March 11, 2007

Ms. Victoria Whitney, Chief
Division of Water Rights
State Water Resources Control Board
1001 I Street
Sacramento, CA 95812

Subject: Recommended Changes to State Water Resources Control Board Order Numbers 98-05 and 98-07 Fisheries Termination Criteria

Dear Ms. Whitney:

The purpose of this memo is to transmit recommended changes to fisheries termination criteria specified in State Water Resources Control Board (SWRCB) Order Nos. 98-05 and 98-07. The recommended changes are the result of eight years of annual monitoring of Rush, Lee Vining, Parker and Walker creeks' trout populations plus a review of published trout population data from other eastern Sierra streams. These recommended changes represent a significant amount of thought and work by myself and the other members of my fish crew (Ross Taylor, Ken Knudson and Brad Shepard). Our intent in preparing these new termination criteria is to provide quantifiable standards against which to evaluate the trout populations of these streams. We have provided earlier drafts to interested parties and have incorporated comments where we could.

It is our belief that the annual monitoring of streams in the Mono basin can be reduced in effort starting in 2008. Annual monitoring will still need to be conducted in order to provide data for the three year running averages we describe in the new termination criteria. We recommend that the upper Lee Vining main and side channel station be discontinued beginning in 2008. The lower Lee Vining main and side channel station should be continued and perhaps lengthened. We recommend that one of the two stations in lower Rush Creek be discontinued. At this time we suggest continuing the County Road section. We also recommend that at least one, and possibly both Parker and Walker creek sections should be discontinued. If one of these sites is to be continued we believe the Walker site would be best. Finally we recommend that the Mono Gate One Return Ditch (MGORD) be established as a monitoring site. We have been monitoring the MGORD for several years and have found it to be an important part of the Rush Creek system.

Should you have any questions concerning our recommendations please contact me at 406-461-7038. I look forward to discussing these recommendations with you and the Board.

Sincerely,

Chris Hunter
Stream Scientist
616 Wintergreen Ct.
Helena, MT 59601

C: Ms. Lisa Cutting, MLC
Mr. Jim Canaday, SWRCB
Mr. Matt Myers, SWRCB
Dr. William Trush, Stream Scientist
Mr. Steve Parmenter, CDFG
Mr. Jim Edmonson, Cal Trout
Mr. Rob Lusardi, Cal Trout
Dr. Mark Hanna, LADWP

Mono Basin Fisheries Termination Criteria

Executive Summary

The purpose of this document is to propose new fisheries termination criteria on Rush and Lee Vining creeks as specified in State Water Resources Control Board's Orders WR98-05 and WR98-07. The rationale for replacing the current termination criteria is to evaluate brown trout populations in a more quantifiable and relevant fashion. As stated in our seven 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). In our earlier reports, we also recommended that at least six to ten years of annual data be collected to objectively evaluate the current termination criteria, as well as assess potential relationships between fish populations and physical habitat components, such as flows, physical habitat parameters and water temperatures.

The Mono Basin Court-Appointed Fisheries Scientist, Chris Hunter, with the assistance of his sub-consultants (Ross Taylor, Ken Knudson and Brad Shepard) proposes employing four repeatable and quantifiable metrics as termination criteria to evaluate the brown trout populations in the Upper, Lower, and County Road study sections of Rush Creek and both study sections on Lee Vining Creek – biomass, density, condition and relative stock density (RSD) of catchable trout ≥225 mm (≥9") fish in the population. A fifth metric for the Rush Creek sections only will be the proportion of brown trout ≥300 mm (≥12").

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

The reasons for selecting these metrics and the associated termination criteria values are further developed in this paper.

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

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

Termination Criterion #2 - Density: Total number of trout per unit length (km) of stream channel. Termination criteria for total number of trout per kilometer will be **≥3,000 trout per kilometer**. Assess trends in total trout/km data with three-year

moving averages by computing the average of the three most current years of data. That average should meet the termination criteria of at least **3,000 trout/km**.

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

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

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

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

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

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

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

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

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

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

Rush Creek Termination Criteria for the MGORD Study Section

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

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

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

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

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

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

Lee Vining Creek Termination Criteria

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

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

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

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

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

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

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

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

Subsequent sections of this document include:

- Review of historic fisheries information used in developing the current termination criteria.
- Background information on Orders WR98-05, WR98-07 and Decision 1631.
- Regional fisheries data utilized for comparisons to our 1999 – 2005 data.
- Condition factor methodology.
- Overview of PSD and RSD calculations and supporting literature review.
- Proposed new termination criteria and examples on how to use them.

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

Background Information

The Mono Basin Court-Appointed Fisheries Scientist, Chris Hunter, with the assistance of his sub-consultants (Ross Taylor, Ken Knudson, and Brad Shepard) is recommending new termination criteria after collecting, analyzing and reviewing seven years (1999-2005) of annual electro-fishing data from Rush and Lee Vining creeks, and two years of pilot study data (1997-1998). Additional Rush Creek studies have included a survey of high-quality (Class 4 and 5) pools conducted in 2002 and a radio-telemetry brown trout movement study initiated in 2005.

The following documents were reviewed in order to have a thorough understanding of all available pre-1941 information, as well as more-current regional data in developing our recommended changes to the fisheries termination criteria:

1) Decision 1631, WR98-05, and WR98-07.
2) Vestal's testimony (CalTrout Exhibit 5, dated 12/6/93). This includes his written deposition, weekly employee records, Fish and Game annual reports and a paper Vestal published in 1954 regarding the 1947-51 creel survey on the Rush Creek test reach below the Narrows.
3) William Platts' opinion of the Rush Creek fishery between 1930 and 1940. This paper is basically a critique of Vestal's testimony in which Platts concluded that the quantity and quality of the historic fishery was overstated and the Rush fishery was already in a depressed state prior to LADWP diversions from decades of irrigation, over-grazing and fishing pressure.
4) Trihey and Associates summary of pre-1941 and post-1942 conditions affecting fish populations in Lower Rush Creek (NAS + MLC Exhibit 137, dated 1993).
5) Water Board Public Hearing proceedings (Volume VIII).
6) Mono Basin EIR – Chapter 3D – Fishery Resources.
7) Interviews with long-time Mono BasinMono Basin residents available online at (www.monobasinresearch.org).
8) Three California Department of Fish and Game (CDFG) reports regarding surveys of eastern Sierra trout populations (Deinstadt et al. 1985, 1986, 1997).
9) Mammoth Community Water District annual fish monitoring reports.
10) Wild trout (primarily brown trout) management plans from California, Montana, Idaho, Maryland, Tennessee, Maine, and New York.

Documents #1-7 comprised most of the information available to make a judgment on the pre-1941 trout fisheries in Rush and Lee Vining creeks. The Vestal deposition is the best record since he actually worked in the creeks as a biologist for the California Department of Fish and Game (CDFG), as well as participated in the recreational fisheries. Most other accounts of pre-diversion conditions default to citations (or interpretations) of Vestal's deposition. However, what is lacking in Vestal's accounts are hard data documenting the weights and lengths of wild brown trout handled at the egg-taking stations or during the creel surveys (i.e., data recorded on sheets or tabulated in field books). Vestal's deposition and weekly logs were carefully examined to determine the location on Rush Creek where he made his observations because it appears there were at least two egg-taking stations – one in the "bottom lands" near the County Road crossing and one between Grant and Silver lakes, as well as a hatchery facility on Fern Creek (just upstream of Silver Lake). This distinction is important since large fish handled upstream of Grant Lake were most likely lake-dwelling trout making spawning migrations in Rush Creek, and these lake-dwelling trout probably attained their large size in a lake environment (Grant Lake), not in a high-altitude stream. For example, the photo taken by Vestal of an 18-inch female brown on 10/16/39 (CalTrout exhibit 5-L) is from the Rush Creek egg-taking station located downstream of Silver Lake and upstream of Grant Lake. Vestal stated this 18-inch trout was typical of the fish handled at this facility, however from reviewing Vestal's weekly logs, we believe this trout most likely originated from Grant Lake and was intercepted on its upstream fall spawning run.

Vestal's work in Mono Basin streams started in 1939, approximately 20 years after CDFG began planting brown trout in Rush Creek. We were unable to find records documenting the magnitude and frequency of brown trout stocking. However, Vestal's Rush Creek test-stream report states that fingerling brown trout plants continued through 1942.

Extensive testimony was presented regarding the different habitat conditions in Rush Creek upstream and downstream of the Narrows, with the downstream habitat and fishery being of higher quality due to a lower gradient channel that meandered across the valley and spring flow near the base of the Narrows which apparently created "spring creek-like" conditions – deep, slow flow with abundant elodea beds and ample food production. A portion of this spring flow was attributed to extensive irrigation that occurred in the Rush Creek basin prior to 1941 (page 3D-6 Mono Basin EIR and section 5.4 Decision 1631). The exact contribution of natural flow versus irrigation return in these springs is unclear, yet statements in the EIR and Decision 1631 range from *"spring-fed channels were **augmented by** irrigation return flow"* to *"the spring-fed flow **resulted from** the seasonal irrigation of approximately 1,500 acres on Cain Ranch and 600 acres in Pumice Valley with an annual average of 30,000 acre-feet of water" (emphasis added).* Testimony also suggested that large trout were present near the mouth of Rush Creek where landowners diverted stream flow into a system of ditches and dikes that created ponds for waterfowl. Apparently the trout also utilized these ponds (page 3D-7 Mono Basin EIR and section 5.4 Decision1631). D-1631 states, *"The fish and wildlife habitat provided by these ponds was present **only** because of the construction of dikes to store water" (emphasis added).* It is important to note these habitat features were, to a large extent, the product of land and water management techniques that no longer occur, and will not occur in the foreseeable future. However, the Mono Basin Fisheries Scientists recognize that, with or without spring-fed flows, the physical recovery of Lower Rush Creek is an ongoing process that began when a more natural flow regime was required to flow down Rush Creek. The maturation of riparian vegetation, future inputs of large wood, scouring of undercut banks, and the formation of deep pools with complex habitat will take time and will depend primarily on climatic conditions and flows released down the channel.

The Rush Creek termination criteria of trout averaging 13-14 inches being regularly observed, appears to be Vestal's personal observation of the Lower Rush Creek fishery; however his deposition says, "people often spoke of catching even larger fish, up to 18-20 inches." Vestal fails to say that he actually observed these larger fish in Lower Rush Creek. This second-hand account appears to be the basis of the termination criteria stating, "Rush Creek fairly consistently produced trout weighing ¾ to 2 pounds." Interviews conducted in the 1990s, with long-time Mono Basin residents recalling their youthful fishing experiences of 50 to nearly 70 years prior, also supported the contention that brown and cutthroat trout of these sizes were caught (Andrews/Hess, Banta, Carrington, and Dondero interviews). However, angler recall of their catch has been found to be biased in several studies and usually has been related to length of time between the angling event and the survey response (Thompson and Hubert 1990; Page et al. 2004).

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

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

Termination Criteria Background

Order WR98-05, section 5.2(2) specifies that LADWP is to implement its proposed stream monitoring plan under the direction of Dr. Trush, Mr. Hunter and other independent scientists. Order WR98-05 also specifies that the monitoring team was to perform several major tasks, including:

- Make recommendations on flows needed for restoration of Rush Creek below the DWP return ditch and the need for a Grant Lake bypass to achieve those flows.
- Submit reports evaluating the results of the monitoring program and recommending any appropriate changes.
- Make a recommendation to the SWRCB that the stream restoration program is complete.

Section 5.2(2) also provides for establishing quantified criteria for determining when monitoring of stream restoration and recovery can be terminated.

Section 5.3.2 of Order WR98-05 summarized the testimony of several experts in supporting the monitoring of restoration efforts, but also highlighted the difficulties in attempting to specify criteria for establishing when restoration should be considered complete. Dr. Kauffman testified that ecological restoration is an ongoing process, which is not completed at any one point in time, but the restoration plan proposed by LADWP "sets the ecosystem in the right trajectory for a goal of naturally functioning ecosystems." Dr. Trush testified that instead of trying to define an end product, that idea should be replaced with establishing a process to allow the channel to react and function alluvially. Hunter agreed with Trush about the difficulty in establishing quantifiable stream restoration goals due mainly to the lack of pre-1941 data by which recovery could be quantitatively judged.

Despite the contrary testimony of various experts, the proposed settlement agreement called for establishment of quantified criteria for determining when stream restoration will be considered complete.

The general description of the fisheries termination is described in Section 5.3.2(2) of WR98-05 and on page 6 of WR98-07:

- Whether fish are in good condition. This includes self-sustaining populations of brown trout similar to those that existed prior to the diversion of water by Los Angeles and which can be harvested in moderate numbers.

Order WR98-07 (amending provisions of WR98-05) on pages 4-6 lists the functions of the stream monitoring team, including:

- The stream monitoring team shall develop and implement a means for counting or evaluating the number, weights, lengths and ages of the fish present in various reaches of Rush Creek, Lee Vining Creek, Parker Creek and Walker Creek.

A brief definition of the fisheries termination criteria is then presented on page 7, item #7: the termination criteria are:

7) Size and structure of fish populations.

The quantified criteria for "size and structure of fish populations" is then provided in R-DWP-68B as,

- The agreed upon termination criterion for Rush Creek states that Rush Creek fairly consistently produced brown trout weighing 0.75 to two pounds (0.34 to 0.91 kg). Trout averaging 13 to 14 inches (330 to 355 mm) were also allegedly observed on a regular basis prior to the 1941 diversion of this stream.

- The agreed upon termination criterion for Lee Vining Creek is to sustain a fishery for naturally-produced brown trout that average eight to 10 inches (200 to 250 mm) in length with some trout reaching 13 to 15 inches (330 to 380 mm).

- No termination criteria were established for Parker and Walker creeks.

Again, we point out that development of the fisheries termination criteria was based on large volumes of testimony, but minimal quantified data. Decision 1631 summarizes this lack of data:

5.1 Lee Vining Creek – No definitive evidence of pre-diversion fish populations in Lee Vining was presented. Despite the amount of testimony and exhibits, detailed information regarding the pre-1941 physical conditions in Lee Vining Creek is limited.

5.4 Rush Creek – Most of the descriptions of the pre-project fishery are either the direct account of Elden Vestal or they reference his testimony in the Superior Court or material he prepared for this proceeding. Mr. Vestal indicated that he regularly observed brown trout averaging 13 to 14 inches. Anglers considered Rush Creek to be a very good trout stream, producing trout weighing ¾ to 2 pounds fairly consistently.

The most direct statement regarding making changes to the termination criteria is included in Decision 1631:

- The monitoring team **will** recommend one or more additional forms of the fish population criteria. The monitoring team **will** consider young-of-year production, survival rates between age classes, growth rates, total fish per mile, and **other quantifiable forms**, although this Settlement Agreement does not compel the choice of any one form. The monitoring team **will** recommend the form or forms which, in its judgment, best describe the structure of the fish population which existed in each of these streams before 1941. For this purpose, the monitoring team **will** consider monitoring results, the Decision1631 record, and comparisons with other Eastern Sierra streams, as appropriate (emphasis added).

Preliminary Reports and Data to Consider

As directed in Decision 1631, we examined data collected from other eastern Sierra streams to assist us in developing specific termination criteria for Rush and Lee Vining creeks. These data were found in three CDFG reports, 12 Mammoth Community Water District reports and Thomas P. Keegan's declaration regarding a Mammoth Water Rights case.

<u>Deinstadt Reports on Eastern Sierra Streams</u>

The final reports of the electro-fishing surveys conducted by CDFG in the Mono Lake basin and the Owens River watershed provide standing crop and size class data for 52 eastern Sierra streams and could be used for developing methods to assess the Mono Lake basin streams currently being monitored (Deinstadt et al. 1985, 1986, 1997). In most cases, the stream reaches surveyed by CDFG supported similar standing crops and age-class structures as we have estimated in Rush, Lee Vining, Walker and Parker creeks over the past seven years. The exceptions were highly productive stream reaches in the Owens River, Hot Creek and the Bishop Creek canal that emulate conditions typical of spring creeks. For example, four sections within the Owens River main-stem, two sections in the Bishop Creek Canal and a Hot Creek section had extremely high standing crops that probably skewed the average of the 1985 report (range of 427 – 829 kg/hectare for these seven sections). In most stream sections, the standing crops of brown trout were between 30 to 120 kg/hectare. The 1986 report also included a Hot Creek section with an extremely high standing crop (717 kg/hectare) and five other stream sections with standing crops ranging between 385 – 605 kg/hectare. The remaining 45 sections had standing crops between 0 – 350 kg/hectare, with 18 stream sections having brown trout standing crops of less than 150 kg/hectare (Deinstadt et al. 1986). Many streams included in the CDFG surveys were also augmented with plants of hatchery rainbow trout.

Regardless of the wide range of values, the initial Owens River report summarized information collected in 80 sections within 29 streams that produced an average brown trout standing crop of **135.6 kg/ha** (Deinstadt et al. 1985). The second Owens River report summarized information collected in 50 sections within 23 streams that produced an average of **85.6 kg/ha** (Deinstadt et al. 1986). For comparison, the average brown trout total standing crops we estimated for all Mono Basin tributaries we sampled from 1999 through 2005, was **119 kg/ha** (overall average of all sections over seven years).

While these CDFG reports provided some of the best available information on standing crop estimates and age-class structures for other eastern Sierra streams, most of these sections were sampled only once by CDFG and sampled reaches were short, typically less than 300 feet in length. Additionally, these sampled streams represented a wide variability of drainage areas, channel slopes, flow volumes, elevations and management activities and impacts.

Further examination of these streams was conducted to select reaches with similar geomorphic and hydrologic characteristics of the Rush and/or Lee Vining creeks' study sections to make more appropriate comparisons. Stream reaches from the DFG reports were selected if:

- Elevation was from 4,500 to 8,800 feet.
- Channel slope was no more than 6%.
- Channel widths for Rush Creek comparisons ranged from 20 to 27 feet.
- Channel widths for Lee Vining Creek comparisons ranged from 10 to 23 feet.

Only eight sections on five streams were selected from the1985 report (Table 1). Of these eight sections, only three had channel widths of at least 20 feet to compare to Rush Creek (South Fork Bishop Creek/Section #2, Owens River/Section #12 and Pine Creek/Section #1). These three sections had brown trout biomasses of 211.6, 189.6, and 64.1 kg/ha, respectively, with an average of **155.1 kg/ha**. Seven sections had channel widths less than 23 feet and were used for Lee Vining Creek comparisons. These sections had brown trout biomasses ranging from 35.4 to 211.6 kg/ha with an average of **108.4 kg/ha**.

Twenty sections on eight streams were selected from the 1986 report (Table 2). Of these 20 sections, only four had channel widths of at least 20 feet to compare to Rush Creek. However, three sections had widths greater than 27 feet (Owens River, sections 13 + 14 and Hot Creek section 1). These four sections had brown trout biomasses ranging from, 93.5 to 717.0 kg/ha, with an average of **307.7 kg/ha**. When the Hot Creek estimate of 717.0 kg/ha was discarded, the average of the remaining three stream sections equaled **171.2 kg/ha**. Fifteen sections had channel widths less than 23 feet and were used for Lee Vining Creek comparisons. These sections had brown trout biomasses ranging from 7.6 to 313.2 kg/ha with an average of **127.5 kg/ha**.

For the seven sections (from both CDFG reports) selected to compare to Rush Creek, the average biomass equaled **242.3 kg/ha.** Without the Hot Creek estimate, the six remaining six sections had an average biomass of **163.2 kg/ha**. For the 21 sections (from both DFG reports) selected to compare to Lee Vining Creek, the average biomass equaled **121.2 kg/ha.** We consider the Hot Creek biomass to be atypical (high end of the spectrum) of most eastern Sierra streams and not valid for comparisons with Rush and Lee Vining creeks. We believe the unique geothermal and hydrologic features that maintain a relatively constant water temperature and high productivity of Hot Creek are not indicative of pre-diversion conditions in Mono Basin tributaries.

For comparison, the seven years of annual data from Rush Creek were summarized and averaged (Table 3). The Upper section had the highest seven-year average (**144.8 kg/ha**), but also experienced the most variability (89.8 – 236.0 kg/ha). The Lower section's seven-year average equaled **99.8 kg/ha**, with a low of 55.8 kg/ha and a high of 158.6 kg/ha. The County Road section had the lowest seven-year average of the three annually-sampled sections (**74.5 kg/ha**), yet exhibited relatively minor variability (65.8 – 84.1 kg/ha). When all three sections were combined, the seven-year average equaled **106.4 kg/ha**. One should note that the densities (standing crops) of trout in Rush Creek typically decline in a downstream direction. This decline is likely related to the upper reaches having flows and temperatures moderated by Grant Lake outflows, while the lower reaches lose this moderating influence as one moves downstream. This effect is most evident during summers following average to below average spring runoff when peak water temperatures approach stressful levels for brown trout along with large diurnal temperature swings of 10 to 15 degrees F.

The seven years of annual data for Lee Vining Creek were also summarized and averaged (Table 3). Data for main and side-channels were combined for both the Upper and Lower Lee Vining Creek sections on the rationale that for a specific quantity of flow this was the total amount of biomass produced for the area of wetted channel. The Upper section had a six-year average biomass of **134.4 kg/ha** and annual values from 87.3 kg/ha to 185.7 kg/ha. The Lower section had a seven-year average biomass of **116.9 kg/ha** and annual values from 100.0 kg/ha to 204.0 kg/ha. When both sections were combined, the multi-year average equaled **125.7 kg/ha.**

The third CDFG report summarized electro-fishing results from seven Mono Basin streams, including three Rush Creek reaches within our study sections (Deinstadt et al. 1997). This report provided brown trout standing crop estimates for three sampling episodes, 1984/85, 1986, and 1991 (Table 4). Standing crop estimates were then averaged for the three sampling periods: County Road section = **91.4 kg/ha;** Lower section = **107.8**; and Upper section = **106.0 kg/ha.**

Table 1. Channel characteristics, water quality parameters, biomass estimates and density estimates in selected stream reaches from Deinstadt et al. 1985.

Stream Name and Section #	Elevation (ft)	Channel Gradient (%)	Average Channel Width (ft)	Conductivity (micromhos/cc)	Alkalinity (mg/l)	Brown Trout Biomass (kg/ha)	Brown Trout Densities (#fish/km)	Percent of Sampled Brown Trout >300 mm	Comments
Birch Creek – Section #2	4,880'	N/A	11.5	35	N/A	103.2	686	0%	
Bishop Creek – Section #3	7,040'	N/A	15.9	27	20.5	86.1	1,159	0%	
Bishop Creek – Section #4	6,640'	2.3	18.0	33	27.4	139.7	2,473	0%	
South Fork Bishop Creek – Section #2	8,880'	1.4	20.5	200	N/A	211.6	2,449	1.2%	Section stocked with rainbows
South Fork Bishop Creek – Section #3	8,640'	2.5	15.0	190	34.2	118.7	905	0%	Section stocked with rainbows
Owens River – Section #12	7,200'	2.0	24.5	129	83.2	189.6	769	23.7%	Sampled in Nov. Probable influence of Lake Crowley browns.
Pine Creek – Section #1	5,840'	N/A	21.7	133	N/A	64.1	474	0%	Section stocked with rainbows
McGee Creek – Section #1	6,840'	1.6	16.9	54	41.1	35.4	584	0%	

Table 2. Channel characteristics, water quality parameters, biomass estimates and density estimates in selected stream reaches from Deinstadt et al. 1986.

Stream Name and Section #	Elevation (ft)	Channel Gradient (%)	Average Channel Width (ft)	Conductivity (micromhos/cc)	Alkalinity (mg/l)	Brown Trout Biomass (kg/ha)	Brown Trout Densities (#fish/km)	Percent of Sampled Brown Trout >300 mm	Comments
Middle Fk. Bishop Ck – Section #2	7,760'	3.4	14.9	32	27	117.7	1,304	0%	
Middle Fk. Bishop Ck – Section #3	7,840'	4.5	14.0	30	41	202.5	2,541	0.5%	
Owens River – Section #13	6,840'	0.2	41.3	170	116	93.5	775	13.3%	Sampled 10/5/85 – probable influence of Crowley spawners.
Owens River – Section #14	6,960'	0.5	32.3	120	123	111.7	615	16.6%	Sampled 10/6/85 – probable influence of Crowley spawners.
Owens River – Section #15	7,120'	1.5	15.9	120	82	52.7	345	3.4%	Sampled 10/11/85 – probable influence of Crowley spawners.
Owens River – Section #16	7,120'	0.8	24.3	130	89	308.5	1,405	13.6%	DFG noted Crowley fish contributed to the population.
Pine Creek – Section #2	6,560'	5.6	19.4	140	48	74.8	631	2.0%	
Pine Creek – Section #3	4,720'	2.5	13.8	128	48	70.3	1,232	0%	
Pine Creek – Section #4	4,500'	0.7	14.2	250	82	114.2	363	14.3%	Three (of 21 sampled) fish over 300 mm.
Rock Creek – Section#6	7,400'	4.7	15.8	20	27	57.4	709	0%	

Table 2 (continued). Channel characteristics, water quality parameters, biomass estimates and density estimates in selected stream reaches from Deinstadt et al. 1986.

Stream Name and Section #	Elevation (ft)	Channel Gradient (%)	Average Channel Width (ft)	Conductivity (micromhos/cc)	Alkalinity (mg/l)	Brown Trout Biomass (kg/ha)	Brown Trout Densities (#fish/km)	Percent of Sampled Brown Trout >300 mm	Comments
McGee Creek – Section #2	7,840'	2.4	16.0	70	55	107.6	972	1.3%	
McGee Creek – Section #4	7,360'	6.5	15.7	75	48	75.1	1,159	0%	
Hot Creek – Section #1	7,050'	N/A	31.3	N/A in sect #1, but 580 in section #2	N/A in sect #1, 82 in sect. #2	717.0	6,225	1.2%	Section #2 is influenced by hot springs
Mammoth Ck - Section #6	7,840'	1.8	11.4	115	89	313.2	3,024	0%	
Mammoth Ck - Section #7	7,840'	0.7	13.0	108	96	196.7	2,363	0%	
Mammoth Ck - Section #8	7,720'	0.5	12.8	128	N/A	67.0	671	0%	
Mammoth Ck - Section #9	7,360'	3.0	14.5	85	82	54.4	382	0%	
Mammoth Ck - Section #10	7,240'	1.9	14.3	77	69	7.6	368	0%	
Mammoth Ck - Ave. All Sections	N/A	N/A	N/A	N/A	N/A	–	Ave = 1,362	–	**Ave.Total Biomass 99.2**
Sherwin Creek - Section #1	7,920'	2.5	12.0	20	21	180.9	2,206	0%	

Table 3. Total brown trout standing crops (kg/ha) for Lee Vining and Rush creeks, sample seasons 1999 – 2005 (Hunter et al. 2000-2006).

Collection Location	1999 Total Brown Trout Standing Crop (kg/ha)	2000 Total Brown Trout Standing Crop (kg/ha)	2001 Total Brown Trout Standing Crop (kg/ha)	2002 Total Brown Trout Standing Crop (kg/ha)	2003 Total Brown Trout Standing Crop (kg/ha)	2004 Total Brown Trout Standing Crop (kg/ha)	2005 Total Brown Trout Standing Crop (kg/ha)	All-years Combined Running Average of Standing Crops (kg/ha)
LV Upper - Main	39.9	145.0	62.3	58.4	51.7	73.5	55.0	**69.4**
LV Upper - Side	47.4	40.7	36.9	80.6	67.3	102.6	N/A	**62.6**
LV Upper–main/side combined	*87.3*	*185.7*	*99.2*	*139.0*	*119.0*	*176.1*	*N/A*	***134.4***
LV Lower - Main	81.4	89.5	99.5	145.7	121.1	133.6	173.7	**120.6**
LV Lower - Side	25.6	10.5	40.3	44.2	30.0	33.1	30.3	**30.6**
LV Lower–main/side combined	*107.0*	*100.0*	*139.8*	*189.9*	*151.1*	*166.7*	*204.0*	***151.2***
Rush Ck - Co. Rd	N/A	74.7	84.1	65.8	79.7	75.9	66.8	**74.5**
Rush Ck - Lower	158.6	124.7	100.8	71.7	92.8	55.8	94.1	**99.8**
Rush Ck - Upper	89.8	236.0	146.1	136.3	124.9	106.5	174.0	**144.8**

Table 4. Brown Trout total standing crop estimates from three CDFG surveys on Rush Creek (Dienstadt et al. 1997).

Collection Locations Similar to both Studies	CDFG 1984/85 Total Standing Crop (kg/ha)	CDFG 1986 Total Standing Crop (kg/ha)	CDFG 1991 Total Standing Crop (kg/ha)	CDFG Average of Total Standing Crops (kg/ha)
Rush Creek - Co. Road	88.6	54.2	131.5	**91.4**
Rush Creek - Lower	152.0	99.3	72.1	**107.8**
Rush Creek - Upper	95.8	131.3	91.1	**106.0**

The number of fish per unit length of stream channel is another commonly utilized metric, expressed as fish per mile or fish per kilometer. Values of brown trout per kilometer for the eastern Sierra streams sampled by CDFG ranged from 345 to 6,225 brown trout per kilometer (Tables 1 and 2). For the seven stream sections utilized for comparisons to Rush Creek, estimates ranged from 345 to 6,225 brown trout per kilometer and averaged 1,755 brown trout per kilometer (Tables 1 and 2). For the 22 stream sections utilized for comparisons to Lee Vining Creek, estimates ranged from 345 to 3,024 brown trout per kilometer and averaged 1,227 brown trout per kilometer (Tables 1 and 2). Estimates of brown trout per kilometer generated from our data collected between 2000-2005 shows that Rush Creek supports densities of brown trout well above the average of comparable eastern Sierra streams, whereas most Lee Vining Creek sections support densities below the average of its comparable eastern Sierra streams (Table 5).

Table 5. Estimated numbers of brown trout per kilometer for Rush and Lee Vining creeks, sample seasons 2000 – 2005 (Hunter et al. 2001-2006). **NOTE:** value within (#) is the estimated number of age-1+ and older fish contributing to the total.

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**	**All-years Combined Running Average of Total Number of Brown Trout per Kilometer**
Rush Ck - Co. Rd	3,804 (697)	2,467 (920)	2,620 (539)	3,136 (764)	2,095 (641)	1,712 (618)	**2,369 (697)**
Rush Ck - Lower	3,728 (563)	2,877 (704)	3,348 (296)	3,642 (578)	2,182 (212)	1,731 (716)	**2,918 (512)**
Rush Ck - Upper	11,326 (1,819)	8,544 (837)	6,137 (900)	2,740 (791)	3,881 (495)	5,032 (1,167)	**6,277 (1,002)**
LV Upper - Main	1,055 (306)	745 (333)	531 (364)	706 (227)	724 (415)	318 (318)	**680 (327)**
LV Upper - Side	308 (189)	308 (189)	612 (368)	886 (254)	1,513 (493)	60 (60)	**615 (259)**
LV Upper - averaged	682 (248)	527 (261)	572 (366)	796 (241)	1,119 (908)	189 (189)	**648 (369)**
LV Lower - Main	1,343 (316)	1,203 (497)	871 (645)	1,142 (316)	2,484 (555)	871 (871)	**1,319 (533)**
LV Lower - Side	504 (65)	492 (168)	523 (200)	559 (87)	467 (139)	108 (108)	**442 (129)**
LV Lower - averaged	924 (191)	848 (333)	697 (423)	851 (202)	1,476 (347)	490 (490)	**881 (331)**

Mammoth Water District's Annual Fish Community Surveys – Trend Analyses

The Mammoth Water District's Fish Community Survey reports were the only long-term data sets we found (first-hand) for a nearby eastern Sierra stream (http://www.mcwd.dst.ca.us/FishSurvey/fish_Survey_index.htm). These reports covered 12 years of sampling from eight reaches of Mammoth Creek between 1992 and 2004 with no sampling in 1998. Population data were reported as total number of trout per mile of stream. Age class structure was assessed by constructing length-frequency distribution graphs, but no scale or otolith analyses were done to interpret fish ages. Annual contributions of age-0 trout were utilized to assess reproductive viability of the population.

The 2004 report (most current available online) reported that brown trout population estimates ranged from 444 to 3,186 fish per mile (715 – 5,130 fish/km) for the eight sections, with a combined-reach average of 1,267 fish per mile (2,040 fish/km). This was the lowest estimate for the previous eight years and was the seventh straight year of declining values. In 2004, age-0 brown trout comprised 59% of the catch, age-1+ comprised 20% of the catch, age-2+ comprised 14% of the catch, and 7% of the catch were most likely age-3 and older fish. Only two brown trout out of 576 sampled from the eight long-term reaches were greater than 300 mm in length (0.3% of the population).

In 2004, a reach within the Valentine Reserve was sampled for the first time and noted as being on private property, closed to fishing, "virtually untouched," and "could be considered the most natural of the upstream sites." In this section, age-0 brown trout comprised 32.3% of the catch (198 fish total), age-1+ comprised 37.4% of the catch, age-2+ comprised 27.3% of the catch, and age-3 and older fish accounted for 3.0% of the total catch. The 2004 report described the Valentine Reach as "dominated by large fish." yet no brown trout greater than 300 mm were sampled.

Regardless of the steady declines in population estimates since 1997, the report concluded that the 2004 estimates were 9% lower than the 12-year running average, age-class structure of age-0 to age-3 fish had remained fairly consistent, and the population was considered to be in good condition. The author of the 2004 Mammoth Creek report considered the results comparable to Convict and McKee creek data from the 1985/86 CDFG reports (Hood 2006).

Keegan Declaration regarding Mammoth Water Rights, SWRCB L5715, L2593, P.17332

Thomas P. Keegan, a fisheries biologist from Roseville, California submitted a declaration on behalf of CalTrout for the Mammoth Water Rights case (http://www.n-h-i.org/rrcdocs/Mammoth%20Exhibits%2020%20-%2029.pdf). The Keegan declaration included a graph depicting 16 standing crop estimates for age 1+ and older brown trout in Hot Creek collected over 22 years (1982-2003). Keegan stated the data were collected by CDFG, but the information was "rarely finalized" into final reports. It is unclear from the declaration how Keegan obtained the Hot Creek data or where on Hot Creek the sampling occurred. The declaration stated that the highest standing crop estimate for age-1 and older brown trout in Hot Creek was 791.6 kg/ha in 1991, the lowest estimate was 308.1 kg/ha in 2002, and the average for 16 seasons of data was 542.5 kg/ha. However, since 1993, estimated standing crops have been less than 415.1 kg/ha.

As stated earlier, we consider the Hot Creek biomass estimates atypical (high end of the spectrum) of all eastern Sierra streams and not valid to compare to Rush and Lee Vining creeks. While we have not measured conductivity and alkalinity in Rush and Lee Vining creeks, data were available in the CDFG survey reports (Table 5; Deinstadt et al. 1997). Conductivity in Lower Rush Creek ranged from 21 to 60 micromhos/cc and alkalinity ranged from 21 to 34 mg/l (Table 6). In comparison, conductivities in Hot Creek ranged from 192 to 302 micromhos/cc and alkalinity ranged from 109 to 120 mg/l (USGS National Water Quality Information System website).

It's probable that both increased productivity and a more constant temperature regime in Hot Creek (particularly moderated winter icing conditions and a longer growing season) contribute to higher standing crops in Hot Creek. This assumption is supported by the USGS descriptions of Hot Creek's hydrothermal characteristics. "Hydrologic conditions, including water flows, temperatures, and quality, at Hot Creek Fish Hatchery are **uniquely** suited for raising trout" (emphasis added). "Use of the warm spring water in the hatchery has increased fish production because trout growth-rates are faster in the warm water than in ambient stream temperatures in Long Valley." A study of water quality and trout production in Minnesota streams concluded that fish density, biomass, or production were not correlated with eight water quality variables describing ionic and nutrient content in these streams, but when data from other United States streams with a wide range in alkalinity were incorporated, salmonid production was strongly and positively correlated with alkalinity (Kwak and Waters 1997).

Data from the Keegan declaration were reported for several reasons, including:

- Data were available and will likely be cited by some stakeholders in reviewing our recommendations.
- Data revealed wide range year-to-year variations of standing crop estimates.
- Data suggested a downward trend in standing crops when comparing 1982-1992 estimates (11-year average of 556 kg/ha) to 1993-2003 estimates (five-year average of 325 kg/ha).

Table 6. Rush Creek water quality parameters measured by CDFG at 10 sections, between 1984 and 1991 (Deinstadt et al. 1985; 1986; 1997). Sections #-1-#5 were located downstream of Grant Reservoir and sections #6-#10 were located upstream of Grant Reservoir.

Section #	Conductivity (micromhos/cc) 1984/85	Conductivity (micromhos/cc) 1986/87	Conductivity (micromhos/cc) 1989/91	Alkalinity (mg/l) 1984/85	Alkalinity (mg/l) 1986/87	Alkalinity (mg/l) 1989/91	Section location
Lower Section #1	32	60	38	N/A	27	26	Approx. 750' u.s. of old CDFG checking station
Lower Section #2	N/A	40	27	N/A	27	21	Just d.s. of MGORD in natural channel
Lower Section #3	45	50	37	21	21	34	Approx. 2.5 miles d.s. of Walker Ck conflu.
Lower Section #4	35	35	41	27	34	27	Just u.s. of power line crossing above Hwy 395
Lower Section #5	35	30	35	21	27	27	Approx. 0.25 miles u.s. of Parker Ck conflu.
Upper Section #6	N/A	20	22	N/A	14	21	Approx. 0.5 miles d.s. of Silver Lake
Upper Section #7	25	22	23	14	27	14	Approx. 1.0 miles u.s. of Grant Res.
Upper Section #8	N/A	20	N/A	N/A	21	N/A	Just d.s. Silver Lk w/in campground
Upper Section #9	N/A	20	N/A	N/A	21	N/A	Approx. 0.4 miles d.s. of Silver Lk.
Upper Section#10	N/A	20	N/A	N/A	21	N/A	Approx. 0.75 miles u.s of Silver Lk.

Condition Factor

Relative condition factors (K_n) have been calculated annually in all sampling sections of Rush, Lee Vining, Parker and Walker creeks since 1999 for all brown trout between 150 to 250 mm in length. Methods for calculating relative condition factors were consistent with those initially developed by Le Cren (1951) and expanded by Swingle (1965) and Swingle and Shell (1971).

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

Annual sampling has shown that brown trout condition factors for most of the Mono Basin monitoring reaches is close to or greater than 1.0 (Figure 1), indicating that these fish are average compared to other waters. Brown trout in Lee Vining Creek appear to be in slightly better condition than Rush Creek brown trout, as indicated by generally higher values between 1999 and 2005 (Figure 1).

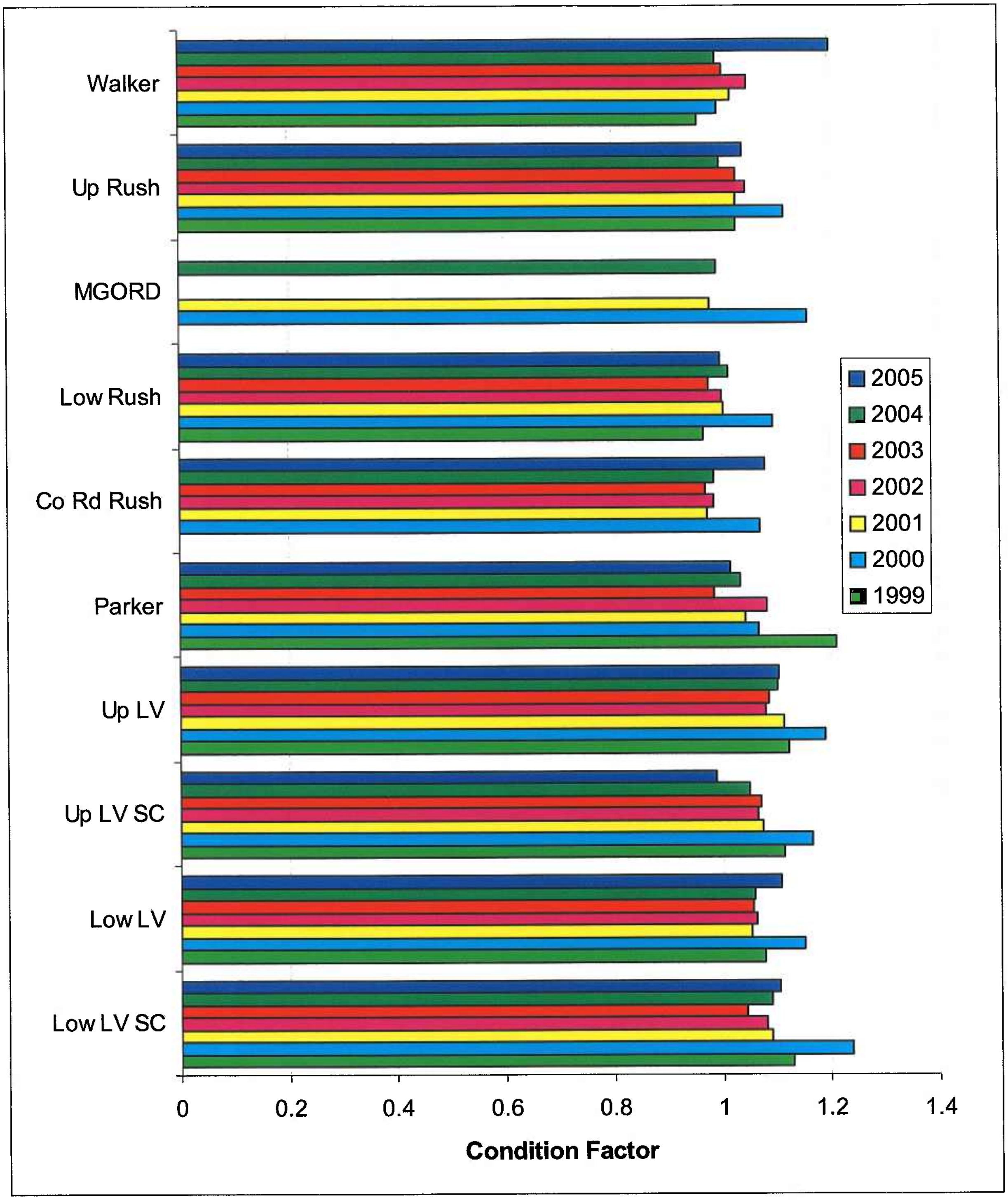

Figure 1. Condition factors for brown trout 150 to 250 mm long in Mono Lake tributaries from 1999 to 2005.

Proportional Stock Density (PSD) and Relative Stock Density (RSD)

Definition and Equations for Calculating PSD and RSD

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

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

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

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

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

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

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

Calculated RSD Values for Mono Basin Streams and Regional Comparisons

In order to compare our Rush and Lee Vining creek data with the regional data collected by CDFG, we had to slightly adjust the size categories proposed by Milewski and Brown (1994) into 25 mm increments, as follows: 225-299 mm, 300-374 mm, ≥375 mm (Table 8). We also dropped the terms "stock," "quality," "preferred," "memorable" and "trophy" and substituted the actual length categories to hopefully reduce any confusion these terms may cause to reviewers (Table 8).

Thus in Table 8, RSD values are simply reported as the proportions (percentage x 100) of the total number of brown trout over 150 mm (6") in length that in turn are greater than 225 mm or 9" (RSD-225), 300 mm or 12" (RSD-300) and 375 mm or 15" (RSD-375) in length, or:

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

When RSD values for the Owens River Basin stream segments shown on Table 8 were calculated, adjoining 100-meter electrofishing sections that were surveyed during the same month and year were often combined to achieve a sample size of at least 100 brown trout greater than 150 mm. The resulting larger sample sizes not only enhanced the reliability of the data, but also essentially increased the total lengths of the Owens stream segments, making them more comparable to our 2000-2006 Mono Basin electrofishing section lengths.

The combined data for Owens River Sections 13-16 (located upstream of Lake Crowley) had an RSD-225 value of 68, an RSD-300 value of 28 and an RSD-375 value of 16 (Table 8). These values are similar to the MGORD data, which had three-year mean values of RSD-225 = 69, RSD-300 = 36 and RSD-375 = 8 (Table 8). Other than the MGORD, Section 5 on Mammoth Creek and the Upper Owens were the only stream segments that had RSD-375 values greater than 2 (Table 8). The Mammoth Creek section was located 0.25 miles upstream of the confluence with Hot Creek. The Upper Owens River data were collected during late October, when large lake-dwelling brown trout had moved upstream for spawning.

The only other stream segments with RSD-225 values greater than 50 were Hot Creek Section 1 and the Bishop Creek Canal Section 2 (Table 8). These two stream segments and Mammoth Creek section 5 also had RSD-300 values greater than 12. All other stream segments had RSD-300 values less than 5 (Table 8).

Data from Sections 9-11 on the Owens River (located 1 to 3 miles downstream of Lake Crowley) are also shown on Table 8. These sections were sampled during summer and had RSD-225 values ranging from only 12 to 44, and RSD-300 and RSD-375 values less than 2. The significantly lower RSD values at these Owens River sections compared to sections 13-16 is likely related to differences in the sampling periods (summer low-flow vs. autumn spawning) as well as the proximity to productive tributaries; e.g. the confluence of Hot Creek is near Owens River section 16.

RSD-225 values on Rush Creek have increased from 2000 through 2006, especially evident in the Upper and Lower study sections (Table 8). RSD-225 values ranged from 30-44 (except during 2005 at Lower Rush) in 2004-2006, which were years with relatively high stream runoff volumes. These are respectable RSD-225 values, similar to the Owens River Sections 9 and 10 and Section 1 on Hot Creek during April 1985. In contrast, from 2000-2003, which were much lower runoff years, RSD-225 values were less than 20 and as low as 5 for Lower Rush in 2001 (Table 8).

Fluctuations in the numbers of larger brown trout (and thus, the RSD values) on Rush Creek could at least partially be influenced by the magnitude and duration of runoff year. However, it is not unusual to have quite significant annual variations in the numbers of adult brown trout in any stream system. During an 18 year-long study of an unexploited brown trout population in a relatively pristine Pennsylvania watershed, Carline (2006) found that numbers of brown trout 150-225 mm in length, as well as those greater than 225 mm in length, varied about five-fold, primarily due to differences in annual stream discharge rates and patterns, along with other natural (non-human influenced) variables.

To account for the wide range of natural variation in numbers of larger brown trout, we propose an RSD-225 value of **35** for the Rush Creek Upper, Lower, and County Road sections. This value is higher than the mean RSD-225 value of 31 for the Upper and Lower sections combined from 2004-2006, and nearly twice as high as the mean RSD-225 value of 18 for these sections during the low flow years of 2000-2003. The high runoff flows of 2005 and 2006 likely created additional large pool (and thus large fish) habitat that was not present from 2000-2003, which should help RSD values steadily increase on Rush Creek in the future.

The highest RSD-300 values that have been measured thus far on Upper and Lower Rush Creek have been 4 and 3, respectively during 2006 (Table 8). A RSD value of **5** was chosen for the Rush Creek Upper, Lower and County Road sections as further acknowledgement of the expected improvement in habitat for larger brown trout within these Rush Creek sections.

The RSD-225 value that is being proposed for the MGORD (**60**) is nearly equal to the RSD-225 values for the Owens River sections 13-16 (68) and Hot Creek during May of 1983 (65). The proposed RSD-300 value for the MGORD (**30**) is higher than all the Owens River stream segments listed on Table 8, including sections 13-16 of the Owens (28), Hot Creek (12) and the section on Mammoth Creek just upstream of Hot Creek (23). The proposed RSD-375 value for the MGORD (**5**) is also higher than most of the Owens River stream segments, except for the Upper Owens sections (16) and the section of Mammoth Creek near Hot Creek (8). These proposed RSD values acknowledge that the MGORD is capable of supporting a catch-and-release fishery for trophy-sized wild brown trout.

As discussed earlier, Lee Vining Creek is subjected to wider variations in runoff rates and volumes compared to Rush Creek. The riparian community and in-stream habitat for big fish has also been slower to recover than on Rush Creek. Because Lee Vining Creek will likely continue to have less suitable habitat for larger brown trout into the foreseeable future, we propose a somewhat lower RSD-225 of **30** for this stream.

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

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

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

The inclusion of RSD as a Mono Basin fisheries termination criterion metric was based on a recommendation made by the CDFG wild trout biologist. We will also be including RSD values in our annual fisheries monitoring reports.

Table 8. Brown trout RSD values for Rush and Lee Vining Creek study sections and for selected eastern Sierra streams. Rush and Lee Vining sections are ordered chronologically by sample year. Comparison streams are reported by RSD-225 in descending value.

Sampling Location	Collection Date	# Fish ≥150 mm	# Fish 150-224 mm	# Fish 225-299 mm	# Fish 300-374 mm	# Fish ≥375 mm	RSD-225	RSD-300	RSD-375
Rush Ck - MGORD	9/2006	567	77	186	279	25	86	54	4
Rush Ck - MGORD	9/2004	424	144	184	65	31	66	23	7
Rush Ck - MGORD	9/2001	744	374	202	126	99	55	30	13
Owens R – Sec 13-16	10/1985	129	41	52	16	20	68	28	16
Hot Ck – Sec 1	5/1983	805	281	427	94	3	65	12	0
Bishop Ck Canal	2/1983	145	69	52	22	2	52	17	1
Owens R – Sec 9	8/1983	133	74	59	0	0	44	0	0
Hot Ck – Sec 1	4/1985	1309	800	492	15	2	39	1	0
Mammoth Ck Sect 5	5/1984	99	60	16	15	8	39	23	8
Owens R – Sec 10	7/1984	283	188	89	6	0	34	2	0
Bishop Ck – Sec 3-5	7/1984	109	89	20	0	0	18	0	0
Convict Ck – Sec 1-4	4/1981	125	102	19	1	3	18	3	2
S. Fk Bishop Ck Sec 2-3	6/1984	163	141	20	2	0	13	1	0
Owens River – Sec 11	7/1984	142	125	16	0	1	12	0	1
Mammoth Ck sec 6-9	10/1985	162	143	19	0	0	12	0	0
Mill Ck – Sec 2-3	10/1985	102	96	5	0	1	6	0	1
Rush Ck – Upper	9/2006	231	154	67	10	0	33	4	0
Rush Ck – Upper	9/2005	202	141	54	5	2	30	3	1
Rush Ck – Upper	9/2004	179	115	57	2	1	34	2	1
Rush Ck – Upper	9/2003	263	217	44	2	0	17	1	0
Rush Ck - Upper	9/2002	217	176	37	2	2	19	2	1
Rush Ck – Upper	9/2001	221	188	27	6	0	15	3	0
Rush Ck – Upper	9/2000	178	156	20	2	0	12	1	0

Table 8 (continued).

Sampling Location	Collection Date	# Fish ≥150mm	# Fish 150-224 mm	# Fish 225-299 mm	# Fish 300-374 mm	# Fish ≥375mm	RSD-225	RSD-300	RSD-375
Rush Ck – Lower	9/2006	152	85	63	4	0	44	3	0
Rush Ck – Lower	9/2005	140	123	17	0	0	12	0	0
Rush Ck – Lower	9/2004	79	54	24	1	0	32	1	0
Rush Ck – Lower	9/2003	209	185	24	0	0	11	0	0
Rush Ck - Lower	9/2002	107	87	20	0	0	19	0	0
Rush Ck – Lower	9/2001	199	189	10	0	0	5	0	0
Rush Ck – Lower	9/2000	165	147	18	0	0	11	0	0
Rush Ck – Co Rd	9/2006	264	189	75	0	0	28	0	0
Rush Ck – Co Rd	9/2005	206	175	29	0	0	14	0	0
Rush Ck – Co Rd	9/2004	407	358	49	0	0	12	0	0
Rush Ck – Co Rd	9/2003	447	383	63	1	0	14	0	0
Rush Ck – Co Rd	9/2002	302	269	32	1	0	11	0	0
Rush Ck – Co Rd	9/2001	421	380	38	3	0	10	1	0
Rush Ck – Co Rd	9/2000	319	276	43	0	0	13	0	0
Lee Vining Ck – Upper	9/2005	81	42	39	0	0	48	0	0
Lee Vining Ck – Upper	9/2004	193	157	35	1	0	19	1	0
Lee Vining Ck – Upper	9/2003	110	76	34	0	0	31	0	0
Lee Vining Ck – Upper	9/2002	224	167	57	0	0	25	0	0
Lee Vining Ck – Upper	9/2001	117	97	19	1	0	17	1	0
Lee Vining Ck – Upper	9/2000	86	59	27	0	0	31	0	0
Lee Vining Ck – Lower	9/2005	74	46	27	1	0	38	1	0
Lee Vining Ck – Lower	9/2004	95	84	9	2	0	12	2	0
Lee Vining Ck – Lower	9/2003	60	34	25	1	0	43	2	0
Lee Vining Ck – Lower	9/2002	167	126	38	3	0	25	2	0
Lee Vining Ck – Lower	9/2001	109	90	16	3	0	17	3	0
Lee Vining Ck – Lower	9/2000	55	35	19	1	0	36	2	0

Chris Hunter's Specific Changes to the Fisheries Termination Criteria

Based on the lack of quantifiable data to accurately describe the pre-1941 fisheries of Rush and Lee Vining creeks, I recommend that new termination criteria be based on values developed from a compilation of sources including data from other high-quality eastern Sierra trout streams. Values were selected based on my review of these data and the collective professional judgment of my sub-consultants. The termination criteria must be statistically valid values measurable by repeatable data-collection methodologies. These methodologies should be generally accepted as standard techniques by fisheries managers for monitoring trends of naturally-reproducing trout populations.

As stated by the stream scientists in WR98-05, selecting a specific point value may not be appropriate, thus I recommend assessing termination criteria based on three-year running averages and examining trends. The rationale for selecting a three-year running average is that this time frame is roughly equal to the life-expectancy of most brown trout in Rush and Lee Vining creeks. Self-sustaining trout populations are naturally variable due to a host of environmental conditions, thus declines and increases should be expected (Carline 2006). If feasible, comparing trends in Rush and Lee Vining creeks to trends in other eastern Sierra streams may assist in separating effects from regional trends due to climatic conditions such as droughts, severe winters, or floods versus stream-specific trends due to flow manipulation.

My recommendations include different termination criteria values for Rush Creek and Lee Vining Creek, with higher values placed on Rush Creek due to the following factors:

- Rush Creek (unlike Lee Vining Creek) is a tail-water fishery downstream of a dam and reservoir with a more controlled flow and moderated thermal regime.

- Rush Creek's channel downstream of the Narrows appears to have more potential for future recovery and development of high-quality brown trout habitat than Lee Vining Creek. Over the past ten years, we have observed this recovery in Rush Creek, whereas Lee Vining Creek's channel has remained relatively static as far as pool development (habitat for larger brown trout).

I also recommend repeating Class 4 and 5 Pool surveys along the entire reach of Rush Creek (lower end of MGORD to Mono Lake). This recommendation is based on my observations that since the initial pool habitat survey in June of 2002 additional high-quality pool habitats have been created, especially after the large spring run-offs in 2005 and 2006. If the physical habitat desirable to larger brown trout continues to increase, populations of larger trout should increase. However, if high-quality pool habitats increase without a response in the trout population other factors such as temperature, flow or nutrients may be limiting populations.

Although the MGORD was not included as a study reach under the initial termination criteria, I would like to point out that, seasonally, larger (>355 mm or 14") brown trout from the MGORD utilize lower reaches of Rush Creek. Preliminary movement study results over two spawning seasons have documented that a sizable portion of large trout tagged in the MGORD (six of 13 fish or 46% in 2005 and 14 of 38 fish or 37% in 2006) seasonally migrated into lower sections of Rush Creek after the time-period when we conduct our annual sampling. Most movement out of the MGORD occurred in November and length of time spent downstream of the MGORD was variable from several weeks to months. As of May 2006, one fish that out-migrated from the MGORD in November of 2005 was still residing downstream of Highway 395. An additional 29 brown trout >300 mm were tagged in September of 2006 to further evaluate the degree of movement exhibited by a larger sample size of radio-tagged MGORD brown trout. Twenty of the 29 radio tags were implanted in two and three year old trout to examine movement behavior of younger fish.

For both Rush and Lee Vining creeks, I have recommended relatively high termination criteria values (regionally) and this is apparent in the comparison graphs (Figures 2 – 5). These above-average values were picked because, in my professional judgment, I consider that Rush and Lee Vining creeks are already in good shape (from a wild brown trout population perspective) and will still experience future habitat improvements that may translate into larger trout populations or larger trout within the populations. I believe one of the reasons Rush and Lee Vining creeks are in good condition is due to the overall management of the lower watershed in contrast to many other eastern Sierra watersheds. These management practices include: implementation of the stream restoration flows, cessation of grazing activities, no commercial timber harvest, DWP's road-closure program, improved fish passage conditions at Highway 395 crossings, no major residential impacts, no future plans for sub-division development, catch-and-release fishing regulations and low levels of fishing pressure.

<u>Rush Creek Termination Criteria for Upper, Lower and County Road Study 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 should also be reported to reflect contribution by age-class (young-of-year and ≥age-1). Termination criteria biomass estimate should be **≥ 175 kg/ha**. This recommended value puts the Rush Creek biomass termination criteria well above the average of most eastern Sierra streams (Figure 2).

Assess trends in brown trout standing crop data with three-year moving averages by computing the average of the three most current years of data. That average should meet the termination criteria of at least **175 kg/ha**.

Termination Criterion #2 - Density: Total number of trout per unit length (km) of stream channel. Termination criteria for total number of trout per kilometer should be **≥3,000 trout per kilometer**. This recommended value puts the Rush Creek density termination criteria well above the average of most eastern Sierra streams (Figure 3).

Assess trends in total trout/km data with three-year moving averages by computing the average of the three most current years of data. That average should meet the termination criteria of at least **3,000 trout/km**.

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

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

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

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

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

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

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

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

Rush Creek Termination Criteria for the MGORD Study Section

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

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

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

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

Assess trends in RSD-255, RSD-300, and RSD-375 with three-year moving averages by computing the average of the three most current years of data. The averages should meet the termination criteria of **60**, **30**, and **5**, respectively.

<u>Lee Vining Creek Termination Criteria</u>

<u>Termination Criterion #1 - Biomass:</u> Total trout (brown and wild rainbow) standing crop estimates based on kilograms per hectare of biomass. Total standing crop estimates should also be reported to reflect contribution by age-class (young-of-year and ≥age-1) and species. Termination criteria for total biomass estimate should be **≥ 150 kg/ha**. This recommended value puts the Lee Vining Creek biomass termination criteria above the values for all the eastern Sierra streams we utilized for comparison (Figure 4).

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

<u>Termination Criterion #2 - Density:</u> Total number of trout per unit length (km) of stream channel. Termination criteria for total number of trout per kilometer should be **≥1,400 trout per kilometer**. This recommended value puts the Lee Vining Creek density termination criteria above the values for all the eastern Sierra streams we utilized for comparison (Figure 5).

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

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

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

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

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

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

Using the Recommended Termination Criteria – Examples with Current Data Sets

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

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

2. 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.

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

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

5. The Rush Creek MGORD study section would be considered "recovered" if met the three RSD termination criteria for three consecutive years.

6. For Lee Vining Creek, a section would be considered “recovered” if it met three of the four termination criteria for three consecutive years.

Upper Rush Creek Example:

Termination Criteria	**2005-2003 Average**	**2004-2002 Average**	**2003-2001 Average**
Biomass (≥175 kg/ha)	135.1	122.6	135.8
Density (≥3,000 fish/km)	3,884.3	4,252.7	5,807
Condition Factor (≥1.0)	1.02	1.03	1.04
RSD-225 (≥ 35)	27	23	17
RSD-300 (≥ 5)	2	2	2
Conclusion	**Meets 3 of 5 TC**	**Meets 2 of 5 TC**	**Meets 2 of 5 TC**

Lower Rush Creek Example:

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

County Road Rush Creek Example:

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

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

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

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

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

Adaptive Management Recommendations

These suggested new fisheries termination criteria are based on what I felt were the best available information and data. However, in keeping with the spirit of the adaptive management approach embraced by stakeholders in the Mono Basin restoration effort, I recommend that the fisheries termination criteria be potentially re-examined at a future time as habitat continues to recover and as additional data are obtained and evaluated.

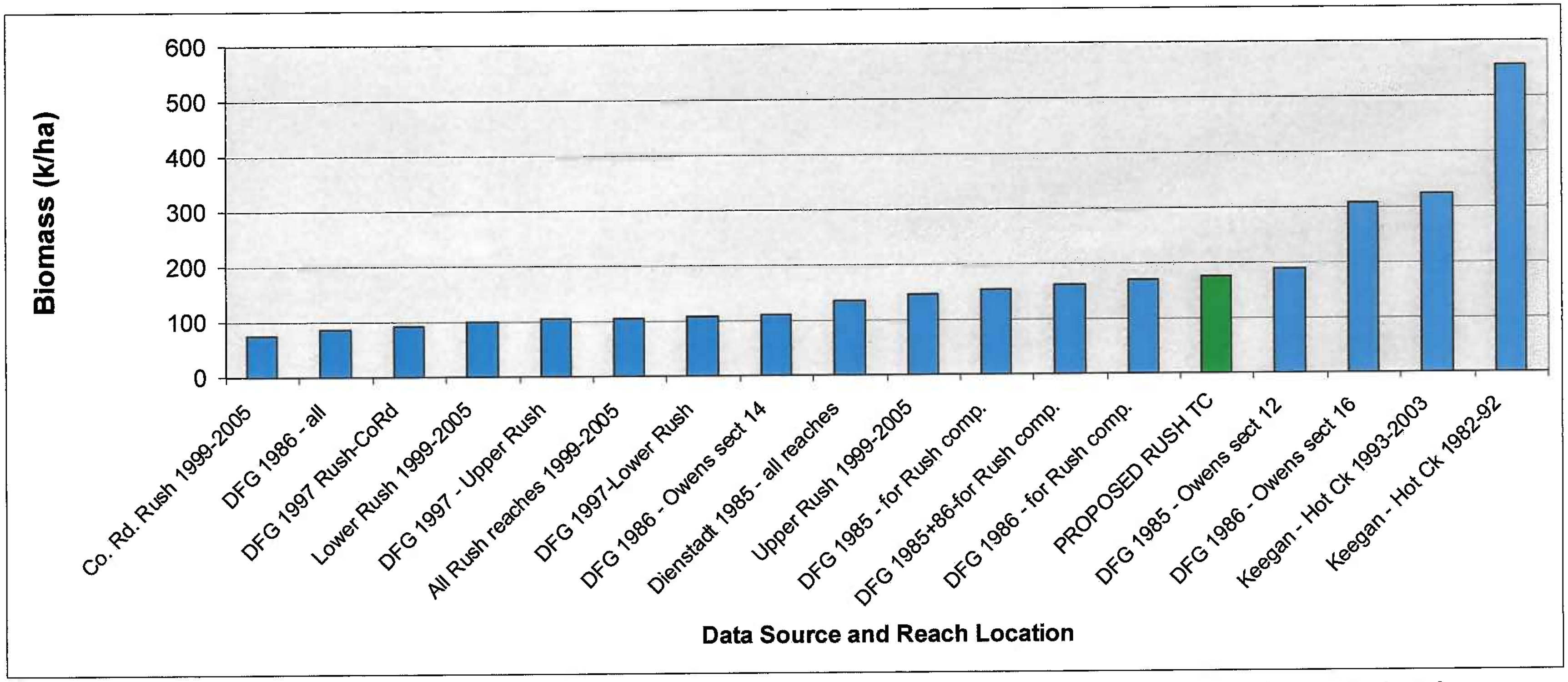

Figure 2. Comparison of proposed Rush Creek biomass termination criteria with biomass values from previously completed Rush Creek surveys and other eastern Sierra streams.

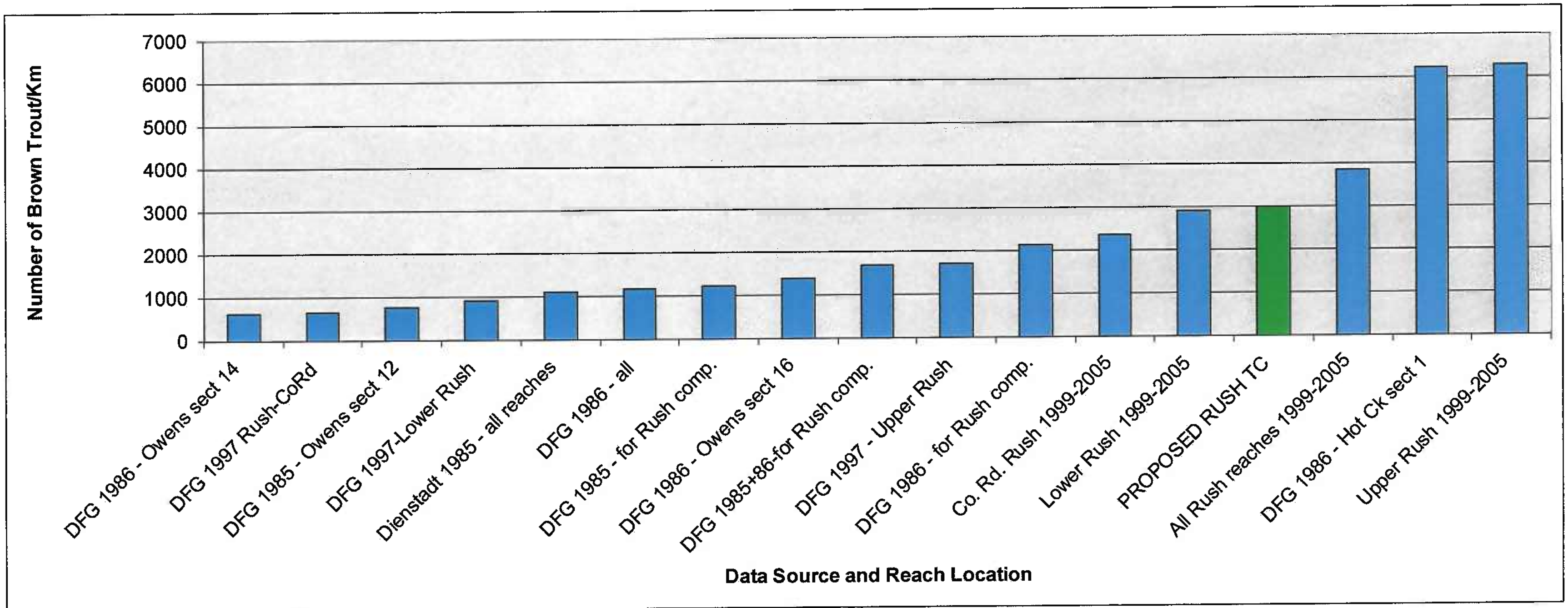

Figure 3. Comparison of proposed Rush Creek density termination criteria with density values from previously completed Rush Creek surveys and other eastern Sierra streams.

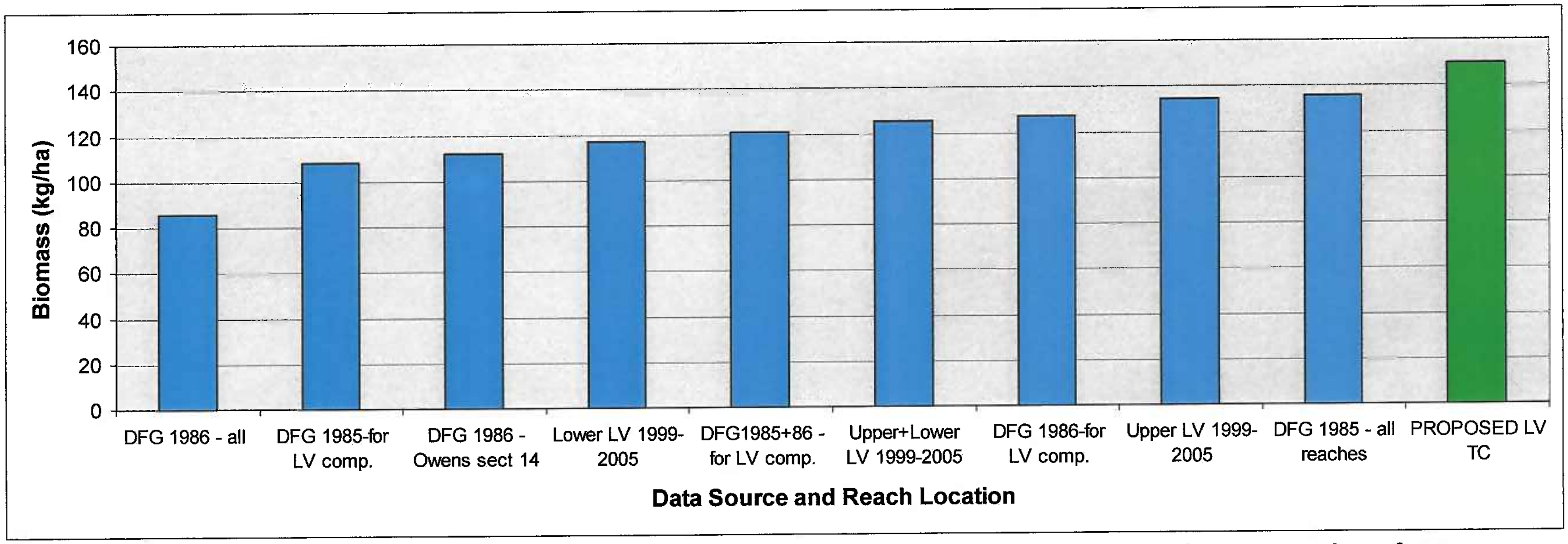

Figure 4. Comparison of proposed Lee Vining (LV) Creek biomass termination criteria with biomass values from previously completed Lee Vining surveys and other eastern Sierra streams.

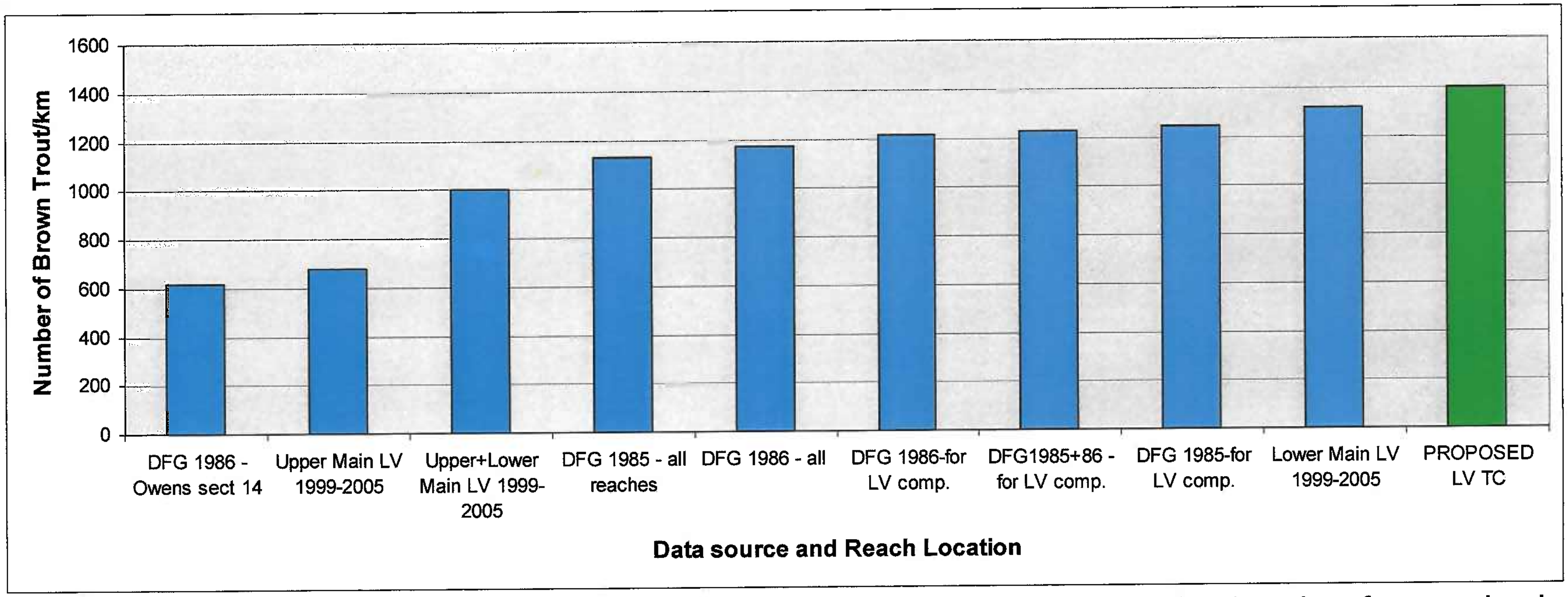

Figure 5. Comparison of proposed Lee Vining (LV) Creek density termination criteria with density values from previously completed Lee Vining surveys and other eastern Sierra streams.

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