Lewis Smith Lake Transition Zone Project Progress Report

2012-2013

Report prepared by:
Craig Roghair[1], John Moran[2], Colin Krause[1], and C. Andrew Dolloff[1]
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[1]USDA Forest Service
Southern Research Station
Center for Aquatic Technology Transfer
1710 Research Center Dr.
Blacksburg, VA 24060

[2]USDA Forest Service
National Forests in Alabama
2946 Chestnut St
Montgomery, AL 36107

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Introduction

A dam converts riverine habitat to a reservoir and a series of reaches, or zones, each with different flow conditions and habitat attributes. The most abrupt change occurs at the dam itself, where the reservoir upstream contrasts sharply with the riverine habitat downstream. The dam structure physically separates these two habitat zones and differences in flow, habitat, and biota are obvious and relatively well described (Bain et al. 1988, Martinez et al. 1994). The reservoir may continue upstream for many kilometers, impacting not only the dammed portion of the river but also its tributaries. At the upstream extent of the reservoir is a transitional reach that may alternately contain characteristics of riverine habitat, impounded habitat, or a combination thereof depending on the water surface elevation in the reservoir (Thornton et al. 1990). This transition zone occurs both on the dammed stream and in tributaries connected to the reservoir, and extends upstream until free flowing riverine habitat is encountered. The total amount of habitat at any particular time within the transition zone depends on stream channel slope and distance from the dam, dam height and release/retention schedule, and the total flow entering the river from all sources above the dam. Changes in water surface elevation within the reservoir cause fluctuations in the extent of the transitional habitats within the river but little is understood of how these fluctuations influence biological communities in the transition zone.

Studies of the effects of dams on biological communities seldom address sampling of the biota within the transition zone as a discrete entitiy. A notable exception (Combes and Edds 2005) attributed decreased mussel abundance and species richness in a transition zone to habitat changes and loss of fish diversity. In contrast, Yang et al. (2012) found a stable fish community in the transition zone of an extremely large reservoir in China. Most studies have focused on comparisons between direct tributaries (flow directly into impounded waters) and tributaries upstream of the impoundments (hereafter indirect tributaries) (Franssen 2012; Matthews and Marsh-Mathews 2007; Skalski et al. 2008), or reference streams outside of the impounded watersheds (Guenther and Spacie 2006; Herbert and Gelwick 2003). Documented effects include loss of genetic diversity and changes in fish assemblages, which most often are attributed to isolation resulting from the lack of movement among direct tributaries. However, most characteristics of the biota and stream habitats in the transition zone or tributaries in the transition zone (hereafter transitional tributaries) are not well described.

The Lewis Smith development impounds several major headwater tributaries in the Black Warrior River watershed, including two large tributaries flowing through the Bankhead National Forest in north Central Alabama: Sipsey Fork and Brushy Creek (Figure 1). The development consists of a 91 m

high dam, and a 56 km long, 8580 ha impoundment. The dam was constructed in 1962 and is operated by the Alabama Power Company to provide flood control and hydroelectric power. Although there is considerable variation associated with climatic conditions and precipitation events, water levels generally fluctuate seasonally and tend to be highest in early spring and lowest in late fall or early winter. Water level fluctuates seasonally up to 6 m (Figure 2) and creates 'transition zones' in the rivers and tributaries extending from the upstream portion of the impoundment at minimum capacity to the corresponding upstream area in the rivers and direct tributaries when the reservoir is filled to capacity. During high water periods lengthy reaches of Sipsey Fork, Brushy Creek and their tributaries become inundated by reservoir water. As lake levels drop portions of the mainstem and tributaries return to more riverine conditions. The frequency, timing, and magnitude of changes in water levels have the potential to affect stream habitat and species distributions within the Sipsey Fork and Brushy Creek watersheds, but the spatial and temporal extent of the transition zone and its effects on biota and habitat are largely unknown.

The Black Warrior River watershed upstream of the Lewis Smith development harbors extremely diverse biological communities comprised of native and introduced species with at least 69 fish, 18 mussel, and 6 crayfish (Table 1). Several species are endemic to the Black Warrior River drainage or are species of conservation concern within their native range. The drainage has been the focus of considerable sampling effort in the past, but a review of fish collection records revealed a lack of information from the transition zone and associated tributaries. In 2012, the Bankhead National Forest partnered with the USDA Forest Service Southern Research Station Center for Aquatic Technology Transfer in a multi-year effort to describe habitat conditions and biological communities within transitional habitats in the Sipsey Fork and Brushy Creek and watersheds. Overall project objectives include:

1. Delineate the extent of the transition zone
2. Collect fish, crayfish and mussel species distribution information with an emphasis on Forest Sensitive Species (FSS), and Federally Threatened and Endangered (T & E) species
3. Assess the role of tributaries as refuge habitats
4. Provide guidance for the establishment of a long-term monitoring program

The purpose of this progress report is to summarize information collected in the 2012 – 2013 field seasons. Results are used to make recommendations for the remainder of the project, which is scheduled to be completed in 2015.

Methods

Transition zone delineation

We defined the transition zone as that area of the stream differing significantly in habitat type between low pool (153.0 m lake elevation) and high pool (155.5 m lake elevation) and used a combination of LiDAR derived elevation contours provided by Alabama Power and reconnaissance visits to determine the potential extent of the transition zone on Sipsey Fork, Brushy Creek, and each of the six tributaries. We plotted the intersection of LiDAR derived 153.0 m and 155.5 m elevation contours and the mainstem stream channel of Sipsey Fork and Brushy Creek in ArcMap as an indicator of the potential extent of the transition zone for each stream (Table 2). We also plotted the intersection of the 155.5 m elevation contour with each of the six tributaries as an estimate of the upstream extent of the transition zone on each tributary.

During reconnaissance visits we traveled through the potential transition zone area of Sipsey Fork, Brushy Creek, and each of the six tributaries by motorboat and/or wading. We noted changes in habitat types to determine the approximate extent of the transition zone. Habitat types included: 1) stream habitat; contains a variety of stream habitat unit types, i.e. pool-riffle channel type, 2) run habitat; deeper, flowing water with no hydraulic breaks forming individual habitat units, and 3) impounded habitat; little to no discernable flow, often deeper and described as lake-like. We marked the location of habitat transitions with a Garmin Oregon GPS unit.

Sample reach selection

We used a combination of lake elevation data and reconnaissance visits during low pool in late September and high pool late in April through early May to determine the approximate extent of the transition zone on Sipsey Fork, Brushy Creek, and six tributaries. We defined high and low pool as lake elevations of 155.5 m (510 ft) and 153 m (502 ft), respectively (Figure 2). Based on our observations, we established reference points at 0.1 km intervals in the mainstem of Sipsey Fork and Brushy Creek, as well as within the tributaries targeted for sampling (Figure 3). River kilometer (rkm) 0.0 was established downstream of any potential sample sites (i.e. downstream of the LiDAR derived 153.0 m elevation) on Sipsey Fork and Brushy Creek. In Sipsey Fork, rkm 0.0 is located at the confluence with Alford Spring Branch. In Brushy Creek, rkm 0.0 is located 0.1 km upstream of the confluence with Slipoff Branch. In the tributaries, rkm 0.0 is located at the confluence with Sipsey Fork or Brushy Creek. We refer to sample sites and landmarks by their rkm location throughout this report.

We selected 3 tributaries from each of the two major drainages for sampling. Tributary selection was based on percentage of Forest Service ownership in the tributary watershed, access, and

location within the drainage. We targeted tributaries spread throughout the transition zone with a relatively high proportion of Forest Service ownership and reasonably good access by boat, road, or trail. In the Sipsey Fork drainage we selected Mill Creek, Grindstone Creek, and Payne Creek. In the Brushy Creek drainage we selected Chimney Branch, Mile Creek, and Inman Creek (Figure 3).

Fish sampling

By definition, the transition zone consists of a wide variety of habitat types, ranging from shallow pool-riffle stream channels to more lake-like impounded areas. We used multiple gears and sampling strategies to collect fish from different habitats. We sampled fish in the mainstem of Sipsey Fork and Brushy Creek between rkm 10 and rkm 24. Sample sites upstream of rkm 23 on both streams are considered to be upstream of the extent of the transition zone. In tributaries we sampled in impounded and transitional habitats hear the confluence with the mainstem and in sites upstream of the transition zone (see results for description of transition zones on each tributary).

Boat electrofishing

We sampled fish from the middle and upper water column in impounded and deep river habitats with a Smith Root SR-14 EB boat electrofisher powered by a 40 hp 4 stroke motor. The boat was outfitted with two SAA-6 anode arrays with electricity supplied by a Honda GX 340 generator via a 5.0 generator powered pulsator. We sampled at 2 – 3 km intervals, or as conditions allowed, between rkm 10.0 and rkm 23.0 on both Sipsey Fork and Brushy Creek. On Sipsey Fork, we were able to sample throughout the reach during high pool, and downstream from rkm 19 during low pool. On Brushy Creek, water depth was sufficient for boat electrofishing downstream of rkm 21 during full pool, and downstream of rkm 17.6 during low pool. At each sample site we made 3 passes; one each on the left, middle, and right side of the stream channel. Our target effort for each pass was 400 seconds, for a total of 1200 seconds of sampling at each site. Two dipnetters in the bow of the boat collected fish and placed them in a live well on the boat. We counted the total number of each species collected during each pass and returned them live to the sample reach. Where water depth allowed we also completed 1 – 3 passes in the lake-like area upstream of the confluence with each of the six tributaries; the number of passes varied depending on channel width at the confluence. Fish that could not be positively identified in the field were vouchered for lab identification. All vouchered samples were identified and archived by the Forest Service Southern Research station fish lab in Oxford, MS.

Mini-trawl

We sampled bottom-dwelling fish species from impounded areas and river habitats too deep for wading using a benthic mini-trawl from Innovative Net Systems (Siamese model). The mouth of the

trawl was 2.4 m wide x 0.3 m tall and had both a float line and a lead line. The trawl's outer bag was constructed of 4 mm mesh; a 38 mm inner bag at the cod end of the trawl allowed smaller fish to be collected by the outer bag without being crushed. The trawl was fished on or near the stream bottom using 0.6 m x 0.3 m otter doors attached to lines up to 30 m long. Our trawl was also outfitted with the following optional attachments: guard mesh to protect the outer bag from abrasion, a rock skirt to prevent cobbles from entering the mouth, mud raisins to keep the lead line from digging deeply into soft substrates. A tickler chain was added to disturb fish hiding in the substrate beginning in fall 2013. The mini-trawl was deployed over the bow of a jon boat, which was operated stern first, pulling the trawl in a downstream direction. The boat proceeded downstream in a zigzag pattern to minimize disturbance of fish by propeller wash. We typically used the mini-trawl at the same sample sites as the boat electrofisher, though sampling occurred either on different days or at least two hours apart if on the same day. Our target sampling effort was a 10 min downstream pull. At the end of each pull we removed all fish from the trawl and recorded the total number of each species captured. We also recorded incidental catch of other species including turtles and salamanders. Fish that could not be positively identified in the field were vouchered for lab identification. All vouchered samples were identified and archived by the Forest Service Southern Research station fish lab in Oxford, MS.

Mainstem backpack electrofishing

We used the Geologic Survey of Alabama 30+2 sampling method (O'Neil and Shepard 2011) to collect fish from wadeable areas in the mainstem of Sipsey Fork and Brushy Creek. The 30+2 approach stratifies collection among four habitat types: riffles, runs, pools, and shorelines. The resulting fish community sample reflects the biological condition of the stream, and may be used for calculating an index of biotic integrity (IBI) (O'Neil and Shepard 2011).

The 30+2 sampling method employs a small-mesh seine net as a compliment to a backpack electrofisher. We sampled using a 3.1 or 4.6 m long seine constructed of 4.8 mm mesh and an Aqua Shock Solutions backpack electrofisher outfitted with two wand-style probes, allocating 10 sampling efforts each to riffle, run, and pool habitat. In riffles and runs a single sampling effort consisted of setting the seine in shallow, rocky areas or deeper, swifter chutes; the electrofisher then walked upstream for 4.6 m to 6.1 m outside of the area to be sampled and shocked downstream through the habitat, walking toward the seine while disturbing the bottom. Stunned fishes in the water column were washed into the net, while benthic fishes were dislodged from the bottom by kicking the substrate. In deeper runs and glides a single sampling effort consisted of seining downstream, either without the backpack shocker or following the backpack shocker for a distance of 4.6 m to 6.1 m. In pools, a single

sampling effort consisted of pulling the seine behind the electrofisher to trap fish against the shore or in a slough at the end of a seine haul. Deep pools with structure were sampled by blocking the downstream end with the seine and making a pass through the pool with the elecrofisher and dipnetter. A minimum of 30 efforts were completed at all sites, and for those sites with missing or reduced habitat components, the effort was proportioned to habitats that were present.

Shorelines along pools, runs, and riffles can have complex habitat structure and yield species not normally found in the basic riffle-run or run-pool sequence, so the 30+2 method prescribes two additional sampling efforts along shorelines. The shoreline sampling technique consisted of an electrofisher and dipnetter working in an upstream direction along a continuous shoreline reach of 46 m. Distance was measured with a hip-chain measuring device. A minimum of two 46 m shoreline samples were collected per station. Fish that could not be positively identified in the field were vouchered for lab identification. All vouchered samples were identified and archived by the Alabama Geologic Survey lab in Tuscaloosa, AL.

Tributary backpack electrofishing

We sampled fish in wadeable areas of the six tributaries with the combination of a seine net and a backpack electrofisher. Each tributary contained at least two potential sample sites: one within the tributary transition zone and one upstream of the tributary transition zone. The tributary transition zone began as far downstream as the confluence with Sipsey Fork or Brushy Creek where conditions allowed, and ended at the high pool impoundment shoreline, as located during the reconnaissance visits. We were able to sample the transition zone only during low pool conditions. The upstream site began approximately 300m upstream of the high pool impoundment shoreline. In Mile Creek we sampled an additional reach 3.7 km upstream of the transition zone. The sampling crew included 1 backpack electrofisher, 1 dipnetter, and 2 persons holding a seine net. Our equipment included a 3.1 or 4.6 m long seine constructed of 4.8 mm mesh and an Aqua Shock Solutions backpack electrofisher outfitted with two wand-style probes.

Sampling began at the downstream end of the sampling reach and proceeded in an upstream direction. In riffles, the seine was set at the downstream end of the riffle. The electrofisher and dipnetter started at the upstream end of the riffle and shocked downstream towards the seine net, netting stunned fish, and disturbing substrate along the way. When the electrofisher reached the seine net it was checked for additional fish and all collected fish were placed in a bucket. Two or more seine sets were used in longer riffles. In pools, the seine was set at the downstream end of the pool. The electrofisher and dipnetter made a single pass through the pool in an upstream direction. In longer

pools and glides the seine was pulled behind the electrofisher as it proceeded upstream. At the completion of the pass the seine was checked for additional fish and all collected fish were placed in a bucket. The crew continued upstream in this manner until the counter on the backpack electrofisher read 1000 seconds. Total effort was less than 1000 seconds in some of the shorter transition zone reaches. At the end of the sampling reach the total number of each fish species captured was tallied and fish were returned live to the sampling reach. Fish that could not be positively identified in the field were vouchered for lab identification. All vouchered samples were identified and archived by the Forest Service Southern Research station fish lab in Oxford, MS.

Crayfish sampling

Traps

We sampled crayfish using minnow traps baited with canned dog food or pieces of freshly caught fish. Gizzard shad appeared to be particularly effective and in future efforts should be replaced daily. Minnow traps were set for two nights and checked daily in mainstem sites in the Sipsey Fork in 2012 and in Brushy Creek in 2013 (N=14 traps). All vouchered samples were identified and archived by the Forest Service Southern Research station fish lab in Oxford, MS.

Timed searches

A crew of three (occasionally four) people conducted visual searches for mussels and crayfish. The majority of crayfish collected were obtained by these crews. A combination of methods was employed, including walking banks and shallow areas, sometimes using view buckets, looking for burrows and crayfish or exuviae (molted exoskeletons), and snorkeling. While walking and snorkeling, rocks were turned and crayfish captured by hand or with an aquarium net. The target sample time was 20 minutes per site, though times varied for several reasons. Sites with more diverse or abundant mussel fauna tended to be sampled longer. Sites in or above the mainstem transition zones were sampled with more people and for much longer. Although the duration of most searches was recorded, the sampling was qualitative. Most of the sites sampled by the backpack electrofishing crew were also sampled by the snorkel crew. In addition, the snorkel crew sampled the impounded zone at the mouth of each sampled tributary and sampled every several km in the mainstem river. In 2012, several crayfish of each species captured were retained at each site. In 2013, all adult and some juvenile crayfish were retained.

Opportunistic sampling

The mussel, backpack electrofishing, and boat electrofishing crews were instructed to watch for and collect crayfish they encountered. Crayfish sampling by boat electrofishing was opportunistic and qualitative. . Backpack electrofishing crews collected crayfish during their fish sampling. In 2012, crews targeted both fish and crayfish and retained specimens of each unique-looking type at each site, emphasizing form 1 (reproductive form) males. In 2013, crews netted crayfish only incidentally while targeting fish. When sorting captured crayfish in 2013, only male form I (reproductive form) crayfish were preserved, and then only if they looked different (to untrained observers) from those already preserved at other sites. Because not all crayfish were recorded or retained, this sampling also was qualitative. All vouchered samples were identified and archived by the Forest Service Southern Research station fish lab in Oxford, MS.

Mussel sampling

Timed searches

We sampled for freshwater mussels in Sipsey Fork, Brushy Creek, and the six tributaries using timed searches. The method used to search for mussels depended on site conditions. At deeper lake sites crews mostly focused on shallower shoreline areas, feeling through the muck with their fingers to locate mussels. At shallower stream sites crews used either viewing buckets or face masks to visually search the surface, taking care to flip over and search beneath large, flat rocks and in the spaces between cobbles and boulders. Sample sites were distributed throughout Sipsey Fork and Brushy Creek at approximately 1 km intervals. We also searched both the transition zone and upstream of the transition zone in the tributaries. Our target effort at each sample site was 30-60 person minutes. For example, if the mussel crew included 3 people and each person sampled for 20 minutes there would be a total of 60 person minutes at that site. We counted, but didn't measure, all mussels we encountered, but if a specimen appeared to be a juvenile or youngster we estimated its age by counting shell rings. We also collected relic shells, which were identified and archived by the Forest Service Southern Research station fish lab in Oxford, MS.

Opportunistic sampling

The fish and crayfish crews were instructed to document the location of any live or relic mussel shells encountered. Relic shells were collected and sent to the Oxford, MS lab for identification. Live mussels were photographed and returned to the stream. If a mussel expert was present and the crew was returning the sample site the next day the mussel was placed in a bag of wet leaves, brought in for identification, and returned to the sample site the following day.

Results

Sipsey Fork

Transition zone extent

When displayed in ArcMap the intersections of LiDAR derived elevation contours with Sipsey Fork indicated a potential 21.4 km transition zone extending from rkm 1.3 to rkm 22.7. All reconnaissance visits were completed between 153.0 m and 155.5 m lake elevation (Table 3). During high pool (spring) reconnaissance visits we found stream habitat upstream of rkm 23 transitioning to run habitat downstream of rkm 23 (Table 4). The transition from run habitat to impounded habitat was more gradual but we estimated it to be near rkm 19. During low pool (fall) reconnaissance visits we found stream habitat upstream of rkm 19, run habitat between rkm 19 and rkm 15, and a gradual transition to impounded habitat downstream of rkm 15. Observations made during the reconnaissance visits suggest the transition zone extends from rkm 23 to rkm 15 and contains two subzones; a stream-run and a run-impounded subzone (Figures 4 and 5). The stream-run subzone extends from rkm 23 to rkm 19 and transitions from stream habitat at low pool to run habitat at high pool, whereas the run-impounded subzone extends from rkm 19 to rkm 15 and transitions from run habitat at low pool to impounded habitat at high pool.

Tributaries transitioned from impounded habitat at high pool to stream habitat at low pool. Mill Creek enters the mainstem near rkm 10.9. Impounded habitat extends upstream 1.1 km and 0.7 km during high and low pool, respectively, providing 0.4 km of transition zone. Grindstone Creek enters the mainstem near rkm 14.9, with impounded habitat 0.4 km and 0.3 km upstream during high and low pool, respectively, providing 0.1 km of transition zone. Payne Creek enters the mainstem near rkm 19.2, with impounded habitat 0.3 km and 0.0 km upstream during high and low pool, respectively, providing 0.3 km of transition zone. We noted a distinct difference in habitat between tributary transition zones and areas upstream; the transition zones were shallow with little habitat unit structure and choked with fine sand and silt, whereas areas upstream were deeper with cobbles and gravels forming typical pool-riffle sequences.

Fish Distribution

In the Sipsey Fork drainage, combining all sample sites (including tributaries), sampling periods, and sampling methods, we collected 42 fish samples (Table 5, Figures 7 and 8) containing a total of 54 fish species from 10 families (Table 6, Figure 9). The transition zone had the highest species richness of any zone in the Sipsey Fork drainage. Of the 54 total species in the Sipsey Fork drainage, 29 were found in the impounded zone, 45 in the mainstem transition zone, 20 in the mainstem stream zone, 30 in

tributary transition zones, and 32 in tributary stream zones (Figure 10). The number of species associated with river, stream, or headwater reaches, but not impounded or swamp habitat (see Habitat, Table 1) was highest in zones containing stream habitat for at least a portion of the year and was lowest in zones without stream habitat (Figure 12).

The highest species richness (32) of the three tributaries was found in Payne Creek (Figure 13), which has a drainage area of 10.1 km^2 and a confluence with the mainstem at rkm 19.2 within the stream-run subzone. The lowest species richness (23) was found in Grindstone Creek, which has the smallest drainage area of the three tributaries at 9.1 km^2. The confluence of Grindstone Creek with the mainstem was at rkm 14.9 and within the impounded zone. Mill Creek had a species richness of 26, the largest drainage area of the three tributaries at 17.4 km^2, and a confluence with the mainstem at rkm 10.4 within the impounded zone.

We collected 3 species from the R8 Foresters Sensitive Species list: Sipsey Darter (*Etheostoma sp. cf. E. bellator "A"*), Tuscaloosa Darter (*Etheostoma douglasi*), and Bankhead Darter (*Percina sipsi*) (Figure 14). The Bankhead Darter was the most widely distributed of the three species with captures extending to the downstream edge of the stream-run subzone (rkm 19) in the mainstem, within the transition zone of Grindstone Creek, and upstream of the transition zone in Payne Creek. Most Bankhead Darter captures occurred during low pool conditions in stream habitat, with the exception of a collection at rkm 20.4 during high pool conditions and in stream-run habitat. The Tuscaloosa Darter was captured upstream of the transition zone in Payne Creek and from mainstem sites both within the stream-run subzone (upstream of rkm 20.8) and upstream of the transition zone (rkm 24.3). All the captures of Tuscaloosa Darter in the mainstem occurred during low pool conditions and in stream habitat. The Sipsey Darter was collected upstream of the transition zone in Payne Creek and from the mainstem at sites both within the stream-run subzone and (upstream of rkm 21.9) and upstream of the transition zone (rkm 24.3). All collections of the Sipsey Darter occurred during low pool conditions and in stream habitat.

Mussel Distribution

We collected 11 mussel species alive during low pool conditions in 2012 and 2013, including three federally listed and three Forest Service sensitive species (Table 7). Two of the species, Giant Floater (*Pyganodon grandis*) and Paper Pondshell (*Utterbackia imbecillis*), are generally associated with lake or impounded habitat while the other 9 are considered stream habitat obligates. *P. grandis* and *U. imbecillis* were restricted to sites downstream of rkm 19.5, were the only species found downstream of rkm 18.6, and were the only species collected in the impounded zone and run-impounded subzone. The

mainstem transition zone had the highest species richness, with all 11 species present (Figure 16). The downstream-most occurrence of any stream habitat obligate and TES mussel was at rkm 19.5, within the stream-run subzone. The mainstem stream zone had a species richness of 8, all are stream habitat obligates. No stream obligates were collected at any of the tributary sites. Lake associates were collected from impounded habitat in the tributaries near the confluence with the mainstem of Sipsey Fork. The non-native invasive Asian clam (*Corbicula fluminea*) was noted as present throughout the mainstem.

Crayfish Distribution

We collected four crayfish species from sites in the Sipsey Fork drainage. The mainstem transition zone contained all 4 species; the mainsteam stream zone contained 3 species and the impounded zone contained 2 species (Table 8, Figure 18). *Orconectes validus* was the most widespread and most often captured crayfish, with at least 1 collection from every habitat zone and subzone in both the mainstem and tributaries. *Orconectes lancifer* was collected in the impounded zone, the run-impounded subzone of the mainstem transition zone, and in the impounded and stream-impounded zones of Grindstone Creek. *Cambarus obstipus* was collected in both sub-zones of the mainstem transition zone, the mainstem stream zone, and from the tributary stream zone in Mill Creek and Grindstone Creek. *Cambarus striatus* was collected in the both sub-zones of the mainstem transition zone and from tributary stream habitat in Payne Creek.

Brushy Fork

Transition zone extent

When displayed in ArcMap the intersections of LiDAR derived elevation contours with Brushy Creek indicated a potential 20.7 km transition zone extending from rkm 2.9 to rkm 23.6. All reconnaissance visits were completed between 153.0 m and 155.5 m lake elevation (Table 3). During high pool (spring) reconnaissance visits we found stream habitat upstream of rkm 23.5 transitioning to run habitat downstream of rkm 23.5. The transition from run habitat to impounded habitat was more gradual but we estimated it to be near rkm 19. During low pool (fall) reconnaissance visits we found stream habitat upstream of rkm 19, run habitat between rkm 19 and rkm 15, and gradual transition to impounded habitat downstream of rkm 15 (Figures 4 and 6). Observations made during the reconnaissance visits suggest the transition zone extends from rkm 23.5 to rkm 15 and contains two subzones; a stream-run and a run-impounded subzone. The stream-run subzone extends from rkm 23.5 to rkm 19 and transitions from stream habitat at low pool to run habitat at high pool, whereas the run-impounded subzone extends from rkm 19 to rkm 15 and transitions from run habitat at low pool to impounded habitat at high pool.

Tributaries transitioned from impounded habitat at high pool to stream habitat at low pool. Chimney Branch enters the mainstem near rkm 10.0. Impounded habitat extends upstream 0.5 km and 0.3 km during high and low pool, respectively, providing 0.2 km of transition zone. Mile Creek enters the mainstem near rkm 17.0, with impounded habitat 0.9 km and 0.2 km upstream during high and low pool, respectively, providing 0.7 km of transition zone. Inman Creek enters the mainstem near rkm 23.7, which is approximately 0.15 km upstream of the extent of the transition zone on Brushy Creek during typical high pool, and thus Inman Creek had no impounded habitat or associated transition zone during our sample periods. We noted a distinct difference in habitat between tributary transition zones and areas upstream; the transition zones were shallow with little habitat unit structure and choked with fine sand and silt, whereas areas upstream were deeper with cobbles and gravels forming typical pool-riffle sequences.

Fish Distribution

In the Brushy Creek drainage, combining all sample sites (including tributaries), sampling periods, and sampling methods, we collected 34 fish samples (Table 9, Figures 7 and 8) containing a total of 49 fish species from 12 families (Table 10, Figure 9). The transition zone had the highest species richness of any zone in the Brushy Creek drainage. Of the 49 total species in the Brushy Creek drainage, 28 were found in the impounded zone, 31 in the mainstem transition zone, 22 in the mainstem stream

zone, 25 in tributary transition zones, and 28 in tributary stream zones (Figure 11). The number of species associated with river, stream, or headwater reaches, but not impounded or swamp habitat (see Habitat, Table 1) was highest in zones containing stream habitat for at least a portion of the year and was lowest in zones without stream habitat (Figure 12).

The highest species richness (31) of the three Brushy Creek tributaries was found in Mile Creek (Figure 13), which has a drainage area of 18.1 km^2 and a confluence with the mainstem at rkm 17.0 within the run-impounded subzone. Chimney Branch had to overall lowest richness (22) but had the highest darter richness (6). Chimney Branch has a smallest drainage area (6.7 km^2) of the three tributaries and a confluence with the mainstem at rkm 10 within the impounded zone. Inman Creek had a species richness of 24, a drainage area of 20.2 km^2, and a confluence with the mainstem at rkm 23.7 within the stream zone.

The only Regional (R8) Foresters Sensitive Species we collected in the Brushy Creek drainage was *Etheostoma douglasi*, the Tuscaloosa Darter (Figure 15). We collected *E. douglasi* from mainstem sites in the stream-run subzone (rkm 21.6) and upstream of the transition zone (rkm 24.0), and at 4 sites upstream of the transition zones in each of the tributaries (Chimney Branch, rkm 0.9; Mile Creek, rkm 1.2 and rkm 3.7; Inman Creek, rkm 0.3). All collections of *E. douglasi* in the mainstem occurred during low pool conditions in stream habitat.

Mussel Distribution

We collected 8 mussel species alive during low pool conditions in 2013, including 2 federally listed species and 1 Forest Service sensitive species. Relic shell collections included 3 species not collected alive, including 2 Forest Service sensitive species (Table 11). Two of the species found alive, Giant Floater (*Pyganodon grandis*) and Paper Pondshell (*Utterbackia imbecillis*), are generally associated with lake or impounded habitat while the other 6 are considered stream habitat obligates. *P. grandis* and *U. imbecillis* were the only species found downstream of rkm 19.0 and were restricted to the run-impounded sub-zone of the mainstem transition zone and the impounded zone (Figure 17). The mainstem stream zone had the highest richness, with 6 stream obligate species. The mainstem transition zone contained 2 lake associate species in the run-impounded subzone and 3 stream obligates in the stream-run subzone, for a total richness of 5 species. The down-stream most occurrence of any stream obligate was at rkm 22, within the stream-run subzone. The down-stream most occurrence of any TES mussel was at rkm 23. No stream obligates were collected at any of the tributary sites. Lake associates were collected from impounded habitat near the confluences of the tributaries and the mainstem of Brushy Creek.

Crayfish Distribution

We collected five crayfish species in the Brushy Creek drainage (Table 12, Figure 19). The impounded zone contained 1 species, the mainstem transition zone contained 4 species, and the tributary stream zone contained 5 species. *Cambarus obstipus* was collected from the mainstem stream zone and stream-run sub-zone, and from the tributary stream zone in Chimney Branch and Mile Creek. *Cambarus striatus* was collected only in Chimney Branch in the tributary stream-impounded and stream zones. *Orconectes juvenilis* was collected in both of the mainstem transition subzones and from tributary transition and stream zones in Chimney Branch and Mile Creek. *Orconectes lancifer* was collected in the impounded zone, the run-impounded subzone of the mainstem transition zone, and in tributary transition and stream habitat in Chimney Branch. *O. validus* was collected from the stream-run sub-zone of the mainstem transition zone, the mainstem stream zone, and from tributary transition and stream zones.

Discussion

We associated differences in fish, mussel, and crayfish distributions to differences among the habitat zones (impounded, transition, stream) and subzones (stream-run, run-impounded) of Sipsey Fork and Brushy Creek. In general, the transition zone appears to function as an ecotone, as suggested by Santos et al. (2010), with a mixture of both stream and impoundment dwelling species, resulting in the highest overall species diversity. Closer examination of habitat subzones within the transition zone revealed that we collected species associated with river, stream, and headwater habitats more frequently from the stream-run subzone than the run-impounded subzone. It is plausible that flow and habitat conditions change enough from the stream-run to the run-impounded subzone to impact species distributions within these streams. However, the relationship between species distributions and habitat zones is unclear because different sampling gears and methods were required to sample each habitat zone (Tables 5 and 9). Additional sampling of the stream bottom within the run-impounded subzone using different approaches is needed to better describe the distribution of mussels, crayfish, and benthic fish species within the run-impounded subzone.

The run-impounded subzone is of particular interest because it may limit the downstream extent of several species of concern, including FSS darters and T & E mussels that prefer stream habitat. Several kilometers of the run-impounded subzone are designated as critical habitat for T&E mussel species, and we collected FSS darter species from several tributaries flowing directly into the run-impounded subzone, as well as the impounded zone. If T&E mussels are not able to survive within the run-impounded subzone, it would mean a loss of several kilometers of designated critical habitat. If FSS

darters are unable to occupy the run-impounded or impounded zone the tributary populations may be isolated, decreasing both the effectiveness of tributaries as refuges and the likelihood of long term persistence within individual tributaries. Additional sampling is needed to determine the extent of T&E mussels and FSS darters within the run-impounded subzone and impounded zone.

Improving sampling efficiency within the run-impounded zone will require new sampling approaches, particularly for the bottom-dwelling FSS fish and T&E mussel species. The run-impounded zone is too deep to be sampled by backpack electrofishing, seining, or snorkeling, and boat electrofishing is ineffective for sampling small, benthic species. We had limited success in collecting benthic species with the mini-trawl in the run-impounded zone. Snags on the river bottom, particularly on Brushy Creek caused us to abort many trawl hauls. The addition of bottom scanning sonar to the trawl boat could improve the efficiency of this gear and provide valuable information of benthic species distributions. Sampling mussels and crayfish within the run-impounded zones will require the use of hookah or scuba equipment. Visibility will be a challenge and sampling may need to focus on late spring and early summer, after high flows but before algae blooms.

Conditions in the transition zone are, by definition, constantly changing. The habitat zones we describe here slide up and down the stream channel as water surface elevation within the reservoir changes. Dam operations and precipitation cause daily changes in the number of river kilometers assigned to a particular habitat zone, but on average the dam is operated to maintain a normal high level of 155.4 m from approximately April – May, with water levels dropping throughout the summer months. Normal lows are reached by late September and held through mid-November with a gradual return to full pool thereafter. Changes in dam operation to retain water for longer periods and/or at higher elevations would change the amount of time stream reaches spend in each of the habitat zones, potentially changing the species distributions we describe here.

We can investigate changes in stream habitat and biological communities with short term exposure to transition zone conditions by extending our monitoring reach upstream. The dam is capable of retaining water to an elevation of 158.5 m, which can temporarily create several additional kilometers of transitional habitats. Alabama Power records indicate this level has been reached many times over the past 60 years, mostly during the months of December – April (Figure 2). Sampling stream habitat and fish communities within and upstream of this short term transition zone would allow us to examine changes associated with short term exposure to transitional habitats. Species with limited mobility, such as mussels, may be particularly susceptible to these short duration changes. We collected only one sample each in Sipsey Fork and Brushy Creek upstream of rkm 23. Additional sampling

upstream of rkm 23 would allow us to more fully describe the biotic communities in short term transitional and stream habitats in both streams.

Transitional habitats provide an opportunity for species preferring impounded habitat to compete directly with closely related species preferring stream habitat. For example, Boschung and Mayden (2004) noted that prior to the creation of Lewis Smith Reservoir the stream-specialist Redeye Bass (*Micropterus coosae*), a known host for several mussel species, were the dominant bass species within the Sipsey Fork watershed. We failed to collect any Redeye Bass, but instead found the reservoir-specialists Spotted Bass (*Micropterus punctulatus*) and Largemouth Bass (*Micropterous salmoides*). Additional work is needed to document the presence, distribution and location of Redeye Bass, a host fish for several native mussel species.

Impounded and transitional habitats also create pathways for introduction of invasive and exotic species. We collected fish, mussel, and crayfish species that have been introduced to Sipsey Fork and Brushy Creek through the reservoir. Blueback Herring (*Alosa aestevalis*), Threadfin Shad (*Dorosoma petenense*), and White Bass (*Morone chrysops*) were collected as far upstream as the stream-run zones, and Common Carp (*Cyprinus carpio*) were collected in the impounded and run-impounded zones of both drainages. Our collections of the lake associated mussel species *Pyganodon grandis* and *Utterbackia imbecillis* are the first recorded for Smith Lake and areas upstream. The crayfish species *Orconectes juvenalis* and *Orconectes lancifer* collected from impounded and transition zones add to the list of introduced species. Some of the introductions are relatively recent and continued monitoring is needed to determine the effect of these and future introductions on the native communities with the stream system.

Ours is just one of several projects describing the effects of Lewis Smith Lake on species within Sipsey Fork and Brushy Creek. Other projects are focused on reptile, amphibian, and plant populations within the drainages. We observed at least two species of management interest during our activities, the Black Warrior Waterdog (*Necturus alabamensis*) and Flattened Musk Turtle (*Sternotherus depressus*). Given the extent of our sampling activities it is likely that we will encounter these and other species of interest during the remainder of the project. Continued collaboration among projects will improve the overall quality of all projects within the drainages.

In summary, we recommend the following modifications and additions to sampling over the remaining years of the project:

1) Adapt existing or apply new sampling methods to the run-impounded zone, focused on detection of benthic species

    a. Employ sonar on trawl boat to detect snags and improve efficiency of sampling
    b. Use hookah, scuba, and/or quadrat traps for sampling mussels, crayfish, and possibly darters
    c. Focus on the presence of FSS fish species and T&E mussel species
2) Extend sampling upstream in Sipsey Fork and Brushy Creek
    a. Add sample sites between 155.4 m and 158.5 m stream bed elevation (i.e. within the short term transition zone) and upstream of 158.5 m stream bed elevation (i.e. outside of any potential transition zone influence)
    b. Determine length of inundation of various stream reaches and tributaries using daily lake elevation data from Alabama Power
    c. Focus on mussel and fish species richness, and the occurrence of Redeye Bass
3) Document differences in habitat conditions among zones
    a. In Sipsey Fork and Brushy Creek describe longitudinal changes in substrate, large wood, water depth and other habitat attributes
    b. Include reaches from the impounded zone upstream through the short term transition zone and into reaches upstream of the short term transition zone (i.e. reference conditions)
    c. Determine how changes in water velocity and depth correspond to changes in substrate, LW distribution, and other stream habitat attributes
4) Extend sampling upstream in tributaries
    a. Collect fin clips from FSS darters and a non-benthic, mobile species (e.g. creek chub) for potential future genetic analysis
    b. Focus on the upstream extent of FSS fish species, upstream extent of *Orconectes juvenilis* (introduced crayfish), and possible presence of Redeye Bass
5) Continued collaboration with other Smith Lake projects
    a. Report observations of other species of interest to the appropriate collaborators on the Smith Lake project
    b. Provide sampling crews with additional training in the identification of species of interest

These changes and additions to our sampling methods will help us to more accurately describe the extent of the transitions zone and its effects on stream habitats and species distribution. The final

project report, due in 2016, will include a re-analysis of species distributions, description of habitat conditions, and recommendations for long-term monitoring of the river system.

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Figures

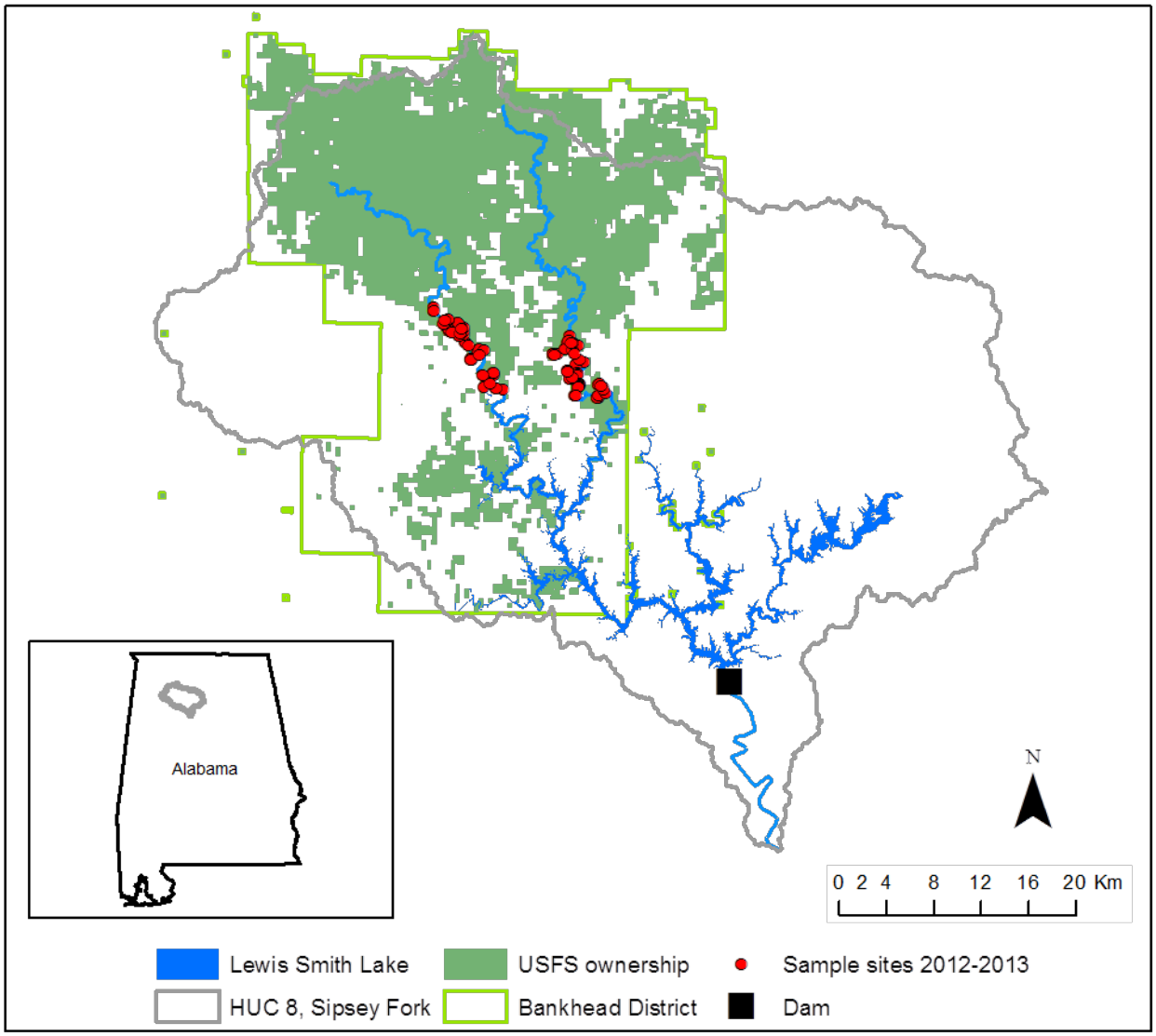

Figure 1. The Sipsey Fork hydrologic unit (HUC) in northwest Alabama. We collected samples upstream of Lewis Smith Lake from the Sipsey Fork (west) and Brushy Creek (east) drainages in fall 2012, spring 2013, and fall 2013.

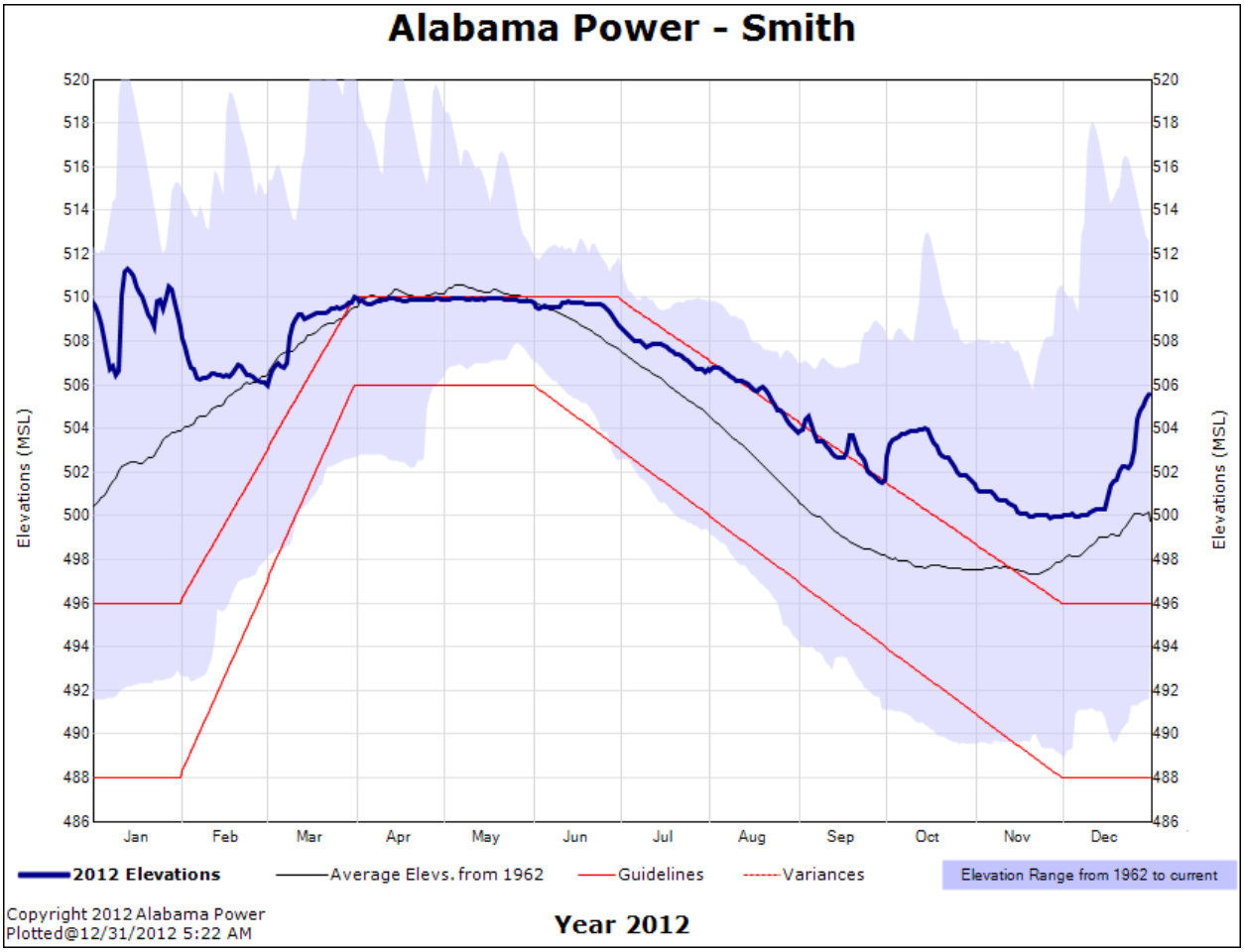

Figure 2. Reservoir operation guidelines, water level elevation range since 1962, average water level elevation, and 2012 water levels in Lewis Smith Lake. Elevation (MSL) is shown in feet: 502 ft. = 153.0 m, 510 ft. = 155.5 m.

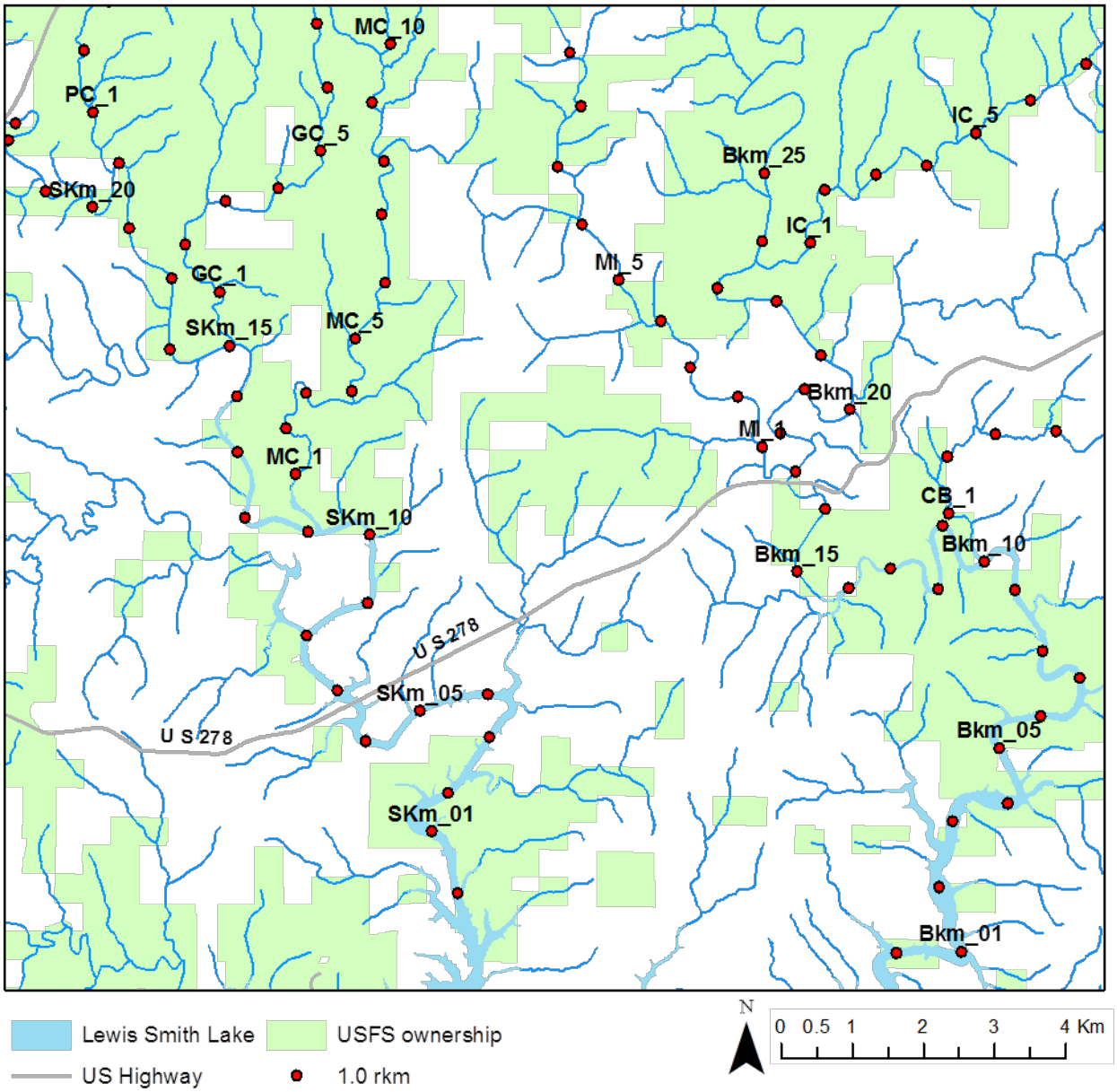

Figure 3. River kilometer (rkm) markers on Sipsey Fork (SKm), Paine Creek (PC), Grindstone Creek (GC), Mill Creek (MC), Brushy Creek (BKm), Inman Creek (IC), Mile Creek (MI), and Chimney Branch (CB).

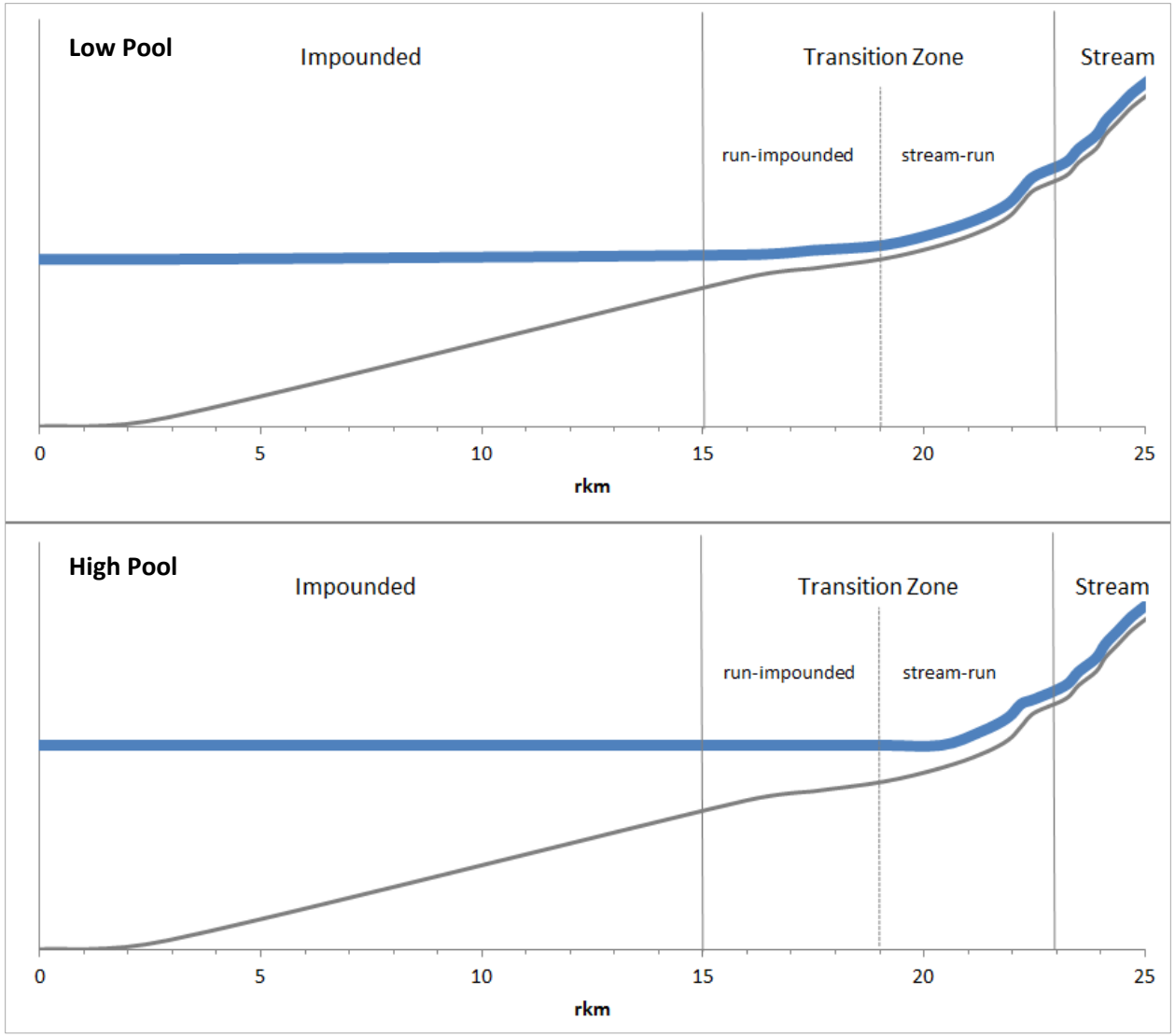

Figure 4. Changes in water surface elevation (not to scale) within habitat zones during low and high pool. Blue line is water surface, grey line is stream bed.

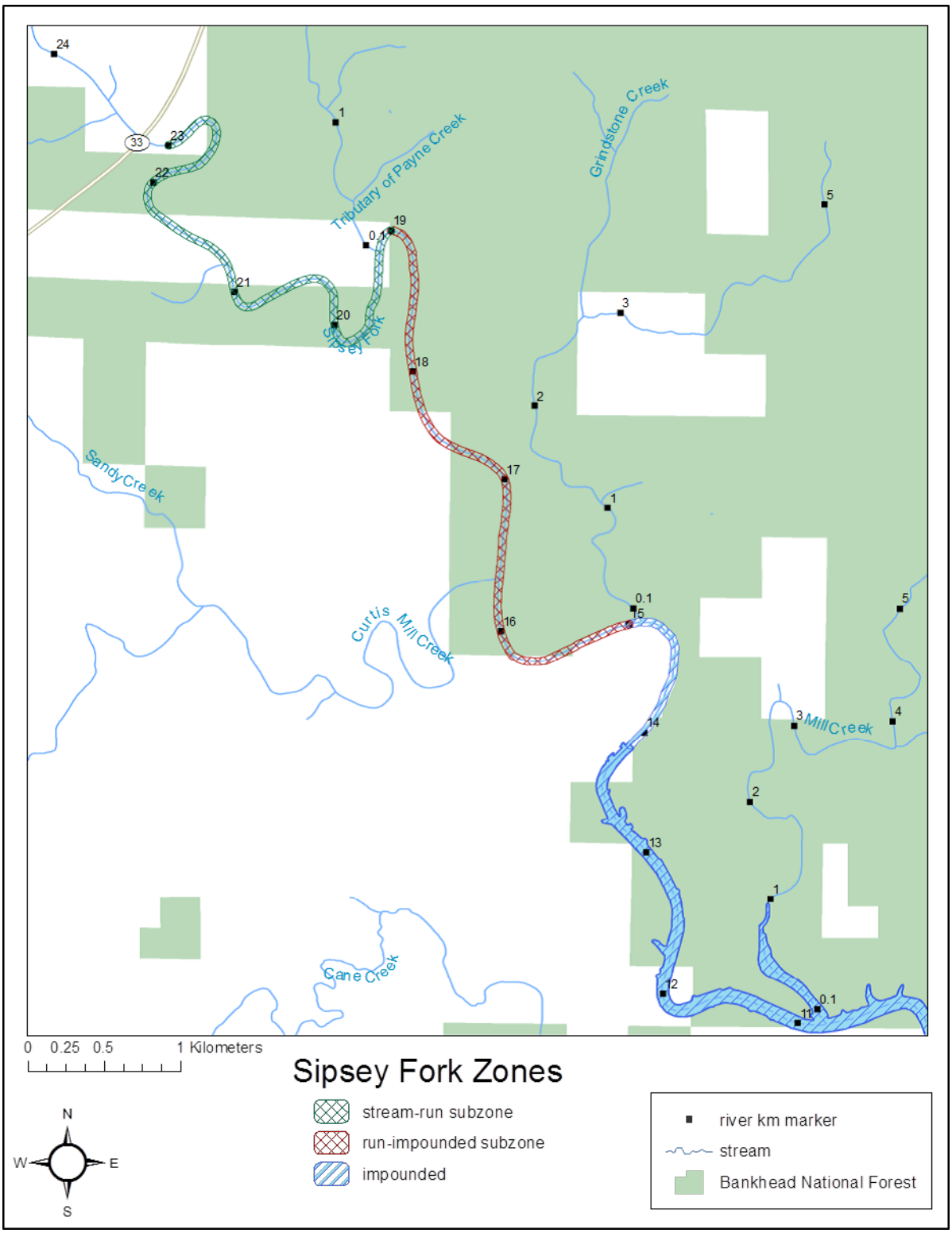

Figure 5. Habitat zones and subzones encountered on Sipsey Fork, 2012-2013. The stream-run and run-impounded subzones comprise the transition zone on the mainstem. Tributary transition zones are not displayed.

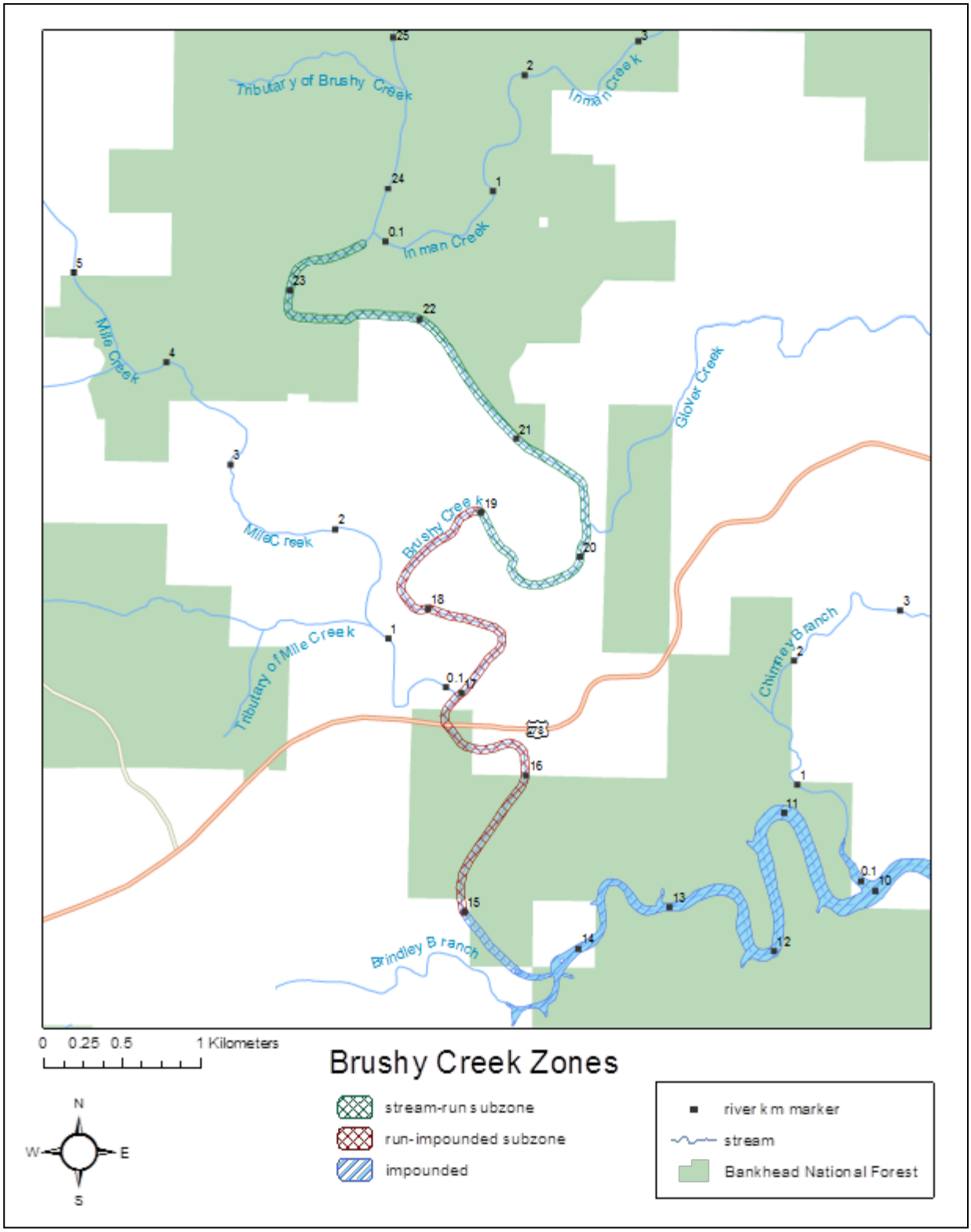

Figure 6. Habitat zones and subzones encountered on Brushy Creek, 2012-2013. The stream-run and run-impounded subzones comprise the transition zone on the mainstem. Tributary transition zones are not displayed.

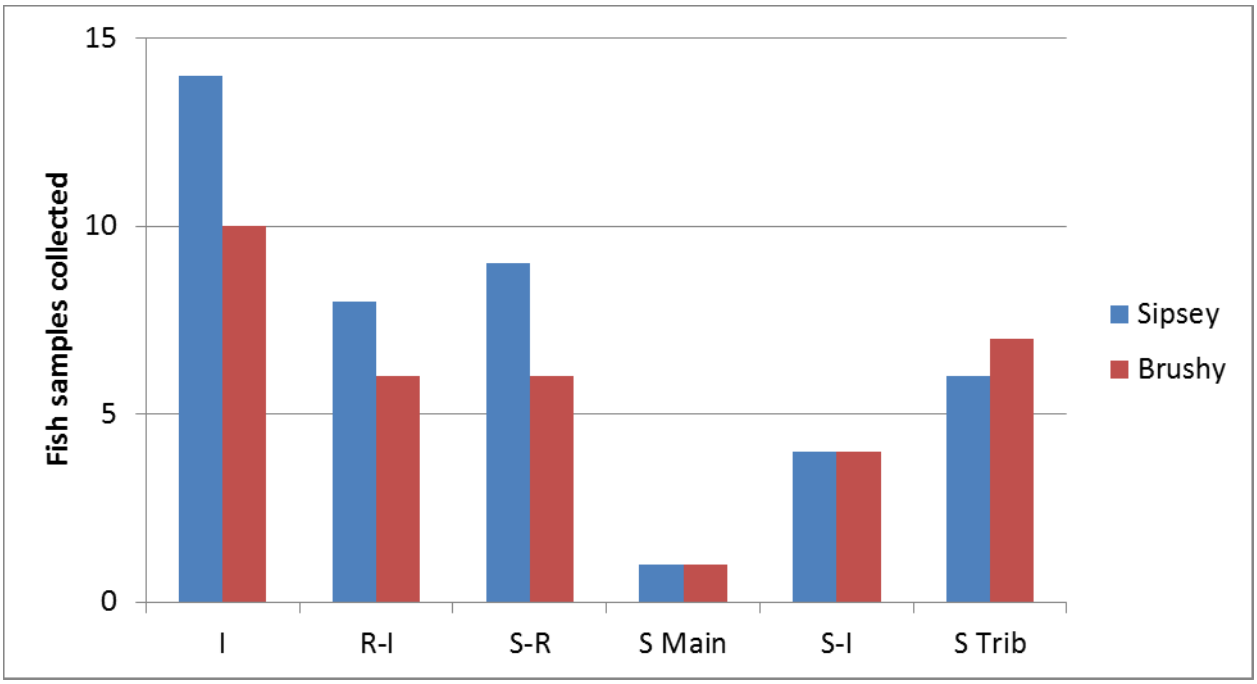

Figure 7. Number of fish samples collected from habitat subzones in the Sipsey Fork and Brushy Creek drainages, 2012-2013. I = Impounded; R-I = run-impounded; S-R = stream-run; S Main = mainstem stream; S-I = stream-impounded; S Trib = tributary stream. Subzones R-I and S-R comprise the mainstem transition zone. Subszone S-I is the tributary transition zone.

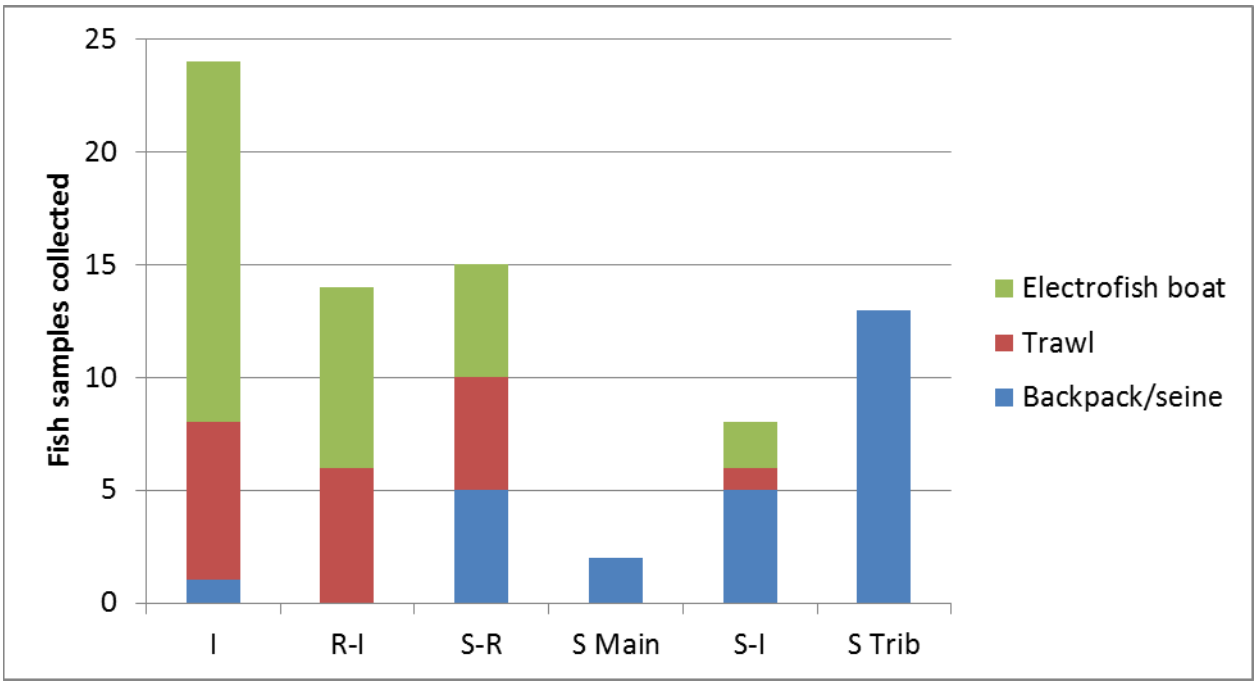

Figure 8. Sampling methods used within each habitat subzone in the Sipsey Fork and Brushy Creek drainages (combined), 2012 – 2013. I = Impounded; R-I = run-impounded; S-R = stream-run; S Main = mainstem stream; S-I = stream-impounded; S Trib = tributary stream. Subzones R-I and S-R comprise the mainstem transition zone. Subszone S-I is the tributary transition zone.

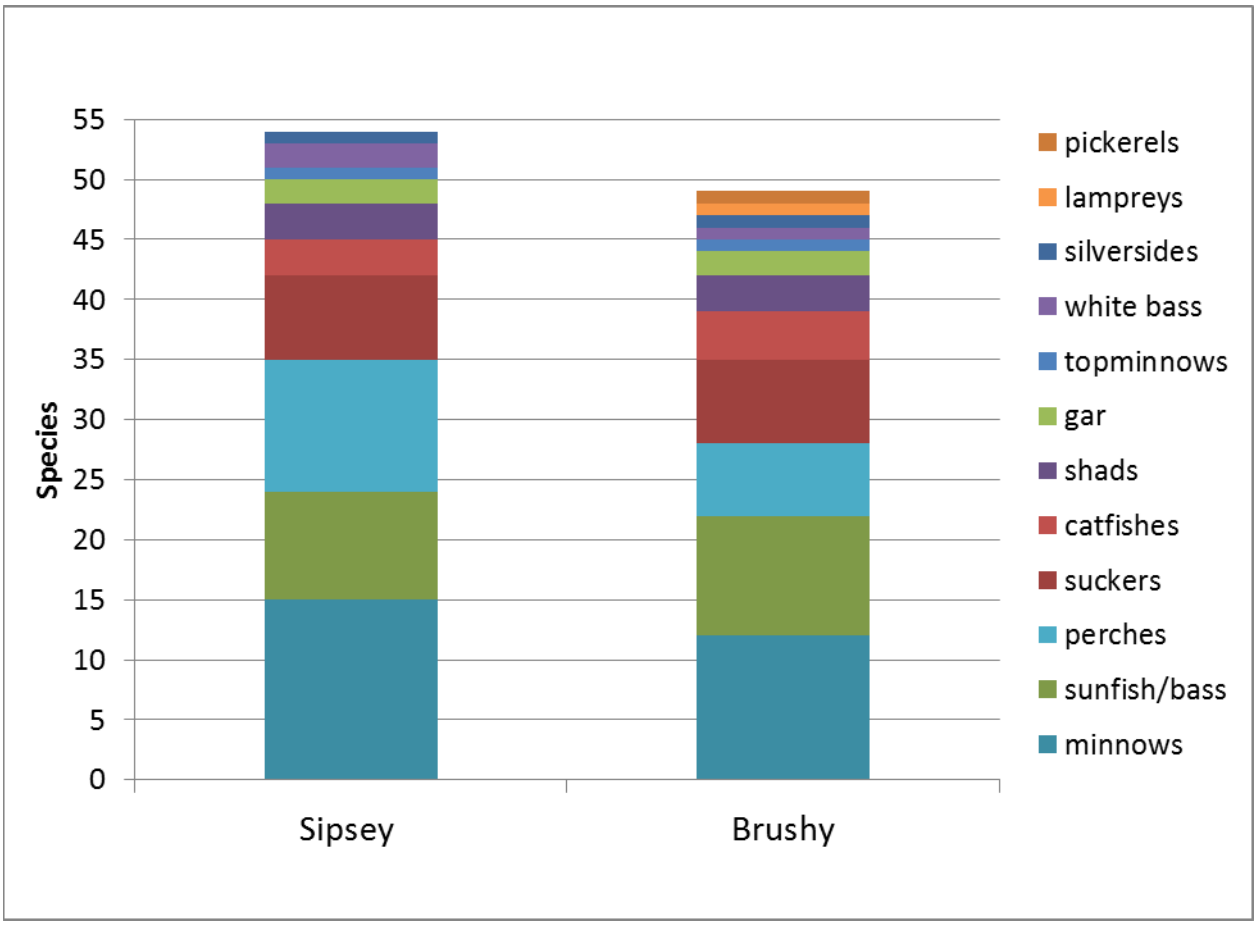

Figure 9. Total species collected (all sample dates, locations, methods combined) from the Sipsey Fork and Brushy Creek watersheds (tributaries included).

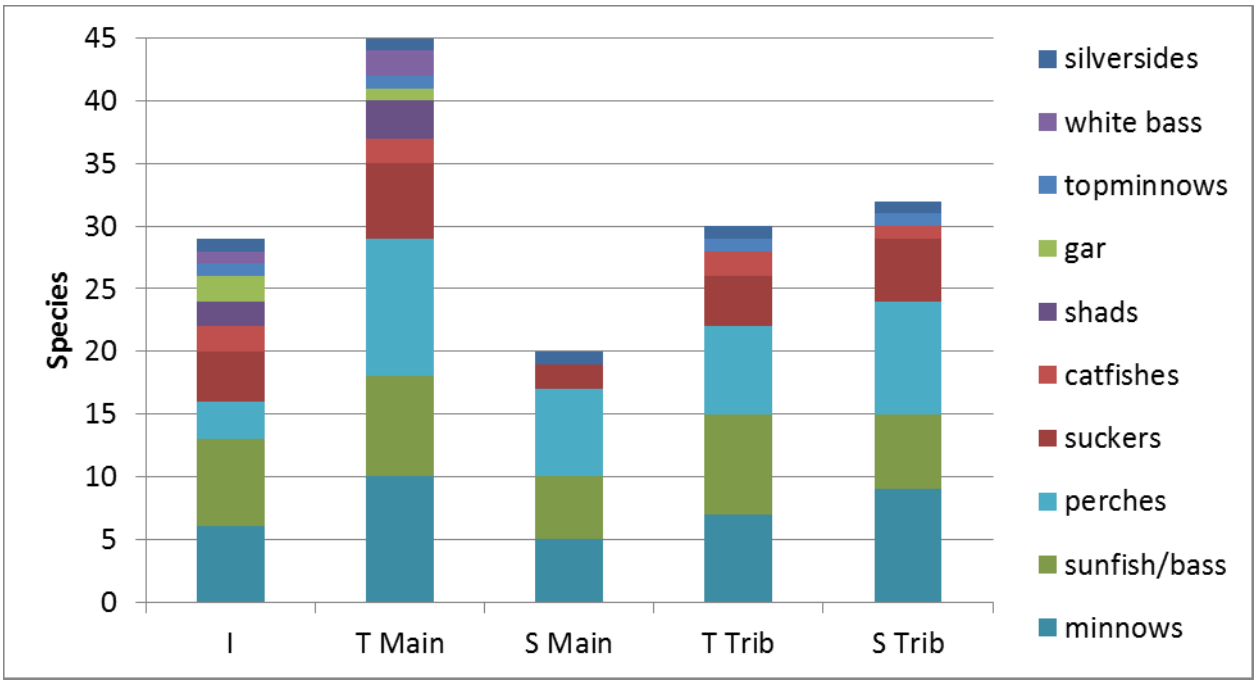

Figure 10. Total number of fish species collected from each habitat zone in the Sipsey Fork drainage, 2012-2013. I = Impounded; T Main = mainstem transition zone; S Main = mainstem stream; T Trib = tributary transition zone; S Trib = tributary stream.

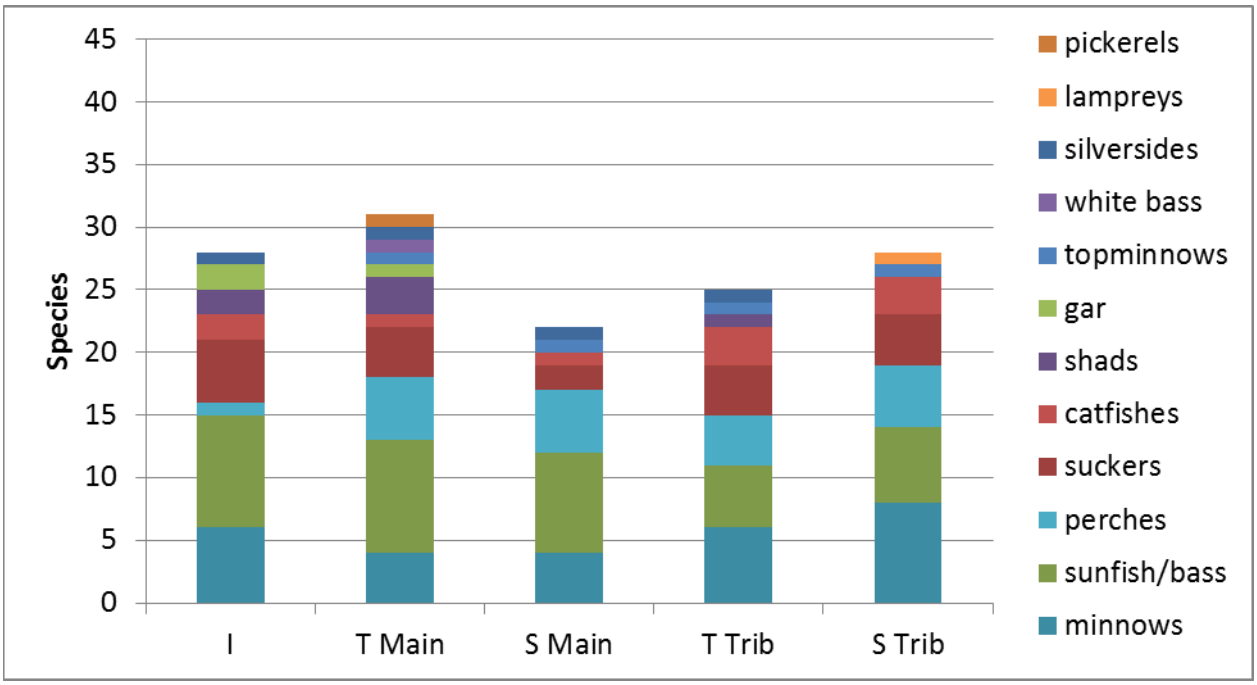

Figure 11. Total number of fish species collected from each habitat zone in the Brushy Creek drainage, 2012-2013. I = Impounded; T Main = mainstem transition zone; S Main = mainstem stream; T Trib = tributary transition zone; S Trib = tributary stream.

Figure 12. Number of fish species associated with river, stream, or headwater habitats (O'Neil and Shepard 2011) collected from each habitat subzone in the Sipsey Fork and Brushy Creek drainages, 2012-2013. I = Impounded; R-I = run-impounded; S-R = stream-run; S Main = mainstem stream; S-I = stream-impounded; S Trib = tributary stream. Subzones R-I and S-R comprise the mainstem transition zone. Subszone S-I is the tributary transition zone.

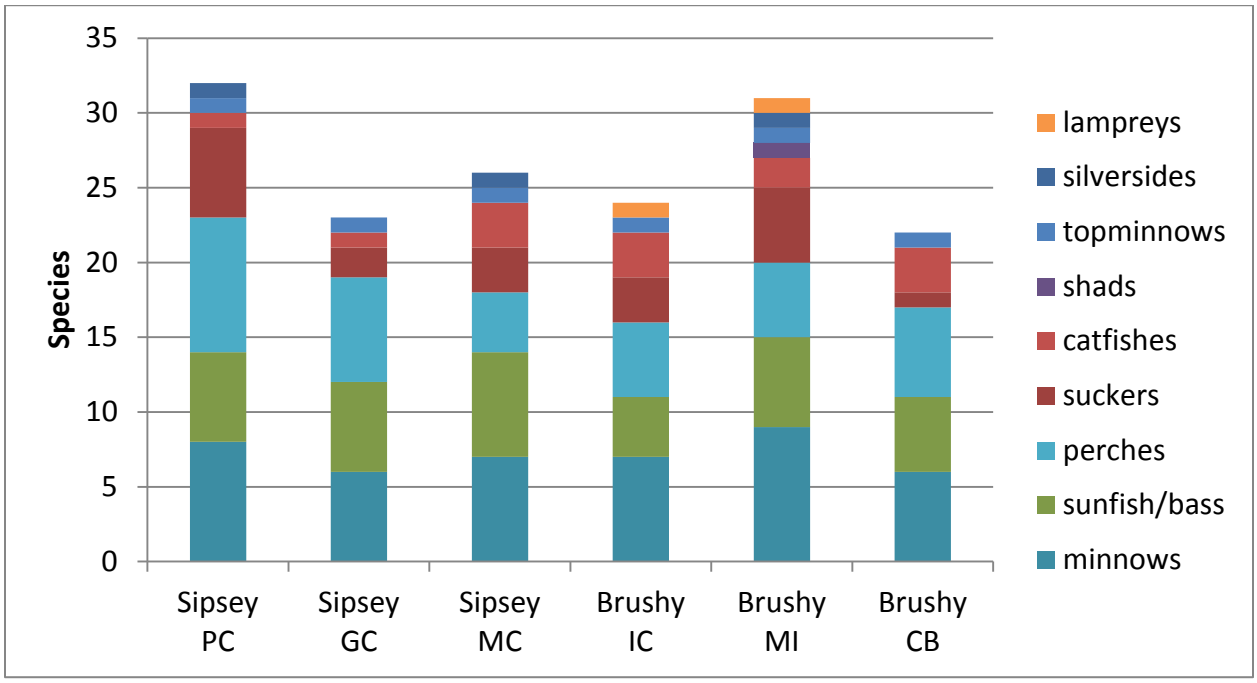

Figure 13. Number of fish species collected from tributary transition and stream zones (impounded zone excluded) in the Sipsey Fork and Brushy Creek drainages, 2012-2013. PC = Payne Creek; GC = Grindstone Creek; MC = Mill Creek; IC = Inman Creek, MI = Mile Creek; CB = Chimney Branch.

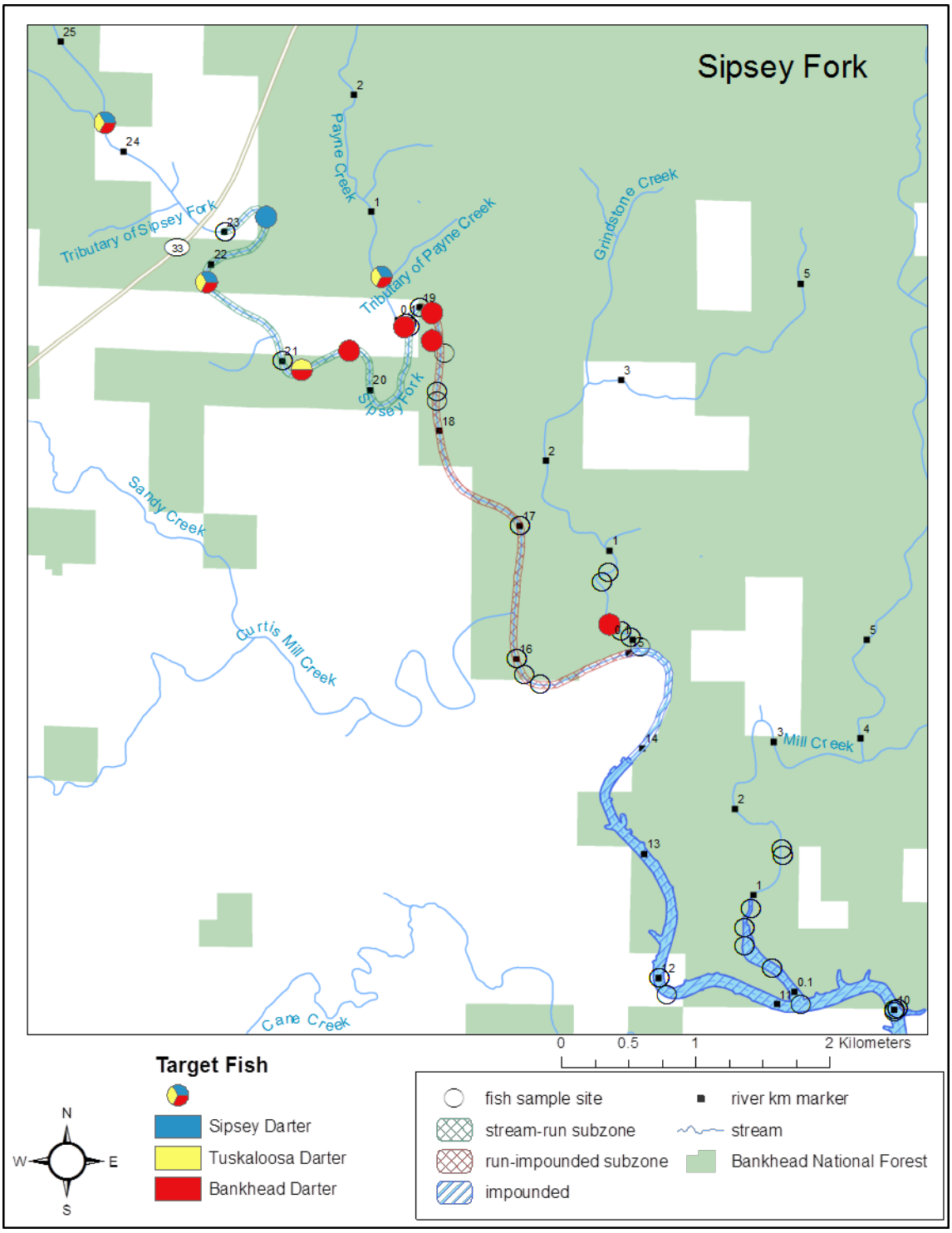

Figure 14. Collection sites of three target species fish from the Forest Service (R8) Sensitive Species (FSS) List in the Sipsey Fork drainage, 2012 and 2013.

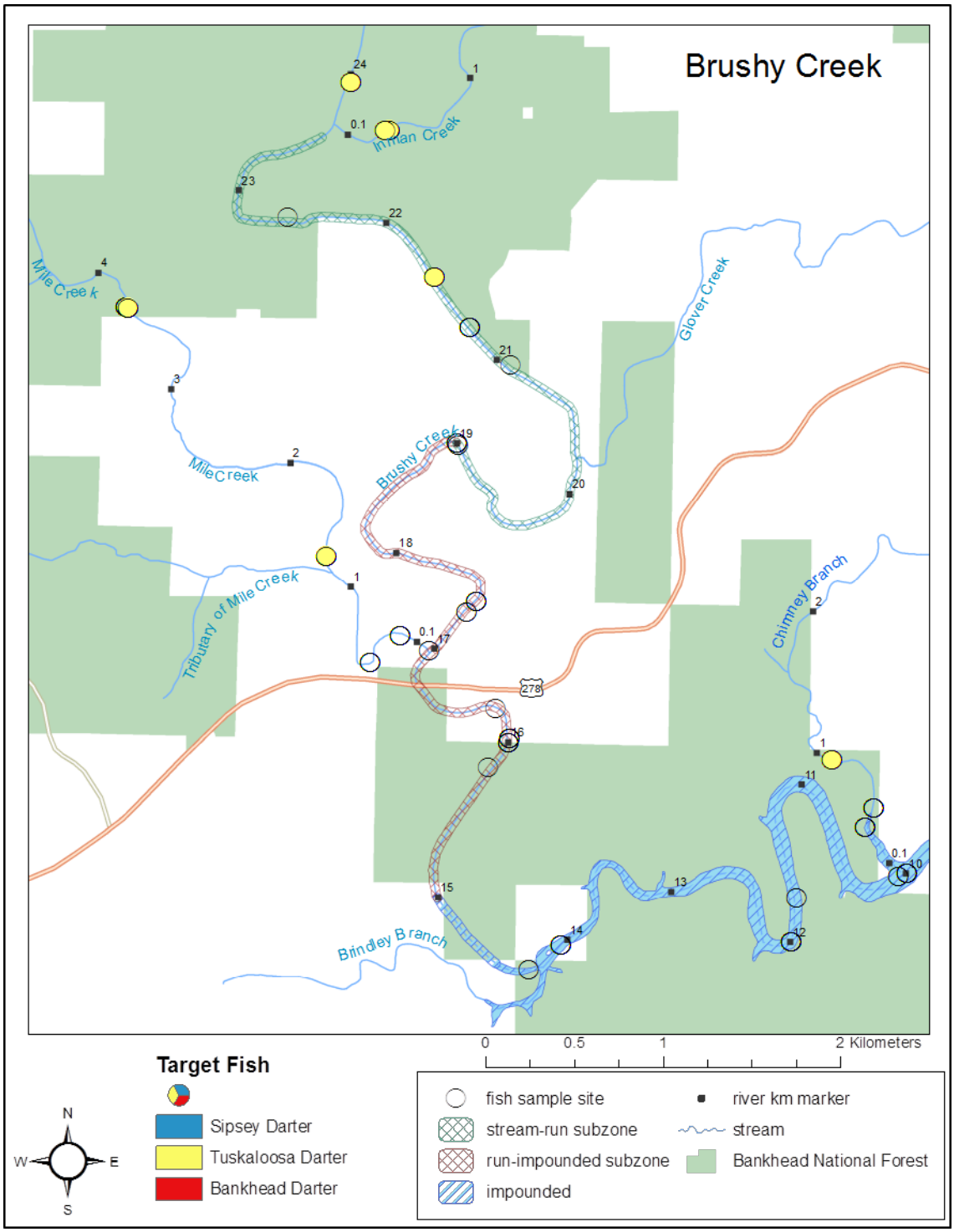

Figure 15. Collection sites of three target species fish from the Forest Service (R8) Sensitive Species (FSS) List in the Brushy Creek drainage, 2012 and 2013. Only *E. douglasi* were collected in the Brushy Creek drainage.

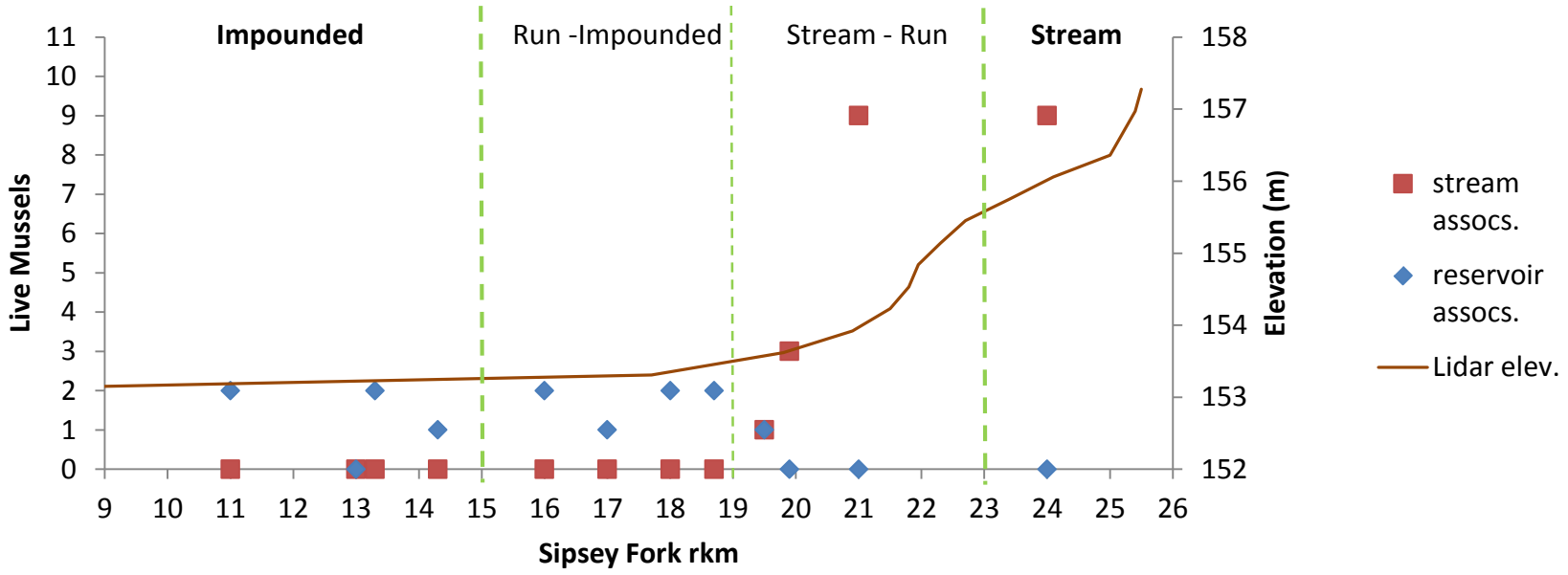

Figure 16. Number of live mussels, categorized as stream associates or reservoir associates, collected at sites (indicated by rkm) in the mainstem of Sipsey Fork, during low pool conditions, 2012 and 2013. The brown line shows LiDAR derived elevation at rkm. Vertical dashed green lines mark the transitions zones. Horizontal blue lines indicate normal high and low reservoir elevations.

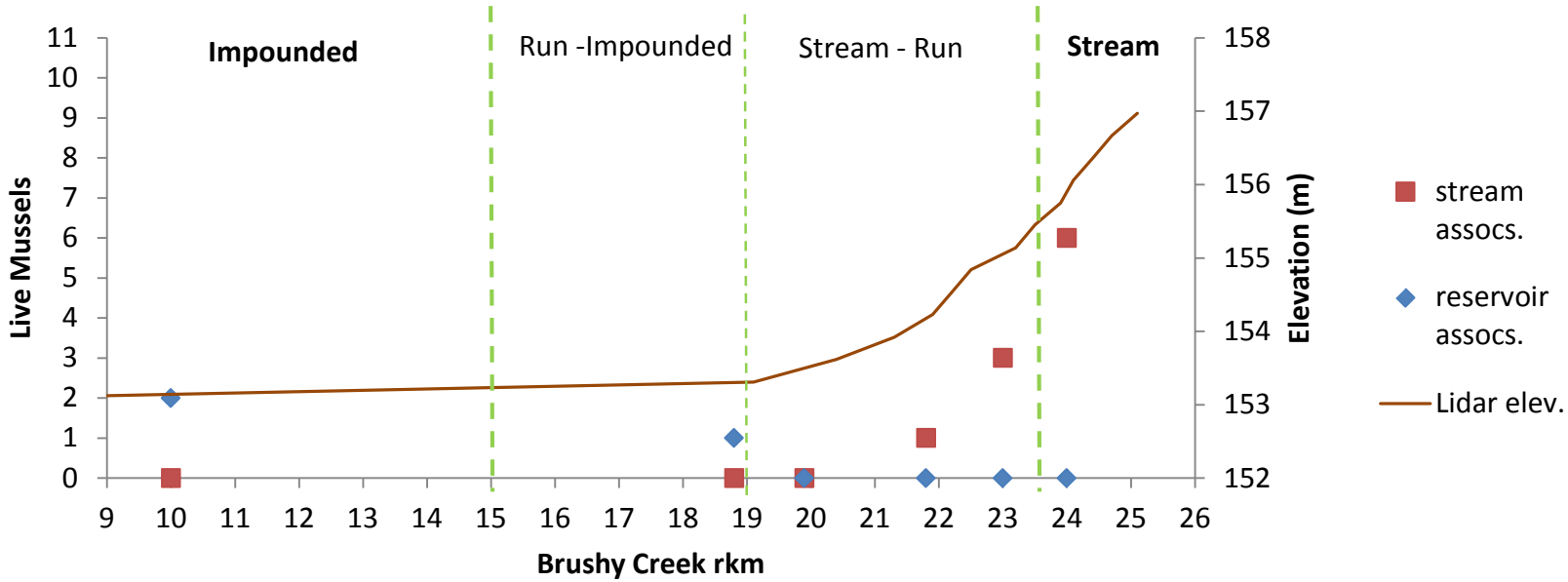

Figure 17. Number of live mussels, categorized as stream associates or reservoir associates, collected at sites (indicated by rkm) in the mainstem of Brushy Creek, during low pool conditions, 2013. The brown line shows LiDAR derived elevation at rkm. Vertical dashed green lines mark the transitions zones. Horizontal blue lines indicate normal high and low reservoir elevations.

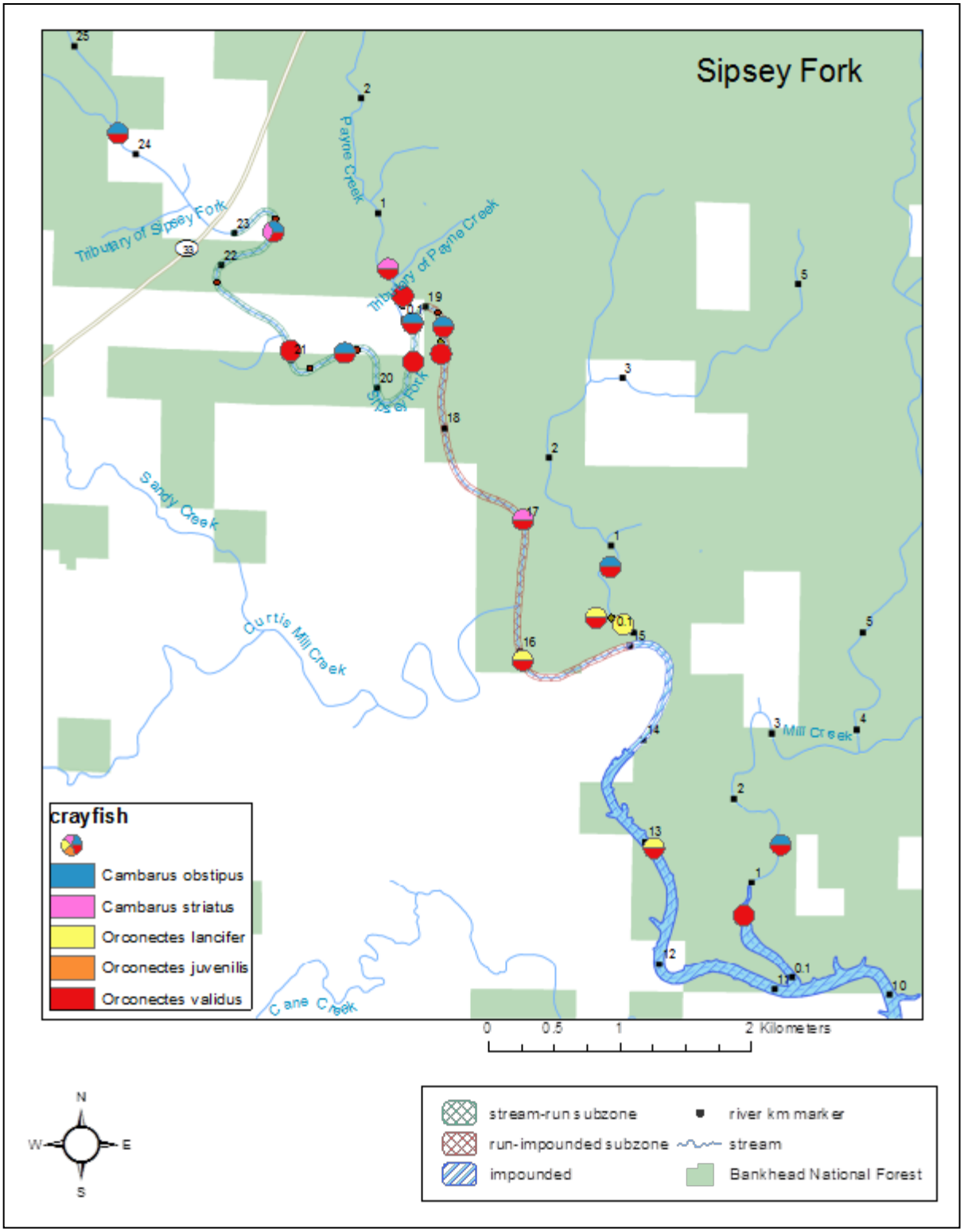

Figure 18. Collection sites of crayfish species in the Sipsey Fork drainage, 2012 and 2013.

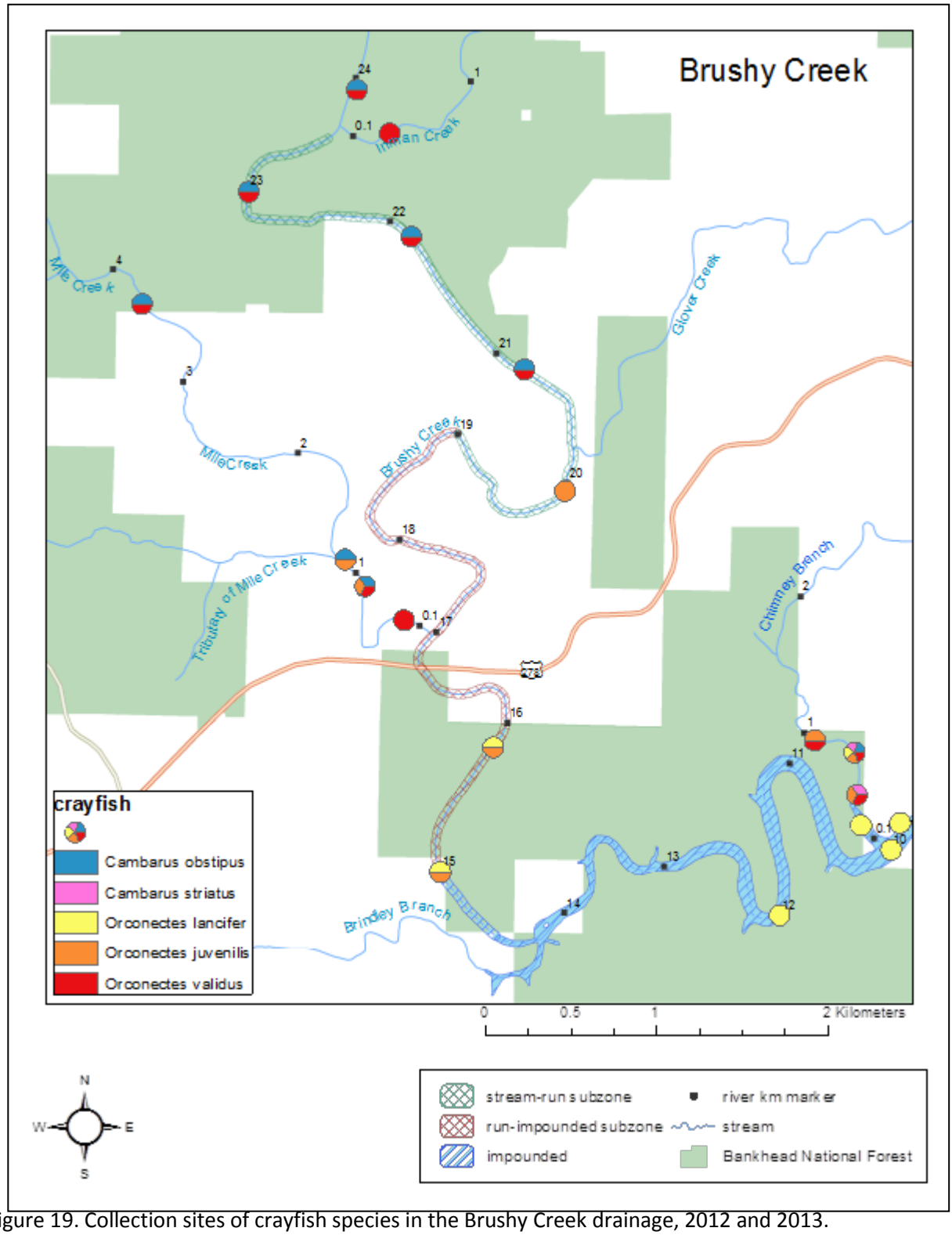

Figure 19. Collection sites of crayfish species in the Brushy Creek drainage, 2012 and 2013.

Tables

Table 1. Species in the Black Warrior River watershed upstream of the Lewis Smith Reservoir dam. Collected: X = captured during our sampling in 2012-2013. History: U = previously unknown from Lewis Smith Lake, Sipsey Fork, and Brushy Creek. Introduced: I = introduced from North America; F = exotic introduction. FSS = Regional Forester's (R8) Forest Sensitive Species. Federal: T = Threatened; E = Endangered. Endemic: Yes = native distribution restricted to the Black Warrior River watershed. Habitat: I = impoundment; R = river; S = stream; H = headwater stream; Sw = swamp or backwater, E = estuary. Habitat information for fishes is from O'Neil and Sheppard (2011).

Family & Species	Common Name	Collected	History	Introduced	FSS	Federal	Endemic	Habitat
Fish								
Atherinopsidae								
Labidesthes sicculus	Brook Silverside	X						I, R, S
Catostomidae								
Erimyzon oblongus	Creek Chubsucker	X						S, H
Hypentelium etowanum	Alabama Hogsucker	X						R, S
Minytrema melanops	Spotted Sucker	X						I, R, S
Moxostoma carinatum	River Redhorse	X						I, R
Moxostoma duquesnii	Black Redhorse	X						I, R, S
Moxostoma erythrurum	Golden Redhorse	X						I, R, S
Moxostoma poecilurum	Blacktail Redhorse	X						I, R, S
Centrarchidae								
Ambloplites ariommus	Shadow Bass	X						R, S
Lepomis cyanellus	Green Sunfish	X						R, S, H
Lepomis gulosus	Warmouth	X						R, S, H
Lepomis macrochirus	Bluegill	X						I, R, S, H
Lepomis marginatus	Dollar Sunfish							R, S
Lepomis megalotis	Longear Sunfish	X						I, R, S, H
Lepomis microlophus	Redear Sunfish	X						I, R, S
Lepomis miniatus	Redspotted Sunfish							R, S, H, Sw
Micropterus coosae	Redeye Bass							I, R, S, H
Micropterus punctulatus	Spotted Bass	X						I, R, S, H
Micropterus salmoides	Largemouth Bass	X						I, R, S, Sw

Family & Species	Common Name	Collected	History	Introduced	FSS	Federal	Endemic	Habitat
Centrarchidae continued…								
Pomoxis annularis	White Crappie	X						I, R, S
Pomoxis nigromaculatus	Black Crappie	X						I, R, S
Clupeidae								
Alosa aestevalis	Blueback Herring	X		I				R, E, I
Dorosoma cepedianum	Gizzard Shad	X						I, R, S
Dorosoma petenense	Threadfin Shad	X		I				I, R, S
Cyprinidae								
Campostoma oligolepis	Largescale Stoneroller	X						S, H
Cyprinella callistia	Alabama Shiner	X					Yes	R, S
Cyprinella venusta	Blacktail Shiner	X						I, R, S
Cyprinus carpio	Carp	X		F				I, R
Hybopsis winchelli	Clear Chub	X						R, S, I
Luxilus chrysocephalus	Striped Shiner	X						S, H
Nocomis leptocephalus	Bluehead Chub	X						S, H
Notemigonus crysoleucas	Golden Shiner	X						I, R, S
Notropis asperifrons	Burrhead Shiner	X					Yes	S
Notropis baileyi	Rough Shiner	X						S, H
Notropis stilbius	Silverstripe Shiner	X					Yes	S
Notropis volucellus	Mimic Shiner	X						R, S
Opsopoeodus emoliae	Pugnose Minnow	X						I, R, S
Phenacobius catostomus	Riffle Minnow	X					Yes	R, S
Pimephales vigilax	Bullhead Minnow	X						I, R, S
Semotilus atromaculatus	Creek Chub	X						S, H, Sp
Esocidae								
Esox niger	Chain Pickerel	X						I, R, S, Sw

Family & Species	Common Name	Collected	History	Introduced	FSS	Federal	Endemic	Habitat
Fundulidae								
Fundulus olivaceus	Blackspotted Topminnow	X						R, S, Sw, H
Ictaluridae								
Ameiurus natalis	Yellow Bullhead	X						I, R, S
Ictalurus punctatus	Channel Catfish	X						I, R, S
Noturus leptacanthus	Speckled Madtom	X						S, H
Pylodictis olivaris	Flathead Catfish	X						I, R
Lepisosteidae								
Lepisosteus oculatus	Spotted Gar	X						R, I, Sw
Lepisosteus osseus	Longnose Gar	X						R, I
Moronidae								
Morone chrysops	White Bass	X		I				I, R
Morone saxatilis	Striped Bass	X						I, R
Percidae								
Etheostoma artesiae	Redspot Darter	X						S, H
Etheostoma douglasi	Tuskaloosa Darter	X			FSS		Yes	S, H
Etheostoma nigrum	Johnny Darter	X	U					S, H
Etheostoma rupestre	Rock Darter							R, S
Etheostoma sp. c.f. E. bellator "A"	Sipsey Darter	X			FSS		Yes	S, H
Etheostoma sp. c.f. E. bellator "B"	Locust Fork Darter							S, H
Etheostoma sp. c.f. E. zonistium	Blueface Darter							S, H
Etheostoma stigmaeum	Speckled Darter	X						S, H
Percina kathae	Mobile Logperch	X					Yes	R, S
Percina maculata	Blackside Darter	X						S, H
Percina nigrofasciata	Blackbanded Darter	X						R, S, H
Percina sciera	Dusky Darter	X						R, S

Family & Species	Common Name	Collected	History	Introduced	FSS	Federal	Endemic	Habitat
Percidae continued…								
Percina shumardi	River Darter	X						R, S
Percina sipsi	Bankhead Darter	X			FSS			R, S
Petromyzontidae								
Ichthyomyzon castaneus	Chestnut Lamprey							I, R, S
Ichthyomyzon gagei	Southern Brook Lamprey	X						R, S
Poeciliidae								
Gambusia affinis	Mosquitofish							I, R, S, Sw, H
Sciaenidae								
Aplodinotus grunniens	Freshwater Drum							I, R
Crayfish								
Cambaridae								
Cambarus latimanus	Variable Crayfish							S
Cambarus obstipus	Sloped Crayfish	X						S
Cambarus striatus	Ambiguous Crayfish	X						R, S
Orconectes juvenilis	Kentucky River Crayfish	X	U	I				S
Orconectes lancifer	Shrimp Crayfish	X	U					Sw, I, S
Orconectes validus	Powerful Crayfish	X						S
Mussels								
Corbiculidae								
Corbicula fluminea	Asian Clam	X		F				I, R

Family & Species	Common Name	Collected	History	Introduced	FSS	Federal	Endemic	Habitat
Unionidae								
Elliptio arca	Alabama Spike	X			FSS			R
Elliptio arctata	Delicate Spike				FSS			R
Hamiota perovalis	Orangenacre Mucket	X				T		R
Lampsilis ornata	Southern Pocketbook							R
Lampsilis straminea	Southern Fatmucket							R
Medionidus acutissimus	Alabama Moccasinshell					T		R
Pleurobema rubellum	Warrior Pigtoe	X				E		R
Ptychobranchus greenii	Triangular Kidneyshell	X				E		R
Pyganodon grandis	Giant Floater	X	U					I
Quadrula asperata	Alabama Orb	X						R
Quadrula verrucosa	Pistolgrip	X						R
Strophitus subvexus	Southern Creekmussel	X			FSS			R
Toxolasma corvunculus	Southern Purple Lilliput							R
Utterbackia imbecillus	Paper Pondshell	X	U					I
Villosa lienosa	Little Spectaclecase							R
Villosa nebulosa	Alabama Rainbow	X			FSS			R
Villosa vibex	Southern Rainbow	X						R

Table 2. Lidar elevation at corresponding river kilometers (rkm) streams in the Sipsey Fork (Sip) and Brushy Creek (Bru) watersheds. SF = Sipsey Fork, MC = Mill Creek, GC = Grindstone Creek, PC = Payne Creek, BC = Brushy Creek, CB = Chimney Branch, MI = Mile Creek, IC = Inman Creek.

Lidar elevation (m/ft)	Sip SF (rkm)	Sip MC (rkm)	Sip GC (rkm)	Sip PC (rkm)	Bru BC (rkm)	Bru CB (rkm)	Bru MI (rkm)	Bru IC (rkm)
153.01 / 502	1.30	-	-	-	2.9	-	-	-
153.31 / 503	17.70	0.70	-	-	19.1	0.3	0.5	-
153.62 / 504	19.80	0.80	0.075	0.03	20.4	0.4	0.6	-
153.92 / 505	20.90	0.90	0.100	0.04	21.3	0.4	0.6	-
154.23 / 506	21.50	0.95	0.300	0.07	21.9	0.4	0.7	-
154.53 / 507	21.80	1.02	0.350	0.11	22.2	0.4	0.8	-
154.84 / 508	21.95	1.03	0.400	0.20	22.5	0.5	0.9	-
155.14 / 509	22.30	1.06	0.410	0.25	23.2	0.5	0.9	-
155.45 / 510	22.70	1.08	0.430	0.30	23.5	0.5	0.9	-
155.75 / 511	23.40	1.12	0.480	0.36	23.9	0.6	1.0	0.2
156.06 / 512	24.10	1.13	0.490	0.37	24.1	0.6	1.1	0.2

Table 3. Lake level elevations in Lewis Smith Lake during our sampling periods. Lake level information is from Alabama Power Company.

Sample Period	Date	Elevation (m)
Fall 2012	9/24/2012	153.02
	9/25/2012	152.99
	9/26/2012	152.97
	9/27/2012	152.93
	9/28/2012	152.89
Spring 2013	4/26/2013	155.37
	4/27/2013	155.39
	4/28/2013	155.46
	4/29/2013	155.48
	4/30/2013	155.42
	5/1/2013	155.40
	5/2/2013	155.38
	5/3/2013	155.37
Fall 2013	9/16/2013	153.15
	9/17/2013	153.08
	9/18/2013	153.03
	9/19/2013	152.97
	9/20/2013	152.88

Table 4. Zone and subzone designations for streams in the Sipsey Fork and Brushy Creek watersheds. Ranges are given in terms of river kilometer (rkm). Sipsey Fork rm 0.0 = confluence with ; Brushy Creek rkm 0.0 = 0.1 rkm upstream of confluence with ; all other streams rkm 0.0 = confluence with their respective mainstem stream. . Zone and Subzone: I = Impounded; T Main = mainstem transition zone; R-I = run-impounded transition subzone; S-R = stream-run transition subzone; S Main = mainstem stream; T trib = tributary transition zone; S-I = stream-impounded transition subzone; S Trib = tributary stream zone.

Zone:	I	T Main	T Main	S Main	T Trib	S Trib
Subzone:	I	R-I	S-R	S Main	S-I	S Trib
Sipsey Fork watershed						
Sipsey Fork	< 15.0	15.0 - 18.9	19.0 - 23.0	> 23	-	-
Mill Creek	< 0.7	-	-	-	0.7 - 1.0	> 1.0
Grindstone Creek	< 0.3	-	-	-	0.3 - 0.3	> 0.3
Payne Creek	-	-	-	-	0.0 - 0.2	> 0.2
Brushy Creek watershed						
Brushy Creek	< 15.0	15.0 - 18.9	19.0 - 23.5	> 23.5	-	-
Chimney Branch	< 0.3	-	-	-	0.3 - 0.4	> 0.4
Mile Creek	< 0.2	-	-	-	0.2 - 0.8	> 0.8
Inman Creek	-	-	-	-	-	> 0.0

Table 5. Fish sample sites in the Sipsey Fork watershed, 2012-2013. Low pool and high pool correspond to lake surface elevations of approximately 153.0 m and 155.5 m, respectively. See Table 3 for lake elevations on particular sample dates. Method: eboat = boat electrofisher; trawl = benthic mini-trawl; 30+2 = backpack electrofisher and seine using Alabama Geologic Survey sampling protocols (O'Neil and Sheppard 2011); 1000 = backpack electrofisher and seine for 1000 seconds

Stream	rkm	Pool	Date	Method	Zone	Subzone
Sipsey Fork	10	Low	9/24/2012	eboat	I	I
	10	High	4/30/2013	trawl	I	I
	10	High	5/1/2013	eboat	I	I
	12	High	4/29/2013	eboat	I	I
	12	Low	9/24/2012	eboat	I	I
	12	High	4/29/2013	trawl	I	I
	15.8	High	4/29/2013	trawl	T Main	R-I
	16	High	4/29/2013	eboat	T Main	R-I
	16	High	4/29/2013	trawl	T Main	R-I
	16	Low	9/25/2012	eboat	T Main	R-I
	17	Low	9/25/2012	eboat	T Main	R-I
	18.3	High	4/29/2013	trawl	T Main	R-I
	18.3	Low	9/25/2012	eboat	T Main	R-I
	18.9	Low	9/25/2012	eboat	T Main	R-I
	19	High	4/29/2013	trawl	T Main	S-R
	19	High	4/29/2013	eboat	T Main	S-R
	19.2	Low	9/24/2012	seine	T Main	S-R
	20.4	High	4/29/2013	trawl	T Main	S-R
	20.8	Low	9/26/2012	30+2	T Main	S-R
	21	High	4/29/2013	eboat	T Main	S-R
	21.9	Low	9/26/2012	30+2	T Main	S-R
	22.6	Low	9/25/2012	seine	T Main	S-R
	23	High	4/29/2013	eboat	T Main	S-R
	24.3	Low	9/18/2013	30+2	S Main	S Main
Mill Creek	0.2	Low	9/24/2012	eboat	I	I
	0.2	High	4/29/2013	trawl	I	I
	0.2	High	5/1/2013	eboat	I	I
	0.6	Low	9/24/2012	eboat	I	I
	0.8	Low	9/25/2012	1000	T Trib	S-I
	1.4	High	4/26/2013	1000	S Trib	S Trib
	1.4	Low	9/25/2012	1000	S Trib	S Trib
Grindstone Creek	0.2	High	4/29/2013	eboat	I	I
	0.2	Low	9/25/2012	eboat	I	I
	0.2	Low	9/25/2012	1000	I	I
	0.2	High	4/29/2013	trawl	I	I
	0.3	Low	9/25/2012	1000	T Trib	S-I
	0.6	High	4/26/2013	1000	S Trib	S Trib

Grindstone Creek, continued						
	0.8	Low	9/25/2012	1000	S Trib	S Trib
Payne Creek	0.1	Low	9/24/2012	1000	T Trib	S-I
	0.1	High	4/29/2013	eboat	T Trib	S-I
	0.5	High	4/26/2013	1000	S Trib	S Trib
	0.5	Low	9/24/2012	1000	S Trib	S Trib

Table 6. Fishes collected from habitat zones and subzones in the Sipsey Fork watershed, 2012 - 2013. See Table 4 for a description of the zones and subzones.

Family	Species Zone:	I	T Main	T Main	S Main	T Trib	S Trib
	subzone:	I	R-I	S-R	S Main	S-I	S Trib
Atherinopsidae	*Labidesthes sicculus*	X	X	X	X	X	X
Catostomidae	*Erimyzon oblongus*						X
	Hypentelium etowanum			X	X	X	X
	Minytrema melanops	X	X	X		X	
	Moxostoma carinatum		X	X			
	Moxostoma duquesnii	X	X	X	X	X	X
	Moxostoma erythrurum	X	X	X		X	X
	Moxostoma poecilurum	X	X	X			X
Centrarchidae	*Ambloplites ariommus*		X	X	X	X	
	Lepomis cyanellus	X	X			X	X
	Lepomis gulosus	X	X	X		X	X
	Lepomis macrochirus	X	X	X	X	X	X
	Lepomis megalotis		X	X	X	X	X
	Lepomis microlophus	X	X	X	X	X	
	Micropterus punctulatus	X	X	X	X	X	X
	Micropterus salmoides	X	X	X		X	X
	Pomoxis annularis	X					
Clupeidae	*Alosa aestevalis*			X			
	Dorosoma cepedianum	X	X	X			
	Dorosoma petenense	X		X			
Cyprinidae	*Campostoma oligolepis*		X	X	X	X	X
	Cyprinella callistia			X	X	X	X
	Cyprinella venusta	X	X	X	X	X	X
	Cyprinus carpio	X	X				
	Hybopsis winchelli	X	X	X			X
	Nocomis leptocephalus						X
	Notemigonus crysoleucas					X	
	Notropis asperifrons			X			
	Notropis baileyi						X
	Notropis stilbius			X	X	X	X
	Notropis volucellus	X					
	Opsopoeodus emoliae	X		X			
	Phenacobius catostomus			X	X		
	Pimephales vigilax	X	X	X		X	X
	Semotilus atromaculatus					X	X
Fundulidae	*Fundulus olivaceus*	X	X	X		X	X
Ictaluridae	*Ictalurus punctatus*	X	X	X		X	
	Noturus leptacanthus						X
	Pylodictis olivaris	X	X			X	

Lepisosteidae	*Lepisosteus oculatus*	X					
	Lepisosteus osseus	X		X			
Moronidae	*Morone chrysops*			X			
	Morone saxatilis	X		X			
Percidae	*Etheostoma artesiae*	X		X	X	X	X
	Etheostoma bellator "A"			X	X		X
	Etheostoma douglasi			X	X		X
	Etheostoma nigrum	X	X			X	X
	Etheostoma stigmaeum			X	X	X	X
	Percina kathae	X	X	X	X	X	X
	Percina maculata		X				
	Percina nigrofasciata			X	X	X	X
	Percina sciera			X		X	X
	Percina shumardi		X	X			
	Percina sipsi		X	X	X	X	X

Table 7. Live mussels collected from the mainstem of Sipsey Fork, 2012 - 2013. Range is the minimum and maximum river kilometers (rkm) of capture. Status: T = federally threatened; E = federally endangered; FSS = Forest Service Sensitive. Preference = habitat preference from Wendell Haag (pers. comm.). Collected = Zone (subzone) where collected; see Table 4 for description of zones and subzones.

Scientific Name	Status	Range (rkm)	Preference	Collected
Elliptio arctata	FSS	21.0 – 24.0	stream	T Main (S-R), S Main
Hamiota perovalis	T	20.0 – 24.0	stream	T Main (S-R), S Main
Pleurobema rubellum	E	21.0 – 24.0	stream	T Main (S-R), S Main
Ptychobranchus greenii	E	21.0 – 24.0	stream	T Main (S-R), S Main
Pyganodon grandis		11.0 – 19.5	impounded	I, T Main (R-I, S-R)
Quadrula asperata		21.0 – 24.0	stream	T Main (S-R), S Main
Quadrula verrucosa		21.0 only	stream	T Main (S-R)
Strophitus subvexus	FSS	21.0 – 24.0	stream	T Main (S-R), S Main
Utterbackia imbecillis		11.0 – 18.6	impounded	I, T Main (R-I)
Villosa nebulosa	FSS	20.0 – 24.0	stream	T Main (S-R), S Main
Villosa vibex		19.5 – 24.0	stream	T Main (S-R), S Main

Table 8. Crayfish species collected from the Sipsey Fork watershed, 2012 and 2013. Range is the minimum and maximum river kilometer of capture. See Table 4 for zone and subzone descriptions.

Species		Sipsey Fork	Mill Creek	Grindstone Creek	Payne Creek
Cambarus obstipus	Range: Zone (subzone):	18.8 – 24.2 T Main (R-I, S-R), S Main	1.4 only S Trib	0.8 only S Trib	- -
Cambarus striatus	Range: Zone (subzone):	17.2 – 22.5 T Main (R-I, S-R),	- -	- -	0.5 only S Trib
Orconectes lancifer	Range: Zone (subzone):	12.9 – 15.9 I, T Main (R-I)	- -	0.2 – 0.3 I, T Trib (S-I)	- -
Orconectes validus	Range: Zone (subzone):	12.9 – 24.2 I, T Main (R-I, S-R), S Main	0.7 – 1.4 T Trib (S-I), S Trib	0.3 – 0.8 T Trib (S-I), S Trib	0.2 – 0.5 T Trib (S-I), S Trib

Table 9. Fish sample sites in the Brushy Creek watershed, 2012-2013. See Table 4 for description of Pool, Method, Zone and Subzone.

Stream	rkm	Pool	Date	Method	Zone	Subzone
Brushy Creek	10	High	4/30/2013	eboat	I	I
	10	Low	9/18/2013	eboat	I	I
	11.8	High	4/30/2013	trawl	I	I
	12	High	4/30/2013	eboat	I	I
	12	Low	9/18/2013	eboat	I	I
	14	Low	9/18/2013	eboat	I	I
	14.3	Low	9/17/2013	trawl	I	I
	16	Low	9/16/2013	eboat	T Main	R-I
	16	High	4/30/2013	trawl	T Main	R-I
	16	High	4/30/2013	eboat	T Main	R-I
	16.2	Low	9/17/2013	trawl	T Main	R-I
	17.3	Low	9/17/2013	trawl	T Main	R-I
	17.4	Low	9/16/2013	eboat	T Main	R-I
	19	High	4/30/2013	eboat	T Main	S-R
	19	High	4/30/2013	trawl	T Main	S-R
	20.9	High	4/30/2013	trawl	T Main	S-R
	21	High	5/1/2013	eboat	T Main	S-R
	21.6	Low	9/18/2013	30+2	T Main	S-R
	22.9	High	4/30/2013	trawl	T Main	S-R
	24	Low	9/17/2013	30+2	S Main	S Main
Chimney Branch	0.1	High	5/1/2013	eboat	I	I
	0.1	Low	9/18/2013	eboat	I	I
	0.2	High	4/30/2013	trawl	I	I
	0.4	Low	9/16/2013	1000	T Trib	S-I
	0.9	Low	9/16/2013	1000	S Trib	S Trib
	0.9	High	4/27/2013	1000	S Trib	S Trib
Mile Creek	0.2	High	4/30/2013	eboat	T Trib	S-I
	0.2	High	4/30/2013	trawl	T Trib	S-I
	0.3	Low	9/17/2013	1000	T Trib	S-I
	1.2	Low	9/17/2013	1000	S Trib	S Trib
	3.7	High	4/27/2013	1000	S Trib	S Trib
	3.7	Low	9/18/2013	1000	S Trib	S Trib
Inman Creek	0.3	Low	9/17/2013	1000	S Trib	S Trib
	0.3	High	4/27/2013	1000	S Trib	S Trib

Table 10. Fishes collected from habitat zones and subzones in the Brushy Creek watershed, 2012 - 2013. See Table 4 for a description of the zones and subzones.

Family	Species	Zone:	I	T Main	T Main	S Main	T Trib	S Trib
		subzone:	I	R-I	S-R	S Main	S-I	S Trib
Atherinopsidae	*Labidesthes sicculus*		X	X	X	X	X	
Catostomidae	*Erimyzon oblongus*							X
	Hypentelium etowanum					X	X	X
	Minytrema melanops		X	X			X	
	Moxostoma carinatum		X					
	Moxostoma duquesnii		X	X	X		X	
	Moxostoma erythrurum		X	X	X	X	X	X
	Moxostoma poecilurum		X	X	X			X
Centrarchidae	*Ambloplites ariommus*					X		
	Lepomis cyanellus		X	X	X	X	X	X
	Lepomis gulosus		X	X	X	X	X	X
	Lepomis macrochirus		X	X	X	X	X	X
	Lepomis megalotis		X	X	X	X		X
	Lepomis microlophus		X	X		X		
	Micropterus punctulatus		X	X	X	X	X	X
	Micropterus salmoides		X	X		X	X	X
	Pomoxis annularis		X	X				
	Pomoxis nigromaculatus		X	X	X			
Clupeidae	*Alosa aestevalis*			X	X		X	
	Dorosoma cepedianum		X	X				
	Dorosoma petenense		X	X				
Cyprinidae	*Campostoma oligolepis*						X	X
	Cyprinella callistia					X	X	X
	Cyprinella venusta		X	X	X	X	X	X
	Cyprinus carpio		X					
	Hybopsis winchelli		X					X
	Luxilus chrysocephalus							X
	Nocomis leptocephalus							X
	Notropis asperifrons				X	X	X	
	Notropis stilbius		X		X	X	X	X
	Opsopoeodus emoliae		X	X	X			
	Pimephales vigilax		X				X	
	Semotilus atromaculatus							X
Esocidae	*Esox niger*			X				
Fundulidae	*Fundulus olivaceus*				X	X	X	X
Ictaluridae	*Ameiurus natalis*						X	X
	Ictalurus punctatus		X	X	X			
	Noturus leptacanthus					X	X	X
	Pylodictis olivaris		X				X	X

Lepisosteidae	*Lepisosteus oculatus*	X					
	Lepisosteus osseus	X		X			
Moronidae	*Morone chrysops*			X			
Percidae	*Etheostoma artesiae*			X	X	X	X
	Etheostoma douglasi			X	X		X
	Etheostoma nigrum					X	
	Etheostoma stigmaeum			X	X	X	X
	Percina kathae	X	X	X	X		X
	Percina nigrofasciata			X	X	X	X
Petromyzontidae	*Ichthyomyzon ammocoete*		X	X	X	X	X
	Ichthyomyzon gagei						X

Table 11. Mussels collected from the mainstem of Brushy Creek, 2013 . Range is the minimum and maximum river kilometers (rkm) of live collection. Condition: L = live, R = relic. Status: T = federally threatened; E = federally endangered; FSS = Forest Service Sensitive. Preference = habitat preference from Wendell Haag (pers. comm.). Collected = Zone (subzone) where collected; see Table 4 for description of zones and subzones.

Scientific Name	Condition	Status	Range (rkm)	Preference	Collected
Elliptio arctata	R	FSS	-	stream	-
Hamiota perovalis	L, R	T	23.0 – 24.0	stream	T Main (S-R), S Main
Lampsilis ornata	R		-	stream	-
Pleurobema rubellum	L	E	24.0 only	stream	S Main
Pyganodon grandis	L, R		10.0 – 18.9	impounded	I, T Main (I-R)
Quadrula asperata	L, R		24.0 only	stream	S Main
Strophitus subvexus	L, R	FSS	23.0 – 24.0	stream	T Main (S-R), S Main
Utterbackia imbecillis	L		10.0 – 18.9	impounded	I, T Main (I-R)
Villosa lienosa	L		22.0 – 23.0	stream	T Main (S-R), S Main
Villosa nebulosa	R	FSS	-	stream	-
Villosa vibex	L, R		24.0 only	stream	S Main

Table 12. Crayfish species collected from the Brushy Creek watershed, 2012 and 2013. Range is the minimum and maximum river kilometers (rkm) of capture. See Table 4 for zone and subzone descriptions.

Species		Brushy Creek	Chimney Branch	Mile Creek	Inman Creek
Cambarus obstipus	Range: Zone (subzone):	21.9 – 23.9 T Main (S-R), S Main	0.7 only S Trib	0.9 – 3.7 S Trib	- -
Cambarus striatus	Range: Zone (subzone):	- -	0.4 – 0.7 T Trib (S-I) S Trib	- -	- -
Orconectes lancifer	Range: Zone (subzone):	10.1 – 15.7 I, T Main (R-I)	0.2 – 0.7 I, T Trib (S-I), S Trib	- -	- -
Orconectes juvenilis	Range: Zone (subzone):	15.0 – 20.0 T Main (R-I, S-R)	0.4 – 0.9 T Trib (S-I) S Trib	0.9 – 1.1 S Trib	- -
Orconectes validus	Range: Zone (subzone):	21.8 – 23.9 T Main (S-R) S Main	0.4 – 0.9 T Trib (S-I) S Trib	0.2 – 3.7 T Trib (S-I) S Trib	0.3 only S Trib