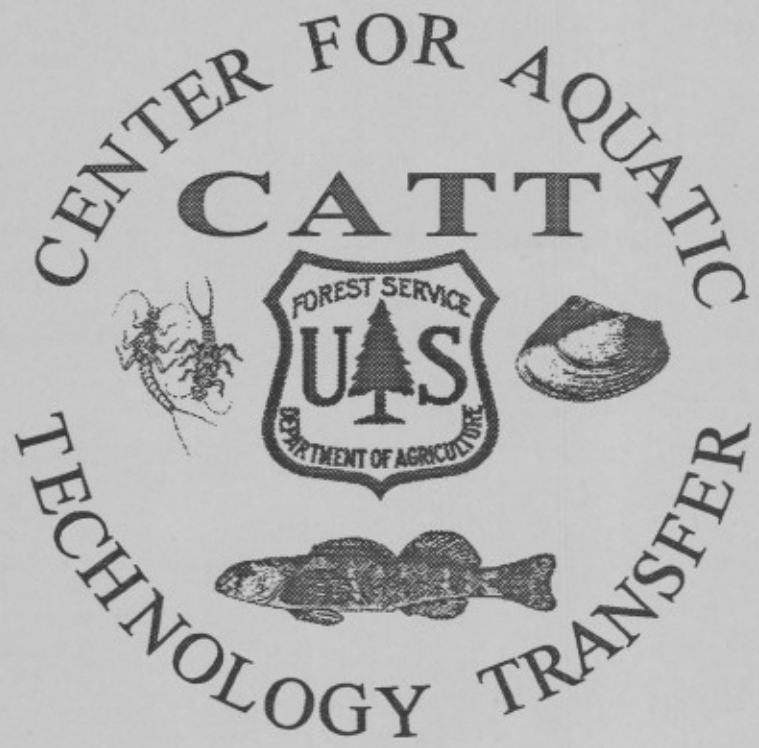
Current Conditions of Citico Creek, Tellico River, and Hiwassee River: Cherokee National Forest



United States Department of Agriculture Forest Service
Center for Aquatic Technology Transfer
Department of Fisheries and Wildlife Sciences
Virginia Tech, Blacksburg, VA 24061-0321

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Introduction

In Summer 1996 we surveyed stream habitat on the Cherokee National Forest (CNF) to quantify current stream conditions and identify suitable habitat for three federally protected fish. We modified standard basinwide visual estimation techniques (BVET)(Dolloff et al. 1993) to include measurements of stream habitat thought to be critical for the smoky madtom *Noturus baileyi*, yellowfin madtom *N. flavipinnis*, and duskytail darter *Etheostoma percnurum* (Pers. Comm., Conservation Fisheries Inc.). These habitat features included 1) number of suitably sized (greater than 20 inches in diameter) and positioned boulders, resting on clean gravel, used by smoky and yellowfin madtoms for spawning and 2) percentage of stream bottom covered by flat stones (12-18 inches in diameter surrounded by gravel) used by smoky madtoms and duskytail darters for cover (cover-stones). The BVET allowed us to estimate total habitat area, percentage of pool and riffle area (pool-riffle ratio), channel width, and substrata embeddedness, and to classify and tally the stream substratum particle size distribution. We also mapped the distribution of woody debris.

In this report we describe the current conditions of habitat in Citico Creek, where all three species are found, and two additional streams, Tellico River and Hiwassee River. In a second report, we will address potential relocation sites for smoky madtom, yellowfin madtom, and duskytail darter in the Tellico River and Hiwassee River.

Study Streams

We divided our survey of Citico Creek into upper and lower sections. The lower section began at the downstream Forest Service boundary and ended 5.3 miles upstream at the junction of Forest Route 35-1 and County Road 1202. The upper section began near this road junction

and ended 5.0 miles upstream near the intersection of Forest Routes 35-1 and 26 (Figure 1). We surveyed 4.9 miles of Tellico River beginning at the downstream Forest Service boundary (just upstream of Tellico Beach) and ending upstream near Buck Branch at the boundary between CNF and a private inholding (Figure 2). Our survey of Hiwassee River included a 3.8 mile section from the confluence of Turtletown Creek, upstream to the State Route 68 Bridge (Figure 3). Because this section of the Hiwassee River was made up multiple stream channels, we limited our survey to the main channel and we did not estimate the overall width of the stream at bankfull. As a result, the habitat inventory we report represents the minimum habitat in this river.

Methods

Sampling strata were based on naturally occurring habitat units including pools (areas in the stream with low water velocity, streambed gradient near zero, and a smooth water surface), glides (areas in the stream that is morphologically similar to pools but with swift flow through most of the unit), runs (areas in the stream with relatively steep gradient, with rapid, non-turbulent flow), and riffles (areas in the stream with relatively steep gradient, shallow water, relatively high velocity, and turbulent surface). To account for within-habitat-unit differences in substrate composition, pools and glides were subdivided into three sections (upper, middle, and lower) unless the substrata composition appeared to be homogenous.

Our three-person crews used two-stage visual estimation techniques to quantify habitat in the study streams. During the first stage, one crew member identified each habitat unit by type, estimated wetted stream width, estimated stream channel width, classified the dominant and subdominant substrata particle size (Table 1), estimated the percentage of the substrata composed of cover-stones (flat stones 12-18 in diameter surrounded by gravel), and assessed substrata

embeddedness (siltation). Substrata embeddedness was assessed by visually estimating the proportion of the substrata and interstitial spaces covered with fine silt and clay particles (Table 2). The remaining crew members classified and inventoried large woody debris (LWD) associated with each habitat unit (within the stream channel), estimated the maximum and average depth of each habitat unit, counted boulders suitable for madtom spawning, and recorded the data on a Husky Hunter field data logger. LWD greater than 4-ft long and greater than 4-in diameter was divided into four classes: 1) less than 15-ft long, less than 14-in diameter, 2) less than 15-ft long, greater than 14-in diameter, 3) greater than 15-ft long, less than 14-in diameter, and 4) greater than 15-ft long, greater than 14-in diameter. Average depth of each habitat unit was estimated by taking depth measurements at various places across the channel profile with a graduated staff marked in 0.1-ft increments. The length and location (0.1 ft) of each habitat unit was measured with a hip chain.

The first unit of each habitat type selected for intensive sampling (accurate measurement of surface area - second stage sampling) was determined randomly. Additional units were selected systematically (about one unit out of five for each habitat type). The wetted width and stream channel width (at bankfull as described by Harrelson et. al 1994) of these systematically selected habitat units was measured with a 50-ft measuring tape at intervals ranging from about 5 ft to 15 ft.

BVET calculations were computed using a Statistical Analysis Systems (SAS) program developed by Dr. Patricia Flebbe (100 Cheatham Hall, VA Tech, Blacksburg, VA 24060). Data were summarized using a Quattro Pro spreadsheet, Sigma Plot graphics software, and SigmaStat statistical software.

Results and Discussion

Lower Citico Creek - We identified 62 pools, 14 glides, 26 runs, and 43 riffles in the lower Citico Creek study section. Visual estimates of habitat areas were paired with measured habitat area for 12 (15%) pools and glides, and 12 (17%) runs and riffles. We estimated that the lower study section of Citico Creek was 70 percent pool-glide habitat (29.3 $\pm$ 2.0 acres) and 21 percent run-riffle habitat (7.7 $\pm$ 0.6 acres). Total area was estimated for each habitat type using correction factors ($\hat{Q}$) that ranged from 0.96 to 1.04.

We estimated the average stream channel width in the lower Citico Creek section was 72.3 ft. Although highly variable, stream channel widths in general were narrowest when associated with pool habitats and widest when associated with riffle habitat (Figure 4).

Substrate in the lower Citico Creek was composed primarily of cobble (dominant substratum) and large gravel (subdominant substratum) and was relatively unembedded (Figure 5). The dominant and subdominant substrata, however, varied between habitat types and pool sections (Figures 6 and 7). The percentage of the substrata composed of suitable cover-stones for smoky madtoms and duskytail darters in pools and glides was relatively high in this section but ranged considerably between individual habitat units (Figure 8). The number of boulders, suitable for smoky madtom and yellowfin madtom spawning, also varied between individual habitat units and sections; ranging from 0 to 13 (Figure 9).

Maximum depth in the lower Citico Creek study section ranged from 0.7 ft in riffles to 9.2 ft in pools (Figure 10). Likewise, average depth ranged from 0.5 ft in riffles to 5.3 ft in pools (Figure 11).

Lower Citico Creek contained about 110 pieces of LWD per mile, which was most abundant near the middle of the study section (Figures 12 and 13). This section, however,

contained less than 10 pieces per mile of the larger size classes which are the most stable and most capable of forming instream habitat and providing cover for fishes (Figure 12).

Upper Citico Creek - We identified 120 pools, 8 glides, 3 runs, and 83 riffles in the upper Citico Creek study section. Visual estimates of habitat areas were paired with measured habitat area for 24 (19%) pools and glides, and 17 (20%) runs and riffles. Pool-riffle ratio was less in upper Citico Creek than in the lower study section. We estimated that the upper study section of Citico Creek contained 53 percent pool and glide habitat (16.9 $\pm$ 1.2 acres) and 47 percent run and riffle habitat (14.8 $\pm$ 0.9 acres). Total area was estimated for each habitat type using correction factors ($\hat{Q}$) that ranged from 0.99 to 1.03.

We estimated the average stream channel width in the upper Citico Creek section to be 69 ft, slightly less than in the lower Citico Creek study area. We observed stream channel widths to be slightly wider when associated with riffle habitats than with pool habitat (Figure 14). Nevertheless, the width of the stream channel was highly variable (Figure 14).

We observed less siltation in the upper Citico Creek study section than in the lower section. The substrata in the upper Citico Creek study section was relatively free of silt; silt covered less than six percent of the substrata in most cases (Figure 15). Substrate composition in both sections of Citico Creek was similar. We identified cobble and large gravel as the most common (modal) dominant and subdominant substratum, respectively. The dominant and subdominant substrata, however, varied between habitat types and pool sections (Figures 16 and 17). We observed the number of pools and glides containing a high percentage of the substrata composed of suitable cover-stones for smoky madtoms and duskytail darters to be lower in this section than in the lower Citico Creek study section (Figure 18). The number of boulders for

suitable spawning varied between individual habitat units and pool sections but was generally higher in this section than in the lower section; ranging from 0 to 29 (Figure 19).

Maximum depth in the upper Citico Creek study section ranged from 0.7 ft in riffles to 7.2 ft in pools and similar to depths in the lower section (Figure 20). Likewise, average depth ranged from 0.5 ft in riffles to 4.3 ft in pools (Figure 21).

Upper Citico Creek contained about 95 pieces of LWD per mile; uniformly distributed throughout the study section (Figures 22 and 23). This section, however, contained less than five pieces per mile of the larger size classes (Figure 22).

Tellico River - We identified 41 pools, 24 glides, 4 runs, and 51 riffles in the Tellico River study section. Visual estimates of habitat areas were paired with measured habitat area for 16 (25%) pools and glides, and 13 (23%) runs and riffles. Pool-riffle ratio was substantially lower in Tellico River than in Citico Creek. We estimated that the Tellico River study section contained 46 percent pool-glide habitat (27.0 ± 2.1 acres) and 54 percent run-riffle habitat (31.4 ± 3.4 acres). Total area was estimated for each habitat type using correction factors ($\hat{Q}$) that ranged from 0.94 to 1.03.

We estimated the average stream channel width in the Tellico River section to be 106.9 ft. In general, we observed stream channel widths to be narrowest when associated with glide habitats and widest when associated with riffle habitat (Figure 24). Nevertheless, the width of the stream channel was highly variable (Figure 24).

We observed higher levels of substrata embeddedness in Tellico River than in Citico Creek (Figure 25). Nevertheless, few pools and glides showed greater than 50 percent embeddedness of substrata particles (Figure 25). We identified bedrock and boulder as the most common (modal)

dominant and subdominant substratum, respectively, in the Tellico River study section. Although substrate composition generally differed from Citico Creek, Tellico River contained a substantial amount of rocky substrata (Figures 26 and 27). We observed the number of pools and glides containing a high percentage of the substrata composed of suitable cover-stones for smoky madtoms and duskytail darters to be lower in Tellico River than in Citico Creek (Figure 28). The number of boulders suitable for spawning was generally greater in Tellico River than in Citico Creek but varied between individual habitat units and sections; ranging from 0 to 37 (Figure 29).

Maximum depth in the Tellico River study section was generally deeper than depths in Citico Creek and ranged from 0.7 ft in riffles to 13.0 ft in pools (Figure 30). Likewise, average depth ranged from 0.7 ft in riffles to 6.5 ft in pools (Figure 31).

Tellico River contained about 45 pieces of LWD per mile which were patchily distributed in the study section (Figures 32 and 33). This section, however, contained less than five pieces per mile of the larger size classes (Figure 32).

Hiwassee River -We identified 24 pools, 38 glides, 23 runs, and 25 riffles in the Hiwassee River study section. Visual estimates of habitat areas were paired with measured habitat area for 10 (16%) pools and glides, and 8 (17%) runs and riffles. Hiwassee River contained the greatest pool-riffle ratio of all the streams surveyed. We estimated that the Hiwassee River study section contained 85 percent pool and glide habitat (25.4 ± 1.2 acres) and 15 percent run-riffle habitat (4.6 ± 0.2 acres). Total area was estimated for each habitat type using correction factors ($\hat{Q}$) that ranged from 0.98 to 1.00.

We observed substrata embeddedness levels to be similar to those in Tellico River (Figure 34). We identified boulder as the most common (modal) dominant and subdominant substratum

in the Hiwassee River study section. The dominant and subdominant substrata, however, varied between habitat types (Figures 35 and 36). We observed the number of pools and glides containing a high percentage of the substrata composed of suitable cover-stones for smoky madtoms and duskytail darters to be lower in Hiwassee River than in Citico Creek but similar to those in Tellico River (Figure 37). The number of boulders suitable for madtom spawning was similar to Tellico River and greater than in Citico Creek. The number of boulders for suitable madtom spawning, however, varied between individual habitat units and pool sections; ranging from 0 to 37 (Figure 38).

Maximum depth in the Hiwassee River was generally deeper than Citico Creek, but shallower than Tellico River and ranged from 1.1 ft in riffles to 9.8 ft in pools (Figure 39). Likewise, average depth ranged from 0.8 ft in riffles to 5.2 ft in pools (Figure 40).

Hiwassee River contained about 4 pieces of LWD per mile and less than one piece per mile of the larger size classes (Figures 41 and 42). However, we only surveyed one of the numerous stream channels within the historical river channel and therefore our LWD inventory is incomplete.

Literature Cited

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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.

Harrelson, C. C.; Rawlins, C. L.; Potyondy, J. P. 1994. Stream channel reference sites: an illustrated guide to field technique. General Technical Report RM-245. Fort Collins, CO:

U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

Table 1. Substrate classification criteria.

SUBSTRATE CLASSES		
Rank	**Size (inches)**	**Common name**
1		organic debris
2		clay
3		silt
4	silt- 0.08	sand
5	0.08 - 0.4	small gravel
6	0.4 - 4.0	large gravel
7	0.4 - 12.0	cobble
8	> 12.0	boulder
9		bedrock

Table 2. Substrata embeddedness: percentage of the substrata and interstitial spaces covered with fine silt and clay particles.

Embeddedness Rating	
Rank	**Percent coverage**
1	0 - 5
2	5 -25
3	25 - 50
4	50 -75
5	75 - 100

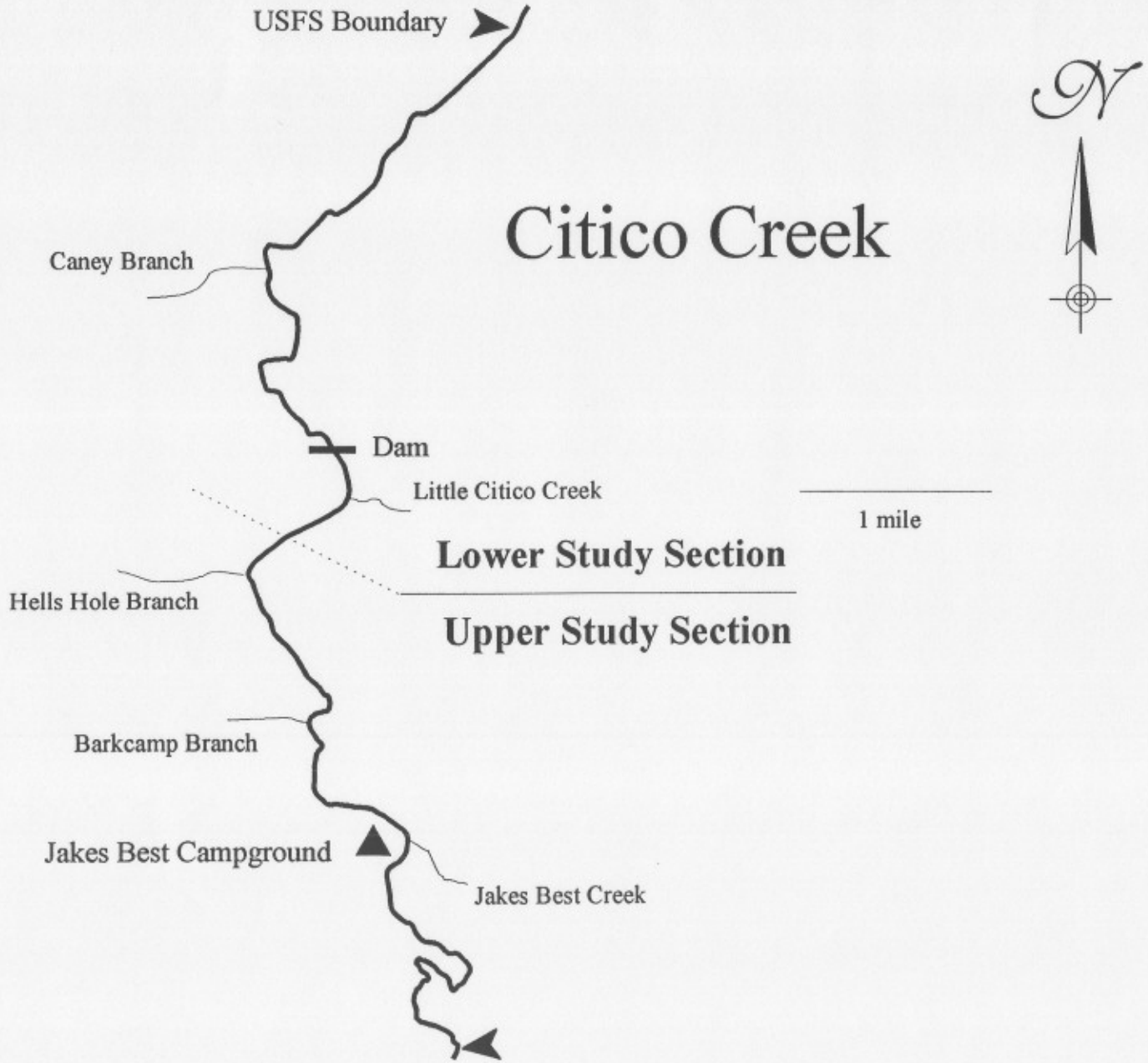

Figure 1. Citico Creek on the Cherokee national Forest, Tennessee. Arrows defines the study reach and broken line separates the lower and upper study sections.

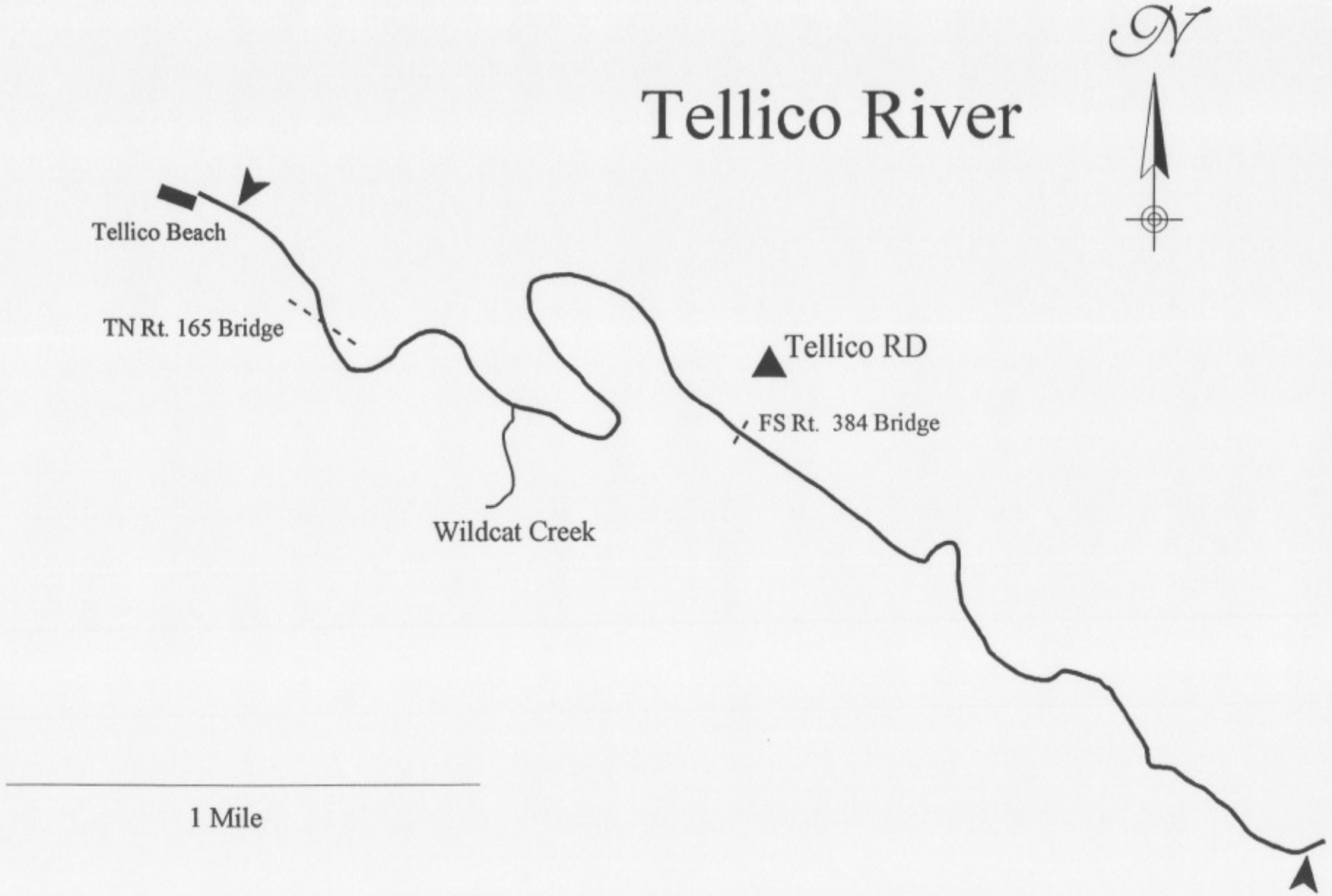

Figure 2. Tellico River on the Cherokee national Forest, Tennessee. Arrows define the study section.

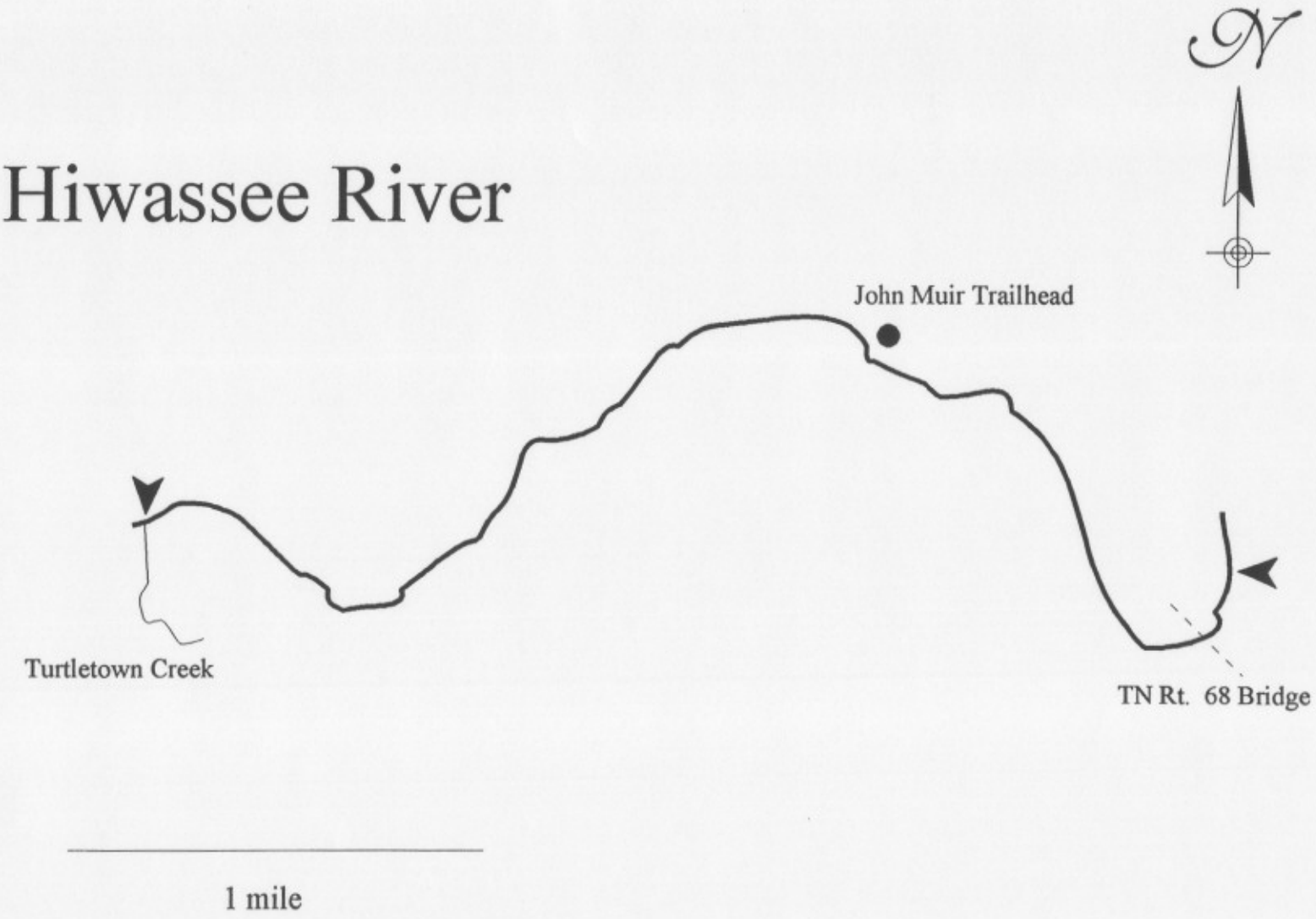

Figure 3. Hiwassee River on the Cherokee national Forest, Tennessee. Arrows define the study section.

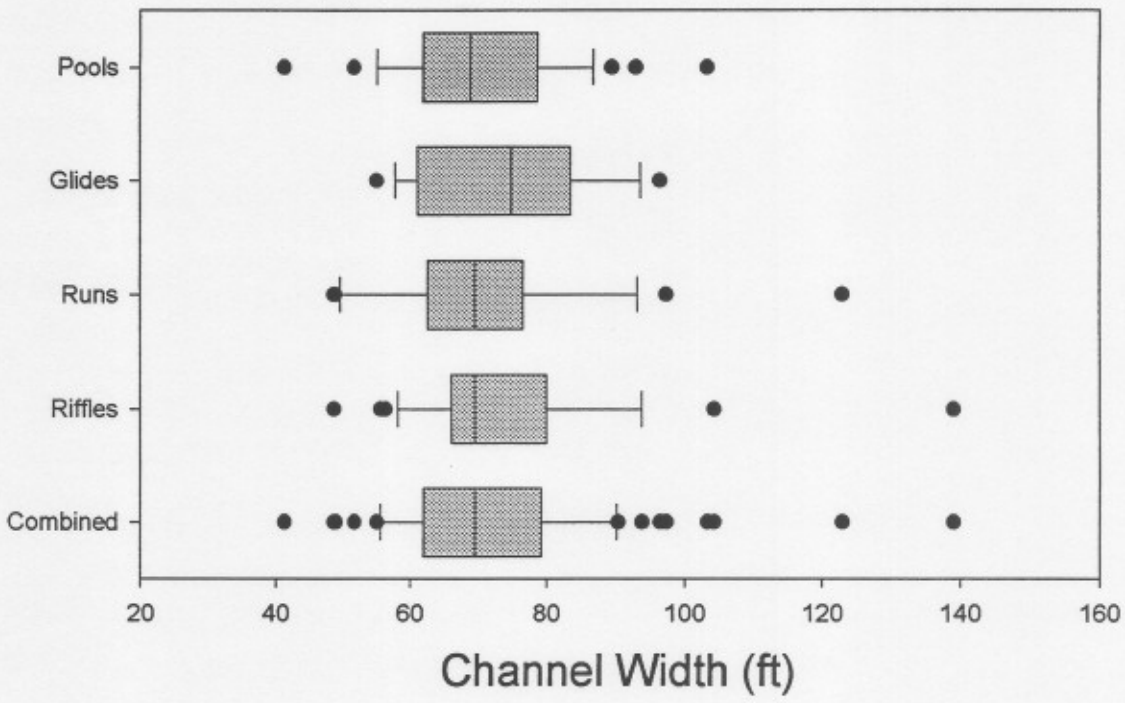

Figure 4. Box plots for stream channel width in habitat-units of lower Citico Creek. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

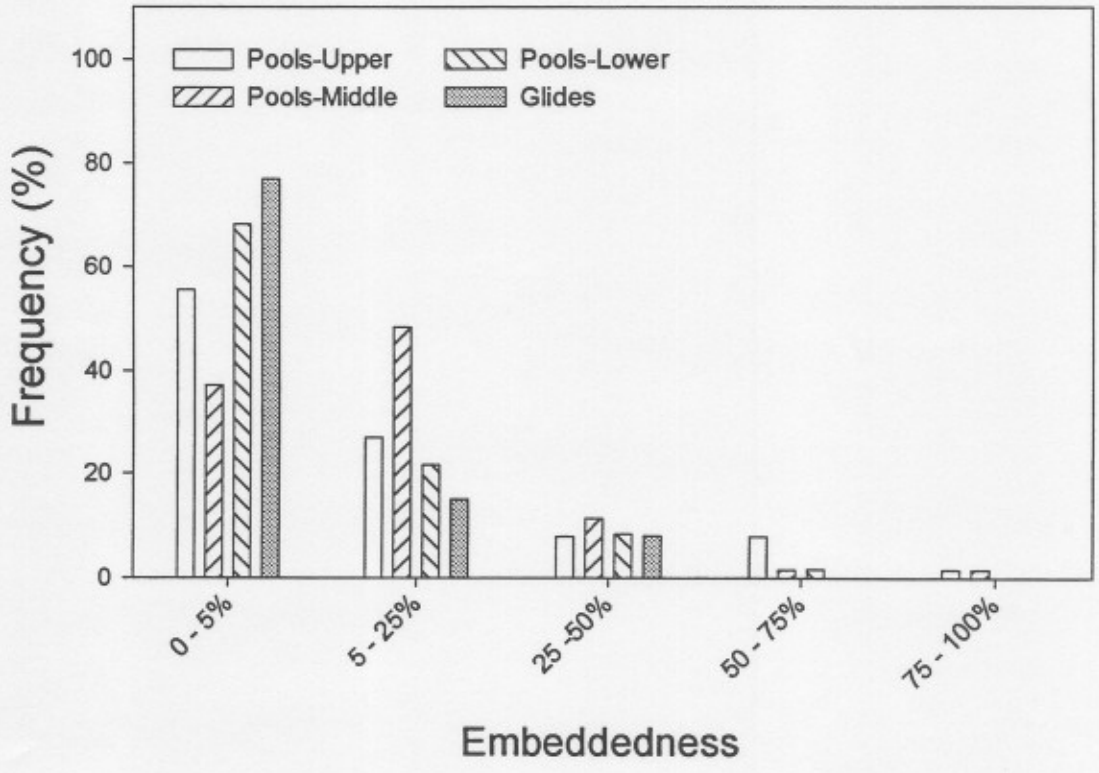

Figure 5. Frequency (percent) of pools and pool-sections in the lower Citico Creek study area best described by one of five classes of embeddedness.

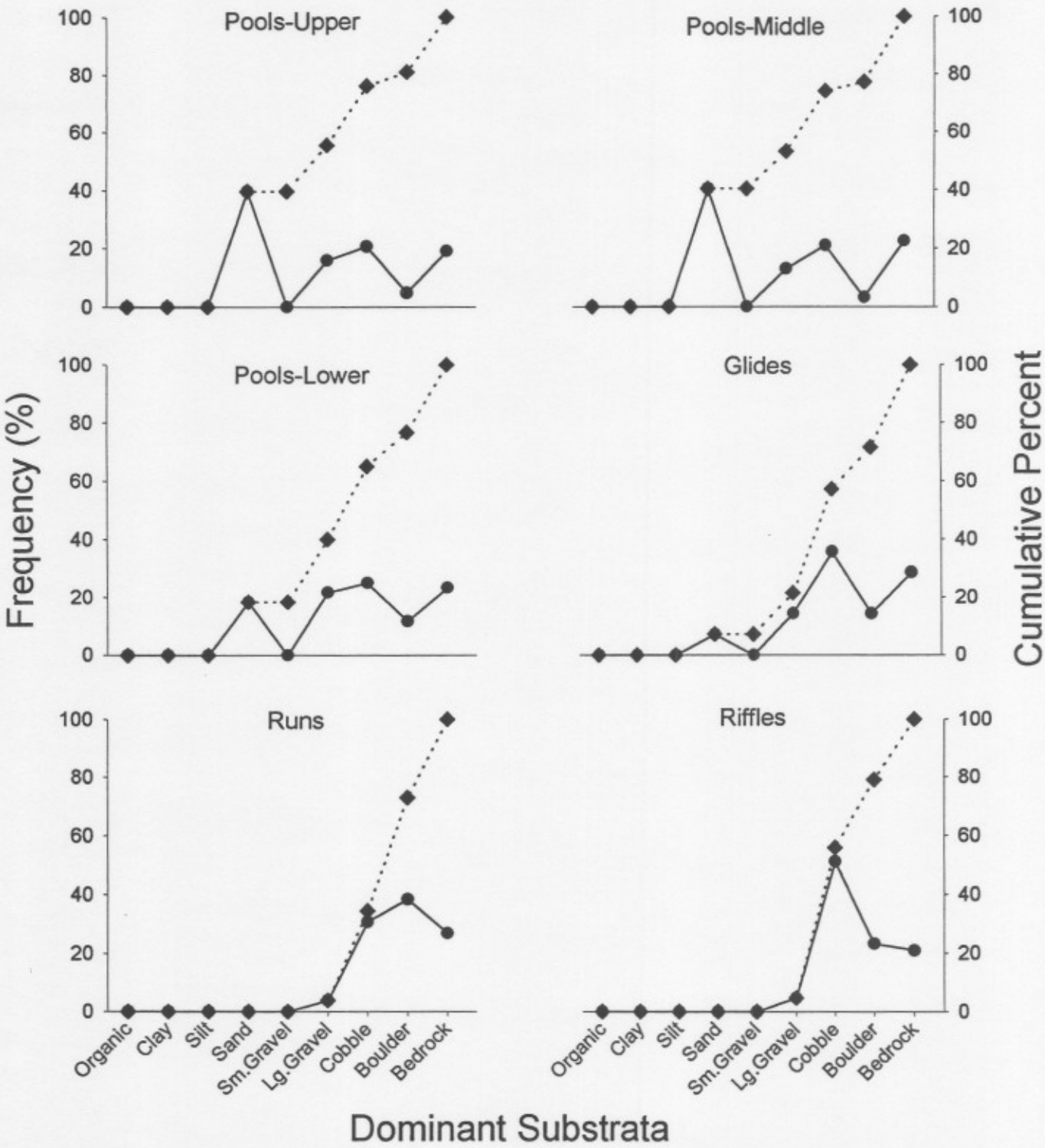

Figure 6. Frequency (percent) of dominant substrate occurrence by habitat type and pool-section in the lower Citico Creek study section. Dots and solid lines represent frequency and diamonds and broken lines represents cumulative percent.

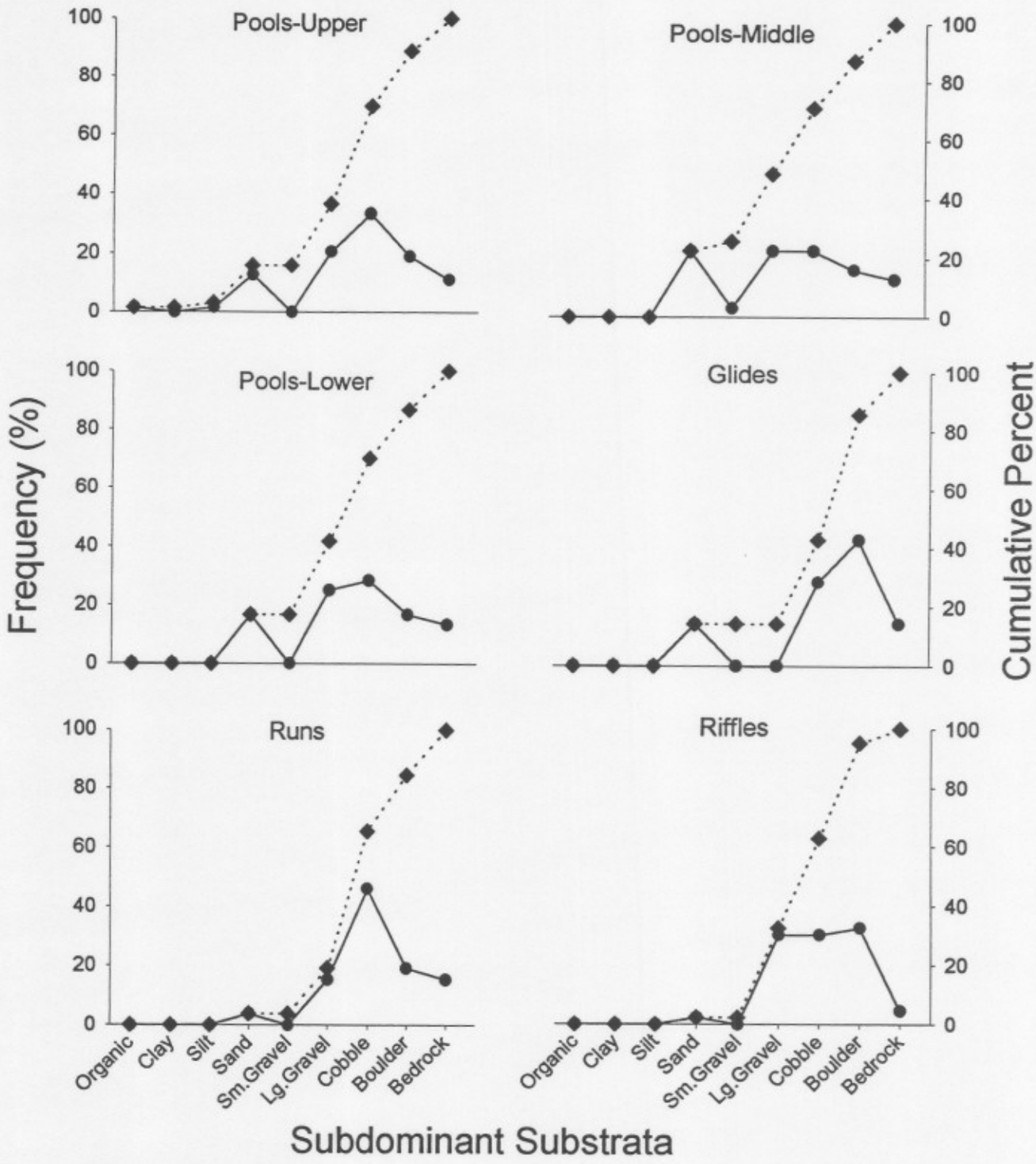

Figure 7. Frequency (percent) of subdominant substrate occurrence by habitat type and pool-section in the lower Citico Creek study section. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

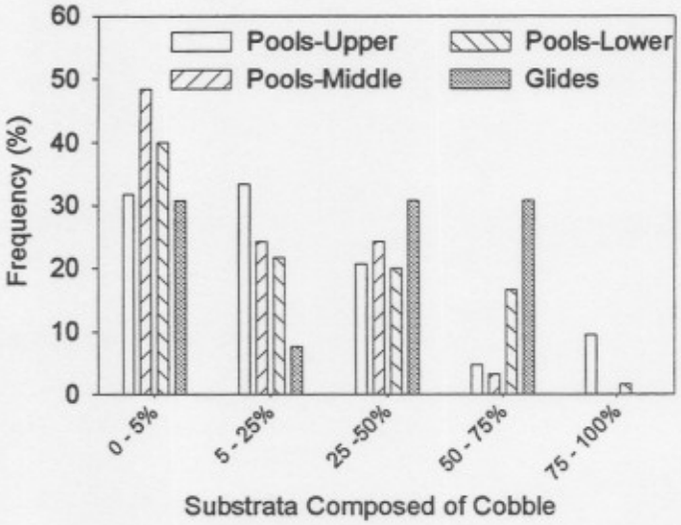

Figure 8. Percentage of substrata composed of suitable cover-stones for smoky madtoms and duskytail darters in pool-sections and glides in the lower Citico Creek study area. The Y-axis shows the percentage of pool-sections and glides best described by one of the of the five classes.

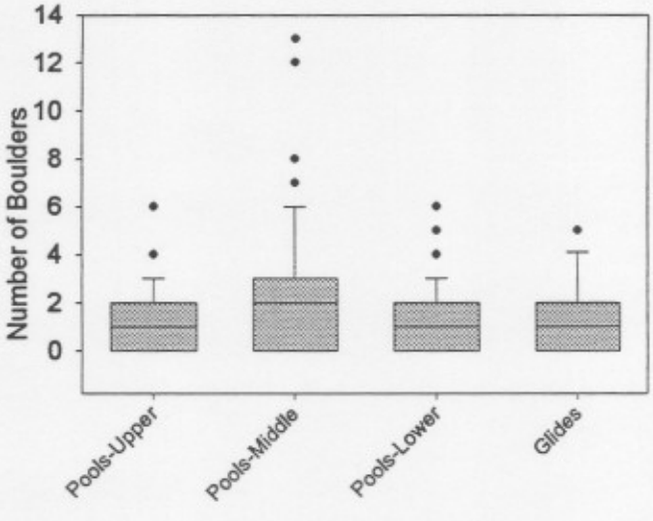

Figure 9. Box plots for number of boulders suitable for madtom spawning in the lower Citico Creek study section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

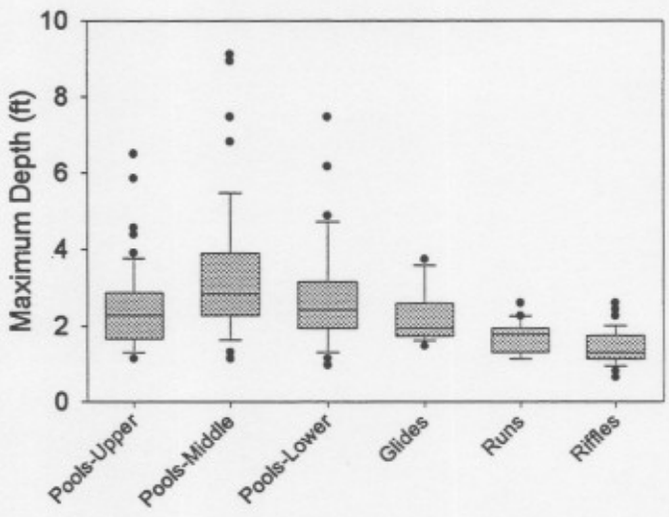

Figure 10. Box plots for habitat-unit and section maximum depth in the lower Citico Creek study section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

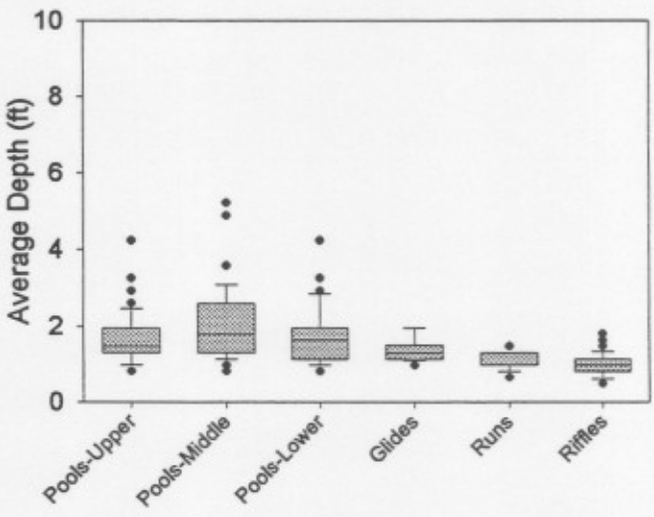

Figure 11. Box plots for habitat-unit and section average depth in the lower Citico Creek study section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

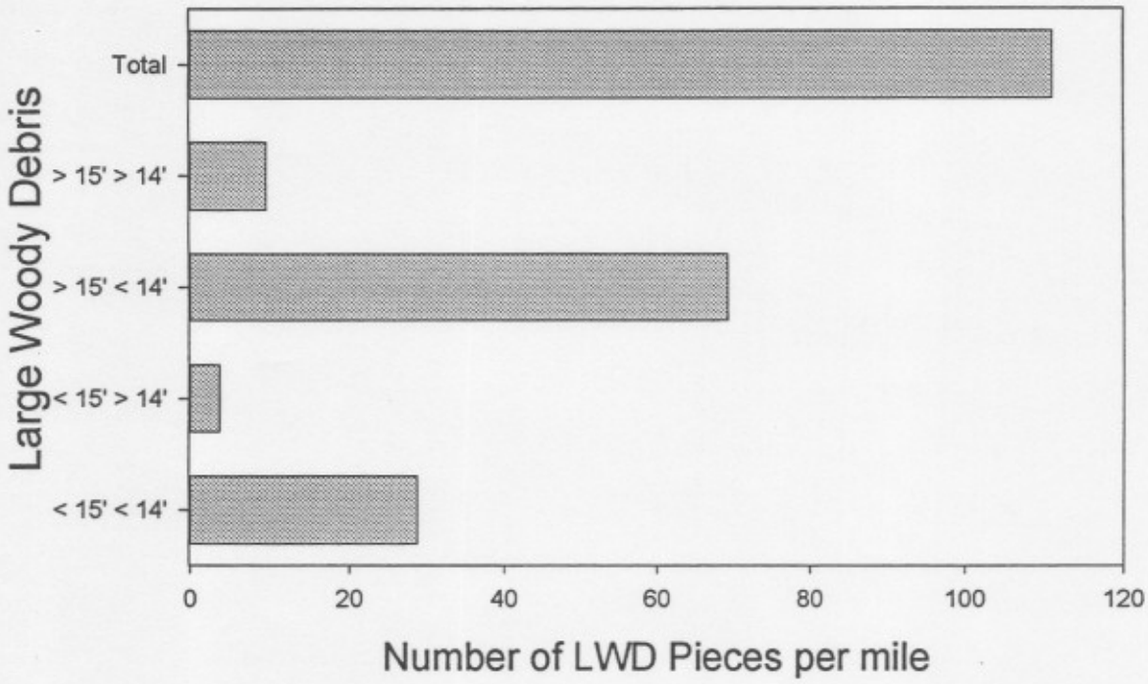

Figure 12. Pieces of large woody debris per mile in the lower Citico Creek study section.

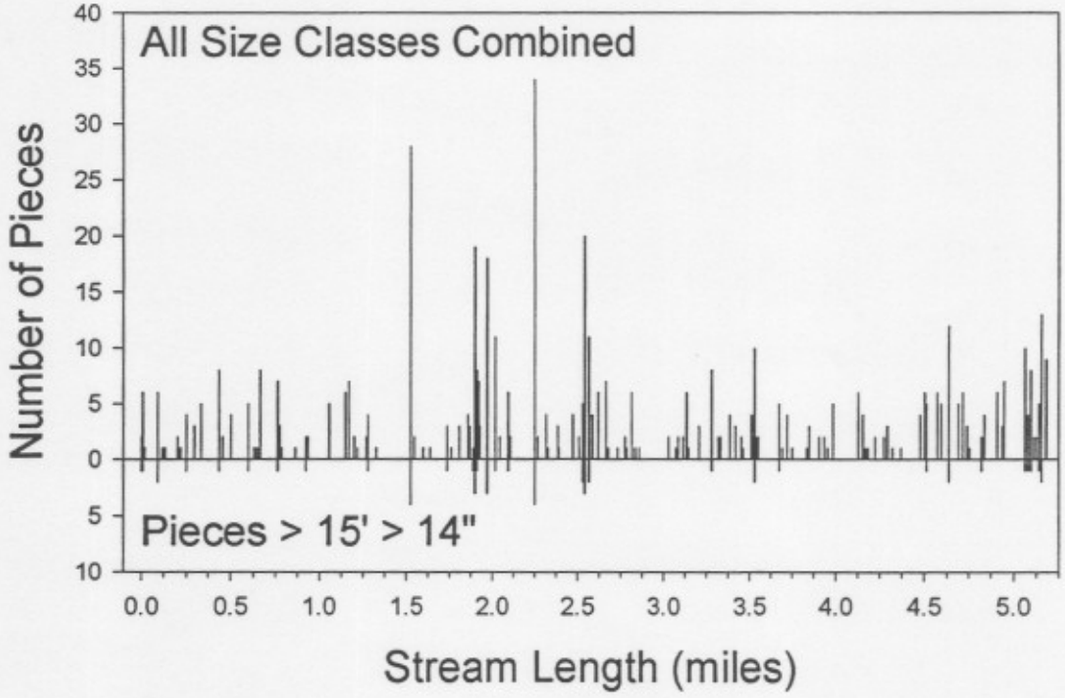

Figure 13. Distribution and total abundance of large woody debris in the lower Citico Creek study section.

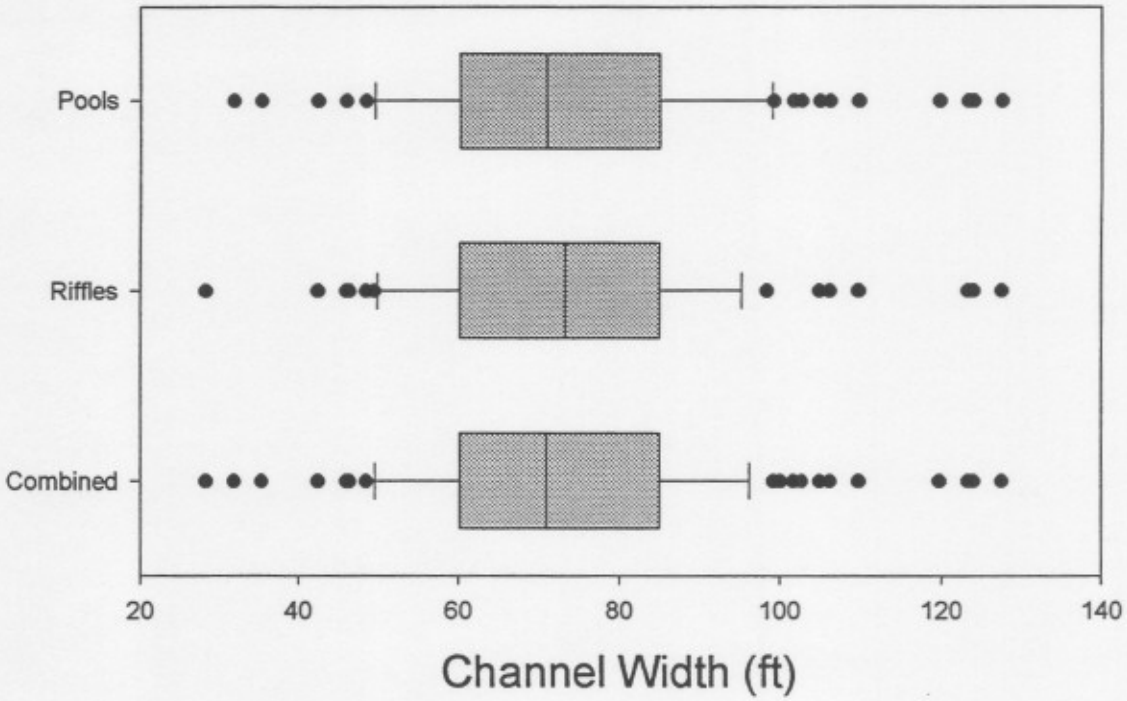

Figure 14. Box plots for stream channel width in habitat-units of upper Citico Creek. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

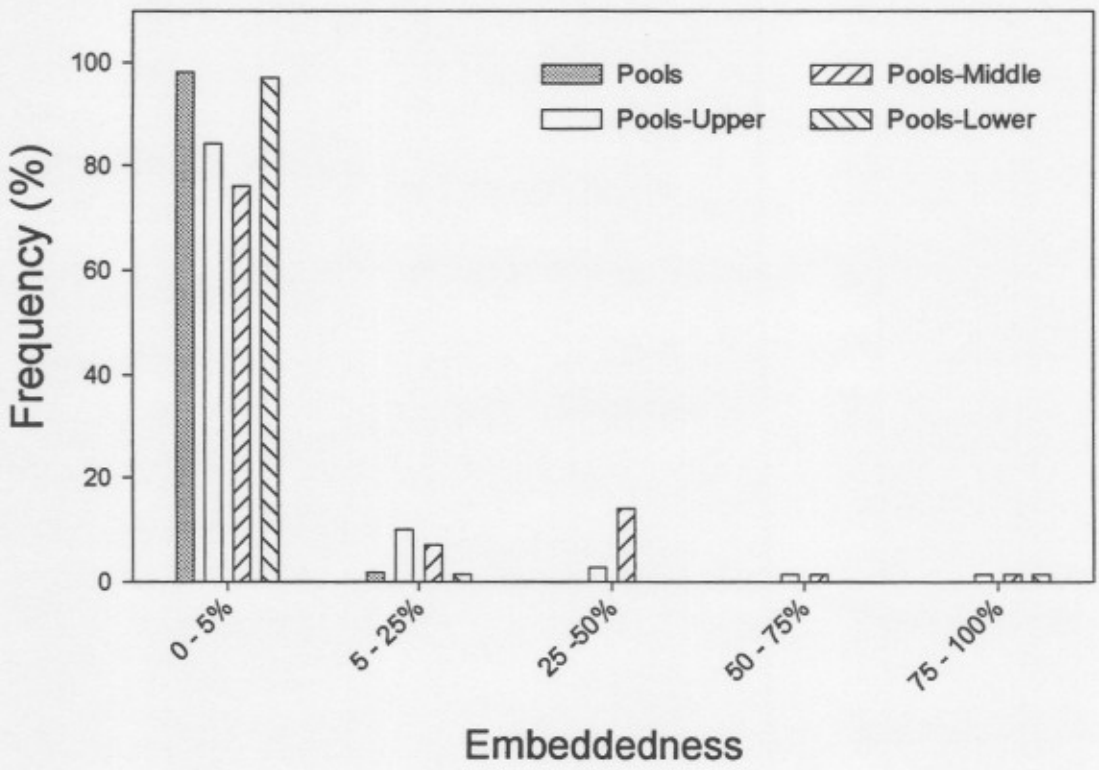

Figure 15. Frequency (percent) of pools and pool-sections in upper Citico Creek best described by one of five classes of embeddedness.

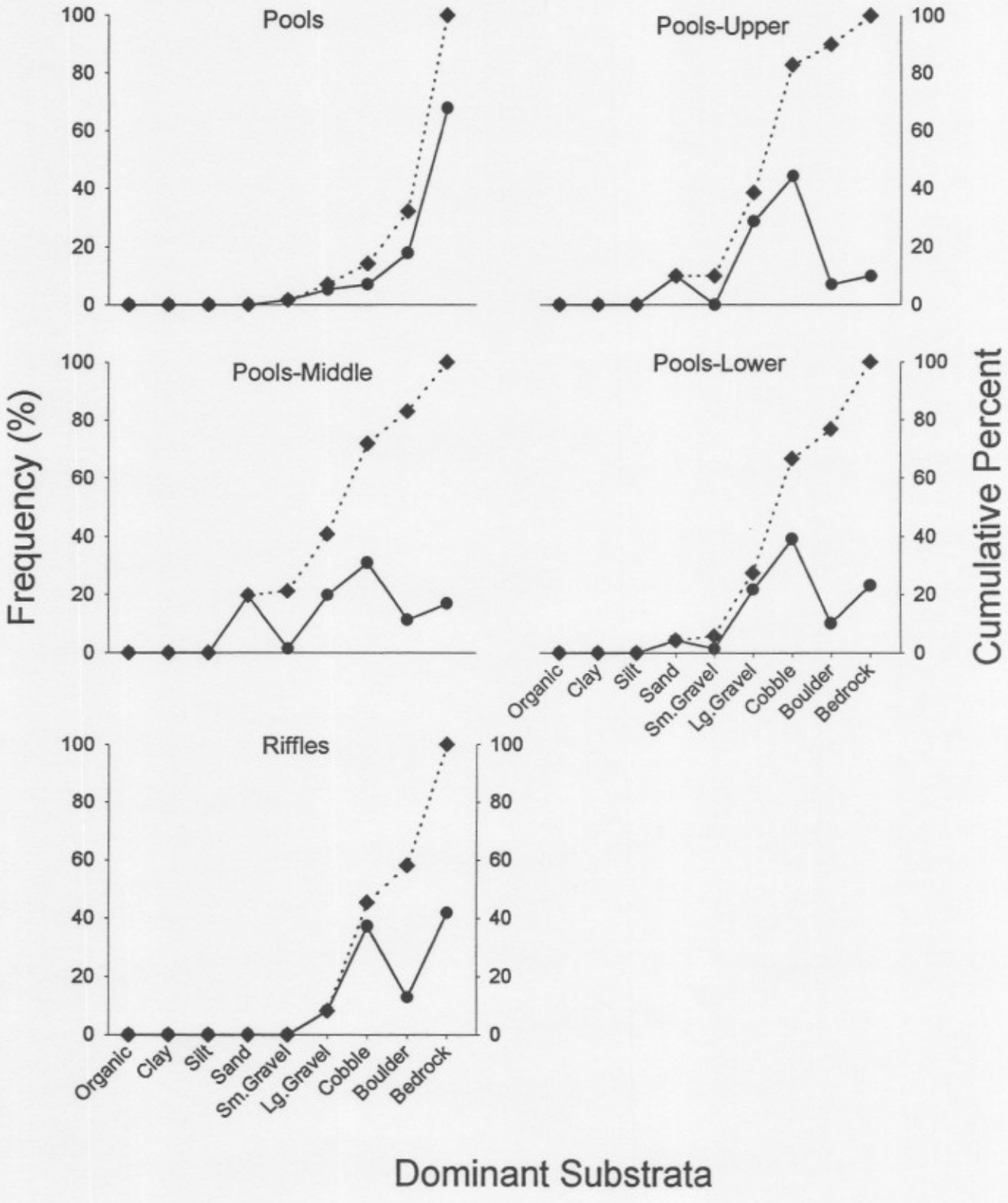

Figure 16. Frequency (percent) of dominant substrate occurrence by habitat type and pool-section in the upper Citico Creek study section. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

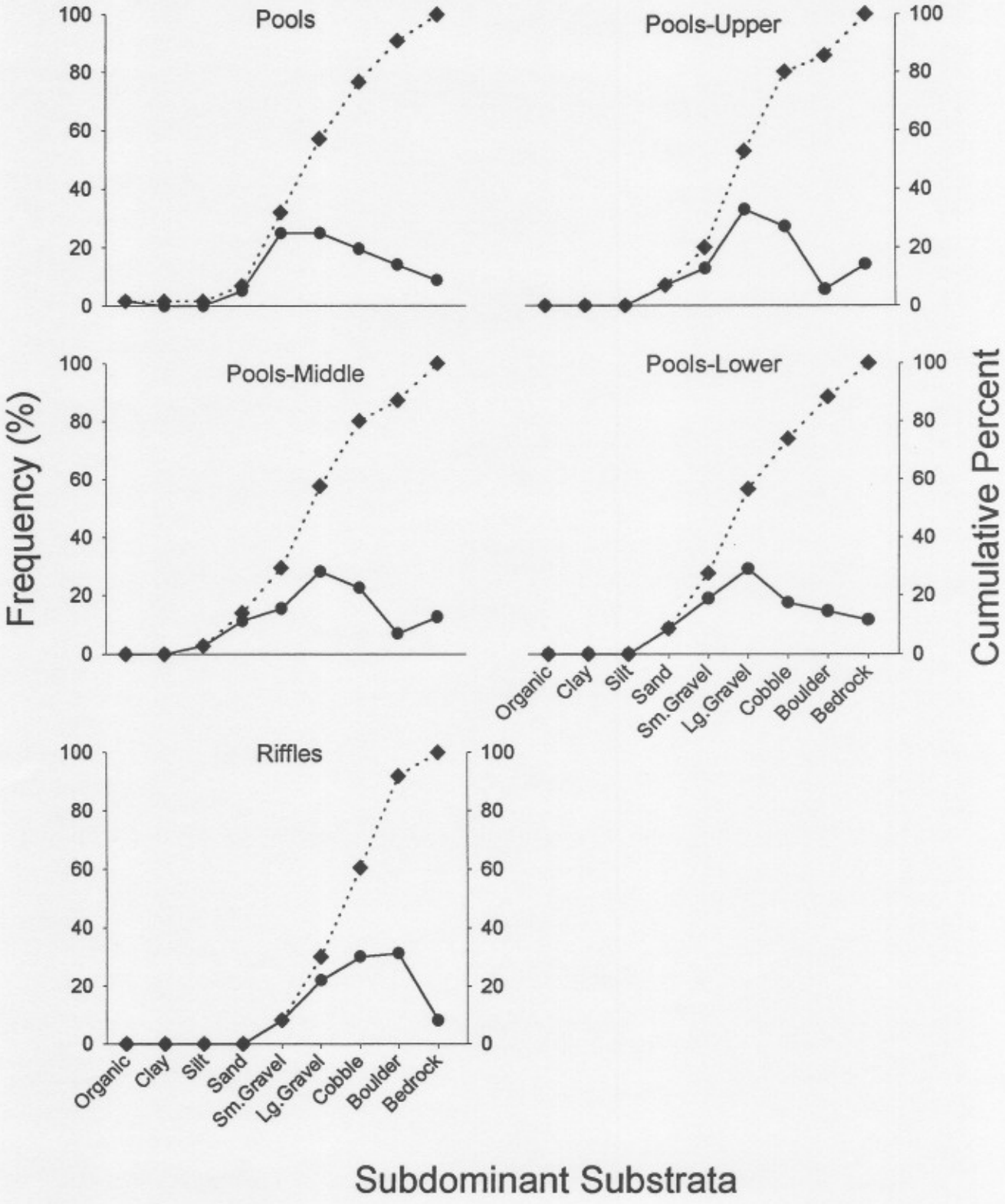

Figure 17. Frequency (percent) of subdominant substrate occurrence by habitat type and pool-section in the upper Citico Creek study section. Dot and solid line represent frequency and diamonds and broken lines represent cumulative percent.

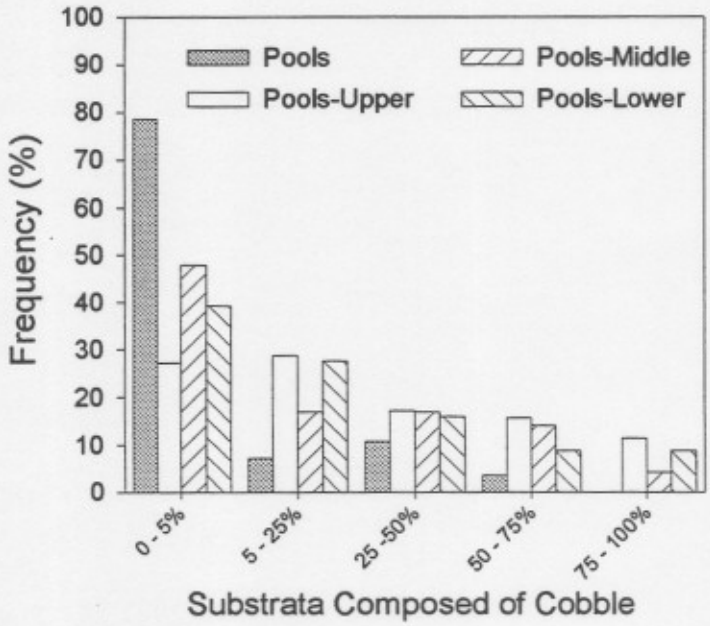

Figure 18. Percentage of substrata composed of suitable cover-stones for smoky madtoms and duskytail darters in pool-sections and glides in the upper Citico Creek study area. The Y-axis shows the percentage of pool-sections and glides best described by one of the of the five classes.

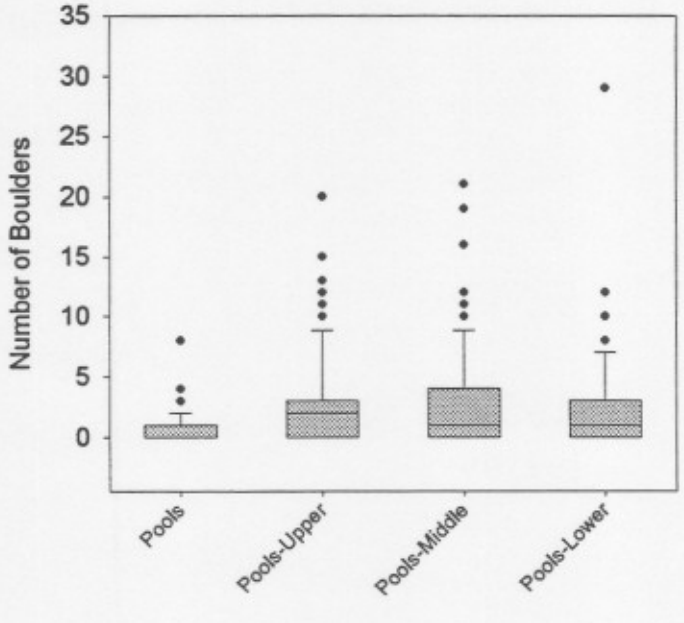

Figure 19. Box plots for number of boulders suitable for madtom spawning in the upper Citico Creek study section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

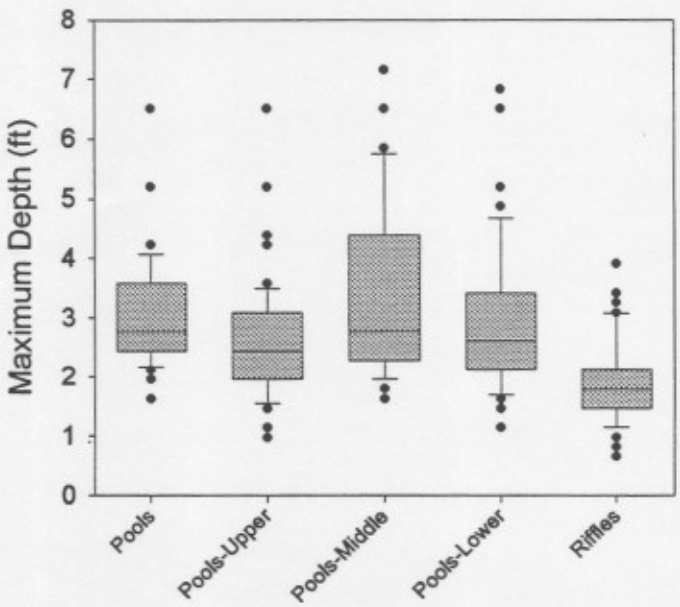

Figure 20. Box plots for habitat-unit and section maximum depth in the upper Citico Creek study section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

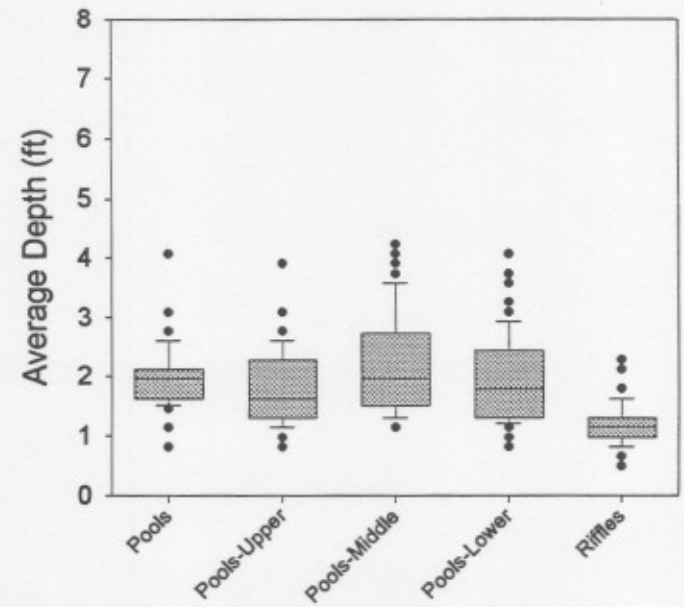

Figure 21. Box plots for habitat-unit and section average depth in the upper Citico Creek study section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

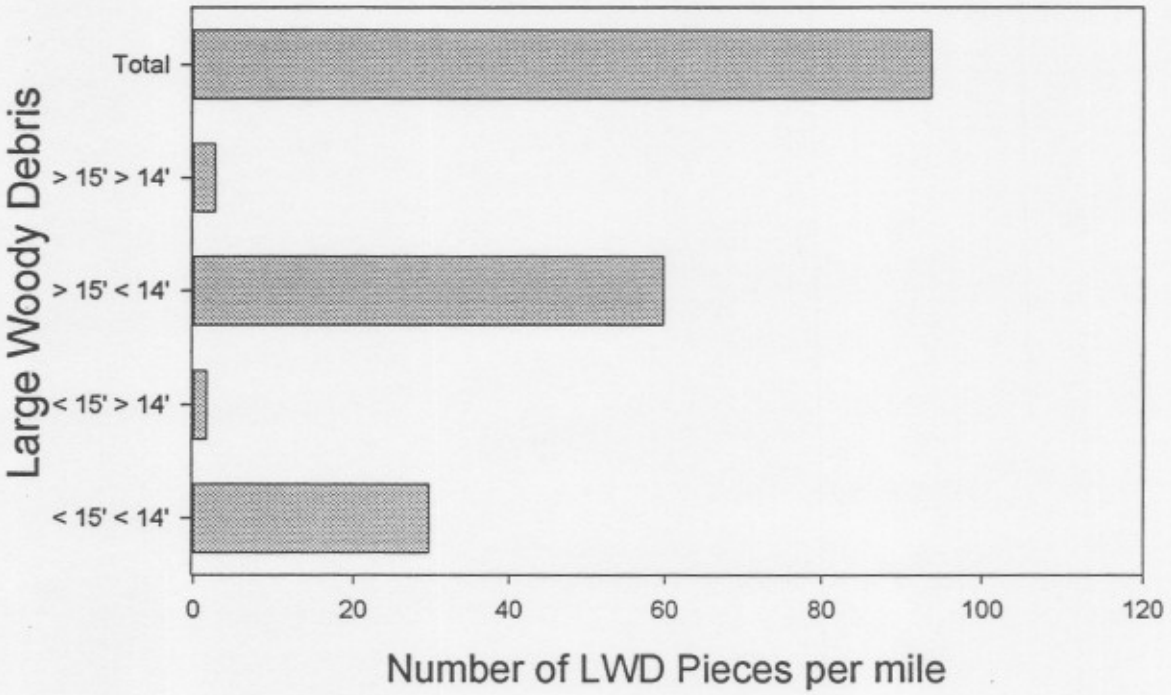

Figure 22. Pieces of large woody debris per mile in the upper Citico Creek study section.

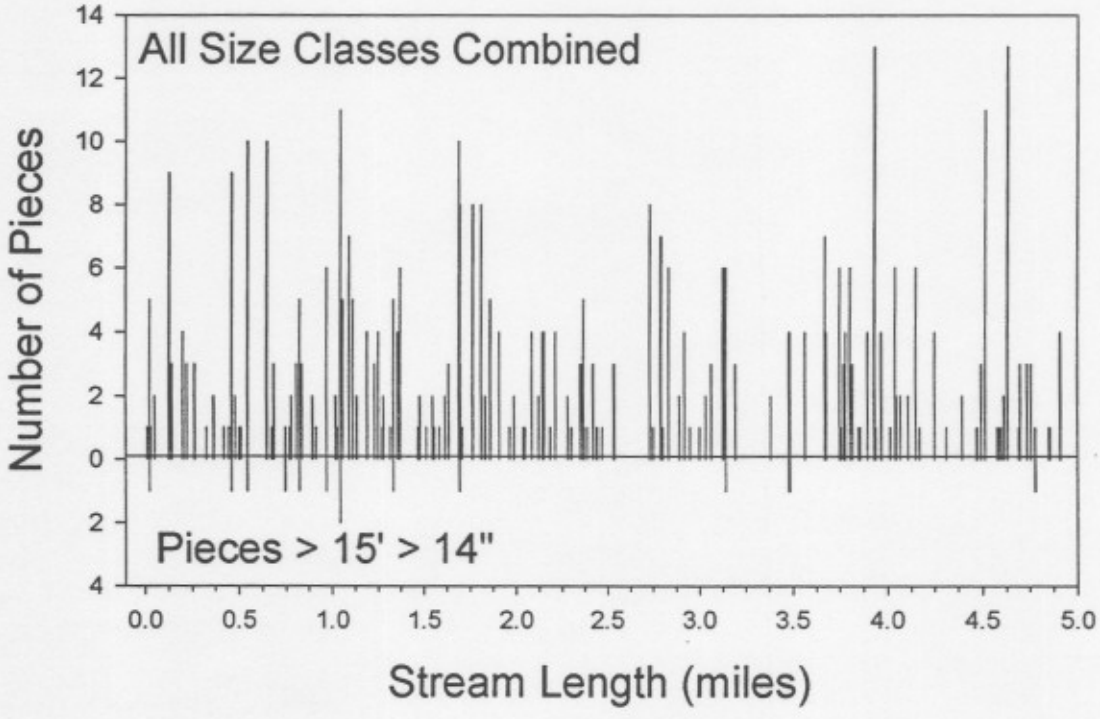

Figure 23. Distribution and total abundance of large woody debris in the upper Citico Creek study section.

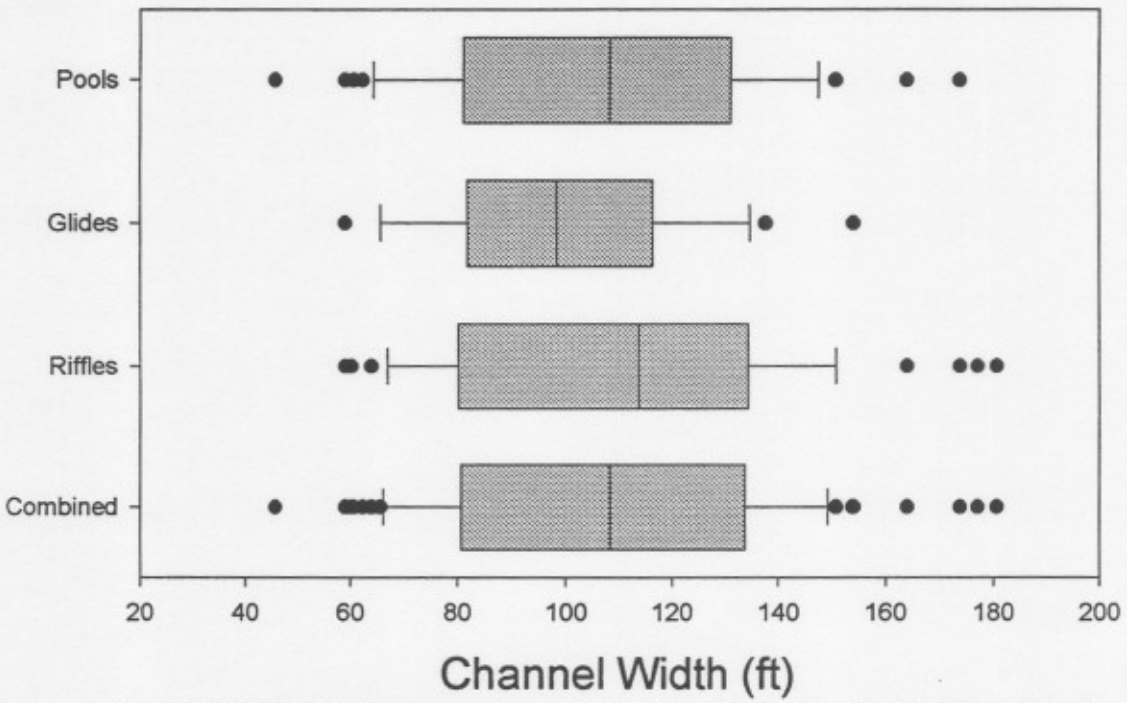

Figure 24. Box plots for stream channel width in habitat-units of Tellico River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

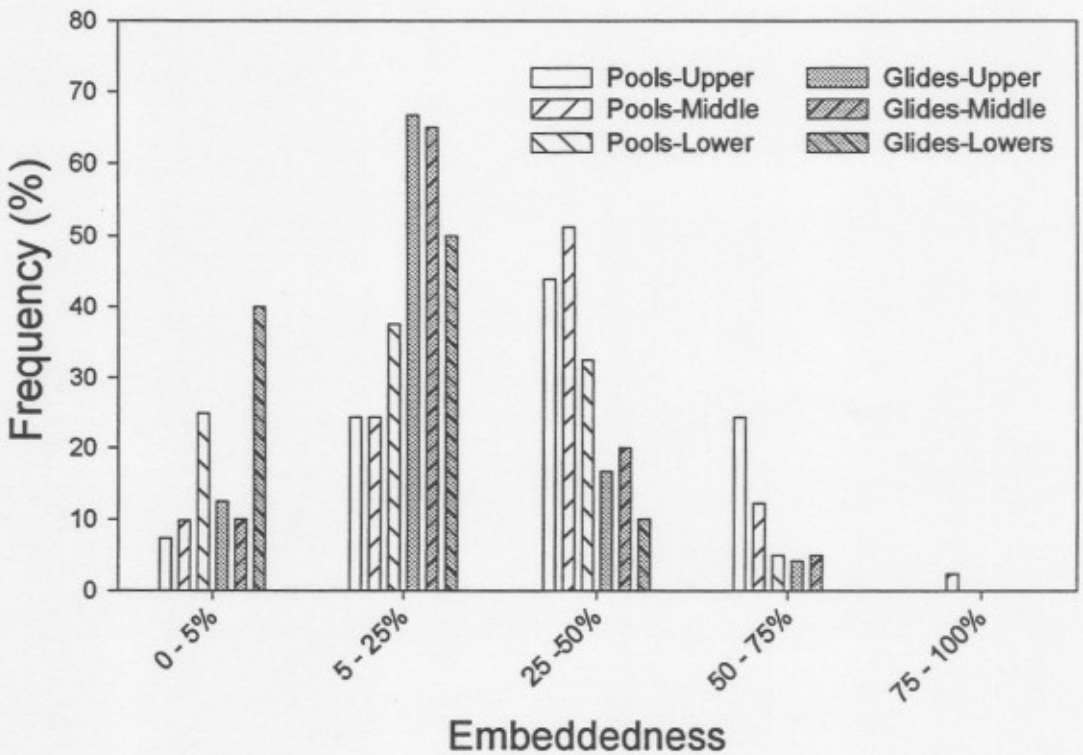

Figure 25. Frequency (percent) of pools and glides in Tellico River best described by one of five classes of embeddedness.

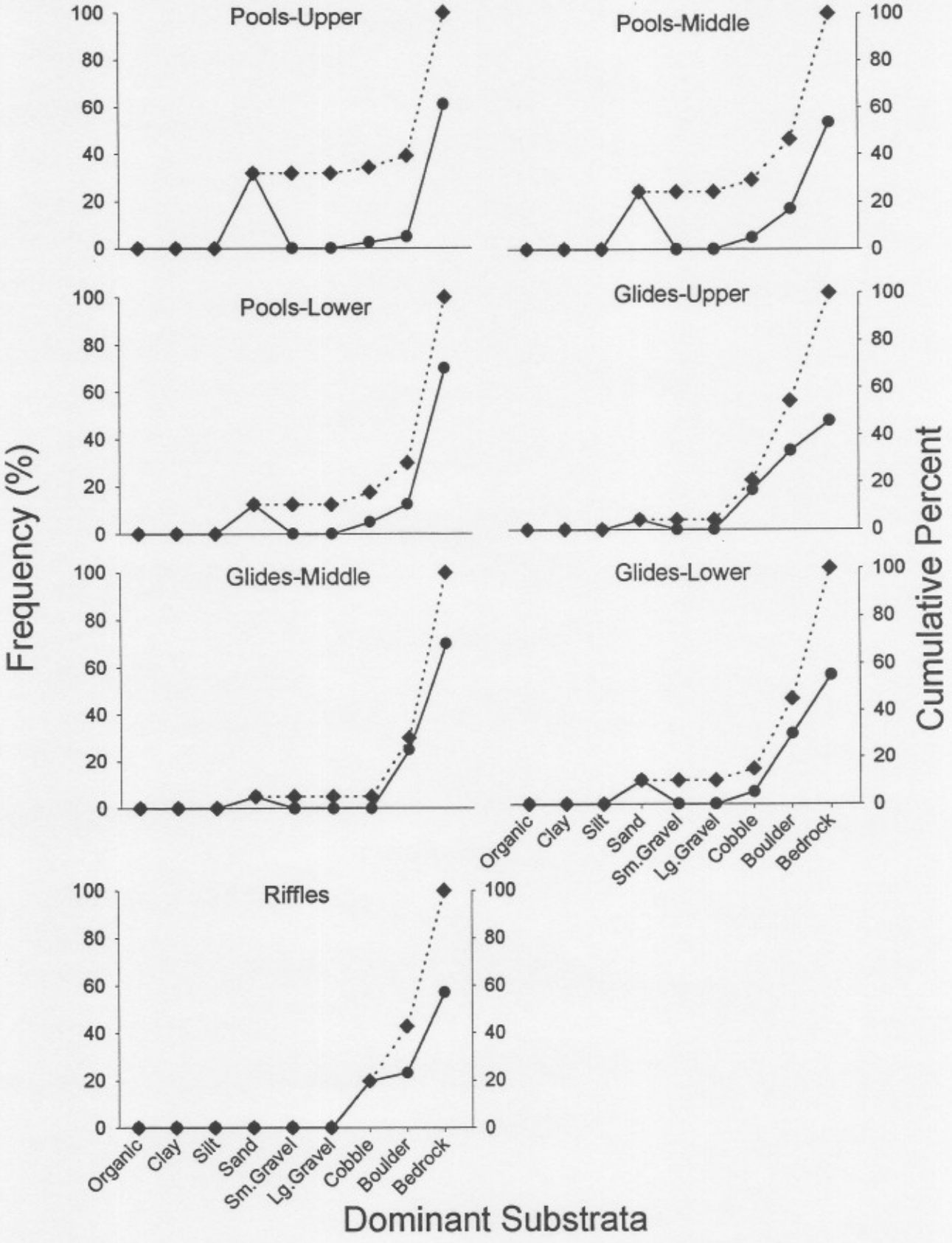

Figure 26. Frequency (percent) of dominant substrate occurrence by habitat type and section in Tellico River. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

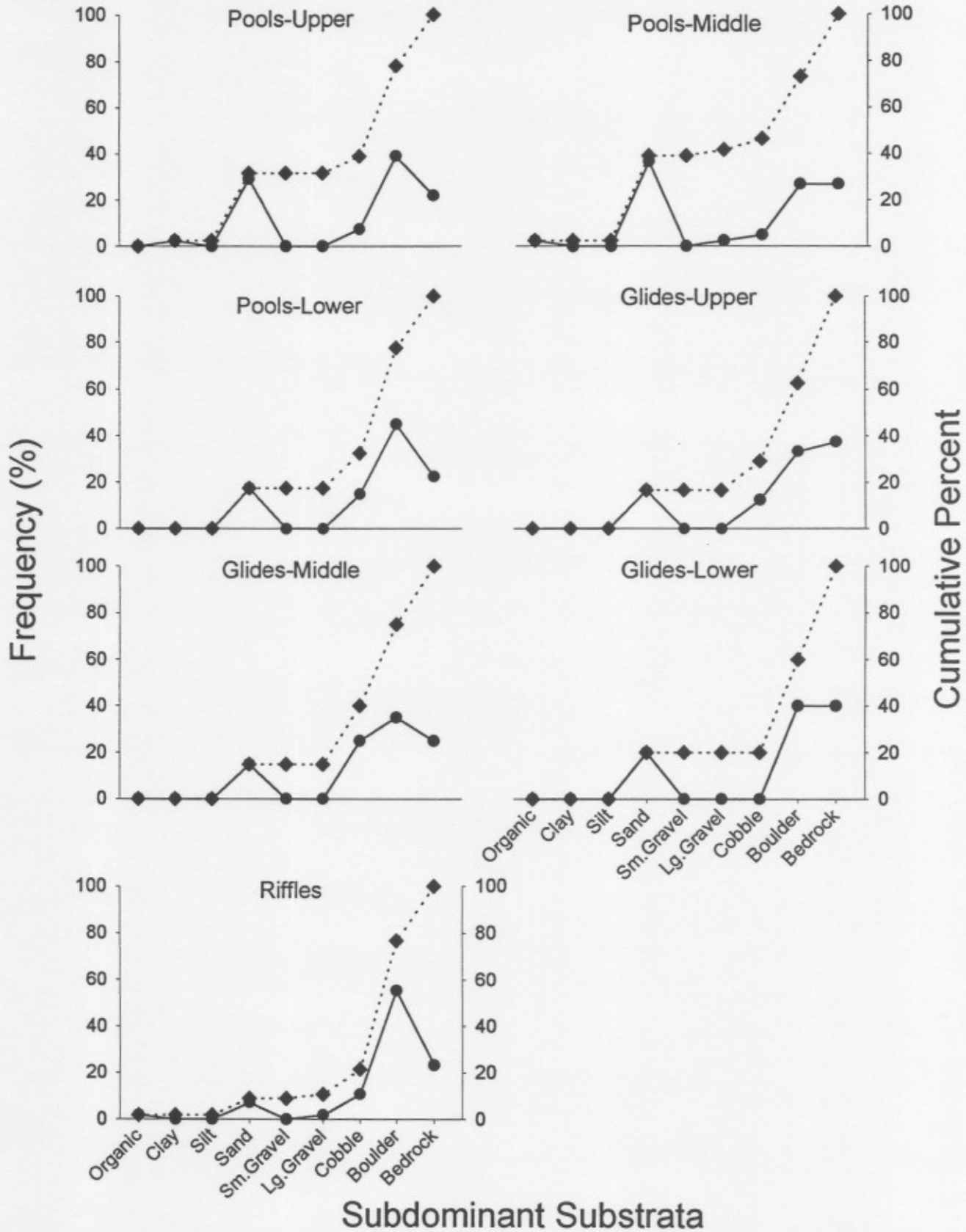

Figure 27. Frequency (percent) of subdominant substrate occurrence by habitat type and section in Tellico River. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

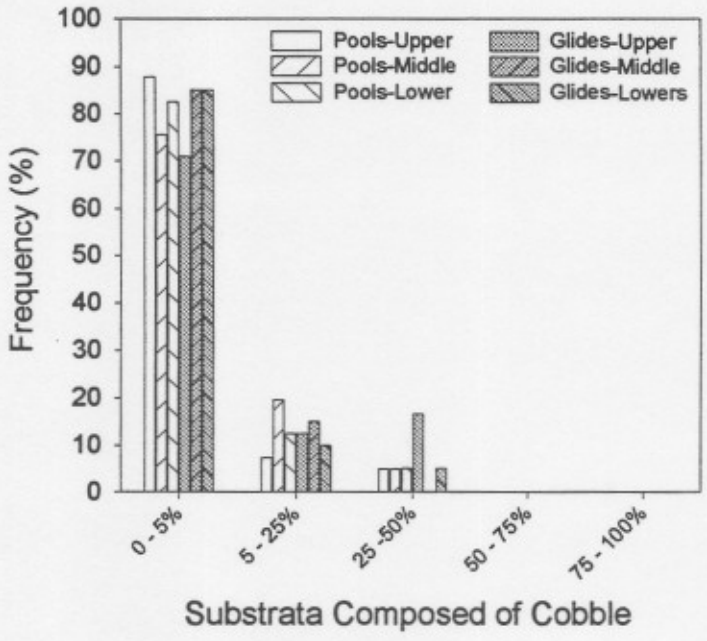

Figure 28. Percentage of substrata composed of suitable cover-stones for smoky madtoms and duskytail darters in pool-sections and glides in Tellico River. The Y-axis shows the percentage of pool-sections and glides best described by one of the of the five classes.

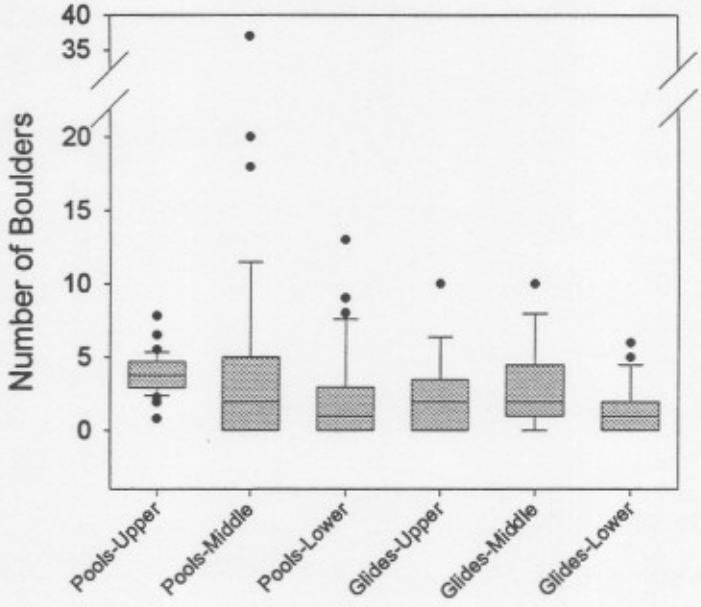

Figure 29. Box plots for number of boulders suitable for madtom spawning in Tellico River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median. Note the break in the Y-axis.

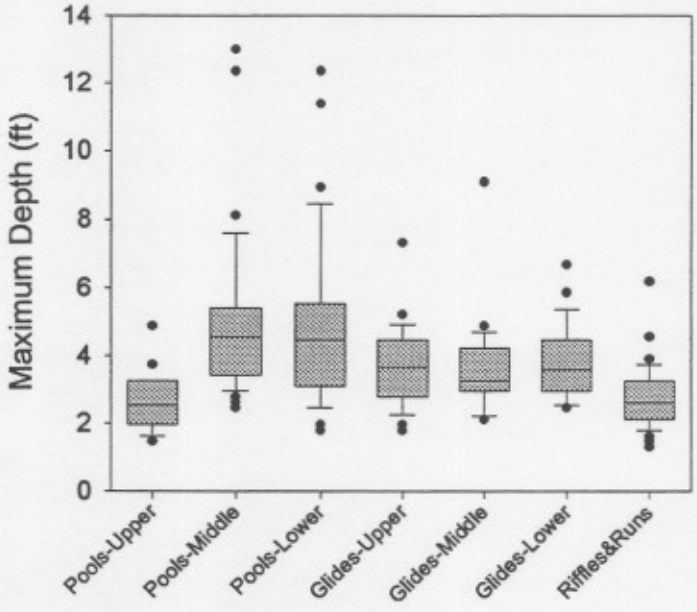

Figure 30. Box plots for habitat-unit and section maximum depth in Tellico River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

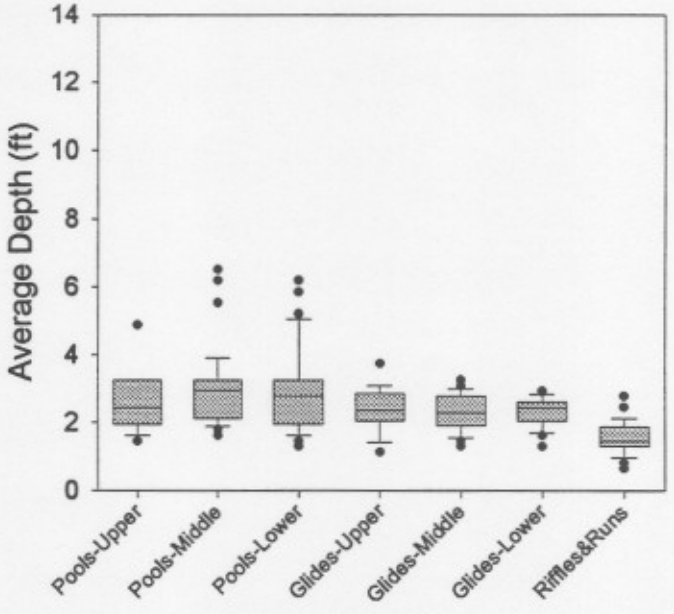

Figure 31. Box plots for habitat-unit and section average depth in Tellico River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

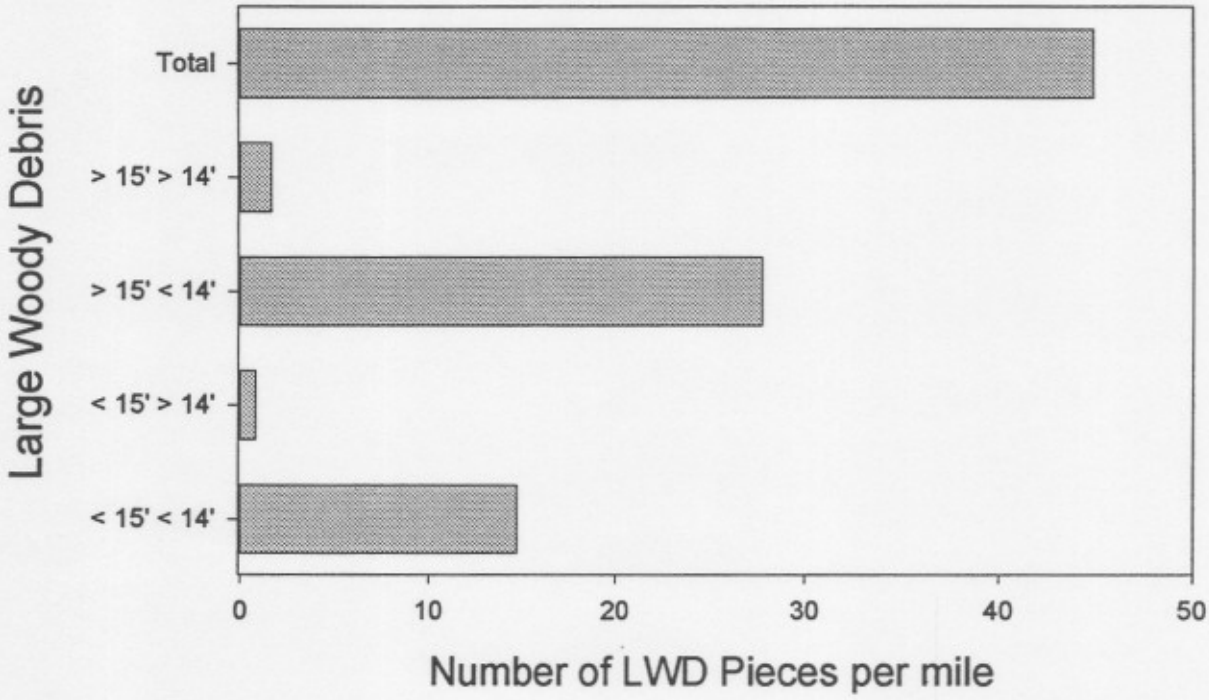

Figure 32. Pieces of large woody debris per mile in Tellico River.

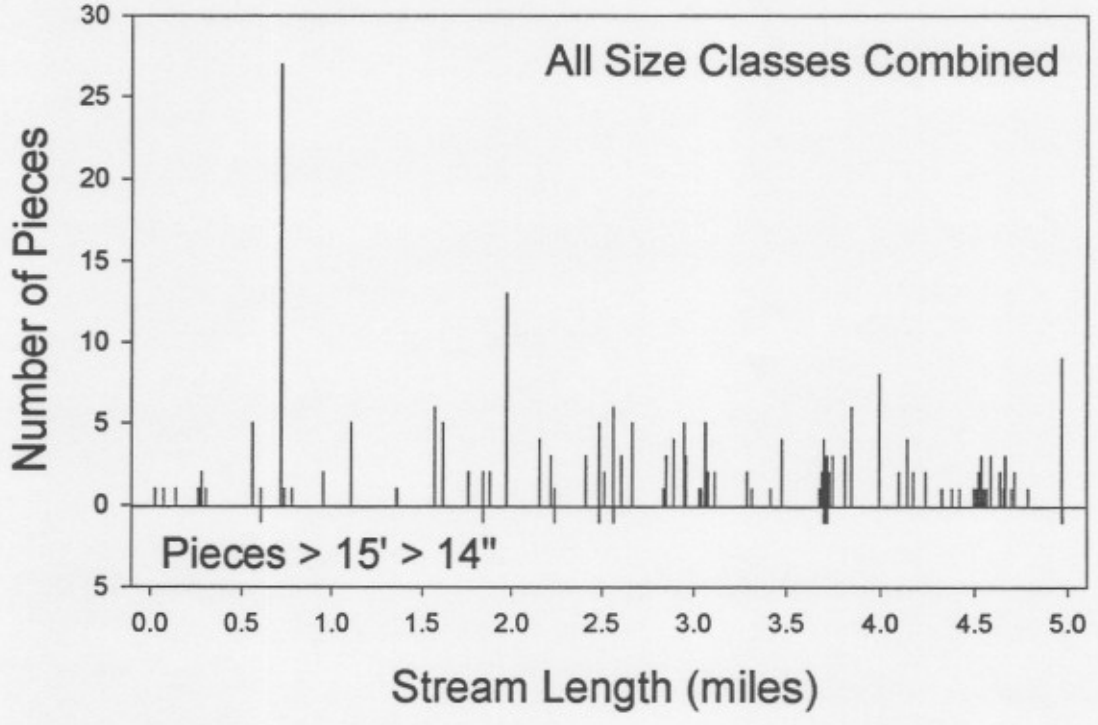

Figure 33. Distribution and total abundance of large woody debris in Tellico River.

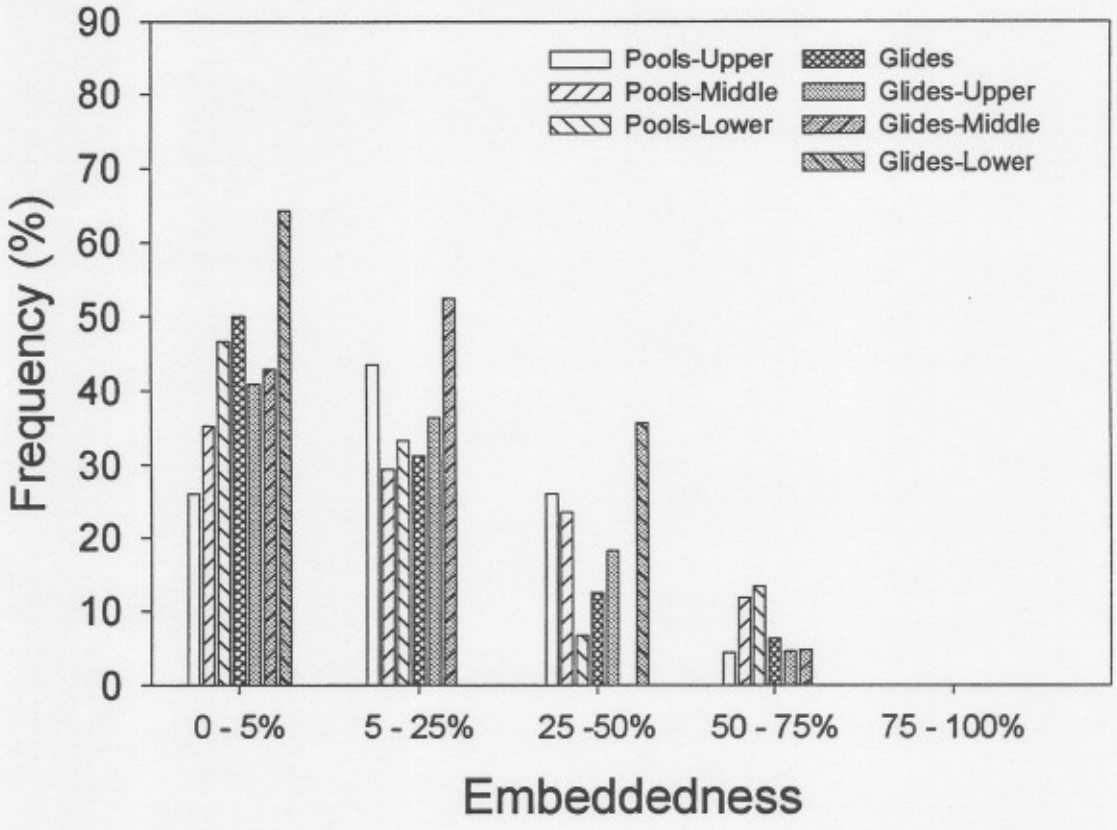

Figure 34. Frequency (percent) of pools and glides in Hiwassee River best described by one of five classes of embeddedness.

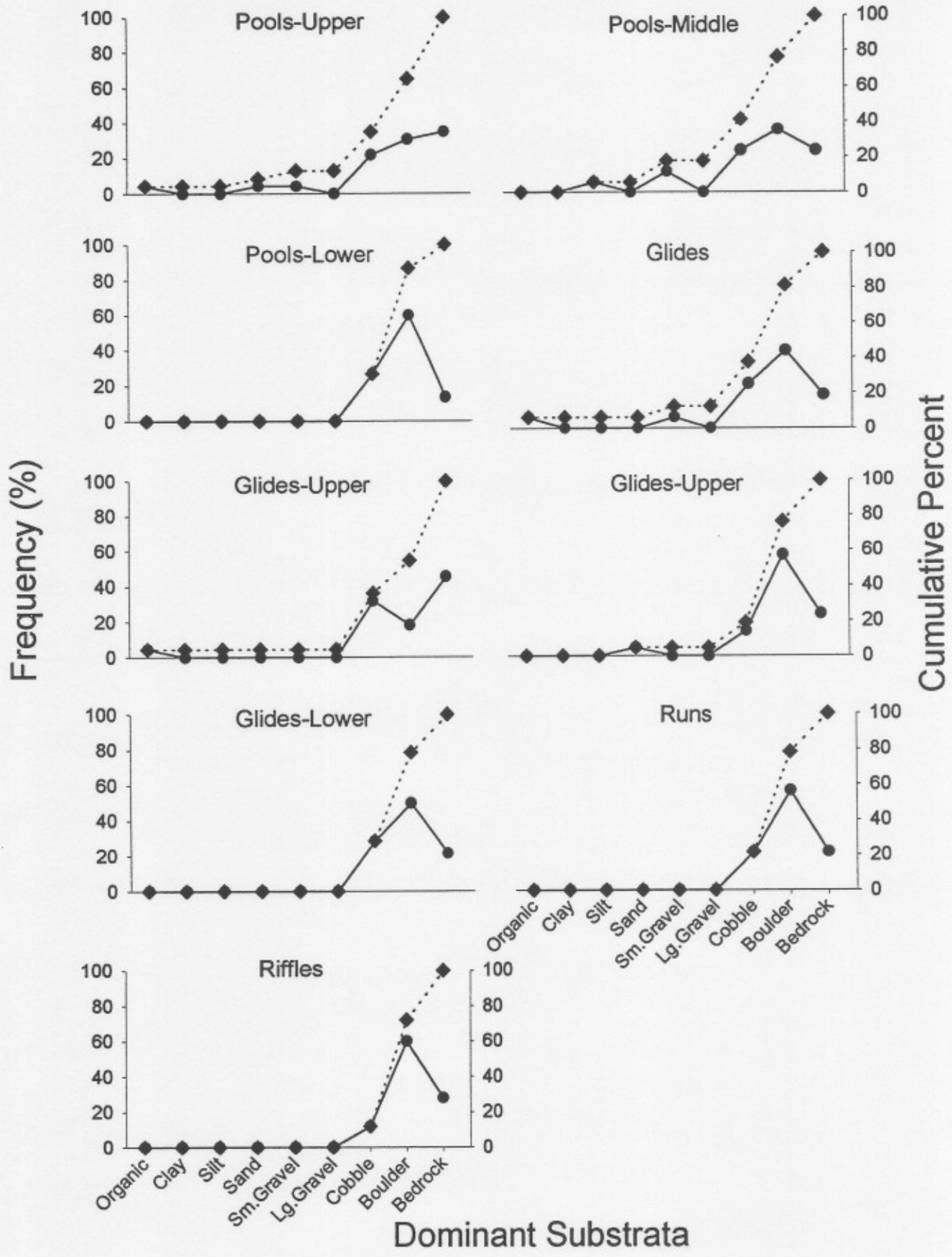

Figure 35. Frequency (percent) of dominant substrate occurrence by habitat type and section in Hiwassee River. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative percent.

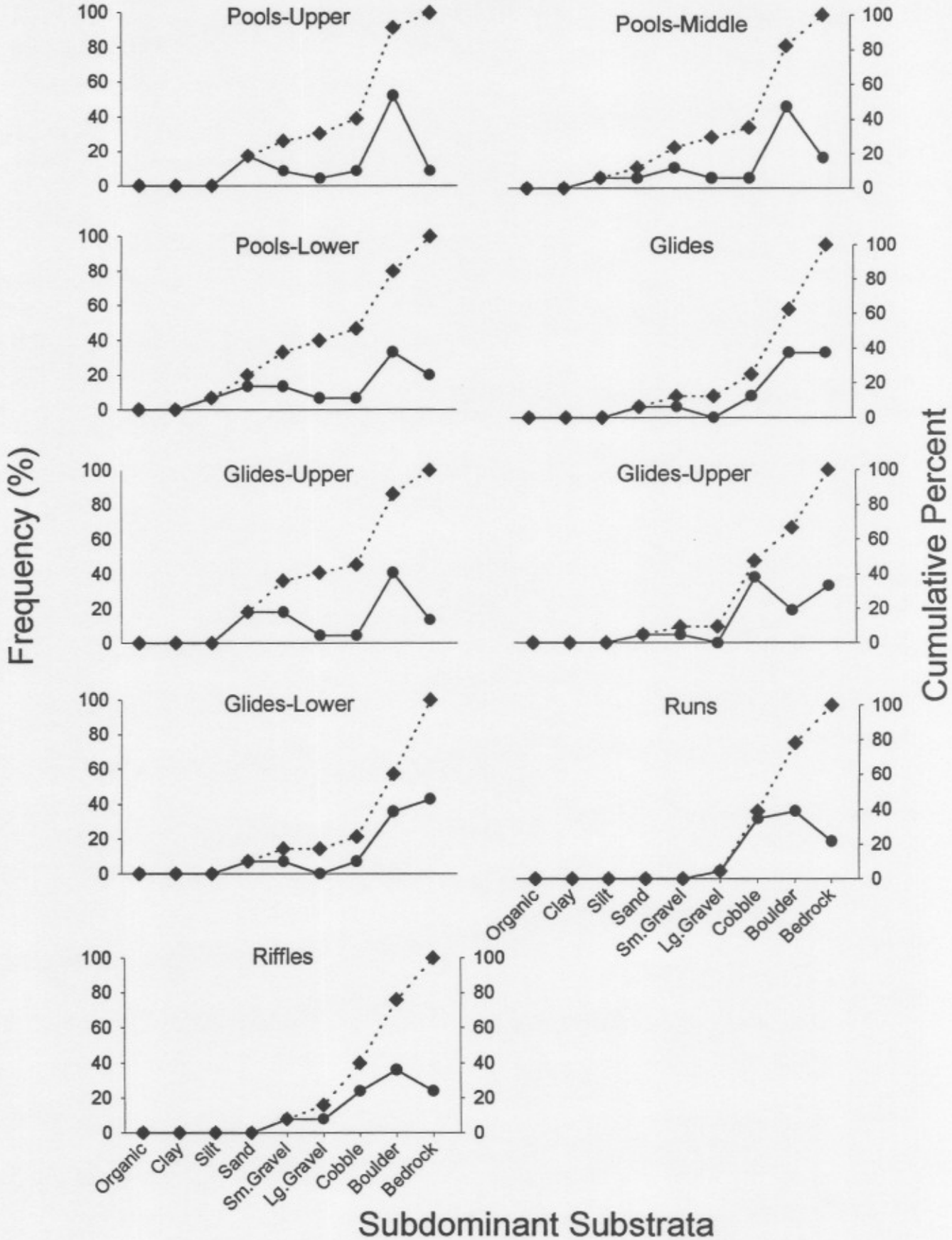

Figure 36. Frequency (percent) of subdominant substrate occurrence by habitat type and section in Hiwassee River. Dots and solid lines represent frequency and diamonds and broken lines represent cumulative precent.

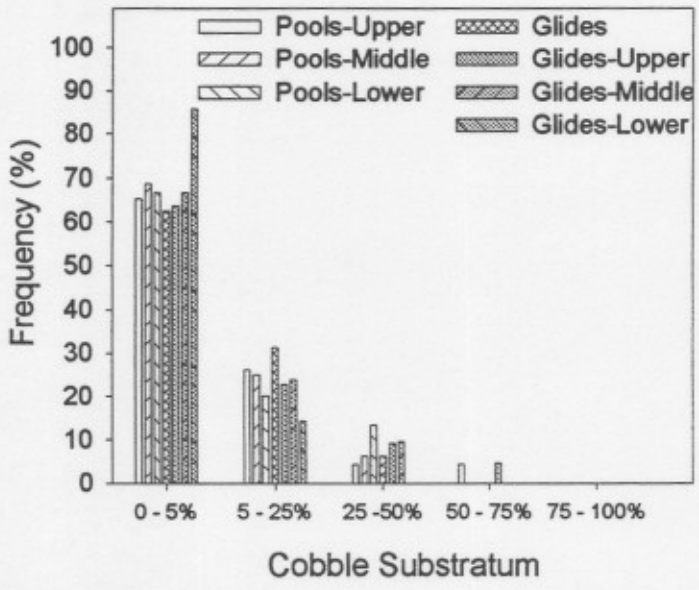

Figure 37. Percentage of substrata composed of suitable cover-stones for smoky madtoms and duskytail darters in pool-sections and glides in Hiwassee River. The Y-axis shows the percentage of pool-sections and glides best described by one of the of the five classes.

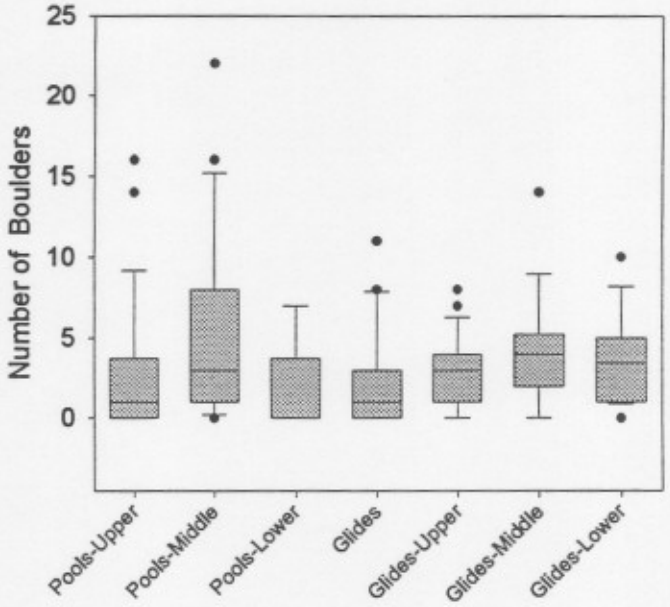

Figure 38. Box plots for number of boulders suitable for madtom spawning in Hiwassee River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers, and the solid line in the box represents the median.

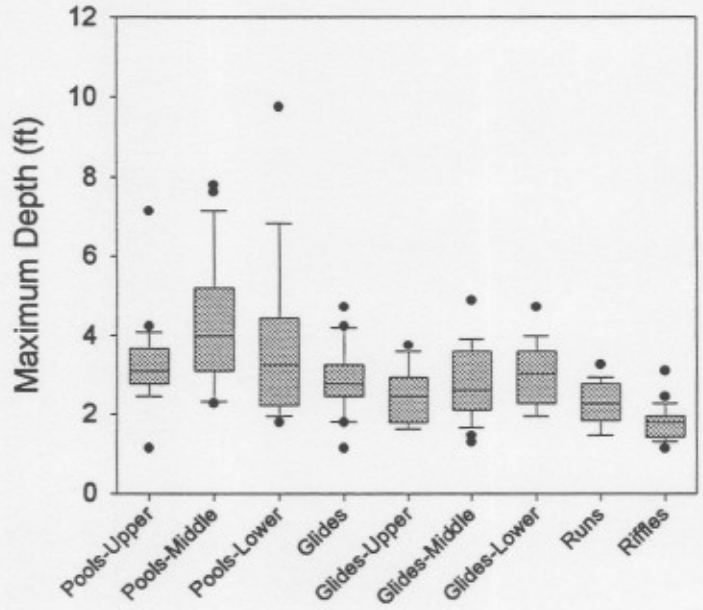

Figure 39. Box plots for habitat-unit and section maximum depth in Hiwassee River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

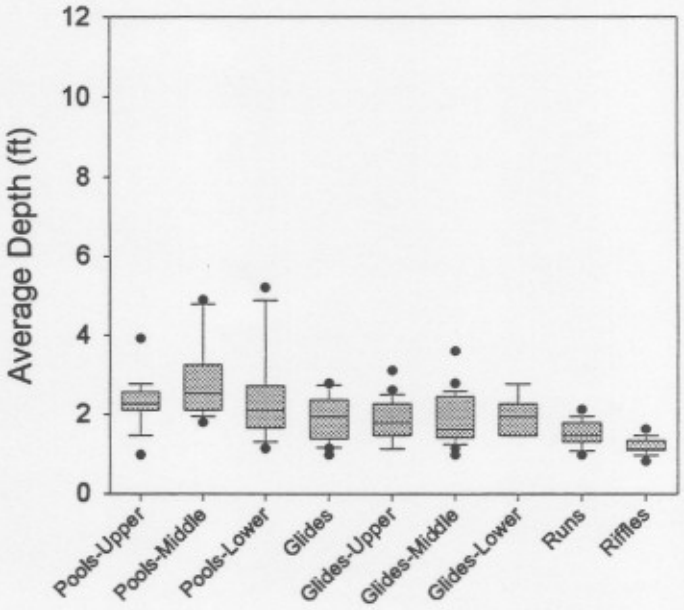

Figure 40. Box plots for habitat-unit and section average depth in Hiwassee River. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

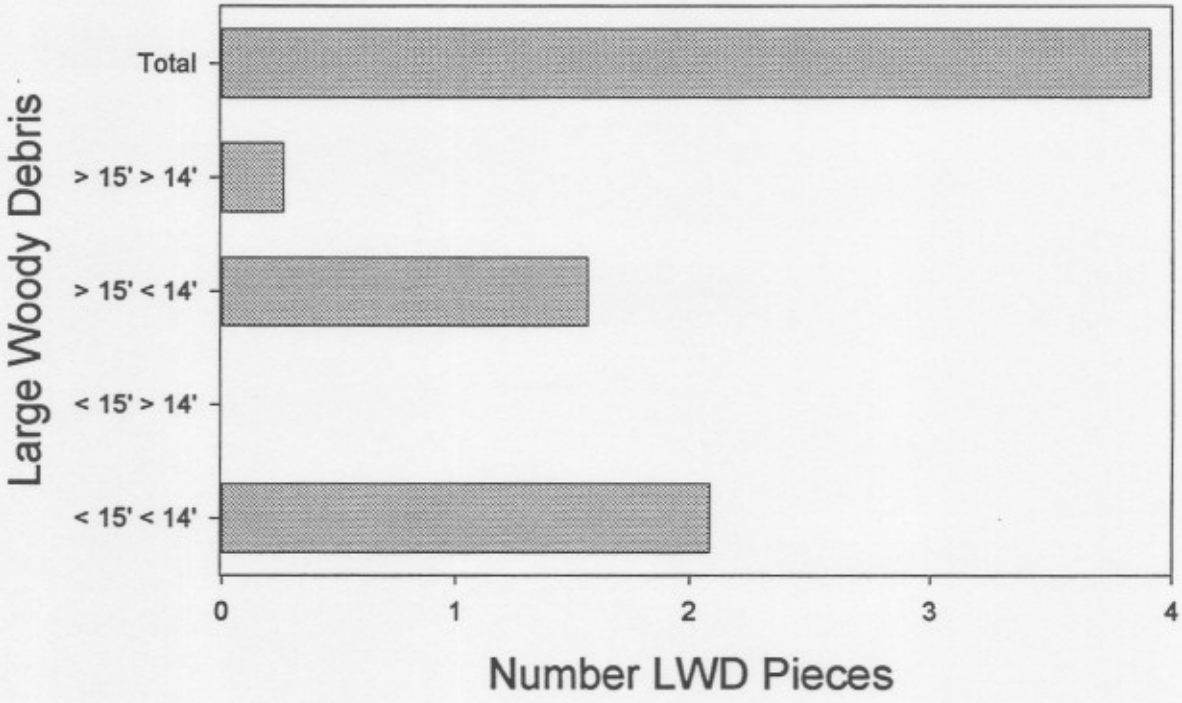

Figure 41. Pieces of large woody debris per mile in Hiwassee River.

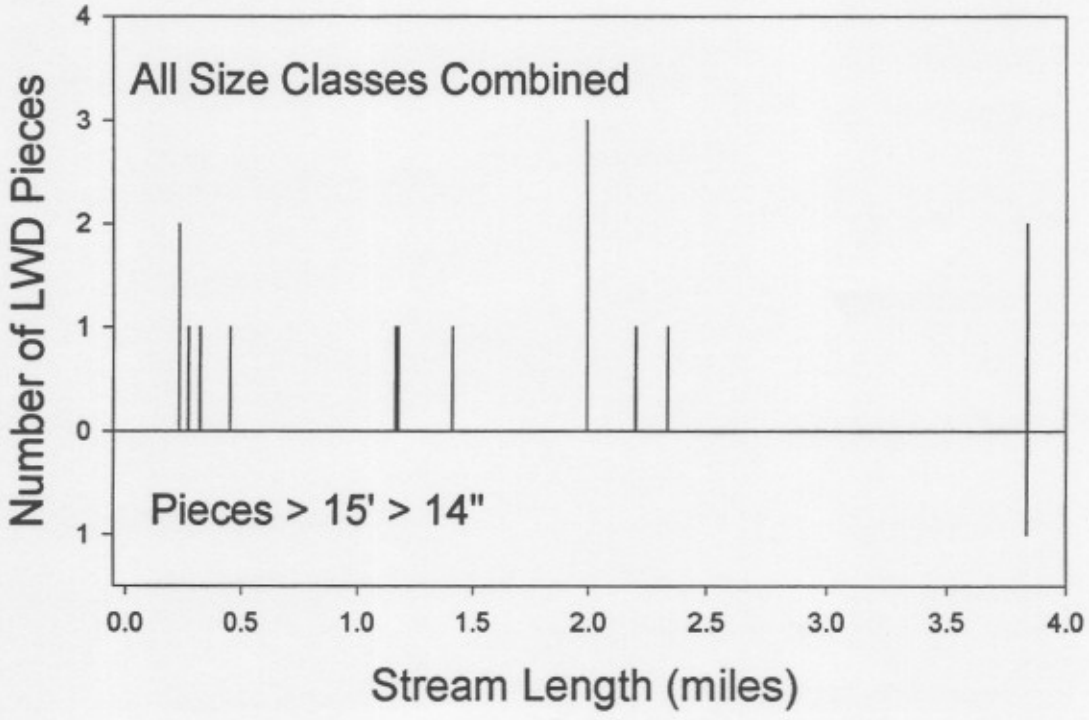

Figure 42. Distribution and total abundance of large woody debris in Hiwassee River.