



*United States Environmental Protection Agency
Office of Water
Office of Environmental Information
Washington, DC
EPA-841-B-07-009*

National Rivers and Streams Assessment Field Operations Manual



April 2009

This document is NOT the full protocol. Non-Wadeable Methods have been extracted from the full protocol, which is available from the EPA. Search for report EPA-841-B-07-009. Or visit, <http://water.epa.gov/type/rsl/monitoring/riverssurvey/>

5.0 NON-WADEABLE RIVERS

5.1 Water Quality

This section describes the procedures and methods for the field collection and analysis of the water quality indicators (in-situ measurements, water chemistry, Secchi Disk transparency, and sediment enzymes) from **non-wadeable** streams and rivers. Refer to Appendix E for PPCP water sampling procedures at the designated urban river sites.

5.1.1 In Situ Measurements of Dissolved Oxygen, pH, Temperature, and Conductivity

5.1.1.1 Summary of Method

Measure dissolved oxygen (DO), pH, temperature, and conductivity using a calibrated multi-parameter water quality meter (or sonde). Take the measurements mid-channel at the X-site. Take the readings at 0.5 m depth. Measure the site depth accurately before taking the measurements. Take care to avoid the probe contacting bottom sediments, as the instruments are delicate.

5.1.1.2 Equipment and Supplies

Table 5.1-1 provides the equipment and supplies needed to measure dissolved oxygen, pH, temperature, and conductivity. Record the measurements on the Field Measurement Form, as seen in Figure 5.1-1.

Table 5.1-1. Equipment and supplies—DO, pH, temperature, and conductivity

For taking measurements and calibrating the water quality meter	<ul style="list-style-type: none"> ▪ Multi-parameter water quality meter with pH, DO, temperature, and conductivity probes. ▪ Extra batteries ▪ De-ionized and tap water ▪ Calibration cups and standards ▪ QCS calibration standard ▪ Barometer or elevation chart to use for calibration
For recording measurements	<ul style="list-style-type: none"> ▪ Field Measurement Form ▪ Pencils (for data forms)

5.1.1.3 Multi-Probe Sonde

Dissolved Oxygen Meter

Calibrate the DO meter prior to each sampling event. It is recommended that the probe be calibrated in the field against an atmospheric standard (ambient air saturated with water) prior to launching the boat. In addition, manufacturers typically recommend periodic comparisons with a DO chemical analysis procedure (e.g., Winkler titration) to check accuracy and linearity.

FIELD MEASUREMENT FORM - BOATABLE

Reviewed by (initials): OJM

SITE ID: FW08 XX001 DATE: 04/14/2009

Instrument manufacturer and model: HydroLab Surveyor with M55 Sonde
 Instrument ID number: EPA 123456 Operator: J. Doe

Thermometer Reading (°C)	Sensor Reading (°C)	Flag	Comments
<u>15.2</u>	<u>15.0</u>		

Elevation	OR	Barometric Pressure (mm Hg)	Calibration Value	Displayed Value	Flag
<u>2000</u> <small>ft</small>			<u>100.0</u> <small>mg/L</small>	<u>100.0</u> <small>mg/L</small>	

Cal. STD 1 Description	Cal. STD 1 Value	Cal. STD 2 Description	Cal. STD 2 Value
<u>pH 7 Buffer</u>	<u>7.00</u>	<u>pH 4 Buffer</u>	<u>4.00</u>

Calibration Verified with Quality Control Sample (QCS)

QCS Description	QCS True	QCS Measured	Flag
<u>Dilute NIST Phosphate Buffer</u>	<u>6.98</u>	<u>6.90</u>	

Cal. STD 1 Description	Cal. STD 1 Value	Cal. STD 2 Description	Cal. STD 2 Value
<u>KCl STANDARD</u>	<u>147</u>		

Calibration Verified with Quality Control Sample (QCS)

QCS Description	QCS True ($\mu\text{S/cm}$ @25°C)	QCS Measured ($\mu\text{S/cm}$ @25°C)	Flag
<u>Dilute NIST Phosphate Buffer</u>	<u>75</u>		

TRANSECT:

	<input type="radio"/> Left	<input type="radio"/> Right	<input type="radio"/> Left Ctr	<input type="radio"/> Right Ctr	<input type="radio"/> CENTER	<input type="radio"/> Right Ctr	<input type="radio"/> Left
Time of Day (HH:MM)					<u>10:15</u>		
DO (mg/L) XX.X					<u>9.7</u>		
Temp. (°C) XX.X					<u>20.4</u>		
pH XX.XX					<u>7.27</u>		
Cond. ($\mu\text{S/cm}$ @25°C) XX.X							
Corrected to 25°C ?	<input type="radio"/> Y <input type="radio"/> N	<input checked="" type="radio"/> Y <input type="radio"/> N	<input type="radio"/> Y <input type="radio"/> N	<input type="radio"/> Y <input type="radio"/> N			
Depth Disk Disappears (m)					<u>1.90</u>		
Depth Disk Reappears (m)					<u>1.70</u>		
Clear to Bottom?	<input type="radio"/> Y <input type="radio"/> N	<input type="radio"/> Y <input type="radio"/> N	<input type="radio"/> Y <input type="radio"/> N				
Flag							

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Figure 5.1-1. Field Measurement Form.

pH Meter

Calibrate the pH meter prior to each sampling event. Calibrate the meter in accordance with the manufacturer's instructions and with the team agency's existing SOP. You must also conduct a quality control check with the provided standard to verify the calibration and periodically evaluate instrument precision (see Section 3.1.2). Once a week, each crew must check their multi-probe against the QCS that was in each base kit. Any irregularities must be reported to the Field logistics coordinator immediately.

Temperature Meter

Check the accuracy of the sensor against a thermometer that is traceable to the National Institute of Standards (NIST) at least once per sampling season. The entire temperature range encountered in the NRSA should be incorporated in the testing procedure and a record of test results kept on file.

Conductivity Meter

Calibrate the conductivity meter prior to each sampling event. Calibrate the meter in accordance with the manufacturer's instructions. The entire conductivity range encountered in the NRSA should be incorporated in the testing procedure and a record of test results kept on file. You must also conduct a quality control check with the provided standard to verify the calibration and periodically evaluate instrument precision (see Section 3.1.2). Once a week, each crew must check their multi-probe against the QCS that was in each base kit. Any irregularities must be reported to the Field logistics coordinator immediately.

5.1.1.4 Sampling Procedure

Table 5.1-2 presents step-by-step procedures for measuring dissolved oxygen, pH, temperature, and conductivity.

Table 5.1-2. Sampling procedure—temperature, pH, conductivity and dissolved oxygen.

1. Check meter and probes and calibrate according to manufacturer's specifications.
2. Check the calibration against the provided QCS solution for pH and conductivity and record the results on the field sheet as the QCS Measured value. This should be done at least once a week.
3. Record the true value of the QCS solution from the stock solution container on the field sheet as QCS True.
4. Samples are taken mid-channel, at the X site, at a depth of 0.5 meters or at a mid-depth if less than 1 meter deep.
5. Lower the sonde in the water and measure DO, pH, temperature, and conductivity at 0.5 m depth.
6. Record the measurements on the Field Measurement Form.
7. Flag any measurements that the team feels needs further comment or when a measurement cannot be made.
8. If sampling at the X-site is not possible, move to another part of the reach to take the measurements (as close to the X-site as possible), record the letter of the nearest transect in the "TRANSECT" box and more detailed reasons and/or information in the Comments section.

5.1.2 Water Chemistry Sample Collection and Preservation

5.1.2.1 Summary of Method

The water chemistry samples will be analyzed for total phosphorus (TP), total nitrogen (TN), total ammonia-nitrogen (NH₄), nitrate (NO₃), basic anions, cations, total suspended solids (TSS), turbidity, acid neutralizing capacity (ANC, alkalinity), dissolved organic carbon (DOC), and total organic carbon (TOC). You will also collect a 2-L sample in an amber Nalgene bottle to be filtered on shore for later analysis of *chlorophyll a* (See Section 7 for filtration procedure). Store all samples in darkness on ice in a closed cooler. After you filter the *chlorophyll a* samples, the filters must be kept frozen until ready to ship.

Collect the samples at mid-channel at the X-site of the river from a depth of 0.5 meters. Use the 3 L Nalgene beaker to fill the individual sample bottles. The 3 L Nalgene beaker will be rinsed and re-used at each sampling location.

5.1.2.2 Equipment and Supplies

Table 5.1-3 provides the equipment and supplies needed to collect water samples at the index site. Record the Water Sample Collection and Preservation data on the Sample Collection Form, Side 1 as seen in Figure 5.1-2.

Table 5.1-3. Equipment and supplies—water chemistry sample collection and preservation

For collecting samples	<ul style="list-style-type: none"> ▪ Laser Rangefinder ▪ Nitrile gloves ▪ one 2-L amber Nalgene bottle (<i>chlorophyll</i>) ▪ 4-L cube container ▪ 3 L Nalgene beaker ▪ Cooler with ice ▪ Field Operations Manual and/or laminated Quick Reference Guide
For recording measurements	<ul style="list-style-type: none"> ▪ Sample Collection Form ▪ Field Measurement Form ▪ Pencils (for data forms) ▪ fine-tipped indelible markers (for labels)

Reviewed by _____
(Initials): _____

SAMPLE COLLECTION FORM - BOATABLE (Front)

SITE ID: FW08 XX000 DATE: 04.11.41.2009

Sample ID	Sample Category*	Chilled	Comments
<u>999001</u>	<input checked="" type="radio"/> P <input type="radio"/> D	<input checked="" type="radio"/>	
	<input type="radio"/> P <input type="radio"/> D	<input type="radio"/>	

Sample ID	Sample Category*	Volume Filtered (mL)	Frozen	Comments
<u>999002</u>	<input checked="" type="radio"/> P <input type="radio"/> D	<u>1200</u>	<input checked="" type="radio"/>	
	<input type="radio"/> P <input type="radio"/> D		<input type="radio"/>	

Sample ID	Sample Category*	Chilled	Comments
<u>999004</u>	<input checked="" type="radio"/> P <input type="radio"/> D	<input checked="" type="radio"/>	
	<input type="radio"/> P <input type="radio"/> D	<input type="radio"/>	

Dominant Habitat: (ONE PER TRANSECT)	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT
Secondary Habitat: (ONE PER TRANSECT)	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT	<input type="radio"/> C <input type="radio"/> L <input type="radio"/> F <input type="radio"/> M <input type="radio"/> OT
Substrate: (ONE PER TRANSECT)	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT	<input type="radio"/> F <input type="radio"/> C <input type="radio"/> G <input type="radio"/> OT
Channel: (ONE PER TRANSECT)	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT	<input type="radio"/> P <input type="radio"/> RA <input type="radio"/> RI <input type="radio"/> GL <input type="radio"/> OT
Habitat: C = Coarse Substrate / LWD L = Leaf Pack F = Organic Fine Muds / Sand M = Macrophyte beds OT = Other (Explain in comment section below)			Substrate: F = Fine / Sand G = Gravel C = Coarse substrate OT = Other (Explain in comment section below)				Channel: P = Pool GL = Glide RI = Riffle RA = Rapid OT = Other (Explain in comment section below)				

<u>999007</u>	<input checked="" type="radio"/> P <input type="radio"/> D	<u>0.1</u>	<input checked="" type="radio"/>	<u>TD Substrate was bedrock.</u>
	<input type="radio"/> P <input type="radio"/> D		<input type="radio"/>	

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew. Explain all flags in comment sections.

*Sample Categories: P = Primary, D = Field Duplicate

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Figure 5.1-2. Sample Collection Form, Side 1.

5.1.2.3 Sampling Procedure

Table 5.1-4 describes the sampling procedures for collecting water chemistry samples in non-wadeable streams and rivers. Refer to Appendix E for PPCP water sampling procedures at the designated urban river sites.

Table 5.1-4. Sampling procedure for non-wadeable sites—water chemistry sample collection

1. Collect the water samples from the X-site in a flowing portion near the middle of the stream.
2. Put on nitrile gloves. Make sure not to handle sunscreen or other chemical contaminants until after the sample is collected.
3. Rinse the 3-L Nalgene beaker three times with water, and discard the rinse downstream.
4. Remove the cube container lid and expand the cube container by pulling out the sides. **NOTE: DO NOT BLOW into the cube container to expand them, this will cause contamination.**
5. Fill the 3-liter beaker with water and slowly pour 30 - 50 mL into the cube container. Cap the cube container and rotate so that the water contacts all the surfaces. Discard the water downstream. Repeat this rinsing procedure 2 more times.
6. Fill the beaker with water and pour into the cube container. Repeat as necessary to fill the cube container. Let the weight of the water expand the cube container. Pour the water slowly as the cube container expands. Fill the cube container to at least three-fourths of its maximum volume. Rinse the cube container lid with water. Eliminate any air space from the cube container, and cap it tightly. Make sure the cap is tightly sealed and not on at an angle.
7. Fill the 3-liter beaker with water and slowly pour 30 - 50 mL into the 2 L amber Nalgene bottle. Cap the bottle and rotate so that the water contacts all the surfaces. Discard the water downstream. Repeat this rinsing procedure 2 more times.
8. Fill the beaker with water and pour into the 2 L amber Nalgene bottle. Cap the bottle tightly.
9. Place the cube container and bottle in a cooler (on ice or water) and shut the lid. If a cooler is not available, place the cube container in an opaque garbage bag and immerse it in the stream.
10. Record the Sample ID on the Sample Collection Form along with the pertinent stream information (stream name, ID, date, etc.). Note anything that could influence sample chemistry (heavy rain, potential contaminants) in the Comments section. If sampling at the X-site is not possible, move to another part of the reach to collect the sample (as close to the X-site as possible), record the letter of the nearest transect and more detailed reasons and/or information in the Comments section.

5.1.3 Secchi Disk Transparency at Non-Wadeable Sites

5.1.3.1 Summary of Method

A Secchi disk is a black and white patterned disk used to measure water clarity (see Figure 5.1-3). A Secchi disk transparency reading will be collected mid-channel at the X-site. The Secchi disk will be affixed to the end of a solid metered rod (e.g., Schedule 80 PVC pipe, or equivalent) and lowered into the water until it disappears from sight. Measurements are recorded at the depth that the disk disappears and again when it reappears. The reading is taken on the shady side of the boat, without sunglasses, hat or view aids.

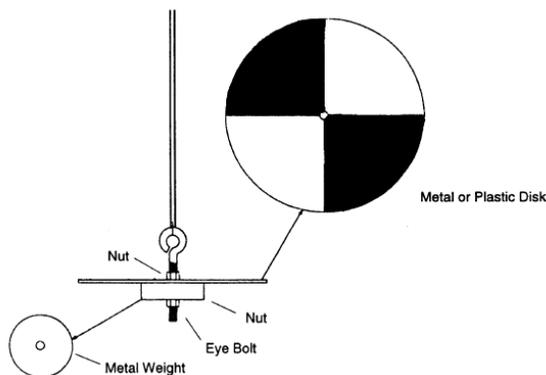


Figure 5.1-3. Secchi disk diagram (EPA, 1991).

5.1.3.2 Equipment and Supplies

Table 5.1-5 lists the equipment and supplies needed to measure Secchi disc transparency. Record the Secchi disk readings on the Field Measurement Form, Side 1 as seen in Figure 5.1-1.

Table 5.1-5. Equipment and supplies—Secchi disc transparency

For taking measurements and calibrating the water quality meter	<ul style="list-style-type: none"> • 20 cm diameter Secchi disk and calibrated sounding rod (marked in half centimeter intervals) • Tape measure (in centimeters)
For recording measurements	<ul style="list-style-type: none"> • Field Measurement Form • Pencils (for data forms)

5.1.3.3 Sampling Procedure

Because different people measuring Secchi disk transparency at the same site may obtain different results (due to differences in vision and interpreting disk disappearance and reappearance), one team member will conduct Secchi disk measurements for all sites. Table 5.1-6 lists the procedure for Secchi disk transparency at non-wadeable sites.

If the water is shallow and clear, the Secchi disk might reach the bottom and still be visible. If this is the case, it is important to not stir up the bottom sediments while anchoring the boat. Be sure to move the boat away from the anchor before taking the reading. If the disk is visible at the bottom, indicate this on the form.

Table 5.1-6. Sampling procedure at non-wadeable sites—Secchi disk transparency

<ol style="list-style-type: none"> 1. Measure Secchi disk transparency mid-channel at the X-site. 2. Confirm that the lowering rod is firmly attached to the Secchi disk. 3. Remove sunglasses and hats. Also, do not use view scopes or other visual aids. If wearing prescription sunglasses, temporarily replace them with regular clear lens prescription glasses. 4. Lower the Secchi disk over the shaded side of the boat until it disappears. 5. Read the depth indicated on the lowering rod. If the disappearance depth is <1.0 meter, determine the depth to the nearest 0.05 meter by marking the line at the nearest depth marker and measuring the remaining length with a tape measure. Otherwise, estimate the disappearance depth to the nearest 0.1 meter. Record the disappearance depth on the Sample Collection Form. 6. Lower the disk a bit farther and then slowly raise the disk until it reappears and record the reappearance depth on the Field Measurement Form. 7. Note any conditions that might affect the accuracy of the measurement in the comments field.
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5.1.4 Sediment Enzymes

5.1.4.1 Summary of Method

Collect sediment samples at the 11 sampling stations at each site and combine all stations at a site, resulting in a single 500 mL sample per site. Collect fine surface sediments (top 5 cm) using a spoon or dredge. Store samples on ice until shipment to the laboratory for processing. Samples will be analyzed for available DIN, NH₄, DIP, TP, TN, total carbon (TC), and enzyme activity.

5.1.4.2 Equipment and Supplies

Table 5.1-7 lists the equipment and supplies needed to collect sediment enzyme samples. Record collection data on Side 2 of the Sample Collection Form, as seen in Figure 5.1-4.

Table 5.1-7. Equipment and supplies—sediment enzymes

For collecting samples	<ul style="list-style-type: none"> ▪ Petite Ponar sampler with plastic tub, drop line, and spare pinch pin. Standard Ponar may substitute. ▪ Graduated plastic bucket with lid 	<ul style="list-style-type: none"> ▪ Large stainless steel spoon for collecting & mixing sediment composite ▪ 500-mL plastic bottle for storing sediment sample
For recording measurements	<ul style="list-style-type: none"> ▪ Sample Collection Form ▪ Sample labels ▪ Pencils 	<ul style="list-style-type: none"> ▪ Fine-tipped indelible markers (for labels) ▪ Clear tape strips

5.1.4.3 Sampling Procedure

Near each of the macroinvertebrate and periphyton sampling locations, collect a fine-grained sediment sample using a spoon. If the depth is too great to reach the bottom with the spoon, a “petite Ponar” grab sampler can be used to collect sediment and the stainless steel

spoon can take the sample to be added to the composite bucket from the ponar. The objective is to collect a 500-mL composite sample that is representative of depositional areas at the site. The composite sample will be subsampled in the laboratory for multiple analyses. Table 5.1-8 presents step-by-step procedures for collecting sediment enzyme samples.

Table 5.1-8. Sampling procedure—sediment enzymes

1. Collect a sediment sample at each of the 11 transect sampling stations, near the periphyton and macroinvertebrate sample locations. Make sure each subsample comprises an approximately equal portion of the total composite. You may collect sediment between stations to insure at least 500 mL of composite volume (note any deviations from standard procedure in a comment.)
2. Locate sediment samples in areas or patches of fine-grained substrate (silty sand, silt, clay, muck) in a zone bounded on the shore side by the apparent low-water mark from daily flow fluctuations (often detected by the presence of periphyton or attached filamentous algae just below the low-water mark) and bounded on the river side by the 0.3-m depth contour (recommended maximum sample depth; deeper sampling may be possible). If samples cannot be safely collected by wading at a station due to vertical banks or other reason go to step 5.
3. Avoid the area that has just been kick sampled for macroinvertebrates. Sampling up-stream from the kick sample location is recommended. If fine substrates are not present within 5 m up- or downstream from the station, flag the station on the form.
4. If fine substrate is present, use the stainless steel spoon to collect a sample (approximately one spoonful of sediment) from the top 5 cm of substrate. Place the sample in a clean bucket. Use gloves for handling sediment. Do not assume rip rapped shorelines lack fine-grained sediment. Look for fines between the large rocks.
5. If the littoral zone cannot be waded, use a petite Ponar (or similar) sampler deployed from the boat to collect a sediment sample adjacent to the station. (*Use caution with Ponar samplers. The jaws are sharp and may close unexpectedly. Replace frayed lines and worn parts.*) Raise the Ponar sampler from the water and into a plastic tub rather than from the boat deck. This prevents feet from getting under the sampler. Release the petite Ponar sample into a tub and use the scoop to collect about 15 x 15 cm (6 x 6 inches) of the top 5 cm of the sample. Using the stainless steel spoon, take a one spoon grab from the top layer of sediment captured in the Ponar. Place this in the composite bucket and discard the rest.
6. Repeat steps 2-5 at each of the 11 littoral stations. Record the total number of replicates (stations) included in the composite. Note in a comment the stations at which sediment was collected using a non-wading method.
7. It is important that a sufficient sediment (not less than 500 mL) composite sample for analysis be collected. If multiple stations have no fine sediment, it is permissible to collect extra sample at stations that do have fine sediment or between stations. *Be sure to note this in a comment.*
8. Using the stainless steel spoon, thoroughly mix the composite sample and transfer 500 mL into the 500 mL plastic bottle. Place in a cooler with ice for final labeling and preservation.
9. Prepare a label for the sample jar. Using a fine-point indelible marker, fill in the site # and sample date. Place the label on the jar and cover it with clear tape. Record the sample ID and other data on sampling form. Place the sample on ice or in a refrigerator. Do not freeze sediment samples. The sediment enzyme sample has a two week holding time.

SAMPLE COLLECTION FORM - BOATABLE - (Back) Reviewed by JD
(initial):

SITE ID: FW08XX000 DATE: 07/01/2008

COMPOSITE PERIPHYTON SAMPLE - Primary No Sample Collected

Sample ID <u>999005</u>		Sample Category* <input checked="" type="radio"/> P <input type="radio"/> D	Composite Volume (mL) <u>4.50</u>			Number of transects sampled (0-11): <u>1,1</u>					
Assemblage ID (.1) (50-mL tube)			Chlorophyll (.2) (GF/F filter)			Biomass (.3) (GF/F Filter)			APA (.4) (50-mL tube)		
Sample Vol. (mL)	Flag	Preserved	Sample Vol. (mL)	Flag	Frozen	Sample Vol. (mL)	Flag	Frozen	Sample Vol. (mL)	Flag	Frozen
<u>40</u>		<input checked="" type="radio"/>	<u>25</u>		<input checked="" type="radio"/>	<u>25</u>		<input checked="" type="radio"/>	<u>50</u>		<input checked="" type="radio"/>

COMPOSITE PERIPHYTON SAMPLE - Duplicate No Sample Collected

Sample ID		Sample Category* <input type="radio"/> P <input type="radio"/> D	Composite Volume (mL)			Number of transects sampled (0-11):					
Assemblage ID (.1) (50-mL tube)			Chlorophyll (.2) (GF/F filter)			Biomass (.3) (GF/F Filter)			APA (.4) (50-mL tube)		
Sample Vol. (mL)	Flag	Preserved	Sample Vol. (mL)	Flag	Frozen	Sample Vol. (mL)	Flag	Frozen	Sample Vol. (mL)	Flag	Frozen
		<input type="radio"/>			<input type="radio"/>			<input type="radio"/>			<input type="radio"/>

Flag Comments

Flag codes: K = No measurement or observation made; U = Suspect measurement or observation; F1, F2, etc. = misc. flags assigned by field crew.
Explain all flags in comment sections.

SEDIMENT CHEMISTRY / ENZYMES No Sample Collected

Sample ID <u>999006</u>	Sample Category* <input type="radio"/> P <input type="radio"/> D	Composite Volume <u>4.00</u>	No. of Transects <u>1,1</u>	Chilled <input checked="" type="radio"/>	Comments						
	<input type="radio"/> P <input type="radio"/> D			<input type="radio"/>							

ENTEROCOCCI (Target Volume = 250 mL) No Sample Collected

Sample ID One unique ID per line	Sample Category* <input type="radio"/> P <input type="radio"/> D	Time Collected (hhmm)	Depth Collected (m)	Sample Volume (mL)	Filt. Start Time (hhmm)	Volume Filtered (Target = 50 mL) **				Filt. End Time (hhmm)	Time Frozen (hhmm)	Flag
						Filt. 1	Filt. 2	Filt. 3	Filt. 4			
<u>50.0020</u>	<input checked="" type="radio"/> P <input type="radio"/> D	<u>1615</u>	<u>0.3</u>	<u>250</u>	<u>1800</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>50</u>	<u>1845</u>	<u>1900</u>	<u>F1</u>
	<input type="radio"/> P <input type="radio"/> D											
	<input type="radio"/> P <input type="radio"/> D											
	<input type="radio"/> F											

Flag Comment

F1 RINSE VOLUMES: 20 mL FOR ALL FOUR FILTERS

* Sample Categories: P = Primary, D = Duplicate; F = Filter Blank (Enterococci sample only) Filter blank is collected at visit where field duplicate sample is NOT taken.
** If <25 ml of buffer solution was used to rinse filter, indicate with an F flag and note in comment section which filter(s) were affected along with the approximate volume(s) of buffer solution used.

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NRSA Sample Collection - Boatable 04/03/2008

Figure 5.1-4. Sample Collection Form, Side 2.

5.2 Physical Habitat Characterization in Non-Wadeable Rivers and Streams

Physical habitat in rivers includes all those physical attributes that influence or provide sustenance to river organisms. Physical habitat varies naturally; thus, expectations differ even in the absence of anthropogenic disturbance. Within a given physiographic-climatic region, river drainage area and channel gradient are likely to be strong natural determinants of many aspects of river habitat, because of their influence on discharge, flood stage, and stream power (the product of discharge times gradient). Kaufmann (1993) identified 7 physical habitat attributes important in influencing stream ecology that are likely applicable in rivers as well. They include:

- Channel Dimensions
- Channel Gradient
- Channel Substrate Size and Type
- Habitat Complexity and Cover
- Riparian Vegetation Cover and Structure
- Anthropogenic Alterations
- Channel-Riparian Interaction

The protocol defines the length of each sampling reach proportional to river wetted width and then systematically places measurements to statistically represent the entire reach. Stream thalweg depth measurements, habitat classification, and mid-channel substrate observations are made at very tightly spaced intervals; whereas channel “littoral” and riparian stations for measuring or observing substrate, fish cover, large woody debris, bank characteristics and riparian vegetation structure are spaced further apart. The tightly spaced depth measures allow calculation of indices of channel structural complexity, objective classification of channel units such as pools, and quantification of residual pool depth, pool volume, and total stream volume.

5.2.1 Equipment and Supplies

Table 5.2-1 lists the equipment and supplies required to conduct all the activities described for characterizing physical habitat. This checklist is similar to the checklist presented in Appendix A, which is used at the base location (Section 3) to ensure that all of the required equipment is brought to the river. Use this checklist to ensure that equipment and supplies are organized and available at the river site in order to conduct the activities efficiently.

Table 5.2-1. Checklist of equipment and supplies for physical habitat

For making measurements	<ul style="list-style-type: none"> ▪ Surveyor’s telescoping leveling rod (round profile, metric scale, 7.5m extended) ▪ Convex spherical canopy densiometer (Lemmon Model B), modified with taped “V” ▪ GPS ▪ 1 roll each colored surveyor’s flagging tape (2 colors) ▪ 2 pair chest waders ▪ 1 or 2 fisherman’s vest with lots of pockets and snap fittings. ▪ Digital camera with extra memory card & battery ▪ 50 m or 100 m measuring tape with reel ▪ Meter stick for bank angle measurements ▪ SONAR unit ▪ Laser rangefinder (400 ft. distance range) and clear waterproof bag ▪ Clinometer
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	<ul style="list-style-type: none"> ▪ Binoculars ▪ Field Operations Manual and/or laminated quick reference guide ▪ Laminated invasive species guide
For recording data	<ul style="list-style-type: none"> ▪ 2 covered clipboards (lightweight, with strap or lanyard) ▪ Soft (#2) lead pencils ▪ 11 plus extras Channel/Riparian Transect Forms ▪ 11 plus extras Thalweg Profile Forms ▪ 1+ extras field Form: Stream Verification Form ▪ 1+ extras field Form: Field Measurement Form ▪ 1+ extras field Form: Sample Collection Form ▪ 1+ extras field Form: Riparian “Legacy” Trees and Invasive Alien Plants ▪ 1+ extras field Form: Channel Constraint ▪ 1+ extras field Form: Fish Gear and Voucher/Tissue Information Form ▪ 1+ extras field Form: Fish Collection Form ▪ 1+ extras field Form: Visual Assessment Form

5.2.2 Components of the Field Habitat Assessment

Field data collection for the physical habitat assessment is accomplished in a single float down each sampling reach. River sample reach lengths are defined as 40 x the wetted width at the x-site, with a minimum of 150m and maximum of 4km. To characterize mid-channel habitat (Table 5.2.2), they measure a longitudinal thalweg (or mid-channel) depth profile, record the presence of snags and off-channel habitats, classify main channel habitat types, characterize mid-channel substrate, and locate the 11 transect locations for littoral/riparian sampling and other habitat observations. At each of the 11 transects (A-K), they measure channel wetted width, bankfull channel dimensions, incision, GPS lat/long, and then assess near-shore, shoreline, and riparian physical habitat characteristics by measuring or observing littoral depths, riparian canopy cover, substrate, large woody debris, fish cover, bank characteristics, riparian vegetation structure, presence of large (“legacy”) riparian trees, non-native riparian and aquatic species, and evidence of human activities. After all the thalweg and littoral/riparian measurements and observations are completed, the crews estimate the extent and type of channel constraint.

Table 5.2-2. Components of river physical habitat protocol

Thalweg Profile:

At 10 equally spaced intervals between each of 11 transects (100 along entire reach):

- Classify habitat type, record presence of backwater and off-channel habitats.

Determine dominant substrate visually or using sounding rod.

At 10 equally spaced intervals between each of 11 transects (100 along entire reach):

Record the presence of mid-channel snags

Measure thalweg (maximum) depth using Sonar or rod

Littoral/Riparian Cross-Sections: @ 11 transects at equal intervals along reach length:

Measure/estimate from one chosen bank on 11 transects :

Wetted width and Mid-channel bar width (laser range finder).

Bankfull width (laser) and height (pole and clinometer used as level).

Incision height (pole and clinometer used as level).

Bank angle (estimate)

Riparian canopy cover (densiometer) in four directions from chosen bank.

Shoreline Substrate in the first 1m above waterline (dominant and subdominant size class).

In 20m long Littoral Plot extending streamward 10m from chosen bank : ¹

Littoral depth at 5 locations systematically-spaced within plot (Sonar or sounding rod).

Dominant and Subdominant substrate size class at 5 systematically-spaced locations (visual or sounding rod).

Tally large woody debris in littoral plot and in bankfull channel by size and length class.

Areal cover class of fish concealment and other features, including:

filamentous algae	overhanging vegetation	aquatic macrophytes
undercut banks	large woody debris	boulders and rock ledges
brush/small woody debris	live trees or roots	artificial structures

In 20m long Riparian Plot extending 10m landward starting at bankfull margin--both sides of river:¹

Estimate areal cover class and type (e.g., woody) of riparian vegetation in Canopy, Mid-Layer, and Ground Cover layers

Observe and record human activities and disturbances and their proximity to the channel.

Record species of alien (non-native) trees, shrubs, grasses visible within riparian plot.

Looking upstream and downstream from each Transect (both sides of river):

Look for largest visible tree within 100m from the water's edge or as far as you can see, if less:

Estimate diameter (Dbh), height, species, and distance from river edge.

For the whole sampling reach, after completing thalweg and littoral/riparian measurements:*

- Classify channel type and degree of constraint, identify features causing constraint, estimate the percentage of constrained channel margin for the whole reach, and estimate the bankfull and valley widths.

¹Note: Boundaries for visual observations are estimated by eye.

5.2.3 Summary of Workflow

Table 5.2-3 lists the activities performed at and between each transect for the physical habitat characterization. The activities are performed along the chosen river bank and mid-channel (thalweg profile).

Table 5.2-3. Summary of workflow—river physical habitat characterization

A. At the chosen bank on first transect (farthest upstream):

Read GPS Lat./Long. and record it in the Transect (Shoreline) space on the field form.

Move boat in a “loop” within 10 x 20 m littoral plot, measuring 5 littoral depths and probing substrate.

Estimate dominant and subdominant littoral substrate, based on probing the 5 locations.

Estimate areal cover of fish concealment features in 10 x 20 meter littoral plot.

Tally LWD within or partially within the 10 x 20 meter littoral plot.

Do densiometer measurements at bank (facing upstream, downstream, left, right).

Choose bank angle class, estimate bankfull height, width and channel incision. (Note that width and incision estimates incorporate both left and right banks.)

Tally LWD entirely out of water but at least partially within the bankfull channel.

Estimate and record distance to riparian vegetation on the chosen bank.

Make visual riparian vegetation cover estimates for the 10 x 20 meter riparian plot on both sides of the channel. (Riparian plot starts where perennial vegetation begins or at bankfull channel margin, whichever is closest to the wetted river margin. The plot continues 10m back from the bankfull line).

Identify taxa, height, diameter at breast height (Dbh), and distance from riverbank of largest tree as far as you can see confidently upstream and downstream within 100m of the wetted river margin.

From a regional listing, record alien invasive tree, shrub, or grass taxa within in the 10m x 20m riparian plots on either side of the river.

Make visual human disturbance tally on both sides of the river. Use the same plot dimensions as for riparian vegetation -- except that if a disturbance item is observed in the river or within the bankfull channel, the proximity code is “B”, the closest rating; “C” if within the riparian plot. If the item is only observed beyond (outside) the riparian plot, the proximity code is “P”.

Get out far enough from the bank so you can see downstream. Then use the laser rangefinder to sight and record the distance to the intended position of the next downstream transect.

B. Thalweg Profile:

As soon as you get out from the bank after doing transect activities, take the first of 10 thalweg depth measurements and substrate/snag probes using sonar and pole -- also classify habitat type and record presence of side-channels and backwaters.

Estimate thalweg measurement distance increments using the GPS course-tracking and trip-meter functions. Alternatively, estimate these distances by keeping track of boat lengths or channel-width distances traversed; each one is 1/10th the distance between transects (also one-half channel-width, which can help you keep track of your downstream progress).

C. Repeat the Whole Process (for the remaining 10 transects and spaces in between).

D. Channel Constraint Assessment

After completing the Thalweg Profile and Littoral-Riparian measurements and observations at all 11 Transects, complete the classification and estimation of channel constraint type, frequency of contact with constraining features, and the width ratio of bankfull channel divided by valley width. You may wish to refer to the individual transect assessments of incision and constraint.

5.2.4 Habitat Sampling Locations on the Study Reach

Measurements are made at two scales of resolution along the mid-channel length of the reach; the results are later aggregated and expressed for the entire reach, a third level of resolution (Figure 5.2-1). Section 4 describes the procedures for locating the X-site, or the midpoint of the sample reach. This sampling location is marked on the maps provided to the field crews in the site dossiers prior to sampling. Sections 4.2 and 5.2.3 describe the protocol for delineating a sample reach that is 40 times its width. Those sections also describe the protocol for measuring out (with a laser range finder or GIS software) and locating the 11 littoral/riparian stations where many habitat measurements will be made (Figure 5.2-3). The distance between each of these transects is 1/10th the total length of the sample reach.

The thalweg profile measurements are spaced as evenly as practicable over the entire sample reach length. In addition, they must be sufficiently close together to not “miss” deep areas and habitat units that are in a size range of about 1/3 to 1/2 of the average channel width. To set the interval between thalweg profile measurements, measure the wetted channel width with a laser rangefinder at 5 locations near the X-site and multiply the average width by 40 to set the river sample reach length. Then divide that reach length by 100 to set the thalweg increment distance. Following these guidelines, you will be making 100 evenly-spaced thalweg profile measurements, 10 between each detailed channel cross-section where littoral/riparian observations are made. If the thalweg is too deep or not physically possible to be measured to, estimate the depth to the best of your ability and flag it on the field form.

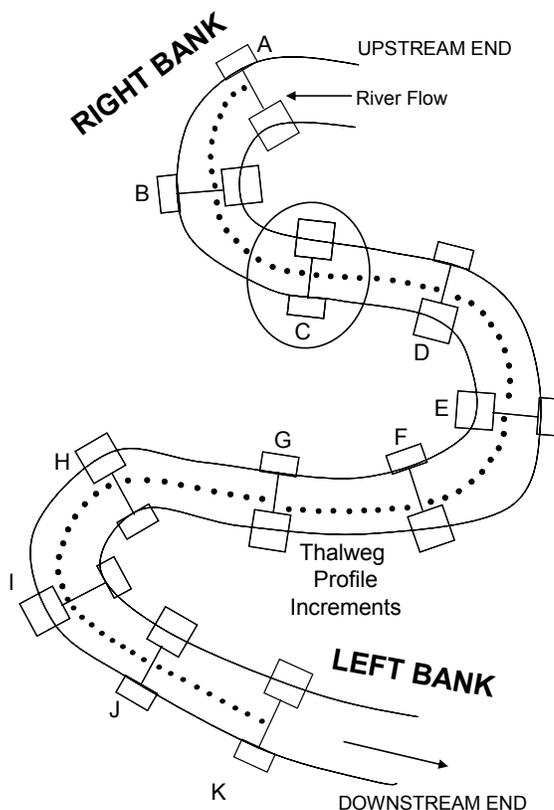


Figure 5.2-1. River reach sample layout.

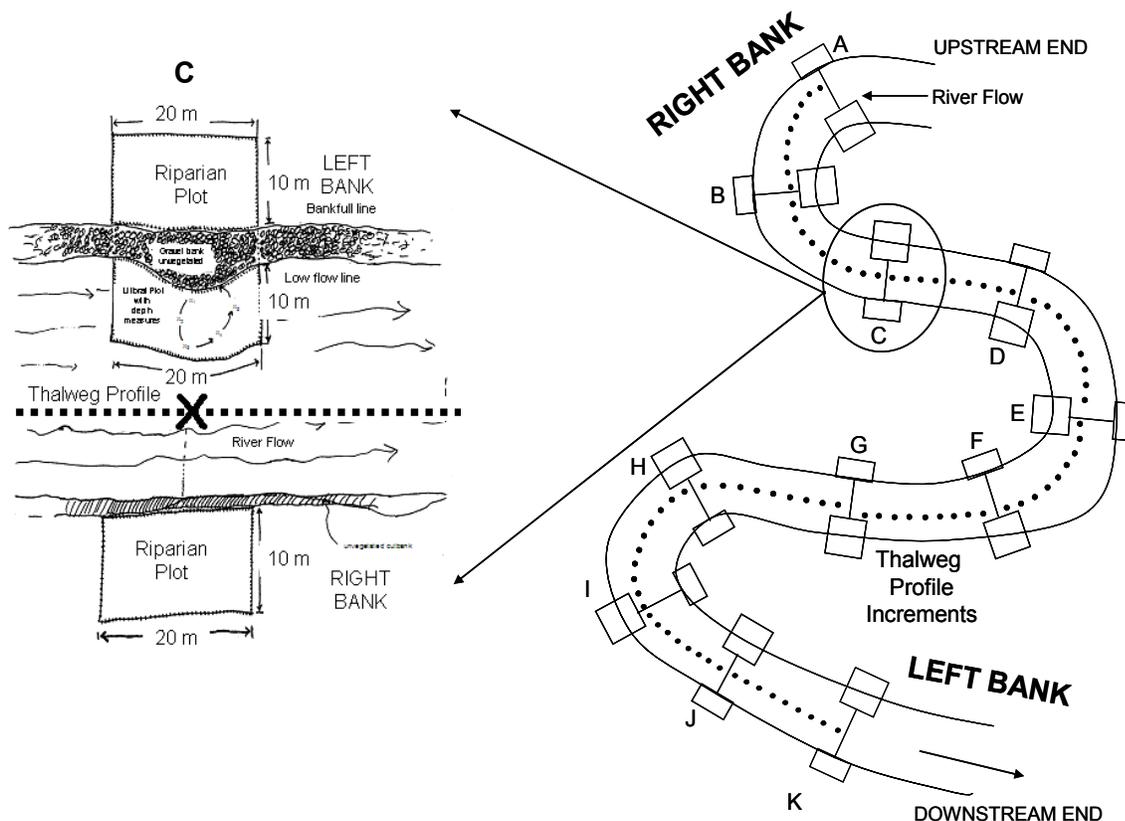


Figure 5.2-2. Littoral-Riparian Plots for characterizing riparian vegetation, human influences, fish cover, littoral substrate, and littoral depths.

5.2.5 Work Flow and Reach Marking

After finding adequate put-in and take-out locations, the team may opt to mark the upstream end of the sample reach end with colored flagging. In a single midstream float down the 40 channel-width reach, the 2-person habitat team accomplishes a reconnaissance, a sonar/pole depth profile, and a pole-drag to tally snags and characterize mid-channel substrate. The float is interrupted by stops at 11 transect locations for littoral/riparian observations. They determine (and mark – optional, but recommended) the intended position of each successive downstream transect using a global positioning system (GPS) or a laser range finder. Each transect is located 4 channel-width's distance from the preceding transect immediately upstream. The crew then floats downstream along the thalweg to the new transect location, making thalweg profile measurements and observations at 10 evenly-spaced increments along the way. When they reach the new downstream transect location, they stop to do cross-section, littoral, and riparian measurements, recording the actual GPS latitude/longitude of the transect position. In addition, while they are stopped at a cross-section station, the crew can fill out the habitat “typing” entries retrospectively and prospectively for the portion of the stream distance that is visible up- and downstream. They will also collect biological and sediment samples.

GPS coordinates are determined for the actual locations of each transect stop. **If GPS unit also has course tracking, trip-meter (accumulated distance and bearing), and waypoint setting/navigation features,** we recommend using it to locate thalweg measurement

points (use course tracking and trip meter). Equipping the boat with a bow or stern anchor to stop at transect locations can greatly ease the shore marking operation and shoreline measurement activities, though such equipment can be dangerous in white-water rivers.

5.2.6 Reconnaissance

The habitat crew will also record reconnaissance and safety notes at this time. They will inform the second boat of the route, craft, and safety precautions needed during its subsequent electrofishing activities. They also assist the electrofishing boat crew over jams and help to conduct shuttles (this can take considerable time where put-ins and take-outs are distant). As the team floats downstream, they may choose and communicate to the electrofishing crew the most practical path to be used when fishing with a less maneuverable boat, taking into consideration multiple channels, blind channels, backwaters, alcoves, impassible riffles, rapids, jams, and hazards such as dams, bridges and power lines. They determine if and where tracking or portages are necessary.

5.2.7 Thalweg Profile

“Thalweg” refers to the flow path of the deepest water in a river channel. The thalweg profile is a longitudinal survey of maximum depth and several other selected characteristics at 100 near-equally spaced points along the centerline of the river between the two ends of the river reach (Figure 5.2-1). For practical reasons, field crews will approximate a thalweg profile by sounding along the river course that they judge is deepest, but also safely navigable.

Locations for observations and measurements along the path of this profile are determined using the GPS course-tracking and trip-meter features (recommended), or by visually estimating distances based upon the river width. Data from the thalweg profile allows calculation of indices of residual pool volume, river size, channel complexity, and the relative proportions of habitat types such as riffles and pools. The procedure for obtaining thalweg profile measurements is presented in Table 5.2-2. Record data on the Thalweg Profile Form as shown in Figure 5.2-3.

5.2.7.1 Thalweg Depth Profile

A thalweg depth profile of the entire 40 channel-width reach is approximated by a sonar or sounding rod depth profile while floating downstream along the deepest part of the channel (or closest navigable path). In the absence of a recording fathometer (sonar depth sounder with strip-chart output or electronic data recorder), the crew records depths at frequent, relatively evenly-spaced downstream intervals while observing a sonar display and holding a surveyor's rod off the side of the boat (see Section 5.2.7.2). The sonar screen is mounted so that the crewmember can read depths on the sonar and the rod at the same time. The sonar sensor may need to be mounted at the opposite end of the boat to avoid mistaking the rod's echo for the bottom, though using a narrow beam (16 degree) sonar transducer minimizes this problem. It is easy to hold the sounding rod vertically if you are going at the same speed as the water. If the thalweg is too deep to safely be recorded, estimate the depth and note on comments form.

5.2.7.2 Pole Drag for Snags and Substrate Characteristics

The procedure for dragging the thalweg pole to detect underwater snags and substrate characteristics is presented in Table 5.2-4. While floating downstream, one crewmember holds a calibrated PVC sounding rod or surveying rod down vertically from the gunwale of the boat,

dragging it lightly on the bottom to simultaneously “feel” the substrate, detect snags, and measure depth with the aid of sonar. The crewmember shall record the dominant substrate type sensed by dragging the rod along the bottom (bedrock/hardpan, boulder, cobble, gravel, sand, silt & finer) on the Thalweg Profile Form (Figure 5.2-3). Substrate characteristics are recorded at every thalweg depth measurement (e.g., 10 determinations between transects A and B). In shallow, fast-water situations, where pole-dragging might be hazardous, crews will estimate bottom conditions the best they can visually and by using paddles and oars. If unavoidable, suspend measurements until out of whitewater situations, but make notes and appropriately flag observations concerning your best judgments of depth and substrate.

Table 5.2-4. Thalweg profile procedure

1. Determine the interval between transects based on the mean wetted width used to determine the reach length. Transects are at 4 channel-width spacings; thalweg depth, snags, off-channel habitats and other downstream longitudinal profile observations are recorded at intervals of 0.4 channel-width.
2. Complete header information on the Thalweg Profile Form, noting transect pair (up- to downstream).
3. Begin at the upstream transect (station “1” of “10”). Determine the locations to take measurements using the course-tracking and trip-meter functions of the GPS. Alternatively, estimate your position.

Thalweg Depth Profile

- a) While floating downstream along the thalweg, record depths at frequent, even-spaced intervals while observing a sonar display and holding a surveyor’s rod off the side of the boat.
- b) A depth recording every 0.4 channel-width distance is required, yielding 10 measurements between channel/riparian cross-section transects.
- c) If the depth is >0.5 meters, or contains a lot of air bubbles, the sonar fathometer will not give reliable depth estimates. In this case, record depths using a calibrated sounding rod. In shallow, fast-water situations depths may have to be visually estimated to the nearest 0.5 m.
- d) Measure depths to nearest 0.1 m and record in the “SONAR” or “POLE” column.

Pole Drag for Snags and Substrate Characteristics

From the gunwale of the boat, hold a surveying rod or calibrated PVC sounding rod down vertically into the water. (CAUTION: Hold the rod over the side or stern of the raft; otherwise it could be jerked out of your hands if it catches on an obstruction in fast water.)

Lightly drag the rod on the river bottom to “feel” the substrate and detect snags.

Record the presence of snags hit by the rod or seen visually, plus the dominant substrate type sensed by dragging the rod along the bottom.

Circle the appropriate “SUBSTRATE” type and record the presence/absence of “SNAGS”.

If it is too deep to safely measure the substrate type, estimate the type based on knowledge and surrounding measurements and flag the date.

Channel Habitat Classification

Classify and record the channel habitat type at increments of every 0.4 channel width.

Check for off-channel and backwater habitat at increments of every 0.4 channel width.

If channel is split by a bar or island, navigate and survey the channel with the most flow.

When a side channel is encountered, circle “Y” in the “OFF-CHANNEL” column beginning with the point of divergence from the main channel, continuing downriver until the side channel converges with the main channel.

Circle the "CHANNEL HABITAT" and record side channels as described in (d) above.

Proceed downriver to the next station, and repeat the above procedures.

Record GPS waypoint (Lat/Long) midstream and at shoreline location on each transect in decimal degrees.

Repeat the above procedures until you reach next transect. Set a waypoint location for the transect location midstream and at the adjacent bank. Record waypoints that you set for channel bends, transect mid-stream, and transect shoreline locations on the Channel-Riparian Transect Form corresponding to the downstream end of the thalweg sub-reach you just traversed.

After completing activities at the shoreline, prepare a new Thalweg Profile Form, then repeat the above procedures for each of the reach segments, until you reach the downriver end of the reach (Transect "K").

PHAB: THALWEG PROFILE FORM - BOATABLE

Reviewed by (initial): JD

SITE ID: FW08 XX000 DATE: 07/01/2008

TRANSECT: A-B B-C C-D D-E E-F F-G G-H H-I I-J J-K

SUBSTRATE CODES				CHANNEL HABITAT CODES				OTHER	
BH = BEDROCK/HARDPAN (SMOOTH OR ROUGH) - (LARGER THAN A CAR) BL = BOULDER (250 TO 4000 mm) - (BASKETBALL TO CAR) CB = COBBLE (64 TO 250 mm) - (TENNIS BALL TO BASKETBALL) GR = COARSE TO FINE GRAVEL (2 TO 64 mm) - (LADYBUG TO TENNIS BALL) SA = SAND (0.06 TO 2 mm) - (GRITTY - UP TO LADYBUG SIZE) FN = SILT/CLAY/MUCK - (NOT GRITTY) OT = OTHER (COMMENT ON OTHER SIDE)				PO = Pool GL = Glide RI = Riffle RA = Rapid CA = Cascade FA = Falls DR = Dry Channel				Off Channel = Off Channel or Backwater	

REMEMBER: A = Upstream end of Reach and K = Downstream end of Reach.

THALWEG PROFILE																			
STATION	SNAG (circle one)	DEPTH (Either)		SUBSTRATE Circle one Substrate Code for each station				CHANNEL HABITAT Circle one Channel Habitat Code for each station				OFF CHAN. (circle one)	FLAG						
		UNITS: ● ft ○ m																	
		SONAR XX	POLE XX																
0	Y (N)	5		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
1	Y (N)	6		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
2	Y (N)	8		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
3	Y (N)	6		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
4	Y (N)	4		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
5	Y (N)	6		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
6	Y (N)	3		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
7	Y (N)	5		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y (N)	
8	(Y) N	6		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	(Y) N	
9	Y (N)	7		BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	(Y) N	
10	Y N			BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y N	
11	Y N			BH	BL	CB	GR	SA	FN	OT	PO	GL	RI	RA	CA	FA	DR	Y N	

FLAG	COMMENT

Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, etc. = flag assigned by field crew. Explain all flags in comment sections.

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Figure 5.2-3. Thalweg Profile Form.

5.2.7.3 Channel Habitat Classification

Classify and record channel habitat types shown in Table 5.2-5 at a spatial resolution of about 0.5 channel-widths and check presence of off-channel and backwater habitat at every 0.4 channel-width increment. The procedures for classifying channel habitat are presented in Table 5.2-2. Designate side channels, backwaters and other off-channel areas independent of the main-channel habitat type. Main channel habitat units are at least half as long as the channel is wide. (e.g., if there is a small, deep, pool-like area at the thalweg within a large riffle area, don't record it as a pool unless it occupies an area about half as wide or long as the channel is wide).

Table 5.2-5 Channel unit categories

Class (Code) ^a	Description
Pools (PO):	Still water, low velocity, smooth, surface, deep compared to other parts of channel
Glide (GL)	Water moving slowly, with <u>a smooth, unbroken surface</u> . Low turbulence.
Riffle (RI)	Water moving, with <u>small ripples, waves and eddies</u> —waves not breaking, <u>surface tension not broken</u> . Sound: “babbling”, “gurgling”.
Rapid (RA)	Water movement rapid and turbulent, surface with <u>intermittent whitewater</u> with breaking waves. Sound: continuous rushing, but not as loud as cascade.
Cascade (CA)	Water movement rapid & very turbulent over steep channel bottom. Most of the water surface is broken in <u>short, irregular plunges, mostly whitewater</u> . Sound: roaring.
Falls (FA)	<u>Free falling water</u> over vertical or near vertical drop into plunge, water turbulent and white over high falls. Sound: splash to roar. (Do not navigate raft over a waterfall!).
Dry channel (DR)	No water in the channel.
Off-channel	Side-channels, sloughs, backwaters, and alcoves separated from the main channel.

^a In order for a channel habitat unit to be distinguished, it must be at least half as wide or long as the channel is wide.

Mid-channel bars, islands, and side channels within a thalweg profile require some guidance. Mid-channel bars are defined as channel features below the bankfull flow level that are dry during baseflow conditions (Section 5.2.8.3 defines bankfull channel). Islands are channel features that are dry even when the river is at bankfull flow. If a mid-channel feature is as high as the surrounding flood plain, it is considered an island. Both mid-channel bars and islands cause the river to split into side channels. If a bar or island is encountered along the thalweg profile, navigate and survey the channel that carries the most flow. Note side channels are present but do not sample them.

When side channels are present, on the Thalweg Profile form check the “Off-Channel” column. These checkmarks will begin at the point of divergence from the main channel, continuing downstream to the point of convergence with the main channel. In the case of a slough or alcove, the “off-channel” checkmarks should continue from the point of divergence downstream to where the off-channel feature is no longer evident. When major side channels occur, flag the “Off-Channel” checkmarks and indicate in the comments section that the feature is a side channel. For dry and intermittent rivers, record zeros for depth and wetted width in places where no water is in the channel. Record habitat type as dry channel (DR).

5.2.8 Channel Margin (“Littoral”) and Riparian Measurements

This section covers channel margin depth and substrate, large woody debris, bank angle, channel cross-section morphology, canopy cover, riparian vegetation structure, fish cover, and human influences. Record measurements on the Channel/Riparian Transect Form (Figures 5.2-4 and 5.2-5).

PHAB: CHANNEL/RIPARIAN TRANSECT FORM - BOATABLE (FRONT) Rev'd by (init.): *JD*

SITE ID: FW08 XX000 DATE: 07/01/2008 Arrival Time 10:15 Leave Time 10:35

TRANSECT: A B C D E F G H I J K X

Chosen bank side: (Facing down stream) Left Right

GPS Latitude - dd mm ss.s GPS Longitude - ddd mm ss.s

Transect Midstream 45 07 12.9 121 07 43.2

Transect Bank 45 07 12.7 121 07 43.1

"LITTORAL" SUBSTRATE INFORMATION					DEPTH <input type="radio"/> ft <input checked="" type="radio"/> m		
SHORE	BOTTOM		CLASS		BOTTOM SUBSTRATE FROM (X ONE): <input type="radio"/> Judgement -or- <input checked="" type="radio"/> OBS. @ 5 Littoral Depths Flag <input type="checkbox"/>		
DOM	SEC	DOM	SEC		SONAR XX	POLE X.X	FLAG
RS	RS	RS	RS	RS = Bedrock (Smooth) - (Larger than a car)		0.4	
RR	RR	RR	RR	RR = Bedrock (Rough) - (Larger than a car)		0.6	
XB	XB	XB	XB	XB = Large Boulder (1000 to 4000 mm) - (Meterstick to car)		0.6	
SB	<input checked="" type="radio"/> SB	SB	<input checked="" type="radio"/> SB	SB = Small Boulder (250 to 1000 mm) - (Basketball to Meterstick)		0.5	
CB	CB	<input checked="" type="radio"/> CB	CB	CB = Cobble (64 to 250 mm) - (Tennis ball to Basketball)		0.4	
<input checked="" type="radio"/> GC	GC	GC	GC	GC = Coarse Gravel (16 to 64 mm) - (Marble to Tennis ball)			
GF	GF	GF	GF	GF = Fine Gravel (2 to 16 mm) - (Ladybug to marble)			
SA	SA	SA	SA	SA = Sand (0.06 to 2 mm) - (Gritty - up to Ladybug size)			
FN	FN	FN	FN	FN = Silt / Clay / Muck - (Not Gritty)			
HP	HP	HP	HP	HP = Hardpan - (Firm, Consolidated Fine Substrate)			
WD	WD	WD	WD	WD = Wood - (Any Size)			
OT	OT	OT	OT	OT = Other (Write comment below)			

BANK CHARACTERISTICS		
	X.XX (m)	FLAG
Wetted Width	47.0	
Bar Width	0	
Bankfull Width	75	
Bankfull Height	0.9	
Incised Height		K

LARGE WOODY DEBRIS (10x20m Plot) TALLY EACH PIECE Flag CHECK IF UNMARKED ARE ZERO

DIAMETER LARGE END	Wood All/Part in Wetted Channel			Dry but All/Part in Bankfull Channel		
	LENGTH 5-15 m	15-30 m	> 30 m	LENGTH 5-15 m	15-30 m	> 30 m
0.3 - 0.6 m		2				
0.6 - 0.8 m					3	
0.8 - 1.0 m			2	2		
> 1.0 m	1					

BANK ANGLES CIRCLE ONE: V S G F

V = Near Vertical/Undercut (>75°)
S = Sleep (30-75°)
G = Gradual (5-30°)
F = Flat (<5°)

SLOPE/BEARING/DISTANCE (Optional): Determine slope if feasible in terms of time and distances. Record GPS coordinates if practical.

Slope and Bearing not determined (use map)

INTENDED transect spacing xxx (m): 420 ACTUAL transect spacing xxx (m): 420

Supplemental Waypoints	Slope XX.X %	Backsite Bearing 0 - 359	Distance (m)	Way Point #	GPS Latitude - dd mm ss.s	GPS Longitude - ddd mm ss.s	Flag
	MAIN	2.0	183	420	6	45 07 12.9	121 07 43.2
1ST							
2ND							
3RD							

Flag Comments

K NO TERRACE - INCISION NOT MEASURED

Figure 5.2-4. Channel/Riparian Transect Form, page 1 (front side).

PHAB: CHANNEL/RIPARIAN TRANSECT FORM - BOATABLE (Back) Rev'd by (init.): **JD**

SITE ID: FW08XX000 DATE: 07/01/2008

TRANSECT: A B C D E F G H I J K O X Chosen bank side: Left Right
(Facing down stream)

VISUAL RIPARIAN ESTIMATES		0 = Absent (0%) D = Deciduous 1 = Sparse (<10%) C = Coniferous 2 = Moderate (10-40%) E = Broadleaf Evergreen 3 = Heavy (40-75%) M = Mixed 4 = Very Heavy (>75%) N = None	
RIPARIAN VEGETATION COVER (10m x 20m Plot)	Left Bank	Right Bank	Flag
Canopy (>5 m high)			
Woody Vegetation Type	D C E M N	D C E M N	
BIG Trees (Trunk >0.3 m DBH)	0 1 2 3 4	0 1 2 3 4	
SMALL Trees (Trunk <0.3 m DBH)	0 1 2 3 4	0 1 2 3 4	
Understory (0.5 to 5 m high)			
Woody Vegetation Type	D C E M N	D C E M N	
Woody Shrubs & Saplings	0 1 2 3 4	0 1 2 3 4	
Non-Woody Herbs, Grasses, & Forbs	0 1 2 3 4	0 1 2 3 4	
Ground Cover (<0.5 m high)			
Woody Shrubs & Saplings	0 1 2 3 4	0 1 2 3 4	
Non-Woody Herbs, Grasses and Forbs	0 1 2 3 4	0 1 2 3 4	
Barren, Bare Dirt or Duff	0 1 2 3 4	0 1 2 3 4	
HUMAN INFLUENCE 0 = Not Present, P => >10 m, C = Within 10 m, B = On Bank			
	Left Bank	Right Bank	
Wall/Dike/Revetment/Riprap/Dam	0 P C B	0 P C B	
Buildings	0 P C B	0 P C B	
Pavement/Cleared Lot	0 P C B	0 P C B	
Road/Railroad	0 P C B	0 P C B	F2
Pipes (Inlet/Outlet)	0 P C B	0 P C B	
Landfill/Trash	0 P C B	0 P C B	
Park/Lawn	0 P C B	0 P C B	
Row Crops	0 P C B	0 P C B	
Pasture/Range/Hay Field	0 P C B	0 P C B	
Logging Operations	0 P C B	0 P C B	
Mining Activity	0 P C B	0 P C B	

FISH COVER/ OTHER (10m x 20m Plot)		COVER CATEGORIES	
		In-Channel Cover (circle one)	Flag
Filamentous Algae		0 1 2 3 4	
Macrophytes		0 1 2 3 4	
Woody Debris >0.3 m (BIG)		0 1 2 3 4	
Brush/Woody Debris <0.3 m (SMALL)		0 1 2 3 4	
Live Trees in Stream		0 1 2 3 4	
Overhanging Veg. =<1 m of Surface		0 1 2 3 4	
Undercut Banks		0 1 2 3 4	
Boulders/Ledges		0 1 2 3 4	
Artificial Structures		0 1 2 3 4	

CHANNEL CONSTRAINT	
DISTANCE FROM SHORE TO RIPARIAN VEGETATION (M) XXX	<input type="text" value="0"/>
CIRCLE ONE	
C	Channel is <u>Constrained</u> .
B	Channel is in <u>Broad Valley</u> but <u>Constrained by Incision</u> .
N	Channel is in <u>Narrow Valley</u> but <u>NOT</u> very constrained.
U	Channel is <u>Unconstrained in Broad Valley</u> .
CHECK ONE	
<input checked="" type="radio"/> YES	I COULD READILY SEE OVER THE BANK.
<input type="radio"/> NO	I COULD NOT READILY SEE OVER THE BANK.
FLAG	<input type="text" value=""/>

Flag	Comments	CANOPY DENSITY @ BANK DENSIOMETER (0 TO 17 MAX)
F2	RAILROAD GRADE	UP <input type="text" value="0"/> DOWN <input type="text" value="1"/> LEFT <input type="text" value="8"/> RIGHT <input type="text" value="12"/> FLAG <input type="text" value=""/>

Flag Codes: K = no measurement made; U = suspect or non-standard measurement; F1, F2, etc. = flags assigned by each field crew. Explain all flags in comments section on this side or on Side 1 of this form.

Rev.03/03/2008 Rv Channel/Riparian Draft

Figure 5.2-5. Channel/Riparian Transect Form, page 2 (back side).

5.2.8.1 Channel Margin Depth and Substrate

Channel margin depths are measured along the designated shoreline at each transect within the 10m x 20m littoral plot that is centered on the transect. Dominant and sub-dominant bottom substrates are determined and recorded at 5 systematically-spaced locations that are located by eye within the 10m x 20m plot. The procedure for obtaining channel margin depth and substrate measurements is described in more detail in Table 5.2-6. Record these measurements on the Channel/Riparian Transect Form as shown in Figure 5.2-4. Identify the dominant and subdominant substrate present along a shoreline swath 20 meters long and 1 meter back from the waterline. The substrate size class choices are as shown in Table 5.2-6.

Table 5.2-6. Channel margin depth and substrate procedure

1. Fill in the header information on page 1 of a Channel/Riparian Transect Form. Be sure to indicate the letter designating the transect location.
2. Measure depth and observe bottom substrates within the 10m x 20 m littoral plot that is centered on each transect location.
3. Determine and record the depth and the dominant and subdominant substrate size class at 5 systematically-spaced locations estimated by eye within this 10m x 20m plot and 1m back from the waterline. **If the substrate particle is “artificial” (e.g. concrete, asphalt), choose the appropriate size class, flag the observation and note that it is artificial in the comment space.**

Code	Size Class	Size Range (mm)	Description
RS	Bedrock (Smooth)	>4000	Smooth surface rock bigger than a car
RR	Bedrock (Rough)	>4000	Rough surface rock bigger than a car
XB	Large Boulders	>1000 to 4000	Meter stick to Car size
SB	Small Boulders	>250 to 1000	Basketball to Meter stick size
CB	Cobbles	>64 to 250	Tennis ball to basketball size
GC	Gravel (Coarse)	>16 to 64	Marble to tennis ball size
GF	Gravel (Fine)	> 2 to 16	Ladybug to marble size
SA	Sand	>0.06 to 2	Gritty – up to ladybug size,
FN	Fines	<0.06	Silt Clay Muck (not gritty between fingers)
HP	Hardpan		Firm, consolidated fine substrate
WD	Wood	Regardless of Size	Wood & other organic particles
OT	Other	Regardless of Size	Concrete, metal, tires, etc. (note in comments)

4. On page 1 of the Channel/Riparian Transect Form, circle the appropriate shore and bottom substrate type and record the depth measurements (“SONAR” or “POLE” columns).
5. Repeat Steps 1 through 4 at each new cross-section transect.

5.2.8.2 Large Woody Debris

Large Woody Debris (LWD) is defined as woody material with small end diameter of ≥ 30 cm (1ft) and length of ≥ 5 m (15 ft). These size criteria are larger than those used in wadeable streams because of the lesser role that small wood plays in controlling velocity and morphology of larger rivers. The procedure for tallying LWD is presented in Table 5.2-7. For each tally (Wood All/Part in Wetted Channel and Dry but All/Part in Bankfull Channel), the field form (Figure 5.2-4) provides 12 entry boxes for tallying debris pieces visually estimated within three length and four diameter class combinations. Tally each LWD piece in only one box. Do not tally

woody debris in the area between channel cross-sections, but the presence and location of large debris dams and accumulations should be mapped (sketched) and noted in the thalweg profile comments.

For each LWD piece, first visually estimate its length and its large and small end diameters and place it in one of the diameter and length categories. The diameter classes on the field form (Figure 5.2-4) refer to the large end diameter. Sometimes LWD is not cylindrical, so it has no clear “diameter”. In these cases visually estimate what the diameter would be for a piece of wood with circular cross-section that would have the same volume. When evaluating length, include only the part of the LWD piece that has a diameter >0.3m (1 ft). Count each of the LWD pieces as one tally entry and include the whole piece when assessing dimensions, even if part of it is outside of the bankfull channel. If you encounter massive, complex debris jams, estimate their length, width, and height. Estimate the diameter and length of large “key” pieces and judge the average diameter and length of the other pieces making up the jam. Record this information in the comments section of the form.

Table 5.2-7. Procedure for tallying large woody debris

Note: Tally pieces of large woody debris (LWD) within the 11 transects of the river reach at the same time the shoreline measurements are being determined. Include all pieces whose large end is located within the transect plot in the tally. Tally wood that is at least partially within the wetted channel separately from that that is not presently wetted, but still within or directly above (bridging) the bankfull channel

1. LWD is tallied in 11 “plots” systematically spaced over the entire length of the stream reach. These plots are each 20 m long in the upstream-downstream direction (10m up, 10m down). They are positioned along the chosen bank and extend from the shore in 10m towards mid-channel and then all the way to the bankfull margin.
2. Tally all LWD pieces within the plot that are at least partially within the presently wetted (baseflow) channel. First, determine if a piece is large enough to be classified as LWD (**small end diameter 30 cm [1 ft.]; length 5 m [15 ft.]**)
3. For each piece of LWD, determine its diameter class **based on the diameter of the large end** (0.3 m to < 0.6 m, 0.6 m to <0.8 m, 0.8 m to <1.0 m, or >1.0 m), and the **length class of the LWD pieces based on the part of its length that has diameter ≥30 cm**. Length classes are 5m to <15m, 15m to <30m, or >30m.
 - If the piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with circular cross-section that would have the same volume.
 - When estimating length, include only the part of the LWD piece that has a diameter >0.3 m (1 ft.)
4. Place a tally mark in the appropriate diameter × length class tally box in the **“WOOD ALL/PART IN WETTED CHANNEL”** section of the Channel/Riparian Transect Form.
5. Tally all shoreline LWD pieces along the littoral plot that are at least partially within or above (bridging) the bankfull channel, but not in the wetted channel. For each piece, determine the diameter class based on the diameter of the **large end** (0.3 m to < 0.6 m, 0.6 m to <0.8 m, 0.8 m to <1.0 m, or >1.0 m), and the **length class based on the length of the piece that has diameter ≥30 cm**. Length classes are 5m to <15m, 15m to <30m, or >30m.
6. Place a tally mark for each piece in the appropriate diameter × length class tally box in the **“DRY BUT ALL/PART IN BANKFULL CHANNEL”** section of the Channel/Riparian Transect Form.
7. After all pieces within the segment have been tallied, write the total number of pieces for each diameter × length class in the small box at the lower right-hand corner of each tally box.
8. Repeat Steps 1 through 7 for the next river transect, using a new Channel/Riparian Transect Form.

5.2.8.3 Bank Angle and Channel Cross-Section Morphology

Bank angles of undercut, vertical, steep, and gradual are visually estimated as defined on the field form (Figure 5.2-4). Observations are made from the wetted channel margin up 5 m (a canoe's length) into the bankfull channel margin on the previously chosen side of the stream.

You will measure or estimate the wetted width, mid-channel bar width, bankfull height and width, the amount of incision, and the degree of channel constraint. These are assessed for **the whole channel (left and right banks)** at each of the 11 cross-section transects. Record each on the Channel/Riparian Transect Form (Figure 5.2-4). The procedures for obtaining bank angle and measurements of channel cross-section morphology are presented in Table 5.2-8.

Wetted width is the width of the channel containing free-standing water; if >15 m, it can be measured with a laser rangefinder. **Mid-channel bar width**, the width of exposed mid-channel gravel or sand bars, is included within the wetted width, but is also recorded separately. In channel cross-section measurements, the wetted and bankfull channel boundaries include mid-channel bars. Therefore, the wetted width is measured as the distance between wetted left and right banks. Measure across and over mid-channel bars and boulders. If islands are present, treat them like bars, but flag these measurements and indicate in the comments that the "bar" is an island. If you are unable to see across the full width of the river when an island separates a side channel from the main channel, record the width of the main channel, flag the observation, and note in the comments section that the width pertains only to the main channel.

Table 5.2-8. Procedure for bank angle and channel cross-section

1. Visually estimate the bank angle (undercut, vertical, steep, gradual), as defined on the field form. Bank angle observations refer to the area from the wetted channel margin up 5 m (canoe's length) into the bankfull channel margin on the previously chosen side of the river. Circle the angle in the "BANK ANGLES" section of the Channel/Riparian Transect Form.
2. Hold the surveyor's rod vertically, with its base planted at the water's edge. Examine both banks, then determine the channel *incision* as the *height up from the water surface to elevation of the first terrace of the valley floodplain* (Note this is at or above the bankfull channel height). Whenever possible, use the clinometer as a level (positioned so it reads 0% slope) to measure this height by transferring (backsighting) it onto the surveyor's rod. Record this value in the *INCISED HEIGHT* field of the bank characteristics section on the field data form.
3. While still holding the surveyor's rod as a guide, and sighting with the clinometer as a level, examine both banks to measure and record the *height of bankfull flow above the present water level*. Look for evidence on one or both banks such as:
 - An obvious slope break that differentiates the channel from a relatively flat floodplain terrace higher than the channel.
 - A transition from exposed stream sediments to terrestrial vegetation.
 - Moss growth on rocks along the banks.
 - Presence of drift material caught on overhanging vegetation.
 - A transition from flood- and scour-tolerant vegetation to that which is relatively intolerant of these conditions.
4. Record the *wetted width* value determined when locating substrate sampling points in the *BANK CHARACTERISTICS* section of the field data form. Also determine the *bankfull channel width* and the *width of exposed mid-channel bars* (if present).
5. Repeat Steps 1 through 6 at each cross-section transect, (including any additional side channel transects established when islands are present). Record data for each transect on a separate field data form.

Bankfull flows are large enough to erode the stream bottom and banks, but frequent enough (every 1 to 2 years) to not allow substantial growth of upland terrestrial vegetation. Consequently, in many regions, it is these flows that have determined the width and depth of the channel. Estimates of the bankfull dimensions of stream channels are extremely important in EMAP surveys. They are used to calculate shear stress and bed stability (see Kaufmann et al., 1999). Unfortunately, we have to depend upon evidence visible during the low-flow sampling season. If available, consult published rating curves relating expected bankfull channel dimensions to stream drainage area within the region of interest. Graphs of these rating curves can help you get a rough idea of where to look for field evidence to determine the level of bankfull flows. Curves such as these are available from the USGS for streams in most regions of the U.S. (e.g., Dunne and Leopold 1978; Harrelson et al. 1994, Leopold 1994). To use them, you need to know the contributing drainage area to your sample site. Interpret the expected bankfull levels from these curves as a height above the streambed in a riffle, but remember that your field measurement will be a height above the present water surface of the stream. Useful resources to aid your determination of bankfull flow levels in streams in the United States are video presentations produced by the USDA Forest Service for western streams (USDA Forest Service 1995) and eastern streams (USDA Forest Service 2002).

After consulting rating curves that show where to expect bankfull levels in a given size of stream, estimate the bankfull flow level by looking at the following indicators:

- First look at the stream and its valley to determine the active floodplain. This is a depositional surface that frequently is flooded and experiences sediment deposition under the current climate and hydrological regime.
- Then look specifically for:
 - An obvious break in the slope of the banks.
 - A change from water-loving and scour-tolerant vegetation to more drought-tolerant vegetation.
 - A change from well-sorted stream sediments to unsorted soil materials.

In the absence of clear bankfull indications, consider the previous season's flooding as the best evidence available (note: you could be wrong if very large floods or prolonged droughts have occurred in recent years.). Look for:

- Drift debris ("sticky wickets" left by the previous seasons flooding).
- The level where deciduous leaf-fall is absent on the ground (carried away by previous winter flooding).
- Unvegetated sand, gravel or mud deposits from previous year's flooding.

In years that have experienced large floods, drift material and other recent high flow markers may be much higher than other bankfull indicators. In such cases, base your determination on less-transient indicators such as channel form, perennial vegetation, and depositional features. In these cases, flag your data entry and also record the height of drift material in the comments section of the field data form.

We use the vertical distance (height) from the observed water surface up to the level of the first major valley depositional surface (Figure 5.2-6) as a measure of the degree of *incision* or *downcutting* of the stream below the general level of its valley. This value is recorded in the

incised height field. It may not be evident at the time of sampling whether the channel is downcutting, stable, or aggrading (raising its bed by depositing sediment). However, by recording incision heights measured in this way and monitoring them over time, we will be able to tell if streams are incising or aggrading.

If the channel is not greatly incised, bankfull channel height and incision height will be the same. However, if the channel is incised greatly, the bankfull level will be below the level of the first terrace of the valley floodplain, making "Bankfull Height" smaller than "Incision" (Figure 5.2-6). **Bankfull height is never greater than incision height.** Look for evidence of recent flows (within about 1 year) to distinguish bankfull and incision heights, though recent flooding of extraordinary magnitude may be misleading. In cases where the channel is cutting a valley sideslope and has oversteepened and destabilized that slope, the bare "cutbank" against the steep hillside at the edge of the valley is not necessarily an indication of recent incision. In such a case, the opposite bank may be lower, with a more obvious terrace above bankfull height; choose that bank for your measurement of incised height. Examine both banks to determine incision height and bankfull height. Remember that incision height is measured as **vertical distance to the first terrace above bankfull; if terrace heights differ on left and right banks, choose the lower of the two terraces.** Even when quite constrained by their valley sideslopes, large rivers often have flood terraces above bankfull height. In some cases, though, your sample reach may be in a steep "V" shaped valley or gorge formed over eons, and the slopes of the channel banks simply extend uphill indefinitely, not reaching a terrace before reaching the top of a ridge. In such cases, record incision height values equal to bankfull values and make appropriate comments that no terrace is evident. Similarly, when the river is extremely incised below an ancient terrace or plateau, (e.g., the Colorado River in the Grand Canyon), you may crudely estimate the terrace height if it is the first one above bankfull level. If you cannot estimate the terrace height, make appropriate comments describing the situation.

Finally, assess the **local degree of river channel constraint** (i.e., at the transect) by following the guidelines on the form (Figure 5.2-5) regarding the relationships among channel incision, valley sideslope, and width of the valley floodplain. You will also do an overall assessment of channel constraint for the whole river reach; see Section 5.2.9 for a discussion of constraint concepts and assessment procedures.

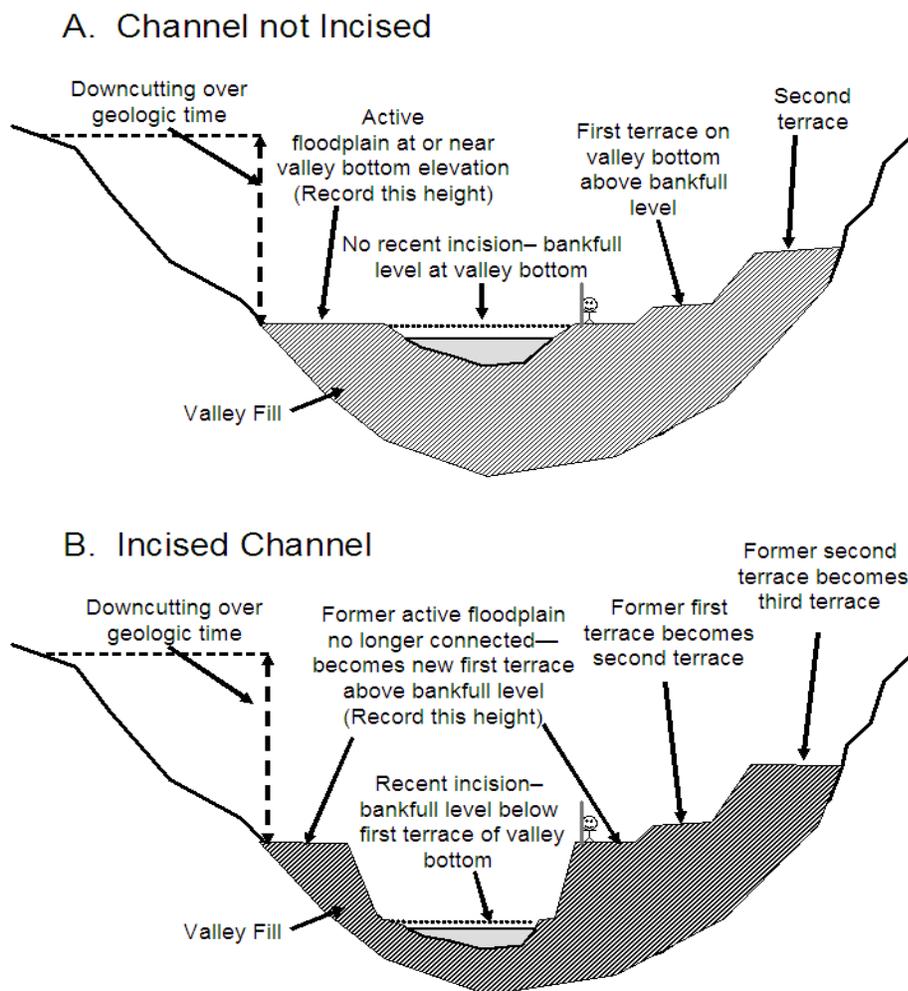


Figure 5.2-6. Schematic showing bankfull channel and incision for channels. (A) not recently incised, and (B) recently incised into valley bottom. Note level of bankfull stage relative to elevation of first terrace on valley bottom (stick figure included for scale)

5.2.8.4 Canopy Cover (Densiometer)

Measure vegetative cover over the reach at the chosen bank at each of the 11 transects (A-K). with a Convex Spherical Densiometer. Tape the densiometer exactly as shown in Figure 5.2-7 to limit the number of grid intersections to 17. Densiometer readings can range from 0 (no canopy cover) to 17 (maximum canopy cover). Four measurements are obtained at each cross-section transect (upriver, downriver, left, and right). The procedure for obtaining canopy cover data is presented in Table 5.2-8. Record the counts in the “Canopy Density @ Bank” section of the Channel/Riparian Transect Form as shown in Figure 5.2-4.

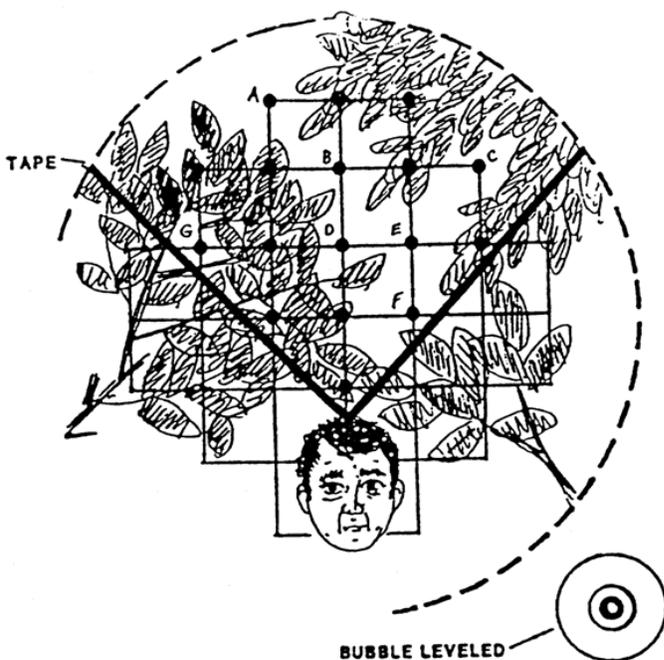


Figure 5.2-7. Schematic of modified convex spherical canopy densiometer (From Mulvey et al., 1992). In this example, 10 of the 17 intersections show canopy cover, giving a densiometer reading of 10. Note proper positioning with the bubble leveled and face reflected at the apex of the “V.”

Table 5.2-9. Procedure for canopy cover measurements

1. Take densiometer readings at a cross-section transect while anchored or tied up at the river margin.
2. Hold the densiometer 0.3 m (1 ft) above the surface of the river. Holding the densiometer level using the bubble level, move it in front of you so your face is just below the apex of the taped “V”.
3. At the channel margin measurement locations, count the number of grid intersection points within the “V” that are covered by either a tree, a leaf, a high branch, or the bank itself.
4. Take 1 reading each facing upstream (UP), downstream (DOWN), left bank (LEFT), and right bank (RIGHT). Right and left banks are defined with reference to an observer facing downstream.
5. Record the UP, DOWN, LEFT, and RIGHT values (0 to 17) in the “CANOPY COVER @ BANK” section of the Channel/Riparian Transect Form.
6. Repeat Steps 1 through 5 at each cross-section transect. Record data for each transect on a separate field data form.

5.2.8.5 Riparian Vegetation Structure

Riparian vegetation observations apply to the riparian area upstream 10 m and downstream 10 m from each of the 11 transects. They include the visible area from the river bankfull margin back a distance of 10 m (30 ft) shoreward from both the left and right banks, creating a 10m X 20m riparian plot on each side of the river (Figure 5.2-2). The riparian plot dimensions are estimated, not measured. Table 5.2-9 presents the procedure for characterizing

riparian vegetation structure and composition. Figure 5.2-5 illustrates how measurement data are recorded in the “Visual Riparian Estimates” section of the Channel/Riparian Transect Form, side 2.

Table 5.2-10. Procedure for characterizing riparian vegetation structure

1. Anchor or tie up at the river margin at a cross-section transect; then make the following observations to characterize riparian vegetation structure.
2. Estimate the distance from the shore to the edge of the riparian vegetation plot; record it just below the title “Channel Constraint” on the Channel/Riparian Transect Form, side 2.
3. Facing the left bank (left as you face downstream), estimate a distance of 10 m back into the riparian vegetation, beginning at the bankfull channel margin. Estimate the cover and structure of riparian vegetation within an estimated 10 m x 20 m plot centered on the transect, and starting where perennial vegetation begins or at the bankfull river margin (whichever is closest to the river shoreline). On steeply-sloping channel margins, estimate the riparian plot dimensions as if they were projected down from an aerial view.
4. Within this 10 m x 20 m area, conceptually divide the riparian vegetation into 3 layers: a CANOPY (>5m high), an UNDERSTORY (0.5 to 5 m high), and a GROUND COVER layer (<0.5 m high).
5. Within this 10 m x 20 m area, determine the dominant **woody** vegetation type for the CANOPY LAYER (vegetation > 5 m high) as either Deciduous, Coniferous, broadleaf Evergreen, Mixed, or None. Consider the layer “Mixed” if more than 10% of the areal coverage is made up of the alternate vegetation type. If the dominant vegetation type in the canopy layer is not woody, record the vegetation type as “None”. Indicate the appropriate vegetation type in the “VISUAL RIPARIAN ESTIMATES” section of the Channel/Riparian Cross-section and Thalweg Profile Form.
6. Determine separately the areal cover class of large trees (> 0.3 m [1 ft] diameter at breast height [DBH]) and small trees (< 0.3 m DBH) within the canopy layer. Estimate areal cover as the amount of shadow that would be cast by a particular layer alone if the sun were directly overhead. Record the appropriate cover class on the field data form (“0” = absent, zero cover; “1” = sparse, <10%; “2” = moderate, 10-40%; “3” = heavy, 40-75%; or “4” = very heavy, >75%).
7. Look at the UNDERSTORY layer (vegetation between 0.5 and 5 m high). Determine the dominant **woody** vegetation type for the understory layer as described in Step 5 for the canopy layer. If the dominant vegetation type in the understory is not woody (e.g., herbaceous), record the vegetation type as “None”.
8. Determine the areal cover class for woody shrubs and saplings separately from non-woody vegetation within the understory, as described in Step 6 for the canopy layer.
9. Look at the GROUND COVER layer (vegetation < 0.5 m high). Determine the areal cover class for woody shrubs and seedlings, non-woody vegetation, and the amount of bare ground or duff (dead organic material) present as described in Step 6 for large canopy trees.
10. Repeat Steps 1-9 for all transects, using a separate field data form for each transect.

You will estimate the areal cover separately in each of the three vegetation layers. Note that the areal cover can be thought of as the amount of shadow cast by a particular layer alone when the sun is directly overhead. The maximum cover in each layer is 100%, so the sum of the areal covers for the combined three layers could add up to 300%. When rating vegetation cover types, mixtures of two or more subdominant classes might all be given sparse (“1”) moderate (“2”) or heavy (“3”) rankings. One very heavy cover class with no clear subdominant class might be ranked “4” with all the remaining classes either moderate (“2”), sparse (“1”) or absent (“0”). Two heavy classes with 40-75% cover can both be ranked “3”.

5.2.8.6 Fish Cover, Algae, Aquatic Macrophytes

Over a defined length and distance from shore at the sampling locations, crews shall estimate by eye and by sounding the proportional cover of fish cover features and trophic level indicators including large woody debris, rootwads and snags, brush, live trees in the wetted channel, undercut banks, overhanging vegetation, rock ledges, aquatic macrophytes, filamentous algae, and artificial structures.

The procedure to estimate the types and amounts of fish cover is outlined in Table 5.2-10. Record data in the "Fish Cover/Other" section of the Channel/Riparian Transect Form as shown in Figure 5.2-5. Crews will estimate the areal cover of all of the fish cover and other listed features that are in the water and on the banks within the 10m x 20m plot (refer to Figure 5.2-2).

Table 5.2.11. Procedure for estimating fish cover

1. Stop at the designated shoreline at a cross-section transect and estimate a 10 m distance upstream and downstream (20 m total length), and a 10 m distance out from the banks to define a 20 m x 10 m littoral plot.
2. Examine the water and the banks within the 20 m x 10 m littoral plot for the following features and types of fish cover: filamentous algae, aquatic macrophytes, large woody debris, in-channel live trees or roots, brush and small woody debris, overhanging vegetation, undercut banks, boulders, and artificial structures.
3. For each cover type, estimate its areal cover by eye and/or by sounding with a pole. Record the appropriate cover class in the "FISH COVER/OTHER" section of the Channel/Riparian Transect Form ("0"=absent: zero cover, "1"=sparse: <10%, "2"=moderate: 10-40%, "3"=heavy: 40-75%, or "4"=very heavy: >75%).
4. Repeat Steps 1 through 3 at each cross-section transect, recording data from each transect on a separate field data form.

Filamentous algae pertains to long streaming algae that often occur in slow moving waters. Aquatic macrophytes are water loving plants in the river, including mosses, that could provide cover for fish or macroinvertebrates. If the river channel contains live wetland grasses, include these as macrophytes. Woody debris are the larger pieces of wood that can provide cover and influence stream morphology (i.e., those pieces that would be included in the large woody debris tally [Section 5.2.8.2]). Brush/woody debris pertains to the smaller wood that primarily affects cover but not morphology. The entry for trees or brush within one meter of the surface is the amount of brush, twigs, small debris etc. that is not in the water but is close to the stream and provides cover. "Live Trees or Roots" are living trees that are within the channel -- estimate the areal cover provided by the parts of these trees or roots that are inundated. For ephemeral channels, estimate the proportional cover of these trees that is inundated during bankfull flows. Boulders are typically basketball to car sized particles. Many streams contain artificial structures designed for fish habitat enhancement. Streams may also have in-channel structures discarded (e.g., cars or tires) or purposefully placed for diversion, impoundment, channel stabilization, or other purposes. Record the cover of these structures on the form.

5.2.8.7 Human Influences

For the left and right banks at each of the 11 detailed Channel/Riparian Cross-Sections, evaluate the presence/absence and the proximity of 11 categories of human influences outlined

in Table 5.2-11. Record human influences on the Channel/Riparian Transect Form (Figure 5.2-5). You may mark “P” more than once for the same human influence observed outside of more than one riparian observation plot (e.g. at both Transect D and E). **The rule is that you count human disturbance items as often as you see them, BUT NOT IF you have to site through a previously counted transect or its 10x20 meter riparian plot.**

Table 5.2-12. Procedure for estimating human influence

1. Stop at the designated shoreline at a cross-section transect, look toward the left bank (left when facing downstream), and estimate a 10m distance upstream and downstream (20 m total length). Also, estimate a distance of 10 m back into the riparian zone to define a riparian plot area.
2. Examine the channel, bank and riparian plot area adjacent to the defined river segment for the following human influences: (1) walls, dikes, revetments, riprap, & dams; (2) buildings; (3) cleared lot, pavement (e.g., paved, graveled, dirt parking lot, foundation); (4) roads or railroads, (5) inlet or outlet pipes; (6) landfills or trash (e.g., cans, bottles, trash heaps); (7) parks or maintained lawns; (8) row crops; (9) pastures, rangeland, or hay fields; (10) logging; and (11) mining (include gravel mining).
3. For each type of influence, determine if it is present and what its proximity is to the river and riparian plot area. Consider human disturbance items as present if you can see them from the cross-section transect. Do not include them if you have to site through another transect or its 10 m × 20 m riparian plot.
4. For each type of influence, record the proximity class in the “HUMAN INFLUENCE” part of the “VISUAL RIPARIAN ESTIMATES” section of the Channel/Riparian Transect Form. Proximity classes are:
 - B (“Bank”) Present within the defined 20 m river segment and located in the stream or on the wetted or bankfull bank.
 - C (“Close”) Present within the 10 × 20 m riparian plot area, but above the bankfull level.
 - P (“Present”) Present, but observed outside the riparian plot area.
 - O (“Absent”) Not present within or adjacent to the 20 m river segment or the riparian plot area at the transect
5. Repeat Steps 1 through 4 for the opposite bank.
6. Repeat Steps 1 through 5 for each cross-section transect, recording data for each transect on a separate field form.

5.2.8.8 Riparian “Legacy” Trees and Invasive Alien Species

At each littoral-riparian station (A-K), search for the largest tree visible. Confine your search to within 100m (or as far as you can see) from the wetted bank on either side of the river from each transect upstream and downstream. Classify this tree as broadleaf deciduous, coniferous, or broadleaf evergreen (classify western larch as coniferous). Identify, if possible, the species or the taxonomic group of this tree from the list provided in Table 5.2-12 (also on field form) and estimate its height, diameter at breast height (dbh) and distance from the wetted margin of the river. You may need to use binoculars to make these determinations. Enter this information on the left hand column of the field form for Riparian “Legacy” Trees and Invasive Alien Plants (Figure 5.2-8). If the largest tree is a dead “snag”, enter “Snag” as the taxonomic group. Note that the tree you choose may not truly be a “Legacy” tree; we use this data to determine if there are Legacy Trees along the stream reach.

Search in the 10 m x 20 m riparian and littoral plots on both banks for the presence of any invasive alien species listed in the NRSA Invasive Species Guide provided to each field crew. Document the species observed on the Riparian “Legacy” Trees and Invasive Alien Plants

form (Figure 5.2-8), answering the question of whether each of the target species is present in the plot. If you have a camera, document the species with a photograph. If you observe no alien taxa within the riparian and littoral plots, but can confidently identify them outside of the plots, include your observations in the comments portion of the form. If the river is too wide to effectively observe the far bank at a transect, record what you observe for the plot on the near bank, record a “U” flag, and explain in the comments section of the form.

Table 5.2-13. Procedure for identifying riparian legacy trees and alien invasive species

Legacy Trees:

Beginning at Transect A, look upstream and downstream as far as you can see within the 100m of the wetted bank but look no further downstream than half of the distance to the next transect. Locate the legacy tree from within that area.

Classify this tree as broadleaf deciduous, coniferous, or broadleaf evergreen (classify western larch as coniferous). Identify, if possible, the species or the taxonomic group of this tree from the list below.

- | | |
|---|--|
| 1. Acacia/Mesquite | 10. Poplar/Cottonwood |
| 2. Alder/Birch | 11. Snag (Dead Tree of Any Species) |
| 3. Ash | 12. Spruce |
| 4. Cedar/Cypress/Sequoia | 13. Sycamore |
| 5. Fir (including Douglas Fir, Hemlock) | 14. Willow |
| 6. Juniper | 15. Unknown, other Broadleaf Evergreen |
| 7. Maple/Boxelder | 16. Unknown or Other Conifer |
| 8. Oak | 17. Unknown or Other Deciduous |
| 9. Pine | 18. Elm |

NOTE: If the largest tree is a dead “snag”, enter “Snag” as the taxonomic group.

Estimate the height of the potential legacy tree, its diameter at breast height (dbh) and its distance from the wetted margin of the stream. Enter this information on the left hand column of the Riparian “Legacy” Trees and Invasive Alien Plants field form.

Alien Invasive Species:

Examine the 10m x 20m riparian and littoral plots on both banks for the presence of alien species. (Species lists will be provided)

Record the presence of any species listed within the plots on either the left or right bank on the Riparian “Legacy” Trees and Invasive Alien Species field form. If none of the species listed is present in the plots at a given transect, fill in the circle indicating “None” for this transect.

Repeat for each remaining transect (B through K). At transect “K”, look upstream a distance of 4 channel widths when locating the legacy tree.

Any invasive species seen but not included on this list should be written in the comments section.

Draft

Reviewed by (initial):

DATE: 07/01/2008

RIPARIAN "LEGACY" TREES AND INVASIVE ALIEN PLANTS

SITE ID: FW08XX000

Tran	LARGEST POTENTIAL LEGACY TREE VISIBLE FROM THIS STATION				ALIEN PLANT SPECIES PRESENT IN LEFT AND RIGHT RIPARIAN PLOTS, AND INSTREAM FISH COVER PLOT	
	Trees not Visible	DBH (m)	Height (m)	Dist. from wetted margin (m)	Type	Taxonomic Category
A	<input type="radio"/> 0-0.1 <input checked="" type="radio"/> 0.1-3 <input type="radio"/> 3-.75	<input type="radio"/> <5 <input checked="" type="radio"/> 5-15 <input type="radio"/> 15-30 <input type="radio"/> >30	<u>10</u>	Deciduous <input checked="" type="radio"/> Coniferous <input type="radio"/> Broadleaf <input type="radio"/> Evergreen <input type="radio"/>	<u>POPULAR / COTTONWOOD</u>	Check all that are present <input checked="" type="radio"/> NONE <input type="radio"/> E Wtrmilf <input type="radio"/> W Hyacinth <input type="radio"/> G Reed <input type="radio"/> MF Rose <input type="radio"/> Hydrilla <input type="radio"/> Yw Fltheart <input type="radio"/> Flwr Rush <input type="radio"/> Spurge <input type="radio"/> E Wtrchest <input type="radio"/> P Lstrife <input type="radio"/> Salt Ced <input type="radio"/> E Wtrmilf <input type="radio"/> W Hyacinth <input type="radio"/> G Reed <input type="radio"/> MF Rose <input type="radio"/> Hydrilla <input type="radio"/> Yw Fltheart <input type="radio"/> Flwr Rush <input type="radio"/> Spurge <input type="radio"/> E Wtrchest <input checked="" type="radio"/> P Lstrife <input type="radio"/> Salt Ced <input type="radio"/> E Wtrmilf <input type="radio"/> W Hyacinth <input type="radio"/> G Reed <input type="radio"/> MF Rose <input type="radio"/> Hydrilla <input type="radio"/> Yw Fltheart <input type="radio"/> Flwr Rush <input checked="" type="radio"/> Spurge <input type="radio"/> E Wtrchest <input checked="" type="radio"/> P Lstrife <input type="radio"/> Salt Ced
B	<input type="radio"/> 0-0.1 <input type="radio"/> 0.1-3 <input checked="" type="radio"/> 3-.75	<input type="radio"/> <5 <input type="radio"/> 5-15 <input checked="" type="radio"/> 15-30 <input type="radio"/> >30	<u>15</u>	Deciduous <input type="radio"/> Coniferous <input type="radio"/> Broadleaf <input type="radio"/> Evergreen <input type="radio"/>	<u>SNAG</u>	<input type="radio"/> NONE <input type="radio"/> E Wtrmilf <input type="radio"/> W Hyacinth <input type="radio"/> G Reed <input type="radio"/> MF Rose <input type="radio"/> Hydrilla <input type="radio"/> Yw Fltheart <input type="radio"/> Flwr Rush <input type="radio"/> Spurge <input type="radio"/> E Wtrchest <input type="radio"/> P Lstrife <input type="radio"/> Salt Ced <input type="radio"/> E Wtrmilf <input type="radio"/> W Hyacinth <input type="radio"/> G Reed <input type="radio"/> MF Rose <input type="radio"/> Hydrilla <input type="radio"/> Yw Fltheart <input type="radio"/> Flwr Rush <input type="radio"/> Spurge <input type="radio"/> E Wtrchest <input checked="" type="radio"/> P Lstrife <input type="radio"/> Salt Ced
C	<input type="radio"/> 0-0.1 <input type="radio"/> 0.1-3 <input type="radio"/> 3-.75	<input type="radio"/> <5 <input type="radio"/> 5-15 <input checked="" type="radio"/> 15-30 <input type="radio"/> >30	<u>5</u>	Deciduous <input checked="" type="radio"/> Coniferous <input type="radio"/> Broadleaf <input type="radio"/> Evergreen <input type="radio"/>	<u>OTHER (ELM)</u>	<input type="radio"/> NONE <input type="radio"/> E Wtrmilf <input type="radio"/> W Hyacinth <input type="radio"/> G Reed <input type="radio"/> MF Rose <input type="radio"/> Hydrilla <input type="radio"/> Yw Fltheart <input type="radio"/> Flwr Rush <input type="radio"/> Spurge <input type="radio"/> E Wtrchest <input checked="" type="radio"/> P Lstrife <input type="radio"/> Salt Ced

INSTRUCTIONS

Potential Legacy trees are defined as the largest tree within your search area, which is as far as you can see, but within maximum limits as follows:
 Wadeable Streams: Confine search to no more than 50 m from left and right bank and extending upstream to next transect (for 'K' look upstream 4 channel widths)
 Non-wadeable Rivers: Confine search to no more than 100 m from left and right bank and extending both upstream and downstream as far as you can see

Alien Plants: Confine search to riparian plots on left and right bank
 Wadeable Streams: 10 m x 10 m
 Non-wadeable Rivers: 10 m x 20 m

Not all aliens are to be identified in all states. See Field Manual and Plant Identification Guide.

TAXONOMIC CATEGORIES

Acacia/Mesquite
Alder/Birch
Ash
Maple/Boxelder
Oak
Poplar/Cottonwood
Sycamore
Willow
Unknown or Other Deciduous
Cedar/Cypress/Sequoia
Fir (including Douglas fir and hemlock)
Juniper
Pine
Spruce
Unknown or Other Conifer
Unknown or Other Broadleaf Evergreen
Snag (Dead tree of any species)

ALIEN SPECIES

E Wtrmilf Eurasian water milfoil Myriophyllum spicatum
Hydrilla Hydrilla Hydrilla verticillata
E Wtrchest European water chestnut Trapa natans
Yw Hyacinth Water Hyacinth Eichhornia crassipes
Yw Fltheart Yellow Floating Heart Nymphaoides peltata
P Lstrife Purple loosestrife Lythrum salicaria
G Reed Giant Reed Arundo donax
Flwr Rush Flowering Rush Butomus umbellatus
Salt Ced Salt Cedar Tamarix spp.
MF Rose Multi-flora rose Rosa multiflora
Spurge Leafy Spurge Euphorbia esula

COMMENTS

Transects D to K continued on other side

03/26/2001 2001 Riparian Legacy Trees

Figure 5.2-8. Field form for Riparian "Legacy" Trees and Invasive Alien Plants (Page 1)

5.2.9 Channel Constraint Assessment

After completing the thalweg profile and littoral-riparian measurements and observations, visualize the stream at bankfull flow and evaluate the degree, extent and type of channel constraint, following the procedure in Table 5.2-12. Figure 5.2-9 illustrates anastomosing and braided channel types. Use the definitions on the Channel Constraint Assessment form (Figure 5.2-10) to classify the channel. Estimate the percent of the channel margin in contact with constraining features (for unconstrained channels, this is 0%). To aid in this estimate, you may wish to refer to the individual transect assessments of incision and constraint. Finally, estimate the “typical” bankfull channel width and visually estimate the average width of the valley floor. (valley floor width can often be determined from 1:24,000-scale topographic maps).

Table 5.2-14. Procedures for assessing channel constraint

NOTE: These activities are conducted after completing the thalweg profile and littoral-riparian measurements and observations, and represent an evaluation of the entire stream reach. Record this information on the Channel Constraint Form.

CHANNEL CONSTRAINT: Determine the degree, extent, and type of channel constraint based on envisioning the stream at **bankfull flow**.

Classify the stream reach channel pattern as predominantly **one** channel, an **anastomosing** channel, or a **braided** channel.

One channel may have occasional in-channel bars or islands with side channels, but feature a predominant single channel, or a dominant main channel with a subordinate side channel.

Anastomosing channels have relatively long major and minor channels branching and rejoining in a complex network separated by vegetated islands, with no obvious dominant channel.

Braided channels also have multiple branching and rejoining channels, separated by unvegetated bars. Subchannels are generally small, short, and numerous, often with no obvious dominant channel.

After classifying the channel pattern, determine whether the channel is constrained within a narrow valley, constrained by local features within a broad valley, unconstrained and free to move about within a broad floodplain, or free to move about, but within a relatively narrow valley floor.

Then examine the channel to ascertain the bank and valley features that constrain the stream. Entry choices for the type of constraining features are bedrock, hillslopes, terraces/alluvial fans, and human land use (e.g., a road, a dike, landfill, rip-rap, etc.).

Estimate the percent of the channel margin in contact with constraining features (for unconstrained channels, this is 0%).

Finally, estimate the “typical” bankfull channel width. To aid in this estimate, you may wish to refer to the individual transect assessments of incision and constraint that were recorded on the Channel/Riparian Cross-Section Forms.

Visually estimate the average width of the valley floor. If the valley is wider than you can directly estimate, record the distance you can see and mark the box on the field form.

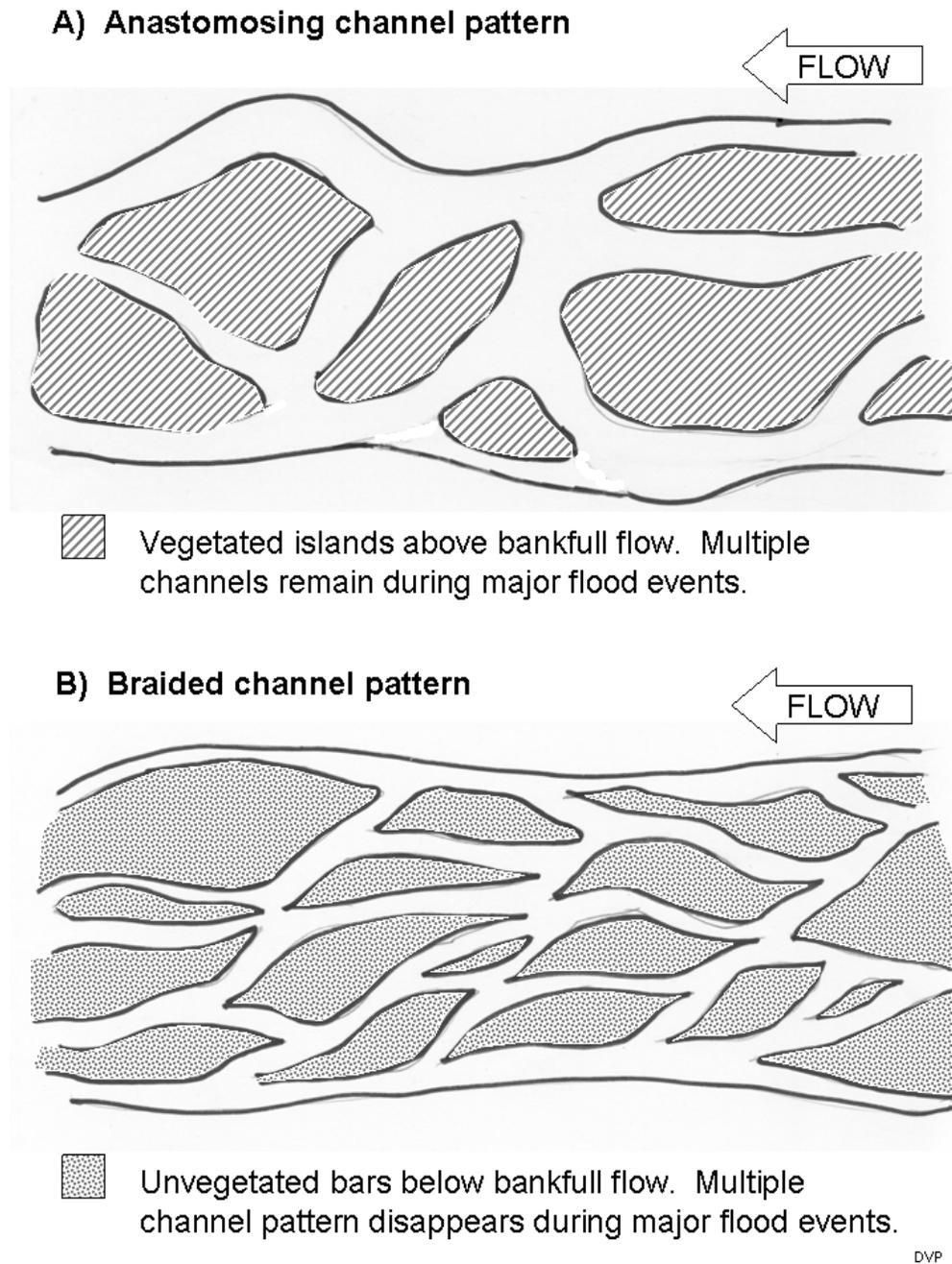
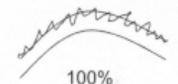
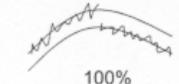
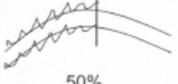
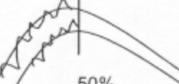


Figure 5.2-9. Types of multiple channel patterns.

CHANNEL CONSTRAINT FORM - WADEABLE/BOATABLE		Reviewed by (initial): JD
SITE <u>FW08 XX000</u>	DATE: <u>07/01/2008</u>	
CHANNEL CONSTRAINT		
CHANNEL PATTERN (Fill in one) <input checked="" type="radio"/> One channel <input type="radio"/> Anastomosing (complex) channel - (Relatively long major and minor channels branching and rejoining.) <input type="radio"/> Braided channel - (Multiple short channels branching and rejoining - mainly one channel broken up by numerous mid-channel bars.)		
CHANNEL CONSTRAINT (Fill in one) <input type="radio"/> Channel very constrained in V-shaped valley (i.e. it is very unlikely to spread out over valley or erode a new channel during flood) <input checked="" type="radio"/> Channel is in Broad Valley but channel movement by erosion during floods is constrained by incision (Flood flows do not commonly spread over valley floor or into multiple channels.) <input type="radio"/> Channel is in Narrow Valley but is not very constrained, but limited in movement by relatively narrow valley floor (< ~10 x bankfull width) <input type="radio"/> Channel is Unconstrained in Broad Valley (i.e. during flood it can fill off-channel areas and side channels, spread out over flood plain, or easily cut new channels by erosion)		
CONSTRAINING FEATURES (Fill in one) <input type="radio"/> Bedrock (i.e. channel is a bedrock-dominated gorge) <input type="radio"/> Hillslope (i.e. channel constrained in narrow V-shaped valley) <input checked="" type="radio"/> Terrace (i.e. channel is constrained by its own incision into river/stream gravel/soil deposits) <input type="radio"/> Human Bank Alterations (i.e. constrained by rip-rap, landfill, dike, road, etc.) <input type="radio"/> No constraining features		
Percent of channel length with margin in contact with constraining feature: <u>100</u> % ---> <small>(0-100%)</small>	Percent of Channel Margin Examples	
Bankfull width: <u>45</u> (m)	 100%	 100%
Valley width (Visual Estimated Average): <u>50.0</u> (m) <small>Note: Be sure to include distances between both sides of valley border for valley width. If you cannot see the valley borders, record the distance you can see and mark this box.</small>	 50%	 50%
Comments 		

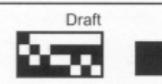


Figure 5.2-10. Channel Constraint Form.

5.2.10 Debris Torrents and Recent Major Floods

Debris torrents, or lahars, differ from conventional floods in that they are flood waves of higher magnitude and shorter duration, and their flow consists of a dense mixture of water and debris. Their high flows of dense material exert tremendous scouring forces on streambeds. For example, in the Pacific Northwest, flood waves from debris torrents can exceed 5 meters deep in small streams normally 3 m wide and 15 cm deep. These torrents move boulders in excess of 1 m diameter and logs >1 m diameter and >10 m long. In temperate regions, debris torrents occur primarily in steep drainages and are relatively infrequent, occurring typically less than once in several centuries. They are usually set into motion by the sudden release of large volumes of water upon the breaching of a natural or human-constructed impoundment, a process often initiated by mass hillslope failures (landslides) during high intensity rainfall or snowmelt. Debris torrents course downstream until the slope of the stream channel can no longer keep their viscous sediment suspension in motion (typically <3% for small streams); at this point, they “set up”, depositing large amounts of sediment, boulders, logs, and whatever else they were transporting. Upstream, the *torrent track* is severely scoured, often reduced in channel complexity and devoid of near-bank riparian vegetation. As with floods, the massive disruption of the stream channel and its biota are transient, and these intense, infrequent events will often lead to a high-quality complex habitat within years or decades, as long as natural delivery of large wood and sediment from riparian and upland areas remains intact.

In arid areas with high runoff potential, debris torrents can occur in conjunction with flash flooding from extremely high-intensity rainfall. They may be nearly annual events in some steep ephemeral channels where drainage area is sufficient to guarantee isolated thunderstorms somewhere within their boundaries, but small enough that the effect of such storms is not dampened out by the portion of the watershed not receiving rainfall during a given storm.

Because they may alter habitat and biota substantially, infrequent major floods and torrents can confuse the interpretation of measurements of stream biota and habitat in regional surveys and monitoring programs. Therefore, it is important to determine if a debris torrent or major flood has occurred within the recent past. After completing the thalweg profile and channel/riparian measurements and observations, examine the stream channel along the entire sample reach, including its substrate, banks, and riparian corridor, checking the presence of features described on the Torrent Evidence Assessment Form (Figure 5.2-11). It may be advantageous to look at the channel upstream and downstream of the actual sample reach to look for areas of torrent scour and massive deposition to answer some of the questions on the field form. For example, you may more clearly recognize the sample reach as a torrent deposition area if you find extensive channel scouring upstream. Conversely, you may more clearly recognize the sample reach as a torrent scour reach if you see massive deposits of sediment, logs, and other debris downstream.

Reviewed by (Initials): JD

TORRENT EVIDENCE ASSESSMENT FORM

SITE ID: <u>FW08 XX000</u>	DATE: <u>07/01/2008</u>
TORRENT EVIDENCE	
Please fill in any of the following that are evident.	
EVIDENCE OF TORRENT SCOURING:	
<input type="radio"/>	01 - Stream channel has a recently devegetated corridor two or more times the width of the low flow channel. This corridor lacks riparian vegetation with possible exception of fireweed, even-aged alder or cottonwood seedlings, grasses, or other herbaceous plants.
<input type="radio"/>	02 - Stream substrate cobbles or large gravel particles are NOT IMBRICATED. (Imbricated means that they lie with flat sides horizontal and that they are stacked like roof shingles -- imagine the upstream direction as the top of the "roof.") In a torrent scour or deposition channel, the stones are laying in unorganized patterns, lying "every which way." In addition many of the substrate particles are angular (not "water-worn.")
<input type="radio"/>	03 - Channel has little evidence of pool-riffle structure. (For example, could you ride a mountain bike down the channel?)
<input type="radio"/>	04 - The stream channel is scoured down to bedrock for substantial portion of reach.
<input type="radio"/>	05 - There are gravel or cobble berms (little levees) above bankfull level.
<input type="radio"/>	06 - Downstream of the scoured reach (possibly several miles), there are massive deposits of sediment, logs, and other debris.
<input type="radio"/>	07 - Riparian trees have fresh bark scars at many points along the stream at seemingly unbelievable heights above the channel bed.
<input type="radio"/>	08 - Riparian trees have fallen into the channel as a result of scouring near their roots.
EVIDENCE OF TORRENT DEPOSITS:	
<input type="radio"/>	09 - There are massive deposits of sediment, logs, and other debris in the reach. They may contain wood and boulders that, in your judgement, could not have been moved by the stream at even extreme flood stage.
<input type="radio"/>	10 - If the stream has begun to erode newly laid deposits, it is evident that these deposits are "MATRIX SUPPORTED." This means that the large particles, like boulders and cobbles, are often not touching each other, but have silt, sand, and other fine particles between them (their weight is supported by these fine particles -- in contrast to a normal stream deposit, where fines, if present, normally "fill-in" the interstices between coarser particles.)
NO EVIDENCE:	
<input checked="" type="radio"/>	11 - No evidence of torrent scouring or torrent deposits.
COMMENTS	



Figure 5.2-11. Torrent Evidence Form.

5.3 Periphyton

5.3.1 Summary of Method

Collect periphyton from the near-shore shallows at each of the sampling stations located on the 11 cross-section transects (“A” through “K”) established within the sampling reach. Collect periphyton samples at the same time as sediment enzyme samples (Section 5.1.4) and benthic macroinvertebrate samples (Section 5.4). Prepare one composite sample of periphyton for each site. At the completion of the day’s sampling activities, but before leaving the site, prepare four types of laboratory samples (an ID/enumeration sample to determine taxonomic composition and relative abundances, a *chlorophyll* sample, a biomass sample (for ash-free dry mass [AFDM]), and an acid/alkaline phosphatase activity [APA] sample) from the composite periphyton sample.

5.3.2 Equipment and Supplies

Table 5.3-1 is a checklist of equipment and supplies required to conduct periphyton sample collection and processing activities. This checklist is similar to the checklist presented in Appendix A, which is used at the base location (Section 3) to ensure that all of the required equipment is brought to the river.

Table 5.3-1. Equipment and supplies list for periphyton at non-wadeable sites

For collecting samples	<ul style="list-style-type: none"> ▪ Large Funnel (15-20 cm diameter) ▪ 12-cm² area delimiter (3.8 cm diameter pipe, 3 cm tall) ▪ Stiff-bristle toothbrush with handle bent at 90° angle ▪ 1-L wash bottle for stream water ▪ 500-mL plastic bottle for the composite sample with marked volume gradations ▪ 60-mL plastic syringe with 3/8” hole bored into the end ▪ Aspirator ▪ Cooler with bags of ice ▪ Field Operations Manual or laminated Quick Reference Guide
For recording measurements	<ul style="list-style-type: none"> ▪ Sample Collection Form ▪ Soft (#2) lead pencils for recording data on field forms ▪ Fine-tipped indelible markers for sample labels ▪ Sample labels (4 per set) with the sample ID number ▪ Clear tape strips for covering labels

5.3.3 Sampling Procedure

At each of the 11 transects, collect samples from the sampling station assigned during the layout of the reach. Collect the substrate selected for sampling from a depth no deeper than 0.5 m. If you cannot collect a sample because the location is too deep, skip the transect. The procedure for collecting samples and preparing a composite sample is presented in Table 5.3-2. Collect one sample from each of the transects and composite in one bottle to produce one composite sample for each site. Record the volume of the sample on the Sample Collection Form as shown in Figure 5.1-4.

Table 5.3-2. Procedure for collecting composite index samples of periphyton at non-wadeable sites

1. Starting with Transect "A", collect a single sample from the assigned sampling station using the procedure below.
 - a) Collect a sample of hard substrate (rock or wood) that is small enough (< 15 cm diameter) and can be easily removed from the river. Place the substrate in a plastic funnel which drains into a 500-mL plastic bottle with volume graduations marked on it.
 - b) Use the area delimiter to define a 12-cm² area on the upper surface of the substrate. Dislodge attached periphyton from the substrate within the delimiter into the funnel by brushing with a stiff-bristled toothbrush for 30 seconds. Take care to ensure that the upper surface of the substrate is the surface that is being scrubbed, and that the entire surface within the delimiter is scrubbed.
 - c) Fill a wash bottle with river water. Wash the dislodged periphyton from the piece of substrate, brush, delimiter and funnel into the 500-mL bottle. Use an appropriate amount of water to bring the sample up to the next gradation. Doing so should result in collecting approximately 45mL of sample at each transect.
 - d) If no coarse sediment (cobbles or larger) are present:
 - Use the area delimiter to confine a 12-cm² area of soft sediments.
 - Either:
 - Vacuum the top 1 cm of sediment from within the delimited area into a de-tipped 60- mL syringe.
 - Use an aspirator to suction the top 1 cm of sediment from within the delimited area into the sample bottle.
 - Empty the syringe into the same 500-mL plastic bottle as above.
 - e) **Put the bottle in a cooler on ice while you travel between transects and collect the subsequent samples. (The samples need to be kept cool and dark because a chlorophyll sample will be filtered from the composite.)**
2. Repeat Step 1 for transects "B" through "K". Place the sample collected at each sampling site into the single 500-mL bottle to produce the composite index sample.
3. After samples have been collected from all 11 transects, thoroughly mix the 500-mL bottle regardless of substrate type.
4. Record the total volume of the composite sample in the periphyton section of the Sample Collection Form.
5. If you are unable to collect a sample at any location, mark it on the field form and record the volume of overall sample collected.

5.3.4 Sample Processing in the Field

You will prepare four different types of laboratory samples from the composite index samples: an **ID/enumeration sample** (to determine taxonomic composition and relative abundances), a **chlorophyll sample**, a **biomass sample** (for ash-free dry mass [AFDM]), and an **acid/alkaline phosphatase activity (APA)** sample. All the sample containers required for an individual site should be sealed in plastic bags until use to avoid external sources of contamination (e.g., dust, dirt, or mud) that are present at site shorelines. Please refer to Sections 7.2.5 and 7.2.6 processing the periphyton samples.

5.4 Benthic Macroinvertebrates

5.4.1 Summary of Method

Collect benthic macroinvertebrate composite samples using a D-frame net with 500 µm mesh openings. Take the samples from the sampling stations at the 11 transects equally distributed along the targeted reach. Composite all sample material and field-preserve with ~95% ethanol.

5.4.2 Equipment and Supplies

Table 5.4-1 shows the checklist of equipment and supplies required to complete the collection of benthic macroinvertebrates at non-wadeable sites. This checklist is similar to the checklist presented in Appendix A, which is used at the base location to ensure that all of the required equipment is brought to the site.

Table 5.4-1. Equipment and supplies list for benthic macroinvertebrate collection at non-wadeable sites

For collecting samples	<ul style="list-style-type: none"> ▪ Modified kick net (D-frame with 500 µm mesh) and 4-5 ft handle ▪ Spare net(s) and/or spare bucket assembly for end of net ▪ Buckets, plastic, 8- to 10-qt ▪ Sieve bucket with 500 µm mesh openings (U.S. std No. 35) ▪ Watchmakers' forceps ▪ Wash bottle, 1-L capacity labeled "STREAM WATER" ▪ Funnel, with large bore spout 	<ul style="list-style-type: none"> ▪ Small spatula, spoon, or scoop to transfer sample ▪ Sample jars, 1-L HDPE plastic suitable for use with ethanol ▪ 95% ethanol, in a proper container ▪ Cooler (with absorbent material) for transporting ethanol & samples ▪ Plastic electrical tape ▪ Scissors ▪ Field Operations Manual or laminated Quick Reference Guide
For recording measurements	<ul style="list-style-type: none"> ▪ Composite benthic sample labels with & without preprinted ID numbers ▪ Blank labels on waterproof paper for inside of jars 	<ul style="list-style-type: none"> ▪ Soft (#2) lead pencils ▪ Fine-tip indelible markers ▪ Clear tape strips ▪ Sample Collection Form

5.4.3 Sampling Procedure

Collect benthic macroinvertebrate samples at the 11 transects and within the sampling stations for non-wadeable streams. The process for selecting the sample stations is described in the Initial Site Procedures Section (Section 4). Collect all benthic samples at non-wadeable sites from the dominant habitat type within the 10 m x 15 m randomly selected sampling station at each transect (Figure 5.4-1). Take 1 linear meter sweep at the dominant habitat type. Record the benthic macroinvertebrate collection data on the Sample Collection Form, Side 1 as seen in Figure 5.1-2.

The sampling process for collecting benthic samples from non-wadeable sites is illustrated in Figure 5.4-2 and described in Table 5.4-2.

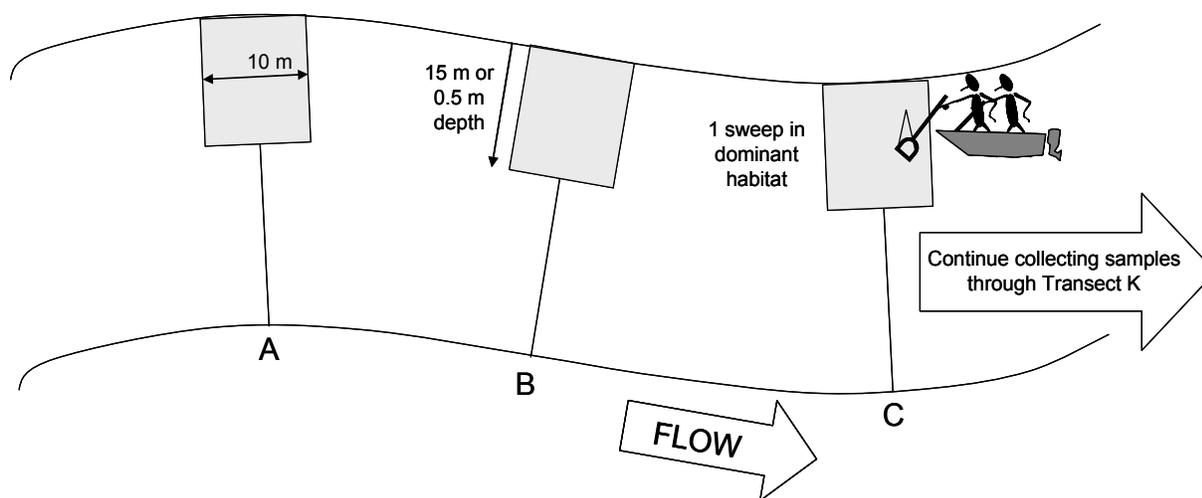


Figure 5.4-1. Transect sample design for collecting benthic macroinvertebrates at non-wadeable sites.

5.4.4 Sample Processing in Field

Use a 500 μ m mesh sieve bucket placed inside a larger bucket full of site water while sampling to carry the composite sample as you travel around the site. It is recommended that teams carry a sample bottle containing a small amount of ethanol with them to enable them to immediately preserve larger predaceous invertebrates such as helgramites and water beetles. Doing so will help reduce the chance that other specimens will be consumed or damaged prior to the end of the field day. Once the sample from all stations is composited, sieved and reduced in volume, store in a 1-liter jar and preserve with 95% ethanol. Multiple jars may be required if detritus is heavy (Table 5.4-3). It is suggested that no more than 5 1-L jars be used at any site. If more than one jar is used for a composite sample, use the "extra jar" label provided; record the SAME sample ID number on this "extra jar" label. **DO NOT use two different sample numbers on two jars containing one single sample.** Remove any inorganic material (rocks, debris, etc) before preserving sample. Cover the labels with clear tape. The sample ID number is also recorded with a No. 2 lead pencil on a waterproof label that is placed inside each jar. Be sure the inside label and outside label describe the same sample. If there is a large amount of organic material in the sample, or there are adverse field conditions (i.e. hot, humid weather), place sample in a 1-L jar with ethanol after each station.

Record information for each composite sample on the Sample Collection Form as shown in Figure 5.1-2. If a sample requires more than one jar, make sure the correct number of jars for the sample is recorded on the Sample Collection Form. **Do not fill out the collection form until you have collected (or confirmed at the site that you will collect) samples.** If forms are filled out before you arrive at the site, and then no samples are collected, a lot of time is wasted by others later trying to find samples that do not exist. If you are unable to collect a sample at any station, make note of it on the sample collection form. Place the samples in a cooler or other secure container for transporting and/or shipping to the laboratory (see Appendix C).

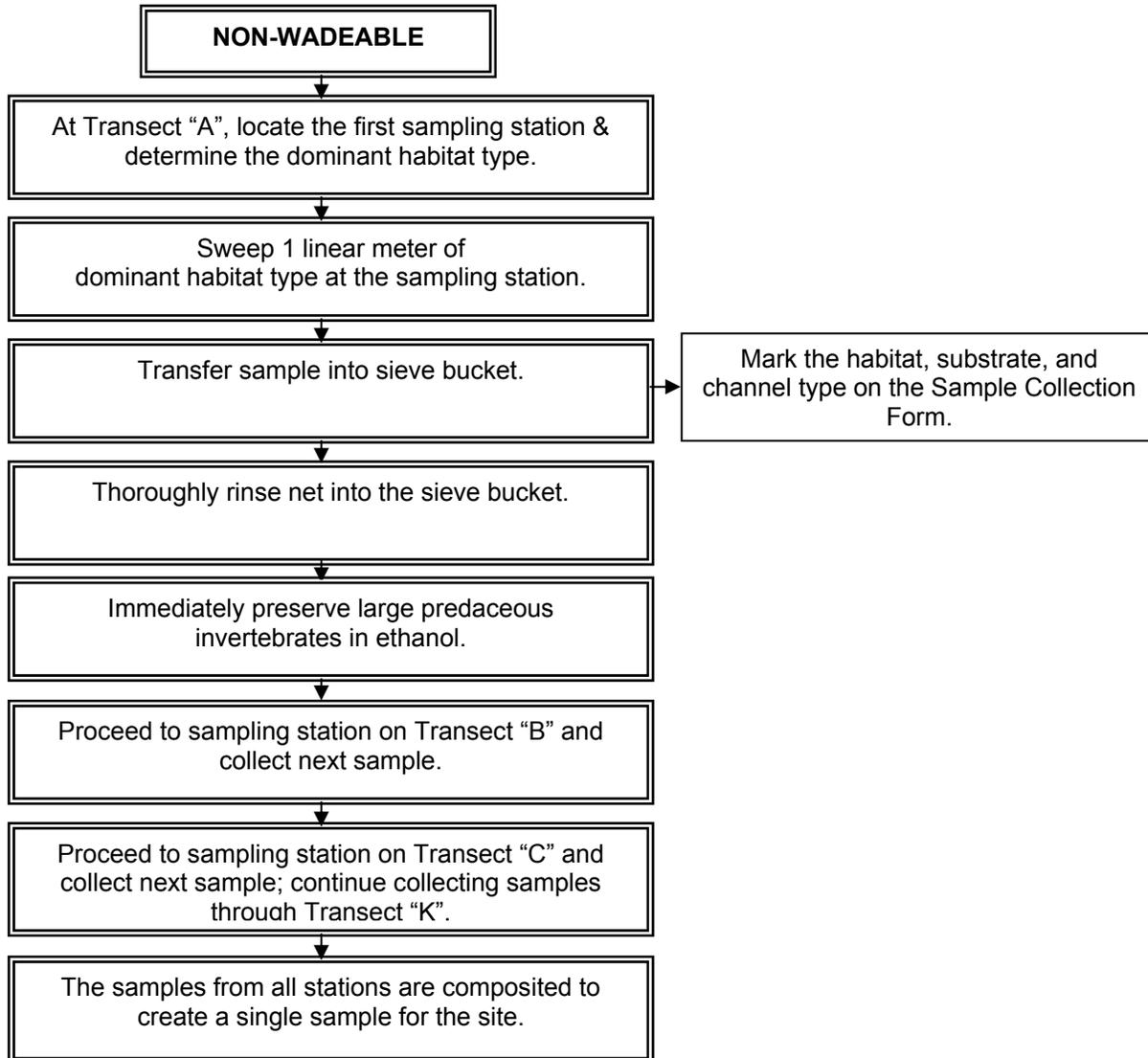


Figure 5.4-2. Benthic macroinvertebrate collection at non-wadeable sites.

Table 5.4-2. Procedure for benthic macroinvertebrate sampling at non-wadeable sites

1. After locating the sampling station site according to procedures described in the physical habitat section, identify the dominant habitat type within the plot:
 - Rocky/cobble/gravel/large woody debris
 - Organic fine mud or sand
 - Macrophyte beds
 - Leaf Pack
2. Use the D-frame dip net (equipped with 500 μ m mesh) to sweep through 1 linear meter of the most dominant habitat type within the 10m x 15m sampling station, making sure to disturb the substrate enough to dislodge organisms.
 - If the dominant habitat is rocky/cobble/large woody debris it may be necessary to exit the boat and disturb the substrate (e.g., overturn rocks, logs) using your feet while sweeping the net through the disturbed area.
 - Because a dip-net is being used for sampling, the maximum depth for sampling will be approximately 0.5 m; therefore, in cases in which the depth of the river quickly drops off it may be necessary to sample in the nearest several meters to the shore.
3. After completing the 1 linear meter sweep, remove all organisms and debris from net and place them in a bucket following sample processing procedures described in the following section.
4. Record the sampled habitat type on the Sample Collection Form.
 - a) **F**ine/sand: not gritty (silt/clay/muck <0.06 mm diam.) to gritty (up to ladybug sized 2 mm diam.)
 - b) **G**ravel: fine to coarse gravel (ladybug to tennis ball sized; 2 mm to 64 mm diam.)
 - c) **C**oarse: Cobble to boulder (tennis ball to car sized; 64 mm to 4000 mm)
 - d) **O**ther: bedrock (larger than car sized; > 4000 mm), hardpan (firm, consolidated fine substrate), wood of any size, aquatic vegetation, etc.). Note "other" substrate in comments on field form.
5. Identify the channel habitat type where the sampling sweep was located. Mark the appropriate channel habitat type for the transect on the Sample collection Form.
 - a) **P**ool; Still water; low velocity; smooth, glassy surface; usually deep compared to other parts of the channel
 - b) **G**Lide: Water moving slowly, with smooth, unbroken surface; low turbulence
 - c) **R**iffle: Water moving, with small ripples, waves, and eddies; waves not breaking, and surface tension is not broken; "babbling" or "gurgling" sound.
 - d) **R**Apid: Water movement is rapid and turbulent; surface with intermittent "white water" with breaking waves; continuous rushing sound.
6. Proceed to the next sampling station and repeat steps 1-5. The organisms and detritus collected at each station on the river should be combined in a single bucket to create a single composite sample for the river. After sampling at all 11 stations is completed, process the composite sample in the bucket according to procedures described in the following section.
7. If the sample contains primarily organic material, or if adverse weather conditions exist (i.e. hot humid weather) process the sample at each station by placing it in a 1-L nalgene jar with ethanol. Follow instructions in Table 5.4-3.
8. Immediately preserve larger predaceous invertebrates such as helgramites and water beetles in ethanol.

Table 5.4-3. Procedure for compositing samples for benthic macroinvertebrates at non-wadeable sites

Estimate the total volume of the sample in the sieve and determine how large a jar will be needed for the sample (500-mL or 1-L) and how many jars will be required. It is suggested that no more than 5 1-L jars are used at each site.

Fill in a sample label with the Sample ID and date of collection. Attach the completed label to the jar and cover it with a clear tape strip. Record the Sample ID for the composite sample on the Sample Collection Form. For each composite sample, make sure the number on the form matches the number on the label.

Wash the contents of the sieve to one side by gently agitating the sieve in the water. Wash the sample into a jar using as little water from the wash bottle as possible. Use a large-bore funnel if necessary. If the jar is too full pour off some water through the sieve until the jar is is not more than 1/3 full, or use a second jar if a larger one is not available. Carefully examine the sieve for any remaining organisms and use watchmakers' forceps to place them into the sample jar. Remove any inorganic material, such as gravel, by rinsing the material, examining it and removing it from the sample.

- If a 2nd jar is needed, fill in a label that does not have a pre-printed ID # on it. Record the ID # from the pre-printed label prepared above in the "SAMPLE ID" field of the label. Attach the label to the 2nd jar and cover it with a strip of clear tape. Record the number of jars on the Sample Collection Form. **Make sure the number you record matches the actual number of jars used.** Write "Jar N of X" on each sample label using a waterproof marker. **Try to use no more than 5 jars per site.**

Place a waterproof label inside each jar with the following information written with a #2 lead pencil:

- Site ID
- Type of sampler and mesh size used
- Name of site
- Date of collection
- Collectors initials
- Number of stations sampled
- Jar "N" of "X"

Completely fill the jar with 95% ethanol (no headspace). It is very important that sufficient ethanol be used, or the organisms will not be properly preserved. Existing water in the jar should not dilute the concentration of ethanol below 70%.

- NOTE: Composite samples can be transported back to the vehicle before adding ethanol if necessary. In this case, fill the jar with stream water, then drain using the net (or sieve) across the opening to prevent loss of organisms, and replace with ethanol at the vehicle.

Replace the cap on each jar. Slowly tip the jar to a horizontal position, then gently rotate the jar to mix the preservative. Do not invert or shake the jar. After mixing, seal each jar with plastic tape.

Store labeled composite samples in a container with absorbent material that is suitable for use with 70% ethanol until transport or shipment to the laboratory.

5.5 Fish

5.5.1 Summary of Method

The fish sampling method is designed to provide a representative sample of the fish community, collecting all but the rarest fish inhabiting the site. It is assumed to accurately represent species richness, species guilds, relative abundance, size, and anomalies. The goal is to collect fish community data that will allow the calculation of an Index of Biotic Integrity (IBI) and Observed/Expected (O/E) models. Boat electrofishing is the preferred method of sampling. If electrofishing is not possible due to safety concerns, high turbidity, or extremes in conductivity, complete the “Not Fished” section of the field form and comment why.

The time and effort necessary to sample the reach in its entirety is prohibitive in the context of the survey, thus sub-sampling is required. Electrofishing will occur in a downstream direction at all habitats along alternating banks (see section 5.5.3), over a length of 20 times the mean channel width (Transects A through F). Collection of a minimum of 500 fish is required. If this target is not attained, sampling will continue until 500 individuals are captured or the downstream extent of the site (transect K) is reached. Identification and processing of fish should occur at the completion of each transect. If sampling cannot happen at any individual transect, record it on the field collection form.

5.5.2 Equipment and Supplies

Table 5.5-1 shows the checklist of equipment and supplies required to complete the non-wadeable fish assessment. This checklist is similar to the one presented in Appendix A, which is used at the base location to ensure that all of the required equipment is brought to the site. Record fish collection data on the Fish Collection Form, Side 1 (Fig. 5.5-1). Additional sheets may be necessary – remember to indicate the transect on each form.

Table 5.5-1. Equipment and supplies — fish assessment at non-wadeable sites.

For collecting samples	<ul style="list-style-type: none"> • Boat, motor, and trailer (and necessary safety equipment) • Gasoline and oil (if using a 2 cycle) • Boat electrofishing equipment <ul style="list-style-type: none"> • Pulsator Control Box • Foot Pedal • Anode Droppers • Generator • Linesman’s Gloves • Hearing Protection • Tow barge electrofishing equipment <ul style="list-style-type: none"> • Probes with extensions. • Appropriate switching box • Dip nets (non-conductive handles) ¼” mesh • Scientific collection permit 	<ul style="list-style-type: none"> • GPS with transect waypoints preloaded • Several Leak-proof HDPE jars for fish voucher specimens (various sizes from 250 mL – 4L) • 1scalpel for slitting open large fish before preservation • 1 container of 10% buffered formalin • 1 Minnow net for dipping small fish from live well • 2 measuring boards (3 cm size classes) • 1 set Fish ID keys • Field Operations Manual and/or laminated Quick Reference Guide • Digital camera with extra memory card & battery
For recording measurements	<ul style="list-style-type: none"> • Sample labels • Sample Collection Form • Clear tape strips 	<ul style="list-style-type: none"> • Soft (#2) lead pencils • Fine-tip indelible markers

5.5.3 Sampling Procedure

Sampling will begin at the upstream half of the overall site, representing 20 times the mean channel width. The total distance fished will depend upon the number of individuals captured. Shoreline electrofishing will begin at transect A and proceed in a downstream direction, alternating banks and terminating with the completion of subreach E-F (Figure 5.5-2). Determination of the initial stream bank sampling location at transect A (i.e., right or left bank) corresponds to the sequence established for physical habitat sampling and is determined at random. Subreaches A-B, B-C, and C-D are sampled along the same bank before alternating to the opposite bank to complete subreaches D-E and E-F. Each subreach is sampled for a maximum of 700 seconds per subreach. Identification and processing of the sample should be completed prior to beginning the next subreach. A minimum of 500 specimens is required. If fewer than 500 individuals are captured, sampling must continue on alternating banks (again following the pattern laid out for physical habitat sampling) until the minimum number is attained or the downstream extent of the site (transect K) is reached (Figure 5.5-2).

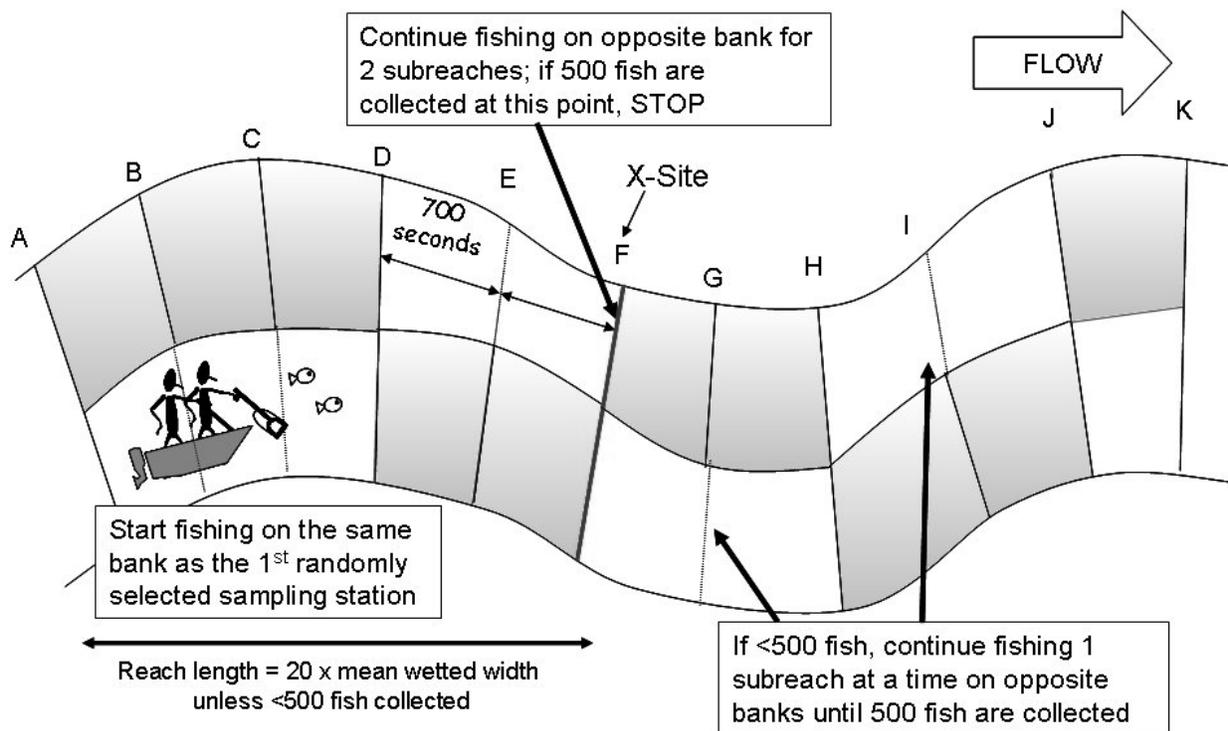


Figure 5.5-2. Transect sampling design for fish sampling at non-wadeable sites.

The sampling crew should consist of one boat operator (also controlling the electrofishing unit) and one dip-netter (1/4" mesh dip nets) situated at the bow. Prior to sampling each subreach, the crew should determine the most appropriate gear for the segment (e.g., boat or barge electrofishing units). Electrofishing should proceed downstream at a pace equal to or slightly greater than the prevailing current to maximize capture efficiency. It may be necessary to maneuver the electrofishing unit in and around complex habitat; however,

discretion should be used in sampling these areas in order to maintain equal effort between subreaches. Total effort expended (i.e., button time) over the five subreaches should be approximately 3500 seconds. If additional subreaches are sampled, additional time will be spent. To reduce stress and mortality, immobilized fish should be netted immediately and deposited into a live-well for processing. For safety, all crew members are required to wear personal floatation devices and insulated gloves. Polarized sunglasses and caps to aid vision are also required. Table 5.5-2 provides the procedure for electrofishing in non-wadeable streams.

Table 5.5-2. Procedure for electrofishing at non-wadeable sites.

1. Review all collecting permits to determine if any sampling restrictions are in effect for the site. In some cases, you may have to cease sampling if you encounter certain State- or Federally-listed species.
2. Boat electrofishing will be used in non-wadeable streams, and the direction of fishing will be downstream. If conductivity, turbidity, or safety precludes electrofishing, complete the "NOT FISHED" field on the Fish Collection Form and comment why.
3. The sampling reach is defined as 20 times the mean channel width, corresponding to transects A through F unless < 500 individuals are captured.
4. Shoreline electrofishing between each transect will occur on alternating banks following the sequence established in the physical habitat procedures. Sampling will begin on the bank selected at random and continue from transect A downstream for 700 seconds or until the next transect is reached. Subreaches B-C and C-D are fished similarly; subreaches D-E and E-F will then be sampled on the opposite bank. If fewer than 500 individuals are captured, sampling should continue until the minimum catch is attained or the last subreach (J-K) is fished. Follow the systematic rotation of banks such that up to two subreaches would be fished on the same bank prior to switching to the opposite bank. Crews must complete each of the additional subreaches as described above, do not stop in the middle of any subreach, even if the 500 fish minimum is attained before the end of the subreach.
5. Set unit to pulsed DC and test settings outside of the sampling area. Start the electrofisher, set the timer, and depress the switch to begin fishing. Typical settings are: 500-1000VDC; 8-20A; and 120 Hz. If fishing success is poor, increase the pulse width first and then the voltage. Increase the pulse rate last to minimize mortality or injury to large fish. If mortalities occur, first decrease pulse rate, then voltage, then pulse width.
6. Once the settings on the electrofisher are adjusted to sample effectively and minimize injury and mortality, begin sampling at the upstream reach (Transect A). Electrofishing proceeds downstream in close proximity to the bank and at a pace equal to or slightly greater than the prevailing current to maximize capture efficiency. Crews may "nose in" to habitat to effectively sample but should not remain in that habitat for too long. Generally effort (i.e., button time) should be 700 seconds per subreach. At sites with maximum reach length (4km) it is likely that the entire subreach (400m) will not be fished. Depending upon the habitat complexity, variable distances may be fished in the time allotted. Distance sampled is recorded on the Fish Collection Form.
7. Recommended mesh size on dip nets is 6mm (1/4"). Dip netters should actively capture stunned fish, removing them from the electric field and immediately placing them in the livewell. Special attention should be devoted to netting small and benthic fishes as well as fishes that may respond differently to the current.
8. Process fish at the completion of each subreach to reduce mortality and track sampling effort. Release fish in a location that eliminates the likelihood of recapture.
9. Complete header information on the Fish Collection Form. Record the number of seconds fished and the estimated distance fished (as tracked by GPS or measured by range finder).

10. Repeat Steps 6 through 8 until subreach E-F and 500 individuals are captured or at a maximum, subreach J-K is finished.

5.5.4 Processing Fish

Process fish when fish show signs of stress (e.g., loss of righting response, gaping, gulping air, excessive mucus). Change water or stop fishing and initiate processing as soon as possible. Similarly, State- and Federally-listed threatened or endangered species or large game fish should be processed and released as they are captured. If periodic processing is required, fish should be released in a location that prevents the likelihood of their recapture.

Use the Fish Collection Form – Large Wadeable/Boatable/Raftable. If several forms are needed, use an extra form and note the page number on the top of the form as well as the subreach sampled (i.e. Page 1 of 3). Taxonomic identification and processing should only be completed on specimens greater than 25 mm total length and by crew members designated as “fish taxonomic specialists” by EPA regional coordinators. Fish are tallied by species, evaluated for maximum and minimum length, and examined for the presence of DELT (Deformities, Eroded Fins, Lesions and Tumors) anomalies. Common names of species should follow those established under the American Fisheries Society’s publication, “Common and Scientific Names of Fishes from the United States, Canada and Mexico” (Nelson, et al. 2004). A list of species common to freshwater systems of the United States is presented in Appendix D.

Species not positively identified in the field should be separately retained (up to 20 individuals per species) for laboratory identification. Common names for retained species should be assigned as “unknown”, followed by its common family name and sequential lettering to designate separate species (e.g., UNKNOWN SCULPIN A). Following positive laboratory identification, field form information should be updated to reflect the actual species count and number in the Final Count field. For example, if a sample of 20 specimens of species A is later identified as 15 individuals of species A and 5 of species B, the Final Count of species A should be corrected by assigning 25% to species B and 75% to species A. Table 5.5-3 presents the procedure for processing fish.

Table 5.5-3. Procedure for processing fish at non-wadeable sites.

1. Complete all header information accurately and completely. If no fish were collected, complete the “NONE COLLECTED” field on the Fish Collection Form.
2. Complete the information on the Fish Gear and Voucher/Tissue Sample Information Form.
3. Only identify and process individuals > 25mm in total length, ideally handling specimens only once. Record the common name on the first blank line in the “COMMON NAME” Field of the Fish Collection Form.
4. Fill in the Tag Number. The tag number is a number starting with 01 and continuing sequentially to a number equal to the total number of species collected within the entire sample reach. Each reoccurrence of a species within the entire reach should be assigned the same tag number as it was assigned initially. For example, if a bluegill is assigned tag number 01 when processing fish from the first subreach, all bluegills from the other subreaches will also be assigned tag number 01. The purpose of the tag number is to connect species identifications with subsequent verification and voucher collections.
5. If a species cannot be positively identified, assign it a sequential tag number in the Tag Number Field and leave the “COMMON NAME” Field Blank. Flag this line and indicate in the “COMMENT”

field its common family name (e.g., UNKNOWN SCULPIN A). Retain a maximum subsample of 20 individuals for in-house laboratory identification of Unknowns. Do not include the number of each species retained solely for in-house lab verification in the Voucher Count column of the fish collection form. This column is reserved only for those fish that are to be sent in for independent re-identification as part of a complete voucher collection.

6. Process species listed as threatened and endangered first and return individuals immediately to the stream. Photograph specimens for verification purposes if conditions permit and stress to individuals will be minimal. Indicate if photographed on Fish Collection Form. If individuals are killed, prepare them as verification specimens and preserve them in field.
7. Tally the number of individuals of each species collected in the "TALLY" box on the Fish Collection Form and record the total number in the "TOTAL COUNT" field on the form. Do not enter a total for fishes that must be identified in the laboratory.
8. Measure the total length of the largest and smallest individual to provide a size range for the species. Record these values in the "LENGTH" area of the Fish Collection Form. If only one fish is collected, leave the maximum field blank.
9. Examine each individual for external anomalies and tally those observed. Readily identify external anomalies including missing organs (eye, fin), skeletal deformities, shortened operculum, eroded fins, irregular fin rays or scales, tumors, lesions, ulcerous sores, blisters, cysts, blackening, white spots, bleeding or reddening, excessive mucus, and fungus. After all of the individuals of a species have been processed, record the total number of individuals affected in the "ANOMALIES" Field of the Fish Collection Form.
10. Record the total number of mortalities due to electrofishing or handling on the Fish Collection Form.
11. Follow the appropriate procedure to prepare voucher specimens and/or to select specimens for tissue samples. Release all remaining individuals so as to avoid their recapture.
12. For any line with a fish name, ensure that all spaces on that line are filled in with a number, even if it is zero.

5.5.5 Taxonomic Quality Assurance/Quality Control

5.5.5.1 Sample Preservation

Fish retained for laboratory identification or voucher purposes should be placed in a large sample jar containing a 10% buffered formalin solution in a volume equal to or greater than the total volume of specimens. Individuals larger than 200 mm in total length should be slit along the right side of the fish in the lower abdominal cavity to allow penetration of the solution.

Fish retained for laboratory identification or as vouchers should be preserved in the field following the precautions outlined in the MSDS. All personnel handling 10% buffered formalin must read the MSDS (Appendix D). **Formalin is a potential carcinogen and should be used with extreme caution, as vapors and solution are highly caustic and may cause severe irritation on contact with skin, eyes, or mucus membranes. Wear vinyl or nitrile gloves and safety glasses, and always work in a well-ventilated area.**

5.5.5.2 Laboratory Identification of Fish

Fish that are difficult to identify in the field should be kept for laboratory identification or to verify difficult field identifications. Table 5.5-4 outlines the laboratory identification process and completing the Fish Collection Form. Field crews may use a supplemental Fish Identification Lab sheet such as that shown in Figure 6.5-4 for internal laboratory use only.

Crews should retain the Fish verification sample – contact your regional EPA coordinator if you cannot store the samples at your facility.

Do not include the number of each species retained solely for in-house lab verification in the Voucher Count column of the fish collection form. This column is reserved only for those fish that are to be sent in for independent re-identification as part of a complete voucher collection.

Field crews should not retain the Fish Collection Form(s) if the laboratory identification process cannot be completed within a short period of time. If the time needed to complete the identification/verification is expected to exceed two weeks, make copies of the Fish Collection Form(s) and send the entire pack of original data forms to the Information Management Coordinator. When the identification/verification process is complete, make the necessary changes to the copied Fish Collection Form(s) and send them as soon as possible to the Information Management Coordinator as well.

Table 5.5-4. Procedure for laboratory identification of fish samples.

1. Fish may be retained for routine laboratory identification and verification purposes. Fish tags are provided with each site kit. Crews may use these tags at their discretion in order to identify fish at their laboratory.
2. Retained fish should be placed in a large sample jar containing a 10% buffered formalin solution in a volume equal to or greater than the total volume of specimens. Individuals larger than 200mm in total length should be slit along the right side of the fish in the lower abdominal cavity to allow penetration of the solution.
3. Following fixation for 5 to 7 days, the volume of formalin should be properly discarded and replaced with tap water for soaking specimens over a 4-5 day period. Soaking may require periodic water changes and should continue until the odor of formalin is barely detectable. Final storage of specimens is done in 45%-50% isopropyl alcohol or 70% ethanol. Formalin is a potential carcinogen and should be used with extreme caution, as vapors and solution are highly caustic and may cause severe irritation on contact with skin, eyes, or mucus membranes. Wear vinyl or nitrile gloves and safety glasses, and always work in a well-ventilated area.
4. Formalin must be disposed of properly. Contact your regional EPA coordinator if your laboratory does not have the capability of handling waste formalin.
5. Unknown fish are identified to species in the laboratory. You may use a Fish Identification Lab Sheet such as the one presented in Figure 6.5-4.
6. Fill in the Unknown species name in the "COMMON NAME" field of the Fish Collection Form and make certain the "FINAL COUNT" field is correct.
7. If species field identifications were incorrect, correct the "COMMON NAME" Field by completely erasing the Common Name and replacing the correct name. Add an additional Common Name if needed. Make certain the "FINAL COUNT" field is correct. If the "COMMON NAME" Field was incorrect or cannot be cleanly erased, cross out the line of data and fill out a new line with the correct "COMMON NAME" and "FINAL COUNT".

5.5.5.3 Voucher Specimens

Approximately 10% of each field crews' sites will be randomly pre-selected for re-identification by an independent taxonomist. A minimum of one complete voucher is required for each person performing field taxonomy and will consist of either preserved specimen(s) or digital images representative of all species in the sample, including common species. Multiple specimens per species can be used as vouchers, if necessary (i.e., to document different life or growth stages, or sexes). Note that a complete sample voucher does not mean that all individuals of each species will be vouchered, only enough so that independent verification can be achieved.

Digital images should be taken as voucher documentation for species that are recognized as Rare, Threatened, or Endangered – they should not be killed. Digital images should also be taken of fish specimens too large for preservation.

Certain states or regions may require that more fish vouchers are taken. Check with your state/regional coordinators to determine if your team will be required to collect complete vouchers at more than 10% of your sites.

For the sample voucher, specimen containers should be labeled with the sample number, site ID number, site name, and collection date. There should be no taxonomic identification labels in or on the container, or in any of the digital photos.

Choose individual specimens that are intact and in good condition, such that re-identification will be possible. Fish that are damaged, have significant scale loss or those that have been dead for a significant amount of time prior to preservation should be avoided if possible. Fish in pristine condition and those possessing clear identification characteristics are preferred. Additionally, fish that are preserved while still live will typically flare their fins and gills and will allow for easier re-identification in the laboratory.

Place one or more representative specimens of each species in plastic mesh sleeves along with one of the corresponding tag number labels provided in your site kit. (Several fish may be placed in a single mesh sleeve, as long as they are of the same species). Ensure that the tag numbers in the voucher collection match the tag numbers on the fish collection data forms. Seal both ends of the mesh sleeve with zip ties and place it inside the voucher collection jar with the appropriate preservative. Unknown fish may be identified in the laboratory as described in section 5.5.5.2 and subsequently included in the voucher collection.

Record the total number of each fish species retained for voucher purposes in each subreach on the fish collection form. Record the voucher sample ID number on the fish gear / voucher / fish tissue collection form. If no voucher is prepared for the site, fill in the "no vouchers preserved" circle on the fish gear form.

Table 5.5-5. Procedure for vouchering of fish samples.

1. Approximately 10% of each field crews' sites will be randomly pre-selected for re-identification by an independent taxonomist. A minimum of one complete voucher is required for each person performing field taxonomy and will consist of either preserved specimen(s) and/or digital images representative of all species in the sample, even common species.
2. Take digital images as voucher documentation for species that are recognized as Rare, Threatened, or Endangered; or when fish specimens are too large for preservation.
3. For the sample voucher, label the specimen containers with the sample number, site ID number, site name, and collection date. Do not put taxonomic identification labels in or on the container.
4. Place one or more representative specimens of each species in plastic mesh sleeves along with one of the corresponding tag number labels provided in your site kit. (Several fish may be placed in a single mesh sleeve, as long as they are of the same species).
5. Ensure that the tag numbers in the voucher collection match the tag numbers on the fish collection data forms.
6. Seal both ends of the mesh sleeve with zip ties and place it inside the voucher collection jar with the appropriate preservative.
7. Unknown fish may be identified in the laboratory as described in section 5.5.5.2 and subsequently included in the voucher collection.
8. Record the total number of each fish species retained for voucher purposes in each subreach on the fish collection form.
9. Record the voucher sample ID number on the fish gear / voucher / fish tissue collection form.
10. If no voucher is prepared for the site, fill in the "no vouchers preserved" circle on the fish gear form.

5.5.5.4 Photovouchering

Digital imagery should be used for fish species that cannot be retained as preserved specimens (e.g., RTE species; or very large bodied fish). Views appropriate and necessary for an independent taxonomist to accurately identify the specimen should be the primary goal of the photography. Additional detail for these guidelines is provided in Stauffer et al. (2001), and is provided to all field crews as a handout.

The recommended specifications for digital images to be used for photovouchering include: 16-bit color at a minimum resolution of 1024x768 pixels; macro lens capability allowing for images to be recorded at a distance of less than 4 cm; and built-in or external flash for use in low-light conditions. Specimens should occupy as much of the field of view as possible, and the use of a fish board is recommended to provide a reference to scale (i.e., ruler or some calibrated device) and an adequate background color for photographs. Information on Station ID, Date and TAG NUMBER should also be captured in the photograph, so that photos can be identified if file names become corrupted. All photovouchered species should have at least a full-body photo (preferably of the left side of the fish) and other zoom images as necessary for individual species, such as lateral line, ocular/oral orientation, fin rays, gill arches, or others. It may also be necessary to photograph males, females, or juveniles.

Images should be saved in medium- to high-quality jpeg format, with the resulting file name of each picture noted on the Fish Collection Form. It is important that time and date stamps are accurate, as this information can also be useful in tracking the origin of photographs. Because close-up photography is difficult in the best of conditions with typical point and shoot cameras, it might be best to take high quality pictures at a greater distance so that the image can be zoomed with a PC. It is recommended that images stored in the camera be transferred to a PC or storage device at the first available opportunity. At this time the original file should be renamed to follow the logic presented below:

F01_CT003_20080326_A.jpg

Where:

F = fish

01 = TAG NUMBER

CT003 = state (Connecticut) and site number

20080326 = date (yyyymmdd)

A = first of several pictures of same fish (e.g., A, B, C)

Field crews should maintain files for the duration of the sampling season. Notification regarding the transfer of all images to the existing database will be provided at the conclusion of the sampling. Only keep photos that are useful for identifications. If photos are to be submitted as vouchers, burn a CD of those photos that can be submitted along with the voucher jar.

5.6 Fish Tissue

5.6.1 Summary of Method

You will collect one predator species composite from each target site for human health related analyses. The focus is on fish species that commonly occur throughout the region of interest, and that are sufficiently abundant within a sampling reach. Each composite sample will consist of five adult fish of the same species that are similar in size (the smallest individual in the composite is no less than 75% of the total length of the largest individual). Collection occurs in the sampling reach.

5.6.2 Equipment and Supplies

Table 5.6-1 lists the equipment and supplies necessary for field crews to collect fish tissue samples. This list is comparable to the checklist presented in Appendix A, which provides information to ensure that field teams bring all of the required equipment to the site. Record the fish tissue sampling data on the Fish Gear and Voucher/Tissue Sample Information Form (Figure 5.6-1).

Table 5.6-1. Equipment and supplies—fish tissue collection at non-wadeable sites

For collecting fish composite sample	<ul style="list-style-type: none"> ▪ Electrofishing equipment (including variable voltage pulsator unit, wiring cables, generator, electrodes, dip nets, protective gloves, boots, and necessary safety equipment) ▪ Scientific collection permit ▪ Sampling vessel (including boat, motor, trailer, oars, gas, and all required safety equipment) 	<ul style="list-style-type: none"> ▪ Coast Guard-approved personal floatation devices ▪ Maps of target sites & access routes ▪ Global Positioning System (GPS) unit ▪ Livewell and/or buckets ▪ Measuring board (millimeter scale) ▪ Clean nitrile gloves
For storing and preserving fish composite sample	<ul style="list-style-type: none"> ▪ Aluminum foil (solvent-rinsed and baked) ▪ Heavy-duty food grade polyethylene tubing ▪ Large plastic (composite) bags 	<ul style="list-style-type: none"> ▪ Knife or scissors ▪ Dry Ice ▪ Plastic cable ties ▪ Coolers
For documenting the fish composite sample	<ul style="list-style-type: none"> ▪ Fish Collection Forms ▪ Clipboard 	<ul style="list-style-type: none"> ▪ Sample Identification Labels ▪ #2 pencils ▪ Fine tipped indelible markers
For shipping the fish composite samples	<ul style="list-style-type: none"> ▪ Preaddressed FedEx airbill ▪ Coolers 	<ul style="list-style-type: none"> ▪ Tracking Form ▪ Chain-of-custody labels ▪ Packing/strapping tape

Reviewed by JD
(Initials):

FISH GEAR AND VOUCHER/TISSUE SAMPLE INFORMATION - WADEABLE/BOATABLE

SITE ID: FW08XX000 Urban DATE: 0710112008 PAGE: 1 of 1

Not Fished - No Permit Not Fished - Equipment Failure Not Fished - Other (Explain Below)
 Not Fished - Permit Restriction Not Fished - Site Conditions Prohibit Sampling Fished - None Collected

Fished All 10 Subreaches Fished 5-9 Subreaches Fished 1-4 Subreaches

COMMENT: TARGET FISHING LENGTH = 500 m (6 SUBREACHES REQUIRED)

Water Visibility: Good Poor Water Temp (°C): 22 Cond (uS): 1250 More than 1 method used to collect fish?

ELECTROFISH: BOAT RAFT BP BANK/TOW No. of Netters: 1 Anodes: Number 2 Diameters 0.12 in. cm Wave Form: AC DC Pulsed DC

Volts: (50-1000) 700 Watts: likely 400 (bp), 2500 or 5000 (boat/raft) 2500 Pulse Rate: pps or Hz 60 Amps: (may not be provided for bp) 2 Pulse Width (ms) _____

Total Shock (button) Time (s) 5000 Total Fishing Time (min) 240 Reach Length Sampled (m) 502 Avg. Subreach Length (m) 84 Electrofish Flag: F1

VOUCHER SAMPLE INFORMATION NO VOUCHERS PRESERVED

Sample ID	Sample Category - Preserved	Comments
<u>939306</u>	<input checked="" type="radio"/> P <input type="radio"/> D	
	<input type="radio"/> P <input type="radio"/> D	

FISH TISSUE SAMPLES NO SAMPLE COLLECTED

SAMPLE ID	Common Name	Total Length(mm)	Subreach	Frozen	Comments
<u>.1</u>	<u>LARGEMOUTH BASS</u>	<u>320</u>	<u>A</u>	<input checked="" type="radio"/>	<u>Primary</u>
<u>.2</u>	<u>LARGEMOUTH BASS</u>	<u>340</u>	<u>B</u>	<input checked="" type="radio"/>	<u>Primary</u>
<u>.3</u>	<u>LARGEMOUTH BASS</u>	<u>300</u>	<u>B</u>	<input checked="" type="radio"/>	<u>Primary</u>
<u>.4</u>	<u>LARGEMOUTH BASS</u>	<u>320</u>	<u>D</u>	<input checked="" type="radio"/>	<u>Primary</u>
<u>.5</u>	<u>LARGEMOUTH BASS</u>	<u>330</u>	<u>E</u>	<input checked="" type="radio"/>	<u>Primary</u>

FLAG: F1 COMMENT: PULSE WIDTH NOT AVAILABLE FOR THIS UNIT

Flag codes: K = No measurement made, U = Suspect measurement, F1,F2, etc. = flags assigned by each field crew. Explain all flags in comments. LENGTH* - Enter single fish as minimum.
*Sample Category P = Primary D = Duplicate

04/21/2008 NRSA - Boatable - Fish/Tissue

Figure 5.6-1. Fish Gear and Voucher/Tissue Sample Information

5.6.3 Sampling Procedure

The fish tissue indicator will be collected using the same gear and procedures used to collect the fish community assemblage. Collection of individuals for fish tissue occurs in the sample reach during the fish community assemblage sampling. If the five fish are not collected during the community sampling, sample for up to one additional hour. If the sample is still not collected, call the Logistics Coordinator at the end of the day and record on the field collection form. If the target species are unavailable, the fisheries biologist will select an alternative species (i.e., a species that is commonly consumed in the study area, with specimens of harvestable or consumable size, and in sufficient numbers to yield a composite) to obtain a fish composite sample from the species that are available. Recommended target species, listed in order of preference, are given in Table 5.6-2.

Table 5.6-2. Recommended target species for fish tissue collection (in order of preference) at non-wadeable sites

	Family name	Common name	Scientific name	Length Guideline (Estimated Minimum)
Predator/Gamefish Species (in order of preference)	Centrarchidae	Largemouth bass	<i>Micropterus salmoides</i>	~280 mm
		Smallmouth bass	<i>Micropterus dolomieu</i>	~300 mm
		Black crappie	<i>Pomoxis nigromaculatus</i>	~330 mm
		White crappie	<i>Pomoxis annularis</i>	~330 mm
	Ictaluridae	Channel Catfish	<i>Ictalurus punctatus</i>	~300 mm
		Blue Catfish	<i>Ictalurus furcatus</i>	~300 mm
		Flathead Catfish	<i>Pylodictis olivaris</i>	~350 mm
	Percidae	Walleye/sauger	<i>Sander vitreus /S. canadensis</i>	~380 mm
		Yellow perch	<i>Perca flavescens</i>	~330 mm
	Percichthyidae	White bass	<i>Morone chrysops</i>	~330 mm
	Esocidae	Northern pike	<i>Esox lucius</i>	~430 mm
	Salmonidae	Brown trout	<i>Salmo trutta</i>	~300 mm
		Rainbow trout	<i>Oncorhynchus mykiss</i>	~300 mm
Brook trout		<i>Salvelinus fontinalis</i>	~330 mm	

The procedures for collecting and processing fish composite samples are presented in Table 5.6-3.

Table 5.6-3. Sampling procedure for fish composite samples at non-wadeable sites

1. Put on clean nitrile gloves before handling the fish. Do not handle any food, drink, sunscreen, or insect repellent until after the composite sample has been collected, measured, and wrapped.
2. Rinse potential target species/individuals in ambient water to remove any foreign material from the external surface and place in clean holding containers (e.g., livewells, buckets). Return non-target fishes or small specimens to the river or stream.
3. Retain one predator species composite from each site. The composite must consist of 5 fish of

adequate size to provide a total of 500 grams of edible tissue for analysis (refer to Table 5.6-2 for minimum species length guidelines). Select fish for each composite based on the following criteria:

- all are of the same species,
- all satisfy legal requirements of harvestable size (or weight) for the sampled river, or at least be of consumable size if no legal harvest requirements are in effect,
- all are of similar size, so that the smallest individual in a composite is no less than 75% of the total length of the largest individual, and
- all are collected at the same time, i.e., collected as close to the same time as possible, but no more than one week apart (Note: Individual fish may have to be frozen until all fish to be included in the composite are available for delivery to the designated laboratory).

Accurate taxonomic identification is essential in assuring and defining the organisms that have been composited and submitted for analysis. Under no circumstances should individuals from different species be used in a single composite sample.

4. Measure each individual fish to determine total body length. Measure total length of each specimen in millimeters, from the anterior-most part of the fish to the tip of the longest caudal fin ray (when the lobes of the caudal fin are depressed dorsoventrally).
5. Record sample number, species retained, specimen length, site ID, and sampling date on the Fish Collection Form (Figure 5.5-1) in black ink. Mark site type ("Urban" or "Non-urban") next to the site identification number at the top left of the fish form, and write primary or duplicate in the comment section. Make sure the sample identification numbers recorded on the collection form match those on the sample labels.
6. Remove each fish retained for analysis from the clean holding container(s) (e.g., livewell) using clean nitrile gloves. Dispatch each fish using a clean wooden bat (or equivalent wooden device).
7. Wrap each fish in extra heavy-duty aluminum foil with the dull side in (foil provided by EPA as solvent-rinsed, oven-baked sheets).
8. Prepare a Sample Identification Label for each sample, ensuring that the label information matches the information recorded on the Fish Collection Form. **Be sure to include fish species and specimen length on each label.**
9. Cut a length of food grade tubing (provided by EPA) that is long enough to contain each individual fish and to allow extra length on each end to secure with cable ties. Place each foil-wrapped specimen into the appropriate length of tubing. Seal each end of the tubing with a plastic cable tie. Attach the fish sample label to the outside of the food-grade tubing with clear tape and secure the label by taping around the entire fish (so that tape sticks to tape).
10. Place all the wrapped fish in the composite from each site in a large plastic bag and seal with another cable tie.
11. After each sample is packaged, place it immediately on dry ice for shipment. If samples will be carried back to a laboratory or other facility to be frozen before shipment, wet ice can be used to transport wrapped and bagged fish samples in the coolers to a laboratory or other interim facility.
12. If possible, keep all (five) specimens designated for a particular composite in the same shipping container (ice chest) for transport.
13. Samples may be stored temporarily on dry ice (replenishing the dry ice daily). You have the option, depending on site logistics, of:
 - shipping the samples packed on dry ice in sufficient quantities to keep samples frozen for up to 48 hours (50 pounds are recommended), via priority overnight delivery service (e.g., Federal Express), so that they arrive at the sample preparation laboratory within less than 24 hours from the time of sample collection, or

- freezing the samples within 24 hours of collection at $\leq -20^{\circ}\text{C}$, and storing the frozen samples until shipment within 2 weeks of sample collection (frozen samples will subsequently be packed on dry ice and shipped to the sample preparation laboratory via priority overnight delivery service).

14. Ship fish tissue samples from urban sites to the EPA NERL lab in Cincinnati, OH and from non-urban sites to the GLEC lab in Traverse City, MI on Monday through Thursday.

5.7 Fecal Indicator (Enterococci)

5.7.1 Summary of Method

Collect a fecal indicator sample at the last transect (Transect K) after all other sampling is completed. Samples must be filtered and the filters must be frozen within 6 hours of collection. Use a pre-sterilized, 250 ml bottle and collect the sample approximately 1 m off the bank at about 0.3 meter (12 inches) below the water surface. Following collection, place the sample in a cooler, chill for at least 15 minutes, and maintain on ice prior to filtration of four 50 mL volumes. (Samples must be filtered and frozen on dry ice within 6 hours of collection). In addition to collecting the sample, look for signs of disturbance throughout the reach that would contribute to the presence of fecal contamination to the waterbody. Record these disturbances on the Site Assessment Form (Figure 7-2).

5.7.2 Equipment and Supplies

Table 5.7-1 provides the equipment and supplies needed to collect the fecal indicator sample. Record the sample data on the Sample Collection Form, Side 2 (Figure 5.1-4).

Table 5.7-1. Equipment and supplies list for fecal indicator sampling at non-wadeable sites

For collecting samples	<ul style="list-style-type: none"> ▪ nitrile gloves ▪ pre-sterilized, 250 ml sample bottle 	<ul style="list-style-type: none"> ▪ sodium thiosulfate tablet ▪ Wet ice ▪ cooler
For recording measurements	<ul style="list-style-type: none"> ▪ Sample Collection Form ▪ Fecal Indicator sample labels (4 vial labels and 1 bag label) ▪ Pencils (for data forms) 	<ul style="list-style-type: none"> ▪ Fine tipped indelible markers (for labels) ▪ Clear tape strips

5.7.3 Sampling Procedure

The procedure for collecting the fecal indicator sample is presented in table 5.7-2.

Table 5.7-2. Procedure for fecal indicator (Enterococci) sample collection at non-wadeable sites

1. Put on nitrile gloves.
2. Select a sampling location at transect K that is approximately 1 m from the bank and approximately 0.3m deep. Approach the sampling location slowly from downstream or downwind.
3. Lower the un-capped, inverted 250 ml sample bottle to a depth of 1 foot below the water surface, avoiding surface scum, vegetation, and substrates. Point the mouth of the container away from the body or boat. Right the bottle and raise it through the water column, allowing bottle to fill completely.

If the depth does not reach 0.3m along the transect at 1 m from the bank, take the sample and flag it on the field form.

4. After removing the container from the water, discard a small portion of the sample to allow for proper mixing before analyses.
5. Add the sodium thiosulfate tablet, cap, and shake bottle 25 times.
6. Store the sample in a cooler on ice to chill (not freeze). Chill for at least 15 minutes and do not hold samples longer than 6 hours before filtration and freezing.