MAMMOTH CREEK FISH COMMUNITY SURVEY

Prepared for:
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Instream flow needs for fish resources in Mammoth Creek, Mono County, California have been the focus of recent investigations in order to establish a minimum flow maintenance schedule. 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. This study was designed and initiated as a method for comparison of population changes over time under various historical conditions. Fish resource assessment surveys were conducted from October 21 through 28, 1992, in the Mammoth Creek study area to evaluate several aspects of species composition, abundance and distribution. Specific objectives were:

1) To estimate the total fish population among sampling sections;

2) To evaluate the size and age class structure of fish throughout Mammoth Creek and within each sampling section; and,

3) 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 a cascade-plunge pool sequence in which the amount of usable fish habitat was not determined by stream discharge, but by sectional (streambed rock) hydraulic controls. Pursuant to concerns expressed by 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 1992 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 ensure representation of distinct zones of riparian cover and dispersion of sampling sections, fish sampling sections were located in high and low zones of riparian cover within each study reach.

The experimental design and sampling sites were consistent with those used in the 1988 study, with the only exception being the length of sampling section. The following is a description of the sampling site selection process used 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 the high and low riparian cover zones) were chosen by the following formalized random selection procedure:

1) 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;

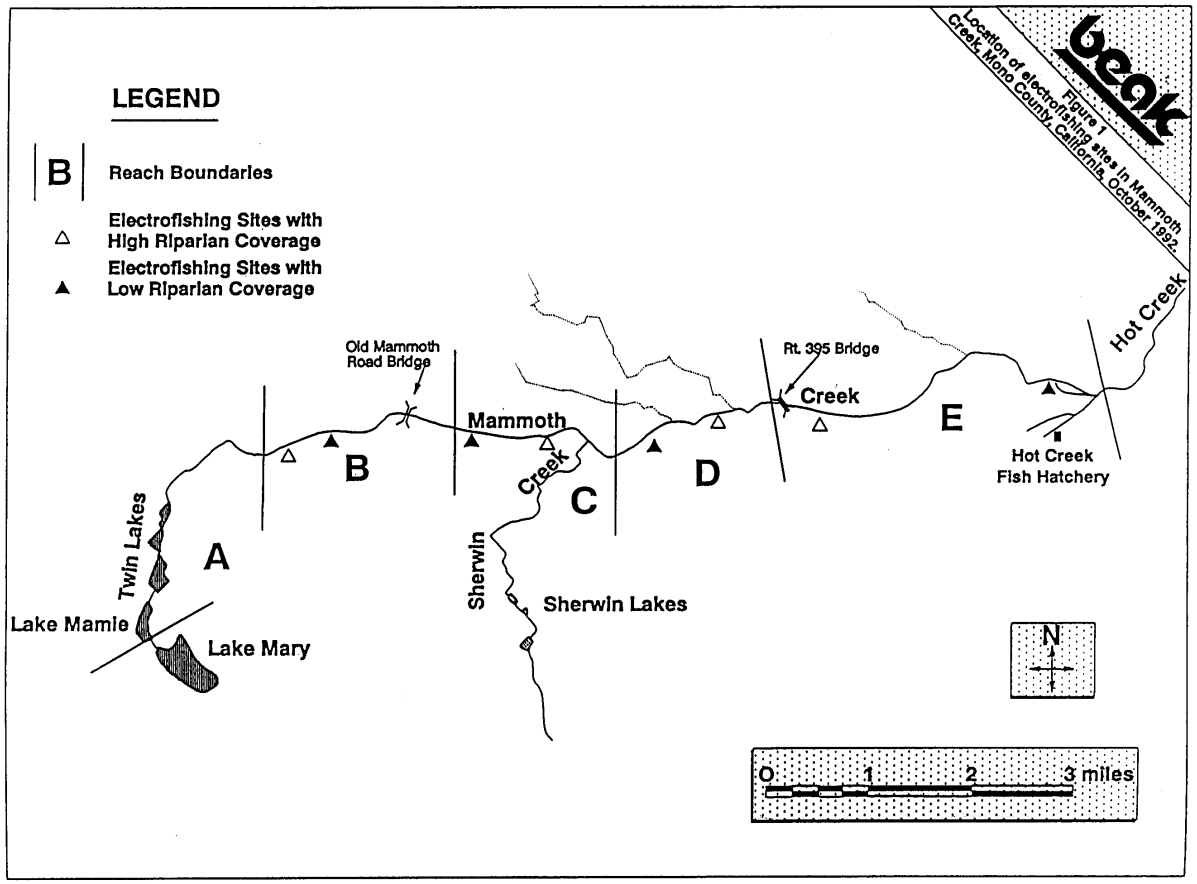
2) A four digit number was selected with a random number generator and treated as a decimal fraction;

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

4) 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,

5) From the point identified in Step 4 (above), a distance of 300 feet was measured in an upstream direction and served as the upstream boundary of the sampling section.

Eight stream sections were sampled, with each 300-foot long section representing a high or low riparian vegetation cover zone within a study reach (**Figure 1**). The downstream boundary of each sampling section was identical between the 1988 and the present study, although the sampling section extended upstream 100-feet during the 1988 study and 300-feet during the present study.


LEGEND
B
Reach Boundaries
Electrofishing Sites with High Riparian Coverage
Electrofishing Sites with Low Riparian Coverage
Location of electrofishing sites in Mammoth Creek, Mono County, California, October 1992.
Figure 1
beak
Old Mammoth Road Bridge
Rt. 395 Bridge
Creek
Hot Creek
Hot Creek Fish Hatchery
Mammoth
Creek
Twin Lakes
Lake Mamie
Lake Mary
Sherwin
Sherwin Lakes
A
B
C
D
E
N
0
1
2
3 miles

Data Acquisition

Fish resource assessment surveys were conducted by electrofishing. At least two days 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. 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 Type VII battery 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 ensure equal effort. The standardized technique included a systematic sampling approach that consisted of:

1) electrofishing along the downstream block net;

2) moving upstream in a recurring diagonal (acute angle) pattern from bank to bank, completely covering the area until encountering the upstream block net;

3) electrofishing along the upstream block net; and,

4) 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 two-foot by two-foot by four-foot holding pen placed in the stream outside 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 expressed as the number of fish per stream mile. Estimated brown trout totals and 95 percent confidence intervals, expressed as the

number of fish per stream mile, were graphically presented for each sampling section and visually compared between 1988 and 1992. In addition, the numbers of brown trout per stream mile in Mammoth Creek were calculated and compared among data collected by CDFG in 1983 and 1984 (Deinstadt et al. 1985), MCWD in 1988 (Bratovich et al. 1990), CDFG in 1991 (unpublished data), and MCWD in 1992 (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 1,504 fish representing four species was captured by electrofishing in Mammoth Creek from October 21 through 28, 1992. Brown trout (*Salmo trutta*) dominated the catch, comprising 50 percent of all fish captured in the creek (Table 1). Rainbow trout (*Oncorhynchus mykiss*), tui chub (*Gila bicolor*), and Owens sucker (*Catostomus fumeiventris*), respectively, accounted for the remaining 8.5, 27.7, and 13.8 percent of all fish caught.

One hundred and twenty-eight rainbow trout were captured in the entire study area. Thirty of these fish (23.4 percent) exhibited evidence that they were of hatchery origin by virtue of abraded dorsal fins. Of all rainbow trout caught, only 4 individuals were captured in the uppermost reach, Reach B. The remaining 124 rainbow trout were fairly evenly distributed among Reaches C, D and E. Slightly more rainbow trout (70 fish or 54.3 percent) were caught in sampling sections characterized by high riparian cover than by low riparian cover. By contrast, all tui chub and over 99 percent of the 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. No rainbow trout were captured in the lower reach (Reach E). 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 11 fish at site EL to 226 fish at site EH (Table 2). Extrapolation of these numbers resulted in a range of 194 to 3,978 trout per mile. Brown trout population estimates in sites characterized by high riparian cover ranged from 32 brown trout at site CH up to 226 brown trout at site EH. The low riparian cover zone population estimates ranged from 11 brown trout at site EL to 105 brown trout at site BL. Maximum-Likelihood catch statistics for brown trout in each of the eight sampling sections are presented in Appendix A.

Table 1. Number of brown trout captured by electrofishing Mammoth Creek, Mono County, California from October 21 through 28, 1992.

COMMON NAME	SCIENTIFIC NAME	REACH	COVER High	COVER Low	TOTAL
brown trout	(*Salmo trutta*)	B	170	104	274
		C	31	47	78
		D	76	90	166
		E	223	11	234
		Total	500	252	752
rainbow trout (undetermined origin)	(*Oncorhynchus mykiss*)	B	4	0	4
		C	8	37	45
		D	31	8	39
		E	10	0	10
		Total	53	45	98
rainbow trout (hatchery origin)	(*Oncorhynchus mykiss*)	B	0	0	0
		C	2	14	16
		D	0	0	0
		E	14	0	14
		Total	16	14	30
tui chub	(*Gila bicolor*)	B	0	0	0
		C	0	0	0
		D	0	0	0
		E	0	417	417
		Total	0	417	417
Owens sucker	(*Catostomus fumeiventris*)	B	0	0	0
		C	0	0	0
		D	2	0	2
		E	0	205	205
		Total	2	205	207
		Grand Total			1,504

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 1992.

Site	Number of brown trout	Brown trout per mile
BH	173	3045
BL	105	1848
CL	48	845
CH	32	563
DL	90	1584
DH	79	1390
EH	226	3978
EL	11	194

[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.

Length-Frequency Distribution

The length-frequency distribution calculated for all brown trout captured during this study did not exhibit as distinct of a multimodal distribution as observed in previous investigations (Bratovich et al. 1992) (**Figure 2**). Although a pronounced peak (54 to 125 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 not as readily apparent. However, given the broad range in lengths of fish captured larger than 125 mm FL, and in comparison with other data sources, multiple age classes are still present in Mammoth Creek.

For the entire brown trout population captured in 1992, the only readily discernable group was comprised of 510 fish ranging from 54 to 125 mm FL, with 58 percent of the fish in this group ranging from 80 to 110 mm FL. Brown trout within the lower size group are most likely YOY fish. The middle group was comprised of 68 fish ranging from 130 to 170 mm FL and were probably Age I fish. The next group was comprised of 95 fish ranging from 172 to 255 mm FL, and most likely were Age II fish. Eleven fish were in the 260 to 310 mm FL size range and may represent Age III fish. Although ages of fish were not directly estimated in this study, the 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).

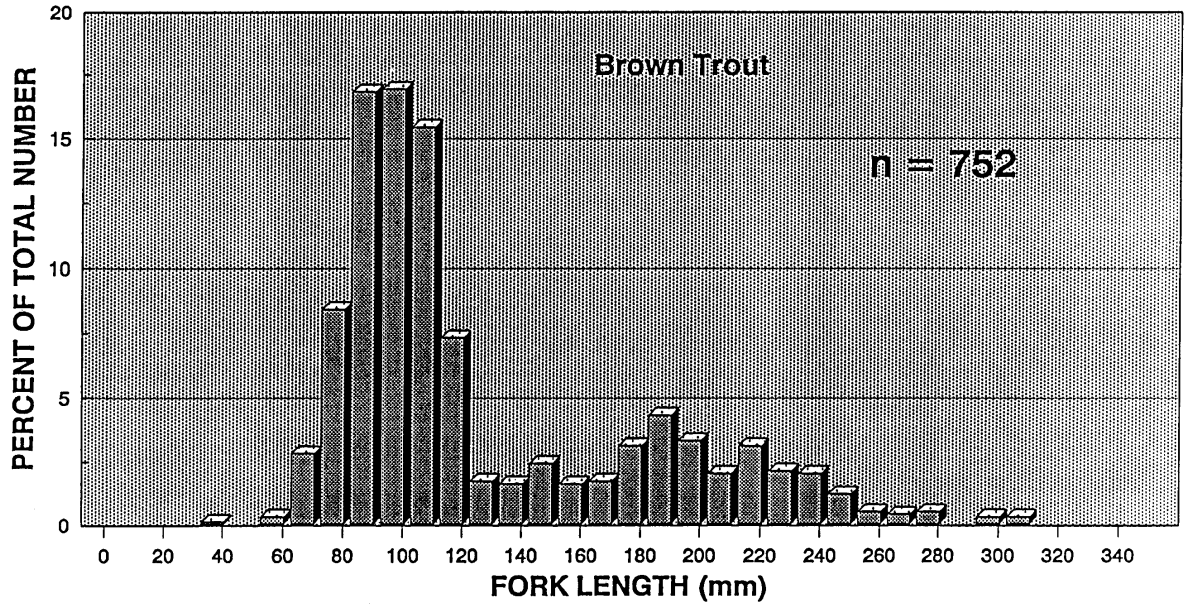
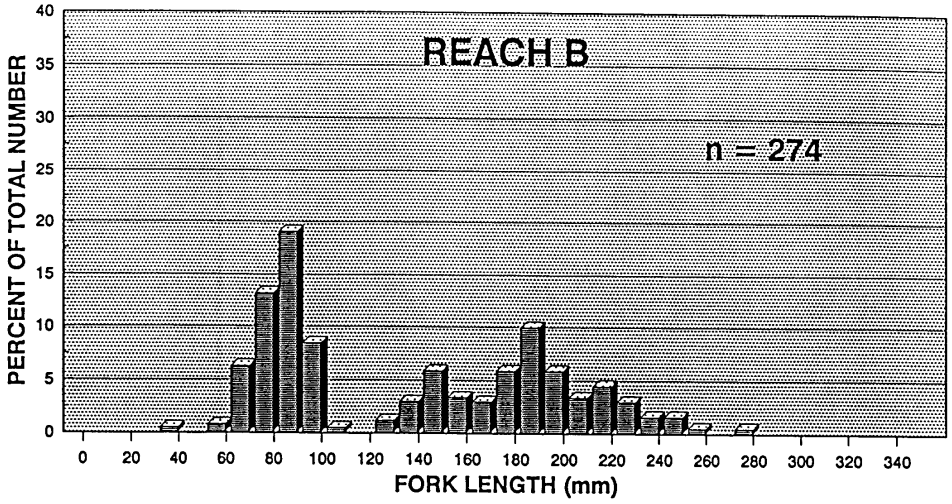


Figure 2. Length-frequency distribution of all brown trout captured at all electrofishing sites in the Mammoth Creek study area, October 21 through 28, 1992.

Brown trout length-frequency distributions differed among study reaches (**Figures 3 and 4**). Of all brown trout captured, a multimodal distribution was only readily apparent in Reach B. The catches for the lower three reaches exhibited distinct length groups for YOY brown trout. The YOY group of fish ($\leq$ 125 mm FL) accounted for only 48 percent of the total catch in Reach B, but accounted for 74, 77 and 87 percent of the catch in Reaches C, D, and E, respectively. Large brown trout (180+ mm FL) were most abundant in Reach B, accounting for 36 percent of the total catch. By contrast, large brown trout comprised only 25, 20, and 10 percent of the total catch in Reaches C, D, and E, respectively. Numbers of Age I fish (130-170mm) were low in Reaches C, D, and E. Reach C was unique in that the middle size group of fish (130 to 170 mm FL) were virtually absent in the catch.

Of the 98 undetermined origin rainbow trout captured, seventy-eight percent ranged in length from 57 to 117 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 (N. Redfern, CDFG, pers. comm.), it is believed that these trout were produced in the stream.



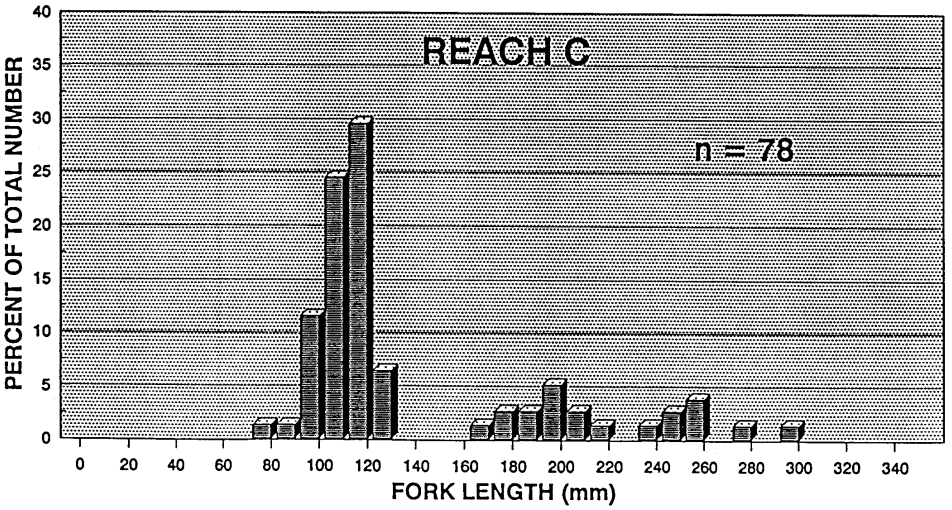


Figure 3. Length-frequency distributions of brown trout captured in Reaches B and C during October 1992 in Mammoth Creek.

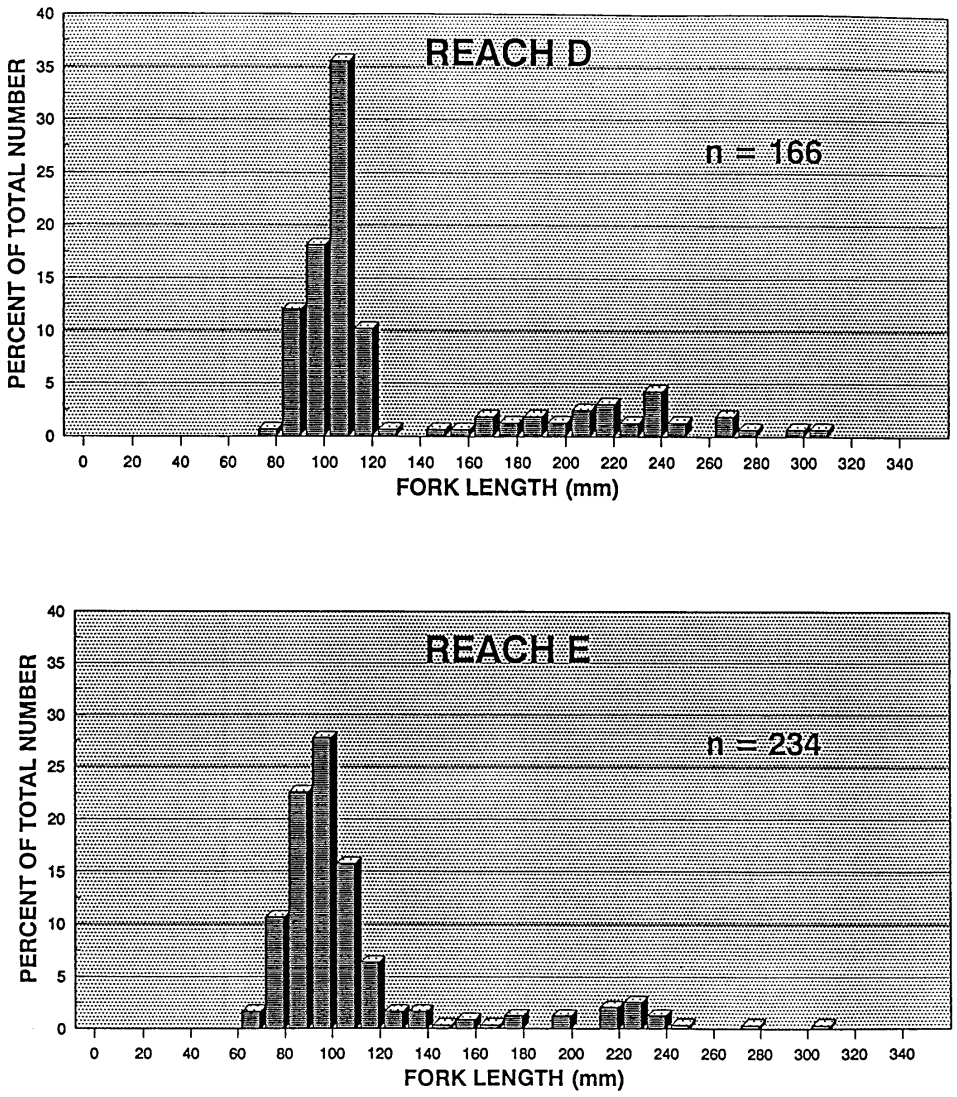


Figure 4. Length-frequency distributions of brown trout captured in Reaches D and E during October 1992 in Mammoth Creek.

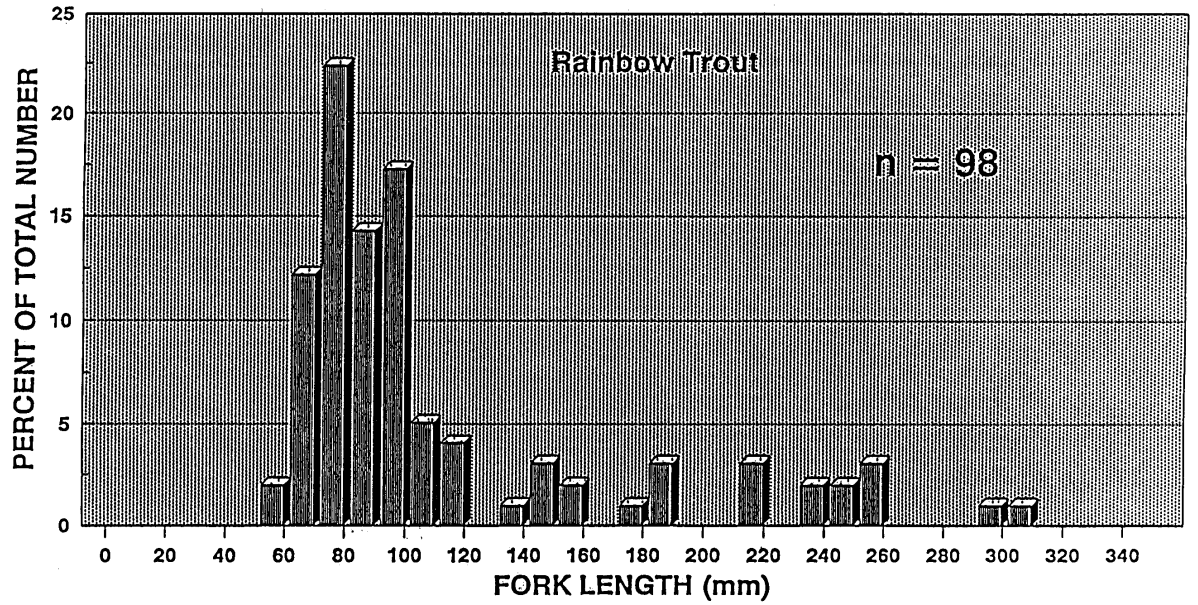


Figure 5. Length-frequency distribution of all rainbow trout (undetermined origin) captured by electrofishing the entire study area in Mammoth Creek, October 21 through 28, 1992.

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. 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 size and age structure information. During the past six years, dry hydrologic conditions have prevailed in Mammoth Creek resulting in flows that are similar, and in some cases lower than, Beak's recommended minimum bypass flow levels (**Appendix B**). Comparison of the population estimates and age structure based on data collected before and after these low flow conditions occurred in the creek provides an opportunity to evaluate the adequacy of the recommended flows for maintaining fish populations in good condition.

In the present study, brown trout densities (trout per mile) were lower than found in 1988 in six of the eight sections sampled (**Table 3**). In general, average brown trout densities (1,681 trout per mile) overall were approximately 27 percent lower in 1992 than in 1988 (2,290 trout per mile). However, average densities found in 1992 remain equal to or higher than other CDFG findings in Mammoth Creek, as summarized in the following.

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 6**).

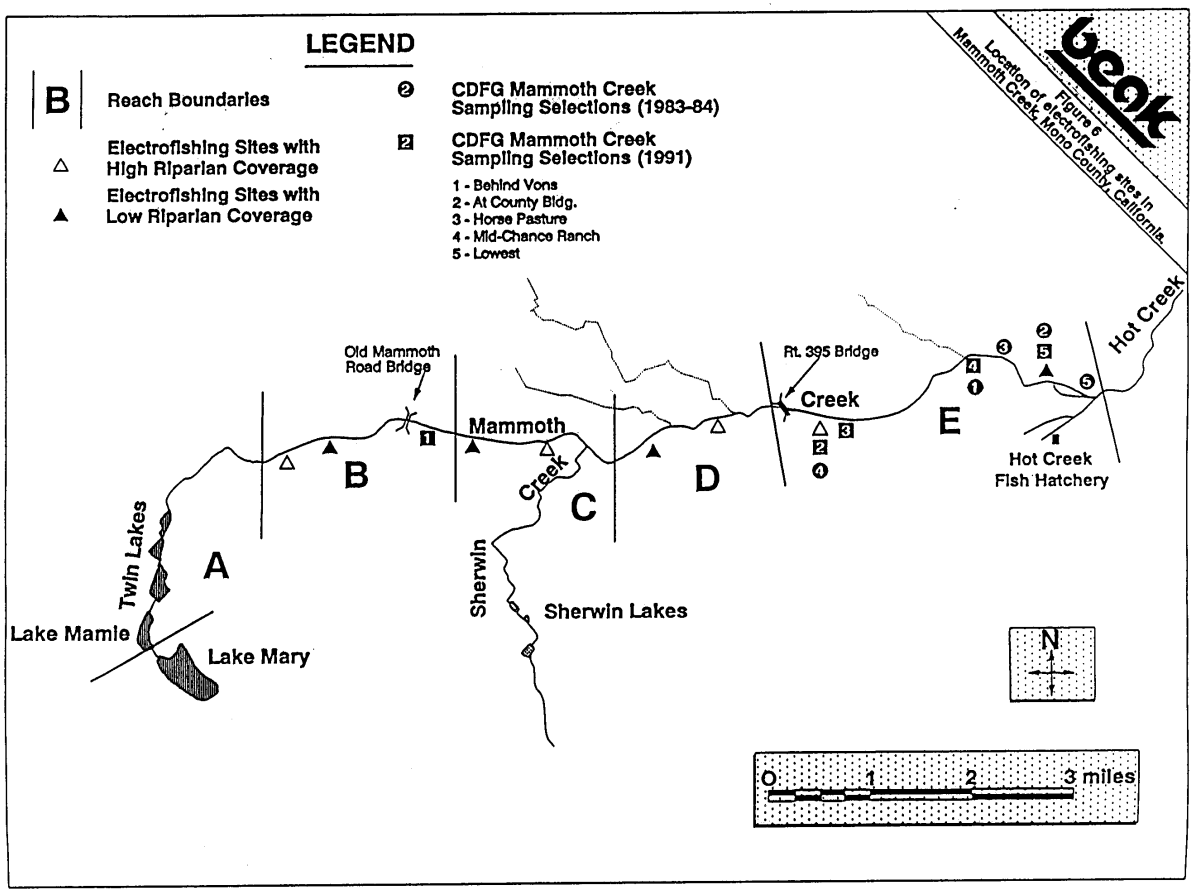
Sampling Section	Brown trout per mile
1	1,109
2	493
3	2,798
4	704
5	1,707

Mean = 1,362

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

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
BH	1988	2904	3168	3617
	1992	2882	3045	3128
BL	1988	4488	4699	5028
	1992	1830	1848	1859
CL	1988	1848	1901	2069
	1992	827	845	906
CH	1988	1109	1109	1202
	1992	546	563	621
DL	1988	1056	1056	1122
	1992	1584	1584	1611
DH	1988	2006	2006	2124
	1992	1338	1390	1482
EH	1988	4171	4277	4493
	1992	3925	3978	4053
EL	1988	106	106	479
	1992	194	194	209

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


LEGEND
B
Reach Boundaries
Electrofishing Sites with High Riparian Coverage
Electrofishing Sites with Low Riparian Coverage
CDFG Mammoth Creek Sampling Selections (1983-84)
CDFG Mammoth Creek Sampling Selections (1991)
1 - Behind Vons
2 - At County Bldg.
3 - Horse Pasture
4 - Mid-Chance Ranch
5 - Lowest
beak
Location of electrofishing sites in Mammoth Creek, Mono County, California.
Figure 6
Old Mammoth Road Bridge
Rt. 395 Bridge
Mammoth Creek
Hot Creek
Hot Creek Fish Hatchery
Twin Lakes
Lake Mamie
Lake Mary
Sherwin
Sherwin Lakes
A
B
C
D
E
N
0 1 2 3 miles

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

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 compare relatively well to other California streams. In nonmigratory trout stream sections within the Northern Sierra where efforts were made to collect all trout, populations from 1,200 to 3,000 trout per mile were encountered, including estimates from Coyote Valley Creek (1,177), Tiger Creek (1,800), Macklin Creek (2,000), Silver King Creek (2,175), Sutter Creek (2,300) and Upper Sagehen Creek (3,000) (Gerstung 1973). In nearby creeks, CDFG estimated 5,490 brown trout (and 2,011 rainbow trout) per mile for one section in Hot Creek, 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 numbers, the age structure of a fish population can provide evidence of reproductive success and survival, and a general indication of a fish population's overall condition. To assess potential differences in the age structure of the brown trout population in Mammoth Creek during the past few years, length-frequency data from the present study were compared to Beak's 1988 and CDFG's 1991 data (Figure 7).

The length-frequency distribution calculated for all brown trout captured during the present 1992 study exhibited a length-frequency distribution very similar to that calculated from Beak's 1988 and CDFG's 1991 data. 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 distributions 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 three years. However, the proportion of YOY fish captured in 1991 was approximately fifteen percent less than in 1988 and 1992. This same group of fish (Age I in 1992), represented a slightly lower proportion of the total catch than seen in previous years. One possible interpretation of this finding is that under dry hydrologic conditions such as those that occurred during the past several years (i.e., flows lower than the recommended flows during the brown trout spawning and incubation period), brown trout spawning success and subsequent recruitment to the population may be relatively low. ~~If this interpretation is correct, flow augmentation would benefit the brown trout population during these low flow periods in Mammoth Creek.~~ Another possible interpretation of the relatively low proportion of

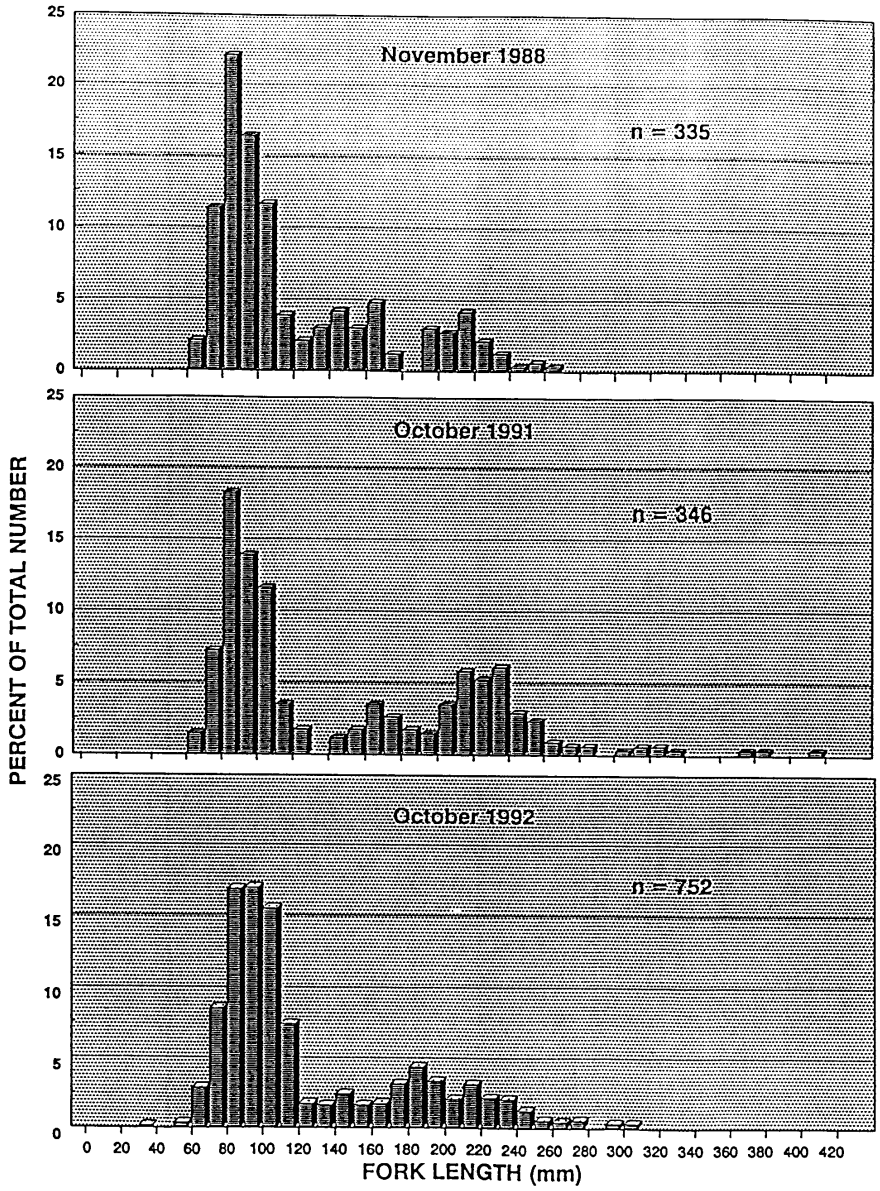


Figure 7. Comparisons of brown trout captured during electrofishing surveys in November of 1988 (Beak), October of 1991 (CDFG) and October of 1992 (Beak).

YOY fish captured in 1991 may be attributed to the habitat composition of the CDFG electrofishing sites. 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. 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. By contrast, 98 rainbow trout of undetermined origin, 78 percent of which were considered YOY, were captured in October of 1992. One possible explanation for the dominance of brown trout in Mammoth Creek and the recent increase in rainbow trout abundance may be related to magnitude and timing of spring snowmelt flows. Kondolf et al. (1991), suggests 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, it is reasonable to expect that rainbow trout spawning success in Mammoth Creek during 1992 (as evidenced by the relatively high number of YOY rainbow trout captured) was higher due to the extreme low flow conditions associated with the 1992 spring snowmelt period.

CONCLUSIONS

- Brown trout density and age structure (length-frequency) information obtained from the electrofishing survey conducted in October 1992 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.

- The appearance of YOY rainbow trout in the catch suggests that the unusually low flow conditions during the spring 1992 spawning period may have improved rainbow trout spawning and incubation success.

- ~~Flow augmentation during the brown trout fall spawning period may enhance spawning conditions and improve spawning success.~~

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PERSONAL COMMUNICATION

Redfern, Nancy. 12 November 1992. Receptionist. California Department of Fish and Game, Hot Creek Fish Hatchery. Telephone conversation.

Appendix A

Maximum-Likelihood Catch Statistics

Stream: Mammoth Creek - Site BH
Species: Brown Trout

Removal Pattern: 122 41 7
Total Catch = 170
Population Estimate = 173

Chi Square = 2.000
Pop Est Standard Err = 2.396
Lower Conf Interval = 170.000
Upper Conf Interval = 177.719

Capture Probability = 0.726
Capt Prob Standard Err = 0.037
Lower Conf Interval = 0.654
Upper Conf Interval = 0.799

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 168.2808 .

Stream: Mammoth Creek - Site BL
Species: Brown Trout

Removal Pattern: 82 16 6
Total Catch = 104
Population Estimate = 105

Chi Square = 1.078
Pop Est Standard Err = 1.345
Lower Conf Interval = 104.000
Upper Conf Interval = 107.663

Capture Probability = 0.770
Capt Prob Standard Err = 0.043
Lower Conf Interval = 0.685
Upper Conf Interval = 0.855

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 102.3369 .

Stream: Mammoth Creek - Site CH
Species: Brown Trout

Removal Pattern: 22 5 4
Total Catch = 31
Population Estimate = 32

Chi Square = 1.692
Pop Est Standard Err = 1.608
Lower Conf Interval = 31.000
Upper Conf Interval = 35.281

Capture Probability = 0.660
Capt Prob Standard Err = 0.097
Lower Conf Interval = 0.461
Upper Conf Interval = 0.858

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 28.71938 .

Stream: Mammoth Creek - Site CL
Species: Brown Trout

Removal Pattern: 32 11 4
Total Catch = 47
Population Estimate = 48

Chi Square = 0.191
Pop Est Standard Err = 1.715
Lower Conf Interval = 47.000
Upper Conf Interval = 51.451

Capture Probability = 0.681
Capt Prob Standard Err = 0.076
Lower Conf Interval = 0.528
Upper Conf Interval = 0.835

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 44.54904 .

Stream: Mammoth Creek - Site DH
Species: Brown Trout

Removal Pattern: 48 11 11 6
Total Catch = 76
Population Estimate = 79

Chi Square = 5.777
Pop Est Standard Err = 2.601
Lower Conf Interval = 76.000
Upper Conf Interval = 84.178

Capture Probability = 0.547
Capt Prob Standard Err = 0.059
Lower Conf Interval = 0.429
Upper Conf Interval = 0.664

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 73.82173 .

Stream: Mammoth Creek - Site DL
Species: Brown Trout

Removal Pattern: 72 17 1
Total Catch = 90
Population Estimate = 90

Chi Square = 2.039
Pop Est Standard Err = 0.768
Lower Conf Interval = 90.000
Upper Conf Interval = 91.527

Capture Probability = 0.826
Capt Prob Standard Err = 0.040
Lower Conf Interval = 0.745
Upper Conf Interval = 0.906

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 88.47315 .

Stream: Mammoth Creek - Site EH
Species: Brown Trout

Removal Pattern: 173 38 12
Total Catch = 223
Population Estimate = 226

Chi Square = 0.695
Pop Est Standard Err = 2.164
Lower Conf Interval = 223.000
Upper Conf Interval = 230.263

Capture Probability = 0.759
Capt Prob Standard Err = 0.030
Lower Conf Interval = 0.699
Upper Conf Interval = 0.818

The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 221.7366 .

Stream: Mammoth Creek - Site EL
Species: Brown Trout

Removal Pattern: 8 3 0
Total Catch = 11
Population Estimate = 11

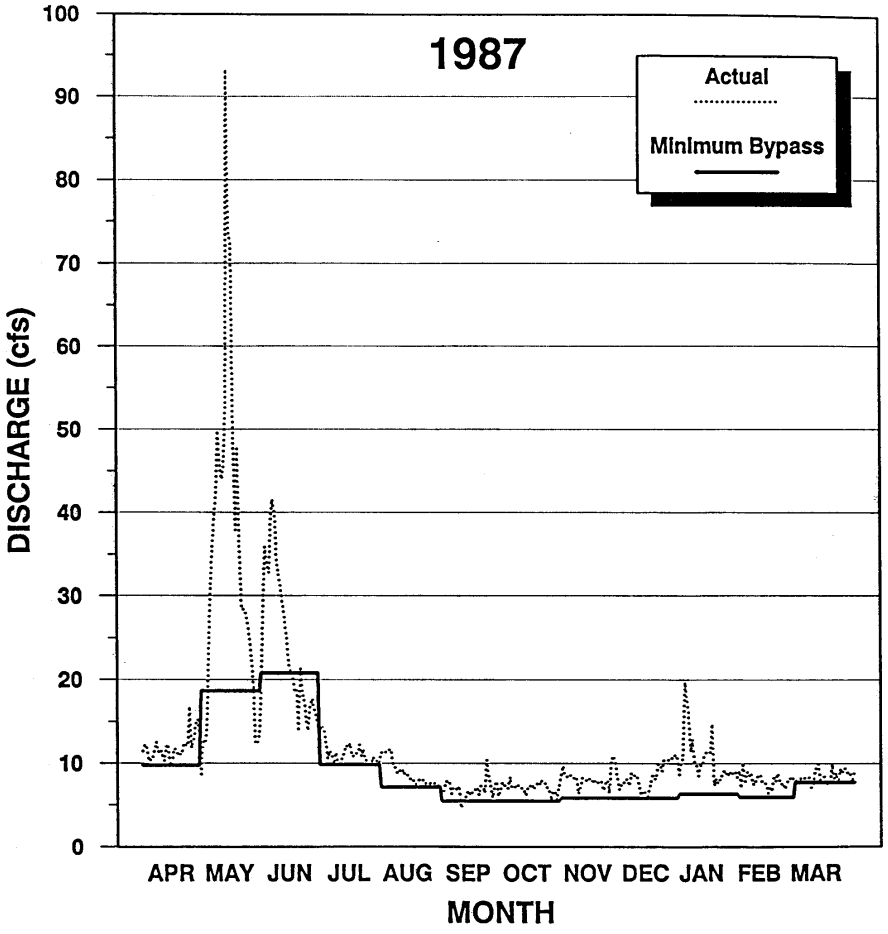
Chi Square = 1.157
Pop Est Standard Err = 0.384
Lower Conf Interval = 11.000
Upper Conf Interval = 11.856

Capture Probability = 0.786
Capt Prob Standard Err = 0.128
Lower Conf Interval = 0.500
Upper Conf Interval = 1.071

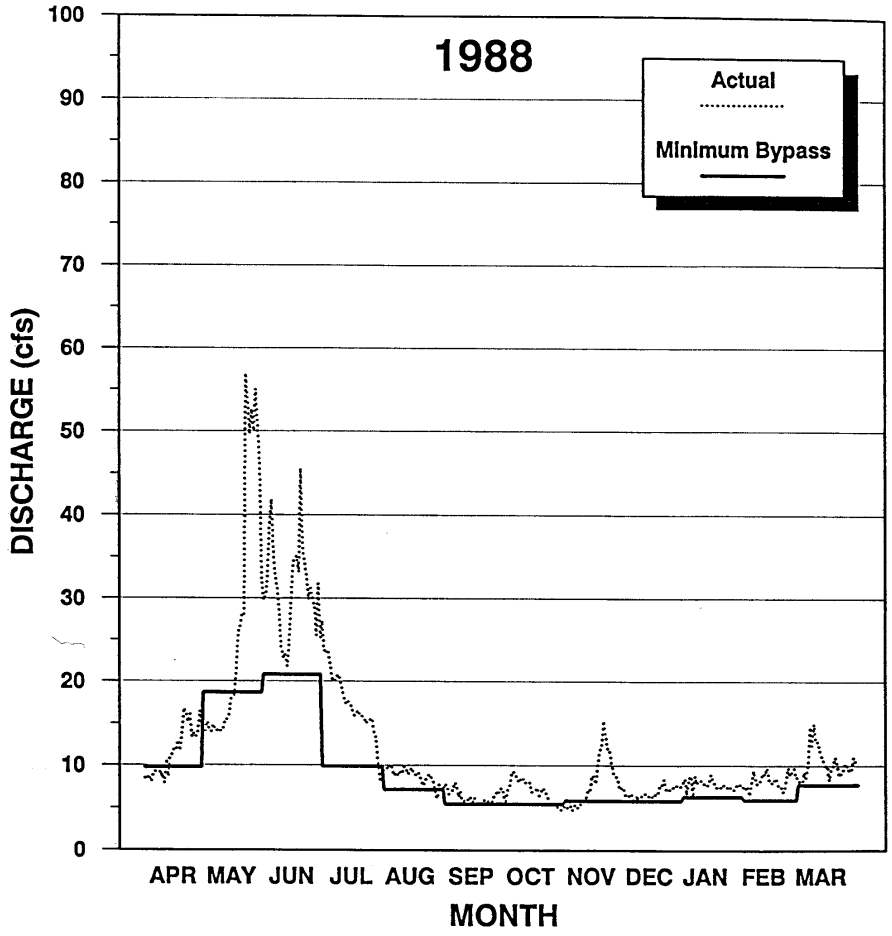
The population estimate lower confidence interval was set equal to the total catch. Actual calculated lower CI was 10.14356 .

Appendix B

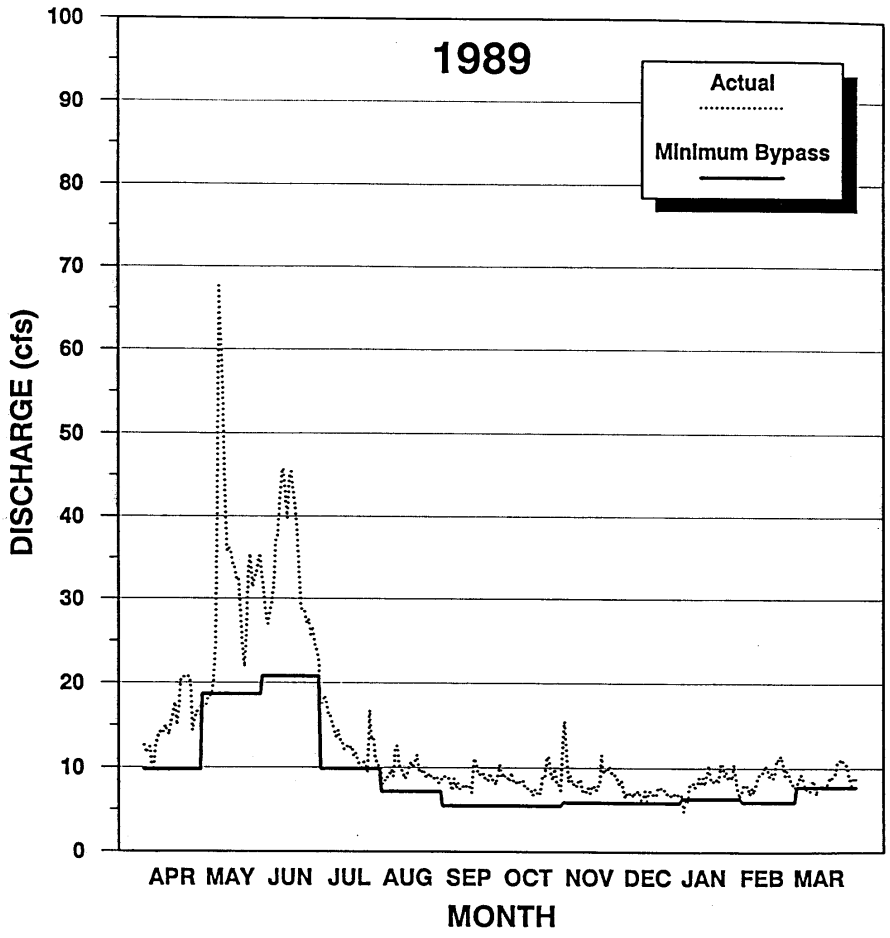
Mammoth Creek Hydrographs 1987-1992



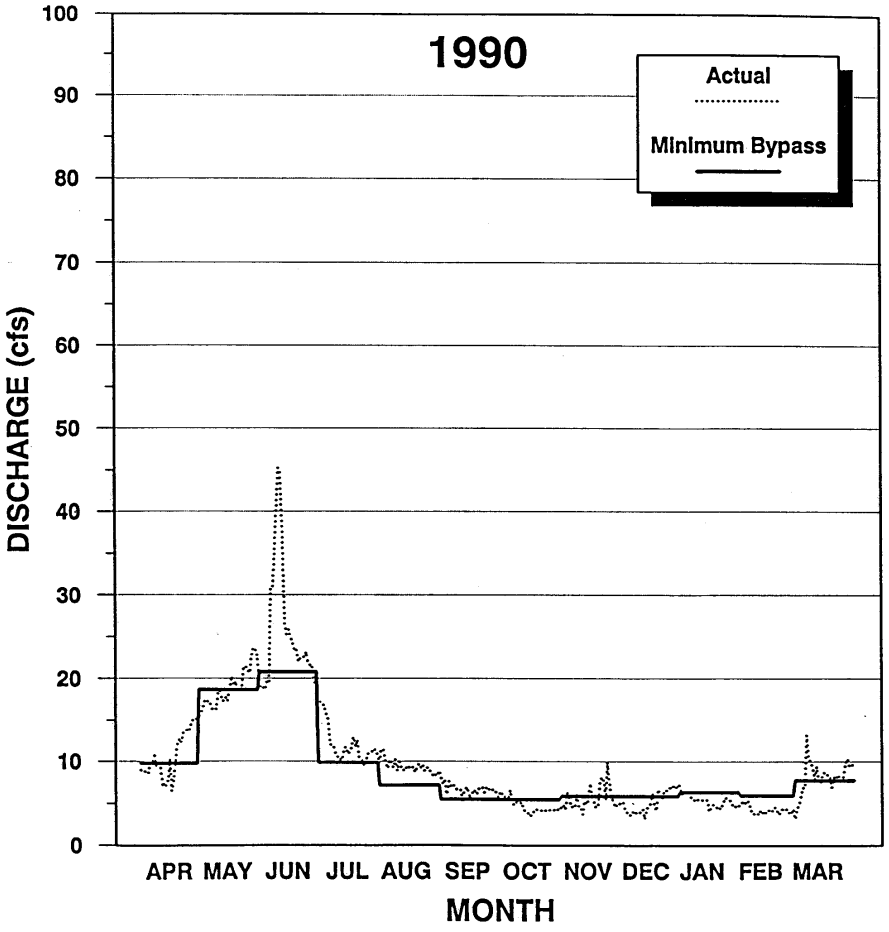
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1987 and the recommended operational minimum mean daily bypass flow regime.



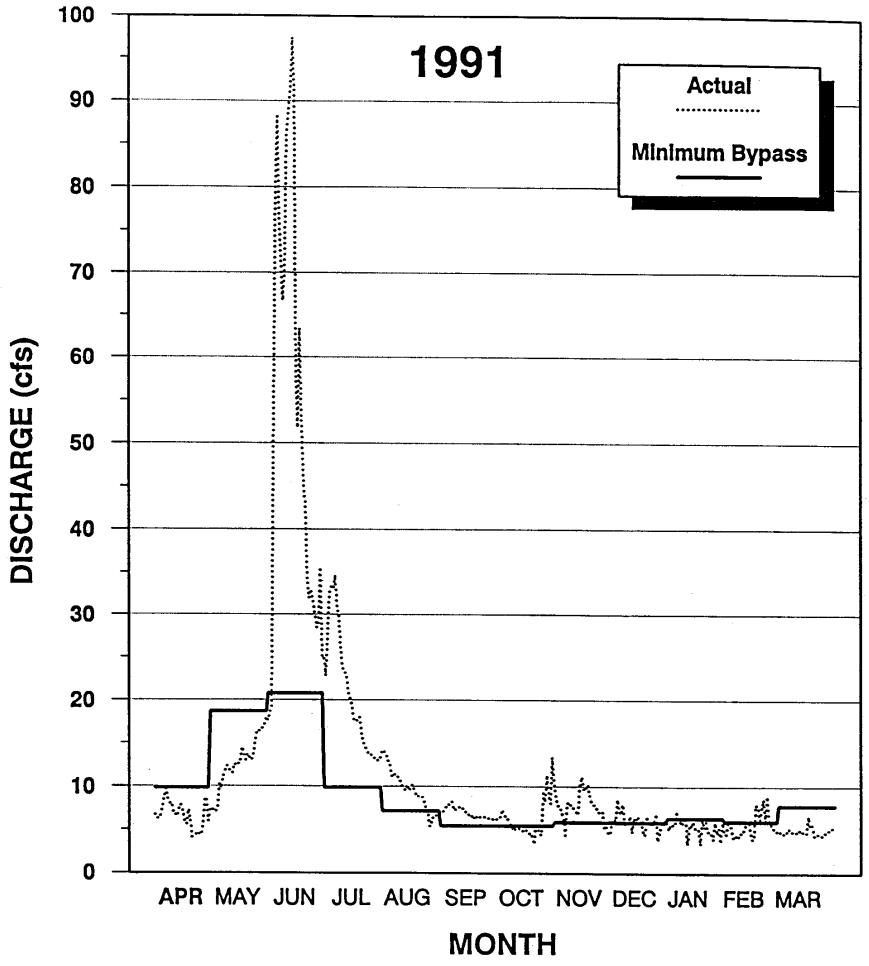
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1988 and the recommended operational minimum mean daily bypass flow regime.



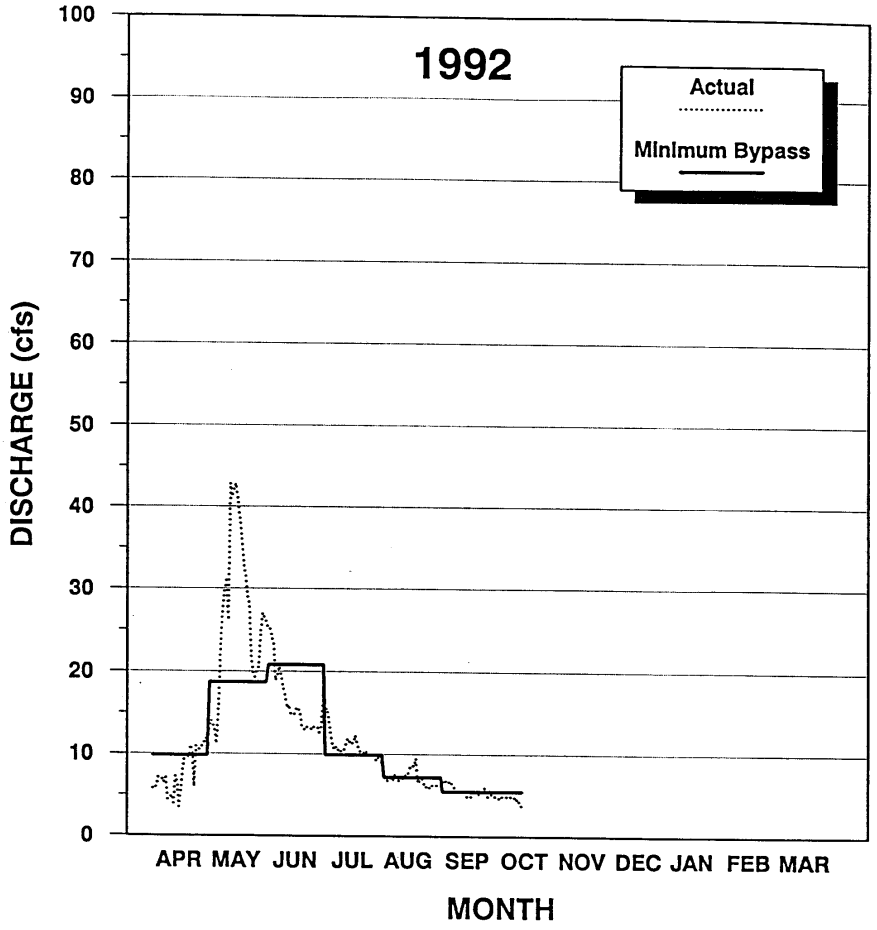
Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) during runoff year 1989 and the recommended operational minimum mean daily bypass flow regime.



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.