MAMMOTH CREEK 1993
FISH COMMUNITY SURVEY

Prepared for:

Mammoth County Water District
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MAMMOTH CREEK 1993 FISH COMMUNITY SURVEY

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INTRODUCTION

Fishery resource needs and the establishment of instream flow requirements remain a significant issue for Mammoth Creek, Mono County, California. Mammoth County Water District (District) retained Beak Consultants Incorporated (Beak) in July of 1988 to evaluate the instream flow needs of the fishery in Mammoth Creek. Since that time, Beak has conducted comprehensive, quantitative studies of instream flows, habitat availability, and fish population estimation on Mammoth Creek. Annual sampling of the fish population of Mammoth Creek serves to evaluate instream flow effects and monitor the fishery of the creek. This study was designed and initiated as a method for comparison of population changes over time under various hydrologic conditions. Fish resource assessment surveys were conducted from October 12 through 19, 1993, in the Mammoth Creek study area to evaluate several aspects of species composition, abundance and distribution. Specific objectives were:

- To estimate the total fish population among sampling sections;
- To evaluate the size and age class structure of fish throughout Mammoth Creek and within each sampling section; and,
- To compare the results of similar studies of Mammoth Creek and other Sierra Nevada streams.

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 by Beak in 1988 (Bratovich et al. 1990), based upon analysis of topographic maps, calculation of gradient profiles, and 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 cascade-plunge pool sequences 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 the California Department of Fish and Game (CDFG) and United States Forest Service (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 1993 investigation.

METHODS AND MATERIALS

Experimental Design

Distinct differences in the amount of riparian cover within each study reach were observed during the habitat mapping survey conducted by Beak in the fall of 1988 (Bratovich et al. 1990). To represent these distinct zones of riparian cover and to disperse sampling sections throughout the creek, fish sampling sections were located in both high and low zones of riparian cover within each study reach.

The experimental design and sampling site selection process were identical to those used in the 1992 and the 1988 surveys. The following is a description of the sampling site selection process established in 1988.

A traditional two-stage sampling design was used to assess fish resources in the Mammoth Creek study area. Within each of the four study reaches, two sampling sections (one each within designated high and low riparian cover zones) were chosen by the following formalized random selection procedure:

- The total thalweg length of both high and low riparian vegetation cover zones within each study reach was determined by summing the lengths of each primary habitat unit;

- A four digit number was selected with a random number generator and treated as a decimal fraction;

- The selected random number (treated as a fraction) was multiplied by the total length of the reach/cover stratum;

- The resultant product (Step 3, above) was measured (linear feet) from the downstream boundary of the study reach/cover stratum, and served as the downstream boundary of the sampling section; and,

- From the point identified in Step 4 (above), a distance of 100 feet was measured in an upstream direction and served as the upstream boundary of the sampling section.

The downstream boundary of each sampling section was identical between the 1988, 1992, and the present study, although the sampling section extended upstream 100-feet during the 1988 study and 300-feet during the 1992 and present study. The locations of the eight electrofishing sites are presented in **Figure 1**.

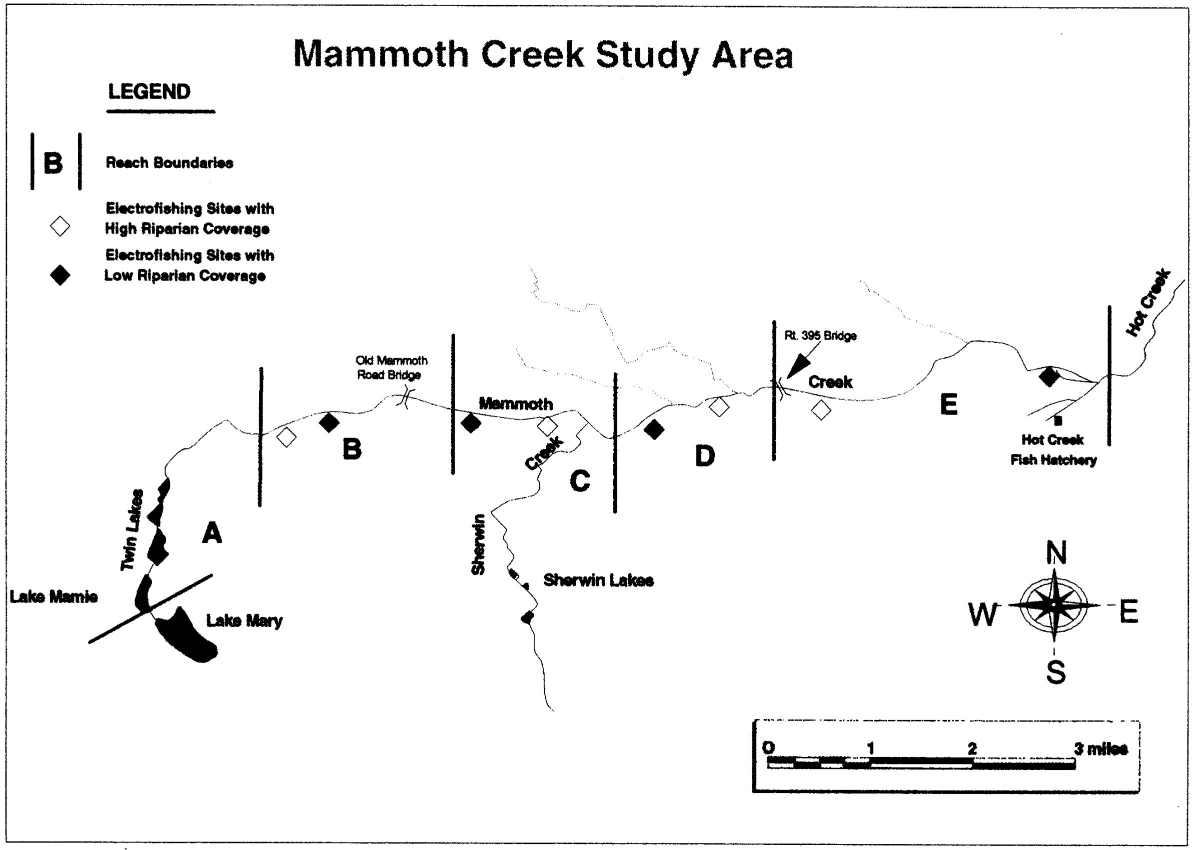

Figure 1. Locations of electrofishing sites sampled during October 1993 in Mammoth Creek, Mono County, California.

Data Acquisition

Fish resource assessment surveys were conducted by electrofishing. At least one day prior to electrofishing, selected sampling sections were 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. Sampling sites were closed using block nets comprised of 0.125-inch stretched mesh, simultaneously placed across the upstream and downstream boundaries to preclude movement of fish into or out of the sampling section. Conductivity of the stream was measured and salt blocks were placed at the upstream boundary of each sampling section to increase electrical conductivity and electrofishing effectiveness.

Electrofishing was conducted using a Smith-Root Model 15B generator powered backpack electrofisher. A four person crew was used to capture fish. One person operated the anode and two people, positioned at each side of the anode operator, netted fish. An additional person processed the catch while electrofishing continued.

A multiple-pass removal method of electrofishing was used for fish population estimation. A minimum of three complete passes were conducted at each sampling section. Each pass (or removal occasion) was conducted using a standardized technique to attain 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. All captured fish were anesthetized using carbon dioxide (CO_2), identified to species, and enumerated. Captured trout were identified, measured (nearest 1 millimeter (mm) fork length, FL), and weighed (nearest 0.1 gram (g) up to 10.0g, nearest 1g over 10g). All possible precautions were taken to prevent stress and handling or holding mortality. Processed fish were held in a holding pen (2 ft. wide by 3 ft. tall by 4 ft. long) placed in the creek downstream of the sampling area. After the completion of all removal passes, fish were returned to 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 trout (and associated 95 percent confidence intervals) were calculated. Estimated brown trout totals were expressed as the number of fish per stream mile for comparison with surveys conducted by CDFG. Estimated numbers of brown trout per stream mile in Mammoth Creek were compared among data collected by CDFG in 1983 and 1984 (Deinstadt et al. 1985), the District in 1988 (Bratovich et al. 1990), CDFG in 1991 (unpublished data), the District in 1992 (Hood et al. 1992), and the District in 1993 (this study).

Length-Frequency

Length-frequency distributions were calculated to summarize body size information for fish captured in the Mammoth Creek study area. Length-frequency distributions of brown trout were calculated for the entire creek, and for each study reach. In addition, length-frequency distributions of rainbow trout were calculated for fish captured throughout the entire creek.

RESULTS

Species Composition and Relative Abundance

A total of 1,914 fish representing five species were captured by electrofishing in Mammoth Creek from October 12 through 19, 1993 (**Table 1**). Tui chub (*Gila bicolor*), comprised the largest portion of the total catch, 44.7 percent. Brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*) and Owens sucker (*Catostomus fumeiventris*) accounted for the remaining 28.3, 4.8, less than 0.1, and 22.2 percent of all fish caught, respectively.

Ninety-one rainbow trout were captured in the entire study area. Sixty-four of these fish (70.3 percent) exhibited evidence that they were of hatchery origin by virtue of abraded dorsal fins. No rainbow trout were captured in the uppermost reach, Reach B. The rainbow trout captured were fairly evenly distributed among Reaches C, D and E. Slightly more rainbow trout (48 fish or 52.8 percent) were caught in sampling sections characterized by high riparian cover than by low riparian cover. By contrast, all tui chub and Owens suckers captured during this study were caught in the sampling section located within the low riparian cover zone of the lowermost reach, Reach E. One rainbow trout was captured in the lowermost section of Reach E. One brook trout was captured in the high riparian portion of the upper reach (Reach B). No further population density analyses were conducted on species other than brown trout.

Brown Trout Population Estimation

The estimated number of brown trout captured in all sampling sections ranged from 9 fish at site EL to 171 fish at site BH (**Table 2**). Extrapolation of these numbers resulted in a range of 158 to 3,010 trout per mile. Brown trout population estimates in sites characterized by high riparian cover ranged from 510 brown trout/mile at site CH up to 3010 brown trout/mile at site BH. The low riparian cover zone population estimates ranged from 158 brown trout/mile at site EL to 2658 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**.

Length-Frequency Distribution

The length-frequency distribution calculated for all brown trout captured during this study exhibit a fairly distinct multimodal distribution (**Figure 2**). This distribution is consistent with those observed in investigations prior to the 1992 study (Bratovich et al. 1992) A pronounced peak (46 to 106 mm FL) in the distribution was apparent for the length groups 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.

Table 1. Number of all fish captured by electrofishing Mammoth Creek, Mono County, California from October 12 through 19, 1993.

COMMON NAME	SCIENTIFIC NAME	REACH	Cover High	Cover Low	TOTAL
brown trout	(*Salmo trutta*)	B	144	146	290
		C	27	59	86
		D	60	29	89
		E	68	9	77
		TOTAL	299	243	542
rainbow trout (undetermined origin)	(*Oncorhynchus mykiss*)	B	0	0	0
		C	4	0	4
		D	17	2	19
		E	3	1	4
		TOTAL	24	3	27
rainbow trout (hatchery origin)	(*Oncorhynchus mykiss*)	B	0	0	0
		C	4	39	43
		D	4	1	5
		E	16	0	16
		TOTAL	24	40	64
brook trout	(*Salvelinus fontinalis*)	B	1	0	1
		C	0	0	0
		D	0	0	0
		E	0	0	0
		TOTAL	1	0	1
tui chub	(*Gila bicolor*)	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	855	855
		TOTAL	0	855	855
Owens sucker	(*Catostomus fumeiventris*)	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	425	425
		TOTAL	0	425	425
				GRAND TOTAL	1914

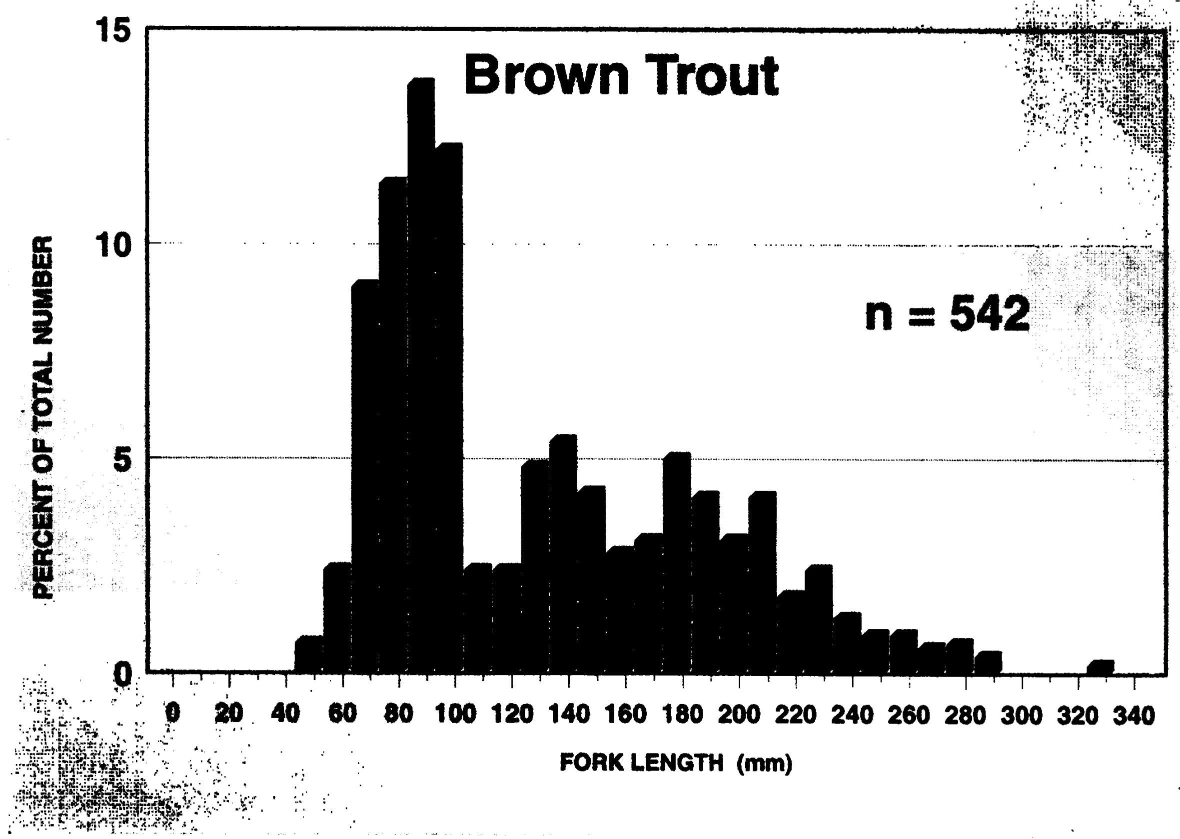

Figure 2. Length-frequency distribution of all brown trout captured at all electrofishing sites in the Mammoth Creek study area, October 12 through 19, 1993.

Table 2. Estimated number[a] and density (trout/mile)[b] of all brown trout captured by electrofishing in Mammoth Creek, Mono County, California during October 1993.

Site	Number of brown trout	Brown trout per mile
BH	171	3010
BL	151	2658
CL	70	1232
CH	29	510
DL	29	510
DH	60	1056
EH	70	1232
EL	9	158

[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.

For the entire brown trout population captured in 1993, there were three readily discernable length groups. The lowest sized group was comprised of 281 fish ranging from 46 to 106 mm FL, with 91 percent of the fish in this group ranging from 60 to 100 mm FL. Brown trout within the lower size group are most likely YOY fish. The next group included 100 fish ranging from 110 to 153 mm FL and were probably Age I fish. The next group was comprised of 146 fish ranging from 155 to 248 mm FL, and most likely were Age II fish. Fifteen fish were in the 250 to 320 mm FL size range and may represent Age III fish. Although ages of fish were not directly estimated in this study, the length groups of this study correlate well with previous investigations. Average length at annulus formation for brown trout in East Slope Sierra Nevada streams has been reported to range from 84-139 mm FL (Age I), 160-257 mm FL (Age II), and 252-318 mm FL (Age III) (Snider and Linden 1981). In nearby Hot Creek, the average length at annulus formation for brown trout was reported to range from 133-157 mm FL (Age I), 227-243 mm FL (Age II), and 291-317 mm FL (Age III) (Snider and Linden 1981).

Brown trout length-frequency distributions differed among study reaches (**Figures 3 and 4**). Each of the distinct length modes were well represented only in Reach B. Distinct length groups for YOY brown trout were apparent in all four reaches. The YOY group of fish (≤ 106 mm FL) accounted for only 35 percent of the total catch in Reach B, but accounted for 91, 55 and 68 percent of the catch in Reaches C, D, and E, respectively. These results are consistent with those found during 1992 (Hood et al. 1992). Numbers of Age I fish (110-153mm) comprised one-third of the catch in Reach B. By contrast, numbers of Age I fish were low in Reaches C (1%) and E (4%), and virtually absent in Reach

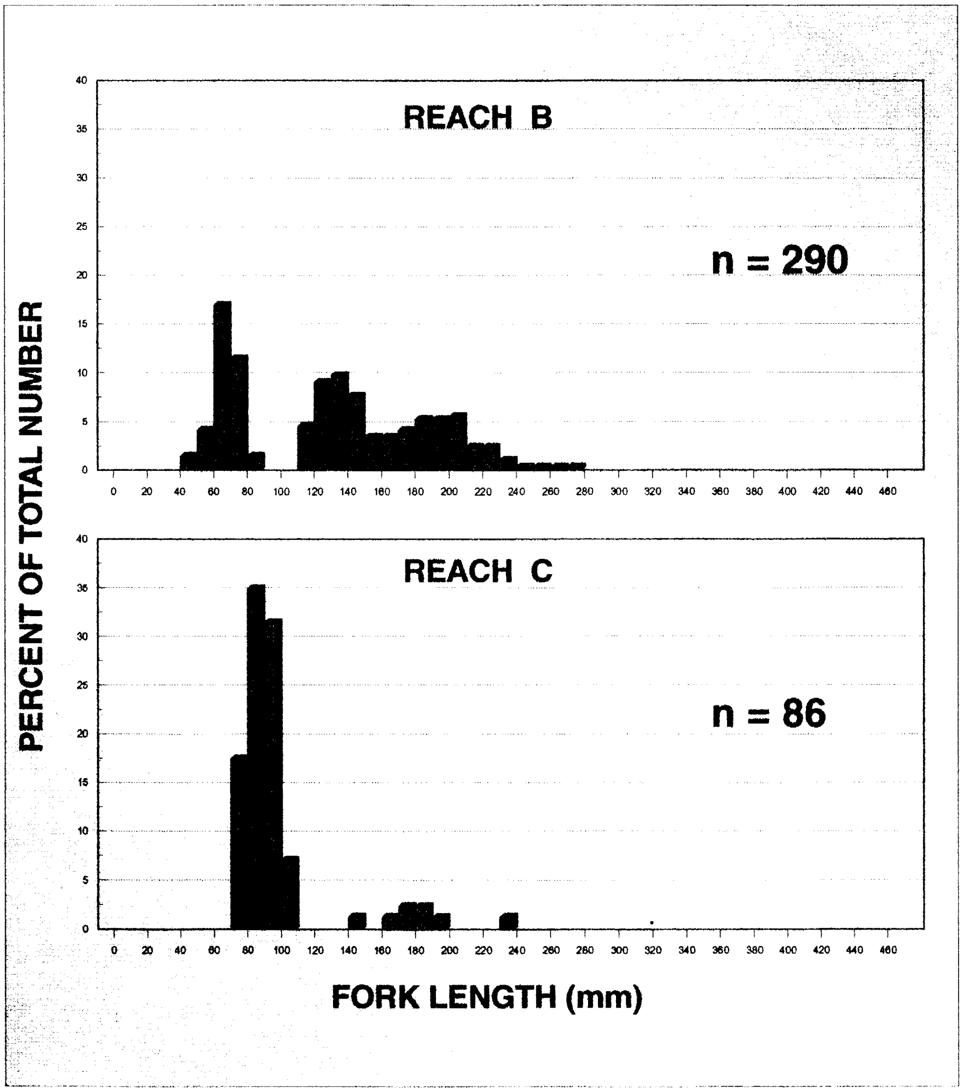

Figure 3. Length-frequency distributions of brown trout captured in Reaches B and C during mid October 1993 in Mammoth Creek.

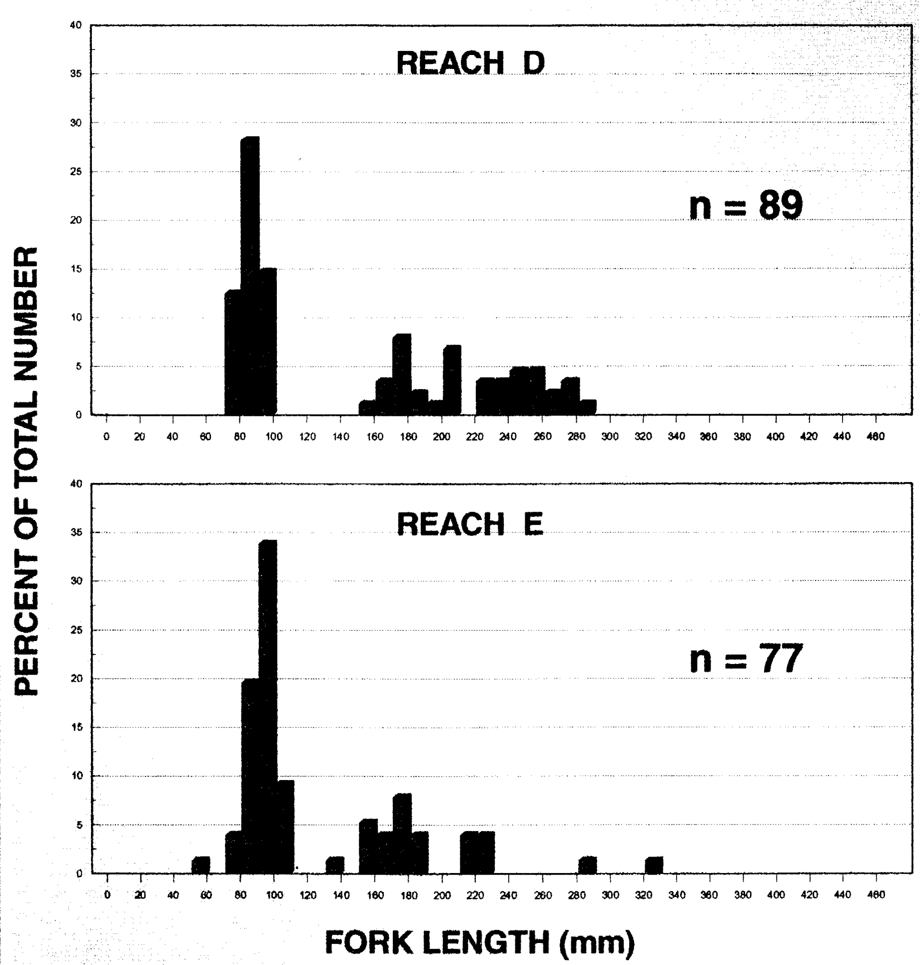

Figure 4. Length-frequency distributions of brown trout captured in Reaches D and E during mid October 1993 in Mammoth Creek.

D. Large brown trout (155+ mm FL) were most abundant in Reaches B, C and D, accounting for 32, 28 and 45 percent of the total catch of brown trout, respectively. By contrast, large brown trout comprised only 8 percent of the total catch in Reach E.

Of the 27 rainbow trout of undetermined origin, sixty-seven percent ranged in length from 49 to 72 mm FL (**Figure 5**). Due to the fact that no fish in this size range have been planted in Mammoth Creek in the last 2 years (D. Redfern, CDFG, pers. comm.), it is believed that these trout were produced in the stream.

DISCUSSION

The overall objective of the 1988 Beak study was to develop flow recommendations that would maintain fish populations in Mammoth Creek in good condition. The objective of the 1992 and the present study is to continue to monitor the condition of the brown trout population in Mammoth Creek. Although the term "good condition" is not well defined, an inherent assumption of the habitat-based approach (IFIM) used in those studies is that fish populations are positively associated with available habitat.

Inferences regarding the "good condition" of the brown trout population in Mammoth Creek can be made by evaluation of available population density and size class structure information. In the 1993 water year, California was relieved of the dry hydrologic conditions which have prevailed over the previous six years. These consecutive dry years resulted in flow conditions in Mammoth Creek that were similar, and in some cases lower than, Beak's recommended minimum bypass flow levels (**Appendix B**). Comparison of the population estimates and size class structure based on data collected before and after these low flow conditions provides an opportunity to evaluate the adequacy of the recommended flows in Mammoth Creek for maintaining fish populations in good condition.

In the present study, brown trout densities (trout per mile) were lower than those found in 1988 in seven of the eight sections sampled, and lower in six of the eight sections sampled in 1992 (**Table 3 and Figure 6**). Averaged over all sampling sites in Mammoth Creek, brown trout densities (trout/mile) were 1232, 1681, and 2290 in 1993, 1992, and 1988, respectively. Although average brown trout densities estimated during the present study compare favorably to nearby creeks, the decrease in density may be related to changes in aquatic habitat characteristics observed at specific sampling sites.

Comparison of trout densities by sampling site between the present study and the 1988 and 1992 investigations reveals generally the same pattern among years, with the notable exception of reduced brown trout densities observed at sampling site EH, The uppermost site in Reach E. The present study estimate of 1232 trout per mile for site EH is 28.8% and 30.9% of the 1988 and 1992 population estimates, respectively. One possible explanation for this decrease is related to a habitat change which has occurred between 1992 and 1993 within this area of Mammoth Creek. In 1992, a large percentage of the streambed within site EH was covered with aquatic vegetation (*Elodea* sp.). A large proportion of the fish captured in 1992 within this site were located within the vegetation. This year, possibly due to the extremely high flows that occurred during the spring of 1993, the vegetation was virtually absent from the site. Given the assumption that the fish populations are positively associated with available habitat, this change in cover could explain the reduced brown trout density observed for site EH this year.

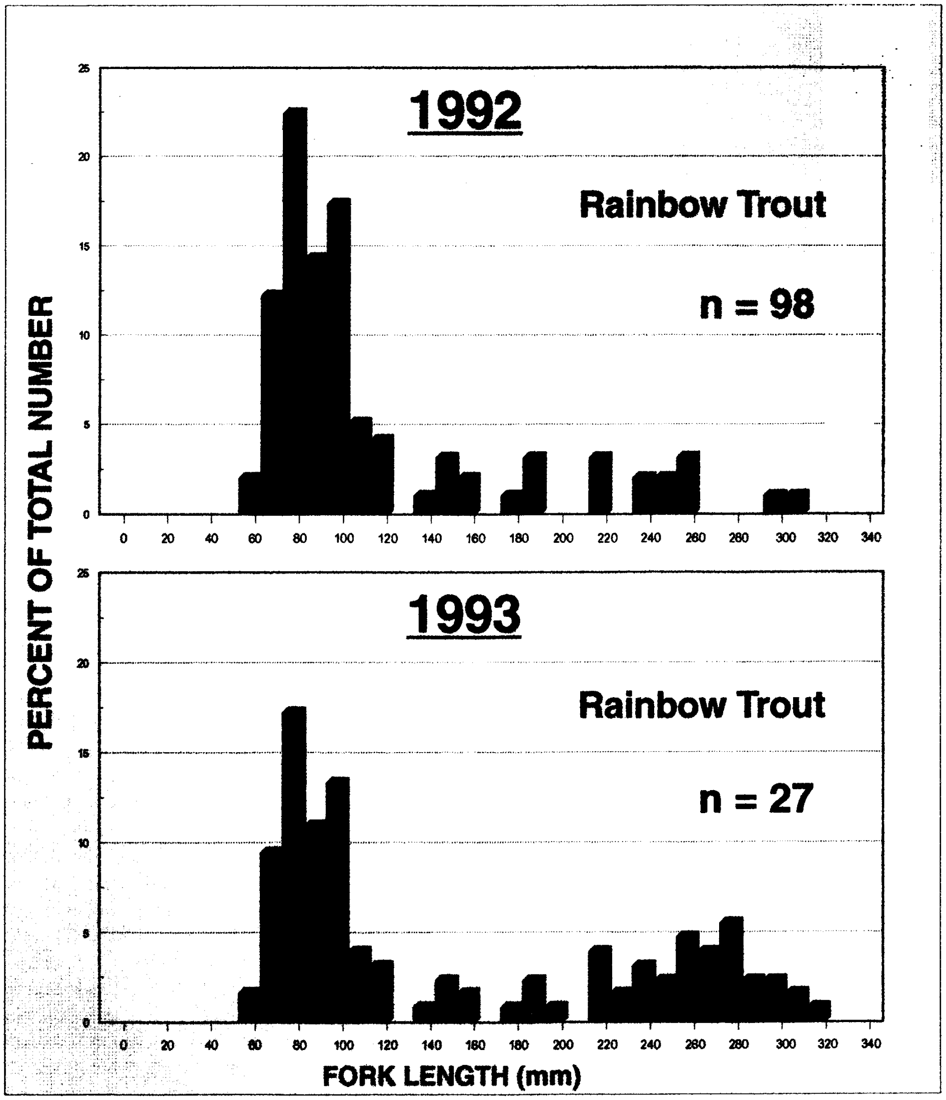

Figure 5. Length-frequency distribution of all rainbow trout (undetermined origin) captured at all electrofishing sites in the Mammoth Creek study area in mid October 1992 and mid October 1993.

Table 3. Population estimates (trout/mile)[a] and 95 percent confidence intervals for brown trout captured by electrofishing Mammoth Creek, Mono County, California from November 2 through 4, 1988, from October 21 through 28, 1992 and from October 11 through 19, 1993.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
BH	1988	2904	3168	3617
	1992	2992	3045	3128
	1993	2582	3010	3437
BL	1988	4488	4699	5028
	1992	1830	1848	1895
	1993	2570	2658	2770
CL	1988	1848	1901	2069
	1992	827	845	906
	1993	1038	1232	1514
CH	1988	1109	1109	1202
	1992	546	563	621
	1993	475	510	609
DL	1988	1056	1056	1122
	1992	1584	1584	1611
	1993	510	510	551
DH	1988	2006	2006	2124
	1992	1338	1390	1482
	1993	1056	1056	1089
EH	1988	4171	4277	4493
	1992	3925	3978	4053
	1993	1197	1232	1305
EL	1988	106	106	479
	1992	194	194	209
	1993	158	158	169

[a] Trout number per stream mile extrapolated from populations estimates.

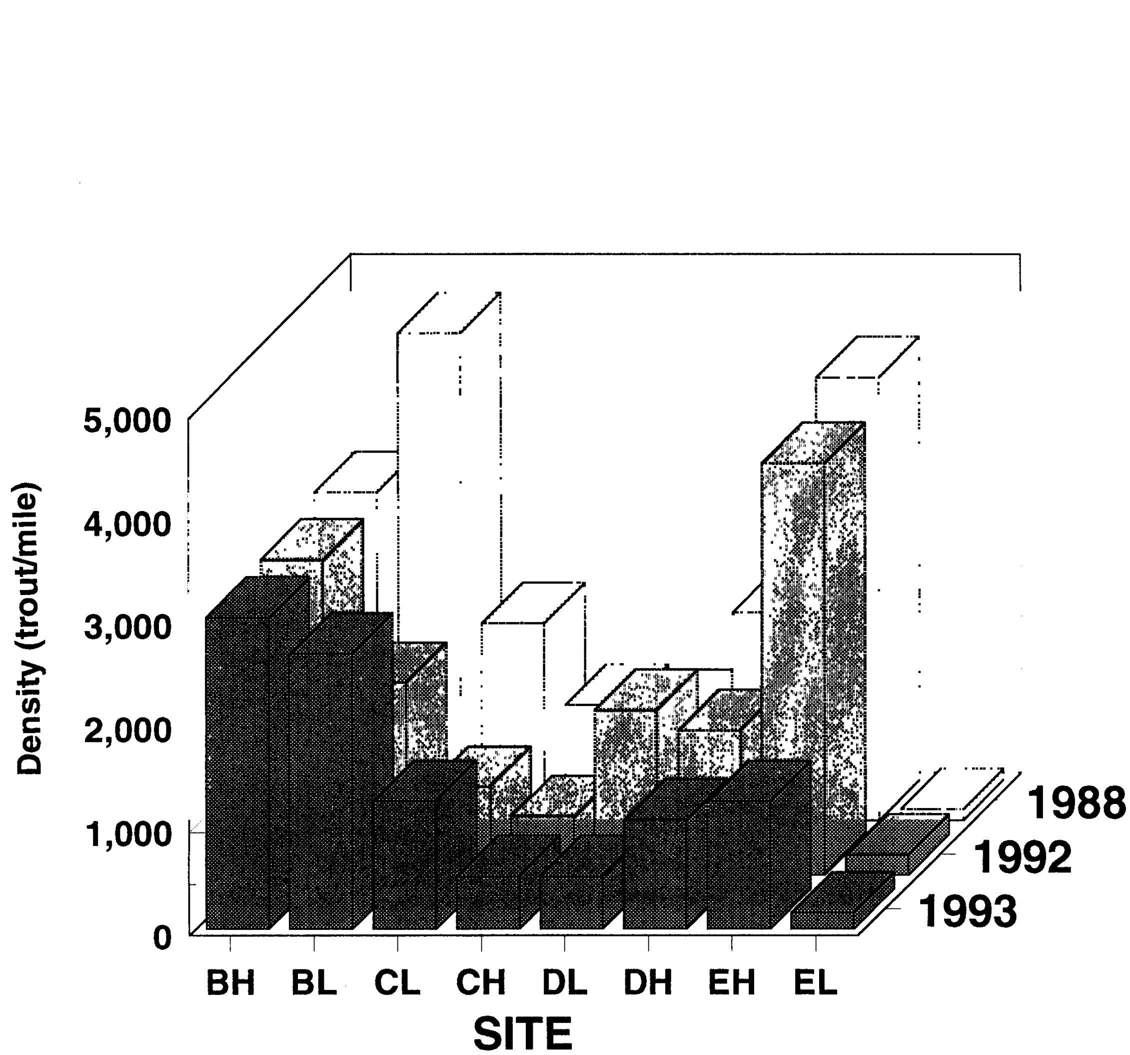

Figure 6. Population density (fish/mile) for brown trout captured by electrofishing Mammoth Creek, Mono County, California from November 2 through 4, 1988, from October 21 through 28, 1992 and from October 12 through 19, 1993.

Average densities for the entire study area in 1993 remain comparable to the results of previous CDFG investigations of Mammoth Creek. Fish population surveys of Mammoth Creek were conducted by CDFG in 1983 and 1984 (Deinstadt et al. 1985) as part of their general survey of streams of the Owens River drainage. These surveys were conducted during and following relatively wet years (sampling site locations are presented in **Figure 7**). Brown trout densities, expressed as number of trout per mile, were as follows:

Sampling Section		Brown trout per mile
1		1,109
2		493
3		2,798
4		704
5		1,707
	Mean =	1,362

CDFG also conducted an electrofishing survey of fish populations in Mammoth Creek on October 24 and 25, 1991.

Sampling Section		Brown trout per mile
Behind Vons		443
At County Bldg.		2,123
Horse Pasture		2,321
Mid-Chance Ranch		1,091
Lowest		0
	Mean =	1,196

Mean brown trout densities calculated from the present study (1,232 trout/mile) are consistent with the CDFG findings during previous years. In addition to comparing favorably with 1983-84 and 1991 CDFG results in Mammoth Creek, the average brown trout densities obtained from Mammoth Creek during 1992 and 1993 compare relatively well to other 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).

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 size class structure of the brown trout population in Mammoth Creek during the past few years, length-frequency data from the present survey were compared to CDFG's 1991 data and to Beak's 1988 and 1992 data (**Figure 8**).

The length-frequency distribution calculated for all brown trout captured during the present (1993) survey exhibited a length-frequency distribution similar to that calculated from the three previous surveys. At least three general size groups of fish were apparent and comprised the vast majority of the observations in all three distributions. The lower group in each distribution most likely represent YOY fish, the middle group represents Age I fish, and the upper group represents Age II fish. The YOY fish in all cases make up the highest proportion of the total catch for all four years. However, YOY fish represented approximately two/thirds of the total catch during 1988 and 1992, but only about one/half during 1991 and 1993. One possible interpretation of the lower percentage of YOY in 1991 is that the relatively low flows (i.e., flows lower than the recommended flows during the brown trout spawning and incubation period) that occurred during the fall and winter of 1990/91 (see Appendix B, runoff year 1990) may have resulted in brown trout spawning success and subsequent recruitment to the population lower than that which occurred in 1987 and 1991. Another possible interpretation of the relatively low proportion of YOY fish captured in 1991 may be attributed to the habitat composition of the CDFG electrofishing sites.

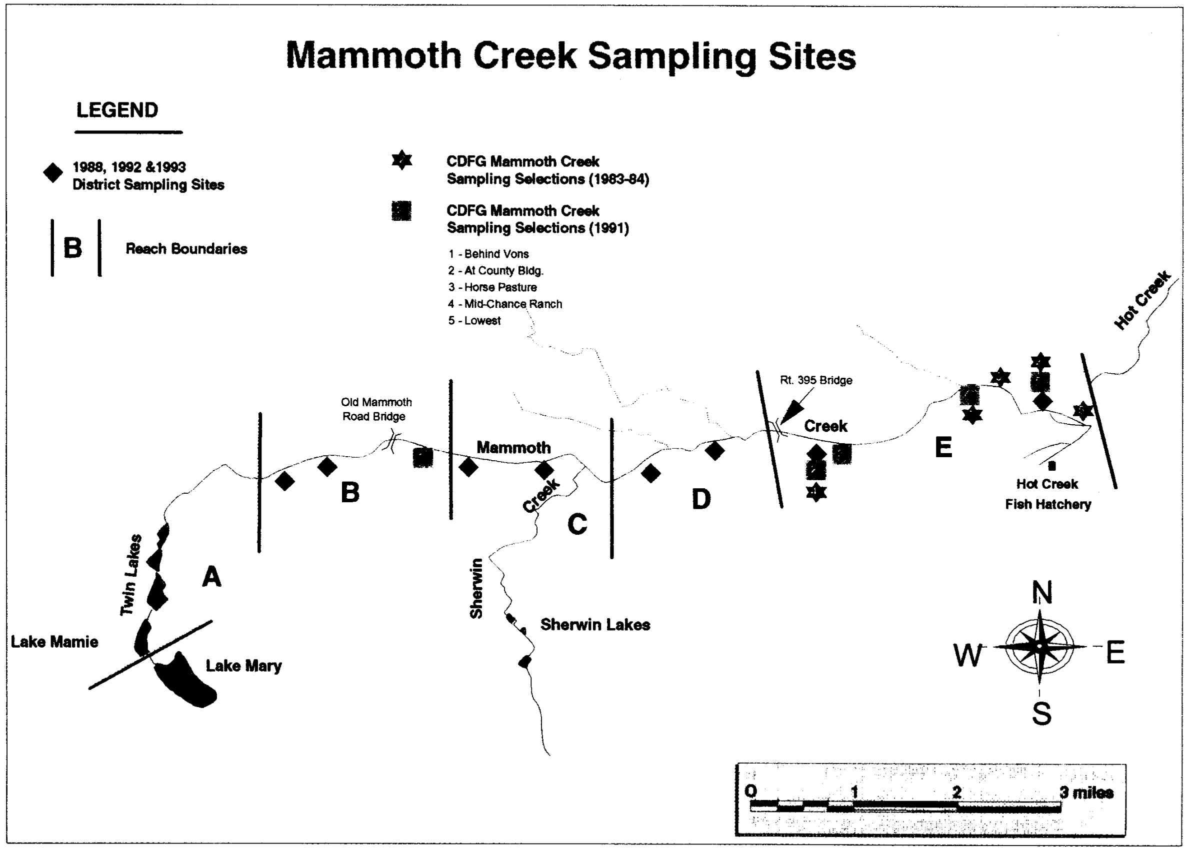

Figure 7. Locations of CDFG 1983-84 and 1991 electrofishing sites in Mammoth Creek, Mono County, California, and their relationship to electrofishing sites sampled by the District during November 1988, October 1992, and October 1993.

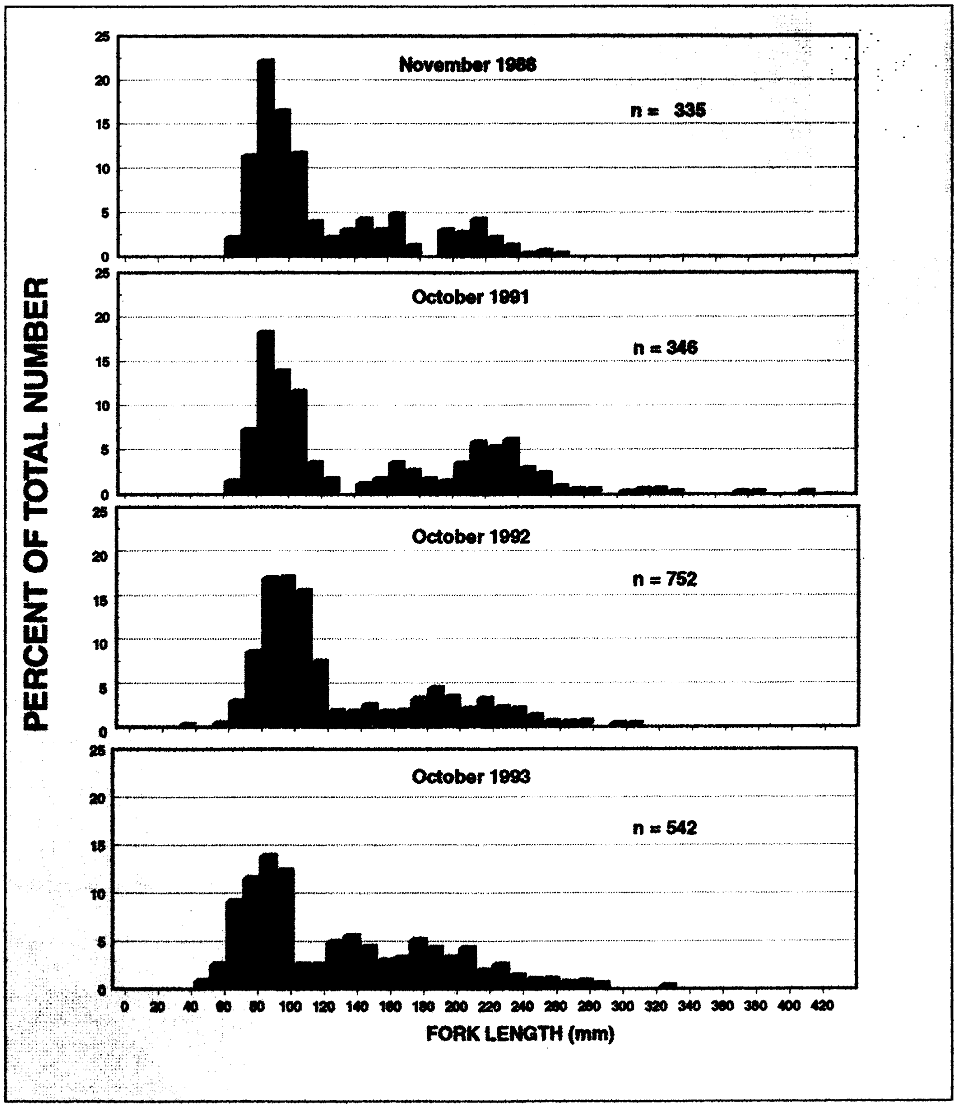

Figure 8. Comparison of brown trout length-frequency distributions from fish collected in Mammoth Creek by electrofishing during November 1988, October 1991, October 1992 and October 1993.

The brown trout length-frequency distribution for CDFG's 1991 data reveal a higher percentage of large fish than were caught in 1988 or 1992. This would suggest that the sites sampled in 1991 may have contained a greater proportion of habitat suitable for large fish than for YOY fish. The lower percentage of YOY fish observed in the 1993 study could be related to the high sustained flows which occurred between May and July of 1993. High spring snowmelt flows, in excess of 140 cfs, may have displaced the YOY fish into lower velocity portions of the creek or even into Hot Creek. Nevertheless, all three length-frequency distributions (considered in conjunction with population density estimates) are suggestive of brown trout populations in good condition.

In 1988, only 9 rainbow trout of undetermined origin were captured over the entire study. CDFG's 1991 study resulted in the capture of only 14 rainbow trout. In 1992, 98 rainbow trout of undetermined origin were captured, 78 percent of which were considered YOY). In 1993, 27 rainbow trout of undetermined origin were captured within the study area. The reduction in the number of YOY captured in the present study supports the explanation for the dominance of brown trout in Mammoth Creek and the relationship of rainbow trout abundance as related to magnitude and timing of spring snowmelt flows. Kondolf et al. (1991) suggest that the spawning and incubation success of brown trout versus that of rainbow trout may be correlated to the annual spring snowmelt in high elevation Sierra streams. Rainbow trout eggs typically remain in the gravel of Owens River tributaries from March through late May or early June, when redds are susceptible to scouring by high snowmelt flows. Brown trout eggs, however, typically remain in the gravel from November until March, before high snowmelt scouring would occur. Therefore, rainbow trout spawning success in Mammoth Creek during 1992 (as evidenced by the relatively high number of YOY rainbow trout captured) may be higher due to the extreme low flow conditions associated with the 1992 spring snowmelt period, and that the lower YOY recruitment to the population observed in 1993 may have resulted from the scouring flows of May, June, and July of 1993.

CONCLUSIONS

- Brown trout density and age structure (length-frequency) information obtained from the electrofishing survey conducted in October 1993 suggest that the brown trout population in Mammoth Creek is in good condition. The data indicate: 1) relatively high densities of fish; 2) successful reproduction; and, 3) long-term survival.
- Habitat changes as a result of hydrologic conditions may result in local fluctuations of population density and size class structure within a given sampling site.
- The low flow conditions during the spring of 1992 may have improved rainbow trout spawning and incubation success, whereas high flow conditions in the spring of 1993 may have depressed YOY rainbow trout recruitment to the population.

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Appendix A

Maximum-Likelihood
Catch Statistics

Stream: Mammoth Creek - Site BH
Species: Brown Trout

Removal Pattern: 78 42 24
Total Catch = 144
Population Estimate = 171

Chi Square = 0.046
Pop Est Standard Err = 12.321
Lower Conf Interval = 146.728
Upper Conf Interval = 195.272

Capture Probability = 0.457
Capt Prob Standard Err = 0.061
Lower Conf Interval = 0.338
Upper Conf Interval = 0.577

Stream: Mammoth Creek - Site CH
Species: Brown Trout

Removal Pattern: 14 11 2
Total Catch = 27
Population Estimate = 29

Chi Square = 2.829
Pop Est Standard Err = 2.749
Lower Conf Interval = 27.000
Upper Conf Interval = 34.630

Capture Probability = 0.563
Capt Prob Standard Err = 0.122
Lower Conf Interval = 0.313
Upper Conf Interval = 0.812

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 23.37033.

Stream: Mammoth Creek - Site BL
Species: Brown Trout

Removal Pattern: 102 32 12
Total Catch = 146
Population Estimate = 151

Chi Square = 0.165
Pop Est Standard Err = 3.211
Lower Conf Interval = 146.000
Upper Conf Interval = 157.358

Capture Probability = 0.673
Capt Prob Standard Err = 0.044
Lower Conf Interval = 0.586
Upper Conf Interval = 0.759

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 144.6424.

Stream: Mammoth Creek - Site CL
Species: Brown Trout

Removal Pattern: 31 18 10
Total Catch = 59
Population Estimate = 70

Chi Square = 0.075
Pop Est Standard Err = 8.037
Lower Conf Interval = 59.000
Upper Conf Interval = 86.035

Capture Probability = 0.454
Capt Prob Standard Err = 0.095
Lower Conf Interval = 0.263
Upper Conf Interval = 0.644

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 53.96523.

Stream: Mammoth Creek - Site DH
Species: Brown Trout

Removal Pattern: 46 11 3
Total Catch = 60
Population Estimate = 60

Chi Square = 0.292
Pop Est Standard Err = 0.947
Lower Conf Interval = 60.000
Upper Conf Interval = 61.895

Capture Probability = 0.779
Capt Prob Standard Err = 0.056
Lower Conf Interval = 0.668
Upper Conf Interval = 0.891

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 58.10503.

Stream: Mammoth Creek - Site EH
Species: Brown Trout

Removal Pattern: 46 18 4
Total Catch = 68
Population Estimate = 70

Chi Square = 0.715
Pop Est Standard Err = 2.087
Lower Conf Interval = 68.000
Upper Conf Interval = 74.163

Capture Probability = 0.680
Capt Prob Standard Err = 0.063
Lower Conf Interval = 0.554
Upper Conf Interval = 0.806

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 65.83652.

Stream: Mammoth Creek - Site DL
Species: Brown Trout

Removal Pattern: 19 8 2
Total Catch = 29
Population Estimate = 29

Chi Square = 0.828
Pop Est Standard Err = 1.120
Lower Conf Interval = 29.000
Upper Conf Interval = 31.294

Capture Probability = 0.707
Capt Prob Standard Err = 0.093
Lower Conf Interval = 0.516
Upper Conf Interval = 0.899

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 26.70557.

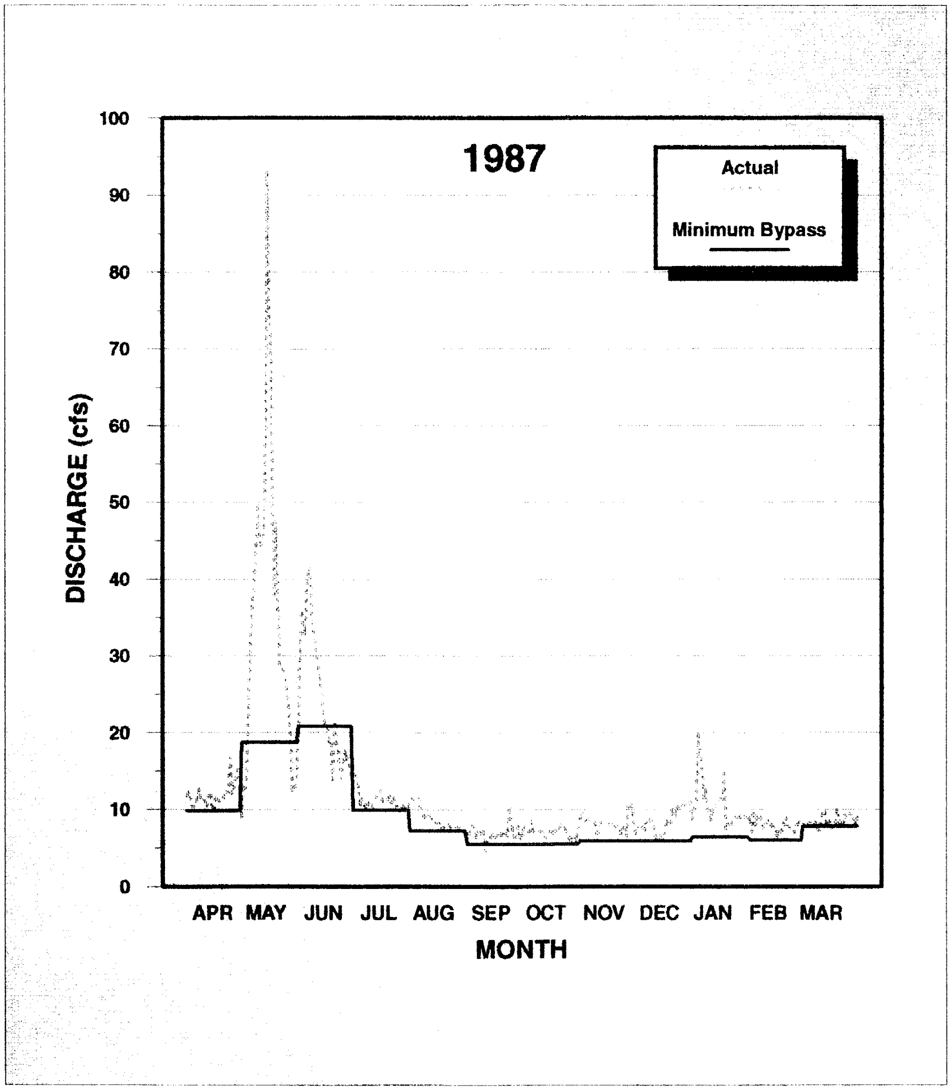
Stream: Mammoth Creek - Site EL
Species: Brown Trout

Removal Pattern: 7 2 0
Total Catch = 9
Population Estimate = 9

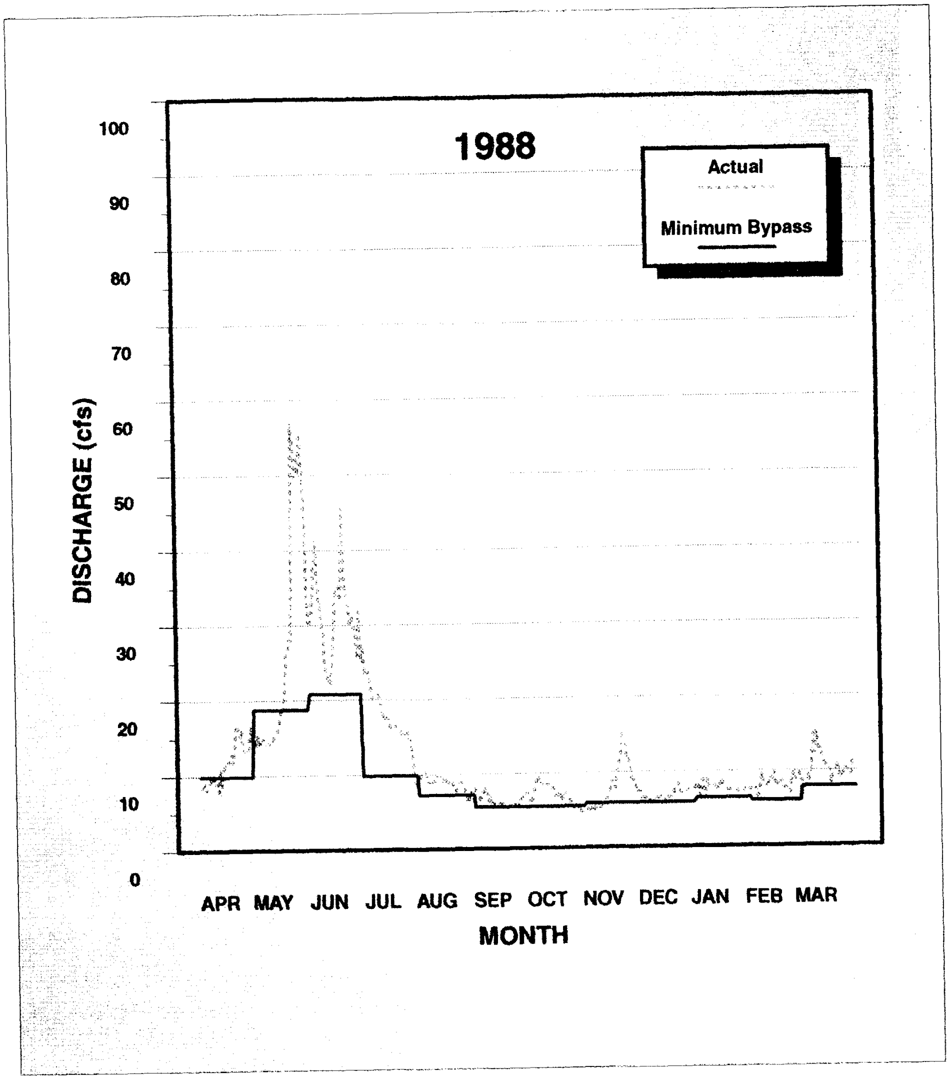
Chi Square = 0.588
Pop Est Standard Err = 0.261
Lower Conf Interval = 9.000
Upper Conf Interval = 9.602

Capture Probability = 0.818
Capt Prob Standard Err = 0.131
Lower Conf Interval = 0.517
Upper Conf Interval = 1.119

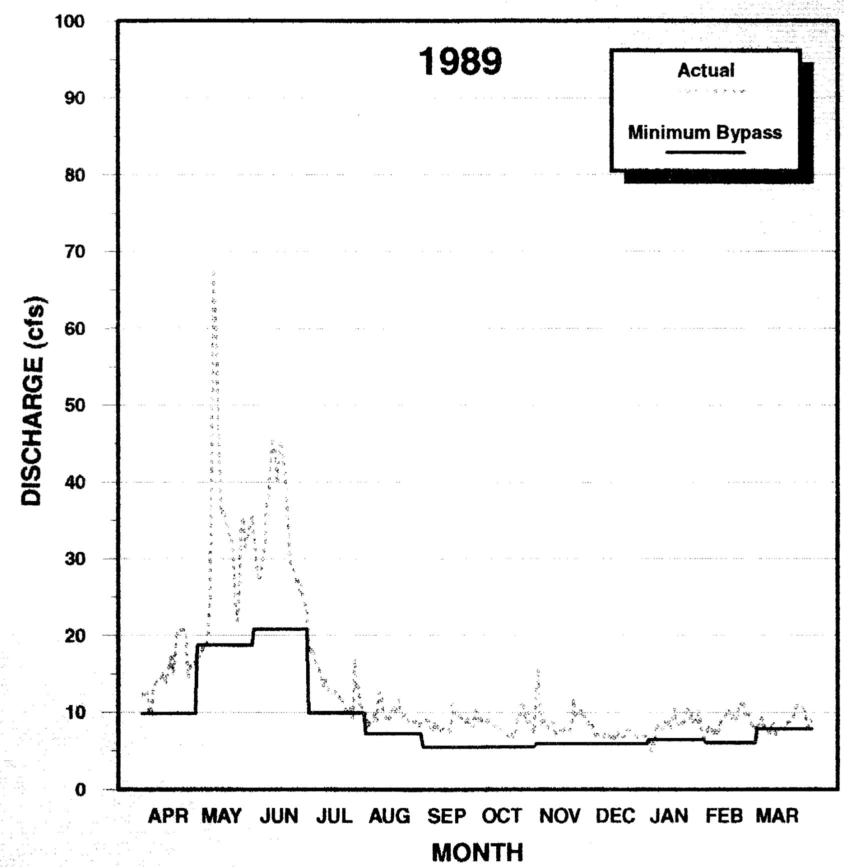
The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 8.397953.



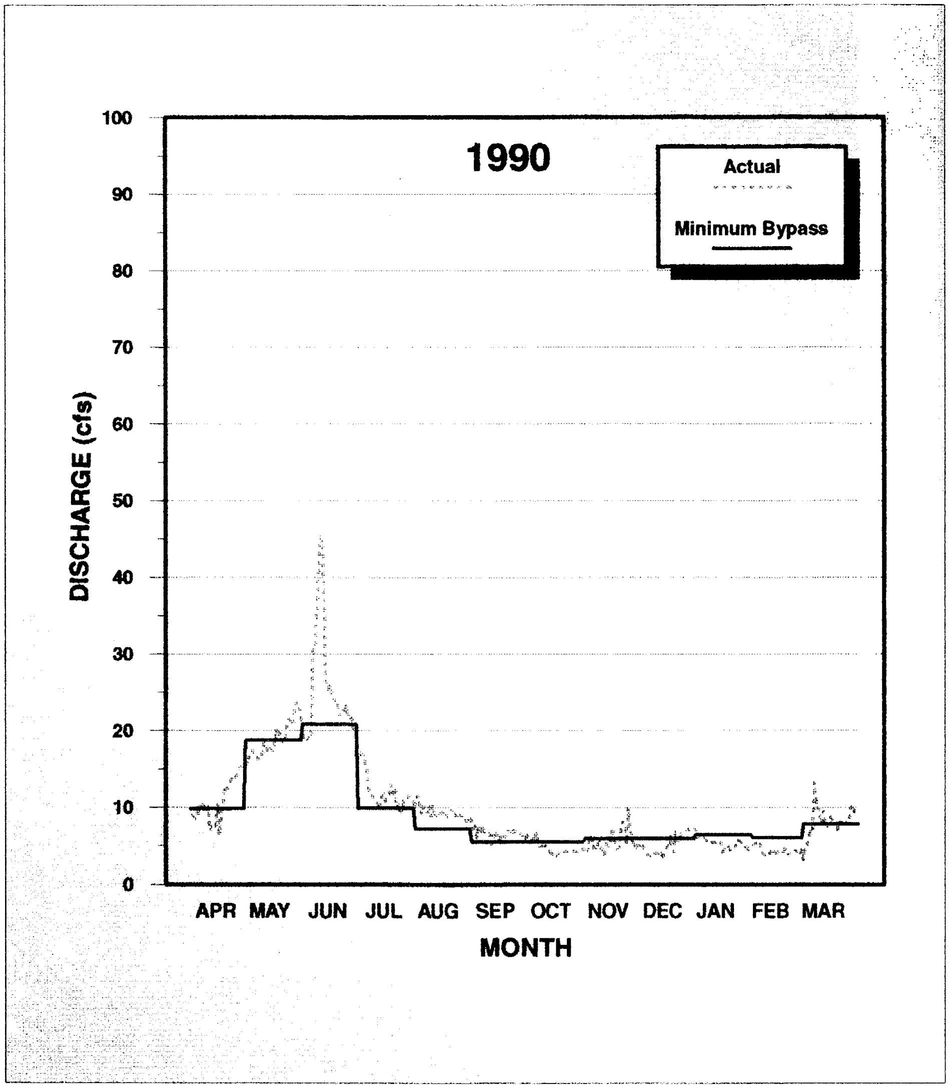
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1987 and the recommended operational minimum mean daily bypass flow regime.



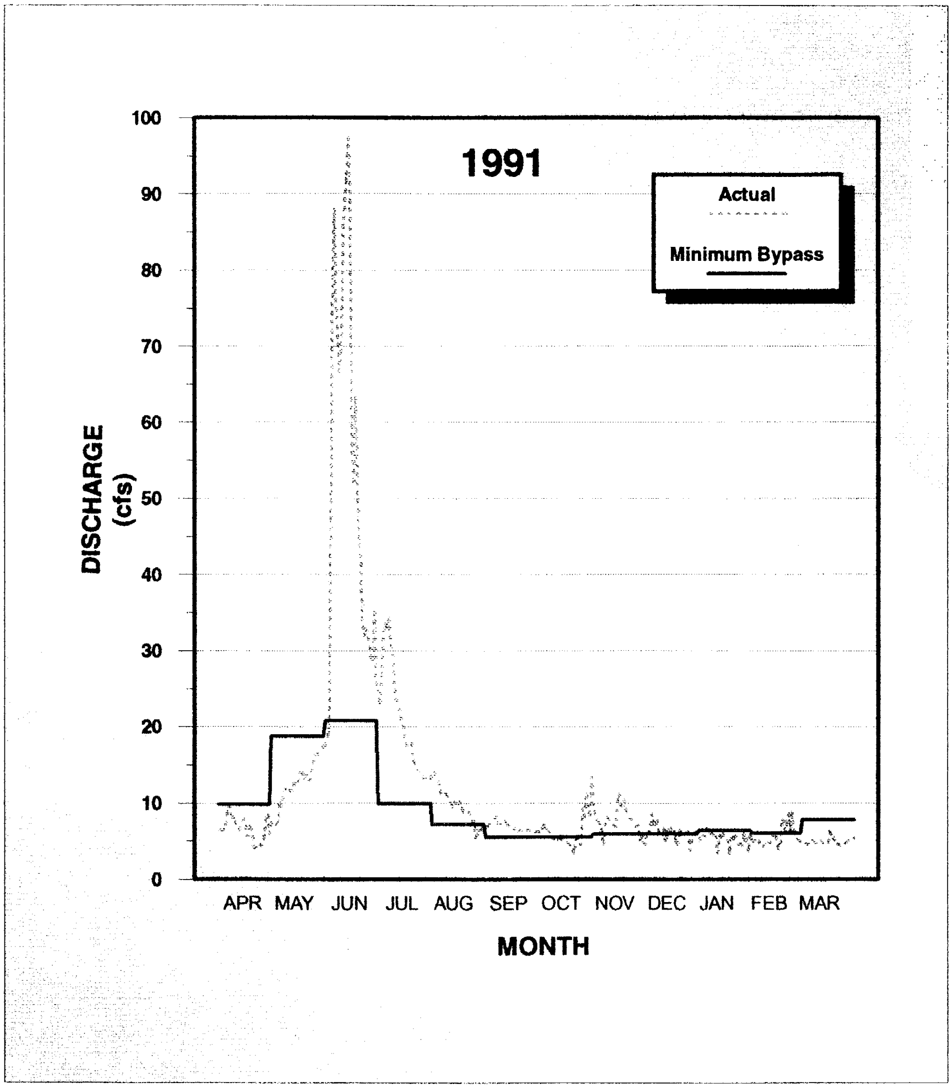
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1988 and the recommended operational minimum mean daily bypass flow regime.



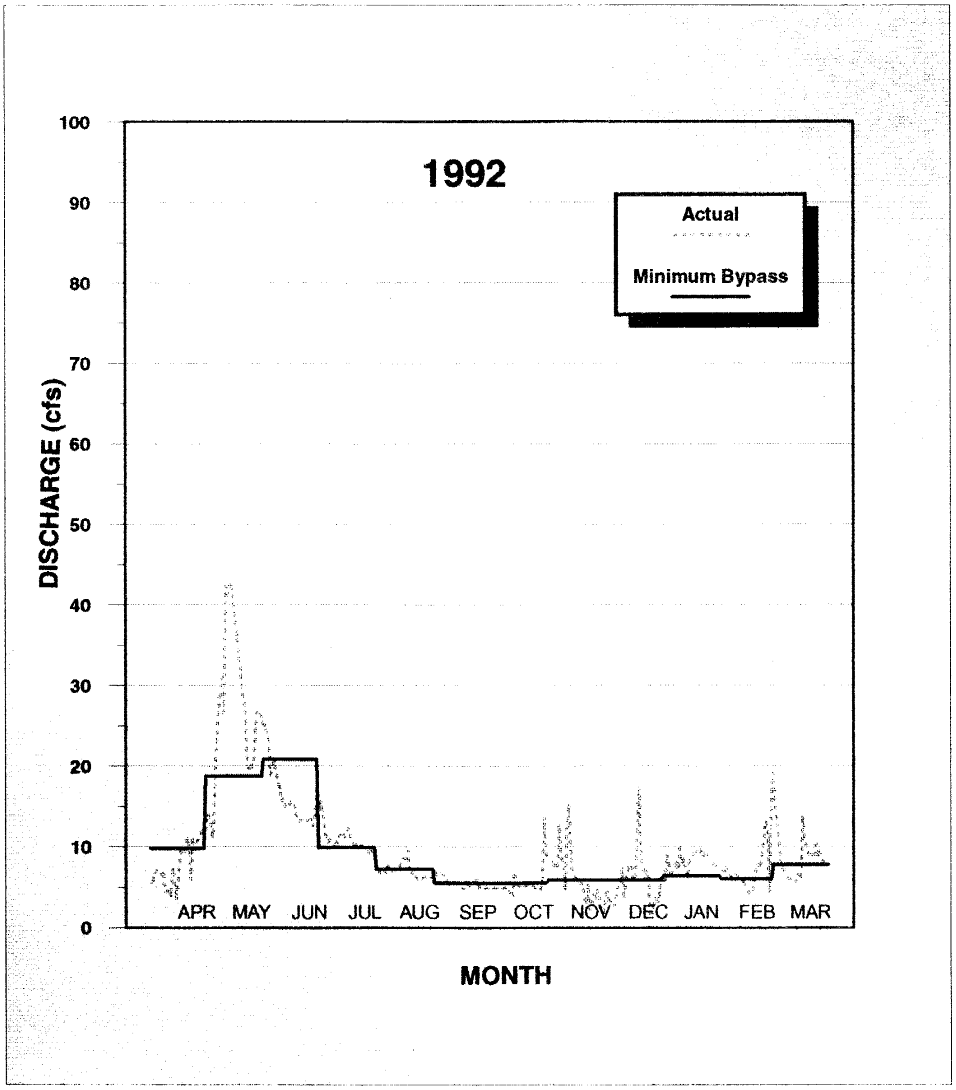
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1989 and the recommended operational minimum mean daily bypass flow regime.



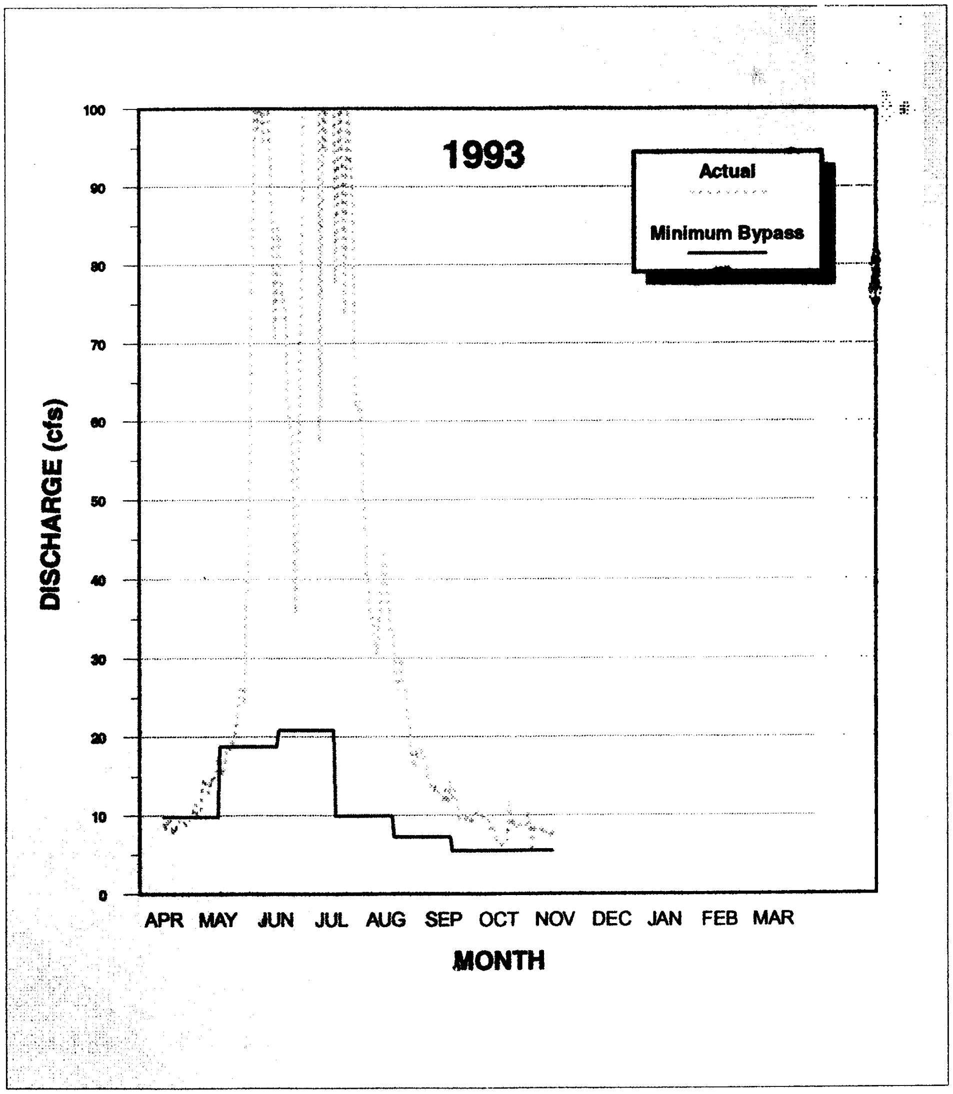
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1990 and the recommended operational minimum mean daily bypass flow regime.



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 flow 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 flow 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 flow regime.