Little River Watershed Survey

-Habitat and Fish Summary for Spring 1993 through Spring 1994-

United States Department of Agriculture Forest Service
Southern Research Station - Coldwater Fisheries Unit

C. Andrew Dolloff
Unit Leader

Prepared by

Holly E. Jennings
Fisheries Biologist

Department of Fisheries and Wildlife
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0321

July 1997

Forward

This report contains a summary of basinwide fish habitat and fish population surveys conducted in the Little River watershed during spring and fall 1993 and spring 1994. It is one product resulting from a five-year study designed to investigate trout production in selected Appalachian stream basins. Habitat surveys were conducted in spring 1989 and 1993, and fish surveys were conducted every spring and fall between 1989 and 1994. This report will be updated periodically as information collected during previous years and seasons is analyzed and incorporated. We thank our cooperators, the US Forest Service-National Forest System, National Park Service - Great Smoky Mountains National Park, the Tennessee Wildlife Resources Agency, Virginia Polytechnic Institute and State University, and the University of Tennessee, whose enthusiastic participation and patience over the years made this study possible.

Background

Self-sustaining populations of wild trout have high recreational and aesthetic value in the mountainous regions of the southeastern United States. To meet the high angler demand for wild trout, many streams in the states of Georgia, North Carolina, South Carolina, Tennessee, and Virginia are managed to support, without artificial stocking, populations of one or more of three salmonid species, rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, and brook trout *Salvelinus fontinalis*. Other streams are stocked either to supplement low natural production of harvestable size trout or, where habitat conditions during some part of the year are inadequate for trout, to provide a seasonal (typically spring and fall) fishery.

Trout populations that support stream fisheries without supplemental stocking are very appealing to budget and quality conscious resource managers. Trout hatcheries are expensive to build and maintain, and many anglers believe that hatchery fish are "inferior" compared to their wild cousins. In contrast, trout populations maintained by natural reproduction cost little and yield wild fish that many anglers prize.

Unfortunately, due to overexploitation and habitat degradation, many streams in the southeast are apparently unable to support significant populations of wild trout. Past or present human land use, particularly the removal of riparian vegetation by logging, livestock grazing, and road building, has caused changes in a variety of habitat characteristics including water temperature, overall water quality, type and quantity of sediment, instream cover (especially large woody debris), and food supply. The restoration and protection of trout habitats depend on our ability to understand and eventually manipulate these and other factors that influence trout production.

Although there have been no comprehensive, long-term studies, trout production is perceived by many fishery managers to be lower in the southeast than in other parts of the country. Low production is usually attributed to a single factor, such as increased temperature, sedimentation, or loss of instream cover. But production may be influenced by interactions among factors or by seasonal changes in the relative importance of individual factors. Streams that support self-sustaining trout populations must meet the demands of all life history stages. Water quantity and quality (dissolved oxygen, pH, temperature, etc.), habitat, and food must be both within the acceptable range and available at the appropriate time for

successful egg and embryo incubation, summer and winter juvenile rearing, adult maintenance, and spawning.

The overall purpose of this study was to investigate aspects of trout production ecology in the Southeast. The range of trout production has not been adequately documented, and the relations of specific habitat features (e.g. large woody debris loading, habitat unit size and complexity, substrate composition) and biological interactions (e.g. variations in annual recruitment, competition with other fish species) to production are not well understood. We are assessing the influence on trout production of these and other factors such as annual climatic variation, season, and within-basin habitat variability by investigating the habitat use and population characteristics of trout in a cross-section of streams in Southern Appalachian watersheds.

Research sites were selected to encompass a broad range of conditions (e.g. amount of LWD, proportion of sediment in different size categories, size of habitat unit, number of non-salmonid fish). Specific attributes (e.g. growth, production) of trout populations were measured during spring and fall in these streams. Particular emphasis was placed on identifying relationships between fish populations and features of physical habitat and on evaluating the effects of biological processes such as recruitment and effect of other fish species (potential competitors) on production estimates.

In this report we provide a summary of spring 1993 habitat conditions, and of spring and fall 1993 and spring 1994 trout distribution, densities, and length frequencies in nine Little River watershed streams in Tennessee. Future products will include the identification of specific factors that appear to control or limit salmonid production and the establishment of a long-term database for estimating habitat and trout production relationships. Pertinent research findings will be published in the scientific and popular literature.

Study Area

The headwaters of the Little River originate in the mountains of Tennessee on lands managed by the Great Smoky Mountains National Park. The 110 or more kilometers of first through fourth order

channels are contained entirely within the national park boundary.

The pattern of historical land use in the Little River drainage is similar to that for much of the southern Appalachian Mountains. Land clearing and logging of the rugged, mountainous terrain did not begin until the early 1900's and continued until the mid-1930's when the Great Smoky Mountains National Park was created. Since then, land use has been limited to recreation.

Nine stream segments in the Little River watershed above Elkmont were chosen for extensive sampling. The study streams were 1) Lower Little River, 2) Upper Little River, 3) Lower Meigs Post Prong, 4) Upper Meigs Post Prong, 5) Sweet Creek, 6) Lower Fish Camp Prong, 7) Middle Fish Camp Prong, 8) Upper Fish Camp Prong, and 9) Buckeye Gap (Figure 1).

Survey Techniques

Habitat Survey - For the BVET (Basinwide Visual Estimation Technique), we identified five habitat types: pools, glides, riffles, cascades, and complexes (Dolloff et.al 1993). Complexes were units containing a combination of fast and slow water. Each habitat unit occupied at least 3 m^2 in area; areas smaller than 3 m^2 were included with the closest adjacent habitat unit. Dominant substrate (substrate in one of nine classes covering the greatest proportion of the wetted stream bottom; Table 1) and counts of pieces of large woody debris (LWD) in each of seven size classes (Table 1) were recorded in each habitat unit sampled.

The BVET for habitat inventory consisted of two phases, estimation and verification (Hankin and Reeves 1988; Dolloff et al. 1993). During the first phase, the watershed was stratified into reaches based on natural features (e.g. change in stream order or change in gradient) or other criteria selected by the observer to ensure repeatability or to meet other specific objectives. Also during phase one, the stream was stratified by habitat types, and areas and other features for each type were visually estimated. During the second phase of the BVET, we verified and calibrated our estimates of habitat characteristics through measurements made with more accurate methods on a subsample of the total habitat units.

BVET surveys started at stream confluences and progressed upstream to the end of the respective stratum. Habitat type, distance from start points, estimated area, average and maximum depths, dominant

substrate, and LWD counts were recorded for every habitat unit in the stratum.

Habitat units were sequentially numbered by habitat type. Distance (to 0.1 m) to each unit was recorded as the length along the thalweg as determined by hip-chain measurement. Average and maximum depths were estimated based on multiple gauges with a depth rod marked into 5 cm increments. Areas were accurately measured with a meter tape in a subset of units (about 20% of all pools, glides, and complexes, and 10% of all riffles and cascades) to account for the bias of visual estimates. Areas were calculated as the product of length and average width. Separate calibrations were calculated for pools and riffles within each stream stratum and watershed. For these calibrations, because of the low number of measured units, glides and complexes were combined with pools, and cascades were combined with riffles. Estimates of habitat area and associated variances were calculated for each habitat type and stream stratum using equations found in Dolloff et al. (1993).

Fish Survey - The BVET for fish population census also consisted of two phases, estimation and verification (Hankin and Reeves 1988; Dolloff et al. 1993). During the first phase, underwater observations were made by divers equipped with face-masks and snorkels. Divers entered habitat units (selected during phase two of the habitat survey - 20% of all pools, glides, and complexes, and 10% of all riffles and cascades) and proceeded slowly upstream identifying and counting all trout and other fish species.

During the second phase of the fish survey, we used multipass depletions with 700 volt AC backpack electrofishing equipment to verify and calibrate the diver counts. About 10% of phase one fish sampling units (one of every 10 habitat units searched by divers) were selected systematically for multipass depletions. Diver counts of fish in each habitat type were corrected by calibration ratios: number observed by divers divided by depletion estimates. Estimates of total fish abundance and associated variances were calculated for each salmonid species using equations found in Dolloff et al. (1993). All fish captured during the two- or three-pass depletions were identified, weighed (g), measured (mm), and returned to the approximate location of capture. During spring 1993, the fish sampling corresponded with the habitat sampling; the actual points of fish sampling (distances upstream) were known. However, only fish sampling occurred during fall 1993 and spring 1994; no hip-chain distances were measured. Therefore, the

distributions of the fish sampled are relative. Also, only Upper Little River, Meigs Post Prong, and Sweet Creek were sampled during spring 1994.

Results

Habitat Survey - Total area of each habitat type was estimated for each of the spring 1993 study streams using correction factors (Q) that ranged from 0.90 to 1.14 (Table 2). Pool-like habitat (pools, glides, and complexes) constituted the greatest proportion of the total surface area in all study streams except Upper Meigs Post Prong and Sweet Creek (Table 2).

In general, pools were deeper than all other habitat types with complexes (where present), glides, riffles, and cascades following in order of decreasing depth. Depth in all habitat types, however, was highly variable (Appendix).

The dominant substrate in the pools and glides varied from small gravel to bedrock, with no one type being more dominant than the others. The dominant substrate of complexes was boulder. Riffles had primarily cobble and boulder substrate, whereas cascades contained mainly boulder and bedrock (Appendix).

Most of the LWD consisted of pieces < 10 cm in diameter. Only Lower Little River showed considerable LWD loading of pieces in the larger size classes (Appendix).

Fish Survey - During spring 1993, the trout community in the Little River watershed was composed of brook trout, rainbow trout, and brown trout which were observed in 78%, 78%, and 11% of the streams surveyed, respectively. Brook trout were most frequent in the upper sections of the study streams. Brook trout were sympatric with rainbow trout throughout Fish Camp and Buckeye Gap prongs and in Lower Meigs Post Prong but were not sympatric with brown trout in any of the streams. Apparently, only Upper Meigs Post Prong and Sweet Creek contained allopatric brook trout populations. Three non-salmonid species were also observed in the Little River watershed during spring 1993: longnose dace *Rhynichthys atratulus* (located from Lower Little River through Lower Meigs Post Prong and Middle Fish Camp Prong), blacknose dace *Rhynichthys cataractae* (in Lower Little River and Lower Fish Camp), and mottled sculpin *Cottus*

bairdi (from Lower Little River through Lower Meigs Post and Lower Fish Camp prongs).

We estimated trout density whenever possible (Table 3). Because of the variation in trout abundance, however, all of these estimates should be viewed as indices rather than true densities. Trout densities (number per 100 m^2) at the sub-basin level (estimated total fish abundance/estimated total habitat area X 100) ranged from 1.04 to 16.82/ 100 m^2 for brook trout, and 1.83 to 10.93/ 100 m^2 for rainbow trout (Table 3).

During fall 1993, brook trout, rainbow trout, and brown trout were observed in 67%, 78%, and 22% of the streams surveyed, respectively. Brook trout occurred with rainbow trout in Middle and Upper Fish Camp, Buckeye Gap, and Lower Meigs Post prongs but did not occur with brown trout, which were found only in Lower Little River and Lower Fish Camp Prong. Again, only Upper Meigs Post Prong and Sweet Creek contained allopatric brook trout populations. Longnose dace and mottled sculpin were found in the same locations as spring 1993. However, no blacknose dace were sampled during the fall. Fall 1993 trout densities at the sub-basin level ranged from 0.65 to 11.85/ 100 m^2 for brook trout, and 4.09 to 31.62/ 100 m^2 for rainbow trout (Table 3).

During spring 1994, only Upper Little River, Meigs Post Prong, and Sweet Creek were sampled. As with the two previous sampling periods, Lower Meigs Post Prong had both brook and rainbow trout, and Upper Meigs Post and Sweet Creek contained only brook trout. Upper Little River contained rainbow trout and, in the lower reaches, brown trout. Longnose dace and mottled sculpin were sampled in Upper Little River and Lower Meigs Post Prong. One blacknose dace was found in Lower Meigs Post Prong. Spring 1994 trout densities at the sub-basin level ranged from 2.17 to 4.95/ 100 m^2 for brook trout, and 2.79 to 9.19/ 100 m^2 for rainbow trout (Table 3). Summaries of the fish surveys are presented in the Appendix to this report.

User's Guide for Appendix

Stream summaries are organized by sub-basin: downstream to upstream. Each stream summary contains up to eleven graphs:

-Length frequencies of all trout species captured during electrofishing surveys in spring and fall 1993, and spring 1994.

-Spring 1993 distribution and relative abundance (number / 100 m^2) of all trout by species in each stream. Densities are based on diver counts. Habitat units where divers did not see trout are denoted by horizontal marks on the x-axis. Age 0+ fish (young-of-year) are labeled YOY. For these plots, glide data have been combined with pool data, and cascade data have been combined with riffle data.

-Fall 1993 relative distribution and abundance (number / 100 m^2) of all trout by species in each stream. During the fall 1993 and spring 1994 fish surveys, distances of habitat units from the downstream starting point were not measured; therefore, distances on the plot are relative, with units being equidistant from each other.

-Spring 1994 relative distribution and abundance (number / 100 m^2) of all trout by species in Upper Little River, Meigs Post Prong, and Sweet Creek. During the fall 1993 and spring 1994 fish surveys, distances of habitat units from the downstream starting point were not measured; therefore, distances on the plot are relative, with units being equidistant from each other.

-Box plots of the surface area of all habitats inventoried in each stream. Visual estimates of surface area were corrected by multiplying all estimates by a calibration ratio ($\hat{Q}$ of Hankin and Reeves 1988). The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, the dots represent the 5% and 95% quantiles, and the solid line in the box represents the median.

-Box plots of the maximum depth of all habitats inventoried in each stream. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, the dots represent the 5% and 95% quantiles, and the solid line in the box represents the median.

-Dominant substrate occurrence by habitat type in each stream. Bars represent frequency (percent) and dots represent cumulative percent.

-Pieces of large woody debris per kilometer of stream by size class in each stream. Bars represent frequency (percent) and dots represent cumulative percent.

-Distribution and total abundance of large woody debris in each stream. Distribution and abundance of LWD 5, LWD 6, and rootwads represent the largest size classes of woody debris and are most likely to remain in the stream channels and influence habitat quality.

Literature Cited

Dolloff, C. A., D. G. Hankin, and G. H. Reeves. 1993. Basinwide estimation of habitat and fish populations in streams. General Technical Report SE-83. Asheville, North Carolina: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 25 pp.

Hankin, D. G. and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences. 45: 834-844.

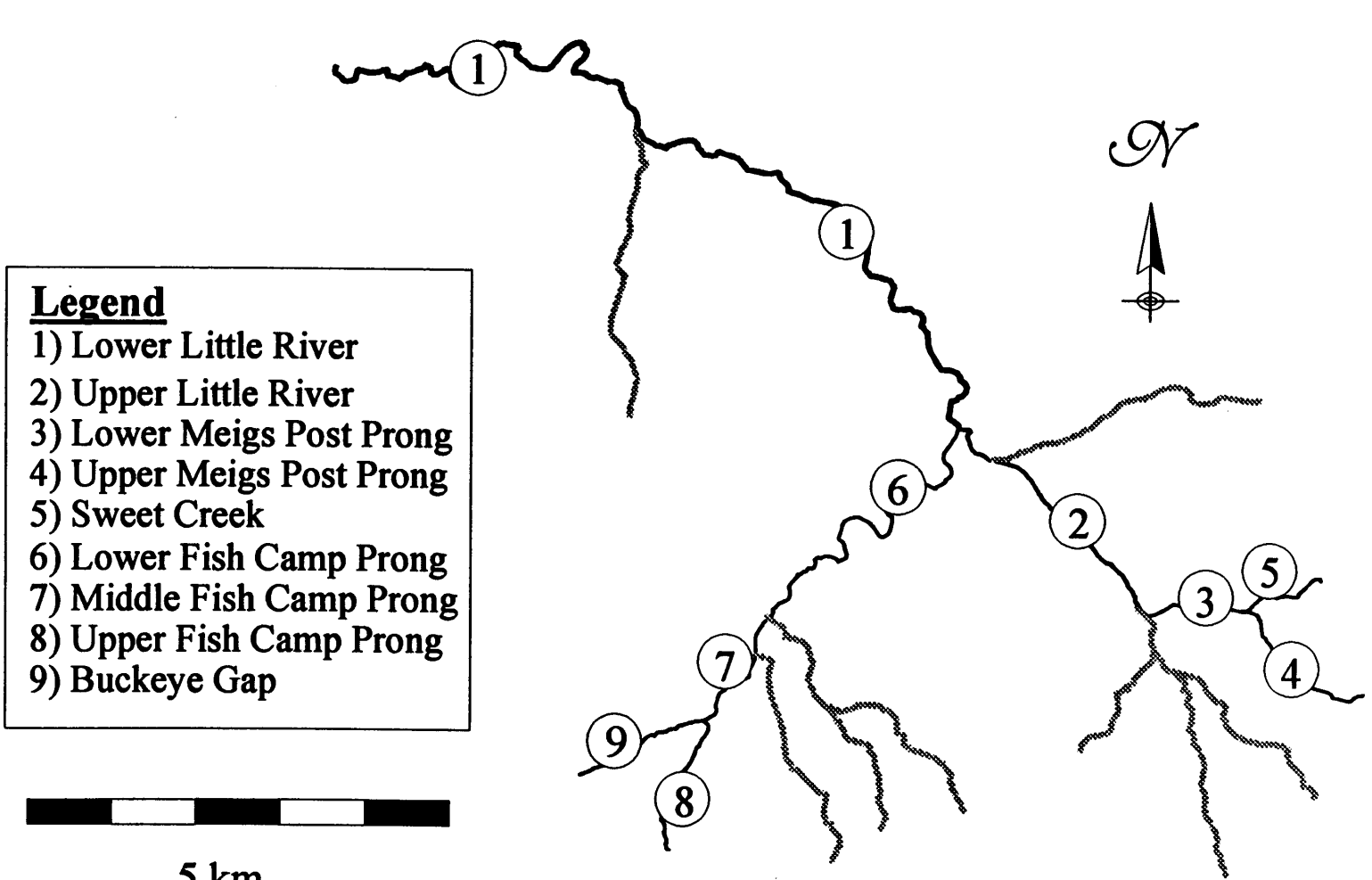

Legend
1) Lower Little River
2) Upper Little River
3) Lower Meigs Post Prong
4) Upper Meigs Post Prong
5) Sweet Creek
6) Lower Fish Camp Prong
7) Middle Fish Camp Prong
8) Upper Fish Camp Prong
9) Buckeye Gap
5 km
N
1
1
6
2
3
5
4
7
9
8

Table 1. Criteria for substrate and large woody debris (LWD) classifications.

Substrate		LWD Size		
Class	Diameter	Class	Length	Diameter
organic debris		1	≥1 and <5 m	5-10 cm
clay		2	≥1 and <5 m	10-50 cm
silt		3	≥1 and <5 m	>50 cm
sand	silt-2mm	4	≥5 m	5-10 cm
small gravel	2-10 mm	5	≥5 m	10-50 cm
large gravel	1-10 cm	6	≥5 m	>50 cm
cobble	11-30 cm	7	root wads	
boulder	>30 cm			
bedrock				

Table 2. Total number of habitat units surveyed (N), number of units measured (n), correction factor ($\hat{Q}$), estimated total habitat area ($\hat{M}$), estimated variance of the estimated total habitat area ($V(\hat{M})$), and 95% confidence interval (C.I.) for the estimated habitat area for Little River streams. Length of streams is given parenthetically. Because of the low number of measured units, glides and complexes have been combined with pools, and cascades have been combined with riffles.

Stream	Type	N	n	$\hat{Q}$	$\hat{M}$	$V(\hat{M})$	95% CI
Lower Little River	Pool	185	36	1.03	41797.3	877475.9	±1901.6
(4882.7 m)	Riffle	62	8	0.96	15704.6	304038.0	±1304.1
Upper Little River	Pool	242	46	0.95	18996.0	899569.2	±1910.2
(3325.0 m)	Riffle	88	12	0.96	6268.0	60472.2	±541.3
Lower Fish Camp Prong	Pool	319	61	1.09	37355.8	634734.7	±1593.4
(5151.8 m)	Riffle	97	11	1.06	13075.0	686936.2	±1846.6
Lower Meigs Post Prong	Pool	212	42	1.09	5399.3	36989.0	±388.5
(1682.3 m)	Riffle	90	10	1.09	2448.1	6877.2	±187.6
Upper Meigs Post Prong	Pool	170	35	1.14	1568.7	3345.2	±117.5
(1289.2 m)	Riffle	132	14	0.90	1952.5	5944.8	±166.5
Sweet Creek	Pool	108	19	1.05	1228.0	2839.5	±112.0
(900.7 m)	Riffle	95	9	0.94	1583.2	14339.9	±276.1
Middle Fish Camp Prong	Pool	119	21	0.96	1517.6	2183.7	±97.5
(1595.2 m)	Riffle	65	3	1.00	1483.7	1569.7	±170.5
Upper Fish Camp Prong	Pool	117	38	1.09	5648.0	46636.4	±439.5
(1012.6 m)	Riffle	65	14	1.02	3675.0	57336.5	±517.2
Buckeye Gap	Pool	203	24	1.00	2573.7	9858.7	±204.9
(1498.5 m)	Riffle	140	7	1.08	1805.8	8182.9	±221.4

Table 3. Correction factor ($\hat{R}$), estimated total abundance ($\hat{Y}$), estimated variance of the total abundance ($\hat{V}(\hat{Y})$), 95% confidence intervals for the total abundance, and density of fish sampled in Little River study streams. Densities are based on spring 1993 habitat areas. Numbers of units sampled are shown in parentheses. Brook trout = BKT, brown trout = BNT, rainbow trout = RBT, blacknose dace = BND, longnose dace = LND, and mottled sculpin = SCLP. Glides and complexes are combined with pools, and cascades with riffles.

Sub-basin	Species	Habitat Type	# Fish Snorkeled	# Fish Shocked	# Fish Snorkeled in Shocked Units	$\hat{R}$	$\hat{Y}$	$\hat{V}(\hat{Y})$	95% Confidence Interval	Density (Number/ 100 m^2)
					Spring 1993					
Little River &	BKT	Pools	3(139)	0(18)	0(18)	*	*	*	*	*
Lower Fish Camp	BNT	Pools	4(139)	0(18)	0(18)	*	*	*	*	*
13359.5 m	RBT	Pools	1881(139)	136(18)	122(18)	1.11	10731	406800	±1346	10.93
	RBT	Riffles	144(24)	5(4)	12(4)	0.42	642	240260	±1560	1.83
	BND	Pools	23(139)	0(18)	0(18)	*	*	*	*	*
	BND	Riffles	3(24)	0(4)	0(4)	*	*	*	*	*
	LND	Pools	74(139)	43(18)	12(18)	3.58	199	18961	±291	0.02
	LND	Riffles	11(24)	5(4)	1(4)	5.00	52	3634	±192	0.15
	SCLP	Pools	12(139)	29(18)	2(18)	14.50	934	681238	±1742	0.95
	SCLP	Riffles	1(24)	6(4)	0(4)	*	*	*	*	*
Meigs Post &	BKT	Pools	107(89)	31(10)	14(10)	2.21	1379	312257	±1264	16.82
Sweet	BKT	Riffles	10(31)	11(7)	3(7)	3.67	712	176860	±1029	11.91
3872.2 m	RBT	Pools	129(89)	16(10)	25(10)	0.64	365	149027	±873	4.46
	RBT	Riffles	4(31)	7(7)	0(7)	*	*	*	*	*
	LND	Pools	0(89)	1(10)	0(10)	*	*	*	*	*
	SCLP	Pools	0(89)	2(10)	0(10)	*	*	*	*	*
Buckeye Gap &	BKT	Pools	65(85)	20(12)	9(12)	2.22	746	68883	±578	7.66
Middle & Upper	BKT	Riffles	7(26)	3(6)	3(6)	1.00	73	5512	±191	1.04
Fish Camp	RBT	Pools	115(85)	30(12)	22(12)	1.36	694	54592	±514	7.13
4106.3 m	RBT	Riffles	6(26)	4(6)	2(6)	2.00	125	6757	±211	1.79
	LND	Pools	0(85)	1(12)	0(12)	*	*	*	*	*
	LND	Riffles	3(26)	2(6)	0(6)	*	*	*	*	*

Table 3. Continued.

Sub-basin	Species	Habitat Type	# Fish Snorkeled	# Fish Shocked	# Fish Snorkeled in Shocked Units	$\hat{R}$	$\hat{Y}$	$\hat{V}(\hat{Y})$	95% Confidence Interval	Density (Number/ 100 m^2)
					Fall 1993					
Upper Little River	BNT	Pools	1(140)	1(16)	1(16)	1.00	5	1764	±89	0.01
& Lower Fish Camp	RBT	Pools	870(140)	129(16)	91(16)	1.42	5990	1150834	±2274	10.63
8476.8 m	RBT	Riffles	67(29)	13(6)	11(6)	1.18	792	279535	±1294	4.09
	LND	Pools	93(140)	42(16)	19(16)	2.21	999	820144	±1920	1.77
	LND	Riffles	2(29)	15(6)	0(6)	*	*	*	*	*
	SCLP	Pools	1(140)	35(16)	0(16)	*	*	*	*	*
	SCLP	Riffles	0(29)	3(6)	0(6)	*	*	*	*	*
Meigs Post &	BKT	Pools	114(106)	25(14)	15(14)	1.67	972	98623	±678	11.85
Sweet	BKT	Riffles	9(51)	4(10)	0(10)	*	*	*	*	*
3872.2 m	RBT	Pools	156(106)	20(14)	19(14)	1.05	840	84876	±629	10.24
	RBT	Riffles	25(51)	8(10)	6(10)	1.33	233	34978	±417	3.90
	LND	Pools	1(106)	0(14)	0(14)	*	*	*	*	*
	LND	Riffles	1(51)	4(10)	0(10)	*	*	*	*	*
	SCLP	Pools	0(106)	1(14)	0(14)	*	*	*	*	*
Buckeye Gap &	BKT	Pools	33(87)	12(10)	9(10)	1.33	212.4	41946	±456	2.18
Middle & Upper	BKT	Riffles	5(22)	2(7)	2(7)	1.00	46	2982	±129	0.65
Fish Camp	RBT	Pools	58(87)	11(10)	1(10)	11.00	3080	147230	±855	31.62
4106.3 m	RBT	Riffles	2(22)	7(7)	0(7)	*	*	*	*	*
	LND	Pools	1(87)	2(10)	0(10)	*	*	*	*	*
	LND	Riffles	1(22)	7(7)	1(7)	7.00	63.6	28133	±397	0.91

Table 3. Continued.

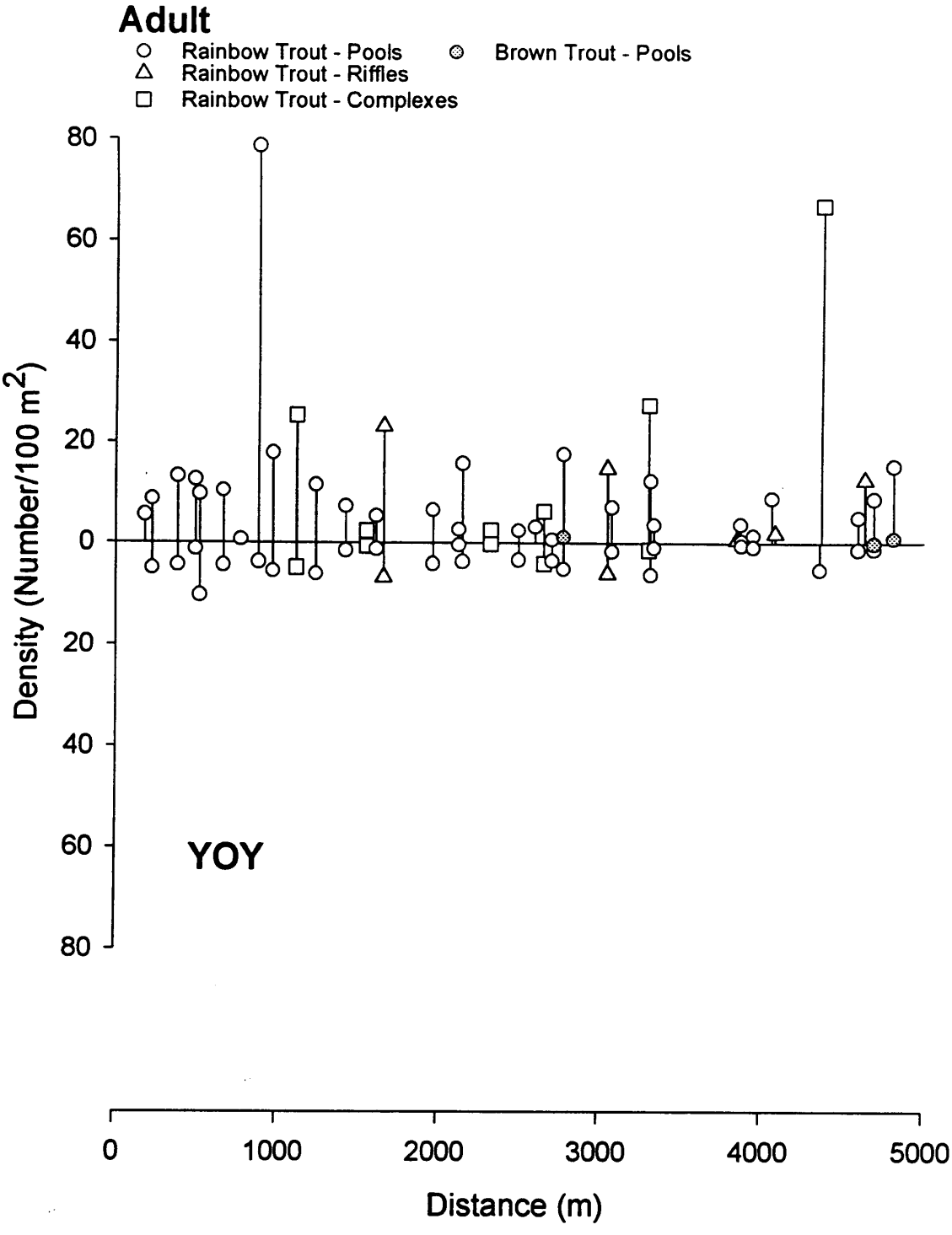
Sub-basin	Species	Habitat Type	# Fish Snorkeled	# Fish Shocked	# Fish Snorkeled in Shocked Units	$\hat{R}$	$\hat{Y}$	$\hat{V}(\hat{Y})$	95% Confidence Interval	Density (Number/ 100 m^2)
					Spring 1994					
Upper Little River	BKT	Riffles	0(32)	1(5)	0(5)	*	*	*	*	*
3325.0 m	BNT	Pools	4(56)	0(11)	0(11)	*	*	*	*	*
	RBT	Pools	292(56)	28(11)	23(11)	1.22	1746	110067	±730	9.19
	RBT	Riffles	14(32)	10(5)	4(5)	2.50	175	53232	±593	2.79
	LND	Pools	1(56)	6(11)	0(11)	*	*	*	*	*
	LND	Riffles	1(32)	4(5)	0(5)	*	*	*	*	*
	SCLP	Pools	0(56)	11(11)	0(11)	*	*	*	*	*
	SCLP	Riffles	0(32)	9(5)	0(5)	*	*	*	*	*
Meigs Post &	BKT	Pools	50(102)	28(24)	17(24)	1.65	405	31539	±367	4.95
Sweet	BKT	Riffles	7(52)	3(21)	1(21)	3.00	130	3842	±129	2.17
3872.2 m	RBT	Pools	70(102)	9(24)	6(24)	1.50	517	10433	±211	6.31
	RBT	Riffles	2(52)	0(21)	1(21)	*	*	*	*	*
	LND	Pools	0(102)	1(24)	0(24)	*	*	*	*	*
	SCLP	Pools	0(102)	1(24)	0(24)	*	*	*	*	*
No Buckeye Gap & Middle & Upper Fish Camp										

* Estimates could not be calculated because snorkeling and/or electrofishing produced no fish in the shocked units.

Appendix

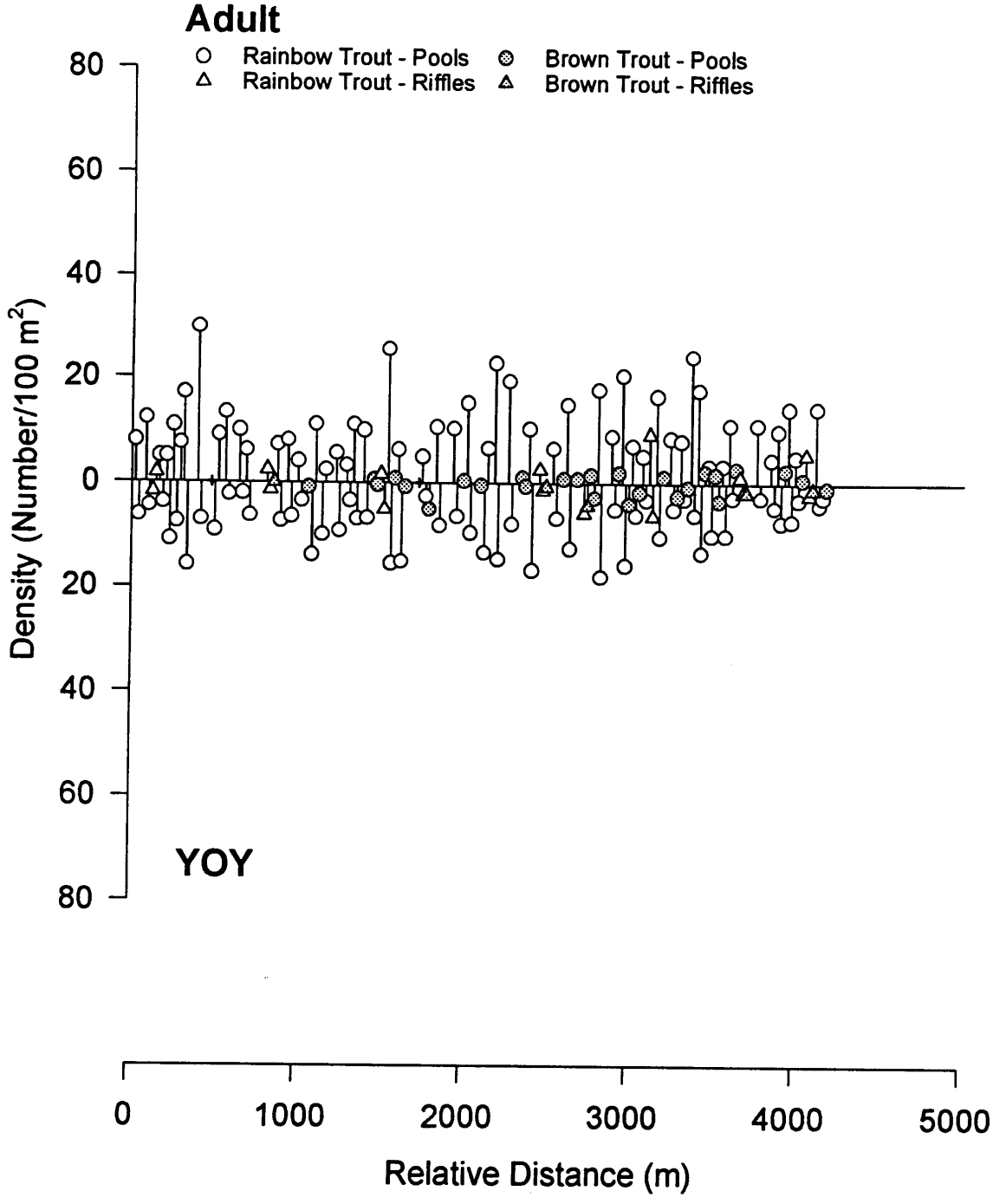
Little River Sub-basin

Lower Little River*
Spring 1993



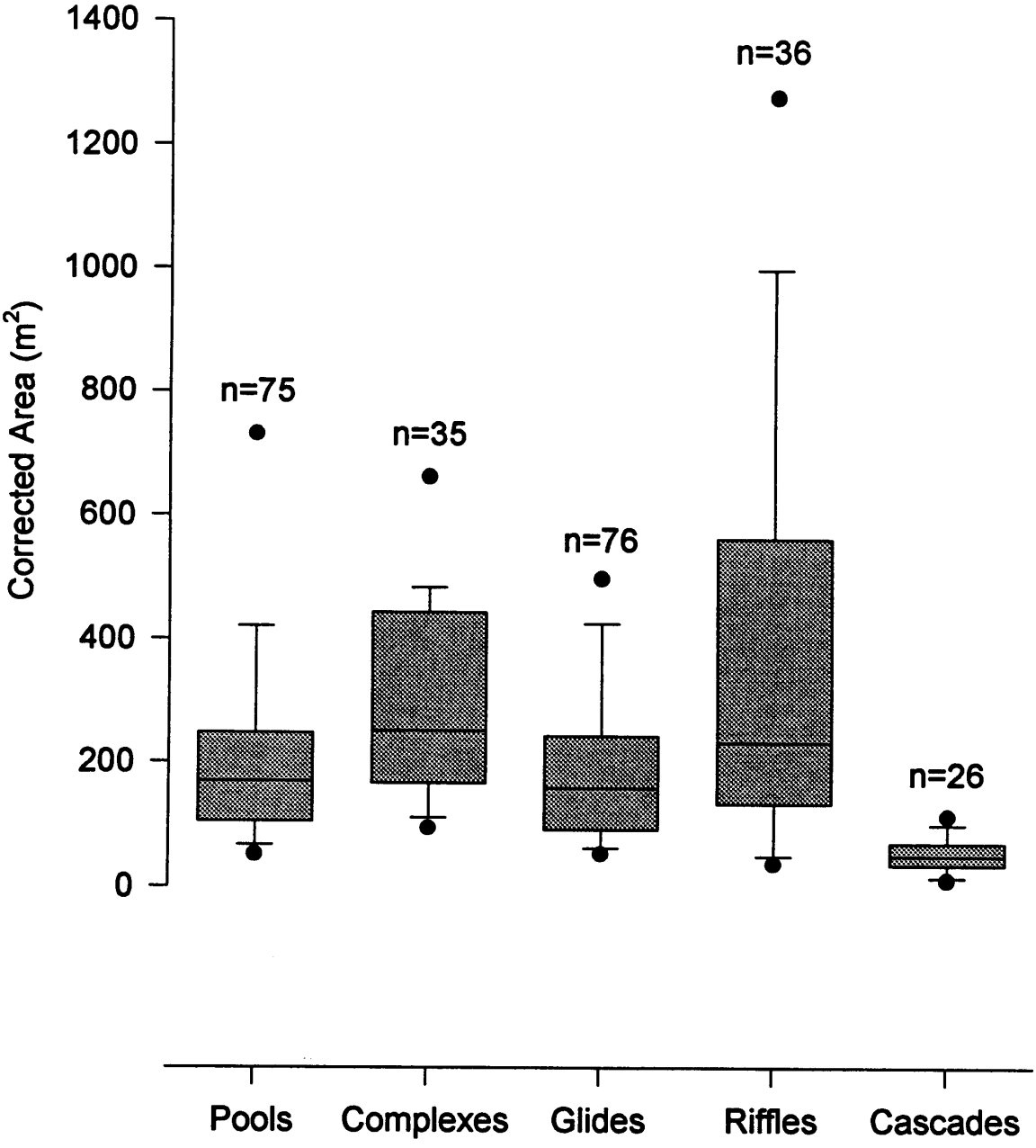
*Length frequency data not available.

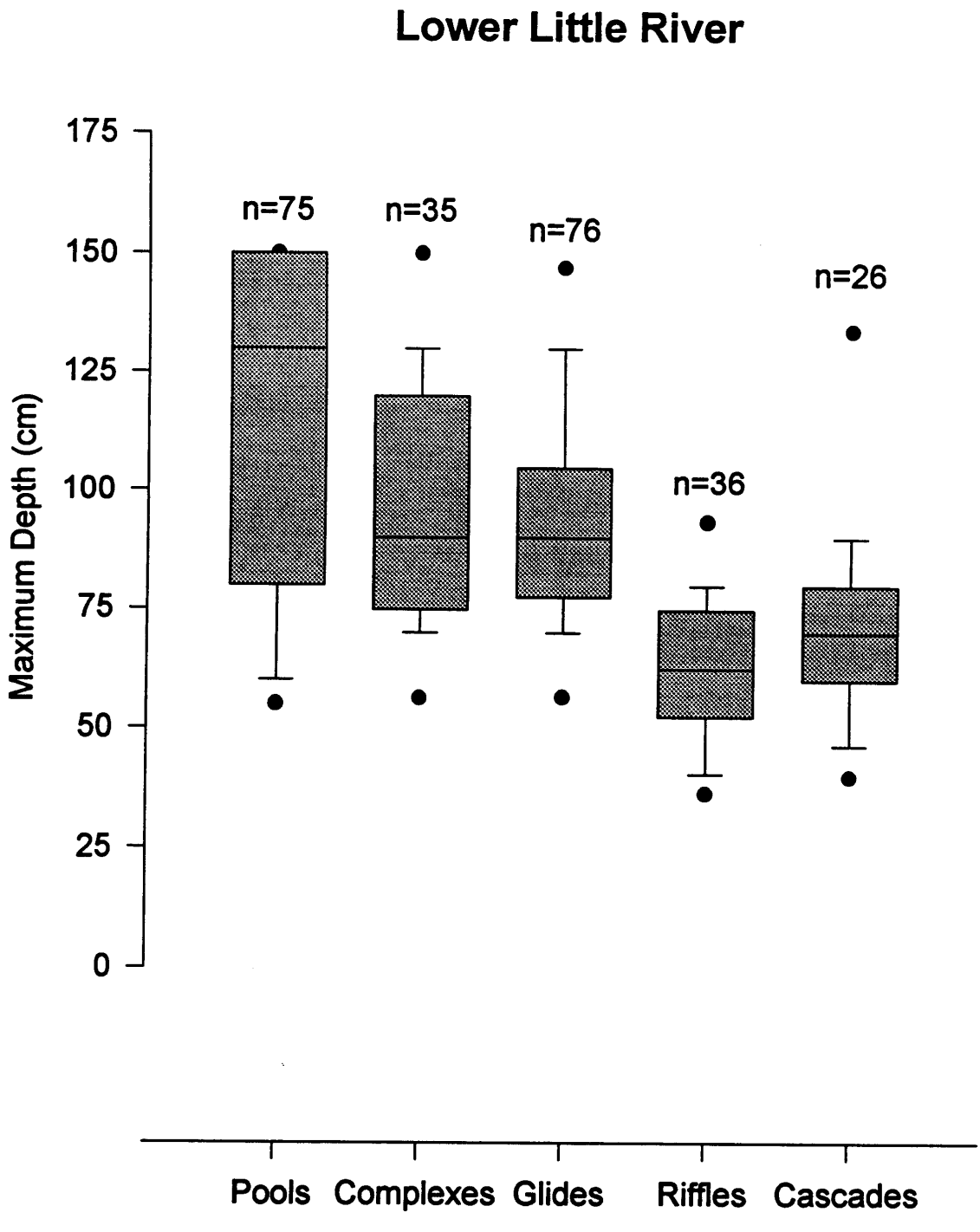
Lower Little River*
Fall 1993



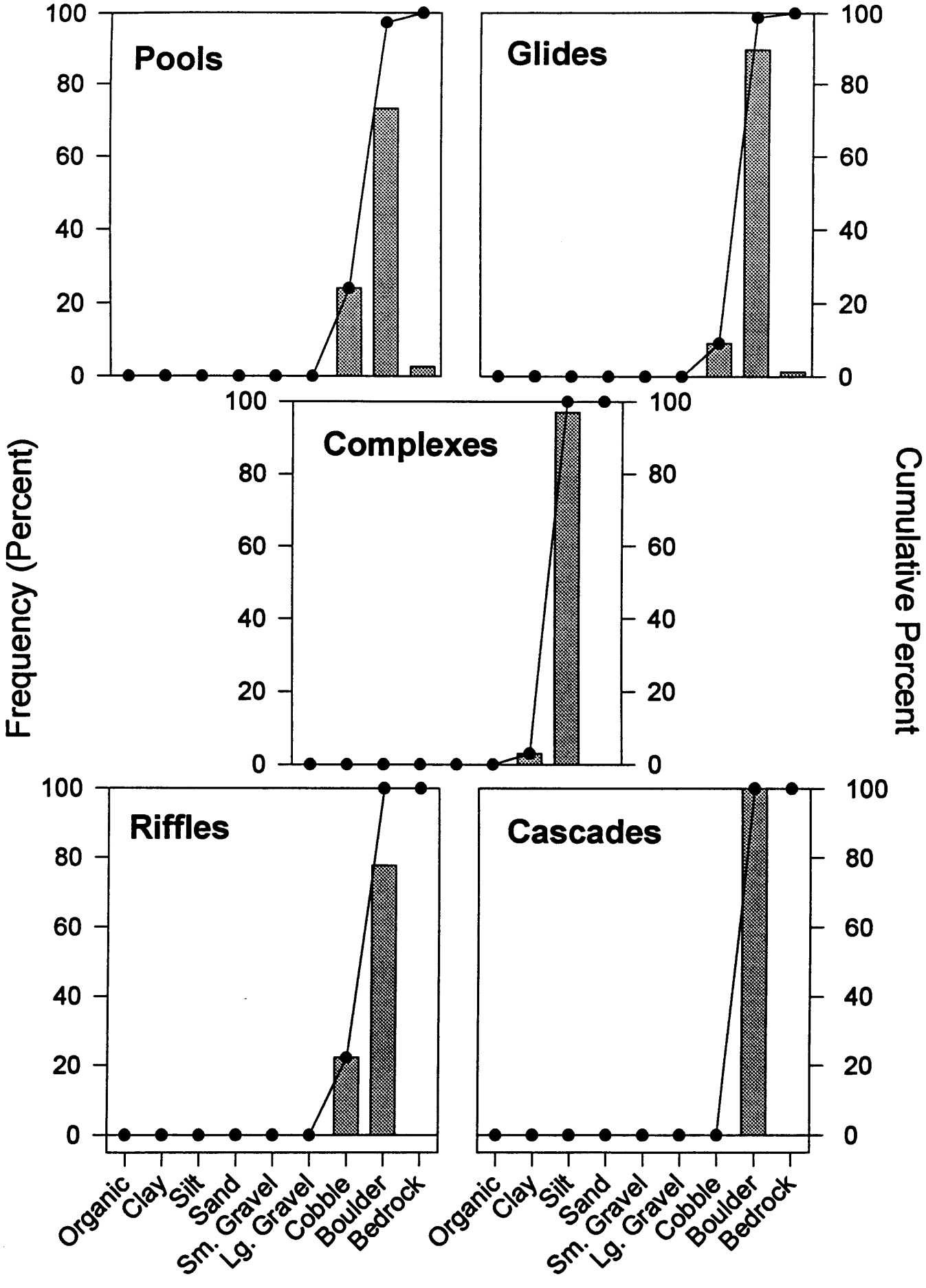
*Spring 1994 density data not available.

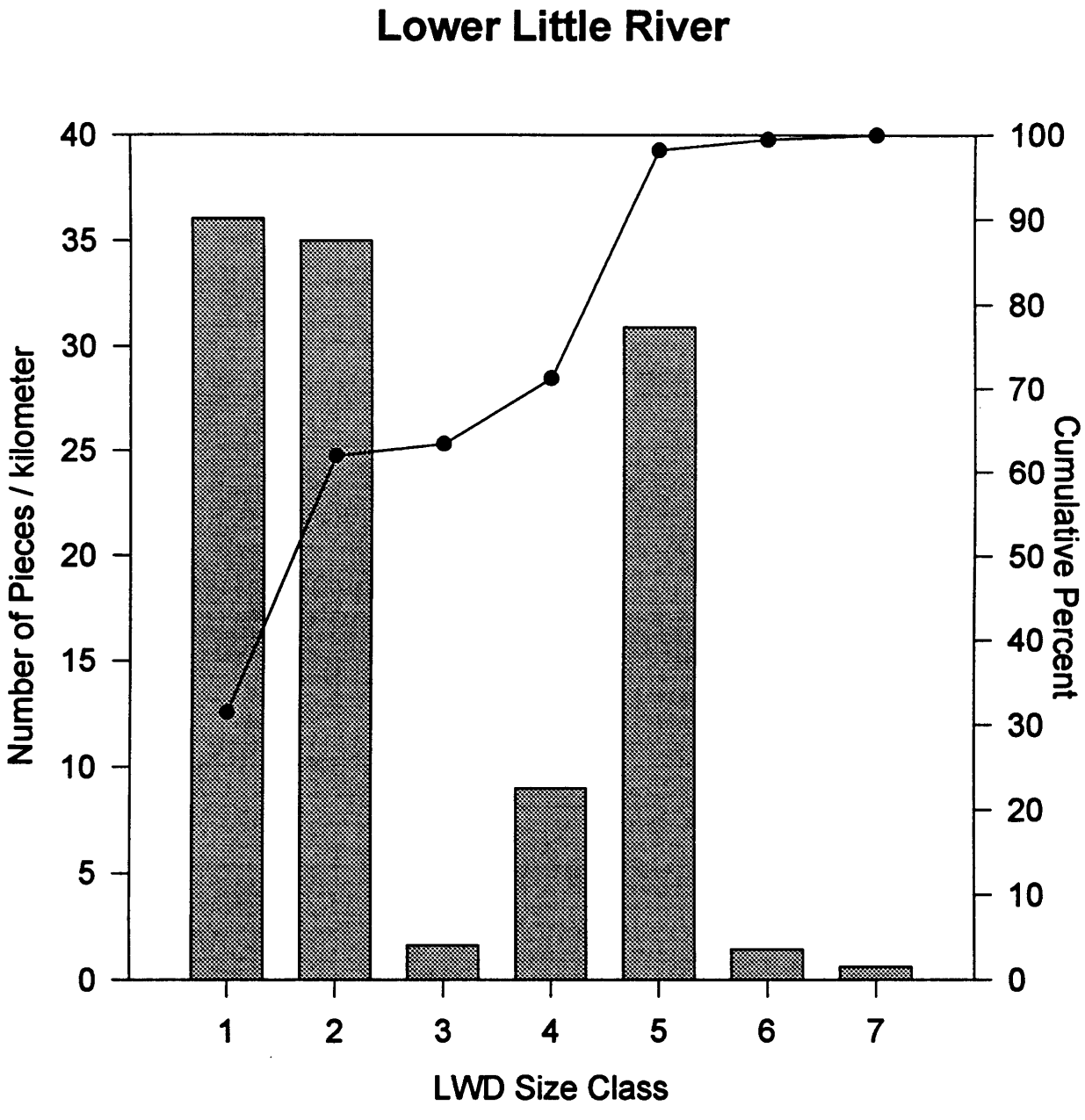
Lower Little River



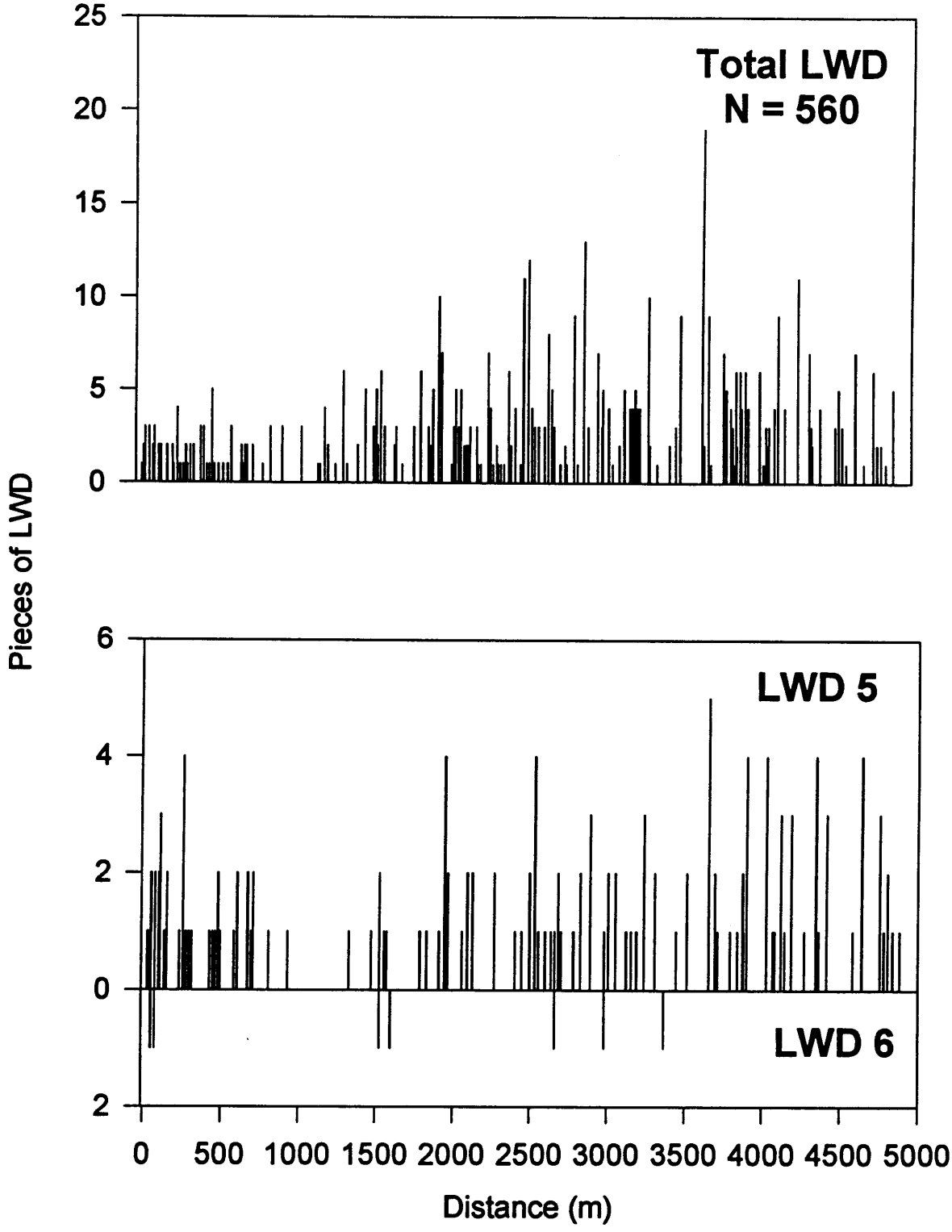

Lower Little River
Maximum Depth (cm)
175
150
125
100
75
50
25
0
n=75
n=35
n=76
n=36
n=26
Pools
Complexes
Glides
Riffles
Cascades

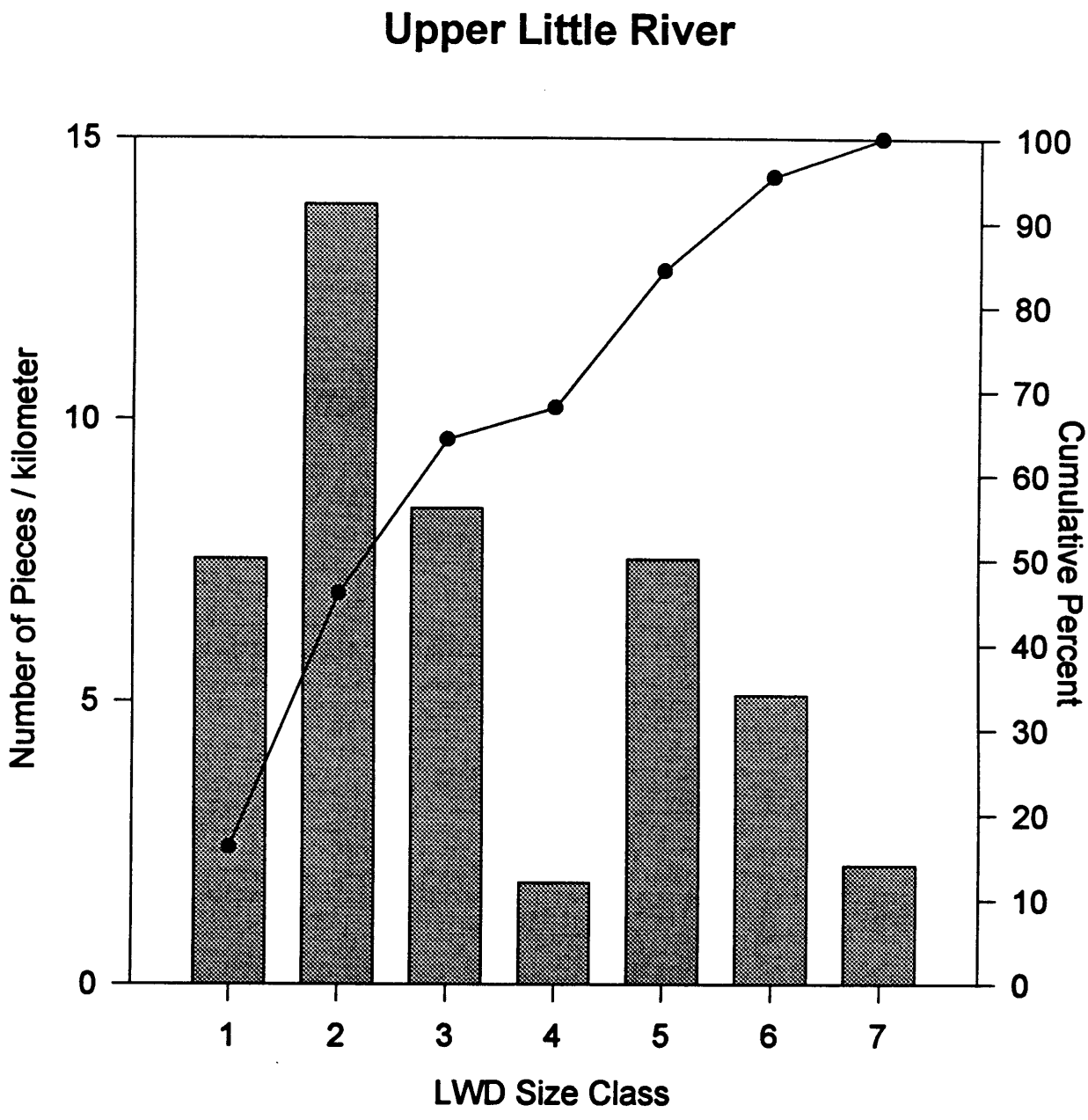
Lower Little River



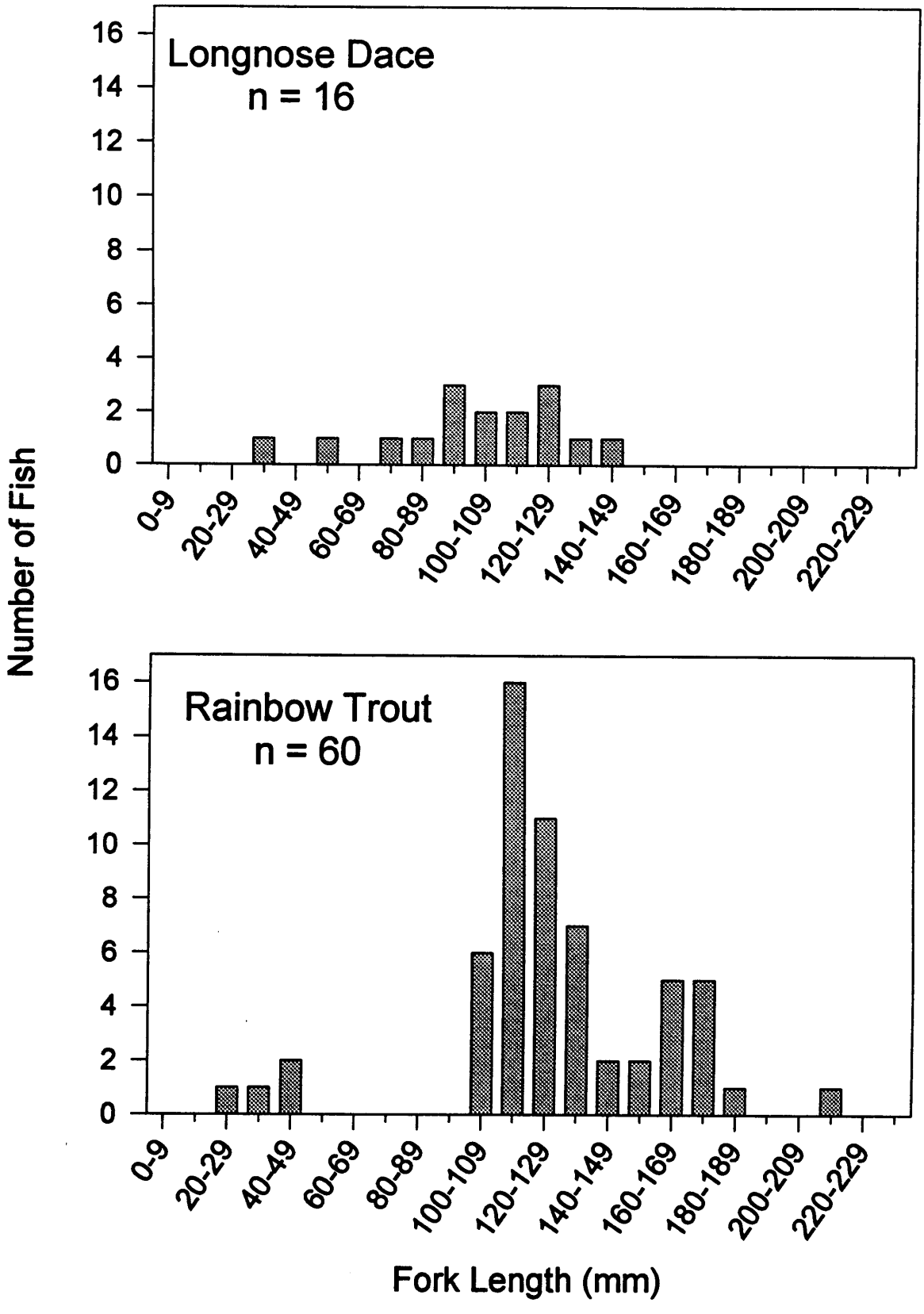

Lower Little River
Number of Pieces / kilometer
Cumulative Percent
LWD Size Class
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7

Lower Little River

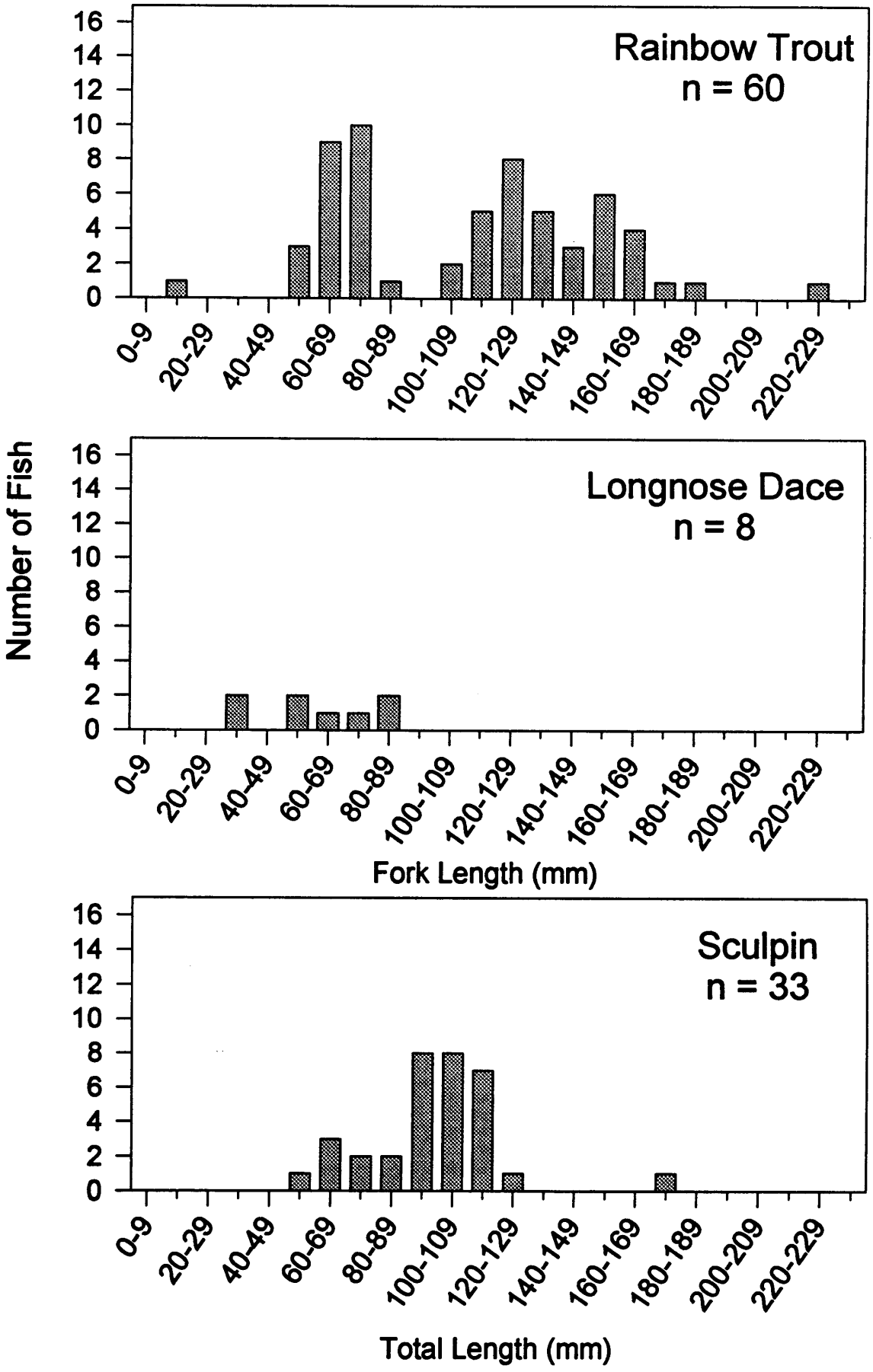



Upper Little River
15
10
5
0
Number of Pieces / kilometer
100
90
80
70
60
50
40
30
20
10
0
Cumulative Percent
1
2
3
4
5
6
7
LWD Size Class

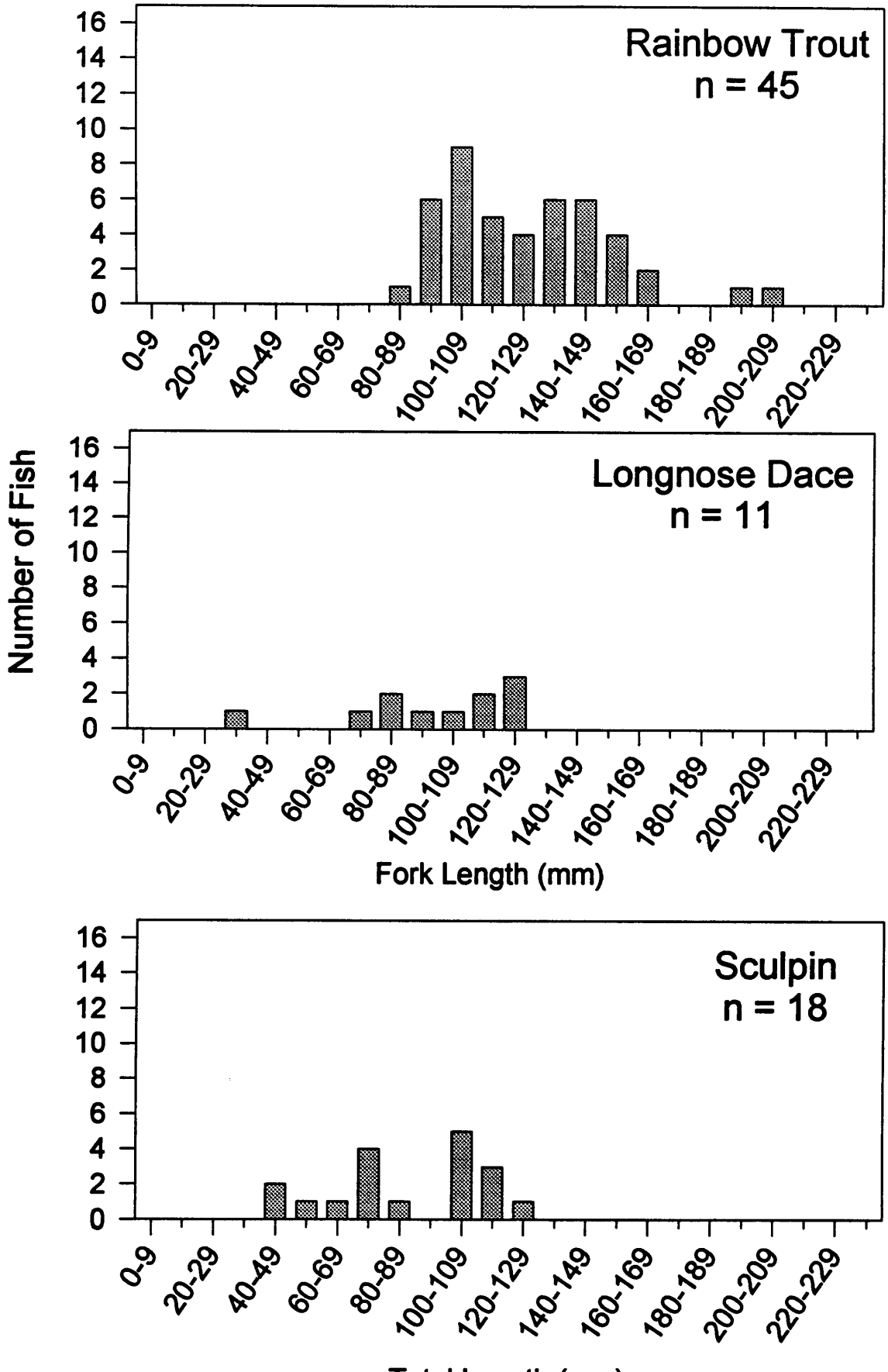
Upper Little River
Spring 1993



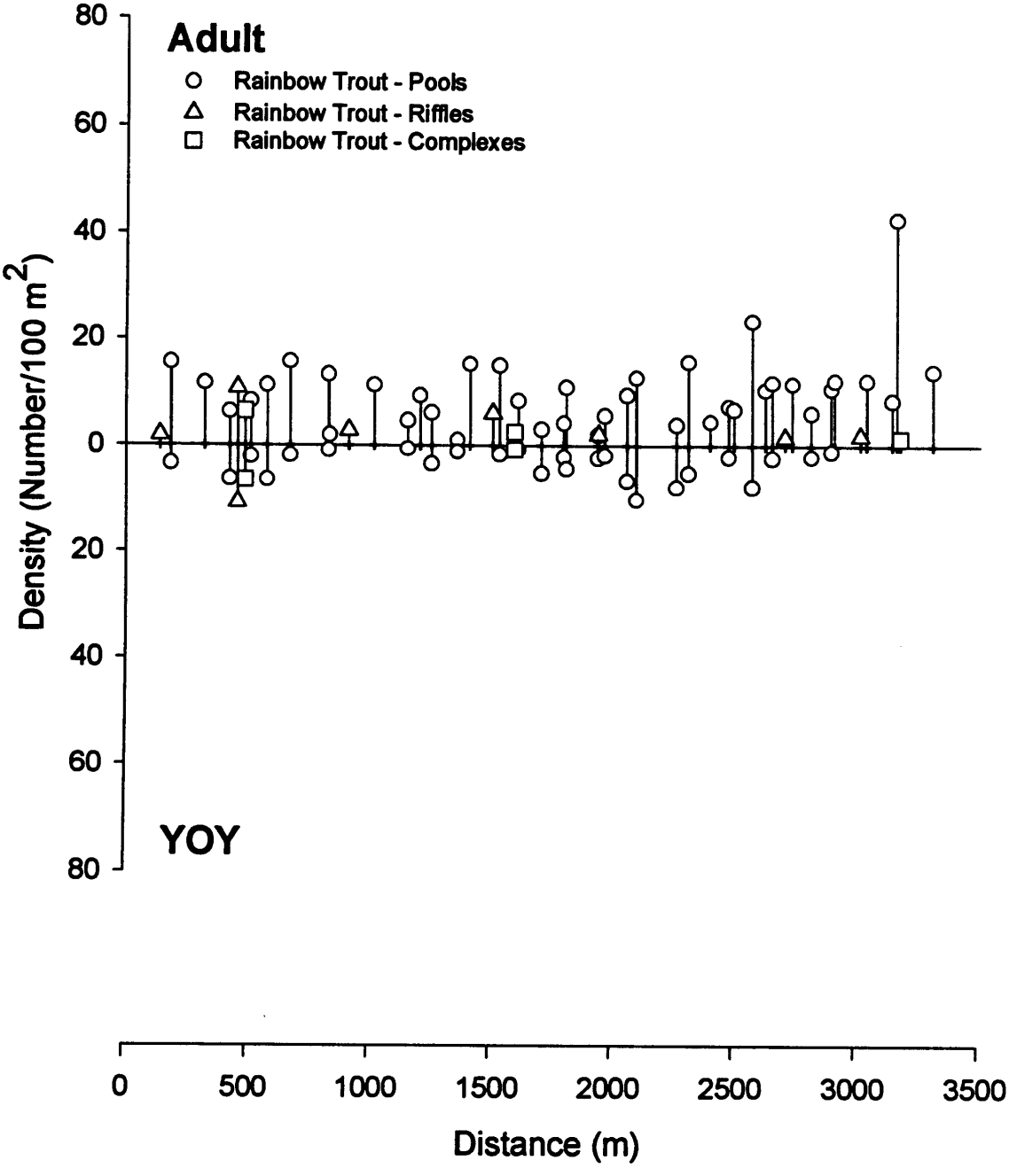
Upper Little River
Fall 1993



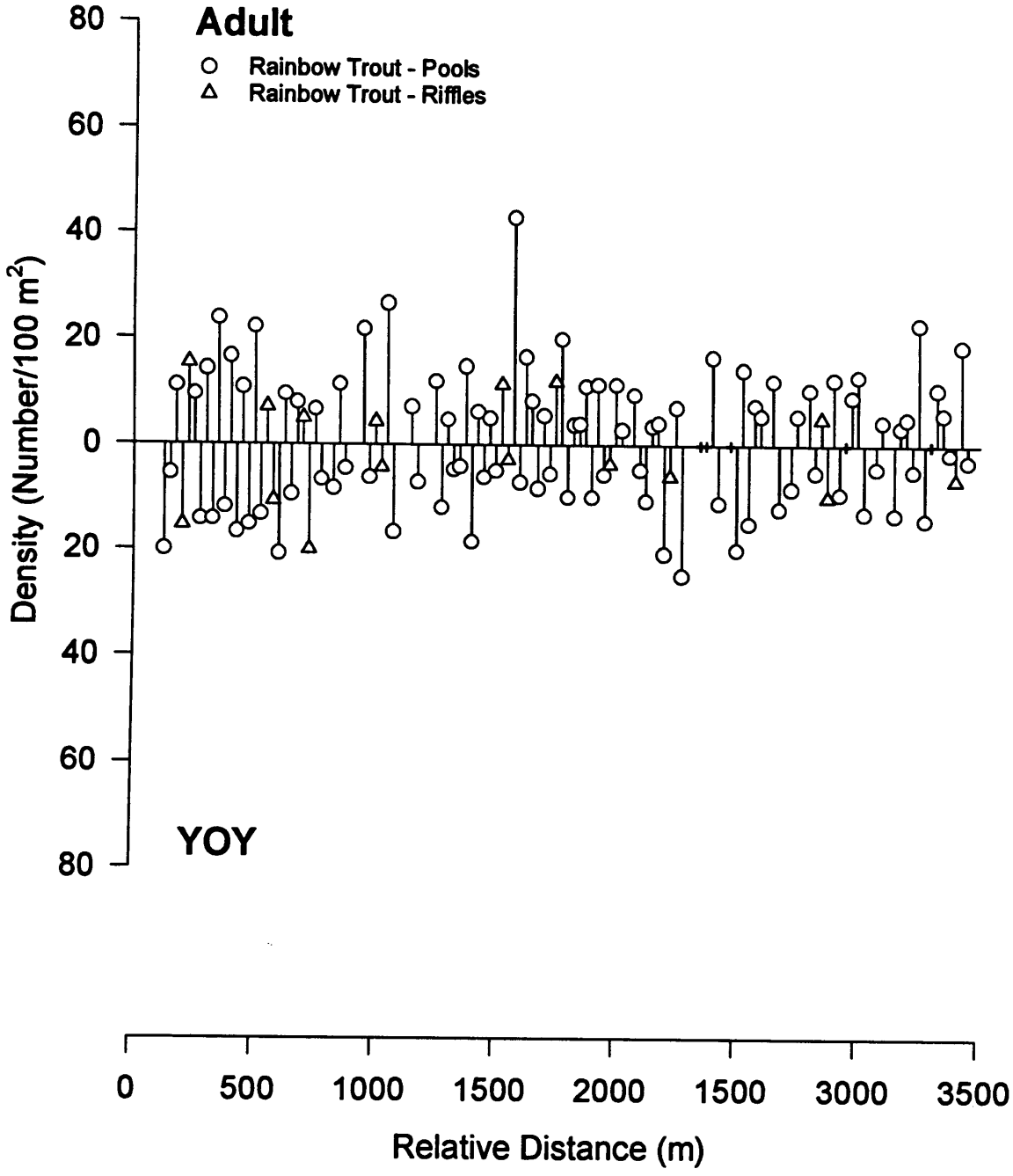
Upper Little River
Spring 1994



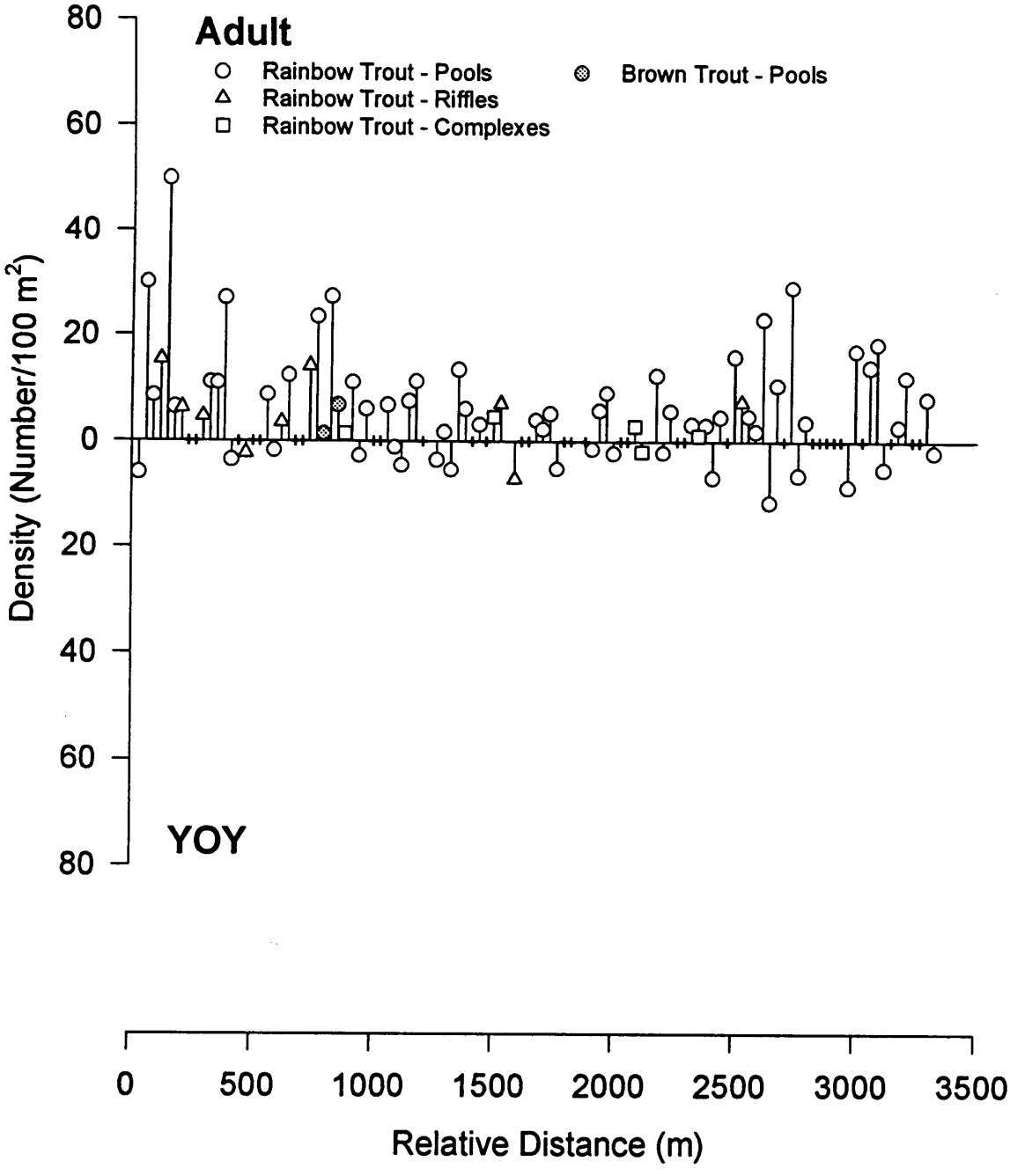
Upper Little River
Spring 1993

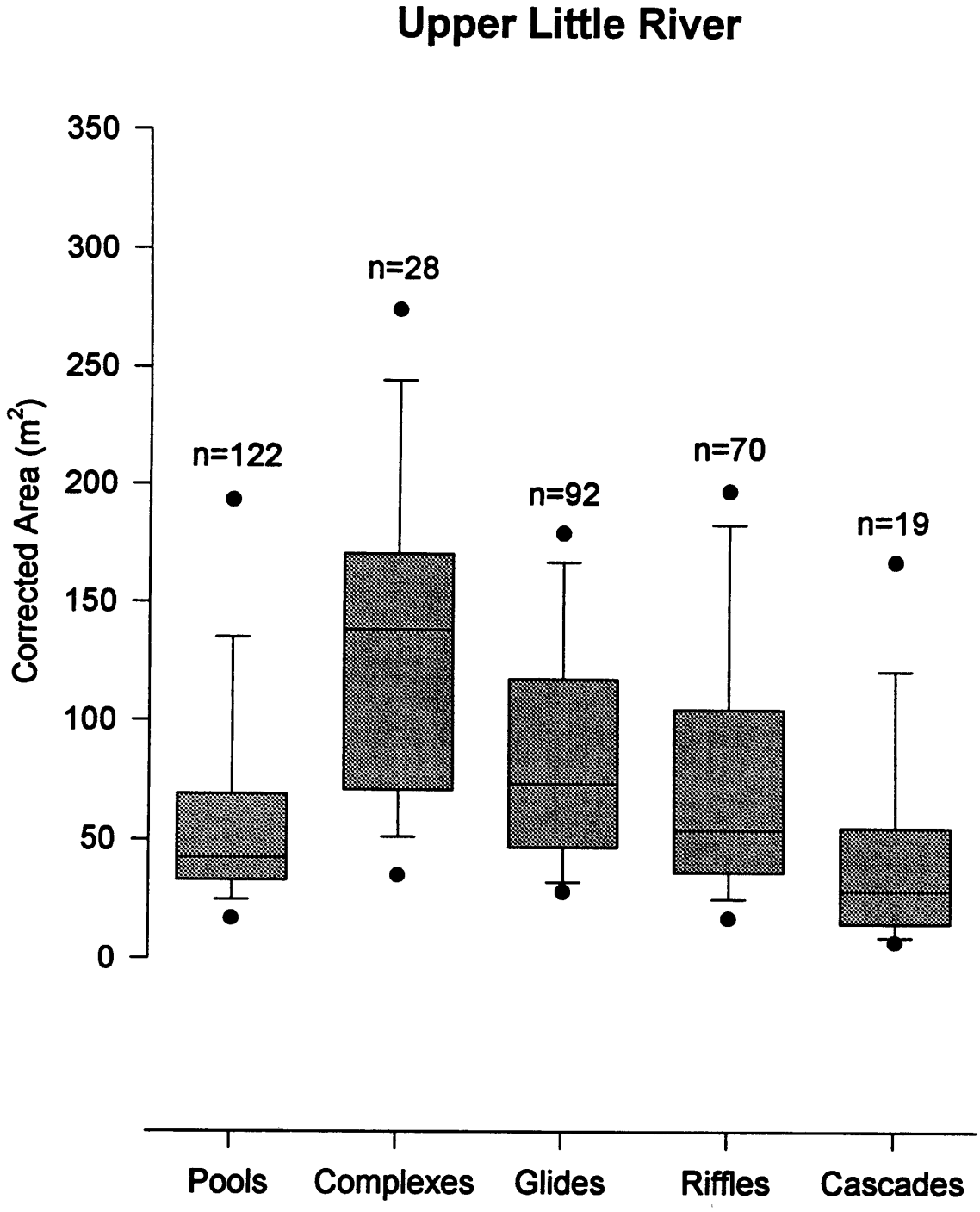


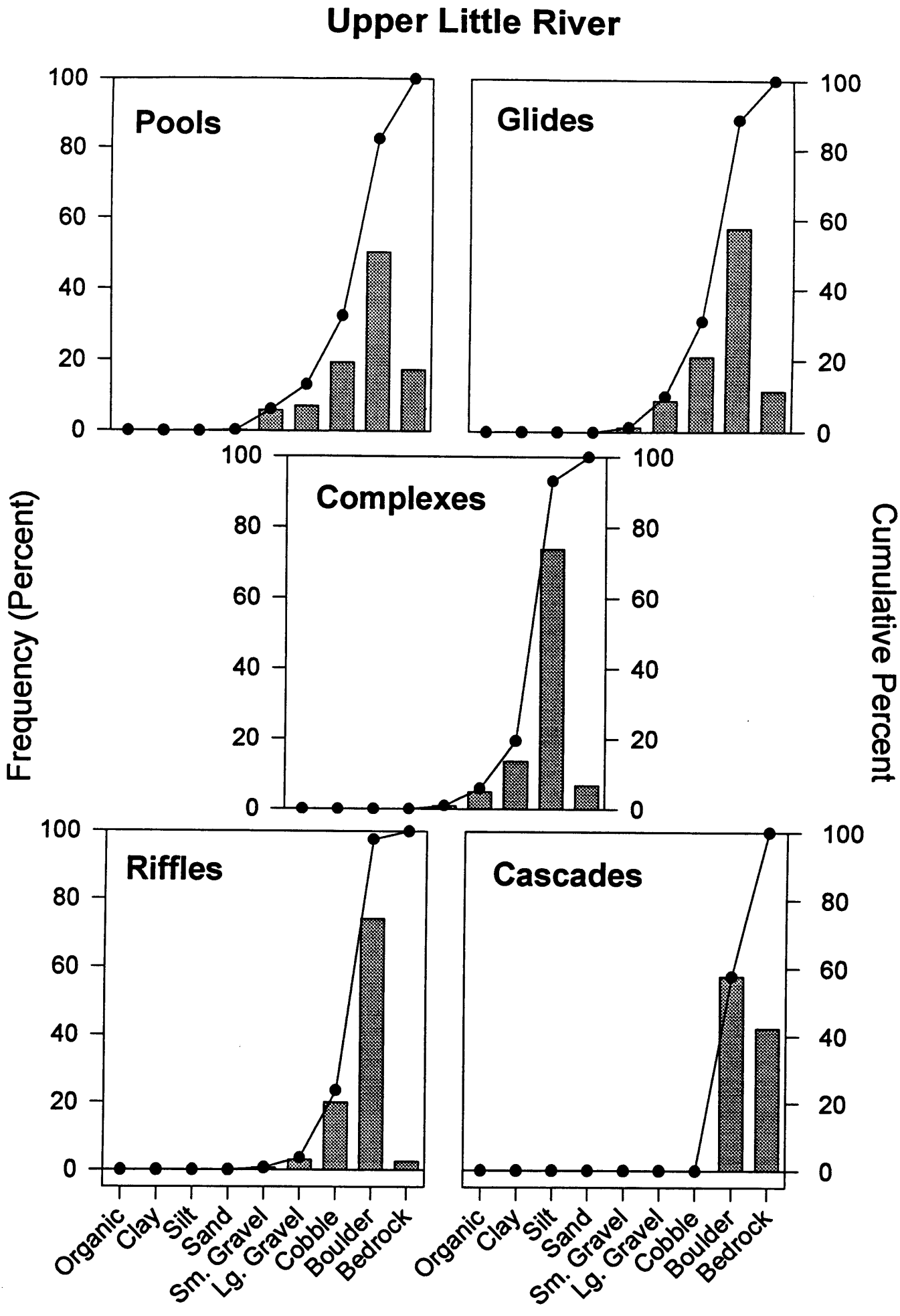
Upper Little River
Fall 1993

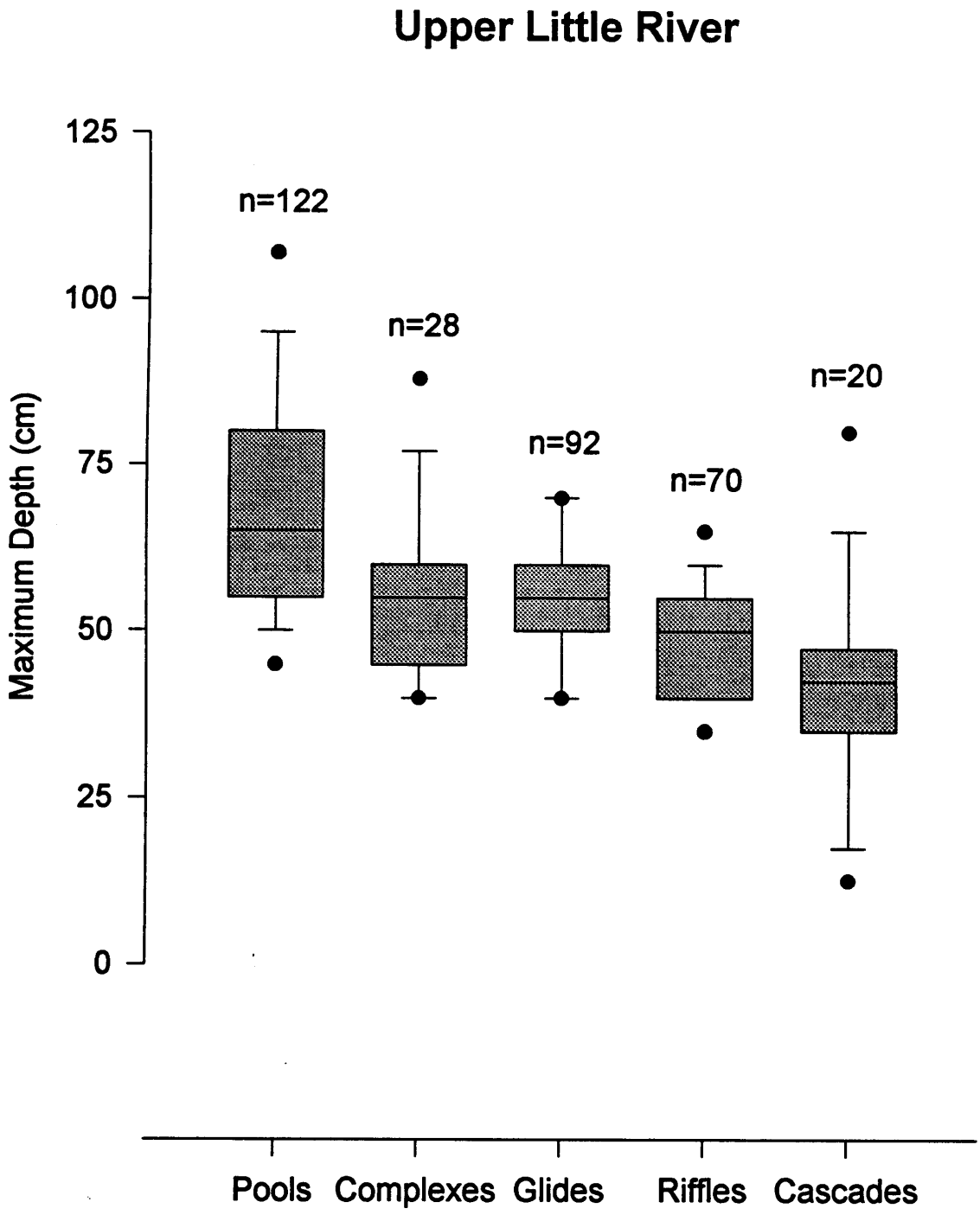


Upper Little River
Spring 1994

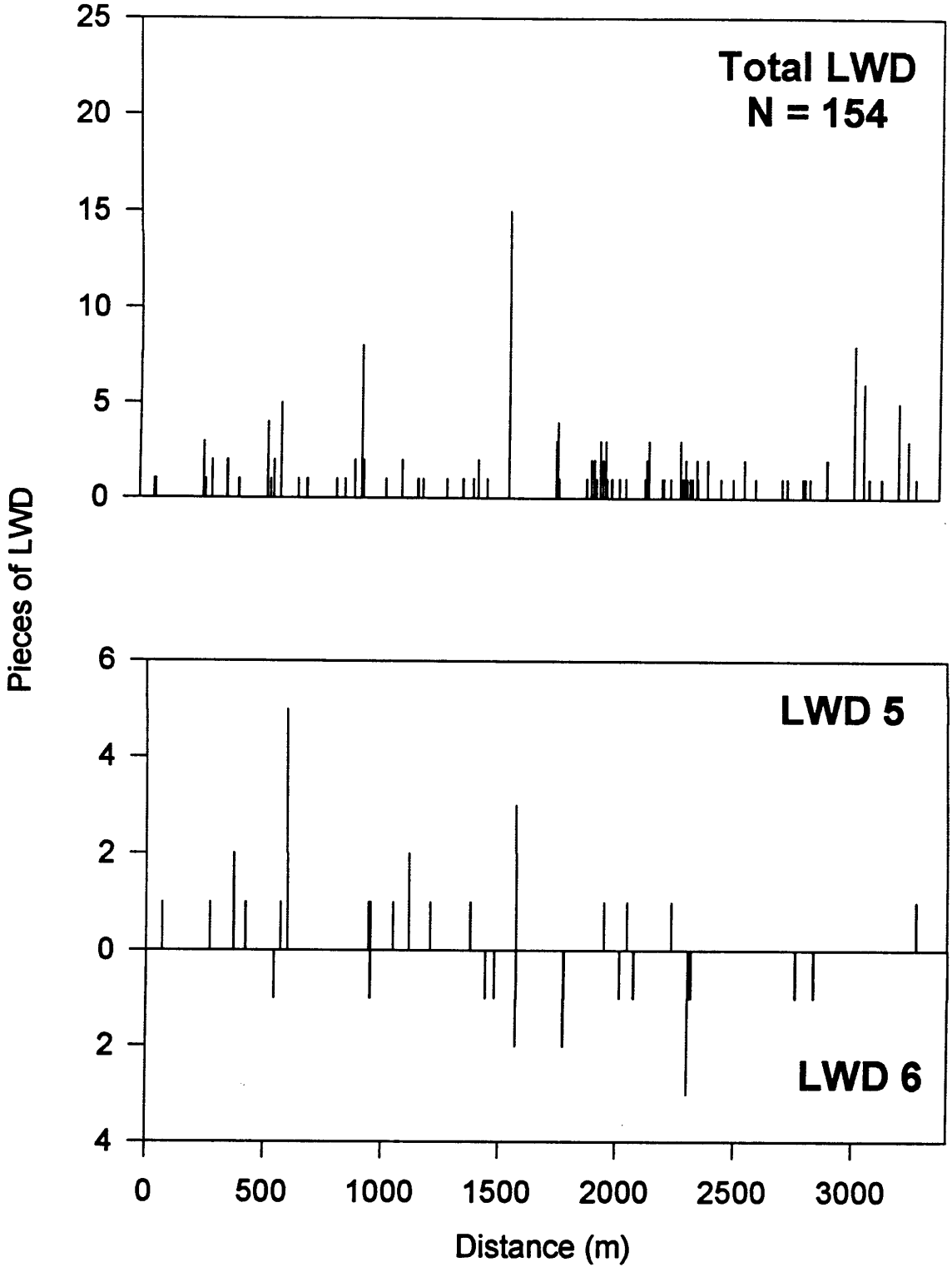



Upper Little River
Corrected Area (m2)
350
300
250
200
150
100
50
0
n=122
n=28
n=92
n=70
n=19
Pools
Complexes
Glides
Riffles
Cascades

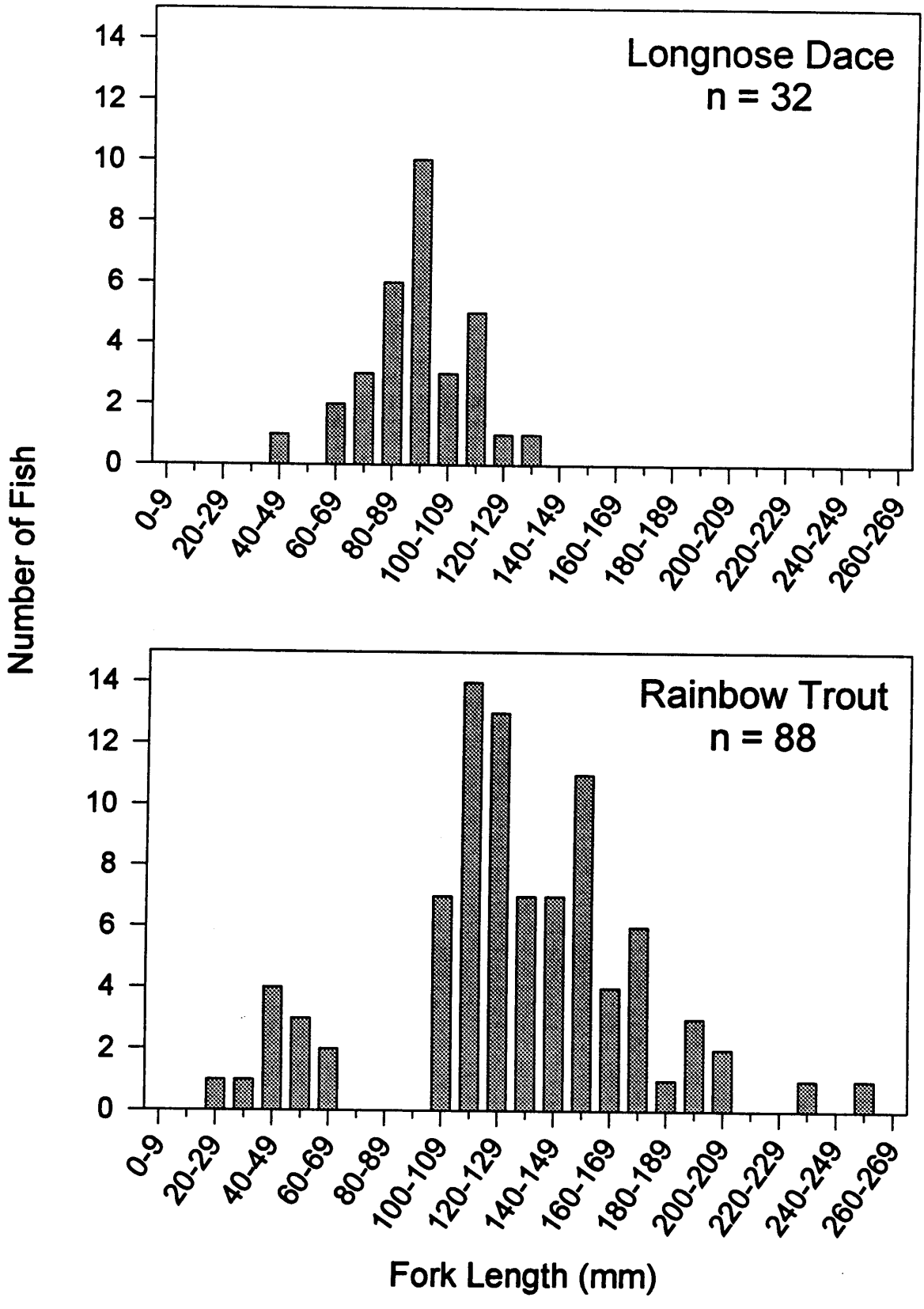

Upper Little River
Pools
Glides
Complexes
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock


Upper Little River
Maximum Depth (cm)
125
100
75
50
25
0
n=122
n=28
n=92
n=70
n=20
Pools
Complexes
Glides
Riffles
Cascades

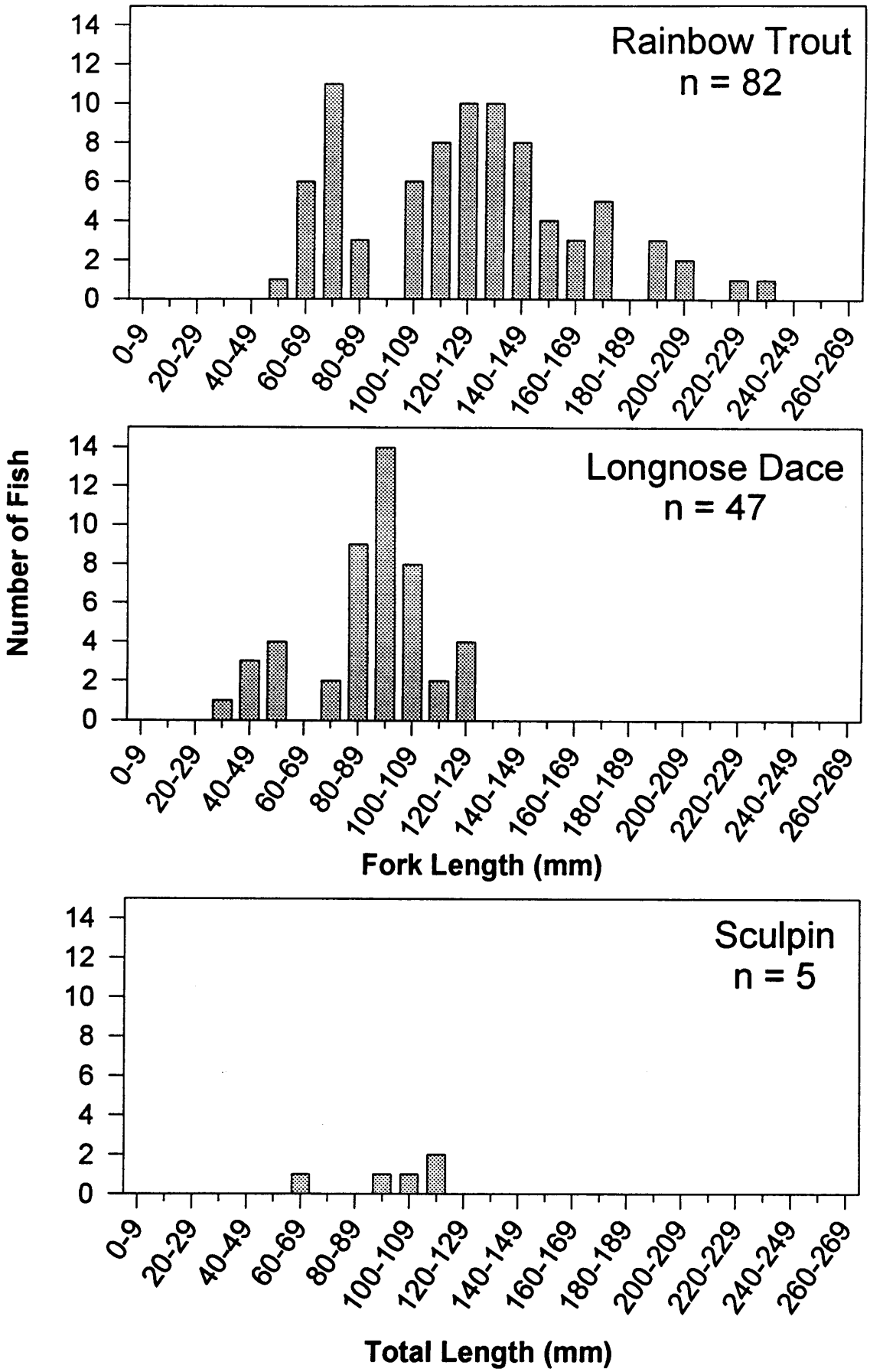
Upper Little River



Lower Fish Camp Prong
Spring 1993

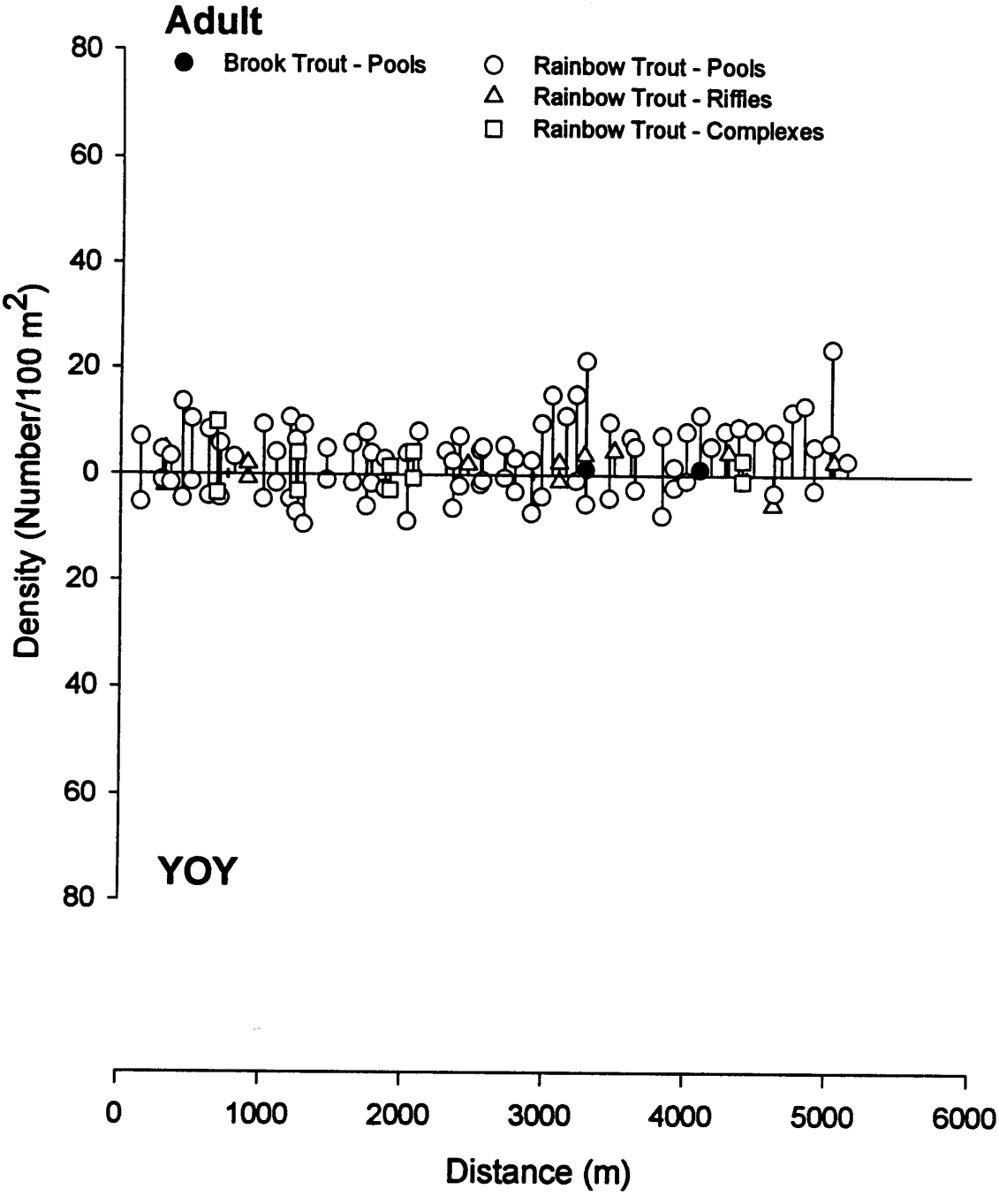


Lower Fish Camp Prong*
Fall 1993

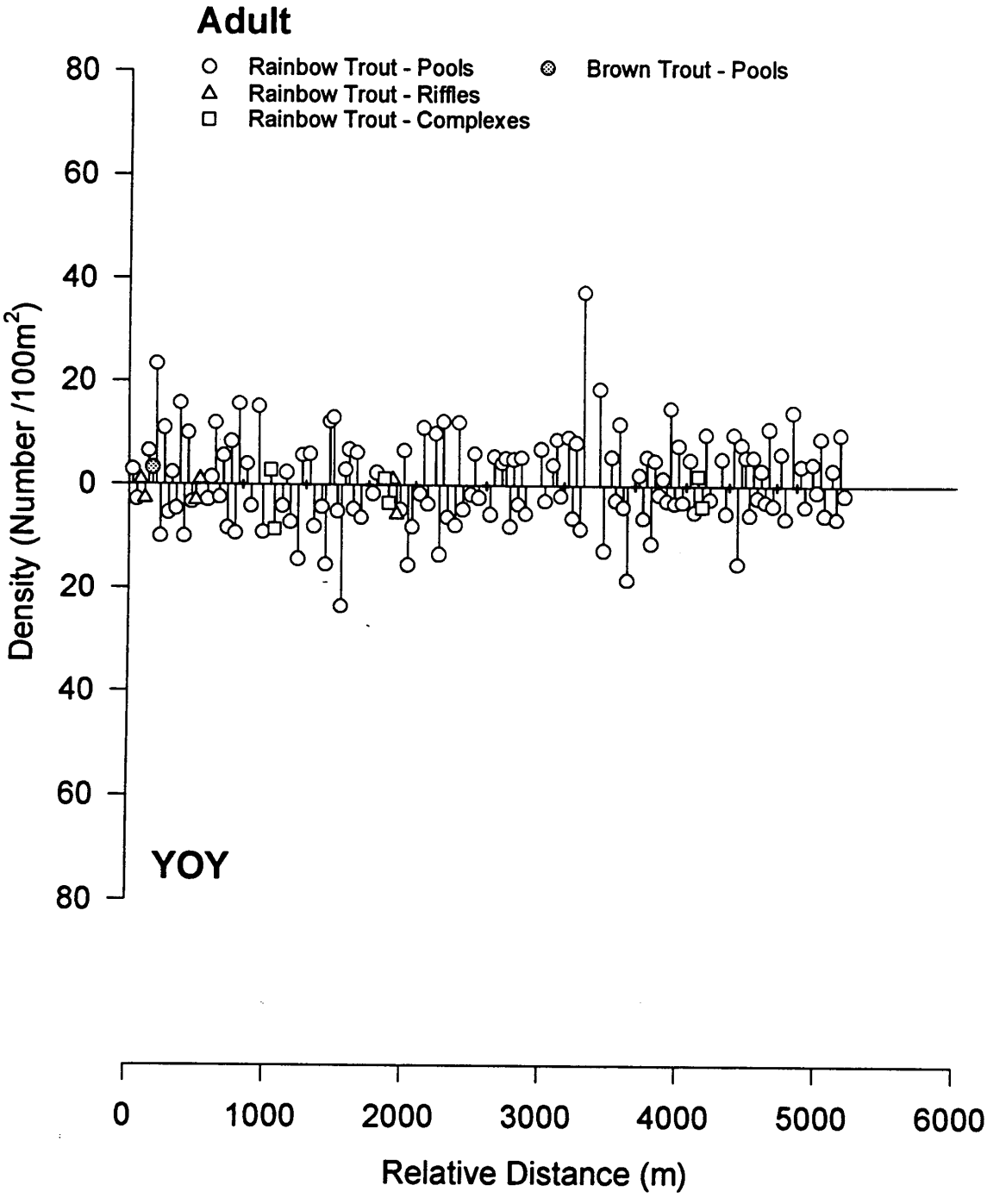


*Spring 1994 length frequency data not available.

Lower Fish Camp Prong
Spring 1993

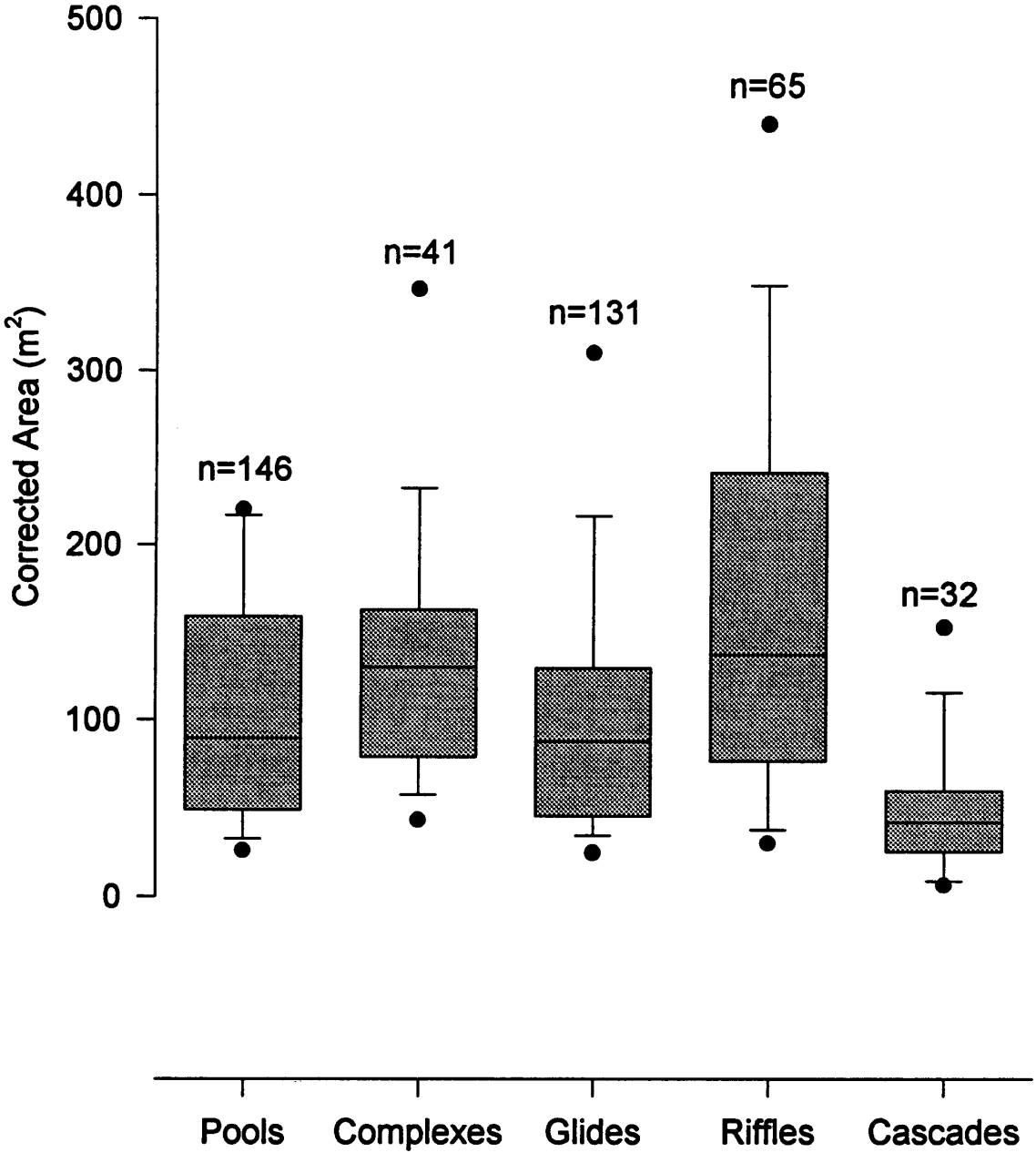


Lower Fish Camp Prong*
Fall 1993

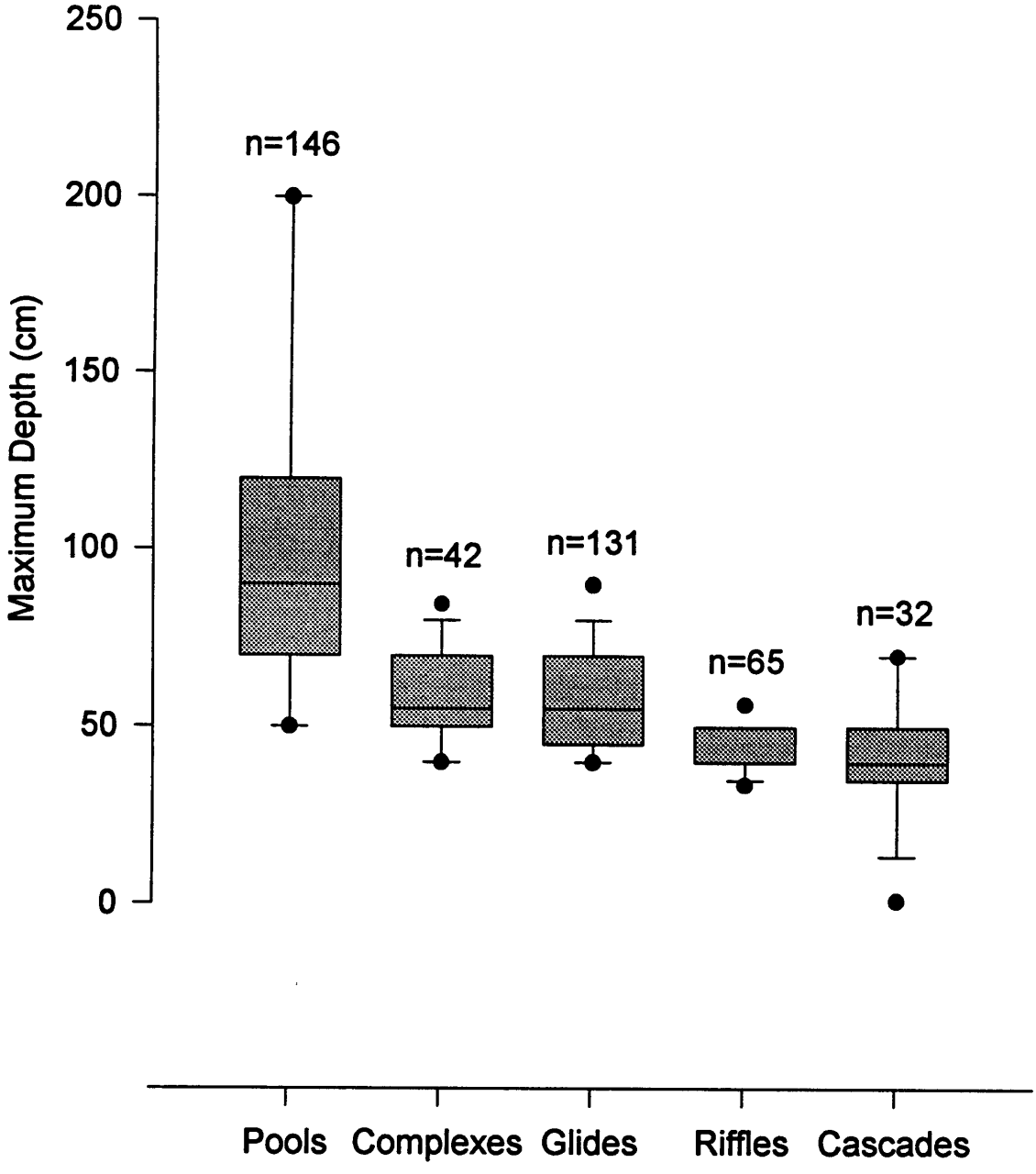


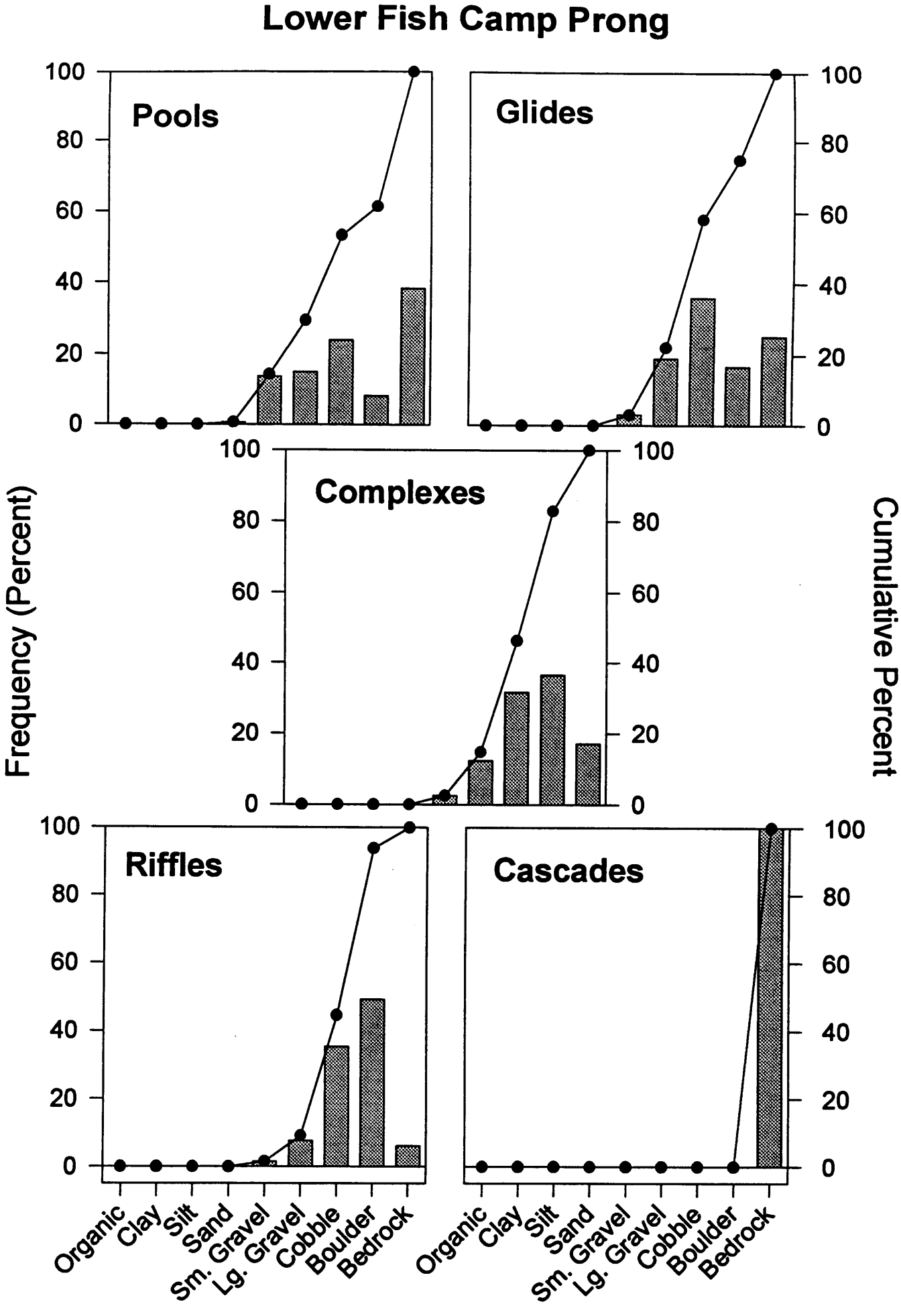
*Spring 1994 density data not available.

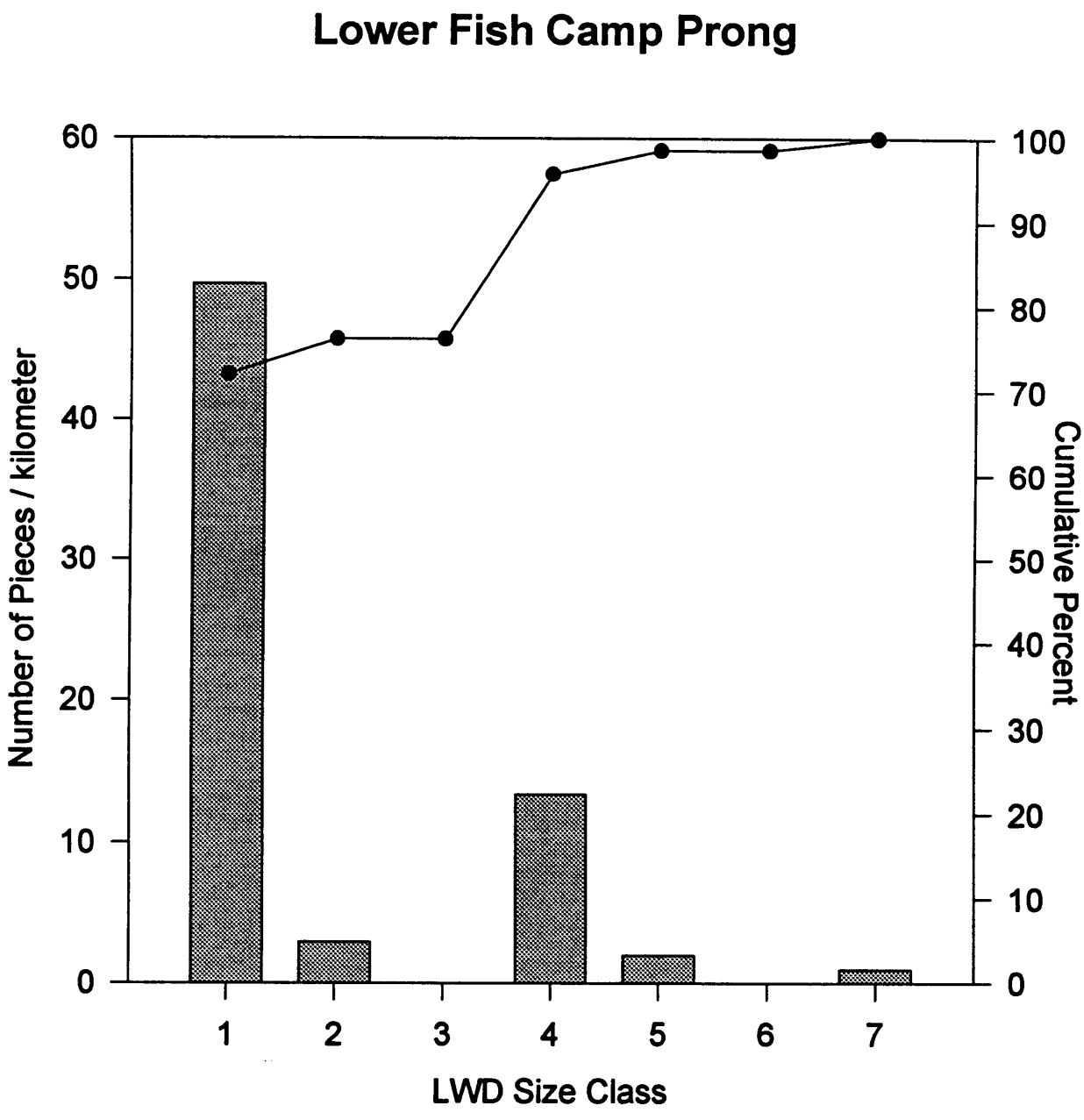
Lower Fish Camp Prong



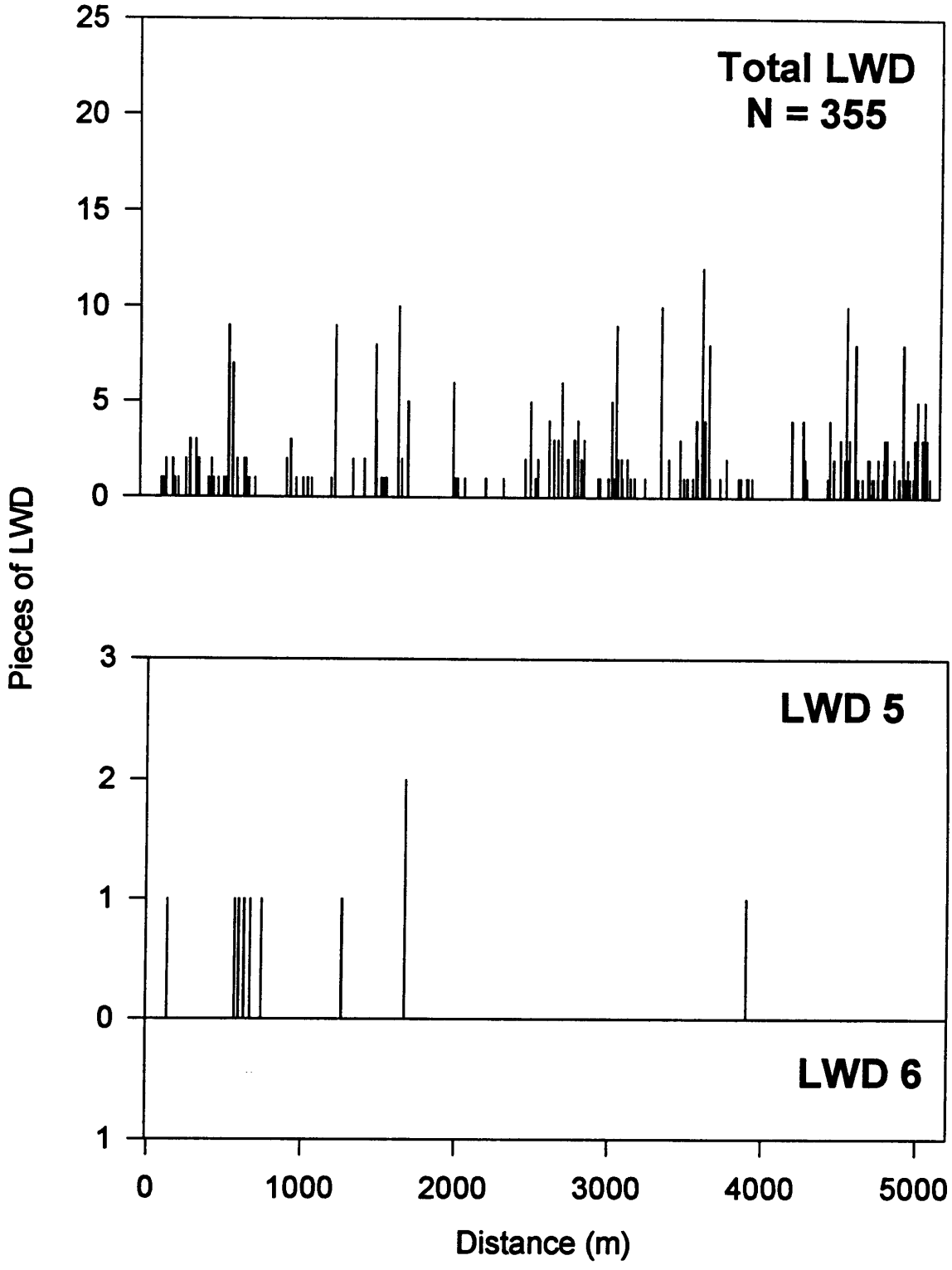
Lower Fish Camp Prong




Lower Fish Camp Prong
Pools
Glides
Complexes
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock

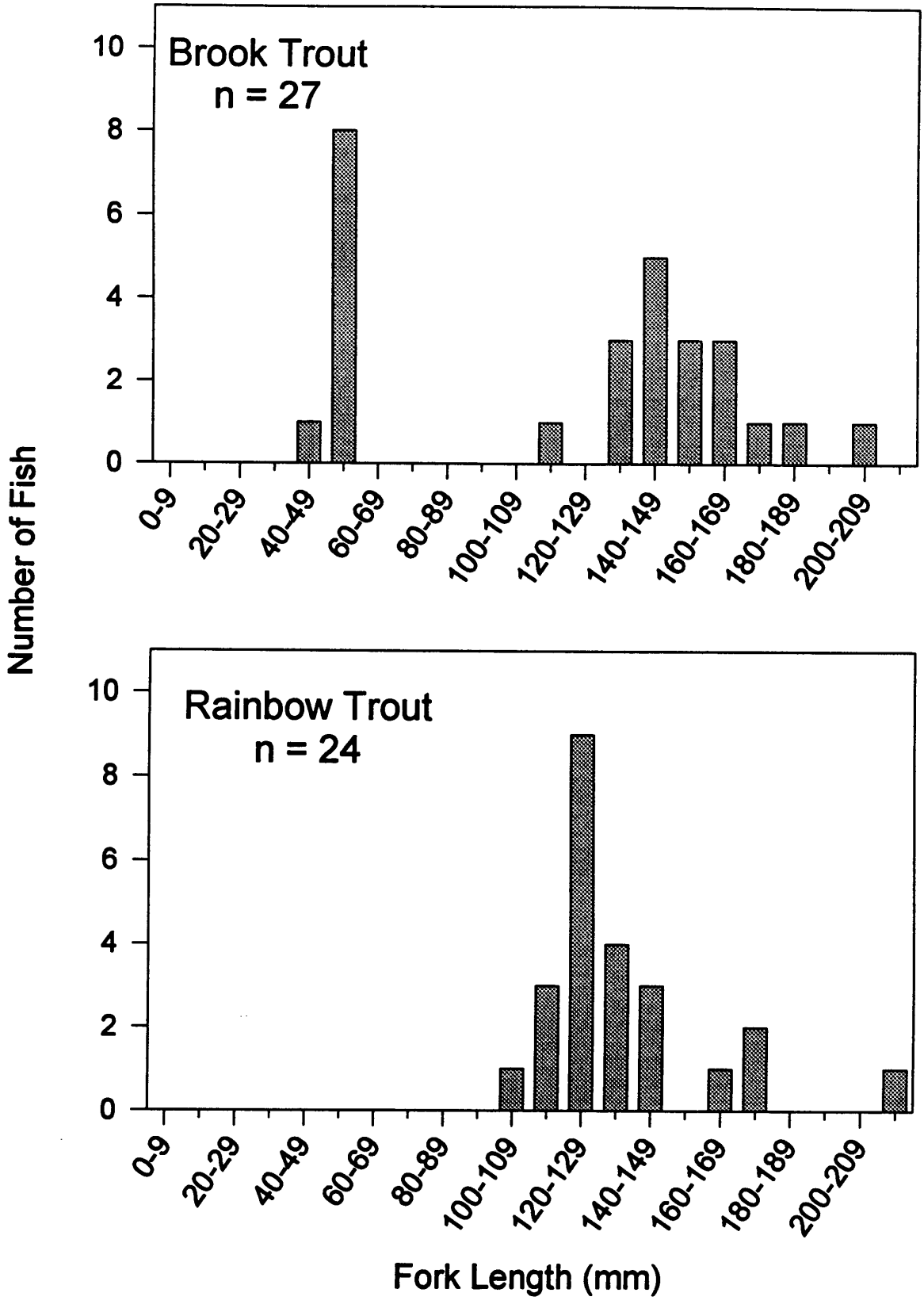

Lower Fish Camp Prong
Number of Pieces / kilometer
Cumulative Percent
LWD Size Class
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7

Lower Fish Camp Prong

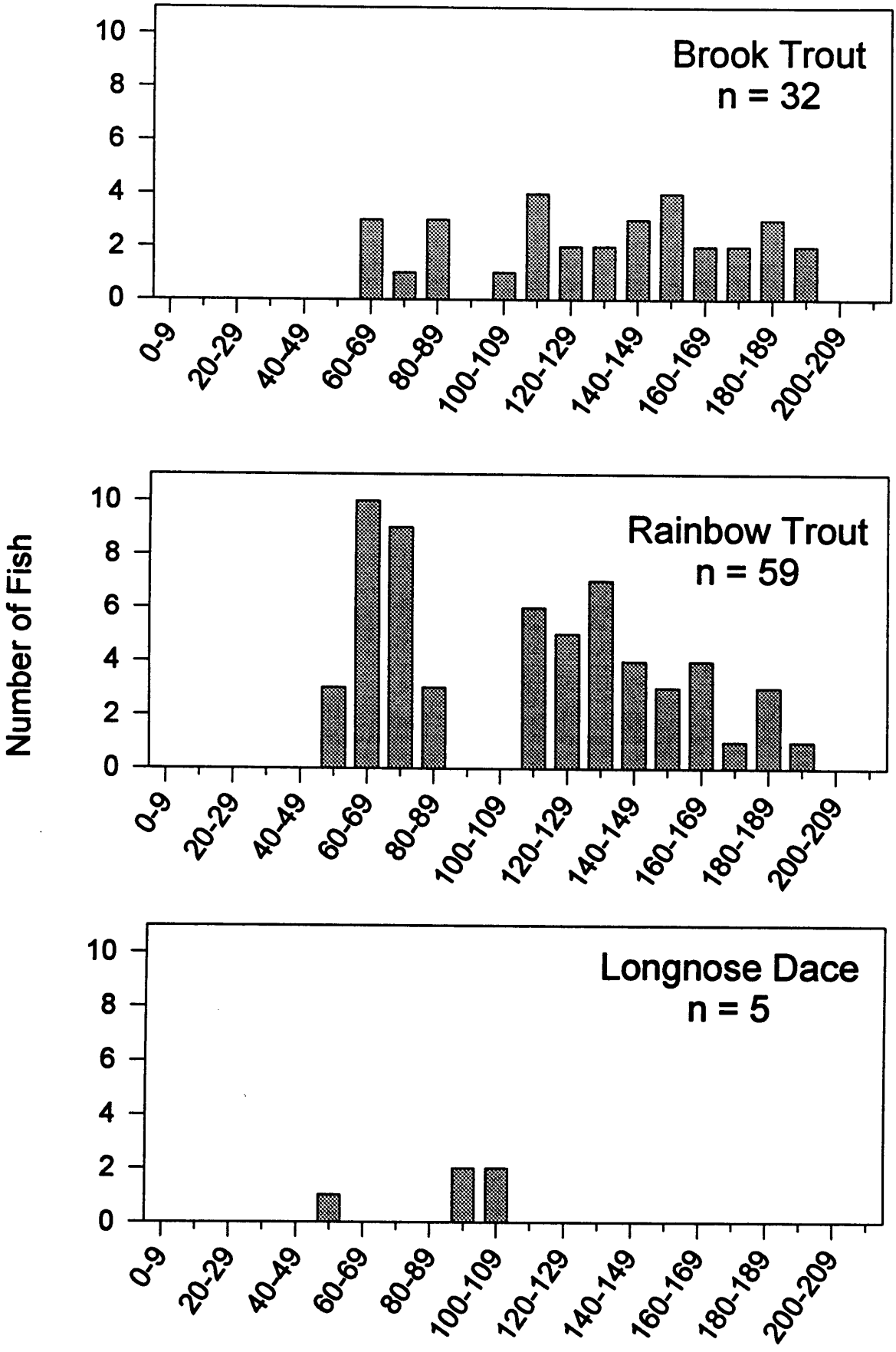


Meigs Post Sub-basin

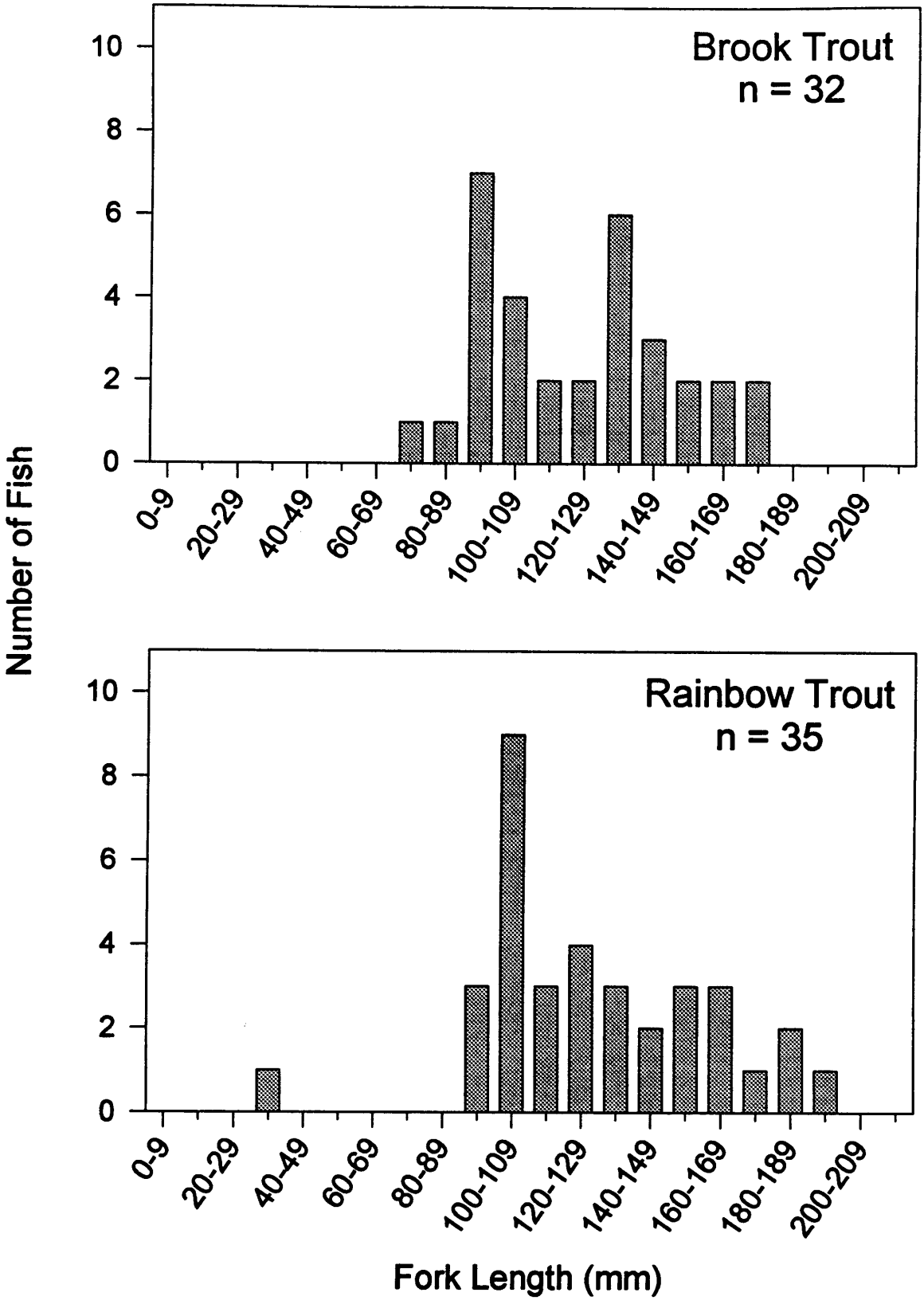
Lower Meigs Post Prong
Spring 1993



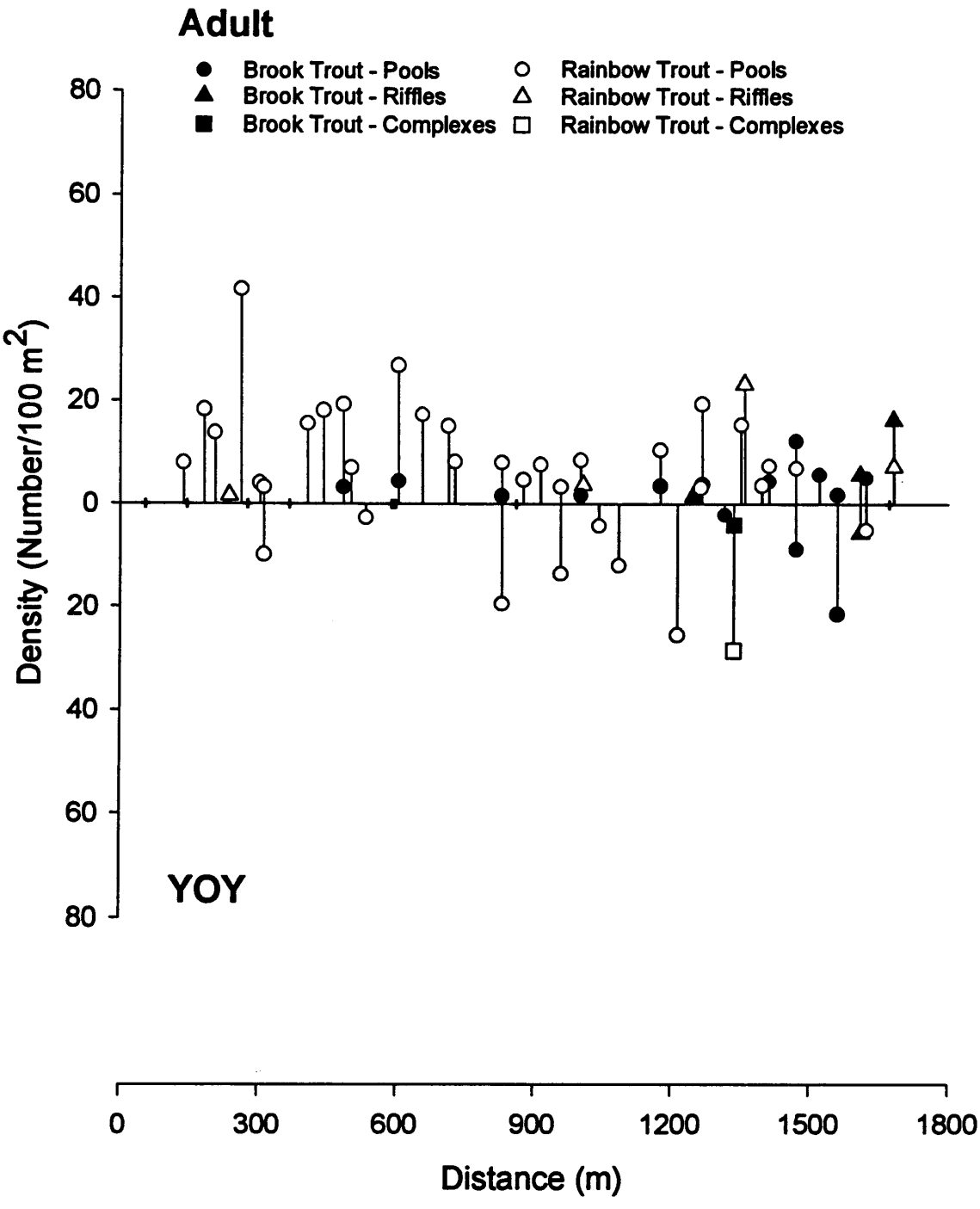
Lower Meigs Post Prong
Fall 1993



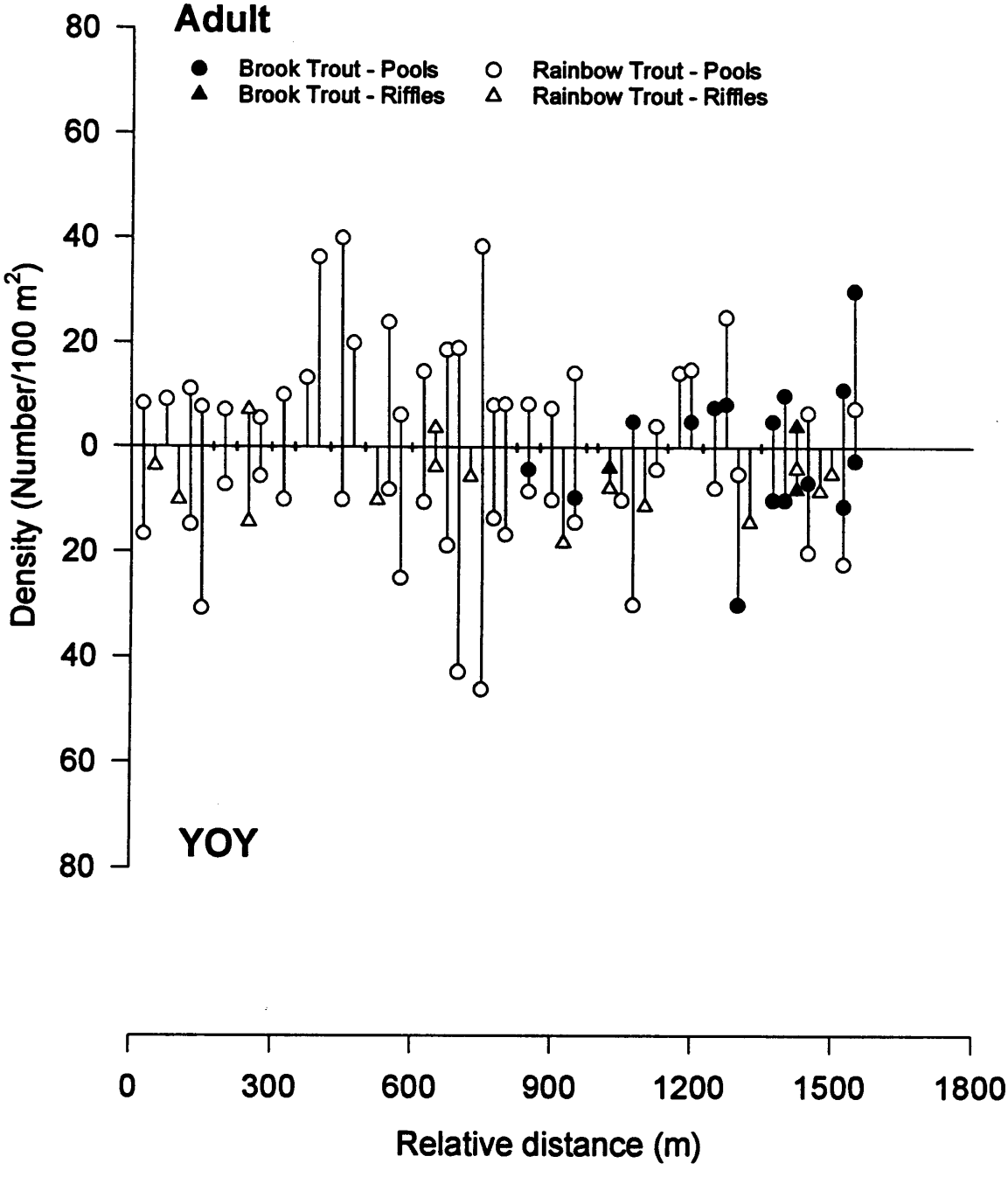
Lower Meigs Post Prong
Spring 1994



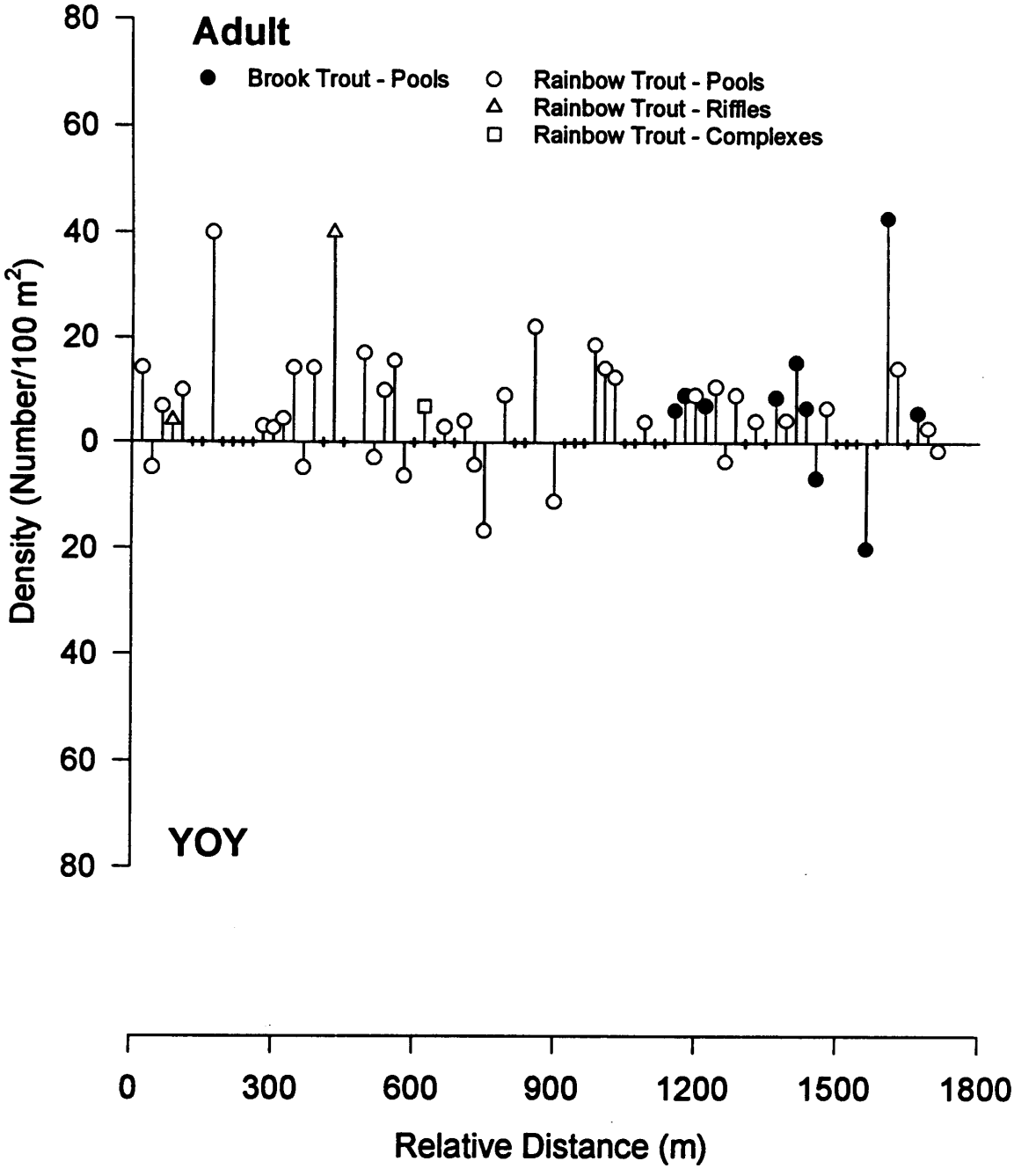
Lower Meigs Post Prong
Spring 1993



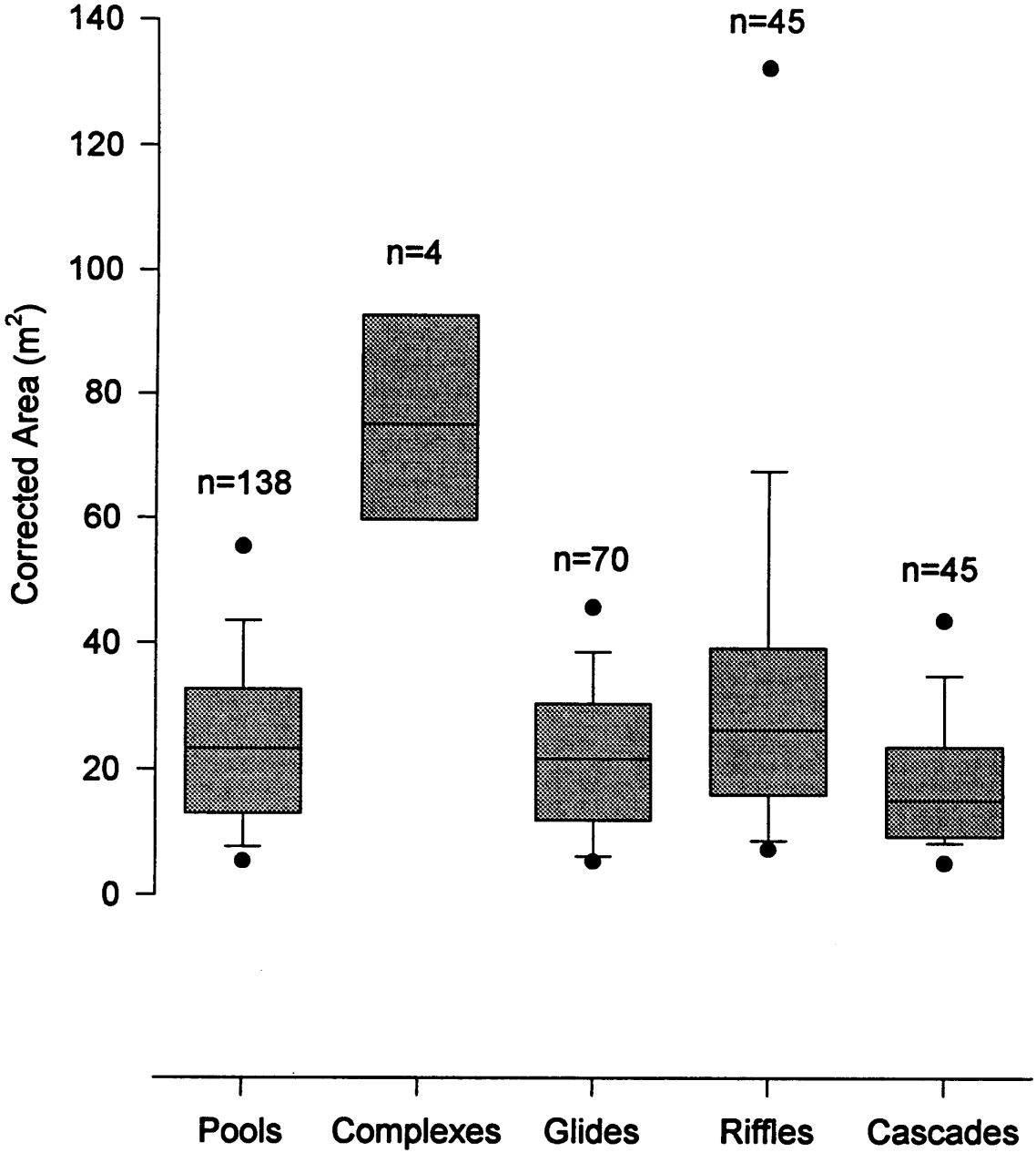
Lower Meigs Post Prong
Fall 1993



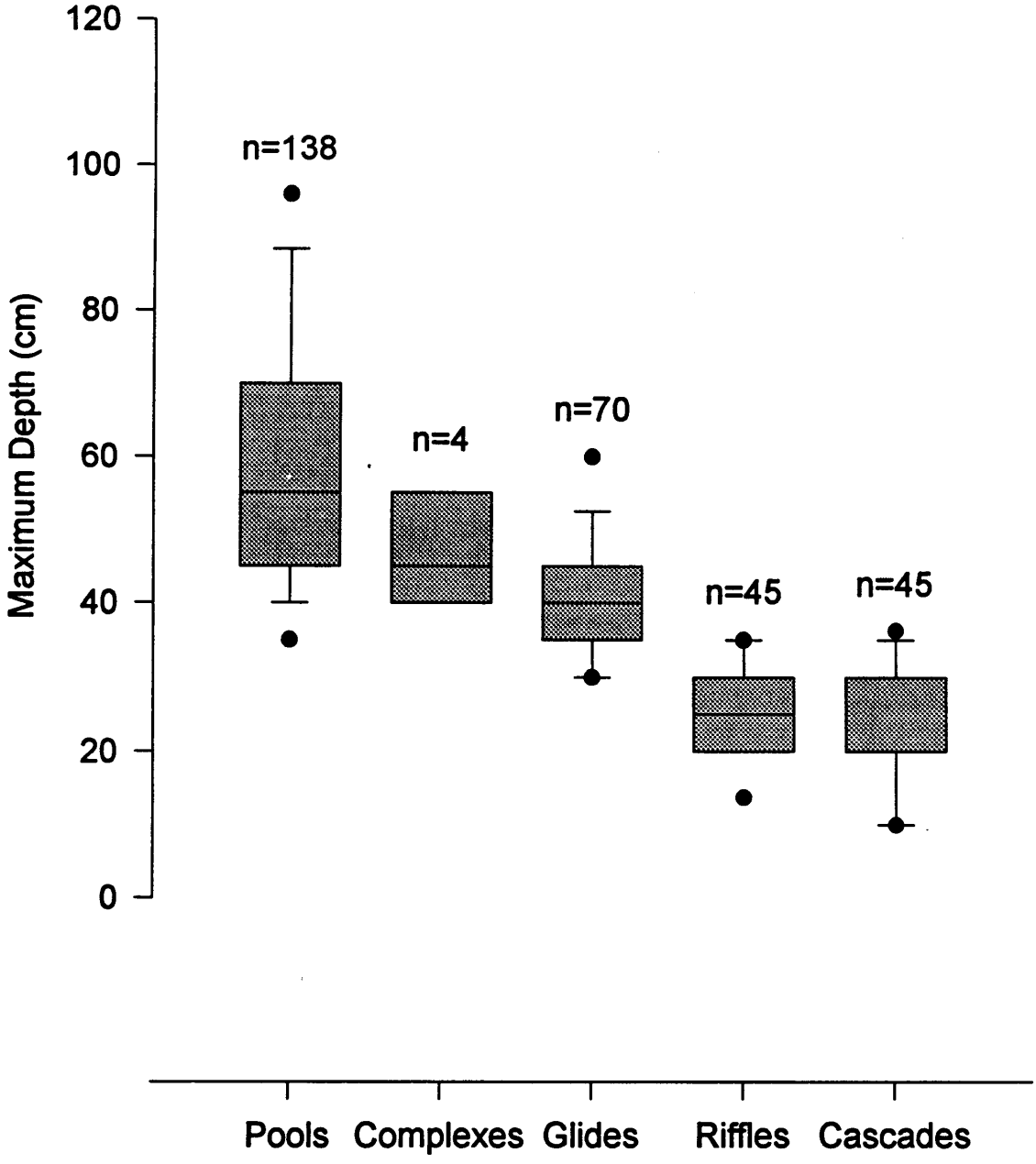
Lower Meigs Post Prong
Spring 1994

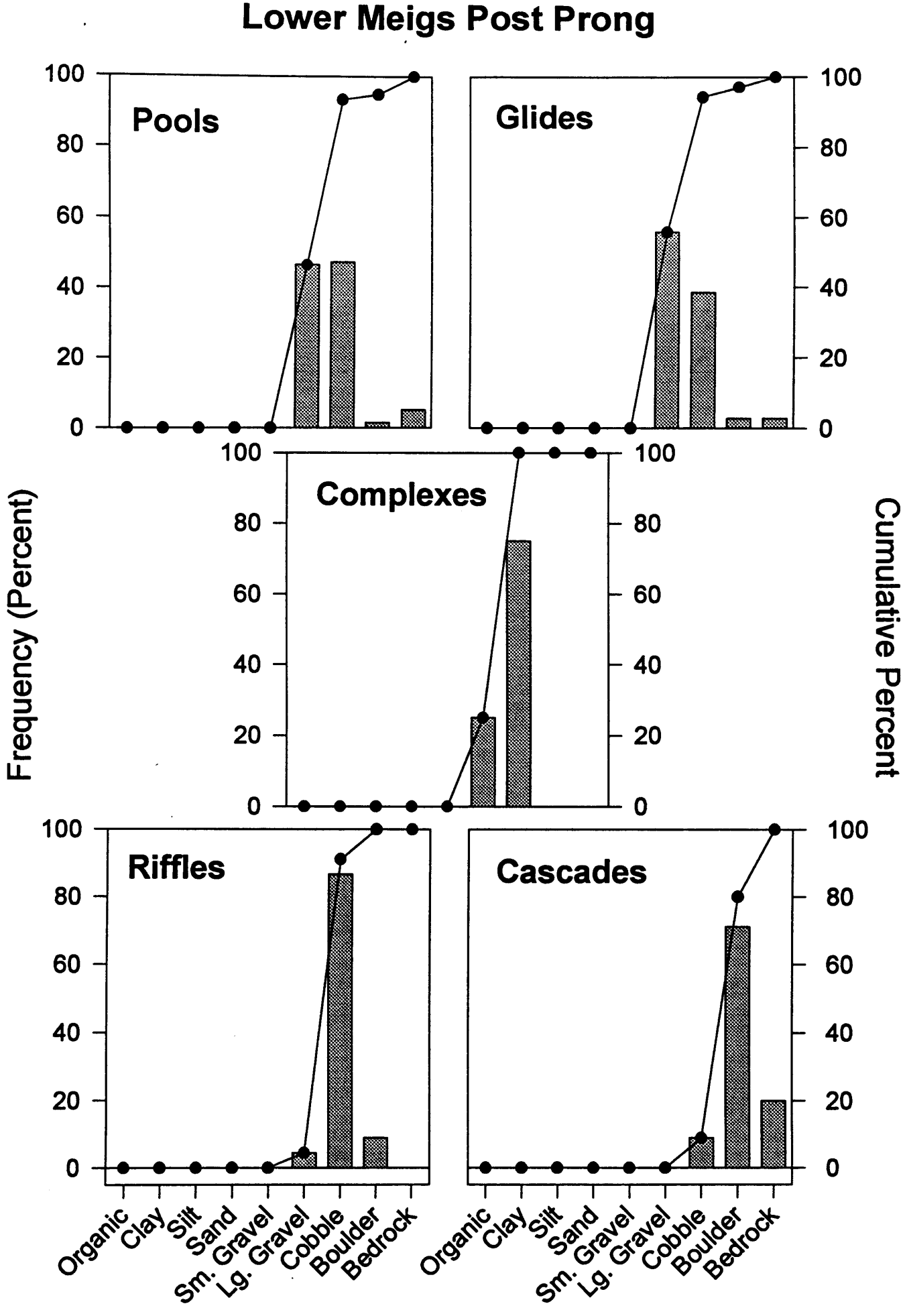


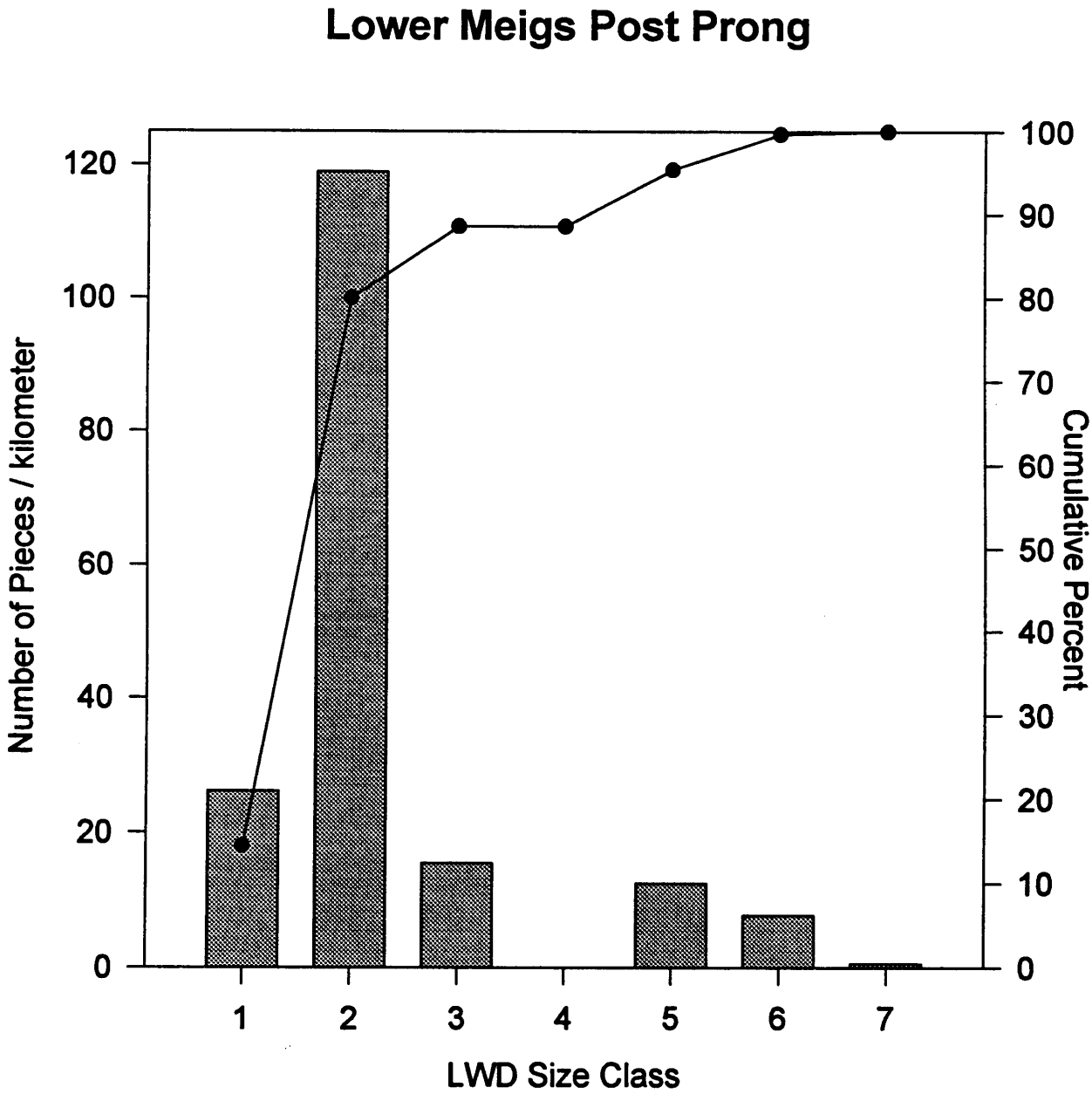
Lower Meigs Post Prong



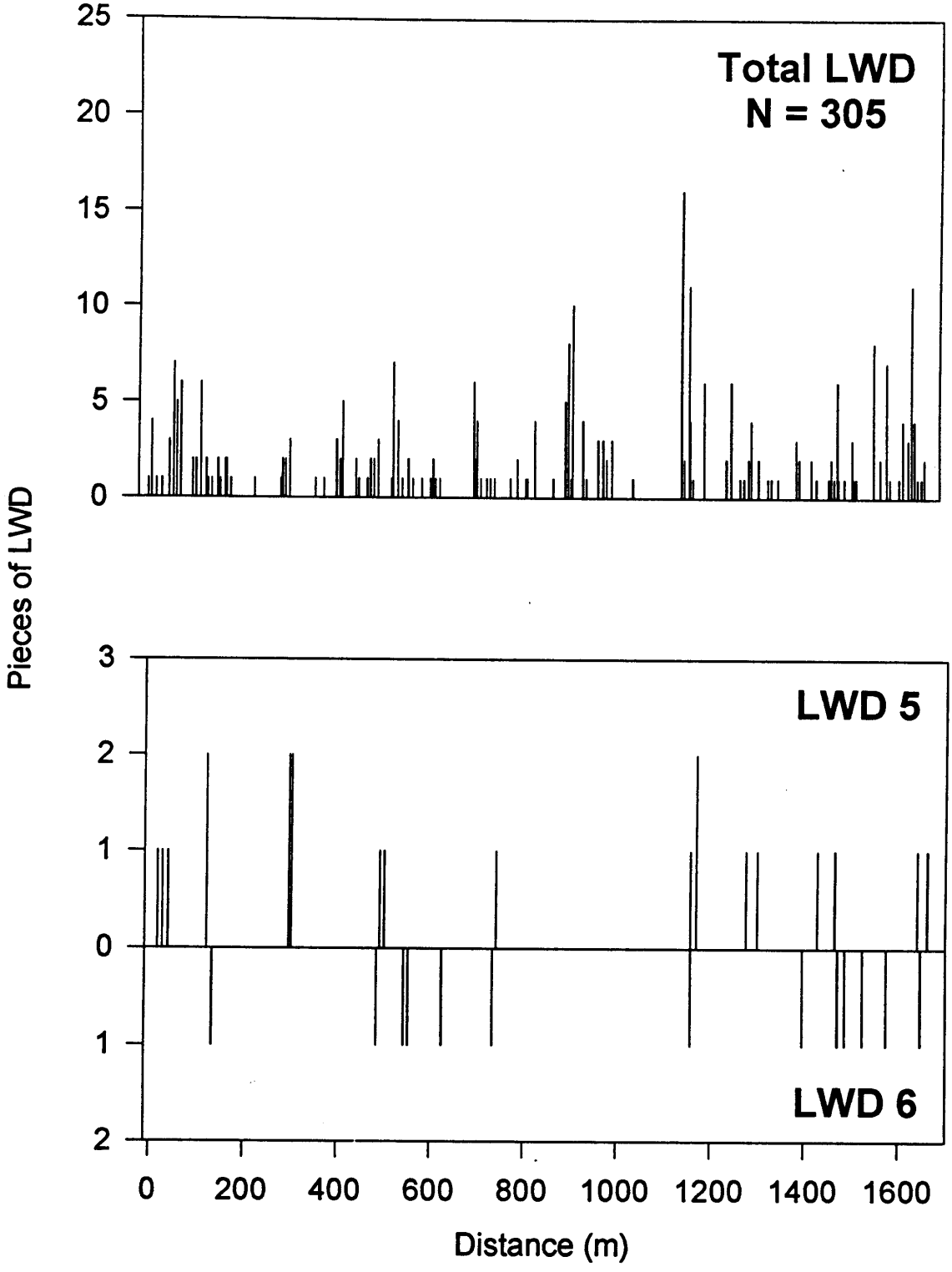
Lower Meigs Post Prong



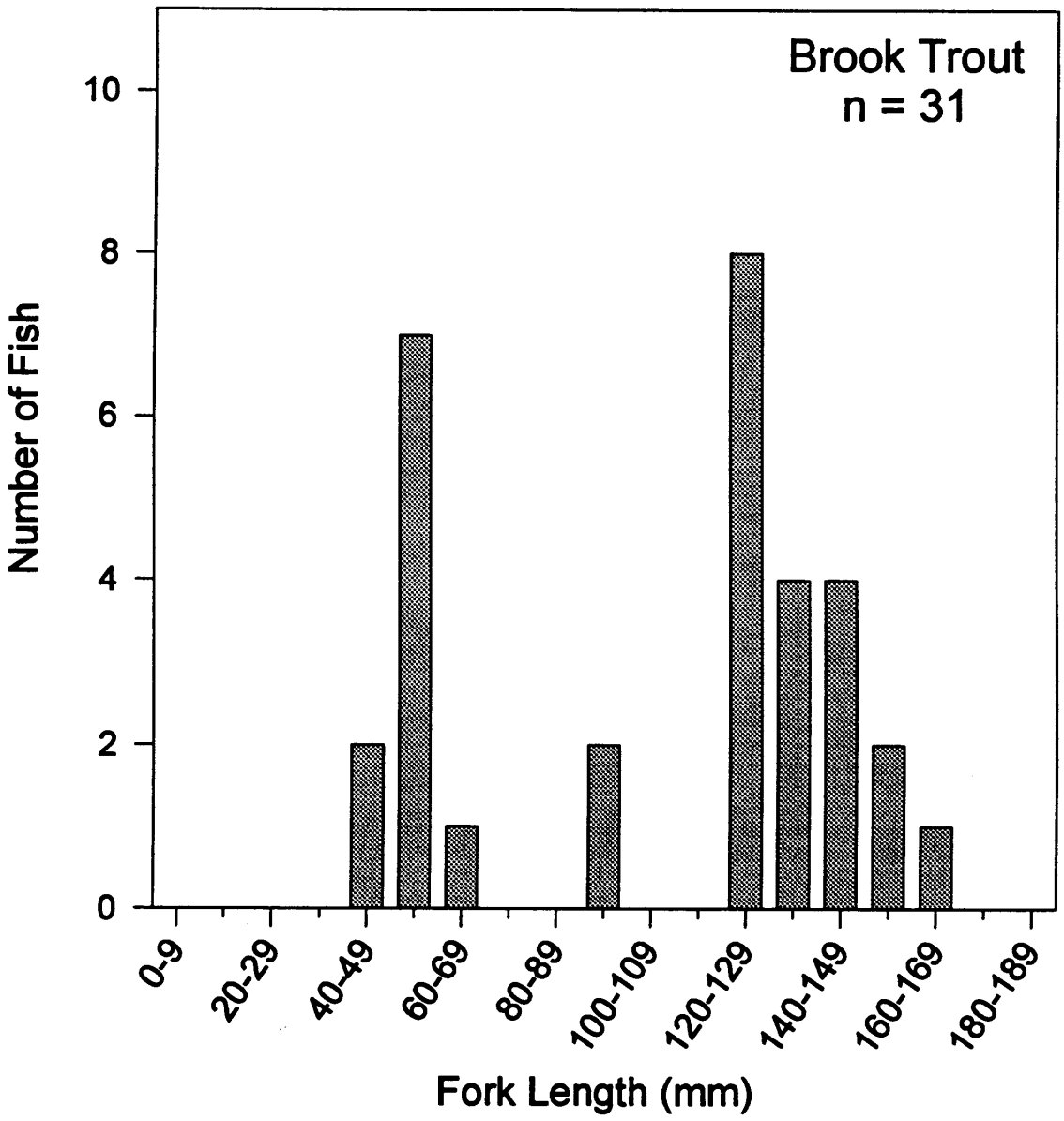

Lower Meigs Post Prong
Pools
Glides
Complexes
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock


Lower Meigs Post Prong
Number of Pieces / kilometer
Cumulative Percent
LWD Size Class
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7

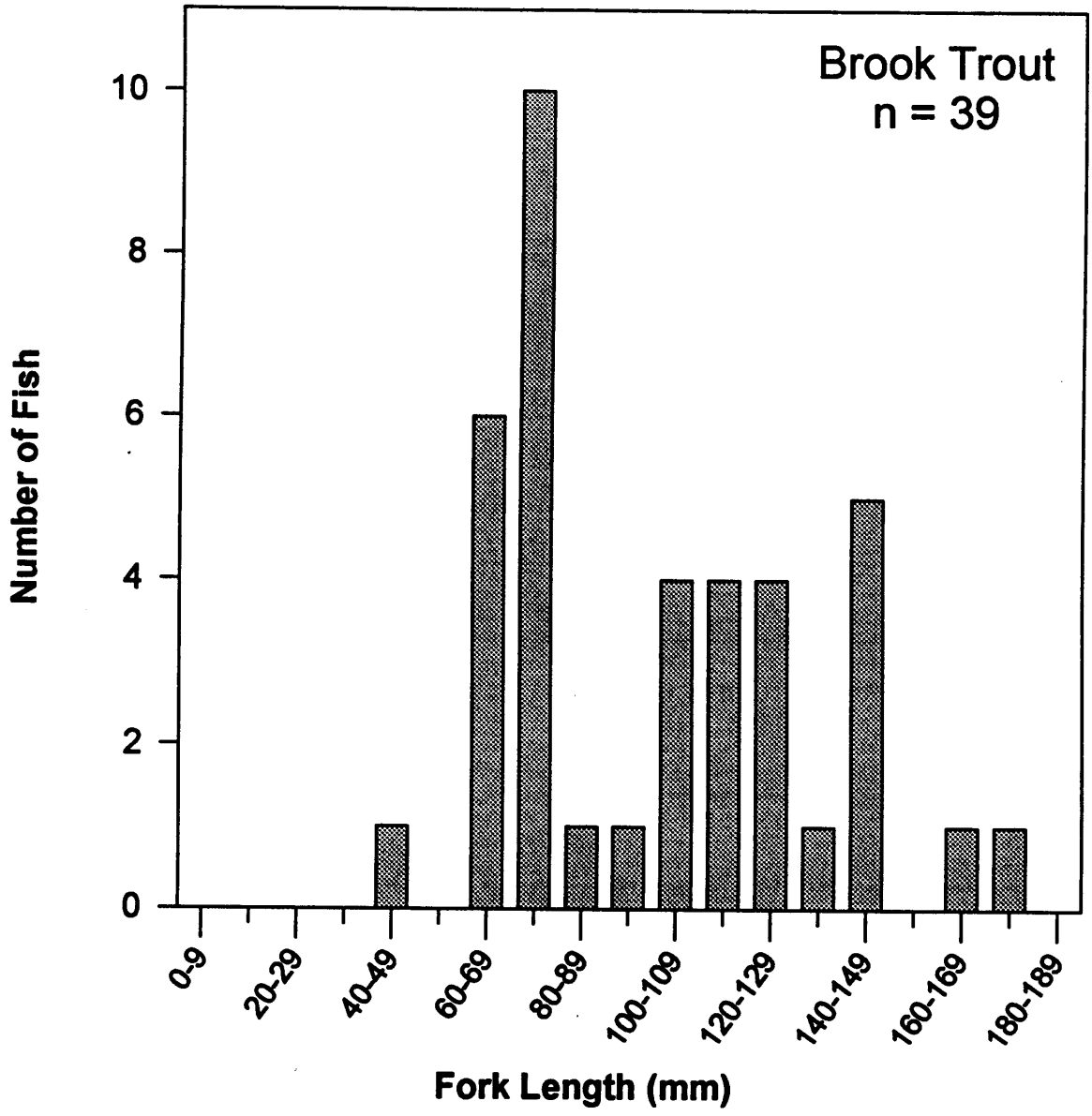
Lower Meigs Post Prong



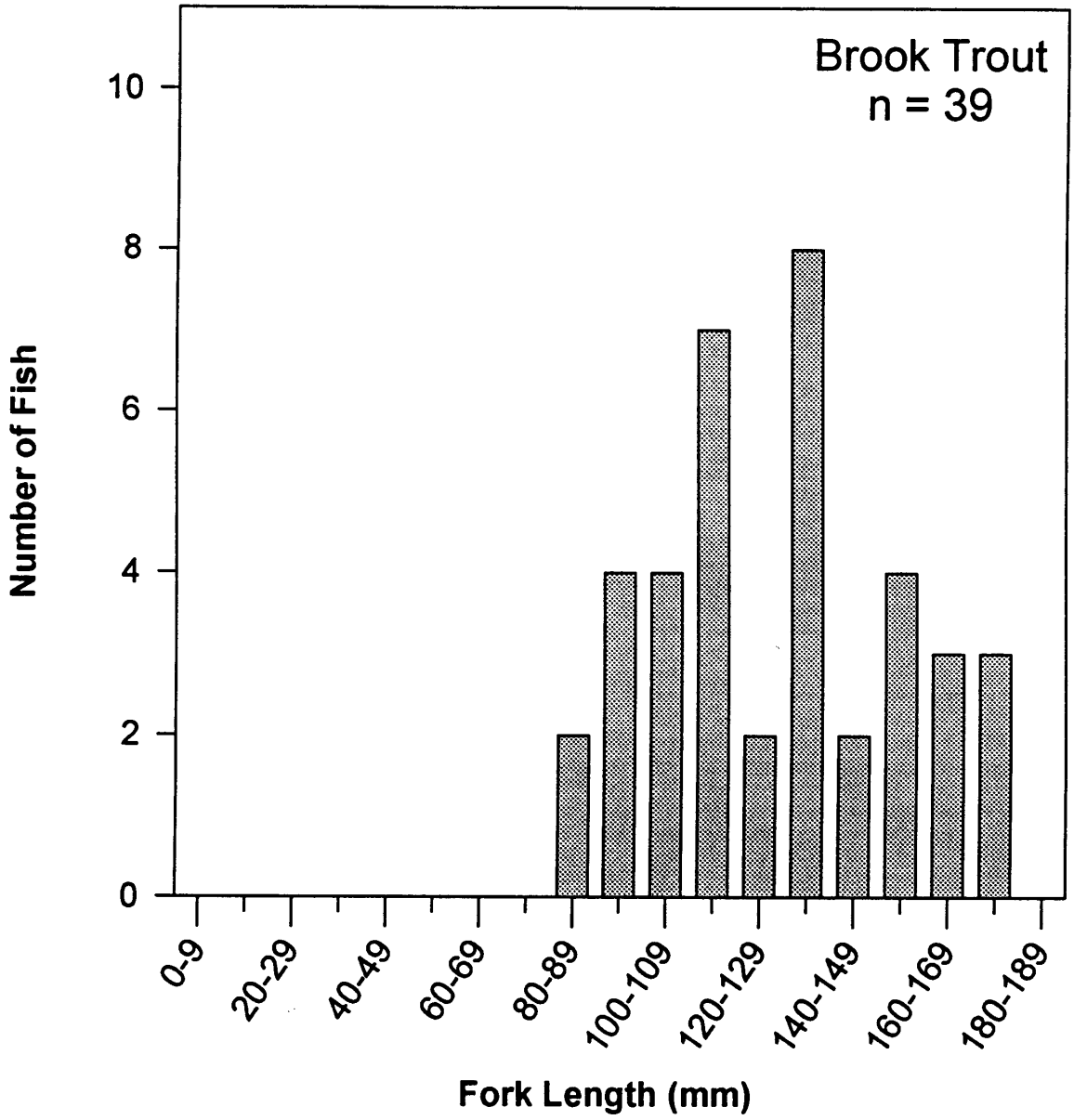
Upper Meigs Post Prong
Spring 1993



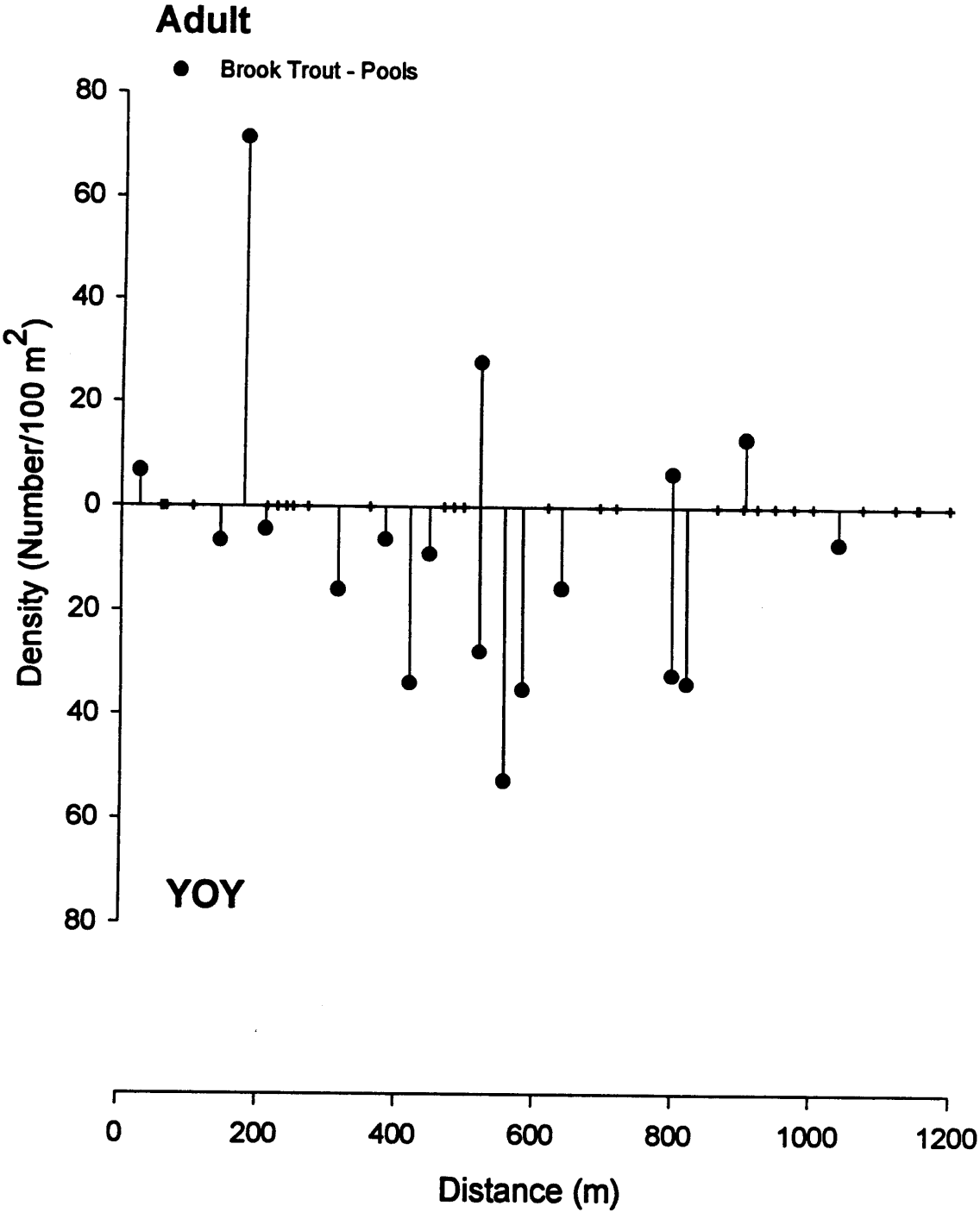
Upper Meigs Post Prong
Fall 1993



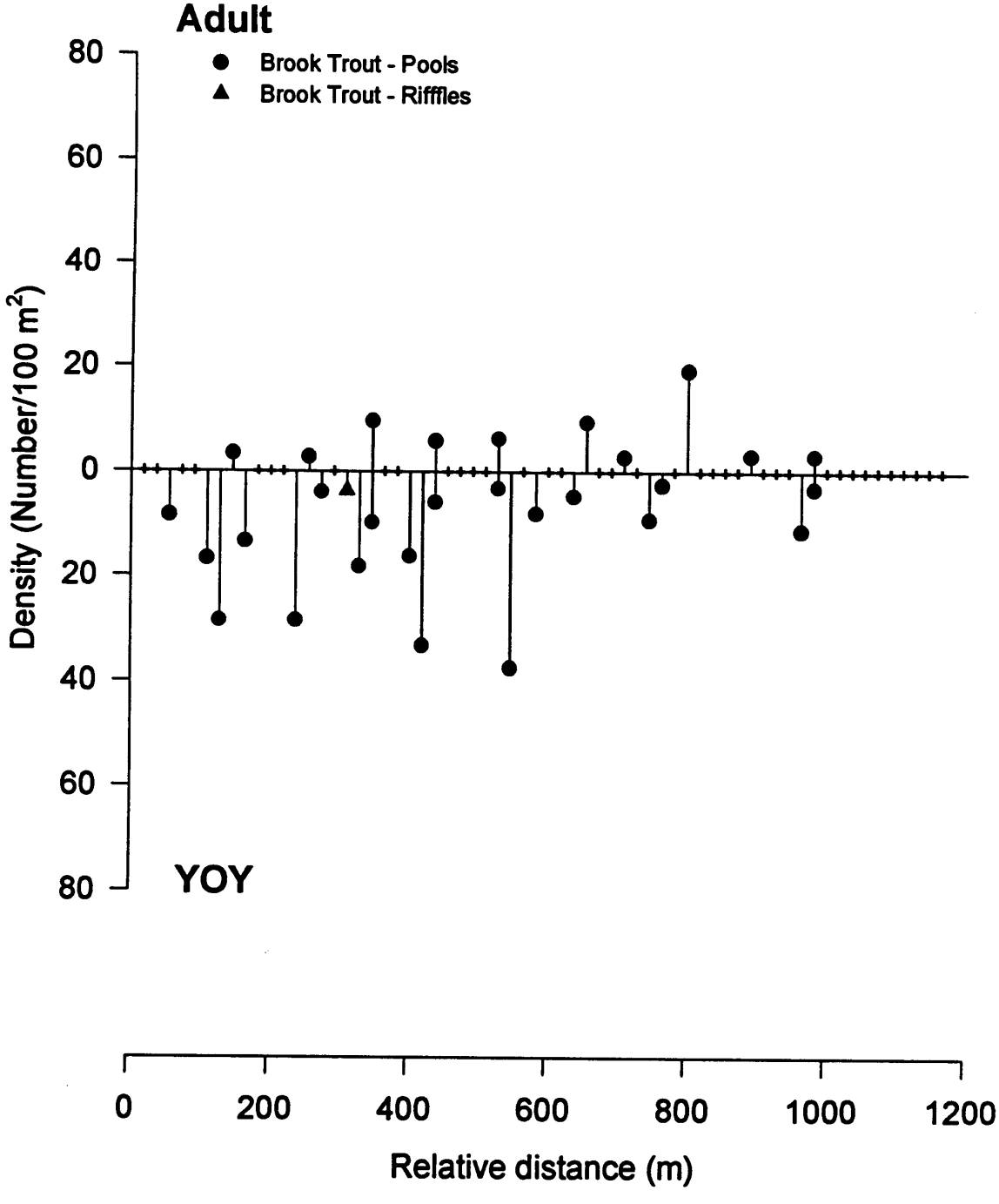
Upper Meigs Post Prong
Spring 1994



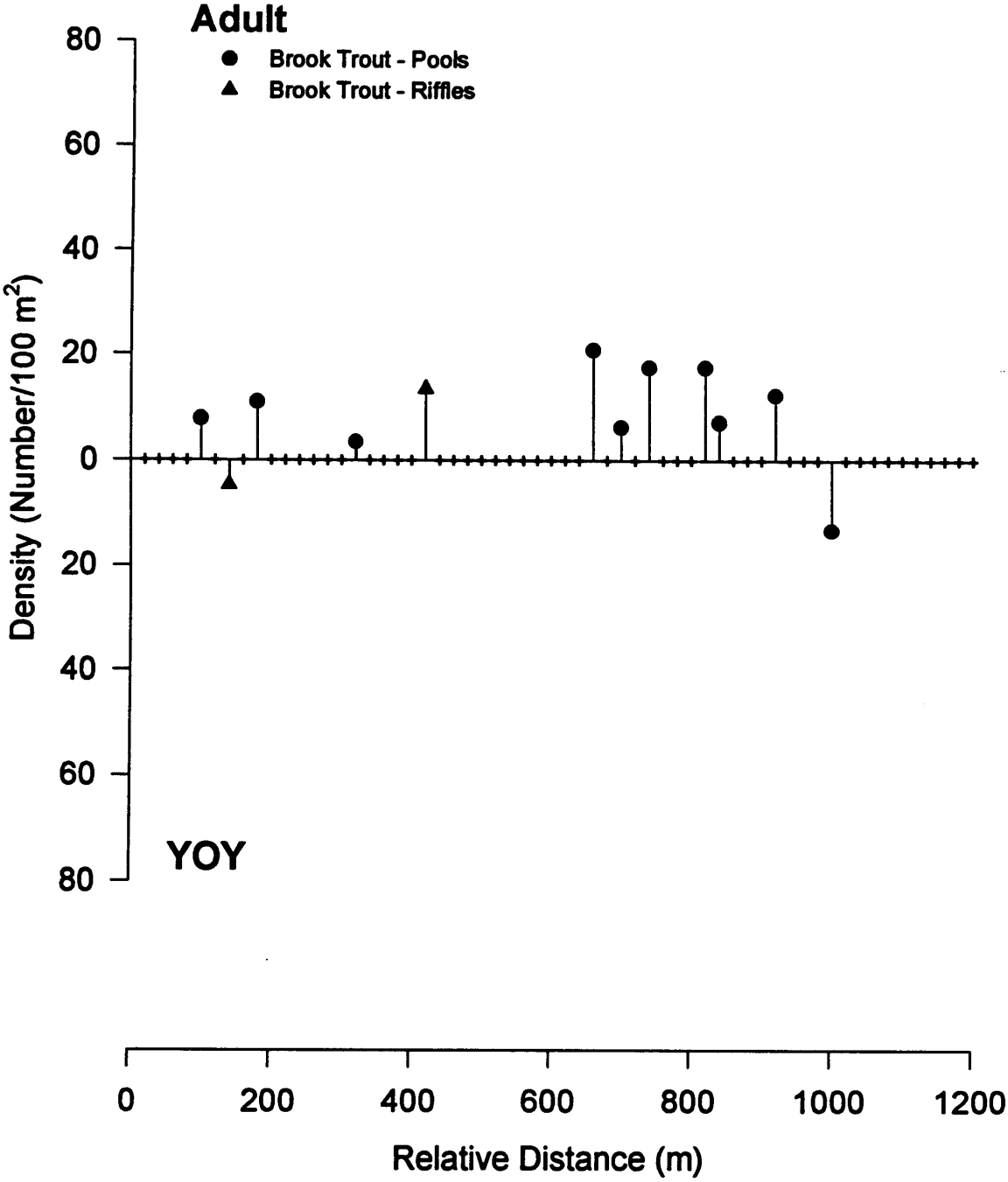
Upper Meigs Post Prong
Spring 1993



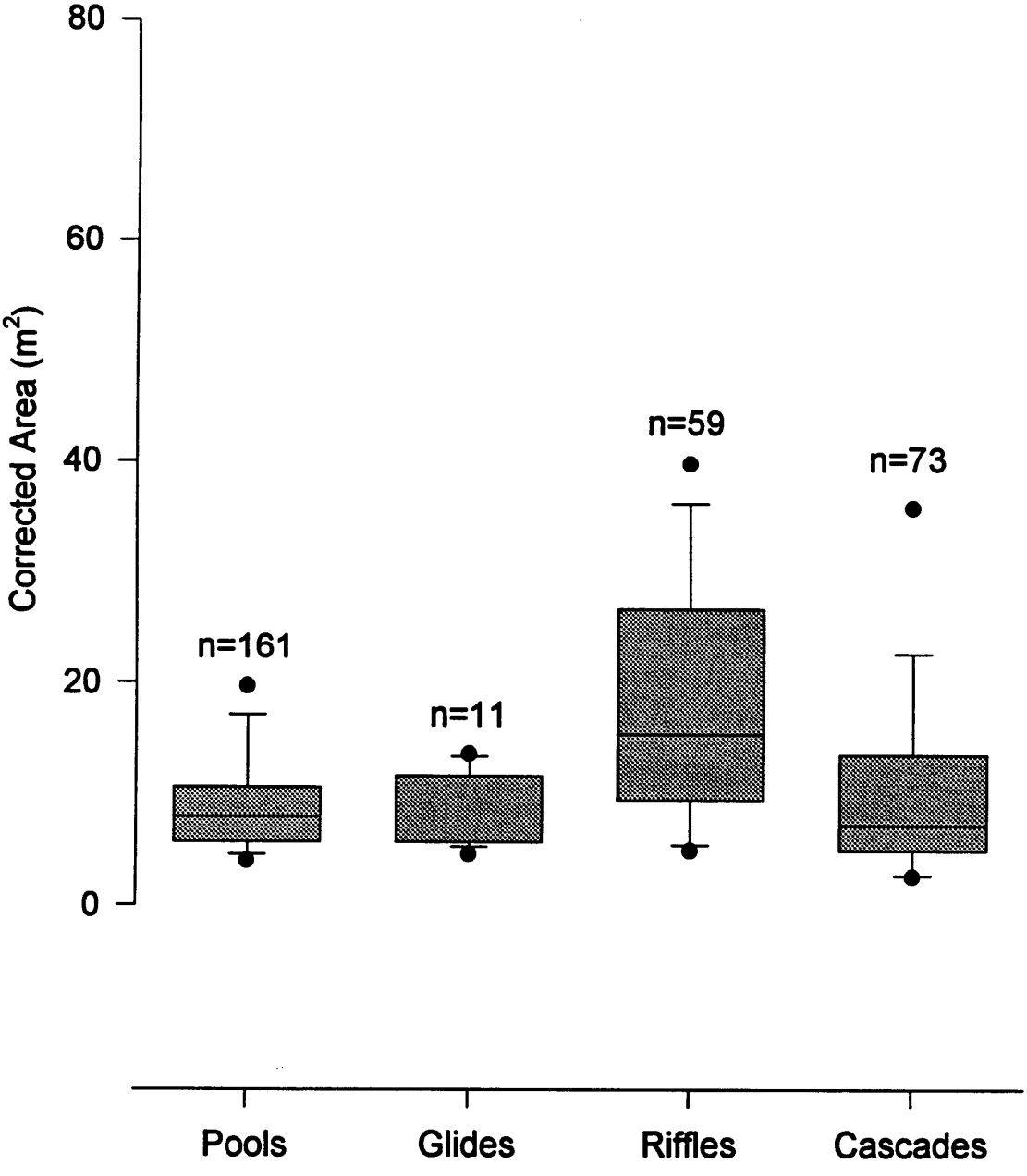
Upper Meigs Post Prong
Fall 1993



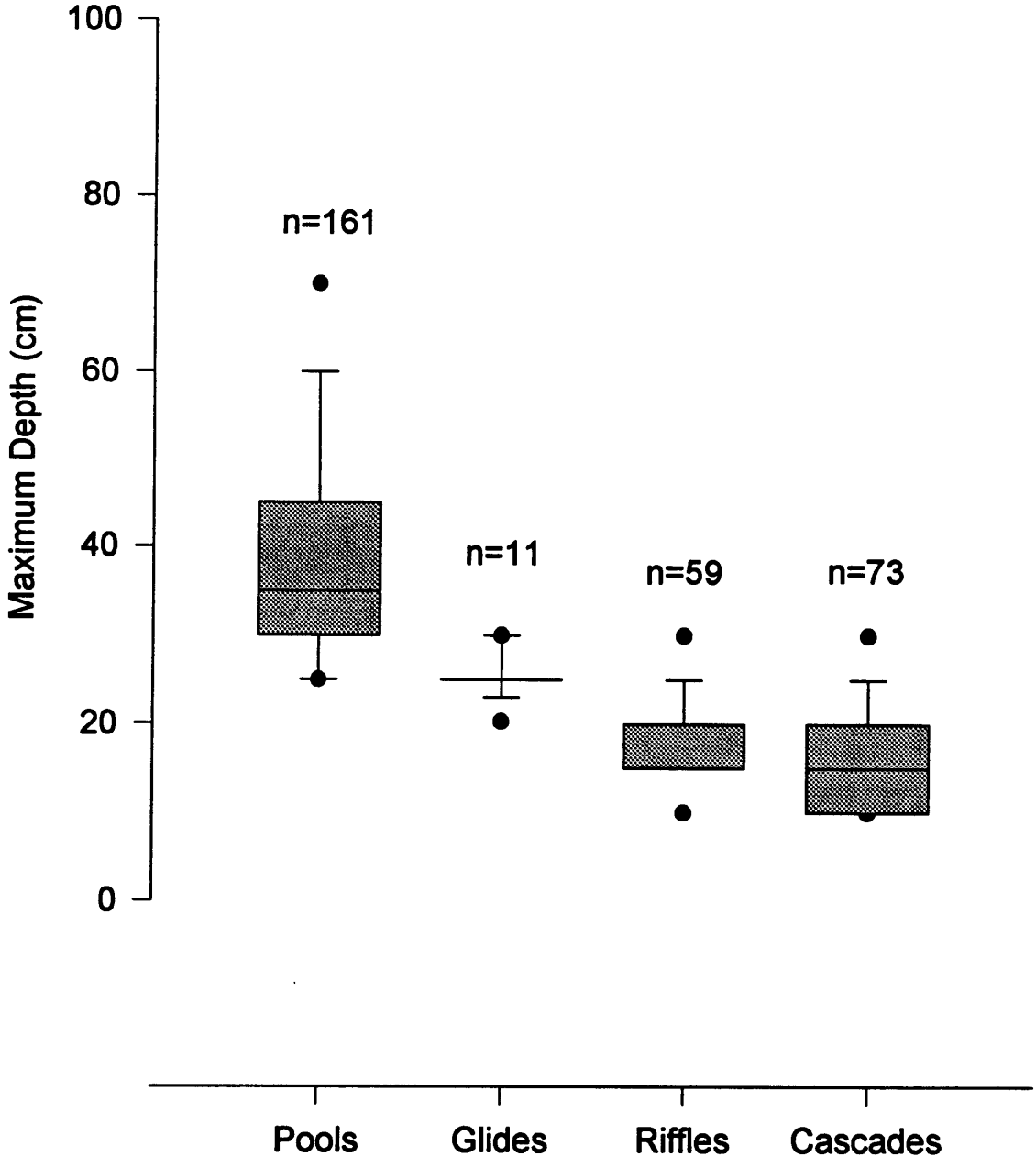
Upper Meigs Post Prong
Spring 1994

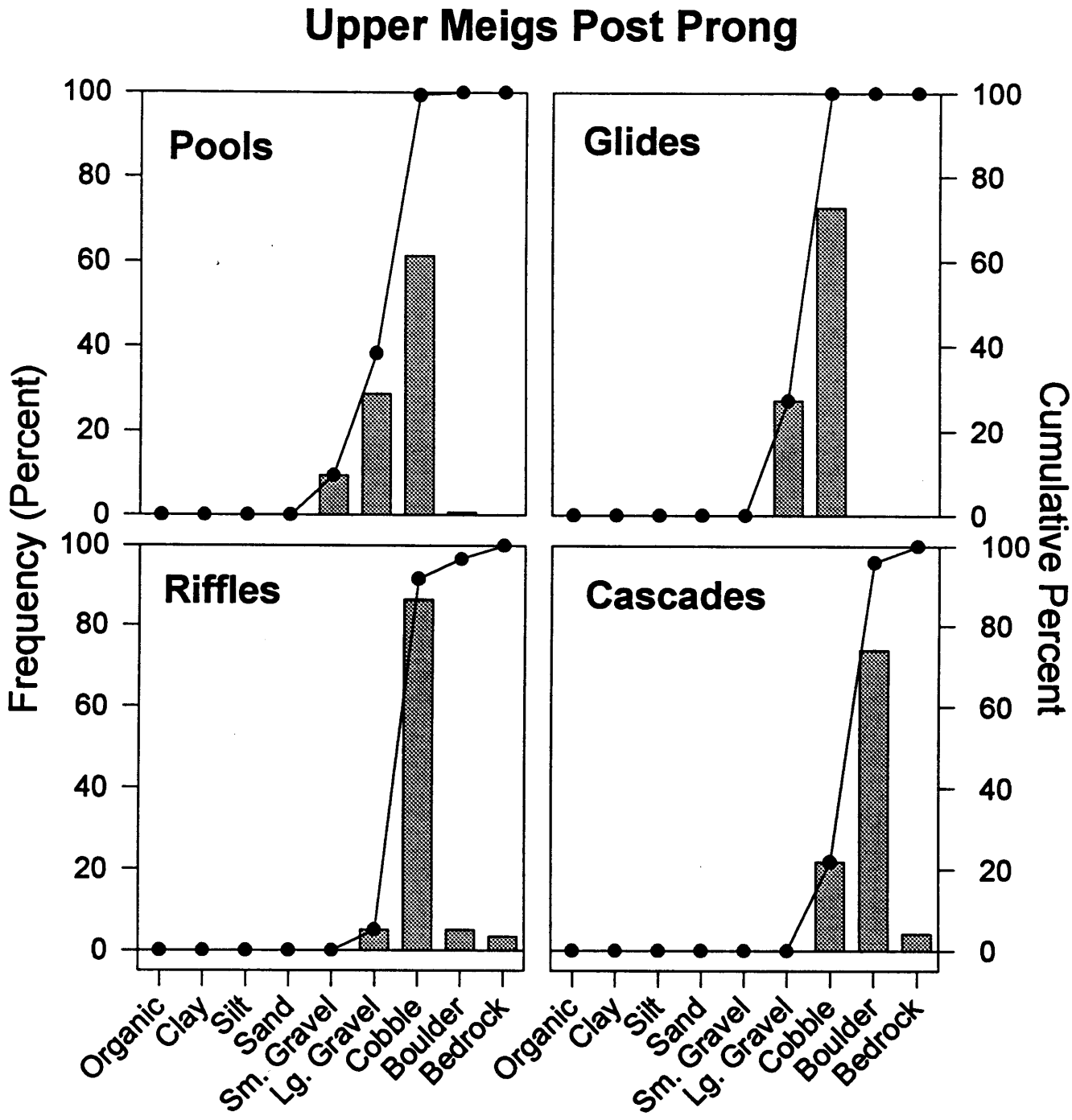


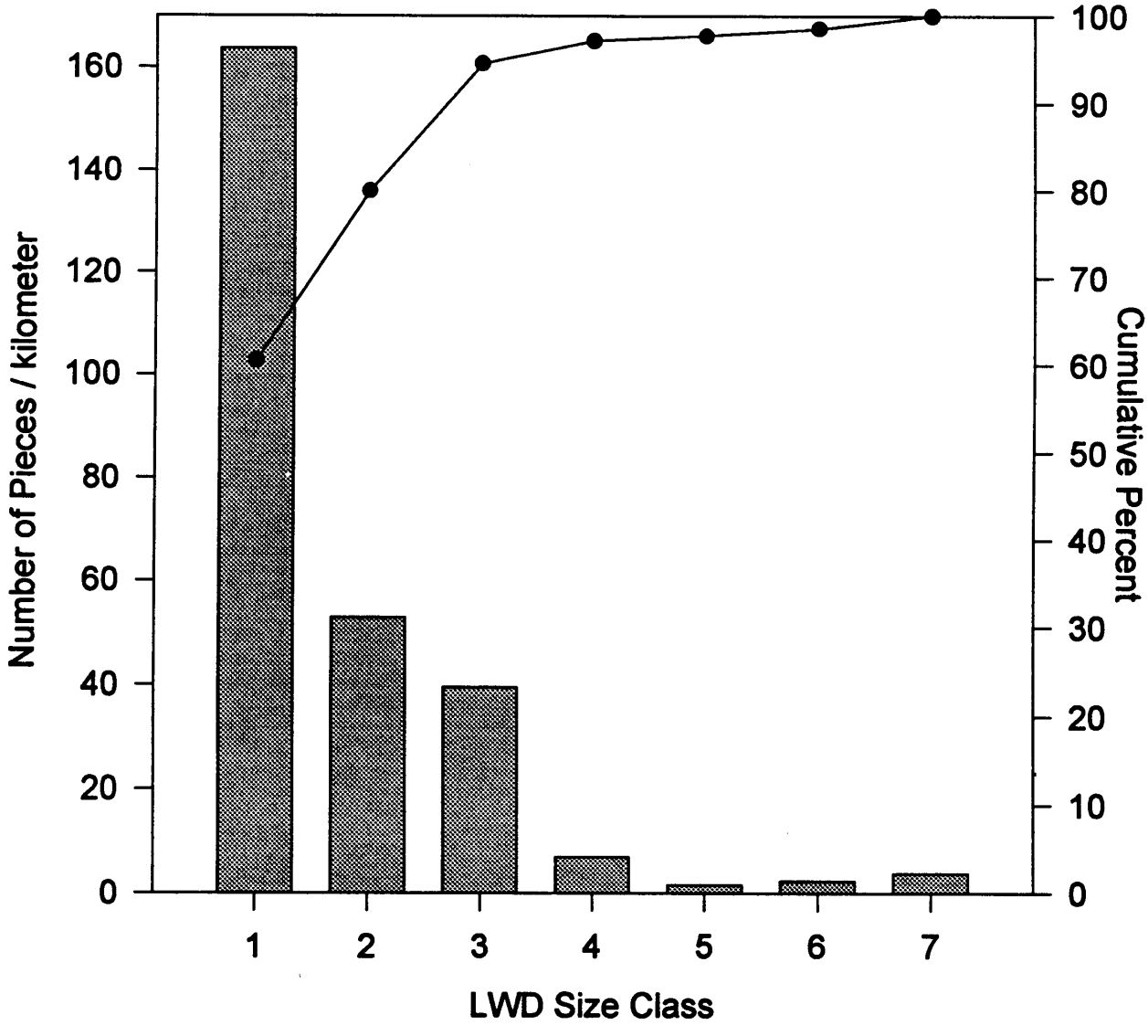
Upper Meigs Post Prong



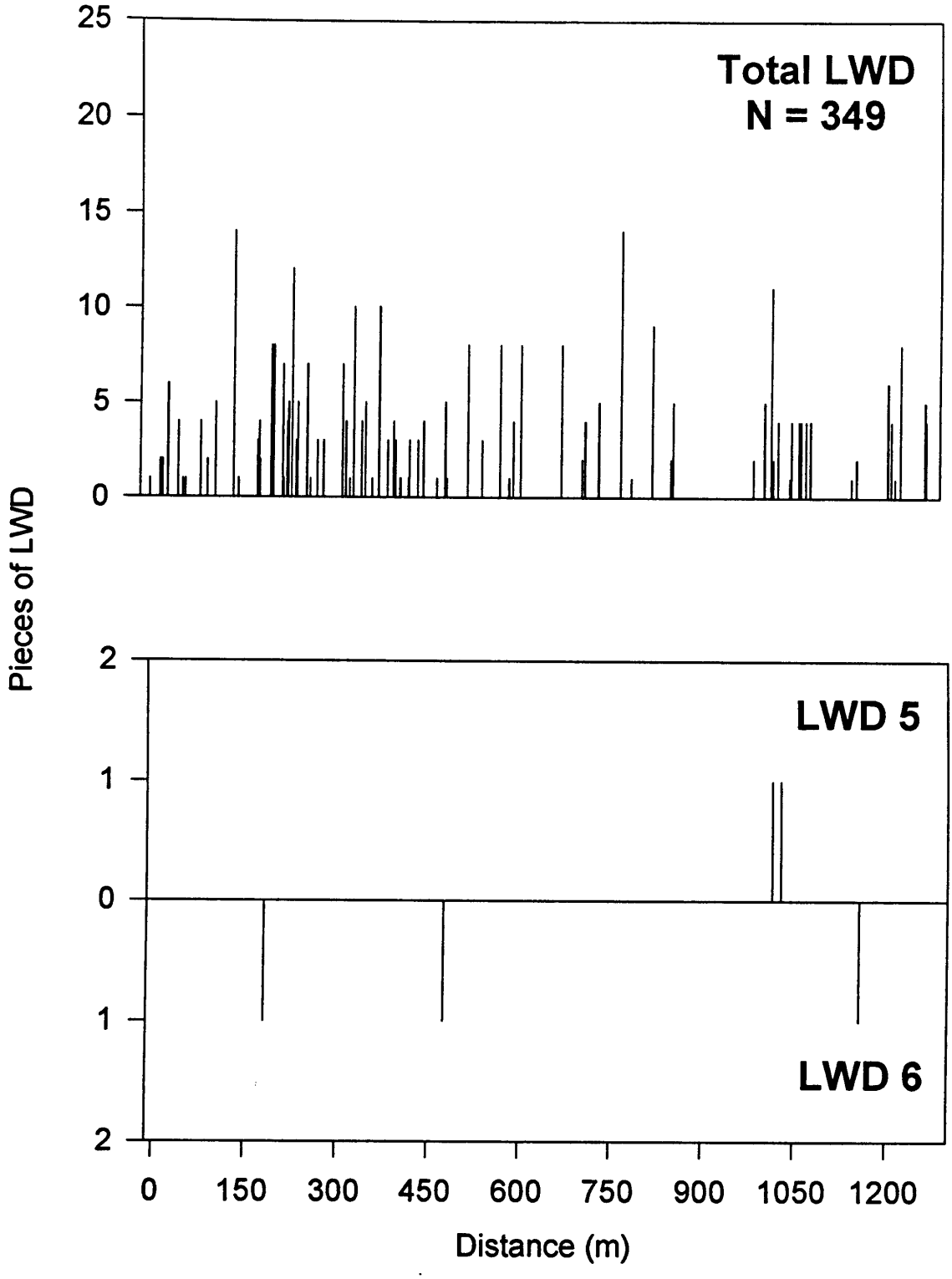
Upper Meigs Post Prong



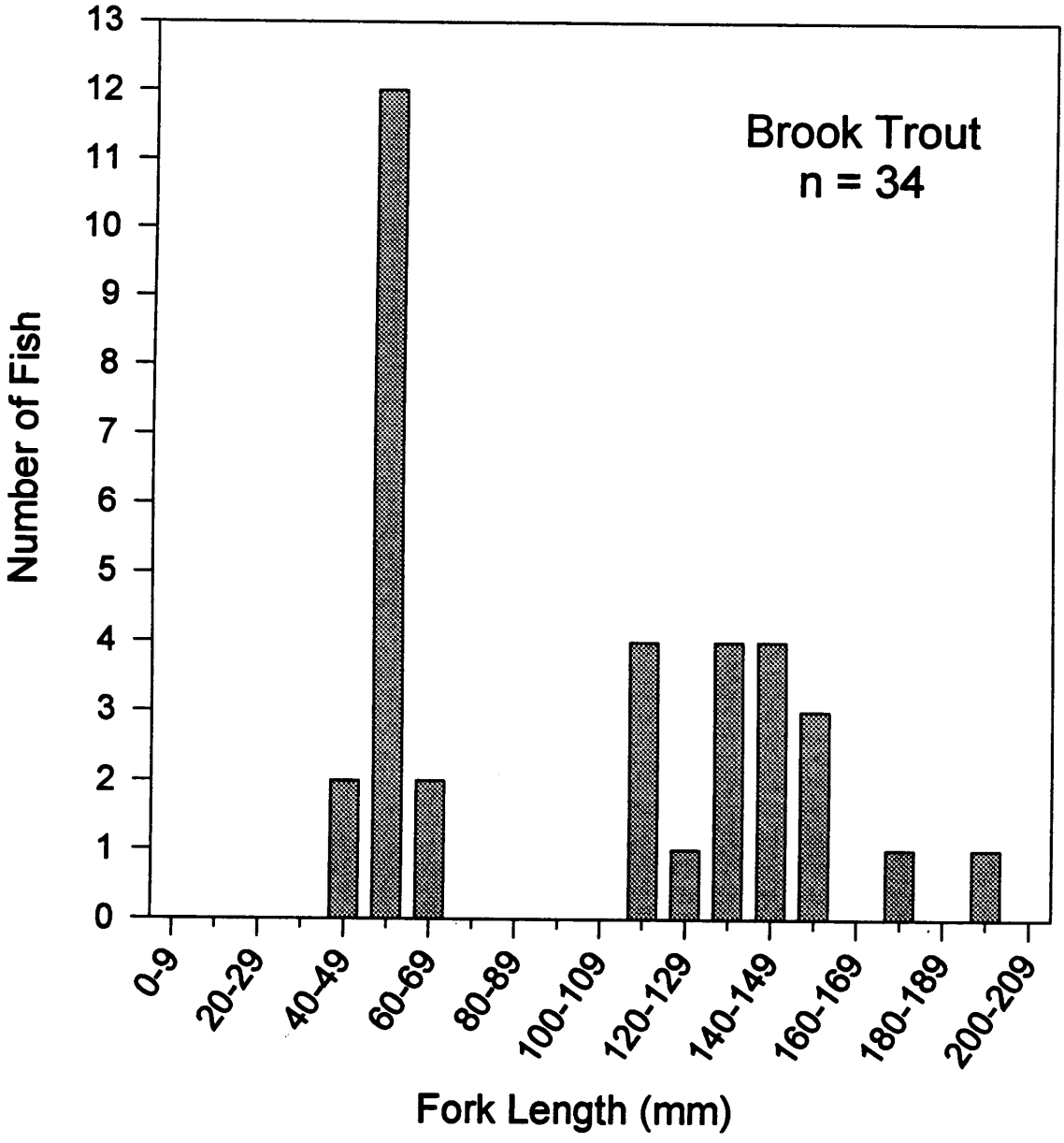

Upper Meigs Post Prong
Pools
Glides
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock


Upper Meigs Post Prong
Number of Pieces / kilometer
Cumulative Percent
LWD Size Class
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7

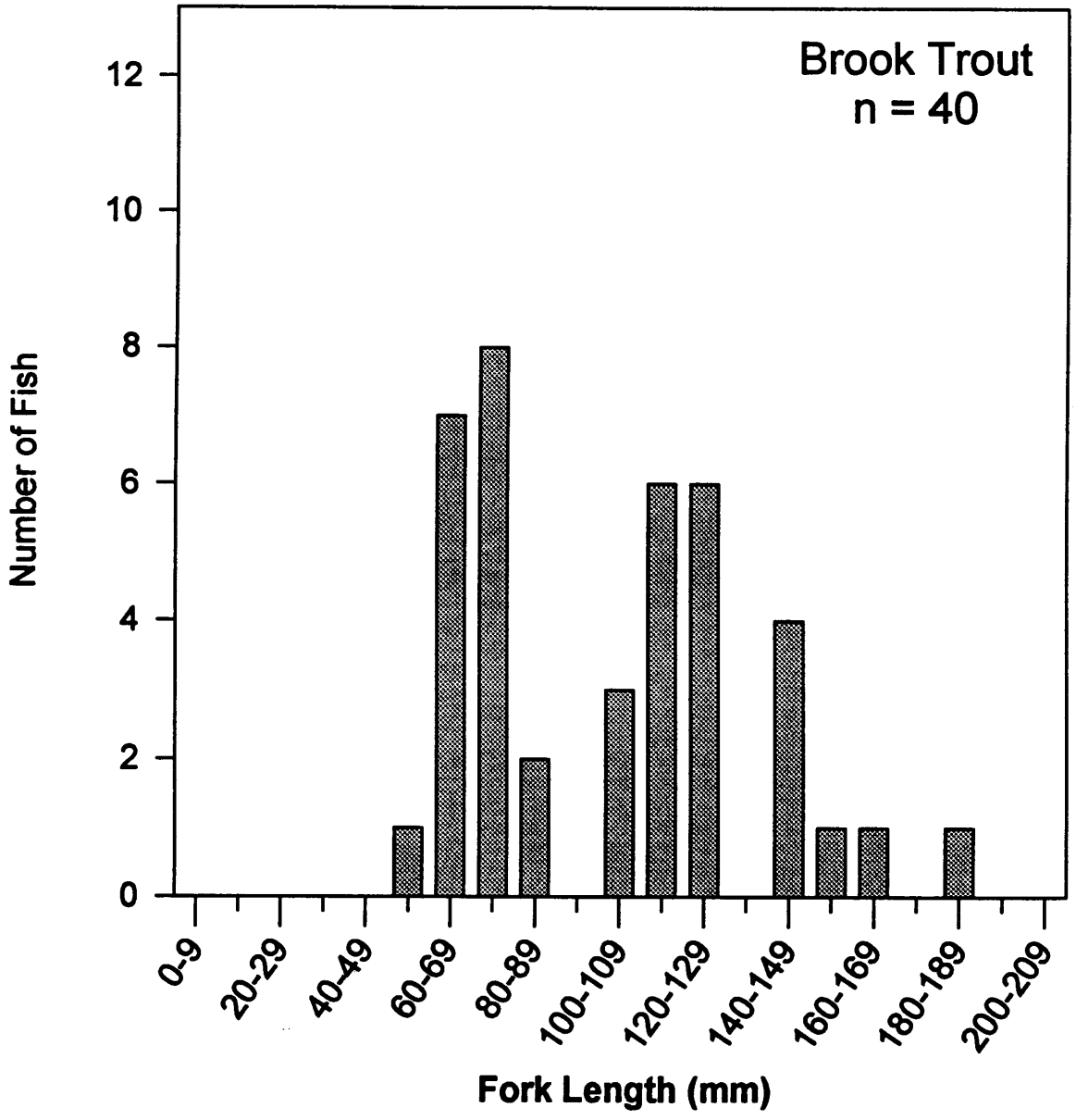
Upper Meigs Post Prong



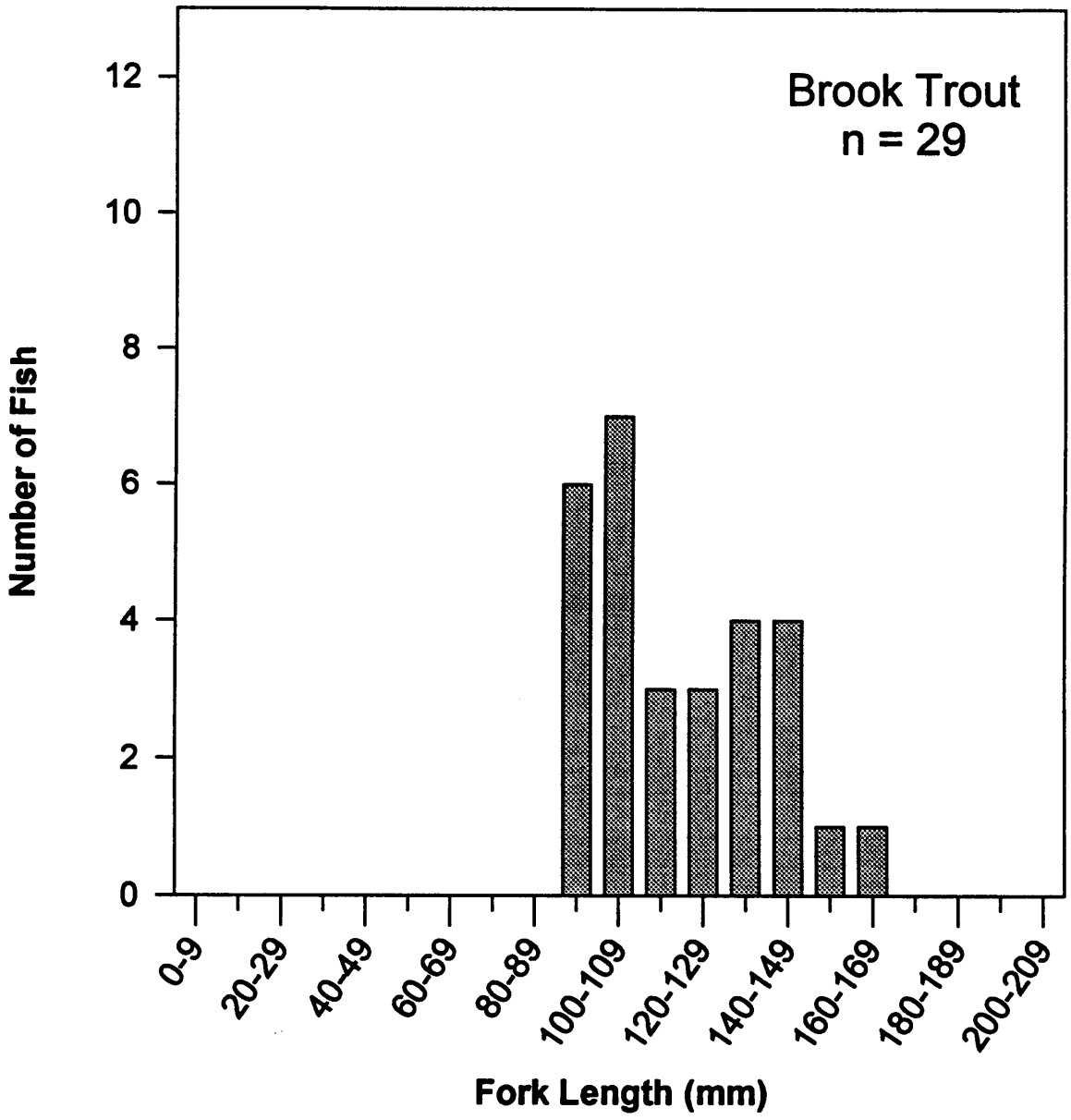
Sweet Creek
Spring 1993



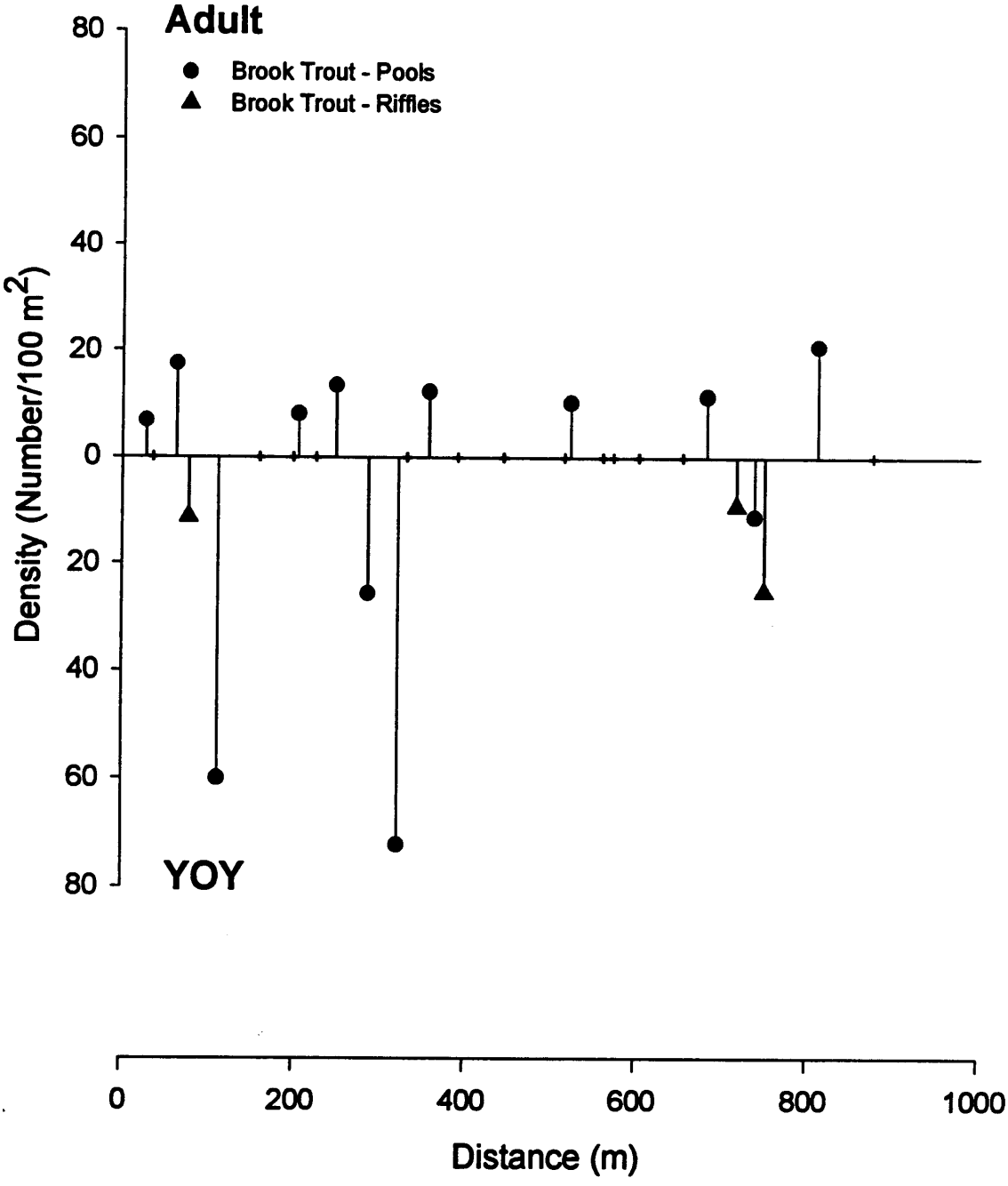
Sweet Creek
Fall 1993



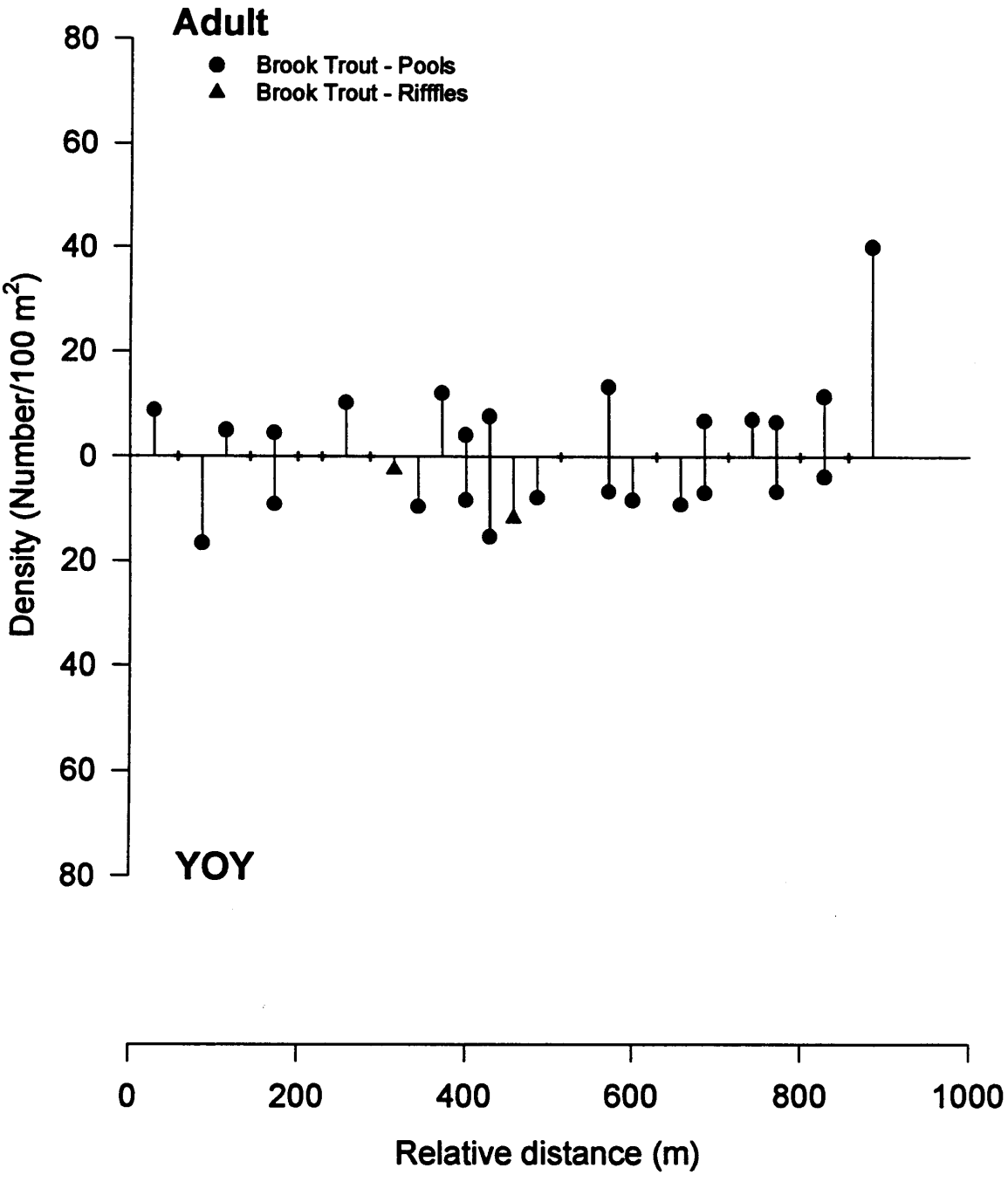
Sweet Creek
Spring 1994



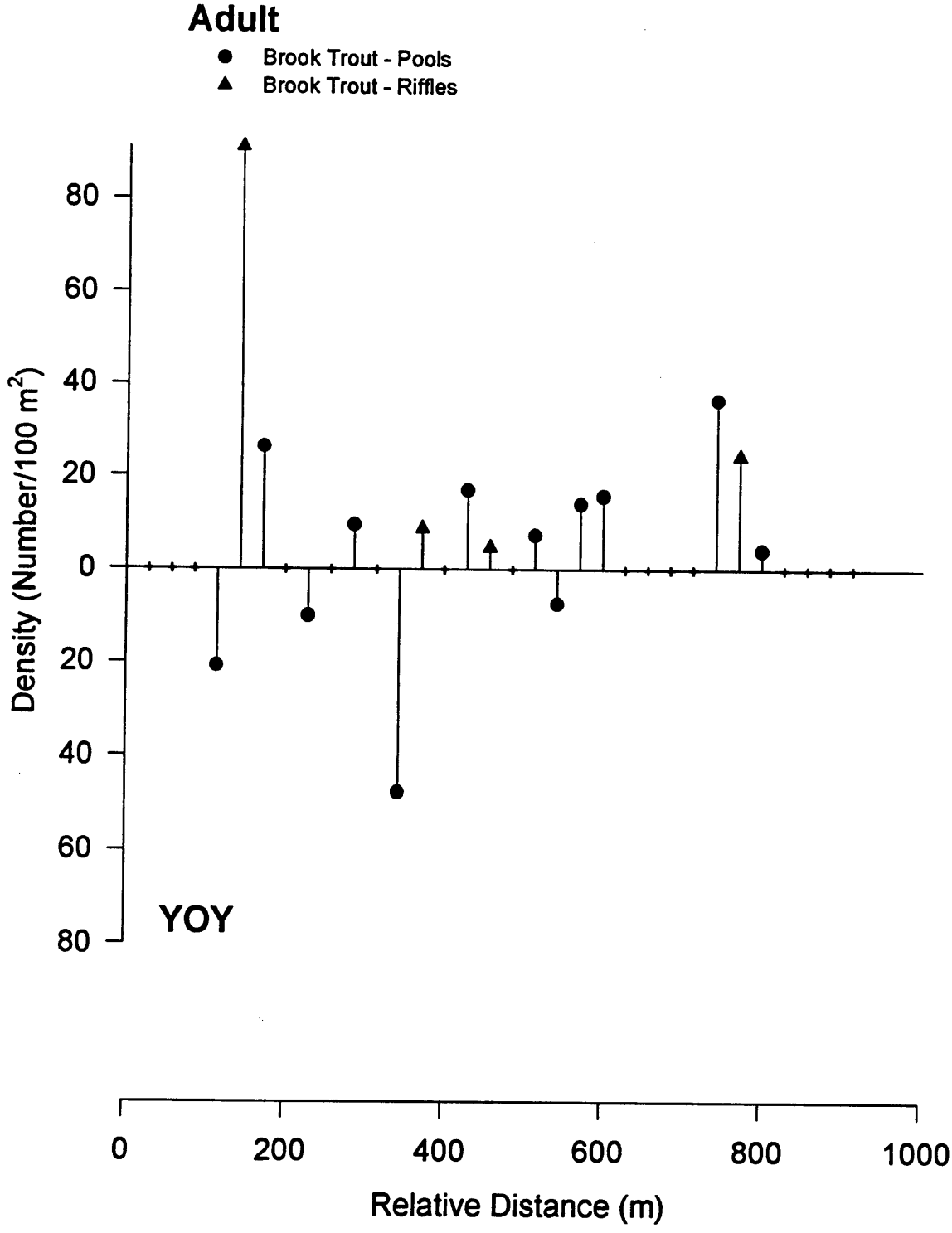
Sweet Creek
Spring 1993

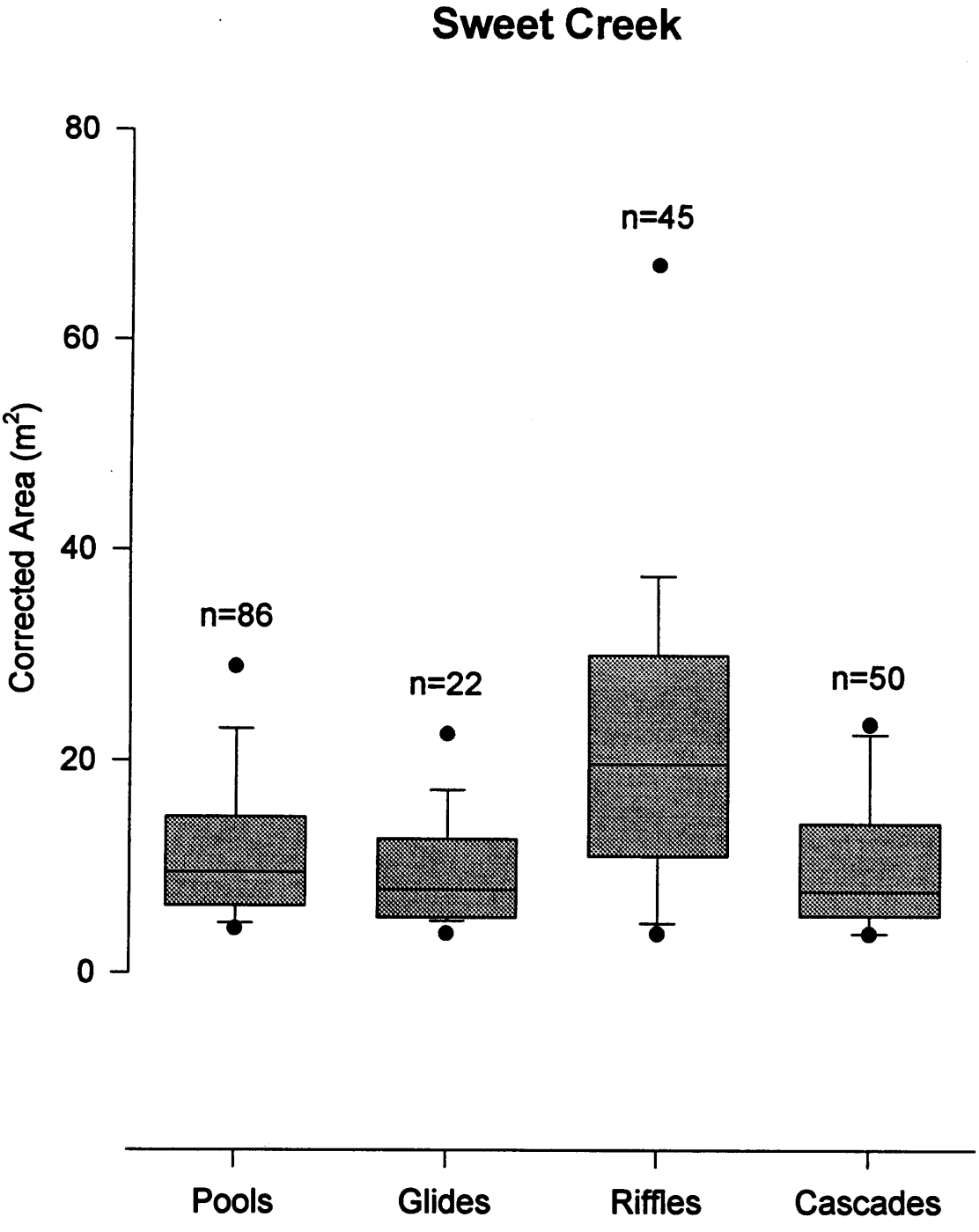


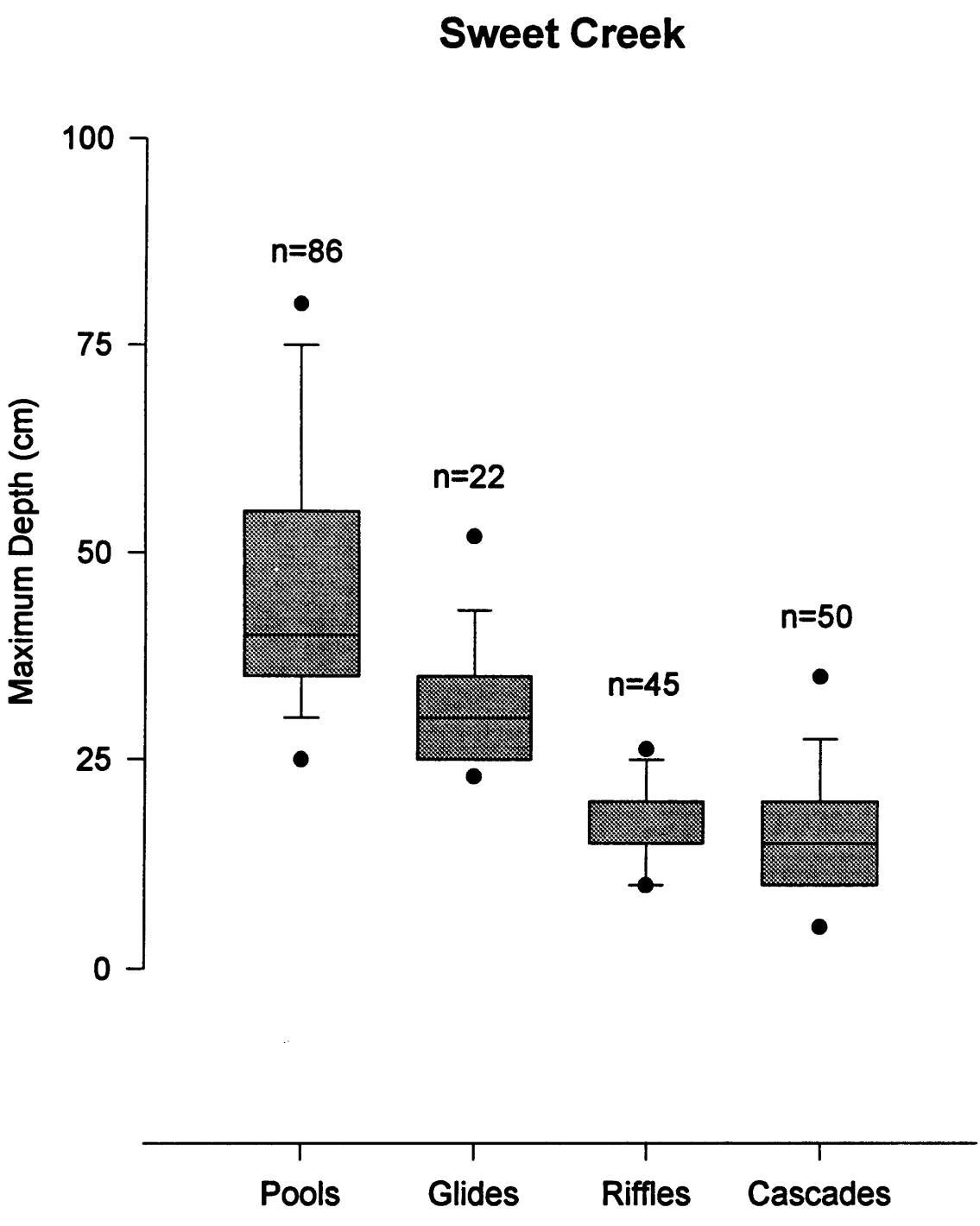
Sweet Creek
Fall 1993

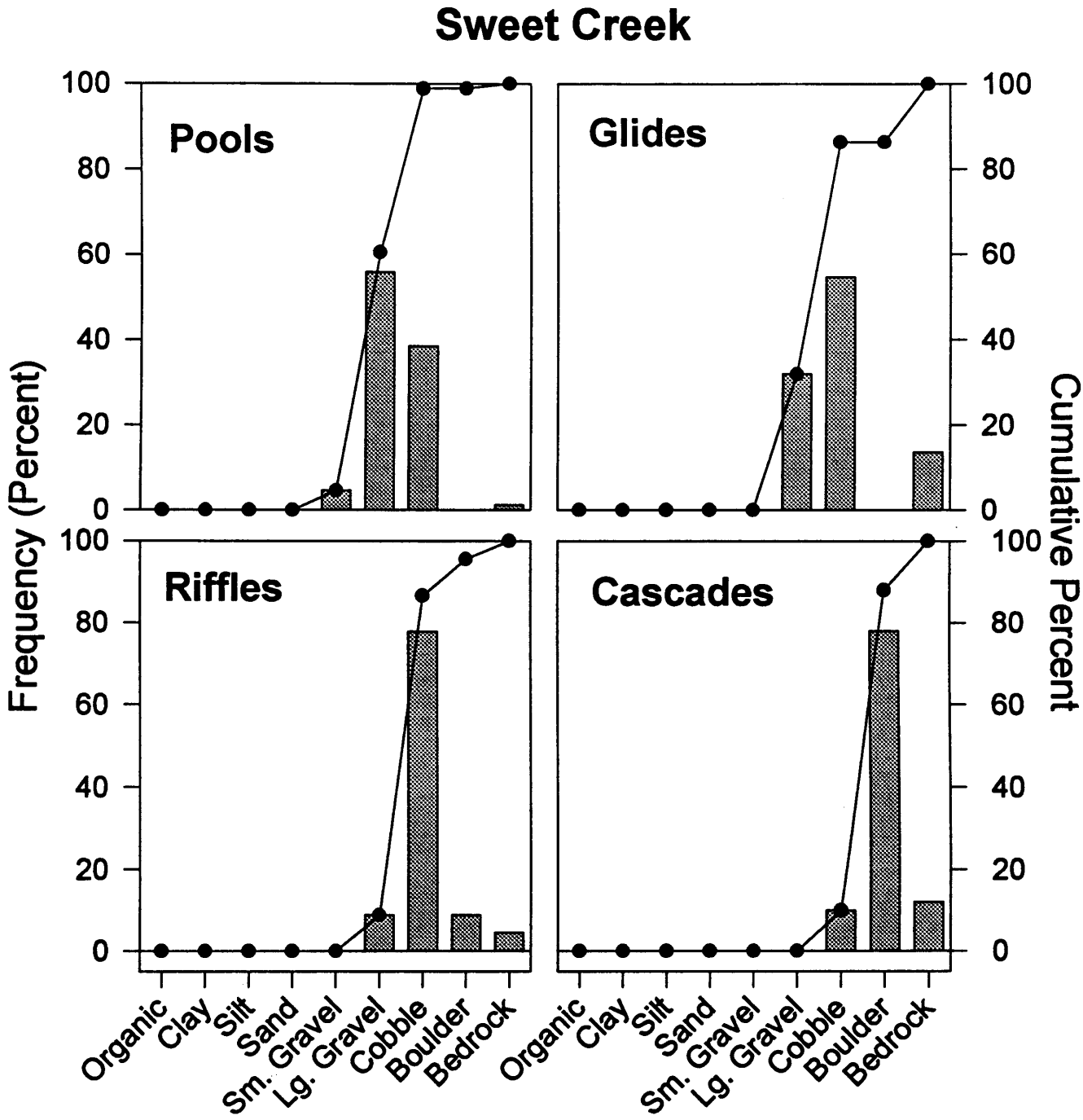


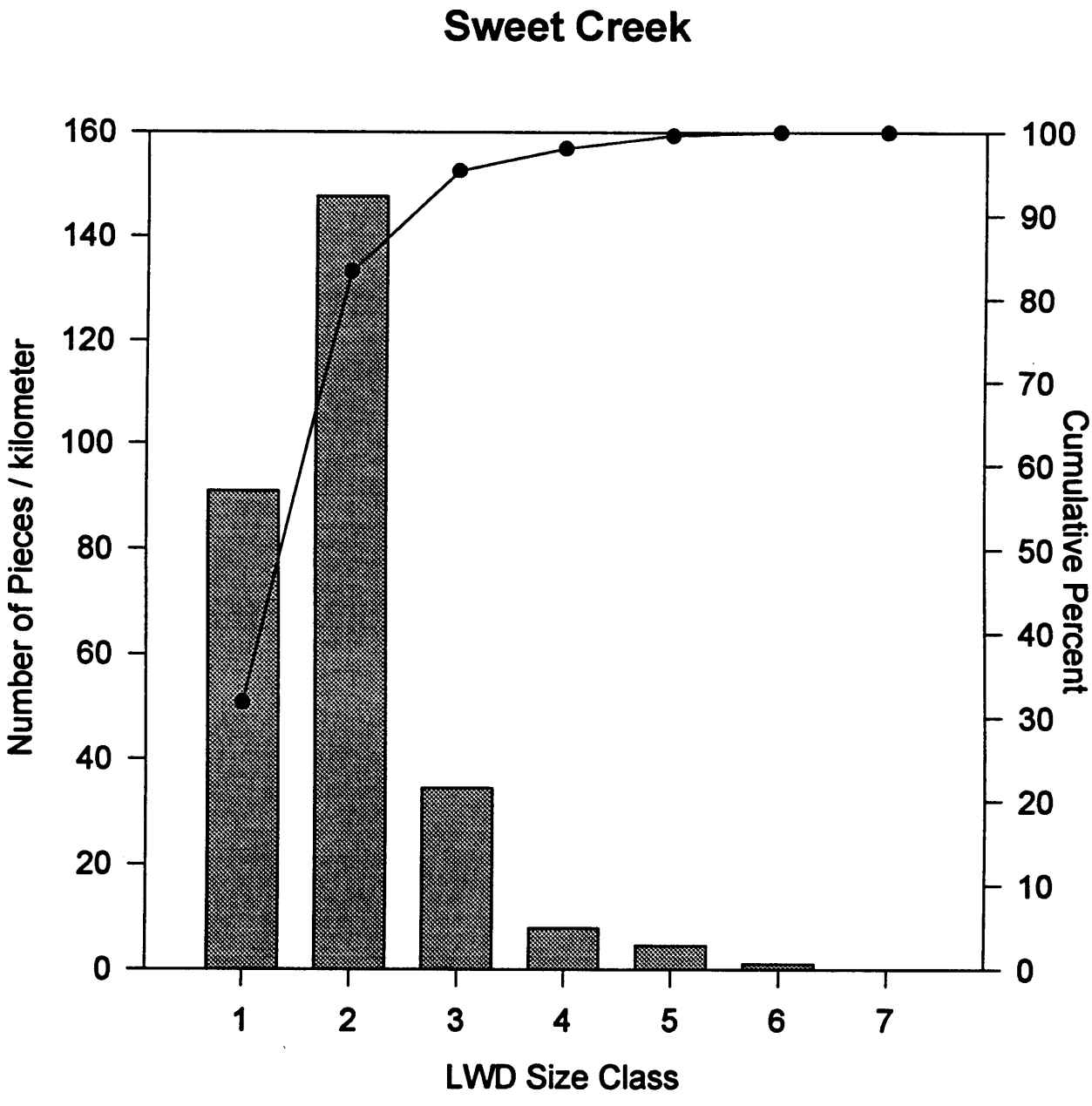
Sweet Creek
Spring 1994



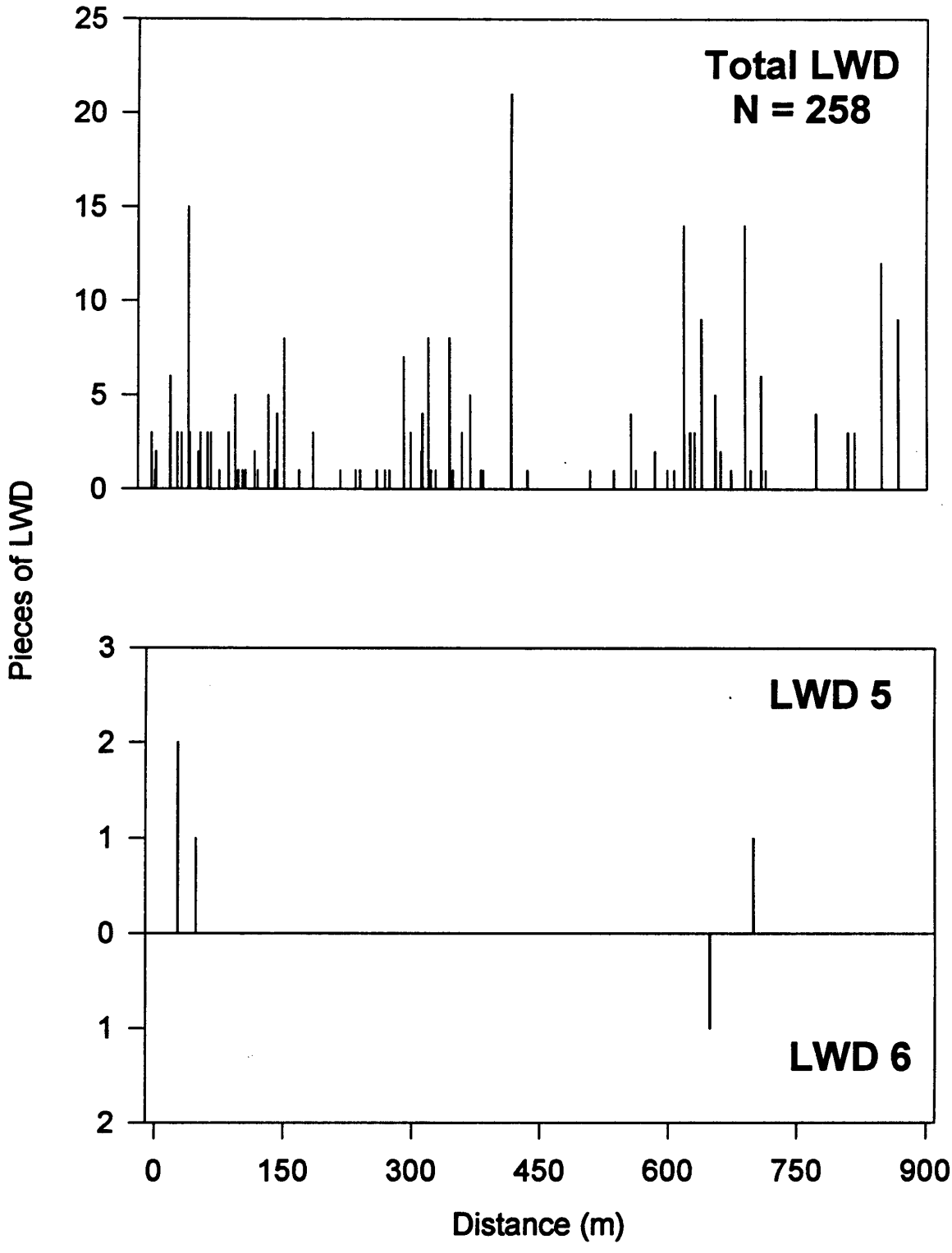

Sweet Creek
80
60
40
20
0
Corrected Area (m2)
n=86
n=22
n=45
n=50
Pools
Glides
Riffles
Cascades


Sweet Creek
Maximum Depth (cm)
100
75
50
25
0
n=86
n=22
n=45
n=50
Pools
Glides
Riffles
Cascades


Sweet Creek
Pools
Glides
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock

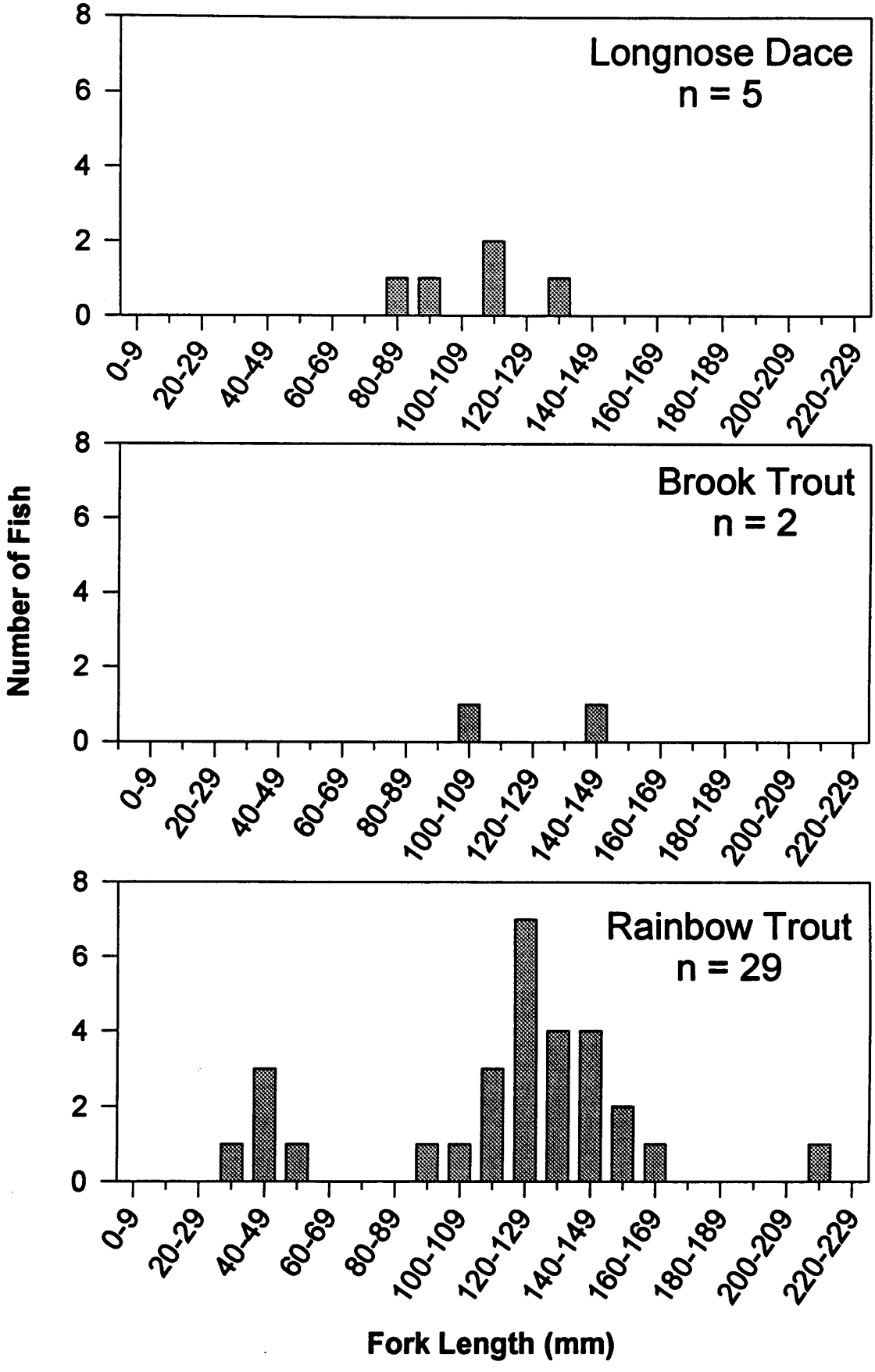

Sweet Creek
160
140
120
100
80
60
40
20
0
Number of Pieces / kilometer
100
90
80
70
60
50
40
30
20
10
0
Cumulative Percent
1
2
3
4
5
6
7
LWD Size Class

Sweet Creek

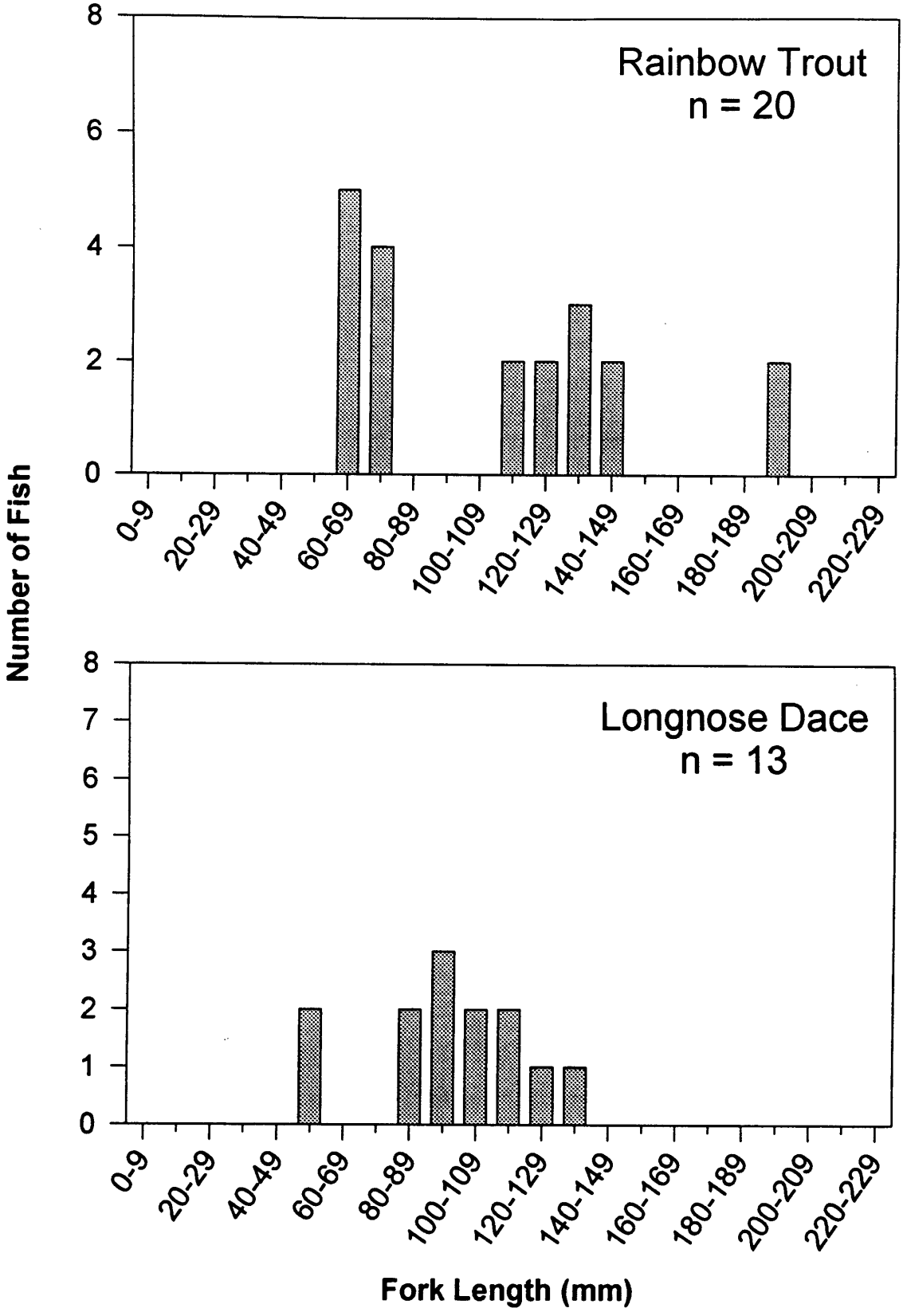

Total LWD
N = 258
25
20
15
10
5
0
LWD 5
LWD 6
3
2
1
0
1
2
0
150
300
450
600
750
900
Distance (m)
Pieces of LWD

Buckeye Sub-basin

Middle Fish Camp Prong
Spring 1993

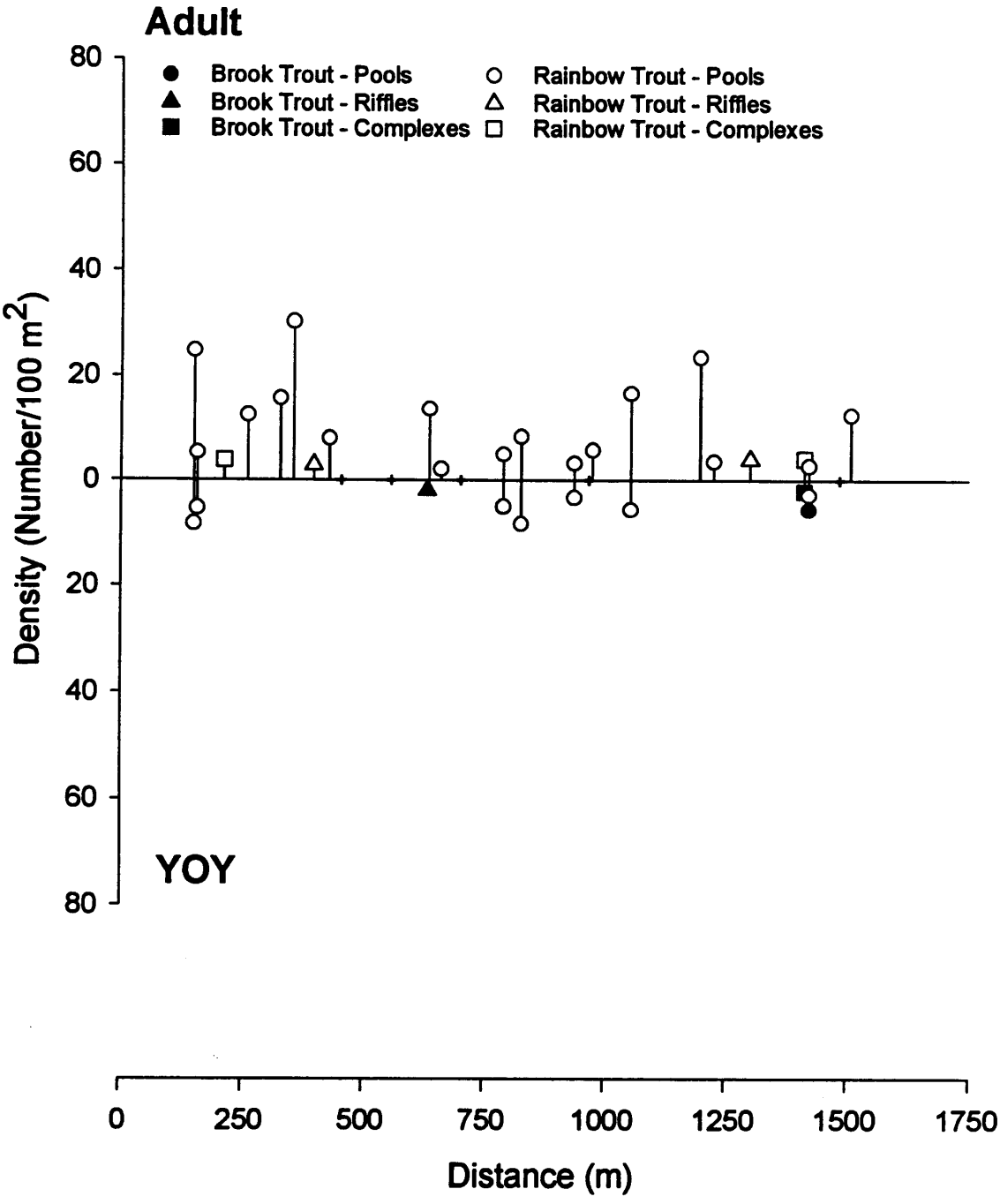


Middle Fish Camp Prong*
Fall 1993

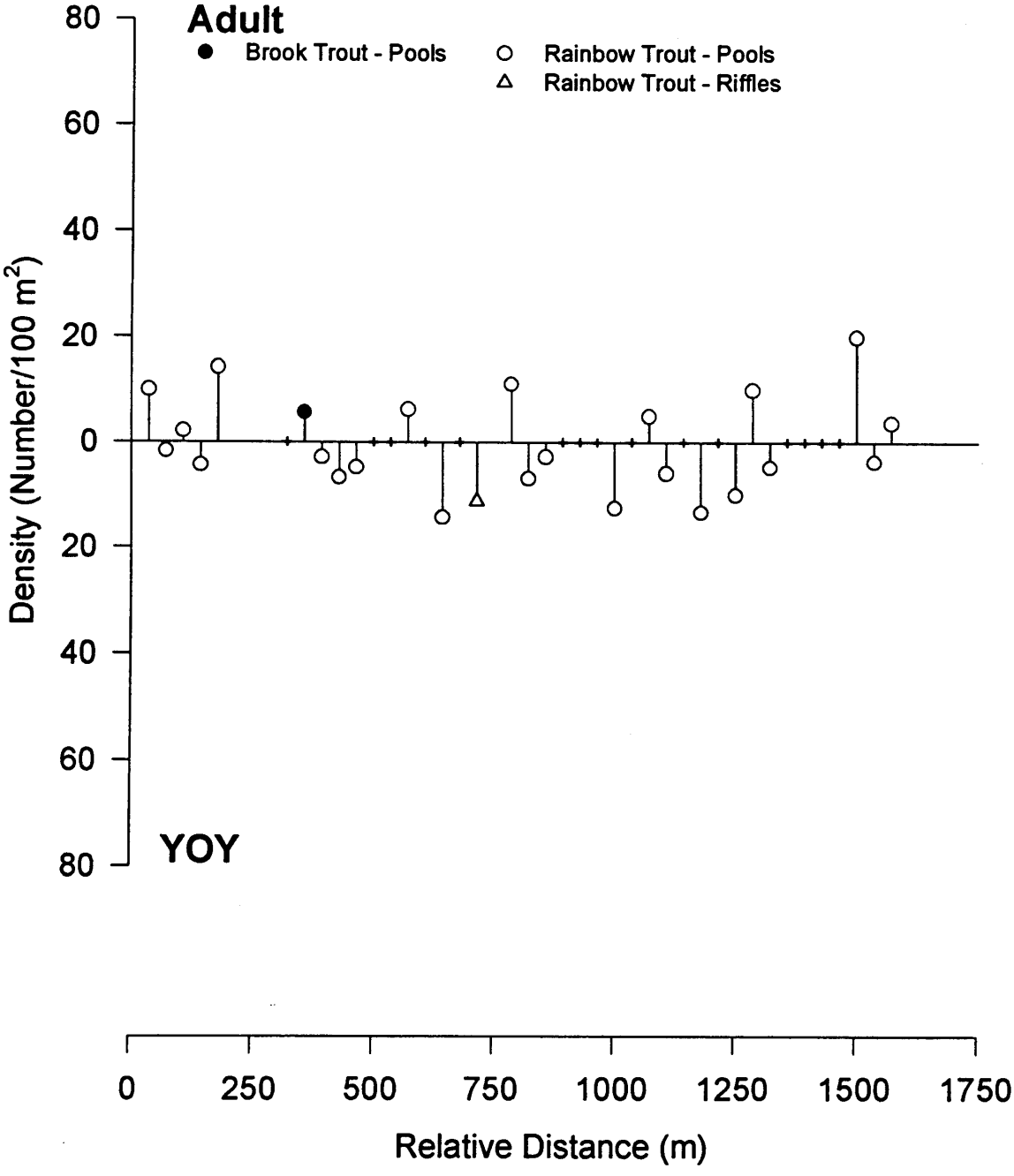


*Spring 1994 length frequency data not available.

Middle Fish Camp Prong
Spring 1993

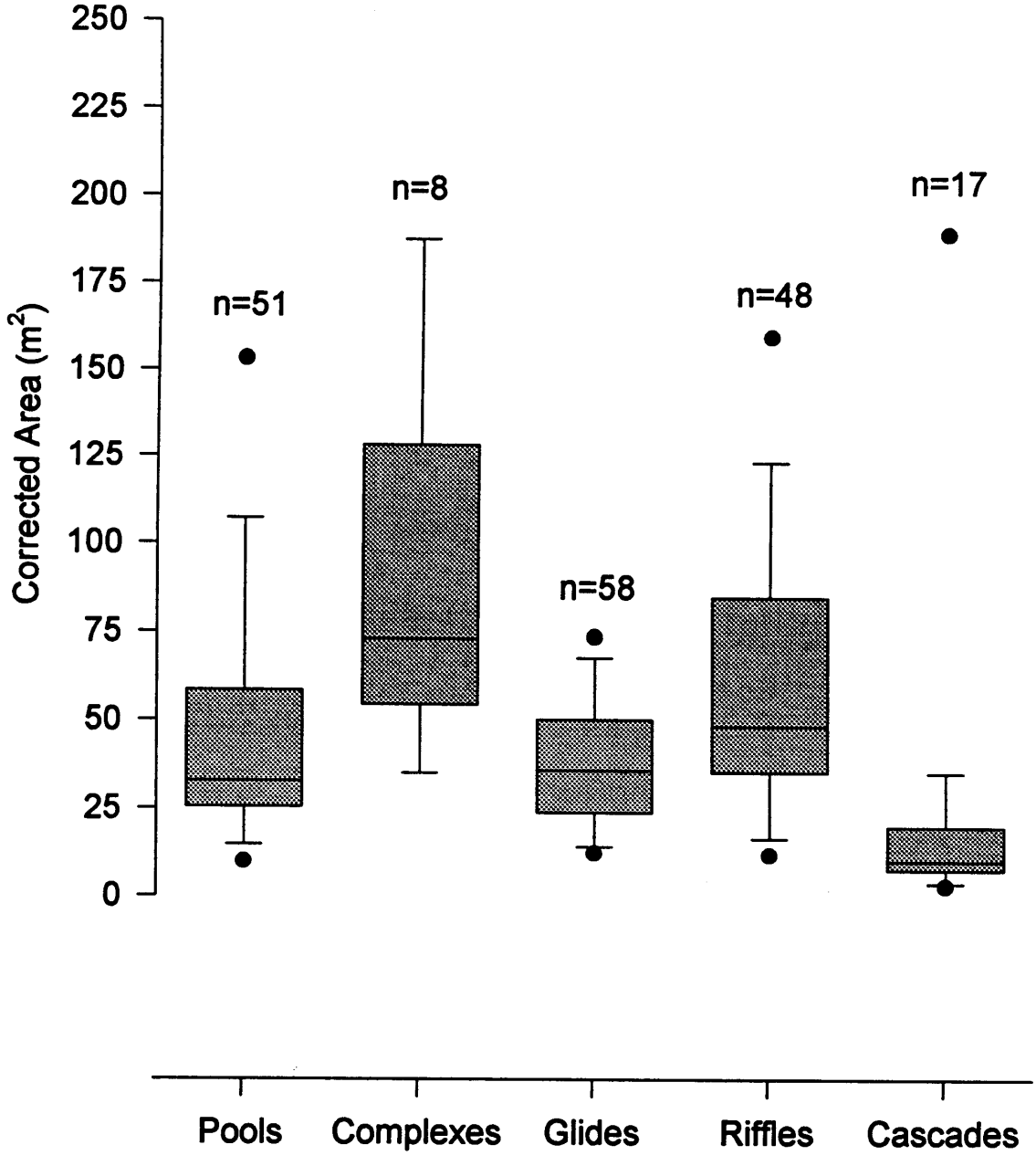


Middle Fish Camp Prong*
Fall 1993

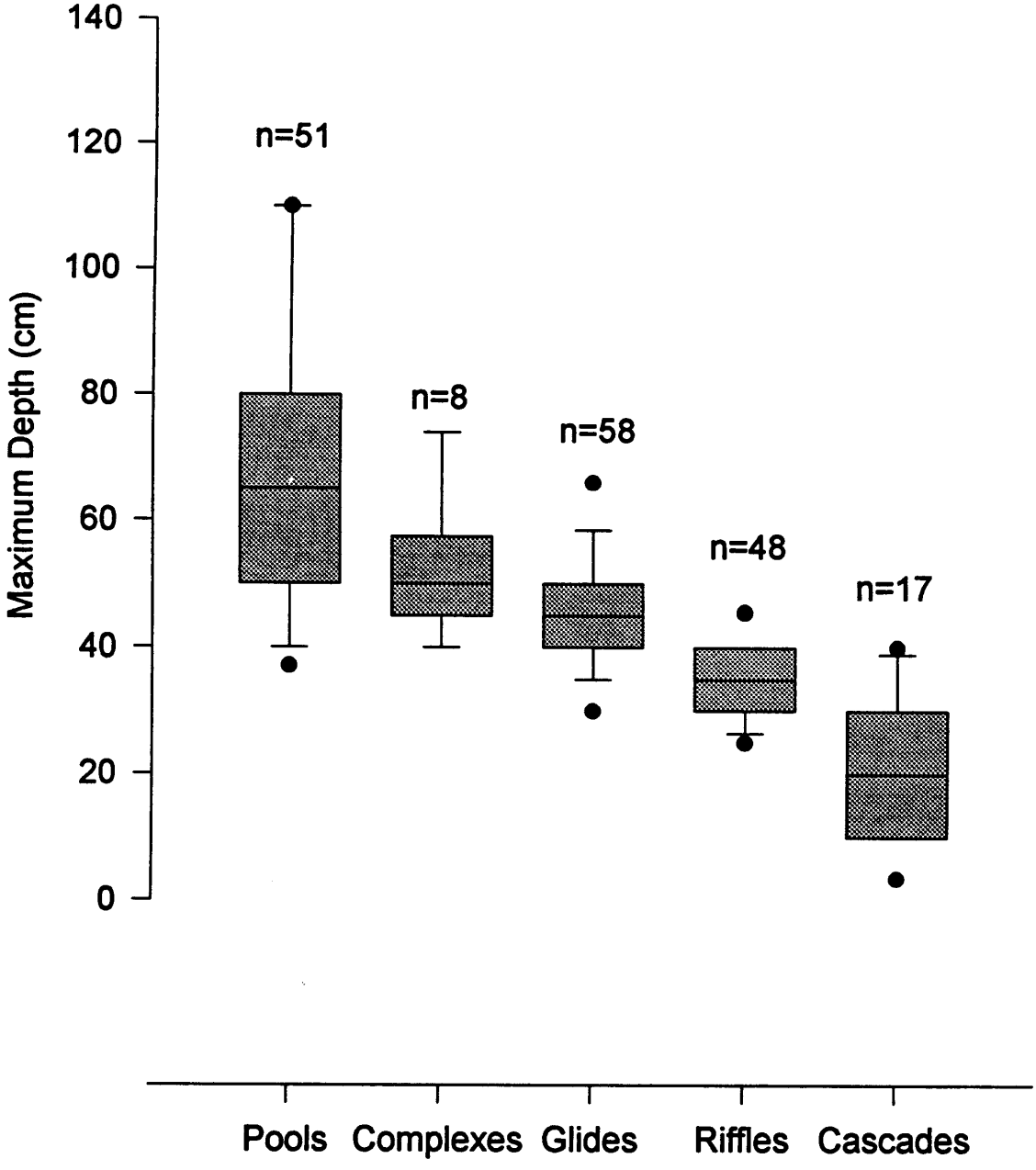


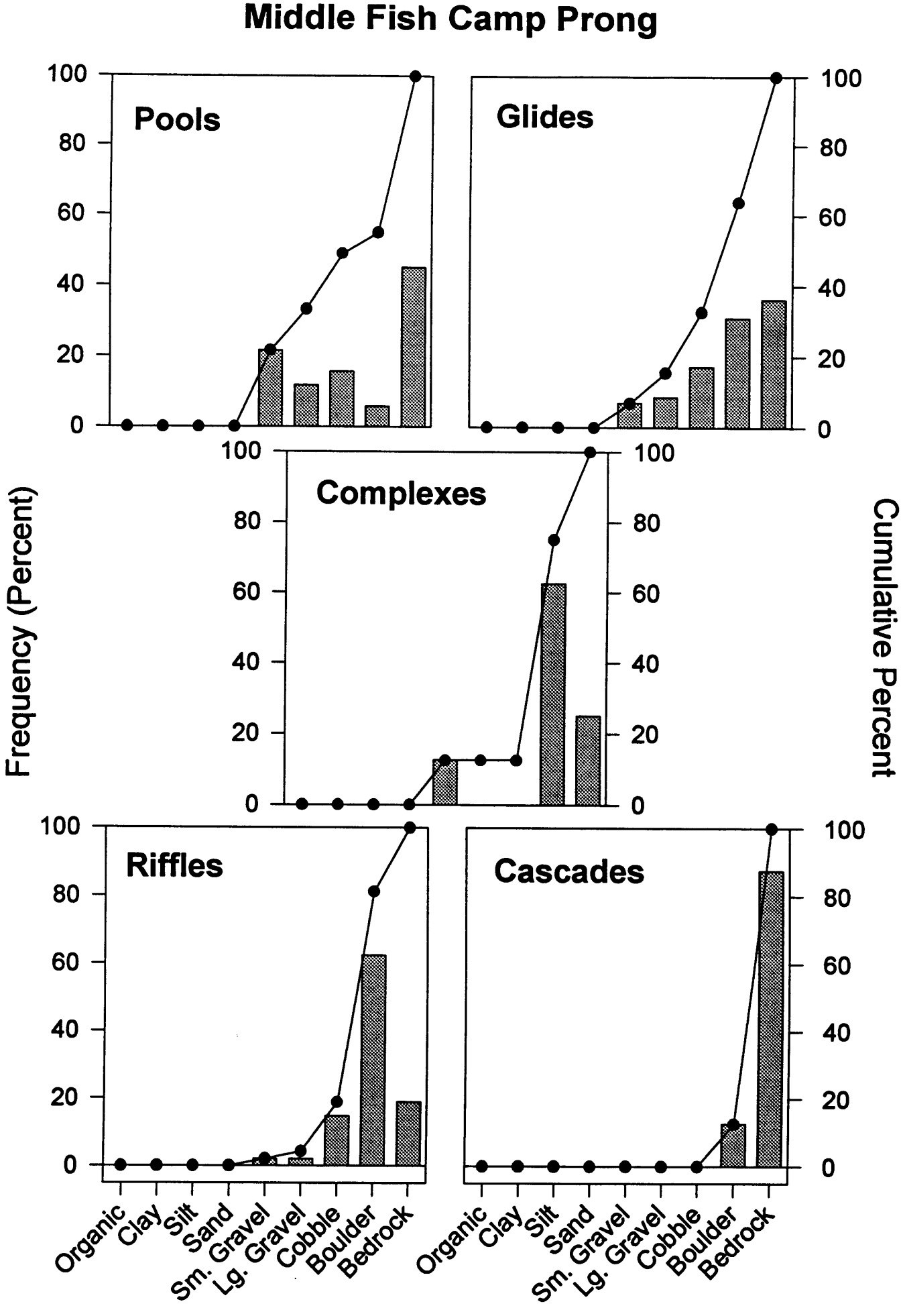
*Spring 1994 density data not available.

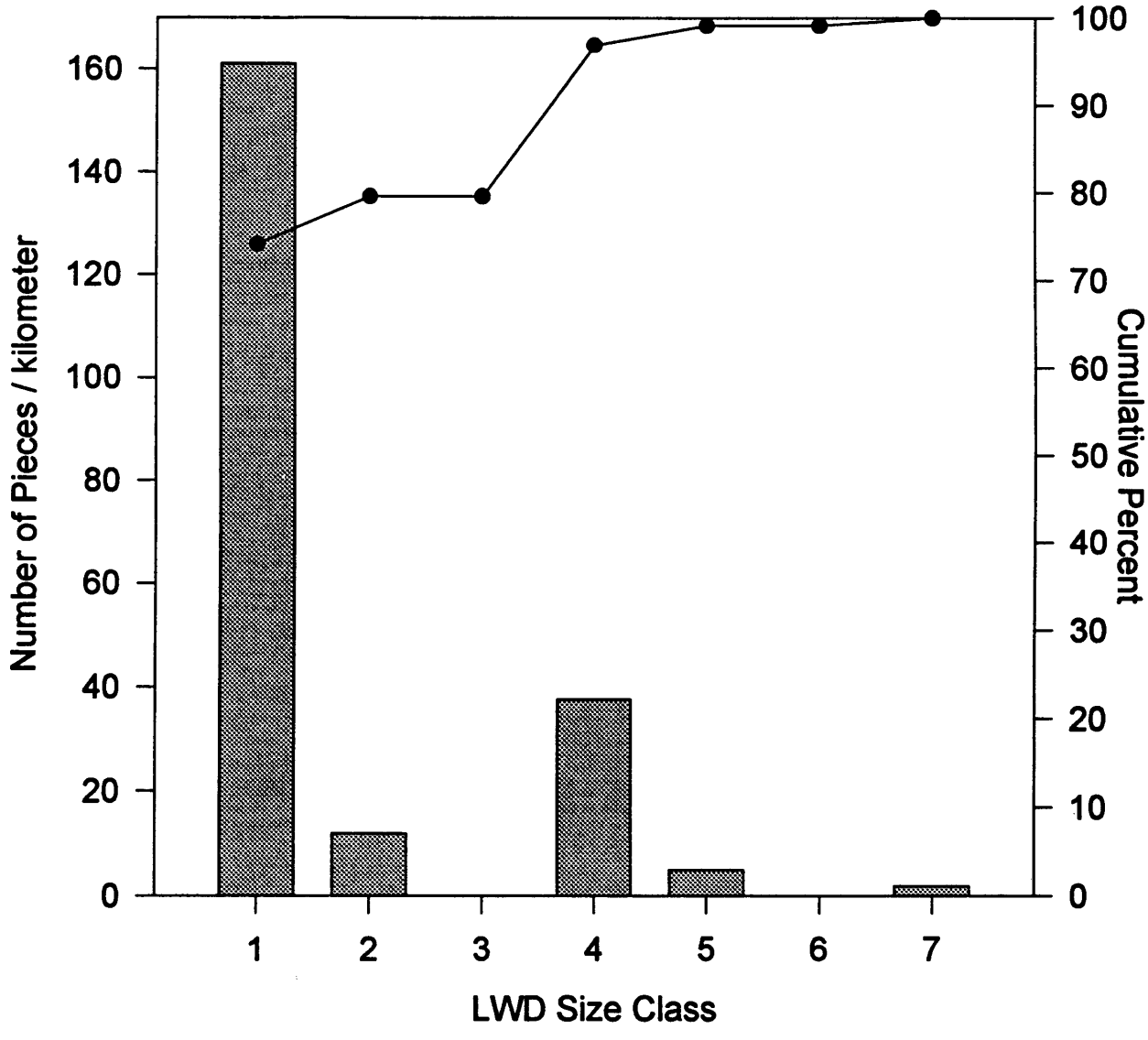
Middle Fish Camp Prong



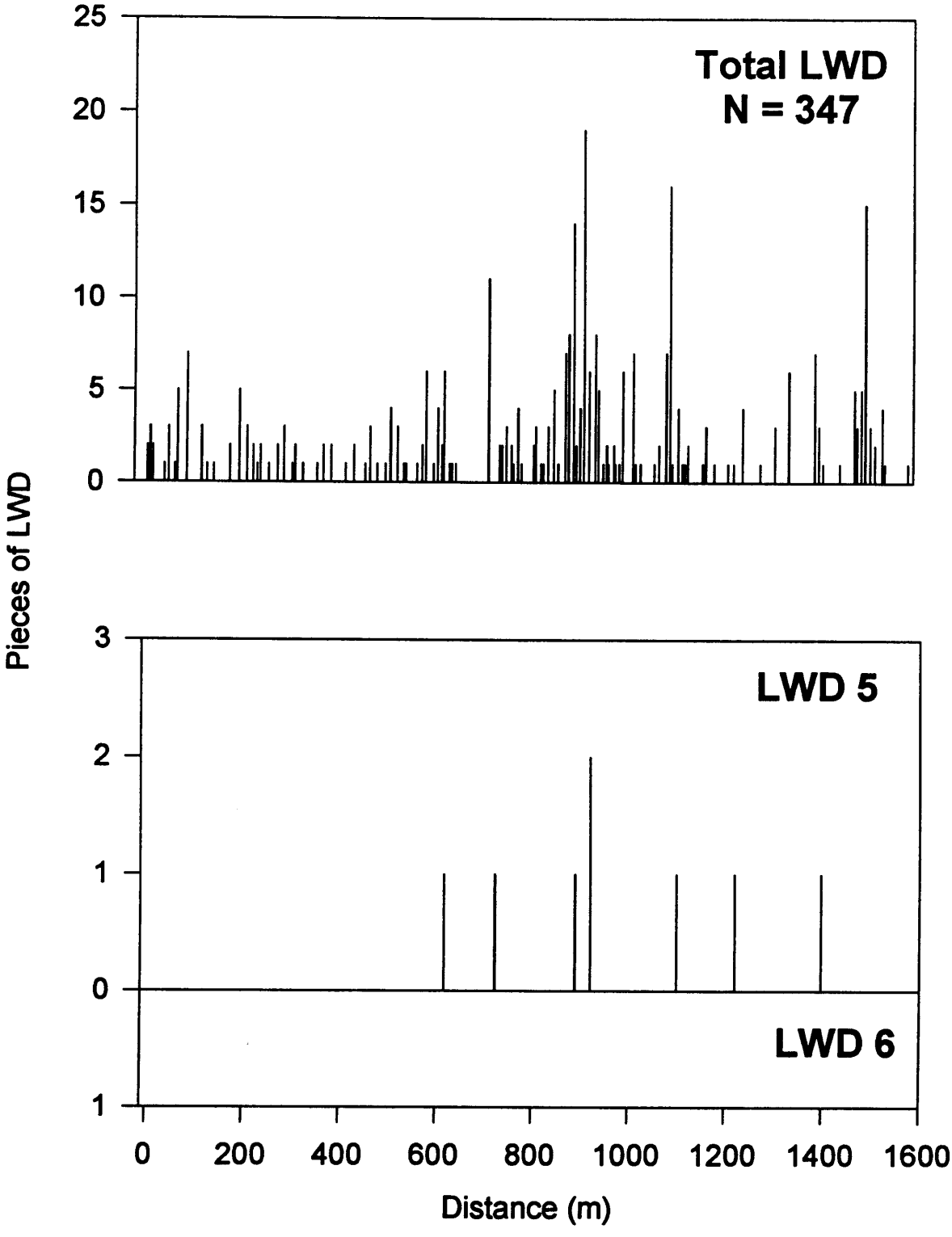
Middle Fish Camp Prong



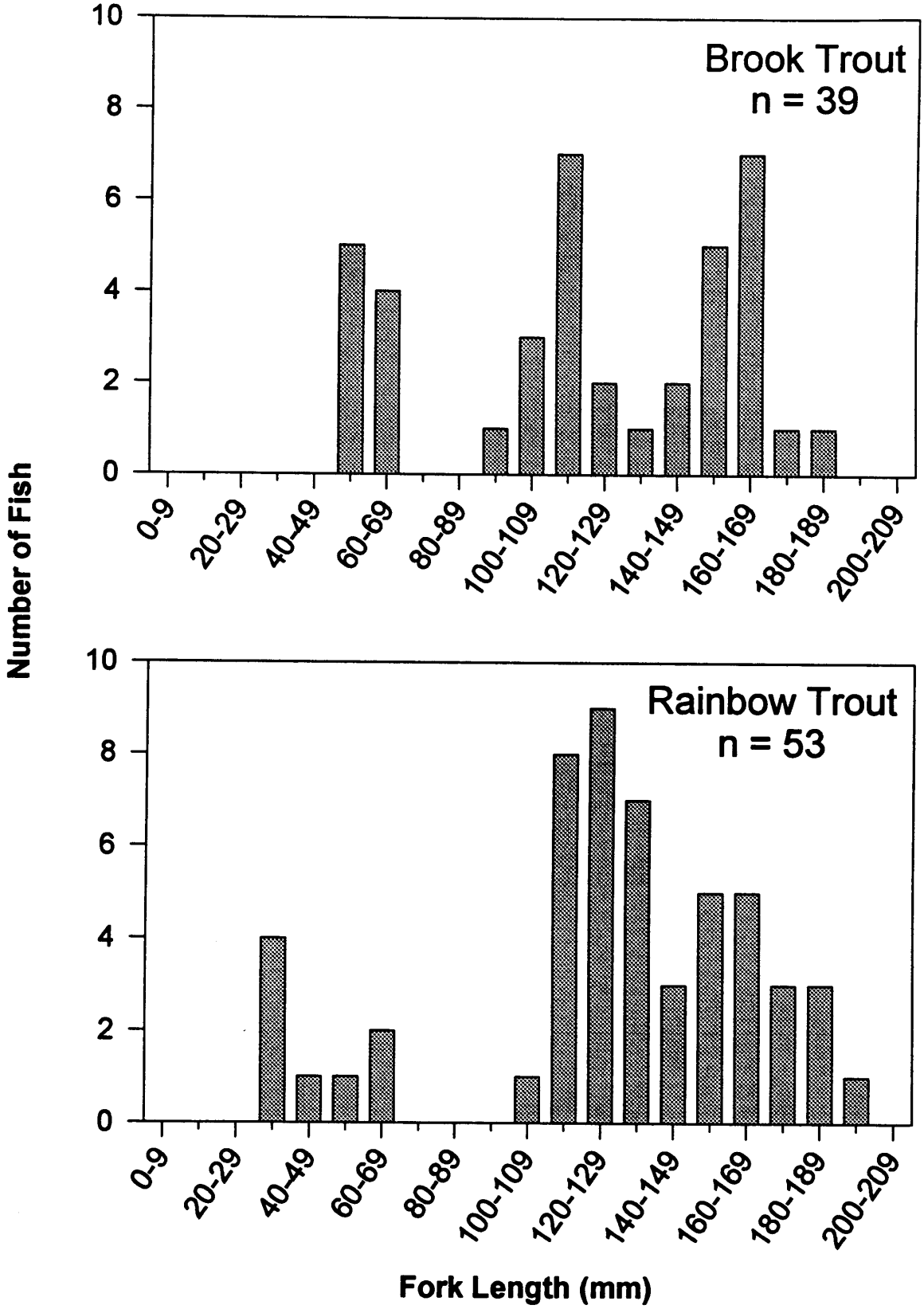

Middle Fish Camp Prong
Pools
Glides
Complexes
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock


Middle Fish Camp Prong
Number of Pieces / kilometer
Cumulative Percent
LWD Size Class
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7

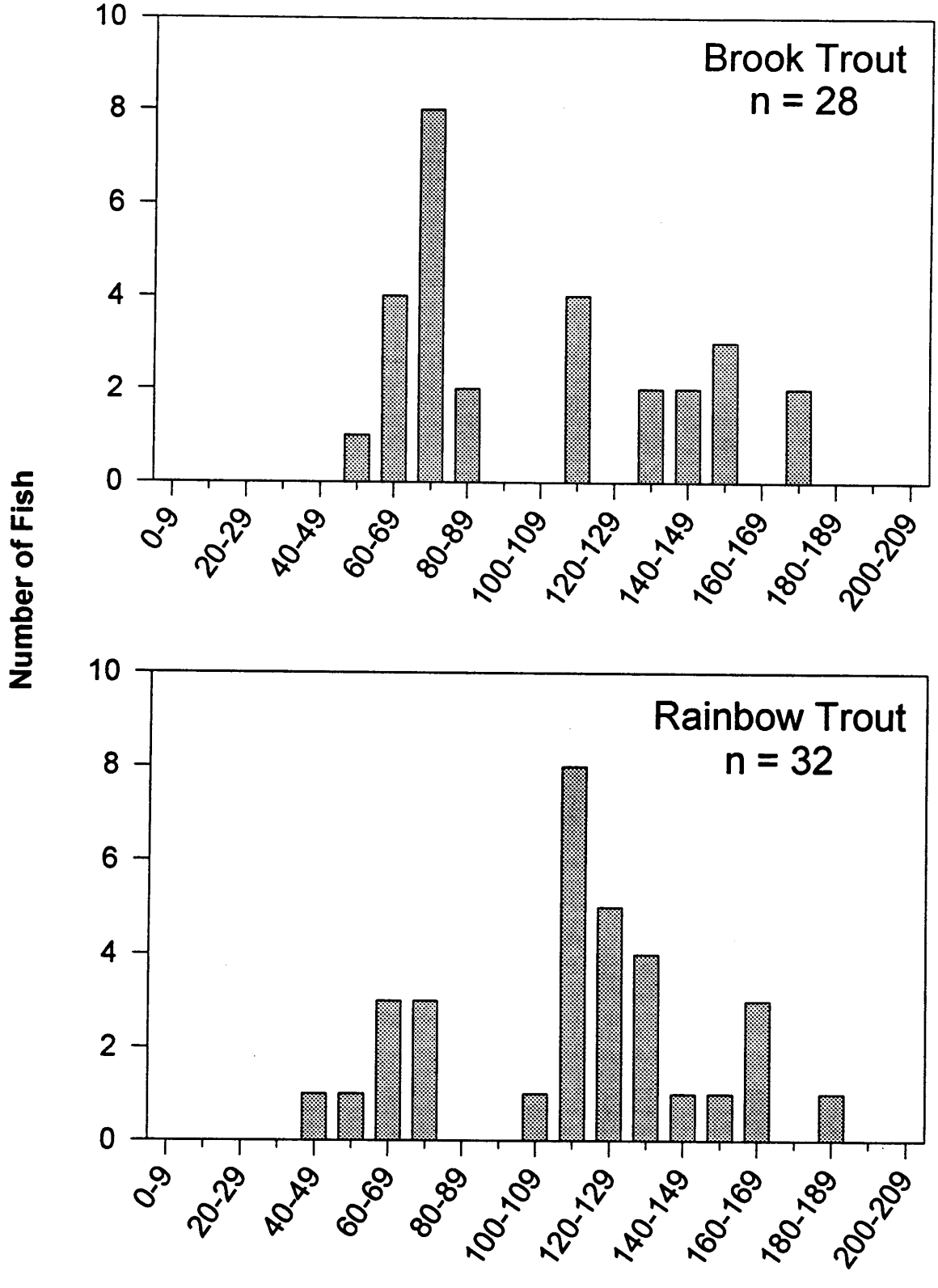
Middle Fish Camp Prong



Upper Fish Camp Prong
Spring 1993

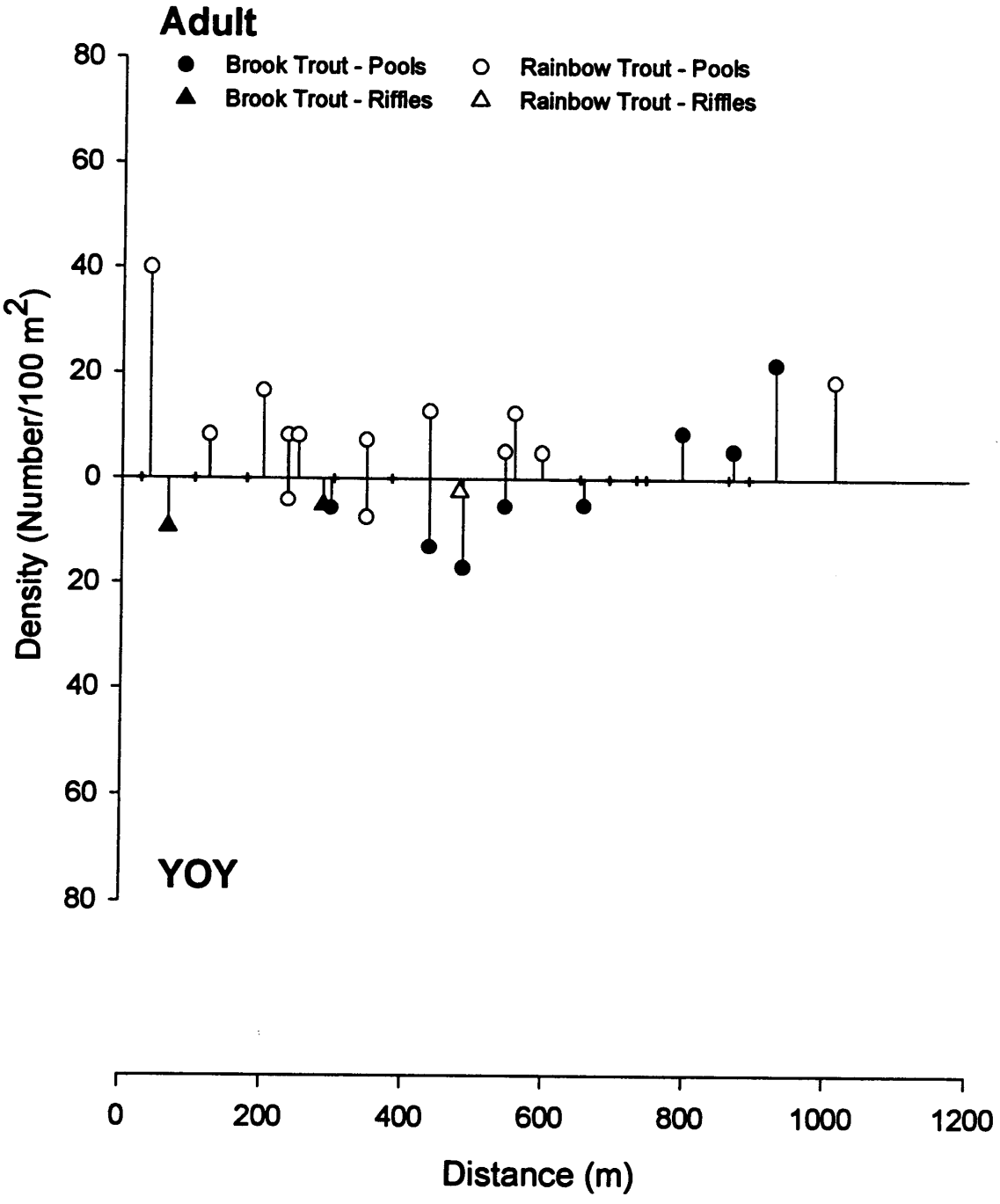


Upper Fish Camp Prong*
Fall 1993

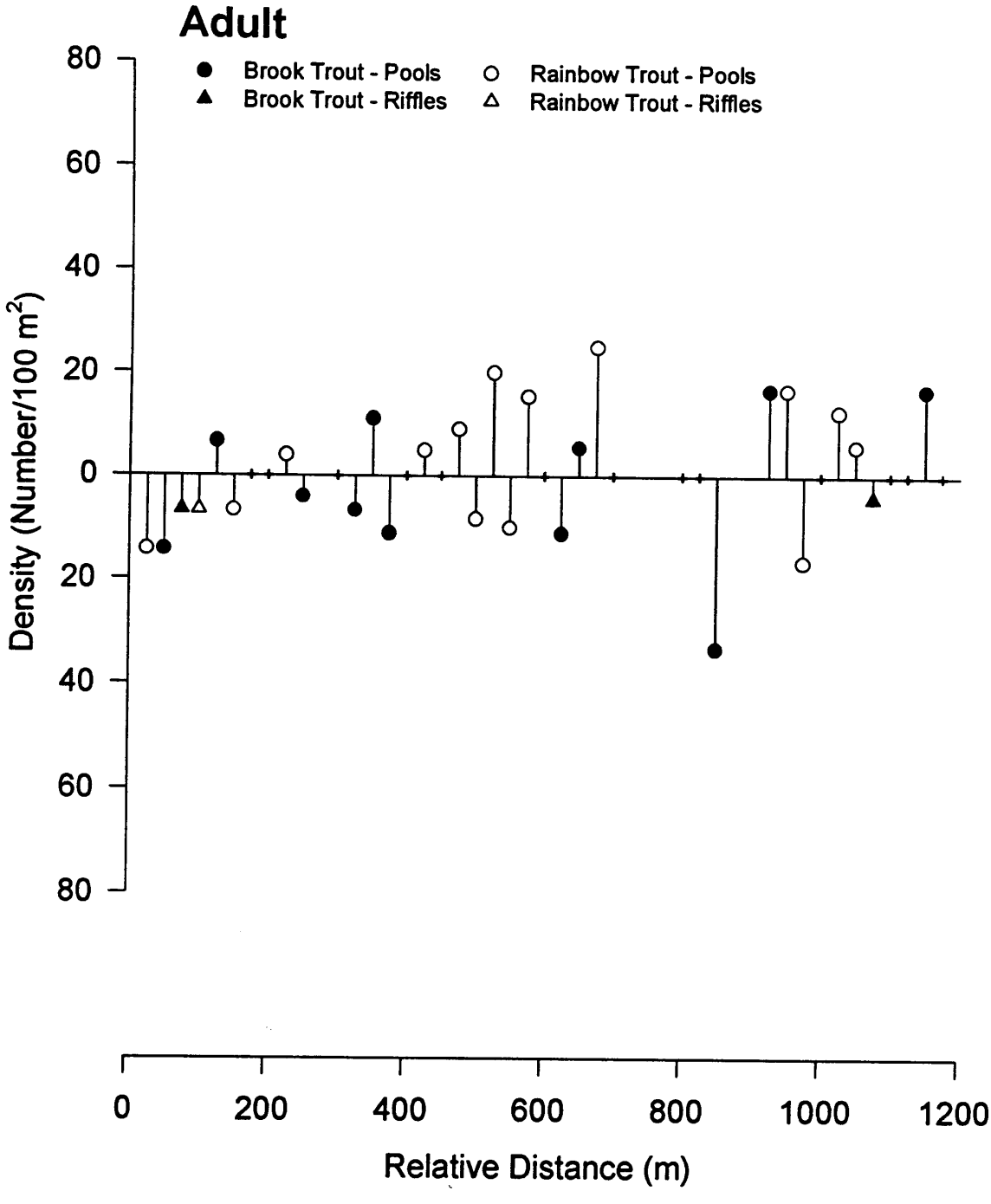


*Spring 1994 length frequency data not available.

Upper Fish Camp Prong
Spring 1993

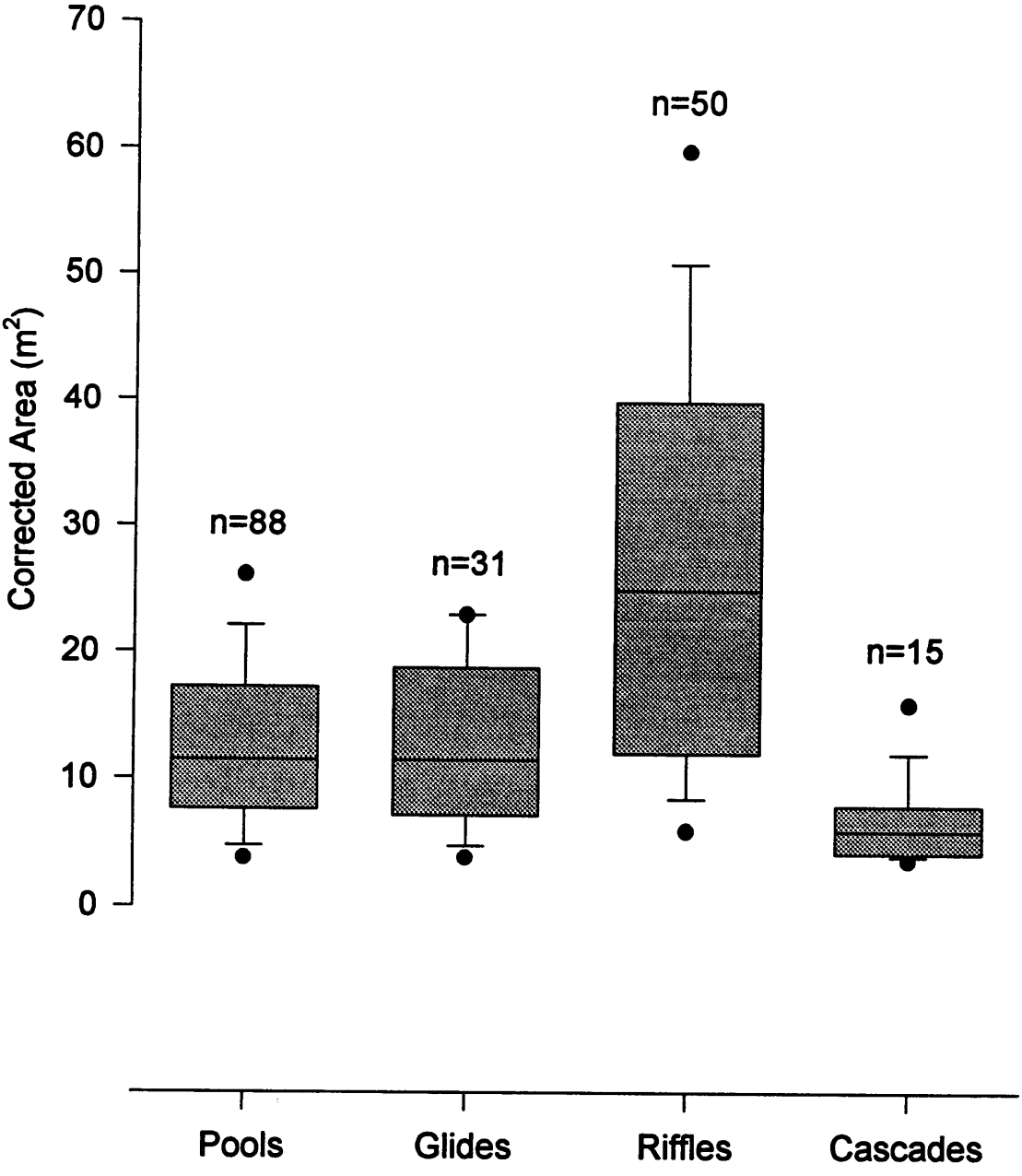


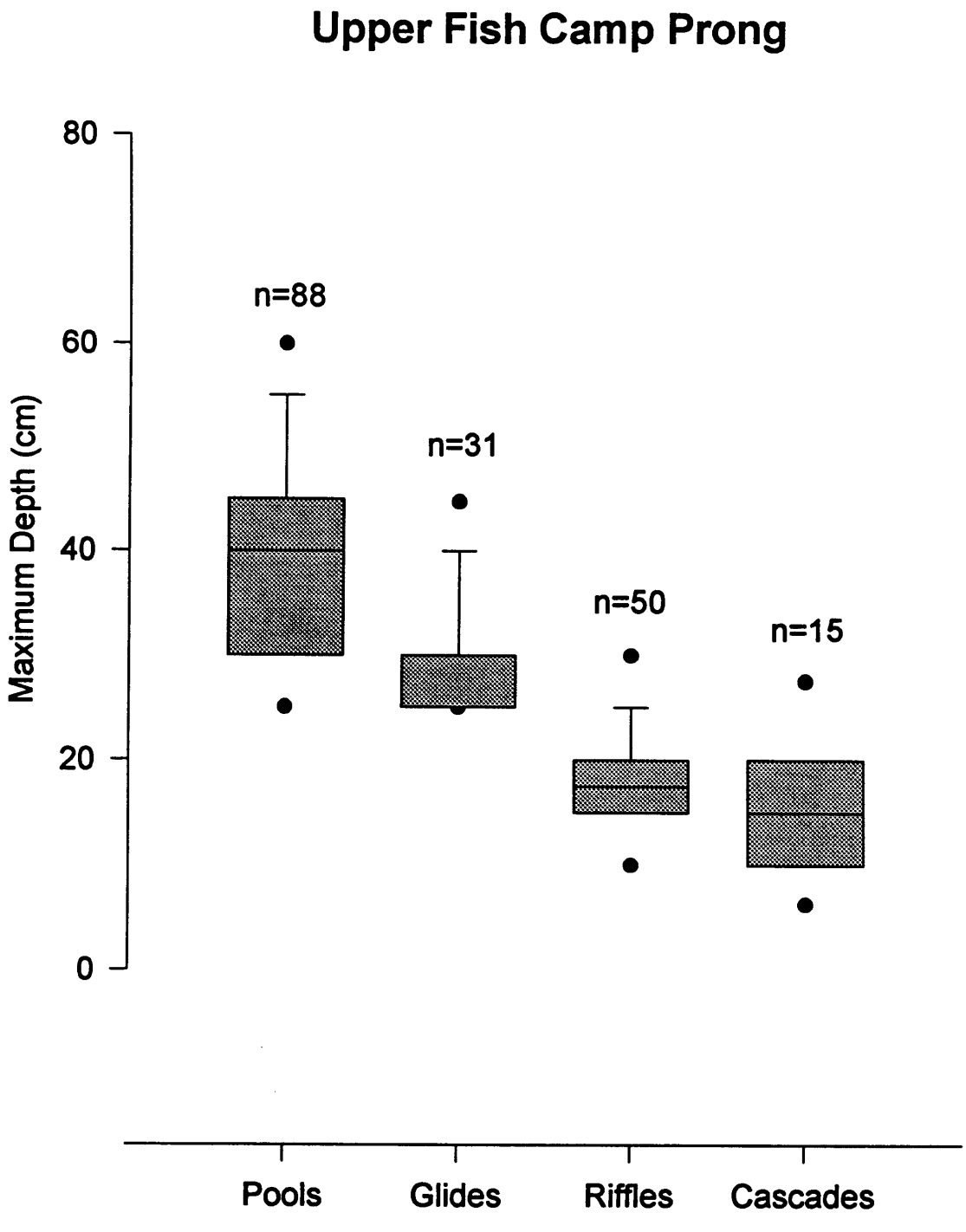
Upper Fish Camp*
Fall 1993

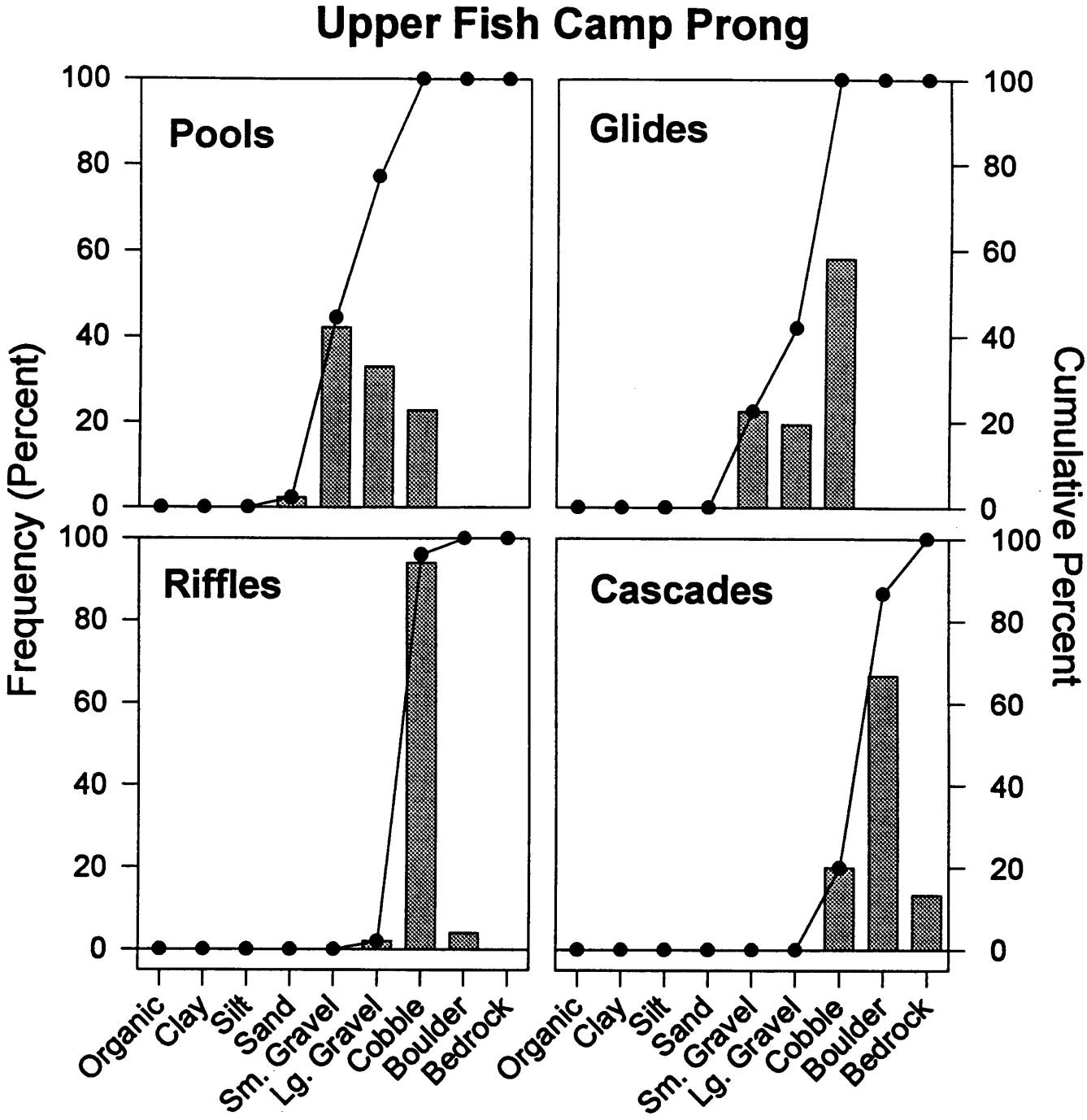


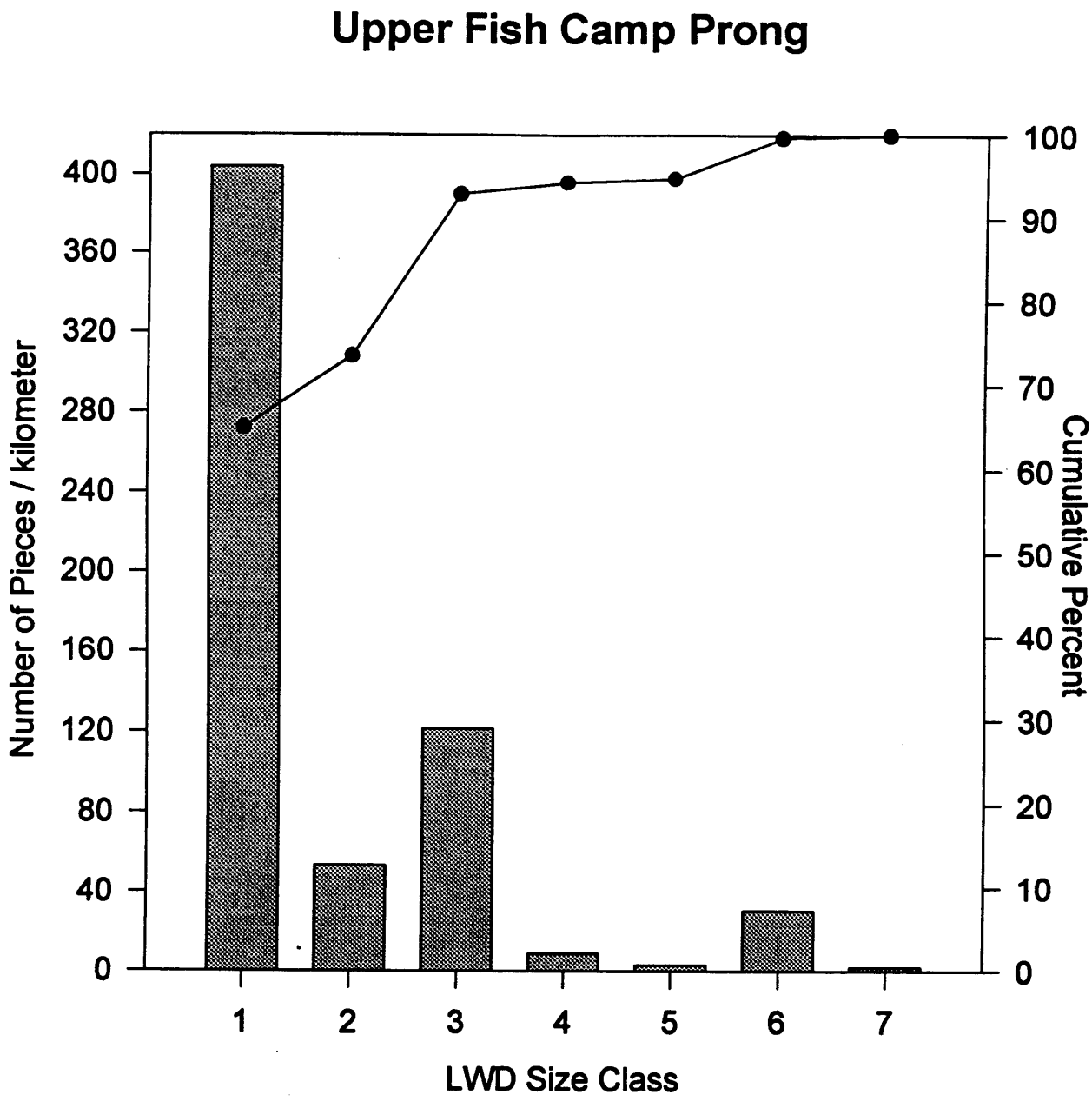
*Spring 1994 density data not available.

Upper Fish Camp Prong

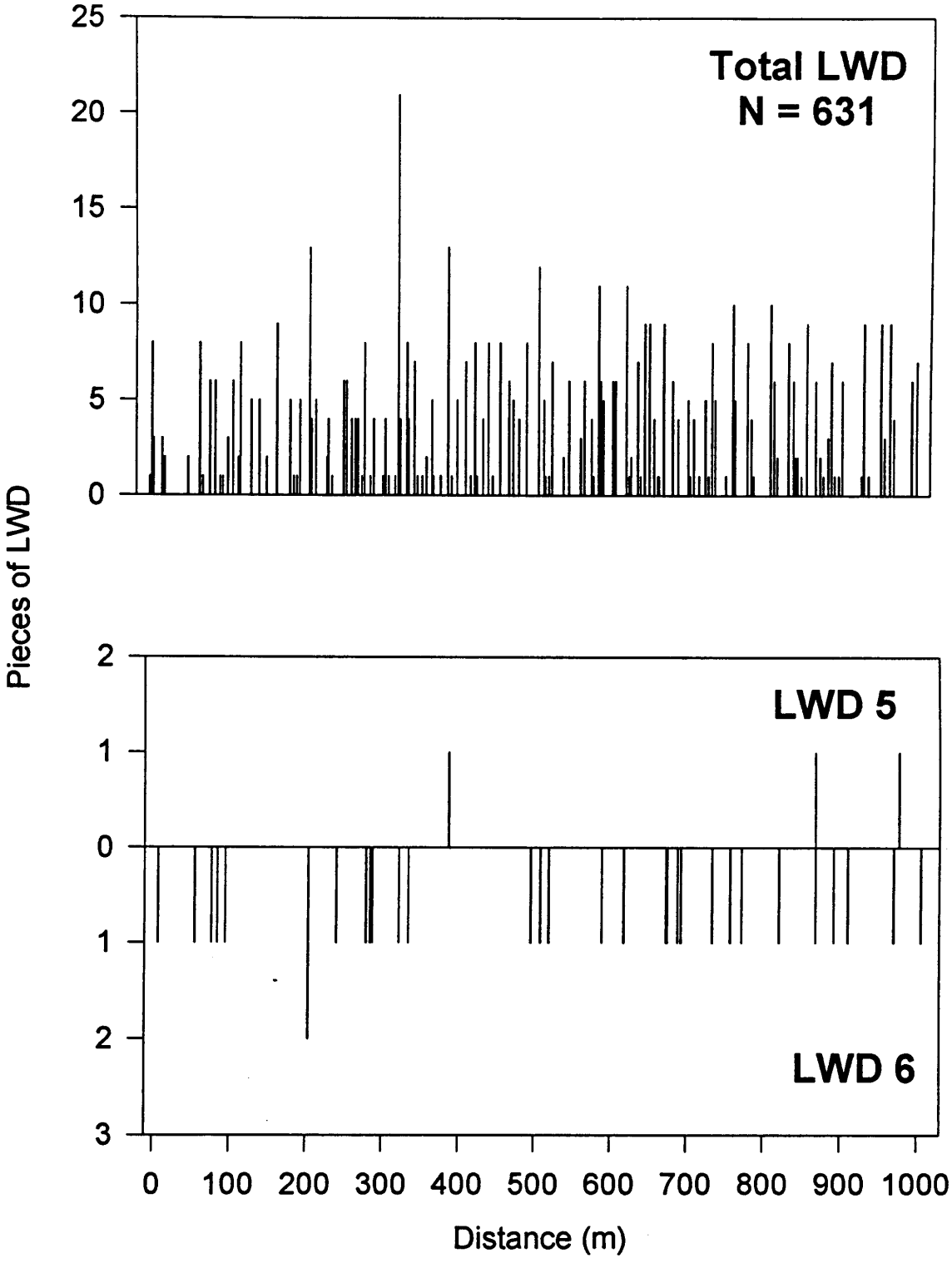



Upper Fish Camp Prong
Maximum Depth (cm)
80
60
40
20
0
n=88
n=31
n=50
n=15
Pools
Glides
Riffles
Cascades

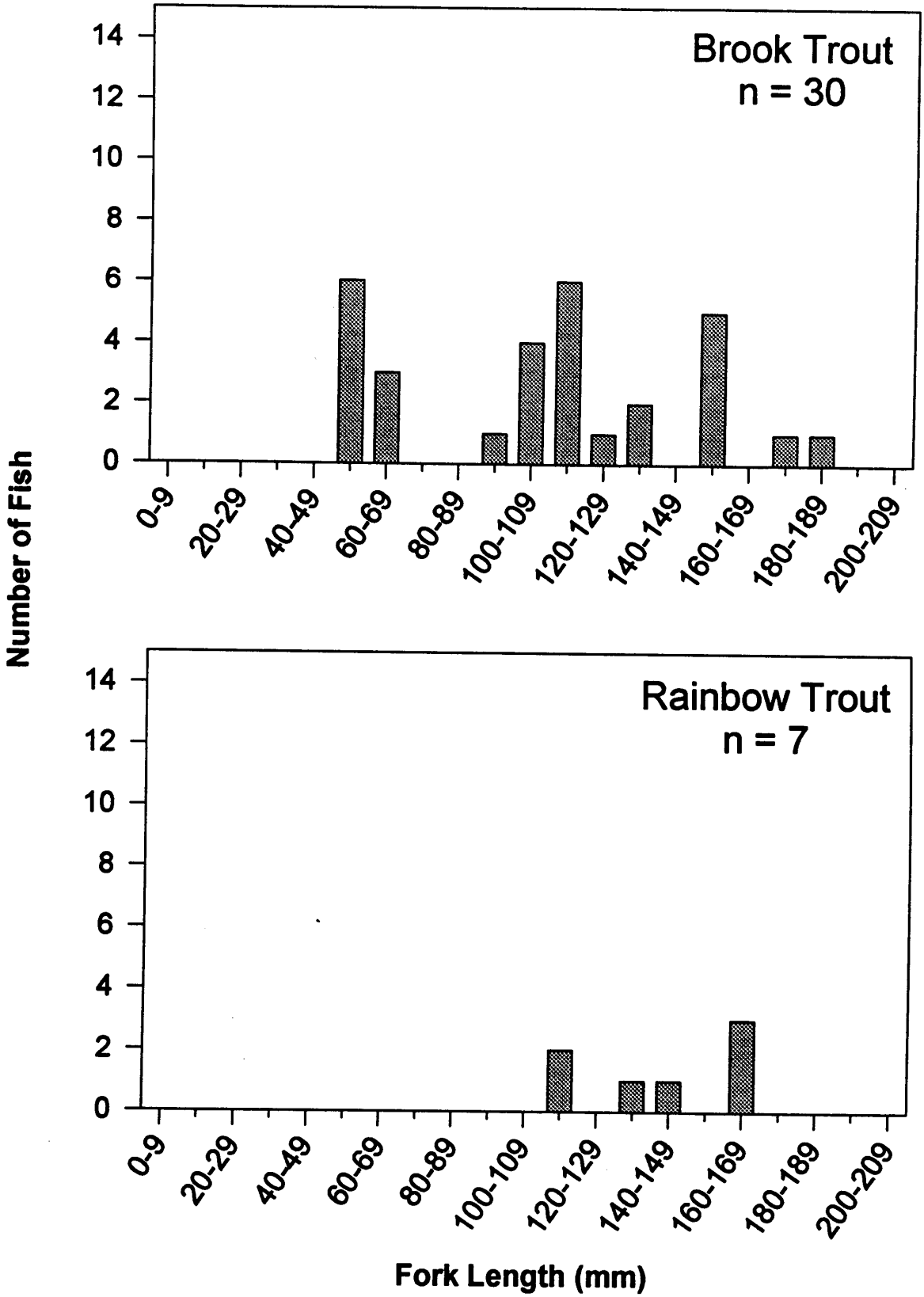

Upper Fish Camp Prong
Pools
Glides
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock


Upper Fish Camp Prong
Number of Pieces / kilometer
0
40
80
120
160
200
240
280
320
360
400
Cumulative Percent
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
LWD Size Class

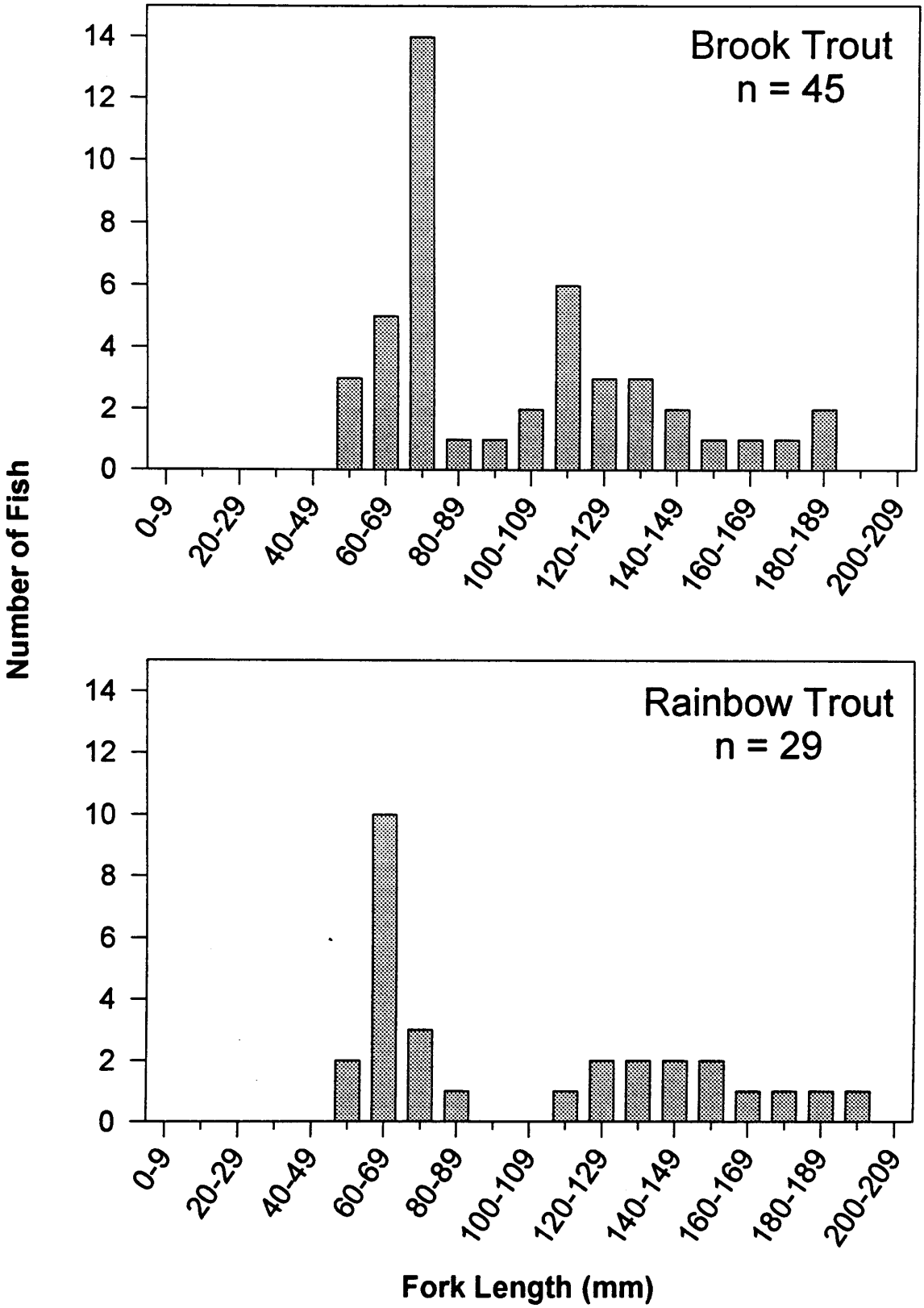
Upper Fish Camp Prong



Buckeye Gap
Spring 1993

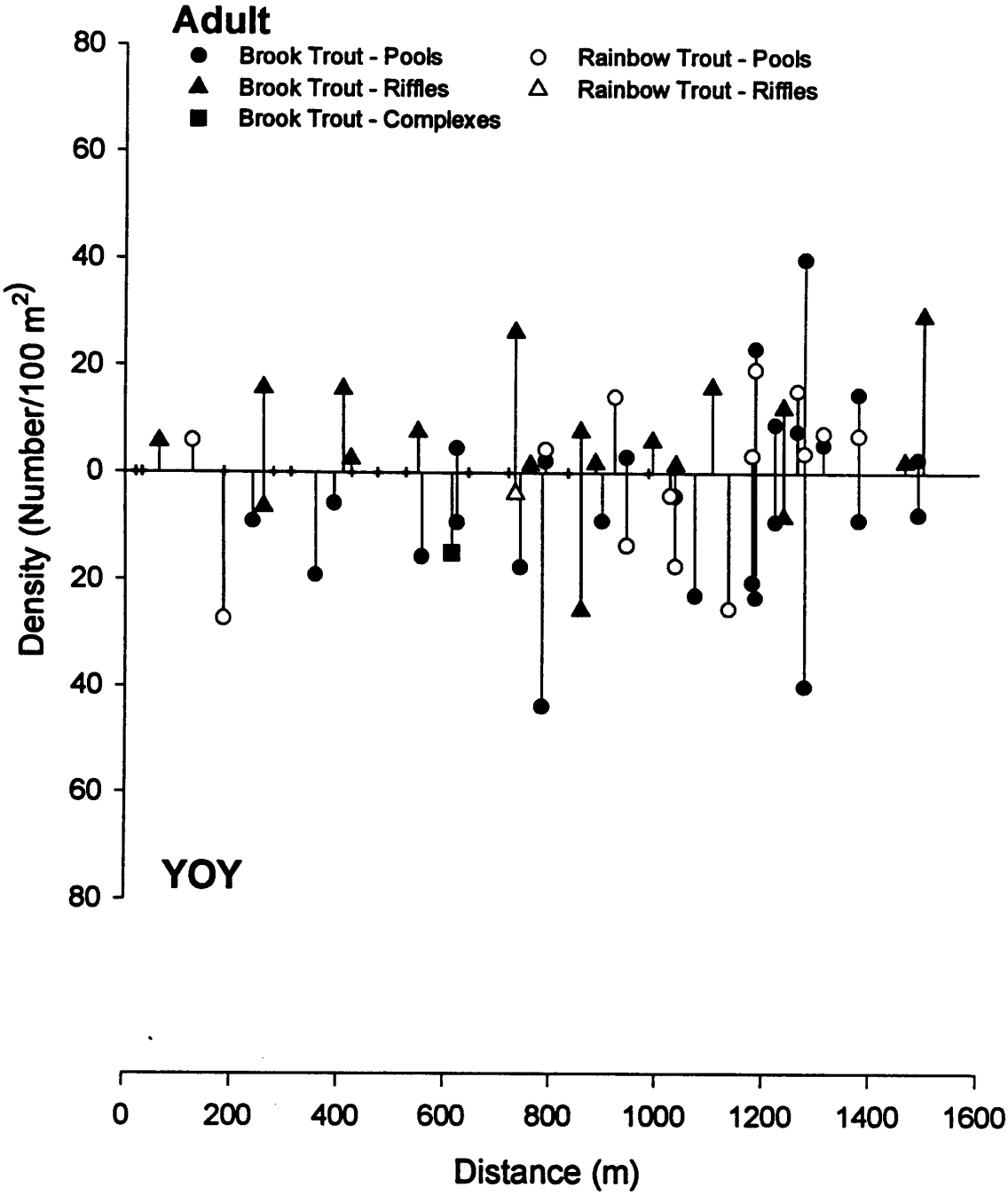


Buckeye Creek*
Fall 1993

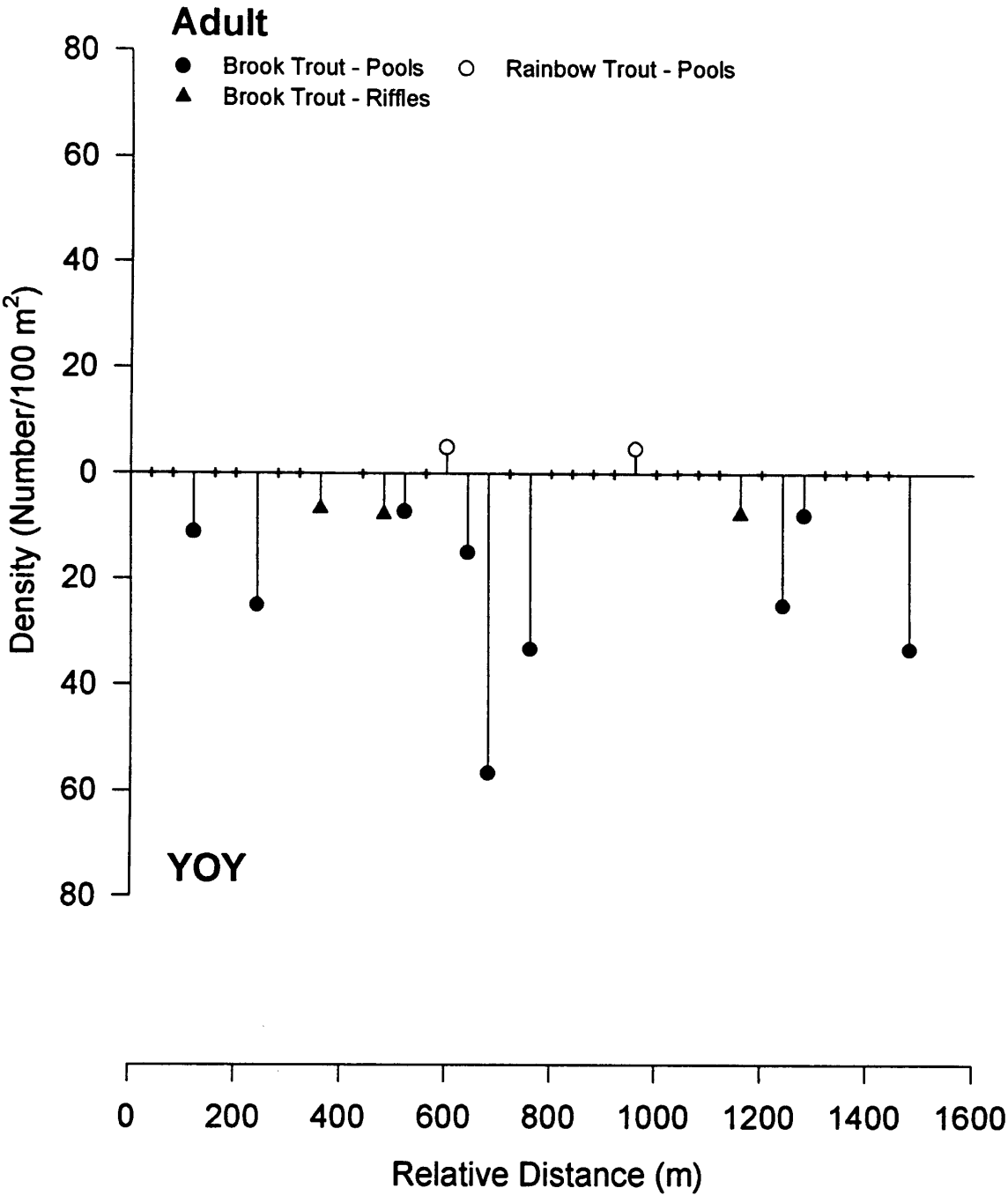


*Spring 1994 length frequency data not available.

Buckeye Gap
Spring 1993

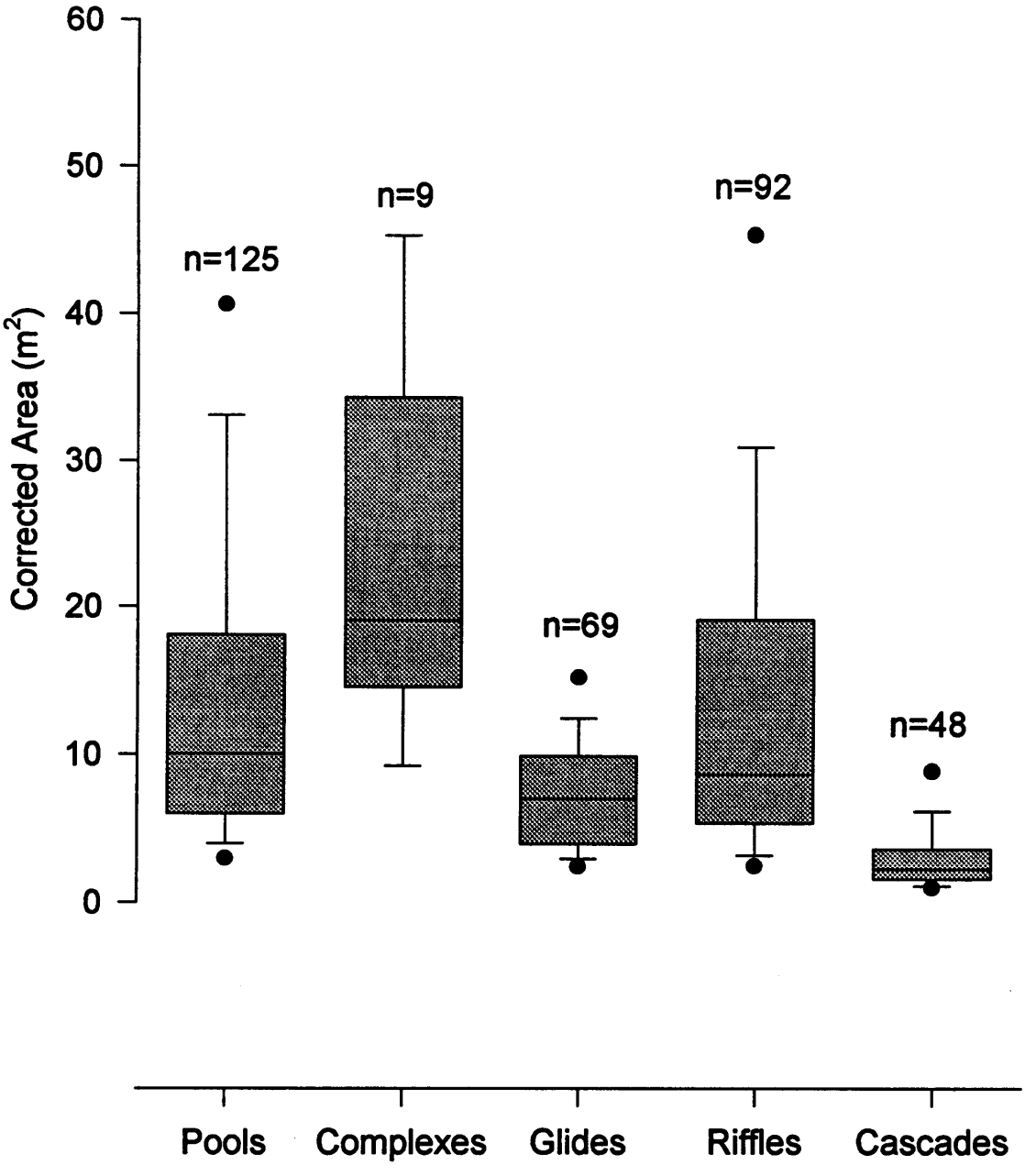


Buckeye Gap*
Fall 1993

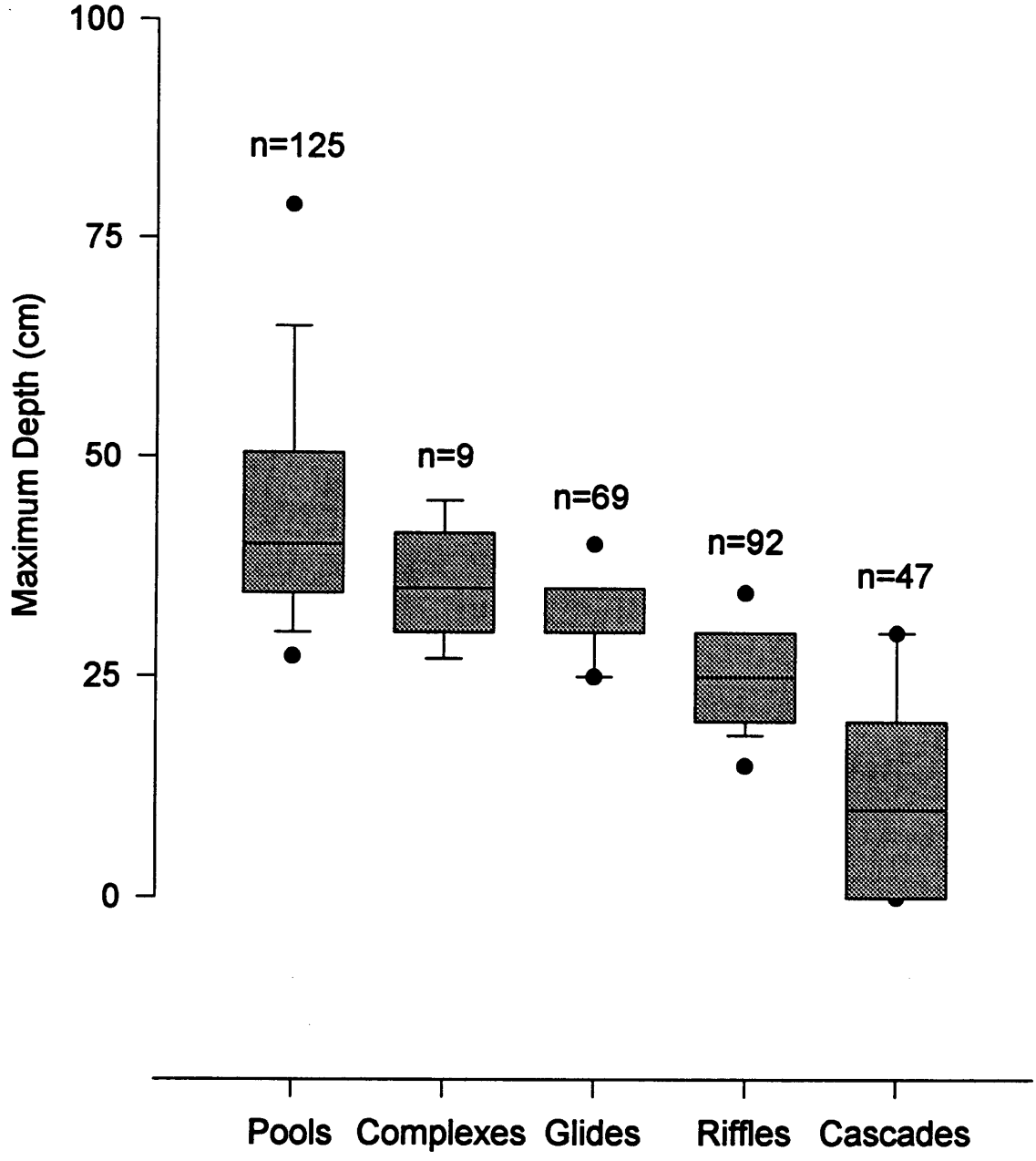


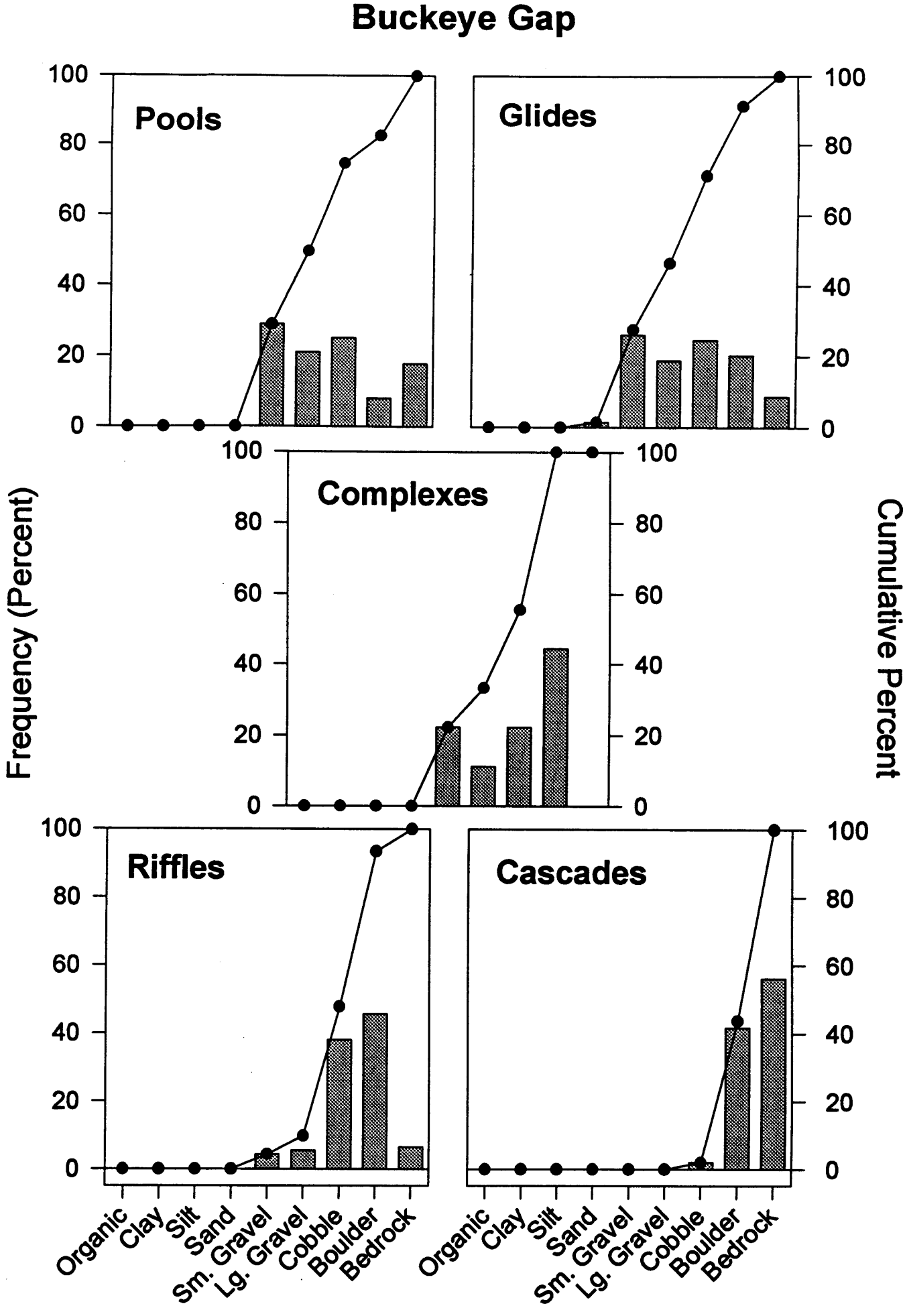
*Spring 1994 density data not available.

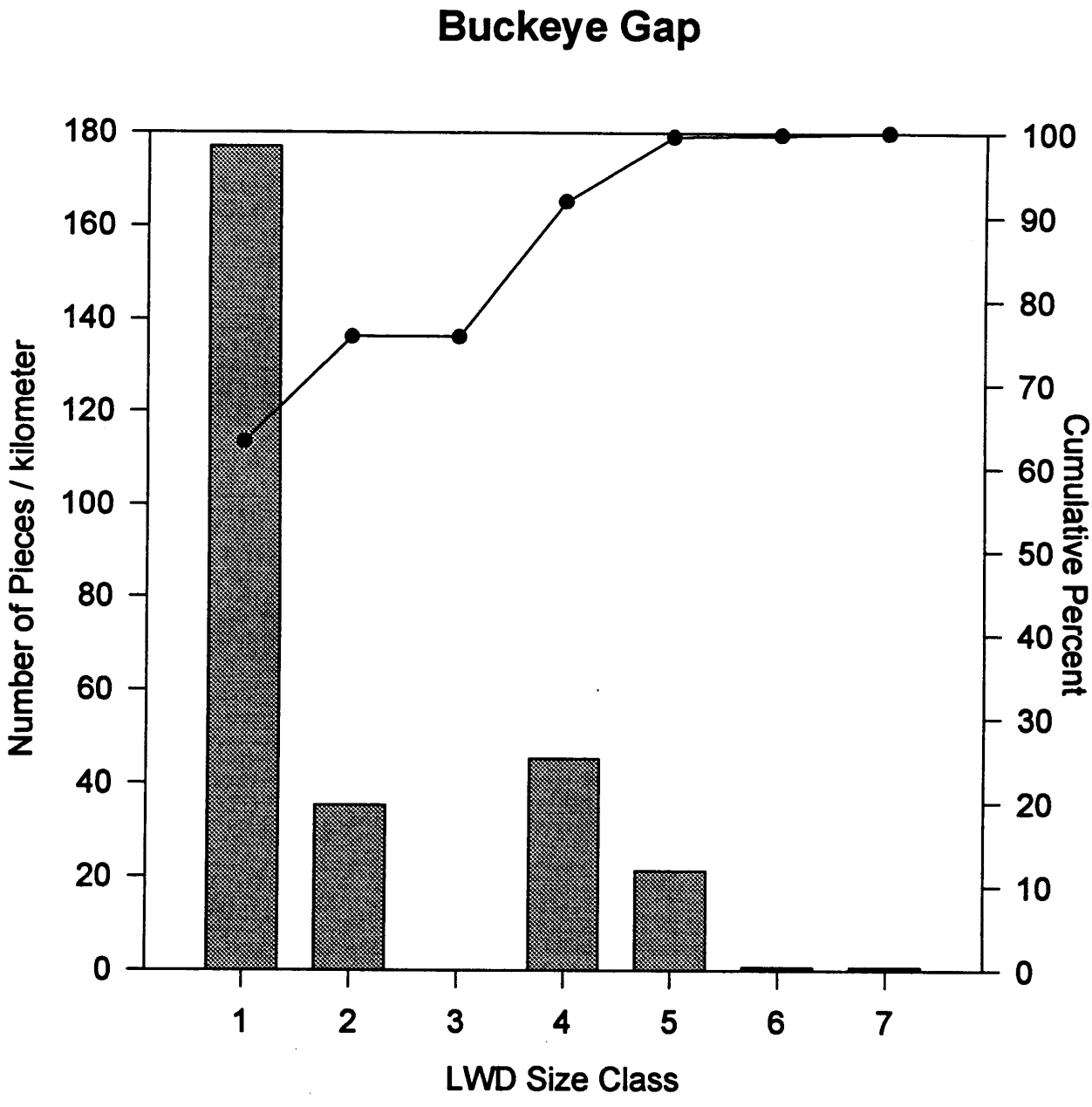
Buckeye Gap


60
50
40
30
20
10
0
Corrected Area (m2)
n=125
n=9
n=69
n=92
n=48
Pools
Complexes
Glides
Riffles
Cascades

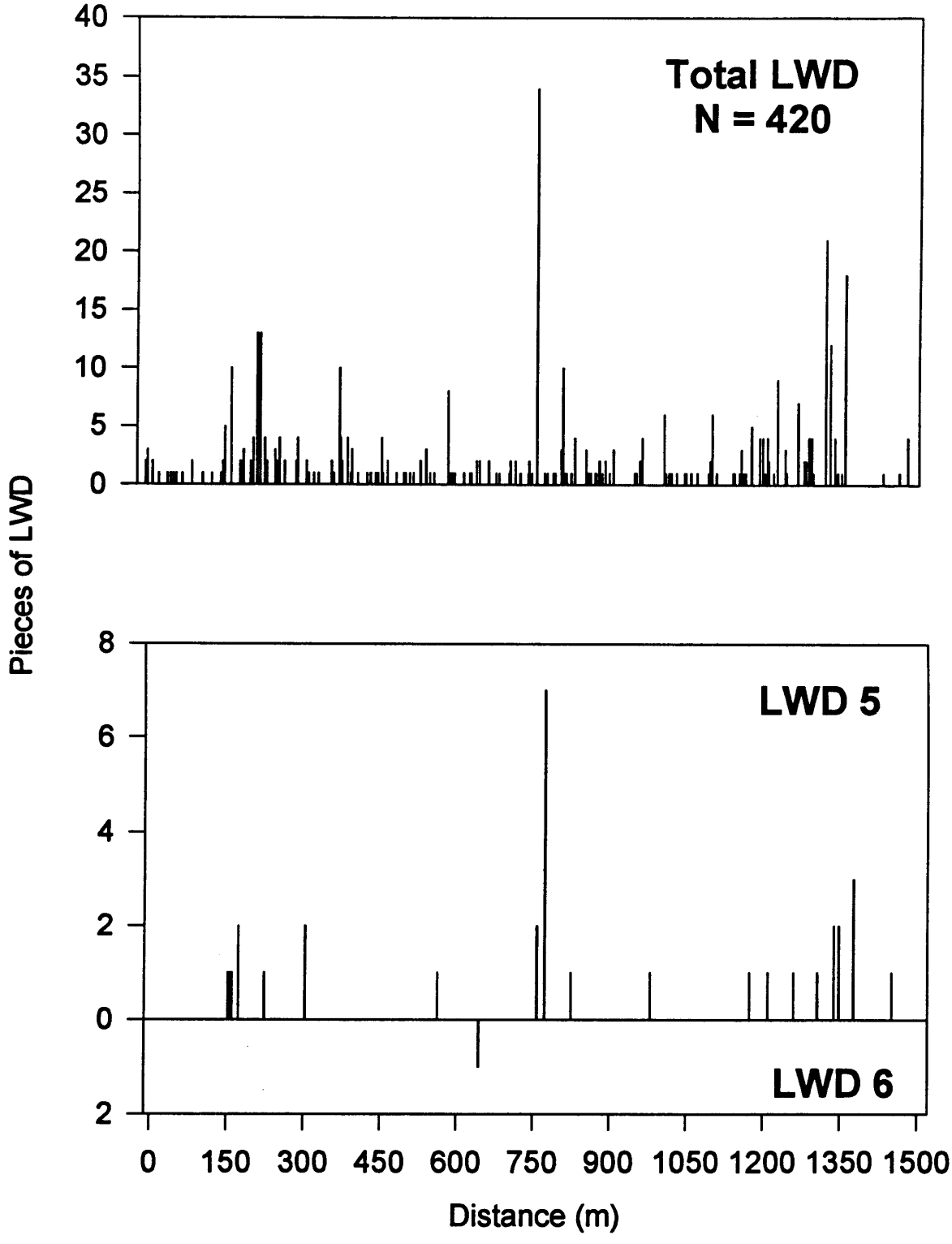
Buckeye Gap


100
75
50
25
0
Maximum Depth (cm)
n=125
n=9
n=69
n=92
n=47
Pools
Complexes
Glides
Riffles
Cascades


Buckeye Gap
Pools
Glides
Complexes
Riffles
Cascades
Frequency (Percent)
Cumulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm. Gravel
Lg. Gravel
Cobble
Boulder
Bedrock


Buckeye Gap
Number of Pieces / kilometer
Cumulative Percent
LWD Size Class
180
160
140
120
100
80
60
40
20
0
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7

Buckeye Gap


Total LWD
N = 420
LWD 5
LWD 6
Pieces of LWD
Distance (m)
40
35
30
25
20
15
10
5
0
8
6
4
2
0
2
0
150
300
450
600
750
900
1050
1200
1350
1500