Aquatic Habitat Characteristics and Trout Demography In Selected Sections of Five Eastern Sierra Streams

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The Federal Energy Regulatory Commission requires permits for hydroelectric projects to be renewed every 50 years. When a permit is issued, a number of conditions are identified to improve environmental concerns, safety issues, operational logistics, etc. The permitting process was recently completed for all projects operated by Southern California Edison Co. in the eastern Sierra on Bishop, Birch, McGee, Mill, Rush, and Lee Vining Creeks. One condition of these permits requires riparian and aquatic monitoring to be conducted and quantify baseline conditions when the permit was issued. Also, these studies are to be conducted every 5 years for the first 30 years of the permit. These data will be used to assess impacts of diversion on streams and vegetation so that future permit conditions can be designed to cause acceptable environmental impacts.

Over the period 1991 -1993 habitats were surveyed in 10 reaches of four streams during spring, summer and autumn, and during the period 1999 - 2001 five additional reaches in two more streams are being surveyed (Table 1). Fish populations were surveyed in five stream reaches during spring, summer, and autumn from 1991 - 1993 and during autumn from 1994 - 1996. Seasonal fish population surveys will be conducted in all reaches surveyed from 1999 - 2001. Habitat assessment and fish surveys are conducted over identical stream reaches to allow evaluation of relationships between habitat fish abundance and community structure. Riparian vegetation is also surveyed at these reaches.

HABITAT SAMPLE PROTOCOL

Aquatic habitat in each reach was assessed by measuring parameters shown in Tables 2 and 3 along transects oriented perpendicular to stream flow. Parameters in Table 1 describe channel characteristics of each reach and those in Table 2 describe aquatic habitat features within the wetted perimeter.

Habitat parameters were measured in each sample reach along 25 transects (Bishop, Birch, McGee, & Mill) or 30 transects (Rush and Lee Vining) spaced at five meter (Bishop, Birch, McGee, & Mill) or three meter intervals (Rush and Lee Vining). Transects were oriented perpendicular to stream flow, and measured by moving upstream from a randomly selected transect at the lowest extent of a reach. Parameters shown in Table 1 were measured or estimated either on both

Table 1. Habitat and fish population survey sample sites.

Stream	Elevation	Dates	**Habitat**	**Fish**
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S.F. Bishop Ck.	7370	1991-1993	X	
M. F. Bishop Ck.	7395	1991-1993	X	
M. F. Bishop Ck.	6520	1991-1993	X	X
M. F. Bishop Ck.	6200	1991-1993	X	
M. F. Bishop Ck.	4880	1991-1993	X	X
M. F. Bishop Ck.	4480	1991-1993	X	
McGee Ck.	7960	1991-1993	X	X
Birch Ck.	7800	1991-1993	X	
Mill Ck.	7840	1991-1993	X	X
Mill Ck.	7440	1991-1993	X	
Rush Ck. (2 reaches)	9400	1999-2001	X	X
Lee Vining Ck. (3 reaches)	9700	1999-2001	X	X

stream banks (e.g. undercuts and bank full height) or across the transect (e.g. wetted perimeter width, channel width, canopy cover, consolidation). Stream canopy cover was measured with a densiometer. Parameters in Table 2 were measured at either 15 (Bishop, Birch, McGee, & Mill) or 10 (Rush and Lee Vining) equally spaced points across the wetted perimeter of each transect.

Current velocity was measured at 60 percent water depth using a 20-second average with a Marsh-McBirney Model 2000 portable current meter. Substrate size was measured at each sample point across the wetted perimeter. Size frequency distribution of the substrate was assessed by categorizing particles as fines (< 1 mm), sand (1 mm - 5 mm), gravel (5 mm -80 mm), cobble (80 mm - 300 mm), boulder (> 300 mm), and bedrock.

Table 2. Parameters and units of measure required by Section 4(e) conditions to describe channel morphology. Each parameter was measured at 30 evenly-spaced transects oriented perpendicular to stream flow. Sample size shows the number of measurements made in each reach during each sample date. m = meters cm = centimeters. ** indicates estimated parameters. Higher sample sizes were compiled for Rush and Lee Vining Creeks, lower were for Bishop, Birch, McGee, & Mill Creeks.

Parameter	**Units**	**Sample Size**
Channel Width	m	25, 30
Wetted Perimeter Width	cm	25, 30
Bank full height	cm	50, 60
Stream bank overhang	cm	50, 60
Stream canopy cover	Percent	25, 30
Consolidation**	Rating	25, 30

Table 3. Parameters and units of measure required by Section 4(e) conditions to describe characteristics of the wetted perimeter (mm = millimeters, cm = centimeters, cm/sec = centimeters per second). Parameters were measured at evenly-spaced points along transects described in Table 1. Sample size shows the number of measurements made in each reach during each sample date. ** indicates estimated parameters. Higher sample sizes were compiled for Rush and Lee Vining Creeks, lower were for Bishop, Birch, McGee, & Mill Creeks.

Parameter	**Units**	**Sample Size**
Water depth	cm	300
Mean water column velocity	cm/sec	300
Substrate size	mm	300
Embeddedness	percent	300
Aquatic vegetation depth	cm	300
Submerged vegetation depth	cm	300

FISH POPULATION SAMPLE PROTOCOL

Population estimates were made using depletion techniques and a Smith-Root Mark XII electrofisher to remove fish during three to four passes through five, 25 meter (Bishop, McGee, & Mill) or 20 meter (Rush and Lee Vining) long stream sections. Three depletion passes were made through each section except when capture success was low it was necessary to increase the number of passes to maximize estimate accuracy. Sections were contiguous with one another, and each one was segregated from the remainder of the stream during electrofishing by 8 mm mesh block seines which spanned the upstream and downstream limits of sections to prevent fish from either entering or leaving the site. Surface area of each section was determined during habitat assessment that involved measuring stream widths at six transects located at three meter intervals along the stream continuum in each section. Habitat evaluations always occurred within two days of population surveys.

Captured fish were sorted and recorded by species. Fork-length (FL.) of all fish was measured to the nearest millimeter. When populations were sufficiently large, at least 50 individuals from each stream were weighed and measured to determine length-weight relationships. All fish were weighed and measured when the number of fish captured in a stream was less than 50. Fish populations in Lee Vining Creek and Rush Creek were small, making it necessary to combine data from all fish captured to accurately assess length-weight relationships and population length-frequency. Total biomass of each species in each section was estimated by measuring the biomass of all captured fish and calculating an estimate of total biomass using the ratio between the number of captured fish and the estimated population size. A scale analysis was conducted to determine length-age relationships in Bishop, McGee, and Mill Creeks. This analysis will be conducted during year 2000 in Rush and Lee Vining Creeks. Biomass of individual fish and the total of all fish in a section was measured to the nearest 0.1 g using an electronic balance.

Fish were held in buckets until length and weight measurements were completed, then released alive into the sample reach. A length-weight regression analysis was conducted for each stream to determine spatial and temporal characteristics of fish body condition, Populations with more robust fish were considered as those with the best body condition. Population and biomass densities (no./m^2 or gms/m^2, respectively) in each reach were calculated as the mean of all sections sampled in a reach. Density of hatchery reared fish and populations occupying usually dry reaches were not calculated because fish were scarce and densities were always lower than 0.01 fish/m*. Population estimates from depletion were calculated using the maximum-likelihood method and MicroFish V. 3.0.

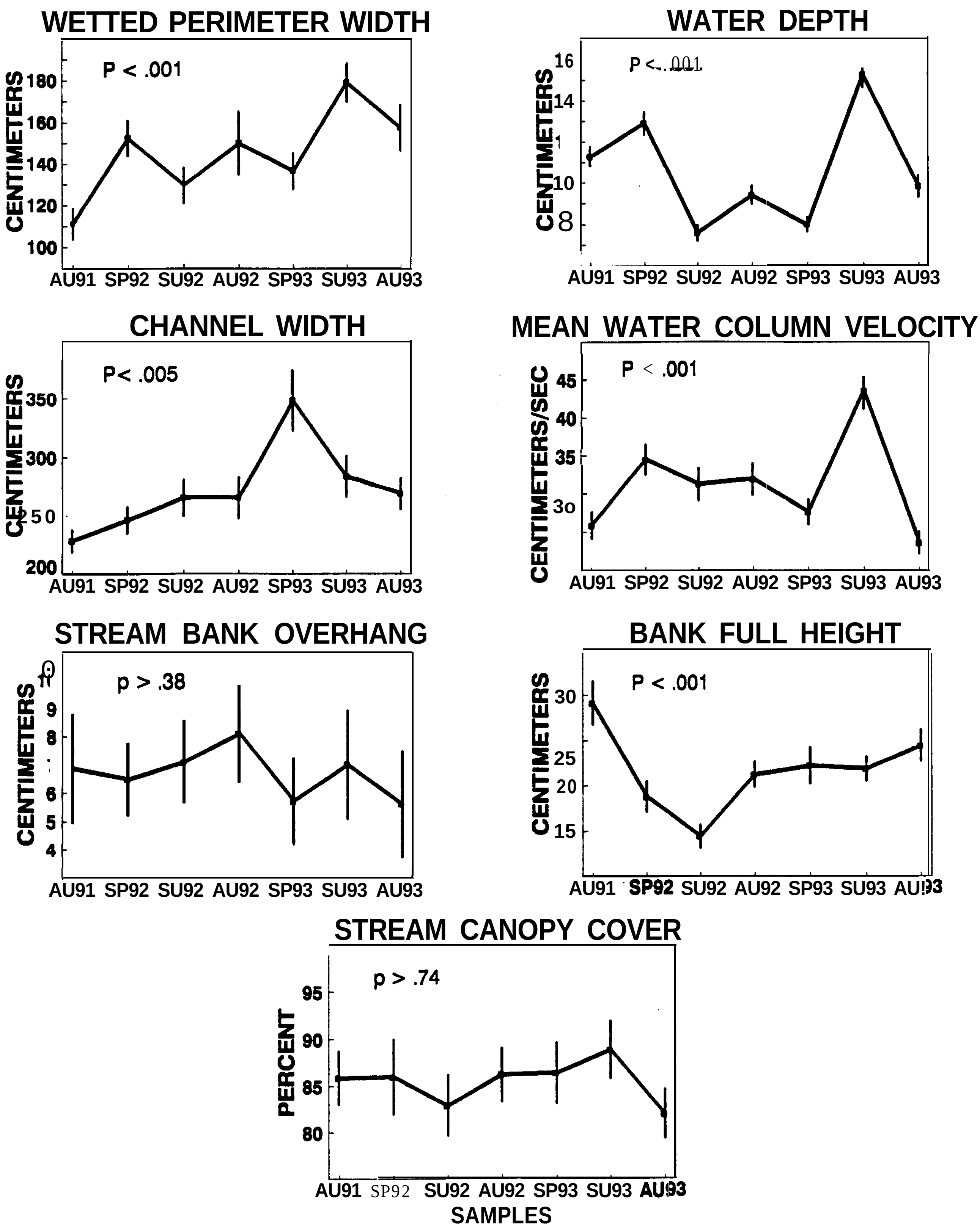


Figure 24. Mean (± 1 SE) of channel and wetted perimeter characteristics of McGee Creek during 1991, 1992, and 1993 samples. Sample abbreviations are as shown in Table 3.

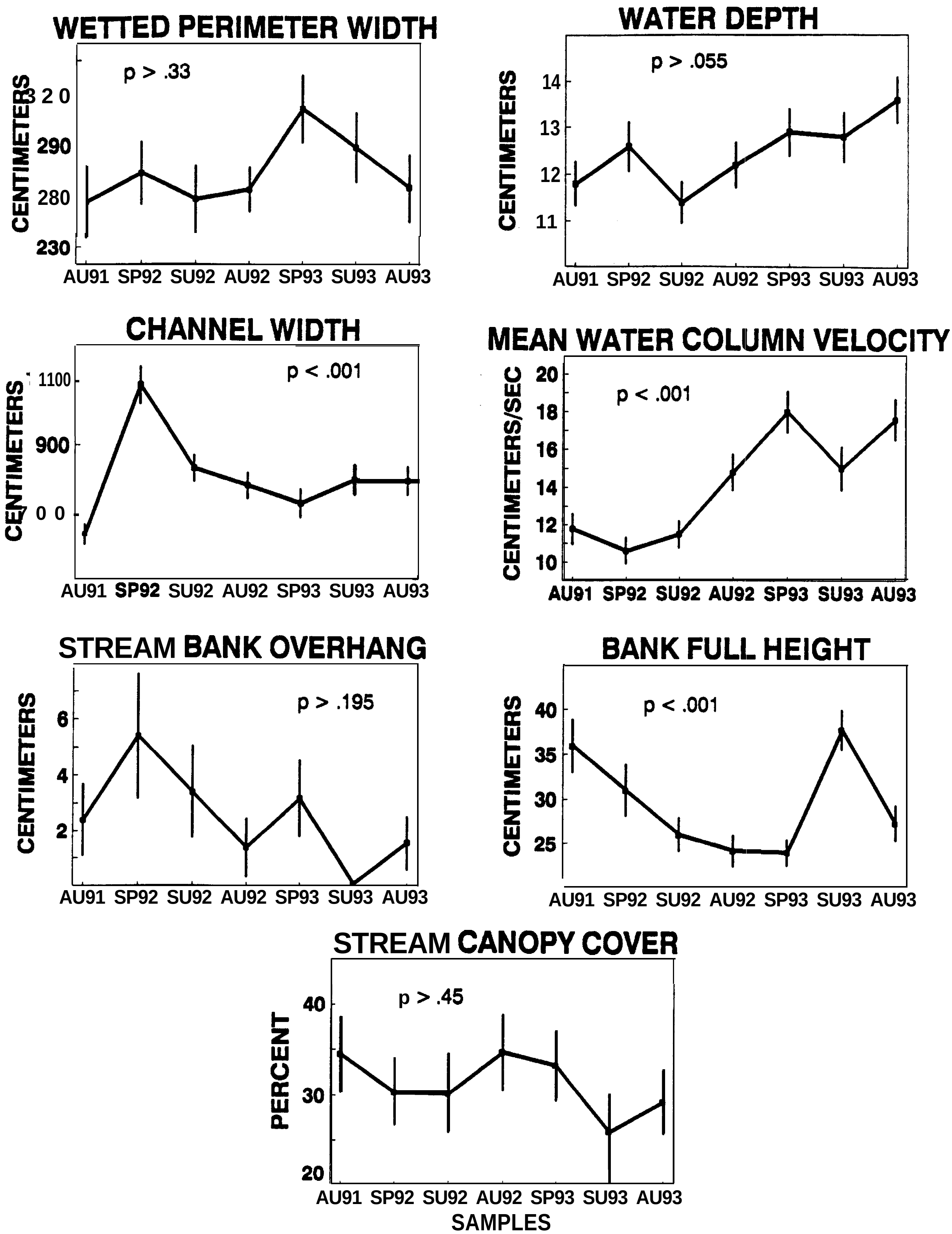


Figure 10. Mean (± 1 SE) of channel and wetted perimeter characteristics of Bishop Creek Reach 3 during 1991, 1992, and 1993. Sample abbreviations are as shown in Table 3.

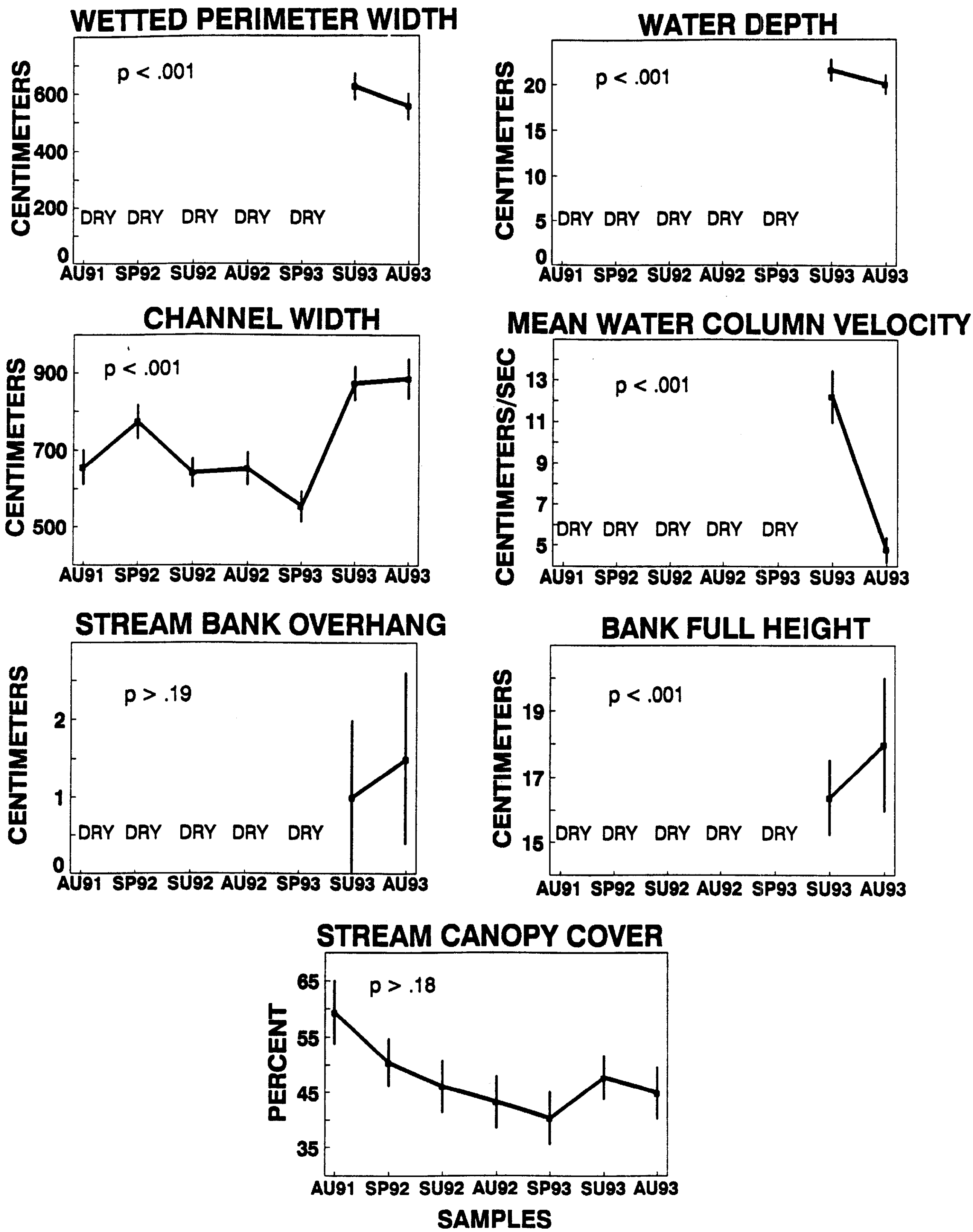


Figure 27. Mean (± 1 SE) of channel and wetted perimeter characteristics of Mill Creek Reach 1 during 1991, 1992, and 1993 samples. Sample abbreviations are as shown in Table 3.

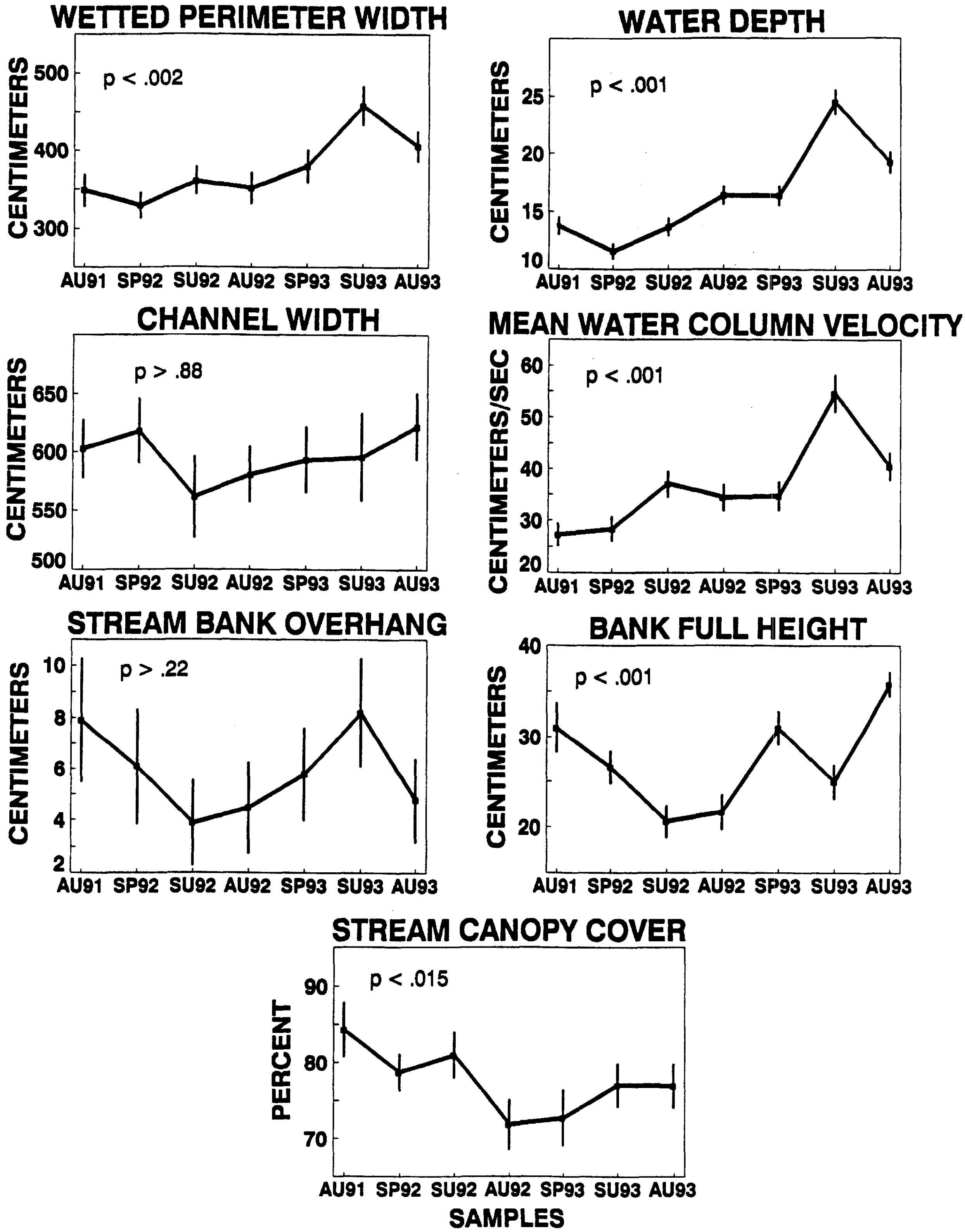
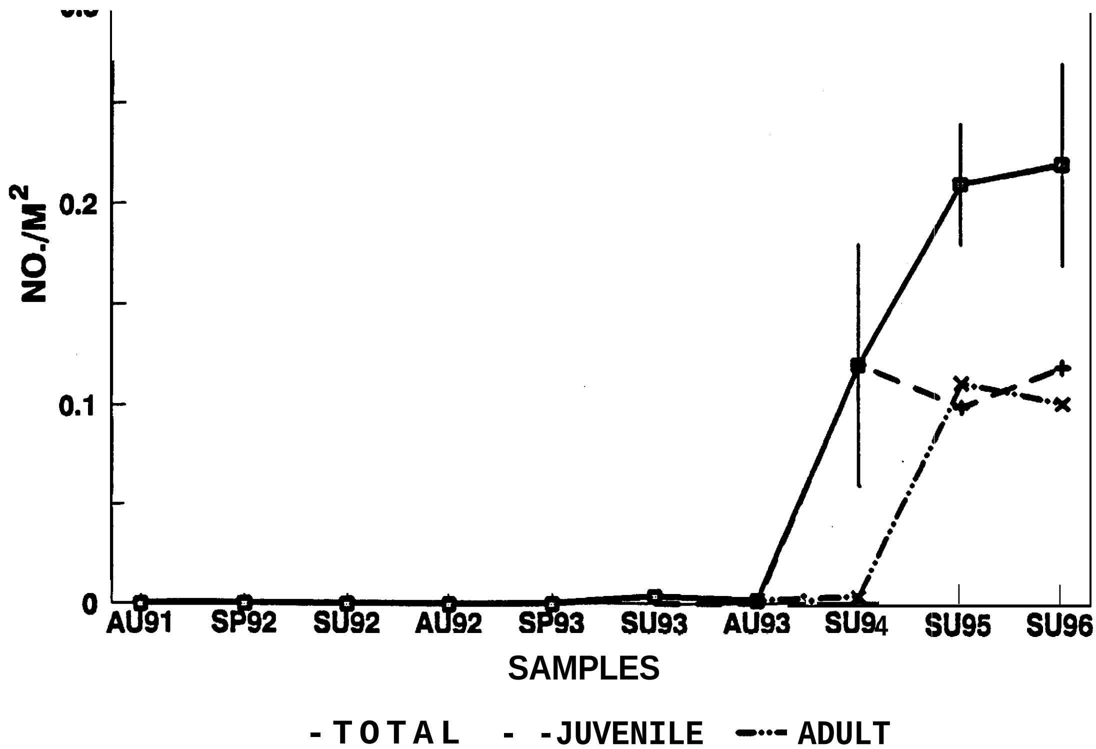


Figure 30. Mean (± 1 SE) of channel and wetted perimeter characteristics of Mill Creek Reach 2 during 1991, 1992, and 1993 samples. Sample abbreviations are as shown in Table 3.

Table 14. The coefficient of variation for mean values of aquatic habitat parameters measured during 1991 through 1993 monitoring in Bishop, McGee, Birch, and Mill Creeks. Parameter 1= Wetted perimeter width, 2 = water depth, 3 = mean water column velocity, 4 = bank full height, 5 = bank overhang, 6 = channel width, 7 = depth of vegetation, 8 = depth of debris, 9 = stream canopy cover.

Stream/Reach	Parameter								
	1	2	3	4	5	6	7	8	9
Bishop 1	15.9	16.1	26.7	25.2	12.5	31.7	170.8	94.7	2.7
Bishop 2	17.6	9.4	19.5	27.6	28.6	11.8	264.6	80.5	8.3
Bishop 3	7.2	5.9	21.0	11.0	68.3	17.0	70.7	74.0	10.1
Bishop 4	9.4	9.2	11.0	43.7	48.4	7.5	75.1	130.7	11.1
Bishop 5	89.2	93.5	51.0	88.6	106.1	13.7	136.9	84.7	9.6
Bishop 6	20.3	20.5	79.3	47.6	77.5	34.9	25.5	124.7	10.5
Birch	----	----	----	----	----	14.8	----	63.8	13.2
McGee	15.0	25.8	21.1	25.2	12.9	13.9	73.1	75.0	2.7
Mill 1	171.2	171.0	61.6	6.6	28.3	17.5	74.5	67.9	13.0
Mill 2	11.6	26.0	25.0	20.2	28.2	3.5	60.4	70.7	5.7



B.

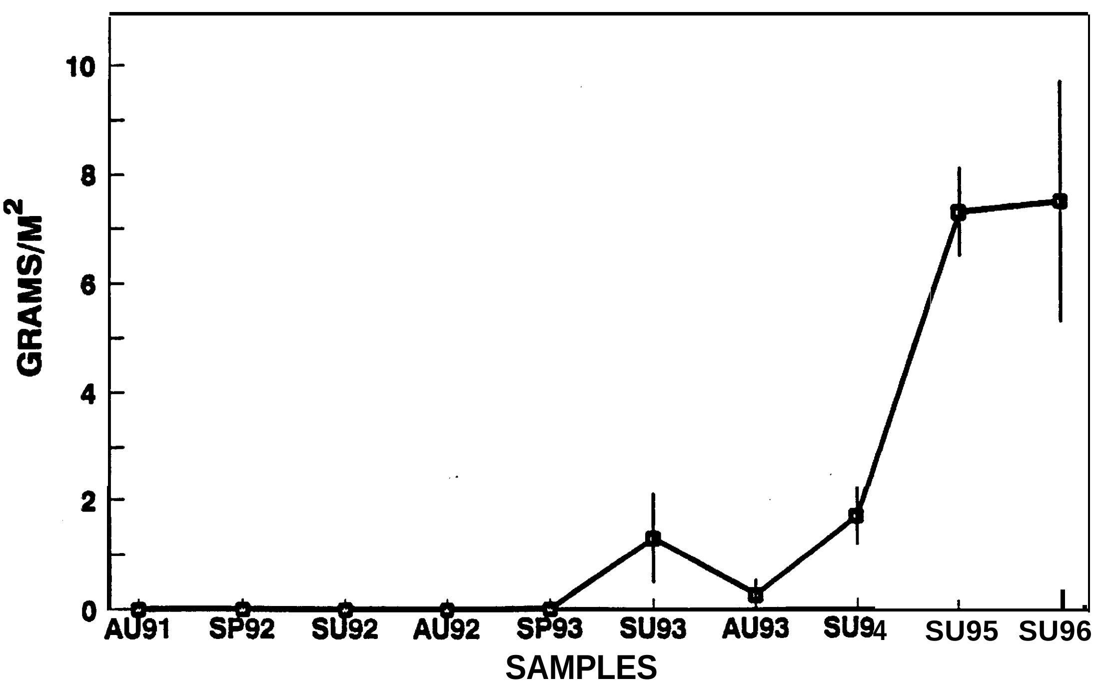


Figure 7. Population size and biomass of S. trutta in Bishop Creek Reach 5 from 1991 - 1996. A. Density of total. population (mean ± 1 SE), adults, and juveniles. B. Population biomass (mean ±1 SE). Samples are identified as in Figure 4.

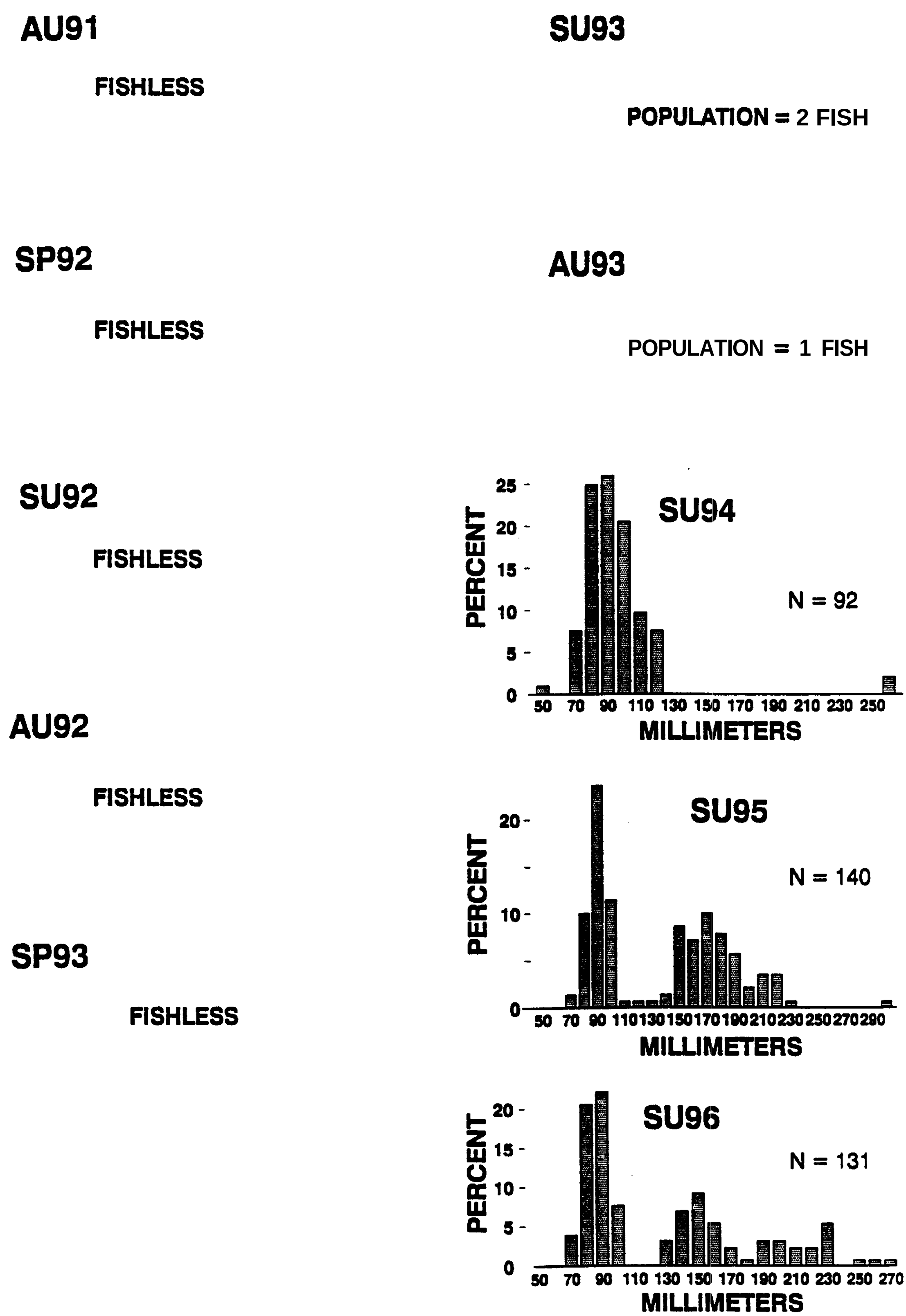
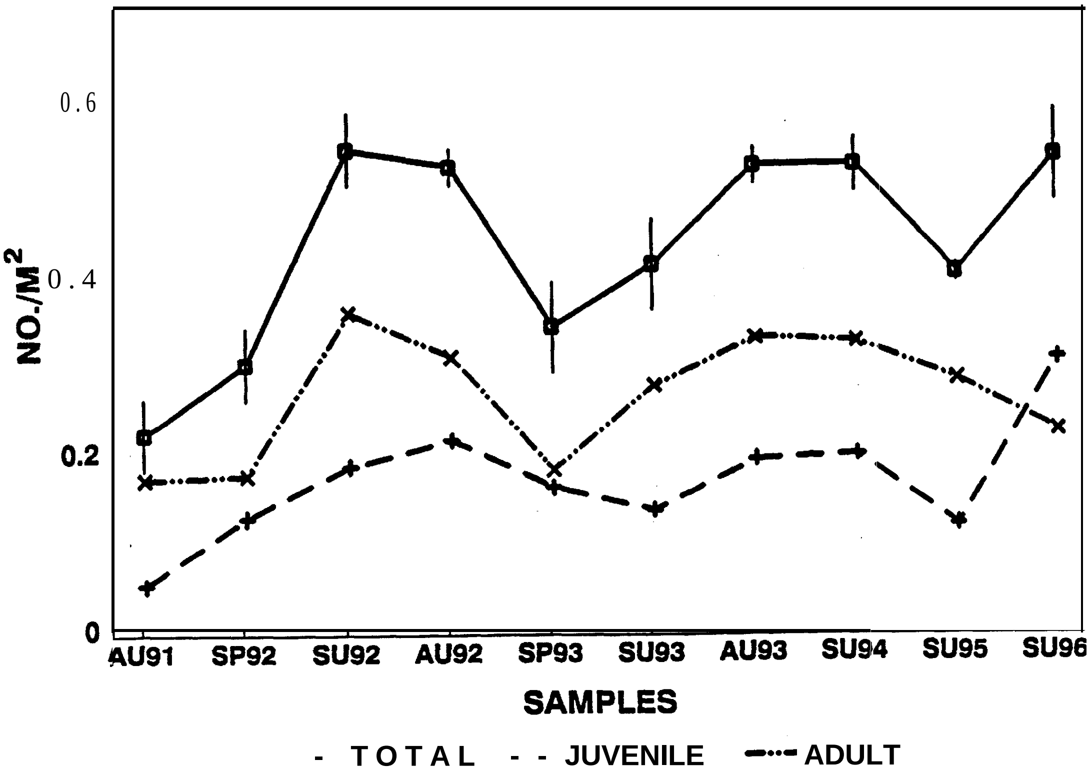


Figure 6. Length-frequency distributions of S. trutta in Bishop Creek Reach 5 during summers of 1994, 1995, and 1996. Distributions are not shown for 1991-1993 due to small population size; a total of three fish were captured during this period.

A.



B.

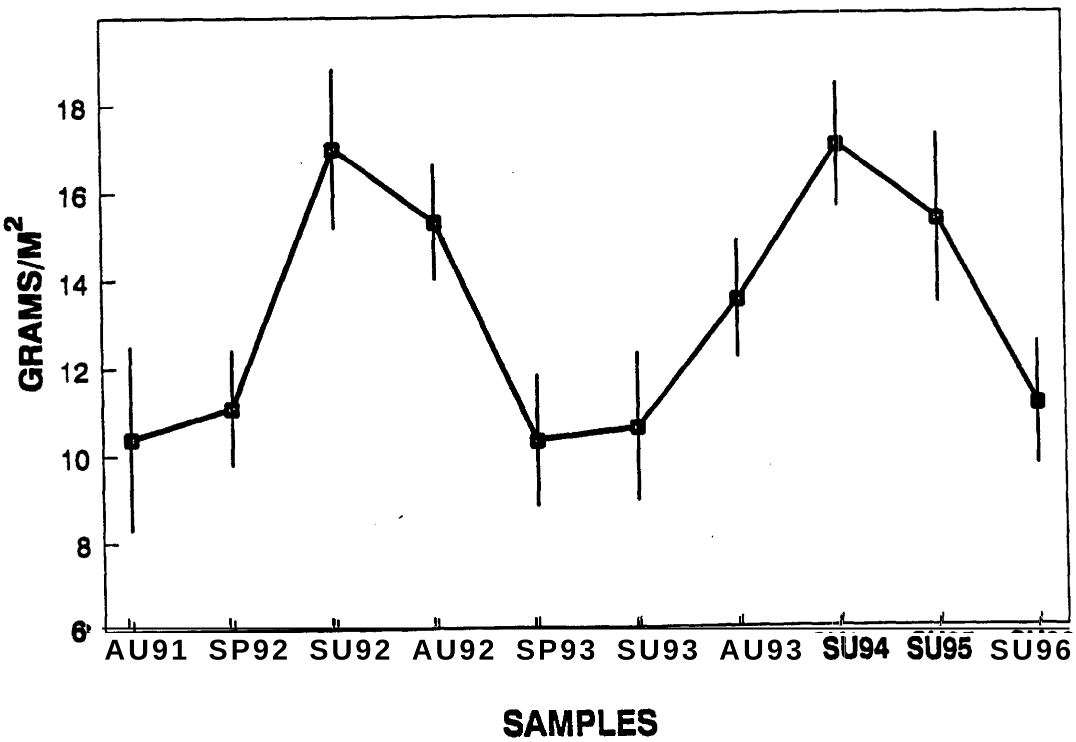


Figure **11. Population size and biomass of S. trutta in Mill Creek Reach** 2 **from 1991 - 1996. A. Density of total population mean + 1 SE), adults, and juveniles. B. Population biomass (mean ±1 SE). Samples are identified as in Figure 4.**

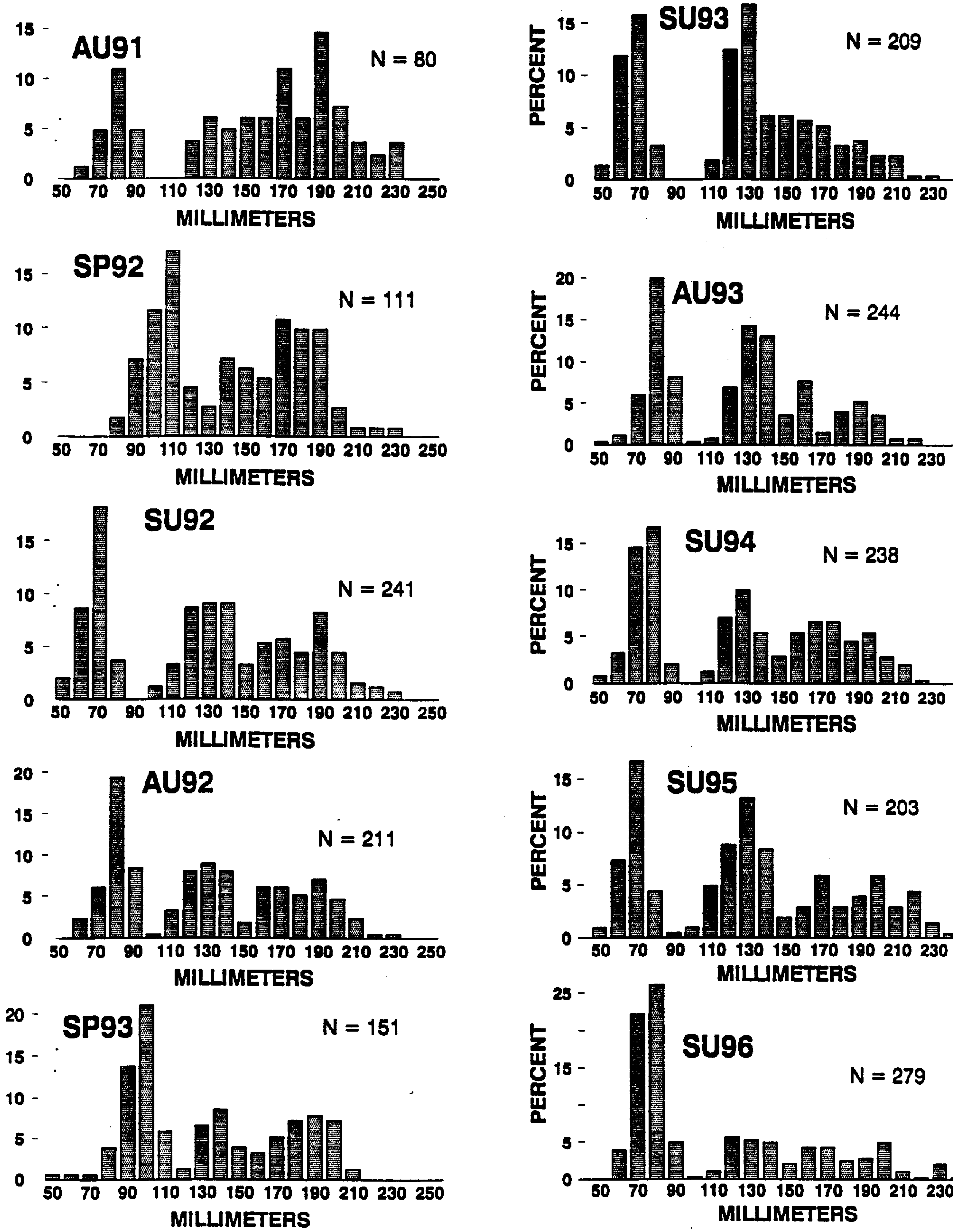
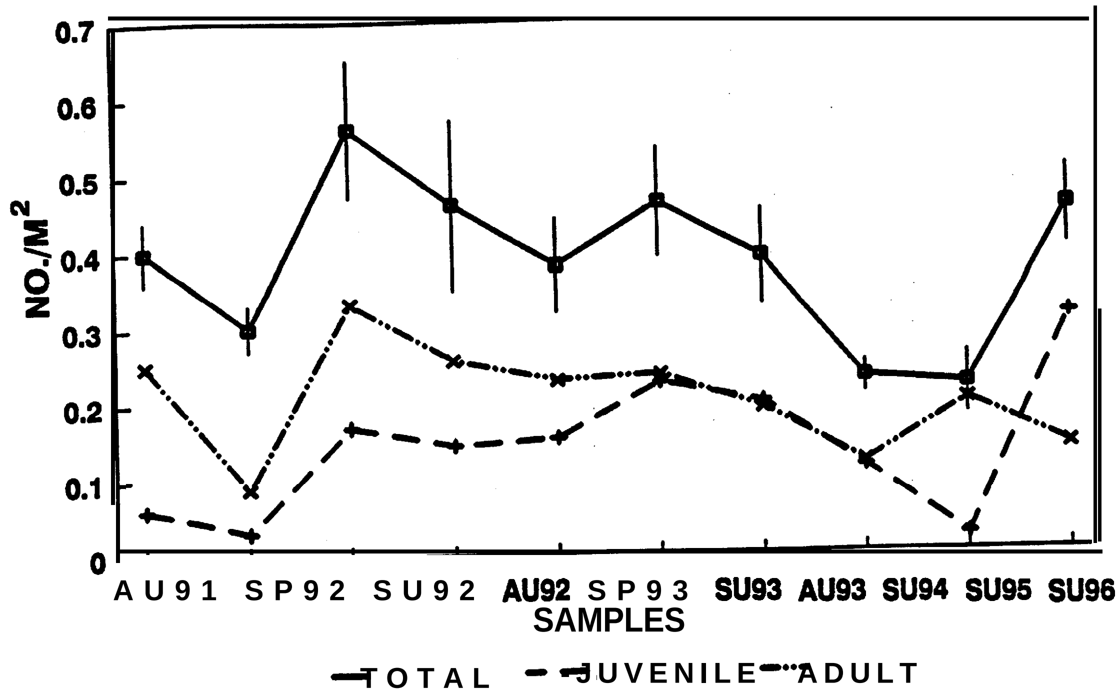


Figure 10. Length-frequency distributions of *S. trutta* in Mill Creek Reach 2 from 1991 - 1996. Samples are as shown in Figure 4.

A.



B.

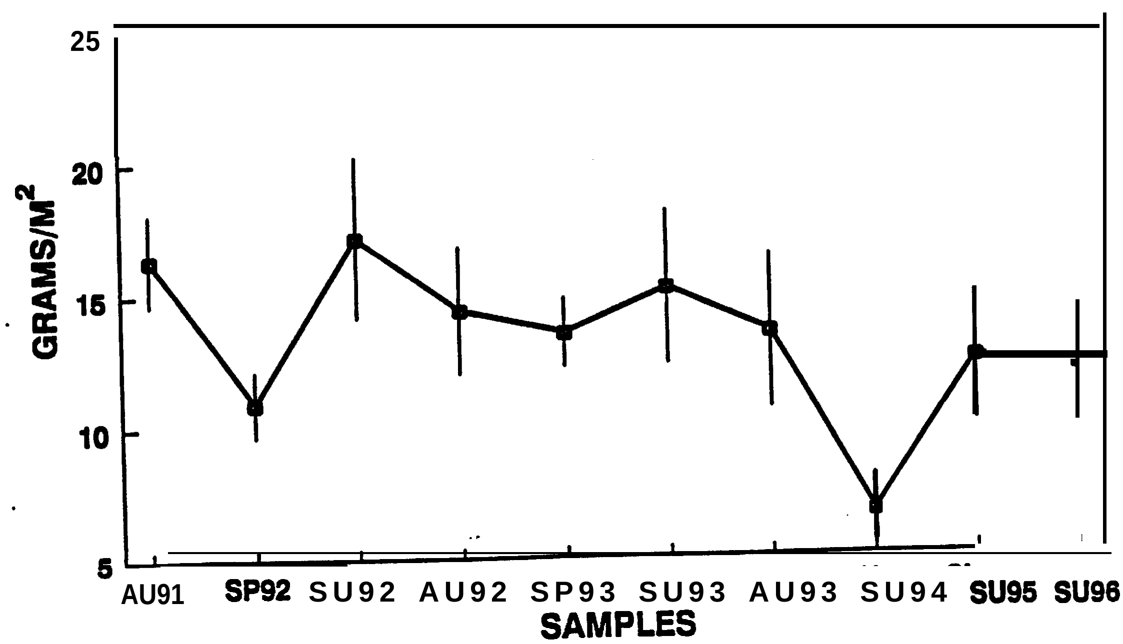


Figure 5. Population size and biomass of *S. trutta* in Bishop Creek Reach 3. A. Density of total population (mean ± 1 SE), adults, and juveniles. B. Population biomass (mean ± 1 SE). Samples are identified as in Figure 4.

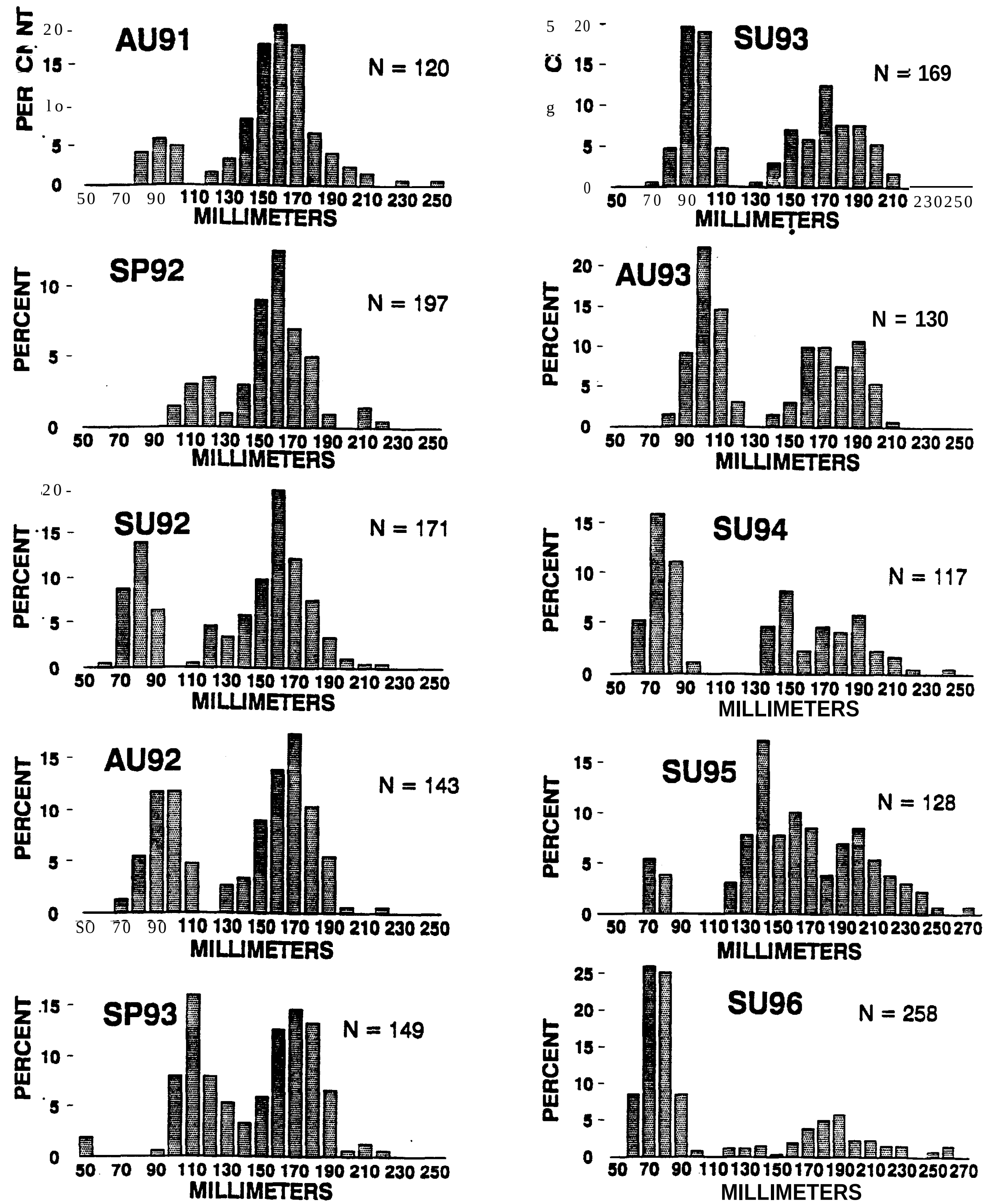


Figure 4. Length-frequency distributions of S. trutta in Bishop Creek Reach 3 during autumn I.991 (AU91), spring 1992 (SP92), summer 1992 (SU92), autumn 1992 (AU92), spring 1993 (SP93), summer 1993 (SU93), autumn 1993 (AU93), summer 1994 (SU94), summer 1995 (SU95), and summer 1996 (SU96) samples.

SUMMARY

1999 Fish Surveys in Rush and Lee Vining Creeks

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Fish population surveys were conducted at sites where riparian vegetation and abiotic aquatic habitat monitoring programs are located. Aquatic habitat and fish population surveys were conducted within several days of one-another during. Fish populations were surveyed in three reaches of upper Lee Vining Creek and two reaches of upper Rush Creek. Surveys were conducted during spring, summer, and autumn in Lee Vining Creek, and during summer and autumn in Rush Creek. Spring sampling in Rush Creek was precluded by equipment failure. A spring **2001** sample will be conducted to compensate for missing this sample.

The Lee Vining Creek fish assemblage included brown trout *(Salmo trutta)* and brook trout *(Salvelinus fontinalis).* Brook trout were from 2 - 8 times more abundant than brown trout, but brown trout biomass occasionally exceeded brook trout biomass. The abundance of both species was low, and did not exceed 0.09 fish/m” (biomass did not exceed 5.3 grams/m”). Abundance of both species was lowest during spring and highest in autumn. The presence of young-of-the-year (YOY) brook trout during summer and autumn indicated that this species successfully spawns in upper Lee Vining Creek. No YOY brown trout were observed, indicating that spawning success of this species is poor in this area. Discharge through upper Lee Vining Creek is comparatively constant (range = 8 - 13 cfs) and regulated by releases from Saddlebag Lake. These releases greatly alter the hydrograph from natural conditions that are indicated by Slate Creek discharge. Slate Creek is tributary to Lee Vining Creek at the downstream limit of sample reaches, and its discharge varies from > 100 cfs during spring to less than 1 cfs during autumn and winter. Hence, winter flow in Lee Vining Creek are greater than the natural hydrograph and spring flows are less. Maintaining these conditions is likely to enhance fish habitat by decreasing juvenile mortality attributed to scouring spring flows and relatively greater amounts of aquatic habitat during winter and autumn periods.

The Rush Creek fish assemblage included brook trout and rainbow trout that were mostly *O.m. gairdneri* (rainbow trout) X O.m. *aguabonita* (golden trout) hybrids, but several fish appeared to be pure *O.m. aguabonita.* In Reach 1, fish abundance was low and brook trout were more abundant than rainbow trout (brook trout density range 0.01 fish/m^2 - 0.1 fish/m^2, rainbow trout

density range 0.01 fish/m^2 - 0.02 fish/m^2). Biomass of brook trout did not exceed 3.3 grams/m^2 and rainbow trout biomass did not exceed 1.1 grams/m^2). Both species were most abundant in autumn. Fish populations were also small in Reach 2, but rainbow trout were slightly more abundant than brook trout during both surveys. Density of both species ranged from 0.01 fish/m^2 - 0.03 fish/m^2 Rainbow trout biomass ranged from 0.3 grams/m^2 - 1.6 grams/m" and brook trout biomass ranged from 0.2 grams/m^2 - 1.0 grams/m^2 Rainbow trout were also more abundant in Reach 2 than in Reach 1, and brook trout were less abundant in Reach 2 than in Reach 1. No YOY of either species was observed in either reach during summer, which indicates that spawning success may be poor in this area of Rush Creek. YOY of both species were present during autumn. Spawning habitat quality for these species may be degraded by high spring time flows (> 300 cfs) that scour incubating eggs from the substrate, and low autumn and winter flows (< 4 cfs) that allow harsh winter conditions to elevate incubating egg mortality. Absence of YOY during summer and presence of YOY during autumn suggests that YOU fish may enter this portion of Rush Creek when Waugh Lake is drained during October.

General Observations

- Little temporal or spatial variation in fish density or standing crop in reaches near the same elevation.
- Temporal variation in age class structure was usually highly predictable.
- Maximum fish size increased when instream flows increased.
- Fish abundance, size, standing crop, and body condition were greater in lower elevation than higher elevation reaches.
- Brown trout recruitment was decreased by elevated spring/summer flows.
- Seasonal variation in stream discharge of regulated streams is comparatively low while in unregulated streams it may exceed three orders of magnitude,
- Young-of-the-year fish did not occur in some higher elevation stream reaches.

IMPLICATIONS OF 'FLOW MANAGEMENT'

- Steep gradients, large substrates, and temporal variations in flow indicates that low order Sierra Nevada streams are comparatively poor trout habitat.
- Reservoirs moderate seasonal variation in flow (maintain higher winter flows and lower runoff flows) that improve habitat for trout.
- Flow moderation created by impoundments may affect riparian systems by minimizing occurrence of scouring floods. Does this adversely affect vegetation community structure and annual recruitment?