



MAMMOTH CREEK 2000 FISH COMMUNITY SURVEY

Prepared for:

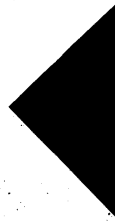
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June 2001



- Final Report -

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Prepared for:

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P.O. Box 597
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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. 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).

This report documents the results of the 2000 fish resource assessment survey conducted from October 10 through 15, 2000. 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 in 1991, the analyses used in this report will focus on the data set collected from the 1992-2000 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 2000 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 seven surveys (1992-97 and 1999), eight stream sections were sampled in 2000, 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 1992-2000 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.

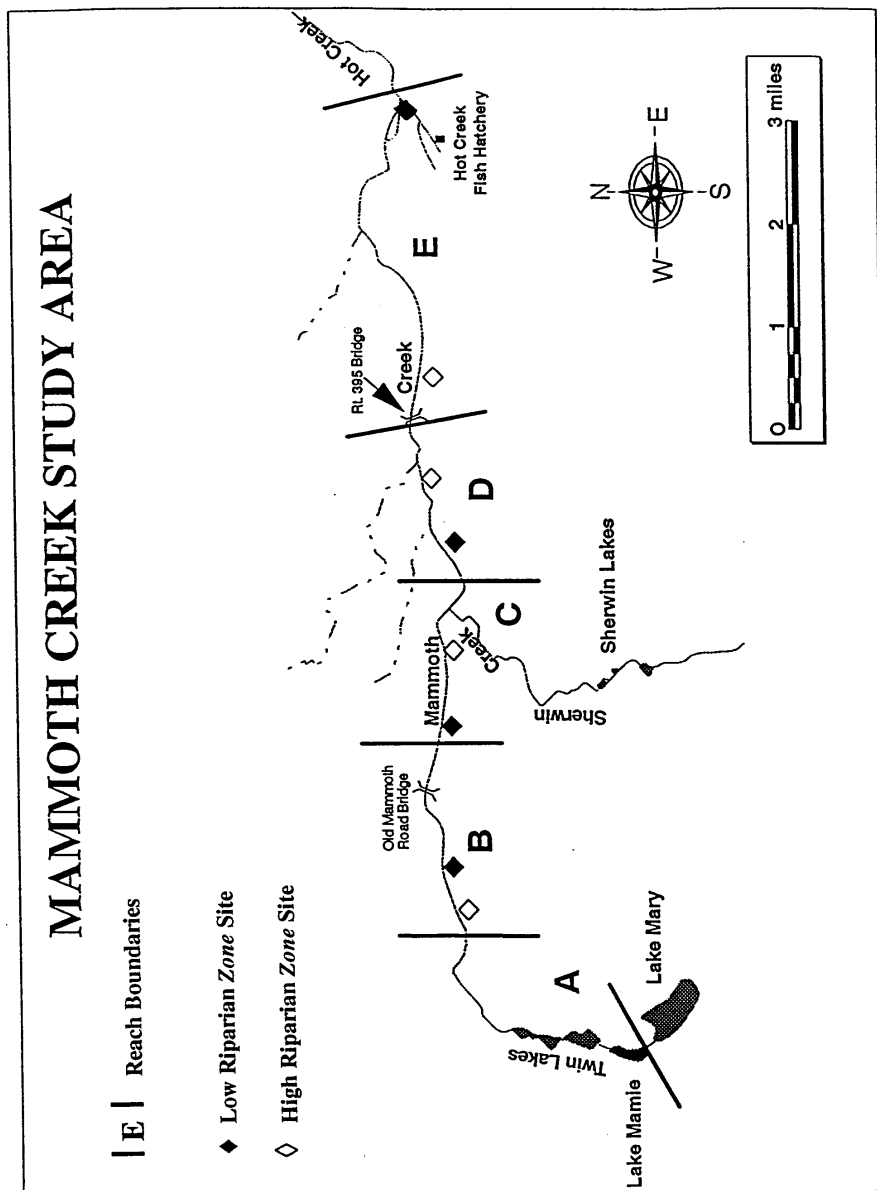


Figure 1. Locations of electrofishing sites sampled on Mammoth Creek, October 10 through 15, 2000 (modified from Hood *et al.* 1995).

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 (CO₂), 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 1992-2000 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 1,376 fish representing four species were captured by electrofishing in Mammoth Creek from October 10 through 15, 2000 (Table 1). Brown trout (*Salmo trutta*), comprised 51.5% of the total catch. Rainbow trout (*Oncorhynchus mykiss*) accounted for 46.9% of the total catch; the highest percentage of all

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previous surveys. Owens sucker (*Catostomus fumeiventris*) comprised 1.4% 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 10 through 15, 2000.

Common Name	Scientific Name	Reach	Cover		Total
			High	Low	
Brown trout	<i>(Salmo trutta)</i>	B	316	35	351
		C	60	5	65
		D	46	65	111
		E	63	119	182
		TOTAL	485	224	709
Rainbow trout (presumed "wild")	<i>(Oncorhynchus mykiss)</i>	B	2	27	29
		C	23	350	373
		D	29	38	67
		E	114	9	123
		TOTAL	168	424	592
Rainbow trout (hatchery origin)	<i>(Oncorhynchus mykiss)</i>	B	0	0	0
		C	0	28	28
		D	5	4	9
		E	17	0	17
		TOTAL	22	32	54
Tui chub	<i>(Gila bicolor)</i>	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	2	2
		TOTAL	0	2	2
Owens sucker	<i>(Catostomus fumeiventris)</i>	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	1	18	19
		TOTAL	1	18	19
GRAND TOTAL					1376

Six hundred and forty-six rainbow trout were captured in the entire study area. Fifty-four of these fish (8.3 %) exhibited evidence that they were of hatchery origin by virtue of abraded fins. The remaining 91.7% 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 nineteen Owens suckers were captured over the entire study area. Both tui chub were caught at site EL. One Owens sucker was caught at site EH. The remaining eighteen Owens suckers 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 5 fish at Site CL to 316 fish at Site BH (Table 2). Extrapolation of these numbers resulted in a range of 88 to 6,670 trout/mile. Brown trout population estimates in sites characterized by “high” riparian cover ranged from 810 brown trout/mile at Site DH up to 6,670 brown trout/mile at Site BH. The “low” riparian cover zone population estimates ranged from 88 brown trout at Site CL to 2,253 brown trout/mile at Site EL. 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 2 fish at Site BH to 361 fish at Site CL (Table 2). Extrapolation of these numbers resulted in a range of 35 to 6,354 rainbow trout/mile. Rainbow trout population estimates in sites characterized by “high” riparian cover ranged from 35 rainbow trout/mile at Site BH up to 2,253 rainbow trout/mile at site EH. The “low” riparian cover zone population estimates ranged from 158 rainbow trout/mile at Site EL to 6,354 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 10 through 15, 2000.

Site	Number of brown trout	Brown trout/mile	Number of rainbow trout	Rainbow trout/mile
BH	379	6,670	2	35
BL	36	634	35	616
CH	61	1,074	23	405
CL	5	88	361	6,354
DH	46	810	30	528
DL	66	1,162	38	669
EH	67	1,179	128	2,253
EL	128	2,253	9	158

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.

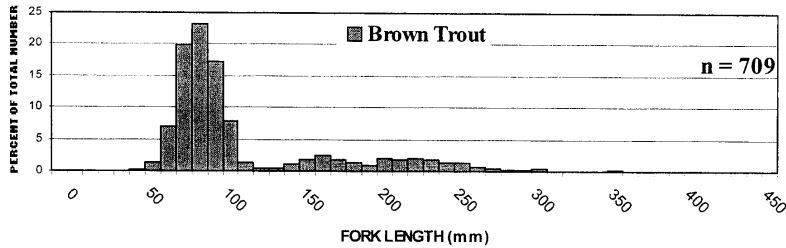


Figure 2. Length-frequency distribution of all brown trout captured at all electrofishing sites in the Mammoth Creek study area, October 10 through 15, 2000.

For the entire brown trout population captured in 2000, 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 551 fish ranging from 49 to 119 mm FL, with 74.9 percent of the fish in this group ranging from 61 to 110 mm FL. Brown trout within the lower size group are most likely YOY fish. The next group included 65 fish ranging from 111 to 190 mm FL and were probably Age I fish. The next group was comprised of 79 fish ranging from 192 to 260 mm FL, and most likely were Age II fish. Thirteen fish were in the 263 to 308 mm FL size range and may represent Age III fish. Only one fish larger than 308 mm FL was captured during this study (356 mm FL) and may be older than an Age III fish.

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 86.3 percent of the total catch in Reach B and accounted for 67.7, 68.5 and 70.3 percent of the catch in Reaches C, D, and E, respectively. The Age I fish group (> 120 but ≤ 190 mm) accounted for 4.6 percent of the total catch in Reach B and was 15.4, 8.1 and 16.5 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 9.1 percent in Reach B up to 23.4 percent in reach D.

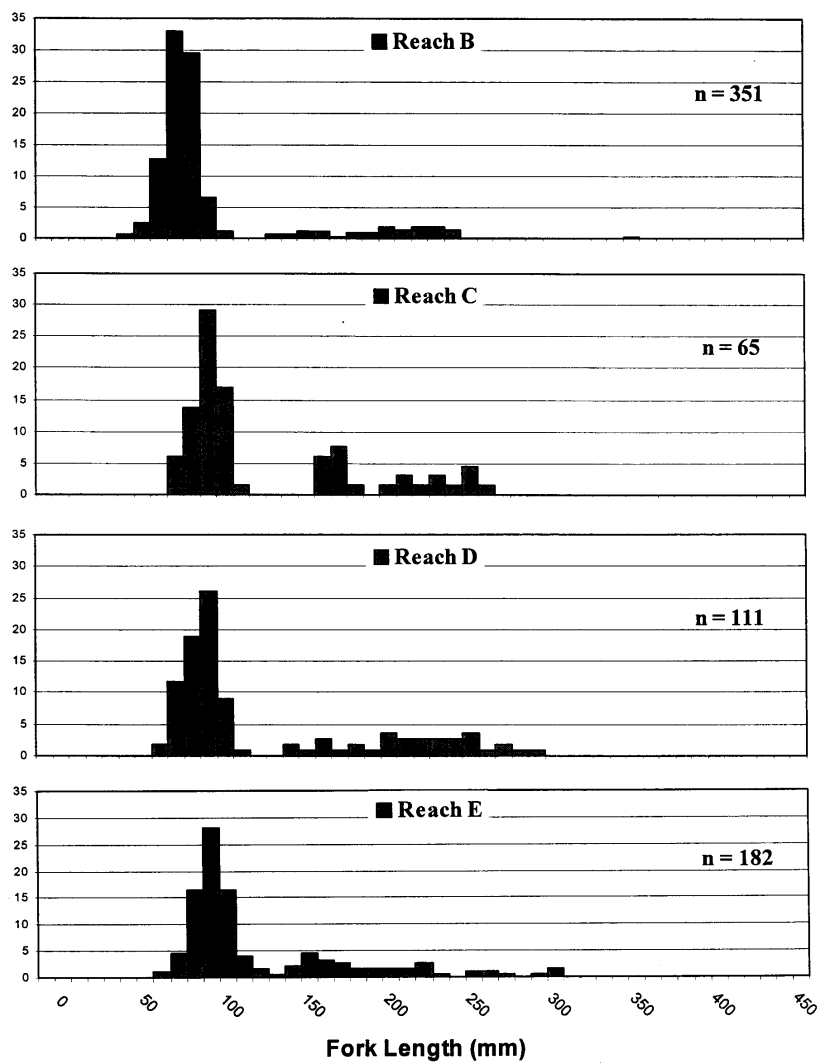


Figure 3. Length-frequency distribution of all brown trout captured in Reaches B, C, D and E in the Mammoth Creek study area, October 10 through 15, 2000.

Of the 592 presumed “wild” rainbow trout captured, 561 (94.8%) fell into the YOY size class range (≤ 120 mm FL) (Figure 4). These results are the highest of all survey years. Fish in this size range are not planted by CDFG in Mammoth Creek and therefore, it is believed that these trout were produced instream.

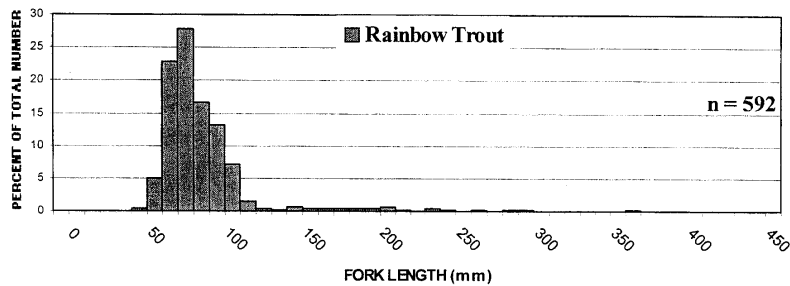


Figure 4. Length-frequency distribution of all presumed “wild” rainbow trout captured at all electrofishing sites in the Mammoth Creek study area, October 10 through 15, 2000.

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 thirteen years there have been ten similar fish community surveys conducted within Mammoth Creek (1988, 1991-2000). 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 (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 nineteen 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, 1992-2000.

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

Rainbow Trout

Presumed "wild" rainbow trout estimates were at an all-time high for all survey years (1,377 fish/mile). Of the estimated 626 fish caught, 361 (57.7%) of those fish were caught at Site CL. This resulted in an estimate of 6,345 trout/mile at that site. Nearly 95% of all "wild" rainbow trout caught at the eight sample sites fell within YOY size range (< 120 mm). This suggests that the spawning and rearing conditions within certain sections of the creek were favorable in 2000. 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 four of the eight sites. As in years past, the largest numbers of those fish were found at sites CL (28 fish) and EH (17 fish).

Brown Trout

Brown trout abundance (estimated number of fish/mile) was the fourth highest recorded (1,734/mile) for the 1992-2000 survey period (Table 4). Brown trout population estimates (trout/mile) for each sampling site for the 1992-2000 survey period are presented in Table 5. 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 (1992-2000) 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 1995-2000, a different site then sampled in 1992-1994.

Year	Brown trout per mile	Rainbow trout per mile	Runoff^a (acre- feet)
2000	1,734 (1484)	1,377 (1466)	
1999	1,951 (1916)	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

Comparison of brown trout densities by sampling site between the 2000 study and the 1992-1999 studies conducted reveals the highest densities ever recorded at one of the eight sites sampled (EL) (Table 6). On average, the estimated trout densities fell within the “average” of the eight years of surveying, with the exception of site CL which tied an all time low of 88 fish/mile (same result as 1995) (Table 6). One possible explanation low numbers at CL may be attributed to the high number of hatchery-reared rainbow trout planted by CDFG in this area. Twenty-eight rainbow trout of hatchery origin were captured at sample Site CL during this survey (2000). As a result of the trout stocking in this area, in conjunction with easy public access, 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.

The results of this years survey suggest that the hydrologic conditions of Mammoth Creek between the 1999 and 2000 survey were favorable in terms of both brown and rainbow trout densities. Comparison of Mammoth Creek hydrology between this past water year and the flow conditions over previous years reveals similar conditions to 1993, 1997 and 1999 (Appendix B).

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 1992-1999 data set (Figure 5). In general, the length-frequency distribution calculated for all brown trout captured during the 2000 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.

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Table 5. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Mammoth Creek, Mono County, California, 21-28 October, 1992, 11-19 October, 1993, 4-11 October, 1994, 1-7 November, 1995, 3-8 October, 1996, 4-10 October, 1997, 24-29 September, 1999 and 10-15 October, 2000.

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
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
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
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

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Table 5. Continued				
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
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
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
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

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

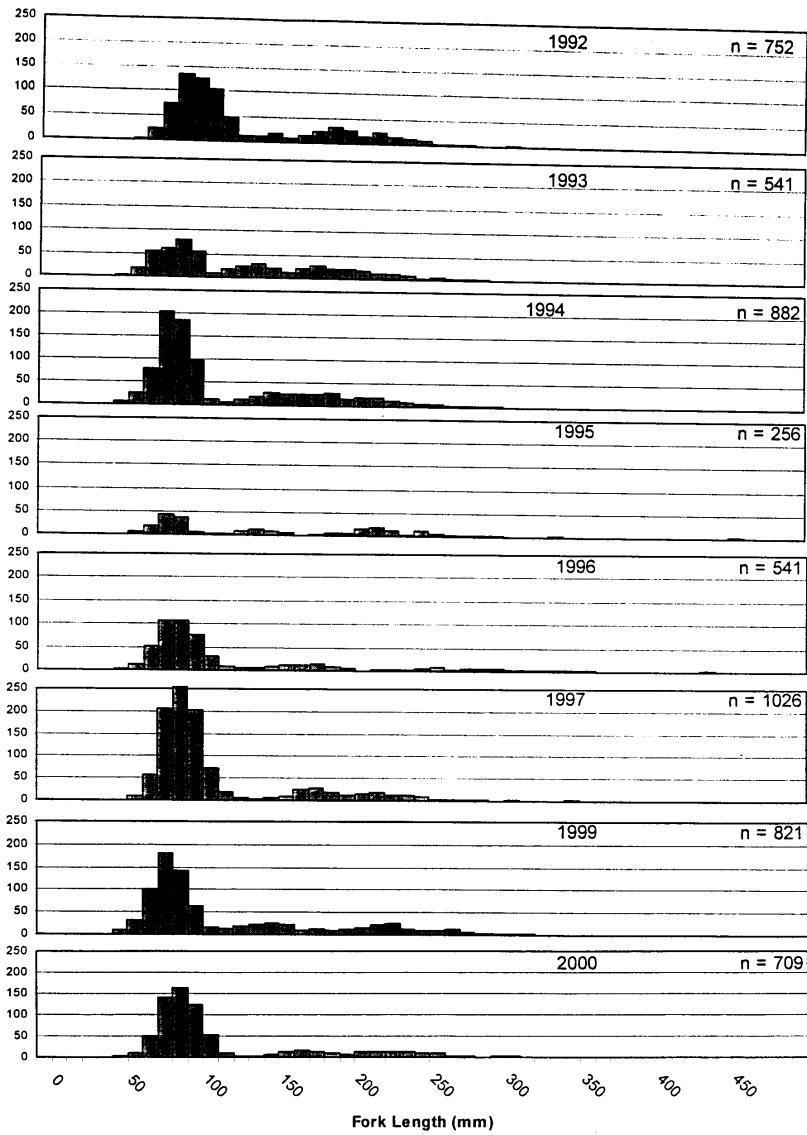


Figure 5. Length-frequency distribution of all brown trout captured in Mammoth Creek, 1992-2000.

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Table 6. Population estimates (trout/mile) for brown trout captured by electrofishing Mammoth Creek, Mono County, California, 1992-2000. Bold numbers indicate highest value for each site. Numbers in parenthesis indicate where the 2000 survey results ranked among the previous years.

	Sample Site							
	BH	BL	CH	CL	DH	DL	EH	EL ^a
2000	6670 (2 nd)	634 (6 th)	1074(4 th)	88(tied-low)	810(6 th)	1162(4 th)	1179(6 th)	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 1995-2000.

Seventy-five percent of this year's catch was comprised of YOY fish. That is the second-highest percentage for all survey years. The highest YOY proportion was in the 1997 survey (81%) followed by 1996 (73%), 1994 (70%), 1999 (68%), 1992 (68%), 1993 (55%) and the lowest in 1995 (46%)¹.

In addition to the YOY age class, at least two or more brown trout age groups were present in every reach for every year (Figure 5). In comparison to the 1992-99 surveys, the overall length-frequency distribution for brown trout this year was most similar to 1992 (Figure 5).

Although brown trout continue to dominate the trout community in the study area, presumed "wild" rainbow trout accounted for approximately forty-four percent of the trout captured in 2000. Rainbow trout per mile estimates were the highest for all survey years and YOY fish comprised approximately ninety-five percent of the total rainbow trout catch (Table 3 and Figure 4).

CONCLUSIONS

- Numbers of native fishes were the second lowest for all surveys conducted. It is unclear as to whether this is a result of some environmental condition(s) or, it may be directly attributed to the movement of Site EL in 1995 to immediately upstream of the Hot Creek confluence.
- Trout density and age structure (length-frequency) information obtained from the electrofishing survey conducted in October 2000 suggest that both the brown and rainbow trout populations in Mammoth Creek remain in good condition. The average density of brown trout for the past eight years (1,636 trout/mile) compares well with the results of this year's survey (1,734 trout/mile). The presumed "wild" rainbow trout density was the highest recorded for the 1992-2000 survey period. These results suggest that both species of trout are not only surviving to sexual maturity, they continue to successfully reproduce and provide subsequent recruitment to the population.

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

- 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.

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APPENDIX A
Maximum Likelihood Catch Statistics

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

Removal Pattern: 170 93 53
Total Catch = 316
Population Estimate = 379

Chi Square = 0.041
Pop Est Standard Err = 19.260
Lower Conf Interval = 341.059
Upper Conf Interval = 416.941

Capture Probability = 0.449
Capt Prob Standard Err = 0.041
Lower Conf Interval = 0.367
Upper Conf Interval = 0.530

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

Removal Pattern: 23 10 2
Total Catch = 35
Population Estimate = 36

Chi Square = 0.744
Pop Est Standard Err = 1.565
Lower Conf Interval = 35.000
Upper Conf Interval = 39.177

Capture Probability = 0.673
Capt Prob Standard Err = 0.090
Lower Conf Interval = 0.491
Upper Conf Interval = 0.855

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

Removal Pattern: 43 11 6
Total Catch = 60
Population Estimate = 61

Chi Square = 1.428
Pop Est Standard Err = 1.734
Lower Conf Interval = 60.000
Upper Conf Interval = 64.468

Capture Probability = 0.698
Capt Prob Standard Err = 0.066
Lower Conf Interval = 0.566
Upper Conf Interval = 0.829

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

Removal Pattern: 4 1 0
Total Catch = 5
Population Estimate = 5

Chi Square = 0.257
Pop Est Standard Err = 0.168
Lower Conf Interval = 5.000
Upper Conf Interval = 5.466

Capture Probability = 0.833
Capt Prob Standard Err = 0.168
Lower Conf Interval = 0.367
Upper Conf Interval = 1.299

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

Removal Pattern: 33 10 3
Total Catch = 46
Population Estimate = 46

Chi Square = 0.445
Pop Est Standard Err = 1.105
Lower Conf Interval = 46.000
Upper Conf Interval = 48.226

Capture Probability = 0.742
Capt Prob Standard Err = 0.069
Lower Conf Interval = 0.603
Upper Conf Interval = 0.881

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

Removal Pattern: 48 14 3
Total Catch = 65
Population Estimate = 66

Chi Square = 0.169
Pop Est Standard Err = 1.356
Lower Conf Interval = 65.000
Upper Conf Interval = 68.710

Capture Probability = 0.739
Capt Prob Standard Err = 0.058
Lower Conf Interval = 0.623
Upper Conf Interval = 0.855

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

Removal Pattern: 39 18 6
Total Catch = 63
Population Estimate = 67

Chi Square = 0.295
Pop Est Standard Err = 3.350
Lower Conf Interval = 63.000
Upper Conf Interval = 73.689

Capture Probability = 0.600
Capt Prob Standard Err = 0.075
Lower Conf Interval = 0.450
Upper Conf Interval = 0.750

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

Removal Pattern: 72 35 12
Total Catch = 119
Population Estimate = 128

Chi Square = 0.632
Pop Est Standard Err = 5.197
Lower Conf Interval = 119.000
Upper Conf Interval = 138.290

Capture Probability = 0.580
Capt Prob Standard Err = 0.056
Lower Conf Interval = 0.469
Upper Conf Interval = 0.692

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	32.82281
CH	57.53194
CL	4.533857
DH	43.77391
DL	63.29022
EH	60.31062
EL	117.71

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

Removal Pattern: 12 10 5
Total Catch = 27
Population Estimate = 35

Chi Square = 0.507
Pop Est Standard Err = 8.864
Lower Conf Interval = 27.000
Upper Conf Interval = 53.012

Capture Probability = 0.380
Capt Prob Standard Err = 0.155
Lower Conf Interval = 0.064
Upper Conf Interval = 0.696

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

Removal Pattern: 15 7 1
Total Catch = 23
Population Estimate = 23

Chi Square = 1.414
Pop Est Standard Err = 0.922
Lower Conf Interval = 23.000
Upper Conf Interval = 24.913

Capture Probability = 0.719
Capt Prob Standard Err = 0.102
Lower Conf Interval = 0.506
Upper Conf Interval = 0.931

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

Removal Pattern: 245 80 25
Total Catch = 350
Population Estimate = 361

Chi Square = 0.047
Pop Est Standard Err = 4.670
Lower Conf Interval = 351.800
Upper Conf Interval = 370.200

Capture Probability = 0.682
Capt Prob Standard Err = 0.028
Lower Conf Interval = 0.628
Upper Conf Interval = 0.737

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

Removal Pattern: 16 12 1
Total Catch = 29
Population Estimate = 30

Chi Square = 5.020
Pop Est Standard Err = 1.866
Lower Conf Interval = 29.000
Upper Conf Interval = 33.815

Capture Probability = 0.630
Capt Prob Standard Err = 0.106
Lower Conf Interval = 0.413
Upper Conf Interval = 0.847

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

Removal Pattern: 30 7 1
Total Catch = 38
Population Estimate = 38

Chi Square = 0.245
Pop Est Standard Err = 0.586
Lower Conf Interval = 38.000
Upper Conf Interval = 39.188

Capture Probability = 0.809
Capt Prob Standard Err = 0.065
Lower Conf Interval = 0.676
Upper Conf Interval = 0.941

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

Removal Pattern: 8 1 0
Total Catch = 9
Population Estimate = 9

Chi Square = 0.127
Pop Est Standard Err = 0.099
Lower Conf Interval = 9.000
Upper Conf Interval = 9.227

Capture Probability = 0.900
Capt Prob Standard Err = 0.099
Lower Conf Interval = 0.673
Upper Conf Interval = 1.127

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

Removal Pattern: 64 35 15
Total Catch = 114
Population Estimate = 128

Chi Square = 0.367
Pop Est Standard Err = 7.574
Lower Conf Interval = 114.000
Upper Conf Interval = 142.996

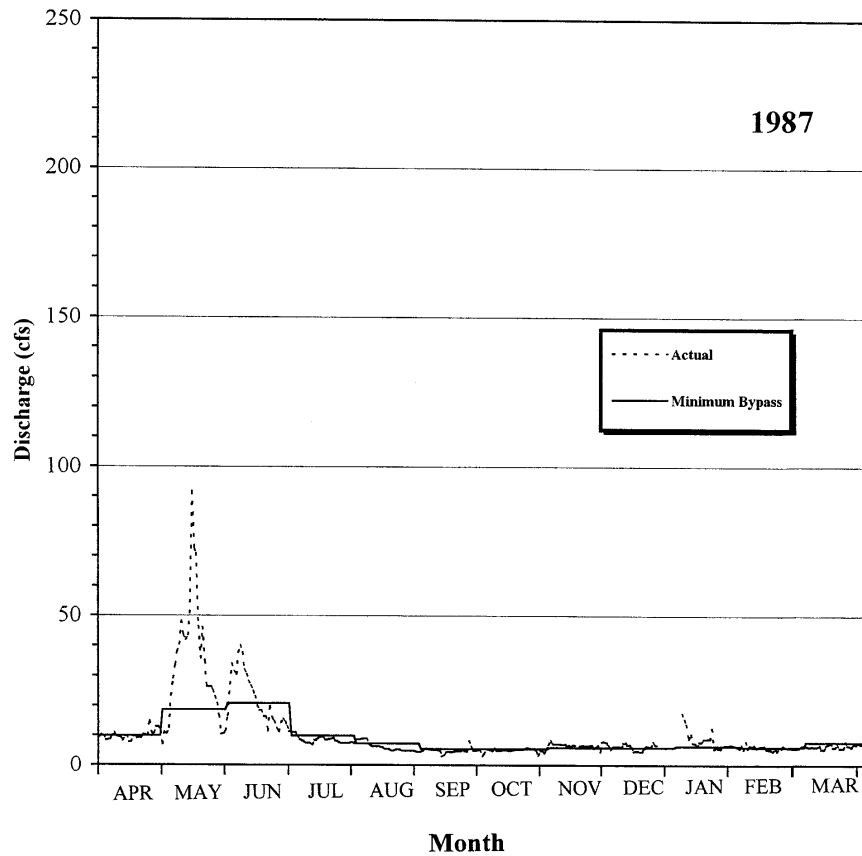
Capture Probability = 0.516
Capt Prob Standard Err = 0.063
Lower Conf Interval = 0.391
Upper Conf Interval = 0.641

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:

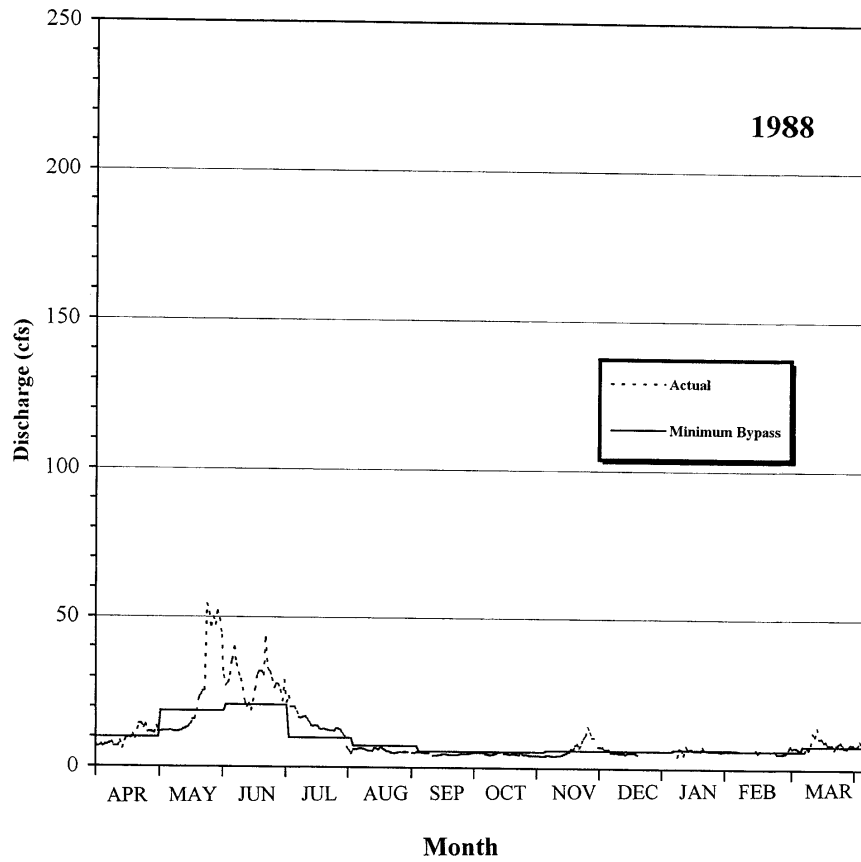
Site	Calculated LCI
BL	16.98821
CH	21.08727
DH	26.18459
DL	36.81179
EL	8.772664
EH	113.0042

At sample site BH the presumed "wild" rainbow trout removal pattern was 2-0-0. Microfish software cannot calculate confidence intervals for these results. Therefore, the estimated population for Site BH is two.

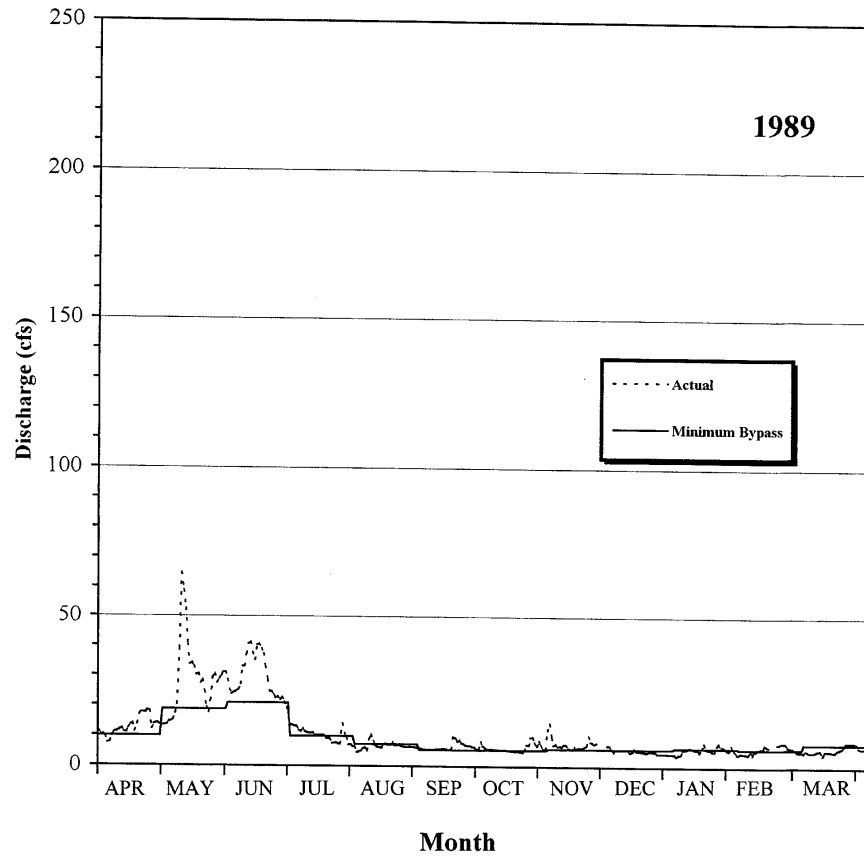
APPENDIX B
Mammoth Creek Hydrographs (1987-2000)



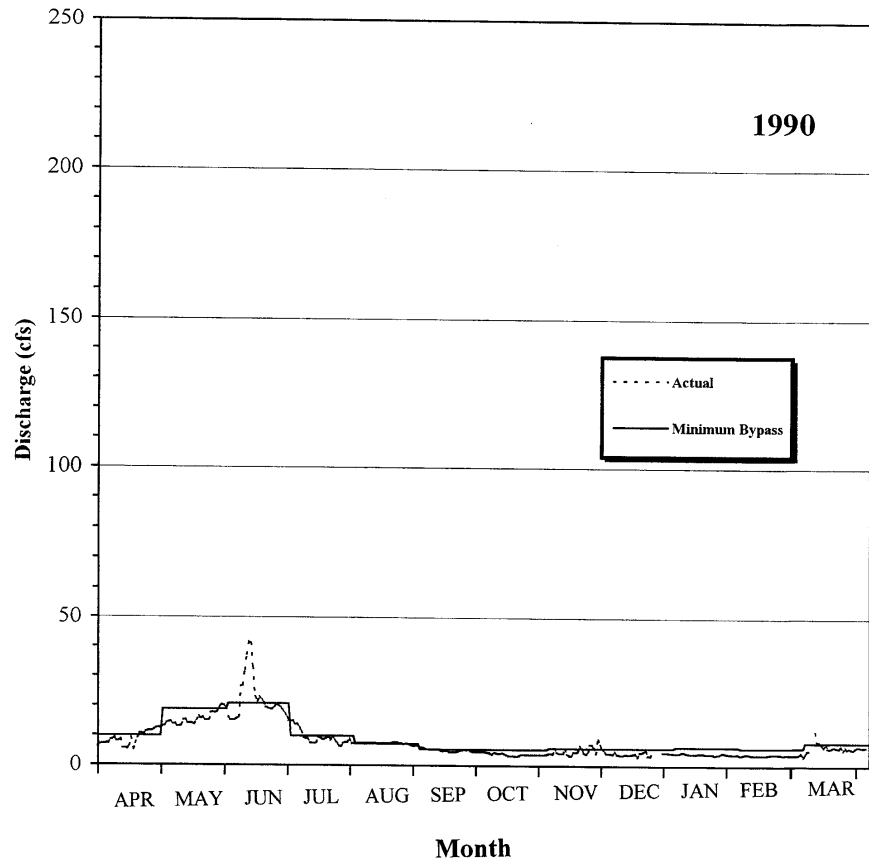
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1987, and the recommended operational minimum mean daily bypass regime.



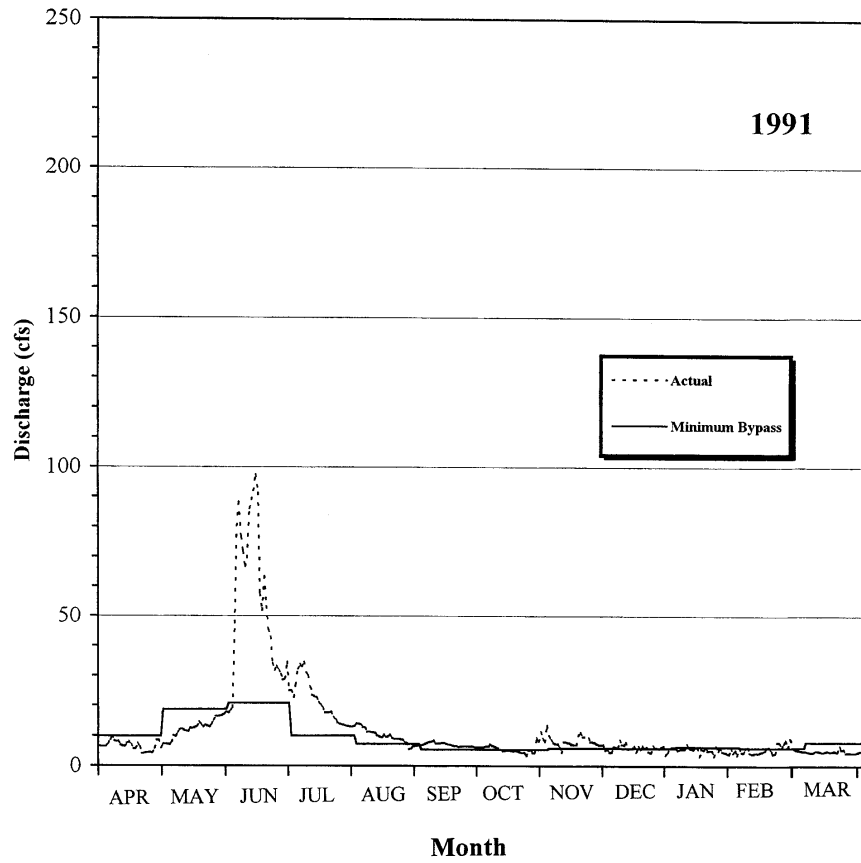
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1988, and the recommended operational minimum mean daily bypass regime.



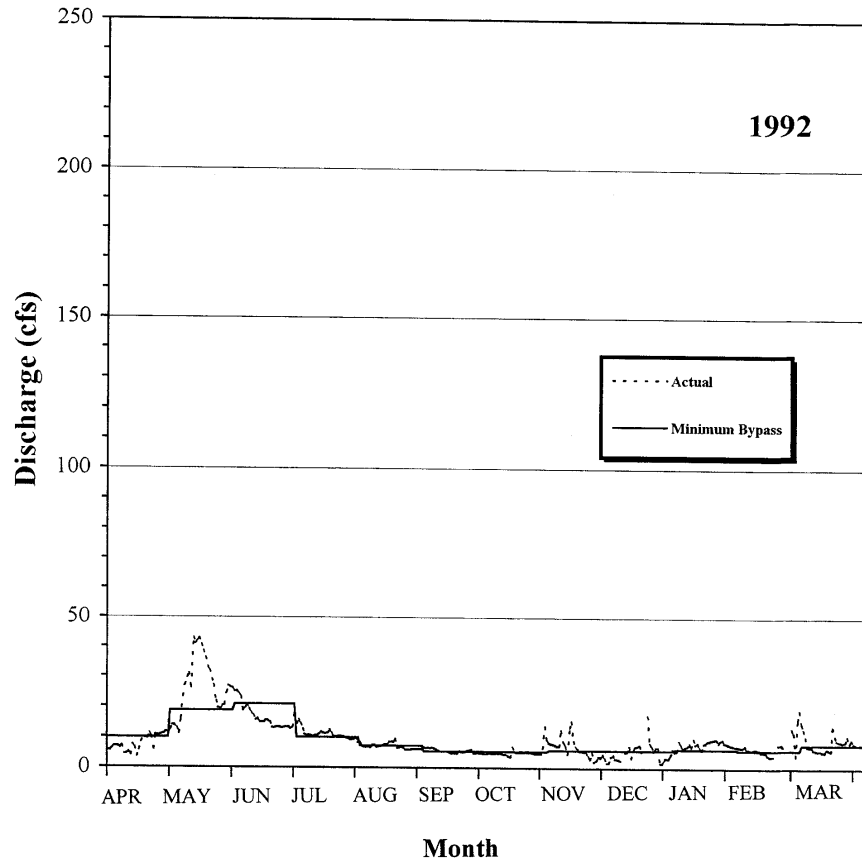
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1989, and the recommended operational minimum mean daily bypass regime.



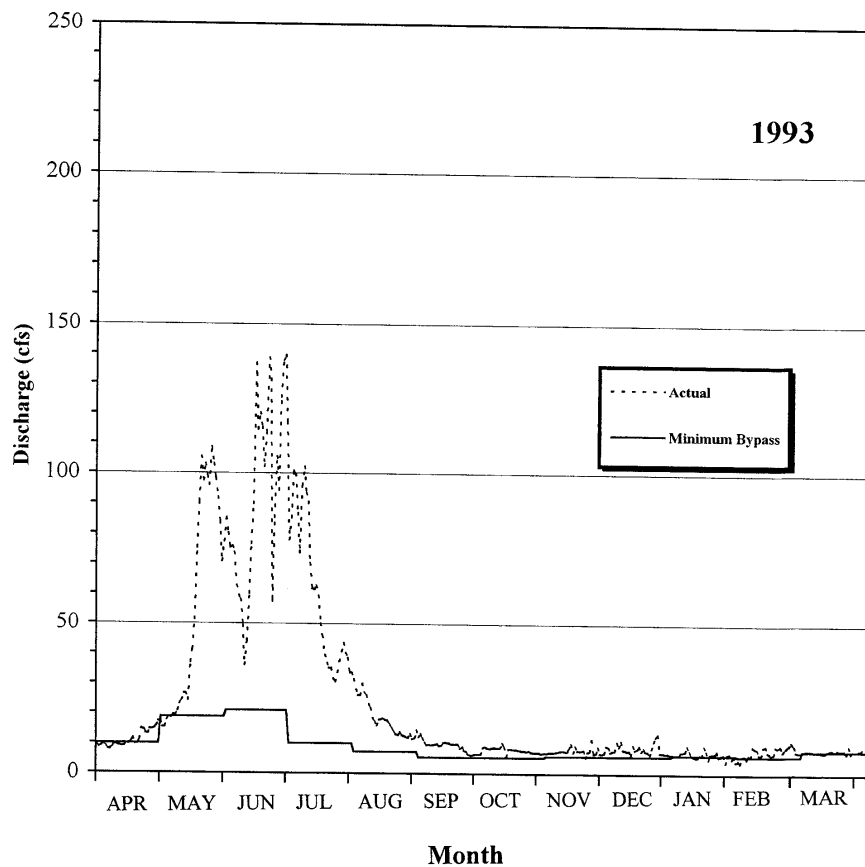
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1990, and the recommended operational minimum mean daily bypass regime.



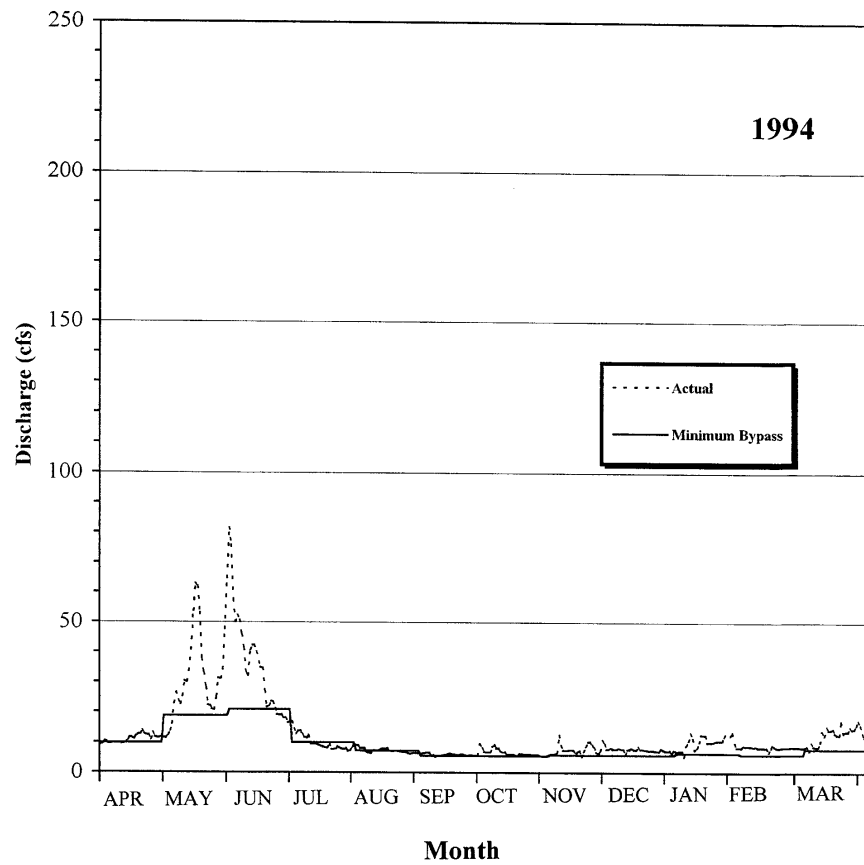
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1991, and the recommended operational minimum mean daily bypass regime.



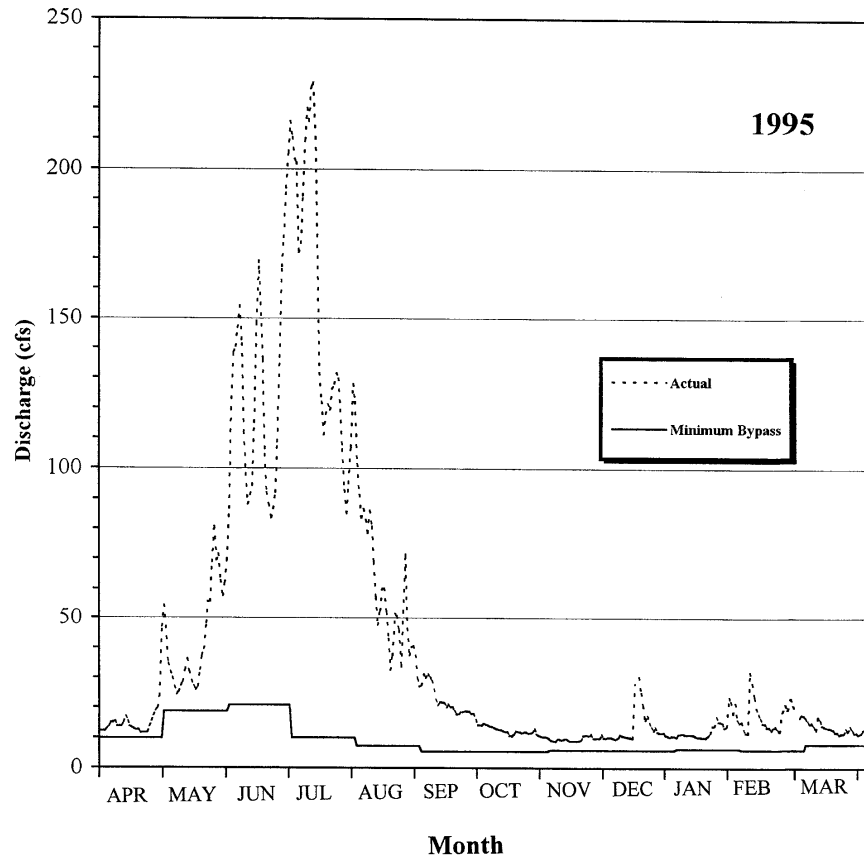
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1992, and the recommended operational minimum mean daily bypass regime.



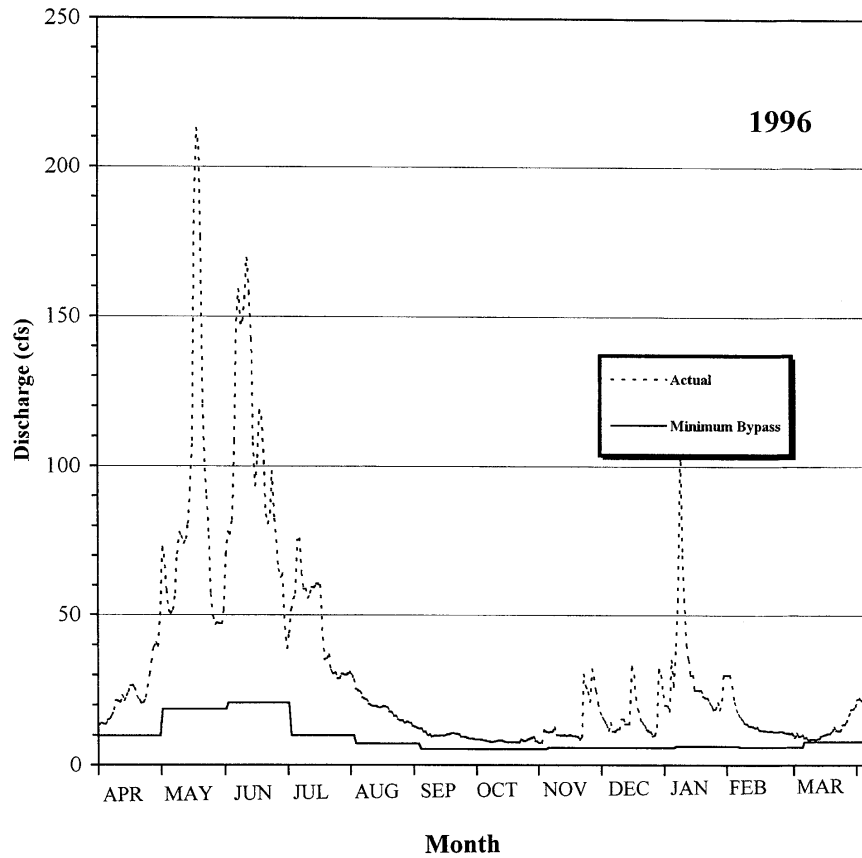
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1993, and the recommended operational minimum mean daily bypass regime.



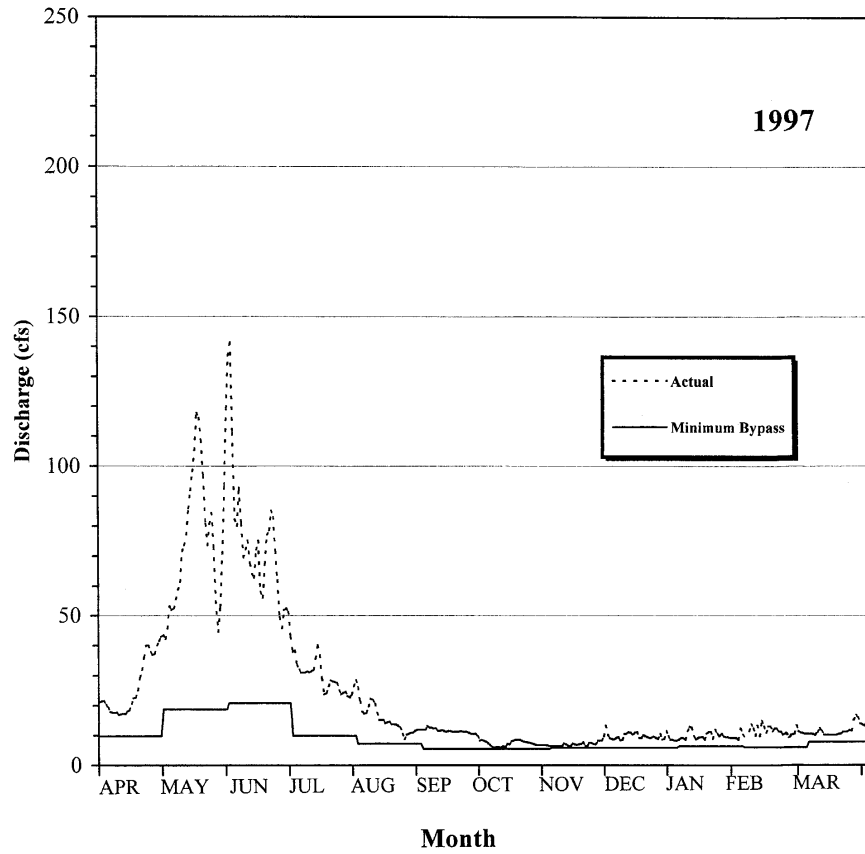
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1994, and the recommended operational minimum mean daily bypass regime.



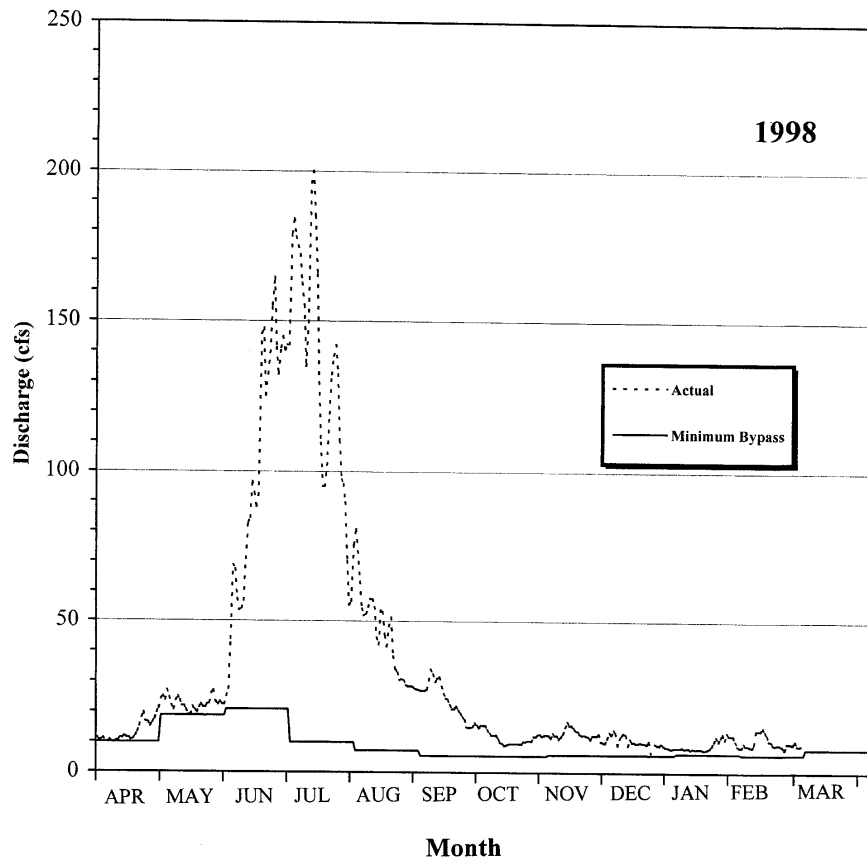
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1995, and the recommended operational minimum mean daily bypass regime.



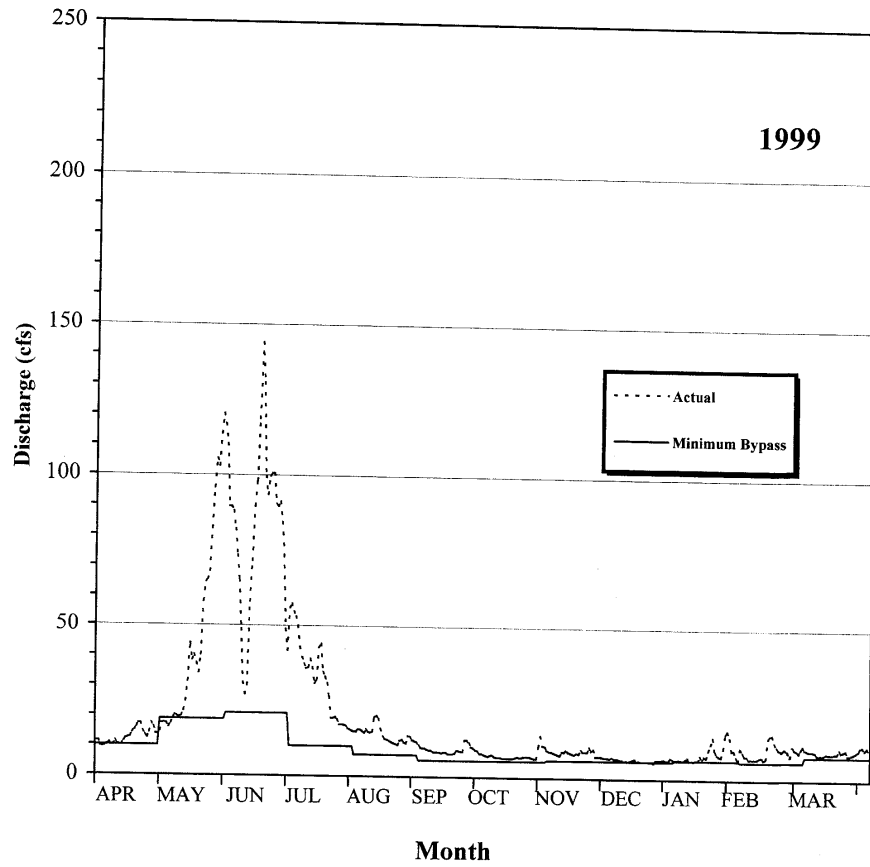
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1996, and the recommended operational minimum mean daily bypass regime.



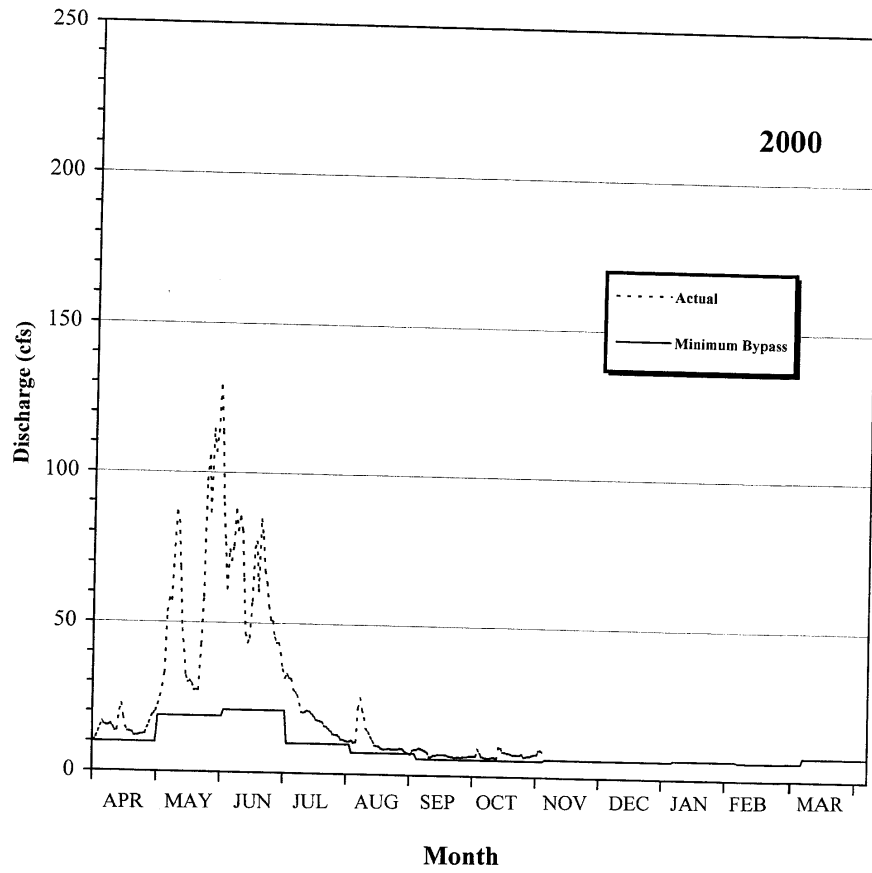
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1997, and the recommended operational minimum mean daily bypass regime.



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.