Summary of the Basin Area Stream Survey (BASS)

Ouachita National Forest, Arkansas: 2016

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February 2017

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Introduction

The USDA Forest Service maintains and enhances water quality and soil productivity as required by the National Forest Management Act (PL 94-588). The Clean Water Act of 1972 (PL 92-500) assigns the U.S. States the associated responsibilities of protecting the beneficial uses of aquatic natural resources for the public good. To fulfill these responsibilities, the Ouachita National Forest (ONF), in conjunction with the States of Arkansas and Oklahoma, has developed a series of best management practices (BMPs) designed to protect water quality and associated beneficial uses (e.g. swimming, fishing, and drinking water) from the effects of nonpoint pollution within the ONF (USDA Forest Service 1994).

The Environmental Protection Agency (EPA) requires the ONF to monitor the success of these BMPs regarding the State's goals for managing nonpoint pollution (EPA 1978). The ONF addressed this need in its Amended Land and Resource Management Plan of 1990 (USDA Forest Service 1990) with the initiation of a forest-wide Basin Area Stream Survey (BASS) developed by Clingenpeel and Cochran (1992, USDA Forest Service 1994). The goals of this monitoring program are to identify the physical, chemical, and biological characteristics of selected streams needed for comparison among entire watersheds over time. The BASS monitoring program intends to allow watershed scale determination of stream health, as well as the effectiveness of BMPs at protecting water quality and beneficial uses within the ONF.

The BASS monitoring program originally focused on six paired watersheds within three ONF upland ecoregions: the Arkansas River Valley, the Upper Ouachita Mountain, and the Lower Ouachita Mountain. Two watersheds were selected and paired within each ecoregion based on past management activities, proximity, ownership, and comparable size. Watersheds containing minimal or no timber harvesting activities served as 'reference' basins, while watersheds containing harvesting activities typical of the ONF served as 'managed' basins.

Candidate watersheds were large enough to support a resident fishery, were primarily in Forest Service ownership, and were proximal to the other watersheds within the ecoregion.

After the ONF completed BASS surveys in 1990, 1991, and 1992, the Forest chose to continue collections once every five years, sampling the original stream pairs again in 1996, 2001, 2006, 2011, and most recently in 2016. In 1998, the Mena/Oden District (Arkansas) expressed concern regarding the cumulative effects of the Wolf Pen Gap Off-Highway Vehicle (OHV) Trail Complex on water quality within the Lower Ouachita Mountain ecoregion. To address these concerns, Board Camp Creek and Gap Creek, which are located within the bounds of the trail system, were selected as a fourth pair of watersheds to be surveyed during the ongoing BASS surveys. The ONF surveyed Board Camp Creek and Gap Creek alone in 1998 as well as together with the original three paired watersheds in the 2001, 2006, and 2011 surveys (Roghair and Dolloff 2013).

Prior to 2016, all BASS surveys were completed under the direction of Forest Hydrologist Alan Clingenpeel (retired), who trained field teams and provided project oversight, quality assurance, data analysis, and reporting. Following Mr. Clingenpeel's retirement, the ONF partnered with the USDA Forest Service Center for Aquatic Technology Transfer (CATT), to produce a detailed BASS field manual (Appendix A). The CATT also provided a field team to complete the majority of the BASS samples in 2016. Another team under the direction of Jade Ryles (ONF Natural Resources Manager) and Mitzi Cole (ONF Forest Liaison) collected the water chemistry samples and conducted the biological stream inventory on Board Camp Creek. This report summarizes work completed in summer 2016. A detailed data analysis will be completed by the ONF.

Methods

Physical Stream Inventory

We began physical stream inventories at the established start locations as described in the field manual (Appendix A) and ended where we 1) encountered dry channel for at least 500 m, 2) measured at least 500 consecutive meters without pool habitat, or 3) completed the same number of stream kilometers as in previous years. During the physical inventory, a 2 to 4-person team divided the stream into a series of consecutive habitat reaches (e.g. riffles, pools, runs) measuring at least 10.0 m in length. Within each habitat reach the team collected a variety of habitat attributes, either at a mid-point transect or for the habitat reach as a whole, and noted any pertinent stream features. We used the results of the physical stream inventory to establish biological sampling areas. See Appendix A for detailed physical inventory methods.

Biological Stream Inventory

We collected fish and macroinvertebrates from 3 – 7 biological sampling areas (BSA) per stream. Each BSA contained between 2 and 9 consecutive habitat reaches, as identified during the physical inventory. We selected BSAs to ensure we sampled 1) between 5% and 10% of the total number of reaches, 2) at least 5.5% of the total sampled stream distance, and 3) a representative proportion of each habitat reach type (riffles, runs, and pools). Within each habitat reach of each BSA, we sampled fish via multi-pass depletion backpack electrofishing. We also conducted one macroinvertebrate sample per BSA using a kick seine using the Izaak Walton League Save Our Streams (SOS) protocol for Rocky Bottom Sampling (Izaak Walton 2006). See Appendix A for detailed biological stream inventory methods.

Water Chemistry

ONF personnel took one water chemistry reading near the designated downstream start location of each stream. See Appendix A for detailed water chemistry sampling methods.

Discharge

We were unable to calculate discharge measurements during the survey due to equipment malfunctions. See Appendix A for detailed discharge sampling methods.

Results

Physical Stream Inventory

We conducted physical stream inventories for 68 field days between May 23rd and August 11th, 2016. A team of 6conducted the physical stream inventory on all 8 streams from May 23rd to July 28th, while a team of 10conducted the physical stream inventory on Caney Creek and Board Camp Creek from August 1st to August 11th. Each field day consisted of a team of 2 to 4 people working 10 to 12 hours. All physical stream inventory data and photos collected by the CATT team were provided to the ONF upon completion of the project. See Table 1 for physical stream inventory effort details.

Table 1: Physical stream inventory effort during the BASS 2016 survey. Shading indicates paired watersheds. *Jack Creek was surveyed for 0.82 km before continuing up Ramsey Creek to its source, in accordance with past sampling efforts.

Creek	Watershed	Start Date	End Date	Total Field Days	Stream Distance (km)
Dry	Upper Ouachita Mountain	5/24	6/8	11	8.0
Jack / Ramsey*		5/23	6/7	9	7.3
South Alum	Arkansas River Valley	6/21	6/29	7	7.3
Bread		6/21	6/29	7	7.5
Caney	Lower Ouachita Mountain	7/12	8/4	16	13.7
Brushy		7/12	7/19	6	9.0
Board Camp	Lower Ouachita Mountain	7/27	8/11	8	11.0
Gap		7/20	7/26	4	5.6
Total		5/23	8/11	68	69.4

We documented 16 reach types, predominantly low gradient riffles, runs, step runs, and mid-channel pools. We also documented seven feature types, predominantly tributaries, side channels, natural fords, and artificial fords.

Biological Stream Inventory

We conducted biological stream inventories for 25 field days between June 12th and September 13th, 2016. Each field day consisted of a team of 4 to 7 people working 8 to 12 hours. ONF personnel collected biological inventory data on Board Camp Creek, while the CATT team collected all other biological inventory data. All biological stream inventory data and photos (including fish and macroinvertebrate vouchers) collected by the CATT team were provided to the ONF upon completion of the project.

Flooding in Board Camp Creek in mid-August prevented the CATT team from conducting this biological stream inventory. Later, when hydrologic conditions returned to base flow the inventory was completed by ONF personnel. Additionally, only 5 out of 14 reaches selected for biological steam inventory in Dry Creek had enough flow for electrofishing. We recommend sampling Dry Creek in the spring when flows are higher. See Table 2 for biological stream inventory effort details.

Table 2: Biological stream inventory effort during the BASS 2016 survey. *Work completed by the ONF.

Creek	Start Date	End Date	Total Field Days	# BSAs	# fish species	Team Size
Dry	6/15	6/15	1	4	2	5
Jack / Ramsey	6/12	6/14	3	4	11	5-6
South Alum	7/5	7/6	2	5	10	6
Bread	6/29	7/3	3	4	3	6
Caney	8/7	8/11	5	6	11	6-7
Brushy	8/2	8/4	3	6	14	6-7
Board Camp*	9/1	9/13	6	7	16	4-6
Gap	7/31	8/1	2	5	13	7
Total	6/12	9/13	25	41	23	4-7

We collected 23 out of the 37 fish species documented during previous BASS sampling efforts. We also visually observed Brook Silversides (*Labidesthes sicculus*) and Logperch (*Percina caprodes*) in Bread Creek, as well as Largemouth Bass (*Micropterus salmoides*) in Brushy Creek. Although we documented markedly low species richness in Dry Creek and Bread Creek, we observed similar and much greater species richness in the remaining six streams. See Table 3 for fish species collected.

We also documented four instances of novel species captures as compared with historical records. These observations included two young-of-year Bluegill (*Lepomis* *macrochirus*) and six adult Freckled Madtoms (*Noturus nocturnus*) in Jack / Ramsey Creek, as well as five adult Orangethroat Darters (*Etheostoma spectabile*) in Brushy Creek and two adult Orangethroat Darters in Gap Creek. However, we did not voucher these specimens or otherwise prove these incidences to be novel records.

Table 3: Inventory of fish species collected in each stream during the BASS 2016 survey. Asterisks (*) indicate documentations unique to previous BASS survey data collected between 1990 and 2011.

Species	Dry	Jack / Ramsey	South Alum	Bread	Caney	Brushy	Board Camp	Gap
Ameiurus natalis		X			X	X	X	X
Campostoma spadiceum	X	X	X	X	X	X	X	X
Erimyzon oblongus		X	X				X	X
Esox americanus			X					
Etheostoma blennioides							X	X
Etheostoma radiosum		X			X	X	X	X
Etheostoma spectabile			X			X*		X*
Etheostoma whipplei	X	X	X	X				
Fundulus catenatus					X	X	X	X
Fundulus olivaceus			X		X	X		
Hypentelium nigricans							X	X
Lepomis cyanellus		X	X		X	X	X	X
Lepomis macrochirus		X*				X		
Lepomis megalotis		X		X	X	X	X	X
Luxilus chrysocephalus					X	X	X	X
Lythrurus umbratilis			X				X	
Micropterus dolomieu					X	X	X	
Micropterus punctulatus						X		
Notropis boops		X			X	X	X	
Noturus exilis		X					X	
Noturus lachneri			X					
Noturus nocturnus		X*					X	X
Semotilus atromaculatus			X		X	X	X	X

Water Chemistry

ONF personnel conducted all collection and analysis of water chemistry data, and are currently in possession of these data.

Discharge

We did not collect discharge measurements in 2016 due to several equipment malfunctions. Flow meters regularly reported water velocities at or below 0.0 m/s despite obvious flow of water over the stream bed. See Appendix A for details regarding future instructions for measuring stream discharge.

Discussion and Recommendations

Logistics

Teams should thoroughly consider stream access before attempting field work. Devoting a day to driving the length of each stream, inspecting potential access points, and noting these in the GPS are critical steps to uncover any surprising challenges. Specifics about stream access, including lodging and travel, are described in Table 4. Teams will need to discuss alternatives regarding lodging for Dry Creek and Jack / Ramsey Creek, as the property at which we stayed in 2016 will soon be auctioned off and may no longer be available. We recommend keeping all other lodging and travel itineraries similar to those followed in 2016.

Table 4: Logistics regarding stream access, travel, and lodging

Creek	Site Access	Avg. Hike Each Way	Longest Hike Each Way	Avg. Car Travel Each Way	Lodging
Dry	Good access at start point at someone's house, contact landowner about parking. Another access point about 2 km upstream of start by hiking down steep mountain loaded with poison ivy. No hiking trails. Must hike mostly through stream bed. Dries up very quickly.	120 min	240 min (5.5 km)	25 min	Camped at Booneville Work Center
Jack / Ramsey	First half of stream has easy access, then access road runs out, flat but long hike without trails	75 min	180 min	25 min	Camped at Booneville Work Center
South Alum	Three main site access points at fords, walks are short and easy. Road access whole way	5 min	20 min	45 min	Stayed at Hot Springs Village Inn
Bread	Road access whole way. Walks are short and easy	5 min	20 min	60 min	Stayed at Hot Springs Village Inn
Caney	Trail parallels all but first 15% or so of stream. Parking exists on each end of Caney at a trailhead. From either end, takes 1 km from trailhead to stream, then up to 7 km further when working at midpoint of creek	90 min	180 min (8 km)	40 min	Traveled from Mena
Brushy	Road access most of the time, walks are short and easy	10 min	20 min	35 min	Traveled from Mena
Board Camp	Roads can be tough to drive, stream access is easy and consistent	10 min	45 min	40 min	Traveled from Mena
Gap	Roads are fine, stream access is easy and consistent	5 min	15 min	35 min	Traveled from Mena

Safety Hazards

Our team experienced several safety hazards over the course of the project. There was an abundance of pit vipers (*Agkistrodon* sp.) in the areas we surveyed. Most notably, we encountered more than 90 cottonmouths (*A. piscivorus*) over the course of the field season. Field teams encountered most of these snakes hiding by undercut banks, while the rest were either on the banks or occasionally in the water. We found that most of the smaller snakes would leave the area on their own, but not before team members were within 10 m of the snake. Larger snakes were exceptionally territorial; they would frequently assume a striking position and occasionally charge. Even less aggressive adults would not flee if approached, and it would be easy to step on one if unnoticed. We also encountered three Copperheads (*A. contortrix*) which were found during the hikes into or out of the streams, well away from the water. These snakes were much less likely to make their presence known, as they tend to hide from view rather than show aggression. This makes them easy to miss and step on. We recommend all field teams receive detailed training of procedures to follow in the event of a snake bite, as this presents a serious safety hazard in these streams.

Black bear (*Ursus americanus*) encounters presented another less common but equally dangerous threat. We observed 12 bears over the course of the field season. Field teams observed bears most frequently off the side of the road while driving to and from work sites, and we encountered bears twice in the forest. The first bear encounter occurred in Jack / Ramsey Creek, when we noticed a bear off in the distance running away from us. This was a typical bear encounter and presented little to no danger to the team. However, during our only electrofishing trip to Dry Creek, we encountered three bear cubs and a large sow atop a cliff about 10-15 m above the stream. Some team members made themselves appear larger by standing on rocks and yelling at the bears in an attempt to scare them away. The sow responded aggressively, roaring and flashing its teeth at the team. The team was required to walk about one mile back through the stream bed to reach the vehicle, as Dry Creek is not navigable through the woods or hiking trails. About halfway back to the vehicle, when the team stopped for a few second to refill water bottles, the sow pushed over a boulder from atop the cliff down into the stream to alert the team of its presence. The sow followed the team the entire distance out of the woods, as is reported to be typical of bear encounters in the area. We recommend future teams to be more cognizant of bear safety and to possibly carry bear spray with them into the field. Bear encounters such as these are rare but possible dangers that may arise during the course of this project.

We also noticed some exceedingly thick patches of poison ivy (*Toxicodendron radicans*), especially at Dry Creek and Jack / Ramsey Creek. We sometimes found poison ivy at these locations to stand up to four feet tall off the forest floor. However, as Dry Creek has no alternative access points besides those noted in Table 4, future field teams should take precautions for hiking through these poison ivy patches. We recommend Tecnu be kept in all packs and vehicles, and that all exposed skin and equipment carried outside the pack (i.e. wading rods, waders) be treated with Tecnu after each trip through these woods. In this way, we were highly successful in preventing poison ivy rash from occurring.

Physical Stream Inventory

We found it imperative to have one person on the 2 to 4 person team focus solely on recording all data. This kept all data formatting consistent and decreased the likelihood of data recording errors. In teams of two, the data collector typically cannot keep up with the rate at which the data recorder can comfortably input all of the data. The recorder ends up either waiting on the data collector to finish (which is inefficient) or assisting in data collection (which, as mentioned above, is also not ideal). We also noted that teams of two sometimes struggle to handle all of the necessary equipment while simultaneously collecting or recording data. Lastly, teams of two are not as safe as teams of three or four because they have fewer eyes and ears focused on what all is happening around them.

In teams of three, we found that two data collectors can collect data at the same pace as the data recorder can comfortably record. The team members waste very little time waiting on each other and everyone moves at a comfortable yet highly efficient pace. Teams of three are also much more comfortable carrying and transporting all equipment, and are safer than teams of two with an extra set of eyes and hands to assist in potentially dangerous situations.

In teams of four, we noticed no increase in efficiency as compared with teams of three. We were able to collect data more quickly, but the data collectors would then have to wait for the data recorder to finish recording data. We therefore consider teams of four unnecessary, teams of three ideal, and teams of two acceptable as short-term alternatives during times when it may not be possible to assemble a team of three.

As team sizes sometimes varied between two and three, we established recommendations for dividing equipment (see Table 5) and responsibilities (see Table 6) among team members for teams of two and three. From the tables, it may appear at first that the data recorder has more responsibilities as compared with the other team members. However, the data recorder can usually complete the “entire reach” observations (i.e. reach type identification, instream cover, bank stabilities, and feature documentation) while the other team member(s) measure the reach length with the hip chain or walk back from the upstream end of the reach to locate the midpoint transect.

Table 5: Equipment assignments for members of two- and three-member teams.

	Two-member Team	Three-member Team
Data Recorder	Backpack, densiometer, flagging, GPS, IPad, ruler	Backpack, flagging, GPS, IPad
Data Collector #1	Clinometer, hip chain, meter tape, ruler, wading rod	Densiometer, hip chain, meter tape, ruler
Data Collector #2		Clinometer, ruler, wading rod

Table 6: Data responsibilities for members in two- and three-member teams.

	Two-member Team	Three-member Team
Data Recorder	Same as three-man teams, plus canopy cover, cobble embeddedness, and five substrate diameters	Record data, document features, all entire reach observations, number each reach, bank full width, mark GPS waypoints, and take photos when necessary
Data Collector #1	Reach length, find midpoint transect, wetted width, bank angles, cross sectional and thalweg depths, five substrate diameters	Reach length, find midpoint transect, wetted width, canopy cover, substrate diameters
Data Collector #2		Bank angles, cross-sectional and thalweg depths, cobble embeddedness

The teams also devised a sequence in which the data were most efficiently collected by minimizing transition time between data measurements. We recommend the electronic datasheets used in 2016 be re-ordered to ensure data are collected in this fashion. The order in which we recommend data be recorded and collected proceeds as follows: reach number, reach type, entire reach observations (instream cover, bank stability, and terrestrial vegetation), reach length, canopy cover, left bank angle, cross-sectional and thalweg depths, wetted width, bank full width, right bank angle, substrate diameters, cobble embeddedness, GPS waypoint ID, photo ID, and comments.

Field teams found most of the physical inventory methods easily applied and repeatable. The team expressed some confusion with bank stability and instream cover. For bank stability, the team found it difficult to consistently keep track of what was “stable” versus “unstable” bank. Additionally, bank stability was only measured in the first ten meters of the reach and there were plenty of instances where the first ten meters was not characteristic of the rest of the reach (especially within reaches >50 m).

Instream cover measurements were inconsistent between team members when coverage was greater than 10% For most instream cover parameters comprising less than 10% coverage we were typically in agreement, so we found it most efficient to have the data recorder estimate all reach observations individually and announce any cover parameters greater than 10% for team approval (Appendix A). Conversations about what values to assign “entire reach” observations are best had while measuring reach length, as this is the easiest time to talk and collect data simultaneously. Field teams quickly resolved differences in instream cover estimates, but discrepancies continued throughout the duration of the project. Thus, the integrity of this data and its usefulness in data analysis may be in question.

Biological Stream Inventory

We found it imperative to have one person on the 5 to 7 person team focus solely on recording all data. The remaining team members were responsible for electrofishing, netting fish, transporting captured fish in a bucket from the stream to the work-up station, and identifying and releasing the fish.

In teams of five, the data recorder is the only team member at the work-up station and therefore is the only one identifying and releasing fish. We discourage this because it interferes with the integrity of the data and it is inefficient for one person to handle this many tasks at once. Additionally, it leaves little time to conduct the macroinvertebrate sample.

In teams of six, the data recorder can focus solely on recording data while another team member identifies and releases fish. The team also increases their chances of being able to simultaneously conduct the macroinvertebrate sample while the rest of the team electrofishes. Or, it provides the opportunity for one team member at a time to take a break, which was beneficial in the hot and humid weather. We worked much more efficiently in teams of six than in teams of five.

In teams of seven, the extra team member is only beneficial when simultaneously conducting the macroinvertebrate sample or the flow measurements, which the team can easily conduct during a third electrofishing pass without aid from the data recorder. We noticed a small but noticeable increase in efficiency between teams of six and teams of seven. We deem teams of six or seven most efficient, and we only recommend teams of five for short periods when necessary.

At all team sizes, we found biological stream inventory methods easily applied and repeatable. However, some fish species remained difficult to differentiate; examples include differentiating Ouachita Madtom (*Noturus lachneri*) from Slender Madtom (*N. exilis*), Orangethroat Darter (*Etheostoma spectabile*) from Orangebelly Darter (*E. radiosum*), and Bigeye Shiner (*Notropis boops*) from Kiamichi Shiner (*N. ortenburgeri*) from Ouachita Mountain Shiner (*Lythrurus snelsoni*). Future field teams should take proactive measures to become as experienced as possible in their fish identification skills before entering the field for the first time. Although we believe we did not capture any Kiamichi Shiners or Ouachita Mountain Shiners, we did not feel confident in our ability to identify these two species.

Literature Cited

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USDA Forest Service, Ouachita National Forest. 1994. A cumulative effects analysis of silvicultural best management practices using basin area stream survey methods (BASS). Hot Springs, AR 71902 Vols. I and II. 134 pp.

Appendix A: Guide to Stream Characterization with Basin Area Stream Survey (BASS) for the Ouachita National Forest, AR

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February 2016

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Introduction

The National Forest Management Act (PL 94-588) requires the Forest Service to maintain or enhance water quality and soil productivity. The Clean Water Act of 1972 (PL 92-500) further requires the protection of beneficial uses and designates the State as the responsible agency. The Environmental Protection Agency (EPA) determined that the development and utilization of Best Management Practices (BMPs) are the appropriate methods to meet state water goals for nonpoint pollution (EPA 1978). In conjunction with the States of Oklahoma and Arkansas, the Ouachita National Forest (ONF) has developed a series of BMPs designed to protect water quality and associated beneficial uses (USDA Forest Service 1994). A monitoring program is required to document the effectiveness of that protection.

In its Amended Land and Resource Management Plan of 1990 (USDA Forest Service 1990), the Ouachita National Forest addressed monitoring at the watershed scale with the initiation of a forest-wide Basin Area Stream Survey (BASS) (Clingenpeel and Cochran 1992, USDA Forest Service 1994). The BASS inventory provided the monitoring link from BMPs and associated beneficial uses to the aquatic ecosystem at a watershed scale. The objectives of the monitoring program were to identify the physical, chemical, and biological characteristics of selected streams needed for comparison among streams over time. The intent was to develop a format that will allow determination of stream health.

The BASS monitoring program originally focused on six paired-watersheds within three ONF upland ecoregions (AR River Valley, Upper Ouachita Mountain, and Lower Ouachita Mountain). Within each ecoregion, two watersheds were selected based on past management activities, comparable size, ownership, and proximity. Watersheds containing little or no timber harvesting activities served as 'reference' basins, and watersheds with harvesting activities typical of the ONF represented 'managed' basins. Candidate watersheds were large enough to support a resident fishery, were primarily in Forest Service ownership, and were proximal to the other watersheds within the ecoregion.

After surveys in 1990, 1991, and 1992, the Forest chose to continue collections every five years, sampling the original ecoregion stream pairs again in 1996, 2001, 2006, and 2011. In 1998, the Mena District expressed a concern about the cumulative effects of the Wolf Pen Gap Off-Highway Vehicle (OHV) Trail Complex on water quality. Gap Creek and Board Camp Creek are located within the trail system boundaries, and were surveyed using the BASS methodology in 1998, 2001, 2006, and 2011 (Roghair and Dolloff 2013).

Prior to 2016 all BASS surveys were completed under the direction of former Forest Hydrologist, Alan Clingenpeel. Alan personally trained each crew to complete the BASS surveys and provided project oversight, quality assurance, data analysis and reporting. BASS methods were summarized in several reports, but a detailed field guide was never produced. This manual provides detailed instructions for field crews collecting BASS data in 2016 and forward. Changes to protocols used prior to 2016 are noted the in Changes to Bass Protocols section below.

References cited in this manual:

Clingenpeel, J.A. and B.G. Cochran. 1992. Using physical, chemical and biological indicators to assess water quality on the Ouachita National Forest utilizing basin area stream survey (BASS) methods. Proceedings of the Arkansas Academy of Science 46: 33-35.

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USDA Forest Service, Ouachita National Forest. 1994. A cumulative effects analysis of silvicultural best management practices using Basin Area Stream Survey Methods (BASS). Hot Springs AR 71902 Vols. I and II. 134 pages.

Changes to BASS Protocol

All changes or modifications were approved by Ouachita National Forest in consultation with CATT. No additional changes will be applied without additional consultation and approval. The following changes to the original BASS protocols will be applied in 2016:

Item	**Change**	**Reason**
Stream name	In 1990 – 2011, BASS documents referred to survey of Jack Creek In 2016, referring to this survey as Jack/Ramsey Creek	Alan Clingenpeel alerted us that the Jack Creek survey starts on Jack Creek but at the confluence with Ramsey Creek (~500 m) the survey proceeds up Ramsey Creek, not Jack Creek.
Length	In 1990 – 2011, reach length was measured with a meter tape. In 2016, we will use a hipchain.	Analysis of BASS data indicated reach lengths averaged 30 – 40 m with maximum length of >400 m. A hipchain will improve efficiency and provide an acceptable level of accuracy.
Depth	In 1990 – 2011, water depth was measured with a 30 ft. telescoping survey rod marked in cm. In 2016, will use 1.5 m PVC rod marked in 5 cm increments to measure water depth.	The length of the surveying rod was excessive for water depths. Analysis of previous BASS data showed that over 90% of habitat was less than 1.5m deep. Marking a rod in 5 cm is adequate for measuring water depths in BASS streams.
Substrate	In 1990 – 2011, visually estimated size classes for each particle sampled In 2016, will measure b-axis of each particle sampled.	There were discrepancies in the original BASS particle size classes. Measuring particles will add minimal time and will allow the application of any desired size classes in the future.
Embedded	In 1990 – 2011, crew members shouted out 10 embeddedness estimates and average was estimated and recorded In 2016, will record embeddedness of all 10 particles	The ‘audio-averaging’ approach lent itself to unnecessary error in estimating cobble embeddedness
Bank angle	In 1990 – 2011, crew subtracted clinometer reading from 180 to obtain bank angle In 2016, crew will record clinometer reading without subtraction	Subtraction can easily be done during data analysis; avoids potential calculation errors in the field
Photo	Not recorded prior to 2016	Added to improve documentation of notable stream features.
GPS	Not recorded prior to 2016	Added to improve documentation of notable stream features.
Feature	Not recorded prior to 2016	Added to improve documentation of notable stream features.
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Item	**Change**	**Reason**
Fish sample	In 1990 – 2011, recorded number of fish in each 10 mm size class and recorded a batch weight for each size class In 2016, we will record total number of each species collected as YOY and adult; no length or weight data are recorded	Previous BASS analyses did not make use of size class or weight information. Field crews indicated length and weight collection significantly increased effort expended on fish sampling.
Macroinvertebrate sample	In 1990 – 2011, collected from each habitat reach within a biological sampling area and preserved for analysis. In 2016, we will use the Izaak Walton League SOS protocol to collect 1 sample from each biological sampling area, and will ID and score on site	Original samples were never processed due to high cost of analysis. Change brings sampling into alignment with Forest and State-wide macroinvertebrate protocols.
Water chemistry	In 1990 – 2011, water samples and meter readings were collected at each biological sampling area following protocols established by Alan Clingenpeel. In 2016, we will collect water samples and meter readings in readily accessible areas near the start point of each physical inventory. Water samples will be collected following ADEQ sampling protocols.	Analysis of the 1990 – 2012 water samples revealed no consistent significant differences among stream pairs and there are no major changes in land use or possible point source polluters that would require collecting multiple samples per stream. A single sample near the watershed outlet should be sufficient to detect any chronic changes in water chemistry attributes. Following ADEQ sampling allows for comparison with State samples.
Re-map habitat	In 1990 – 2011, biological sampling areas were subjected to a second round of physical inventory at the completion of fish sampling In 2016, we will not complete a second round of physical inventory following biological sampling	Analysis of 1990 – 2011 data showed that only 7% of habitat reaches were reclassified during the second round of physical inventory. The reclassification was not used in any subsequent analysis. The original habitat reaches were always applied to analysis. A second round of physical inventory is largely redundant and not meaningful in the larger context of the BASS analysis.

Outline of BASS Protocol

The BASS is comprised of the following steps:

1) Complete required training
   - First aid / CPR class
   - Defensive driving
   - BASS training

2) Complete physical inventory on 1 pair of streams
   - Working upstream, delineate and describe habitat reaches
   - Stop inventory where stream runs dry – will take multiple days
   - Results are used to determine location of biological and chemical sample areas

3) Select areas for biological sampling
   - Use results of the physical inventory
   - Select 10% of each reach type for sampling
   - Divide the reaches among 5-7 sampling areas spaced throughout the length of the stream
   - Each sample area consists of 3-5 contiguous reach types

4) Complete biological sampling
   - Block net individual habitat reaches
   - Collect fish sample from within each individual reach in the sampling area
   - Collect macroinvertebrate sample from the first riffle upstream (preferred) or downstream of the fish sampling area

5) Complete discharge measurement
   - Establish discharge transect in riffle or run in or near the biological sampling area

6) Complete water chemistry sampling (may be completed during physical or biological samples)
   - Select sample site in accessible location near start of physical inventory
   - Use water chemistry meter to collect water quality parameters
   - Collect water samples per ADEQ sampling protocol

7) Repeat steps 4 - 6
   - Proceed upstream to each designated sampling area until entire stream is completed

8) Repeat steps 2 – 7 until all 4 pairs of streams are finished

Section 1: Orientation Information

First Aid / CPR – required training

The Ouachita National Forest will schedule first aid and CPR training for all crew members during the first week of employment.

The Ouachita National Forest will supply field crews with the location and contact information for local emergency facilities for each of the 4 pairs of BASS streams.

Defensive Driving – required training

The CATT will provide training required to obtain FS driver certifications for all crew members per FSH 7109 .19, ch. 60. The CATT will consult with the Ouachita National Forest to determine if additional Forest-specific training is required.

Reporting Injuries

CATT field crew personnel are Virginia Tech employees. Injured personnel in need of medical attention should be taken to a medical facility and at admittance the emergency care provider should be notified that this will be billed to workers comp through Virginia Tech. The injured party should not pay anything out of pocket for the treatment. Dana Keith is our Virginia Tech contact. Report all injuries to her by calling 540-231-5573 as soon as possible after the injury occurs. Dana is not available after normal business hours or on weekends. If you cannot reach Dana the injury should be reported through Colin Krause 540-250-0786 or Craig Roghair 540-230-8126.

Injuries that do not require immediate medical attention, but may require future medical attention should also be reported to Dana Keith by phone or by email (dkeith@vt.edu). Dana will need to know the nature of the injury, date and time of injury, location where injury occurred, circumstances that led to injury, and name and contact info for at least 1 witness.

Internal Contacts

The Ouachita National Forest will provide the field crew with a list of Forest contacts for each aspect of the field surveys. Contacts will be needed for the following at a minimum:

- Field methods consultant
- Fish and macroinvertebrate identification
- Site access and logistics
- Primary Forest liaison
- Check out/in for each set of streams
- Fleet
- Equipment
- Law enforcement officer
- After-hours contact

External Contacts

You may in the course of your assigned duties have the opportunity to interact with individuals interested in learning more about Forest Service management activities. The most direct route for people to obtain additional information in through their local District office:

District	Office	Front Desk
Caddo/Womble	Mt. Ida	(870) 867-2101
Jessieville/Winona/Fourche	Jessieville	(501) 984-5313
Mena/Oden	Mena	(479) 394-2382
Poteau/Cold Springs	Waldron	(479) 637-4174
Oklahoma	Hochatown	(580) 494-6402

The Forest Service also provides these talking points for use at your discretion:

If you encounter an openly hostile or threatening person or group:

- Apologize and leave immediately, do not argue
- Report to District office and your supervisor
- Alert your team at tailgate safety meeting next day

If you encounter an irritated person, consider these talking points:

- Explain that our work is helping to ensure the Forest Service is a source of clean water for drinking and recreation
- Forest Service manages a lot of land for a lot of different users
- The Forest Service values your input
- Consider contacting your local District office to share your opinion (see numbers above)
- If they become hostile at any point, apologize and leave, do not argue

If you encounter someone that is interested in learning more about what you are doing:

- Share what you are doing
- Explain that our work is helping to ensure the Forest Service is a source of clean water for drinking and recreation
- Provide a local contact for follow up (see numbers above)

Check-out / Check-in

Check-out and check-in are an essential part of our safety program. Provide a designated contact with this information every day before going to the field:

- Names of each person on your crew
- SPOT unit number
- Vehicle
- Work location

Only go to a new location if you are able to update your plans with your contact. Always work with a partner – never go to the field alone.

Check in with the designated contact at the end of each day.

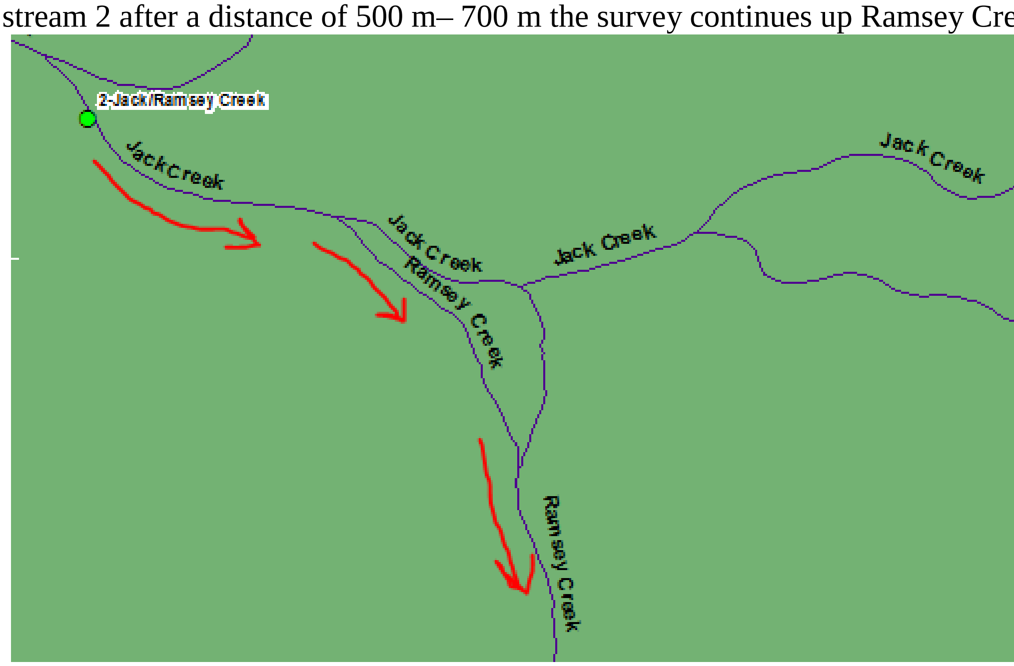
Section 2: Stream Locations

Complete streams in this order, as streams towards the top of the list are prone to drying:

Stream	Length (km)	Area (ha)	Ecoregion	Status
1 Dry Creek	9.1	2,500	Arkansas River Valley	Reference
2 Jack/Ramsey Creek	7.0	3,400	Arkansas River Valley	Managed
3 South Alum Creek	7.7	1,500	Upper Ouachita Mountain	Reference
4 Bread Creek	8.5	1,500	Upper Ouachita Mountain	Managed
5 Caney Creek	13.5	2,200	Lower Ouachita Mountain	Reference
6 Brushy Creek	8.8	2,900	Lower Ouachita Mountain	Managed
7 Board Camp Creek	11.1	2,000	Lower Ouachita Mountain	OHV
8 Gap Creek	4.7	850	Lower Ouachita Mountain	OHV

Stream	District	Office	Front Desk
1 Dry Creek	Poteau/Cold Springs	Waldron	(479) 637-4174
2 Jack/Ramsey Creek			
3 South Alum Creek	Jessieville/Winona/Fourche	Jessieville	(501) 984-5313
4 Bread Creek			
5 Caney Creek	Mena/Oden	Mena	(479) 394-2382
6 Brushy Creek			
7 Board Camp Creek	Mena/Oden	Mena	(479) 394-2382
8 Gap Creek			

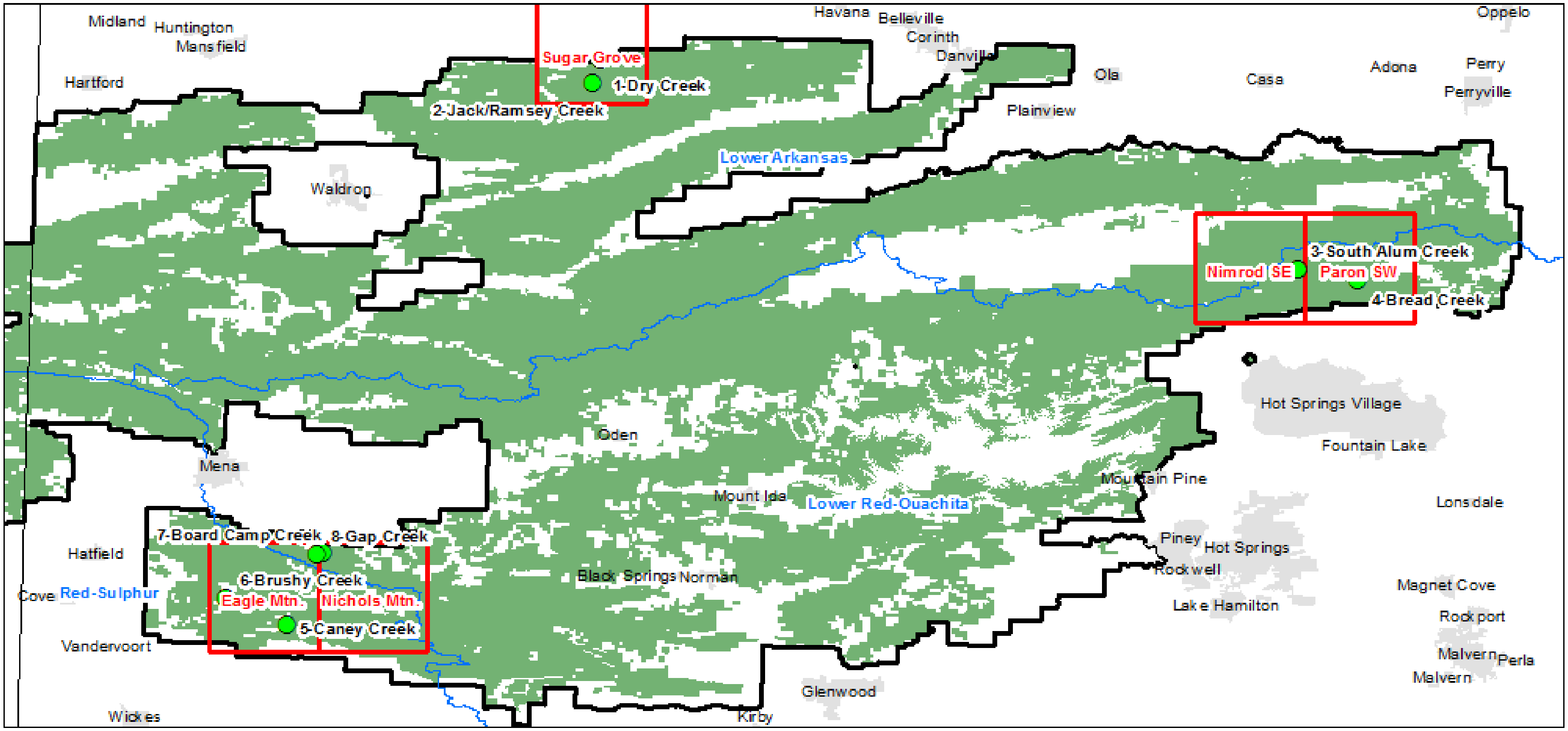
Note on stream 2 after a distance of 500 m– 700 m the survey continues up Ramsey Creek:



Start point locations and descriptions provided by Alan Clingenpeel:

Stream	Start Point	Start Description
1 Dry Creek	35.048985, -93.803221	From FS road 99 turn onto Loveall Road. The start point is where Dry Creek crosses Loveall Road at the burned out bridge. The people who live at the house have always been very nice about allowing parking at the end of the open road. Walk down the old road bed (est 500 feet) to the burned out bridge.
2 Jack/Ramsey Creek	35.023215, -93.811734	From FS road 141 (Jack Creek Road on map) begin at the bridge. Around 500 m bear to the right at confluence to proceed with survey up Ramsey Creek.
3 South Alum Creek	34.810559, -93.008088	Survey begins at confluence of S. Alum and N. Alum Creek. Park at low water crossing (S. Alum Creek) on FS road 961 and walk downstream to confluence (est 1 mile).
4 Bread Creek	34.797936, -92.939269	Survey begins at confluence of Bread Creek and Alum Creek. Park at Horsley creek culverts and walk downstream to Alum Creek then upstream to Bread Creek confluence. (est 500 feet).
5 Caney Creek	34.404094, -94.160448	Park at wilderness parking area off FS road 31 or County Rd 79 (34.409558, -94.165379 or gray dot on map). Walk down trail to Cossatot River. Walk downstream to Caney Creek confluence (total distance 2/3 mile).
6 Brushy Creek	34.435570, -94.228834	Begin where Brushy Creek crosses FS Road 30c also known as Polk Co 633
7 Board Camp Creek	34.486143, -94.117996	Begin at bridge. Polk County Road 618
8 Gap Creek	34.485749, -94.125601	Travel on the FS road 277 and cross Gap Creek (a ford) continue to road 644 turn left and begin survey where 644 crosses Gap Creek (an old crossing that has been closed).

Numbers in front of stream names indicate order in which inventories should be completed. In 2016, the field crew will be stationed in Mena. USGS 1:24,000 quadrangle names are in red.



Section 3: Physical Inventory

Outline of Physical Inventory

The physical inventory is comprised of the following steps:

1) Review equipment list
    - Check that all equipment on list is present
    - Check charge on all battery-operated devices

2) Complete check-out
    - Provide designated contact with crew names, work location, SPOT number, vehicle

3) Complete header information on datasheet
    - Complete all header information prior to starting the inventory

4) Enter stream at downstream end of first reach
    - Locate starting point using information in Section 1

5) Proceed upstream until you encounter a break between 2 reaches
    - Note: Reaches must be at least 10 m long
    - Record the following:
        - Reach Number
        - Reach Type
        - Length
    - Mark **downstream** end of reach
        - Write habitat reach number on flag and hang at downstream break
    - Identify the mid-point transect
        - Stretch hipchain along middle of channel to upstream break
        - Divide reach length by 2 to establish location of mid-point transect
    - Record the following at the mid-point transect:
        - Wetted Width
        - Bankfull Width
        - Depth
        - Thalweg Depth
        - Substrate
        - Cobble Embeddedness
        - Bank Angle
        - Canopy Closure
    - Record the following after observing the entire reach:
        - Instream Cover
        - Bank Stability
        - Terrestrial Vegetation

6) Proceed upstream into next reach and repeat step 5 until end of work day, or end of stream
    - Hang flag and record GPS location at end of work day
    - Check in with designated contact at end of work day
    - Repeat steps 1 and 2 each new work day before proceeding with step 5
    - End = no intermittent pools for a minimum of 500 m

Header Information

Header information is **vitally important** for future reference. Take the time to record all items completely and accurately **before starting** the inventory.

Stream	Full name, no abbreviations
Drainage	See stream list
Ranger District	See stream list
Start GPS	Record at downstream end of first habitat unit – e.g S3, see GPS section
Start Date	First day of inventory; record other dates in comments
Team Members	Full name, no abbreviations
Page number	For paper datasheets only
Notes	Anything pertinent to inventory such as recent rain, drought

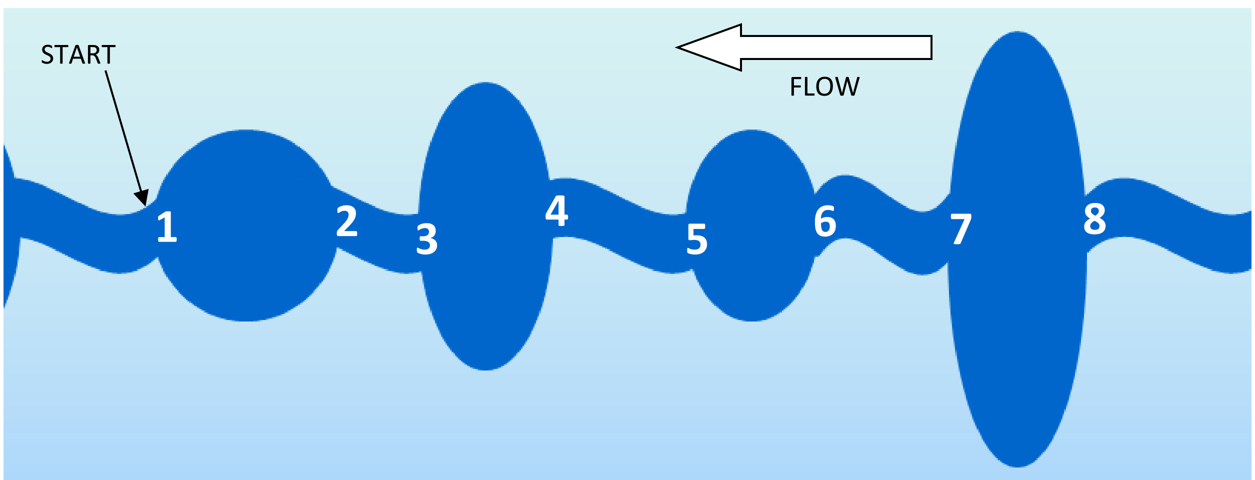
Reach Number (#)

Definition:
Count of reaches, numbered consecutively in an upstream direction

How to number reaches:
The first reach encountered as walking upstream is Reach Number 1. The next reach encountered walking upstream is Unit # 2, etc. Note that each individual reach must be at least 10 m long. See Unit Type section on following page for detailed information on minimum unit lengths and classifying reaches.

Hang a flag with the reach number at the **downstream** end of every reach – see example below.

Equipment used: Flip chart of habitat unit types, flagging, marker



Reach Type (0 - 24)

Reach types, adapted from McCain et al.1990:
Reach types grouped by primary type and shown in descending order from most common to least common. Dashed line separates common from rare types (from BASS data 1990 – 2011).

	Riffles		**Runs**		**Pools**
1	Low Gradient (<4%)	16	Step Run	17	Mid-Channel Pool
2	High Gradient (≥4%)	15	Runs	12	Lateral Scour Pool (Bedrock Formed)
24	Bedrock Sheet	14	Glide	23	Step Pool
3	Cascade (≥12%)	21	Pocket Water	11	Lateral Scour Pool (Rootwad Formed)
18	Edgewater			13	Dammed Pool
				20	Lateral Scour Pool (Boulder Formed)
	Dry			22	Corner Pool
0	Dry Channel			9	Plunge Pool
				5	Backwater Pool (Boulder Formed)
				19	Channel Confluence Pool
				6	Backwater Pool (Rootwad Formed)
				10	Lateral Scour Pool (Log Formed)
				4	Secondary Channel Pool
				7	Backwater Pool (Log Formed)
				8	Trench/Chute

How to identify habitat reaches:
The 25 reach types can be divided among four primary groups: **Riffles** have fast water and turbulent surface and are differentiated based on gradient; **Runs** are low gradient with moderate to low velocity and turbulence and are differentiated based on depth and velocity; **Pools** are low velocity and low to high turbulence and are differentiated by position in the stream channel and cause of scour; **Dry** channels are completely dry or contain too little water to determine a primary habitat type. Each group contains one or more reach types as shown in the table above. On the datasheet, record the reach type number (0-24). Use the laminated Ouachita National Forest Habitat Typing Field Guide to distinguish among reach types.

Habitat reaches are separated by 'breaks'. Breaks can be obvious physical barriers, such as a debris dam separating two pools or a small waterfall separating a pool and riffle, or may be less obvious transitional areas. Questions often arise as to whether a break is substantial enough to split two reaches and where the exact location of the break occurs. When in doubt the team should 'think like a fish'. Would a fish have to make an effort to move across the break? Would a fish encounter noticeably different water velocity after moving across the break? If the answer to either of these questions is yes, then you are likely looking at a break between two different reaches.

Questions also often arise as to the minimum length of individual reaches. Standard BASS protocol states that reaches must be at least 10 m long. Any reach that is less than 10 m should be included within the most similar habitat either upstream or downstream (ex. long pool, small riffle, long run = 2 units: 1 pool, and 1 run) or incorporated within the same habitat types (ex. pool, small riffle, pool = 1 unit: pool). Use best professional judgment in such cases.

The channel may have two habitat types in the same cross-sectional area, particularly in braided sections or reaches with side channels. Determine the dominant habitat type and record it as the reach type. For example if a cross-section contains both pool and riffle, but the majority of the flow is into and out of the pool habitat, then call a pool.

Equipment used: Ouachita National Forest Habitat Typing Field Guide - laminated

Length (0.1 m)

Definition:
Distance from the break at the downstream end of the reach to the break at its upstream end. Minimum length for any individual reach is 10 meters.

How to measure:
One crew member ties hipchain string at downstream end of habitat reach and proceeds to upstream end keeping the string aligned with the thalweg (deepest portion of the channel). At the upstream end report the total reach length to the data recorder. Divide the total length by 2 to obtain the location of the midpoint transect. Set the hipchain counter to 0.0 m, tie off, and walk downstream using the hipchain to locate the midpoint transect.

Standard BASS protocol states that **habitat units must be at least 10 m long**. Any reach that is less than 10 m should be included within the most similar habitat either upstream or downstream (ex. long pool, small riffle, long run = 2 units: 1 pool, and 1 run) or incorporated within the same habitat types (ex. pool, small riffle, pool = 1 unit: pool). Use best professional judgment in such cases.

Where to measure:
Care is taken to keep the measuring tape in the thalweg (deepest part of the stream), especially around bends.

Equipment used: hip chain

Wetted Width (0.1 m)

Definition:
Width from the edge of the water on the left to the edge of the water on the right. Dry channels have wetted width of 0.0 m by definition.

How to measure:
Stretch the measuring tape across the wetted channel perpendicular to flow. Where gravel bars, braids, or side channels exist include them in wetted width. Note these situations in the comments.

Where to measure: At the mid-point transect

Equipment used: measuring tape

Bankfull Width (0.5 m)

Definition:
Width of the stream channel at the elevation of the bankfull channel.

How to estimate:
Identify the bankfull elevation on the left and right banks – left and right bankfull should be at the same elevation. Often the bankfull elevation can be identified by locating flat, depositional areas adjacent to the stream channel. It is often helpful to look up and down the entire stream channel to visualize the bankfull elevation. The bankfull elevation should not change dramatically between adjacent habitat units unless there is a major change in the landform, or a major disturbance in the area. Bankfull elevation cannot be reliably identified near major confluences or road crossings. For more information on identifying the bankfull channel refer to your Rosgen field guide.

Visually estimate the width of the bankfull channel after measuring the wetted width.

Where to estimate: At the mid-point transect

Equipment used: Rosgen field guide, visual estimate

Thalweg Depth (1 cm)

Definition:
Vertical distance from top of substrate to water surface at the intersection of mid-point transect and thalweg

How to measure:
The thalweg is the deepest point in the channel cross section. Identify the deepest point in the cross section by probing across the mid-point transect with the wading rod.

Where to measure: At the intersection of the mid-point transect and the thalweg

Equipment used: Wading rod

Depth (1 cm)

Definitions:
Vertical distance from top of substrate to water surface at left bank (as facing downstream), ¼ width, ½ width, ¾ width, and right bank

How to measure:
Place wading rod at each of the locations indicated above – visually estimate ¼ width, ½ width, ¾ width. The bank measurements should be at the edge of the wetted channel (if water is very shallow at bank record depth of 1 cm). While standing downstream of the wading rod record water depth as centimeters from stream bed to water surface. In areas of high water velocity read the water depth on the left or right side of the wading rod (not on the upstream or downstream facing sides).

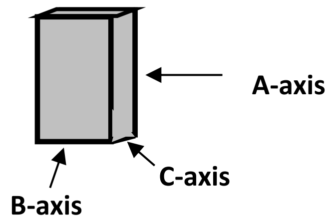
Where side channels, braids, and gravel bars exist it is possible to record 0.0 depth; note these situations in the comments.

Where to measure: mid-point transect at left bank (as facing downstream), ¼ width, ½ width, ¾ width, and right bank – visually estimate location of points

Equipment used: Wading rod

Substrate (1 mm)

Definitions:
Substrate is the inorganic material that composes the bed of the stream channel within the **wetted** channel. Individual substrate particles are measured on their intermediate, or b-axis. The b-axis determines the minimum size hole through which a particle can be pushed.



How to measure:
Collect 10 particles at equal intervals along the mid-point transect within the wetted channel. Starting at the water's edge on the left bank (facing downstream), place your toe at the edge of the wetted channel, look away from the stream bed, then place your finger tip on the particle at the tip of your wading boot. Pick up the particle, measure its b-axis to the nearest mm and record it on the datasheet. Pace to the location of the next particle sample, look away from the stream bed, then place your finger on the stream bed at the tip of your wading boot; measure the b-axis of the first particle you touch. Continue to pace across the stream to the right bank (facing downstream) and measure particles at equal intervals; the final particle should be at the water's edge on the right bank.

For clay and silt record size as 1 mm. For sand record size as 2 mm. For bedrock record 4000 mm.

In transects too deep to collect substrate visual estimates will suffice. Use the chart below to determine substrate size to record. Note in comments that water was too deep to measure substrate by hand.

ONLY USE THIS TABLE IN TRANSECTS TOO DEEP TO MEASURE SUBSTRATE BY HAND:

Type	Size (mm)	Record in Data	Description
Clay		1	sticky, holds form when rolled into a ball
Silt		1	slippery, does not hold form when rolled into a ball
Sand	silt – 2	2	grainy, does not hold form when rolled into ball
Small Gravel	3-16	10	sand to thumbnail
Large Gravel	17-64	40	thumbnail to fist
Cobble	65-256	160	fist to head
Boulder	>256	300	larger than head
Bedrock		4000	solid rock, parent material, may extend into bank

Where to measure: 10 equally spaced points along the mid-point transect – spacing is visually estimated

Equipment used: Ruler

Embedded (5 %)

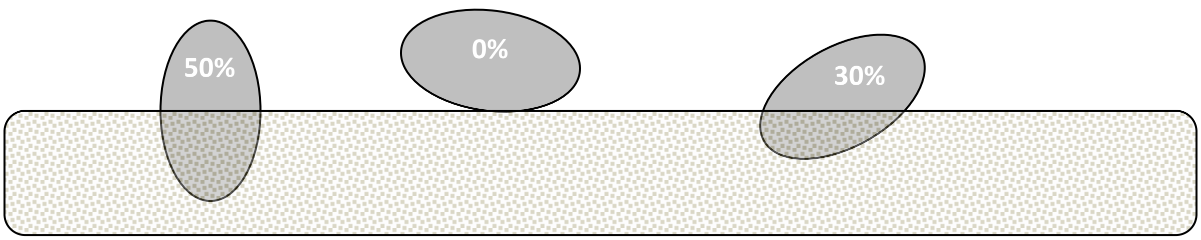
Definition:
The degree to which a cobble sized substrate particle is surrounded by finer substrate particles such as gravel, sand, silt, and clay.

How to estimate:
Locate a cobble-sized substrate particle (65-256 mm) on or near the mid-point transect. Extract the cobble, making note of what portion of the particle was buried in the stream bed by smaller substrate particles such as gravel, sand, silt, or clay. Visually estimate the percentage of the cobble particle that was surrounded by smaller particles and record the percentage on the datasheet. Repeat until a total of 10 cobbles are recorded. Indicate in the comments if fewer than 10 cobbles were available along or near the mid-point transect. See figure below for examples.

In reaches too deep to collect cobbles by hand, estimate the percent embedded by dislodging substrate with your feet. Record in comments that water was too deep to collect cobbles by hand.

Where to estimate: near mid-point transect

Equipment used: visual estimate



Bank Angle (5 degree)

Definition:
Slope of stream bank at edge of wetted channel

How to measure:
Place the bottom of the wading rod at the edge of the wetted channel then lay the top of the wading rod flat against the left bank (facing downstream). Place the clinometer on the wading rod and read the degree slope of the rod. Repeat for the right bank. Flat (i.e. level) banks are recorded as 0^{o}, vertical banks are recorded as 90^{o}

If bank is undercut, push bottom of wading rod as far beneath bank as possible, then pull up on other end of rod until it contacts the underside of the undercut bank. Place the clinometer on the rod to measure the undercut bank angle. Record the bank angle as a negative number to indicate undercut, of example if clinometer reading is 32, record -32.

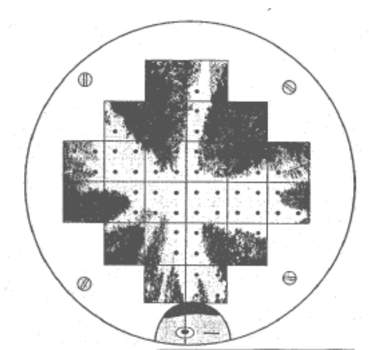
Where to measure: mid-point cross section, for left and right bank separately (left and right as facing downstream)

Equipment used: clinometer and wading rod

Canopy Closure (1 %)

Definition:
Percent of vegetation closure from tree canopy over the stream channel

How to measure:
Stand with densitometer held flat in palm at chest height in the center of the mid-point transect, facing upstream. The cross-shaped grid etched upon the convex surface of the mirror has 24 quarter-inch squares. When in areas of heavy overhead cover it is easier and faster to estimate the relative amount of overstory coverage by assuming the presence of four equi-spaced dots in each square and by counting dots representing openings in the canopy. The percentage of canopy cover is then assumed to be the complement of this number. For example, if 18 dots are not covered by canopy the percent canopy cover is 100 – 18 = 82%. This value will be slightly different than the value calculated using the instructions on the inside of the lid but the difference is so small relative to the error in measurement as to be negligible.



Where to measure: center of mid-point transect, facing upstream

Equipment used: concave spherical densiometer

Instream Cover (5 %)

Definition:
Natural features either on or below the water surface, or within 30 cm of the water surface if above the water surface, that obscure overhead viewing.

Cover Type	Definition
Undercut bank (UCB)	Bank overhangs the water surface
Large wood (LW)	Diameter 30 cm or more; can be below, on, or within 30 cm of surface
Small wood (SW)	Diameter less than 30 cm – includes loose accumulations such as tree tops
Terrestrial Vegetation (TV)	Vegetation overhanging wetted channel within 30 cm of the water surface
Whitewater (WW)	Sufficient bubbles or foam on surface to obscure view below
Boulder (BO)	Diameter 30 cm or greater
Bedrock ledge (BRL)	Shelf or crevice below water surface or overhangs within 30 cm of surface
Clinging Vegetation (CL)	Mosses or filamentous algae
Rooted Vegetation (RT)	Water willow or other rooted emergent aquatic vegetation

How to estimate:
Observe the entire habitat unit and determine the percent of the total wetted habitat unit area that is protected from overhead view by each of the cover types listed above. Since the cover types can overlap (e.g. large wood over whitewater) it is technically possible to sum the percentages to greater than 100%.

Where to estimate: wetted area of entire habitat unit

Equipment used: visual estimate

Stability (5 %)

Definition:
Percent of streambank immediately adjacent to the wetted channel that is covered by vegetation or protected by materials that do not allow bank erosion (e.g. armored by rock or large wood).

How to estimate:
Starting at the downstream end of the reach, take 10 paces along the stream bank immediately adjacent and parallel to the wetted channel. Multiply the number of paces that fall on vegetation, rock, wood, or other non-erodible material by 10 to obtain the percent stability. For example, if 8 of 10 paces fall on non-erodible material the percent stability is 80%. Repeat on the opposite stream bank.

In areas where banks cannot be walked on (vertical, covered in poison ivy, etc.) you may visually estimate bank stability. Record in comments that stability was visual estimate and reason bank was not traversed.

Where to estimate: entire unit, for left and right bank separately (left and right as facing downstream)

Equipment used: visual estimate

Terrestrial Vegetation (1 – 4)

Definition:
Vegetation cover type in the stream side zone (i.e. riparian) starting at the top of the bankfull channel and extending out a distance of 10 m

How to estimate:
Visually estimate the dominant cover type the zone starting at the top of the bankfull channel and extending away from the stream channel for distance of 10 m.

Category	**Description**
1. Exposed	Very little to no vegetation cover (soil, rock, gavel, bedrock, etc.)
2. Grass	Dominant vegetation is herbaceous (grasses, sedges, etc.)
3. Forested	Dominant vegetation is trees with some brush
4. Brush	Dominant vegetation is brush with some trees

Where to estimate: entire unit, for left and right bank separately (left and right as facing downstream)

Equipment used: visual estimate

Photo (#)

Definition:
Photograph number (shown on camera) of photo taken of habitat unit or crossing feature.

How to take a photo:
Take photo facing upstream with observer holding wading rod in picture. Be sure to get entire width (and length if possible) of feature in the photo. Record photo number shown on digital camera – the last 3 digits are sufficient. Also record the camera number in the comments with the first photo each day.

Record a brief description of the photo in the comments.

Where to take a photo: required for any crossing features (bridge, ford, dam, culvert) and waterfalls encountered; optional at other features

Equipment used: waterproof digital camera or GPS camera

GPS (ID)

Definition:
Name of the waypoint recorded on GPS to mark a waterfall, crossing feature, or other location

How to record GPS waypoint:
Stand as close to the feature as possible and allow the GPS to have a clear view of the sky. Mark a waypoint on the GPS, then edit the waypoint name as follows:

Category	**Record in GPS**	**Description**
Start	S + stream number*	Day 1 start point for physical inventory
End	E + stream number*	Final day end point for physical inventory
Pause	P + stream number* + date	Location at end of day when habitat inventory is to be continued, e.g. pause on stream 4 on July 12 = P4-0712
Waterfall	FALL + stream number* + reach number	e.g. waterfall on stream 1 reach 21= FALL1-21
Bridge	BRG + stream number* + reach number	bridge on stream 3, reach 5 = BRG3-5
Ford	FORD + stream number* + reach number	Follow examples above
Dam	DAM + stream number* + reach number	Follow examples above
Culvert	V + stream number* + reach number	Follow examples above
Other	OTR + stream number* + reach number	Follow examples above

*See section 2 for list of stream numbers

If multiples of the same feature fall within the same habitat reach add a, b, c… to label. For example if 2 waterfall are within reach 9 or stream 1, then FALL1-9a, FALL1-9b for GPS.

Where to record GPS waypoint: all waterfalls, all crossing features (bridge, ford, dam, culvert), any other notable features encountered during the survey that we may want to locate in the future or that could serve as landmarks

Features

Definition: points on a stream that could potentially serve as landmarks; may be natural or manmade

How to document: record feature abbreviation in the Reach Type field and assign the Reach Number to the feature. For example if you are working in Low Gradient Riffle with reach number 79 and encounter a bridge across the riffle, record BRG for the reach type and 79 for the reach number, respectively. This system allows us to quickly identify the reach with which each feature is identified. Record additional information as described in the table below.

Where to document: wherever found, record number of meters into reach for each feature

Channel Feature	Abbreviation	What to Record
Waterfall[1]	**FALL**	Photo, GPS, estimated height
Tributary	**TRIB**	Average wetted width, into main channel on left or right (as facing downstream)
Side channel[2]	**SCH**	Average wetted width, whether it is flowing into or out of main channel on left or right (as facing downstream)
Braid[3]	**BRD**	Start and end locations of braid within habitat reach, number of braided channels, estimated width of individual braids
Seep (Spring)	**SEEP**	Left or right bank (as facing downstream), size, coloration
Landslide	**SLID**	Left or right bank (as facing downstream), estimated size
Other	**OTR**	Description of feature, *example:* found water intake pipe going to house here; old burned out shack on side of stream; Big Gap campground on left; alligator slide here, etc.

1 must be vertical with water falling through air to be a waterfall and not a cascade, do not record unless >1m high
2 two channels separated by feature not likely to be moved during bankfull flow (e.g. island with trees). Do NOT include channels separated by materials mobilized during bankfull flows such as gravel or cobble bars.
3 special case of habitat reach containing more than 1 side channel; see description of side channel in 2 above

Crossing Feature	Abbreviation	What to Record*
Bridge	**BRG**	Photo, GPS, Road or trail name and type (gravel, paved, dirt, horse, ATV)
Ford	**FORD**	Photo, GPS, Road or trail name and type (gravel, paved, dirt, horse, ATV)
Dam	**DAM**	Photo, GPS, type, condition, estimated height, dam use, name of road or trail, if applicable; include beaver dams
Culvert	**V**	Photo, GPS, Road or trail name, type, # of outlets, diameter/width, height, material, perch (distance from top of water to bottom lip of culvert, natural substrate (present or absent through length)

* photograph all crossing features with person and wading rod for scale, record 'Y' in 'Photo' column

We cannot stress enough the importance of fully and accurately describing features. This means getting out a quadrangle map and finding road, trail, and tributary names and recording them in 'Comments' and taking the time to describe the location of features in relation to landmarks found on quadrangle maps.

Section 4: How to select areas for biological sampling

Areas for biological and chemical sampling are selected upon completion of the physical habitat inventory. The following procedure is used:

1) Determine the number of reaches that fall into each of the 24 wetted reach types

2) Divide the total number of reaches in each of the 24 reach types by 10 to determine the number of reaches to target for biological sampling. If the total count for a particular reach type is less than 10, then target 1 of that type for sampling. Exclude dry reaches.

3) Divide the stream into 5 – 7 segments of approximately equal length

4) Within each stream segment establish a biological sampling area – see next page for example

    a. Each biological sampling area should include 3-5 contiguous reaches
    b. Reaches should not be excessively large or too deep for electrofishing
    c. Distribute reach types among biological sampling areas to the extent possible
    d. Rare reach types that can't easily be grouped into biological sample areas may be dropped from sampling

5) Return to the stream and use stream features, GPS coordinates, and flagging markers to locate the biological sampling areas
    a. If the biological sampling area has gone dry please note this on the data sheet and drop the area from additional sampling – no replacement reach is needed

6) Complete biological sampling as described in the following section

Example from Brushy Creek, 2011

The crew classified a total of 217 habitat reaches during the physical inventory. The total number of each reach type, and the number of each reach type sampled during the biological inventory is shown below:

Reach Type	Reach Type Description	Physical Inventory Count	10% Sampling Target	Final Sample Size
17	Mid-channel Pool	56	6	6
14	Glide	50	5	5
1	Low Gradient Riffle	37	4	4
16	Step Run	30	3	3
23	Step Pool	19	2	2
15	Run	14	1	2
24	Bedrock Sheet	4	1	1
13	Dammed Pool	2	1	0
12	Lateral Scour Pool (Bedrock Formed)	2	1	2
22	Corner Pool	1	1	0
2	High Gradient Riffle	1	1	1
0	Dry Channel	1	NA	NA
	Total:	217	26	26

The stream was divided into 6 sections of approximately the same length.

The crew reviewed the physical inventory data to locate 1 biological sampling area (3-5 back-to-back reaches) within each section.

Care was taken to select reaches that were not excessively long or too deep for backpack electrofishing.

Reach types were distributed among biological sampling areas to the extent possible.

Rare types were only sampled where they allowed for ease in grouping continuous reaches of more common types

After selecting the biological sampling areas the crew summed the reach types to assure the final sample size was as close as possible to the 10% sampling target for each reach type.

The distribution of reaches within the biological sampling areas is shown on the following page.

Biological sampling areas established on Brushy Creek, 2011.

Sampling Area	Reach Number	Reach Type	Reach Type
A	6	16	Step Run
A	7	15	Lateral Scour Pool (Bedrock Formed)
A	8	1	Step Run
A	9	14	Glide
A	10	17	Mid-channel Pool
B	55	17	Step Pool
B	56	14	Glide
B	57	16	Mid-channel Pool
B	58	1	Low Gradient Riffle
C	70	14	Glide
C	71	23	Step Pool
C	72	17	Mid-channel Pool
C	73	15	Run
D	105	17	Mid-channel Pool
D	106	2	High Gradient Riffle
D	107	14	Glide
D	108	12	Step Pool
E	163	24	Bedrock Sheet
E	164	17	Mid-channel Pool
E	165	23	Step Pool
E	166	12	Lateral Scour Pool (Bedrock Formed)
E	167	1	Low Gradient Riffle
F	178	14	Glide
F	179	1	Low Gradient Riffle
F	180	17	Mid-channel Pool
F	181	16	Step Run

Section 5: Biological Sampling

Fish Sample

Fish sampling is completed **before** macroinvertebrate sampling. Macroinvertebrate sampling involves significant disturbance of the reach and could cause fish to move out of the sample area.

Collect a fish sample using the following approach:

1) Each habitat reach in the biological sampling area is blocked individually with blocknets ⅛ - ¼ inch mesh) at the down and upstream ends
    a. Record GPS coordinates at the downstream end of each reach as F+stream number+reach number

2) Block off at least the first 2 habitat reaches prior to starting electrofishing on the downstream most reach

3) Electrofishing should proceed from downstream to upstream
    a. Use 1 backpack electrofisher, 2 dipnetters, 1 bucket person, 2 workup
    b. Set Smith Root shocker with mode switches at I and 5 (60 Hz 6 ms) and output voltage range at 200; adjust output voltage range in response to fish behavior. Increase voltage if fish seem to escape field of shock; decrease if fish mortality occurs
    c. Reset timer to zero seconds before each pass and record shock time (sec) after each pass

4) Complete pass 1 through the reach
    a. Fish mortality can be a problem, particularly in high temperatures
        i. Avoid overcrowding buckets with too many fish
        ii. Separate large predatory species from smaller species
        iii. Keep fish well aerated with air pumps
        iv. Keep fish out of direct sun if possible

5) Check the downstream blocknet for fish

6) Record total number of adults and YOY for each species in each pass
    a. Fish that cannot be identified in the field are preserved in 10% formalin (wear PPE when handling formalin) and labeled for lab identification – YOY should not be preserved; be certain to record vouchers on the datasheet
    b. Check the species list to be certain no sensitive species are preserved
    c. Identify fish and release them downstream of the most downstream blocknet as quickly as possible

7) Complete pass 2 using effort equal to pass 1
    a. Repeat steps 4 - 6

8) Complete pass 3 using effort equal to pass 1
    a. Repeat steps 4 - 6

9) If more fish (all species combined) are captured in pass 3 than in pass 2, complete a 4th pass

10) Move the downstream blocknet to the upstream end of the next unblocked reach.

11) Repeat steps 3 – 9 until all reaches in the biological sampling area are complete.

Fish species collected during BASS fish surveys 1990 – 2011, provided by Rich Standage, ONF Fish Biologist. **BOLD*** = Sensitive Species, do NOT voucher.

Row Labels	***Genus species***	**Dry**	**Jack/Ramsey**	**South Alum**	**Bread**	**Caney**	**Brushy**	**Board Camp**	**Gap**
Pirate Perch	*Aphredoderus sayanus*			X	X				
Brook Silverside	*Labidesthes sicculus*				X				
Creek Chubsucker	*Erimyzon oblongus*	X	X	X	X	X	X	X	X
Northern Hog Sucker	*Hypentelium nigricans*							X	X
Shadow Bass	*Ambloplites ariommus*							X	
Green Sunfish	*Lepomis cyanellus*	X	X	X	X	X	X	X	X
Bluegill	*Lepomis macrochirus*			X	X	X	X		X
Longear Sunfish	*Lepomis megalotis*		X	X	X	X	X	X	X
Redear Sunfish	*Lepomis microlophus*			X					
Spotted Sunfish	*Lepomis punctatus*			X				X	
Smallmouth Bass	*Micropterus dolomieu*					X	X	X	X
Spotted Bass	*Micropterus punctulatus*				X		X		
Largemouth Bass	*Micropterus salmoides*				X		X		
Highland Stoneroller	*Campostoma spadiceum*	X	X	X	X	X	X	X	X
Steelcolor Shiner	*Cyprinella whipplei*		X						
Striped Shiner	*Luxilus chrysocephalus*		X		X	X	X	X	X
Ouachita Mountain Shiner*	***Lythrurus snelsoni***					**X***	**X***		
Redfin Shiner	*Lythrurus umbratilis*		X	X	X	X	X	X	X
Bigeye Shiner	*Notropis boops*		X	X	X	X	X	X	X
Kiamichi Shiner*	***Notropis ortenburgeri***			**X***	**X***			**X***	**X***
Bluntnose Minnow	*Pimephales notatus*		X	X	X		X	X	X
Creek Chub	*Semotilus atromaculatus*	X	X	X	X	X	X	X	X
Redfin Pickerel	*Esox americanus*			X	X		X		
Northern Studfish	*Fundulus catenatus*			X		X	X	X	X
Blackspotted Topminnow	*Fundulus olivaceus*			X	X	X	X		X
Yellow Bullhead	*Ameiurus natalis*		X	X	X	X	X	X	X
Slender Madtom	*Noturus exilis*		X				X	X	X
Ouachita Madtom*	***Noturus lachneri***			**X***	**X***			**X***	
Freckled Madtom	*Noturus nocturnus*							X	X
Greenside Darter	*Etheostoma blennioides*			X				X	X
Creole Darter	*Etheostoma collettei*			X	X		X		
Orangebelly Darter	*Etheostoma radiosum*		X	X	X	X	X	X	X
Orangethroat Darter	*Etheostoma spectabile*	X		X		X			
Redfin Darter	*Etheostoma whipplei*	X	X	X	X	X	X		X
Banded Darter	*Etheostoma zonale*				X				
Logperch	*Percina caprodes*				X			X	X
Southern Brook Lamprey	*Ichthyomyzon gagei*			X				X	

Macroinvertebrate Sample

A single macroinvertebrate sample is collected in the vicinity of the fish sampling area, preferably the next riffle upstream. If no riffle is available immediately upstream then a downstream site may be used. Be sure to record the reach number and GPS coordinates of the sample location.

GPS is recorded as M + stream number-reach number, so stream 3, reach 154 = M3-154

Macroinvertebrate sampling follows the Izaak Walton League Save our Streams (SOS) protocol (Izaak Walton League 2006). There are two SOS sampling methods available to collect macroinvertebrates: Muddy Bottom Sampling and Rocky Bottom Sampling. Muddy Bottom Sampling is used in streams that do not have riffles. All BASS streams have riffles, and will follow the Rocky Bottom Sampling approach.

From Izaak Walton League Volunteer Stream Monitoring Protocol:

The Rocky Bottom Method is intended for sampling streams that have rocky bottoms or riffles. A kick-seine net, a finely meshed net with supporting poles on each side, is the best tool to use for collecting macroinvertebrates in rocky bottom streams. The League's Rocky Bottom Sampling method uses a kick-seine net that is 3 square feet with 1/16 or 1/32-inch mesh.

Select a riffle that is a shallow, fast-moving area of water with a depth of 3 to 12 inches (10 to 30 cm) and cobble-sized stones (2 to 10 inches) (5 cm) or larger.

Place the kick-seine at the downstream edge of the riffle. Remember to use rocks to secure the net tightly against the streambed so that no organisms escape under the net. Also, don't allow any water to flow over the top of the net; organisms can escape over the net. Also, if water is flowing over the top of the net, the water level is too high for safe monitoring.

Monitor the streambed for a distance of three feet upstream of the kick-seine and across the width of the net. Firmly and thoroughly rub your hands over all rock surfaces to dislodge any attached insects.

Carefully place all large rocks outside of your three-foot sampling area after you have rubbed off any macroinvertebrates. Stir up the bed with your hands and feet until the entire area has been searched. All exposed and detached organisms will be carried into the net. Then, for at least 60 seconds, use the toe of your shoe to jab the streambed with a shuffling motion towards the kick seine. Disturb the first few inches of sediment to dislodge burrowing organisms.

Before removing the net, rub any rocks that you used to anchor the net to the stream bottom and remove the rocks from the bottom. Firmly grab the bottom of the net so that your sample does not fall from the net, and then remove it with a forward-scooping motion. The idea is to remove the net without allowing any insects to be washed under or off it.

Placing a white trash bag or white sheet under the net before separating the sample will catch any tiny organisms that may have crawled through the net. Use a watering can or spray bottle to periodically water your net. The organisms will stop moving as the net dries out. Occasionally wetting the net will cause the organisms to move, making them easier to spot. Watering the net is especially important on hot, dry days.

Place the net on a flat, bright area, out of direct sunlight. Using tweezers or your fingers, separate all the organisms from the net and place them in your collecting container which should be half full of water. Sort organisms into similar groups as you separate your sample. This will make your identification quicker when you are ready to record results on your survey form. Plastic ice cube trays are helpful when sorting the catch. For example, put all organisms with legs in one section and all organisms with no legs in another section. Any organism that moves, even if it looks like a worm, is part of the sample. Look closely, since most aquatic macroinvertebrates are only a fraction of an inch long.

Macroinvertebrate Identification

Refer to the provided macroinvertebrate field guide to assist with identification.

After identifying the organisms, record your results on the IWLA Stream Quality Survey data form, or the iPad form provided by CATT. Return the organisms to the stream after sampling is completed. Note that you record total number of each taxa collected on the CATT form, whereas the League's form uses letters to indicate the number of each type of organism (A=1–9, B=10–99, C=100 or more).

The League updates the sensitivity rankings for macroinvertebrates based on the most recent scientific research. To purchase a copy of the latest stream survey form, please visit http://www.iwla.org/resource/sos-equipment

Section 6: Discharge Measurement

Locating discharge transect:

Stream discharge is calculated at 1 transect per biological sampling area. Record the location of the discharge transect on the GPS as follows: Q + stream number-stream reach. For example, if the transect is located in stream 5, reach 114 the GPS waypoint is labeled Q5-114.

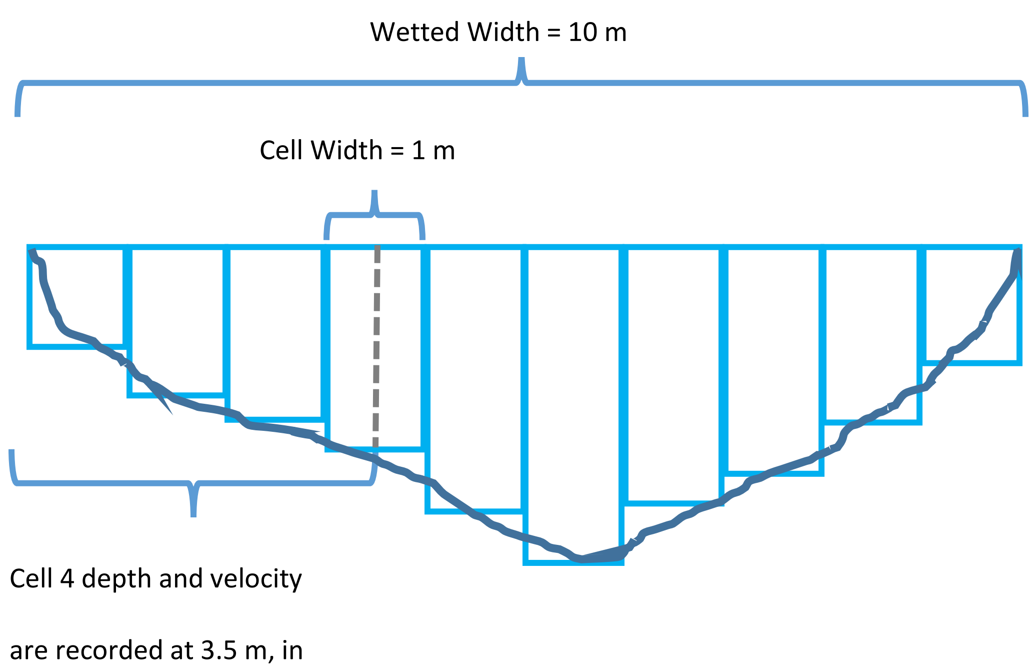
The transect may be located in or near the biological sampling area and should meet as many of the following criteria as possible:

- A relatively straight channel with parallel edges upstream and downstream of the cross section.
- Defined edges on both sides of the cross section.
- A channel of uniform shape - roughly parabolic, trapezoidal, or rectangular in shape.
- A channel free of vegetative growth, large cobbles, and boulders.
- A cross section free of eddies, slack water, and turbulence.
- A cross section with depths greater than 15 cm (0.5 ft), 6 cm is the minimum we can measure.
- A cross section with flow distributed evenly across the channel.
- Sites should not be immediately downstream of sharp bends or vertical drops

Meeting all of the selection criteria is often not possible. The crew should choose the best available cross section based on these characteristics.

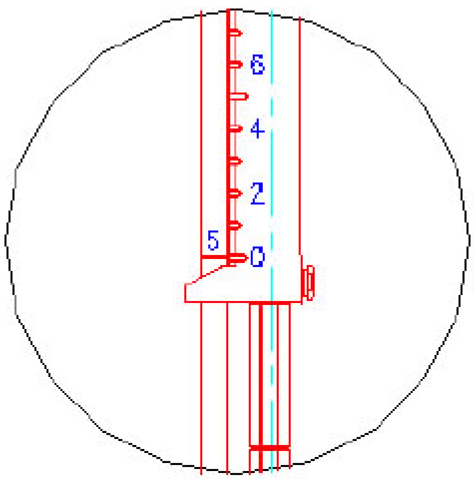
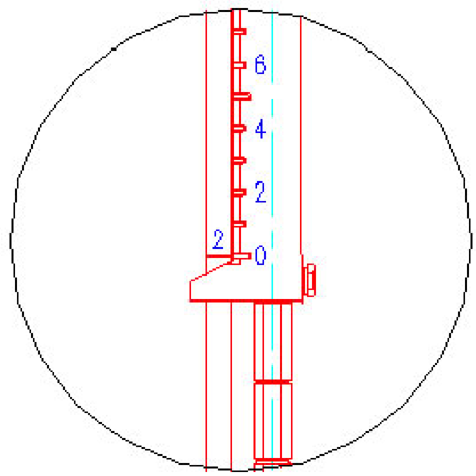
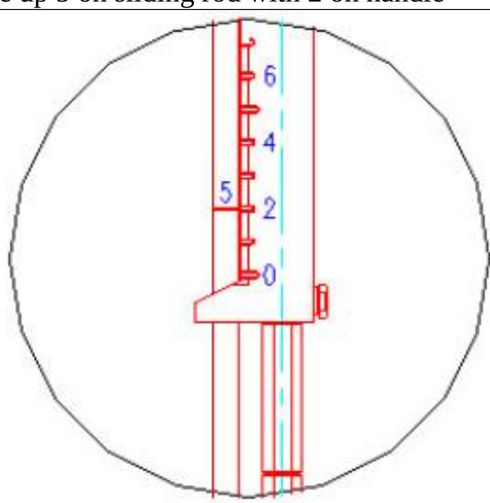
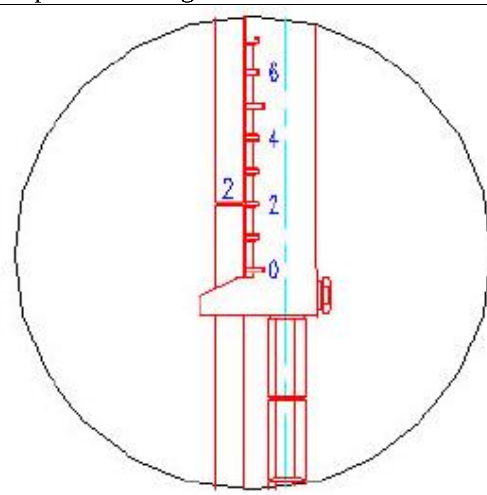
Measurement Locations:

Stretch the meter tape across the transect perpendicular to flow. Pull the tape as tight as possible and secure it on both the left and right banks. Divide the wetted stream width by 10 to create 10 evenly spaced cells across the stream. Measure water depth in middle of cell to determine if 1 or 2 water velocity readings are required (see following pages). Record water velocity reading(s) at the mid-point of each cell. For example, if the stream is 10 m wide, take velocity reading(s) at 0.5, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5, and 9.5 meters.



Using the top setting rod:

For depths measuring 6 cm to 75 cm (0.2 ft to 2.5 ft) record one velocity reading with probe set to 0.6 of the total depth from the water surface (0.4 of the total depth from the bottom). Examples of how to set the probe to 0.6 depth are shown below:

Example 1:	
Metric Rod	English Rod
Water depth 50 cm Record 1 velocity reading Set to 0.6 from surface (20 cm from streambed) Line up 5 on sliding rod with 0 on handle	Water depth 2.0 ft. Record 1 velocity reading Set to 0.6 from surface (0.8 ft from streambed) Line up 2 on sliding rod with 0 on handle
	
Example 2:	
Water depth 52 cm Record 1 velocity reading Set to 0.6 from surface (21 cm from streambed) Line up 5 on sliding rod with 2 on handle	Water depth 2.2 ft. Record 1 velocity reading Set to 0.6 from surface (0.88 ft from streambed) Line up 2 on sliding rod with 2 on handle
	

Note: our equipment cannot obtain velocity readings where water depth is less than 6 cm (0.2 ft.). If water depth is less than 6 cm in a cell record the depth on the datasheet and in comments indicate no velocity reading – too shallow.

For depths equal to or greater than 75 cm (2.5 ft.) obtain 2 velocity readings with the probe set to 0.2 and 0.8 of the total depth from the water surface. Set the rod to 0.2 and 0.8 of the total depth as shown in the examples below:

Example 1 (metric rod):

Water depth is 88 cm in cell 5, so a reading at 0.2 and a reading at 0.8 are required for the cell 5.

To obtain rod setting for 0.2 reading multiply water depth by 2.
88 * 2 = 176
Line up 17 on sliding rod with 6 on handle (probe will be 70.4 cm from stream bed)
Record the velocity reading for the 0.2 depth.

To obtain the rod setting for 0.8 reading multiply water depth by 0.5.
88 * 0.5 = 44
Line up 4 on sliding rod with 4 on handle (probe will be 17.6 cm from stream bed)
Record the velocity reading for the 0.8 depth.

Note that no reading is needed at 0.6 of total depth.

Example 2 (English rod):

Water depth is 2.8 ft. in cell 5, so a reading at 0.2 and a reading at 0.8 are required for the cell 5.

To obtain rod setting for 0.2 reading multiply water depth by 2.
2.8 * 2 = 5.6
Line up 5 on sliding rod with 6 on handle (probe will be 2.2 ft. from stream bed)
Record the velocity reading for the 0.2 depth.

To obtain the rod setting for 0.8 reading multiply water depth by 0.5.
2.8 * 0.5 = 1.4
Line up 1 on sliding rod with 4 on handle (probe will be 0.6 ft. from stream bed)
Record the velocity reading for the 0.8 depth.

Note that no reading is needed at 0.6 of total depth.

Section 7: Water Chemistry Sampling

Water chemistry sampling consists of both on-site measurements and water sample collections. Sampling may be completed by either CATT or Ouachita National Forest at any time during the collection of BASS data. Close coordination between CATT and Ouachita National Forest is needed to determine where, when, and who will be completing water chemistry samples.

Sample Sites

All water chemistry samples will be collected at a single easily accessible site near the downstream end of the physical inventory reach. Alternative sites may be considered if no good access point is near the downstream end of the physical inventory reach. The GPS location for each sample should be recorded along with a written description of site access.

For GPS location record waypoint name as WC + stream number, for example on stream 5 record WC5.

On-site Water Chemistry Measurements

A Vernier Meter or equivalent will be used to record DO, pH, hardness, and conductivity per standard operating procedures provided by the Ouachita National Forest.

Water Sample Collection (ADEQ methodology)

Water samples for lab analysis are collected following the ADEQ standard operating procedures (SOPs) for surface water sampling in wadeable streams. The latest SOPs should be acquired from ADEQ prior to sample collection.

Note that analysis is time sensitive and samples must be kept on ice or refrigerated. Careful coordination among Ouachita National Forest personnel, BASS field crew, and ADEQ is required to assure that samples are collected and stored properly and analyzed in a timely manner.

Appendix: Master Equipment List

Copy the master list into excel to create check lists for field use.

Equipment	Essential	Ideal	Source	Physical	Biological	Water Chem	Discharge
Backpack	3	4	CATT	X	X	X	X
Backup paper datasheets for all types of sampling			CATT	X	X	X	X
Battery charger (AA)	2	3	CATT	X	X	X	X
Bee killer spray for gate locks	4	6	Ouachita	X	X	X	X
Bow saws	4	4	CATT	X	X	X	X
Camera (regular or GPS)	2	4	CATT	X	X	X	X
Camera charger	2	4	CATT	X	X	X	X
Camping equipment			CATT	X	X	X	X
Clipboards	2	3	Ouachita	X	X	X	X
Directions	2	2	Ouachita	X	X	X	X
District maps	2 sets	3 sets	Ouachita	X	X	X	X
Electronic data logger: iPad	2	3	CATT	X	X	X	X
Emergency Contact Sheet	1 per person	1 per person	Ouachita	X	X	X	X
Field protocol for BASS	1 per person	1 per person	CATT	X	X	X	X
First Aid kit - truck	2	3	Ouachita	X	X	X	X
First Aid kit - backpack	4	6	CATT	X	X	X	X
Flagging - orange	A lot	A lot	Ouachita	X	X	X	X
Framepack	3	4	CATT	X	X	X	X
FS Radio	2	3	Ouachita	X	X	X	X
FS Radio batteries			Ouachita	X	X	X	X
Gate keys	2 sets	3 sets	Ouachita	X	X	X	X
GPS (truck)	2	3	CATT	X	X	X	X
GPS with waypoints (mobile)	2	4	CATT	X	X	X	X
Hardhat	1 per person	8	CATT	X	X	X	X
Hot weather gear (cooling towels, light weight clothes, etc)			Self	X	X	X	X
Hydrocorisone ointment / cream / Tecnu			Self	X	X	X	X
Insect repellent			Self	X	X	X	X
iPad Chargers	2	3	CATT	X	X	X	X
Laptop	1	2	CATT	X	X	X	X
Lunch			Self	X	X	X	X
Moleskin / antibiotic ointment / waterproof bandages			Self	X	X	X	X

Equipment	Essential	Ideal	Source	Physical	Biological	Water Chem	Discharge
Pencils	A lot	A lot	Ouachita	X	X	X	X
Permits & JHA	2	3	Ouachita	X	X	X	X
Power strip	2	3	CATT	X	X	X	X
Rain gear			Self	X	X	X	X
Sharpies / markers	A lot	A lot	Ouachita	X	X	X	X
Site Location Maps	2 sets	3 sets	CATT	X	X	X	X
SPOT Unit	2	3	CATT	X	X	X	X
SPOT unit batteries			CATT	X	X	X	X
Sunscreen			Self	X	X	X	X
Tailgate meeting checklist	1 per person	1 per person	CATT	X	X	X	X
Tick remover kit	1 per person	1 per person	Self	X	X	X	X
Toilet paper	A lot	A lot	Self	X	X	X	X
Tools / Fix-it kit	2	2	CATT	X	X	X	X
Topography maps	2 sets	3 sets	Ouachita	X	X	X	X
Truck keys (extra)	2	2	Ouachita	X	X	X	X
Truck keys (primary)	2	2	Ouachita	X	X	X	X
Vehicle logs	1 per vehicle	1 per vehicle	Ouachita	X	X	X	X
Vehicle power inverter	2	3	CATT	X	X	X	X
Vehicles with cages	2	3	Ouachita	X	X	X	X
Volunteer agreements	1 per person	1 per person	CATT	X	X	X	X
Wading Boots	1 pair per person	1 pair per person	CATT	X	X	X	X
Wading Socks	1 pair per person	1 pair per person	CATT	X	X	X	X
Walking rod / stick			Self	X	X	X	X
Water			Self	X	X	X	X
Water jug			Self	X	X	X	X
Water jug for truck	2	3	CATT	X	X	X	X
Water purification pump	2	3	CATT	X	X	X	X
Waterproof work gloves (non-electrofishing)			Self	X	X	X	X
Weather Forecast	1	1	Lee	X	X	X	X
WEX or other fleet gas card	1 per vehicle	1 per vehicle	Ouachita	X	X	X	X
Ziplock bags	A lot	A lot	CATT	X	X	X	X

Equipment	Essential	Ideal	Source	Physical	Biological	Water Chem	Discharge
External hard drive	1	2	CATT	X	X	X	X
Wet Wipes	A lot	A lot	CATT	X	X	X	X
Duct Tape	A lot	A lot	CATT	X	X	X	X
Electrical Tape	A lot	A lot	CATT	X	X	X	X
Smaller rulers with mm delineated	4	8	Ouachita	X	X		
Meter Tape	2	4	Ouachita	X			X
Clinometer	2	3	Ouachita	X			
Concave densiometer	2	3	Ouachita	X			
Habitat type flip book	2	3	Ouachita	X			
Long ruler with mm delineated	2	4	Ouachita	X			
Rosgen guide	2	3	CATT	X			
Wading rod	2	3	CATT	X			
Hipchain	2	3	CATT	X			
Hipchain String	69	100	CATT	X			
Aquarium nets	4	6	Ouachita		X		
Block nets	4	4	Ouachita		X		
Buckets (5 gal)	6	10	Ouachita		X		
Dipnets	2	4	Ouachita		X		
Electrofishing gloves	4	6	CATT		X		
Ethanol			Ouachita		X		
Fish list by creek	1 per person	1 per person	CATT		X		
Fishes of AR book	2	3	Ouachita		X		
Forceps	4	6	Ouachita		X		
Formalin, pre-mixed (10%)			Ouachita		X		
Macroinvertebrate ID cards	2 sets	4 sets	Ouachita		X		
Macroinvertebrate score forms	1 per person	1 per person	Ouachita		X		
Magnifier (hand held)	2	4	Ouachita		X		
Pelican case for shocker batteries	1	2	Ouachita		X		
Rat tail, if shocker has only 1 probe	2	3	Ouachita		X		
Rinse bucket	2	3	Ouachita		X		
Rite-in-the-rain paper (blank)	Few boxes	Few boxes	CATT		X		
Sample jars for fish	A lot	A lot	Ouachita		X		
Sample jars for invertebrates	A lot	A lot	Ouachita		X		
Shocker batteries	9	18	Ouachita		X		

Equipment	Essential	Ideal	Source	Physical	Biological	Water Chem	Discharge
Shocker battery chargers	4	5	Ouachita		X		
Shocker probes	4	6	Ouachita		X		
Shocker rain cover	2	2	Ouachita		X		
Smith Root shockers	2	3	Ouachita		X		
Squirt bottle	2	4	Ouachita		X		
Waders	1 per person	1 per person	CATT		X		
Wash bucket	2	3	Ouachita		X		
White pans	2	4	Ouachita		X		
Kick seine for invertebrates (3 ft square)	1	2	Ouachita		X		
Bucket aerators	3	4	Ouachita		X		
Bucket aerator batteries	A lot	A lot	Ouachita		X		
Ice cube trays	4	6	CATT		X		
Fish ID cards	2	3	CATT		X		
Buckets (2 gal)	6	10	Ouachita		X		
Viewing Container	3	4	CATT		X		
Coolers	Few	Few	Ouachita			X	
Ice			Ouachita			X	
Water sampling protocol for on-site water chemistry	1 per person	1 per person	CATT			X	
Discharge measurement instructions	1 per person	1 per person	CATT				X
March McBirney flow meter	2	3	Ouachita				X
March McBirney flow meter batteries			Ouachita				X
March McBirney flow meter manual	2	3	CATT				X
Stakes	4	6	Ouachita				X
Topsetting rod (4 ft)	2	3	Ouachita				X