- Final Report -

MAMMOTH CREEK 2003 FISH COMMUNITY SURVEY

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September 2004

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INTRODUCTION

Instream flow needs for fish resources in Mammoth Creek, Mono County, California have been the focus of several investigations since the 1970's. As a result of these investigations, mean daily instream flow regimes have been recommended that are intended to sustain aquatic habitat and the fishery resources in Mammoth Creek. Several entities have been involved in the collection of Mammoth Creek fisheries data (see Hood et al., 1993-95, Jenkins and Dawson 1996-97, Hood 1998, 2000-2002, and Jenkins 1999). However, this report focuses on the data set collected from the 1992 through 2003 fish community surveys. For these surveys, data was collected using a consistent sampling methodology and therefore is most useful in assessing the Mammoth Creek fishery in terms of species composition, abundance, and size and age class structure. The 1992-2003 surveys compare population changes over time under various hydrological conditions.

This report documents the results of the 2003 fish resource assessment survey conducted from September 29, 2003 through October 3, 2003. Specific objectives of this study were:

- To estimate the total fish population and evaluate the size and age class structure and species composition of fish throughout the Mammoth Creek study area and within each sampling section;
- To compare the results of this year's study with previous studies of Mammoth Creek and other similar Sierra Nevada streams; and
- To relate the results of this year's fish population dynamics with the hydrologic conditions of Mammoth Creek over the water year preceding the survey.

Because of the differences in the sampling methodology used by Beak in 1988 and CDFG in 1991, the analyses used in this report will focus on the data set collected from the 1992-2003 surveys.

STUDY AREA

The Mammoth Creek study area extends from Lake Mary downstream to the confluence of Mammoth Creek and Hot Creek, a distance of approximately 10.4 miles. Five distinct reaches were identified in Mammoth Creek in 1988 (Bratovich *et al.* 1990), based upon analysis of topographic maps, calculation of gradient profiles, visual inspection of the creek and associated morphological characteristics, tributaries, riparian vegetation and surrounding topography. Four of these reaches were located in the lower 8.9 miles (86.3 percent of the entire length) of the creek, and were characterized by gradients that range from 0.7 to 3.8 percent. By contrast, a fifth reach comprised of approximately the upper 1.4 miles (13.7 percent) of the creek was characterized by a gradient of approximately 12.3 percent. Habitat in this high-gradient reach typically consisted of a cascade-plunge pool sequence in which the amount of usable fish habitat was not determined by stream discharge, but by sectional (streambed rock) hydraulic controls. Pursuant to concerns expressed by CDFG and the USFS during the preliminary scoping meeting held in 1988 regarding the accuracy of modeling Reach A using the Instream Flow Incremental Methodology (IFIM), habitat characterization and all subsequent investigations were

restricted to the remaining four study reaches (Bratovich *et al.* 1992). Therefore, for comparative purposes, the same four reaches were the focus of this 2003 investigation.

METHODS AND MATERIALS

Experimental Design

The experimental design and rationale of sampling site selection are described in detail in Bratovich *et al.* 1990. Distinct differences in the amount of riparian cover within each study reach were observed during the habitat mapping survey conducted in 1988 (Bratovich *et al.* 1990). To ensure representation of riparian cover and dispersion of sampling sections, fish sampling sections were located within *zones* of "high" and "low" riparian cover within each study reach. However, discretion must be used when comparing and interpreting the results between "high" and "low" riparian cover sites. For example, Site EH represents a *zone* of "high" riparian cover within Reach E. However, in comparison with other "high" riparian cover sites, it is characterized by a relatively low amount of riparian cover. Conversely, Site DL was randomly selected within a "low" riparian *zone* for Reach D but in fact has a high amount of willow cover. Additionally, since the initiation of these fish community surveys in 1988, the riparian cover at Site BL has changed significantly, and although it remains in a "low" riparian cover *zone,* rapid willow tree growth at this site has resulted in high riparian cover at the sample site. Streamside cover at Site BH has also been altered significantly by landscape activities at the adjacent condominiums.

Consistent with the previous ten surveys (1992-97 and 1999-2002), eight stream sections were sampled in 2003, with each 300-foot long sample site representing a "high" or "low" riparian vegetation cover *zone* within a study reach (Figure 1). The downstream boundary of the sampling sites remained the same for the 1992-2003 surveys with two exceptions. In 1995, the organization that conducted the 1995-96 surveys was unable to access the lowermost site. An alternate site extending 300 feet downstream from the eastern boundary of the Chance Ranch, just upstream from the confluence of Mammoth and Hot Creeks was established (Figure 1). The second sample site change occurred at Site CH because of a channel split. For this study we established the bottom of Site CH immediately upstream of the channel split. Although the sample site was moved upstream for this survey, the site was similarly characterized to the previous sample site and, therefore, no significant differences in the fish composition are likely.

Data Acquisition

Fish resource assessment surveys were conducted by electrofishing. One day prior to electrofishing, selected sampling sites were re-located and the upstream and downstream boundaries marked with 0.5-inch diameter rebar driven into each bank. The rebar also served as anchors for block nets. On the day of sampling, sites were closed using block nets comprised of 0.25-inch stretched mesh. The nets were placed simultaneously across the upstream and downstream boundaries to preclude movement of fish into or out of the sampling section.

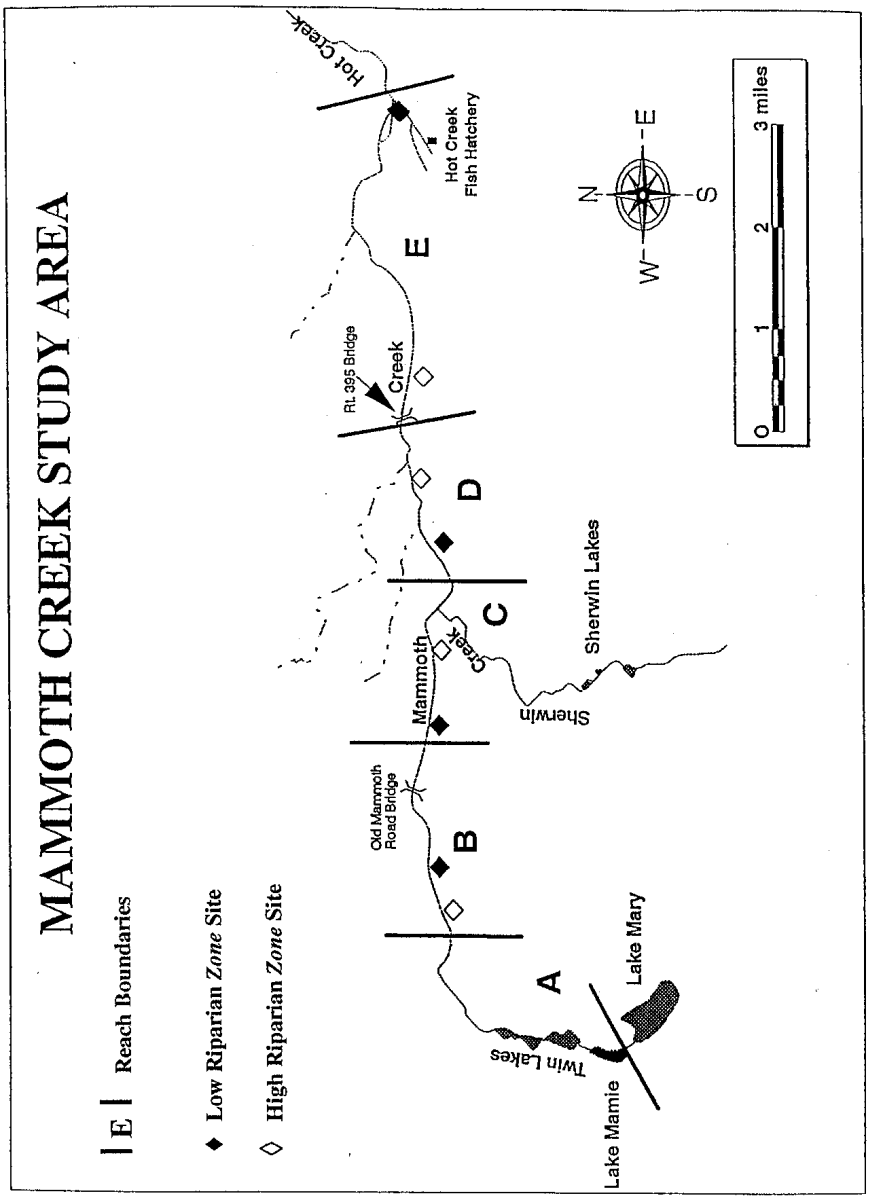

Figure 1. Electrofishing sites sampled on Mammoth Creek, September 29 through October 3, 2003 (modified from Hood *et al.* 1995).

Electrofishing was conducted using a Smith-Root Model 12 battery powered backpack electrofisher. A four-person crew was used to capture and process fish. One person operated the electrofisher and two people, one positioned at each side of the operator, netted fish. The fourth person processed the catch while electrofishing continued.

A multiple-pass removal method of electrofishing was used for fish population estimation. Three complete passes were conducted at each sampling section. Each pass (or removal occasion) was conducted using a standardized technique to ensure equal effort.

The standardized technique included a systematic sampling approach that consisted of:

- electrofishing along the downstream block net;
- moving upstream in a recurring diagonal (acute angle) pattern from bank to bank, completely covering the area until encountering the upstream block net;
- electrofishing along the upstream block net; and,
- sampling along the downstream block net to collect any impinged fish.

Captured fish were placed in 5-gallon buckets and transferred to shore for processing. Captured fish were anesthetized (as necessary) using carbon dioxide (CO_2), identified to species, measured (to the nearest millimeter (mm) fork length (FL)), and weighed (to the nearest 0.1-gram (g) up to 10.0g and to the nearest 1g over 10g). When possible, fish of hatchery origin were identified by typical deformed and abraded fins. All possible precautions were taken to prevent stress and handling or holding mortality. Anesthetized, processed fish were immediately revived in oxygen-rich water. Processed fish were held in holding pens placed in the stream outside of the sampling area. After the completion of all removal passes, fish were returned to the general area of the stream section from which they were captured.

Data Analysis

Population Estimation

Fish numbers occurring within each sampling section were estimated with a maximum likelihood estimator (White *et al.* 1982) facilitated by use of the Microfish 2.3 software package (Van Deventer and Platts 1986). For each sampling section, the estimated total numbers of brown and presumed "wild" rainbow trout (and associated 95 percent confidence intervals) were expressed as the number of fish per stream mile. Estimated brown trout totals and 95 percent confidence intervals, expressed as the number of fish per stream mile, were summarized in a tabular format for each sampling section and visually compared between the 1992-2002 surveys. Additionally, the numbers of brown trout per stream mile in Mammoth Creek were calculated and compared among data collected by CDFG on nearby similar creeks in 1983 and 1984 (Deinstadt *et al.* 1985), and the previous consecutive year's surveys. Numbers of presumed "wild" rainbow trout per stream mile in Mammoth Creek were calculated and compared among data collected in the previous consecutive year's surveys.

Size and Age Structure
Length-frequency distributions were calculated and graphed (using 10 mm size groups) on frequency histograms to summarize body size and *inferred* age class information for all trout captured in the Mammoth Creek study area in 2003. Length-frequency (and inferred age) distributions of brown trout were calculated for the entire creek and for each study reach. In addition, length-frequency distributions of presumed "wild" rainbow trout were calculated and graphed for fish captured throughout the entire creek.

RESULTS

Species Composition and Relative Abundance

This report assumes that native fishes in Mammoth Creek include non-hatchery rainbow trout (*Oncorhynchus mykiss*), tui chub (*Gila bicolor*) and Owen's sucker (*Catostomus fumeiventris*). Brown trout (*Salmo trutta*) were brought to the United States in 1883 and were introduced into trout streams in most states by the late 1800's or early 1900's (Fuller 1999). CDFG regularly stocks catchable-sized rainbow trout in Mammoth Creek.

A total of 739 fish representing five species were captured by electrofishing in Mammoth Creek from September 29, 2003 through October 3, 2003 (Table 1). Brown trout comprised 73.2% of the total catch, the same percentage as in 2002.

Rainbow trout accounted for 16.5% of the total catch. Owen's sucker comprised 7.3% of the total catch, tui chub made up 2.6% of the total catch and brook trout (*Salvelinus fontinalis*) accounted for approximately 0.2% of the total catch.

One hundred and twenty-two rainbow trout were captured in the entire study area. Forty of these fish (32.8 %) exhibited evidence that they were of hatchery origin by virtue of abraded fins. The remaining 67.2% of rainbow trout captured were presumed to be "wild". Brown and rainbow trout were captured in all four reaches and at each of the eight sample sites. All tui chub and Owen's sucker were caught in the lowermost reach, Reach E. One brook trout was captured at Site BH.

Trout Population Estimation

The estimated number of brown trout captured in all sampling sections ranged from 26 fish at Site BL to 163 fish at Site BH (Table 2). Extrapolation of these numbers resulted in a range of 458 to 2,869 trout/mile. Brown trout population estimates in sites characterized by "high" riparian cover ranged from 616 brown trout/mile at Site DH up to 2,869 brown trout/mile at Site BH. The "low" riparian cover *zone* population estimates ranged from 669 brown trout/mile at site BL to 1,426 brown trout/mile at Site DL. Maximum likelihood catch statistics for brown trout in each of the eight sampling sections are presented in Appendix A.

Table 1. All fish captured by electrofishing Mammoth Creek, Mono County, California from September 29, 2003 through October 3, 2003.

Common Name	Scientific Name	Reach	Cover		Total
			High	Low	
Brown trout	(*Salmo trutta*)	B	142	26	**168**
		C	95	52	**147**
		D	34	79	**113**
		E	78	35	**113**
		TOTAL	**349**	**192**	**541**
Rainbow trout (presumed "wild")	(*Oncorhynchus mykiss*)	B	29	11	**40**
		C	6	2	**8**
		D	11	16	**27**
		E	9	0	**9**
		TOTAL	**55**	**29**	**84**
Rainbow trout (hatchery origin)	(*Oncorhynchus mykiss*)	B	1	1	**2**
		C	4	13	**17**
		D	15	4	**19**
		E	2	0	**2**
		TOTAL	**22**	**18**	**40**
Brook trout	(*Salvelinus fontinalis*)	B	1	0	**1**
		C	0	0	**0**
		D	0	0	**0**
		E	0	0	**0**
		TOTAL	**1**	**0**	**1**
Tui chub	(*Gila bicolor*)	B	0	0	**0**
		C	0	0	**0**
		D	0	0	**0**
		E	13	6	**19**
		TOTAL	**13**	**6**	**19**
Owen's sucker	(*Catostomus fumeiventris*)	B	0	0	**0**
		C	0	0	**0**
		D	0	0	**0**
		E	0	54	**54**
		TOTAL	**0**	**54**	**54**

The estimated number of presumed "wild" rainbow trout captured in all sampling sections ranged from 0 fish at Site EL to 38 fish at Site BH (Table 2). Extrapolation of these numbers resulted in a range of 0 to 458 rainbow trout/mile. Rainbow trout population estimates in sites characterized by "high" riparian cover ranged from 106 rainbow trout/mile at Site CH up to 669 rainbow trout/mile at Site BH. The "low" riparian cover zone population estimates ranged from 35 rainbow trout/mile at Site CL to 282 rainbow trout/mile at Site DL. Maximum likelihood catch statistics for presumed "wild" rainbow trout in each of the eight sampling sections are presented in Appendix A.

Table 2. Estimated abundance by sample site and extrapolated densities (trout/mile) of brown and presumed "wild" rainbow trout captured by electrofishing in Mammoth Creek, Mono County, California, from September 29, 2003 through October 3, 2003.

Site	Number of brown trout	Brown trout/mile	Number of rainbow trout	Rainbow trout/mile
BH	163	2,869	38	669
BL	26	458	11	194
CH	108	1,901	6	106
CL	53	933	2	35
DH	35	616	12	211
DL	81	1,426	16	282
EH	79	1,390	9	158
EL	35	616	0	0

Trout Length-Frequency Distribution

The length-frequency distribution calculated for all brown trout captured during this study exhibit a multimodal distribution similar to that observed in previous years studies (Figure 2). A distinct group (51 to 120 mm FL) in the distribution was apparent for the length-group likely representing young-of-year (YOY) fish. Additional age groups within the catch were also readily apparent, representing multiple age classes present in Mammoth Creek in 2003.

For the entire brown trout population captured in 2003, there were at least three distinct age groups similar to the groupings used in previous studies (Bratovich *et al.* 1990; Hood 1998). The group of the smallest sized fish was comprised of 370 fish ranging from 59 to 117 mm FL, which represents 68.4 percent of the entire brown trout catch. Brown trout within the lower size group are most likely YOY fish. The next group included 73 fish ranging from 121 to 179 mm FL, and was probably Age I fish. The next group was comprised of 82 fish ranging from 181 to 230 mm FL, and most likely was Age II fish. Sixteen fish were in the 239 to 289 mm FL size range and may represent Age III fish.

Although ages of fish were not determined in this study, the length groups of this study correlate well with previous investigations for brown trout in East Slope Sierra Nevada streams as reported in Snider and Linden (1981).

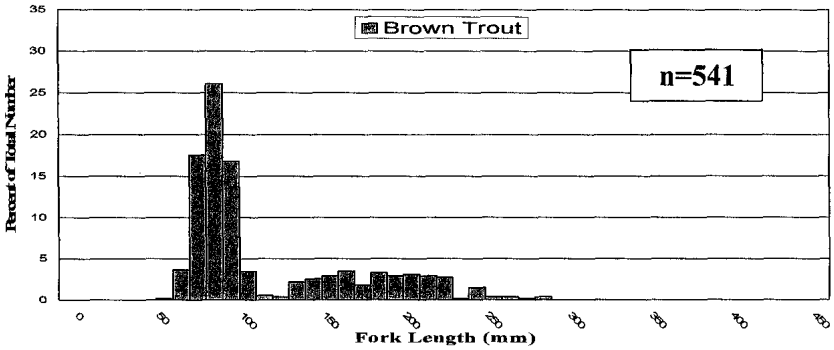

Figure 2. Length-frequency distribution of all brown trout captured at all electrofishing sites in the Mammoth Creek study area, September 29, 2003 through October 3, 2003.

Brown trout length-frequency distributions varied slightly among study reaches (Figure 3). Distinct length groups for YOY brown trout were dominant in all four reaches. YOY were most abundant in Reach B. The YOY group of fish (≤120 mm FL) accounted for 84.5 percent of the total catch in Reach B and accounted for 72.1, 47.7, and 60.1 percent of the catch in Reaches C, D, and E, respectively. The Age I fish group (>120 but ≤179mm FL) accounted for 3.6 percent of the total catch in Reach B and was 11.6, 26.5, and 19.5 percent of the catch in Reaches C, D, and E, respectively. Large brown trout (>179 mm FL) were present in all four reaches ranging from 11.9 percent in Reach B up to 25.7 percent in Reach D.

Of the 84 presumed "wild" rainbow trout captured, 54 (64.3%) fell into the YOY size class range (≤ 120 mm FL) (Figure 4). Fish in this size range are not planted by CDFG in Mammoth Creek and therefore, it is believed that these trout were produced instream.

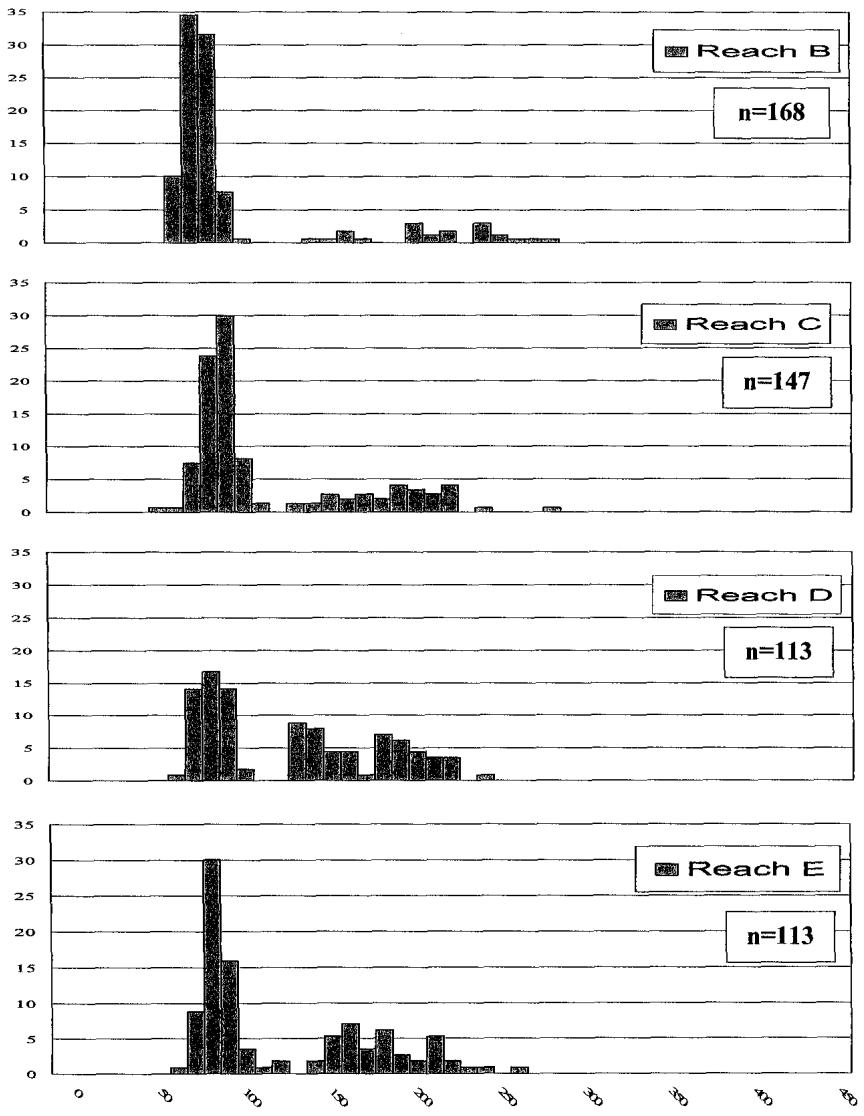

Figure 3. Length-frequency distribution of all brown trout captured in Reaches B, C, D and E in the Mammoth Creek study area, September 29, 2003 through October 3, 2003.

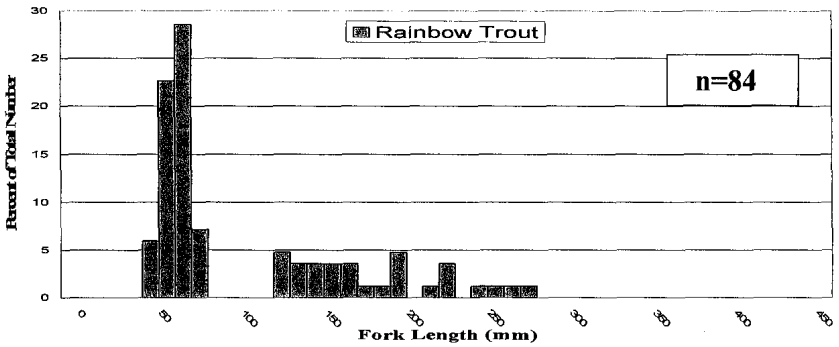

Figure 4. Length-frequency distribution of all presumed "wild" rainbow trout captured at all sites in the Mammoth Creek study area, September 29, 2003 through October 3, 2003.

DISCUSSION

Sufficient instream flow is necessary for maintaining an aquatic environment that allows for a healthy fish population both in terms of population size and the ability to maintain successful reproduction (i.e. "good condition"). Over the past sixteen years there have been thirteen similar fish community surveys conducted within Mammoth Creek (1988, 1991-2003). Trout abundance and length-frequency data collected from these studies allows us to compare the responses of the fish community to the various hydrologic conditions to which they were exposed over that same time period and make general inferences as to the "condition" of the Mammoth Creek fishery.

Relatively dry hydrologic conditions prevailed in Mammoth Creek from the late 1980's through 1992 and in 1994. In contrast, wetter conditions were predominant in 1993 and 1995-2000 with the 1995 runoff year being the wettest of the past fourteen years. The 2001-2003 water years have gone back to a dry period. The 2003 runoff pattern is different from the other water years during the 1992-2003 fish sampling study period. It is most similar to 1999. Comparison of the population estimates and age structure, based on data collected before and after differing flow conditions that have occurred throughout the study period (1992-2003) in Mammoth Creek, provides an opportunity to evaluate the adequacy of the historical flows for maintaining fish populations in "good condition". However, it is only one of many factors influencing population and age structure.

Results discussed in this report do not take into account other factors that may influence trout populations; most notably, information regarding rainbow trout stocking and harvesting. Because hatchery-reared fish may increase fishing pressure, influence instream reproduction, and displace other fish species it is difficult to quantify their influence on Mammoth Creek fish populations.

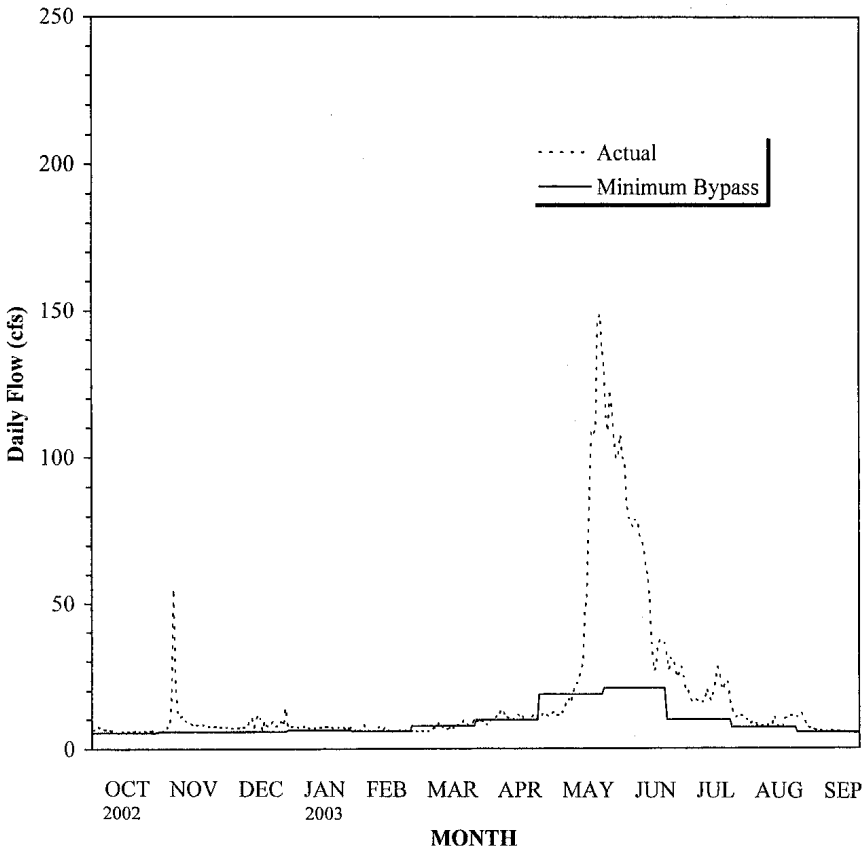

Figure 5. Mean daily flow (cfs) in Mammoth Creek (measured at the Old Mammoth Road Gage) for the twelve month period preceding the 2003 fish survey and the recommended operational minimum mean daily bypass regime. (Data source: MCWD).

Species Composition and Relative Abundance Estimates

Native Species

The numbers of native fishes (tui chub and Owen's sucker) captured during this study were up from recent years. Nineteen tui chub and fifty four Owen's sucker were caught in the lowermost reach. Although most of the study area does not provide the slower-moving, warmer water preferred by these species, they historically dominated the catch in Reach E through 1994 (Table 3) where the stream gradient decreases, riparian cover is minimal and cut-banks are the primary instream cover. After 1994, the sample site was moved downstream and it's proximity to the confluence with Hot Creek may explain the shift in composition and abundance. Additional annual fluxuations may be attributed to water management activities of the land owner on the Chance Meadow Ranch, which comprises approximately a three-mile long section of Mammoth Creek in Reach E.

In 2003, one brook trout was captured at site BH (identical to 2002). Brook trout have been recorded at this site in previous years although they are clearly not part of the natural trout population within Mammoth Creek. It is likely that brook trout occasionally spill over from upstream lakes and can therefore be found in upstream areas of Mammoth Creek.

Table 3. Total number of all tui chub and Owen's sucker captured in Reach E by electrofishing in Mammoth Creek, Mono County, California, 1992-2003.

Year	Number of Tui Chub	Number of Owen's Sucker
1992	417	205
1993	855	425
1994	392	524
1995	69	58
1996	48	84
1997	2	2
1999	6	49
2000	2	18
2001	2	6
2002	2	2
2003	19	54

Rainbow Trout

The highest estimates of presumed "wild" rainbow trout were captured in Reach B (669 trout/mile). Hatchery-origin rainbow trout were recorded at seven of the eight electrofishing sites. Estimated abundance of presumed "wild" rainbow trout ranged from zero trout/mile at Site EL to 669 trout/mile at Site BH, down from the high of 1,038 trout/mile in 2002. As part of the CDFG's "put-and-take" planting program, Mammoth Creek is regularly stocked with hatchery-reared rainbow trout. Hatchery reared rainbow trout were caught at seven of the eight sites. The largest numbers of hatchery fish were captured at the same sites as in previous years, Site CL (13 fish) and Site DH (15 fish). Presumed "wild" rainbow trout outnumbered hatchery-origin fish by

approximately two-to-one in 2003 (Table 1). In comparison with previous survey years, the presumed "wild" rainbow trout population in 2003 was below the average by approximately 40 percent (Table 4). The numbers of rainbow trout decreased from 418 trout/mile in 2002 to 207 trout/mile in 2003. When ranking survey years by total estimated population of presumed "wild" rainbow trout, the 2003 survey year ranks as the third lowest.

Brown Trout

Brown trout numbers ranged from 616 trout/mile at Sites DH and EL up to 2,869 trout/mile at Site BH. Overall, brown trout numbers were up from the 2002 survey year at four of the eight sites, however, the trout/mile numbers in 2003 are below the eleven year average at five of the eight sites (BH, BL, DH, EH and EL). There were notable declines between the 2002 survey and this year at Site BH (down 50%) and Site BL (down 51%). The population estimates at both these sites are the second lowest for the 1992-2003 survey period. Conversely, Site CH had the highest brown trout abundance (1,901 trout/mile) recorded throughout the 1992-2003 survey period.

Brown trout population estimates (trout/mile) for each sampling site for the 1992-2003 survey period are presented in Appendix B. Mammoth Creek remains similar to nearby creeks in terms of estimated trout abundance. CDFG estimated from 877 to 4,822 brown trout/mile for four sections in Convict Creek, and from 600 to 1,109 brown trout per mile in McGee Creek in 1983 and 1984 (Deinstadt *et al.* 1985). Note that the CDFG surveys were conducted during and following relatively wet years and the sampling design may not lend itself to proper scientific comparisons. The sites were not selected randomly and were chosen because of their accessibility by road. (Jones & Stokes Associates, Mono Basin EIR, 1994)

Table 4. Estimated average population densities (trout/mile) of brown and presumed "wild" rainbow trout captured by electrofishing in Mammoth Creek (1992-2003).

Year	Brown trout per mile	Rainbow trout per mile
2003	1,303	207
2002	1,549	418
2001	1,558	379
2000	1,734	1,377
1999	1,951	530
1997	2,385	579
1996	1,379	588
1995	592	78
1994*	2,079	437
1993*	1,289	57
1992*	1,681	222

* Note: Site EL was moved from its original location in 1995.

Brown trout populations in Mammoth Creek have fluctuated throughout the eleven year period and have declined steadily since the 1997 record high numbers (Figure 6). The one anomaly to the eleven year survey period was 1995, when flows were dramatically high. It is presumed that the high flows adversely affected the fish community by flushing fish and debris downstream. The mean estimated population of brown trout in Mammoth Creek is 1,591 trout/mile over the eleven year period of this study. The 2003 estimate of 1,303 brown trout/mile is approximately 18 percent below that average.

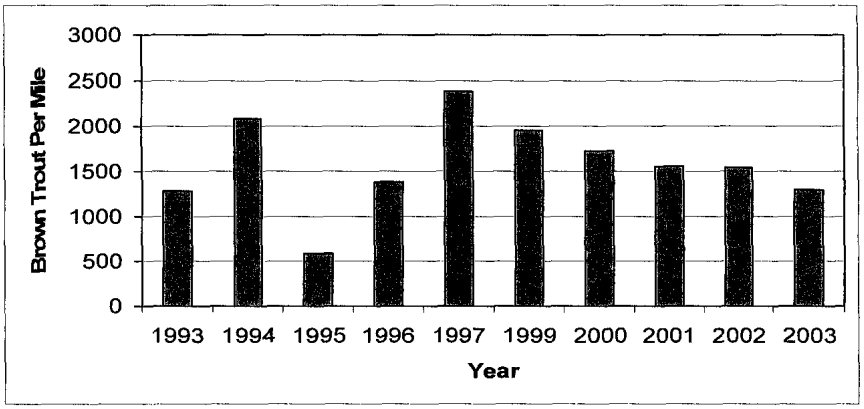

Figure 6. Estimated average population densities (trout/mile) of brown trout captured by electro-fishing in Mammoth Creek (1992-2003).

Table 5. Population estimates (trout/mile) for brown trout captured by electrofishing Mammoth Creek, Mono County, California, 1992-2003. Bold numbers indicate highest value for each site. Numbers in parenthesis indicate where the 2003 survey results ranked among the previous years.

	Sample Site							
	BH	BL	CH	CL	DH	DL	EH	EL [a]
2003	2869(10th)	458 (10th)	**1901** (1st)	933 (2nd)	616 (8th)	1426 (5th)	1390 (7th)	616 (6th)
2002	5826	898	1056	246	563	**1672**	1866	264
2001	4717	1707	1496	246	1144	1162	1461	528
2000	6670	634	1074	88	810	1162	1179	**2253**
1999	5333	1338	1443	299	2200	616	2182	2200
1997	**8589**	704	1690	211	616	1654	3819	1795
1996	4840	158	1302	158	1901	634	898	1144
1995	1760	546	334	88	616	18	334	1038
1994	4171	2253	810	528	**4418**	1584	2464	405
1993	2957	**2658**	510	**1232**	1056	510	1232	158
1992	3045	1848	563	845	1390	1584	**3978**	194

[a] Different EL site locations were used for survey years 1992-94 and 1995-2003.

Trout Length-Frequency Distribution

In addition to population densities, the size class structure of a fish population can provide evidence of reproductive success and survival, and a general indication of a fish population's overall condition. To assess potential differences in the age structure of the brown trout population in Mammoth Creek during the past eleven years, length-frequency data from the present study were compared to the 1992-2001 data set (Hood. 2001., Figures 5a and 5b). In general, the length-frequency distribution calculated for all brown trout captured during the 2003 survey exhibited a length-frequency distribution very similar to that calculated from previous studies. YOY fish continue to make up the highest proportion of the total catch for all years sampled.

Sixty-nine percent of this year's catch was comprised of YOY fish. The highest YOY proportion was in the 1997 survey (81%) followed by 2000 (75%), 1996 (73%), 2002 (71%), 1994 and 2001 (70%), 1992 and 1999 (68%), 1993 (55%) and the lowest in 1995 (46%)[1]. Hydrologic conditions in the fall of 1999 and the spring of 2000 exhibit the most similarities to the fall of 2002/spring of 2003 conditions which most likely influence the proportion of YOY fish for the subsequent fall survey. Comparison of the catches between those two years (1,734 fish/mile in 2000 and 1,303 fish/mile in 2003) suggests that hydrologic conditions are not the only environmental factor influencing fish population. In addition to the YOY age class, at least two or more brown trout age groups were present in every reach for every year.

CONCLUSIONS

- In the early 1990s, some criteria were suggested (Hood, *et al.*, 1993) for judging whether or not a trout population was in "good condition" in Mammoth Creek. These same criteria were referenced in later studies of Mammoth Creek (Jenkins and Dawson, 1997). Further definition of the term "good condition" has been reported as "...a self sustaining population of desirably-sized adult vertebrate fish which are in good physical condition, i.e.-well proportioned and disease free...Fish population should contain good numbers of different age classes and habitat for these life-stages should not be limiting." (CH2M Hill, 2000). Using these criteria, the brown and rainbow trout populations present in 2003 remain in "good condition". Additionally, Mammoth Creek appears to have sufficient habitat necessary for all trout life-stages.

- A significant reduction in the estimated brown trout population was observed in Reach B of this year (down approximately 50 percent from 2002). Drier hydrologic conditions over the past three years may be affecting fish recruitment in the upper reach. Additionally, this section of the stream is located within the town limits of Mammoth Lakes and may be adversely and cumulatively impacted by various land use practices associated with urbanized areas.

- Trout age structure (length-frequency) information obtained from the electrofishing survey conducted in September and October 2003 suggest that both the brown and rainbow trout age distribution remains stable in Mammoth Creek. The analysis of the data shows no drastic changes in age-class distribution for the entire eleven year survey period. The high proportion of YOY fish (both brown trout and rainbow trout) suggests that the fish community of Mammoth

[1] YOY proportion estimates are approximated using the same size class grouping for all years ($\leq$ 120 mm FL).

Creek continues to successfully reproduce and provide subsequent recruitment to the population.

- It appears that the trout population in Mammoth Creek continues to endure natural annual population density variation as a result of the hydrologic conditions to which they are subjected. They have exhibited the ability to withstand and continue to recover from various uncontrollable environmental factors such as the extreme snowmelt conditions as experienced in 1995 and the drought induced low flow conditions of the early 90's. If future environmental conditions remain similar to the previous 11 fish census years, we would expect the trout populations to stay within the ranges reported.

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APPENDIX A
Maximum Likelihood Catch Statistics

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

Removal Pattern: 80 40 22
Total Catch = 142
Population Estimate = 163

Chi Square = 0.094
Pop Est Standard Err = 9.851
Lower Conf Interval = 143.495
Upper Conf Interval = 182.505

Capture Probability = 0.491
Capt Prob Standard Err = 0.058
Lower Conf Interval = 0.376
Upper Conf Interval = 0.607

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

Removal Pattern: 22 4 0
Total Catch = 26
Population Estimate = 26

Chi Square = 0.743
Pop Est Standard Err = 0.265
Lower Conf Interval = 26.000
Upper Conf Interval = 26.546

Capture Probability = 0.867
Capt Prob Standard Err = 0.066
Lower Conf Interval = 0.730
Upper Conf Interval = 1.003

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

Removal Pattern: 53 28 14
Total Catch = 95
Population Estimate = 108

Chi Square = 0.077
Pop Est Standard Err = 7.626
Lower Conf Interval = 95.000
Upper Conf Interval = 123.099

Capture Probability = 0.500
Capt Prob Standard Err = 0.071
Lower Conf Interval = 0.360
Upper Conf Interval = 0.640

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

Removal Pattern: 37 11 4
Total Catch = 52
Population Estimate = 53

Chi Square = 0.157
Pop Est Standard Err = 1.563
Lower Conf Interval = 52.000
Upper Conf Interval = 56.136

Capture Probability = 0.703
Capt Prob Standard Err = 0.070
Lower Conf Interval = 0.563
Upper Conf Interval = 0.843

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

Removal Pattern: 23 7 4
Total Catch = 34
Population Estimate = 35

Chi Square = 0.691
Pop Est Standard Err = 1.744
Lower Conf Interval = 34.000
Upper Conf Interval = 38.543

Capture Probability = 0.654
Capt Prob Standard Err = 0.094
Lower Conf Interval = 0.463
Upper Conf Interval = 0.845

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

Removal Pattern: 56 17 6
Total Catch = 79
Population Estimate = 81

Chi Square = 0.100
Pop Est Standard Err = 2.062
Lower Conf Interval = 79.000
Upper Conf Interval = 85.103

Capture Probability = 0.693
Capt Prob Standard Err = 0.057
Lower Conf Interval = 0.579
Upper Conf Interval = 0.807

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

Removal Pattern: 57 19 2
Total Catch = 78
Population Estimate = 79

Chi Square = 2.053
Pop Est Standard Err = 1.365
Lower Conf Interval = 78.000
Upper Conf Interval = 81.717

Capture Probability = 0.750
Capt Prob Standard Err = 0.052
Lower Conf Interval = 0.647
Upper Conf Interval = 0.853

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

Removal Pattern: 32 2 1
Total Catch = 35
Population Estimate = 35

Chi Square = 1.831
Pop Est Standard Err = 0.202
Lower Conf Interval = 35.000
Upper Conf Interval = 35.411

Capture Probability = 0.897
Capt Prob Standard Err = 0.051
Lower Conf Interval = 0.795
Upper Conf Interval = 1.000

The population estimate lower confidence intervals for seven of the sites were set equal to the total catches. Actual calculated lower confidence intervals (LCI) were:

Site	Calculated LCI
BL	25.45396
CH	92.90078
CL	49.86375
DH	31.45712
DL	76.89742
EH	76.28321
EL	34.5889

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

Removal Pattern: 13 10 6
Total Catch = 29
Population Estimate = 38

Chi Square = 0.271
Pop Est Standard Err = 9.741
Lower Conf Interval = 29.000
Upper Conf Interval = 57.736

Capture Probability = 0.372
Capt Prob Standard Err = 0.152
Lower Conf Interval = 0.064
Upper Conf Interval = 0.679

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

Removal Pattern: 7 3 1
Total Catch = 11
Population Estimate = 11

Chi Square = 0.317
Pop Est Standard Err = 0.788
Lower Conf Interval = 11.000
Upper Conf Interval = 12.755

Capture Probability = 0.688
Capt Prob Standard Err = 0.158
Lower Conf Interval = 0.336
Upper Conf Interval = 1.039

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

Removal Pattern: 1 1 0
Total Catch = 2
Population Estimate = 2

Chi Square = 0.929
Pop Est Standard Err = 0.384
Lower Conf Interval = 2.000
Upper Conf Interval = 6.884

Capture Probability = 0.667
Capt Prob Standard Err = 0.384
Lower Conf Interval = %-4.217
Upper Conf Interval = 5.550

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

Removal Pattern: 3 1 2
Total Catch = 6
Population Estimate = 6

Chi Square = 2.833
Pop Est Standard Err = 1.381
Lower Conf Interval = 6.000
Upper Conf Interval = 9.550

Capture Probability = 0.545
Capt Prob Standard Err = 0.276
Lower Conf Interval = -.165
Upper Conf Interval = 1.256

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

Removal Pattern: 5 4 2
Total Catch = 11
Population Estimate = 12

Chi Square = 0.690
Pop Est Standard Err = 2.542
Lower Conf Interval = 11.000
Upper Conf Interval = 17.618

Capture Probability = 0.500
Capt Prob Standard Err = 0.212
Lower Conf Interval = 0.032
Upper Conf Interval = 0.968

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

Removal Pattern: 12 4 0
Total Catch = 16
Population Estimate = 16

Chi Square = 1.373
Pop Est Standard Err = 0.410
Lower Conf Interval = 16.000
Upper Conf Interval = 16.875

Capture Probability = 0.800
Capt Prob Standard Err = 0.103
Lower Conf Interval = 0.581
Upper Conf Interval = 1.019

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

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

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

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

The population estimate lower confidence intervals for seven of the sites were set equal to the total catches. Actual calculated lower confidence intervals (LCI) were:

Site	Calculated LCI
BH	18.26385
BL	9.244932
CL	-2.883589
CH	2.449714
DH	6.382278
DL	15.12531
EH	8.772664

APPENDIX B
Population Estimate for all Electrofishing Reaches (1992 – 2003)

Appendix B
Population Estimates for All Electrofishing Reaches from 1992 through 2003

Table B-1. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach B, Mammoth Creek, Mono County, California, 1992 through 2003.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
BH	1992	2992	3045	3128
	1993	2558	2957	3356
	1994	3915	4171	4427
	1995	1654	1760	1901
	1996	3942	4840	5738
	1997	8200	8589	8978
	1999	4789	5333	5877
	2000	6003	6670	7337
	2001	4290	4717	5144
	2002	5295	5826	6356
	2003	2526	2869	3212
Average			**4616**	
BL	1992		1848	1895
	1993	2570	2658	2770
	1994	2235	2253	2309
	1995	528	546	616
	1996	158	158	158
	1997	669	704	788
	1999	1162	1338	1582
	2000	616	634	690
	2001	1637	1707	1814
	2002	845	898	1006
	2003	458	458	467
Average			**1200**	

Table B-2. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach C, Mammoth Creek, Mono County, California, 1992 through 2003.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
CH	1992	546	563	621
	1993	475	510	609
	1994	722	810	980
	1995	299	334	453
	1996	1250	1302	1390
	1997	1637	1690	1785
	1999	1426	1443	1494
	2000	1056	1074	1135
	2001	1461	1496	1571
	2002	1038	1056	1108
	2003	1672	1901	2167
Average			**1107**	
CL	1992	827	845	906
	1993	1038	1232	1514
	1994	528	528	567
	1995	88	88	100
	1996	158	158	194
	1997	211	211	232
	1999	299	299	330
	2000	88	88	97
	2001	246	246	270
	2002	246	246	253
	2003	915	933	988
Average			**443**	

Table B-3. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach D, Mammoth Creek, Mono County, California, 1992 through 2003.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
DH	1992	1338	1390	1482
	1993	1056	1056	1089
	1994	4268	4418	4567
	1995	563	616	737
	1996	1778	1901	2059
	1997	546	616	771
	1999	2042	2200	2383
	2000	810	810	848
	2001	1126	1144	1201
	2002	528	563	658
	2003	598	616	678
Average			**1394**	
DL	1992	1584	1584	1611
	1993	510	510	551
	1994	1514	1584	1696
	1995	a	18	a
	1996	563	634	792
	1997	1619	1654	1725
	1999	598	616	678
	2000	1144	1162	1209
	2001	1091	1162	1281
	2002	1637	1672	1749
	2003	1390	1426	1498
Average			**1093**	

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

Table B-4. Population estimates (trout/mile) and 95 percent confidence intervals for brown trout captured by electrofishing Reach E, Mammoth Creek, Mono County, California, 1992 through 2003.

Site	Year	Lower Confidence Boundary	Population Estimate	Upper Confidence Boundary
EH	1992	3925	3978	4053
	1993	1197	1232	1302
	1994	2006	2464	2929
	1995	299	334	458
	1996	810	898	1056
	1997	3749	3819	3911
	1999	2147	2182	2255
	2000	1109	1179	1109
	2001	1355	1461	1616
	2002	1813	1866	1959
	2003	1373	1390	1438
Average			**1891**	
EL	1992	194	194	209
	1993	158	158	169
	1994	405	405	412
	1995	1038	1038	1062
	1996	1144	1144	1162
	1997	1742	1795	1880
	1999	2076	2200	2349
	2000	2094	2253	2434
	2001	528	528	546
	2002	264	264	300
	2003	616	616	623
Average			**963**	