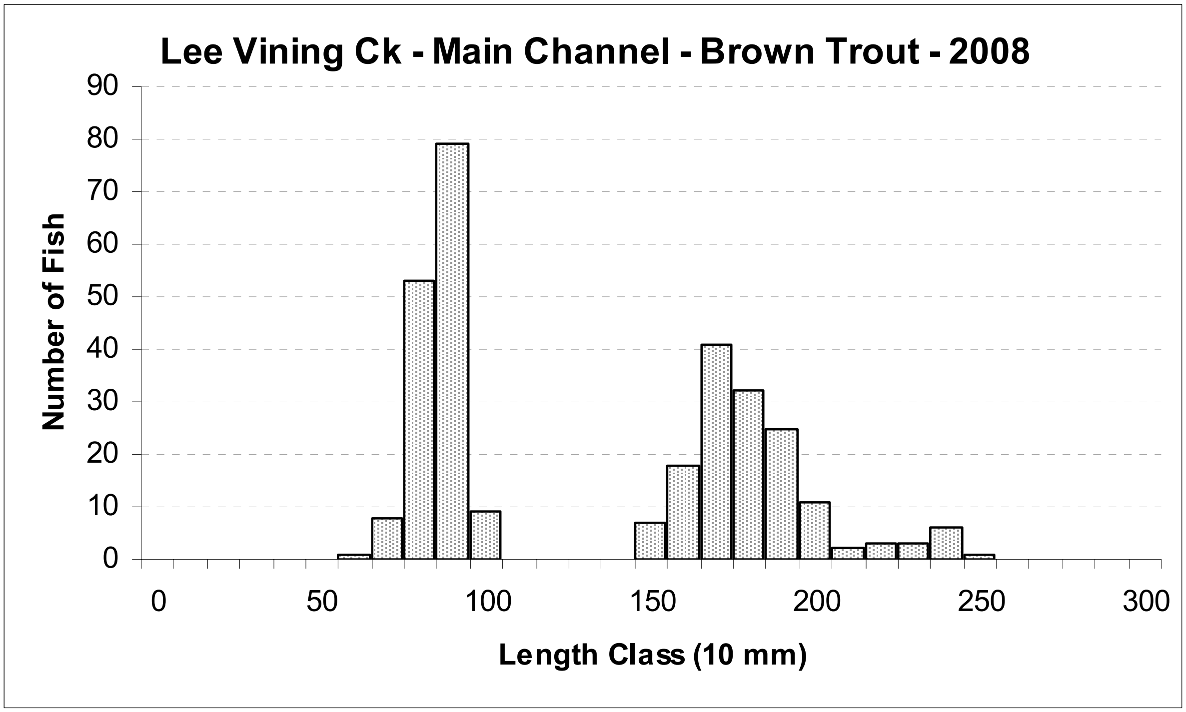
Lee Vining Creek – Side Channel Section

In 2008, only nine brown trout were captured in the side channel section of Lee Vining Creek and all were age-1 and older with the smallest being 183 mm (Figure 11). The longest brown trout captured was 217 mm (Figure 11). All fish were captured on the first two of the three electro-fishing depletion passes made. This section supported an estimated nine age-1 and older brown trout (Table 3).

For rainbow trout, only 11 fish were sampled in 2008 and seven were age-0 fish between 84 and 93 mm in length (Figure 12). The longest rainbow trout captured in this side-channel was 199 mm (Figure 12). As for brown trout, all fish were captured on the first two of the three electro-fishing depletion passes made. This section supported an estimated seven age-0 and four age-1 and older rainbow trout (Table 3).

Walker Creek

In 2008, 456 brown trout were captured in two electro-fishing passes and 323 of these brown trout were age-0 fish (Figure 13). For the past five years, age-0 brown trout numbers have fluctuated widely in Walker Creek with very high numbers (>300) captured in 2007 and 2008, 80 captured in 2006, four captured in 2005, and 203 captured in 2004. In 2008, Walker Creek supported an estimated 332 age-0 and 133 age-1 and older brown trout (Table 3).



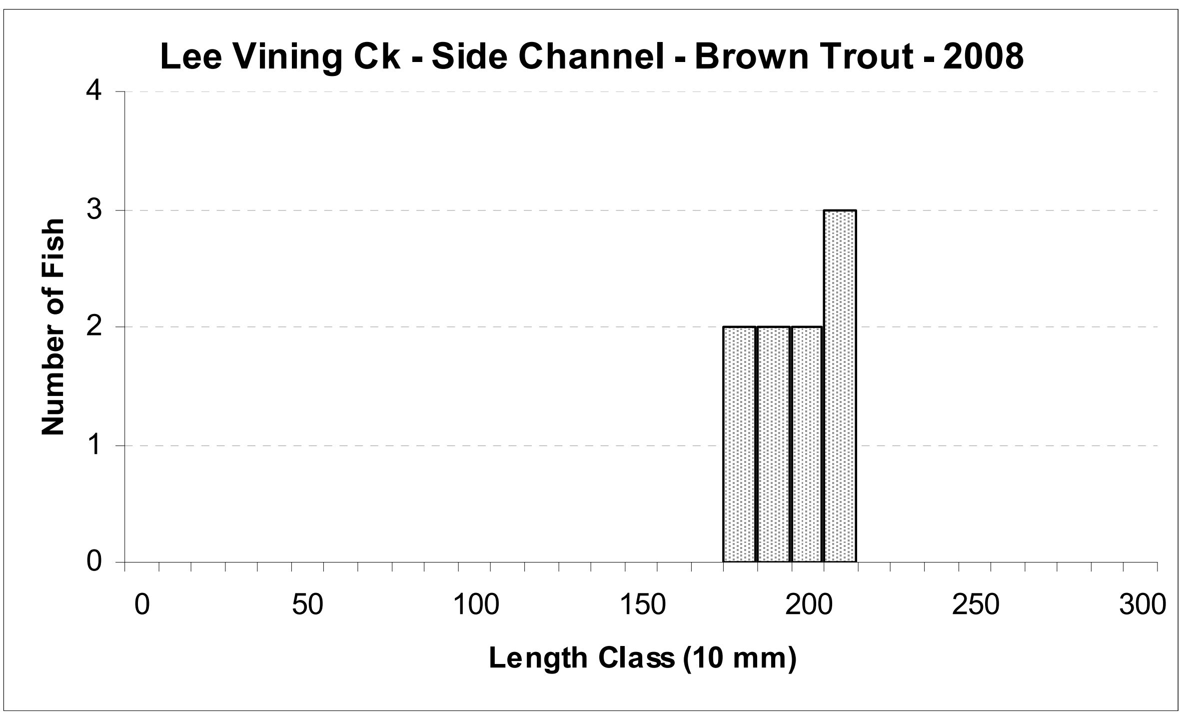
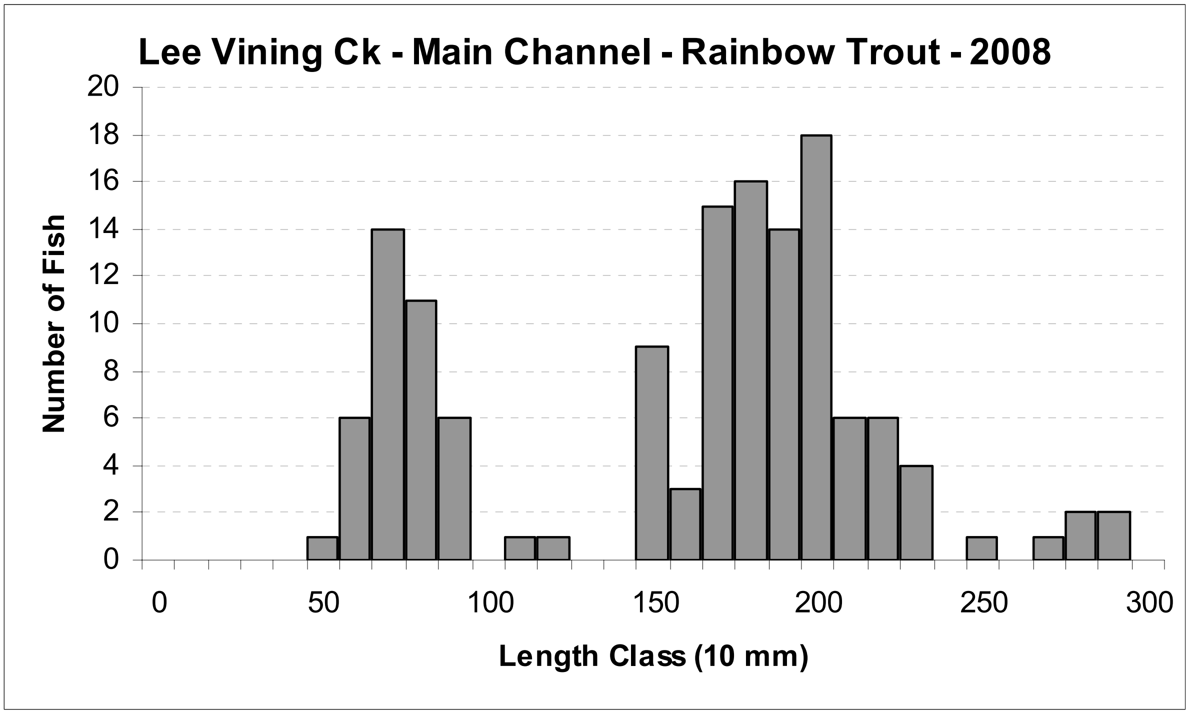


Figure 11. Length-frequency histograms of brown trout captured in the Main channel (top) and Side channel (bottom) sections of Lee Vining Creek between September 8th and 18th, 2008. Note the different scale on the vertical axis for the side-channel histogram.



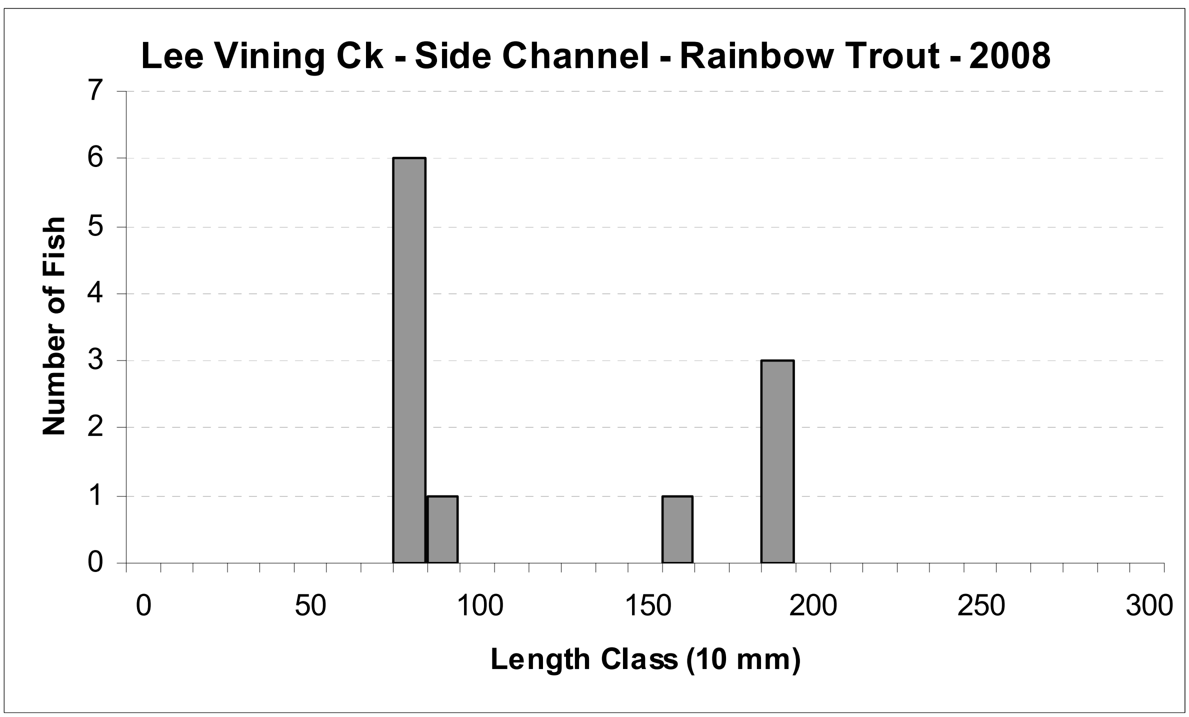


Figure 12. Length-frequency histograms of rainbow trout captured in the Main channel (top) and Side channel (bottom) sections of Lee Vining Creek between September 8th and 18th, 2008. Note the different scale on the vertical axis for the Side channel histogram.

Table 3. Depletion estimates made in the Lower side channel section of Lee Vining Creek and Walker Creek during September 2008 showing number of fish captured in each pass, estimated number and standard error (S.E.) by species and length group.

Stream - Section Date / **Species**	Size Class (mm)	Removals	Removal Pattern	**Estimate**	S.E.
Lee Vining Creek - Lower - B1 Channel 9/13/2008					
Brown Trout					
	0 - 124 mm	3	0 0 0	**0**	0.0
	125 - 199 mm	3	4 0 0	**4**	0.0
	200 + mm	3	3 2 0	**5**	0.4
Rainbow Trout					
	0 - 124 mm	3	5 2 0	**7**	0.3
	125 - 199 mm	3	3 1 0	**4**	0.2
	200 + mm	3	0 0 0	**0**	0.0
Walker Creek - Walker above road near Cane 9/12/2008					
Brown Trout					
	0 - 124 mm	2	276 47	**332**	4.3
	125 - 199 mm	2	100 4	**104**	0.4
	200 + mm	2	28 1	**29**	0.2
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

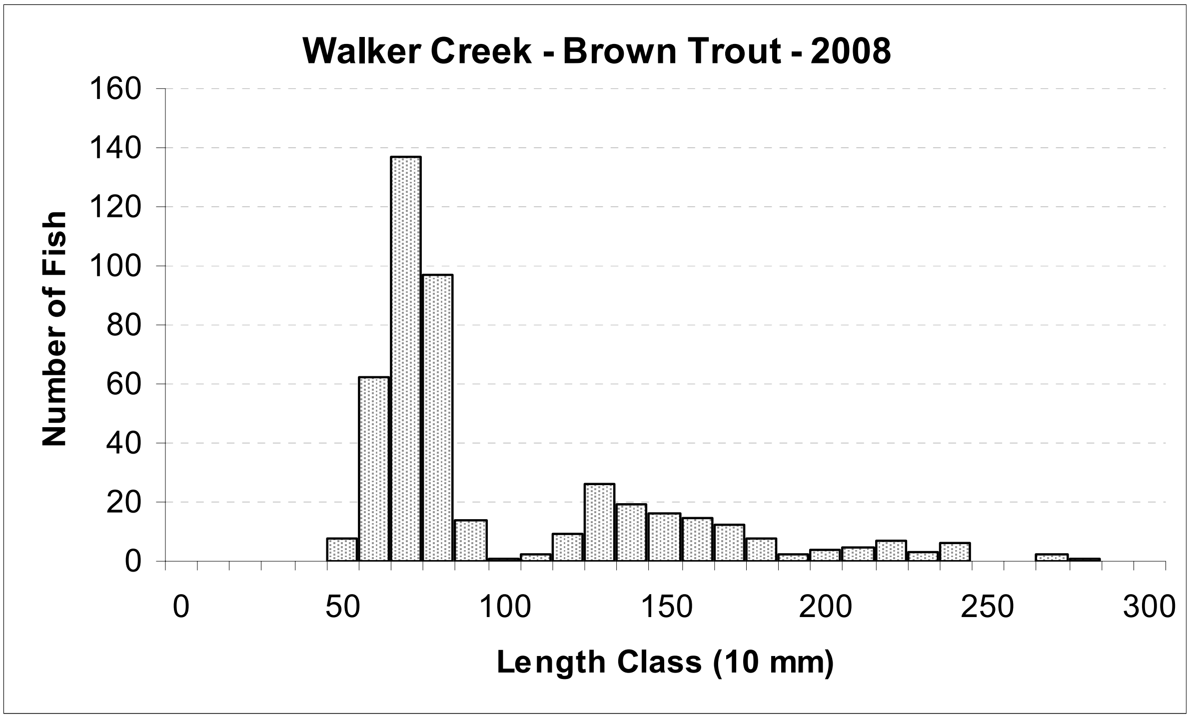


Figure 13. Length-frequency histogram of brown trout captured in Walker Creek on September 12, 2008.

Catch of Rainbow Trout in Rush and Lee Vining Creeks

For the past ten years of annual sampling, rainbow trout have been a minor component of the Rush Creek fishery, typically accounting for less than five percent of the total catch of trout. For example, in 2008 a total of 2,921 individual trout were captured by electrofishing in the Rush Creek sections (including Walker Creek), yet only 43 were rainbow trout. These rainbow trout comprised 1.5% of the fish sampled. Starting with the 2008 annual report we propose that the catch of rainbow trout in Rush Creek will simply be reported. No effort will made to extrapolate rainbow trout catch numbers into density estimates or utilized in the computation of total biomass estimates for annual reports or TC purposes.

Rainbow trout numbers in Lee Vining Creek have been variable over the past nine years, with enough fish sampled to generate estimates of age-0 fish or age-1 and older fish in some years (Tables 4 - 7). In the main channel section, sufficient numbers of age-0 rainbow trout were sampled to generate population estimates in four out of nine years (Table 4). In the main channel section, sufficient numbers of age-1 and older rainbow trout were sampled to generate population estimates in only two out of nine years (Table 5). Using depletion electrofishing, sufficient numbers of age-0 rainbow trout were captured in the side channel section to generate population estimates in eight of nine years (Table 6). In the side channel, population estimates of age-1 and older rainbow were generated in four of nine years (Table 7).

Because rainbow trout constitute a significant component of the Lee Vining trout fishery, an effort has been made to utilize whatever data were available in all years to generate density and biomass values. In years when sufficient numbers of rainbow trout were sampled to generate population estimates, these statistically valid estimates were used to compute density and biomass estimates. In years when insufficient numbers of rainbow trout were sampled to generate population estimates, catch numbers were used to compute density and biomass values. Although catch numbers are not statistically valid, density estimates generated by catch numbers are consistently lower than mark-recapture estimates in seasons when comparisons can be made (Tables 4 and 5).

Table 4. Numbers of age-0 rainbow trout caught in Lee Vining Creek main channel section, 2000-2008.

Sample Year	Area of Sample Section (Ha)	Number of Fish on Marking Run	Number of Fish on Capture Run	Number of Recap Fish	Pop Estimate	Estimated Number of Fish per Hectare	Number of Fish Caught (Catch)	Catch per Hectare
2008	0.1377	17	31	9	57	414	39	283
2007	0.0884	42	56	22	106	1,199	76	860
2006	NS*	--	--	--	--	--	--	--
2005	0.0744	0	0	0	0	0	0	0
2004	0.0744	1	0	0	NP	NP	1	13
2003	0.0744	0	0	0	0	0	0	0
2002	0.0744	0	1	0	NP	NP	1	13
2001	0.0898	3	5	1	NP	NP	7	78
2000	0.0898	0	1	0	NP	NP	1	22

*NS stands for not sampled due to high flows

Table 5. Numbers of age-1 and older rainbow trout caught in Lee Vining Creek main channel section, 2000-2008.

Sample Year	Area of Sample Section (Ha)	Number of Fish on Marking Run	Number of Fish on Capture Run	Number of Recap Fish	Pop Estimate	Estimated Number of Fish per Hectare	Number of Fish Caught (Catch)	Catch per Hectare
2008	0.1377	71	64	37	122	886	98	712
2007	0.0884	3	5	1	NP	NP	7	79
2006	NS*	--	--	--	--	--	--	--
2005	0.0744	3	3	0	NP	NP	6	81
2004	0.0744	2	2	2	NP	NP	2	27
2003	0.0744	5	6	5	NP	NP	6	81
2002	0.0744	10	10	7	14	188	13	175
2001	0.0898	9	8	4	NP	NP	13	145
2000	0.0898	1	3	0	NP	NP	4	45

*NS stands for not sampled due to high flows

Table 6. Numbers of age-0 rainbow trout caught in Lee Vining Creek side channel section, 2000-2008.

Sample Year	Area of Sample Section (Ha)	Number of Fish Caught on Pass #1	Number of Fish Caught on Pass #2	Number of Fish Caught on Pass #3	Pop Estimate	Estimated Number of Fish per Hectare	Number of Fish Caught (Catch)	Catch per Hectare
2008	0.0488	5	2		7	143	7	143
2007	0.0488	4	0		NP	NP	4	82
2006	0.0761	46	26		100	1,314	72	946
2005	0.0936	0	0		0	0	0	0
2004	0.0936	82	30		127	1,357	112	1,197
2003	0.0936	0	0		0	0	0	0
2002	0.0936	28	17		64	684	45	481
2001	0.1310	69	23		102	779	92	702
2000	0.0945	32	15		57	603	47	497

Table 7. Numbers of age-1 and older rainbow trout caught in Lee Vining Creek side channel section, 2000-2008.

Sample Year	Area of Sample Section (Ha)	Number of Fish on Marking Run	Number of Fish on Capture Run	Number of Recap Fish	Pop Estimate	Estimated Number of Fish per Hectare	Number of Fish Caught (Catch)	Catch per Hectare
2008	0.0488	3	1		4	82	4	82
2007	0.0488	6	0		NP	NP	6	123
2006	0.0761	5	0		NP	NP	5	66
2005	0.0936	7	2		9	96	9	96
2004	0.0936	5	0		NP	NP	5	53
2003	0.0936	13	0		NP	NP	13	139
2002	0.0936	29	4		33	353	33	353
2001	0.1310	38	3		41	313	41	313
2000	0.0945	9	0		NP	NP	9	95

Relative Condition of Brown Trout

Log_{10} transformed length-weight regressions for captured brown trout ≥100 mm had R^2-values over 0.98 for almost all sample events, indicating that weight was strongly correlated to length (Table 8). The length-weight relationships observed during 2008 indicated condition of brown trout 100 mm and longer in Rush Creek were among the poorest recorded since 1999, as the low regression slopes and intercept values show (Table 8). Conversely, brown trout in Lee Vining Creek appeared to be in good condition (Table 4 and Figure 14).

A fish condition factor of 1.00 is considered average and mean condition factors for brown trout 150 to 250 mm were less than 1.00 for all sections in Rush Creek and in Walker Creek, indicating that brown trout condition was moderately poor in these sections during 2008 (Figure 15). Generally, condition factors in all sections have declined since the 2005 sampling season (Figure 15). Specifically, in 2008 the County Road section had a condition factor of less than 0.9 and this was the lowest value documented in 10 years of annual sampling (Figure 15). For 2008, the Upper Rush Creek section experienced a slight increase in condition factor from the previous year; however 2008 was the second consecutive year where the condition factor was less than 1.00 (Figure 15). The new Bottomlands section of Rush Creek recorded a condition factor of 0.92 for the 2008 sampling season (Figure 15).

The mean condition factor for 150 to 250 mm brown trout in Lee Vining Creek during 2008 was over 1.00, indicating that brown trout condition was good; however, the mean condition factor in 2008 was the lowest condition factor documented since annual sampling started in 1999 (Figure 15).

Table 8. 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 2008 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	$Log_{10}(WT) = 3.00*Log_{10}(L) – 5.00$	0.99	<0.01
	2007	912	$Log_{10}(WT) = 2.789*Log_{10}(L) – 4.565$	0.98	<0.01
	2008	**398**	$\mathbf{Log_{10}(WT) = 2.794*Log_{10}(L) – 4.585}$	**0.99**	**<0.01**
Bottomlands	**2008**	**611**	$\mathbf{Log_{10}(WT) = 2.773*Log_{10}(L) – 4.524}$	**0.99**	**<0.01**
Lower	2007	235	$Log_{10}(WT) = 2.905*Log_{10}(L) – 4.815$	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	$Log_{10}(WT) = 2.99*Log_{10}(L) – 4.98$	0.99	<0.01
	2007	436	$Log_{10}(WT) = 2.867*Log_{10}(L) – 4.715$	0.99	<0.01
	2008	**594**	$\mathbf{Log_{10}(WT) = 2.967*Log_{10}(L) – 4.937}$	**0.99**	**<0.01**
MGORD	2000	82	$Log_{10}(WT) = 2.909*Log_{10}(L) – 4.733$	0.98	<0.01
	2001	769	$Log_{10}(WT) = 2.873*Log_{10}(L) – 4.719$	0.99	<0.01
	2004	449	$Log_{10}(WT) = 2.984*Log_{10}(L) – 4.973$	0.99	<0.01
	2006	593	$Log_{10}(WT) = 2.956*Log_{10}(L) – 4.872$	0.98	<0.01
	2007	643	$Log_{10}(WT) = 2.914*Log_{10}(L) – 4.825$	0.98	<0.01
	2008	**862**	$\mathbf{Log_{10}(WT) = 2.827*Log_{10}(L) – 4.602}$	**0.98**	**<0.01**

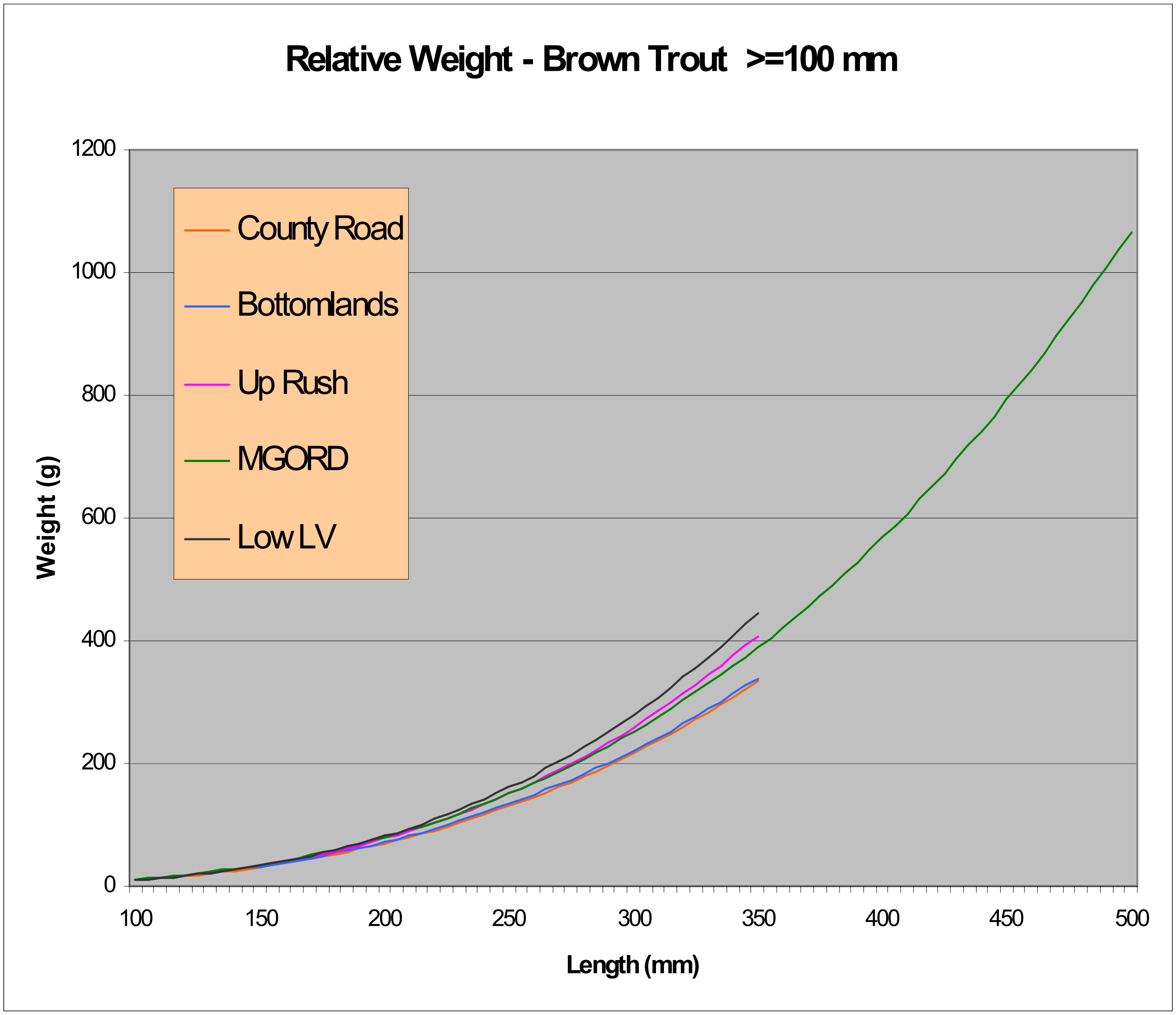


Figure 14. Relative length-weight relationships for brown trout 100 mm and longer in four sections of Rush Creek (County Road, Bottomlands, Up Rush, and the MGORD) and the Lower section of Lee Vining Creek during 2008.

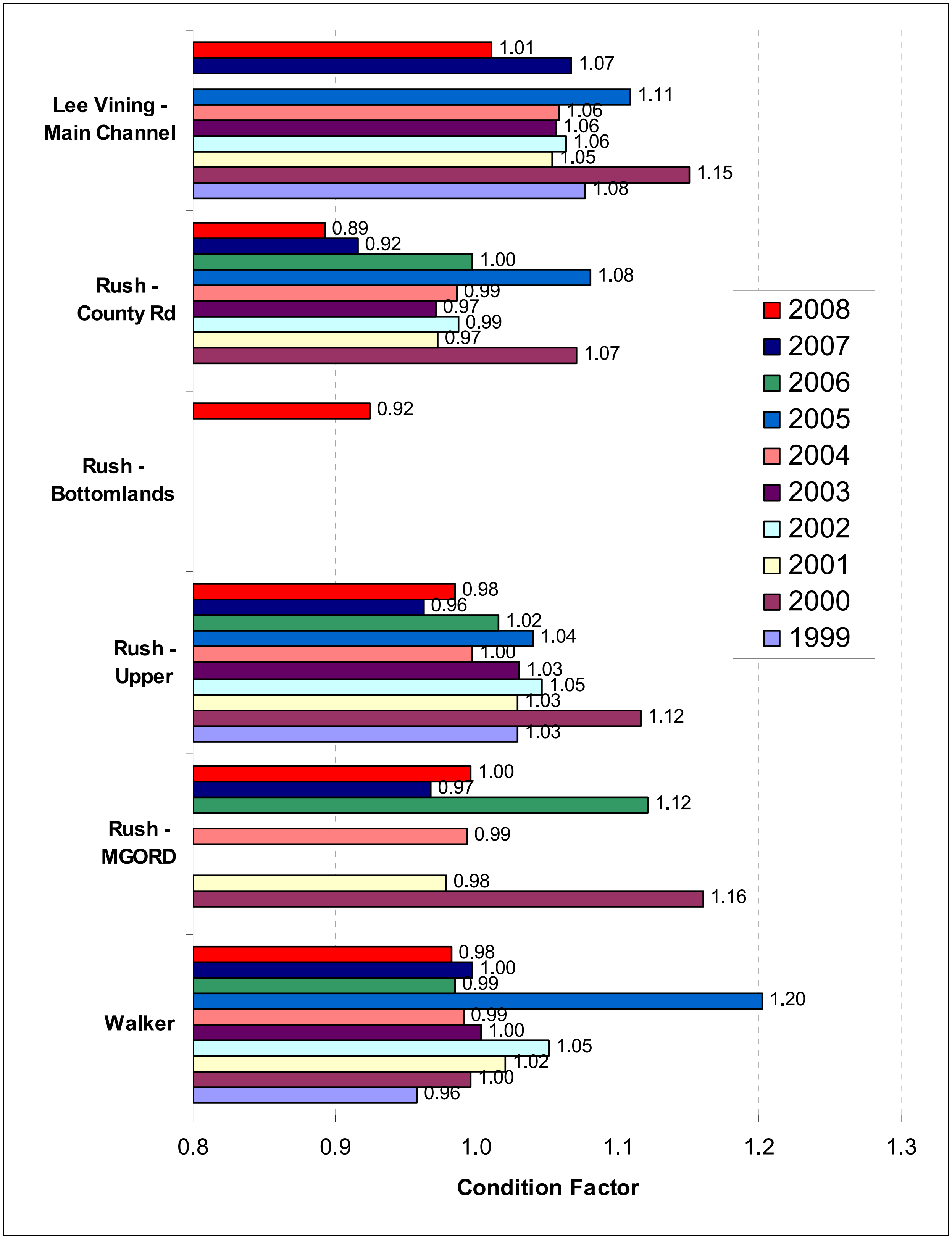


Figure 15. Condition factors for brown trout 150 to 250 mm long in sample sections of Rush, Lee Vining, and Walker creeks from 1999 to 2008. Note the x-scale starts at 0.8.

Fin Clips and Growth Estimates of Brown Trout

During the 2006 sampling season 1,753 age-0 brown trout and 75 age-0 rainbow trout had their adipose fin removed so that growth of this cohort of fish could be tracked in subsequent years (Table 9). In 2008, 17 adipose fin-clipped fish were re-captured as age-2 fish, 11 in Rush Creek and six in Walker Creek (Table 10). No recaptured fin-clipped fish were found in Lee Vining Creek. Growth for the two years between 2006 and 2008, based on these recaptures, was 112 mm in length and 67 g in weight for brown trout in the County Road section of Rush Creek, 127 mm and 86 g for brown trout in the Upper Rush Creek section, and 124 mm and 94 g for brown trout in Walker Creek (Table 10). Apparent two-year survivals (2006 to 2008), based on the number originally clipped and assuming that any fish that left the sampling area died ("apparent mortality"), were about 0.7% for the County Road and 1.3% for the Upper sections of Rush Creek and 7.8% for Walker Creek.

In 2008, a total of 1,240 age-0 trout received adipose fin clips, 1,201 were brown trout and 39 were rainbow trout (Table 11). In Rush Creek, 733 age-0 trout were clipped, in Walker Creek 319 age-0 fish were clipped, and in Lee Vining Creek 188 age-0 fish were clipped (Table 11).

Table 9. Average length (mm), minimum length, maximum length, average weight (g), and number (1,828 total fish) of age-0 trout that received adipose fin clips during the 2006 sampling season, by stream and sample section. Number in parentheses (#) 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 Creek - County Road	607	91	65	119	8.1
Rush Creek – Lower	345 (6)	95 (74)	56 (63)	121 (84)	9.2 (4.2)
Rush Creek – Upper	560 (3)	80 (61)	56 (58)	124 (65)	5.5 (2.0)
Rush Creek – MGORD	62	96	76	112	9.3
Lee Vining – Lower Main	NS	-	-	-	-
Lee Vining – Lower Side	11 (66)	86 (52)	78 (43)	99 (70)	6.5
Lee Vining – Upper Main	NS	-	-	-	-
Lee Vining – Upper Side	16	77	57	92	4.6
Walker Creek	77	95	72	115	8.9
Parker Creek	75	72	54	94	3.8

NS = not sampled due to high flow.

Table 10. Age-2 brown trout captured in 2008 with adipose fin clips administered during the 2006 sampling season, by stream reach.

Collection Location	Number of Fish Recap.	Ave. Total Length (mm)	Min. Total Length (mm)	Max. Total Length (mm)	Ave. Weight (g)	Percent Recap.	Growth Ave. Length (mm)	Growth Ave. Weight (g)
Rush - Co. Road	4	203	187	222	75.0	0.7%	112	66.9
Rush - Upper	7	207	183	225	91.7	1.3%	127.4	86.2
Walker Creek	6	219	202	227	102.7	7.8%	123.8	93.8

Table 11. Average length (mm), minimum length, maximum length, average weight (g), and number (1,240 total fish) of age-0 trout that received adipose fin clips during the 2008 sampling season, by stream, sample section, and species.

Stream	Sample Section	Species	Number of Fish Clipped	Mean Length (mm)	Mean Weight (g)	Minimum Length (mm)	Maximum Length (mm)
Lee Vining Creek	Main Channel	Rainbow Trout	38	79.1	5.9	59.0	100.0
Lee Vining Creek	Main Channel	Brown Trout	150	91.6	8.0	70.0	107.0
Rush Creek	County Road	Brown Trout	109	88.0	7.2	60.0	120.0
Rush Creek	Bottom-lands	Brown Trout	274	86.8	6.7	58.0	119.0
Rush Creek	Upper	Rainbow Trout	1	82.0	--	82.0	82.0
Rush Creek	Upper	Brown Trout	349	90.7	7.8	61.0	120.0
Walker Creek	Above old 395	Brown Trout	319	77.1	4.7	56.0	119.0

Estimated Trout Density Comparisons

Trout populations were dominated by brown trout in all sample sections during 2008, similar to past years (Figure 16; Hunter et al. 2000; 2001; 2002; 2003; 2004; 2005; 2006; 2007; 2008). One rainbow trout was captured in Walker Creek during 2008. The only other year in which a rainbow trout was captured in Walker Creek was 2002. Rainbow trout densities in the Lee Vining Creek main channel section were nearly equal to the densities of brown trout estimated in this section during 2008.

In 2008, estimated densities (number per hectare) of age-1 and older brown trout in the Upper and County Road sections of Rush Creek declined slightly from 2007 estimates (Figure 17). In the County Road section, the 2008 estimate of 1,642 age-1 and older brown trout /ha was the second highest density estimate over the ten-year sampling period (Figure 17). The new Bottomlands section of Rush Creek had an estimated density of 1,834 age-1 and older brown trout/ha (Figure 17). The Upper section of Rush

Creek had an estimated density of 1,424 age-1 and older brown trout/ha (Figure 17). In 2008, the MGORD section of Rush Creek had an estimated density of 566 age-1 and older brown trout/ha, which was a slight decrease (14.3%) from the 2006 estimated density of 660 age-1 and older brown trout/ha (Figure 17).

In Walker Creek the 2008 density estimate was more than twice the 2007 estimate (Figure 17). Since 2002 Walker Creek has annually had the highest density estimates of age-1 and older brown trout for all sample sections (Figure 17).

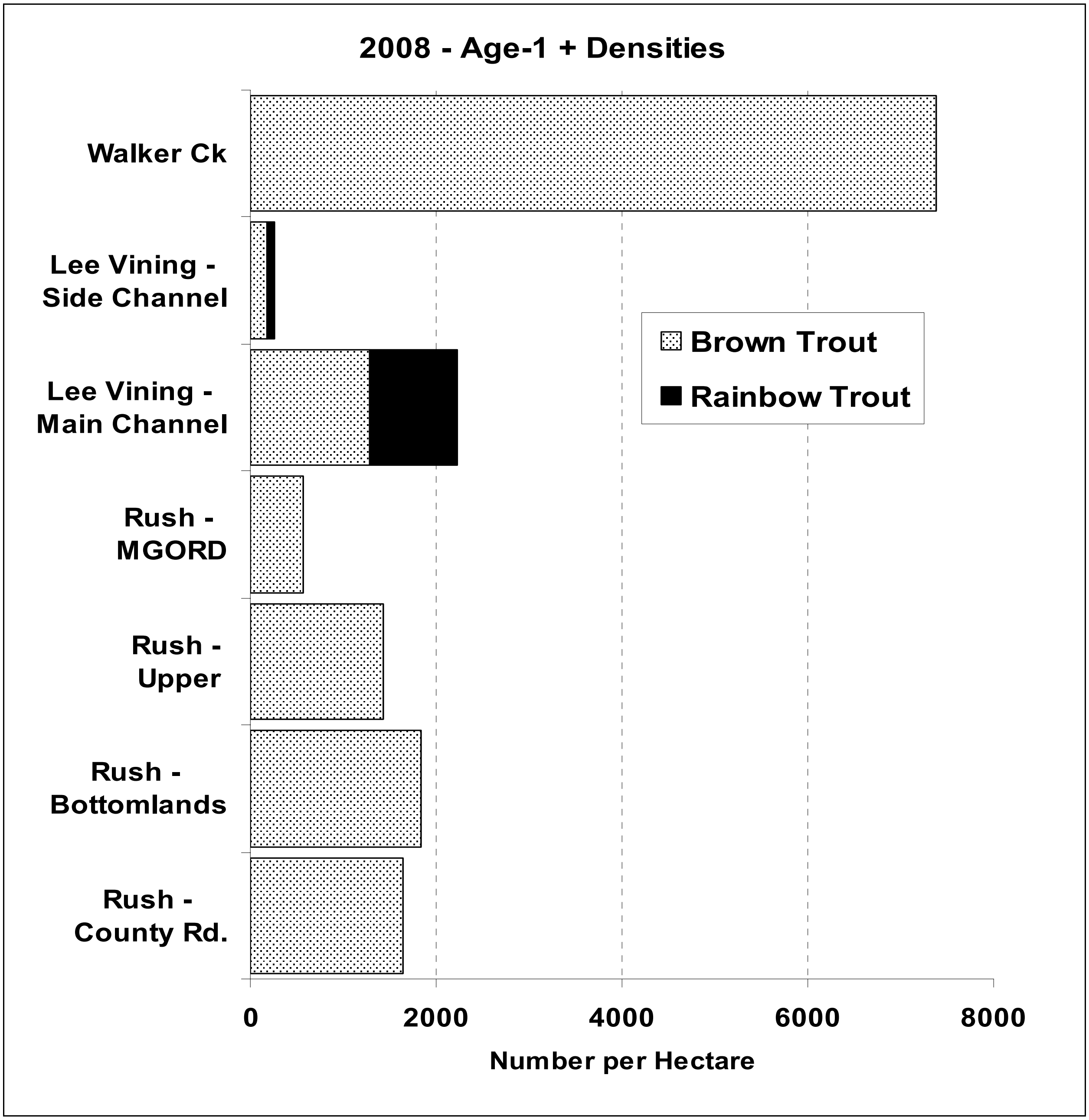


Figure 16. Densities (number/hectare) of age-1 and older brown and rainbow trout in selected Mono Lake tributaries in 2008.

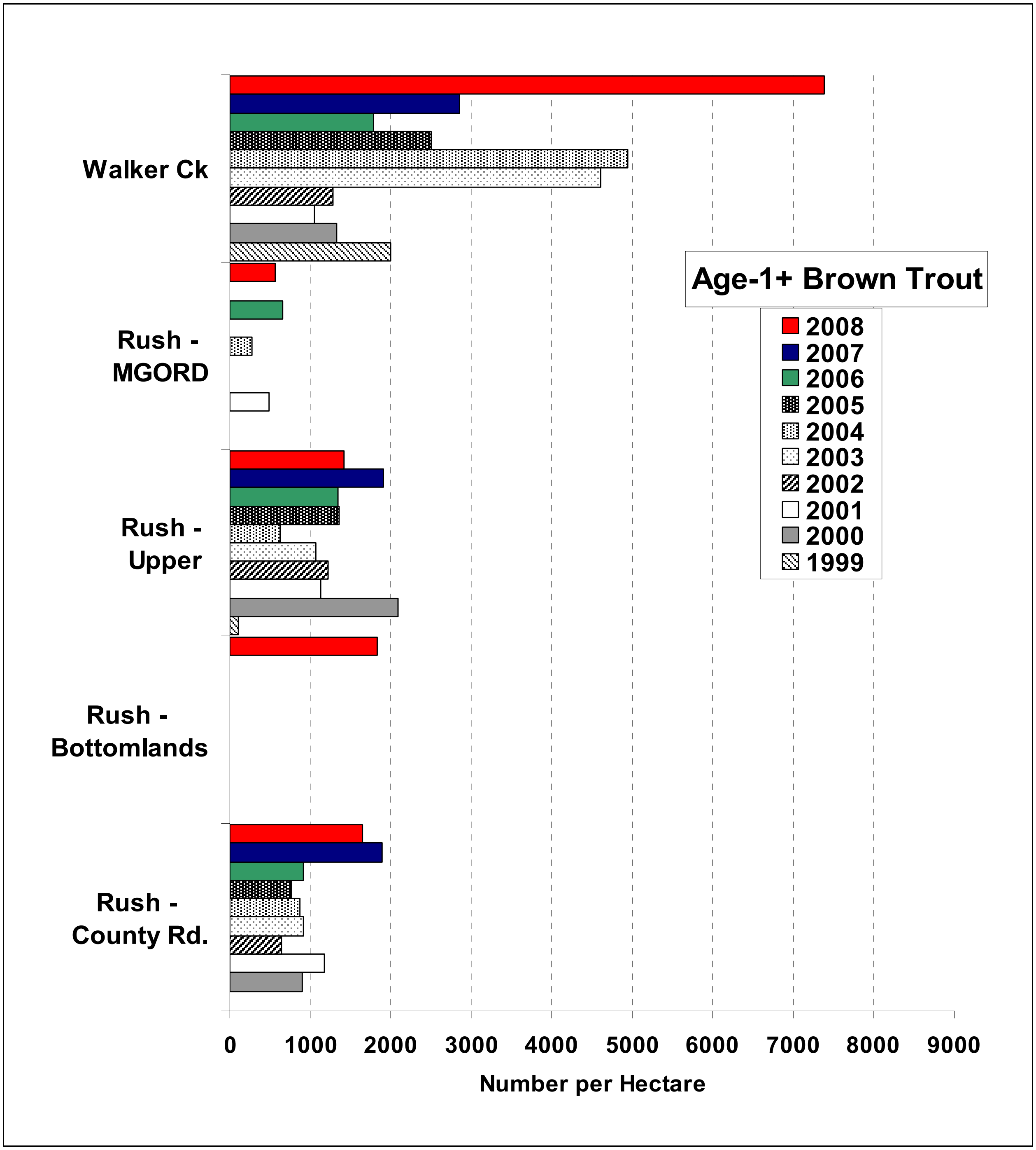


Figure 17. Estimated number of age-1 and older brown trout per hectare in sections of Rush and Walker creeks from 1999 to 2008.

The nine age-1 and older brown trout captured in the side channel section of Lee Vining Creek produced an estimated density of 184.6 fish/ha in 2008 (Figure 18). This side channel had very low flows during 2008 and therefore contained few fish; however the 2008 estimated density of age-1 and older brown trout was three times greater than the 2007 estimate of 61.5 fish/ha (Figure 18). Estimated densities of age-1 and older brown trout in the main channel of Lee Vining Creek were 714% higher in 2008 than in 2007 and the 2008 density estimate was the third highest for the ten years of annual sampling (Figure 18).

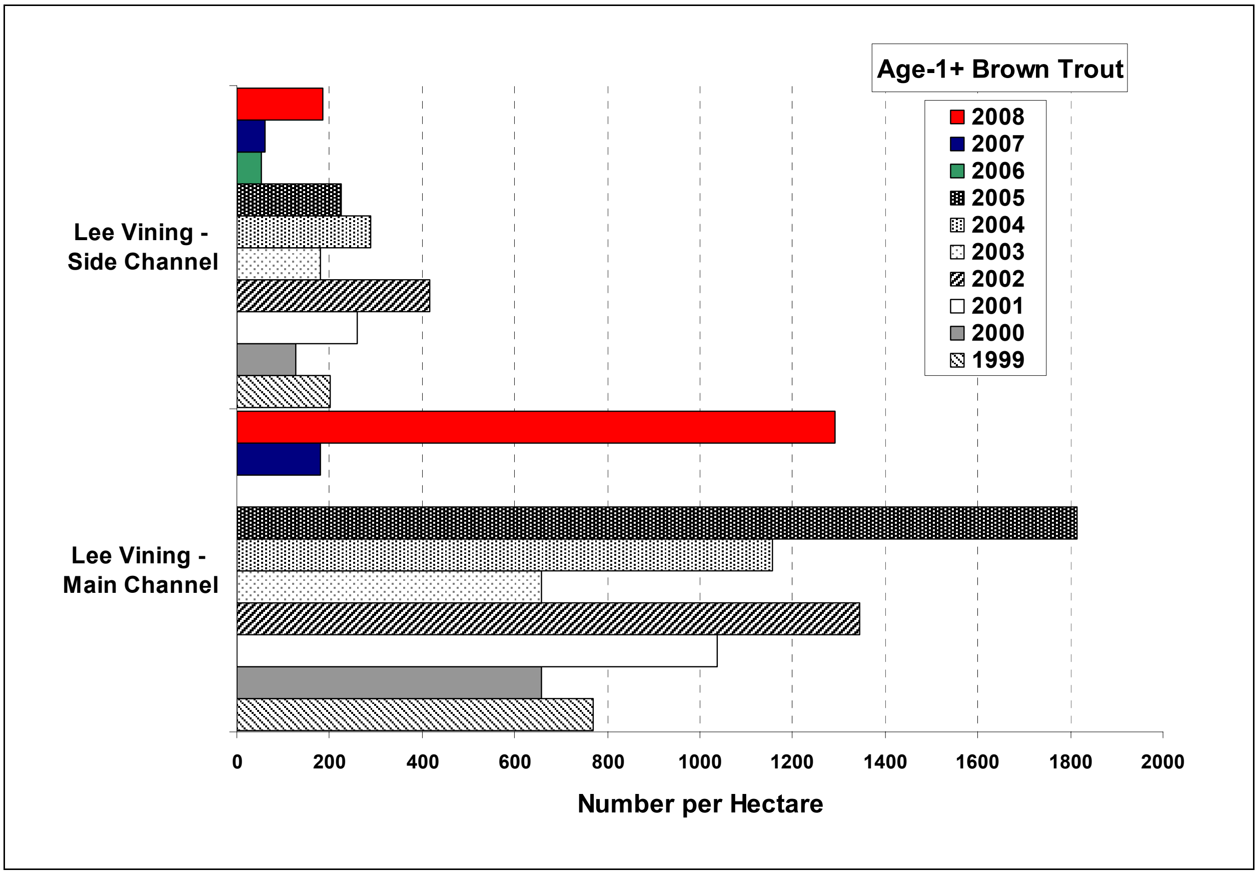


Figure 18. Estimated number of age-1 and older brown trout per hectare in sections of Lee Vining Creek from 1999 to 2008.

Estimated densities of age-1 and older rainbow trout during 2008 in the Lee Vining Creek main channel section were the highest recorded for the ten years of annual sampling (Figure 19). For Lee Vining Creek, the 2008 main channel density estimate was the first rainbow trout density estimate derived from a population estimate since the 2002 sampling season. For the years 1999-2001, 2003-2005 and 2007 insufficient numbers of age-1 and older rainbow trout were captured to generate population estimates, thus these density estimates were derived from catch data. In 2006 the flow was too high to safely electro-fish the main channel.

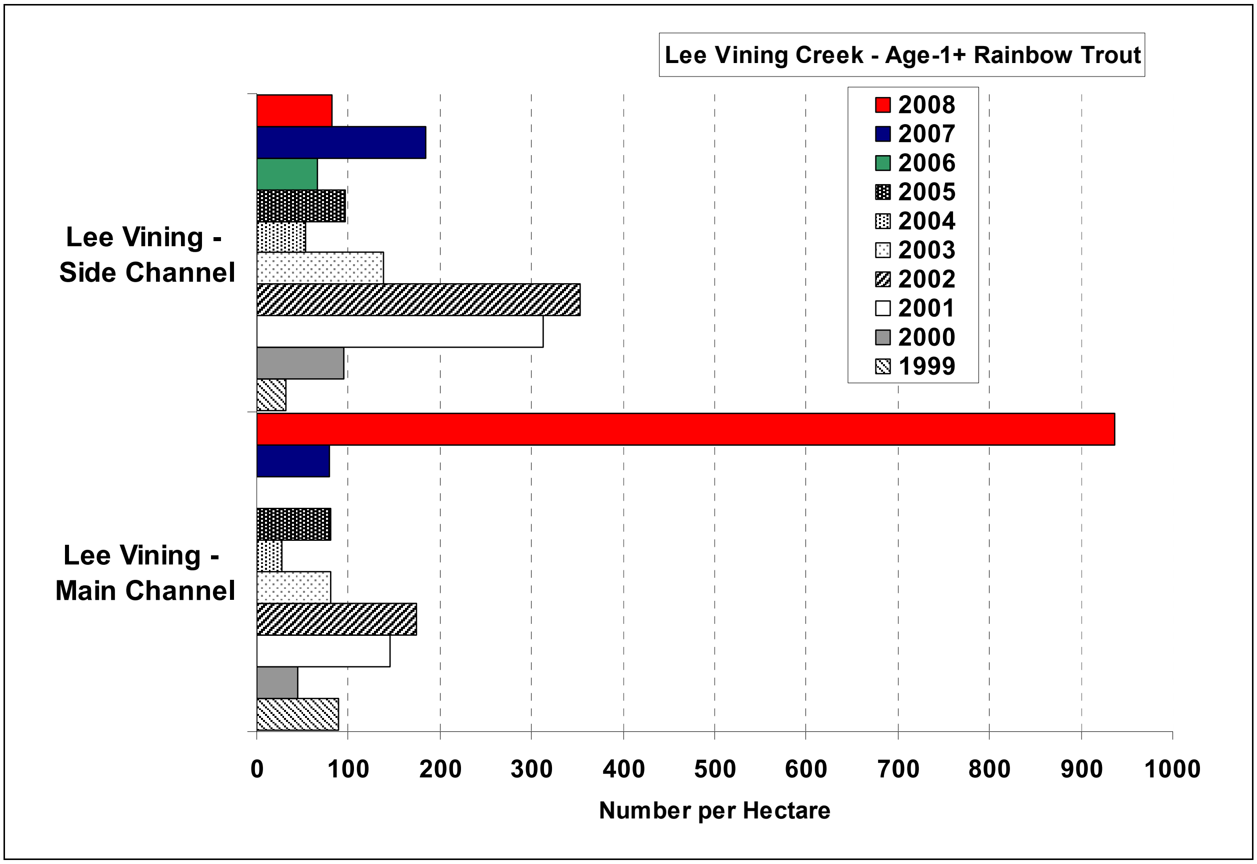


Figure 19. Estimated number of age-1 and older rainbow trout per hectare in sections of Lee Vining Creek from 1999 to 2008.

In 2008, estimated densities of age-0 brown trout in the Rush Creek County Road and Upper sections were less than half those estimated in 2007 (Figure 20). Between 2007 and 2008, the County Road section's density estimate of age-0 brown trout dropped by 54% and the Upper section's density estimate dropped by 68%. The new Rush Creek Bottomlands section had an estimated density of 2,640.2 age-0 brown trout/ha in 2008, which was comparable to the County Road and Upper section estimates of 2,243.5 and 2,628.7 age-0 brown trout/ha, respectively (Figure 20).

In Walker Creek age-0 densities of brown trout decreased by 8% in 2008 from 2007, which had the highest densities (22,571 fish/ha) ever estimated for any of the sample sections (Figure 20).

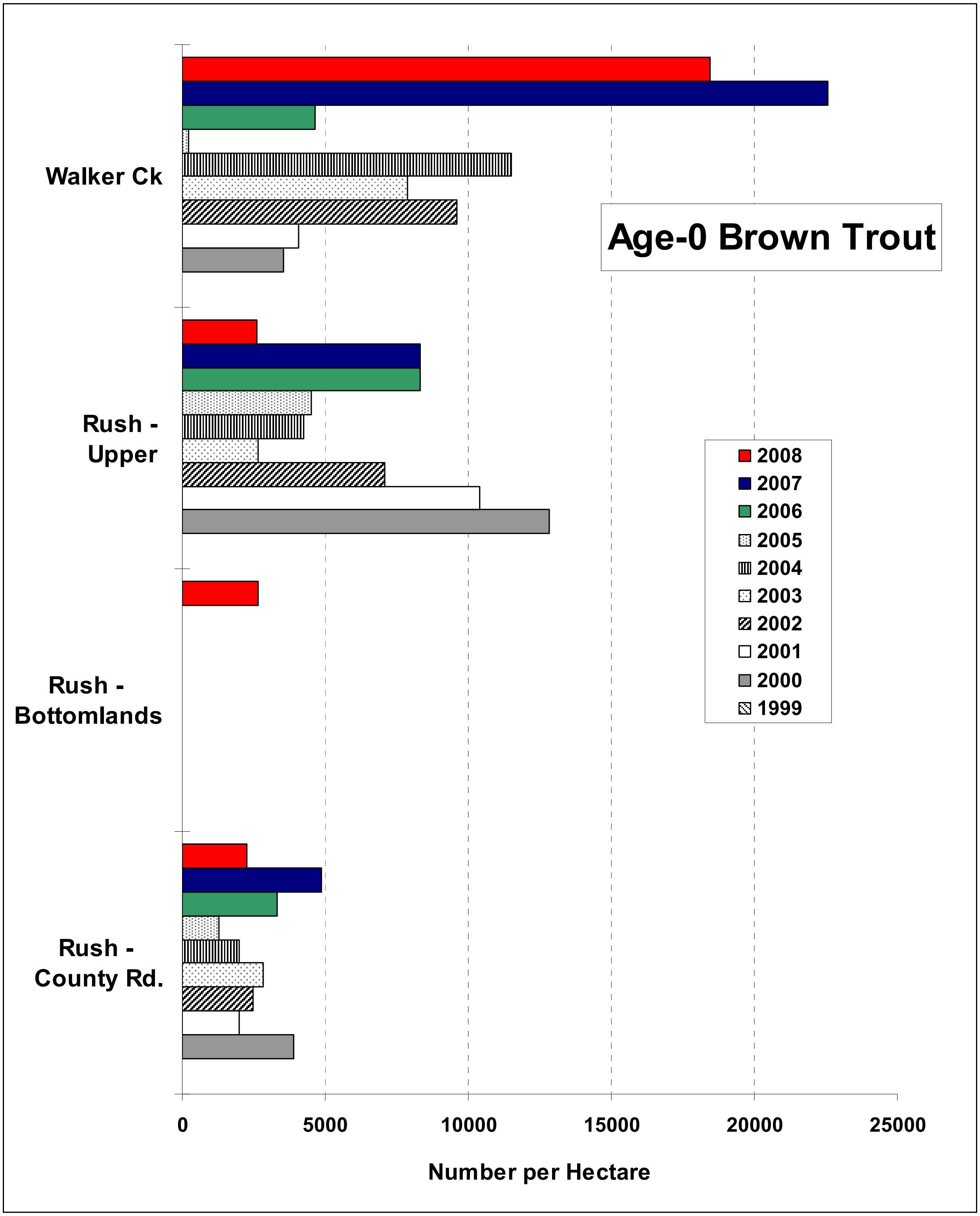


Figure 20. Estimated number of age-0 brown trout per hectare in sections of Rush Creek (bottom) and Walker creeks (top) from 1999 to 2008.

In 2008, age-0 brown trout density estimates in the main channel section of Lee Vining Creek dropped by 23% from densities estimated in 2007 (Figure 21). No age-0 brown trout were captured during 2008 within the Lee Vining Creek side channel. In four of these years (2000, 2002, 2004, 2005) densities were derived from catch data.

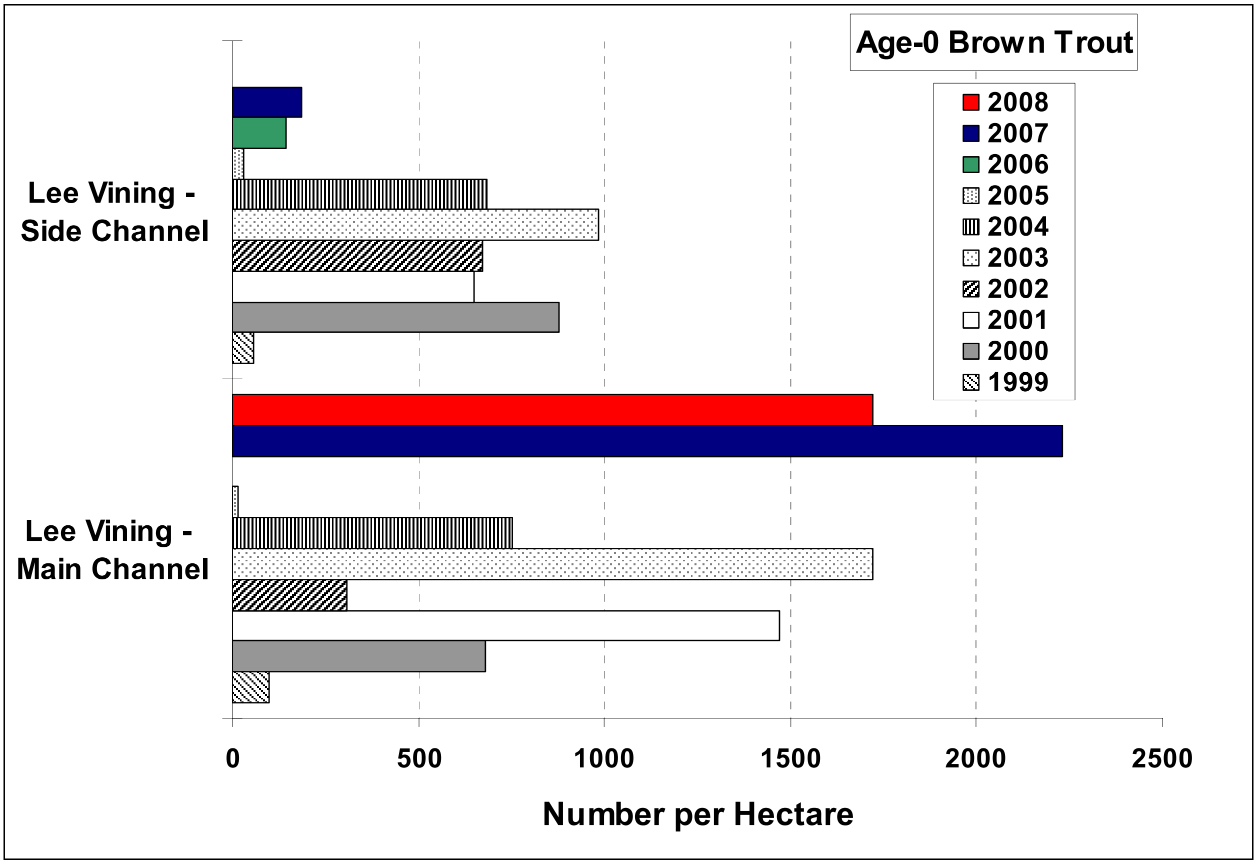


Figure 21. Estimated number of age-0 brown trout per hectare in sections of Lee Vining Creek from 1999 to 2008.

In 2008, age-0 rainbow trout density estimates in the main channel section of Lee Vining Creek dropped by 65% from densities estimated in 2007 (Figure 22). In contrast, the density estimates of age-0 rainbow trout within the Lee Vining Creek side channel increased by 42% in 2008 from the 2007 estimate (Figure 22).

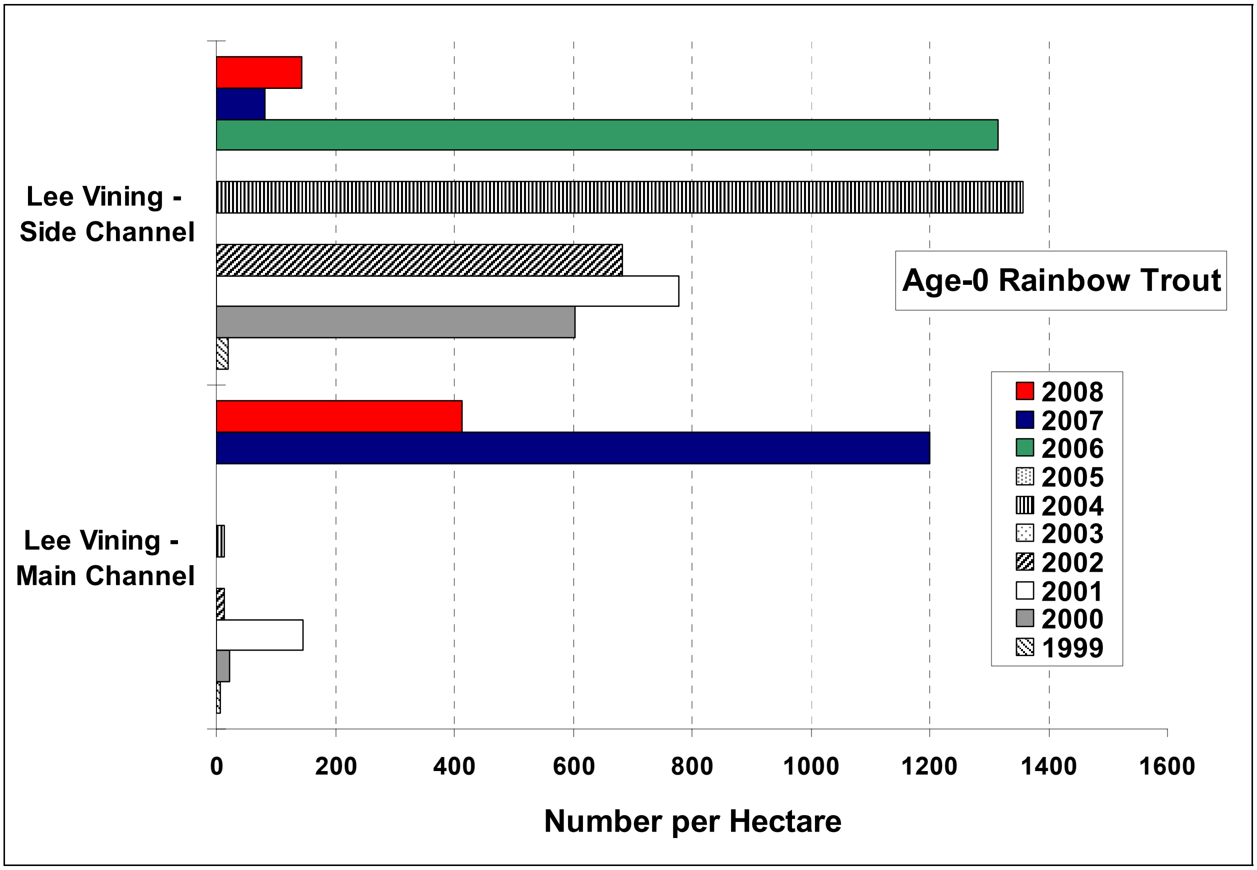


Figure 22. Estimated number of age-0 rainbow trout per hectare in sections of Lee Vining Creek from 1999 to 2008.

Estimated Trout Densities Expressed in Numbers per Unit Length

For termination criteria purposes, trout density estimates were also calculated by number of fish per kilometer of stream channel. In the Rush Creek sections the numbers of fish per kilometer were estimated for brown trout only (Table 12). In the Lee Vining Creek sections the numbers of fish per kilometer were estimated for brown and rainbow trout combined (Table 13). In Rush Creek from 2007 to 2008, the County Road section experienced a 36% drop in total numbers of brown trout per km, but only a 4% drop in the numbers of age-1 and older brown trout per km (Table 12). The Upper section experienced a 59% drop in total numbers of brown trout per km and a 22% decrease in the numbers of age-1 and older brown trout per km (Table 12).

In Lee Vining Creek from 2007 to 2008, the main channel section experienced a 12% increase in the total numbers of trout per km; however the numbers of age-1 and older trout per km increased by eight-fold from 148 fish/km to 1,204 fish/km (Table 13).

Table 12. Total number of brown trout per kilometer of stream channel for Rush Creek sample sections, 2000 - 2008. The value within (#) denotes the number of age-1 and older trout per kilometer.

Collection Location	2000 Total Number of Brown Trout per Km	2001 Total Number of Brown Trout per Km	2002 Total Number of Brown Trout per Km	2003 Total Number of Brown Trout per Km	2004 Total Number of Brown Trout per Km	2005 Total Number of Brown Trout per Km	2006 Total Number of Brown Trout per Km	2007 Total Number of Brown Trout per Km	2008 Total Number of Brown Trout per Km
Rush Ck-County Road	3,832 (725)	2,530 (942)	2,618 (536)	3,136 (764)	2,095 (641)	1,737 (641)	3,242 (702)	5,011 (1,402)	3,186 (1,346)
Rush Ck – Bottomland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,579 (1,467)
Rush Ck-Lower	3,728 (563)	2,877 (704)	3,348 (296)	3,642 (578)	2,182 (212)	1,731 (716)	2,684 (637)	4,222 (669)	Section dropped in 2008
Rush Ck-Upper	11,054 (1,547)	8,535 (837)	6,137 (900)	2,740 (791)	3,881 (495)	5,032 (1,167)	7,905 (1,100)	8,698 (1,621)	3,607 (1,267)

Table 13. Total number of brown and rainbow trout per kilometer of stream channel for Lee Vining Creek sample sections, 2000 – 2008. The value within (#) denotes the number of age-1 and older trout per kilometer.

Collection Location	2000 Total Number of Brown and Rainbow Trout per Km	2001 Total Number of Brown and Rainbow Trout per Km	2002 Total Number of Brown and Rainbow Trout per Km	2003 Total Number of Brown and Rainbow Trout per Km	2004 Total Number of Brown and Rainbow Trout per Km	2005 Total Number of Brown and Rainbow Trout per Km	2006 Total Number of Brown and Rainbow Trout per Km	2007 Total Number of Brown and Rainbow Trout per Km	2008 Total Number of Brown and Rainbow Trout per Km
Lee Vining - Main Channel	674 (337)	1,333 (567)	883 (729)	1,181 (355)	936 (568)	917 (910)	Not Sampled – high flow	2,103 (148)	2,357 (1,204)
Lee Vining - Side Channel	853 (112)	623 (287)	731 (369)	626 (154)	1,144 (165)	169 (154)	618 (48)	129 (62)	103 (67)
LV Main and Side Averaged	764 (225)	978 (427)	807 (549)	904 (255)	1,040 (367)	543 (532)	Not Averaged In 2006	1,116 (105)	1,230 (636)

Estimated Trout Standing Crop Comparisons

In Rush Creek, brown trout standing crop estimates decreased from 2007 to 2008 in all sample sections (Table 14 and Figure 23). In the County Road section, the 2008 estimated standing crop of 85.7 kg/ha was a 29% decrease from the 2007 estimate (Table 14). In the Upper Rush section, the 2008 estimated standing crop of 107.2 kg/ha was a 34% decrease from the 2007 estimate (Table 14). Because the MGORD section was only sampled using the mark-recapture method in even years, the comparison was between sampling years 2006 and 2008. In this two-year time period, the estimated standing crop decreased by nearly 70% in the MGORD (Table 14). Between 2007 and 2008, Walker Creek experienced a decrease of 24% in estimated standing crop (Table 14). In Lee Vining Creek total standing crops dropped slightly between 2007 and 2008 in the side channel area, but in the main channel total standing crops increased dramatically from 2007 to 2008 (Table 15 and Figure 24).

Total standing crops (all age classes and species combined) have been estimated since 1999 to determine potential trends (Figures 23 and 24). 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 estimated total standing crop remained fairly constant from 2000 through 2005; followed by two straight seasons of increased production in 2006 and 2007; and in 2008 a nearly 30% decrease (Figure 23). The County Road section's 2008 estimated total standing crop was the fourth highest estimate for this section in 10 years of sampling (Figure 23). In the Rush Creek Upper section after the peak standing crop estimate in 2000; estimates declined for four straight years (2001 - 2004); followed by three consecutive seasons with estimates greater than 150 kg/ha; and in 2008 a 34% decrease to 107.2 kg/ha (Figure 23). In the Upper section, total standing crop estimates have declined for two consecutive sample years, 2007 and 2008 (Figure 23). The new Rush Creek Bottomlands section had an estimated total standing crop of 98.2 kg/ha in 2008, which was comparable to both the County Road and Upper sections (Figure 23).

In Walker Creek, total standing crop estimates have generally increased since annual sampling started in 1999 (Figure 23). Although the 2008 total standing crop estimate was a 24% decrease from 2007, the 2008 estimate of 290.1 kg/ha was still higher than the maximum value for any other section of Rush Creek in the ten years of sampling (Figure 23).

In Lee Vining Creek, the main channel section's 2008 total standing crop estimate re-bounded to levels observed in 2005; however, rainbow trout comprised more of the total standing crop during 2008 than in 2005 (Figure 24). In 2008, rainbow trout constituted nearly 80 kg/ha to the total standing crop estimate, which was, by far the greatest biomass of rainbow trout estimated in Lee Vining Creek for ten years of annual sampling (Figure 24). The Lee Vining Creek side channel section's total standing crop estimate has continued to hover at approximately 20 kg/ha since 2005, when the main channel started capturing a larger portion of the total summer base flow (Figure 24).

Table 14. Comparison of 2007-2008 brown trout standing crop (kg/ha) estimates in Rush Creek study sections.

Collection Location	2007 Total Standing Crop (kg/ha)	2008 Total Standing Crop (kg/ha)	Percent Change Between 2007 and 2008
Rush Creek - County Road	120.9	85.7	- 29%
Rush Creek – Upper	162.5	107.2	- 34%
Rush Creek – MGORD*	208.0*	66.2	- 68%
Walker Creek	384.0	290.1	- 24%

* MGORD is comparisons of 2006 and 2008 standing crop estimates.

Table 15. Comparison of 2007-2008 total (brown and rainbow trout) standing crop (kg/ha) estimates in Lee Vining Creek study sections.

Collection Location	2007 Total Standing Crop (kg/ha)	2008 Total Standing Crop (kg/ha)	Percent Change Between 2007 and 2008
Lee Vining Creek - Main Channel	75.3	212.7	+ 282%
Lee Vining Creek - Side Channel	27.9	23.1	- 17%

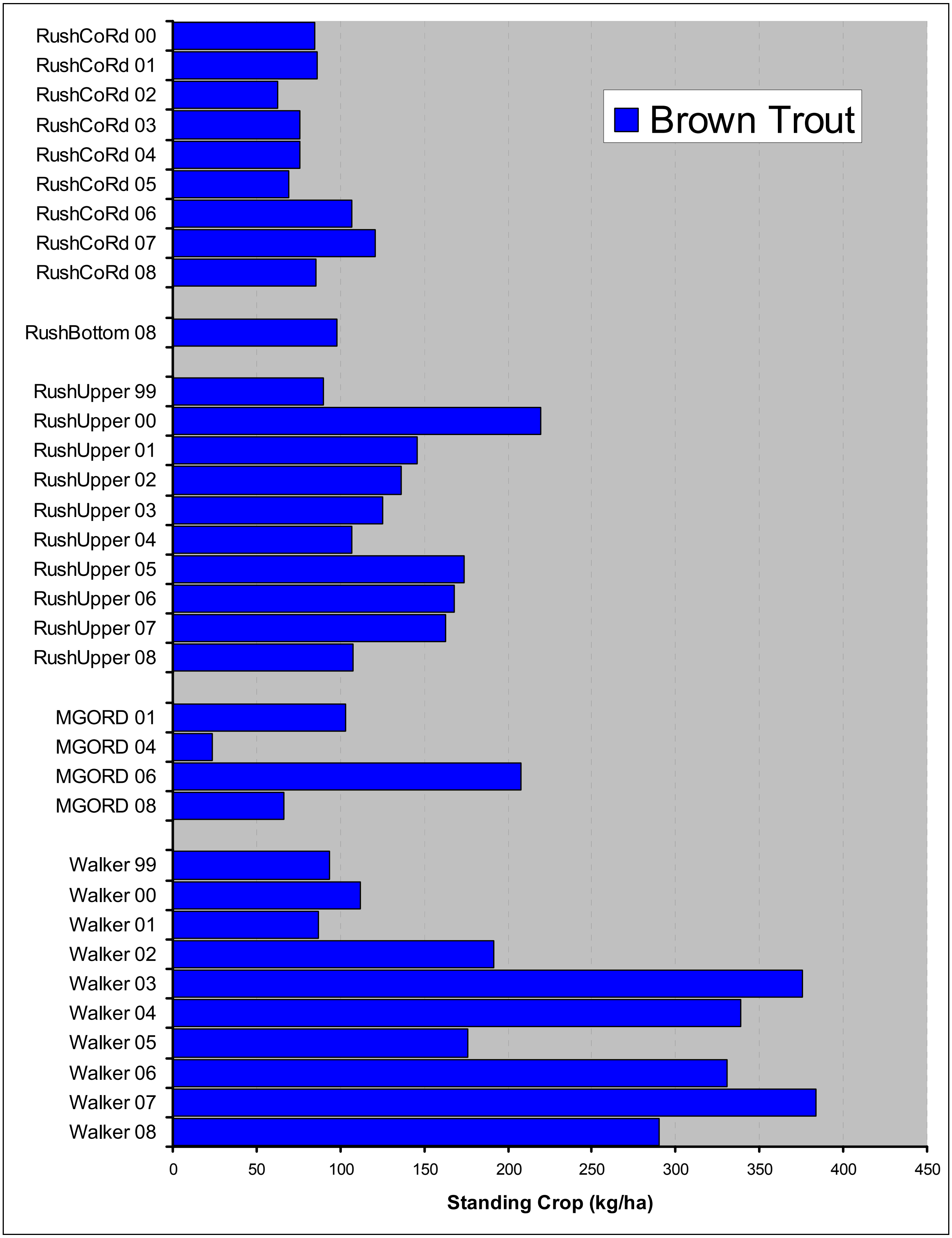


Figure 23. Estimated total standing crop (kilograms per hectare) of brown trout in all sample sections within the Rush Creek drainage, 1999 – 2008. Section and year are shown on the y-axis.

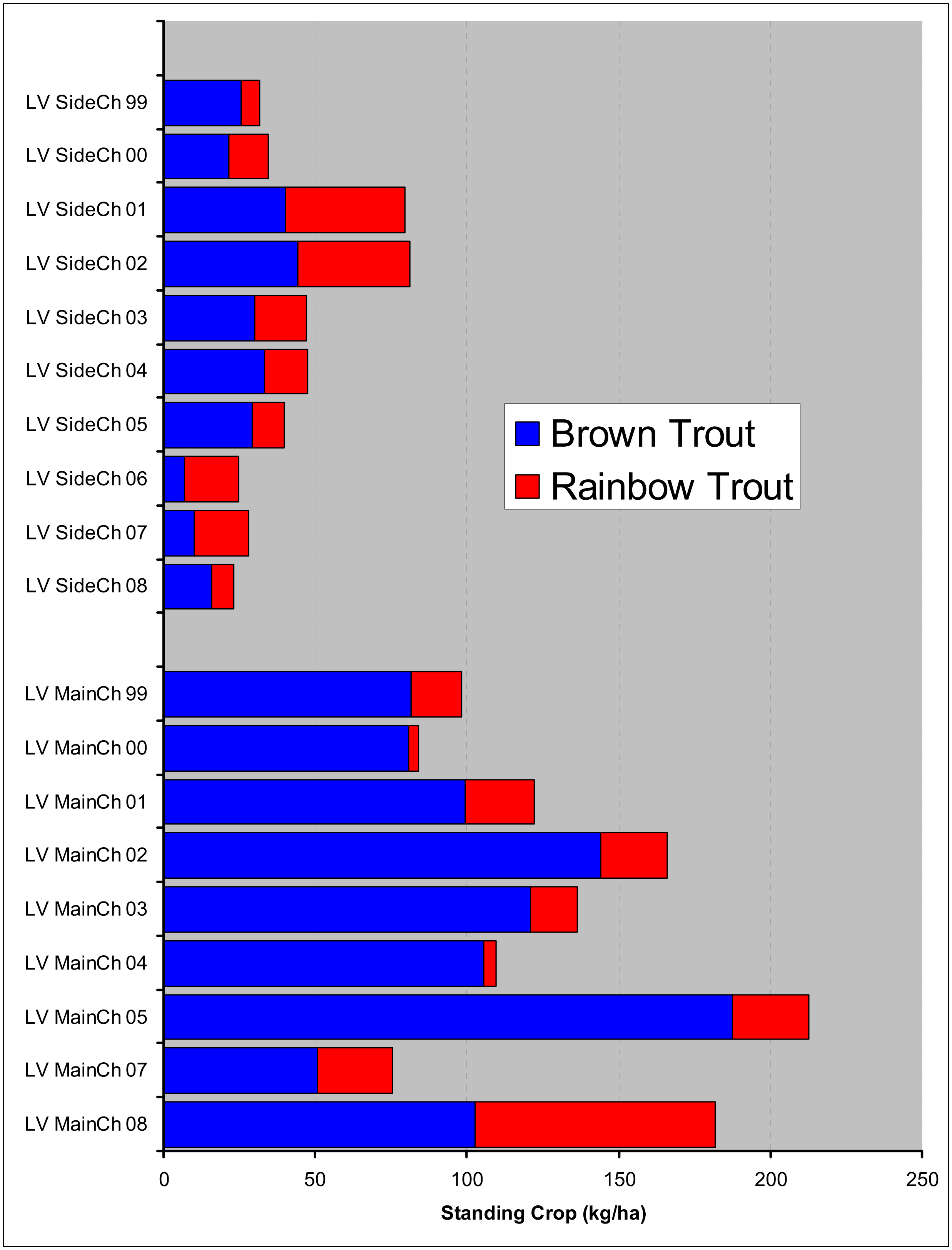


Figure 24. Estimated total standing crop (kilograms per hectare) of brown trout and rainbow trout in all sample sections within the Lee Vining Creek drainage, 1999 – 2008. Section and year are shown on the y-axis.

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

RSD-225 values for brown trout in all Rush Creek sample sections decreased between 2007 and 2008, ranging from a 25% drop in the County Road section to a 35% decrease in the Upper section (Table 16). RSD-225 values for brown trout in all Rush Creek sample sections have now decreased for two consecutive sampling years (Table 16). This drop in RSD-225 values during two straight low run-off years appears consistent with the relatively low RSD-225 values recorded between 2000 and 2003 in Rush Creek. Conversely in 2004-2006, which were years with relatively high stream run-off volumes, RSD-225 values were typically greater than 30.

RSD-300 values remained low in the Upper Rush Creek section, with a drop from 3 to 4 between 2007 and 2008 (Table 16). The Rush Creek County Road section has had an RSD-300 value of 0 since 2002, in other words, no fish greater than 300 mm (~12") have been captured in this section in the past six seasons (Table 16).

The RSD-225 and RSD-300 values in the MGORD section of Rush Creek dropped between 2007 and 2008; however, remained much higher than any of the other sample sections (Table 16). As with the other two Rush Creek sections, all RSD values for the MGORD have decreased for two consecutive seasons. The drop in the RSD-225 value was more a function of the large numbers of brown trout between 150 – 224 mm captured in 2008. A closer examination of the data shows that the total number of trout between 225-299 mm actually increased between 2007 and 2008, but not as much as the number of trout between 150-224 mm (Table16). The RSD-300 value experienced a 65% drop between 2007 and 2008 (Table 16). The RSD-375 value for 2008 was 3 and has been 4 or less for three consecutive sampling years (Table 16).

In the Lee Vining Creek sample section, the RSD-225 value for all trout (brown and rainbow trout combined) decreased by 75% between 2007 and 2008 (Table 17). This large drop in RSD-225 can be attributed to the large numbers of trout that were between 150 – 224 mm in length; most likely age-1 fish (Table 17). In 2008, the Lee Vining Creek section had a RSD-300 value of 0 for the second consecutive year (Table 17).

Table 16. RSD values for brown trout in Rush Creek study sections, for 2000-2008.

Sampling Location	Sample Year	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 – Co Rd	2008*	97	88	9	0	0	9	0	
Rush Ck – Co Rd	2007	591	518	73	0	0	12	0	
Rush Ck – Co Rd	2006	264	189	75	0	0	28	0	
Rush Ck – Co Rd	2005	206	175	29	0	0	14	0	
Rush Ck – Co Rd	2004	407	358	49	0	0	12	0	
Rush Ck – Co Rd	2003	447	383	63	1	0	14	0	
Rush Ck – Co Rd	2002	302	269	32	1	0	11	0	
Rush Ck – Co Rd	2001	421	380	38	3	0	10	1	
Rush Ck – Co Rd	2000	319	276	43	0	0	13	0	
Rush Ck - Bottomlands	2008	160	141	19	0	0	12	0	
Rush Ck – Upper	2008	227	181	38	7	1	17	3	
Rush Ck – Upper	2007	282	210	61	9	2	26	4	
Rush Ck – Upper	2006	231	154	67	10	0	33	4	
Rush Ck – Upper	2005	202	141	54	5	2	30	3	
Rush Ck – Upper	2004	179	115	57	2	1	34	2	
Rush Ck – Upper	2003	263	217	44	2	0	17	1	
Rush Ck – Upper	2002	217	176	37	2	2	19	2	
Rush Ck – Upper	2001	221	188	27	6	0	15	3	
Rush Ck – Upper	2000	178	156	20	2	0	12	1	
Rush Ck - MGORD	2008	856	253	441	140	22	52	16	3
Rush Ck - MGORD	2007	621	144	191	259	27	77	46	4
Rush Ck - MGORD	2006	567	77	186	279	25	86	54	4
Rush Ck - MGORD	2004	424	144	184	65	31	66	23	7
Rush Ck - MGORD	2001	744	374	202	126	99	55	30	13

* The relatively low number of fish captured ≥150 mm in 2008 is due to the shortening of the County Road section.

Table 17. RSD values for brown and rainbow trout in the Lee Vining Creek study section, for 2000-2008.

Sampling Location	Sample Year	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
Lee Vining Creek	2008	149	138	11	0	0	7	0
Lee Vining Creek	2007	29	21	8	0	0	28	0
Lee Vining Creek	2006	NS	NS	NS	NS	NS	-	-
Lee Vining Creek	2005	74	46	27	1	0	38	1
Lee Vining Creek	2004	95	84	9	2	0	12	2
Lee Vining Creek	2003	60	34	25	1	0	43	2
Lee Vining Creek	2002	167	126	38	3	0	25	2
Lee Vining Creek	2001	109	90	16	3	0	17	3
Lee Vining Creek	2000	55	35	19	1	0	36	2

NS = not sampled due to high flow.

Termination Criteria Results

The following four tables summarize the termination criteria analyses of three-year running averages for the Rush Creek and Lee Vining Creek sample sections (Tables 18-21). In Rush Creek, none of the annually sampled sections met the target of meeting four out of five termination criteria (Tables 18 and 19). The County Road and Upper sections met only one of the five the termination criteria (density) (Tables 18 and 19).

Table 18. Termination criteria analyses for the County Road section of Rush Creek.

Termination Criteria	2006 – 2008 Average	2005 – 2007 Average	2004 – 2006 Average
Biomass (≥175 kg/ha)	104.4	98.9	83.9
Density (≥3,000 fish/km	**3,813.0**	**3,330.0**	2,358.0
Condition Factor (≥1.00)	0.91	0.95	**1.02**
RSD-225 (≥35)	16	18	18
RSD-300 (≥5)	0	0	0
Conclusion	**Met one of five TC**	**Met one of five TC**	**Met one of five TC**

Table 19. Termination criteria analyses for the Upper section of Rush Creek.

Termination Criteria	2006 – 2008 Average	2005 – 2007 Average	2004 – 2006 Average
Biomass (≥175 kg/ha)	145.8	168.1	149.4
Density (≥3,000 fish/km	**6,736.7**	**7,211.7**	**5,606.0**
Condition Factor (≥1.00)	0.97	0.98	**1.02**
RSD-225 (≥35)	25	30	32
RSD-300 (≥5)	4	4	2
Conclusion	**Met one of five TC**	**Met one of five TC**	**Met two of five TC**

The MGORD section of Rush Creek met two of three RSD termination criteria for the average of years 2006-2008 (Table 20). The RSD-375 average for 2006-2008 failed to meet termination criteria due to three consecutive years where low (less than 5) values were recorded (Table 20).

Table 20. Termination criteria analyses for the MGORD section of Rush Creek.

Termination Criteria	2006 - 2008 Average	2004/2006/2007 Average	2001/2004/2006 Average
RSD-225 (≥60)	**72**	**76**	**69**
RSD-300 (≥30)	**39**	**41**	**36**
RSD-375 (≥5)	4	**5**	**8**
Conclusion	**Met TC two of three RSD values**	**Met TC for all three RSD values**	**Met TC for all three RSD values**

Because the Lee Vining Creek main channel section was not sampled in 2006, the most recent three-year running average was comprised of data collected in 2005, 2007 and 2008. In Lee Vining Creek, the current sampling section failed to achieve the target of meeting three out of four termination criteria (Table 21). The current sampling section met two of the four termination criteria (biomass and condition factor) (Table 21).

Table 21. Termination criteria analyses for the Lee Vining Creek sample section.

Termination Criteria	2005/2007/2008 Average	2004/2005/2007 Average	2003 – 2005 Average
Biomass (≥150 kg/ha)	**187.1**	**172.1**	**198.1**
Density (≥1,400 fish/km	963.0	899.7	829.0
Condition Factor (≥1.00)	**1.06**	**1.06**	**1.08**
RSD-225 (≥30)	24	26	**31**
Conclusion	**Met two of four TC**	**Met two of four TC**	**Met three of four TC**

Discussion

The 2008 sampling year was the tenth consecutive year in which fish population data were collected in Rush and Lee Vining creeks with the methods refined from the two years of pilot studies (1997 and 1998). Over this ten-year sampling period, a diversity of flow regimes combined with the recovering channel and riparian systems has provided a varying range of habitat conditions for these trout populations. In 2008, the Mono Basin experienced a second straight year of drier conditions in which the level of Grant Reservoir dropped to extremely low levels. At the time of drafting this report it appears that the Mono Basin may experience yet another dry year in 2009, leading to poorer stream habitat conditions due to lower flows and higher water temperatures that could further impact already taxed trout populations (especially in Rush Creek).

This discussion section will expand on some of the 2008 results and the termination criteria analysis; examine the varying responses of Rush and Lee Vining creeks to annual hydrographs; and evaluate the current sampling methods. The 2008 annual monitoring report will also be the final report completed by the Fishery Stream Scientist and his team prior to completion of a synthesis report that will include recommended changes to the flow regimes in Rush and Lee Vining creeks. Monitoring in 2009 and beyond will be focused at evaluating responses of the fish populations to flow regimes recommended in the synthesis report.

Fish Species Composition and Abundance

The higher proportion of brown trout to rainbow trout in all Rush Creek sections and the Lee Vining Creek section 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 and Owens River tributaries (Deinstadt et al. 1985; 1986; 1997). Kondolf et al. (1991) suggested that periodic mobility of the streambed may explain why brown trout are more abundant than rainbow trout in many eastern Sierra streams where high flows typically occur in May and June due to snow melt when rainbow trout eggs (or alevin) are on the gravel, and thus, more vulnerable to scour during larger snowmelt flows.

Lee Vining Creek's rainbow trout population, especially age-0 production, appears to fluctuate according to run-off type, with increases in fish during average to low run-off years and decreases during high run-off years (such as 2004-06). This pattern is consistent with the theory of streambed scour during high run-off years and streambed stability in low run-off years as suggested by Kondolf et al. (1991). Fausch et al. (2001) examined the influences of flood regimes on rainbow trout invasion success and concluded that success was best explained by a match between timing of fry emergence and months of low flood probability. We also suspect that the enduring presence of rainbow trout in lower Lee Vining Creek is influenced by the frequent planting of hatchery rainbow trout in the ponded area upstream of LADWP's diversion.

In every sample season we have captured obvious hatchery rainbow (identified by eroded fins) in lower Lee Vining Creek and suspect that hold-over fish contribute to the spawning population each year. This may be the reason that rainbow trout numbers rebound quickly after years of low to no age-0 recruitment in our sample sections. We also suspect that if the frequent stocking of rainbow trout were to cease, that the Lee Vining Creek fishery would move towards an almost exclusive brown trout fishery (similar to Rush Creek).

The density of age-1 and older rainbow trout increased dramatically in the main channel section of Lee Vining Creek from 2007 to 2008 (Figure 19). This increase was most likely due to two consecutive years of relatively low runoff during the spring snowmelt period that translated into two seasons of good survival and growth for trout within Lee Vining Creek. Part of the reason for this dramatic increase could also be the expansion of this sample section that included the addition of one high quality pool habitat; however, trout appeared extremely abundant throughout the sample reach when electrofishing was conducted.

Between 2007 and 2008, densities of age-0 brown trout declined in all the Rush Creek sample section. These declines occurred even though the densities of age-1 and older fish (potential spawners) in 2006 that produced the 2007 age-0's were less than the densities of age-1 and older fish in 2007 that produced the 2008 age-0's. We speculate that these drops in age-0 densities are probably a function of one or more of the following reasons: (1) lower fecundity of spawners in 2007, (2) lower viability of eggs produced in 2007, (3) lower survival rates of fertilized eggs in 2007, or (4) lower survival rates of newly emerged fry in the spring of 2008. Because the flow regime in Rush Creek during the period of spawning through 30 days post-emergence (roughly November 2007 – May 2008) was relatively benign, there were probably not significant flow-induced mortalities from either desiccation of redds from de-watering events or from mobilization of eggs, alevins, or newly emerged fry from high (bed-load moving) spring flows.

Because there were relatively large drops in condition factors of brown trout in Rush Creek between 2006 and 2007, it is possible that the poorer condition of spawners in 2007 affected the fecundity and viability of eggs produced. A study of tailwater brown trout fisheries in the White River (Arkansas) compared fecundity, reproductive chronology, physical habitat, water quality, trout density, food availability, diet, predation, and competitive interactions among four tailwater reaches to identify factors influencing brown trout reproductive success (Pender and Kwak 2002). The fecundity and condition factor of pre-spawning brown trout were significantly lower at Beaver Tailwater, a reach known for reproductive failure, than at other sites, among which no differences were found (Pender and Kwak 2002). Campbell et al. (1992) used rainbow trout as a model animal to study the biological consequences of stress in terms of gamete quality and quantity. Exposure of rainbow trout to repeated acute stress during reproductive development resulted in a significant delay in ovulation and reduced egg size in females, significantly lower sperm counts in males, and, perhaps most importantly, significantly lower survival rates for progeny from stressed fish compared to progeny from unstressed control fish (Campbell et al. 1992).

It will be interesting to find out if the lower abundance of age-0 brown trout in Rush Creek during 2008, as well as continued poor condition factors, will translate into measurably lower densities of age-1 brown trout in 2009. We hypothesized in earlier reports that age-0 recruitment was not limiting abundances of age-1 and older brown trout in Rush Creek at the densities of age-0 brown trout we had observed from 1999 through 2004 (Hunter et al. 2005). Conversely, Carl Mesick Consultants (1994) speculated that age-1 and older brown trout in Rush Creek were being limited by recruitment of age-0 brown trout in the late 1980s and early 1990s, when age-0 densities were much lower (age-0 densities of 25 to 700/km then compared to 2,000 to 3,000/km from 1999 through 2007 and approximately 2,100/km in 2008). It will be enlightening to find out at what lower threshold level of age-0 densities do we begin to detect measurable affects on densities of age-1 and older brown trout.

Densities of age-1 and older brown trout in Walker Creek increased between 2007 and 2008 and were the highest recorded for this sample section during 2008. Part of this increase can be explained by the reduction in stream width (translating to a reduction in surface area sampled) due to lower flows in Walker Creek during 2008; however, estimated fish numbers increased in this section, so these narrower widths do not explain all of this increase. In fact, from 2007 to 2008 there was a 15% reduction in surface area within the study section and more than a doubling in the densities of age-1 and older brown trout. We speculate that high density estimates in Walker Creek are related to the quality of habitat, smaller stream size, and possibly higher productivity of this stream. The consistently high trout production in Walker Creek since 2003 can also be attributed to better management of the Walker Lake dam. We had previously expressed concerns about how the dam was managed prior to 2003, specifically the importance of reducing the flushing of sediments from the lake when flash-boards were pulled and de-watering the stream below the lake when flash-boards were re-installed (Hunter et al. 2005).

The 2008 standing crop estimates declined in all Rush Creek study sections, ranging from 24% in Walker Creek to 68% in the MGORD. In the Lee Vining Creek main channel section, the 2008 estimated total standing crop was the second-highest value recorded for this section and was comprised of the highest standing crop of rainbow trout in the ten years of annual sampling (Figure 24). When viewing Figure 24, it is unfortunate that high flows prevented us from sampling the main section of Lee Vining in 2006. We suspect the numbers of fish would have been low in 2006, possibly lower than the 2007 numbers, and the 2008 estimates show the resiliency of the stream's fishery. 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 fish greater than 225 mm in length, varied about five-fold, primarily due to differences in annual volumes and patterns of stream discharges, along with other natural (non-human influenced) variables.

Termination Criteria

This report represents the third time that the proposed termination criteria (TC) (computed by calculating three-year running averages of biomass, density, condition factor and RSD values) were applied to the monitoring data. To date, none of the Rush Creek sections has met the overall TC objective of meeting four out of five TC metrics for three consecutive years using three-year running averages. Computing three-year running averages from the 2004-2008 monitoring data indicated that the County Road section has only met one out of five TC metrics during each of the three computations years (the density requirement twice and the condition factor once) (Table 14). The biomass metric has increased steadily since the 2004-2006 average; however, condition factors have steadily dropped during this time period (Table 14). The RSD-225 metric has remained steady, but low; and the RSD-300 has remained at 0 (Table 14). In conclusion, the County Road section is far from meeting TC; the section has abundant numbers of brown trout (≥3,000 fish/km), but there's a lack of larger fish (as indicated by the biomass and RSD values), and the trout are generally in poor condition.

The Upper section of Rush Creek met two out of five TC metrics for the 2004-2006 calculations (density and condition factor), but only one TC metric (density) for the 2005-2007 and 2006-2008 calculations (Table 15). As with the County Road section, brown trout condition factors have steadily declined in the Upper Rush section (Table 15). The RSD-225 metric has dropped slightly, but remains close to the TC value of 35. Unlike County Road, the Upper Rush Creek section has supported trout greater than 300 mm in length, but has not yet met the TC value of 5 (Table 15). In conclusion, the Upper Rush Creek section has abundant numbers of brown trout (≥3,000 fish/km), is close to meeting the TC metrics of larger fish (as indicated by the biomass and RSD values), and the trout are generally in fair-to-poor condition.

The TC for the MGORD section of Rush Creek is based solely on RSD values. The most recent 2006-2008 three-year average was the first time the MGORD failed to meet all of the TC RSD metrics, and the RSD-375 metric was less than 5 (Table 16). The numbers of brown trout ≥375 mm sampled within the MGORD have generally declined since this section was initially sampled in 2001 (Table 12). For the TC Recommendations document, a preliminary comparison of the MGORD's RSD-300 and RSD-375 values with other eastern Sierra streams indicated that this Rush Creek section 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). Unfortunately, no current data were available from the Upper Owens River and Hot Creek to determine if these systems also experienced reductions in numbers of larger trout due to low-runoff years in 2007 and 2008.

The Lee Vining Creek sampling section (previously named the "Lower" section) came close to the objective of meeting three out of four TC metrics for three consecutive years using three-year running averages (Table 16). However, the lack of data from 2006 confounds the analysis. We speculate that both the biomass and density of fish in this section likely would have been relatively low during 2006 based on the large peak flows in June and high flows throughout the summer of 2006. Condition factor and biomass TC metrics have been met for three consecutive computations of three-year running averages; however, the density metric has never been met and the RSD-225 was met only for the 2003-2005 running average (Table 16). The density metric may be difficult to attain because the densities of the main and side channels are averaged to compute the TC, and while the main channel portion has supported >1,400 fish/km for the past two sampling seasons, the associated side channel consistently produced about 500 fish/km up to the 2005 season (Table 9). The amount of suitable habitat in the side channel dropped considerably in 2005 when the peak run-off caused a channel change with most of the flow going down the main channel. The densities per unit length also dropped considerably since this time too (Table 9). In conclusion, Lee Vining Creek has moderate numbers of brown and rainbow trout that are in good condition. In addition, the lack of a 2006 data set will hamper computation of three-year running averages until 2011.

At the December 2008 semi-annual Mono Basin meeting in Sacramento, several stakeholders again asked questions regarding the biomass estimates in Rush and Lee Vining creeks as related to TC metrics. How do these creeks compare regionally? How do these creeks compare on a wider scale to brown trout streams in general? The Fisheries Stream Scientist presented data collected by California Department of Fish and Game in the TC Recommendation document that showed the suggested biomass TC values for Rush and Lee Vining Creek were surpassed by only the Upper Owens River and Hot Creek (Hunter 2007). Additional literature reviewed since the completion of the TC document confirms that not only are the target TC values for biomass robust, but that the current biomass of trout in Rush and Lee Vining creeks are well above average. Gerstung (1973) analyzed fish population data from 278 sample sections within 102 coldwater streams within the northern Sierras and found that the average biomass of trout was 46 kg/ha. In terms of cumulative frequency, two-thirds of the stream sections contained standing crops less than 46 kg/ha and approximately one-quarter of the sections contained standing crops greater than 67 kg/ha (Gerstung 1973). Another study examined the density and biomass of resident trout populations in 313 Western United States for tendencies and significant differences (Platts and McHenry 1988). The overall average trout biomass for the 313 streams was 54 kg/ha (Platts and McHenry 1988). Generally, trout densities were highest in the Rocky Mountain eco-region, while trout biomass was greatest in the Sierra Nevada and Upper Gila Mountain eco-regions (Platts and McHenry 1988).

During preparation of the TC Recommendation document we were unable to obtain CDFG's electrofishing data from the East Walker River. These data were finally obtained last year and we computed RSD values for three East Walker Rivers sections located downstream of Bridgeport Reservoir (Table 22). For additional comparisons, the RSD values for the Upper Owens River, Hot Creek, and the MGORD section of Rush Creek were included (Table 22). In 1997, the East Walker River sections 1 and 2 recorded the highest RSD-300 and RSD-375 values, yet the sample sizes were relatively small (Table 22). This table suggests that the MGORD section of Rush Creek supports a trophy brown trout fishery on par with three watersheds considered by many as the "best" fisheries of the eastern Sierras.

Table 22. Comparison of RSD values for brown trout in the East Walker River, Owens River, Hot Creek and the MGORD section of Rush Creek.

Sampling Location	Sample Year	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
East Walker – Section 1 – 0.25 mi. downstream of Bridgeport dam	1997	36	4	4	23	5	11	64	14
	1995	355	343	6	4	2	2	1	1
	1994	27	13	9	4	1	15	15	4
East Walker – Section 2 – Camping flat	1997	178	27	71	61	19	40	34	11
	1995	554	435	99	13	7	18	2	1
	1994	475	326	137	11	1	29	2	1
	1993	448	406	37	5	0	8	1	0
	1991	76	63	13	0	0	17	0	0
East Walker – Section 3 Above Murphy Pond	1995	48	28	14	4	2	29	8	4
	1994	90	6	78	6	0	87	7	0
	1993	126	111	12	3	0	10	2	0
	1991	21	7	10	0	4	48	0	19
Owens Sections 13-16	1985	129	41	52	16	20	68	28	16
Owens R. – Section 10	1984	283	188	89	6	0	34	2	0
Owens R. – Section 11	1984	142	125	16	0	1	12	0	1
Owens R. – Section 9	1983	133	74	59	0	0	44	0	0
Hot Creek – Section 1	1985	1,309	800	492	15	2	39	1	0
Hot Creek – Section 1	1983	805	281	427	94	3	65	12	0
Rush Ck - MGORD	2008	856	253	441	140	22	52	16	3
Rush Ck - MGORD	2007	621	144	191	259	27	77	46	4
Rush Ck - MGORD	2006	567	77	186	279	25	86	54	4
Rush Ck - MGORD	2004	424	144	184	65	31	66	23	7
Rush Ck - MGORD	2001	744	374	202	126	99	55	30	13

Biomass estimates were also computed from CDFG's East Walker River electrofishing data. In Section 1, the annual biomass estimates ranged from 34.5 to 163.1 kg/ha with a three-year average of 95.9 kg/ha. In Section 2, the annual biomass estimates ranged from 49.3 to 315.9 kg/ha with a five-year average of 208.7 kg/ha. In Section 3, the annual biomass estimates ranged from 43.1 to 91.6 kg/ha. The high biomass estimate of 315.9 kg/ha in Section 2 was recorded in 1995 and nearly 80% of the estimate was comprised of 150-225 mm (~6"-9") fish (Table 22).

Water-year Types and Effects on Rush and Lee Vining creeks

The 2008 annual fisheries sampling occurred after the second consecutive year of average-to-below average snow-pack and runoff in the eastern Sierras. The two preceding years, 2005 and 2006, higher snow-packs resulted in larger peak spring runoffs with descending limbs that extended farther into the summer baseflow period. The trout fisheries in Rush and Lee Vining creeks appear to respond quite differently to water-year types, and these responses were apparent in 2008 in regards to the fish data from each stream. Generally, in years of lower snow packs and lower peak runoffs trout populations in Rush Creek exhibit lower production of age-0 fish, lower total standing crop estimates and poorer condition factors. In contrast, fish populations in Lee Vining Creek appear to thrive during the lower-water years and tend to drop following wetter years with high peak flows.

In Rush Creek we suspect that summer water temperatures affect the growth and condition factor of trout. In turn, summer water temperatures are influenced by the water-year type, peak and duration of snow-melt hydrograph, and water levels in Grant Reservoir. We are currently analyzing the Rush Creek flow and temperature data for affects on the trout populations and expect a completed report by late April 2009. The Rush Creek SNTEMP model will also be completed by June 2009 and will allow us to model a variety of scenarios to assist in recommending flow regimes that best meet the thermal requirements of the downstream trout populations. The Grant Reservoir thermal study concluded that the most efficient method to provide cool water releases from Grant Reservoir in late summer was to increase the water surface elevation above 7,110' in early summer and maintain water surface elevation above 7,110' through August (Cullen and Railsback 1993).

In Lee Vining Creek we suspect that larger peak runoffs affect the age-0 recruitment of both brown and rainbow trout; however we are unsure what aspect of the peak hydrograph most affects recruitment. Because brown trout are fall spawners, peak flows may displace newly emerged fry or fry are stranded in side channels in years when the descending limb drops quickly. Rainbow trout are spring spawners, thus their eggs are most likely incubating in the streambed during peak flows. These developing eggs are susceptible to either bedload movement during larger peak flows or if redds are constructed during the peak flows, dewatering when flows drop to baseflow levels.

Methods Evaluation

Electro-fishing to conduct mark-recapture estimates in larger streams and depletion estimates in smaller streams and side channels have consistently provided relatively reliable estimates. Using a field technician dedicated to maintaining block fences has reduced the frequency of block fence failures in recent years (2003-2008) compared to previous years. Maintaining block fences ensures that the assumption of population closure is met, thus estimates are more reliable. During the 2008 field season there were no block fence failures.

In 2008, no major changes to the stream channel were observed within the annual sample sections, as would be expected during a normal run-off year with no large, channel-forming, peaks in the hydrographs. However, continued subtle changes were observed in the County Road section. These channel changes were expected because of changes in the flow regime, Mono Lake levels, and continuing maturation of riparian vegetation. In 2008, sample section locations and lengths were modified to take advantage of conditions considered to best represent a “desired future condition” (i.e. new “Bottomlands” section), consolidate sampling into fewer, but still representative sections, and increasing lengths of a few sections to better represent available habitats.

We have consistently sampled within the three main reaches in Rush Creek (MGORD, Upper Rush, and Lower Rush) and have time-series fish abundance and condition data for the past ten years that represent fish population responses to changing climatic and flow management regimes. The upstream and downstream boundaries of all sample sections have been permanently marked. While continued channel evolution within Rush and Lee Vining creeks is anticipated, channel lengths and widths will be re-measured annually.

Modifying the sections sampled could represent a loss of time-series data unless efforts are made to index relative changes between individual sample sections. Length-weight regression lines for the Bottomlands and County Road sections were nearly identical in 2008 (Figure 14), indicating that brown trout in these two sections were responding in a similar fashion to their environment. This response suggests that replacing the County Road section with the Bottomlands section should not result in any loss of time-series information related individual fish condition factor analyses.

Because rainbow trout have comprised such a minor portion of the Rush Creek trout population during the last ten years of annual sampling, we recommend reporting only numbers of rainbow trout sampled and not attempting to make estimates of density or biomass. In Lee Vining Creek, during years when sufficient numbers of fish are captured to generate reliable population estimates, these estimates will be used to compute density and biomass estimates. However; in years when relatively few fish are captured, catch numbers will be used to generate catch per unit effort (CPUE) density and biomass values. We will compute CPUE density and biomass values for all years for comparative purposes. Prior to the 2009 sampling season, we will determine what CPUE metric(s) to use.

During the past ten years we experimented in our selection of length class break points to provide the most precise estimates using mark-recapture estimators. While selection of different length class break points across years allows for slightly more precise estimates, we have found that standardizing length class break points provides for better data consistency at a very modest loss of precision. Another issue in selection of length class break points was our desires to have the lowest length class encompass all age-0 fish during any given year. However, we have found that brown trout from 120 to 130 mm could be either age-0 or age-1 depending upon the growth conditions during any given year. Consequently, in earlier annual reports, a variety of length categories were used, which lead to difficulties in comparing age-0 and age-1 and older density and biomass estimates across all sample years (Hunter et al. 1999, 2000, 2001, 2002, 2003). For the 2008 report, we re-adjusted earlier data sets and standardized estimates into three size class categories: <125mm, 125-199 mm, and ≥200 mm. We recommend that all future monitoring use these size categories to generate population estimates and associated population metrics. Although we may misclassify a few large age-0 fish or a few small age-1 fish, we feel that consistency in managing the long-term data sets is more important.

Clipping of age-0 trout for tracking empirical growth has provided valuable data to estimate annual growth by recapturing marked fish. However, altering methods for marking age-0 fish should be considered and a change made for the 2009 sampling period. As previously mentioned, the adipose fin is the only fin clip that is reliably recognized in subsequent years, however it is not feasible to use this clip annually because of problems distinguishing older trout (age-2 and older) due to potentially varying growth rates. We have proposed (Hunter et al. 2006 and 2007), and LADWP has recently approved, the use of small passive integrated transponder tags (PIT tags) that will allow us to track the survival, growth, and movement of individual age-0 brown trout through the 2009 to 2011 period. We will also be able to more accurately determine the size ranges of age-1 (and eventually age-2, 3 and 4) fish in subsequent years. PIT tags have an indefinite life (no batteries), 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).

Because 2008 was a dry run-off year there were no safety issues in wading and sampling the Rush Creek and Lee Vining Creek sections. However, to avoid potential problems caused by last-minute requests in reducing flows to safely sample during high run-off years, the Fisheries Stream Scientist recommends that maximum flow criteria be set for both creeks in early September to ensure that electro-fishing sampling is safe and efficient. We recommend that flows in Rush and Lee Vining creeks not exceed 40 c.f.s. (± 5 c.f.s.) during the annual sampling period (two week-period of September starting the Wednesday after Labor Day holiday).

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