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MAMMOTH CREEK 1996

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; Jenkins and Dawson 1996). 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 3-8 October, 1996. 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 boundaries of all but one sampling section remained the same through the 1988 and 1992-96 surveys. The lowermost section was not accessible in 1995 and 1996, 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). The 1988 sections covered 100 feet of channel and the 1992-1996 sections have been 300 feet in length (Bratovich et al. 1990; Hood et al. 1992).

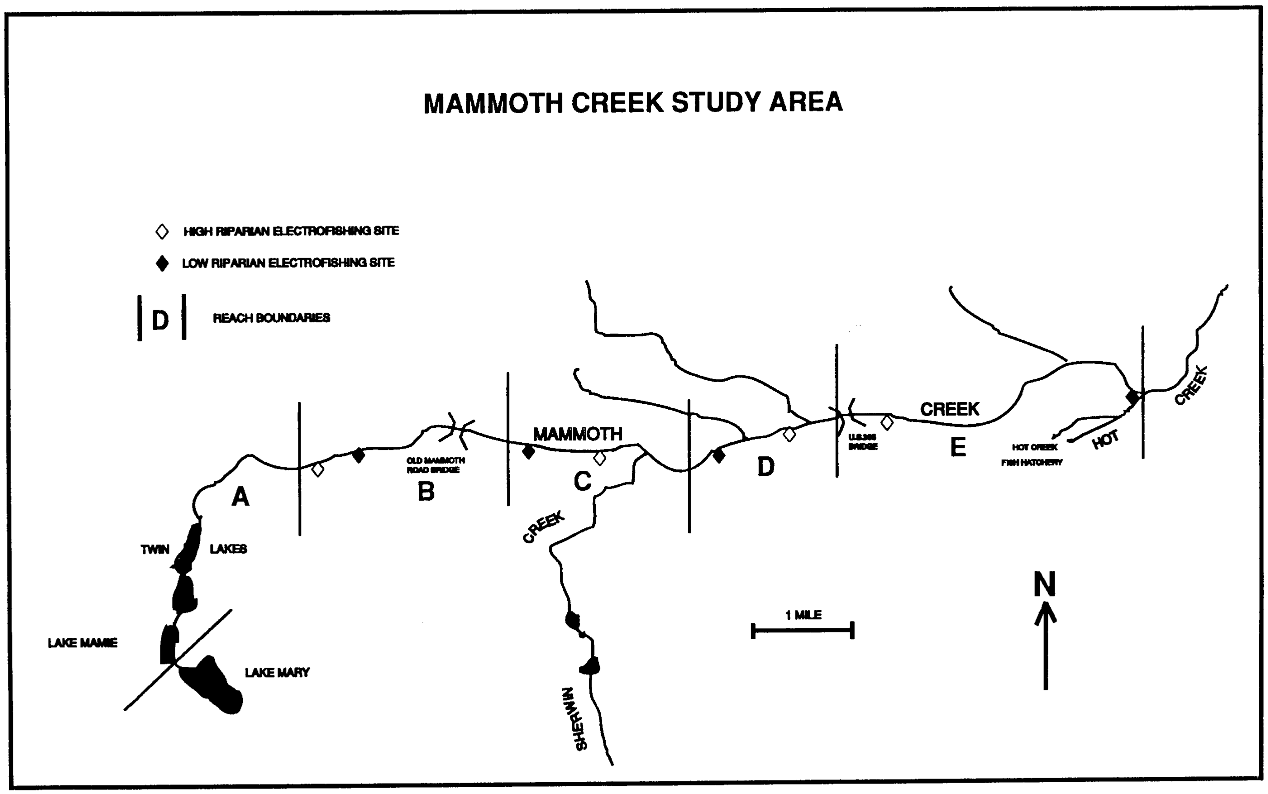

Figure 1. Electrofishing sites on Mammoth Creek, October, 1996 (modified from Hood et al. 1993).

METHODS AND MATERIALS

Selection of Sampling Sites

For compatibility with previous studies, we utilized the same "representative" electrofishing sites established by Beak Consultants Incorporated (Beak), the firm that designed and carried out population studies on Mammoth Creek until 1995 (see Bratovich et al. 1990 for rationale of site selection). One day or more prior to operations, we visited the sites and sank lengths of 0.5 inch rebar in the banks at the upstream and downstream ends to mark the boundaries and to help anchor block nets.

Collection Methods

On census days, we simultaneously placed block nets of 0.125 inch 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.

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.

Population Estimation

For consistency with previous Mammoth Creek studies (Hood et al. 1993, 1994; Jenkins and Dawson 1996), we estimated brown 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 comparison with prior censuses (Bratovich et al. 1990; Hood et al. 1992, 1993, 1994; Jenkins and Dawson 1996). We also estimated rainbow trout population densities and compared them with similar data from past MCWD research.

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 there were often too few adults to support a separate analysis, we estimated their numbers by subtraction of YOY estimates from the total population estimates. Although trout were not aged directly, separation of YOY from older fish on the basis of length appeared unambiguous within individual sampling sections. 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; Jenkins and Dawson 1996).

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 1996 and among years for the entire study area.

RESULTS

Species Composition and Relative Abundance in Samples

We captured 981 fish from four species, ranking in abundance: brown trout (541, 55%), rainbow trout (308, 31%), Owens suckers (84, 9%), and tui chubs (48, 5%) (Table 1). Tui chubs and suckers were found only in electrofishing section EL. The proportion of brown trout was down slightly (from 57% in 1995), but the proportion of rainbow trout increased (from 15% in 1995), and the numerical ranking of rainbow trout rose from third to second. Only tui chubs dropped somewhat in absolute abundance in the samples.

We found "wild" rainbow trout in all sections, and they were accompanied by apparent hatchery plants except in Sections BH, BL and DL. Most larger rainbow trout appeared to be of hatchery origin, except in Section EL (Fig. 2). Thirty percent of the presumed wild rainbow trout and 60% of the presumed hatchery rainbow trout were living in "low riparian" habitats (Table 1). In contrast, only 21% of the brown trout were found in "low riparian" habitats.

Table 1. Electrofishing results in Mammoth Creek, Mono County, California, 3-8 October, 1996.

COMMON NAME	SCIENTIFIC NAME	REACH	COVER		TOTAL
			HIGH	LOW	
brown trout	*Salmo trutta*	B	208	9	217
		C	71	9	80
		D	101	32	133
		E	46	65	111
		TOTAL	426	115	541
rainbow trout (presumed wild)	*Oncorhynchus mykiss*	B	16	1	17
		C	89	30	119
		D	50	13	63
		E	25	32	57
		TOTAL	180	76	256
rainbow trout (presumed hatchery)	*Oncorhynchus mykiss*	B	0	0	0
		C	1	27	28
		D	5	0	5
		E	15	4	19
		TOTAL	21	31	52
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	48	48
		TOTAL	0	48	48
Owens sucker	*Catostomus fumeiventris*	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	84	84
		TOTAL	0	84	84
			GRAND TOTAL		981

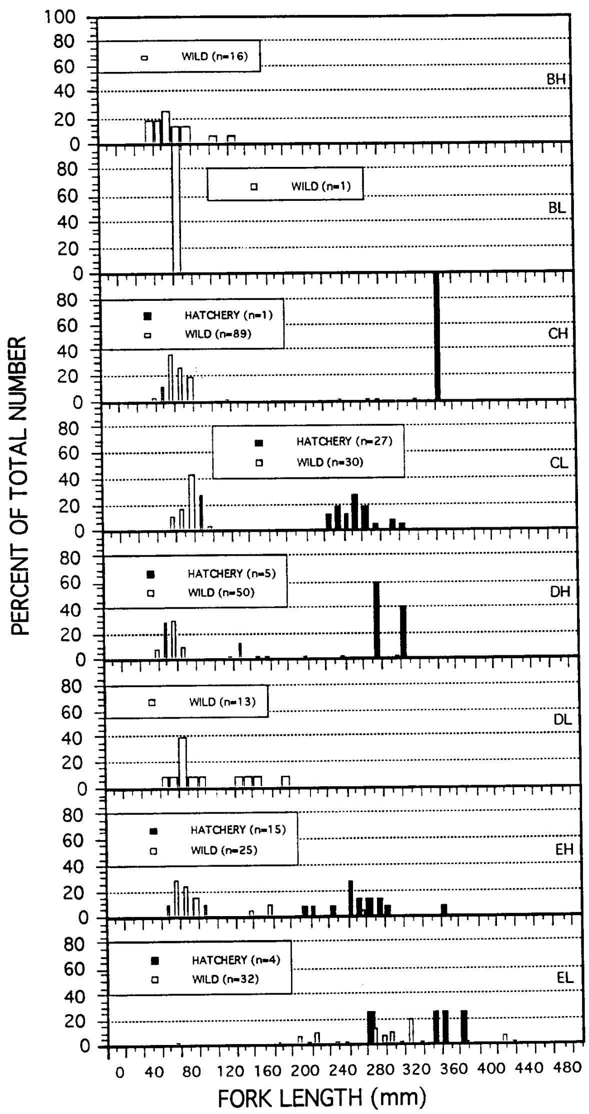

Figure 2. Length distributions of "wild" and "hatchery" rainbow trout in Mammoth Creek, 3-8 October , 1996. Tick marks are the upper boundaries of size intervals. For example, 200 is the upper boundary of the size class >190 mm but ≤200 mm.

Trout Population Estimates

Estimated brown trout population densities varied from 158 to 4840 fish/mile in the sampling sections (average 1379), with the greatest number occurring in the highest elevation section (Table 2 and Appendix A). Density averaged 2235/mile in the "high riparian" sections and 524/mile in the "low riparian" sections. If we exclude data from the new Section EL, which has extensive cover in the form of undercut banks, brown trout from low riparian sections averaged only 317/mile.

Presumed wild rainbow trout were considerably less abundant than brown trout in all sections but CH and CL, their densities ranging from 18 to 194/mile (average 588, Table 2). Wild rainbow trout density averaged 841/mile in the high riparian sections and 335/mile in the low riparian sections.

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, 3-8 October, 1996.

SECTION	BROWN TROUT PER SECTION	BROWN TROUT PER MILE	RAINBOW TROUT PER SECTION	RAINBOW TROUT PER MILE
BH	275	4840	16	282
BL	9	158	1	18
CH	74	1302	96	1690
CL	9	158	30	528
DH	108	1901	53	933
DL	36	634	13	229
EH	51	898	26	458
EL	65	1144	32	563

Trout Size Distributions

All Reaches Combined: We counted all fish in a size/age class by examining distributions from individual sections and pooling the results. This was necessary because variability in growth rates among sections shifted length distributions up or down the size scale, enhancing the appearance of overlap among size groups (Fig. 3). Fish in the most numerous brown trout size class ranged from 44 to 126 mm fork length and accounted for 74% of the 541 brown trout captured; undoubtedly almost all of this class were young-of-year (YOY). The next larger size class, ranging from 135 to 193 mm fork length and accounting for 10% of the total, presumably were nearly all one-year-old fish. A third size class (12% of the total) ranged from 171 to 302 mm FL, and probably consisted primarily of 2-year-olds. The remaining 21 individuals (4%) ranged from 263 to 462 mm fork length, and were undoubtedly at least 3 years old.

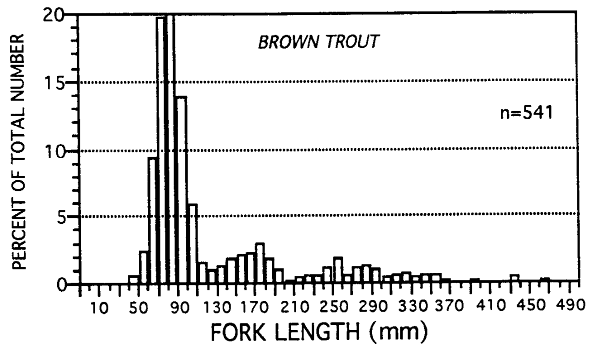

Figure 3. Length-frequency distribution of all brown trout captured at 8 electrofishing sites in the Mammoth Creek study area, 3-8 October, 1996. Size intervals are 10 millimeters. Tick marks are the upper boundaries of size intervals. For example, 200 is the upper boundary of the size class >190 mm but ≤200 mm.

Individual reaches: The majority of brown trout in all reaches were young-of-year, although YOY were relatively least abundant in Reach E (54%) (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 (76% YOY), whereas YOY were relatively uncommon (38%) and large fish were exceptionally numerous in Section EL.

The rainbow trout population contained about the same proportion of YOY as the brown trout population (77%), and rainbow trout YOY were collected in all 8 sections (Fig. 2). As was the case with brown trout, most of the presumed wild rainbow trout over 300 mm resided in the lowermost section.

DISCUSSION

Species Composition in Samples

Among native and non-native fishes in the Mammoth Creek study area, the European brown trout (*Salmo trutta*) evidently finds conditions most favorable. Introduced rainbow trout (*Oncorhynchus mykiss*) have fared less well, although 1996 was their best year since censuses were initiated in 1988 (Table 3). Both species appear to be reproducing in all of the sampling sections (Figs 2, 5). Brook trout (*Salvelinus fontinalis*) from the eastern U.S. were not found in the study reaches this year. Native Tui chubs and suckers were collected only in the most downstream section of the creek.

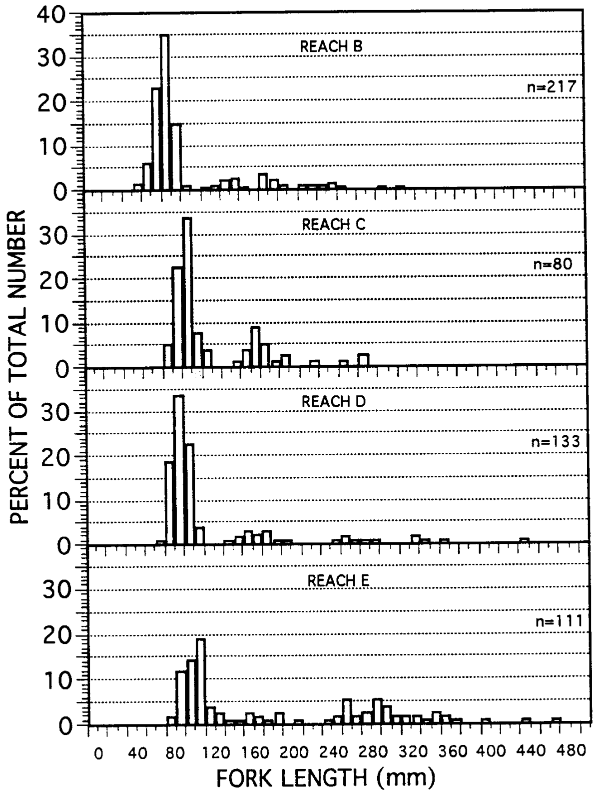

Figure 4. Length-frequency distributions of brown trout captured by electrofishing in Reaches B, C, D, and E of Mammoth Creek, 3-8 October, 1996. Size intervals are 10 millimeters. Tick marks are the upper boundaries of size intervals. For example, 200 is the upper boundary of the size class >190 mm but ≤200 mm.

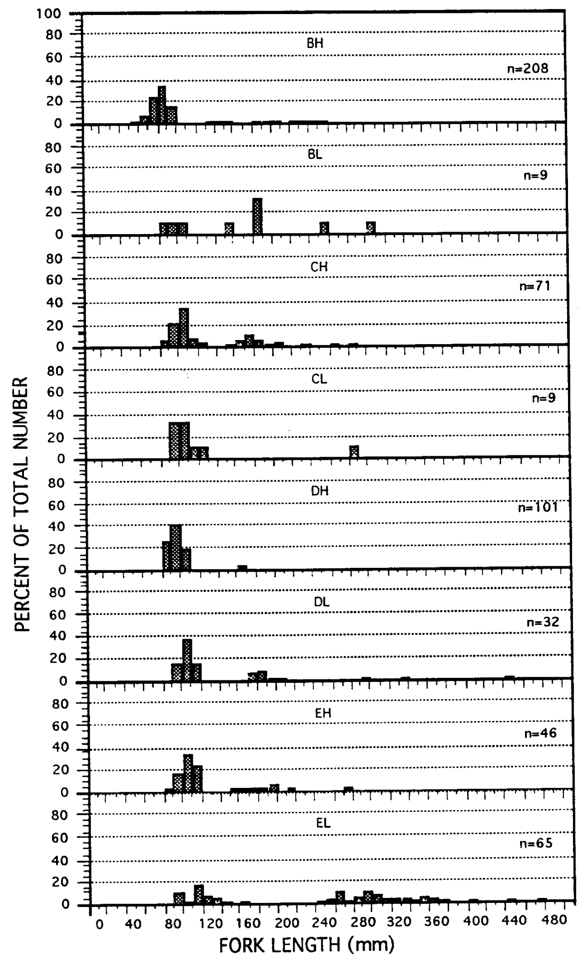

Fig. 5. Length distributions of brown trout captured in 8 sampling sections on Mammoth Creek, 3-8 October, 1996. Tick marks are the upper boundaries of size intervals. For example, 200 is the upper boundary of the size class >190 mm but ≤200 mm.

Table 3. Estimated average population densities for brown and presumed wild rainbow trout in Mammoth Creek. Numbers in parentheses eliminate data from our new Section EL, a location somewhat downstream from that used by Beak in 1988-1994 studies.

YEAR	BROWN TROUT PER MILE	RAINBOW TROUT PER MILE
1996	**1379(1413)**	**588(591)**
1995	**592 (528)**	**78 (61)**
1994	2079	437
1993	1289	57
1992	1681	222
1988	2290	60

Brown and Rainbow Trout Population Estimates

Trout populations in Mammoth Creek were depressed in 1995 relative to most other years for which data are available (Jenkins and Dawson 1996), but they have rebounded nicely in 1996. Brown trout numbers are back to 60% of the highest recorded levels in 1988 (up from 26% in 1995), and rainbow trout populations are the largest that have been documented in MCWD studies (Table 3). Brown trout continue to dominate the trout community, but they have dropped to an estimated 70% owing to increased success of rainbow trout this year (Table 3). How the relative numbers of adult brown and rainbow trout will change remains to be seen.

Size and Age Structure of Trout Populations

Despite the usual numerical dominance of YOY in the brown trout population, at least two additional age groups were present in every reach, and possibly many more (Fig. 4). Some of the larger fish we captured in this study were not present in 1995, perhaps because, as we have suggested (Jenkins and Dawson 1996), they had moved to slower and less turbulent habitats during the high spring-autumn flows of 1995, and returned during the lower flows of 1996.

Possible Causes of Population Fluctuations

Year-to-year changes 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, 1994 and 1996 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 the 1988 year class appears to have been small (or small fish were poorly sampled), and we have no data for 1991 (Fig. 8).

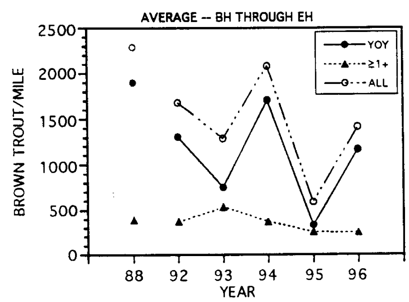

Figure 6 Average estimated numbers of young-of-year and older brown trout in Sections BH through EH during the census years 1988 and 1992-1996. Adult numbers were obtained by subtraction of separate YOY estimates from total estimates. Note that data are not available for 1989-1991. Data from EL were eliminated because a new location somewhat downstream of previous years was used in 1995 and 1996.

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 suggested a negative, possibly graded, response of juvenile fish to high flows in some parts of the stream (Table 3, Figs. 9,10), for which we have advanced a possible mechanism (Jenkins and Dawson 1996).

With another year of data, we again performed regression analyses relating average estimated brown and rainbow trout densities to maximum stream discharge during the months April-August, when flows differed most from year to year. As in our previous analysis, densities of YOY brown trout were negatively correlated with discharge (r^2 values for linear regressions: 0.35 for April, 0.07 for May, and 0.65, 0.81, and 0.75 for June, July and August respectively). Again, the best single fit of the data is to a power curve relating YOY brown trout densities to maximum August discharge, suggesting a

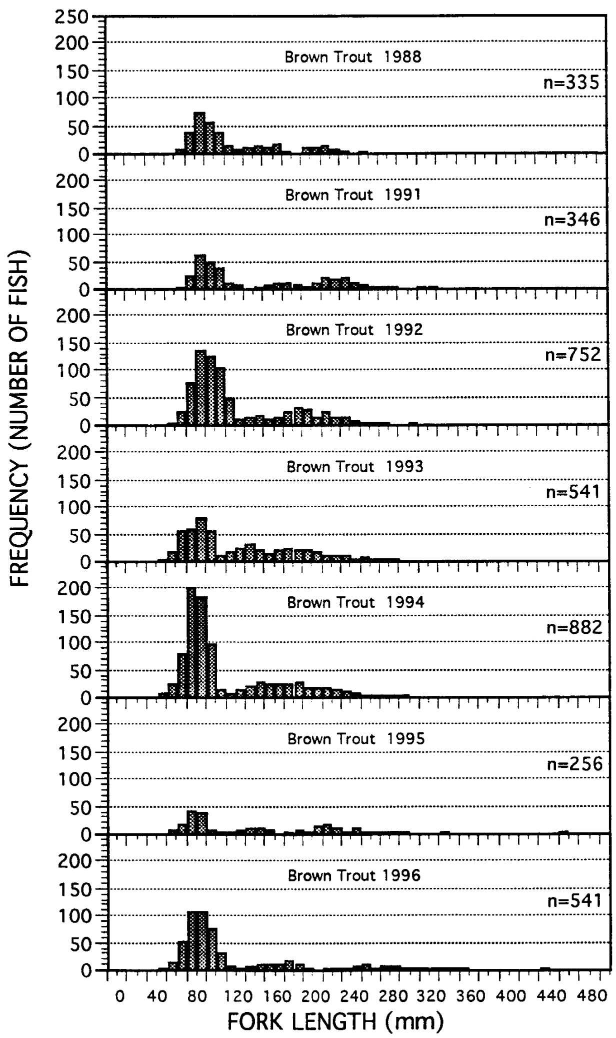

Figure 7. Length-frequency distributions of brown trout captured in Mammoth Creek during the censuses of 1988 and 1991-1996. Note that the 1988 samples covered one-third the length of those in subsequent years, so comparable bars would be 3 times as high. Tick marks are the upper boundaries of size intervals. For example, 200 is the upper boundary of the size class >190 mm but ≤200 mm.

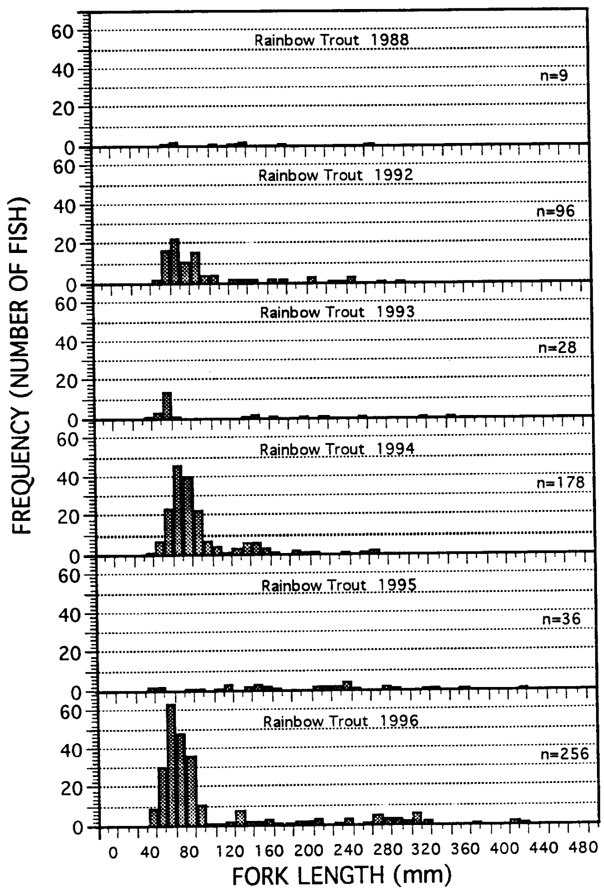

Figure 8. Length-frequency distributions of "wild" rainbow trout captured in Mammoth Creek during the censuses of 1988 and 1992-1996. Tick marks are the upper boundaries of size intervals. For example, 200 is the upper boundary of the size class >190 mm but ≤200 mm.

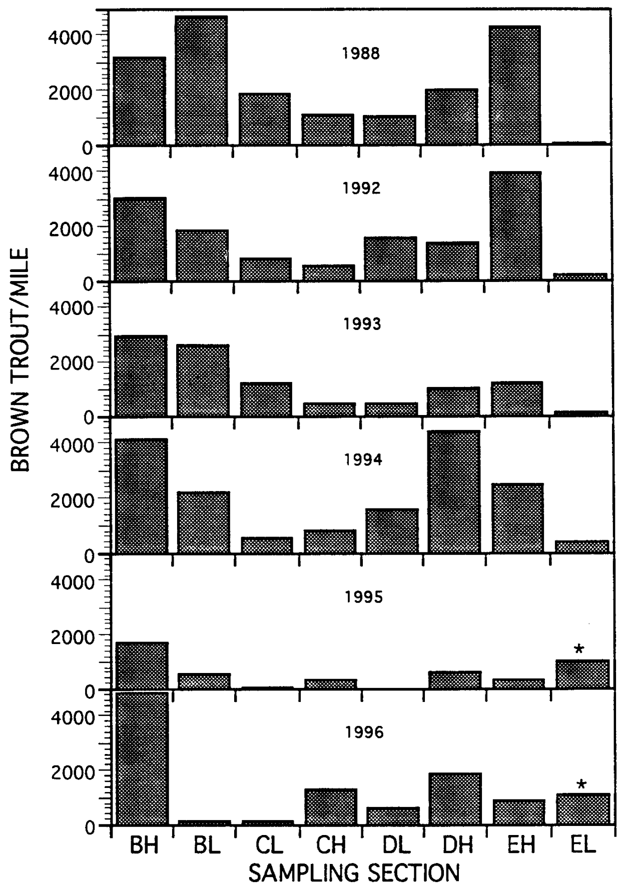

Figure 9 Population density (fish/mile) of brown trout at 8 sites on Mammoth Creek, as determined by census in the years 1988 and 1992-1996. EL (see asterisk) was at a different location in 1995 and 1996 than in previous years).

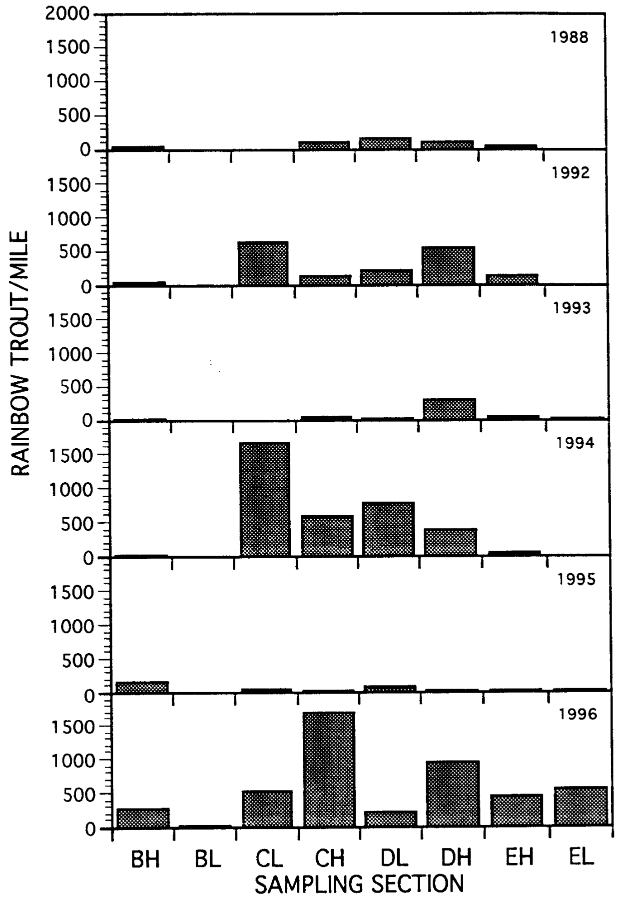

Figure 10. Population density (fish/mile) of presumed wild rainbow trout at 8 sites on Mammoth Creek, as determined by census in the years 1988 and 1992-1995. EL (see asterisk) was at a different location than in previous years).

rapid drop in survival at modest flows (Fig. 11). There was no apparent relationship between stream discharge and density of older brown trout comparable to this YOY phenomenon. The difference between the two size/age groups is most evident if January-October flows are combined in a total discharge measurement (Fig. 12).

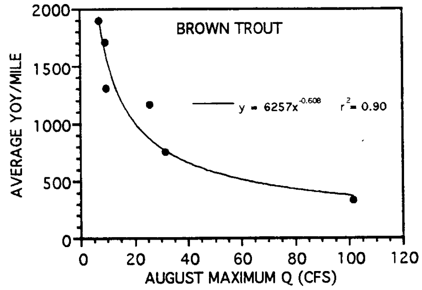

Figure 11. Average estimated density of YOY brown trout in the upper 7 sampling sections relative to August maximum discharge, measured at the Old Mammoth Road gage. Years covered are 1988 and 1992-1996. All data from Section EL were omitted because the 1995-96 location was different from that used in past years.

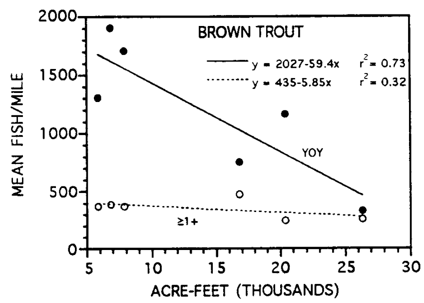

Fig. 12. Estimated mean densities of 0+ (YOY) and older (≥1+) brown trout in the Mammoth Creek study area, relative to total discharge (at Old Mammoth Road gage) from January through October, 1988 and 1992-1996. Data from EL are not used because the 1995-96 site was different from that used in earlier years.

Several correlations between YOY densities and discharge were weaker than those based on data from the first 5 census years (Jenkins and Dawson 1996), because YOY densities in some sampling sections were anomalously high in 1996 (Table 4, and compare Table 5 in this report and Table 5 in Jenkins and Dawson 1996). Two important variables were

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, 1-7 November, 1995, and 3-8 October, 1996. From data in Hood et al. 1994, Jenkins and Dawson 1995, 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
	1996	3942	4840	5738
BL	1988	4488	4699	5028
	1992	1830	1848	1895
	1993	2570	2658	2770
	1994	2235	2253	2309
	1995	528	546	616
	1996	158	158	158
CH	1988	1109	1109	1202
	1992	546	563	621
	1993	475	510	609
	1994	722	810	980
	1995	299	334	453
	1996	1250	1302	1390
CL	1988	1848	1901	2069
	1992	827	845	906
	1993	1038	1232	1514
	1994	528	528	567
	1995	88	88	100
	1996	158	158	194
DH	1988	2006	2006	2124
	1992	1338	1390	1482
	1993	1056	1056	1089
	1994	4268	4418	4567
	1995	563	616	737
	1996	1778	1901	2059
DL	1988	1056	1056	1122
	1992	1584	1584	1611
	1993	510	510	551
	1994	1514	1584	1696
	1995	-[a]	18	-[a]
	1996	563	634	792
EH	1988	4171	4277	4493
	1992	3925	3978	4053
	1993	1197	1232	1302
	1994	2006	2464	2929
	1995	299	334	458
	1996	810	898	1056

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

Table 4 (concluded). 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, 1-7 November, 1995, and 3-8 October, 1996. From data in Hood et al. 1994, Jenkins and Dawson 1995, and present study.

SITE	YEAR	LOWER CONFIDENCE BOUNDARY	POPULATION ESTIMATE	UPPER CONFIDENCE BOUNDARY
EL	1988	106	106	47[illegible]
	1992	194	194	20[illegible]
	1993	158	158	[illegible]59
	1994	405	405	412
	1995	1038	1038	1062
	1996	1144	1144	1162

Table 5. Proportion of variation in estimated young-of-year densities explained by regressions on discharge at Old Mammoth Road, 1988, 1992-1996. Comparable Section EL data were not available in 1995-96 and earlier years. All values are based on fits to power curves (Number of YOY = aQ^{-b}).

	SAMPLING SECTION						
	BH	BL	CH	CL	DH	DL	EH
APRIL	0.02	0.16	0.01	-0.18	0.07	0.61	0.83
MAY	0.28	0.14	0.01	0.07	0.00	0.36	0.83
JUNE	0.00	0.12	0.07	0.09	0.00	0.56	0.79
JULY	0.07	0.12	0.23	0.03	0.30	0.89	0.84
AUGUST	0.12	0.41	0.44	0.23	0.20	0.48	0.86

unusual in 1996, and therefore could have contributed to this result. One is the runoff pattern, with a highly unusual May peak, followed by a precipitous drop, and another, lower, peak, well before the usual late June surge (Appendix B). Conceivably fish emerged from the gravel in an advantageous low-flow window in May, and benefited from an unusually early drop to lower discharge levels than would have been expected from the total runoff volumes or monthly maxima. Another factor could have been unusually low densities of older fish (especially yearlings) living with YOY of the 1996 year-class during their first summer, which would have increased the latter's growth rate directly (Jenkins, Diehl, Cooper and Kratz, M.S. in review), and perhaps their survival indirectly. Smaller numbers of large fish (combined with faster YOY growth) might also have reduced the susceptibility of YOY to cannibalism (Jenkins, unpublished).

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. Whereas 1995 was such a year of wasted reproductive effort, 1996 was a year of recovery for both the brown and rainbow trout populations. Data from this study continue to suggest that stream discharge early in the lives of trout is the major source of variation in Mammoth Creek trout populations, and that high flows in 1995 and moderate flows in 1996 largely explain low trout numbers in the former year and higher numbers in the latter.

- Hood et al. (1993, 1994) 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, both the brown and rainbow trout populations are once again in "good" condition. Reproduction of both species was "normal" by known standards for Mammoth Creek, some fish were surviving to at least their fourth year, and densities were as high as could be expected following the poor 1995 year-class. In terms of trout/mile, 1996 brown trout densities were 60% of the high in 1988, and 230% of the low in 1995. Rainbow trout densities were 135% of the previous high in 1994, and more than 10 times the low in 1993.

- Again, we emphasize that brown and rainbow trout populations of Mammoth Creek are undergoing natural variation in population density, almost certainly in synchrony with other snowmelt-dominated Eastern Sierra Nevada streams. The future trajectory of Mammoth Creek trout populations will depend primarily on future weather patterns, and to a lesser extent on biological factors in the populations themselves.

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Appendix A

Maximum-Likelihood
Catch Statistics

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

Removal Pattern: 105 59 44

Total Catch	= 208
Population Estimate	= 275
Chi Square	= 0.835
Pop Est Standard Err	= 25.828
Lower Conf Interval	= 224.119
Upper Conf Interval	= 325.881
Capture Probability	= 0.374
Capt Prob Standard Err	= 0.056
Lower Conf Interval	= 0.264
Upper Conf Interval	= 0.485

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

Removal Pattern: 8 0 1 0

Total Catch	= 9
Population Estimate	= 9
Chi Square	= 3.790
Pop Est Standard Err	= 0.103
Lower Conf Interval	= 9.000
Upper Conf Interval	= 9.237
Capture Probability	= 0.818
Capt Prob Standard Err	= 0.120
Lower Conf Interval	= 0.541
Upper Conf Interval	= 1.096

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

Removal Pattern: 49 14 8

Total Catch	= 71
Population Estimate	= 74
Chi Square	= 1.205
Pop Est Standard Err	= 2.671
Lower Conf Interval	= 71.000
Upper Conf Interval	= 79.324
Capture Probability	= 0.645
Capt Prob Standard Err	= 0.066
Lower Conf Interval	= 0.514
Upper Conf Interval	= 0.776

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

Removal Pattern: 6 1 2

Total Catch	= 9
Population Estimate	= 9
Chi Square	= 2.736
Pop Est Standard Err	= 0.947
Lower Conf Interval	= 9.000
Upper Conf Interval	= 11.183
Capture Probability	= 0.643
Capt Prob Standard Err	= 0.189
Lower Conf Interval	= 0.206
Upper Conf Interval	= 1.080

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

Removal Pattern: 59 34 8

Total Catch	= 101
Population Estimate	= 108
Chi Square	= 3.377
Pop Est Standard Err	= 4.588
Lower Conf Interval	= 101.000
Upper Conf Interval	= 117.085
Capture Probability	= 0.587
Capt Prob Standard Err	= 0.060
Lower Conf Interval	= 0.468
Upper Conf Interval	= 0.707

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

Removal Pattern: 18 8 6

Total Catch	= 32
Population Estimate	= 36
Chi Square	= 0.619
Pop Est Standard Err	= 4.403
Lower Conf Interval	= 32.000
Upper Conf Interval	= 44.938
Capture Probability	= 0.500
Capt Prob Standard Err	= 0.122
Lower Conf Interval	= 0.252
Upper Conf Interval	= 0.748

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

Removal Pattern: 21 12 9 4	
Total Catch	= 46
Population Estimate	= 51
Chi Square	= 0.525
Pop Est Standard Err	= 4.485
Lower Conf Interval	= 46.000
Upper Conf Interval	= 60.011
Capture Probability	= 0.426
Capt Prob Standard Err	= 0.086
Lower Conf Interval	= 0.253
Upper Conf Interval	= 0.599

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

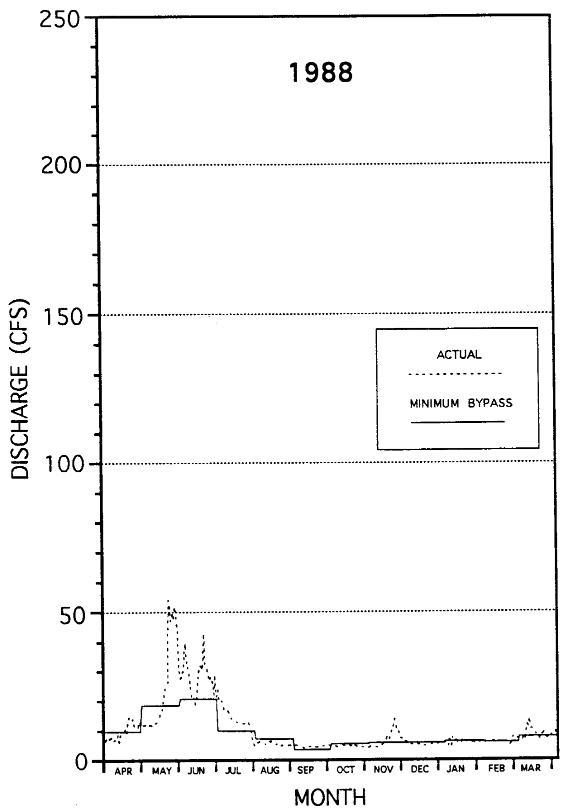
Removal Pattern: 55 9 1	
Total Catch	= 65
Population Estimate	= 65
Chi Square	= 0.143
Pop Est Standard Err	= 0.479
Lower Conf Interval	= 65.000
Upper Conf Interval	= 65.957
Capture Probability	= 0.855
Capt Prob Standard Err	= 0.044
Lower Conf Interval	= 0.768
Upper Conf Interval	= 0.942

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

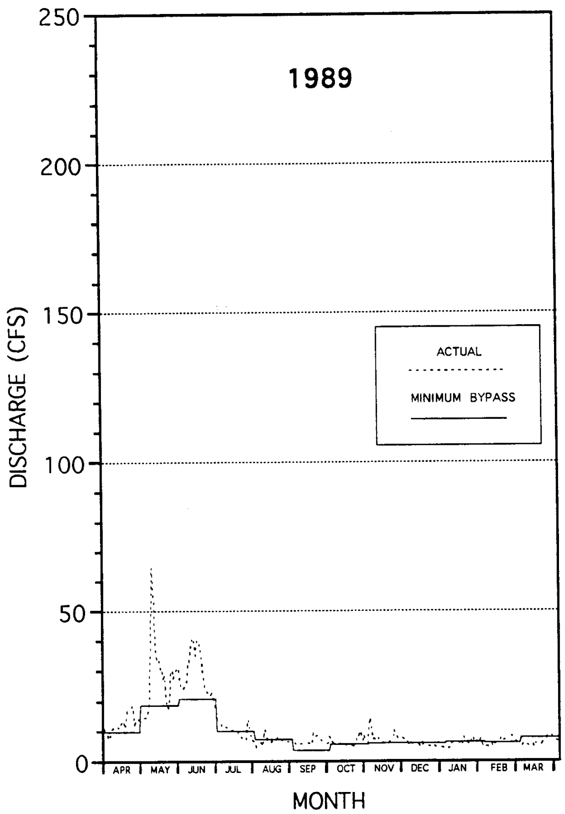
SITE	CALCULATED LCI
BL	8.763422
CH	68.67584
CL	6.816771
DH	98.91544
DL	27.06232
EH	41.98894
EL	64.04277

Appendix B

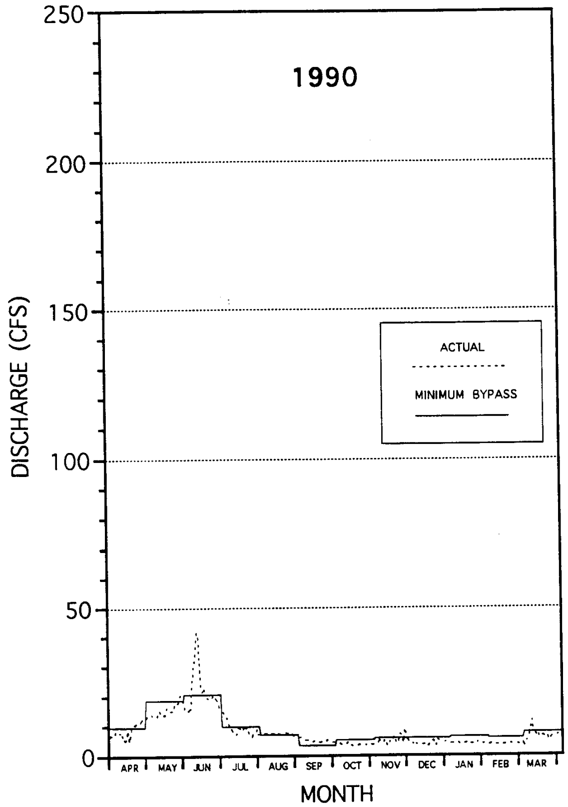
Mammoth Creek
Hydrographs
1988-1996



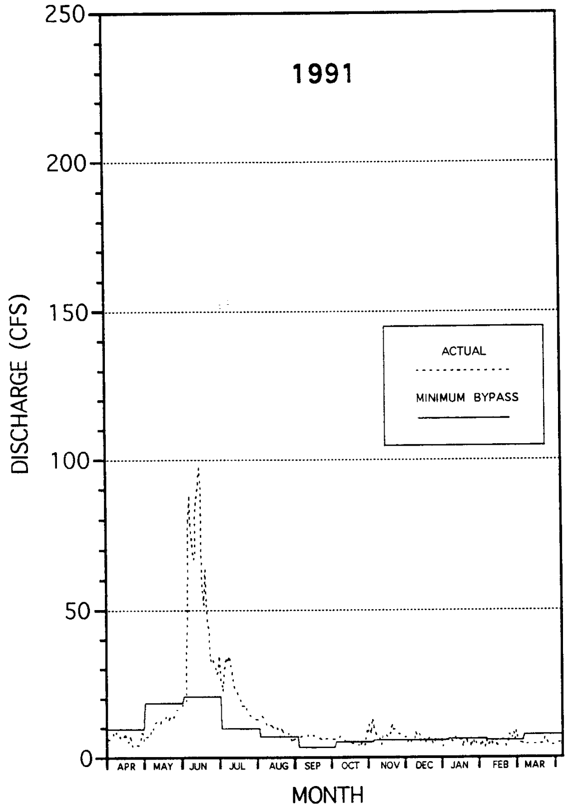
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1988, and the recommended operational minimum mean daily bypass flow regime.



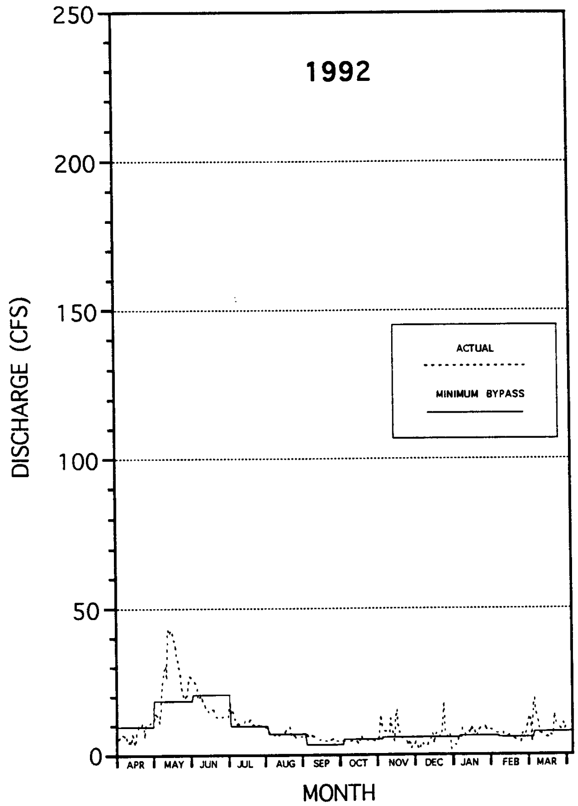
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1989, and the recommended operational minimum mean daily bypass flow regime.



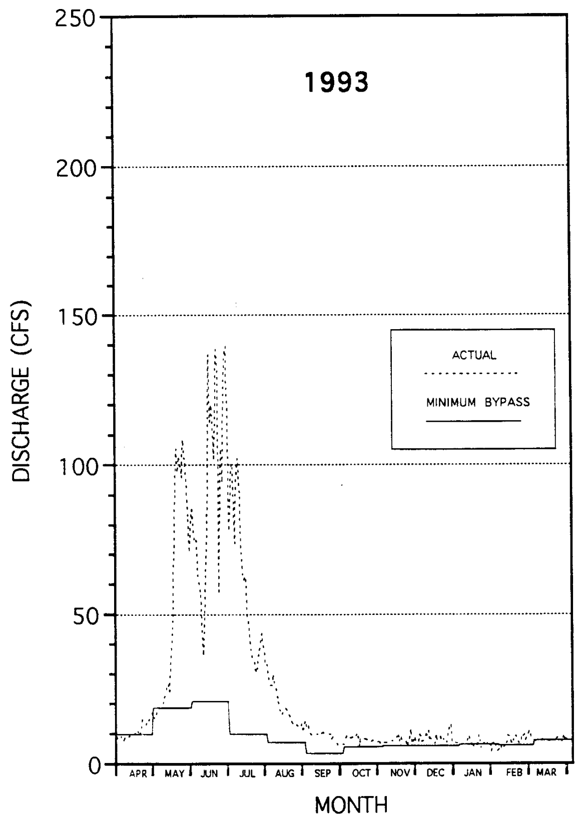
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1990 and the recommended operational minimum mean daily bypass flow regime.



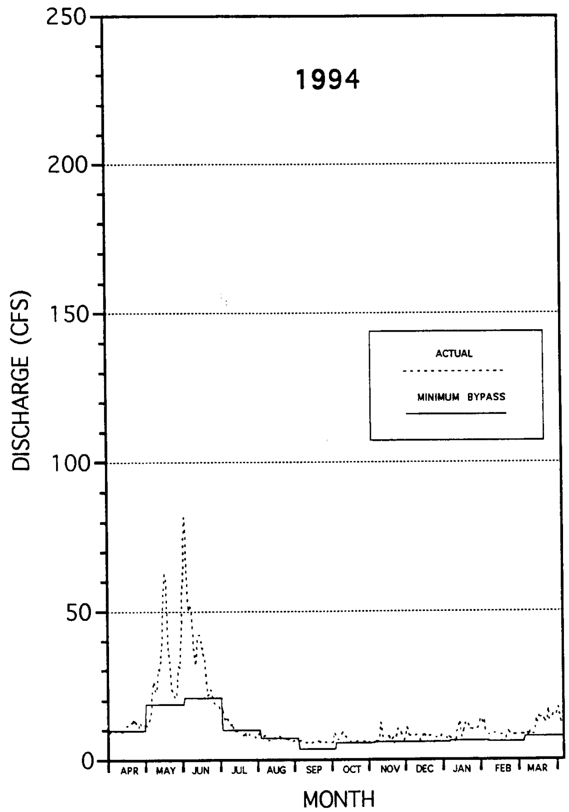
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1991, and the recommended operational minimum mean daily bypass flow regime.



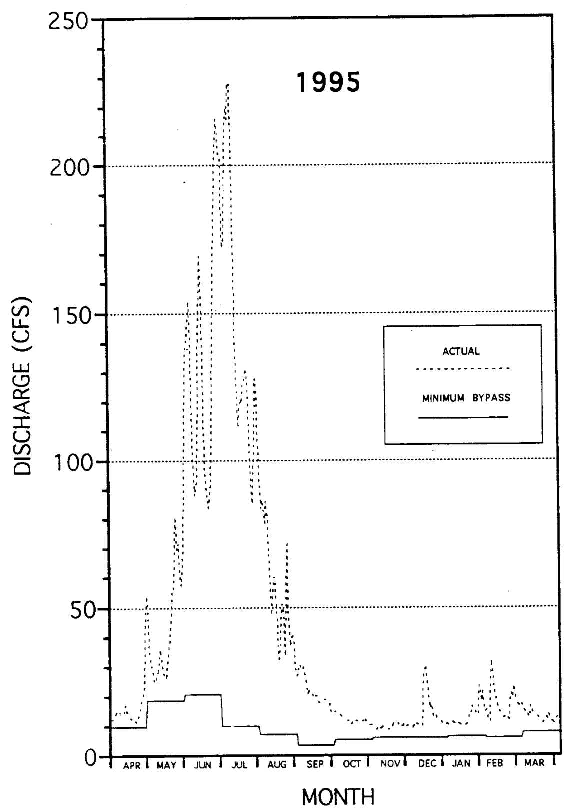
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1992 and the recommended operational minimum mean daily bypass flow regime.



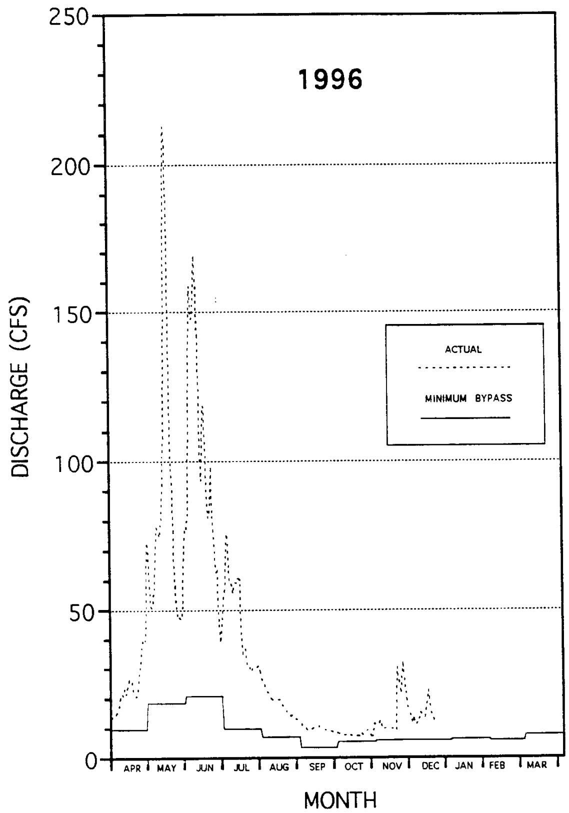
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1993, and the recommended operational minimum mean daily bypass flow regime.



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.



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 flow regime.