MAMMOTH CREEK 2001 FISH COMMUNITY SURVEY

Prepared for:

Mammoth Community Water District
P.O. Box 597
Mammoth Lakes, California 93546

Prepared by:

KDH

P.O. Box 1107
West Point, California 95255

Final Report
June 2002

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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 monthly instream flow regimes have been recommended that are intended to sustain aquatic habitat and the fishery resources in Mammoth Creek. In addition to studies of instream flow and habitat availability conducted by the U.S. Forest Service (USFS) in 1977 and Beak Consultants Incorporated (Beak) in 1988, several fish community studies have been conducted on Mammoth Creek. Fish community surveys have been conducted by several entities including the California Department of Fish and Game (CDFG) in 1991, Beak in 1988 and 1992-1994, Sierra Nevada Aquatic Research Lab (SNARL) in 1995 and 1996, KDH Environmental Services (KDH) in 1997, Horseshoe Canyon Biological Consultants in 1999 and KDH in 2000 and 2001. These fish community surveys have allowed for evaluation of the Mammoth Creek fishery in terms of species composition, abundance, and size and age class structure. They compare population changes over time under various hydrological conditions (Hood et al. 1993, 1994, 1995; Jenkins and Dawson 1996, 1997; Hood 1998; Jenkins 1999; Hood 2000 and 2001).

This report documents the results of the 2001 fish resource assessment survey conducted from October 9 through 13, 2001. 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.

Because of the differences in the sampling methodology used by Beak in 1988 and CDFG in1991, the analyses used in this report will focus on the data set collected from the 1992-2001 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 2001 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.

Consistent with the previous eight surveys (1992-97 and 1999-2000), eight stream sections were sampled in 2001, with each 300-foot long sample site representing a "high" or "low" riparian vegetation cover *zone* within a study reach (Figure 1). The downstream boundary of the sampling sites remained the same for the 1992-2001 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 boundary of USFS land, 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. For this study we established the bottom of Site CH immediately upstream of the channel split. Although the sample sight 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 is 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.

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.

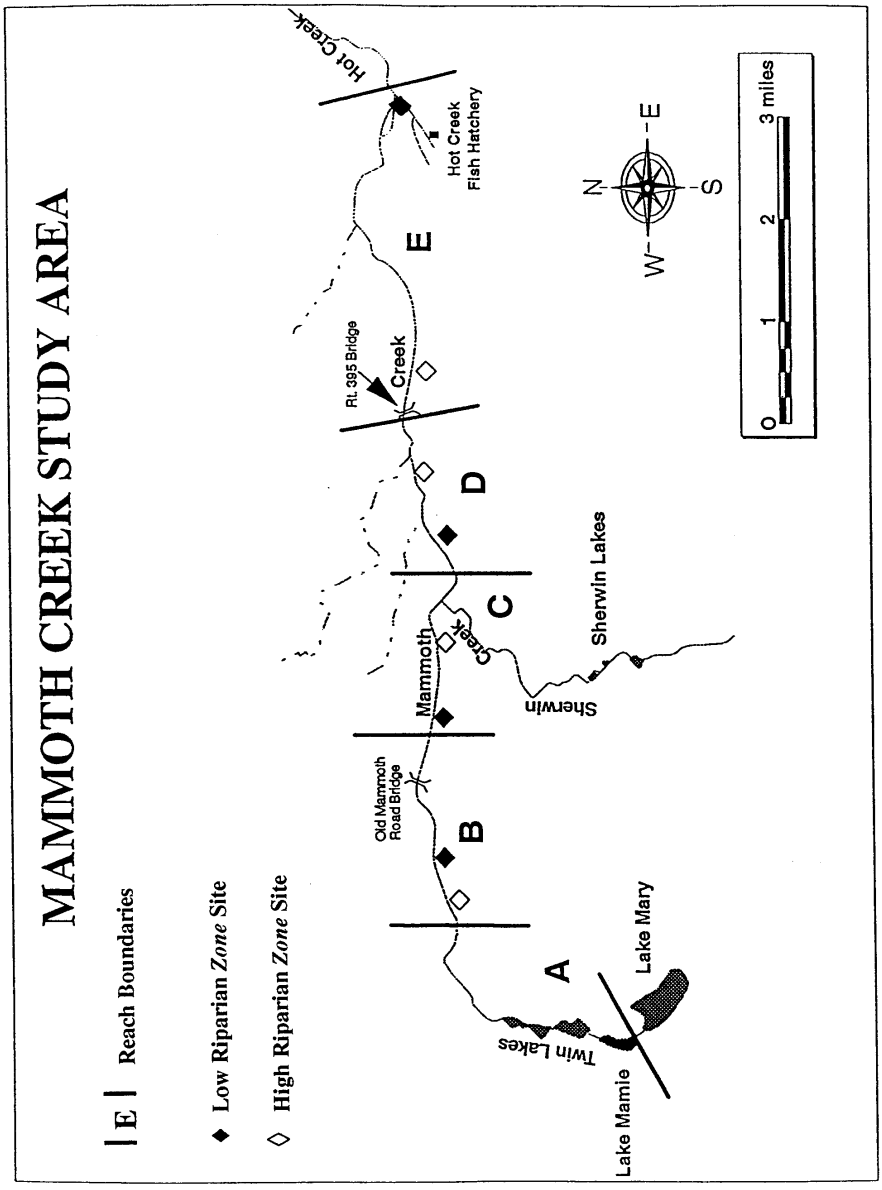


Figure 1. Locations of electrofishing sites sampled on Mammoth Creek October 9th through 13th, 2001.

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 1992-2001 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 2000. 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

A total of 886 fish representing four species were captured by electrofishing in Mammoth Creek from October 9 through 13, 2001 (Table 1). Brown trout (*Salmo trutta*), comprised 74.2% of the total catch.

Rainbow trout (*Oncorhynchus mykiss*) accounted for 24.9% of the total catch. Owens sucker (*Catostomus fumeiventris*) comprised 0.7% of the total catch and Tui chub (*Gila bicolor*) made up 0.2% of the catch.

Table 1. Number of all fish captured by electrofishing Mammoth Creek, Mono County, California from October 9 through 13, 2001.

Common Name	Scientific Name	Reach	Cover		Total
			High	Low	
Brown trout	(*Salmo trutta*)	B	234	93	327
		C	83	14	97
		D	64	62	126
		E	77	30	107
		TOTAL	458	199	657
Rainbow trout (presumed "wild")	(*Oncorhynchus mykiss*)	B	32	6	38
		C	5	40	45
		D	31	24	55
		E	25	1	26
		TOTAL	93	71	164
Rainbow trout (hatchery origin)	(*Oncorhynchus mykiss*)	B	0	1	1
		C	1	44	45
		D	4	0	4
		E	7	0	7
		TOTAL	12	45	57
Tui chub	(*Gila bicolor*)	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	2	2
		TOTAL	0	2	2
Owens sucker	(*Catostomus fumeiventris*)	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	6	6
		TOTAL	0	6	6
GRAND TOTAL					886

Two hundred and twenty-one rainbow trout were captured in the entire study area. Fifty-seven of these fish (25.8 %) exhibited evidence that they were of hatchery origin by virtue of abraded fins. The remaining 74.2% 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. Only two tui chub and six Owens suckers were captured over the entire study area. All tui chub and Owens sucker were caught in the "low" riparian cover *zone* of the lowermost reach, Reach E.

Trout Population Estimation

The estimated number of brown trout captured in all sampling sections ranged from 14 fish at Site CL to 268 fish at Site BH (Table 2). Extrapolation of these numbers resulted in a range of 246 to 4,717 trout/mile. Brown trout population estimates in sites characterized by "high" riparian cover ranged from 1,144 brown trout/mile at Site DH up to 4,717 brown trout/mile at Site BH. The "low" riparian cover *zone* population estimates ranged from 246 brown trout at Site CL to 1,707 brown trout/mile at Site BL. Maximum likelihood catch statistics for brown trout in each of the eight sampling sections are presented in Appendix A.

The estimated number of presumed "wild" rainbow trout captured in all sampling sections ranged from 1 fish at Site EL to 41 fish at Site CL (Table 2). Extrapolation of these numbers resulted in a range of 18 to 722 rainbow trout/mile. Rainbow trout population estimates in sites characterized by "high" riparian cover ranged from 88 rainbow trout/mile at Site CH up to 616 rainbow trout/mile at site BH. The "low" riparian cover zone population estimates ranged from 18 rainbow trout/mile at Site EL to 722 rainbow trout/mile at Site CL. 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 by sample site and extrapolated densities (trout/mile) of brown and presumed "wild" rainbow trout captured by electrofishing in Mammoth Creek, Mono County, California, from October 9 through 13, 2001.

Site	Number of brown trout	Brown trout/mile	Number of rainbow trout	Rainbow trout/mile
BH	268	4,717	35	616
BL	97	1,707	6	106
CH	85	1,496	5	88
CL	14	246	41	722
DH	65	1,144	32	563
DL	66	1,162	24	422
EH	83	1,461	28	493
EL	30	528	1	18

Trout Length-Frequency Distribution

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 (49 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.

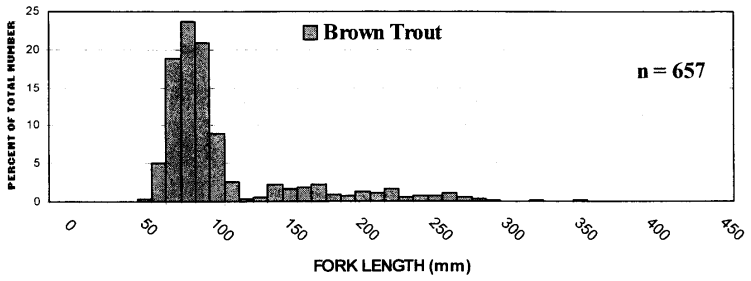


Figure 2. Length-frequency distribution of all brown trout captured at all electrofishing sites in the Mammoth Creek study area, October 9 through 13, 2001.

For the entire brown trout population captured in 2001, 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 526 fish ranging from 57 to 116 mm FL, with 61.2 percent of the fish in this group ranging from 64 to 96 mm FL. Brown trout within the lower size group are most likely YOY fish. The next group included 69 fish ranging from 115 to 180 mm FL, and was probably Age I fish. The next group was comprised of 28 fish ranging from 204 to 235 mm FL, and most likely was Age II fish. Thirteen fish were in the 264 to 299 mm FL size range and may represent Age III fish. Two fish captured may be older than Age III fish; one at 325 mm FL, and one at 360 mm FL.

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).

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 82.6 percent of the total catch in Reach B and accounted for 84.5, 77.0 and 74.8 percent of the catch in Reaches C, D, and E, respectively. The Age I fish group (>120 but ≤190mm) accounted for 8.0 percent of the total catch in Reach B and was 3.1, 19.0 and 12.1 percent of the catch in Reaches C, D, and E, respectively. Large brown trout (>190 mm FL) were present in all four Reaches ranging from 4.0 percent in Reach D up to 12.1 percent in reach E.

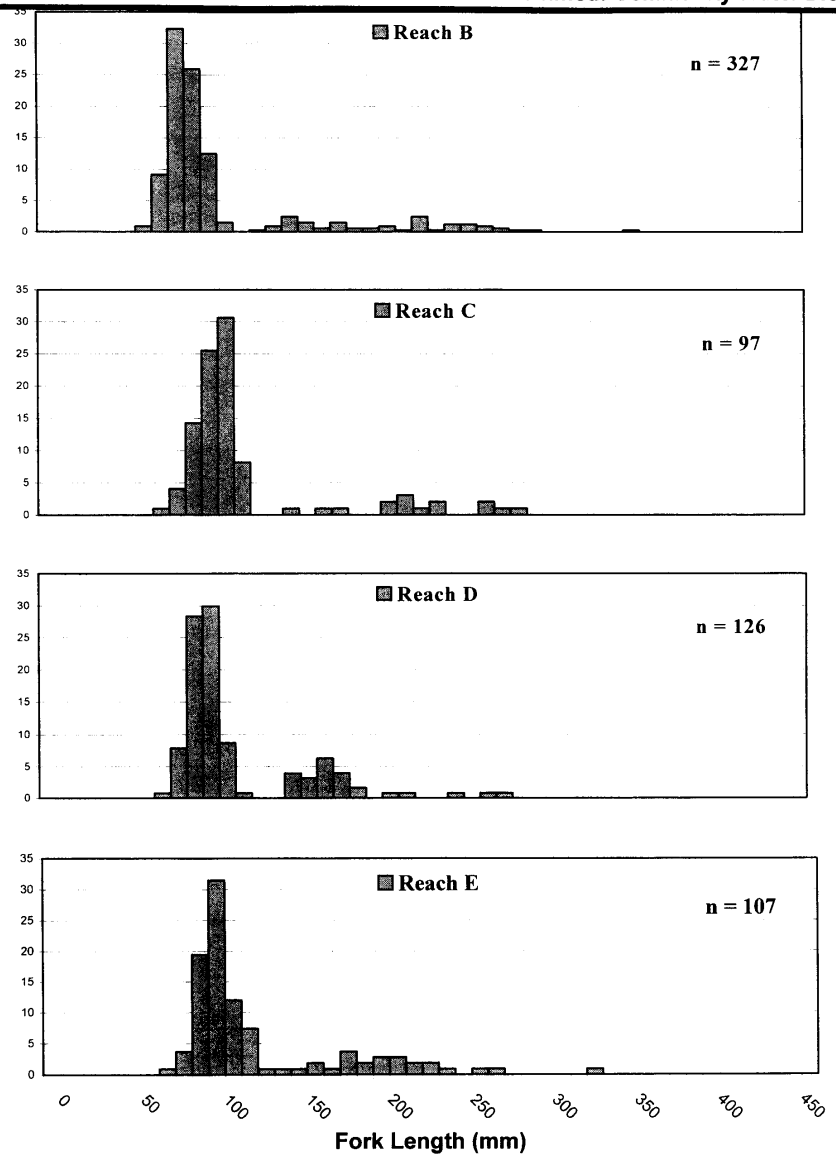


Figure 3. Length-frequency distribution of all brown trout captured in Reaches B, C, D and E in the Mammoth Creek study area, October 9 through 13, 2001.

Of the 164 presumed "wild" rainbow trout captured, 85 (51.8%) 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.

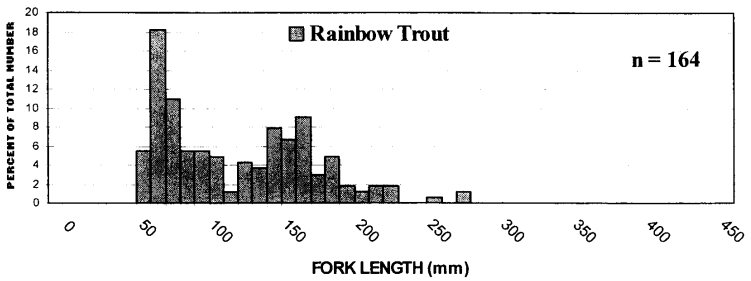


Figure 4. Length-frequency distribution of all presumed "wild" rainbow trout captured at all electrofishing sites in the Mammoth Creek study area, October 9 through 13, 2001.

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 fourteen years there have been eleven similar fish community surveys conducted within Mammoth Creek (1988, 1991-2001). 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 eleven years. The 2001 hydrologic year was relatively dry, with flows remaining below 100 cfs (Appendix B). Comparison of the population estimates and age structure, based on data collected before and after these flow conditions occurred in the creek, provides an opportunity to evaluate the adequacy of the historical flows for maintaining fish populations in "good condition".

Species Composition and Relative Abundance Estimates

Native Fishes

The numbers of native fishes (tui chub and Owens sucker) captured during this study continue to be extremely low. Only two tui chub and six Owen's sucker were caught in the lowermost reach. These

species historically dominated the catch in Reach E through 1994 (Table 3). After that year's survey, the sample site was moved downstream and it's proximity to the confluence with Hot Creek may explain the shift in composition and abundance.

Table 3. Total number of all Tui Chub and Owens Sucker captured in Reach E by electrofishing in Mammoth Creek, Mono County, California, 1992-2001.

Year	Number of Tui Chub	Number of Owens 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

Rainbow Trout

Presumed "wild" rainbow trout estimates were down in 2001 in comparison to survey year 2000. The highest estimates of presumed "wild" rainbow trout were captured in Reach CL, although numbers were significantly lower in 2001 than in 2000. Seven hundred twenty-two (722) trout/mile (24%) were estimated within Reach CL in 2001, as compared with 6,345 trout/mile in 2000. In contrast with previous survey years, however, rainbow trout were more equitably distributed among the reaches in 2001, with a range of 422 to 722 trout/mile in five of the eight study reaches. The remaining three reaches ranged from 18 to 106 trout/mile. Rainbow trout YOY (<120mm) decreased 43% from 94.8% in 2000 to 51.8% in 2001. As part of the CDFG's "put-and-take" planting program, Mammoth Creek is regularly stocked with hatchery-reared rainbow trout. Hatchery reared rainbow trout were caught at five of the eight sites. As in years past, the largest numbers of those fish were found at sites CL (44 fish) and EH (7 fish).

Brown Trout

Brown trout abundance (estimated number of fish/mile) was the fourth highest recorded (1,558 fish/mile) for the 1992-2001 survey period (Table 4). Brown trout population estimates (trout/mile) for each sampling site for the 1992-2001 survey period are presented in Tables 5a-d. Average densities compare well with studies conducted previously in nearby creeks. CDFG estimated from 877 to 4,822 brown trout per mile for four sections in Convict Creek, and from 600 to 1,109 brown trout per mile in McGee Creek (Deinstadt *et al.* 1985).

Table 4. Estimated average population densities (trout/mile) of brown and presumed "wild" rainbow trout captured by electrofishing in Mammoth Creek (1992-2001) and total annual runoff measured at the MCWD gage for the period October through September preceding the fish sampling. Numbers in parenthesis exclude data from Site EL for 1995-2001, a different site then sampled in 1992-1994.

Year	Brown trout per mile	Rainbow trout per mile	Runoff[a] (acre-feet)
2001	1,558 (1,705)	379 (430)	
2000	1,734 (1,484)	1,377 (1,466)	
1999	1,951 (1,916)	530 (578)	19,564
1997	2,385 (2,469)	579 (649)	19,280
1996	1,379 (1,413)	588 (591)	22,031
1995	592 (528)	78 (61)	28,663
1994	2,079	437	8,902
1993	1,289	57	17,305
1992	1,681	222	6,703

A comparison of brown trout densities by sampling site between the 2001 study and those of previous survey years finds that brown trout densities increased within all sites except two; BH and EL (Tables 5a-d). The 2001 brown trout estimate at site DL was the same as that in 2000. The estimate of trout/mile at site BH was down approximately 30% from the 2000 study, however, it remains within the range of average densities recorded at that site over the nine-year study period. In contrast, brown trout densities at site EL were down significantly (approximately 77%) from the 2000 study. The 2001 study is the first record of decline in trout/mile estimates at site EL since 1992. In addition, the estimate is only about 50% of the range of average densities recorded at that site over the nine-year study period. Brown trout numbers rebounded from the low 2000 survey numbers although brown trout are still outnumbered by rainbow trout in that reach, presumably as a result of trout stocking in this area. As documented in previous reports, site CL is easily accessible to the public and therefore recreational fishing pressure in this area appears to be higher than at any of the other seven sample sites. Brown trout at sample site CL may be displaced by the larger hatchery fish, and/or, brown trout densities are being reduced by increased angler harvest in the area.

Although hydrologic conditions appear to have declined over the 2000-2001 water year (Appendix B), brown trout and rainbow trout densities do not seem to have been drastically affected. Over the nine-year fish community survey, only two water-years (1992 and 1994), have had lower flows than in 2001. Comparison of Mammoth Creek hydrology between this past water year and the flow conditions over previous years reveals conditions most similar to 1991 (Appendix B).

Table 5a. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach B, Mammoth Creek, Mono County, California, 1992 through 2001.

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
BL	1992	1830	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

Table 5b. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach C, Mammoth Creek, Mono County, California, 1992 through 2001.

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
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

Table 5c. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach D, Mammoth Creek, Mono County, California, 1992 through 2001.

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
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

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

Table 5d. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach E, Mammoth Creek, Mono County, California, 1992 through 2001.

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
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

Table 6. Population estimates (trout/mile) for brown trout captured by electrofishing Mammoth Creek, Mono County, California, 1992-2001. Bold numbers indicate highest value for each site. Numbers in parenthesis indicate where the 2001 survey results ranked among the previous years.

	Sample Site							
	BH	BL	CH	CL	DH	DL	EH	EL [a]
2001	4717(5^{th})	1707(4^{th})	1496(2^{nd})	246(5^{th})	1144(5^{th})	1162($tie4^{th}$)	1461(5^{th})	528(5^{th})
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 1995-2001.

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 nine years, length-frequency data from the present study were compared to the 1992-2000 data set (Figures 5a and 5b). In general, the length-frequency distribution calculated for all brown trout captured during the 2001 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.

The percentage of YOY fish in 2001 tied that estimated for survey year 1994. Seventy 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%), 1994 (70%), 1999 (68%), 1992 (68%), 1993 (55%) and the lowest in 1995 (46%)[1]. Water years 1992, 1994 and 2001 resulted in similar flows in Mammoth Creek. Those same years exhibit similar estimates of YOY trout, linking the hydrologic conditions of the creek to trout rearing potential. In addition to the YOY age class, at least two or more brown trout age groups were present in every reach for every year (Figures 5a and 5b).

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

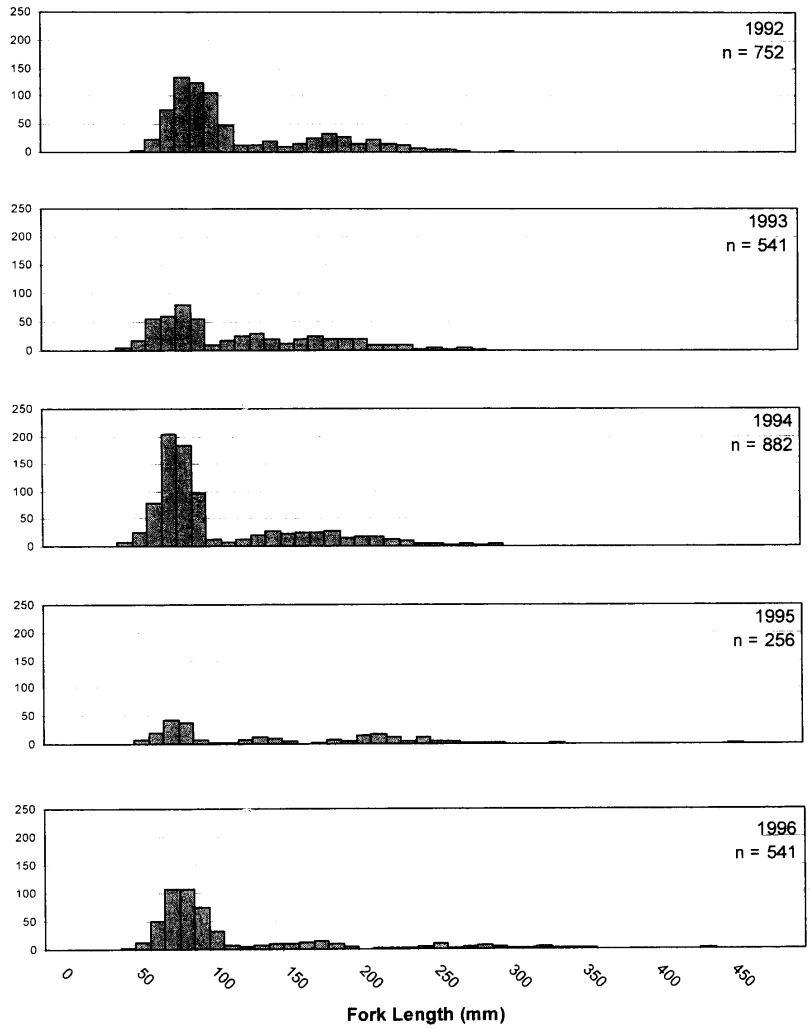


Figure 5a. Length-frequency distribution of all brown trout captured in Mammoth Creek, 1992-1996.

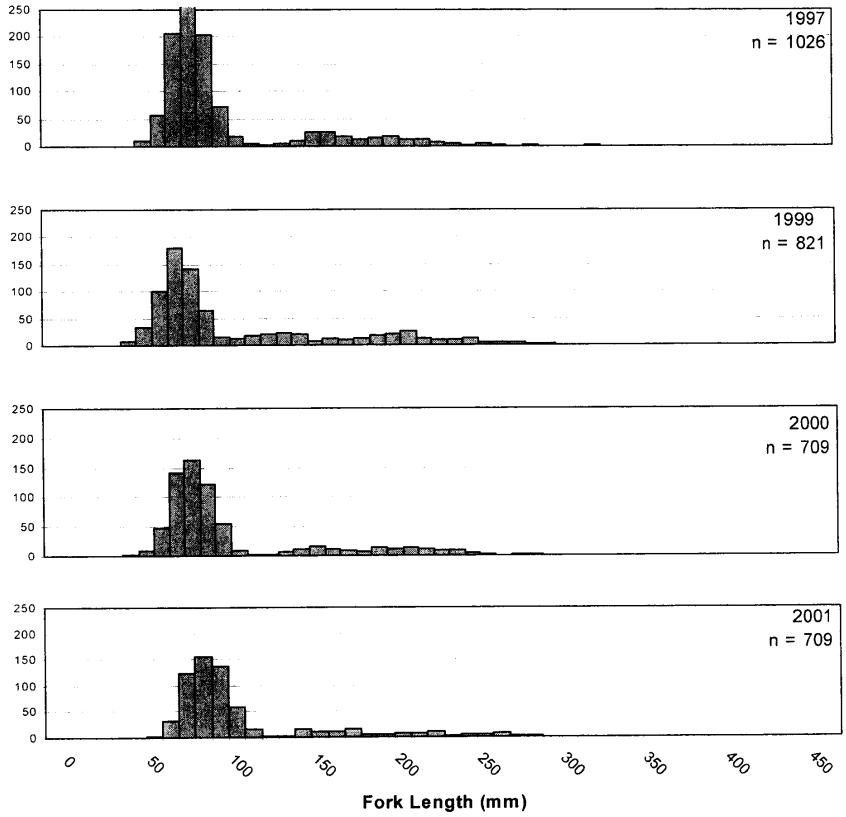


Figure 5b. Length-frequency distribution of all brown trout captured in Mammoth Creek, 1997, 1999, 2000 and 2001.

CONCLUSIONS

- Trout density and age structure (length-frequency) information obtained from the electrofishing survey conducted in October 2001 suggest that both the brown and rainbow trout populations in Mammoth Creek remain in good condition. Analysis of the data shows no drastic changes in the fish community's overall numbers or age-class distribution. 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 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.

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.

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

Hood, D.J. 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.

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: 133 66 35
Total Catch = 234
Population Estimate = 268

Chi Square = 0.059
Pop Est Standard Err = 12.312
Lower Conf Interval = 243.746
Upper Conf Interval = 292.254

Capture Probability = 0.496
Capt Prob Standard Err = 0.045
Lower Conf Interval = 0.407
Upper Conf Interval = 0.585

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

Removal Pattern: 64 19 10
Total Catch = 93
Population Estimate = 97

Chi Square = 1.072
Pop Est Standard Err = 3.051
Lower Conf Interval = 93.000
Upper Conf Interval = 103.057

Capture Probability = 0.646
Capt Prob Standard Err = 0.057
Lower Conf Interval = 0.532
Upper Conf Interval = 0.760

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

Removal Pattern: 58 19 6
Total Catch = 83
Population Estimate = 85

Chi Square = 0.086
Pop Est Standard Err = 2.130
Lower Conf Interval = 83.000
Upper Conf Interval = 89.237

Capture Probability = 0.692
Capt Prob Standard Err = 0.056
Lower Conf Interval = 0.580
Upper Conf Interval = 0.803

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

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

Removal Pattern: 46 13 5
Total Catch = 64
Population Estimate = 65

Chi Square = 0.354
Pop Est Standard Err = 1.634
Lower Conf Interval = 64.000
Upper Conf Interval = 68.265

Capture Probability = 0.711
Capt Prob Standard Err = 0.062
Lower Conf Interval = 0.587
Upper Conf Interval = 0.835

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

Removal Pattern: 40 14 8
Total Catch = 62
Population Estimate = 66

Chi Square = 0.628
Pop Est Standard Err = 3.402
Lower Conf Interval = 62.000
Upper Conf Interval = 72.796

Capture Probability = 0.596
Capt Prob Standard Err = 0.076
Lower Conf Interval = 0.444
Upper Conf Interval = 0.748

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

Removal Pattern: 47 20 10
Total Catch = 77
Population Estimate = 83

Chi Square = 0.195
Pop Est Standard Err = 4.441
Lower Conf Interval = 77.000
Upper Conf Interval = 91.833

Capture Probability = 0.570
Capt Prob Standard Err = 0.071
Lower Conf Interval = 0.429
Upper Conf Interval = 0.712

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

Removal Pattern: 25 3 2
Total Catch = 30
Population Estimate = 30

Chi Square = 2.043
Pop Est Standard Err = 0.510
Lower Conf Interval = 30.000
Upper Conf Interval = 31.044

Capture Probability = 0.811
Capt Prob Standard Err = 0.073
Lower Conf Interval = 0.662
Upper Conf Interval = 0.960

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	90.94306
CH	80.76267
CL	12.63309
DH	61.73453
DL	59.20364
EH	74.16658
EL	28.95637

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

Removal Pattern: 18 10 4
Total Catch = 32
Population Estimate = 35

Chi Square = 0.253
Pop Est Standard Err = 3.395
Lower Conf Interval = 32.000
Upper Conf Interval = 41.900

Capture Probability = 0.542
Capt Prob Standard Err = 0.115
Lower Conf Interval = 0.309
Upper Conf Interval = 0.776

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

Removal Pattern: 4 2 0
Total Catch = 6
Population Estimate = 6

Chi Square = 1.019
Pop Est Standard Err = 0.376
Lower Conf Interval = 6.000
Upper Conf Interval = 6.967

Capture Probability = 0.750
Capt Prob Standard Err = 0.188
Lower Conf Interval = 0.267
Upper Conf Interval = 1.233

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

Removal Pattern: 27 8 5
Total Catch = 40
Population Estimate = 41

Chi Square = 1.215
Pop Est Standard Err = 1.865
Lower Conf Interval = 40.000
Upper Conf Interval = 44.769

Capture Probability = 0.656
Capt Prob Standard Err = 0.087
Lower Conf Interval = 0.481
Upper Conf Interval = 0.831

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

Removal Pattern: 18 5 1
Total Catch = 24
Population Estimate = 24

Chi Square = 0.178
Pop Est Standard Err = 0.624
Lower Conf Interval = 24.000
Upper Conf Interval = 25.291

Capture Probability = 0.774
Capt Prob Standard Err = 0.089
Lower Conf Interval = 0.590
Upper Conf Interval = 0.959

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

Removal Pattern: 21 6 4
Total Catch = 31
Population Estimate = 32

Chi Square = 1.013
Pop Est Standard Err = 1.753
Lower Conf Interval = 31.000
Upper Conf Interval = 35.575

Capture Probability = 0.646
Capt Prob Standard Err = 0.100
Lower Conf Interval = 0.442
Upper Conf Interval = 0.850

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

Removal Pattern: 12 10 3
Total Catch = 25
Population Estimate = 28

Chi Square = 1.653
Pop Est Standard Err = 3.883
Lower Conf Interval = 25.000
Upper Conf Interval = 35.968

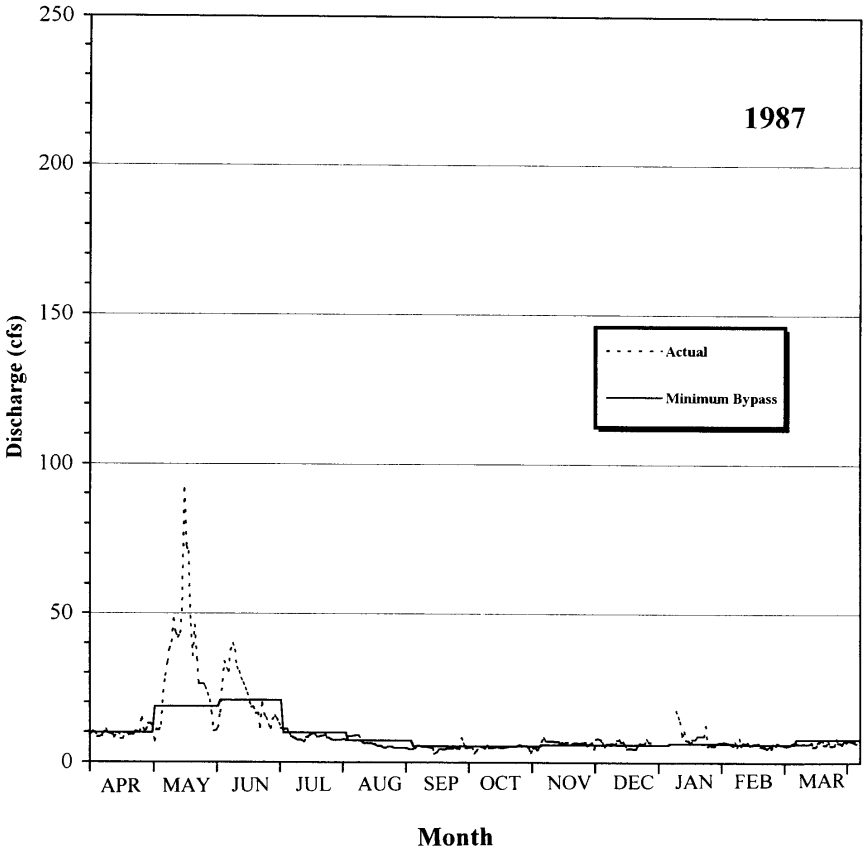
Capture Probability = 0.500
Capt Prob Standard Err = 0.139
Lower Conf Interval = 0.215
Upper Conf Interval = 0.785

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:

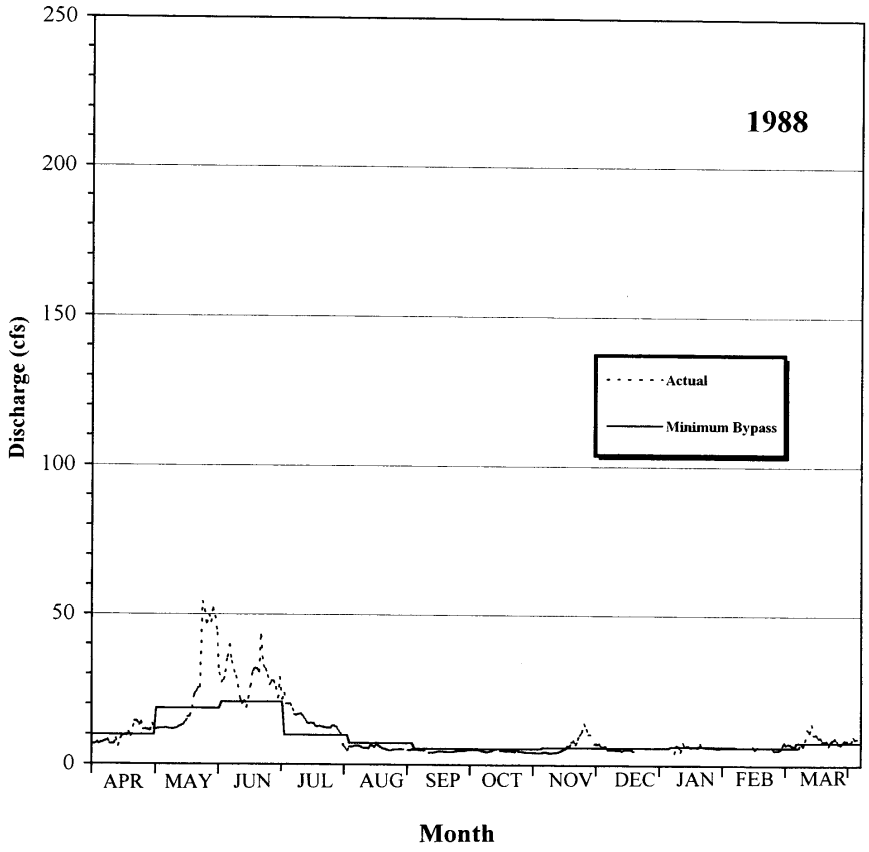
Site	Calculated LCI
BH	28.10045
BL	5.033174
CL	37.23121
DH	28.4247
DL	22.70946
EH	20.03229

The presumed "wild" rainbow trout removal pattern for sample site CH was 5-0-0 and for sample site EL was 0-1-0. Microfish software cannot calculate confidence intervals for these results. Therefore, the estimated population for site CH is five and for site EL is one.

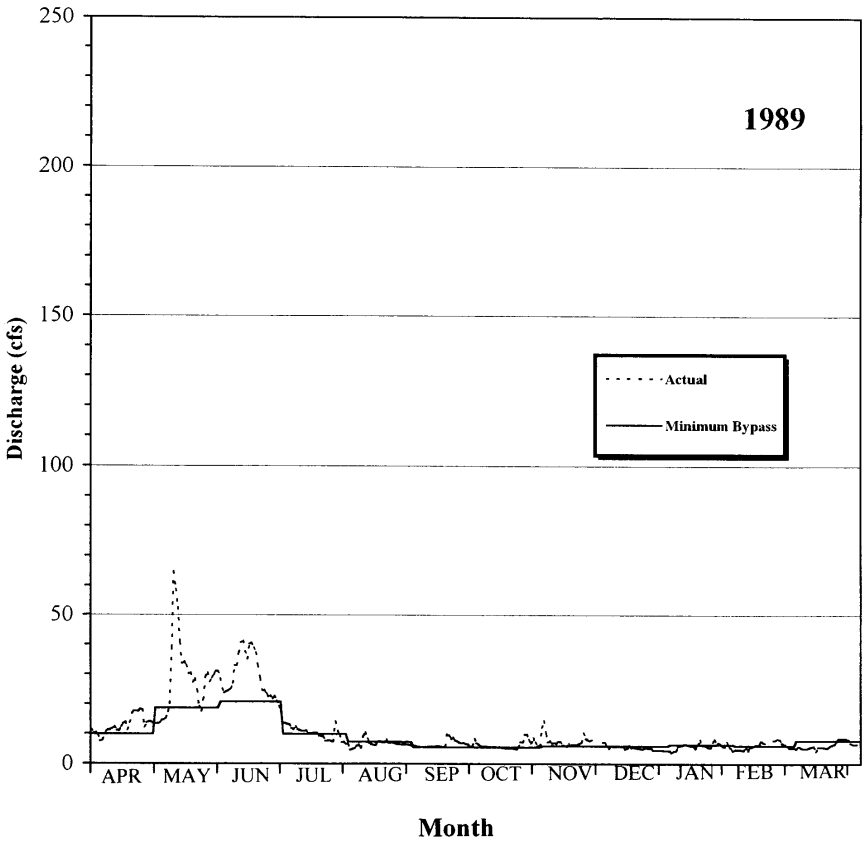
APPENDIX B
Mammoth Creek Hydrographs (1987-2001)



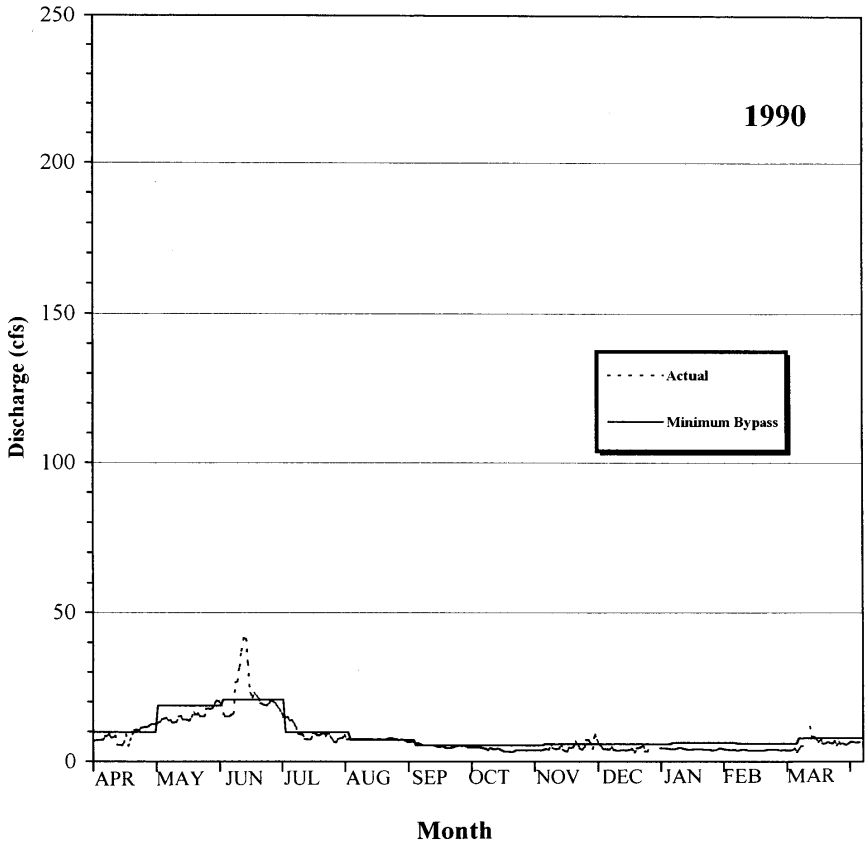
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1987, and the recommended operational minimum mean daily bypass regime.



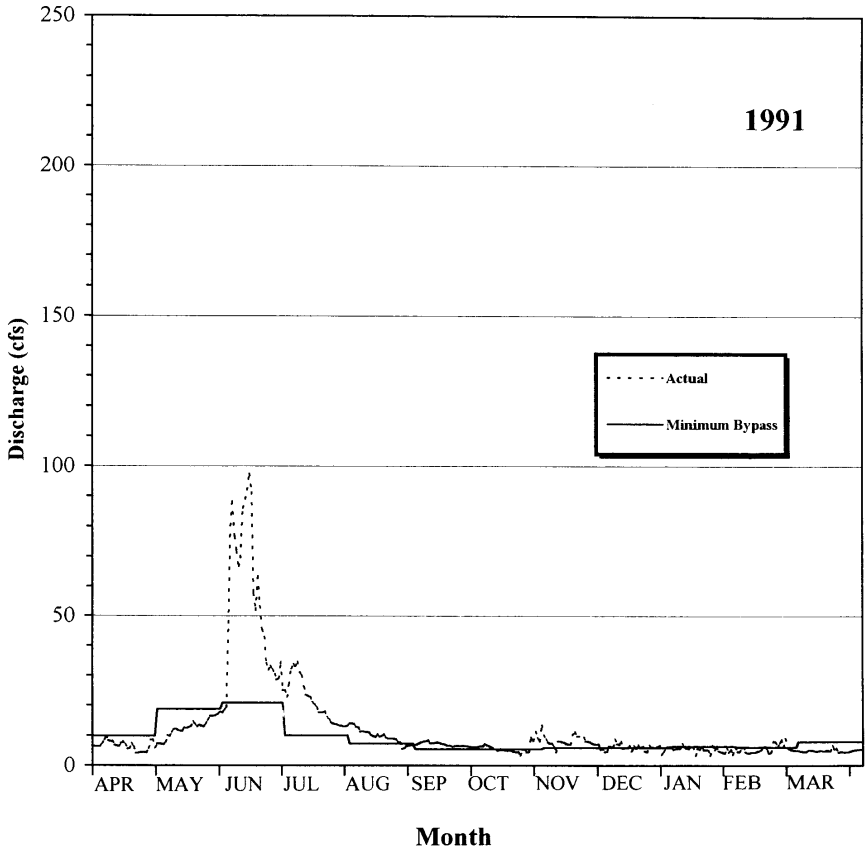
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1988, and the recommended operational minimum mean daily bypass regime.



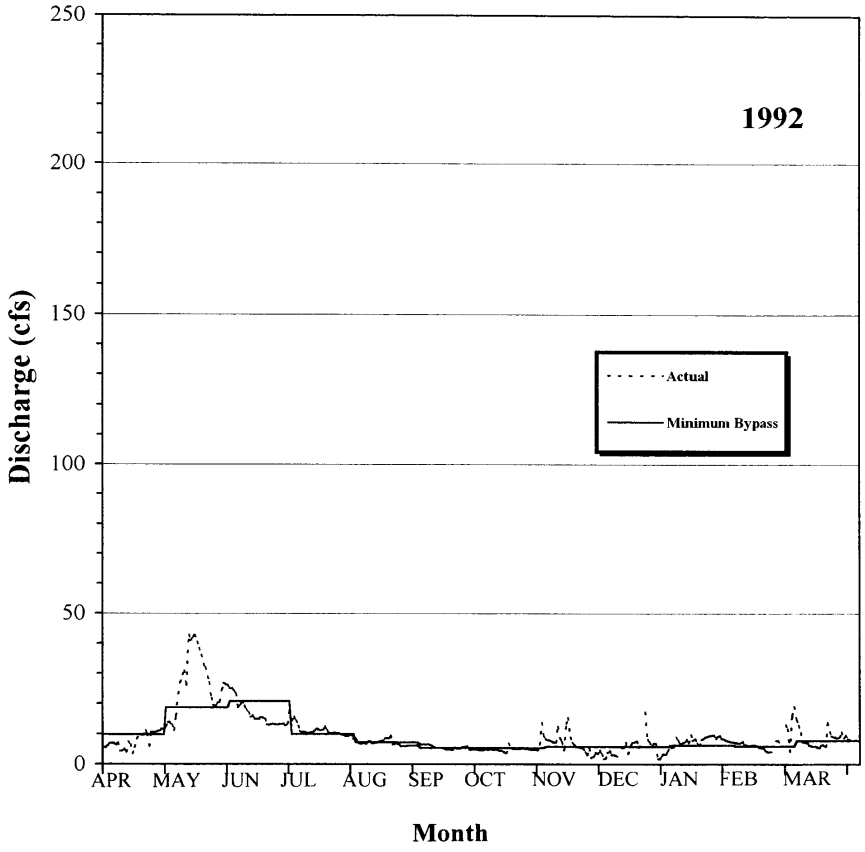
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1989, and the recommended operational minimum mean daily bypass regime.



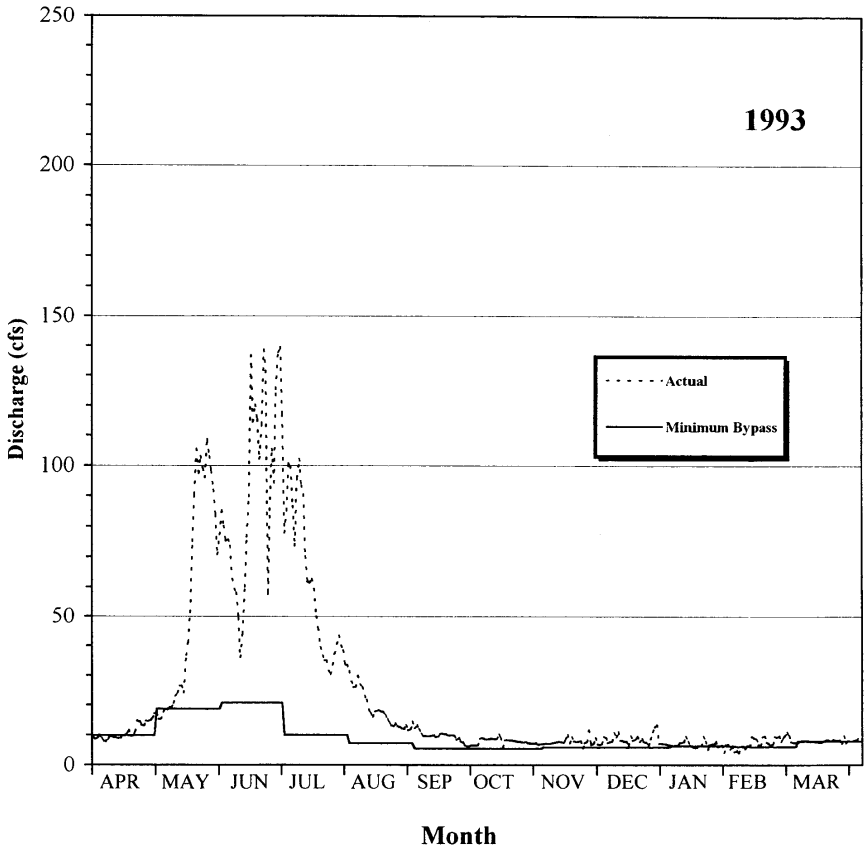
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1990, and the recommended operational minimum mean daily bypass regime.



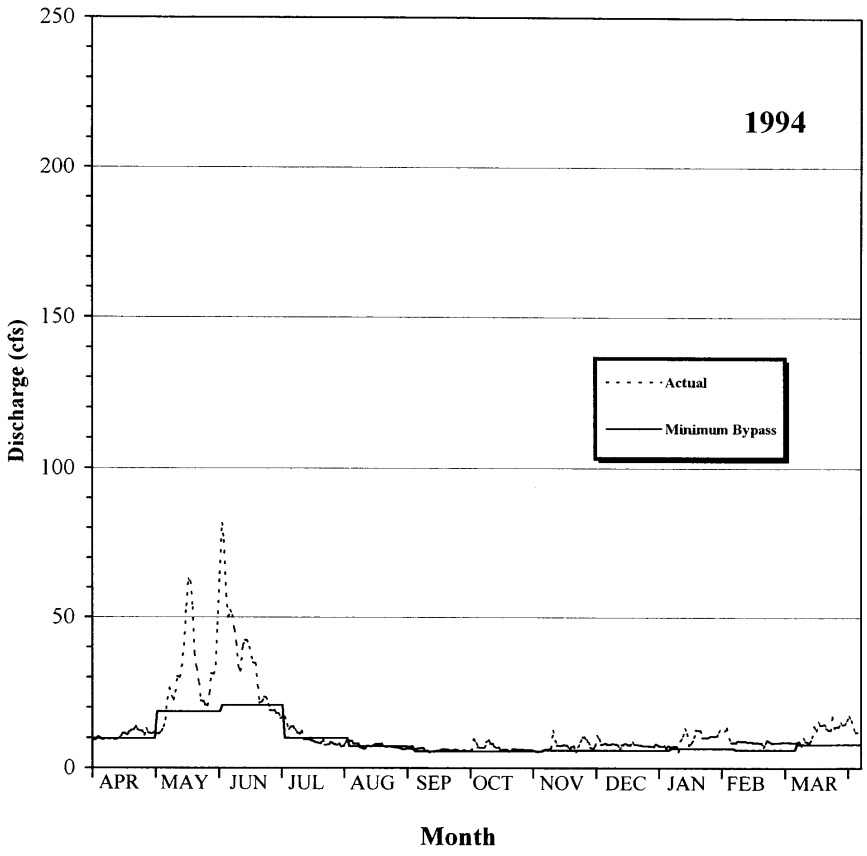
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1991, and the recommended operational minimum mean daily bypass regime.



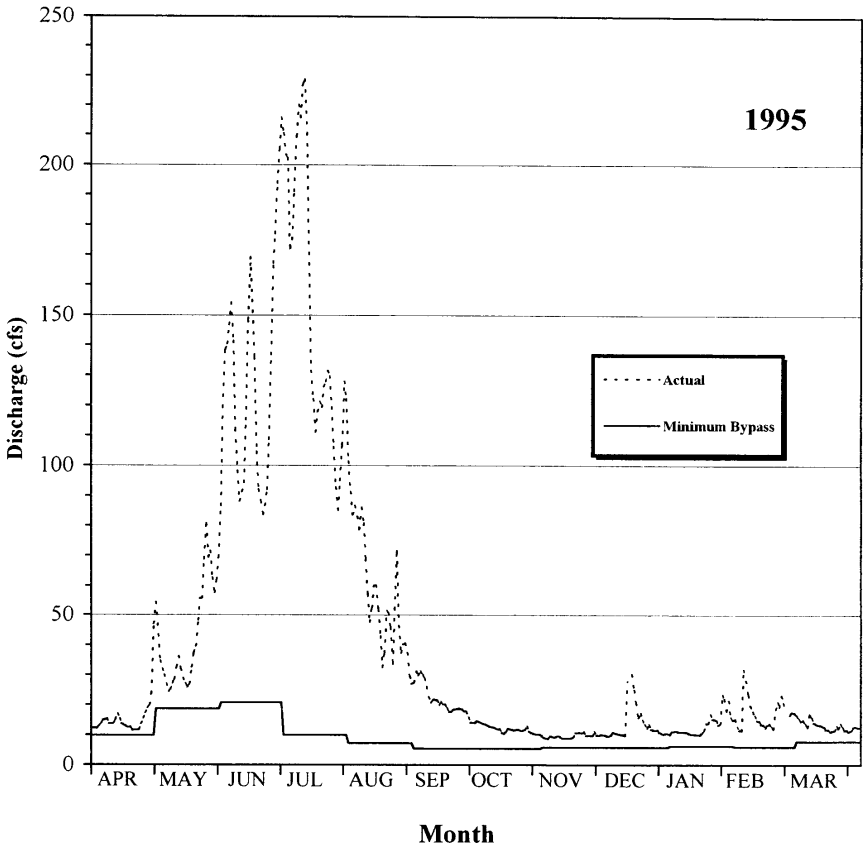
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1992, and the recommended operational minimum mean daily bypass regime.



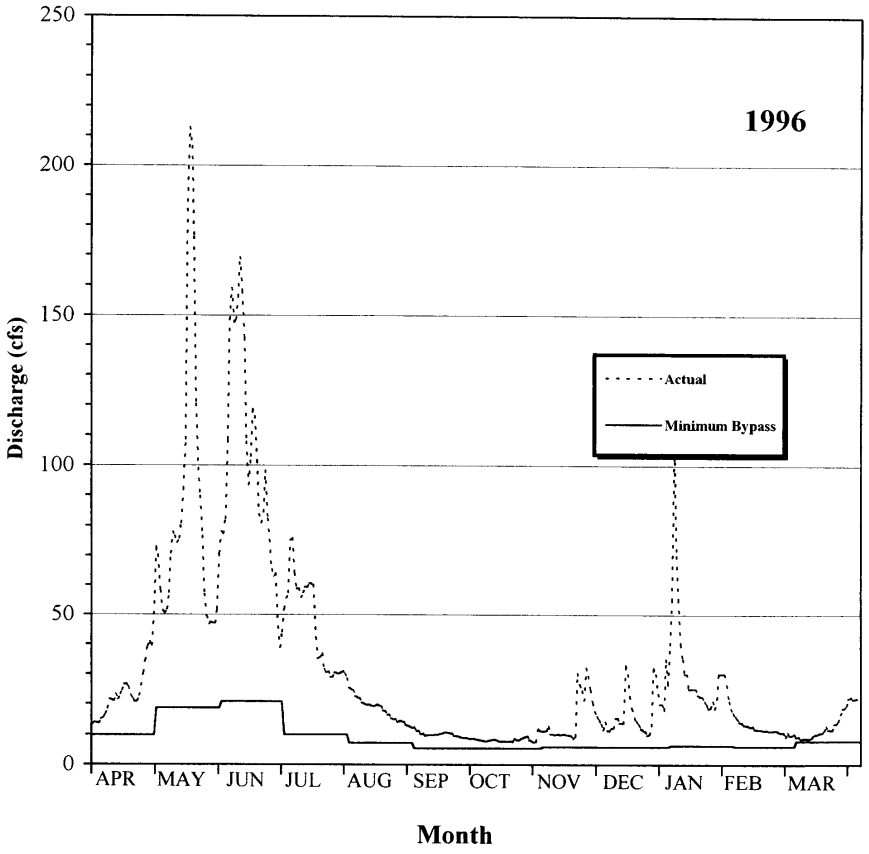
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1993, and the recommended operational minimum mean daily bypass regime.



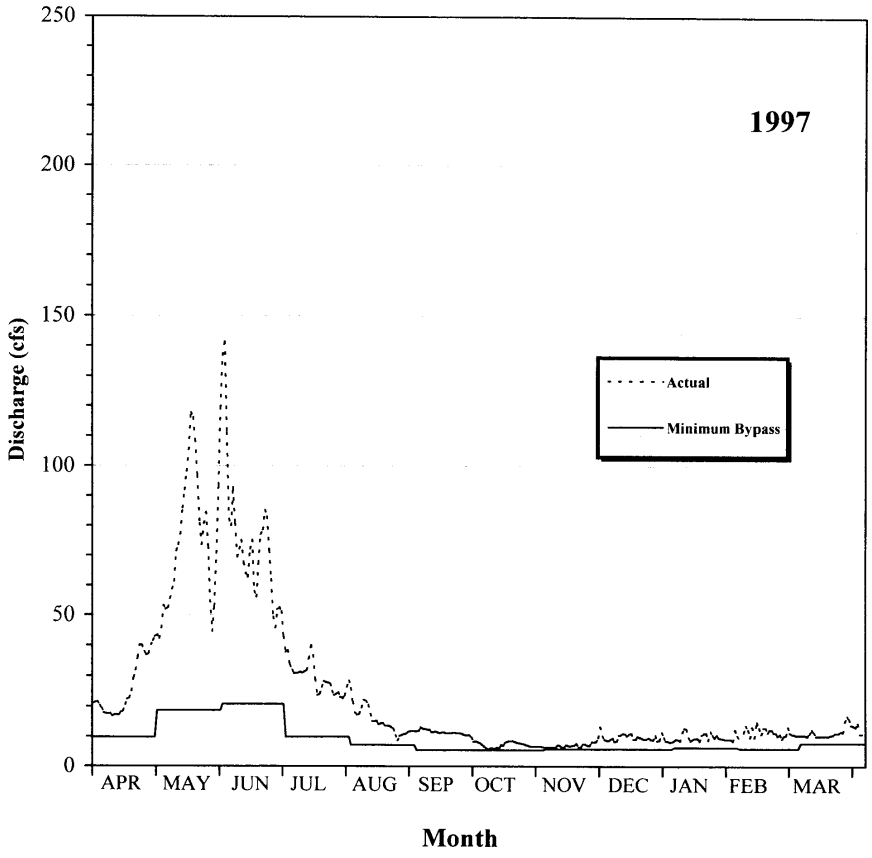
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1994, and the recommended operational minimum mean daily bypass regime.



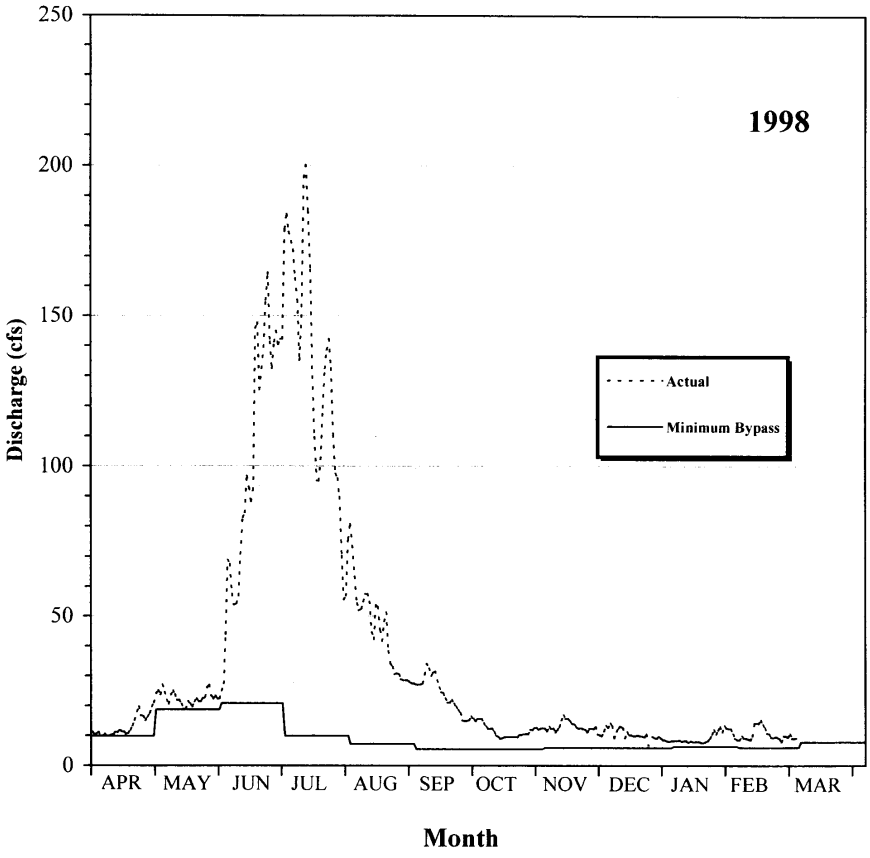
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1995, and the recommended operational minimum mean daily bypass regime.



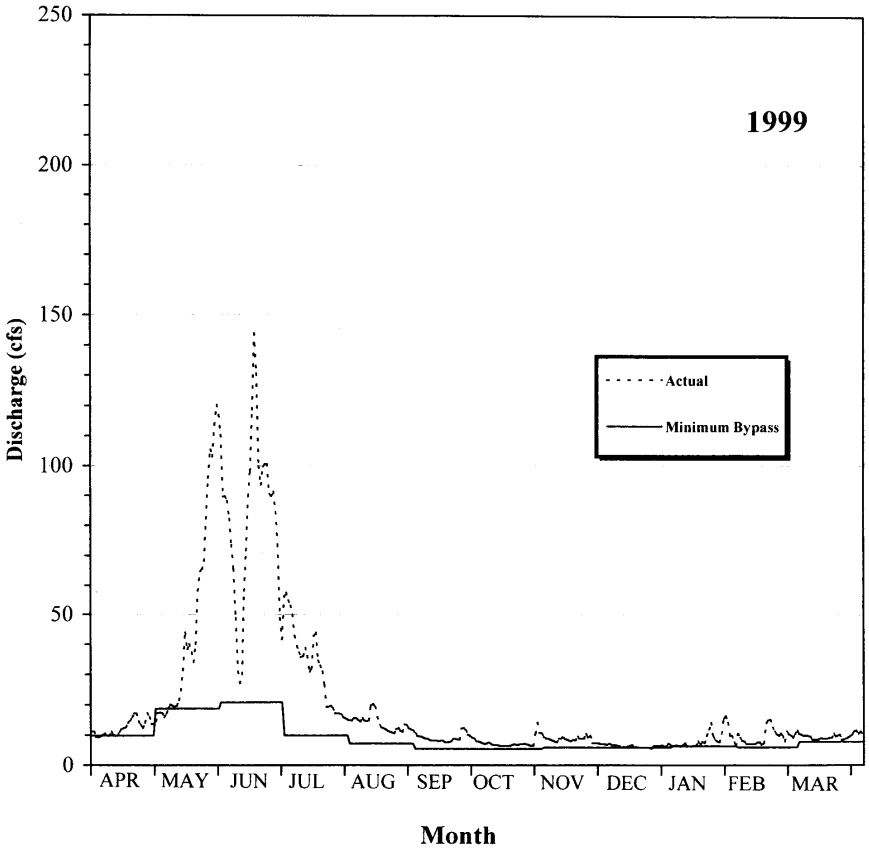
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1996, and the recommended operational minimum mean daily bypass regime.



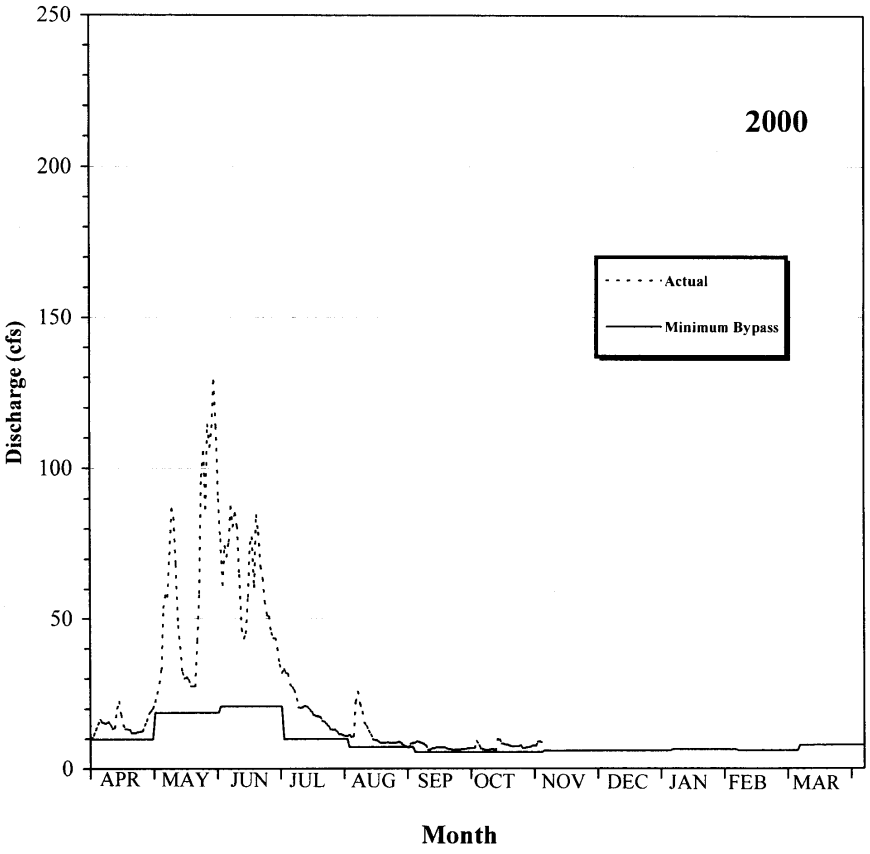
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1997, and the recommended operational minimum mean daily bypass regime.



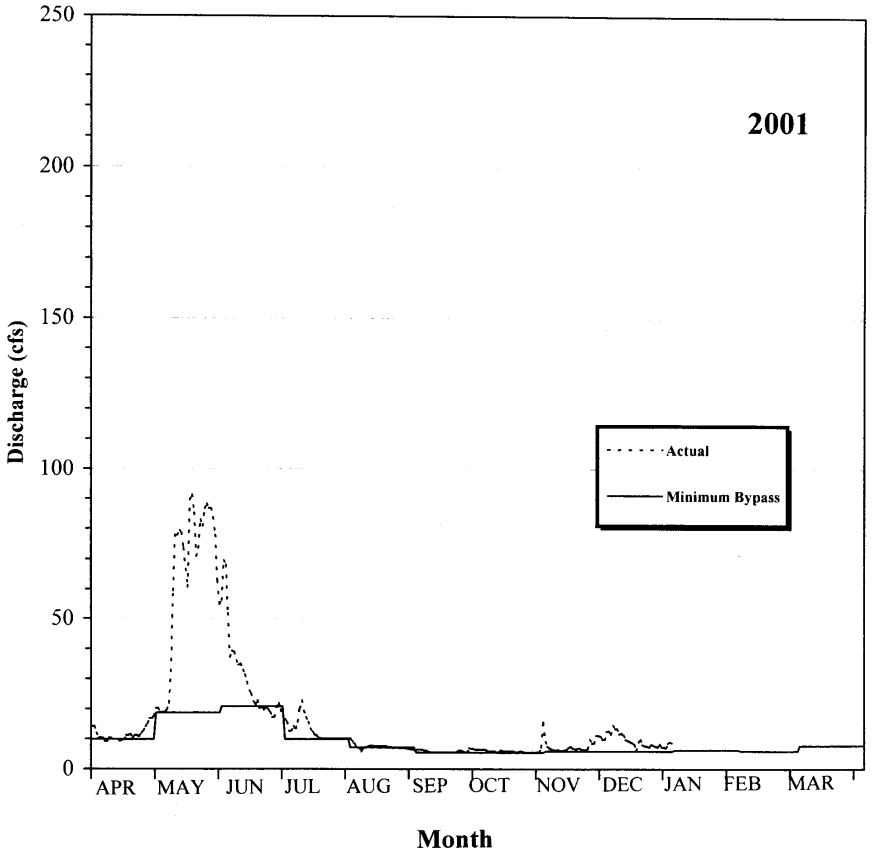
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1998, and the recommended operational minimum mean daily bypass regime.



Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1999, and the recommended operational minimum mean daily bypass regime.



Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 2000, and the recommended operational minimum mean daily bypass regime.



Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 2001, and the recommended operational minimum mean daily bypass regime.