# An Inventory of Stream Habitat and Blackside Dace (*Phoxinus cumberlandensis*) Abundance in the Indian Creek Drainage, Daniel Boone National Forest, Kentucky

United States Department of Agriculture Forest Service
**Center for Aquatic Technology Transfer**
Virginia Polytechnic Institute and State University
1650 Ramble Road
Blacksburg, VA  24060-6349

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1650 Ramble Road
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Craig N. Roghair
Fisheries Biologist

J. Keith Whalen
John Moran
Fisheries Technicians

and

C. Andrew Dolloff
Project Leader
Coldwater Fisheries Research Unit
Southern Research Station

Prepared By:
**Craig N. Roghair and J. Keith Whalen**

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## Introduction

The resource managers of the Daniel Boone National Forest (DBNF) require information on the distribution and abundance of threatened, endangered, and sensitive species to meet their responsibilities under the Endangered Species Act. The federally threatened blackside dace (*Phoxinus cumberlandensis*), first described as a species in 1978, is endemic to the Upper Cumberland River drainage (Etnier and Starnes 1993). The full distribution of the species within the drainage is yet to be determined (Eisenhour and Strange 1998), however some of the largest encountered populations of blackside dace have been found within the proclamation boundaries of the DBNF, KY (Starnes and Starnes 1981, Etnier and Starnes 1993). The USFS Center for Aquatic Technology Transfer (CATT) has been working with the DBNF since 1995 to collect distribution, abundance, and related physical habitat information on the blackside dace (Leftwich et al. 1995, Leftwich et al 1997, Leftwich and Quarles 1998, Underwood et al. 1999). During summer 2000, the CATT surveyed several streams in the Indian Creek drainage, including Indian Creek, Barren Fork, Pigeon Roost Branch, and Railroad Fork to inventory stream habitat and search for blackside dace populations.

## Methods

### Study Sites

Four streams within the Indian Creek drainage, DBNF, KY were surveyed in 2000 (Figure 1). Indian Creek is located on the Wiborg quadrangle, in the Cumberland River drainage, east of Flat Rock, KY. The Indian Creek survey began at the Forest Service boundary and ended 10.6 km upstream. Barren Fork flows into Indian Creek approximately 2.6 km upstream from the Forest Service boundary. The Barren Fork survey began at the confluence with Indian Creek and ended 10.3 km upstream. Pigeon Fork and Railroad Fork are both tributaries to Barren Fork, entering the stream 2.0 km and 4.8 km upstream from its confluence with Indian Creek, respectively. Lands surrounding the surveyed reaches are currently owned by the Forest Service and are used for a variety of recreational activities. We observed or found evidence of hiking, horseback riding, and all-terrain vehicle (ATV) use within the watersheds.

### Habitat Survey

Habitat in each stream was classified and inventoried by a two-person crew using two-stage visual estimation techniques. During the first stage, one crew member identified each habitat unit by type, estimated surface area, average and maximum depth, and substrate composition (Table 1) for each habitat unit, estimated residual pool depth, and determined if pool substrates were embedded. Habitat unit types included pools (areas in the stream with concave bottom profile, gradient equal to zero, greater than average depth, and smooth water surface), and riffles (areas in the stream with convex bottom profile, greater than average gradient, less than average depth, and turbulent water surface). Glides (areas in the stream similar to pools, but with average depth and flat bottom profile) were identified during the survey but were grouped with pools for data analysis. Runs (areas in the stream similar to riffles but with average depth, less turbulent

flow, and flat bottom profile) and cascades (areas in the stream with > 12% gradient, high velocity, and exposed bedrock or boulders) were grouped with riffles for data analysis. Braids (areas in the stream where three or more channels occur regardless of habitat type) were not noted during any of the surveys. Substrate was considered to be embedded if larger size substrate was surrounded by smaller size substrate over greater than 35% of the surface area of the stream bed in a given habitat unit. 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 5 cm increments. Residual pool depth was calculated by subtracting the riffle crest depth (depth of water at the hydraulic control) from average pool depth. The length (0.1 m) of each habitat unit was measured with a hip chain.

The second crew member classified and inventoried large woody debris (LWD) within the stream channel, determined the Rosgen (1996) channel type associated with each habitat unit, and recorded data on a Husky Hunter data logger. LWD was divided into four classes: 1) less than 5 m long, less than 55 cm in diameter, 2) less than 5 m long, greater than 55 cm in diameter, 3) greater than 5 m long, less than 55 cm in diameter, and 4) greater than 5 m long, greater than 55 cm in diameter. All woody debris less than 1 m long and less than 10 cm in diameter were omitted from the survey. Rosgen's channel type was estimated visually based on channel type descriptions found in Rosgen (1996).

The first unit of each habitat type selected for intensive (second stage) sampling (i.e. accurate measurement of surface area) was determined randomly. Additional units were selected systematically (every $10^{th}$ unit for each habitat type). The width of each systematically selected habitat unit was measured with a 30-m measuring tape at intervals ranging from about 1 m to 15 m. Interval size was determined by the length and the morphology of the unit (i.e. interval of measured width increased with increasing unit length). In each of the systematically selected riffles we also estimated the bankfull stream channel width (Harrelson et al. 1994) and measured the channel gradient with a clinometer. Water temperature was recorded three times per day, typically in the morning, at midday, and in late afternoon. Surveys were terminated when we determined the stream to be intermittent (generally < 1 m wetted width).

The relationship between estimated surface area and measured surface area typically is strongly and positively correlated when the estimates are made by experienced personnel; thus we could correct visual estimates by multiplying them by a calibration ratio (Hankin and Reeves 1988). The calibration ratio, the estimated true total area, and the variance of the area estimator were calculated separately for each habitat type and each stream. BVET calculations were computed with a Microsoft Excel spreadsheet using the formulas found in Dolloff et al. (1993). Data were summarized using Excel spreadsheets and SigmaPlot graphics software.

**Fish Survey**

Fish species in each stream were classified and inventoried using two-stage visual estimation techniques. During the first stage, a diver counted the number of *Phoxinus* species and noted occurrence of other species in approximately every 10$^{th}$ pool and every 15$^{th}$ riffle in the stream. During the second stage, we attempted to calibrate the *Phoxinus* spp. counts by performing three-pass electrofishing depletions on approximately every 5$^{th}$ pool and every other riffle visited by divers. Calibrated diver counts may be used to estimate fish population size when there is a consistent relationship between dive counts and electrofishing estimates (Dolloff et al. 1993). We recorded the number of all species captured during each pass and weighed and measured individual *Phoxinus* spp. that were captured. We encountered both *P. erythrogaster* and *P. cumberlandensis* during diving and electrofishing. Due to similarity in physical traits and possible hybridization between species (Eisenhour and Piller 1997), we could not consistently distinguished between *Phoxinus* species in the field, and grouped them together for data analysis.

## Results

**Habitat Survey**

Summary data for all four surveys are presented in Table 2.

*Indian Creek*

We identified 333 pools (including four glides) and 233 riffles (including six cascades) in the 10.6 km survey reach of Indian Creek. Visual estimates of habitat area were paired with measured habitat area for 31 pools and 15 riffles. Using BVET calculations, we estimated that the survey reach contained 85% (43231±4636 m$^2$) pool habitat and 15% (7880±877 m$^2$) riffle habitat (Figure 2). Total area was estimated using correction factors of 0.96 for pools and 0.95 for riffles. The mean area of individual pools and riffles was 130 m$^2$ and 34 m$^2$, respectively.

Mean maximum depth in Indian Creek ranged from 39 cm in pools to 13 cm in riffles (Figure 3). The mean average depth ranged from 17 cm in pools to 6 cm in riffles. The mean pool residual depth was 10 cm.

Indian Creek contained 164 total pieces of LWD per km. Small diameter (<55 cm) LWD comprised the majority of the total LWD (Figure 4). There were 56 pieces per km of the smallest size class of LWD. LWD was fairly evenly spread throughout the study reach (Figure 5).

Cobble and large gravel were the most common dominant and subdominant substrates in the survey reach (Figure 6). Bedrock and sand were the next most common dominant substrates in pools.

Comments from the habitat survey indicated that there were over 25 debris or log jams in the survey reach (Appendix A). Water temperature ranged from 17 C to 22 C in the study reach. At least three trail crossings or fords were encountered, some not marked on maps. One beaver dam was encountered.

*Barren Fork*

We identified 410 pools (including 38 glides) and 259 riffles (including eight runs and four cascades) in the 10.3 km survey reach of Barren Fork. Visual estimates of habitat area were paired with measured habitat area for 38 pools and 21 riffles. Using BVET calculations, we estimated that the survey reach contained 84% (35170±1169 $m^2$) pool habitat and 16% (6492±221 $m^2$) riffle habitat (Figure 7). Total area was estimated using correction factors of 1.03 for pools and 0.99 for riffles. The mean area of individual pools and riffles was 86 $m^2$ and 25 $m^2$, respectively.

Mean maximum depth in Barren Fork ranged from 32 cm in pools to 11 cm in riffles (Figure 8). The mean average depth ranged from 15 cm in pools to 5 cm in riffles. The mean pool residual depth was 9 cm.

Barren Fork contained 356 total pieces of LWD per km. Small diameter (<55 cm) LWD comprised the majority of the total LWD (Figure 9). There were 251 pieces per km of the smallest size class of LWD. LWD was more abundant in the downstream reaches of the surveyed section (Figure 10).

Bedrock was the most common dominant substrate in the survey reach (Figure 11). Silt was the subdominant substrate in greater than 20% of pools and riffles.

Comments from the habitat survey indicated that there were more than 50 debris/log jams and several rootwads in the study reach (Appendix B). Silt and trash, such as old tires and rubber rafts, were noted several times in the comments. We also encountered old coal mines, a tributary with reddish water reddish color, several trails, and one culvert in the reach. Several beaver dams were noted throughout the stream. Water temperatures ranged from 18 C to 21 C.

*Pigeon Roost Branch*

We identified 45 pools and 38 riffles in the 1.4 km survey reach of Pigeon Roost Branch. Visual estimates of habitat area were paired with measured habitat area for four pools and two riffles. Using BVET calculations, we estimated that the survey reach contained 71% (2915±360 $m^2$) pool habitat and 29% (1187±610 $m^2$) riffle habitat (Figure 12). Total area was estimated using correction factors of 1.11 for pools and 1.07 for riffles. The mean area of individual pools and riffles was 65 $m^2$ and 31 $m^2$, respectively.

Mean maximum depth in Pigeon Roost Branch ranged from 36 cm in pools to 10 cm in riffles (Figure 13). The mean average depth ranged from 21 cm in pools to 8 cm in riffles. The mean pool residual depth was 13 cm.

Pigeon Roost Branch contained 117 total pieces of LWD per km (Figure 14). Small diameter (<55 cm) LWD comprised the majority of the total LWD. There were 15 pieces per km of the smallest size class of LWD. LWD was scattered throughout the surveyed section (Figure 15).

Pools contained bedrock, cobble, boulder, and sand as dominant substrates (Figure 16). Silt and sand were the subdominant substrate in nearly half of all pools. Cobble and boulder were the most common dominant and subdominant substrates in riffles.

Comments from the habitat survey indicated that Pigeon Roost Branch was impacted by sedimentation and silt (Appendix C). One tributary, noted as a source of silt, contained an orange water color. An old mine was found approximately half-way through the survey. Water temperature recorded in the late afternoon was 17.5 C.

*Railroad Fork*

We identified 43 pools and 31 riffles in the 0.9 km survey reach of Railroad Fork. Visual estimates of habitat area were paired with measured habitat area for four pools and two riffles. Using BVET calculations, we estimated that the survey reach contained 78% (2056±610 $m^2$) pool habitat and 22% (573±398 $m^2$) riffle habitat (Figure 17). Total area was estimated using correction factors of 1.08 for pools and 1.11 for riffles. The mean area of individual pools and riffles was 48 $m^2$ and 18 $m^2$, respectively.

Mean maximum depth in Railroad Fork ranged from 38 cm in pools to 10 cm in riffles (Figure 18). The mean average depth ranged from 18 cm in pools to 5 cm in riffles. The mean pool residual depth was 15 cm.

Railroad Fork contained 310 total pieces of LWD per km (Figure 19). Small diameter (<55 cm) LWD comprised the majority of the total LWD. There were 225 pieces per km of the smallest size class of LWD. LWD was scattered throughout the surveyed section (Figure 20).

Large and small gravel were the dominant and subdominant substrates in the majority of pools and riffles (Figure 21). Other substrates were either absent or infrequently encountered.

Comments from the habitat survey indicated that a red/orange color scum was found on the substrate of the stream for the majority of the survey (Appendix D). We located one horse trail crossing in the survey section and found an old mine on a tributary upstream from the end of the survey. Water temperature in Railroad Fork was 17 C. Water flowing out of the mine was 11.5 C.

**Fish Survey**

In total, we captured 12 species in Indian Creek, 9 in Barren Fork, 6 in Pigeon Roost Branch, and 1 in Railroad Fork (Figures 23, 25, 27, 29, Table 3). Creek chubs were the only species present in all four streams, and were the only species present in Railroad Fork. Creek chubs and darters were the most widely distributed and commonly encountered species.

*Phoxinus* species (*P. cumberlandensis* and *P. erythrogaster*) were found in Indian Creek, Barren Fork, and Pigeon Roost Branch (Figures 22, 24, 26, 28). They were most frequently encountered in Indian Creek. Inconsistent relationships between diver counts and electrofishing captures, and a lack of paired samples containing at least one *Phoxinus* prevented us from estimating total population sizes using BVET methods. Where possible we estimated 3-pass depletion estimates for individual habitat units (Tables 4-11). We estimate that where we found *Phoxinus* species, the ratio of southern redbelly dace to blackside dace was 90:10.

## Conclusions and Recommendations

The literature on blackside dace, although limited, suggests that they prefer cool streams (<23 C) of moderate gradient, with abundant riparian vegetation and shading, undercut banks, rootwads and brushy materials for cover, and 'rubble' substrates (Starnes and Starnes 1981, O'Bara 1990, Etnier and Starnes 1993, Eisenhour and Strange 1998). They have been extirpated from streams due to activities such as mining, agriculture, and road building that destroy riparian vegetation or increase siltation. Loss of riparian vegetation results in increased water temperatures, loss of bank and rootwad cover, and increased sedimentation. Increased siltation results in the loss of suitable spawning habitat.

The streams we surveyed contained several of the blackside dace's preferred habitat conditions. Stream gradient did not exceed 4% in any of the streams. Water temperature, recorded in the morning, at mid-day, and in late afternoon, never exceeded 23 C and the stream channel was mostly well shaded (pers. obs.). Log/debris jams, brush bundles, small diameter LWD, undercut banks and rootwads were noted in several locations and with the exception of Railroad Fork, 'rubble' substrates (assumed here to mean cobble, boulder, and bedrock) were relatively abundant.

Although the streams contained several favorable characteristics, there was also evidence of degradation. Old mines were observed on Barren Fork and Railroad Fork and all of the streams had trail and road crossings, some unauthorized. Several of the streams had tributaries that contained reddish/orange water and in Railroad Fork the substrate was covered in a reddish/orange scum. In addition, heavy silt was noted in several areas of Barren Fork and Pigeon Roost Branch.

Repeated monitoring of these streams is the only way to know if the amount of suitable blackside dace habitat and population abundance is increasing, decreasing or remaining steady. In addition, given the small number of blackside dace present in the Indian Creek watershed, we recommend that the DBNF implement management designed to decrease the amount of siltation, improve water quality, and maintain or increase riparian vegetation. In particular, we suggest closing all unauthorized trails to decrease the amount of point-source siltation and to recover riparian vegetation and bank stability. We also recommend that the DBNF locate the sources and investigate the influence of the orange colored water and sediment deposits.

Mining activities, loss of riparian vegetation, siltation, and loss of instream cover have all been identified as detrimental to blackside dace habitat. During our habitat surveys we noted evidence of past mining activity and identied whether silt was the dominant or subdominant substrate. Future surveys may benefit by adding estimates of overstream canopy cover and by estimating the amount of available instream cover (undercut banks, rootwads, etc.).

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Table 1. Substrate size categories (based on a modified Wentworth scale) used during BVET habitat surveys in the Daniel Boone National Forest, July 2000.

| Substrate | Description |
|---|---|
| Organic Material | |
| Clay | |
| Silt | |
| Sand | silt - 2 mm |
| Small Gravel | 3 mm - 10 mm |
| Large Gravel | 11 mm - 100 mm |
| Cobble | 101 mm - 300 mm |
| Boulder | > 300 mm |
| Bedrock | |

Table 2. Summary of 2000 BVET habitat survey results for streams in the Indian Creek drainage, Daniel Boone National Forest, KY.

| **Stream:** | **Indian Creek** | **Barren Fork** | **Pigeon Roost Br.** | **Railroad Fork** |
|---|---|---|---|---|
| **Quadrangle:** | Wiborg | Wiborg | Wiborg | Wiborg |
| **Survey Date:** | 07/25/00 | 07/27/00 | 07/27/00 | 07/25/00 |
| **Downstream Starting Point:** | FS boundary | Indian Cr. | Barren Fk. | Barren Fk. |
| **Total Distance Surveyed (km):** | 10.6 | 10.3 | 1.4 | 0.9 |
| **Percent of Total Area Pools:** | 85 | 84 | 71 | 78 |
| **Number of Pools:** | 333 | 410 | 45 | 43 |
| **Number of Pools per km:** | 31 | 40 | 33 | 49 |
| **Total Pool Area ($m^2$):** | 43231 | 35170 | 2915 | 2056 |
| **+/- ($m^2$):** | 4636 | 1169 | 360 | 610 |
| **Mean Pool Area ($m^2$):** | 130 | 86 | 65 | 48 |
| **Correction Factor:** | 0.96 | 1.03 | 1.11 | 1.08 |
| **Mean Maximum Depth (cm):** | 39 | 32 | 36 | 38 |
| **Mean Average Depth (cm):** | 17 | 15 | 21 | 18 |
| **Mean Residual Pool Depth (cm):** | 10 | 9 | 13 | 15 |
| **Percent of Pool Habitat Surveyed as Glides:** | 1 | 9 | 0 | 5 |
| **Percent Pools with > 35% Embeddedness:** | 32 | 75 | 2 | 9 |
| **Percent of Total Area Riffles:** | 15 | 16 | 29 | 22 |
| **Number of Riffles:** | 233 | 259 | 38 | 31 |
| **Number of Riffles per km:** | 22 | 25 | 27 | 35 |
| **Total Riffle Area ($m^2$):** | 7880 | 6400 | 1187 | 573 |
| **+/- ($m^2$):** | 877 | 221 | 610 | 398 |
| **Mean Riffle Area ($m^2$):** | 34 | 25 | 31 | 18 |
| **Correction Factor:** | 0.95 | 0.99 | 1.07 | 1.11 |
| **Mean Maximum Depth (cm):** | 13 | 11 | 10 | 10 |
| **Mean Average Depth (cm):** | 6 | 5 | 8 | 5 |
| **Number of LWD pieces per km:** | 164 | 356 | 117 | 310 |
| **LWD < 5 m, < 55 cm:** | 56 | 251 | 15 | 225 |
| **LWD < 5 m, > 55 cm:** | 11 | 6 | 3 | 14 |
| **LWD > 5 m, < 55 cm:** | 78 | 93 | 81 | 66 |
| **LWD > 5 m, > 55 cm:** | 18 | 5 | 18 | 6 |
| **Mean Bankfull Channel Width (m):** | 8.4 | 6.0 | 7.2 | 5.5 |
| **Rosgen's Channel Type Frequency (%):** | | | | |
| **Type A:** | 0 | 0 | 0 | 0 |
| **Type B:** | 100 | 100 | 100 | 100 |
| **Type C:** | 0 | 0 | 0 | 0 |
| **Type D:** | 0 | 0 | 0 | 0 |
| **Type E:** | 0 | 0 | 0 | 0 |
| **Type F:** | 0 | 0 | 0 | 0 |
| **Type G:** | 0 | 0 | 0 | 0 |
| **Average Channel Gradient (%):** | 1 | 3 | 1 | 2 |

Table 3. List of species found in the Indian Creek drainage, Daniel Boone National Forest, KY during 2000 stream surveys. Species were observed during diving and/or captured and identified during electrofishing. Species that could not be positively identified during diving, and were not subsequently captured during electrofishing were identified to genus.

| | Indian Creek | Barren Fork | Pigeon Roost Branch | Railroad Fork |
|---|---|---|---|---|
| *Phoxinus* spp.* | X | X | X | |
| *Semotilus atromaculatus* | X | X | X | X |
| *Etheostoma* spp.** | X | X | X | |
| *Hypentelium nigricans* | X | X | | |
| *Catostomus commersoni* | X | X | X | |
| *Lampetra spp.* | X | X | X | |
| *Ambloplites rupestris* | X | | | |
| *Micropterus dolomieu* | X | | | |
| *Lepomis* spp.*** | X | | | |

**Phoxinus* spp. captured during electrofishing included *P. erythrogaster* and *P. cumberlandensis*. They could not be consistently distinguished during field identification.
***Etheostoma* spp. captured during electrofishing included *E. kennicotti*, *E. sagitta*, and *E. nigrum*. *E. kennicotti* was the only species identified in Pigeon Roost Branch.
****Lepomis* spp. were not captured during electrofishing, only observed by divers.

Table 4. Diver counts and electrofishing results for *Phoxinus* in pools in Indian Creek, DBNF, KY, 2000. Distance is meters upstream from the Forest Service boundary. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 307.4 | 0 | | | | | |
| 783.2 | 0 | | | | | |
| 1296 | 0 | | | | | |
| 2151 | 0 | | | | | |
| 2461.7 | 0 | | | | | |
| 2908.6 | 17 | 17 | 9 | 9 | 35 | N/A |
| 3028.4 | 0 | | | | | |
| 3239.3 | 8 | | | | | |
| 3401.4 | 18 | | | | | |
| 3614.7 | 8 | | | | | |
| 3898.6 | 16 | 7 | 5 | 4 | 16 | 28 |
| 4174.4 | 0 | | | | | |
| 4462 | 0 | | | | | |
| 4684.4 | 0 | | | | | |
| 5031.9 | 0 | | | | | |
| 5270.8 | 25 | | | | | |
| 5546.4 | 18 | 12 | 9 | 2 | 23 | 26 |
| 5797.9 | 6 | | | | | |
| 6018.9 | 0 | | | | | |
| 6245.5 | 5 | | | | | |
| 6477.7 | 9 | | | | | |
| 6720.5 | 9 | 5 | 0 | 1 | 6 | N/A |
| 6960.8 | 15 | | | | | |
| 7167.9 | 0 | | | | | |
| 7644.6 | 0 | | | | | |
| 7941.5 | 0 | | | | | |
| 8333.1 | 0 | | | | | |
| 8713.8 | 47 | 15 | 9 | 7 | 31 | 45 |
| 9003 | 0 | 0 | 0 | 0 | 0 | N/A |
| 9310 | 0 | | | | | |
| 9625.2 | 0 | | | | | |
| 9986.2 | 0 | 0 | 0 | 0 | 0 | N/A |
| 10302.5 | 0 | 0 | 0 | 0 | 0 | N/A |

Table 5. Diver counts and electrofishing results for *Phoxinus* in riffles in Indian Creek, DBNF, KY, 2000. Distance is meters upstream from Forest Service boundary. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 358.1 | 0 | | | | | |
| 2173.7 | 0 | | | | | |
| 2937.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 3363.6 | 0 | | | | | |
| 3853.5 | 0 | 0 | 0 | 0 | 0 | N/A |
| 4439.3 | 0 | | | | | |
| 5403.7 | 0 | 1 | 0 | 0 | 1 | N/A |
| 6204.7 | 0 | | | | | |
| 6695.2 | 0 | 0 | 0 | 0 | 0 | N/A |
| 7269 | 0 | | | | | |
| 7435.5 | 0 | 0 | 0 | 0 | 0 | N/A |
| 7787.4 | 0 | | | | | |
| 8422.7 | 7 | | | | | |
| 9052.5 | 0 | 0 | 0 | 0 | 0 | N/A |
| 9542.2 | 9 | | | | | |
| 10057.9 | 0 | 0 | 0 | 0 | 0 | N/A |

Table 6. Diver counts and electrofishing results for *Phoxinus* in pools in Barren Fork, DBNF, KY, 2000. Distance is meters upstream from confluence with Indian Creek. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 91.5 | 0 | | | | | |
| 548.5 | 8 | 0 | 0 | 0 | 0 | N/A |
| 804.7 | 0 | | | | | |
| 1290.5 | 0 | | | | | |
| 1860.3 | 0 | | | | | |
| 2194 | 0 | 0 | 0 | 0 | 0 | N/A |
| 2464.5 | 0 | 0 | 0 | 0 | 0 | N/A |
| 2826.2 | 0 | 0 | 0 | 0 | 0 | N/A |
| 2885.2 | 0 | 0 | 0 | 0 | 0 | N/A |
| 3079.1 | 0 | | | | | |
| 3212.1 | 0 | | | | | |
| 3508.8 | 6 | 1 | 0 | 1 | 2 | N/A |
| 3767.5 | 0 | | | | | |
| 4530.5 | 0 | | | | | |
| 4849.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 5141.8 | 0 | | | | | |
| 5353.8 | 0 | | | | | |
| 5509.8 | 0 | 0 | 0 | 0 | 0 | N/A |
| 5899.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 6066.9 | 0 | 0 | 0 | 0 | 0 | N/A |
| 6275.6 | 0 | | | | | |
| 6448.2 | 0 | | | | | |
| 6688 | 0 | 0 | 0 | 0 | 0 | N/A |
| 6909.9 | 0 | | | | | |
| 7083.5 | 0 | | | | | |
| 7335.9 | 0 | | | | | |
| 7579.8 | 0 | | | | | |
| 7827.3 | 0 | | | | | |
| 8090.5 | 0 | | | | | |
| 9238.8 | 0 | | | | | |
| 9356 | 0 | | | | | |
| 9517.7 | 0 | 0 | 0 | 0 | 0 | N/A |
| 9718.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 9992.2 | 0 | | | | | |

Table 7. Diver counts and electrofishing results for *Phoxinus* in riffles in Barren Fork, DBNF, KY, 2000. Distance is meters upstream from confluence with Indian Creek. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 590.1 | 0 | 0 | 0 | 0 | 0 | N/A |
| 2000.2 | 0 | 0 | 0 | 0 | 0 | N/A |
| 2921.9 | 0 | 0 | 0 | 0 | 0 | N/A |
| 3531.1 | 0 | 0 | 0 | 0 | 0 | N/A |
| 4838.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 5281.2 | 0 | | | | | |
| 5599.8 | 0 | 0 | 0 | 0 | 0 | N/A |
| 6049.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 6364.6 | 0 | 0 | 0 | 0 | 0 | N/A |
| 6696.9 | 0 | 0 | 0 | 0 | 0 | N/A |
| 7143.6 | 0 | 0 | 0 | 0 | 0 | N/A |
| 7425.1 | 0 | | | | | |
| 7791.9 | 0 | | | | | |
| 8096 | 0 | | | | | |
| 8334.9 | 0 | | | | | |
| 9249.5 | 0 | | | | | |
| 9440.7 | 0 | | | | | |
| 9560.5 | 0 | 0 | 0 | 0 | 0 | N/A |
| 9711.5 | 0 | 0 | 0 | 0 | 0 | N/A |
| 10043.5 | 0 | | | | | |

Table 8. Diver counts and electrofishing results for *Phoxinus* in pools in Pigeon Roost Branch, DBNF, KY, 2000. Distance is meters upstream from confluence with Indian Creek. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 140.8 | 0 | 0 | 0 | 0 | 0 | N/A |
| 434.6 | 0 | | | | | |
| 801.4 | 0 | 7 | 4 | 0 | 11 | 11 |
| 1125.6 | 0 | | | | | |
| 1354.9 | 0 | | | | | |

Table 9. Diver counts and electrofishing results for *Phoxinus* in riffles in Pigeon Roost Branch, DBNF, KY, 2000. Distance is meters upstream from confluence with Indian Creek. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 215.8 | 0 | 0 | 0 | 0 | 0 | N/A |
| 1293 | 0 | | | | | |

Table 10. Diver counts and electrofishing results for *Phoxinus* in pools in Railroad Fork, DBNF, KY, 2000. Distance is meters upstream from confluence with Indian Creek. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 57.3 | 0 | 0 | 0 | 0 | 0 | N/A |
| 252.2 | 0 | | | | | |
| 473.7 | 0 | 0 | 0 | 0 | 0 | N/A |
| 664.5 | 0 | | | | | |

Table 11. Diver counts and electrofishing results for *Phoxinus* in riffles in Railroad Fork, DBNF, KY, 2000. Distance is meters upstream from confluence with Indian Creek. Three-pass estimates performed using calculations in Kwak (1992). N/A indicates that there was an invalid depletion (fewer fish captured in each successive pass) and estimates could not be made.

| Distance (m) | Diver Count | Electrofishing | | | | |
|---|---|---|---|---|---|---|
| | | Pass 1 | Pass 2 | Pass 3 | Sum of Passes | 3-pass Estimate |
| 59.9 | 0 | 0 | 0 | 0 | 0 | N/A |
| 557 | 0 | 0 | 0 | 0 | 0 | N/A |

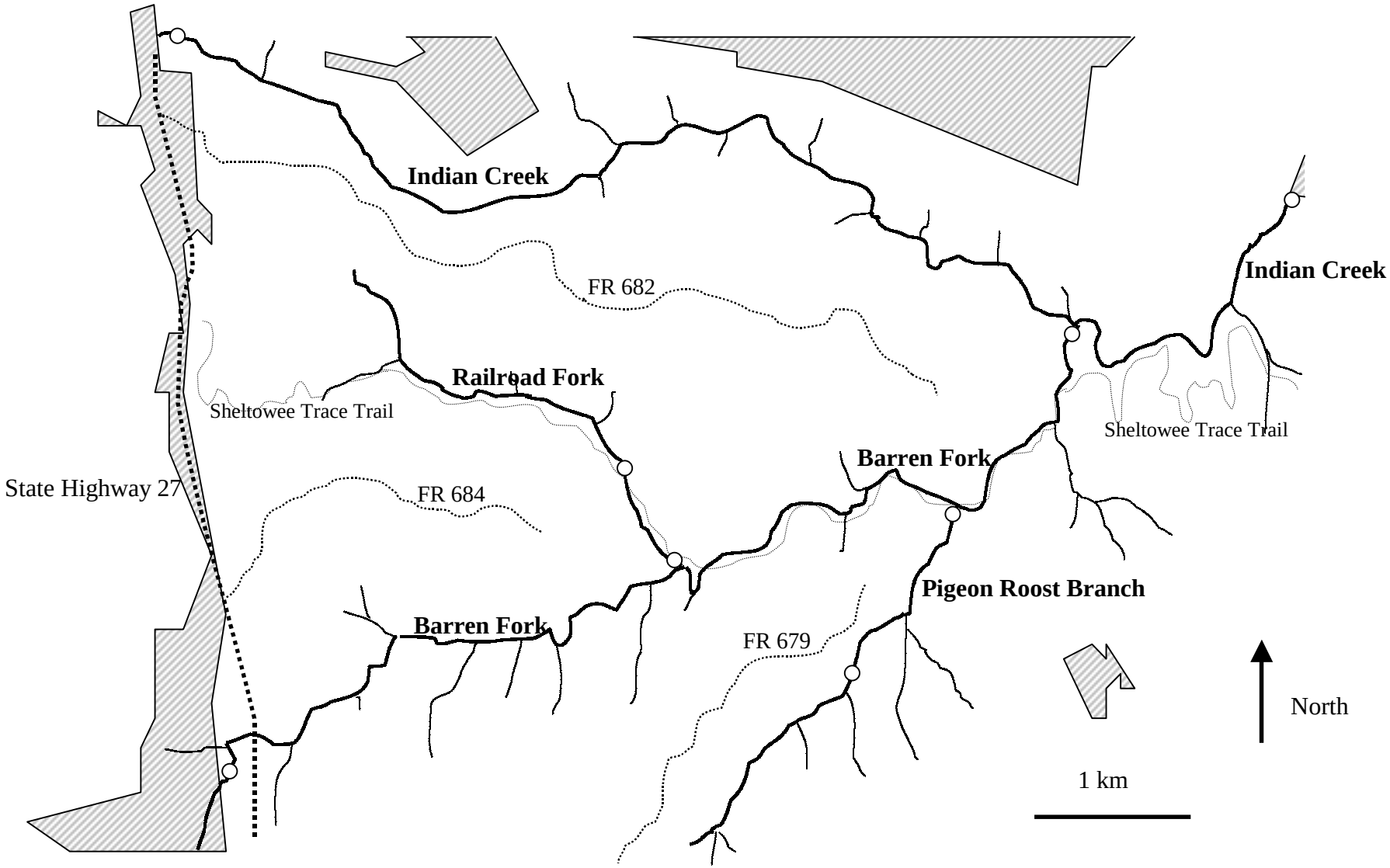


Figure 1. Indian Creek, Barren Fork, Pigeon Roost Branch, and Railroad Fork, DBNF, Kentucky. Open circles indicate starting and ending points for each stream survey. The location of highways, Forest roads (FR), trails, and private lands (shaded) are also shown.

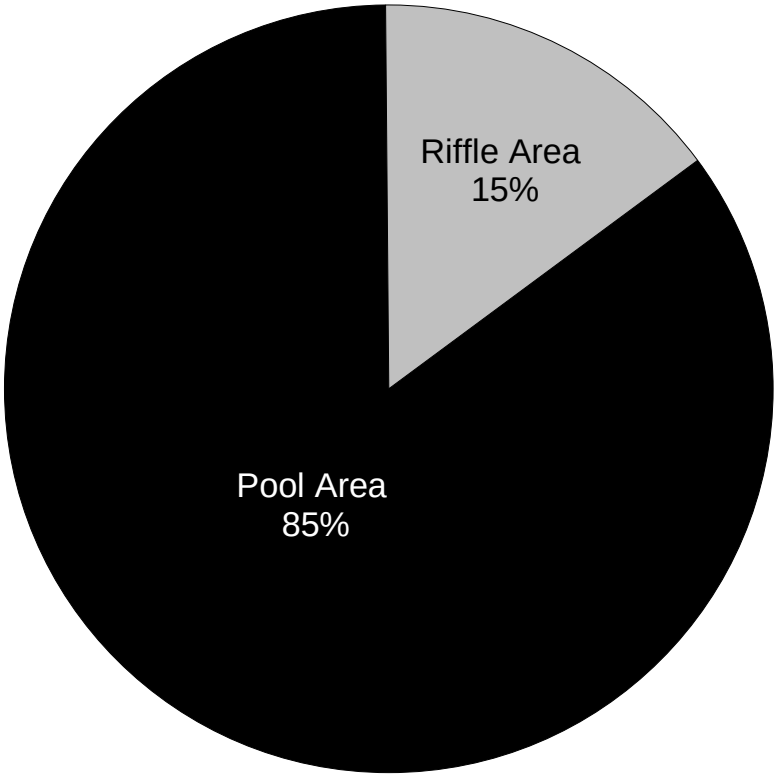


Figure 2. Percent surface area of Indian Creek in pools and riffles, as estimated using BVET techniques, July 2000.

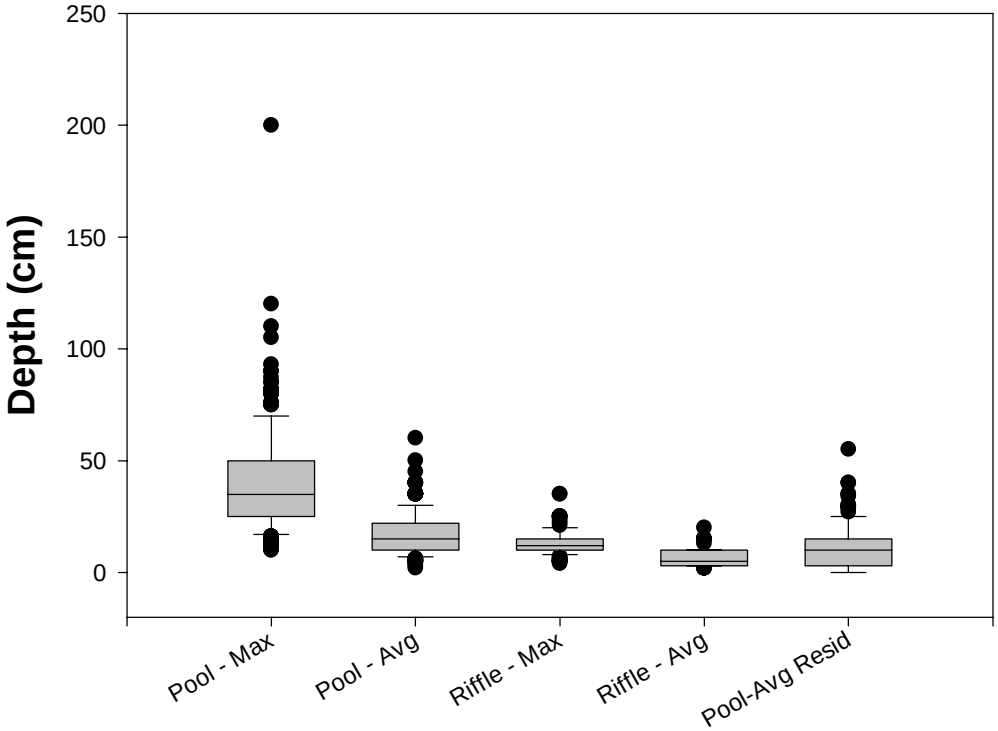


Figure 3. Maximum and average depths for all pools and riffles in Indian Creek, as estimated using BVET techniques, July 2000. The top and bottom of the boxes represent the 25$^{th}$ and 75$^{th}$ percentiles, the bar in the center represents the median, whiskers represent the 10$^{th}$ and 90$^{th}$ percentiles, and closed circles represent the entire range of the data.

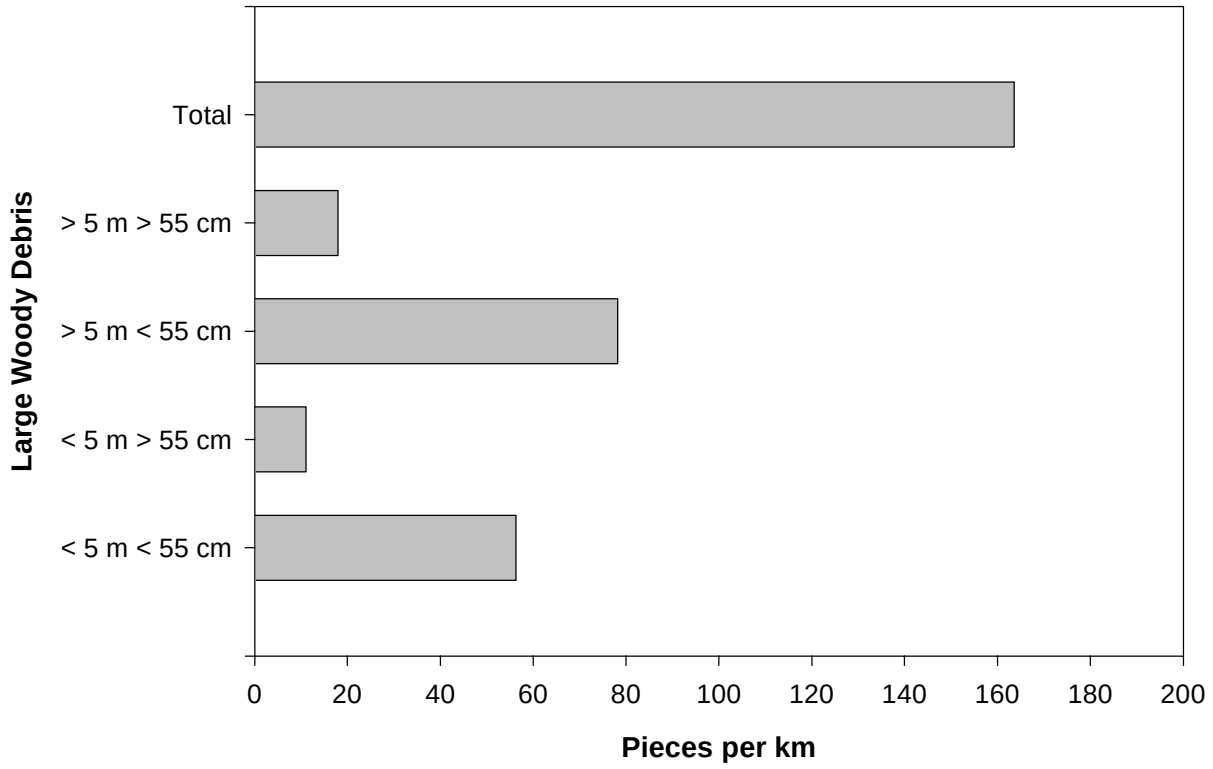


Figure 4. LWD per kilometer in Indian Creek, as estimated using BVET techniques, July 2000. Y-axis labels are LWD size classes with the first number indicating length and the second indicating diameter.

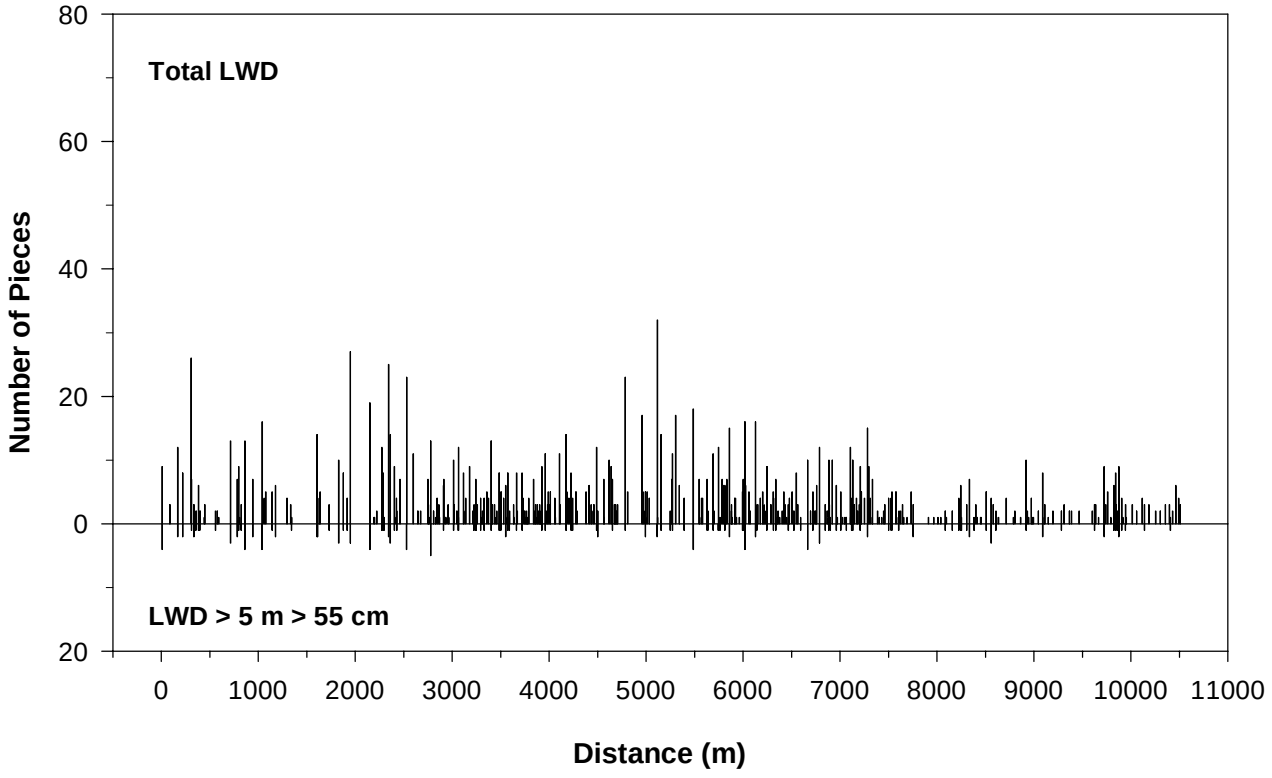


Figure 5. Distribution and abundance of LWD in each habitat unit in Indian Creek, as estimated using BVET techniques, July 2000. The amount of the total LWD in each unit >5 m long, >55 cm diameter is displayed below zero on the x-axis. Distance is meters upstream from Forest Service boundary.

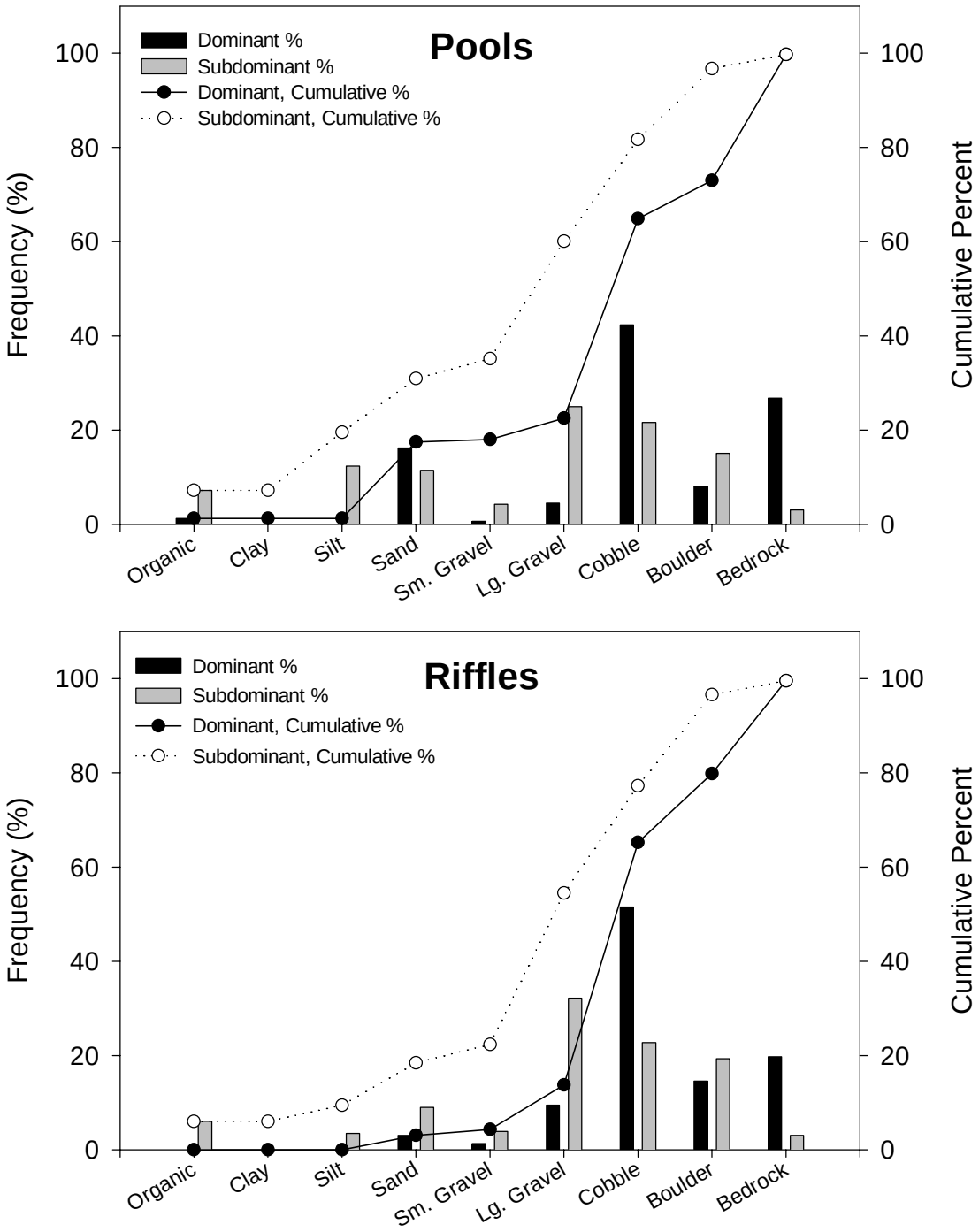


Figure 6. Frequency (percent) and cumulative percent of dominant and subdominant substrate occurrence for all pools and riffles in Indian Creek, as estimated using BVET techniques, July 2000.

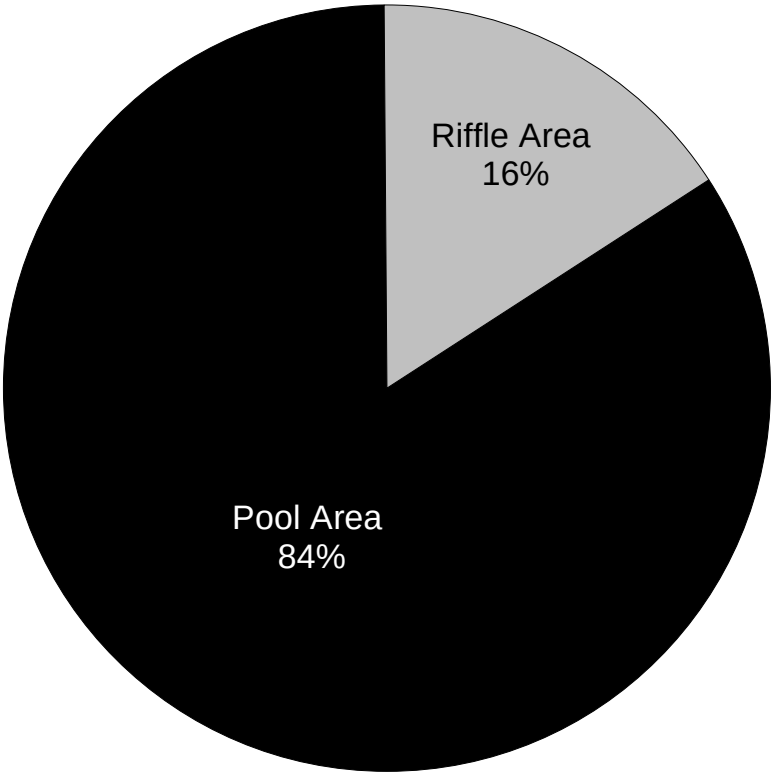


Figure 7. Percent surface area of Barren Fork in pools and riffles, as estimated using BVET techniques, July 2000.

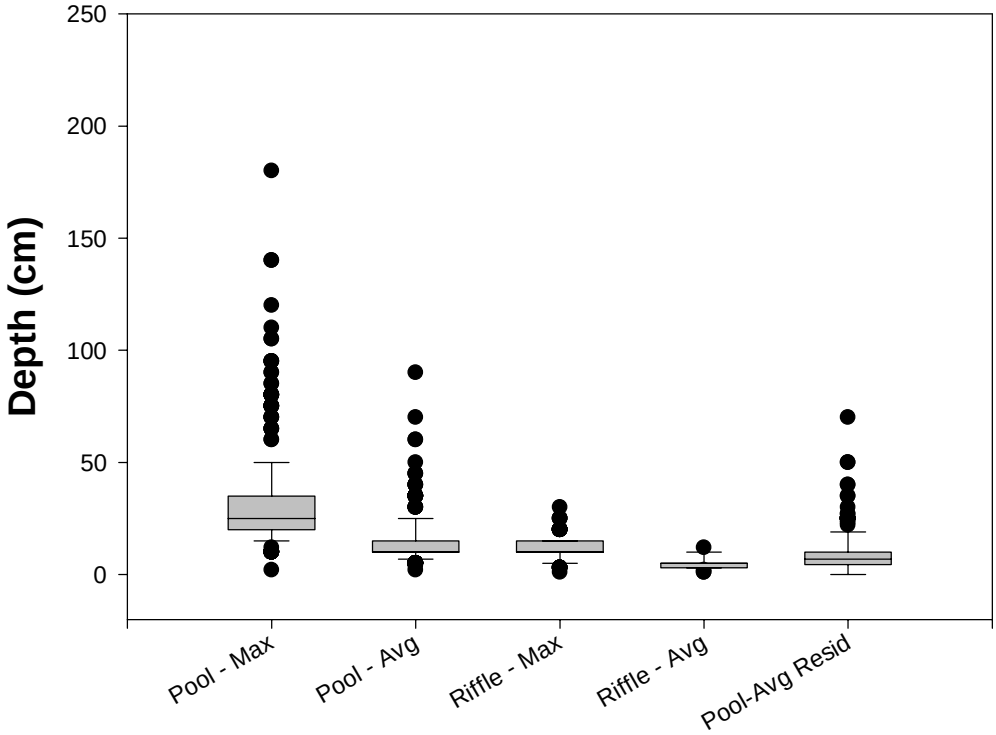


Figure 8. Maximum and average depths for all pools and riffles in Barren Fork, as estimated using BVET techniques, July 2000. The top and bottom of the boxes represent the 25$^{th}$ and 75$^{th}$ percentiles, the bar in the center represents the median, whiskers represent the 10$^{th}$ and 90$^{th}$ percentiles, and closed circles represent the entire range of the data.

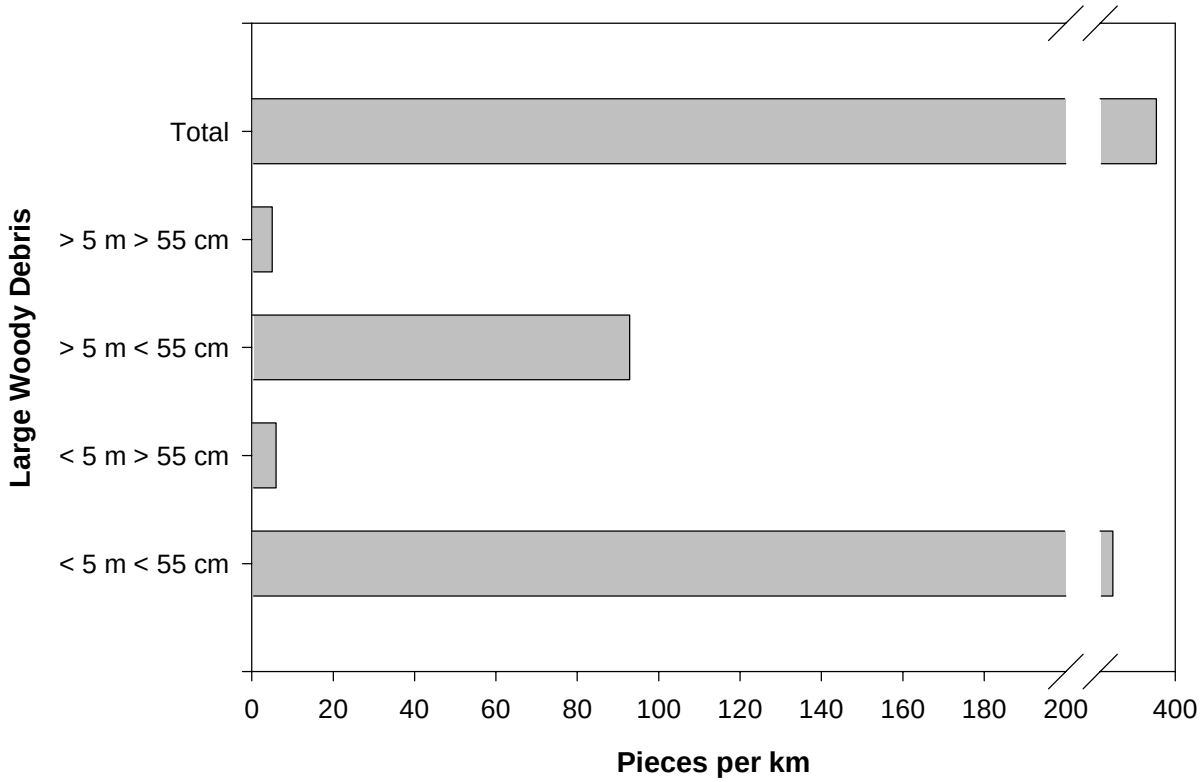


Figure 9. LWD per kilometer in Barren Fork, as estimated using BVET techniques, July 2000. Y-axis labels are LWD size classes with the first number indicating length and the second indicating diameter.

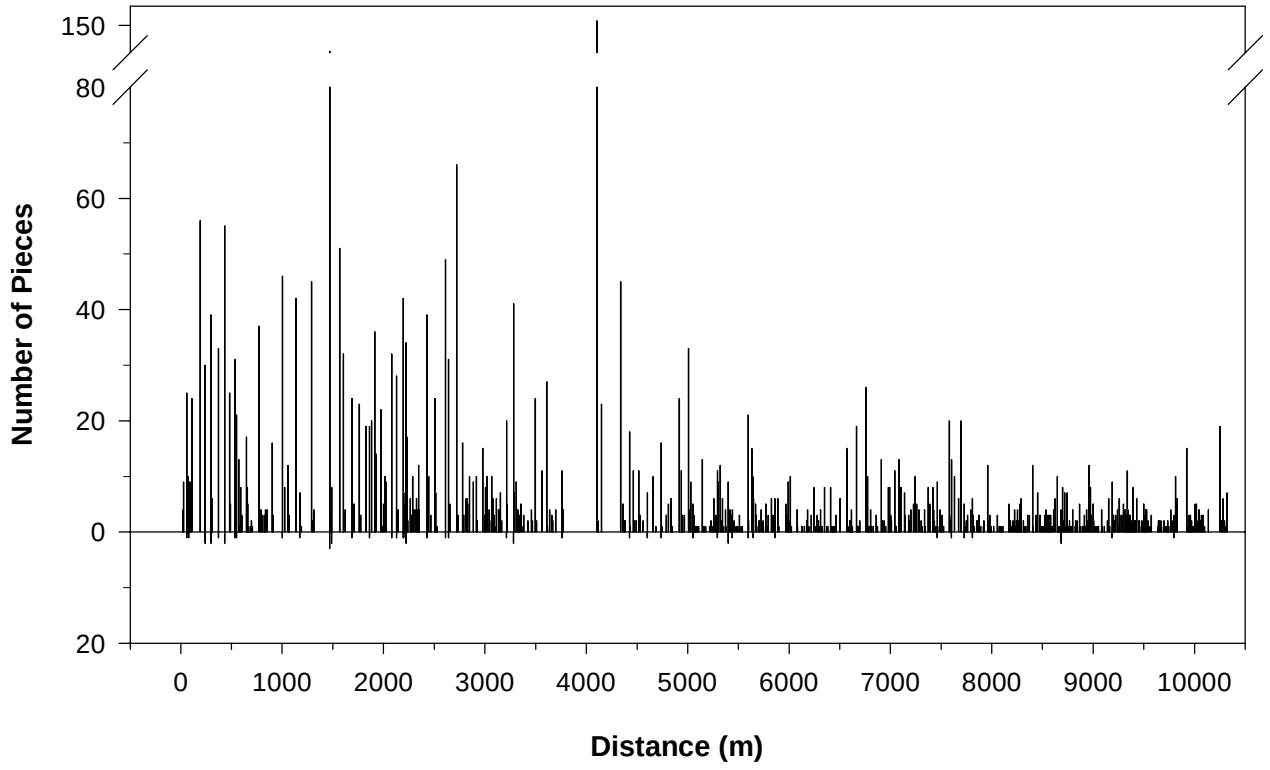


Figure 10. Distribution and abundance of LWD in each habitat unit in Barren Fork, as estimated using BVET techniques, July 2000. The amount of the total LWD in each unit >5 m long, >55 cm diameter is displayed below zero on the x-axis. Distance is meters upstream from Indian Creek.

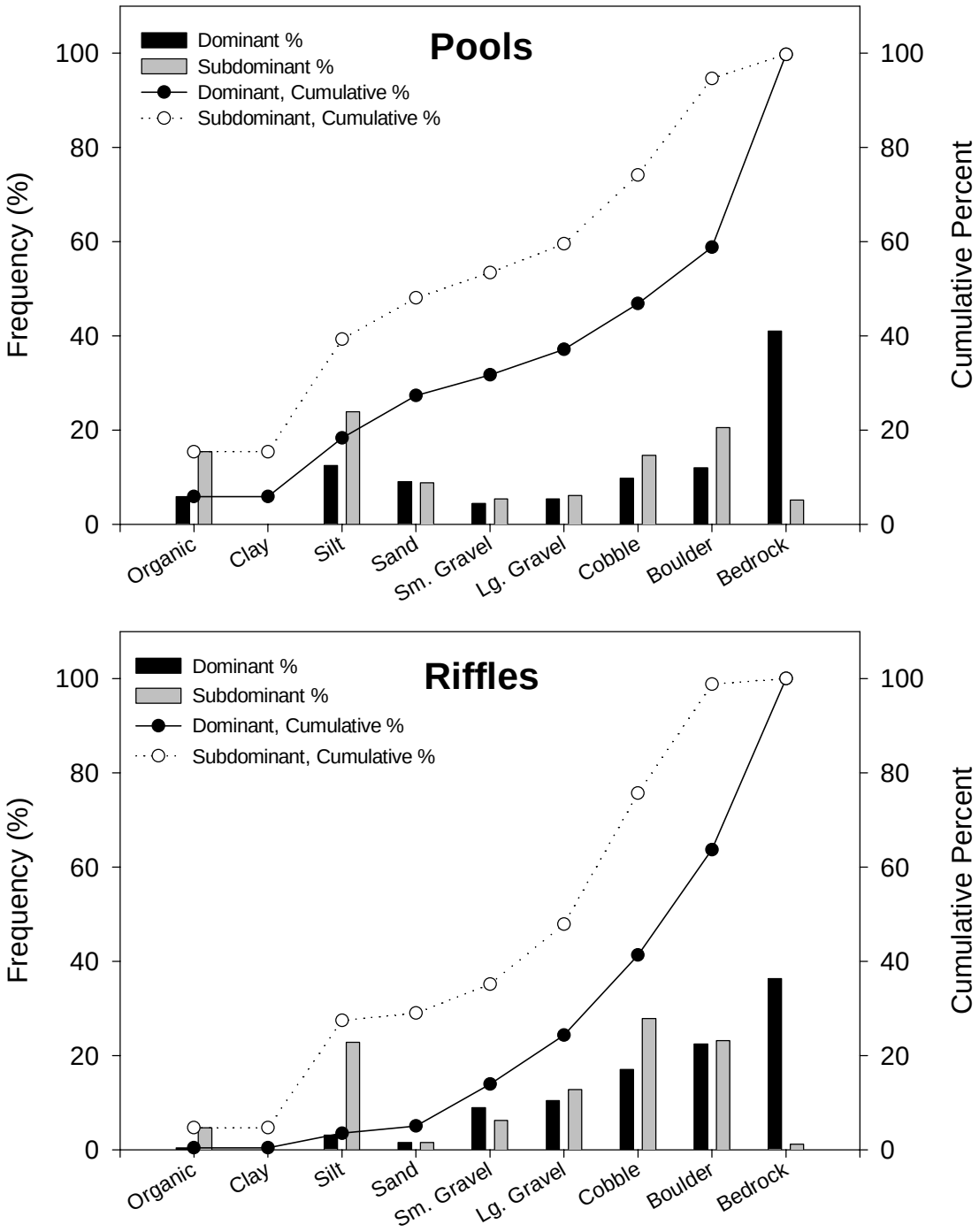


Figure 11. Frequency (percent) and cumulative percent of dominant and subdominant substrate occurrence for all pools and riffles in Barren Fork, as estimated using BVET techniques, July 2000.

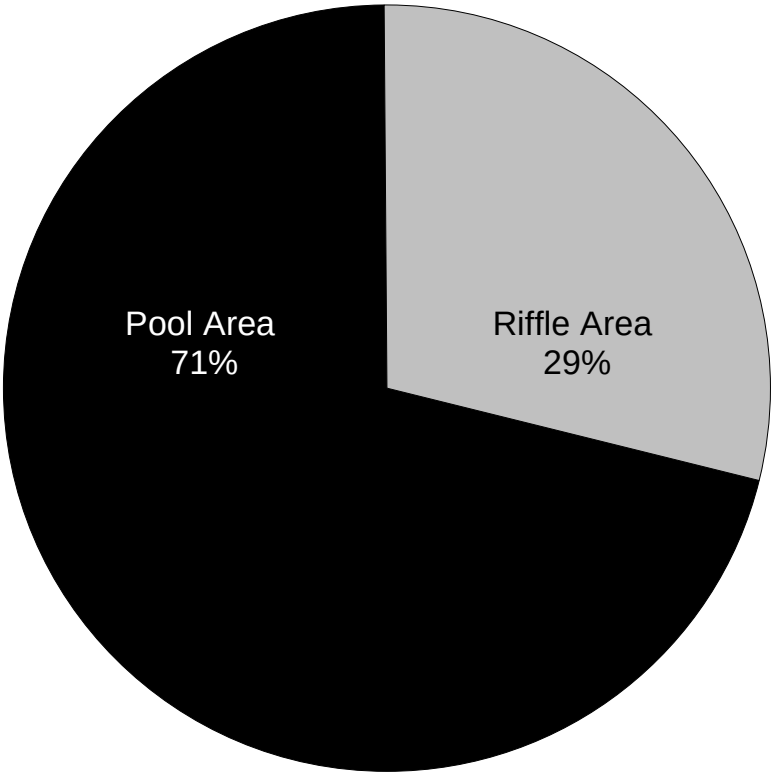


Figure 12. Percent surface area of Pigeon Roost Branch in pools and riffles, as estimated using BVET techniques, July 2000.

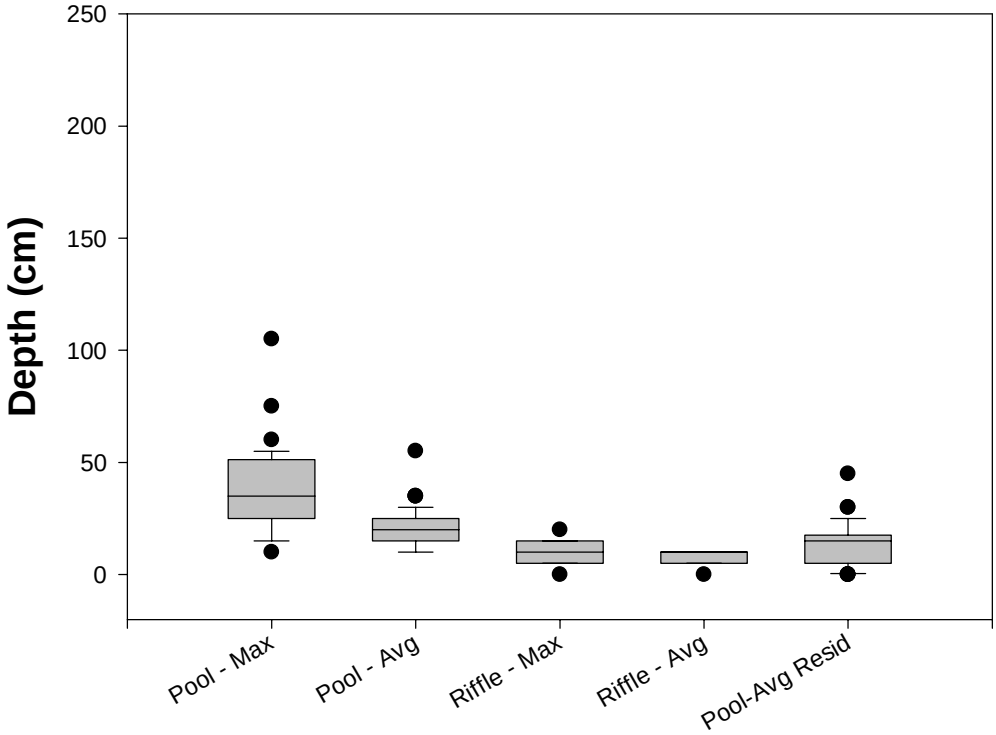


Figure 13. Maximum and average depths for all pools and riffles in Pigeon Roost Branch, as estimated using BVET techniques, July 2000. The top and bottom of the boxes represent the 25$^{th}$ and 75$^{th}$ percentiles, the bar in the center represents the median, whiskers represent the 10$^{th}$ and 90$^{th}$ percentiles, and closed circles represent the entire range of the data.

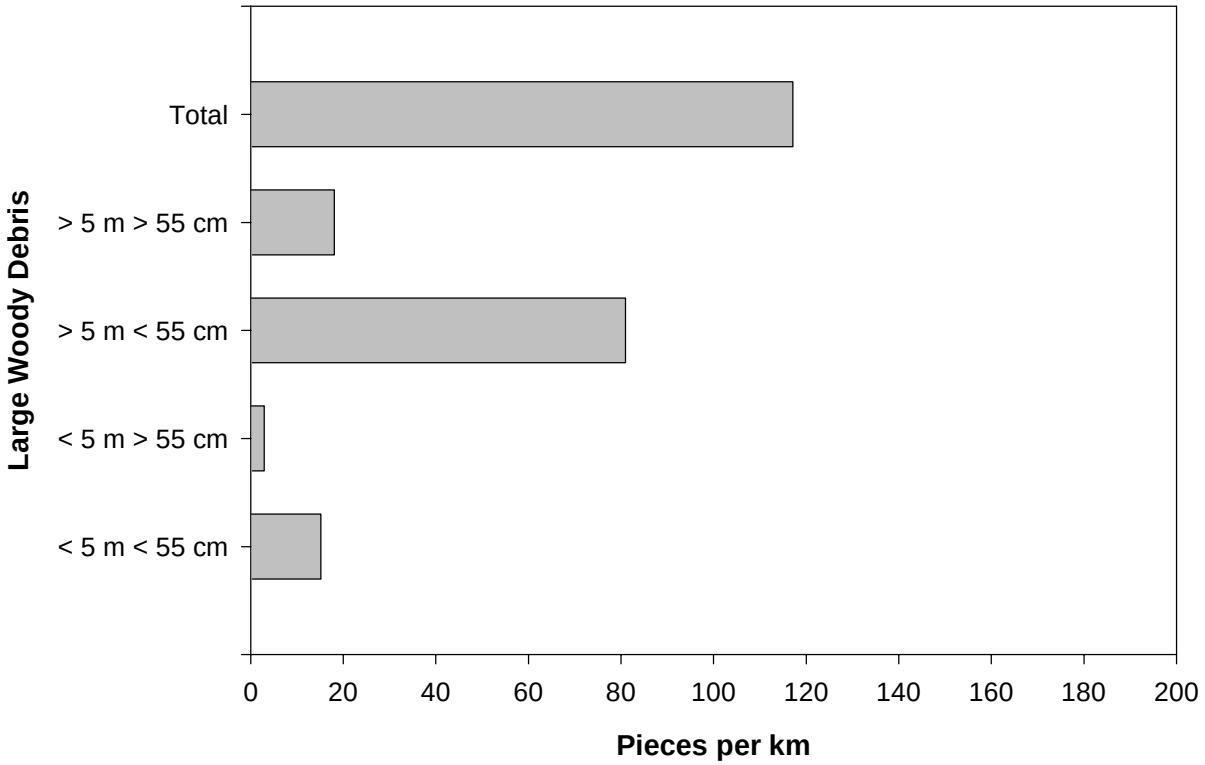


Figure 14. LWD per kilometer in Pigeon Roost Branch, as estimated using BVET techniques, July 2000. Y-axis labels are LWD size classes with the first number indicating length and the second indicating diameter.

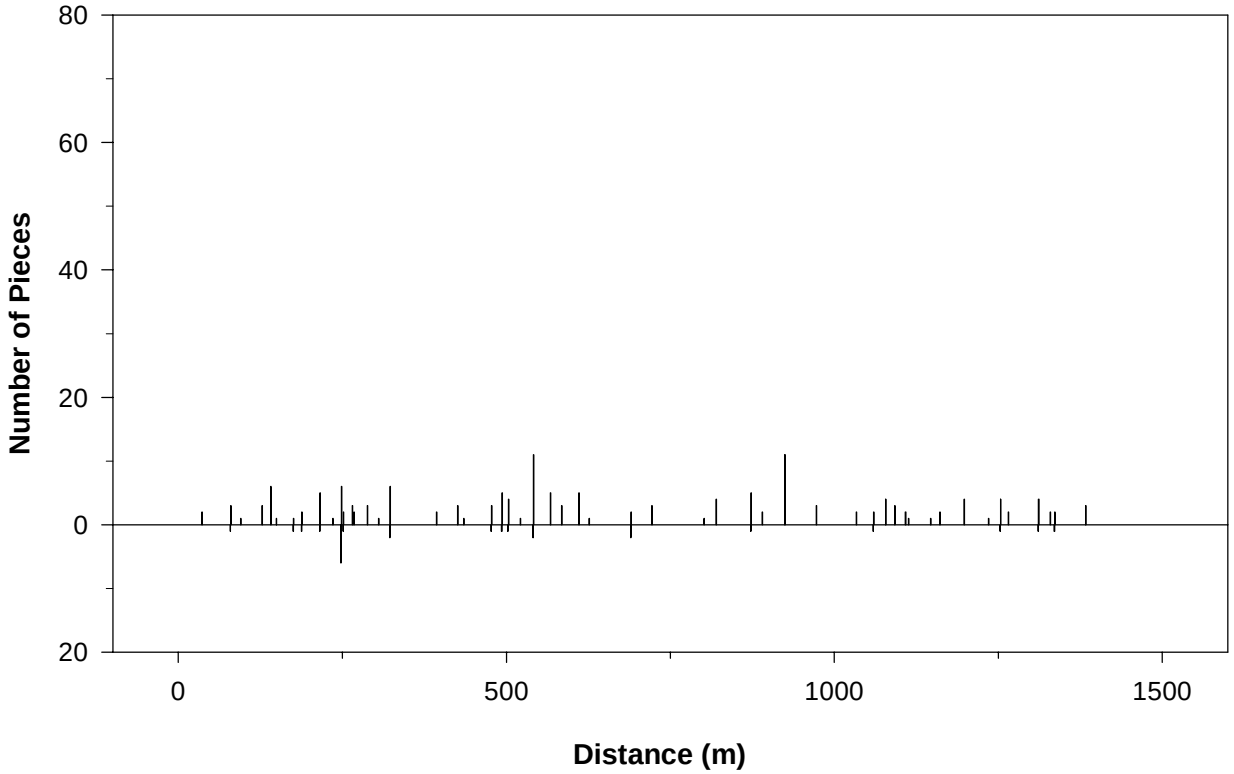


Figure 15. Distribution and abundance of LWD in each habitat unit in Pigeon Roost Branch, as estimated using BVET techniques, July 2000. The amount of the total LWD in each unit >5 m long, >55 cm diameter is displayed below zero on the x-axis. Distance is meters upstream from Barren Fork.

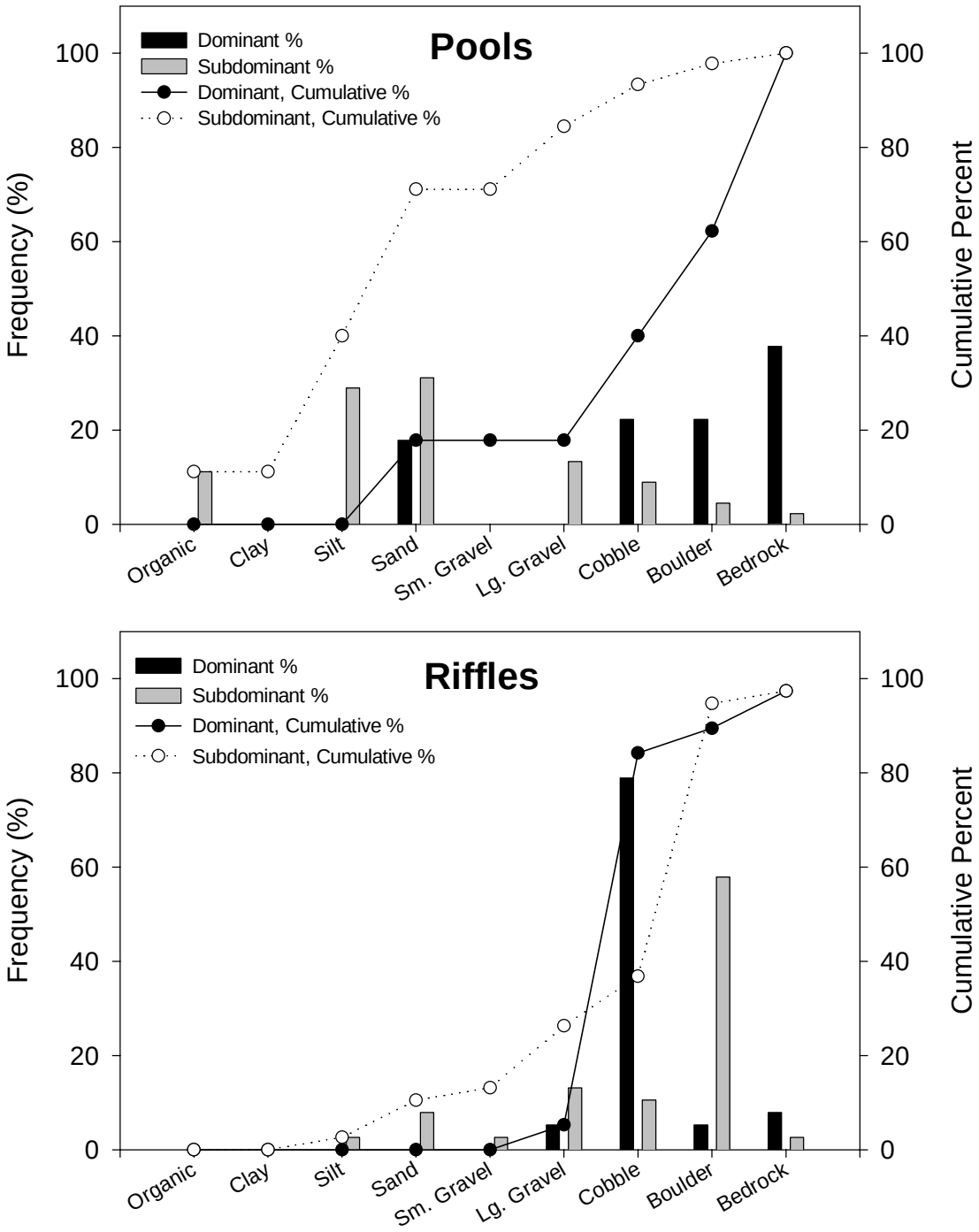


Figure 16. Frequency (percent) and cumulative percent of dominant and subdominant substrate occurrence for all pools and riffles in Pigeon Roost Branch, as estimated using BVET techniques, July 2000.

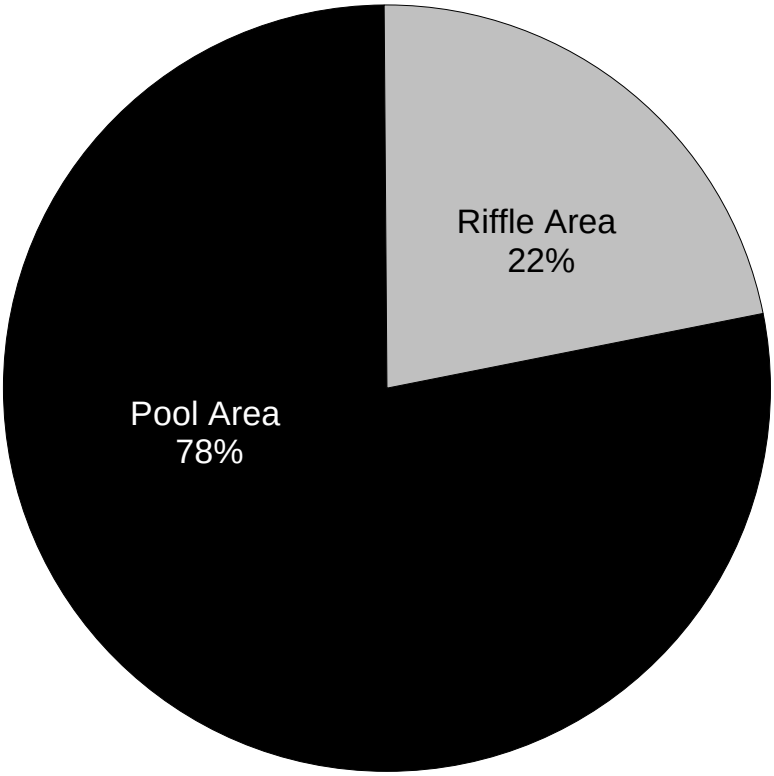


Figure 17. Percent surface area of Railroad Fork in pools and riffles, as estimated using BVET techniques, July 2000.

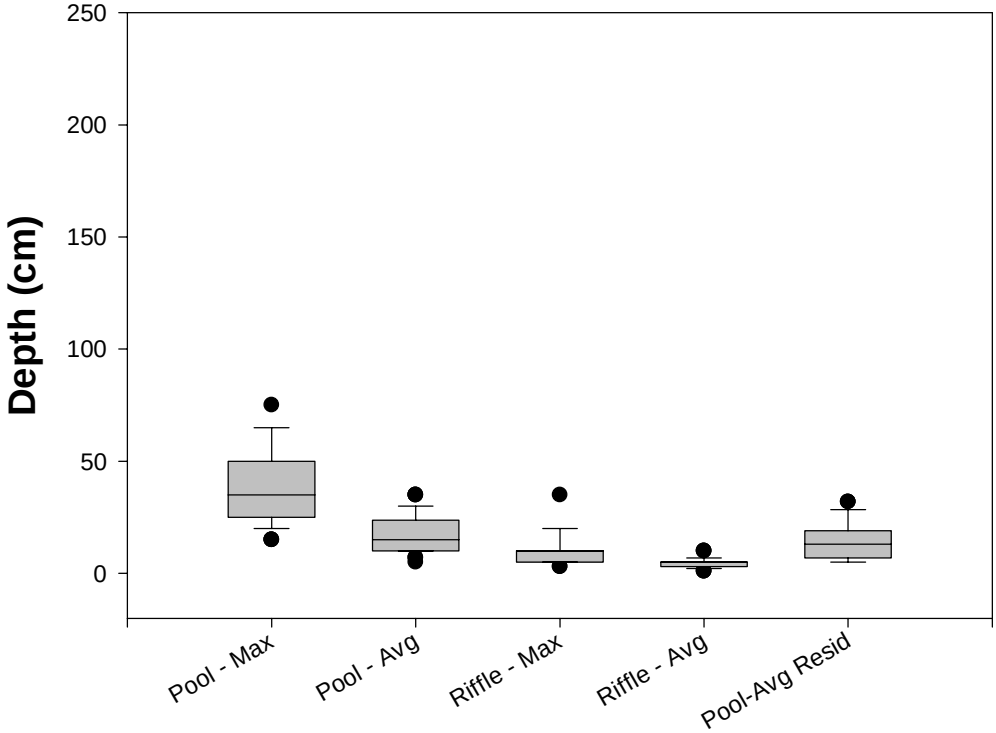


Figure 18. Maximum and average depths for all pools and riffles in Railroad Fork, as estimated using BVET techniques, July 2000. The top and bottom of the boxes represent the 25$^{th}$ and 75$^{th}$ percentiles, the bar in the center represents the median, whiskers represent the 10$^{th}$ and 90$^{th}$ percentiles, and closed circles represent the entire range of the data.

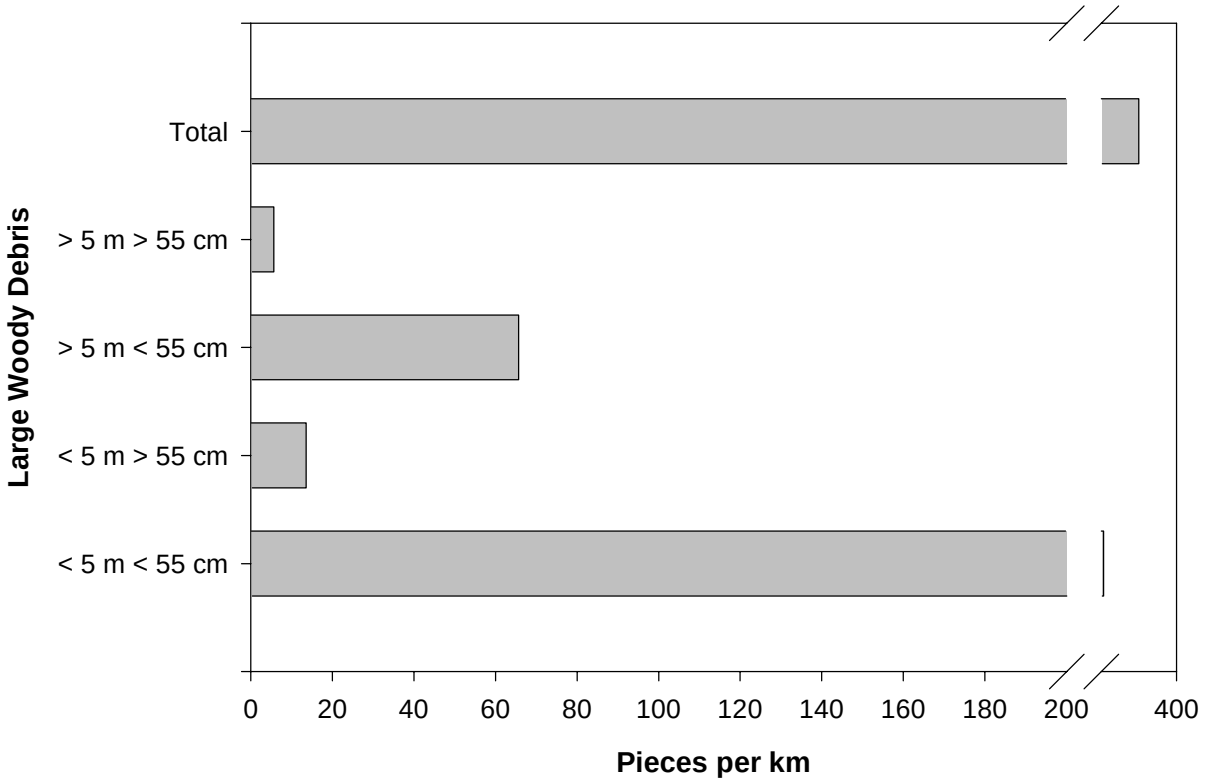


Figure 19. LWD per kilometer in Railroad Fork, as estimated using BVET techniques, July 2000. Y-axis labels are LWD size classes with the first number indicating length and the second indicating diameter.

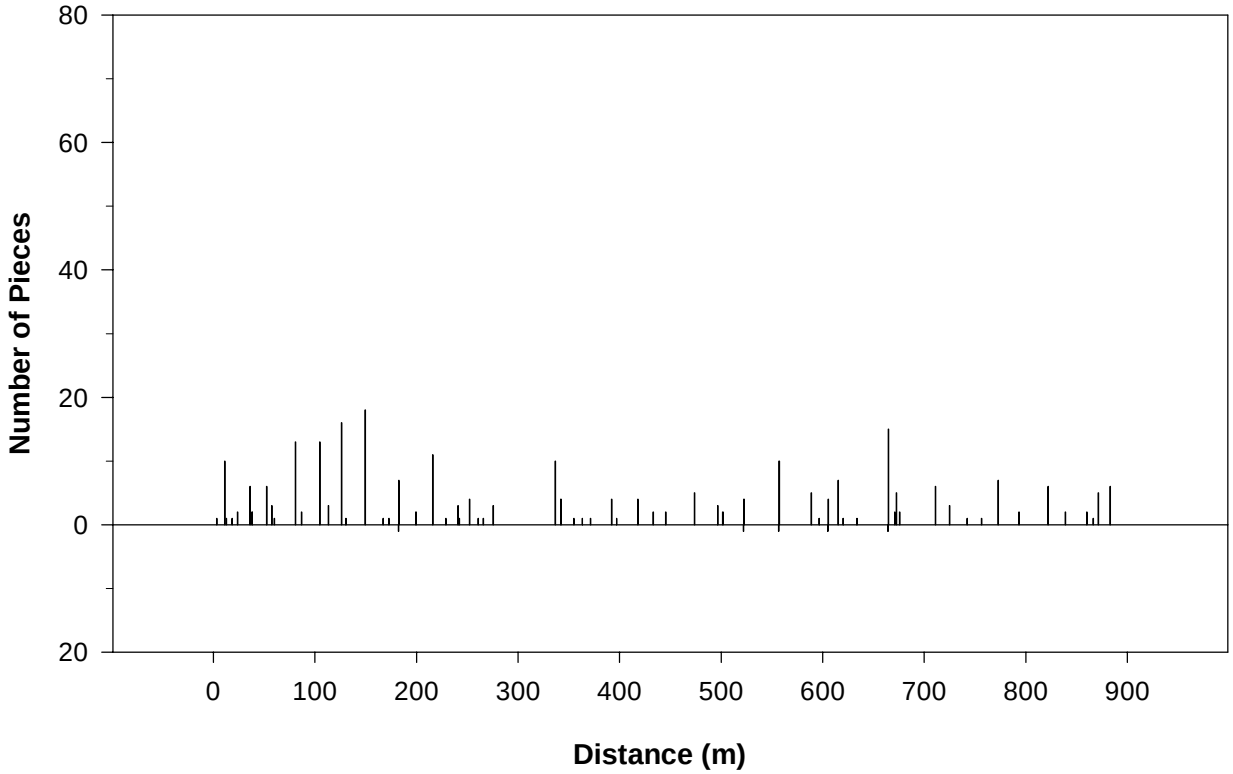


Figure 20. Distribution and abundance of LWD in each habitat unit in Railroad Fork, as estimated using BVET techniques, July 2000. The amount of the total LWD in each unit >5 m long, >55 cm diameter is displayed below zero on the x-axis. Distance is meters upstream from Barren Fork.

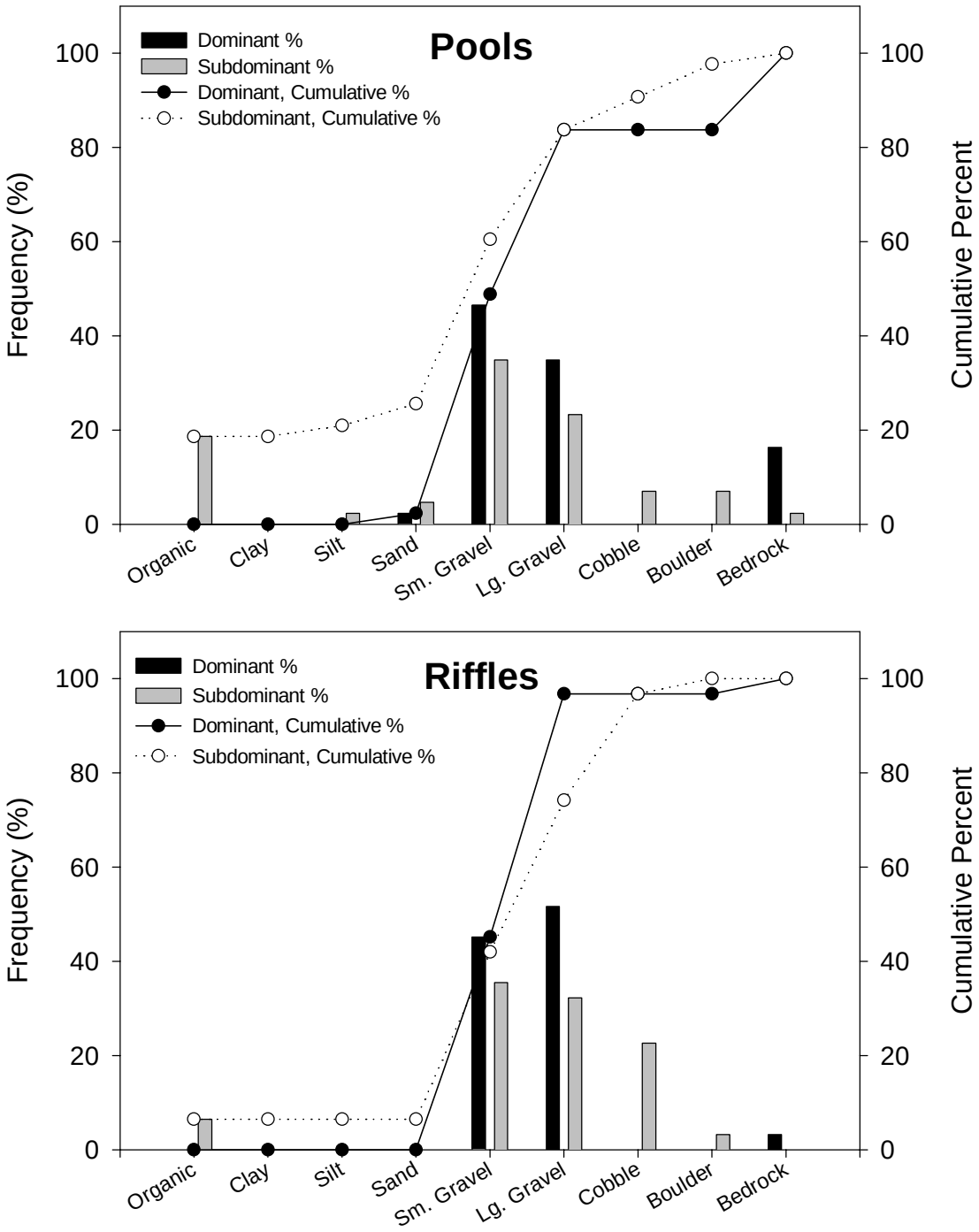


Figure 21. Frequency (percent) and cumulative percent of dominant and subdominant substrate occurrence for all pools and riffles in Railroad Fork, as estimated using BVET techniques, July 2000.

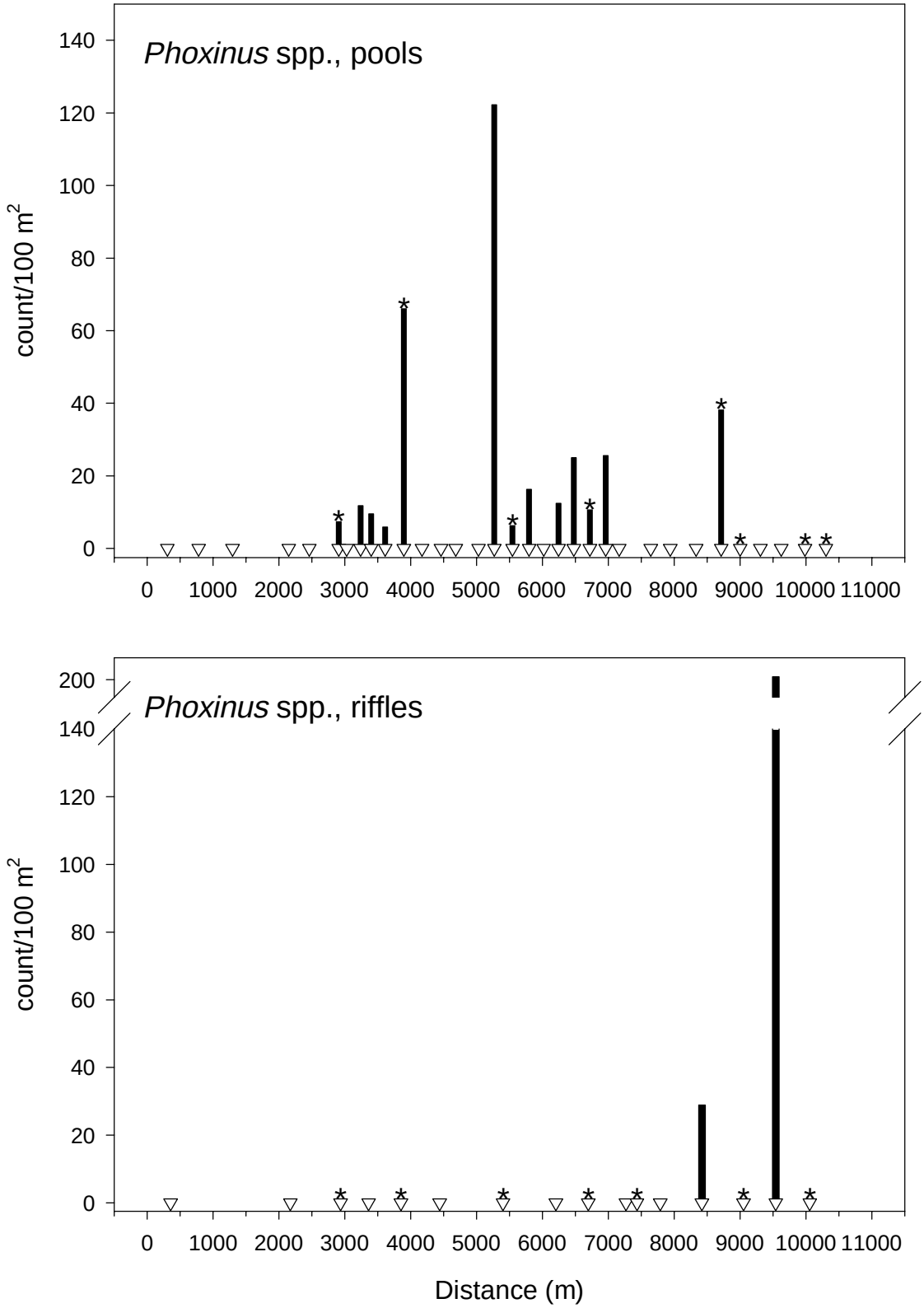


Figure 22. Diver counts of *Phoxinus* species (*P. cumberlandensis* and *P. erythrogaster*, combined) in Indian Creek, July 2000. Note that counts are standardized to 100 m$^2$ of habitat unit surface area. Open triangles indicate dive sites, asterisks indicate electrofishing sites (see Tables 4 & 5 for electrofishing results). Distance is meters upstream from Forest Service boundary.

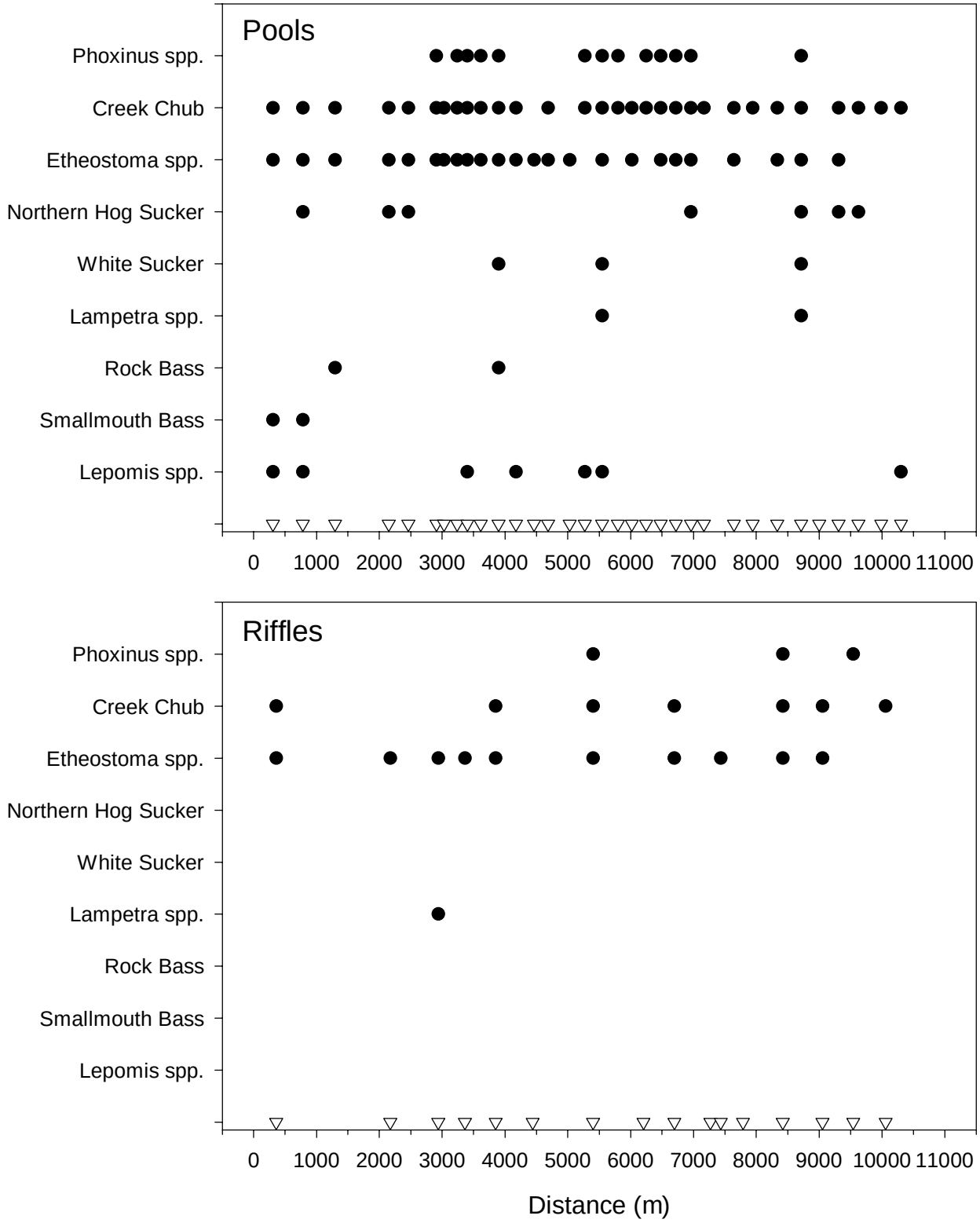


Figure 23. Occurrence of all species sighted by divers and/or captured during electrofishing in Indian Creek, July 2000. Open triangles indicate sample sites. Distance is meters upstream from Forest Service boundary.

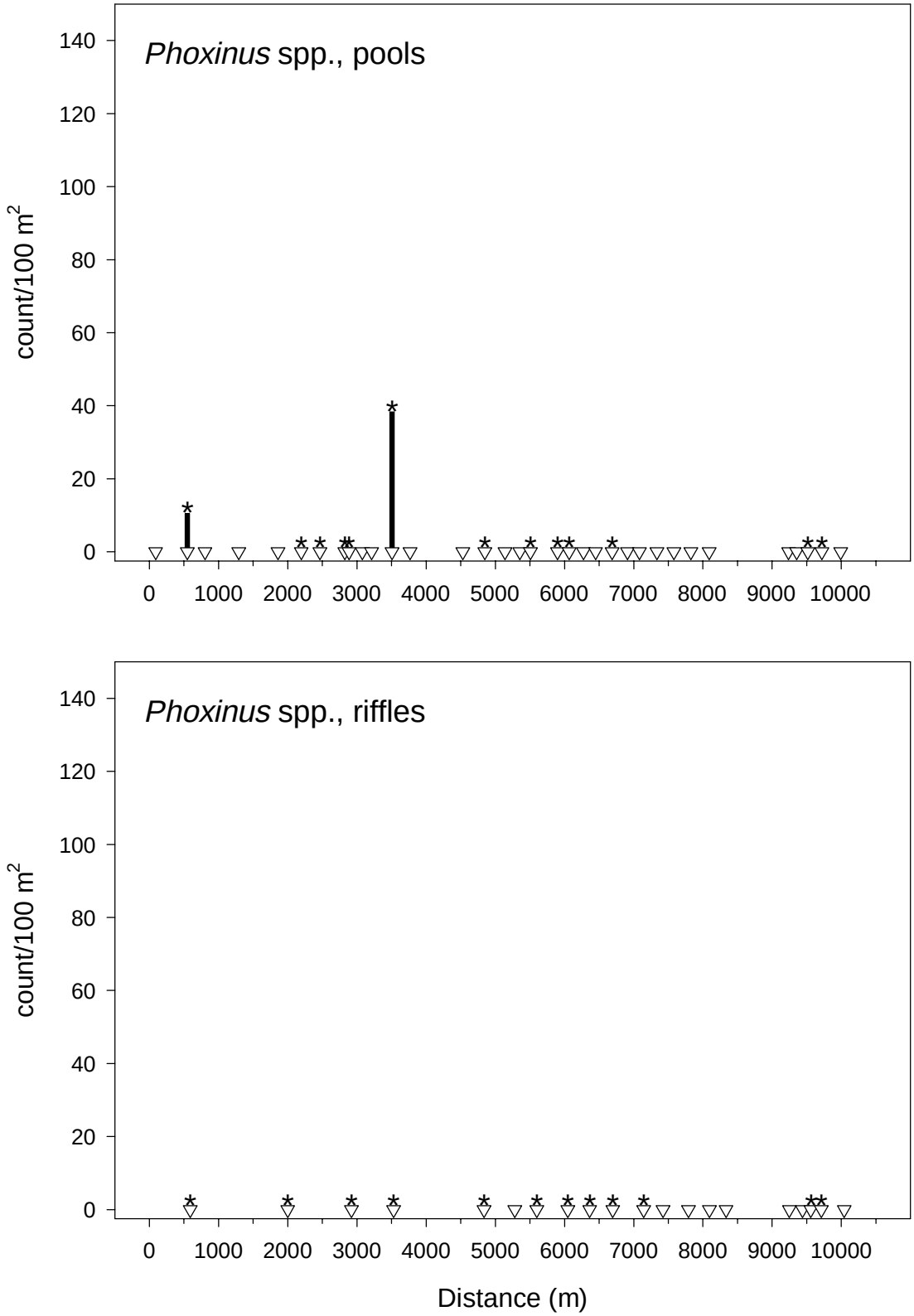


Figure 24. Diver counts of *Phoxinus* species (*P. cumberlandensis* and *P. erythrogaster*, combined) in Barren Fork, July 2000. Note that counts are standardized to 100 $m^2$ of habitat unit surface area. Open triangles indicate dive sites, asterisks indicate electrofishing sites (see Tables 6 & 7 for electrofishing results). Distance is meters upstream from Indian Creek.

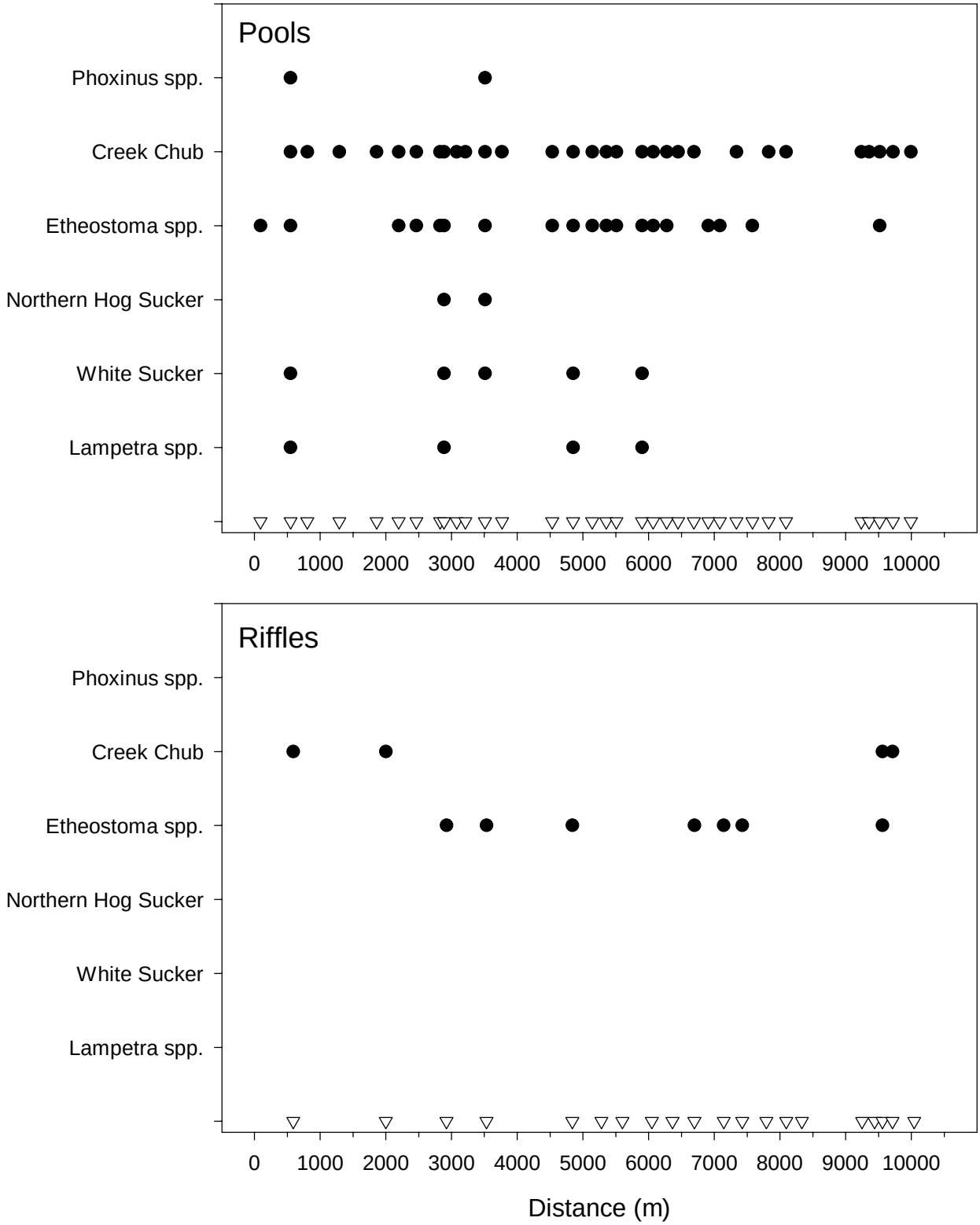


Figure 25. Occurrence of all species sighted by divers and/or captured during electrofishing in Barren Fork, July 2000. Open triangles indicate sample sites. Distance is meters upstream from Indian Creek.

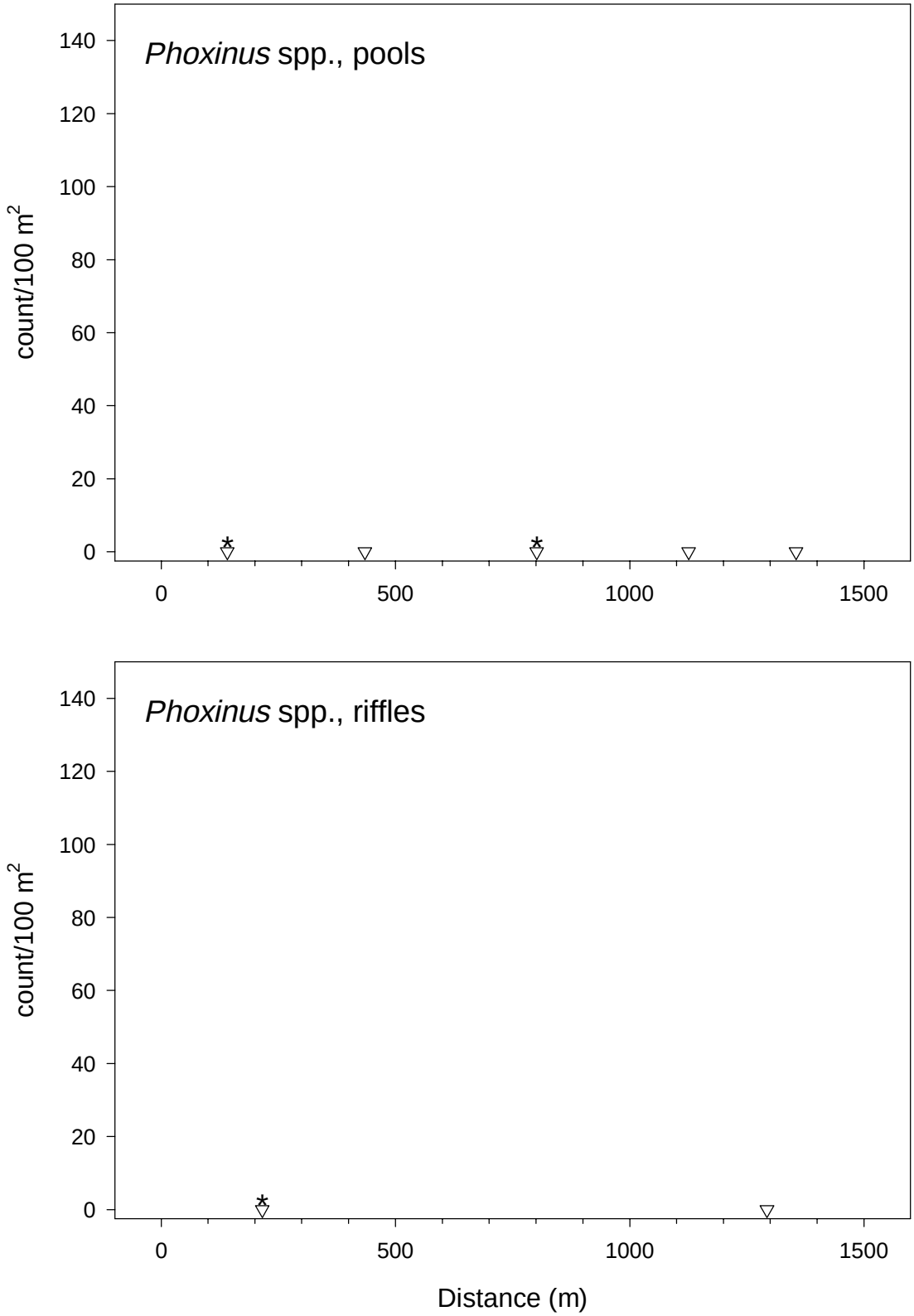


Figure 26. Diver counts of *Phoxinus* species (*P. cumberlandensis* and *P. erythrogaster*, combined) in Pigeon Roost Branch, July 2000. Note that counts are standardized to 100 $m^2$ of habitat unit surface area. Open triangles indicate dive sites, asterisks indicate electrofishing sites (see Tables 8 & 9 for electrofishing results). Distance is meters upstream from Barren Fork.

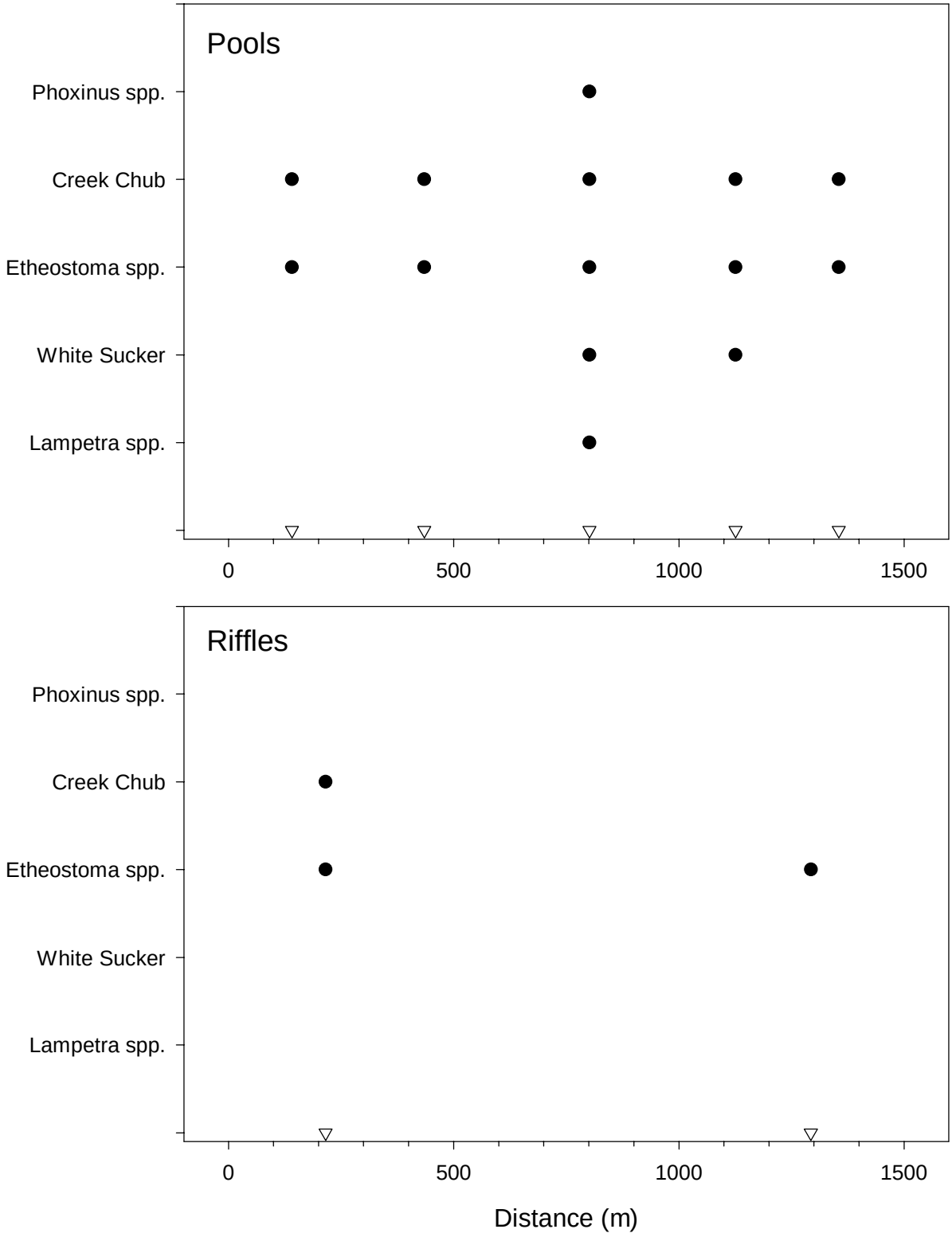


Figure 27. Occurrence of all species sighted by divers and/or captured during electrofishing in Pigeon Roost Branch, July 2000. Open triangles indicate sample sites. Distance is meters upstream from Barren Fork.

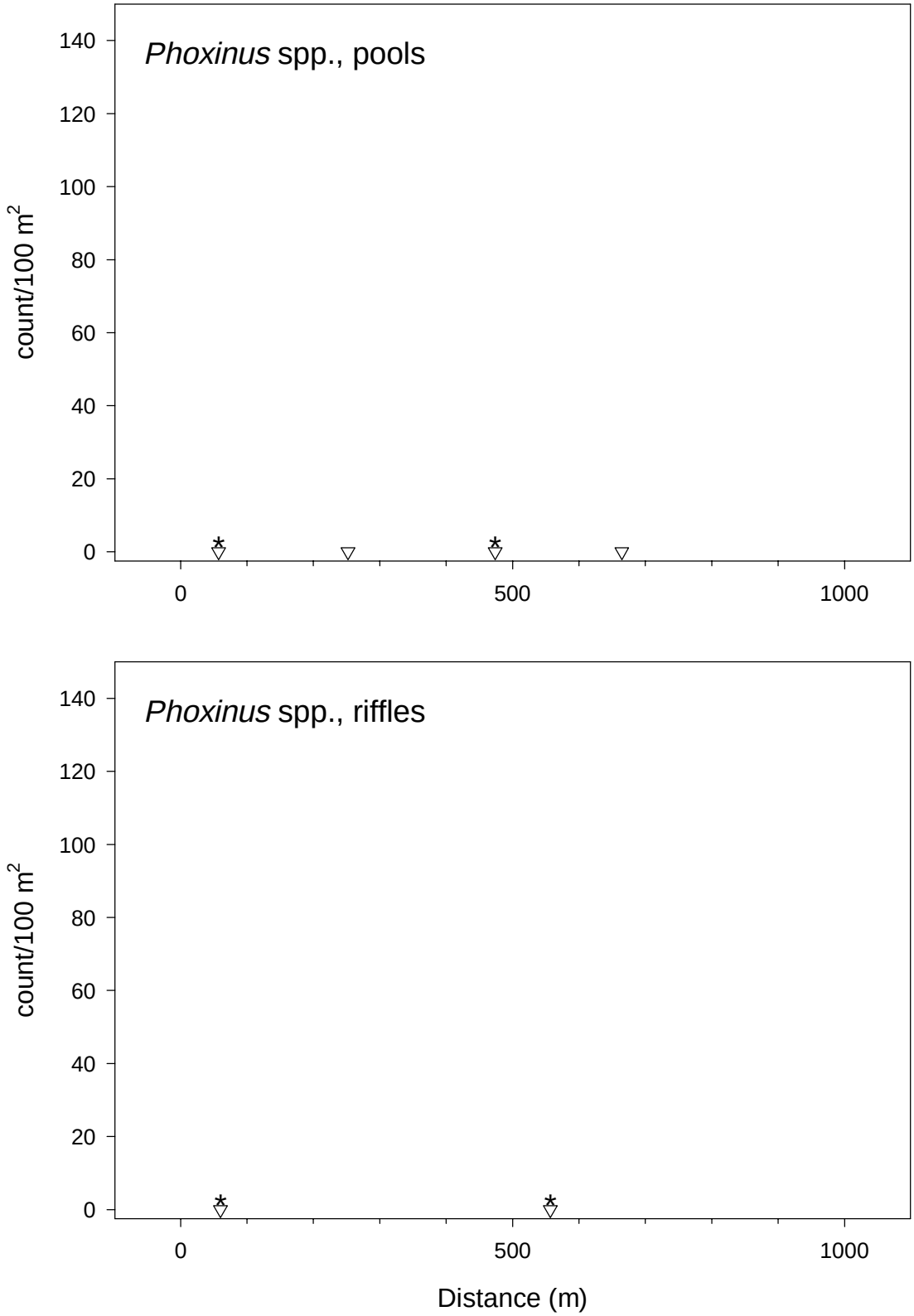


Figure 28. Diver counts of *Phoxinus* species (*P. cumberlandensis* and *P. erythrogaster*, combined) in Railroad Fork, July 2000. Note that counts are standardized to 100 $m^2$ of habitat unit surface area. Open triangles indicate dive sites, asterisks indicate electrofishing sites (see Tables 10 & 11 for electrofishing results). Distance is meters upstream from Barren Fork.

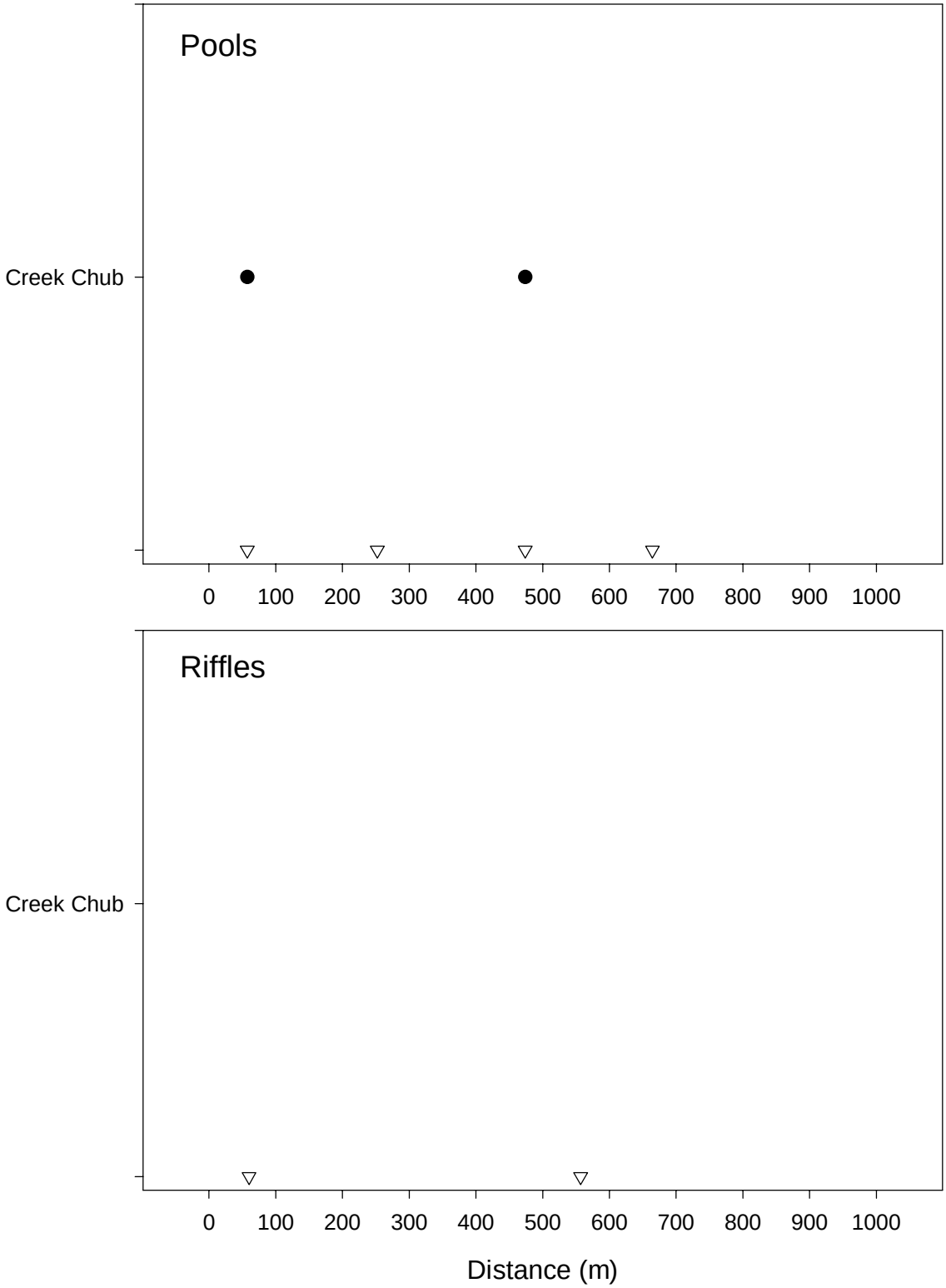


Figure 29. Occurrence of all species sighted by divers and/or captured during electrofishing in Railroad Fork, July 2000. Open triangles indicate sample sites. Distance is meters upstream from Barren Fork.

## Appendix A

Comments from Indian Creek BVET habitat and fish surveys, Daniel Boone National Forest, KY, 2000. Distance is meters upstream from Forest Service boundary.

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 8.3 | P | begin at pool at tributary on right, log jam at end of pool |
| 8.4 | TRIB | tributary in on right, water temperature 19C |
| 64.8 | TRIB | dry tributary, in left |
| 168.5 | P | some bedrok covered by silt |
| 220 | P | logs separate pool 2 and 3 |
| 307.4 | P | big debris jam separates pools 3 and 4 |
| 254 | TRIB | tributary on left dry |
| 336.3 | R | debris jam on right |
| 384.4 | P | rock ledge on left  lots of fish |
| 557.1 | P | rock cliff on left |
| 768 | TRIB | tributary |
| 797.8 | P | logs down |
| 860.9 | P | log jam |
| 942.9 | P | pool above log jam |
| 907.4 | TRIB | tributary on right, dry |
| 946.7 | R | debis jam, small sticks/logs |
| 1040 | P | downed trees on left |
| 1087 | SCH | side channel, in on right |
| 1103.5 | SCH | side channel, out on right |
| 1110.4 | TRIB | not much water |
| 1297 | TRIB | tributary |
| 1624.8 | TRIB | tributary in on right |
| 1916.6 | SCH | old side channel, out on right |
| 1946.1 | SCH | old sedechannel, in on right |
| 2151 | P | debris jam on left |
| 2084.5 | TRIB | tributary in on left |
| 2275.3 | P | debris jam |
| 2286 | P | debris jam |
| 2320 | SCH | side channel in on right |
| 2359.8 | SCH | debris jam causes side channel |
| 2530 | P | downed trees |
| 2536.8 | TRIB | tributary on right |
| 2662.2 | TRIB | tributary in on left, Barren Fork |
| 2695.7 | P | extremely silted |
| 2723 | R | beaver dam causing pool above |
| 2759.5 | FORD | ford, well worn trail not on map |
| 2860.9 | R | water temperature 22C |
| 2912.6 | R | 17 dace, water temperature 21C |
| 3085.8 | P | log jammed pool |
| 3147.3 | P | log jam on right |
| 3440.4 | TRIB | tributary |
| 3959.1 | P | big log jam |

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 3945.3 | TRIB | tributary in on right |
| 4174.4 | P | long deep pool |
| 4285 | TRIB | tributary on right |
| 4684.4 | TRIB | tributary in on left |
| 4817.8 | P | debris jam on left |
| 4956.6 | P | pool alongside a huge rock wall on right |
| 5026.4 | TRIB | tributary in on right, dry |
| 5254.6 | P | lots of woody debris |
| 5164.3 | TRIB | triburary on right, dry |
| 5264.7 | R | big log jam, *Phoxinus* under logs |
| 5411.5 | TRIB | tributary in on right, almost dry |
| 5569.7 | TRIB | tributary |
| 5744.8 | P | log jam |
| 5813.6 | TRIB | tributary in on left, water temperature 22C, end day |
| 5823.8 | R | water temperature 20C, start day |
| 5934.4 | FORD | trail crossing, sign of 4-wheelers |
| 5934.4 | TRIB | tributary in on right, dry |
| 6202.3 | P | log jammed pool |
| 6245.5 | P | leaf litter above log jam |
| 6245.5 | TRIB | tributary in on left |
| 6584.5 | TRIB | tributary in on right, mostly dry |
| 6592.6 | P | large tree down |
| 6918.7 | P | debris jam on right |
| 7065.4 | R | debris jam on left |
| 7082.2 | TRIB | tributary on right |
| 7259.8 | SCH | in on right, dry |
| 7334 | BRDG | bridge for trail |
| 7403 | P | slow moving stream here |
| 7471.3 | R | cave on right side of stream |
| 7606 | R | root jam |
| 7655.6 | R | lots of little woody debris in stream |
| 7732 | P | lots of little woody debris in stream |
| 7864 | R | dry tributary in on right |
| 8157.7 | G | seep on right |
| 8713.8 | P | dry tributary in on right |
| 8972.1 | P | log jam in mid-pool, water temperature 17C, end day |
| 8984.7 | R | water temperature 17C, start day |
| 9090.3 | P | log jam in mid-pool |
| 9146.2 | P | root jam on right |
| 9240.3 | P | tibutary on right |
| 9365.4 | P | log jam in mid-pool |
| 9385.6 | R | log jam in riffle |
| 9515.9 | P | dry tributary in on right |
| 9664.5 | P | dry tributary in on right |
| 9721.9 | R | log jam in mid-stream |

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 9962.4 | C | cascade height = 100cm |
| 10053 | P | rocks overhang stream on right |
| 10093.9 | C | cascade height = 70cm |
| 10198.8 | P | tributary on right |
| 10302.5 | P | tributary on left |
| 10464.8 | C | cascade height = 170cm |
| 10490.4 | P | log jam |
| 10560.9 | P | water temperature 17.5C |
| 10582.8 | R | stream too small to continue |

## Appendix B

Comments from Barren Fork BVET habitat and fish surveys, Daniel Boone National Forest, KY, 2000. Distance is meters upstream from the Indian Creek confluence.

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 22 | P | elevation 930 ft. |
| 28.1 | R | old tire in stream |
| 58 | P | debris jam makes upstream break |
| 91.5 | G | bad coal mines along stream |
| 109.1 | P | beaver dam makes upstream break |
| 191.2 | P | beaver pond |
| 238.3 | P | many small trees fallen in stream, debris jam makes upstream break |
| 295.8 | P | human-cut wood pieces here |
| 370.2 | P | debris jam makes upstream break |
| 432.1 | P | debris jam in unit, debris jam also upstream break |
| 481.2 | P | old tire in stream |
| 535 | P | rootwad |
| 548.5 | P | fish like dace in pool head, beaver dam is upstream break, near total flow stoppage |
| 654.7 | P | silted, beaver dam at upstream break |
| 915.7 | TRIB | in on left |
| 1057.6 | P | silty |
| 1297.6 | R | lunch, water temperature 20C |
| 1453 | TRIB | in on right, trickle |
| 1860.3 | P | silty |
| 1972.1 | P | road/horse trail crosses in unit |
| 1989 | TRIB | in on left, Pigeon Roost Branch, also Sheltowee Trace horse trail here |
| 2079.8 | P | debris jam in unit |
| 2194 | P | debris jam makes upstream break |
| 2198.9 | R | debris jam makes upstream break |
| 2222.4 | P | debris jam in unit and making upstream break |
| 2263 | TRIB | in on left, little flow |
| 2344.4 | R | runs through debris jam |
| 2428.2 | P | many trees fallen in pool, lots of leaves on bottom, smells! |
| 2506.8 | P | trees fallen in stream |
| 2610.4 | P | rootwad, big debris jam is upstream break |
| 2529.1 | SEEP | on right, good seep |
| 2590.7 | TRIB | in on right, trickle |
| 2643 | TRIB | in on right, good flow |
| 2720.2 | P | debris jam in unit |
| 2978.4 | P | end day, water temperature 21C |
| 2995.3 | P | start day, water temperature 18C |
| 3041.5 | P | rootwad |
| 3120.5 | P | rootwad |
| 3212.1 | P | rootwad |
| 3457.4 | P | trail crossing in unit leads to gravel road |
| 3495.8 | P | campsite on left, six trees fallen in pool |
| 3508.8 | P | rootwad, unit next to trail crossing |

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 3527.7 | P | trail crossing in unit, ford |
| 3531.1 | R | unit next to trail crossing |
| 3562.9 | P | rootwad |
| 3608 | P | debris jam in unit, trees fallen in |
| 3637.4 | P | rootwad, old rubber raft in stream |
| 3643.4 | SCH | in on right, dry |
| 3668.2 | SCH | out on right, dry |
| 3761 | P | smelly, leaf filled beaver pool |
| 3767.5 | P | log jam makes upstream break |
| 3771.3 | R | big beaver dam makes upstream break |
| 4102.4 | P | two rootwads, beaver pool, lunch, water temperature 19C |
| 3950 | TRIB | in left, no flow but is wet |
| 4114.6 | P | small beaver dam makes upstream break |
| 4149.4 | P | some undercut banks, debris jam makes upstream break |
| 4168.1 | TRIB | in on left, trickle |
| 4339.4 | P | rootwad, some undercut banks, indication of fire on left bank |
| 4426.9 | P | burn still evident on left bank |
| 4487.3 | P | trail comes down on right |
| 4601.8 | P | almost all bedrock |
| 4632.8 | SEEP | left, coming out of rock-groove |
| 4660.9 | R | seepy areas coming out of rock on left bank |
| 4675.6 | R | more seeps on left |
| 4713.9 | TRIB | in on left, trickle |
| 4807.6 | P | debris jam makes upstream break |
| 4849.3 | P | creek chubs more abundant upstream of Railroad Fork |
| 4916.6 | P | rootwad, some undercut banks |
| 4898.6 | TRIB | in on right, Railroad Fork, good flow |
| 5196.7 | TRIB | in on left, trickle |
| 5293.1 | P | major debris jam on left |
| 5299.2 | P | big log with debris makes upstream break |
| 5596 | P | debris jam in unit |
| 5599.8 | R | end day, water temperature 21C |
| 5610.9 | P | start day, water temperature 18.5C |
| 5631.8 | P | major debris jam in unit |
| 5859.3 | P | debris jam makes upstream break |
| 5899.3 | P | lots of silt in most of the pools in this area, not enough to call substrate though |
| 5990.4 | R | half of unit under fallen trees |
| 6010.4 | R | major debirs jam on left |
| 6226 | TRIB | in on left, trickle |
| 6260.4 | R | trail crossing in unit, evidence of fire on right |
| 6607.5 | R | debris jam left |
| 6665.6 | P | debris jam left at start |
| 6673.3 | R | lunch, water temperature 19C |
| 6773.9 | P | debris jam makes upstream break |
| 6909.9 | P | lots of silt in units but nothing to embed |

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 6991.6 | R | debris jam on right |
| 7099.6 | TRIB | in on right, from underground, good flow |
| 7139.3 | P | silty |
| 7187.6 | P | silty |
| 7226.4 | P | silty |
| 7241.6 | R | debris jam left, silty |
| 7335.9 | P | silty |
| 7407.2 | TRIB | in on right, wet but no flow |
| 7425.1 | R | big debris jam makes upstream break |
| 7584.4 | R | debris jam makes upstream break |
| 7601.8 | P | undercut bank right, debris jam at upstream break nearly stops flow |
| 7694 | P | debris jam around mouth of tributary |
| 7712 | TRIB | in on right, good trickle, shown as fork in stream on map |
| 7747.6 | P | small debris jam on right |
| 7791.9 | R | low gradient bedrock slide, rhododendron canopy covers stream now |
| 7814.6 | R | stream still silty |
| 7853.5 | R | bedrock slide |
| 8035.6 | TRIB | in on left, dry |
| 8107.3 | P | silty, end day, water temperature 19.5C |
| 8109 | R | start day, water temperture 18.5C |
| 8217 | TRIB | in on right, trickle, reddish color |
| 8245.9 | R | stream almost all bedrock still |
| 8278.5 | P | tire in debris jam, makes upstream break |
| 8334.9 | R | units before too mucky, but abundance of crayfish, creek chubs and darters seen |
| 8512.1 | TRIB | in on left, trickle |
| 8534.1 | P | debris jam makes upstream break |
| 8622.6 | P | lunch, water temperature 19C |
| 8645.9 | P | debris jam in unit |
| 8681.9 | R | huge log makes upsteam break |
| 8698.1 | P | debris jam in unit |
| 8719.5 | P | log jam makes upstream break |
| 8742.5 | P | debris jam in unit |
| 8782.5 | SEEP | on left, trickle down rocks |
| 8958.1 | P | big debris jam makes upstream break |
| 8971.8 | P | debris jam in unit |
| 8998.2 | P | log jam makes upstream break |
| 9187 | P | big debris jam makes upstream break |
| 9191.5 | P | debris jam makes upstream break |
| 9216.3 | TRIB | in on left from underground, good flow |
| 9238.8 | P | log jam makes upstream break |
| 9293 | TRIB | in on right, trickle |
| 9330.8 | P | debris jam makes upstream break |
| 9336 | P | under big debris jam mostly |
| 9346 | P | debris jam makes upstream break |
| 9356 | P | lots of large creek chubs |

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 9365.5 | R | some water goes underground |
| 9410 | P | debris jam makes upstream break |
| 9468.8 | TRIB | in on left, dry |
| 9498.4 | P | log jam makes upstream break |
| 9545.7 | P | rootwad |
| 9577.8 | C | upstream break is 0.7m fall out of square culvert under interstate |
| 9637.6 | CULVERT | flat glide through culvert |
| 9643.3 | P | debris jam makes upstream break |
| 9646 | TRIB | in on left, tiny trickle |
| 9667.1 | P | debris jam makes upstream break |
| 9715.5 | TRIB | in on right, trickle |
| 9813.1 | R | big debris jam in unit |
| 9922.4 | RN | debris mess in unit |
| 9933.1 | TRIB | in on right, about a third of total stream flow |
| 9944.8 | P | debris jam makes upstream break |
| 9958.5 | P | small log jam makes upstream break |
| 9977.2 | P | debris jam makes upstream break |
| 9975 | TRIB | in on right, about a third of total stream flow |
| 10005.2 | R | debris jam in unit |
| 10015.9 | R | covered in debris jam |
| 10043.5 | C | 1.5m fall at start, debris jam at break, no fish above last pool |
| 10048.7 | P | debris jam makes upstream break |
| 10072.6 | P | debris jam makes upstream break |
| 10105 | TRIB | in on left, trickle along rock wall |
| 10251.8 | RN | stream runs along edge of rock wall |
| 10183.7 | SEEP | in on left, little trickle |
| 10320.9 | R | end at old powerline right-of-way, 50m below FS boundary, no fish seen above falls |

## Appendix C

Comments from Pigeon Roost Branch BVET habitat and fish surveys, Daniel Boone National Forest, KY, 2000. Distance is meters upstream from the Barren Fork confluence.

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 127.6 | P | log break between pools |
| 235 | P | have only seen three tiny fish so far |
| 267.4 | R | no flow in pools, lots of sedimentation |
| 388.1 | P | one more tiny fish seen |
| 322.8 | TRIB | in on left, big source of silt, orange color |
| 354.2 | R | seep in on right in unit |
| 369.5 | P | bunch of fish in this pool |
| 503.1 | P | seep in unit, big log jam |
| 541.2 | P | huge log jam |
| 801.4 | P | log jam breaks pools |
| 873.1 | R | old mine found on right side of stream |
| 983.6 | TRIB | about half of water comes from this tributary |
| 1078 | P | some trees along right bank burned |
| 1108.3 | P | water temperature 17.5C |
| 1125.6 | P | haven't seen fish for a while, stream very small |
| 1179.3 | P | debris jam in middle of pool |
| 1197.8 | R | log jam between pool and riffle |
| 1183.9 | TRIB | in on right |
| 1311.3 | P | see fish again |

## Appendix D

Comments from Railroad Fork BVET habitat and fish surveys, Daniel Boone National Forest, KY, 2000. Distance is meters upstream from the Barren Fork confluence.

| Distance (m) | Unit Type | Habitat and Fish Survey Comments |
|---|---|---|
| 3.3 | R | elevation 990 ft. |
| 10.9 | P | debris jam makes upstream break |
| 57.3 | P | lots of crayfish |
| 80.7 | P | some leaves in places |
| 104.5 | P | lots of leaves/organics |
| 126.1 | P | lots of small gravel too |
| 149.3 | P | rootwad, debris jams in unit |
| 133 | TRIB | in on right, dry |
| 167 | R | lots of gravel is red/orange colored |
| 215.8 | P | debris jam in unit |
| 260.7 | P | some bedrock too |
| 313.9 | TRIB | in on right, wet, no flow |
| 432.8 | P | rootwad |
| 434 | TRIB | in on left, dry |
| 458 | TRIB | in on left, wet, no flow |
| 596.4 | P | rootwad |
| 605.4 | P | log jam makes upstream break |
| 615 | P | log jam in unit |
| 620 | R | reddish scum on substrate |
| 633.5 | P | rootwad, red scum continues |
| 637.9 | TRIB | in on left, wet, little flow |
| 664.5 | P | major debris jam makes upstream break, old coal mine with water running into stream |
| 672.5 | P | big debris jam makes upstream break |
| 710.8 | P | reddish scum still on substrate here, jam makes upstream break |
| 699 | TRIB | in on left, wet, no flow |
| 742.1 | P | rootwad |
| 733.7 | TRIB | in on left, trickle |
| 772.7 | P | debris jam near upstream end |
| 821.7 | P | undercut bank on right |
| 838.9 | P | bank of red, brittle shale on left |
| 838.9 | TRIB | in on right, wet, no flow |
| 859.8 | R | horse trail crosses unit |
| 871.2 | R | debris jam mid-way |
| 871 | TRIB | in on right, good trickle |
| 882.9 | P | rootwad, undercut bank on left, stream underground, water temperature 17C |
| | | *notes upstream of survey end point*: |
| | | stream channel 7-8 m wide but dry 75m upstream, |
| 906 | TRIB | at 906m tributary on left near brick stucture, up the hill tributary flows out of cave, water temperature at cave 11.5C, saw copperhead snake |