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

Standard Operating Procedure (SOP) 6: Habitat Collection Version 1.2

Revision History Log:

Previous version number	Revision date	Author	Changes made	Reason for change	New version number
1.0	6/15/2016	Dodd	Moved equipment list and field sheets from Protocol Narrative appendices to SOP	Make SOP stand-alone document for field use	1.1
1.0	6/15/2016	Dodd	Minor modifications to field sheets	Make field sheets easier to read in the field.	1.1
1.0	6/15/2016	Dodd	Moved weather conditions and water quality form from SOP 4 to SOP 6	All habitat related forms are included in one SOP	1.1
1.1	4/9/2020	Dodd	Revised field forms and added QA/QC and certification section	Maintain high quality data collection and data entry	1.2

Habitat composition within a stream is an important component in shaping fish communities. The type and abundance of specific habitats (for example, riffles, woody debris, and pools) will influence species presence and relative abundance, as well as size structure of the populations. Because of its importance to fish, physical habitat data will be collected as part of the fish community monitoring to examine relations between environmental conditions and fish communities. The methods described here have been modified from NAWQA protocols (Fitzpatrick *et al*. 1998) to meet NPS objectives.

Weather and Reach Conditions

Because weather conditions can affect water quality, physical habitat, and sampling efficiency, weather conditions should be recorded on the field sheet prior to fish sampling (Figure 1). Discrete Core 4 water quality measurements (see SOP 4 for water quality parameter descriptions and lab calibration and field operation of meters) are collected at the lower reach boundary prior to and following fish sampling (Figure 1). Water quality (temperature, dissolved oxygen, etc.) will change during the several hours in which fish sampling is conducted at a reach. Therefore, collecting discrete water quality measurements before and after sampling gives a general measure of water quality conditions at that location during the day of sampling and gives an indication of the change in conditions over the sampling time at the reach. In addition, conductivity (not compensated to 25 ºC) of the stream should be recorded for determining correct voltage and amperage settings during electrofishing.

Weather and Reach Conditions – River Parks (Electrofish)

Reach ID:_____ Date:_____ Reach Length(m):_____

Recorder:_____ Reach Description: _____

_____

_____

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

Precipitation(circle): *None Rain Sleet Snow* Precip Intensity(circle): *N/A Light Moderate Heavy*

Other Weather:_____

Beginning Measurements:

Time	
Water Temperature (°C)	
Air Temperature (°C)	
pH	
Specific Conductance (µS/cm)	
Conductivity (µS/cm)	
Dissolved Oxygen (mg/L)	

Ending Measurements:

Time	
Water Temperature (°C)	
Air Temperature (°C)	
pH	
Specific Conductance (µS/cm)	
Conductivity (µS/cm)	
Dissolved Oxygen (mg/L)	

Additional Comments:_____

_____

_____

Figure 1. Weather and reach conditions field form.

Physical Habitat Collection

Once fish sampling is completed, a crew of two to three persons will collect physical habitat data within that same reach. Equipment necessary to complete habitat sampling is found in Table 1. Eleven equally-spaced transects will be placed perpendicular to flow to collect instream habitat, fish cover, bank stability, and bank vegetation data (Figure 2). For example, a reach of 1,000 m length would have 11 transects placed at 100 m intervals. Crewmembers can either establish all 11 transects prior to data collection by temporarily flagging them, or transects can be located as the crew moves upstream during data collection.

For very wide or deep reaches, it may be necessary to take measurements from a boat or canoe. In this situation, a rope or tagline may be used to stretch across the channel allowing crewmembers to stay on the transect while taking measurements. In some deep channels with fast flow, it may be difficult or impossible to get a measurement along the transect because of safety considerations. If this situation occurs, a note should be made in the comments section of the field sheets for that sample point and transect. Some reaches may also have backwater areas that will need to be recorded separately from the main channel. In backwater areas, length of the backwater is recorded and instream and fish cover habitat data are collected at three relatively equally-spaced transects. When collecting data (in both main channel and backwaters), streambanks are referred to in a downstream perspective. Therefore, if the crew is collecting data in an upstream direction, river right is on the workers' left, and river left is on the right.

Table 1. Equipment necessary for sampling physical habitat at fish reaches.

Equipment	Units of measurement	Quantity/Size
Velocity meter	meters/second	1 (a second meter as backup, if possible)
Top-setting wading rod	centimeters	1 – 1m rod; 1 – 2m rod
Tape measure	meters	1 or 2 100m tape(s)
Range finder	meters	1 with a range of 5-100m
5 gallon bucket		1
Manufacturer's manual		1
Data sheets on waterproof paper		
Weather and reach conditions form		1 per sample reach
In-stream form		1 per channel type within reach
Fish cover form		1 per channel type within reach
Bank measurement form		1 per channel type within reach
Velocity meter manual		
Stakes for tying off tape measure		2 (if needed)

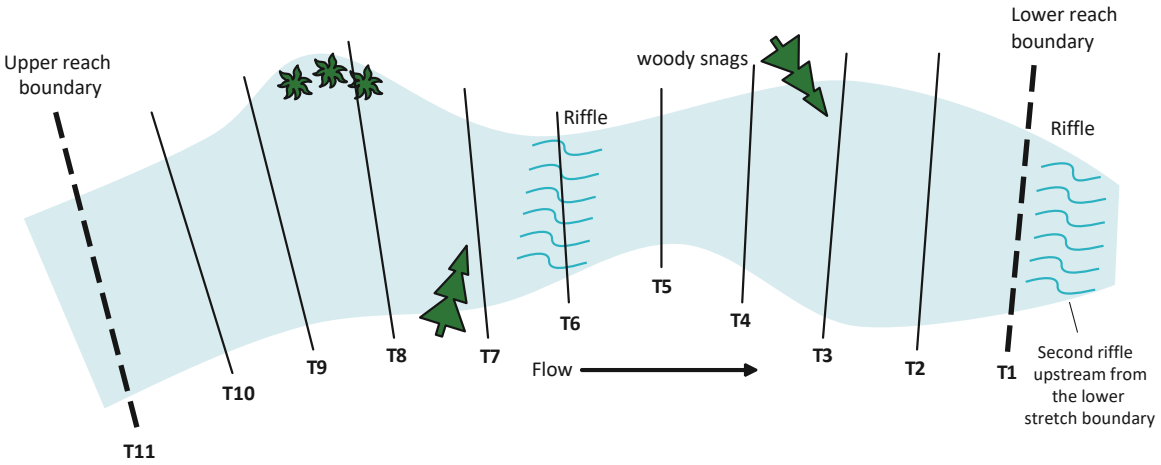

Figure 2. Transect placement for habitat data collection in the main channel.

Instream Habitat Assessment

Data on channel morphometry, velocity, substrate, and canopy cover are collected at three points (middle of channel and half the distance between middle and the left and right banks; Figure 3) along each of 11 transects. In backwaters, instream habitat data are collected at three points along each of three equally-spaced transects. At each transect, wetted width, channel unit (pool, riffle, run, glide, etc.), and pool form (if applicable) are recorded on the instream field sheet (Figure 4). Definitions of channel unit types can be found in Table 2. At each point, depth and velocity are measured. A single stream velocity reading will be measured at each point at 60 percent of the depth from the surface of the water (see SOP 7 on collecting velocity readings). Dominant substrate size and substrate embeddedness are visually observed within a 10 cm diameter circle around each point (Figure 3). Dominant substrate size is defined as the average substrate size within the circle using the Wentworth scale (Table 3; Figure 5; Wentworth 1922). For substrate codes 1-3, there are no boxes shown in Figure 5 by which to estimate their respective sizes because these substrates are so small. However, the general rule is that code 1 (silt or clay) feels slick between thumb and finger with no evidence of grit. Code 2 (very fine sand) has a barely perceptible gritty feel, and code 3 (fine sand) has a distinct gritty texture. For these three substrate codes, it is necessary to grab a sample from the 10 cm circle for assessment of dominate substrate. The Wentworth code is recorded on the instream field form. Canopy cover also is visually observed by looking directly overhead at each point and categorizing the percentage cover within 1 m upstream and downstream from the transect (Figure 3). If a bridge or other manmade structure is producing the canopy, this should be clearly indicated in the comments section.

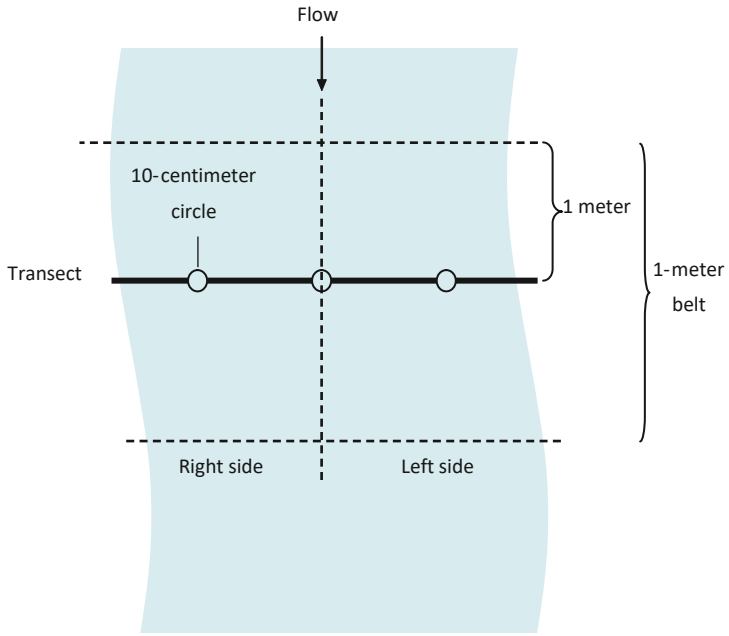

Figure 3. Location of instream habitat and fish cover collection at a transect.

In-stream Habitat Assessment Form - River parks (Electrofish) Page ____ of ____

Reach ID: Date: Crew:

Reach Length: Transect Spacing Interval* (reach length / 10): Channel Type: (circle one) Main Side channel Backwater-Main Backwater-Side

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

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 complex	M	Mid-Channel Pool	4 = Very Heavy (>75%)
PGX	Pool-Glide complex	O	Obstruction Pool	(Canopy within 1m on each side of transect)

*Transects are equally spaced as determined by dividing the reach length by 10.
Transect 1 is located at the downstream end of the reach; Transect 11 is located at the upstream end of the reach
** Dominate substrate is average substrate within a 10 cm diameter circle around the point where depth is taken
***Embeddness is assessed within a 10 cm diameter circle around point

Figure 4. Instream habitat field form.

Table 2. Description of channel units for in-stream habitat collection.

Channel Unit Types	Description
Riffle	An area of the stream with steepest slope and shallowest depth, often rocky substrate, and swift current. Thalweg is usually poorly defined.
Run	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. Runs sometimes are referred to as races.
Riffle/Run Complex	This code is recorded when a portion of the channel is a riffle habitat (shallow, fast turbulent flow, large substrate) and the other portion is run habitat (deeper and fast but not turbulent flow). This type of habitat unit is typically formed by instream gravel bars.
Glide	Transition zone that is located immediately downstream from pools and upstream from riffles. The slope of the channel bed through a glide is negative while the slope of the water surface is positive. Characteristics of a glide: increased flow velocity coming out of the pool, location at which the steeply sloped bed rising out of the pool decreases to a lesser gradient, the thalweg coming out of the pool becomes less defined and fades completely.
Pool	Has a relatively slow current and is usually found at stream channel bends, upstream from 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.
Pool/Glide Complex	This code is recorded when a pool is transitioning into a glide. Because the head of a glide is difficult to identify, use this code if unsure about the exact location of the glide.

Table 3. Substrate size classes 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	Coarse 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	512-1,024	Boulder
23	>1,024	Boulder
24	Bedrock	Bedrock

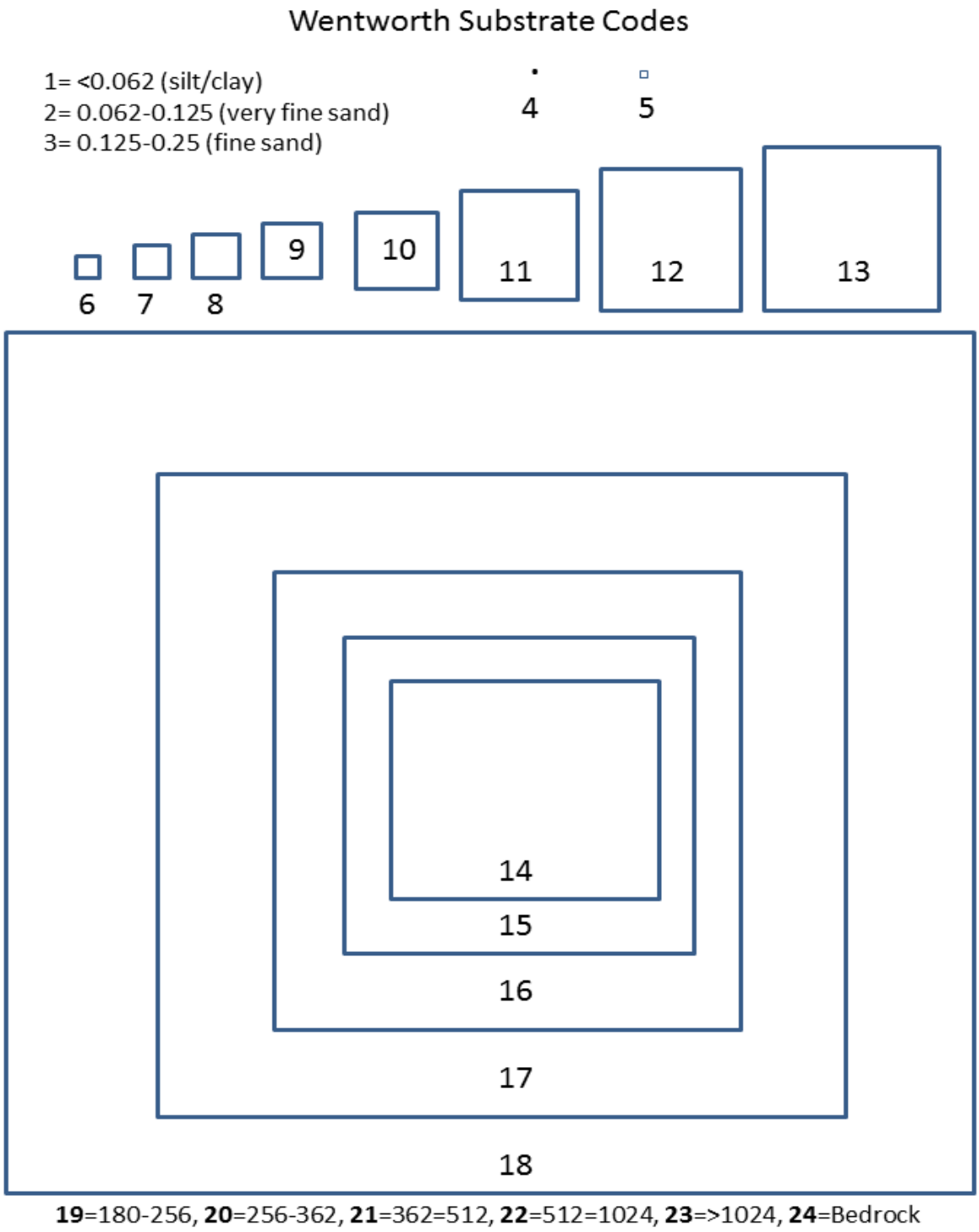

Figure 5. Wentworth code and scale for particle-size diameter used to categorize dominant substrate for instream habitat (not drawn to correct scale).

Fish Cover

It is important to document the presence of fish cover in a stream because different species have affinities for various cover types. For example, sunfish species typically inhabit woody structure or boulder fields along the banks and in pools. Therefore, a reach with several snags or large boulders will likely have a large number of sunfish.

To assess fish cover within a reach, all cover types present will be documented along each transect (Figure 6). Filamentous algae, hydrophytes, boulders (sizes 21 to 23 on the Wentworth substrate sheet, see Table 3 and Figure 5), and any artificial cover are assessed within a 10 cm diameter circle around each of the three points at a transect (Figure 3). If artificial cover (cinder blocks and car tires, for example) is present, the type of cover should be noted in the comments section. Small and large woody debris are assessed in a 1m belt along the transect (1 m upstream and 1 m downstream of transect); dividing the belt into left and right side of middle channel (Figure 3). 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. Fish cover along the banks is assessed within a 1 m belt from the transect. Cover along the banks include trees/roots, overhanging vegetation, undercut banks, and bluffs within 5 m of the wetted edge.

Bank Measurements

Characteristics of the bank and riparian areas can affect instream processes and fish habitat. For example, banks that are mostly bare with steep angles are likely to erode during high flow events, increasing the amount of fine sediment entering the stream. This, in turn, degrades habitat for benthic species (both fish and invertebrates) by burying large gravel/cobble substrates. Therefore, collection of bank stability and vegetation data may help explain fish community composition and abundance.

Before discussing data collection for bank/riparian areas, it is necessary to describe what is meant by the term “bank” (Figure 7). 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 flood plain (Fitzpatrick *et al*. 1998). The flood plain 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 because of 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 sand, gravel, or cobble. These areas will be covered by water during normal flow (that is, at flows slightly higher than low flow) and therefore, are not considered part of the bank. Each bank measurement begins at the “true” bank (that is, the area of steep slope). In some instances, the bank will begin at the wetted edge. However, 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 width of the bar from water’s edge to the bank.

Fish Cover Form - River parks (Electrofish) Page ____ of ____

Reach ID: Date: Crew:

Reach Length: Transect Spacing Interval: Channel Type: (circle one) Main Side channel Backwater-Main Backwater-Side

		Fish Cover* Circle all cover types present										
Trans.		10 cm circle at 3pts/trans**				Assessed 1 m up & down of transect***						Comment
1	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
2	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
3	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
4	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
5	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
6	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
7	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
8	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
9	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
10	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
11	L	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	
	M	FA	HY	BO	AR							
	R	FA	HY	BO	AR	SWD	LWD	T/R	OV	UC	BL	

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 Vegetation
UC = Undercut Bank
BL = Bluff within 5m of water

Additional comments:

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

10 cm or 0.1m

Figure 6. Fish cover field form.

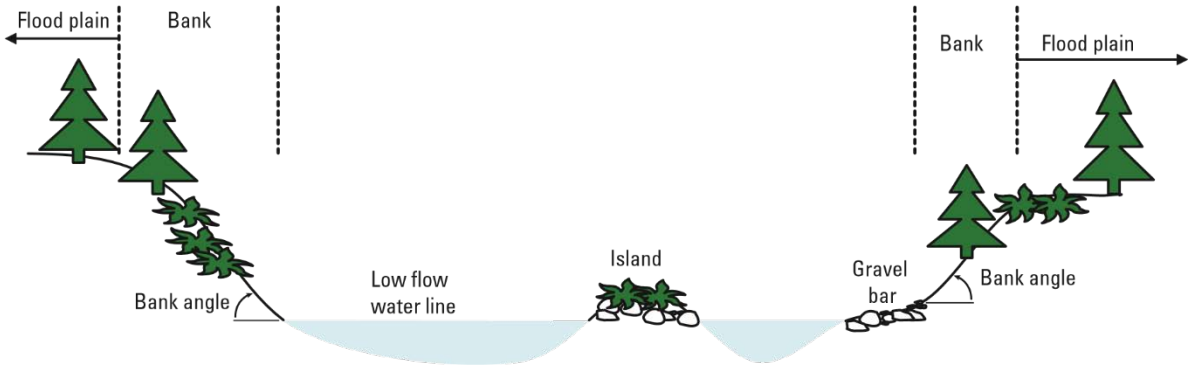

Figure 7. Location of banks and flood plain.

Islands (stable areas with woody vegetation and mature trees that split or divide the channel) are treated as banks. For reaches with islands, width of the island will be measured at each transect as well as the length of the island that is located within the reach (recorded in the comments section). At transect locations where the channel is split, data will be collected at three points on either side of the island, and the island will be considered the "bank" for measuring bank stability/ vegetation because of its stability and role in structuring the channel (Figure 8). This will require recording data on two copies of each instream, fish cover, and bank data sheet (Figures 4, 6, and 9).

Bank characteristics are observed at each transect. Bank stability is visually observed at the transect, and each bank characteristic is categorized (Figure 9). Bank angle and substrate are observed from the bottom of the bank (at wetted edge or at the top base of the bar, if one is present), and the category code is recorded. To assess the bank substrate, the Wentworth scale is used to define the substrate type (silt = code 1, sand = codes 2 – 6, gravel = codes 7 – 16, cobble = codes 17 – 20, boulder = codes 21 – 23), but the substrate category code on the bank data sheet (Figure 9; code of 1, 2, 5, 8, or 10) is recorded and not the Wentworth code. Percent vegetative cover, bank height, and bank cover are assessed from the bank bottom to 10 m into the bank. For bank cover, more than one cover type may be recorded if two cover types are relatively equal in abundance. Bank cover categories include large trees, small trees/shrubs, grass/ forbs, bare rock/sediment, and artificial cover. If artificial cover is present on the bank (for example, rip-rap or concrete structures), the type of cover should be noted in the comments section.

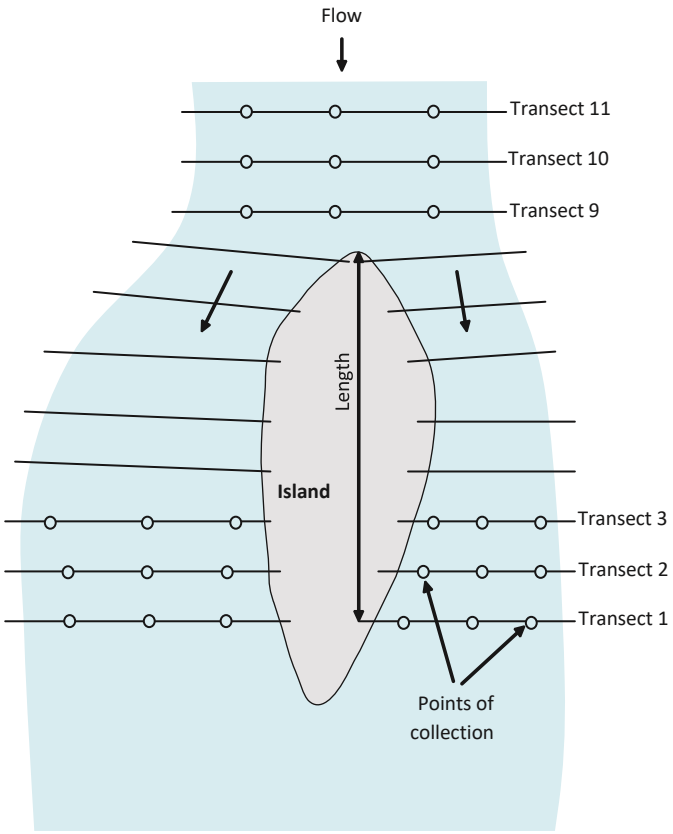

Figure 8. Habitat collection points in a reach with a split channel.

Bank Measurment Form - River parks (Electrofish)

Reach ID: Date: Crew:

Reach Length: Transect Spacing Interval: Channel Type: (circle one) Main Side channel Backwater-Main Backwater-Side

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

*Bank cover is assessed within 1 m on each side of transect and 10 m up the bank from wetted edge
If two cover types each cover ~50% of the bank at a transect, circle both cover types

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/Cobble	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

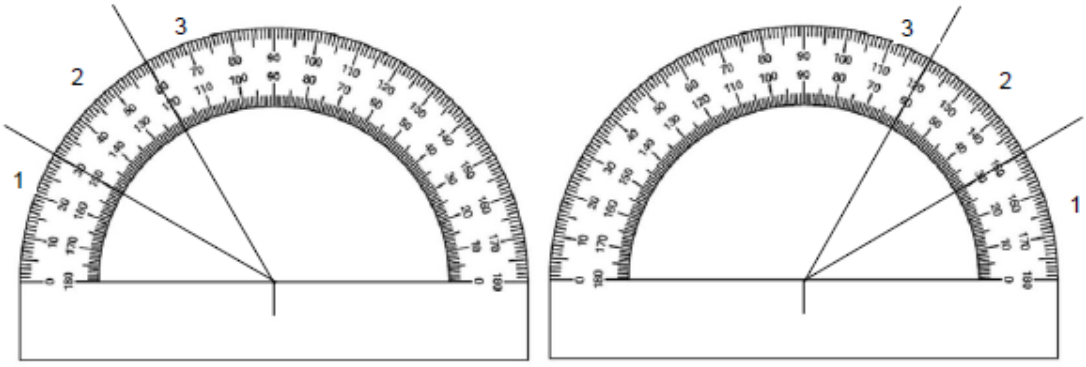

Figure 9. Bank measurement field form.

QA/QC Procedures for Collection of Habitat Data

Field crew leads responsible for collecting habitat data will review this SOP prior to the field season and be certified in collection of habitat data. The QA officer (project lead or previously certified crew lead) will conduct the certification. Certification entails that new 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/certified crew lead. An agreement of 90% between the new crew leads and project/certified crew lead is required for certification. A minimum of 11 transects will be used for certification within a sample reach that has diverse channel unit types (riffle, run, glide, pool). For crew members who will assist with habitat data collection (i.e., not a crew lead), a nearby stream will be used to practice collecting habitat data under the supervision of a certified crew lead.

References Cited

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. 67 p.

Wentworth, C. K. 1922. A scale of grade and class terms for clastic sediments. Journal of Geology 30:377-392.