Protocol for Monitoring Springs at Ozark National Scenic Riverways, Missouri. Heartland I&M Network

SOP 9: Physical Habitat Measurements

Version 1.20 (11/26/2019)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	6/6/2018	D.E. Bowles	Specified using a minimum of three substrate pieces to estimate size	Clarity of actions required to perform function	1.1
1.1	11/26/2019	Dodd and Bowles	Modified Instream and Fish Cover forms. Moved Reach & Weather Conditions form from Fish SOP.	Removed variables (Organics and Periphyton) that are not used in analysis of the biotic data and moved algae and vegetation assessment to fish cover form. Location of Reach & Weather from more appropriate in this SOP than in Fish SOP.	1.2

Habitat composition within a stream is an important component in shaping biotic communities. The type and abundance of specific habitat characteristics (*i.e*., woody debris, substrate size, *etc*.) will influence species presence and relative abundance, as well as size structure of the populations. Because of its importance to invertebrates and fish, physical habitat data will be collected as part of this protocol to examine relationships between environmental conditions and biotic communities. The methods described in this SOP have been modified from EMAP (Lazorchak *et al*., 1998) and NAWQA protocols (Fitzpatrick *et al*., 1998) to meet the objectives of the National Park Service. The methods described here are the same methods used at river and tributary sites at OZAR (Dodd et al. 2018).

I. Collecting Instream Point Habitat Data

Procedures:

A. Prior to collecting samples and taking habitat measurements, always complete data sheet information for spring name, date and time of survey, and initials of personnel who collect the samples (Fig 1).

B. A crew of two to three persons will collect physical habitat data along 11 equally-spaced transects described in SOP #3 (Reach Selection).

In-stream Habitat Assessment Form

Page ____ of ____

Spring Name: Date: Crew:

Reach Length: Transect Spacing Interval (reach length / 10):

Trans	Channel Unit	Pool Form	Width (m)	Depth (cm)	Velocity (m/sec)	Dominant ** Substrate	Embededness	Canopy Cover
1*				L M R	L M R	L M R	L M R	L M R
2				L M R	L M R	L M R	L M R	L M R
3				L M R	L M R	L M R	L M R	L M R
4				L M R	L M R	L M R	L M R	L M R
5				L M R	L M R	L M R	L M R	L M R
6				L M R	L M R	L M R	L M R	L M R
7				L M R	L M R	L M R	L M R	L M R
8				L M R	L M R	L M R	L M R	L M R
9				L M R	L M R	L M R	L M R	L M R
10				L M R	L M R	L M R	L M R	L M R
11*				L M R	L M R	L M R	L M R	L M R

*Transect 1 is located at the upstream end near spring source . Transect 11 is located at the downstream end of the reach

CHANNEL UNIT CODES		POOL FORM CODES		Embededness & Canopy Cover
GL	Glide	B	Backwater Pool	0 = Absent (0%)
RI	Riffle	F	Bluff Pool	1 = Sparse (<10%)
RU	Run/Race	I	Impoundment	2 = Moderate (10-40%)
PO	Pool	L	Lateral Pool	3 = Heavy (40-75%)
RRX	Riffle-Run comple:	M	Mid-Channel Pool	4 = Very Heavy (>75%)
PGX	Pool-Glide comple	O	Obstruction Pool	(Canopy within 1m on each side of transect)

Transects are equally spaced as determined by dividing the reach length by 10.

** Dominate substrate is average substrate within the sample frame

Embeddness is assessed within the entire sample frame

Figure 1. In-stream habitat form for springs monitoring.

C. Equipment necessary to complete habitat sampling is found in SOP #1 (Preparation for Sampling).

D. When collecting data, stream banks are referred to in a downstream perspective. Therefore, if the crew is working/collecting data in an upstream direction, river right is on the workers' left, and river left is on the right. For habitat in springs, transect #1 is the most upstream transect and the transect #11 is the downstream most transect.

E. At each transect, measure wetted width and record channel unit and pool form (if applicable). Channel unit definitions are as follows:

1. Riffle. An area of the stream with steepest slope and shallowest depth, often rocky substrate, and a swift moving current. Thalweg is usually poorly defined.

2. Run or Race. Differ from riffles in that depth of flow is typically greater and slope of the bed is less than that of riffles. Runs will often have a well defined thalweg.

3. Glide. Normally located immediately downstream of pools. The slope of the channel bed through a glide is negative while the slope of the water surface is positive. The head of the glide can be difficult to identify. Use the following characteristics to help you locate the head of the glide:

    a. A location of increased flow velocity coming out of the pool,
    b. A location with a steeply sloped bed rising out of the pool and decreasing to a lesser gradient,
    c. A location where the thalweg coming out of the pool becomes less well defined and essentially fades completely.
    d. A location approximately the same elevation as the tail of the run.

4. Pool. Has a relatively slow current and is usually found at stream channel bends, upstream of riffles, or on the downstream side of obstructions such as boulders or fallen trees. The stream bottom in a pool is often bowl shaped and represents the deepest locations of the reach. Water surface slope of pools at below bankfull flows is near zero.

F. In-stream habitat is collected at three points along each transect: middle (i.e., center of channel and half the distance between middle and the left and right banks (Fig. 1 and 2).

G. Place $1m^2$ sampling frame on bottom of spring-run centered on the location (left, middle, right) of the transect (Fig. 2).

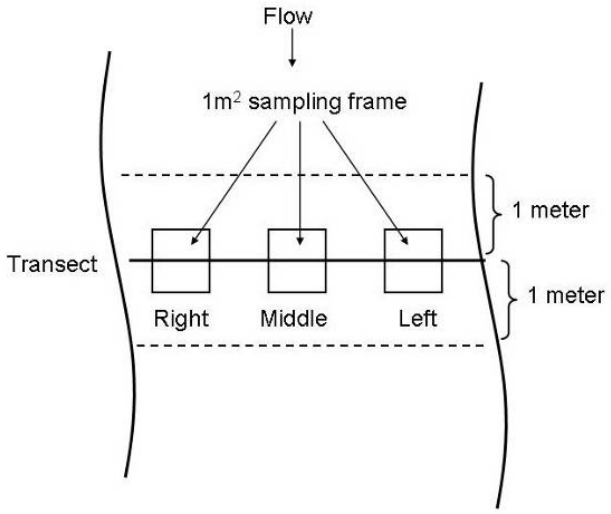

Figure 2. Location of in-stream habitat and fish cover collection at a transect.

1. Velocity (meters/second) and depth (centimeters) are measured concurrently at each sample point and immediately in front of the sample frame (Fig. 3). Depth and velocity can be measured by a third team member while the other two members collect the aquatic vegetation and benthic invertebrate sample described in SOPs 5 and 6. Measurements are done using a velocity meter attached to a top-setting wading rod. The rod allows for quick and easy measurements of depth with incremental markings and an adjustable arm that places the current meter at the proper depth for measuring velocity (60% of the depth from the surface of the water). Velocity should be recorded in meters per second and increments on the wading rod are in centimeters. Greater detail regarding use of the velocity meter is provided in SOP #10 (Measuring Spring Discharge).

Figure 3. Measuring depth and current velocity in front of a sampling frame.

Table 1. Substrate size classes to be used for characterizing substrate based on the Wentworth Scale.

Size Code	Particle Diameter Range (mm)	Category
1	<0.062	Silt/clay
2	0.062-0.125	Very fine sand
3	0.125-0.25	Fine sand
4	0.25-0.50	Medium sand
5	0.50-1	Course sand
6	1-2	Coarse sand
7	2-4	Fine gravel
8	4-5.7	Medium gravel
9	5.7-8	Medium gravel
10	8-11.3	Coarse gravel
11	11.3-16	Coarse gravel
12	16-22.6	Small pebble
13	22.6-32	Small pebble
14	32-45	Large pebble
15	45-64	Large pebble
16	64-90	Small cobble
17	90-128	Small cobble
18	128-180	Large cobble
19	180-256	Large cobble
20	256-362	Boulder
21	362-512	Boulder
22	512-1024	Boulder
23	>1024	Boulder
24	Bedrock	Bedrock

2. Within the sampling frame, visually assess dominant substrate size (most common size) present based on a minimum of three substrate pieces and using the Wentworth Scale (Table 1). The substrate size category field sheet (Fig 4) can aid in visually assessing size categories. A piece of substrate belongs to the smallest size box through which it will fit on any axis. Record the corresponding substrate code for the most dominant size on the data sheet. For substrate codes 1-3, there are no boxes shown on the field sheet to estimate their respective sizes because these substrates are so small. For these three substrate codes, it is necessary to grab a sample from the plot for assessment. The general rule is:

    a. Code 1 (silt/clay) feels slick between thumb and finger with no evidence of grit.
    b. Code 2 (very fine sand) has a barely perceptible gritty feel.
    c. Code 3 (fine sand) has a distinct gritty texture.

Note: This technique is used to assess the dominant substrate in the sample area. It is not intended to fully characterize the substrate profile of the stream bottom.

3. Record measurements for embeddedness and canopy cover based on visual estimates from within the sample frame. Percentage categories are: 0= none (0%), 1= sparse (<10%), 2= moderate (10-40%), 3= heavy (40-75%), 4= very heavy (>75):

    a. Canopy cover is visually observed by looking directly overhead at each point and categorizing the percentage cover within one meter upstream and downstream of a transect. If a bridge or other manmade structure is producing the canopy, this should be clearly indicated in the comments section.

III. Collecting Fish Cover and Bank Habitat Data

Procedures:

Fish Cover

It is important to document the presence of fish cover in a spring because different species have affinities for various cover types.

1. Assess fish cover by recording all cover types present along each transect (Fig 5). Filamentous algae, hydrophytes, boulders (sizes 21 to 23 on the Wentworth substrate sheet), and any artificial cover are assessed within a 1 m^2 plot at left, middle, and right locations along the transect (Fig 2). If artificial cover (*e.g.*, cinder block, car tire, *etc.*) is present, the type of cover should be noted in the comments section.

2. Assess small and large woody debris along a 1m belt along the transect (1 m upstream and downstream of the transect), dividing the belt into left and right side of center (Fig. 2). Small woody debris is defined as being less than or equal to 10 cm in diameter at its largest end, and large woody debris is greater than 10 cm in diameter at its largest end (Fig 5).

3. Fish cover along the banks is assessed within 1 meter upstream and downstream of the transect (Fig 2). Cover along the banks include trees/roots, overhanging vegetation, undercut banks, and bluffs (within 5 m of wetted edge).

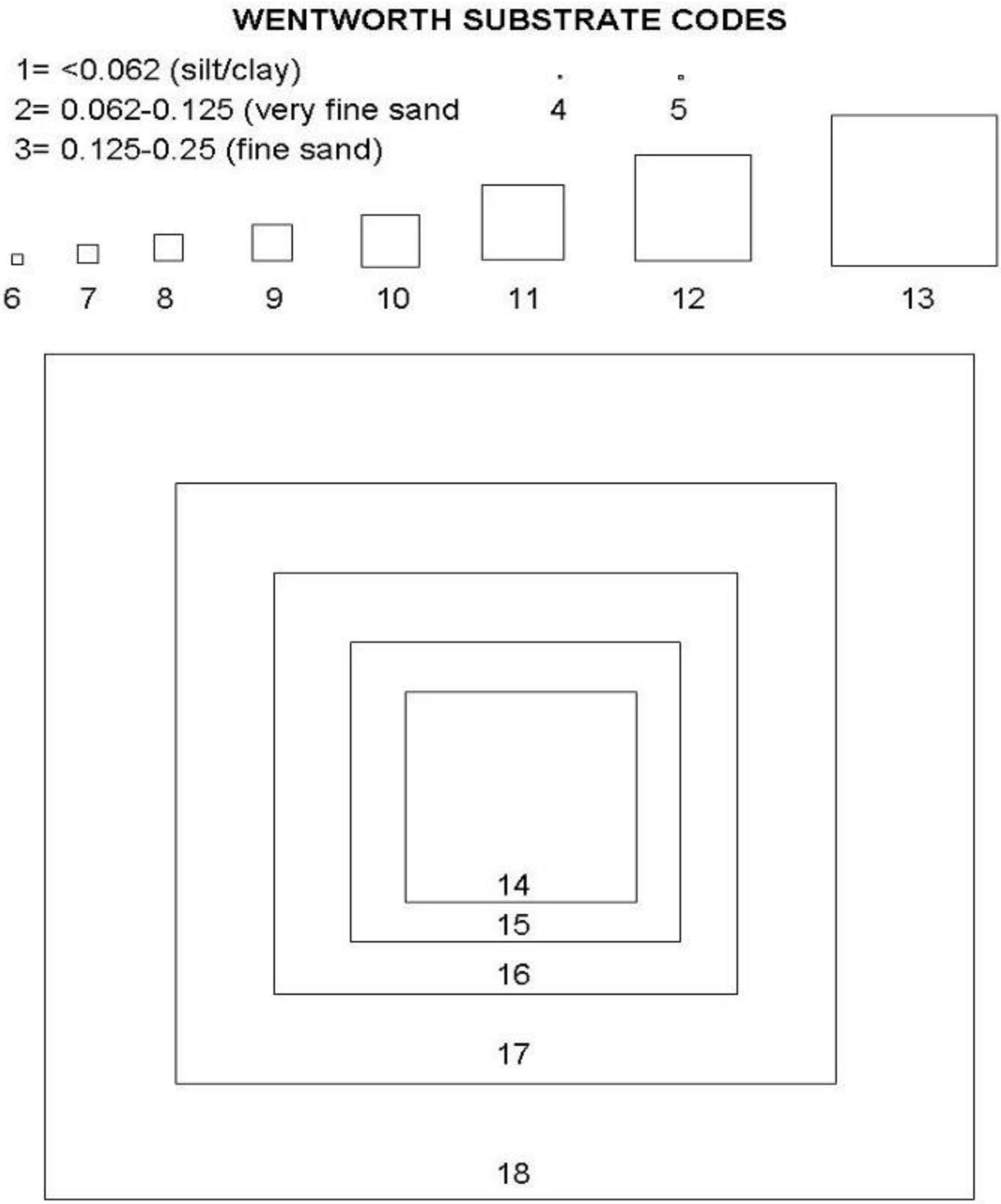

Figure 4. Wentworth substrate field sheet for determining dominate substrate size.

Fish Cover Form

Page ____ of ____

Spring Name: Date: Crew:

Reach Length: Transect Spacing Interval:

Trans.		Fish Cover Circle all cover types present.										Comment
1*	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
2	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
3	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
4	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
5	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
6	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
7	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
8	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
9	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
10	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
11*	Lt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	Ctr	FA	HY	BO	AR							
	Rt	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	

***Transect 1 is located at the upstream end near spring source . Transect 11 is located at the downstream end of the reach**

Fish Cover Types
FA = Filamentous Algae
HY = Hydrophytes & Mosses
BO = Boulders
AR = Artificial
SWD = Small Woody Debris
LWD = Large Woody Debris
T/R = Trees/Roots
OV = Overhanging Veg
UC = Undercut bank
BL = Bluff within 5m of water

Additional comments:

FA, HY, BO, AR are assessed within the sample frame
SWD is < 10 cm in diameter at largest end; LWD is >10 cm at largest end
SWD & LWD assessed on a 1m belt along transect on left and right side of center channel
T/R, OV, UC, BL are assessed within 1 m on either side of transect along bank

10 cm or 0.1m

Figure 5. Fish cover field form.

Bank Measurements

Characteristics of both the bank and riparian areas can affect spring processes and fish habitat. For example, banks that are bare with steep angles are likely to erode during high flow events, increasing the amount of fine sediment entering a spring and degrading habitat for benthic species (both fish and invertebrates) by burying large gravel/cobble substrates.

The bank is defined as the area of steep sloping ground bordering the stream that confines the water within the channel at normal water levels, and is located between the channel and the floodplain (Fig. 6, Fitzpatrick *et al*., 1998). The floodplain is defined as a flat or gently sloping depositional area adjacent to the stream. At low flows, it may be difficult to determine the location of the bank due to the presence of bars. Bars are defined as areas usually devoid of woody vegetation (such as small trees and shrubs), and contain coarse materials such as large gravel or cobble. These areas will be covered by water during normal flow and therefore are not considered part of the bank. Each bank measurement begins at the "true" bank (*i.e*., area of steep slope). In some instances the bank will begin at the wetted edge. If gravel or sand bars are present at a transect, these will not be included in the bank assessment, but will be noted in the comments section by recording the length of the bar from water's edge to the bank.

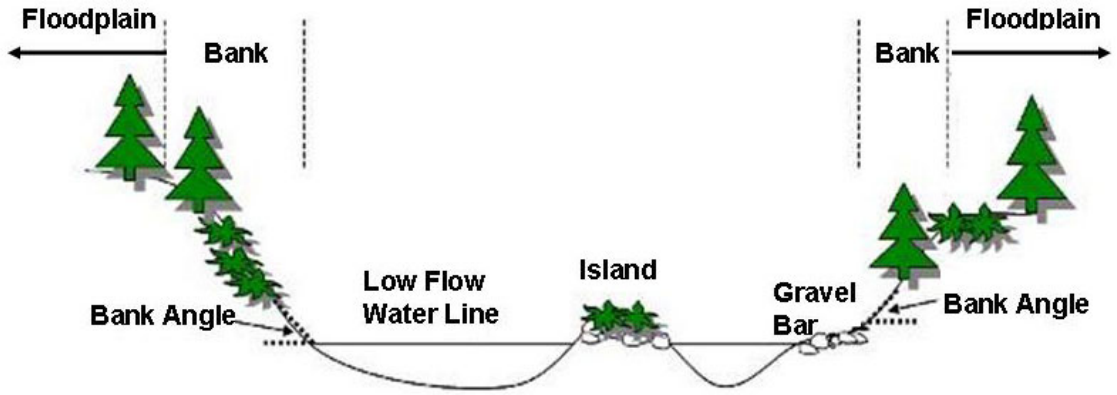

Figure 6. Illustration showing banks and floodplains of a stream.

1. Assess bank stability at each transect and record the category for each characteristic (Fig 7). Bank characteristics used to measure bank stability are: Angle, Substrate, Percent Vegetative Cover, and Height.

    a. Bank angle and substrate are observed from the bottom of the bank (*i.e.*, at wetted edge or at the top base of the bar, if one is present; Fig 6), and the category code is recorded. To assess the bank substrate, the Wentworth scale is used to visually estimate the dominant substrate type, and the corresponding category code on the data sheet (**not** the Wentworth code) is recorded.
    b. Percent vegetative cover and bank height are assessed from the bank

bottom to 10 meters into the bank and the category code recorded.

2. Assess the dominant bank cover present for each bank from the bottom of the bank to 10 meters into the bank. Bank cover categories include large trees, small trees/shrubs, grass/forbs, bare sediment, and artificial cover. If artificial cover is present on the bank (*i.e.*, rip-rap, concrete structures), the type of cover should be noted in the comments section. NOTE: For bank cover, more than one cover type may be recorded if two cover types are relatively equal in abundance.

IV. Reach and Weather Conditions

Procedures:

A. Record the spring name, date, reach length, and reach description or condition on the field form (Fig 8).

B. Record weather conditions (cloud cover, wind, and precipitation) and note any other weather or site conditions that might affect sampling efficiency.

C. The coordinates of upper and lower reach boundaries (see SOP #3, Reach Selection) will be recorded with a GPS unit and stored in a geodatabase. This should be done only on the first visit to a spring and not again thereafter unless some unforsee event causes the reach within the spring-run to be moved.

V. Additional Collection

A. Record any necessary notes about the collection site.

B. Take digital photographs of the reach sampled from upstream and downstream perspectives at mid-channel.

VI. QA/QC Procedures for Collection of Habitat Data

A. Field crew leads responsible for collecting habitat data will review this SOP prior to the field season and be certified in collection of habiat data. The QA officer (project lead or certified crew lead) will conduct the certification.

B. Certification entails that crew leads responsible for assessing habitat will independently measure physical habitat and assign class codes or presence/absence to observational habitat data independently of each other and the project lead. An agreement of 90% between the crew leads and project lead is required for certificaion. A minimum of 11 transects will be used for certification. Because springs consist mostly of run channel units, certification procedures conducted at one spring is sufficient. If crew leads have

been certified based on procedures described in the habitat sampling SOP of the HTLN River Fish Monitoring Protocol for BUFF and OZAR (Dodd et al. 2018), this certification is valid for habitat assessment of springs.

C. For new crew members who will assist with habitat data collection, a nearby stream will be used to practice collecting habitat data under the supervision of a certified crew lead.

Bank Measurment Form

Spring Name: Date: Crew:

Reach Length: Transect Spacing Interval:

Trans.	Bank Stability Angle	Veg	Height	Sub	Bank Cover** Circle Dominant (>50%) Cover	Comment
1* Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
2 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
3 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
4 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
5 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
6 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
7 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
8 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
9 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
10 Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	
11* Lt					TR SH GR BA AR	
Rt					TR SH GR BA AR	

***Transect 1 is located at the upstream end near spring source . Transect 11 is located at the downstream end of the reach**

****Bank cover is assessed within 1 m upstream and downstream of transect and 10 m up the bank from wetted edge**

Bank Angle, Degrees	Vegetative Cover (%)	Height (m)	Substrate	Bank Cover Types*
1 = 0 - 30	1 = >80	1 = 0-1	1 = Bedrock/Artificial	TR = Large trees (> 3 in. dbh)
2 = 31-60	2 = 50-80	2 = 1.1-2	2 = Boulder/Couble	SH = Small trees and shrubs
3 = >60	3 = 20-49	3 = 2.1-3	5 = Silt	GR = Grass and Forbes
	4 = <20	4 = 3.1-4	8 = Sand	BA = Bare rock/sediment
		5 = >4	10 = Gravel/Sand	AR = Artificial

Bank Angles

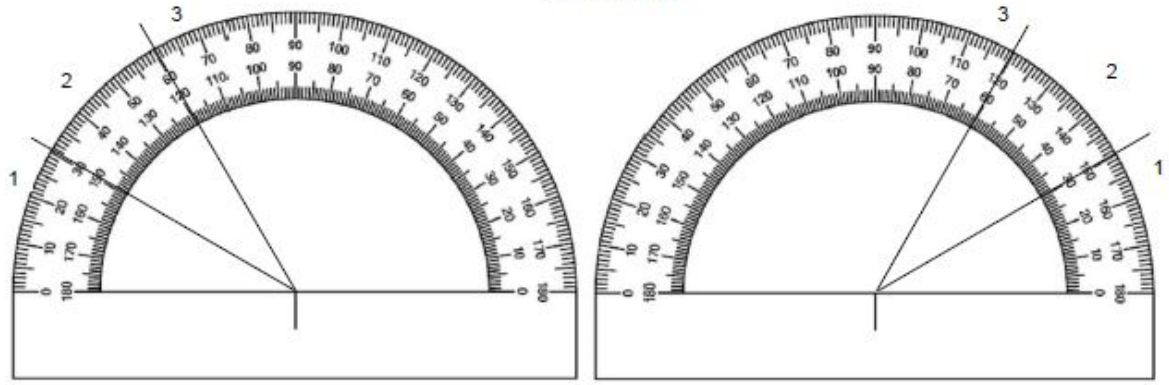

Figure 7. Bank measurement field form.

Reach and Weather Conditions - Springs

Spring Name: Date:

Crew: Reach Length:

Reach Description or Conditions:_____

_____

Weather Conditions: Cloud cover:_____% Wind: *Calm* *Light* *Moderate* *Gusty*

Precipitation: *None* *Rain* *Sleet* *Snow* Intensity: *N/A* *Light* *Moderate* *Heavy*

Other Weather:_____

_____

Additional Comments:_____

_____

_____

_____

	Date	Initials
Data Entered		
Data Verified		

Figure 8. Reach and weather conditions form for springs monitoring.

References Cited

Dodd, H. R., J. C. Petersen, B. G. Justus, D. E. Bowles, L. W. Morrison, G. A. Rowell, J. A. Hinsey, and J. M. Williams. 2018. Methods for monitoring fish communities of Buffalo National River and Ozark National Scenic Riverways in the Ozark Plateaus of Arkansas and Missouri, Version 2.0. Natural Resource Report NPS/HTLN/ NRR—2018/1633. National Park Service, Fort Collins, Colorado.

Fitzpatrick, F. A., I. R. Waite, P. J. D'Arconte, M. R. Meador, M. A. Maupin, and M. E. Gurtz. 1998. Revised methods for characterizing stream habitat in the National Water-Quality Assessment Program. U.S. Geological Survey Water-Resources Investigations Report 98-4052.

Lazorchak, J. M., Klemm, D. J., and D. V. Peck. 1998. Environmental monitoring and assessment program-surface waters: field operations and methods for measuring the ecological condition of wadeable streams. EPA/620/R-94/004F, U.S. Environmental Protection Agency, Washington, DC.