- Final Report -

MAMMOTH CREEK 2004 FISH COMMUNITY SURVEY

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INTRODUCTION

Instream flow needs for fish resources in Mammoth Creek, Mono County, California have been the focus of several investigations since the 1970's. As a result of these investigations, mean daily instream flow regimes have been recommended that are intended to sustain aquatic habitat and the fishery resources in Mammoth Creek. Several entities have been involved in the collection of Mammoth Creek fisheries data (see Hood et al., 1993-95, Jenkins and Dawson 1996-97, Hood 1998, 2000-2003, and Jenkins 1999). However, this report focuses on the data set collected from the 1992 through 2004 fish community surveys. For the surveys listed above, data was collected using a consistent sampling methodology and analysis has focused on assessing the Mammoth Creek fishery in terms of species composition, abundance, and size and age class structure. The 1992-2004 surveys compare population changes over time under various hydrological conditions and other influential factors.

This report documents the results of the 2004 fish resource assessment survey conducted from October 4, 2004 through October 8, 2004. Specific objectives of this study were:

- To estimate the total fish population and evaluate the size and age class structure and species composition of fish throughout the Mammoth Creek study area and within each sampling section;
- To compare the results of this year's study with previous studies of Mammoth Creek and other similar Sierra Nevada streams; and
- To relate the results of this year's fish population dynamics with the hydrologic conditions of Mammoth Creek over the water year preceding the survey.
- To examine the fish population at a new site on Mammoth Creek within the Valentine Reserve.

Because of the differences in the sampling methodology used by Beak in 1988 and CDFG in 1991, the analyses used in this report will focus on the data set collected from the 1992-2004 surveys.

STUDY AREA

The Mammoth Creek study area extends from Lake Mary downstream to the confluence of Mammoth Creek and Hot Creek, a distance of approximately 10.4 miles. Five distinct reaches were identified in Mammoth Creek in 1988 (Bratovich *et al*. 1990), based upon analysis of topographic maps, calculation of gradient profiles, visual inspection of the creek and associated morphological characteristics, tributaries, riparian vegetation and surrounding topography. Four of these reaches were located in the lower 8.9 miles (86.3 percent of the entire length) of the creek, and were characterized by gradients that range from 0.7 to 3.8 percent. By contrast, a fifth reach comprised of approximately the upper 1.4 miles (13.7 percent) of the creek was characterized by a gradient of approximately 12.3 percent. Habitat in this high-gradient reach typically consisted of a cascade-plunge pool sequence in which the amount of usable fish habitat was not determined by stream discharge, but by sectional (streambed rock) hydraulic controls. Pursuant to concerns expressed by CDFG and the USFS during the preliminary scoping meeting held in 1988 regarding the accuracy of modeling Reach A using the Instream Flow Incremental Methodology (IFIM), habitat characterization and all subsequent investigations were restricted to the remaining four study reaches (Bratovich *et al*. 1992). Therefore, for comparative purposes, the same four reaches were the focus of this 2004 investigation.

METHODS AND MATERIALS

Experimental Design

The experimental design and rationale of sampling site selection are described in detail in Bratovich *et al*. 1990. Distinct differences in the amount of riparian cover within each study reach were observed during the habitat mapping survey conducted in 1988 (Bratovich *et al*. 1990). To ensure representation of riparian cover and dispersion of sampling sections, fish sampling sections were located within *zones* of "high" and "low" riparian cover within each study reach. However, discretion must be used when comparing and interpreting the results between "high" and "low" riparian cover sites. For example, Site EH represents a *zone* of "high" riparian cover within Reach E. However, in comparison with other "high" riparian cover sites, it is characterized by a relatively low amount of riparian cover. Conversely, Site DL was randomly selected within a "low" riparian *zone* for Reach D but in fact has a high amount of willow cover. Additionally, since the initiation of these fish community surveys in 1988, the riparian cover at Site BL has changed significantly, and although it remains in a "low" riparian cover *zone*, rapid willow tree growth at this site has resulted in high riparian cover at the sample site. Streamside cover at Site BH has also been altered significantly by landscape activities at the adjacent condominiums.

Consistent with the previous eleven surveys (1992-97 and 1999-2003), eight stream sections were sampled in 2004, with each 300-foot long sample site representing a "high" or "low" riparian vegetation cover *zone* within a study reach (Figure 1). This year, however, a ninth stream section located on the University of California's Valentine Reserve was also surveyed. It is located above Site BH and, unlike the eight sections downstream, has remained virtually untouched and could be considered the most natural of the upstream sites. The Valentine Site is classified as a "high" riparian site. It was sampled this year to see how it differed from the other sites in fish composition. The downstream boundary of the sampling sites remained the same for the 1992-2004 surveys with two exceptions. In 1995, the organization that conducted the 1995-96 surveys was unable to access the lowermost site. An alternate site extending 300 feet downstream from the eastern boundary of the Chance Ranch, just upstream from the confluence of Mammoth and Hot Creeks was established (Figure 1). The second sample site change occurred at Site CH because of a channel split in the late 90's. For this study we established the bottom of Site CH immediately upstream of the channel split. Although the sample site was moved upstream for this survey, the site was similarly characterized to the previous sample site and, therefore, no significant differences in the fish composition are likely.

Data Acquisition

Fish resource assessment surveys were conducted by electrofishing. One day prior to electrofishing, selected sampling sites were re-located and the upstream and downstream boundaries marked with 0.5-inch diameter rebar driven into each bank. The rebar also served as anchors for block nets. On the day of sampling, sites were closed using block nets comprised of 0.25-inch stretched mesh. The nets were placed simultaneously across the upstream and downstream boundaries to preclude movement of fish into or out of the sampling section.

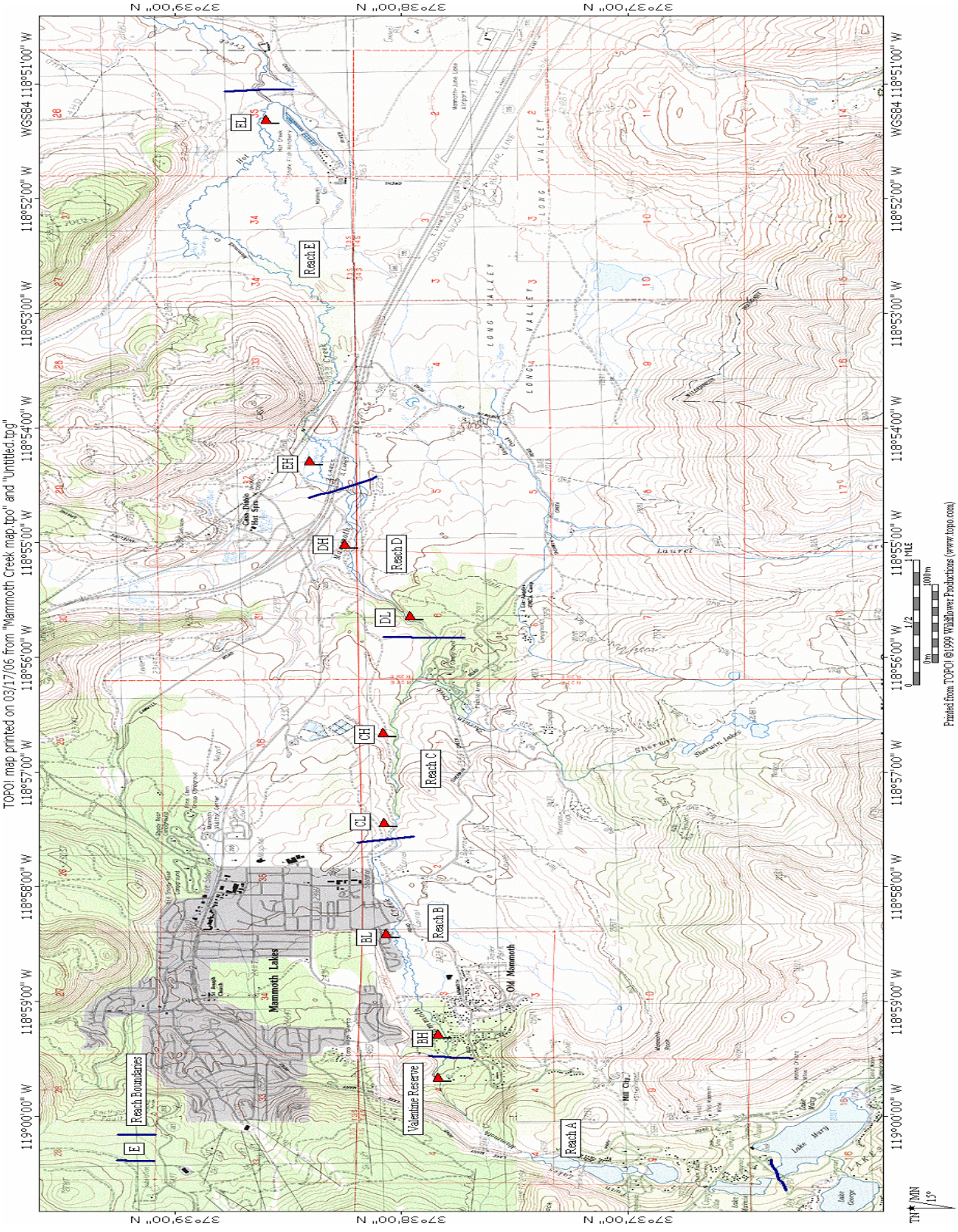

Figure 1. Electrofishing sites sampled on Mammoth Creek, September 29 through October 4, 2005. Red flags represent electrofishing site locations, blue dashes represent reach boundaries.

Electrofishing was conducted using a Smith-Root Model 12 battery powered backpack electrofisher. A four-person crew was used to capture and process fish. One person operated the electrofisher and two people, one positioned at each side of the operator, netted fish. The fourth person processed the catch while electrofishing continued.

A multiple-pass removal method of electrofishing was used for fish population estimation. Three complete passes were conducted at each sampling section. Each pass (or removal occasion) was conducted using a standardized technique to ensure equal effort.

The standardized technique included a systematic sampling approach that consisted of:

- electrofishing along the downstream block net;
- moving upstream in a recurring diagonal (acute angle) pattern from bank to bank, completely covering the area until encountering the upstream block net;
- electrofishing along the upstream block net; and,
- sampling along the downstream block net to collect any impinged fish.

Captured fish were placed in 5-gallon buckets and transferred to shore for processing. Captured fish were anesthetized (as necessary) using carbon dioxide (CO_2), identified to species, measured (to the nearest millimeter (mm) fork length (FL)), and weighed (to the nearest 0.1-gram (g) up to 10.0g and to the nearest 1g over 10g). When possible, fish of hatchery origin were identified by typical deformed and abraded fins. All possible precautions were taken to prevent stress and handling or holding mortality. Anesthetized, processed fish were immediately revived in oxygen-rich water. Processed fish were held in holding pens placed in the stream outside of the sampling area. After the completion of all removal passes, fish were returned to the general area of the stream section from which they were captured.

Data Analysis

Population Estimation

Fish numbers occurring within each sampling section were estimated with a maximum likelihood estimator (White *et al*. 1982) facilitated by use of the Microfish 2.3 software package (Van Deventer and Platts 1986). For each sampling section, the estimated total numbers of brown and presumed "wild" rainbow trout (and associated 95 percent confidence intervals) were expressed as the number of fish per stream mile. Estimated brown trout totals and 95 percent confidence intervals, expressed as the number of fish per stream mile, were summarized in a tabular format for each sampling section and visually compared between the 1992-2003 surveys. Additionally, the numbers of brown trout per stream mile in Mammoth Creek were calculated and compared among data collected by CDFG on nearby similar creeks in 1983 and 1984 (Deinstadt *et al*. 1985), and the previous consecutive year's surveys. Numbers of presumed "wild" rainbow trout per stream mile in Mammoth Creek were calculated and compared among data collected in the previous consecutive year's surveys.

Size and Age Structure

Length-frequency distributions were calculated and graphed (using 10 mm size groups) on frequency histograms to summarize body size and *inferred* age class information for all trout captured in the Mammoth Creek study area in 2004. Length-frequency (and inferred age)

distributions of brown trout were calculated for the entire creek and for each study reach. In addition, length-frequency distributions of presumed "wild" rainbow trout were calculated and graphed for fish captured throughout the entire creek.

RESULTS

Species Composition and Relative Abundance

This report assumes that native fishes in Mammoth Creek include tui chub (*Gila bicolor*) and Owen's sucker (*Catostomus fumeiventris*). Although rainbow trout (*Oncorhynchus mykiss*) are capable of reproducing, they are not considered a native species. Brown trout (*Salmo trutta*) were brought to the United States in 1883 and were introduced into trout streams in most states by the late 1800's or early 1900's (Fuller 1999). California Department of Fish and Game (CDFG) regularly stocks catchable-sized rainbow trout in Mammoth Creek.

A total of 806 fish representing four species were captured by electrofishing in Mammoth Creek from October 4, 2004 through October 8, 2004 (Table 1). Brown trout, which historically have been the dominant fish species in Mammoth Creek, continued that trend, and comprised 68.2% of the total catch. Rainbow trout accounted for 13% of the total catch. Owen's sucker comprised 15.1% of the total catch, tui chub made up 3.7% of the total catch. No brook trout (*Salvelinus fontinalis*) were captured during the 2004 survey effort. Brook trout are present in Twin Lakes and since only a few were seen in 2003, 2002, and 1993, and just at the uppermost site BH, they are assumed to be incidental sightings and occasional spillover from Twin Lakes.

One hundred and four rainbow trout were captured in the entire study area. Twenty-five of these fish (24.0%) exhibited evidence that they were of hatchery origin by virtue of abraded fins. The remaining 76.0% of rainbow trout captured were presumed to be "wild". Brown and rainbow trout were captured in all four reaches and at each of the eight sample sites. All tui chub and Owen's sucker were caught in the lowermost reach, Reach E.

Trout Population Estimation

The estimated number of brown trout captured in all sampling sections ranged from 25 fish at Site BL to 181 fish at Site BH (Table 2). Extrapolation of these numbers resulted in a range of 440 to 3,186 trout/mile. Brown trout population estimates in sites characterized by "high" riparian cover ranged from 880 brown trout/mile at Site DH up to 3,186 brown trout/mile at Site BH. The "low" riparian cover *zone* population estimates ranged from 440 brown trout/mile at site BL to 1,549 brown trout/mile at Site DL. Maximum likelihood catch statistics for brown trout in each of the eight sampling sections are presented in Appendix A.

Table 1. All fish captured by electrofishing Mammoth Creek, Mono County, California from October 4, 2004 through October 8, 2004.

			Cover		
Common Name	**Scientific Name**	**Reach**	**High**	**Low**	**Total**
Brown trout	(*Salmo trutta*)	B	163	25	**188**
		C	73	46	**119**
		D	49	87	**136**
		E	75	32	**107**
		TOTAL	**360**	**190**	**550**
Rainbow trout (presumed "wild")	(*Oncorhynchus mykiss*)	B	23	14	**37**
		C	7	2	**9**
		D	13	14	**27**
		E	5	1	**6**
		TOTAL	**48**	**31**	**79**
Rainbow trout (hatchery origin)	(*Oncorhynchus mykiss*)	B	0	0	**0**
		C	1	15	**16**
		D	2	1	**3**
		E	6	0	**6**
		TOTAL	**9**	**16**	**25**
Tui chub	(*Gila bicolor*)	B	0	0	**0**
		C	0	0	**0**
		D	0	0	**0**
		E	0	30	**30**
		TOTAL	**0**	**30**	**30**
Owens sucker	(*Catostomus fumeiventris*)	B	0	0	**0**
		C	0	0	**0**
		D	0	0	**0**
		E	0	122	**122**
		TOTAL	**0**	**122**	**122**

The estimated number of presumed "wild" rainbow trout captured in all sampling sections ranged from 1 fish at Site EL to 24 fish at Site BH (Table 2). Extrapolation of these numbers resulted in a range of 18 to 422 rainbow trout/mile. Rainbow trout population estimates in sites characterized by "high" riparian cover ranged from 88 rainbow trout/mile at Site EH up to 422 rainbow trout/mile at Site BH. The "low" riparian cover zone population estimates ranged from 18 rainbow trout/mile at Site EL to 246 rainbow trout/mile at Sites BL and DL. Maximum likelihood catch statistics for presumed "wild" rainbow trout in each of the eight sampling sections are presented in Appendix A.

Table 2. Estimated abundance[a] by sample site and extrapolated densities (trout/mile)[b] of brown and presumed "wild" rainbow trout captured by electrofishing in Mammoth Creek, Mono County, California, from October 4, 2004 through October 8, 2004.

Site	Number of brown trout	Brown trout/mile	Number of rainbow trout	Rainbow trout/mile
BH	181	3186	24	422
BL	25	440	14	246
CH	74	1302	7	123
CL	48	845	2	35
DH	50	880	13	229
DL	88	1549	14	246
EH	77	1355	5	88
EL	33	581	1	18

[a] Estimated number is generated by using a maximum-likelihood estimator based on actual catch.

[b] Trout number per stream mile extrapolated from population estimates.

Trout Length-Frequency Distribution

The following descriptions of the results excludes the results from the Valentine Reserve, which will be discussed in a separate section. The length-frequency distribution calculated for all brown trout captured during this study exhibit a multimodal distribution similar to that observed in previous years studies (Figure 2). A distinct group (66 to 120 mm FL) in the distribution was apparent for the length-group likely representing young-of-year (YOY) fish. Additional age groups within the catch were also readily apparent, representing multiple age classes present in Mammoth Creek in 2004.

For the entire brown trout population captured in 2004, there were at least three distinct age groups similar to the groupings used in previous studies (Bratovich *et al*. 1990; Hood 1998). The group of the smallest sized fish was comprised of 325 fish ranging from 66 to 114 mm FL, which represents 59.1 percent of the entire brown trout catch. Brown trout within the lower size group are most likely YOY fish. The next group included 115 fish ranging from 128 to 190 mm FL, and was probably Age I fish. The next group was comprised of 82 fish ranging from 191 to 230 mm FL, and most likely was Age II fish. Twenty-eight fish were in the 231 to 350 mm FL size range and may represent Age III fish. These results do not reflect those from the Valentine Reserve, which do not display the same multimodal distribution where the YOY represent the majority of the catch. Although ages of fish were not determined in this study, the length groups of this study correlate well with previous investigations for brown trout in East Slope Sierra Nevada streams as reported in Snider and Linden (1981).

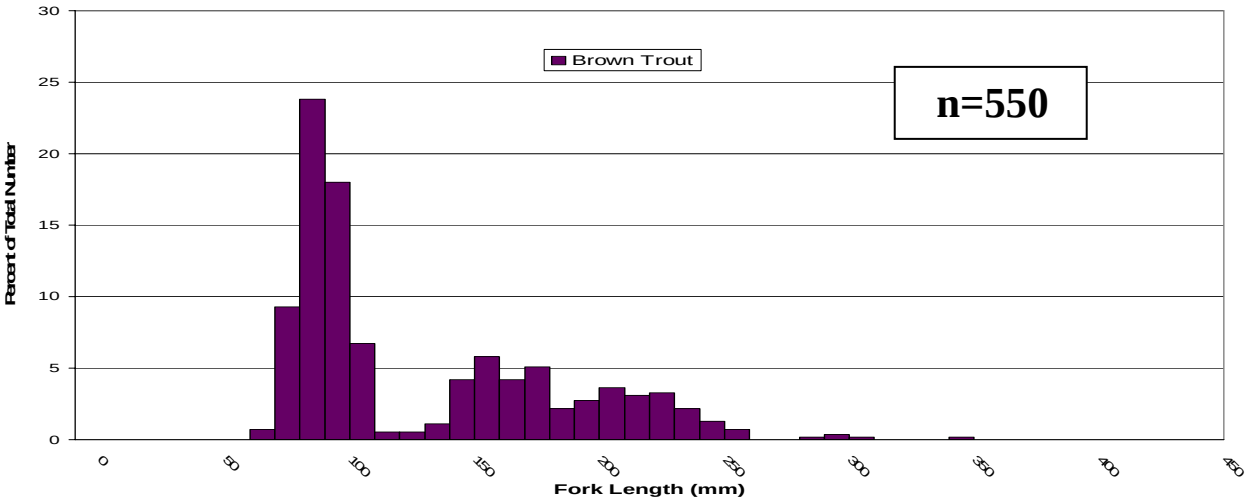

Figure 2. Length-frequency distribution of all brown trout captured at all electrofishing sites in the Mammoth Creek study area, October 4, 2004 through October 8, 2004.

Brown trout length-frequency distributions varied slightly among study reaches (Figure 3). Distinct length groups for YOY brown trout were dominant in all four reaches. YOY were most abundant in Reach B. The YOY group of fish (<120 mm FL) accounted for 75.0 percent of the total catch in Reach B and accounted for 46.6, 52.1, and 52.8 percent of the catch in Reaches C, D, and E, respectively. The Age I fish group (>120 but <179mm FL) accounted for 11.1 percent of the total catch in Reach B and was 29.7, 26.4, and 21.7 percent of the catch in Reaches C, D, and E, respectively. Large brown trout (>179 mm FL) were present in all four reaches ranging from 13.9 percent in Reach B up to 25.4 percent in Reach E.

Of the 79 presumed "wild" rainbow trout captured, 45 (57.0%) fell into the YOY size class range (< 120 mm FL) (Figure 4). Fish in this size range are not planted by CDFG in Mammoth Creek and therefore, it is believed that these trout were produced instream. CDFG plants only catchable-size trout, which is defined as about 10-14 inches or about 250-350 mm (per communications with Hot Creek Hatchery).

Valentine Reserve

The total catch consisted entirely of 198 brown trout in this reach, and the length-frequency distribution was mostly dominated by large fish (Figure 4). The group of the smallest sized fish was comprised of 64 fish ranging from 52 to 120 mm FL, and is most likely YOY fish. The next group included 74 fish ranging from 121 to 190 mm FL, and was probably Age I fish. The next group was comprised of 54 fish ranging from 192 to 228 mm FL, and most likely was Age II fish. Six fish were in the 231 to 350 mm FL size range and may represent Age III fish. This site had the greatest numbers of large fish by far compared to all the other reaches. The YOY group of fish (<120 mm FL) accounted for 32.3 percent of the total catch in the Valentine Reserve. The Age I fish group (>120 but <179mm FL) accounted for 37.4 percent, and large brown trout (>179 mm FL) represented 30.3 percent of the catch at this site. Compared to the other eight reaches, the Valentine Reserve had the lowest percentage of YOY brown trout, but also had the highest percentages of the Age I fish group and fish larger than 190 mm FL.

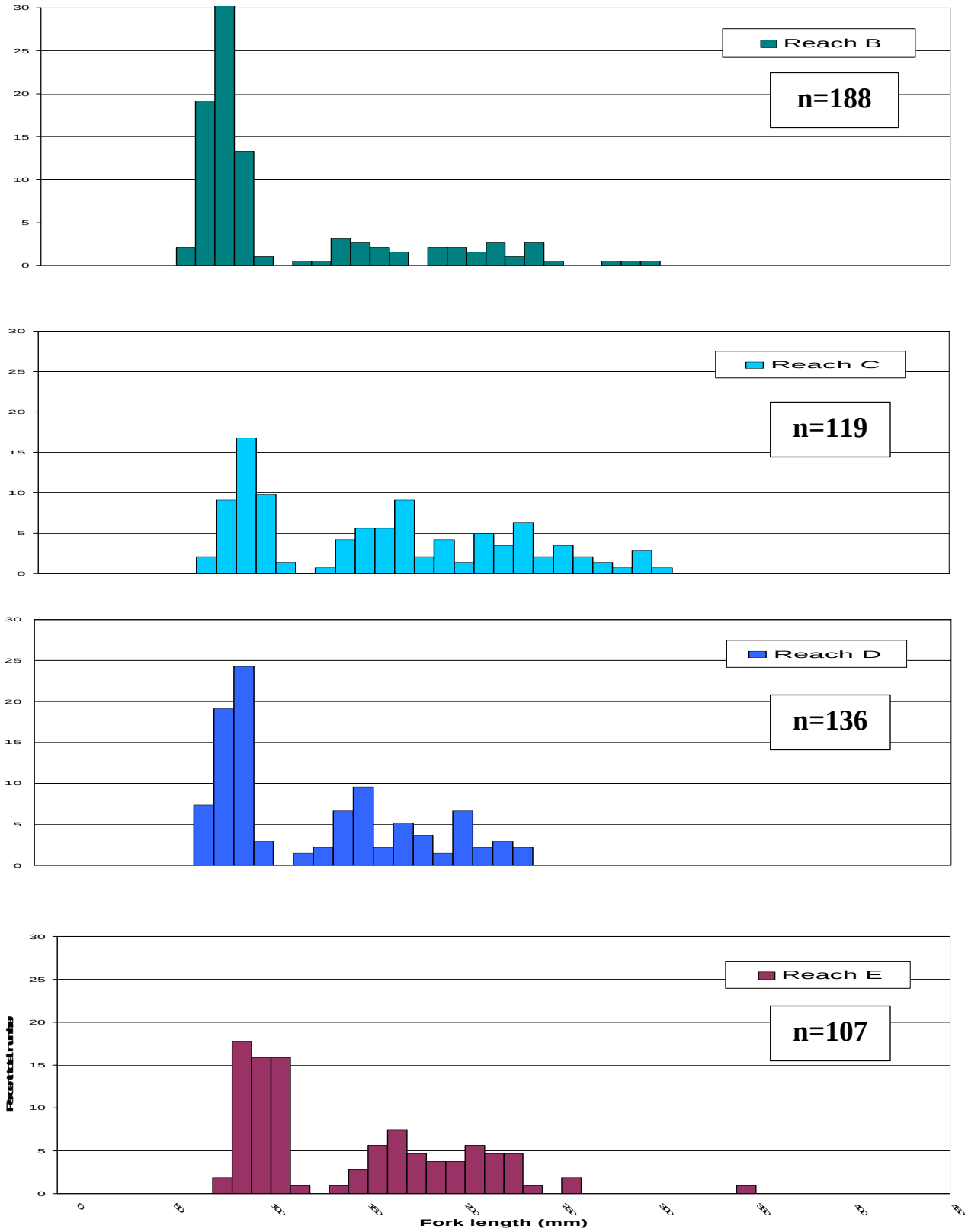

Figure 3. Length-frequency distribution of all brown trout captured in Reaches B, C, D and E in the Mammoth Creek study area, October 4, 2004 through October 8, 2004.

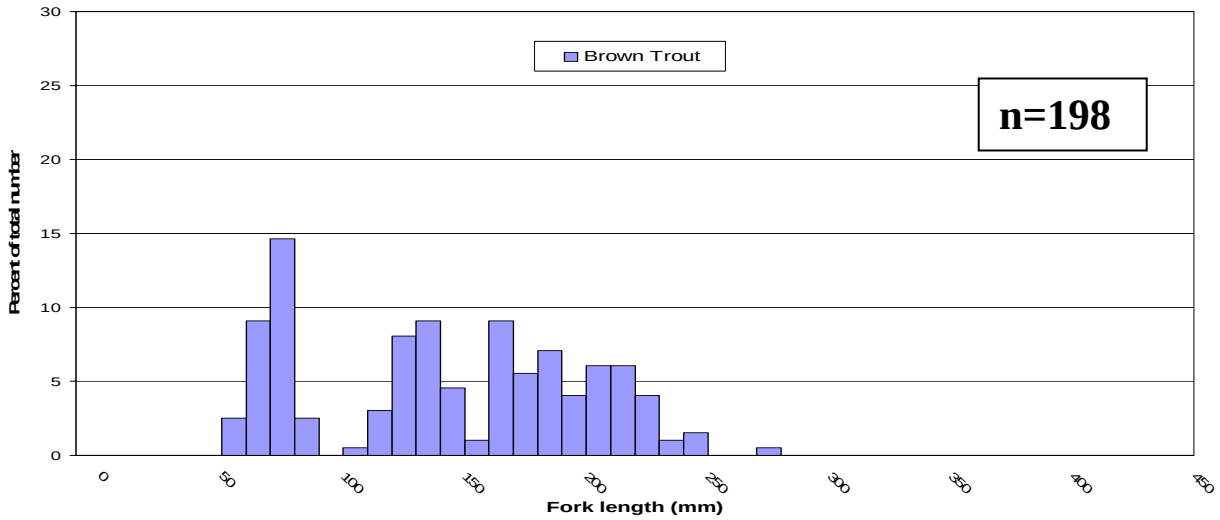

Figure 4. Length-frequency distribution of all brown trout captured in the Valentine Reserve in the Mammoth Creek study area, October 4, 2004 through October 8, 2004.

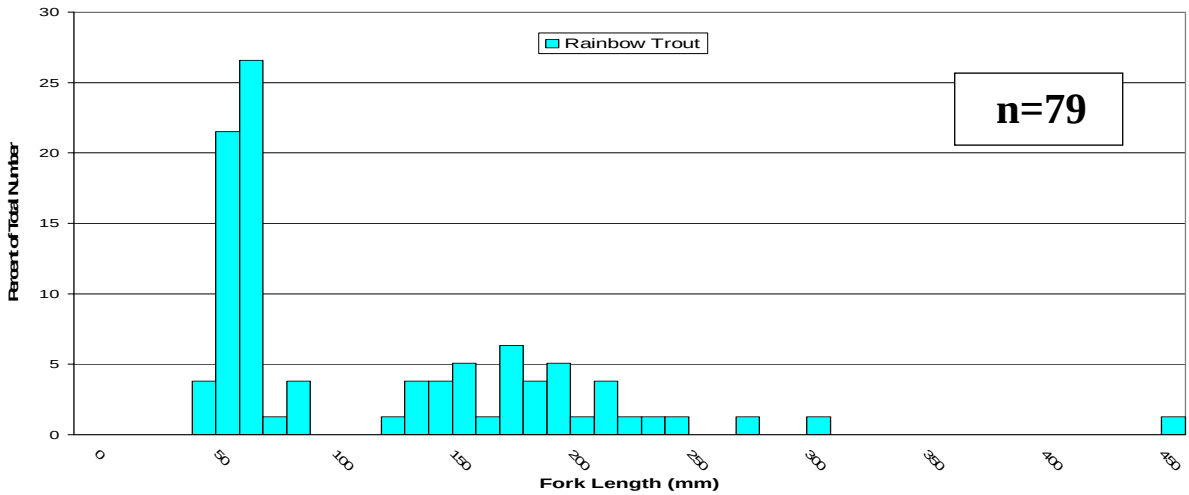

Figure 5. Length-frequency distribution of all presumed "wild" rainbow trout captured at all sites in the Mammoth Creek study area, October 4, 2004 through October 8, 2004.

DISCUSSION

Sufficient instream flow is necessary for maintaining an aquatic environment that allows for a healthy fish population both in terms of population size and the ability to maintain successful reproduction (i.e. "good condition"). Over the past seventeen years there have been fourteen similar fish community surveys conducted within Mammoth Creek (1988, 1991-2004). Trout abundance and length-frequency data collected from these studies allows us to compare the responses of the fish community to the various hydrologic conditions to which they were exposed over that same time period and make general inferences as to the "condition" of the Mammoth Creek fishery.

Relatively dry hydrologic conditions prevailed in Mammoth Creek from the late 1980's through 1992 and in 1994. In contrast, wetter conditions were predominant in 1993 and 1995-2000 with the 1995 runoff year being the wettest of the past fourteen years. The 2001-2004 water years have gone back to a dry period. The 2004 runoff pattern is most similar to 1994 because each year had a total runoff of approximately 9,000 acre-ft. Comparison of the population estimates and age structure, based on data collected before and after differing flow conditions that have occurred throughout the study period (1992-2004) in Mammoth Creek, provides an opportunity to evaluate the adequacy of the historical flows for maintaining fish populations in "good condition". However, it is only one of many factors potentially influencing population and age structure.

Results discussed in this report do not take into account other factors that may influence trout populations, including but not limited to information regarding hatchery-reared rainbow trout stocking and harvesting. Because hatchery-reared fish may increase fishing pressure, influence instream reproduction, and displace other fish species it is difficult to quantify their influence on Mammoth Creek fish populations.

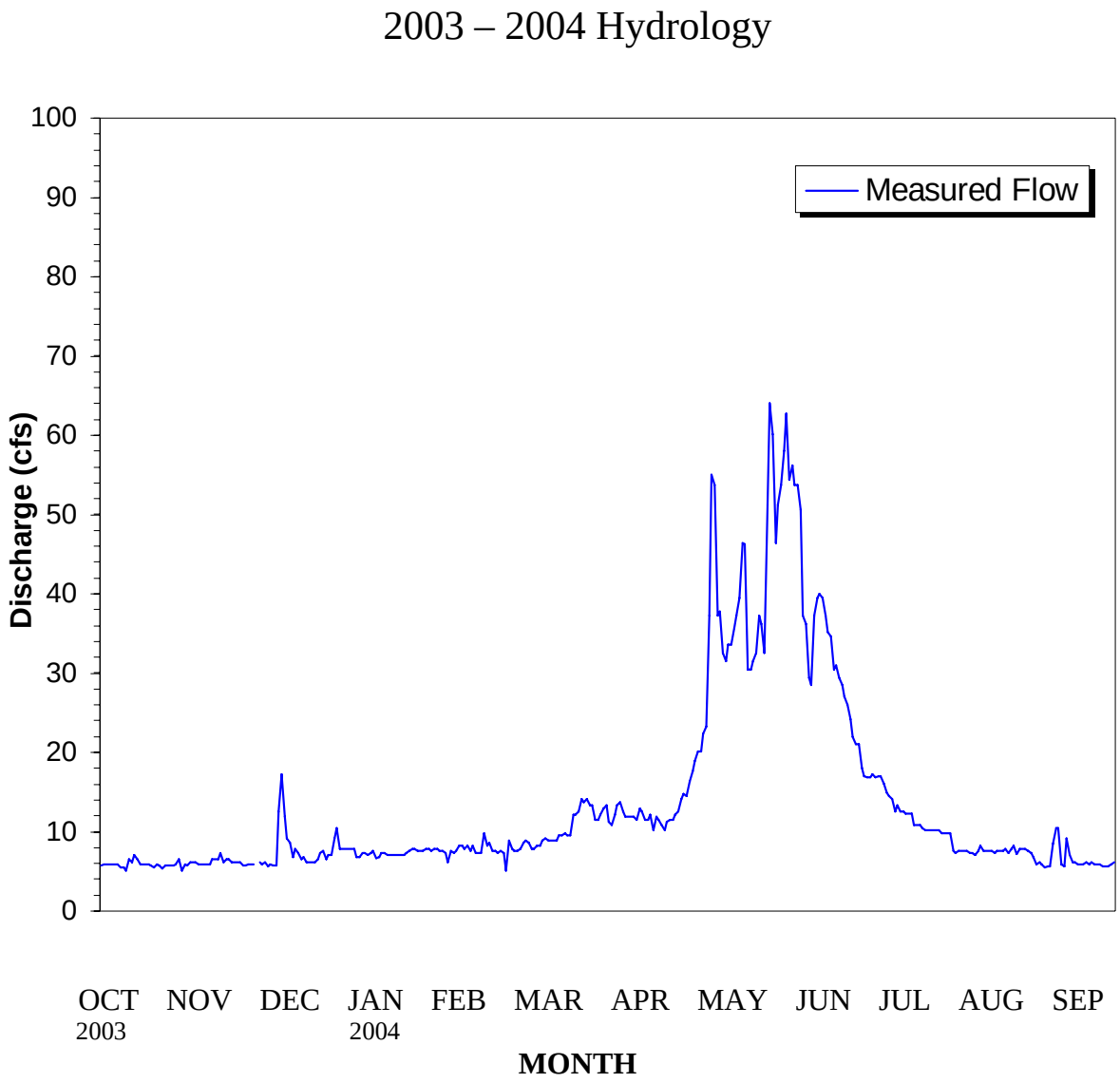

Figure 6. Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) for the twelve month period preceding the 2004 fish survey. (Data source: MCWD).

Species Composition and Relative Abundance Estimates

Native Species

The numbers of native fishes (tui chub and Owen's sucker) captured during this study were up from recent years. Thirty tui chub and one hundred and twenty-two Owen's sucker were caught in the lowermost reach. Although most of the study area does not provide the slower-moving, warmer water preferred by these species, they historically dominated the catch in Reach E through 1994 (Table 3) where the stream gradient decreases, riparian cover is minimal and cut-banks are the primary instream cover. After 1994, the sample site was moved downstream and its proximity to the confluence with Hot Creek may explain the shift in composition and abundance. Additional annual fluctuations may be attributed to water management activities of the land owner on the Chance

Meadow Ranch, which comprises approximately a three-mile long section of Mammoth Creek in Reach E.

Table 3. Total number of all tui chub and Owen's sucker captured in Reach E by electrofishing in Mammoth Creek, Mono County, California, 1992-2004.

Year	Number of Tui Chub	Number of Owen's Sucker
1992	417	205
1993	855	425
1994	392	524
1995	69	58
1996	48	84
1997	2	2
1999	6	49
2000	2	18
2001	2	6
2002	2	2
2003	19	54
2004	30	122

Rainbow Trout

The highest estimates of presumed "wild" rainbow trout were captured in Reach B (422 trout/mile). Estimated abundance of presumed "wild" rainbow trout ranged from 18 trout/mile at Site EL to 422 trout/mile at Site BH, down from the high of 669 trout/mile in 2003. As part of the CDFG's "put-and-take" planting program, Mammoth Creek is regularly stocked with hatchery-reared rainbow trout. Hatchery-origin rainbow trout were recorded at five of the eight electrofishing sites. The largest numbers of hatchery fish were captured at Site CL (15 fish) and Site EH (6 fish). Presumed "wild" rainbow trout outnumbered hatchery-origin fish by approximately three-to-one in 2004 (Table 1). In comparison with previous survey years, the presumed "wild" rainbow trout population in 2004 was below the average by approximately 40 percent (Table 4). The numbers of rainbow trout decreased from 207 trout/mile in 2003 to 176 trout/mile in 2004. When ranking survey years by total estimated population of presumed "wild" rainbow trout, the 2004 survey year ranks as the third lowest.

Brown Trout

Brown trout numbers ranged from 440 trout/mile at Site BL up to 3,186 trout/mile at Site BH. Overall, brown trout numbers were up from the 2003 survey year at three of the eight sites, however, the trout/mile numbers in 2004 are below the twelve year average at five of the eight sites (BH, BL, DH, EH and EL). There were notable declines between the 2003 survey and this year at Site CH (down 31.5%) and Site CL (down 9.4%). However, the population estimates at both these sites are the 5th and 3rd highest respectively for the 1992-2004 survey period. Conversely, while Sites BH and BL had higher estimates this year than in 2003, they also had the 4th and 2nd lowest respectfully brown trout abundances recorded throughout the 1992-2003 survey period.

Brown trout population estimates (trout/mile) for each sampling site for the 1992-2004 survey period are presented in Appendix B. Mammoth Creek remains similar to nearby creeks in terms of estimated trout abundance. CDFG estimated from 877 to 4,822 brown trout/mile for four sections in Convict Creek, and from 600 to 1,109 brown trout per mile in McGee Creek in 1983 and 1984 (Deinstadt *et al*. 1985). Note that the CDFG surveys were conducted during and following relatively wet years and the sampling design may not lend itself to proper scientific comparisons. The sites were not selected randomly and were chosen because of their accessibility by road (Jones & Stokes Associates, Mono Basin EIR, 1994).

Valentine Reach

This year was the first time that the Valentine Reserve was surveyed, and therefore there are no previous years of data to compare to. However, by comparing the length-frequency distribution to that of the other eight reaches, it is apparent that this site may have some characteristic(s) that attracts greater numbers of large brown trout. Due to the fact that this section is located on private land that has remained unaltered and is closed to fishing, it may provide better habitat and protection for fish, especially for the older, larger ones who experience more fishing pressures.

Table 4. Estimated average population densities (trout/mile) of brown and presumed "wild" rainbow trout captured by electrofishing in Mammoth Creek (1992-2004).

Year	Brown trout per mile	Rainbow trout per mile
2004	1,267	176
2003	1,303	207
2002	1,549	418
2001	1,558	379
2000	1,734	1,377
1999	1,951	530
1997	2,385	579
1996	1,379	588
1995	592	78
1994*	2,079	437
1993*	1,289	57
1992*	1,681	222

* Note: Site EL was moved from its original location in 1995.

Brown trout populations in Mammoth Creek have fluctuated throughout the twelve year period and have declined steadily since the 1997 record high numbers (Figure 6). The one anomaly to the twelve year survey period was 1995, when flows were dramatically high. It is presumed that the high flows adversely affected the fish community by flushing fish and debris downstream. The mean estimated population of brown trout in Mammoth Creek is 1,564 trout/mile over the twelve year period of this study. The 2004 estimate of 1,267 brown trout/mile is approximately 19 percent below that average.

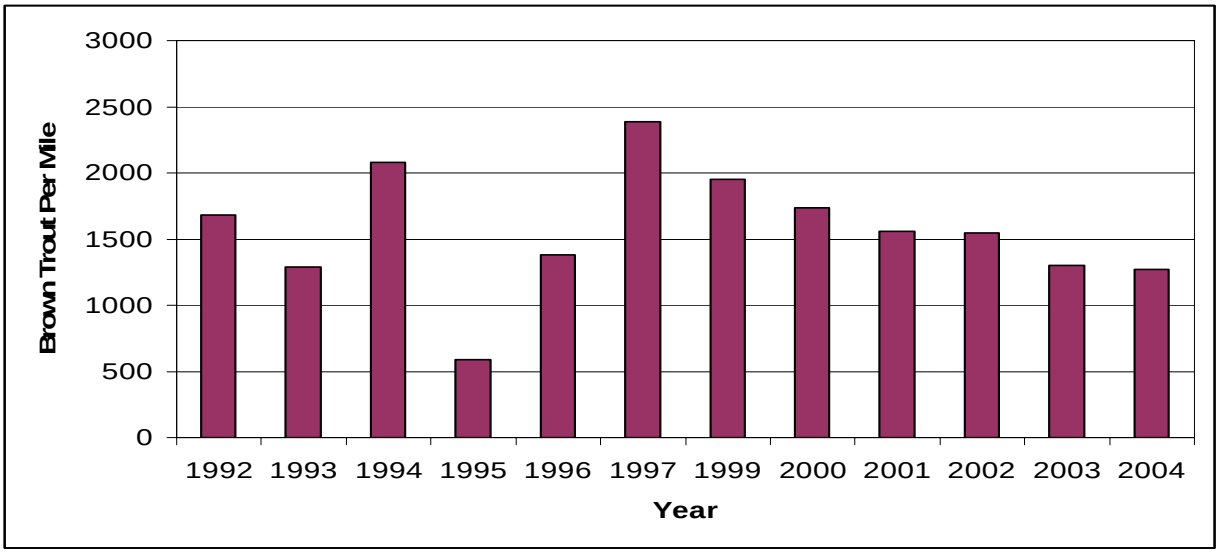

Figure 7. Estimated average population densities (trout/mile) of brown trout captured by electro-fishing in Mammoth Creek (1992-2004).

Table 5. Population estimates (trout/mile) for brown trout captured by electrofishing Mammoth Creek, Mono County, California, 1992-2004. Bold numbers indicate highest value for each site. Numbers in parenthesis indicate where the 2004 survey results ranked among the previous years.

	Sample Site							
	BH	BL	CH	CL	DH	DL	EH	EL [a]
2004	3186 (8th)	440 (11th)	1302 (5th)	845 (3rd)	880 (7th)	1549 (5th)	1355 (8th)	581 (7th)
2003	2869	458	**1901**	933	616	1426	1390	616
2002	5826	898	1056	246	563	**1672**	1866	264
2001	4717	1707	1496	246	1144	1162	1461	528
2000	6670	634	1074	88	810	1162	1179	**2253**
1999	5333	1338	1443	299	2200	616	2182	2200
1997	**8589**	704	1690	211	616	1654	3819	1795
1996	4840	158	1302	158	1901	634	898	1144
1995	1760	546	334	88	616	18	334	1038
1994	4171	2253	810	528	**4418**	1584	2464	405
1993	2957	**2658**	510	**1232**	1056	510	1232	158
1992	3045	1848	563	845	1390	1584	**3978**	194

[a] Different EL site locations were used for survey years 1992-94 and 1995-2004.

Trout Length-Frequency Distribution

In addition to population densities, the size class structure of a fish population can provide evidence of reproductive success and survival, and a general indication of a fish population's overall condition. To assess potential differences in the age structure of the brown trout population in

Mammoth Creek during the past twelve years, length-frequency data from the present study were compared to the 1992-2001 data set (Hood 2001 Figures 5a and 5b). In general, the length-frequency distribution calculated for all brown trout captured during the 2003 survey exhibited a length-frequency distribution very similar to that calculated from previous studies. YOY fish continue to make up the highest proportion of the total catch for all years sampled.

Fifty-nine percent of this year's catch was comprised of YOY fish. The highest YOY proportion was in the 1997 survey (81%) followed by 2000 (75%), 1996 (73%), 2002 (71%), 1994 and 2001 (70%), 1992 and 1999 (68%), 1993 (55%) and the lowest in 1995 (46%)[1]. Hydrologic conditions in the fall of 1993 and the spring of 1994 exhibit the most similarities to the fall of 2003/spring of 2004 conditions which most likely influence the proportion of YOY fish for the subsequent fall survey. Comparison of the catches between those two years (2,079 fish/mile in 1994 and 1,267 fish/mile in 2004) suggests that hydrologic conditions are not the only environmental factor influencing fish population. In addition to the YOY age class, at least two or more brown trout age groups were present in every reach for every year.

CONCLUSIONS

- In the early 1990s, some criteria were suggested (Hood, *et al*., 1993) for judging whether or not a trout population was in "good condition" in Mammoth Creek. These same criteria were referenced in later studies of Mammoth Creek (Jenkins and Dawson, 1997). Further definition of the term "good condition" has been reported as "…a self sustaining population of desirably-sized adult vertebrate fish which are in good physical condition, i.e.-well proportioned and disease free…Fish population should contain good numbers of different age classes and habitat for these life-stages should not be limiting." (CH2M Hill, 2000). Using these criteria, the brown and rainbow trout populations present in 2004 remain in "good condition". Additionally, Mammoth Creek appears to have sufficient habitat necessary for all trout life-stages.

- A significant reduction in the estimated brown trout population that was observed in Reach B in 2003 continues in 2004 with the estimated number only about 9 percent greater than what was observed in 2003 (which was down approximately 50 percent from 2002). Drier hydrologic conditions over the past three years may be affecting fish recruitment in the upper reach. Additionally, this section of the stream is located within the town limits of Mammoth Lakes and may be adversely and cumulatively impacted by various land use practices associated with urbanized areas.

- Trout age structure (length-frequency) information obtained from the electrofishing survey conducted in September and October 2004 suggest that both the brown and rainbow trout age distribution remains stable in Mammoth Creek. The analysis of the data shows no drastic changes in age-class distribution for the entire twelve year survey period. The high proportion of YOY fish (both brown trout and rainbow trout) suggests that the fish community of Mammoth Creek continues to successfully reproduce and provide subsequent recruitment to the population.

- It appears that the trout population in Mammoth Creek continues to endure natural annual population density variation as a result of the hydrologic conditions to which they are

[1] YOY proportion estimates are approximated using the same size class grouping for all years ($\leq$ 120 mm FL).

subjected. They have exhibited the ability to withstand and continue to recover from various uncontrollable environmental factors such as the extreme snowmelt conditions as experienced in 1995 and the drought induced low flow conditions of the early 90's. If future environmental conditions remain similar to the previous 12 fish census years, we would expect the trout populations to stay within the ranges reported.

LITERATURE CITED

Bratovich, P.M., K.L. Carlson, D.B. Christophel, and T.A. Jackson. 1992. Expert Testimony on Mammoth Creek Instream Flow Issues by Beak Consultants Incorporated Representing Mammoth County Water District. Prepared for: California State Water Resources Control Board Water Rights Hearing on Mammoth Creek, March 10, 1992.

__. 1990. Mammoth Creek Instream Flow Investigations. Prepared for: Mammoth County Water District, Mammoth Lakes, California.

CH2M Hill. 2000. Environmental Impact Report/ Environmental Impact Statement – Changes in Mammoth Creek Instream Flow Requirements, Change of Point of Measurement, and Change of Place of Use. Prepared for: Mammoth Community Water District and United States Forest Service.

Deinstadt, J.M., D.R. McEwan, and D.M. Wong. 1985. Survey of fish populations in streams of the Owen's River Drainage: 1983-84. California Department of Fish and Game, Inland Fisheries Administrative Report No. 85-2, Rancho Cordova, California.

Hood, D.J. 2002. Mammoth Creek 2001 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

___. 2001. Mammoth Creek 2000 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

___. 1998. Mammoth Creek 1997 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

Hood, D.J., P.M. Bratovich, and D.B. Christophel. 1995. Mammoth Creek 1994 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

__. 1994. Mammoth Creek 1993 Fish Community Survey. Prepared for: Mammoth County Water District, Mammoth Lakes, California.

__. 1993. Mammoth Creek 1992 Fish Community Survey. Prepared for: Mammoth County Water District, Mammoth Lakes, California.

Jenkins, T.M., Jr. 1999. Mammoth Creek 1999 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

Jenkins, T.M., Jr., and D.R. Dawson. 1997. Mammoth Creek 1996 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

__. 1996. Mammoth Creek 1995 Fish Community Survey. Prepared for: Mammoth Community Water District, Mammoth Lakes, California.

Jones and Stokes Associates. 1994. Mono Basin Environmental Impact Report. Prepared for: The State Water Resources Control Board for the Mono Basin Water Rights Hearings.

Snider, W.M. and A. Linden. 1981. Trout growth in California streams. California Department of Fish and Game, Inland Fisheries Administrative Report No. 81-1, Sacramento, California.

Van Deventer, J.S. and W.S. Platts. 1986. User's guide for Microfish 2.3. A software package for processing electrofishing data obtained by the Removal method. Forestry Sciences Laboratory, Boise, Idaho.

White, G.C., D.R. Anderson, K.P. Burnham and D.L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory Report, LA-8787NERP: 235 pp.

APPENDIX A
Maximum Likelihood Catch Statistics

Stream: **MAMMOTH CREEK-SITE BH**
Species: Brown Trout

Removal Pattern: 85 36 23 19
Total Catch = 163
Population Estimate = 181

Chi Square = 3.927
Pop Est Standard Err = 7.932
Lower Conf Interval = 165.374
Upper Conf Interval = 196.626

Capture Probability = 0.436
Capt Prob Standard Err = 0.045
Lower Conf Interval = 0.347
Upper Conf Interval = 0.525

Stream: **MAMMOTH CREEK-SITE CH**
Species: Brown Trout

Removal Pattern: 53 18 2
Total Catch = 73
Population Estimate = 74

Chi Square = 1.888
Pop Est Standard Err = 1.372
Lower Conf Interval = 73.000
Upper Conf Interval = 76.734

Capture Probability = 0.745
Capt Prob Standard Err = 0.054
Lower Conf Interval = 0.637
Upper Conf Interval = 0.853

Stream: **MAMMOTH CREEK-SITE DH**
Species: Brown Trout

Removal Pattern: 34 11 4
Total Catch = 49
Population Estimate = 50

Chi Square = 0.164
Pop Est Standard Err = 1.650
Lower Conf Interval = 49.000
Upper Conf Interval = 53.317

Capture Probability = 0.690
Capt Prob Standard Err = 0.074
Lower Conf Interval = 0.542
Upper Conf Interval = 0.838

Stream: **MAMMOTH CREEK-SITE BL**
Species: Brown Trout

Removal Pattern: 22 1 2
Total Catch = 25
Population Estimate = 25

Chi Square = 5.317
Pop Est Standard Err = 0.375
Lower Conf Interval = 25.000
Upper Conf Interval = 25.775

Capture Probability = 0.833
Capt Prob Standard Err = 0.075
Lower Conf Interval = 0.678
Upper Conf Interval = 0.988

Stream: **MAMMOTH CREEK-SITE CL**
Species: Brown Trout

Removal Pattern: 30 12 4
Total Catch = 46
Population Estimate = 48

Chi Square = 0.093
Pop Est Standard Err = 2.241
Lower Conf Interval = 46.000
Upper Conf Interval = 52.508

Capture Probability = 0.639
Capt Prob Standard Err = 0.083
Lower Conf Interval = 0.473
Upper Conf Interval = 0.805

Stream: **MAMMOTH CREEK-SITE DL**
Species: Brown Trout

Removal Pattern: 63 21 3
Total Catch = 87
Population Estimate = 88

Chi Square = 1.550
Pop Est Standard Err = 1.510
Lower Conf Interval = 87.000
Upper Conf Interval = 91.003

Capture Probability = 0.744
Capt Prob Standard Err = 0.050
Lower Conf Interval = 0.645
Upper Conf Interval = 0.843

Stream: **MAMMOTH CREEK-SITE EH**
Species: Brown Trout

Removal Pattern: 45 16 10 4
Total Catch = 75
Population Estimate = 77

Chi Square = 1.012
Pop Est Standard Err = 2.177
Lower Conf Interval = 75.000
Upper Conf Interval = 81.336

Capture Probability = 0.573
Capt Prob Standard Err = 0.058
Lower Conf Interval = 0.457
Upper Conf Interval = 0.688

Stream: **MAMMOTH CREEK-SITE EL**
Species: Brown Trout

Removal Pattern: 20 9 3
Total Catch = 32
Population Estimate = 33

Chi Square = 0.351
Pop Est Standard Err = 1.845
Lower Conf Interval = 32.000
Upper Conf Interval = 36.759

Capture Probability = 0.640
Capt Prob Standard Err = 0.099
Lower Conf Interval = 0.438
Upper Conf Interval = 0.842

The population estimate lower confidence intervals for seven of the sites were set equal to the total catches. Actual calculated lower confidence intervals (LCI) were:

Site	Calculated LCI
BL	24.22501
CH	71.26624
CL	43.49173
DH	46.68252
DL	84.99749
EH	72.66428
EL	29.24133

Stream: **MAMMOTH CREEK-SITE BH**
Species: Presumed "wild" rainbow trout

Removal Pattern: 13 5 2 3
Total Catch = 23
Population Estimate = 24

Chi Square = 2.224
Pop Est Standard Err = 1.796
Lower Conf Interval = 23.000
Upper Conf Interval = 27.717

Capture Probability = 0.511
Capt Prob Standard Err = 0.112
Lower Conf Interval = 0.280
Upper Conf Interval = 0.743

Stream: **MAMMOTH CREEK-SITE BL**
Species: Presumed "wild" rainbow trout

Removal Pattern: 9 4 1
Total Catch = 14
Population Estimate = 14

Chi Square = 0.474
Pop Est Standard Err = 0.818
Lower Conf Interval = 14.000
Upper Conf Interval = 15.767

Capture Probability = 0.700
Capt Prob Standard Err = 0.136
Lower Conf Interval = 0.406
Upper Conf Interval = 0.994

Stream: **MAMMOTH CREEK-SITE CH**
Species: Presumed "wild" rainbow trout

Removal Pattern: 6 1
Total Catch = 7
Population Estimate = 7

Chi Square = 0.076
Pop Est Standard Err = 0.429
Lower Conf Interval = 7.000
Upper Conf Interval = 8.049

Capture Probability = 0.875
Capt Prob Standard Err = 0.152
Lower Conf Interval = 0.504
Upper Conf Interval = 1.246

Stream: **MAMMOTH CREEK-SITE EH**
Species: Presumed "wild" rainbow trout

Removal Pattern: 3 1 1
Total Catch = 5
Population Estimate = 5

Chi Square = 0.760
Pop Est Standard Err = 0.787
Lower Conf Interval = 5.000
Upper Conf Interval = 7.186

Capture Probability = 0.625
Capt Prob Standard Err = 0.262
Lower Conf Interval = -.104
Upper Conf Interval = 1.354

Stream: **MAMMOTH CREEK-SITE DH**
Species: Presumed "wild" rainbow trout

Removal Pattern: 9 3 1
Total Catch = 13
Population Estimate = 13

Chi Square = 0.186
Pop Est Standard Err = 0.677
Lower Conf Interval = 13.000
Upper Conf Interval = 14.475

Capture Probability = 0.722
Capt Prob Standard Err = 0.135
Lower Conf Interval = 0.427
Upper Conf Interval = 1.017

Stream: **MAMMOTH CREEK-SITE DL**
Species: Presumed "wild" rainbow trout

Removal Pattern: 10 3 1
Total Catch = 14
Population Estimate = 14

Chi Square = 0.159
Pop Est Standard Err = 0.633
Lower Conf Interval = 14.000
Upper Conf Interval = 15.367

Capture Probability = 0.737
Capt Prob Standard Err = 0.127
Lower Conf Interval = 0.463
Upper Conf Interval = 1.010

The population estimate lower confidence intervals for six of the sites were set equal to the total catches. Actual calculated lower confidence intervals (LCI) were:

Site	Calculated LCI
BH	20.28332
BL	12.23338
CH	5.951286
DH	11.52539
DL	12.63309
EH	2.814384

APPENDIX B
Population Estimate for all Electrofishing Reaches (1992 – 2004)

Appendix B
Population Estimates for All Electrofishing Reaches from 1992 through 2004

Table B-1. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach B, Mammoth Creek, Mono County, California, 1992 through 2004.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
BH	1992	2992	3045	3128
	1993	2558	2957	3356
	1994	3915	4171	4427
	1995	1654	1760	1901
	1996	3942	4840	5738
	1997	8200	8589	8978
	1999	4789	5333	5877
	2000	6003	6670	7337
	2001	4290	4717	5144
	2002	5295	5826	6356
	2003	2526	2869	3212
	2004	2911	3186	3461
Average			**4497**	
BL	1992		1848	1895
	1993	2570	2658	2770
	1994	2235	2253	2309
	1995	528	546	616
	1996	158	158	158
	1997	669	704	788
	1999	1162	1338	1582
	2000	616	634	690
	2001	1637	1707	1814
	2002	845	898	1006
	2003	458	458	467
	2004	440	440	454
Average			**1137**	

Table B-2. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach C, Mammoth Creek, Mono County, California, 1992 through 2004.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
CH	1992	546	563	621
	1993	475	510	609
	1994	722	810	980
	1995	299	334	453
	1996	1250	1302	1390
	1997	1637	1690	1785
	1999	1426	1443	1494
	2000	1056	1074	1135
	2001	1461	1496	1571
	2002	1038	1056	1108
	2003	1672	1901	2167
	2004	1285	1302	1351
Average			**1123**	
CL	1992	827	845	906
	1993	1038	1232	1514
	1994	528	528	567
	1995	88	88	100
	1996	158	158	194
	1997	211	211	232
	1999	299	299	330
	2000	88	88	97
	2001	246	246	270
	2002	246	246	253
	2003	915	933	988
	2004	810	845	924
Average			**477**	

Table B-3. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach D, Mammoth Creek, Mono County, California, 1992 through 2004.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
DH	1992	1338	1390	1482
	1993	1056	1056	1089
	1994	4268	4418	4567
	1995	563	616	737
	1996	1778	1901	2059
	1997	546	616	771
	1999	2042	2200	2383
	2000	810	810	848
	2001	1126	1144	1201
	2002	528	563	658
	2003	598	616	678
	2004	862	880	938
Average			**1351**	
DL	1992	1584	1584	1611
	1993	510	510	551
	1994	1514	1584	1696
	1995	a	18	a
	1996	563	634	792
	1997	1619	1654	1725
	1999	598	616	678
	2000	1144	1162	1209
	2001	1091	1162	1281
	2002	1637	1672	1749
	2003	1390	1426	1498
	2004	1531	1549	1602
Average			**1131**	

[a]Due to a capture pattern of 1-0-0, estimate is assumed to be exactly correct, with no confidence limits.

Table B-4. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach E, Mammoth Creek, Mono County, California, 1992 through 2004.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
EH	1992	3925	3978	4053
	1993	1197	1232	1302
	1994	2006	2464	2929
	1995	299	334	458
	1996	810	898	1056
	1997	3749	3819	3911
	1999	2147	2182	2255
	2000	1109	1179	1109
	2001	1355	1461	1616
	2002	1813	1866	1959
	2003	1373	1390	1438
	2004	1320	1355	1432
Average			**1847**	
EL	1992	194	194	209
	1993	158	158	169
	1994	405	405	412
	1995	1038	1038	1062
	1996	1144	1144	1162
	1997	1742	1795	1880
	1999	2076	2200	2349
	2000	2094	2253	2434
	2001	528	528	546
	2002	264	264	300
	2003	616	616	623
	2004	563	581	647
Average			**931**	