MAMMOTH CREEK 1995

FISH COMMUNITY SURVEY

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INTRODUCTION

Fishery resource needs and the establishment of instream flow requirements remain significant issues for Mammoth Creek in Mono County, California. Mammoth Community Water District (MCWD) has conducted comprehensive, quantitative studies of instream flows, habitat availability, and fish populations in Mammoth Creek, resulting in suggestions for a "minimum bypass flow regime" and several years of fish population data. (Hood et al. 1992, 1993, 1994). The fish data have been used to evaluate fluctuations in "condition" of the resident trout populations as hydrologic conditions change from year to year.

We report here the results of continued Mammoth Creek fish community monitoring, carried out from 1-7 November, 1995. The specific objectives of this study were: (1) to compare population densities and age structures of trout among stream reaches, and among years for stream reaches and the combined study area; (2) to correlate these interannual changes in Mammoth Creek fish populations with changes in hydrologic conditions, and (3) to interpret these data in terms of "condition" of the Mammoth Creek brown trout population, particularly as it might be related to flow regime.

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 (Fig. 1). Previous fish population studies have concentrated on the lower 8.9 miles, where stream discharge is apparently considered most likely to influence the amount of trout habitat (Bratovich et al. 1992; Hood et al. 1993). This lower stream area has been divided into four contiguous stream *reaches*, each of which contains two randomly located *sampling sections* or *electrofishing sites* for assessment of fish populations (one high riparian cover, one low riparian cover, Bratovich et al. 1990).

The downstream boundary of all but one sampling section has remained the same through the 1988, 1992-94 and the present 1995 surveys, although the 1988 sections covered 100 feet of channel and the 1992-1995 sections are nominally 300 feet in length (Bratovich et al. 1990; Hood et al. 1992). The lowermost section was not accessible this year, so we established an alternate site extending 300 feet downstream from the boundary of U.S. Forest Service land, just upstream from the confluence of Mammoth and Hot Creeks (Fig. 1). This section is most nearly comparable to Section 5 in Deinstadt et al. (1985).

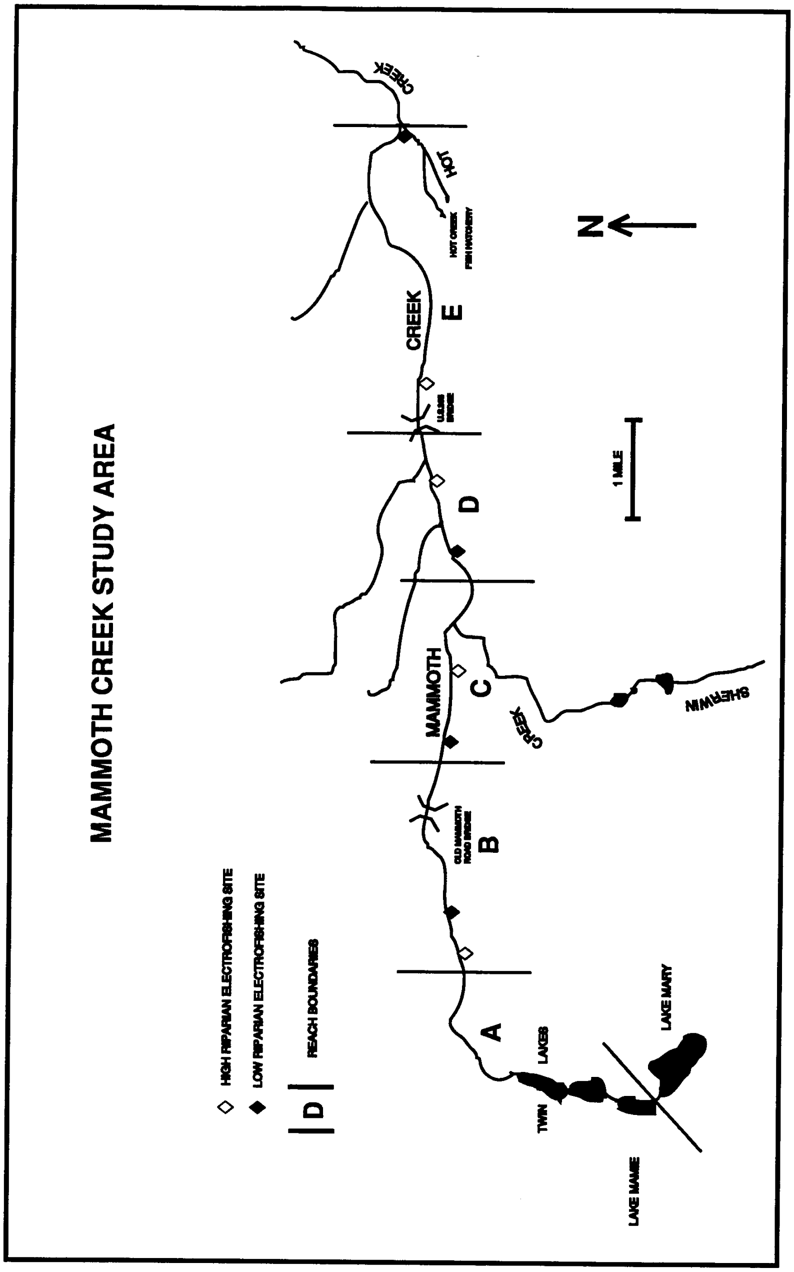

Figure 1. Electrofishing sites on Mammoth Creek, November, 1995 (modified from Hood et al. 1993).

MATERIALS AND METHODS

Selection of Sampling Sites

For compatibility with previous reports, we utilized the same "representative" electrofishing sites established by Beak Consultants Incorporated (Beak), the firm that designed and carried out past population studies on Mammoth Creek (see Bratovich et al. 1990 for rationale of site selection). These sampling sections were located for us a day or more prior to operations by D.B. Christophel of Beak. At this time, we sank lengths of 0.5 inch rebar in the banks at the upstream and downstream ends of each site to mark the boundaries and to help anchor block nets.

The Sampling Section CL described to us was actually 360 feet in length rather than 300 feet, but we did not discover Beak's error until well into the first electrofishing "pass" (see below). Due to the relative uniformity of trout habitat along the Creek, we decided that utilizing the longer section for all passes would not significantly affect density estimates, and was in any case the only acceptable alternative to abandoning the section.

Collection Methods

On census days, we simultaneously placed block nets of 0.125 inch stretched mesh at the upstream and downstream ends of a section to prevent fish from moving across the boundaries. We captured fish with a Smith-Root Type 12 portable electrofisher, our crew typically consisting of one person operating the anode, two persons with nets flanking the operator, one person receiving, transporting and processing fish, and a person maintaining the block nets. We collected fish in a series of "passes", consisting of shocking across the downstream net, proceeding in a "zig-zag" pattern to the upper net, shocking across the upper net, then passing once again across the lower net to capture any fish that were impinged there by the current. Because multiple-pass depletion estimates of populations assume equal "effort" on each pass, we standardized the technique and elapsed time as much as possible.

Addition of salt to increase conductivity for electrofishing was contemplated, but a preliminary test of our electrofishing gear indicated more than ample electrolyte concentration for efficient collecting. Since both electrofishing and salt addition cause increased downstream "drift" of trout food organisms (T. Jenkins, unpub. observ.), we chose to eliminate the unnecessary procedure.

We collected fish in 3 gallon buckets and transfered them to submerged mesh bags outside the electrofishing field until time was available for processing. Young-of-Year (YOY) were stored separately to prevent cannibalism. As time permitted, we slowed the fish with CO_2 (if necessary), identified them to species, measured their fork length to the nearest millimeter and weighed them to the nearest 0.1 gram. Fish of hatchery origin were tentatively distinguished from wild fish by typical deformation of dorsal fin rays and other, more subjective, aspects of their appearance. Non-salmonid fish were identified and counted, but we measured only those fish from the first passes. At the termination of electrofishing, we returned fish to the stream.

Population Estimation

For consistency with previous Mammoth Creek studies (Hood et al. 1993, 1994), we estimated trout numbers in sampling sections with a multiple-pass depletion algorithm executed by Microfish software (Van Deventer and Platts 1986), then extrapolated to fish/mile densities for comparision with prior censuses (Bratovich et al. 1990; Hood et al. 1992, 1993, 1994). We also combined data from the Beak studies and the present study to estimate rainbow trout population densities, although the results are less precise due to low numbers encountered at most sites.

The numbers of YOY surviving their first summer, particularly in relation to the numbers of older fish, give additional insight concerning reproductive success. Consequently, in a separate analysis, we divided the fish from each electrofishing pass into YOY and ≥1+ components, and estimated YOY numbers by the depletion method noted above. Since they were often too few to support a separate analysis, we estimated the numbers of older fish by subtraction of the YOY estimate from the total population estimate. Although trout were not aged directly, separation of YOY from older fish on the basis of length appeared unambiguous within individual reaches. The first (presumptive YOY) and second length modes rarely overlapped, as was often the case with subsequent size classes (e.g., Hood et al. 1993, 1994).

Analysis of Size Distribution

We sorted fork lengths of trout into 10 millimeter size intervals and plotted them on frequency histograms. In this manner, we compared size (and inferred age) distributions of brown and rainbow trout among reaches for 1995 and among years for the entire study area.

RESULTS

Species Composition and Relative Abundance in Samples

We captured 452 fish from four species, ranking in abundance: brown trout (256, 57%), tui chubs (69, 15%), rainbow trout (69, 15%), and Owens suckers (58, 13%) (Table 1). Tui chubs and suckers were found only in Reach E (almost exclusively in EL). According to our length analysis (not presented here), tui chubs in the sample were primarily YOY, whereas suckers were mostly yearlings or older.

We found small numbers of "wild" rainbow trout in all sections but BL, and they were accompanied by apparent hatchery plants in all sections but BH. Most of the larger fish appeared to be of hatchery origin (Fig. 2). 56% of the presumed wild rainbow trout and 64% of the presumed hatchery rainbow trout were living in "low riparian" habitats (Table 1). In contrast, only 38% of the brown trout were found in "low riparian" habitats.

Trout Population Estimates

Estimated brown trout population densities varied from 18 to 1760 fish/mile in the sampling sections, with the greatest numbers occurring in the highest and lowest elevation sections (Table 2 and Appendix A). Density averaged 761/mile in the "high riparian" sections and 423/mile in the "low riparian" sections. If data from the new Section EL are excluded, brown trout from the low riparian sections average 217/mile.

Presumed wild rainbow trout were much less abundant than brown trout in all sections but CL and DL, their densities ranging from 0 to 194/mile (Table 2). Like brown trout, they were most abundant at the highest and lowest elevation sections. Wild rainbow trout density averaged 71/mile in the high riparian sections and 85/mile in the low riparian sections.

Trout Size Distribution

The most abundant brown trout size class, ranging from 49 to 113 mm fork length and accounting for 46% of the 256 brown trout captured, presumably consisted of young-of-year (YOY) (Fig. 3). A second size class (presumably yearlings) ranged from 121 to 160 mm fork length, and accounted for 14% of the total. A third size class (32% of total) ranged from 166 to 261 mm FL and were probably 2 years old. The remaining 20 individuals (8%) ranged from 268 to 460 mm fork length, and were probably at least 3 years old.

Table 1. Electrofishing results in Mammoth Creek, Mono County, California, 1- 7 November, 1995.

COMMON NAME	SCIENTIFIC NAME	REACH	COVER HIGH	COVER LOW	TOTAL
brown trout	*Salmo trutta*	B	94	30	124
		C	17	6	23
		D	32	1	33
		E	17	59	76
		TOTAL	160	96	256
rainbow trout (presumed wild)	*Oncorhynchus mykiss*	B	9	0	9
		C	3	4	7
		D	1	5	6
		E	3	11	14
		TOTAL	16	20	36
rainbow trout (presumed hatchery)	*Oncorhynchus mykiss*	B	0	0	0
		C	7	9	16
		D	1	5	6
		E	4	7	11
		TOTAL	12	21	33
brook trout	*Salvelinus fontinalis*	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	0	0
		TOTAL	0	0	0
tui chub	*Gila bicolor*	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	69	69
		TOTAL	0	69	69
Owens sucker	*Catostomus fumeiventris*	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	1	57	58
		TOTAL	1	57	58
			GRAND TOTAL		452

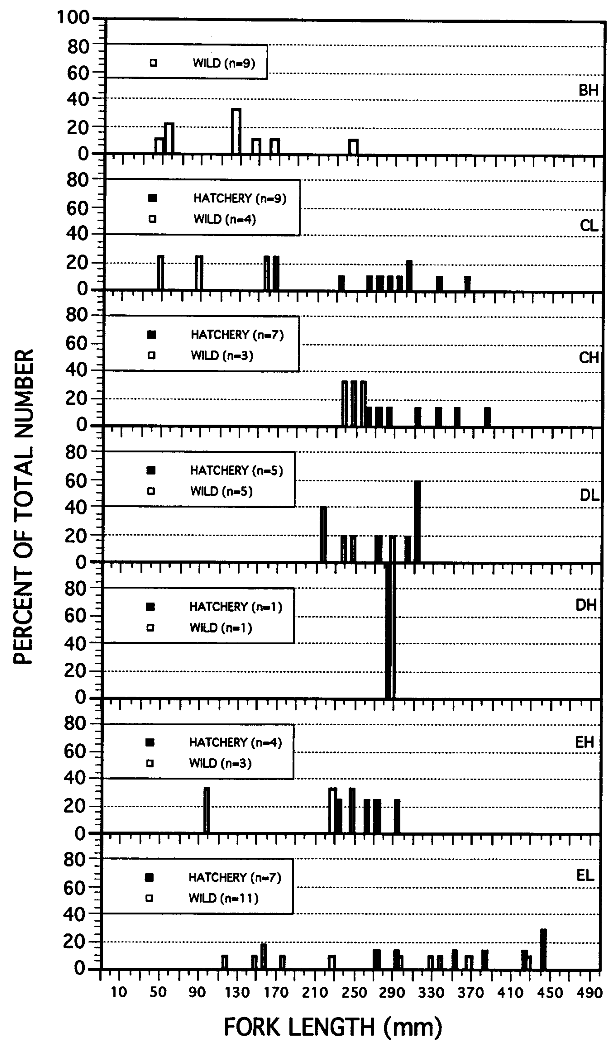

Figure 2. Length distributions of "wild" and "hatchery" rainbow trout in Mammoth Creek, 1- 7 November, 1995. No rainbow trout were captured in Section BL. Tick marks are the upper boundaries of size intervals. For example, 210 is the upper boundary of the size class >200 mm but ≤210 mm.

Table 2. Estimated numbers, by section, and extrapolated densities (trout/mile) of brown and presumed wild rainbow trout captured by electrofishing in Mammoth Creek, Mono County, California, 1- 7 November, 1995.

SECTION	BROWN TROUT PER SECTION	BROWN TROUT PER MILE	RAINBOW TROUT PER SECTION	RAINBOW TROUT PER MILE
BH	100	1760	9	158
BL	31	546	0	0
CH	19	334	3	53
CL	6	88	4	59
DH	35	616	1	18
DL	1	18	5	88
EH	19	334	3	53
EL	59	1038	11	194

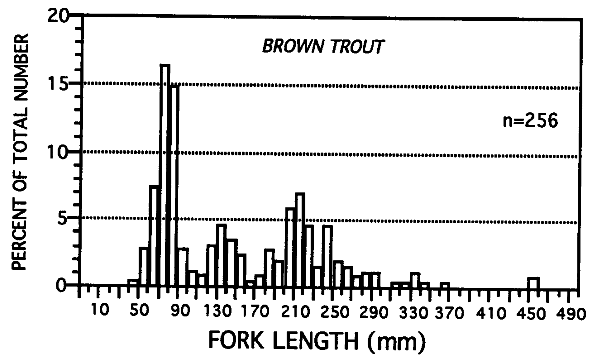

Figure 3. Length-frequency distribution of all brown trout captured at 8 electrofishing sites in the Mammoth Creek study area, 1 through 7 November, 1995. Size intervals are 10 millimeters. Tick marks are the upper boundaries of size intervals. For example, 210 is the upper boundary of the size class >200 mm but ≤210 mm.

The size distribution of brown trout in Reach B was similar to the composite picture (44% YOY), whereas brown trout in Reaches C and D were mostly YOY (78 and 91%), and brown trout in Reach E were primarily older, larger fish (only 21% YOY) (Fig. 4). However, analysis by individual sections (Fig. 5) shows that the size distribution of brown trout in Section EH was similar to that in upstream sections, whereas YOY were almost absent and large fish were exceptionally numerous in the new Section EL. It also appears that the apparent overlap of presumptive age classes 0+ (YOY) and 1+ in Fig. 4 was due to a slight upward shifting of the YOY size distribution with decreasing elevation, a trend evident in earlier studies (Fig. 5; Hood et al. 1993, 1994).

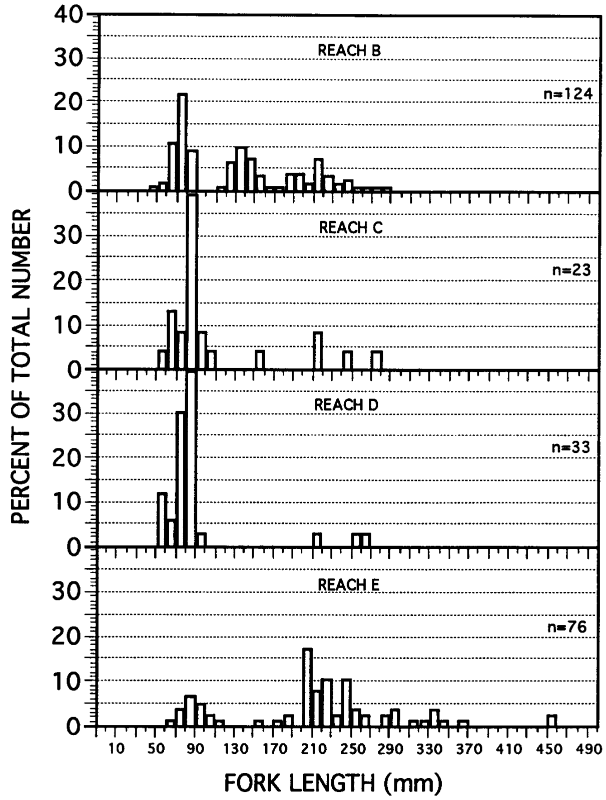

Figure 4 Length-frequency distributions of brown trout captured by electrofishing in Reaches B, C, D, and E of Mammoth Creek, 1 through 7 November, 1995. Size intervals are 10 millimeters. Tick marks are the upper boundaries of size intervals. For example, 210 is the upper boundary of the size class >200 mm but ≤210 mm.

The rainbow trout population contained a smaller proportion of YOY (19%) than the brown trout population, and no YOY were collected in 3 of the 7 sections where rainbow trout were present (Fig. 2). As was the case with brown trout, all of the presumed wild rainbow trout over 300 mm in length resided in the lowermost section.

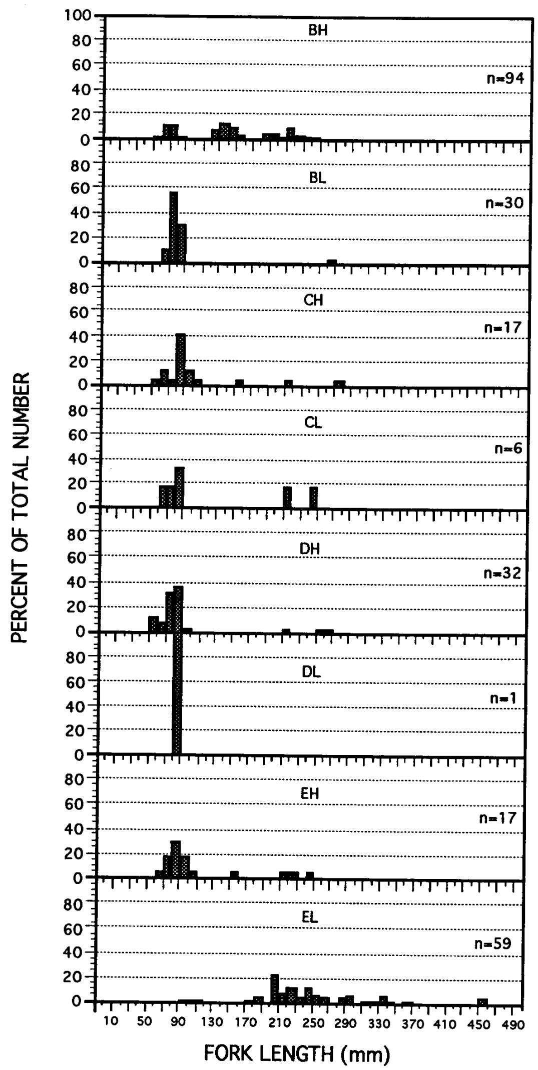

Fig. 5. Length distributions of brown trout captured in 8 sampling sections on Mammoth Creek, 1-7 November, 1995. Tick marks are the upper boundaries of size intervals. For example, 210 is the upper boundary of the size class >200 mm but ≤210 mm.

DISCUSSION

Species Composition

Among native and non-native fishes in the Mammoth Creek study area, the European brown trout (*Salmo trutta*) evidently finds conditions most favorable. Rainbow trout (*Oncorhynchus mykiss*), although native elsewhere in California, seem rarely to exceed 10% of the trout community, and brook trout (*Salvelinus fontinalis*) from the eastern U.S. were not found in the study reaches this year. Tui chubs and suckers were collected only in the two most downstream sections of the creek.

Brown and Rainbow Trout Populations

Trout populations in Mammoth Creek were depressed in 1995 relative to most other years for which data are available. Brown trout densities averaged less than one-half of the previous low in 1993, and one-fourth of the high in 1988. Average rainbow trout density was slightly higher than in 1993, but less than 18% of the high in 1994. Brown trout continue to dominate the trout community, accounting for 88% of the estimated numbers (Table 3).

Table 3. Estimated average population densities for brown and presumed wild rainbow trout in Mammoth Creek. Numbers in parentheses eliminate data from Section EL, a different location from previous studies. 1988-1994 data from Beak.

YEAR	BROWN TROUT PER MILE	RAINBOW TROUT PER MILE
1995	**592 (528)**	**78 (61)**
1994	2079	437
1993	1289	57
1992	1681	222
1988	2290	60

Year-to-year fluctuations in Mammoth Creek brown trout population density have consisted largely of variations in YOY density, with the adult population remaining relatively stable (Fig. 6). In 1988, 1992 and 1994 brown trout YOY were relatively abundant compared to older fish, whereas in 1991, 1993 and 1995 the proportions of YOY were down (Fig. 7). The same alternation of density perhaps characterized rainbow trout during the same period, but we have no data for 1991 (Fig. 8).

PRECIP: 1988 = 40% 1991 = 85%
1992 = 68% 1993 = 169%
1994 = 53% 1995 = 168%

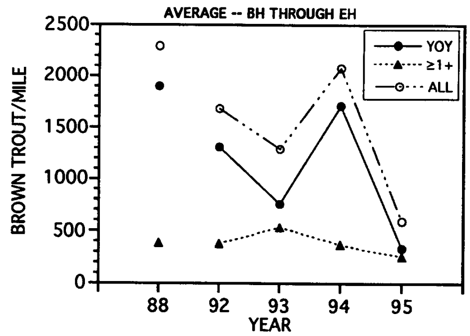

Figure 6 Average estimated numbers of young-of-year and older brown trout in Sections BH through EH during the census years 1988 and 1992-1995. Adult numbers were obtained by subtraction of separate YOY estimates from total estimates. Note that data are not available for 1989-1991. Data from EL were eliminated because its location was moved for 1995.

Despite the usual numerical dominance of YOY brown trout, at least one additional age group was present in every reach (Fig. 4). However, the 1+ age class seems to have been missing at 4 of the 8 sampling sites, and no fish older than YOY were collected at Site DL (Fig. 5). Unusual mortality of juveniles and adults probably occurred in 1995, but some of the missing fish might have moved to slower and less turbulent habitat, perhaps some distance downstream.

Possible Causes of Population Fluctuations

In the highest discharge year of Mammoth Creek fish surveys, 1995, brown trout population density in 7 of the 8 sampling sections ranked lowest of the five census years, and in the second highest discharge year, 1993, density ranked second lowest in 5 of 8 sections. This suggests a negative, possibly graded, response of fish populations to high flows in some parts of the stream (Table 3, Fig. 9). Rainbow trout densities likewise showed some negative correlation with flow, but it was weaker due to anomalously low densities in 1988 (Fig. 10).

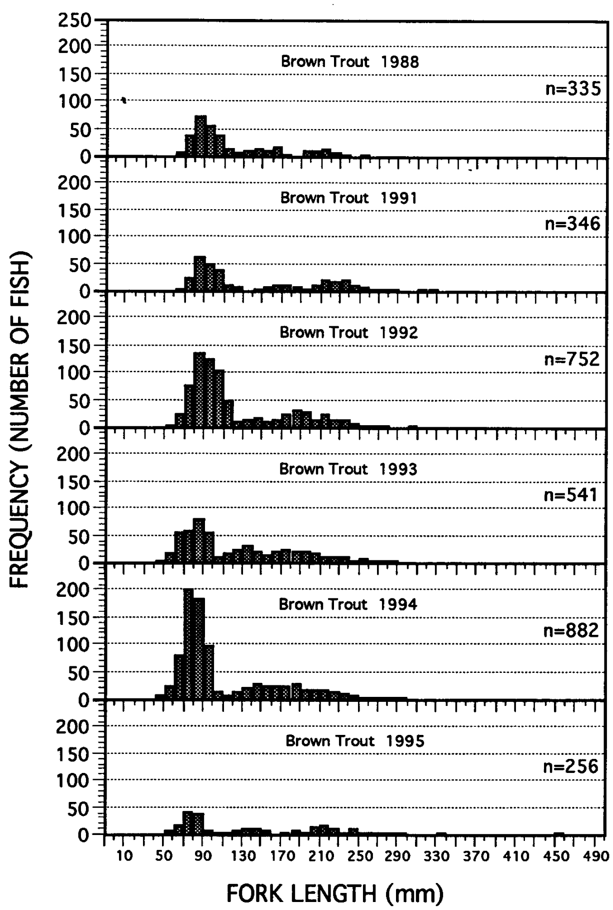

Figure 7. Length-frequency distributions of brown trout captured in Mammoth Creek during the censuses of 1988 and 1991-1995. Note that the 1988 samples covered one-third the length of those in subsequent years, so comparable bars would be 3 times as high. Tick marks are the upper boundaries of size intervals. For example, 210 is the upper boundary of the size class >200 mm but ≤210 mm.

To evaluate the hypothesis that high flows are detrimental to the survival of trout in Mammoth Creek, we performed regression analyses on 5 years of average estimated brown and rainbow trout densities relative to maximum stream discharge during the months April-August, when flows differed most from year to year. The two variables

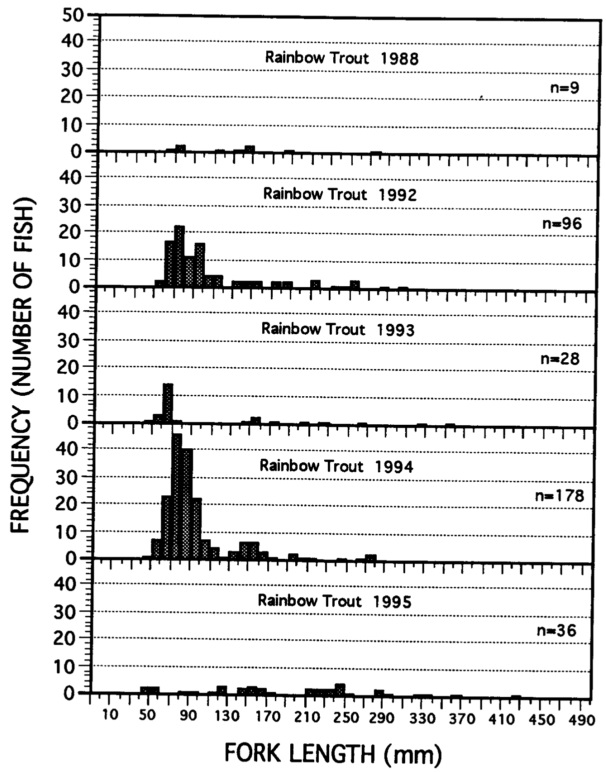

Figure 8 Length-frequency distributions of "wild" rainbow trout captured in Mammoth Creek during the censuses of 1988 and 1992-1995. Tick marks are the upper boundaries of size intervals. For example, 210 is the upper boundary of the size class >200 mm but ≤210 mm.

were in fact negatively correlated for YOY brown trout, although r^2 values for linear regressions are modest (0.61 for April, 0.42 for May, and 0.74, 0.73, and 0.76 for June, July and August). It is not clear that the YOY-Q relationship is linear, however, since the best fits are to power curves that suggest a rapid drop in survival at modest summer discharges (e.g., Fig. 11).

There was no comparable relationship between stream discharge and density of older brown trout. The difference between the two size/age groups is most evident if the January-October flows are combined in a total discharge measurement (Fig. 12).

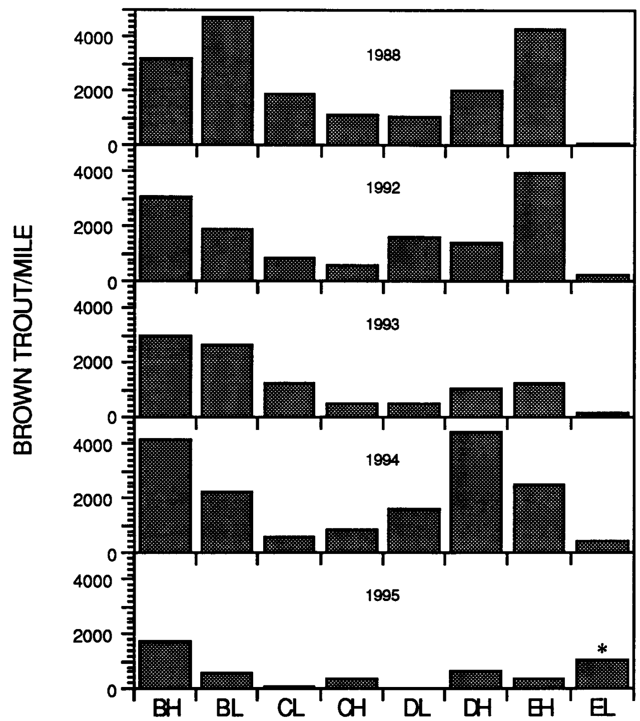

Figure 9 Population density (fish/mile) of brown trout at 8 sites on Mammoth Creek, as determined by census in the years 1988 and 1992-1995. EL (see asterisk) was at a different location than in previous years).

So few rainbow trout were captured that YOY densities had to be approximated by raw catch data rather than depletion estimates, and only weak negative relationships were found between density and discharge. Adult rainbow trout densities showed no relationship to Q.

Higher correlations between discharge and YOY numbers should be expected at individual sampling sections, since conditions from site to site vary so much at a given flow volume. We consequently repeated the regression analyses for individual sections. Negative correlations between YOY densities and Q, as expressed by Coefficient of Determination (r^2) values, appeared important in some sections (BH, CH, DL, and EH), but there appeared to be little or no relationship in others (BL, CL, DH) (Table 5).

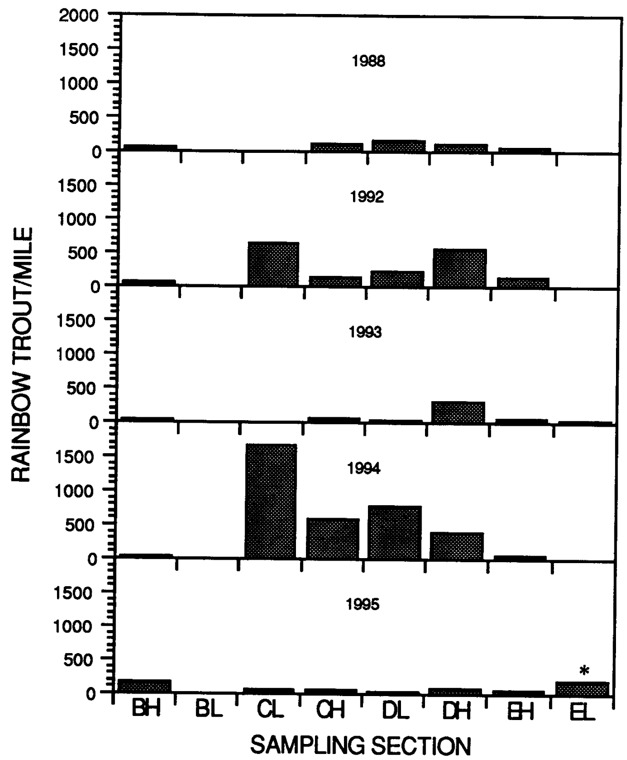

Figure 10. Population density (fish/mile) of presumed wild rainbow trout at 8 sites on Mammoth Creek, as determined by census in the years 1988 and 1992-1995. EL (see asterisk) was at a different location than in previous years).

Although we have only *correlations* between YOY numbers and peak stream discharge, the biology of trout supports a causal connection. In nearby Convict Creek, brown trout emerge from the gravel early in May (Needham et al. 1945) to as late as mid-June or beyond (T. Jenkins, pers. observ.), presumably in response to spring water temperatures. Rainbow trout in Convict Creek have been observed spawning at the end of May, and fry probably emerge between mid-June to early July (T. Jenkins, pers. observ.). Since Mammoth Creek is located at elevations at or above those of S.N.A.R.L., we assume that Mammoth Creek brown trout emerge no earlier than Convict Creek fish (due to lower water temperatures), which would subject them to high flows while they are still in the gravel or during the critical post-emergence weeks when they have almost no energy

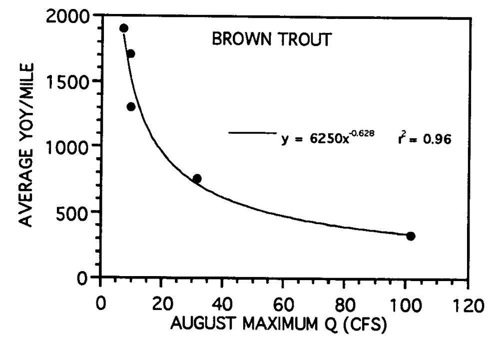

Figure 11. Average estimated density of YOY brown trout in the upper 7 sampling sections relative to August maximum discharge, measured at the Old Mammoth Road gage. Years covered are 1988 and 1992-1995. All data from Section EL were omitted because the 1995 location was different from that used in past years.

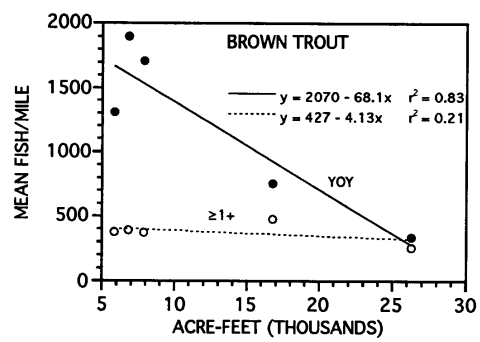

Fig. 12. Estimated mean densities of 0+ (YOY) and older (≥1+) brown trout in the Mammoth Creek study area, relative to total discharge (at Old Mammoth Road gage) from January through October, 1988 and 1992-1995. Data from EL are not used because comparable 1995 values are not available.

Table 4. Population estimates (trout/mile) and 95 percent confidence limits for brown trout captured by electrofishing Mammoth Creek, Mono County, California, 2-4 November, 1988, 21-28 October, 1992, 11-19 October, 1993, 4-11 October, 1994, and 1-7 November, 1995. From data in Hood et al. 1994 and present study.

SITE	YEAR	LOWER CONFIDENCE BOUNDARY	POPULATION ESTIMATE	UPPER CONFIDENCE BOUNDARY
BH	1988	2904	3168	3617
	1992	2992	3045	3128
	1993	2558	2957	3356
	1994	3915	4171	4427
	1995	1654	1760	1901
BL	1988	4488	4699	5028
	1992	1830	1848	1895
	1993	2570	2658	2770
	1994	2235	2253	2309
	1995	528	546	616
CH	1988	1109	1109	1202
	1992	546	563	621
	1993	475	510	609
	1994	722	810	980
	1995	299	334	453
CL	1988	1848	1901	2069
	1992	827	845	906
	1993	1038	1232	1514
	1994	528	528	567
	1995	88	88	100
DH	1988	2006	2006	2124
	1992	1338	1390	1482
	1993	1056	1056	1089
	1994	4268	4418	4567
	1995	563	616	737
DL	1988	1056	1056	1122
	1992	1584	1584	1611
	1993	510	510	551
	1994	1514	1584	1696
	1995	-[a]	18	-[a]
EH	1988	4171	4277	4493
	1992	3925	3978	4053
	1993	1197	1232	1302
	1994	2006	2464	2929
	1995	299	334	458
EL	1988	106	106	479
	1992	194	194	209
	1993	158	158	169
	1994	405	405	412
	1995	1038	1038	1062

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

Table 5. Proportion of variation in estimated young-of-year densities explained by regressions on discharge at Old Mammoth Road, 1988, 1992-1995. Comparable Section EL data were not available in 1995. All values are based on fits to power curves (Number of YOY = aQ^{-b}) except those in bold type, where linear fits were significantly better.

			SAMPLING SECTION				
	BH	BL	CH	CL	DH	DL	EH
APRIL	0.58	0.07	0.33	0.06	0.25	0.86	0.80
MAY	0.22	0.07	0.24	0.00	0.02	0.63	0.78
JUNE	0.22	0.10	0.26	0.04	0.00	0.55	**0.96**
JULY	**0.78**	0.08	0.47	0.01	0.35	0.99	0.84
AUGUST	0.84	0.34	0.77	0.18	0.23	0.50	0.88

reserves. We concur with Hood et al. (1994) that rainbow trout in Mammoth Creek also experience high flows while still in the gravel or shortly after they have emerged, but spawning could also be disrupted some years (Appendix B).

In view of the timing of trout life-cycle events with respect to high water during spring snowmelt, we conclude that even normal Mammoth Creek flows can negatively impact pre- and post-emergence survival of both brown and rainbow trout fry, and possibly the number of eggs deposited by rainbow trout as well. Presumably the magnitude of this effect is proportional to the magnitude and duration of high flow, since water velocities are proportional to discharge. Larger fish with higher energy reserves and greater swimming ability would be expected to cope better with high flows, and they could move more readily within the stream to escape locally high velocities.

There is also a possibility that some of the weakly cyclical variation in Mammoth Creek YOY survival is intrinsic to their populations. White and Hunt (1964), for example, concluded that alternating high and low first-summer survival of brook trout in two Wisconsin streams was due to feedback by yearling fish on YOY survival. Needham et al. (1945), in a four-year study of Convict Creek brown trout, concluded that winter severity was the primary influence on population density; however, his data show that YOY survival from August to the following April was inversely proportional to August YOY density. Insufficient data are currently available to evaluate such biological effects in Mammoth Creek populations, but they appear at present to be of minor significance compared to annual precipitation .

CONCLUSIONS

- Like other Eastern Sierra Nevada snowmelt-dominated streams, Mammoth Creek is difficult habitat for trout. They persist by high reproductive capacity and relatively long life spans, which allow them to recover from periods when reproductive effort is largely wasted. We think 1995 may have been just such a year, presumably because the prolonged high snowmelt runoff led to unusual mortality in some or all of the early life stages.

- Hood et al. (1993, 1994) have suggested some criteria for judging whether or not a fish population is in "good condition": (1) relatively high densities of fish, (2) successful reproduction, and (3) long-term survival. By these criteria, the brown trout population is not in "good" condition. Successful reproduction took place the previous season, and fish are surviving to at least to their fourth year, but densities are not "relatively high" in most reaches or in the stream as a whole. In terms of trout/mile, 1995 brown trout densities were 48% of the previous low in 1993, and 26% of the high in 1988. Compared to 40 brown trout populations in 15 local streams (Deinstadt et al. 1985), Mammoth Creek in 1995 ranks only in the 15th percentile. The population of wild rainbow trout, on the other hand, must be considered in "good condition" by the Beak criteria. Reproduction is taking place, fish are living up to several years, and the 1995 density ranks third highest out of 5 sampling years. Compared to 25 populations in 10 local streams, Mammoth Creek rainbow trout in 1995 rank in the 44th percentile (Deinstadt et al. 1985).

- Despite the above conclusion, we believe that both rainbow and brown trout populations of Mammoth Creek are undergoing natural variation in population density, most likely in response to high "spring runoff" flows during two of the last three water years. The situation for rainbow trout looks relatively good only because the species fares poorly in almost all Eastern Sierra Nevada streams.

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Appendix A

Maximum-Likelihood
Catch Statistics

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

Removal Pattern: 60 23 11

Total Catch	= 94
Population Estimate	= 100
Chi Square	= 0.238
Pop Est Standard Err	= 4.123
Lower Conf Interval	= 94.000
Upper Conf Interval	= 108.181
Capture Probability	= 0.599
Capt Prob Standard Err	= 0.062
Lower Conf Interval	= 0.477
Upper Conf Interval	= 0.721

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

Removal Pattern: 4 1 1 0

Total Catch	= 6
Population Estimate	= 6
Chi Square	= 0.927
Pop Est Standard Err	= 0.321
Lower Conf Interval	= 6.000
Upper Conf Interval	= 6.824
Capture Probability	= 0.667
Capt Prob Standard Err	= 0.185
Lower Conf Interval	= 0.191
Upper Conf Interval	= 1.142

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

Removal Pattern: 17 11 2

Total Catch	= 30
Population Estimate	= 31
Chi Square	= 2.417
Pop Est Standard Err	= 1.960
Lower Conf Interval	= 30.000
Upper Conf Interval	= 35.003
Capture Probability	= 0.625
Capt Prob Standard Err	= 0.105
Lower Conf Interval	= 0.410
Upper Conf Interval	= 0.840

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

Removal Pattern: 9 5 3

Total Catch	= 17
Population Estimate	= 19
Chi Square	= 0.212
Pop Est Standard Err	= 3.199
Lower Conf Interval	= 17.000
Upper Conf Interval	= 25.720
Capture Probability	= 0.500
Capt Prob Standard Err	= 0.168
Lower Conf Interval	= 0.146
Upper Conf Interval	= 0.854

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

Removal Pattern: 8 3 3 3

Total Catch	= 17
Population Estimate	= 19
Chi Square	= 1.677
Pop Est Standard Err	= 3.336
Lower Conf Interval	= 17.000
Upper Conf Interval	= 26.009
Capture Probability	= 0.395
Capt Prob Standard Err	= 0.148
Lower Conf Interval	= 0.085
Upper Conf Interval	= 0.706

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

Removal Pattern: 48 9 2		
Total Catch	=	59
Population Estimate	=	59
Chi Square	=	0.127
Pop Est Standard Err	=	0.661
Lower Conf Interval	=	59.000
Upper Conf Interval	=	60.322
Capture Probability	=	0.819
Capt Prob Standard Err	=	0.051
Lower Conf Interval	=	0.718
Upper Conf Interval	=	0.921

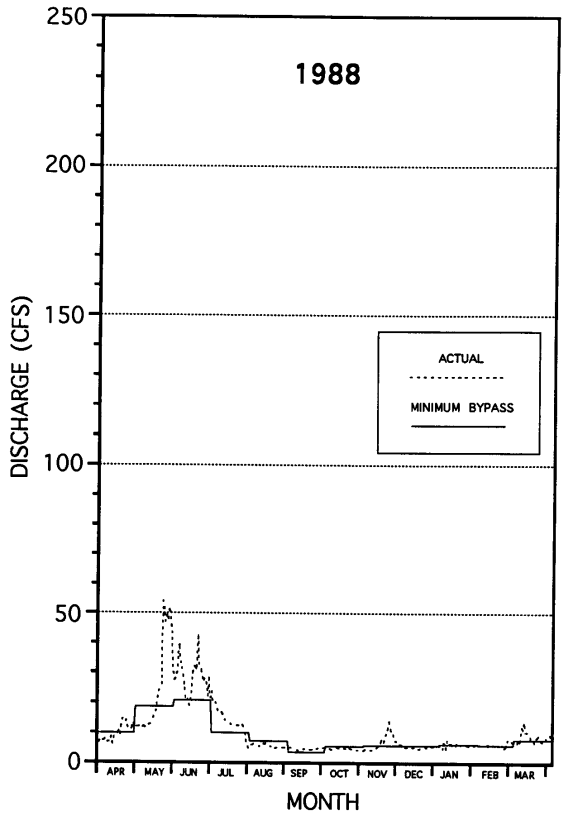
The population estimate lower confidence intervalsfor seven of the sites were set equal to the total catches. Actual calculated lower CIs were as follows:

SITE	CALCULATED LCI
BH	91.81899
BL	26.99681
CH	12.27983
CL	5.175917
DH	28.10045
EH	11.99107
EL	57.67758

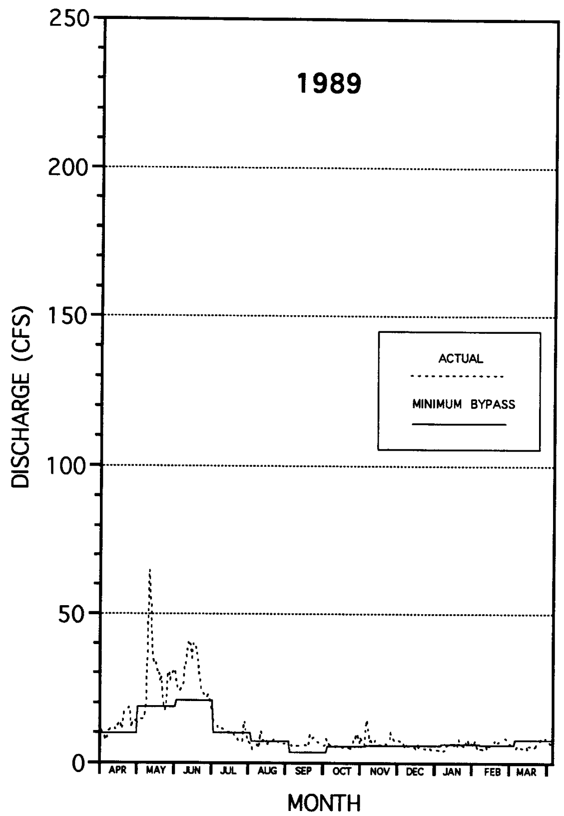
In reach DL the capture pattern for brown trout was 1-0-0. Microfish software cannot compute confidence intervals this small, so the estimated populationis exactly one fish.

Appendix B

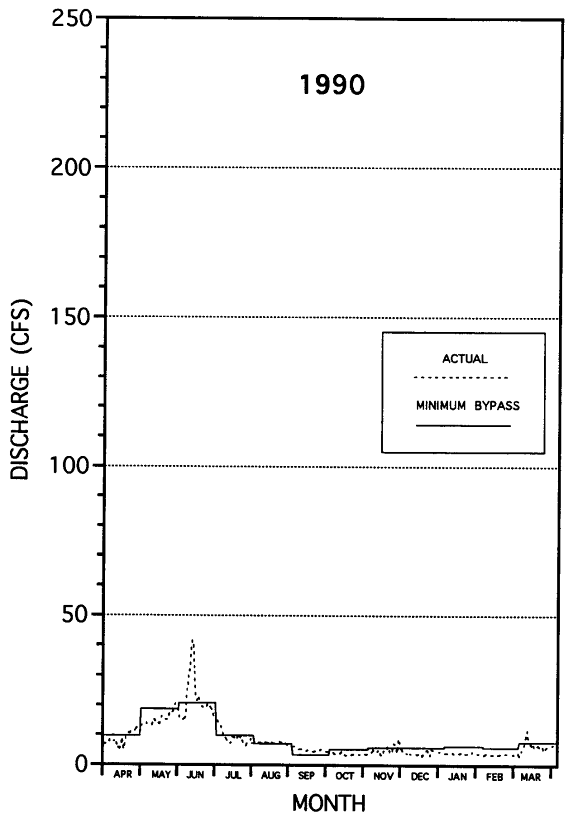
Mammoth Creek
Hydrographs
1988-1995



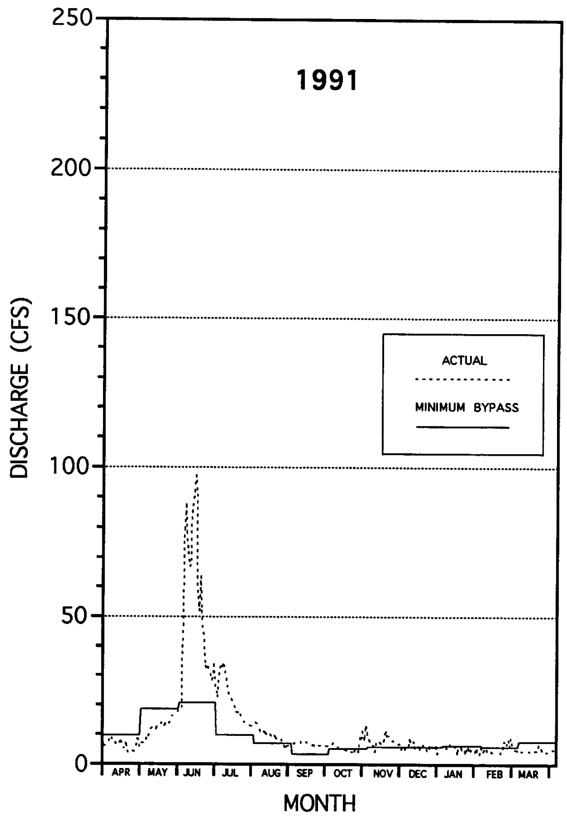
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1988, and the recommended operational minimum mean daily bypass flow regime.



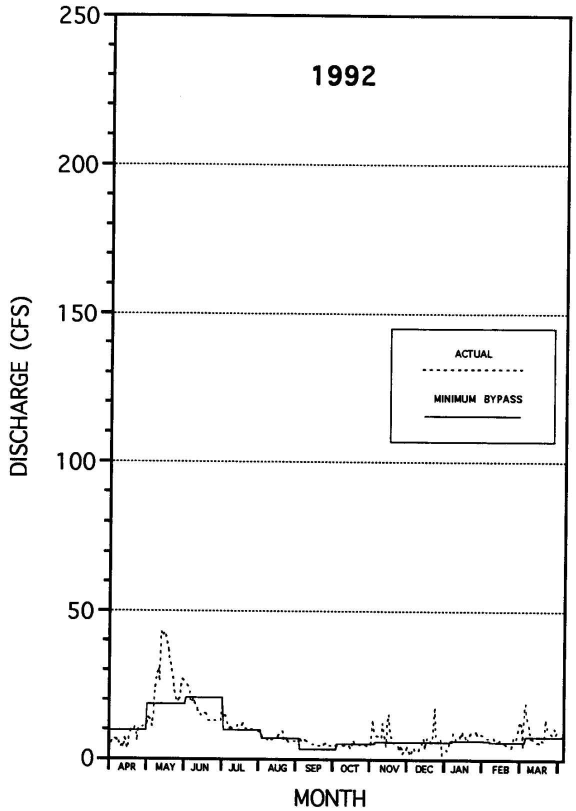
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1989, and the recommended operational minimum mean daily bypass flow regime.



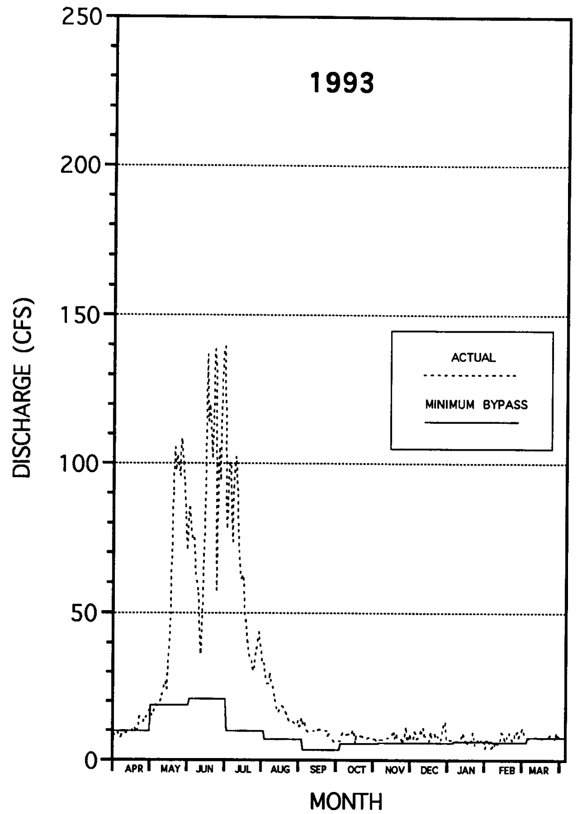
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1990 and the recommended operational minimum mean daily bypass flow regime.



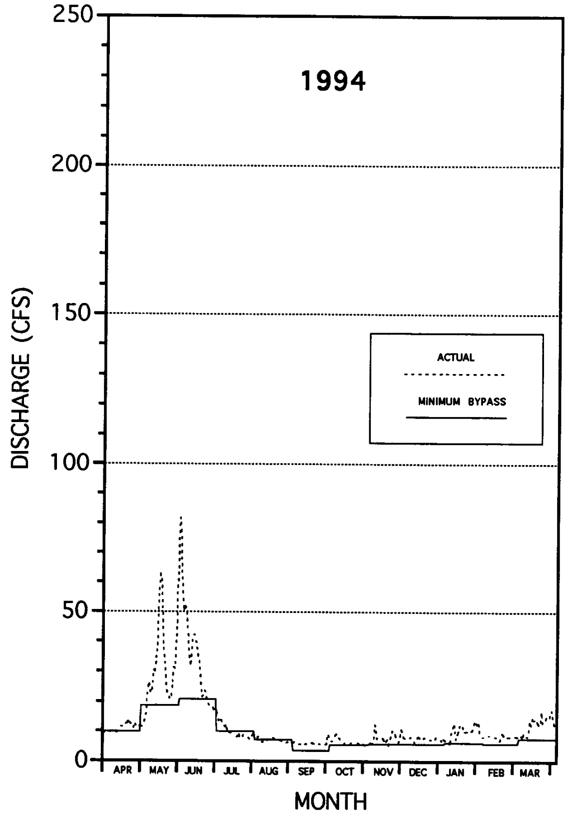
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1991, and the recommended operational minimum mean daily bypass flow regime.



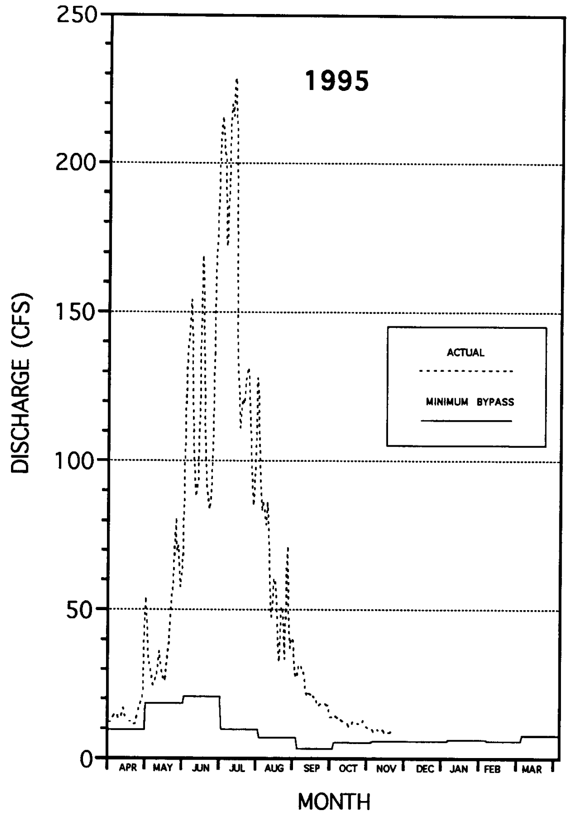
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1992 and the recommended operational minimum mean daily bypass flow regime.



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.



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 flow 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 flow regime.