Summary of Stream Inventories on the Francis Marion National Forest, South Carolina, 2019

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Project Type

Stream fish and habitat inventory.

Goal

Provide stream biota and habitat information needed for project-level and Forest-level planning.

Objective

Complete stream fish and habitat inventory in November 2019.

Approach

Forest identifies streams with gaps in fish or habitat information. The CATT trains and deploys field teams to complete inventories. The CATT provides project database for incorporation into Forest datasets.

Accomplishments

Completed 16 miles of habitat inventory on 22 streams using the basinwide visual estimation technique (BVET). Sampled fish in 6 streams at a total of 12 sites. Entered data into project database and provided to project partner.

Partners and Contacts

Forest Contact: Keith Whalen, Forest Fisheries Biologist

Project Summary

Periodic aquatic resource assessments provide the information National Forest managers need to effectively identify current status and trends, management options and impacts, and threats and impacts of fire, insects, disease, and other natural processes on aquatic resources. In 2019, Francis Marion National Forest partnered with the CATT to assess stream habitat and fish in high-priority management areas, the latest effort in a long history of inventory and monitoring partnerships on the Forest. Our current effort is intended to fill data gaps and update aquatic resource information needed for Forest- and project-level analyses. We will return to the Francis Marion in 2020 to continue stream assessments in high priority watersheds identified by the Francis Marion National Forest.

Field Methods

Appendix A

- Guide to Stream Habitat Characterization using the BVET Methodology in Coastal Plain Streams of the Francis Marion National Forest, SC

Appendix B

- Electrofishing Methods for Coastal Plain Streams, Francis Marion National Forest

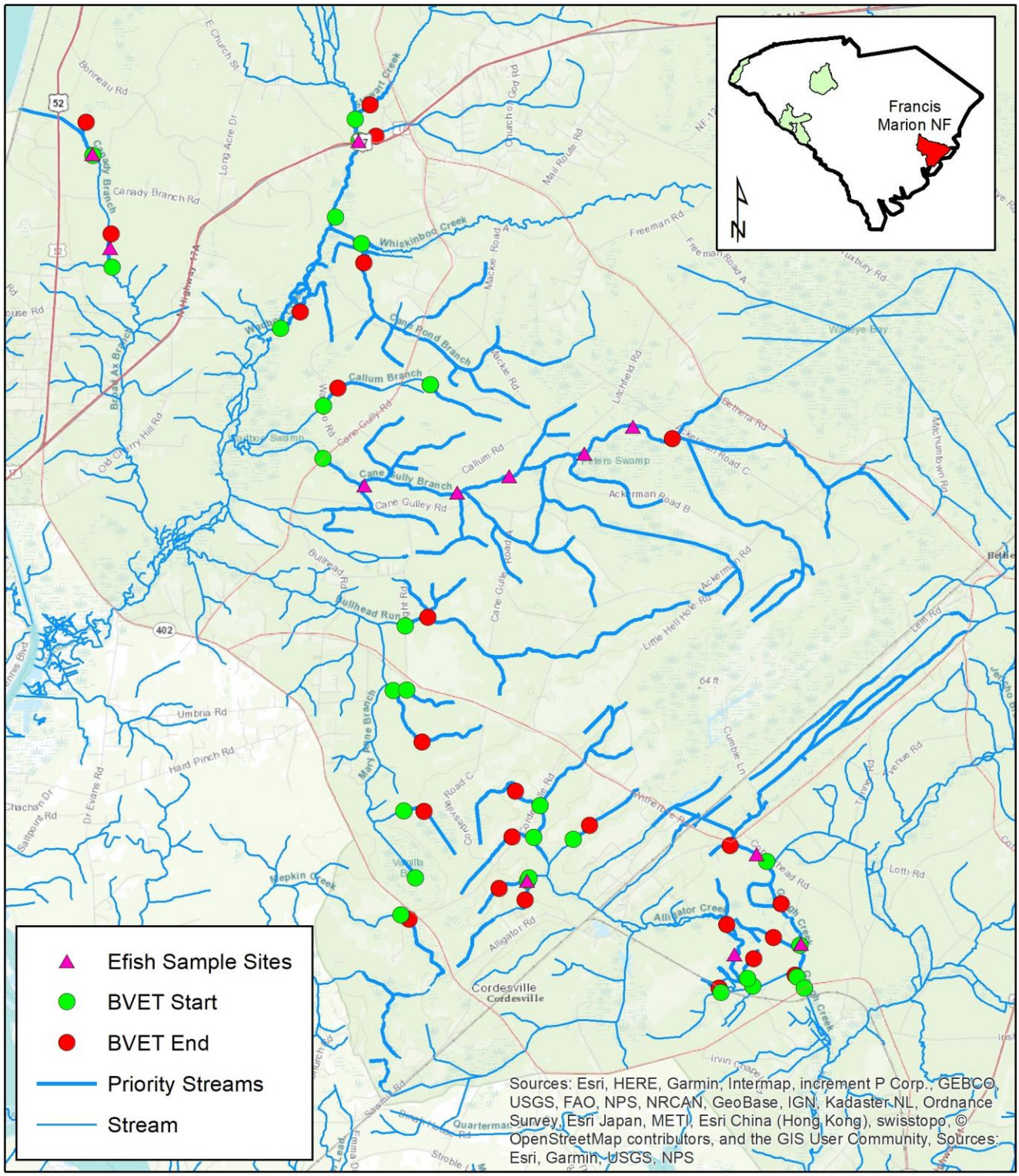

Figure 1. BVET inventory and electrofishing sample site locations on the Francis Marion National Forest, SC.

Table 1. Summary of BVET inventories completed on the Francis Marion National Forest, SC, 2019.

Priority Order	Stream	Inventory Dist. (m)	BVET Start Location	BVET End Location	Notes
1	Cane Gully Branch	10,070	Bridge on Cane Gully Rd.	Beginning of Peters Swamp (~0.7 km downstream of Litchfield Rd.)	heavy rain event on night of 3rd day's inventory, water level higher on 4th and final day of BVET
2	Bullhead Run	501	Bridge on Wright Rd.	Ended after 500 m of dry channel with some small isolated pools along way.	
3	Cane Pond Branch	501	Confleunce with Wiskinboo Cr. (dry at start)	Ended after 500 m of dry channel	
4	Gough Creek (section 1)	2,040	Bridge on Rt. 402	At property boundary	
	Gough Creek (section 2)	898	At property boundary near State Rd. 125	At powerline	
	Gough Creek Levee	500	Confluence with Gough Cr. (dry at start)	Ended after 500 m of dry channel	
5	Wadboo Creek	501	Property boundary	Ended after 500 m of dry channel	
6	Callum Branch (section 1)	501	Culvert on FS Rd. 128	Ended after 500 m of dry channel with some small isolated pools along way.	checked 1.6 km upstream at private/USFS boundary; no channel found

Table 1 continued. Summary of BVET inventories completed on the Francis Marion National Forest, SC, 2019.

Priority Order	Stream	Inventory Dist. (m)	BVET Start Location	BVET End Location	Notes
7	Alligator Creek (section 1)	48	Confluence with Gough Creek	Dry forest with no water or channel	Parked next to bridge. Start area is marsh. Small isolated pools; not enough to declare a stream.
	Alligator Creek (section 2)	1,895	Property boundary	Ended at Ned Dam; stream continues into larger swamp	
	Alligator Creek (section 3)	500	285m from FS256	Ended after 500 m of swamp	Super thick vegetation getting to start location; lots of islands with water “flowing” in multiple directions in swamp
8	Stewart Creek	500	Confluence with Wadboo Creek	Ended after 500 m of swamp	
9	Canady Branch (section 1)	1,020	Property boundary	Ended at USFS boundary	
	Canady Branch (section 2)	767	Property boundary	Channel with habitat units for 267 m then swamp for 500 m	
10	Mepkin Creek	315	Property boundary	Ended after 315 m of swamp	
11	Whiskinboo Creek	0	Could not find		Couldn't find/does not exist; no stream channel or swamp ever flow in on right of Wadboo Cr., walked over 250 m above and below waypoint for confluence location
12	Mary Anne Branch	0	Could not find		Couldn't find/does not exist; walked all around Vanilla Bay near stream line; area has been clear cut and vegetation is above head and extremely thick; channel was destroyed in cutting?
13	Island Branch	500	Confluence with Wadboo Creek	Ended after 500 m of swamp	

Table 2. Summary of BVET inventories, on unnamed tributaries, completed on the Francis Marion National Forest, SC, 2019.

Unnamed Tributary	Inventory Dist. (m)	BVET Start Location	BVET End Location	Notes
UT1 Alligator	405	Confluence with Alligator Cr. (dry at start)	Ended at USFS boundary and 405 m of dry channel	
UT7 Alligator	500	Property boundary	Ended after 500 m of swamp	
UT1UT7 Alligator	390	Confluence with trib. UT7 Alligator	Property boundary	
UT1UT8 Alligator	500	Confluence with Alligator Cr./swamp	500m of less than 0.5 m wetted width	
UT2UT8 Alligator	600	Small swamp at confluence with UT8 Alligator	Did not finish due to weather	Had to pause habitat survey due to weather and lack of time to complete.
UT1 CanalAlligator	82	Start of trib. to canal on FS property	Canal trib. runs into drainage ditch	
UT1 Mary Anne	1,368	Property boundry	Property boundry	
UT5 Mary Anne	500	Disused Forest rd.	Ended after 500 m of dry/swamp/<0.5 m wetted width	
UT1UT1 Mary Anne	0	Could not find		Couldn't find/does not exist

Table 3. Coordinates for the start location and end location of BVET inventories on the Francis Marion National Forest, SC, 2019.

Priority Order	Stream	Inventory Start		Inventory End	
		Latitude	Longitude	Latitude	Longitude
1	Cane Gully Branch	33.21913902	-79.91332639	33.22167565	-79.84732280
2	Bullhead Run	33.19243048	-79.89814080	33.19377482	-79.89387287
3	Cane Pond Branch	33.25316422	-79.90560099	33.25014305	-79.90516324
4	Gough Creek (section 1)	33.13436566	-79.82357314	33.14774864	-79.82778193
	Gough Creek (section 2)	33.15452241	-79.83039091	33.15710197	-79.83728992
	Gough Creek Levee	33.14112321	-79.82427944	33.14243000	-79.82930000
5	Wadboo Creek	33.23986778	-79.92101574	33.24244580	-79.91726523
6	Callum Branch (section 1)	33.22749818	-79.91309870	33.23027760	-79.91037408
7	Alligator Creek (section 1)	33.13608409	-79.82493431	33.13640026	-79.82528075
	Alligator Creek (section 2)	33.13477589	-79.83327566	33.14456805	-79.83809207
	Alligator Creek (section 3)	33.15837028	-79.86688659	33.16053934	-79.86373981
8	Stewart Creek	33.27291238	-79.90660449	33.27513409	-79.90372729
9	Canady Branch (section 1)	33.24985808	-79.95274988	33.25507318	-79.95290210
	Canady Branch (section 2)	33.26761343	-79.95617658	33.27288847	-79.95740140
10	Mepkin Creek	33.14665341	-79.89948222	33.14597274	-79.89795946
11	Whiskinboo Creek	33.25738931	-79.91049108	NA	NA
12	Mary Anne Branch	33.15252228	-79.89666862	NA	NA
13	Island Branch	33.26947425	-79.90586679	33.27018000	-79.90269000
Unnammed Tribs.	UT1 Alligator	33.13598637	-79.83426908	33.13911540	-79.83305246
	UT7 Alligator	33.15232500	-79.87529690	33.15072000	-79.88091000
	UT1UT7 Alligator	33.15187682	-79.87560745	33.14884000	-79.87608000
	UT1UT8 Alligator	33.15874206	-79.87430767	33.15881000	-79.87842000
	UT2UT8 Alligator	33.16374916	-79.87306179	33.16612000	-79.87767000
	UT1 CanalAlligator	33.13381994	-79.83929018	33.13449468	-79.83963978
	UT1 Mary Anne	33.18222124	-79.90055267	33.17403000	-79.89517000
	UT5 Mary Anne	33.16312994	-79.89878442	33.16300000	-79.89494000
	UT1UT1 Mary Anne	33.18231742	-79.89797129	NA	NA

Table 4. BVET inventory distance by habitat type and habitat area for inventoried streams on the Francis Marion National Forest, SC, 2019.

Priority Order	Stream	Inventory Distance (m) Pools & Glides	Riffles & Runs	Swamp	Dry Channel	Total	Habitat Area (m^2) Pools & Glides	Riffles & Runs
1	Cane Gully Branch	7,906	1,161	1,003	0	10,070	34,902	4,094
2	Bullhead Run	0	0	0	500	501	0	0
3	Cane Pond Branch	0	0	0	500	501	0	0
4	Gough Creek (section 1)	1,646	394	0	0	2,040	5,607	1,108
	Gough Creek (section 2)	830	0	0	68	898	1,423	0
	Gough Creek Levee	0	0	0	500	500	0	0
5	Wadboo Creek	0	0	357	143	501	0	0
6	Callum Branch (section 1)	0	0	0	500	501	0	0
7	Alligator Creek (section 1)	0	0	0	47	48	0	0
	Alligator Creek (section 2)	1,101	489	305	0	1,895	5,229	1,988
	Alligator Creek (section 3)	0	0	500	0	500	0	0
8	Stewart Creek	0	0	480	0	500	0	0
9	Canady Branch (section 1)	889	131	0	0	1,020	5,285	863
	Canady Branch (section 2)	187	80	500	0	767	846	358*
10	Mepkin Creek	0	0	315	0	315	0	0
11	Whiskinboo Creek	NA	NA	NA	NA	NA	NA	NA
12	Mary Anne Branch	NA	NA	NA	NA	NA	NA	NA
13	Island Branch	27	63	410	0	500	81*	96*
Unnammed Tribs.	UT1 Alligator	0	0	0	405	405	0	0
	UT7 Alligator	85	0	415	0	500	1,870*	0
	UT1UT7 Alligator	360	30	0	0	390	538	45*
	UT1UT8 Alligator	399	0	101	0	500	296	0
	UT2UT8 Alligator	308	43	249	0	600	416	66
	UT1 CanalAlligator	49	33	0	0	82	47*	19*
	UT1 Mary Anne	335	0	0	1,033	1,368	595	0
	UT5 Mary Anne	66	0	247	187	500	33*	0
	UT1UT1 Mary Anne	NA	NA	NA	NA	NA	NA	NA

*area calculated with uncalibrated width estimates due to insufficient paired units
NA = stream could not be found

Table 5. Summary of electrofishing inventories completed on the Francis Marion National Forest, SC, 2019.

Priority Order	Stream	BVET Km that Eifsh Reach is Within	Reach Length (m)	Wetted Wdith (m)	Area (m^2)	Efish Time (sec)	Water Temp. (C)	# Backpack Efishers Used	Crayfish Observed	Efish Inventory Start	
										Latitude	Longitude
1	Cane Gully Branch	1	227	5.7	1,286	1,939	11	2	Yes	33.21483497	-79.90557720
		3	300	9.0	2,690	2,370	12	2	No	33.21349931	-79.88799621
		5	209	5.2	1,094	1,613	10	2	Yes	33.21606564	-79.87818539
		7	235	5.9	1,379	1,983	12	2	Yes	33.21948376	-79.86395739
		9	167	4.2	696	757	10	2	No	33.22365852	-79.85477205
4	Gough Creek (section 1)	1	120	1.7	200	400	8	1	Yes	33.14134990	-79.82414634
	Gough Creek (section 2)	1	120	2.4	288	359	12	1	Yes	33.15566150	-79.83234057
7	Alligator Creek (section 2)	1	171	4.3	730	1,267	8	2	Yes	33.13981781	-79.83665599
9	Canady Branch (section 1)	1	167	4.2	696	2,767	9	2	No	33.25286857	-79.95311659
	Canady Branch (section 2)	1	136	3.4	462	1,284	8	2	No	33.26777205	-79.95624715
13	Island Branch	1	88	3.0	261	195	10	1	No	33.26944282	-79.90592379
UT	UT7 Alligator	1	120	1.1	136	374	11	1	Yes	33.15183642	-79.87566227

Table 6. Quantity of fish by species and stream sampled on the Francis Marion National Forest, SC, 2019.

		Cane Gully Branch					Gough Creek		Alligator Cr.	Canady Br.		Island	UT7
		Km	Km	Km	Km	Km	Sec. 1	Sec. 2	Sec. 2	Sec. 1	Sec. 2	Br.	Alligator
Scientific Name	Common Name	1	3	5	7	9	Km 1	Km 1	Km 1	Km 1	Km 1	Km 1	Km 1
Anguillidae													
Anguilla rostrata	American Eel	0	0	0	0	0	0	0	0	**11**	**4**	0	0
Aphredoderidae													
Aphredoderus sayanus	Pirate Perch	0	0	0	0	0	0	0	**1**	0	0	0	0
Atherinidae													
Labidesthes sicculus	Brook Silverside	0	0	0	0	0	0	0	0	**1**	0	0	0
Catostomidae													
Erimyzon oblongus	Creek Chubsucker	0	0	0	0	0	0	0	0	**6**	**3**	0	0
Centrarchidae													
Centrarchus macropterus	Flier	0	**1**	0	0	0	0	0	0	0	0	0	0
Lepomis auritus	Redbreast Sunfish	0	0	0	0	0	0	0	**1**	**3**	**1**	0	0
Lepomis macrochirus	Bluegill	0	0	0	0	0	0	0	0	**1**	0	0	0
Lepomis microlophus	Redear Sunfish	0	0	0	0	0	0	0	0	**3**	0	0	0
Lepomis punctatus	Spotted Sunfish	0	0	0	**3**	0	0	0	0	0	0	0	0
Micropterus salmoides	Largemouth Bass	0	0	0	0	0	0	0	0	**1**	0	0	0
Cyprinidae													
Notropis petersoni	Coastal Shiner	**1**	0	0	0	0	0	0	0	**56**	**19**	0	0
Esocidae													
Esox americanus	Redfin Pickerel	0	0	0	**1**	**1**	0	0	0	0	**1**	0	0
Ictaluridae													
Ameiurus natalis	Yellow Bullhead	0	0	0	**1**	0	0	0	0	0	0	0	0
Percidae													
Etheostoma fusiforme	Swamp Darter	0	0	0	0	0	0	0	0	**1**	**1**	0	0

Appendix A:

Guide to Stream Habitat Characterization using the BVET Methodology in Coastal Plain Streams of the Francis Marion National Forest, SC

Guide to Stream Habitat Characterization using the BVET Methodology in Coastal Plain Streams of the Francis Marion National Forest, SC

Prepared by:

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Introduction

The basinwide visual estimation technique (BVET) is a versatile tool used to assess streamwide habitat conditions in wadeable size streams and rivers. A crew of two individuals performs the survey using two-stage visual estimation techniques described in Hankin and Reeves (1988) and Dolloff et al. (1993). In its most basic form the BVET combines visual estimates with actual measurements to provide a calibrated estimate of stream area with confidence intervals, however the crew may inventory any number of other habitat characteristics as they walk the length of the stream. Experienced crews can survey an average of 2.0 – 3.0 km per day, but this will vary depending on stream size and the number of stream characteristics inventoried.

Before a crew begins a BVET survey they must receive adequate training, both in the classroom and in the field. Estimating and measuring a large number of habitat characteristics can confuse and overwhelm an inexperienced crew. Individuals must have an understanding of the basic concepts behind the BVET and be familiar with habitat characteristics before they can effectively and efficiently perform a survey.

The USFS Center for Aquatic Technology Transfer (CATT) has been working directly with resource managers on the Francis Marion National Forest (FMNF) since 2001 to implement BVET surveys and adapt them to the specific needs of the forest. This document was developed to serve as a guide for classroom and field instruction for the FMNF BVET habitat survey and to provide a post-training reference for field crews. It includes an overview of the BVET survey, defines habitat characteristics, instructs how and when to measure characteristics, and provides reference sheets for use in the field. Each trainee should receive a copy of this manual and is encouraged to take notes in the spaces provided.

References cited in this manual:

Armantrout, N. B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland.

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

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

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, Colorado.

Changes to the 2019 manual:

Attribute	Action	Reason
Distance	Modified	We shortened the paired sample interval from 300 m to 150 m. Previous inventories showed that most streams were too short to gather enough paired samples for calibration using a 300 m interval. The 150 m interval will provide more paired samples for calibration of visual estimates.
Rooted macrophytes	Removed	Project partner did not need this data
Bank instability	Removed	Project partner did not need this data
Canopy cover	Removed	Project partner did not need this data

Other minor changes, mostly modifications in terminology and definitions to provide increased clarity are found throughout the manual.

Outline of BVET Habitat Survey

The survey is comprised of the following steps:

1. Enter 'header' information in the data sheet
    - 'Header' information includes date, stream, start location, crew, etc. and is **vitally important** to record for future reference

2. Know the estimate and measurement intervals
    - Visual estimates are made at least once every 30 m and at habitat unit breaks, and measurements are made at 150 m intervals

3. Enter downstream of the starting point, then move upstream and begin the survey
    - Tie off the hipchain, proceed upstream to the starting point, reset the hipchain to zero, and proceed upstream estimating parameters and recording data in every 30 m section

4. At 150 m intervals perform visual estimates, then perform measurements
    - At 150, 300, 450, 600, etc. meters stop and make a visual estimate of stream characteristics, then make the necessary measurements

5. Proceed upstream estimating characteristics at least once every 30 m and at habitat unit breaks, then repeat step 4
    - In the above example, the crew would stop at the 30 meter intervals and habitat unit breaks to make visual estimates, they would stop at 150 meter intervals to make paired samples – visual estimates followed by measurements

The following sections describe the BVET habitat survey in detail:

Section 1: Getting Started – equipment lists, header information, starting the survey

Section 2: Habitat Characteristics – definitions, how to measure, when to record

Section 3: Wrapping Up – what to do when the survey is complete

Appendix: field guide, equipment checklist

Section 1: Getting Started

Equipment List

hipchain	backpack
extra string for hipchain	pencils
wading rod marked in 5 cm increments	flagging
50 m tape measure	markers
clinometer	SPOT unit
thermometer	BVET manual and field guide
iPad	topographic maps
GPS unit	Hardhat
stakes for bankfull measurements	wading boots

Other useful equipment: lunch, water, water filter, 1st aid kit, toilet paper, rain gear, radio/cell phone

The crew consists of two individuals, the 'observer' and the 'recorder'. The observer wears the hipchain and carries the wading rod. The recorder wears the data logger and carries other equipment in the backpack. The duties of each individual are listed below.

Duties

Observer	Recorder
Designate habitat units	Record data
Measure distance	Classify and count LW
Estimate width	Document features
Estimate depths	Assist with measurements
Classify substrates	
Make measurements	

Both crew members are needed to make channel morphology and actual width measurements every 150 m. Although the crew has assigned duties, they should not hesitate to consult with each other if they have questions or feel that a mistake may have been made. Working as a team will provide the best possible results.

Header Information

Header information is **vitally important** for future reference. Take the time to record all categories completely and accurately.

Stream Name	Full name of stream as designated on USGS quadrangle map
District	Forest Service District name
Quad	Name of USGS 1:24,000 quadrangle on which survey start point is located
Date	Record date(s) of survey
Recorder	Full name of recorder
Observer	Full name of observer
GPS	coordinates at start and end of survey, always use NAD27 CONUS, UTM
Start Location	**Detailed** description of start point, use features found on quadrangle map
Notes	Record signs of activity in area, water conditions, other pertinent information

Starting the Survey

After the crew has organized their gear and filled in the header information, including a **detailed** description of the survey start point on their data logger or data sheet, they are ready to begin the habitat survey. The observer should enter the stream slightly downstream of the starting point, tie off the hipchain, progress upstream to the starting point, reset the hipchain to zero and begin walking upstream through the first habitat unit.

As the observer moves upstream they use the wading rod to measure water depth at several locations in the wetted channel and make observations of unit type, wetted width, and substrate. When they reach the upstream end of the habitat unit or the end of a 30 m interval they stop, turn to face the recorder and report the distance, unit type, estimated wetted width, maximum and average depth, dominant and subdominant substrate classes to the recorder.

The recorder follows the observer up through the unit and records the amount of LWD in the habitat unit. The recorder also assigns a number to the habitat unit. It is also the responsibility of the recorder to remind the observer to stop at 150 m intervals to perform measurements.

The crew continues upstream making estimates in every 30 m section and at each habitat unit break and making estimates and measurements every 150 m until the survey endpoint is reached.

Note: it is not possible to perform the survey when swamp habitat types are encountered. Water becomes dispersed across a wide area and trees such as cypress are growing within the wetted area. When swamps are encountered, simply continue upstream stopping every 30 meters to record swamp as the habitat type, and if possible, estimate the wetted width of the swamp. If possible, continue upstream at least 500 m into the swamp to determine if the stream returns to a channel. If after 500 m it does not appear that the stream will return to a channel, end the survey and follow your hipchain string out of the swamp. If possible, you may access the stream from a known location further upstream.

Definitions of habitat characteristics, how to measure them, when to record them, and what to do when the survey is complete are covered in the following sections.

Section 2: Stream Attributes

Unit Type (see abbreviations)

Definitions:*

Unit Type	Abbreviation	Definition
Riffle	**R**	**Fast water, turbulent, gradient <12%**; shallow reaches characterized by water flowing over or around rough bed materials that break the surface during low flows; also **includes rapids** (turbulent with intermittent whitewater, breaking waves, and exposed boulders), **chutes** (rapidly flowing water within narrow, steep slots of bedrock), and **sheets** (shallow water flowing over bedrock) if gradient <12%
Cascade	**C**	**Fast water, turbulent, gradient ≥12%**; highly turbulent series of short falls and small scour basins, with very rapid water movement; also **includes sheets** (shallow water flowing over bedrock) and **chutes** (rapidly flowing water within narrow, steep slots of bedrock) if gradient ≥12%
Run	**RN**	**Fast water, non-turbulent, gradient <12%**; deeper than riffles with little or no surface agitation or flow obstructions and a flat bottom profile
Pool	**P**	**Slow water, surface turbulence may or may not be present, gradient <1%**; generally deeper and wider than habitat immediately upstream and downstream, concave bottom profile; **includes dammed pools, scour pools, and plunge pools**
Glide	**G**	**Slow water, no surface turbulence, gradient <1%**; shallow with little to no flow and flat bottom profile
Swamp	**S**	Channel poorly defined or non-existent, water dispersed across wide area
Underground	**UNGR**	Stream channel is dry or not containing enough water to form distinguishable habitat units

*modified from Armantrout (1998)

How to estimate:

Habitat units 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 habitat units and where the exact location of the break occurs. When in doubt, the observer should consult with the recorder and the team should 'think like a fish'. To determine if a break should be made, consider whether a fish would have to make an effort to move across the break and into the next habitat unit. If not, then it is probably a single habitat unit.

In coastal plain streams breaks may be very subtle. The channel may switch from fast water to slow water with no physical break between units. In this case locate the point where the fish would consider itself to have moved from one habitat type to the next, for example, where the fish would have to make extra effort to hold its position when moving from a pool to a run.

The crew will also encounter areas with mixed habitat units. For example, the channel may have both pool and riffle type habitat in the same cross-sectional area. Determine the predominate habitat type (through which most flow is occurring, thalweg) and record it as the unit type. For example if an area contains both pool and riffle, but the majority of the flow is into and out of the pool habitat, then call a pool.

Questions also often arise as to the minimum size of individual habitat units. Generally, if a habitat unit is not at least as long as the wetted channel is wide, then do not count it as a separate habitat unit. This general rule may need to be adjusted for streams wider than 5 m. Best professional judgment should be used in these situations.

See ‘Features’ section for a list of other stream features that should also be recorded while performing the survey.

When to record:
Every habitat unit break, 30 m interval, 150 m interval

Unit Number (#)

Definition:
Count of habitat units of similar types

How to estimate:
When counting habitat units, group pools and glides (slow water) together, and group riffles, runs, and cascades (fast water) together. For example, consider the following series of habitat units:

Pool – Glide – Pool – Pool – Run - Pool – Riffle

Habitat units in this series would be counted in the following manner (similar types are shaded same color):

Unit Type	Unit Number
P	1
G	2
P	3
P	4
RN	1
P	5
R	2

In the above example, the crew has counted five pool/glide (slow water) units and two riffle/run/cascade (fast water) units.

When to record:
Every habitat unit break, 30 m interval, 150 m interval

Distance (m)

Definition:
Number of meters from the start of the survey to the upstream end of the habitat unit (riffle, pool, etc.) or distance from the start of the survey to the upstream end of a feature (culvert, bridge, tributary, sidechannel, etc.), used as spatial reference for data analysis and to locate features in the future

How to estimate:
The observer walks upstream in the middle of the stream channel with a hipchain; a device to measure distance. When they reach the upstream end of the unit or a 30 m or 150 m interval (or the upstream end of a feature) the observer stops and reports the distance to the recorder.

Be sure the hipchain string follows the middle path of the stream around bends and meanders by looping the string around branches or other objects. If the hipchain should break, retreat to the location where the break occurred, tie off the hipchain, and continue. If the hipchain is reset for any reason be sure to make a note in the comments.

When to record:
Every habitat unit break, 30 m interval, 150 m interval

Note on unit numbers and distances in units longer than 30 meters

If a habitat unit is longer than 30 m, the crew breaks the habitat unit into 30 m sections and makes visual estimates of habitat characteristics at the 30 m intervals. **The unit number for all 30 m sections within a single habitat unit should be the same.** Consider the following series of habitat units as an example:

Pool (166m long) – Glide (21 m long) – Pool (162 m long) – Run (20 m long)

Unit Type	**Unit Number**	**Distance (m)**	***Explanation***
P	1	30	*Visual estimate in pool 1 at 30 m interval*
P	1	60	*Visual estimate in pool 1 at 30 m interval*
P	1	90	*Visual estimate in pool 1 at 30 m interval*
P	1	120	*Visual estimate in pool 1 at 30 m interval*
P	1	**150**	*Visual estimate + **measurement** in pool 1*
P	1	166	*Visual estimate in pool 1 at habitat unit break*
G	2	187	*Visual estimate in glide 2 at habitat unit break*
P	3	210	*Visual estimate in pool 3 at habitat unit break* *-note the return to a 30 m interval here*
P	3	240	*Visual estimate in pool 4 at 30 m interval*
P	3	270	*Visual estimate in pool 4 at 30 m interval*
P	3	**300**	*Visual estimate+**measurement** in pool 4 at 300 m interval*
P	3	330	*Visual estimate in pool 4 at 30 m interval*
P	3	349	*Visual estimate in pool 4 at habitat unit break*
RN	1	369	*Visual estimate in run 1 at habitat unit break*

Estimated Width (m)

Definition:
Average wetted width of the habitat unit as estimated visually, used to calculate stream area. Wetted width is the average distance from the left edge to the right edge of the water within the main stream channel.

How to estimate:
The observer notes the general shape of the unit or section while walking to the upstream end. When they reach the upstream end of the unit or a 30 m or 150 m interval the observer stops, turns to face the unit, and estimates the average wetted width.

When to record:
Every habitat unit break, 30 m interval, 150 m interval

Maximum and Average Depth (cm)

Definitions:

Maximum Depth –	vertical distance from streambed to water surface at the deepest point in the habitat unit or section
Average Depth –	average vertical distance from streambed to water surface throughout the habitat unit or section

How to estimate:
The observer uses a wading rod marked in 5 cm increments to measure the water depths as they walk upstream through the habitat unit or section. Water depth in the deepest spot is recorded as the maximum depth. Average depth is the average of several depth measurements taken throughout the habitat unit or section.

When to record:
Every habitat unit break, 30 m interval, 150 m interval

Dominant and Subdominant Substrate (1-9)

Definitions:

Dominant Substrate – size class of material that covers the greatest amount of surface area in the wetted channel of the habitat unit

Subdominant Substrate – size class of material that covers the 2nd greatest amount of surface area in the wetted channel of the habitat unit

How to estimate:

The following size classes are used to categorize substrates*. The substrate 'Number' is entered into the dominant and subdominant substrate columns on the datasheet.

Type	Number	Size (mm)	Description
Organic Matter	1		dead leaves, detritus, etc. – **not live plants**
Clay	2		sticky, holds form when rolled into a ball
Silt	3		slippery, does not hold form when rolled into a ball
Sand	4	Silt-2	grainy, does not hold form when rolled into ball
Small Gravel	5	3-16	sand to thumbnail
Large Gravel	6	17-64	thumbnail to fist
Cobble	7	65-256	fist to head
Boulder	8	>256	larger than head
Bedrock	9		solid rock, parent material, may extend into bank

** these size classes are based on the modified Wentworth scale*

As the observer walks through the unit they scan the substrate. When they reach the upstream end of the unit or a 30 m or 150 m interval the observer stops, turns to face the unit, and determines the dominant and subdominant substrates.

Estimate substrate size along the intermediate axis (b-axis). The b-axis is not the longest or shortest axis, but the intermediate length axis (see below). It is the axis that determines what size sieve the particle could pass through.

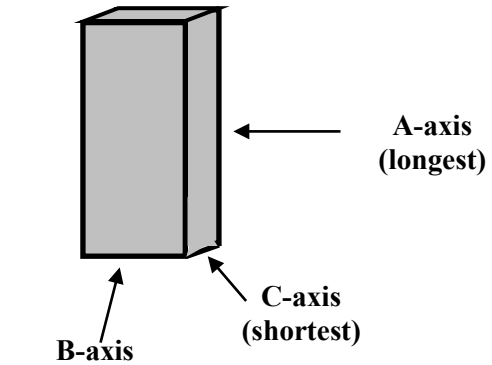
Remember that your eyes are naturally drawn to larger size substrates. Be careful not to bias your estimate by focusing on the large size substrate.

Some units will contain a mixture of particle sizes. Consult with the recorder and use your best professional judgment to choose the dominant and subdominant sizes.

In units where the substrate is covered in moss, algae, or macrophytes classify the underlying substrate and make note of the plant growth in the comments. Only call organic substrate where there are dead and down leaves or other detritus covering the bottom of the unit.

When to record:

Every habitat unit break, 30 m interval, 150 m interval



Large Wood (1-4)

Definition:
Count of dead and down wood within the bankfull channel of a habitat unit

How to estimate:
The recorder classifies and counts LWD as they walk through the habitat unit. LWD counts are grouped by the size classes listed below:

Category	Length (m)	Diameter (cm)	Description
1	<5	10-55	short, skinny
2	<5	>55	short, fat
3	>5	10-55	long, skinny
4	>5	>55	long, fat
RW	rootwad	rootwad	roots on dead and down tree

Only count wood that is:
- > 1.0 m in length and > 10.0 cm in diameter
- within the bankfull channel
- fallen, not standing dead

- Count rootwads separately from attached pieces of LWD
- Estimate the diameter of LWD at the widest end of the piece
- A piece that is forked, but is still joined counts as only one piece of LWD
- Only count each piece one time, do not count a piece that is in two habitat units twice
- Enter the total count for each size category into the appropriate column on the datasheet

When to record:
Every habitat unit break, 30 m interval, 150 m interval

Actual Width (m)

Definition:
Average wetted width of channel at 150 m interval, measured with a meter tape

How to measure:
Use a meter tape to measure the wetted width of the channel at the 150 m interval point (at the same location as the visual estimate)

When to record:
150 m interval*****

***Note**: Do not perform this measurement in a swamp, rather make the measurement at the next available opportunity (where the stream returns to a channel) and continue with the normal intervals thereafter. For example if you are in a swamp at 150 m and the stream does not return to a channel until 250 m, make a measurement at 250 m, then return to your normal 150 m intervals and make the next measurement at 300 m.

Bankfull Channel Width (m)

Definition:
Average width of channel at bankfull elevation measured with meter tape. Depending on channel type, bankfull may or may not be represented by the top of the banks. Use bankfull indicators to locate the top of the bankfull channel (Rosgen 1996).

How to measure:
Determine the location of bankfull water depth on both banks of the habitat unit and measure across the channel perpendicular to flow from top of bankfull to top of bankfull.

When to record:
150 m interval, do not record in swamp (see note in 'Actual Width')

Average Bankfull Depth (cm)

Definition:
Average depth from bottom of stream channel to top of bankfull channel across bankfull width transect, measured with wading rod

How to measure:
With meter tape stretched across top of bankfull channel take at least five depth measurements across the transect (depth from channel bottom to height of meter tape) and determine the average

When to record:
150 m interval, do not record in swamp (see note in 'Actual Width')

Riparian Width (m)

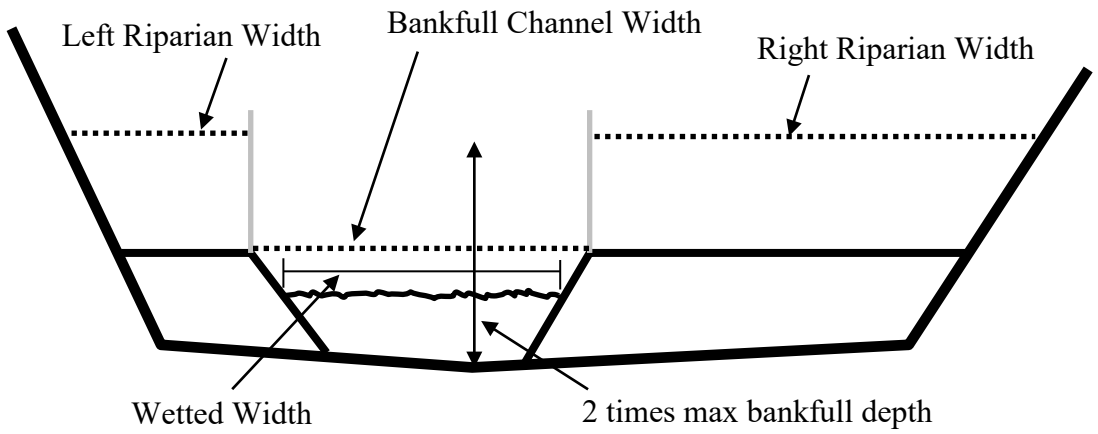
Definition:
Width of the riparian area at an elevation of two times the maximum bankfull depth, measured for both left and right banks (left and right as oriented facing upstream). Maximum bankfull depth is the greatest vertical distance from the substrate to the top of the bankfull channel across a bankfull transect.

How to measure:

1. Stretch a measuring tape across the top of the bankfull channel – this is your bankfull transect
2. Use a wading rod to find the maximum bankfull depth along the transect
3. Place the clinometer against the wading rod at two-times the maximum bankfull depth
4. Using the clinometer to maintain a slope of zero degrees, site perpendicular to the channel to the intersection with the nearest landform. It may be necessary to site to an intermediate point, move the wading and clinometer, and site again if the tape measure is too short or the view is obstructed
5. Measure the distance from the edge of the bankfull channel to the landform – do this separately for the left and right (as facing upstream) riparian areas

Note: if riparian width is more than 50 m, record 51 as the riparian width and note in 'Comments' that riparian width was longer than meter tape

Where to measure:
150 m interval, do not record in swamp (see note in 'Actual Width')



Gradient (%)

Definition:
Change in vertical elevation per unit of horizontal distance of the water surface (Armantrout 1998)

How to measure:
Gradient is measured in riffles with a clinometer using the following steps:

- Observer stands at upstream end of riffle, recorder stands at downstream end of riffle
- Recorder sites upstream to the height of their eye on the observer using clinometer
- Record the **percent** slope, **not the degrees** (tip the clinometer all the way back to determine which side of the scale is percent)

The recorder should determine the height of their eye on the observer at the beginning of the inventory. Be certain that the observer and recorder are standing with their feet in the same position (preferably with feet at top of water surface) within the stream channel. If the observer is standing on top of a boulder and the recorder is standing in a depression, the measured gradient will be incorrect.

Where to measure: paired sample riffles, runs, or cascades

Bank Height (cm)

Definition:
Vertical distance from edge of bankfull channel to top of bank, measured for both left and right banks (as facing upsteam)

How to measure:
Measure with wading rod or tape measure the vertical distance from the edge of the bankfull channel to the top of the bank (these will be different in entrenched channels), record left and right banks separately

When to record:
150 m interval, do not record in swamp (see note in 'Actual Width')

Riparian Vegetation (0-4)

Definition:
Category describing the dominant vegetation type in the riparian area, estimated for both left and right riparian areas

How to measure:
Look at riparian areas on left and right of stream, assign a category number that best describes the majority of the area that is within the left and right riparian areas based on the following descriptions:

Category	Description
0	Developed or disturbed, little or no vegetation, describe development in 'Comments' section, example: paved road parallel to stream, housing development, corn field, etc.
1	A few widely scattered trees, little overhead canopy in most areas, shrubs, grasses and herbaceous plants dominant
2	Forested, overhead canopy in most areas, pine trees dominant
3	Forested, overhead canopy in most areas, cypress dominant
4	Forested, overhead canopy in most areas, hardwoods dominant

When to record:
150 m interval, do not record in swamp (see note in 'Actual Width')

Water Temperature (C)

Definition:
Temperature of water in main channel as measured with thermometer

How to measure:
Place thermometer underwater in area with flow out of direct sunlight, leave thermometer in place for at least two minutes, then read temperature in degrees Celsius

When to record:
150 m interval, do not record in swamp (see note in 'Actual Width')

Features

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

How to measure: Record the distance to the upstream end of a feature, measure characteristics of features and record them in the 'Comments' section of datasheet

When to record: Wherever found, record distance to most upstream point of feature

Feature	Abbreviation	What to Record
Channel Features		
Waterfall[1]	**FALL**	Distance, estimated height
Tributary	**TRIB**	Distance, average wetted width, on left or right (as facing upstream)
Gully[2]	**GU**	Distance, width, bank height, on left or right (as facing upstream)
Side channel[3]	**SCH**	Distance, average wetted width, whether it is flowing into or out of main channel on left or right (as facing upstream)
Braid[4]	**BRD**	Distance at start and distance at end; continue with normal survey up channel with greatest discharge
Seep (Spring)	**SEEP**	Distance, on left or right (as facing upstream), size, coloration
Landslide	**SLID**	Distance, on left or right (as facing upstream), estimated size
Crossing Features		
Culvert[5]	**V**	Distance, length, type (single pipe, cement box, etc.), size (diameter or height), road or trail name and type (gravel, paved, unpaved horse trail, ATV, etc.), perched or not perched, slope
Bridge	**BRG**	Distance, width, height, road or trail name and type (gravel, paved, dirt, horse, ATV, etc.)
Ford	**FORD**	Distance, road or trail name and type (gravel, paved, dirt, horse, ATV, etc.)
Dam	**DAM**	Distance, type, condition, estimated height, dam use, name of road or trail, if applicable; include beaver dams
Other	**OTR**	Distance, description of feature not listed above, 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 narrow channel formed by rapid erosion, may be several meters deep, carries water only during and immediately after rain, perennial flowing channels should be recorded as tributaries; note that they are entrenched in 'Comments'
3 two channels, continue with normal survey up channel with most volume
4 three or more channels intertwined, continue with normal survey up channel with most volume
5 continue with normal survey through culverts, if you can't walk through it then determine the habitat type, water depth, substrate (if any; you can leave substrate blank on culverts if none present, note this in comments), etc. by looking into the pipe and walk over the top of it with the hipchain

The abbreviation is recorded in 'Unit Type' and other information is recorded in appropriate location on datasheet or in 'Comments'. Features are not assigned a unit number. These features serve as landmarks for future surveys and can be important in data interpretation. Crews are encouraged to use the 'Comments' and 'Other' to help fully describe stream conditions.

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 3: Wrapping Up

End the survey where:

- Forest Service property ends
- stream channel becomes swamp for more than 500 m
- stream is dry for more than 500 m
- stream channel is < 0.5 m wide for more than 500 m

Record the following in the Comments:

- Time and date
- Reason for ending the survey
- GPS coordinates
- Detailed written description of location using landmarks for reference

** be sure the header information is completed **

When you return to home base:

- Immediately download the data and check file to be sure all data downloaded
- Check header information to be sure it is complete – especially a detailed description of starting point!
- Note in all files if more than one file was used during the survey
- Save to the computer and create a backup copy
- If using paper, make a photocopy of the data and store in secure location
- Record on master list that survey is complete, with data and names of crewmembers
- Record starting and ending point of survey on set of master maps

Section 4: Summary

Before starting, know your interval and fill in header information

Record for every habitat unit, 30 m interval, and 150 m interval:

- Unit Type
- Unit Number
- Distance
- Estimated Width
- Maximum Depth
- Average Depth
- Dominant Substrate
- Subdominant Substrate
- Large Wood

Record at every 150 m interval:

- Actual (measured) width
- Channel (bankfull) width
- Average bankfull depth
- Riparian width (left and right)
- Gradient
- Rosgen
- Bank Height (left and right)
- Riparian Vegetation (left and right)
- Water temperature

Record features and full descriptions wherever they are encountered.

When end of survey is reached record reason for ending, date, and time. Be sure data is saved in safe location and record survey start and end points on master maps.

Appendix: Field Guide, Equipment Checklist

Record for every habitat unit break, 30 m interval, or 150 m interval:

Unit Type: pool, riffle, run, cascade, glide, feature (see below)
Unit Number: group pools & glides; group riffles, runs, cascades
Distance: (m) at upstream end of unit
Estimated Width: (m) visual estimate of average wetted width
Maximum Depth: (cm) deepest spot in unit
Average Depth: (cm) average depth of unit
Dominant Substrate: (1-9) covers greatest amount of surface area in unit
Subdominant Substrate: (1-9) covers 2nd most surface area in unit
Large Wood: (1-4) count of dead and down wood in the bankfull channel

Record for every 150m interval:

Actual (Measured) Width: (m) measurement of average wetted width
Bankfull Channel Width: (m) measurement of bankfull channel width
Gradient : (%) clinometer measurement of channel slope
Avg Bankfull Depth (cm): measurement of bankfull channel depths
Riparian Width: (L&R) (m) measurement of floodplain
Bank Height: (L&R) (cm) vertical distance from bankfull to top of bank
Riparian Vegetation: (0-4), dominant riparian vegetative cover type
Water Temperature: (C) temperature of water in main channel

Unit Types

Riffle (R) fast water, turbulent, gradient <12%; includes rapids, chutes, and sheets if gradient <12%
Cascade (C) fast water, turbulent, gradient ≥12%, includes sheets and chutes if gradient ≥12%
Run (RN) fast water, little to no turbulence, gradient <12%, flat bottom profile, deeper than riffles
Pool (P) slow water, may or may not be turbulent, gradient <1%, includes dammed, scour, and plunge pools
Glide (G) slow water, no surface turbulence, gradient <1%, shallow with little flow and flat bottom profile
Swamp (S) channel poorly defined or non-existent, water dispersed across wide area
Underground (UNGR) distance at upstream end, why dry

Stream Features

Waterfall (FALL) distance, height
Tributary (TRIB) distance, width, in on L or R
Gully (GU) distance, width, bank height, on L or R
Side Channel (SCH) distance, width, in or out on L or R
Braid (BRD) distance at downstream and upstream ends
Seep or Spring (SEEP) distance, on left or right, amount of flow
Landslide (SLID) distance, L or R, est. size and cause
Culvert (V) distance, type, size, road or trail name & type
Bridge (BRG) distance, height, width, road or trail name & type
Dam (DAM) distance, type, est. height, road or trail name &type
Ford (FORD) distance, road or trail name & type
Other (OTR) record distance, describe feature in comments

Substrates

1. **Organic Matter**, dead leaves detritus, etc., not living plants
2. **Clay**, sticky, holds form when balled
3. **Silt**, slick, does not hold form when balled
4. **Sand**, >silt-2mm, gritty, doesn't hold form
5. **Small Gravel**,3-16mm, sand to thumbnail
6. **Large Gravel**, 17-64mm, thumbnail to fist
7. **Cobble**, 65-256mm, fist to head
8. **Boulder**, >256, > head
9. **Bedrock**, solid parent material

Large Wood

1. <5m long, 10-55cm diameter
2. <5m long, >55cm diameter
3. >5m long, 10-55cm diameter
4. >5m long, >55cm diameter

rootwad – count separately from attached LWD and record in comments

wood must be >1.0m long, >10cm diameter to be counted

Measuring Riparian Width

Place clinometer against the wading rod at two times max bankfull depth
Use the clinometer as a level – keep the slope at 0.0 – and site to the nearest landform perpendicular to the channel
Measure the distance from the edge of the bankfull channel to the intersection with the landform
Do this for both the left and right banks
If riparian width in more than 50 m, record 51 as the riparian width and in 'Comments' note that riparian was > 50 m wide

End survey

Where stream is less than 0.5 m wide for more than 500 m, where the channel runs dry for more than 500 m, is swamp for more than 500 m or where forest boundary is reached. Comment on why survey was ended. Record time of day, detailed description of location, and GPS coordinates at endpoint, and be sure all header info is filled in on datasheets.

Equipment Checklist

hipchain
extra string for hipchain
wading rod
50 m tape measure
clinometer
stakes for bankfull measurements
thermometer
Ipad
SPOT unit
GPS unit
backpack
pencils
flagging
markers
waterproof backup datasheets
clipboard
BVET manual
BVET field guide on waterproof paper
compass
topographic maps
water
water filter
lunch
first aid kit
radio/cell phone
toilet paper
wading boots
rain gear

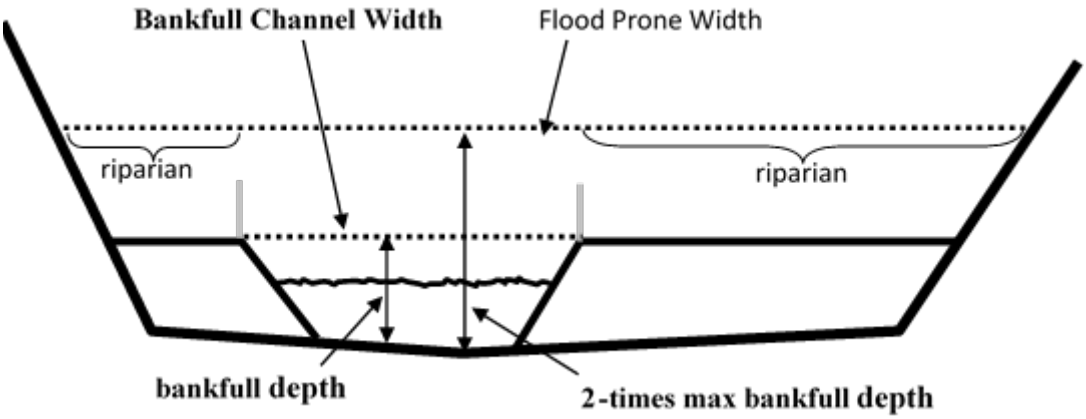
Rosgen Measurements

All measurements should be made across a transect in an area of uniform flow, specifically riffle or run sections with few irregularities in cross-sectional shape. **Avoid** areas influenced by culverts, bridges, tributaries, side-channels, etc.

- What is the **entrenchment ratio**?
    - Entrenchment ratio = flood prone width / bankfull width
    - Floodprone width = width at two-times maximum bankfull depth

- What is the **width/depth ratio**?
    - Width/depth ratio = bankfull width / average bankfull depth
    - Be sure to use same units of measure (centimeters) for width and depth
    - Measure *bankfull* depth (**not** *water* depth) at several locations across transect to obtain average bankfull depth

- What is the **gradient**?
    - Measure riffle to riffle slope (%) with clinometer



Rosgen Worksheet

A. Bankfull Channel Width (m) _____

B. Maximum Bankfull Depth (cm) _____ *2 = _____

C. Average Bankfull Depth (cm) _____

D. Right Riparian Width (m) _____

E. Left Riparian Width (m) _____

F. Gradient (%) _____

Entrenchment Ratio = (A+D+E)/A

(_____ + _____ + _____) / _____ = _____

Width Depth Ratio = (100*A)/C

(100* _____) / _____ = _____

	A	B	C	D	E	F	G
Entrench. ratio	< 1.4	1.4 – 2.2	> 2.2	n/a	> 2.2	< 1.4	< 1.4
W/D ratio	< 12	> 12	> 12	> 40	< 12	> 12	< 12
Gradient (%)	4 – 9.9	2 – 3.9	< 2	< 4	< 2	< 2	2 – 3.9

*these are the dominant ranges, values may be slightly outside these ranges

Appendix B:

Electrofishing Methods for Coastal Plain Streams,
Francis Marion National Forest

2019 SC Francis Marion NF Electrofishing Sampling Methods

Electrofishing Reach Location and Layout

- At least one efish reach should be sampled per 2 km of stream that was BVET inventoried. When a BVET inventory was broken into multiple segments due to blocks of private land, one efish reach should be sampled per segment (if a segment is >2 km then additional efish reaches need to be sampled per 2 km distances)

- The placement/location of efish reaches should be distributed within the BVET inventoried stream and avoid road/stream crossings and confluences when possible

    - For example, for a 2 km BVET inventory the efish reach should be placed near the mid-point (1 km) area
    - For a 3 km BVET inventory the efish reaches should be placed in the near the 0.5 km and 2.5 km areas
    - For a 4km BVET inventory the efish reaches should be placed near the 1 km and 3 km areas.

- Record within which kilometer of the BVET inventory the efish reach is located

- At the efish sample area, locate 1 – 2 representative areas (can measure both fast and/or slow water) and determine the average **wetted** width by making several measurements and computing the average. Measure width perpendicular to thalweg.

    - If the average wetted width is **≤3.0 m**, then the reach length will be **120 m**

    - If the average wetted width is **≥7.5 m**, then the reach length will be **300 m**

    - If the average wetted width is **between 3.0 and 7.5 m**, then reach length is **40-times** the average wetted width, example: average wetted width = 5 m; reach length = 5 x 40 = 200 m

- When possible, the efish reach should include both slow and fast water habitat units, or at least part of each

- When possible, start the efish reach at a habitat unit break

- Record coordinates at the downstream start location of the reach

- Take a photo at the downstream start looking upstream and at the upstream end looking downstream

- Record water temperature

- From the downstream end of the reach, electrofish upstream while using a hipchain to determine the upstream end of the sample reach

Electrofishing Inventory

Objective - Determine relative abundance and determine catch-per-unit-effort (CPUE). Note: we are not attempting to estimate population size or density for individual species, only assessing the fish assemblage

Methods:

- Fish team uses 1or 2 backpack electrofishing units (use 2 units when the average wetted width is **>4.0 m**), 2 dip-netters, and 1 bucket person
- Single-pass backpack electrofishing with **DC** unit
- No block-nets
- Reset electrofisher's timer before starting sampling and when finished record shock time for each electrofishing unit
- Fish collected within the sample reach are identified to species, counted, and released at the site (fish length and weight are not measured)
- Voucher unidentifiable fish species
- Record counts of age-0 fish and all fish older than age-0 separately for each species
- Keep all relic mussel shells encountered
- Record presence/absence of corbicula, mussels, mussel relics, and crayfish