BASIC BIOASSESSMENT AND PHYSICAL HABITAT MONITORING

CLEAN WATER TEAM

Water Boards

SWAMP
Surface Water
Ambient Monitoring
Program
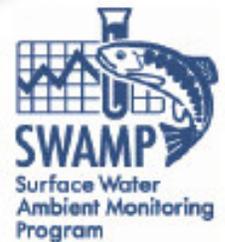
REACH DELINEATION/ WATER QUALITY

Reach Layout/ General Documentation

The systematic positioning of transects is essential to collecting representative RWB samples and to the objective quantification of physical habitat measures. The standard sampling layout consists of a 150 m long reach (length measured along the bank) divided into 11 equidistant transects that are arranged perpendicular to the direction of flow (Figure 1, Figure 2). Ten additional transects (designated "inter-transects" here) located between the main transects give a total of 21 transects per reach. Main transects are designated A through K while inter-transects are designated by their nearest upstream and downstream transects (e.g., AB, BC, etc.). In extreme circumstances, reach length can be shorter than 150 m (e.g., if upstream and downstream barriers preclude a 150 m reach), but this should be avoided when possible. If the actual reach length is other than 150 m or 250 m this should be noted and explained on the field forms.

SWAMP
Surface Water
Ambient Monitoring
Program
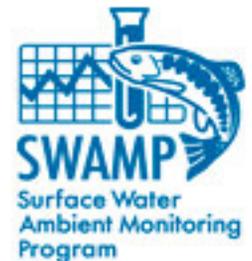
Layout Steps 1 and 2

Step 1. Upon arrival at the sampling site, fill out the reach documentation section of the field forms (site and project Identification, stream and watershed name, crew members and date/time). If known at the time of sampling, record the Site Code following SWAMP site code formats. Determine the geographic coordinates of the **downstream end** of the reach **(preferably in decimal degrees to at least four decimal places**) with a GPS receiver and record the datum setting of the unit (**preferably NAD 83/ WGS84).**

Step 2. Once a site has been identified, make an initial survey of the reach from the stream banks (being sure to not disturb the instream habitat). If TRC samples will be collected, identify all riffle habitats suitable for sampling (see Section IIIa for suitable habitat types) and note their positions so that a subset can be identified for sampling.
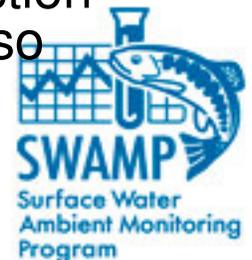
Layout Step 3- Determining Reach Length

Step 3. Determine if the average wetted width is greater or less than 10 m. If average wetted width is less than 10 m use a 150 m reach length If average wetted width > 10 m then use a 250 m reach length.

SWAMP
Surface Water
Ambient Monitoring
Program
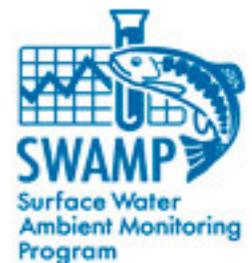
Layout Step 4

Step 4. Starting at one end of the reach, establish the position of the 11 main transects (labeled A-K from downstream to upstream) by measuring 15 meters (*25 m for streams > 10 m wetted width*) along the bank from the previous transect. Since the data collection will start at the downstream end, it's often easiest to establish transects starting from the upstream end. For easy setup and breakdown **mark the main transects with** easily removable markers (e.g., large washers tied with strips of flagging, surveyor's flags).

Layout Review

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

Left Bank
Right Bank

Flow Direction
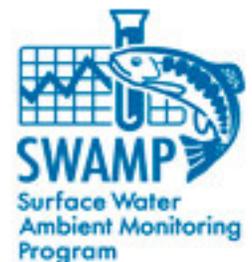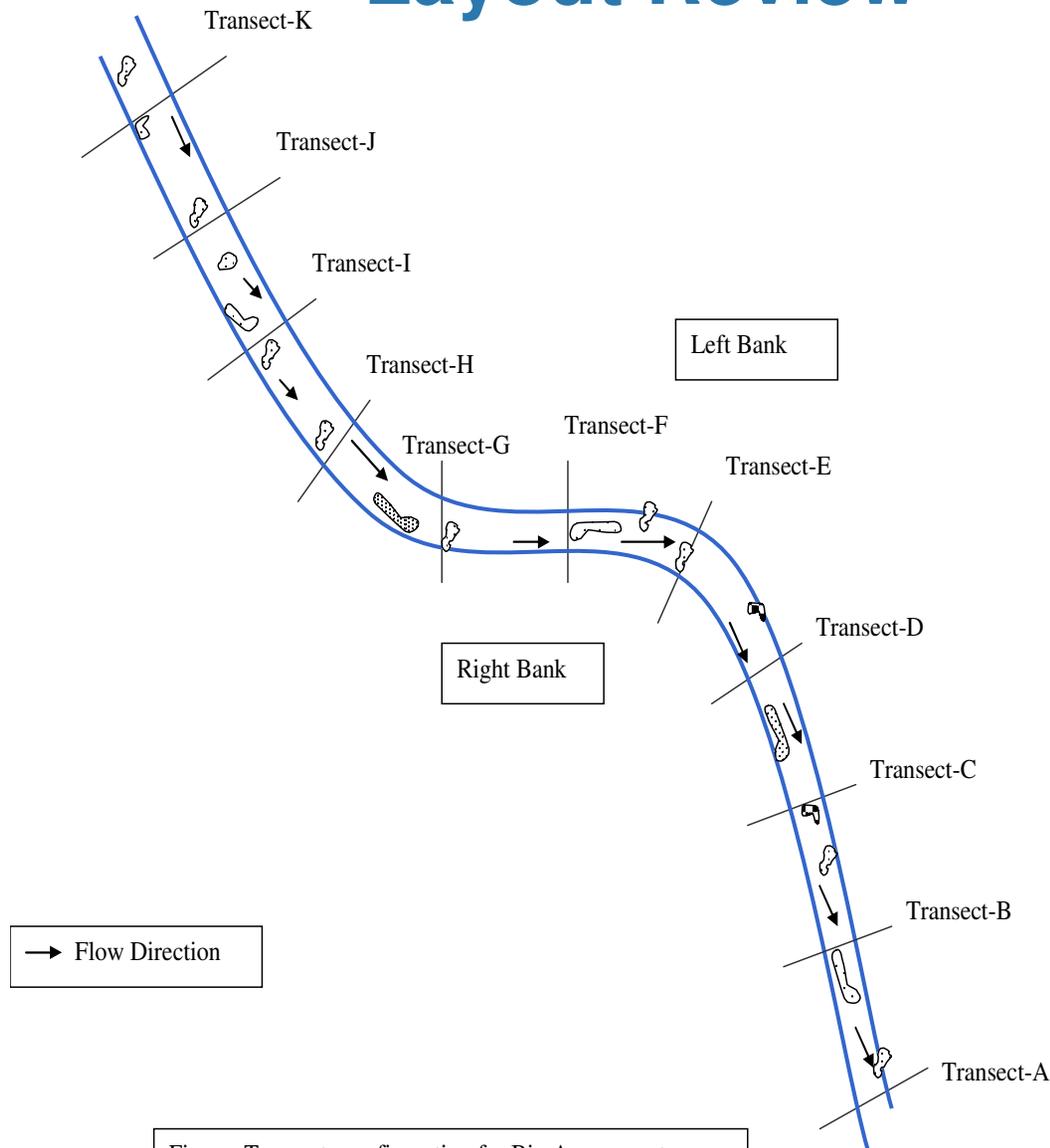
Figure: Transects configuration for Bio Assessment

Figure 1. Reach layout geometry for physical habitat and biological sampling showing positions of 11 main transects (A – K) The area highlighted in the figure is expanded in Figure 2. Note: reach length = 150 m for streams   10 m average wetted width and reach length = 250 m for streams > 10 m average wetted width.

SWAMP
Surface Water
Ambient Monitoring
Program
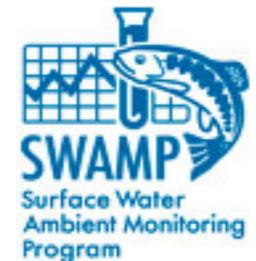
Layout Step 5- Ambient Water Chemistry

Step 5. Measure and record common ambient water chemistry measurements (pH, DO, specific conductance, alkalinity, water temperature) at the downstream end of the reach (near same location as the GPS coordinates were taken). These are typically taken with a handheld water quality meter (e.g., YSI, Hydrolab), but field test kits (e.g., Hach) can provide acceptable information if they are properly calibrated. For appropriate calibration methods and calibration frequency, consult the current SWAMP QAMP (Appendix F), or follow manufacturer's guidelines.

Calibration Chamber

Probe

Figure 2
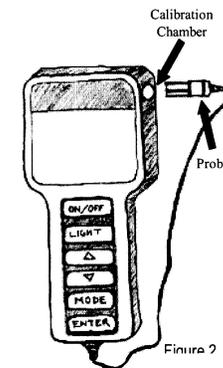
Layout Step 6- Initial Photographs

Step 6. Take a minimum of four (4) photographs of the reach at transect A facing up stream and facing downstream. Digital photographs should be used when possible. Record the image numbers on the front page of the field form.

Layout Steps 7 and 8

Step 7. Record the dominant land use/ land cover in the area surrounding the reach (evaluate land cover within 50 meters of either side of the stream reach).

Step 8. Record evidence of recent flooding, fire or other disturbances that might influence bioassessment samples at the bottom of the form. Especially note if flow conditions have been affected by recent rainfall, which can cause significant under-sampling of BMI diversity (see note on following page). If you are unaware of recent fire or rainfall events, select the "no" option on the forms.

SWAMP
Surface Water
Ambient Monitoring
Program
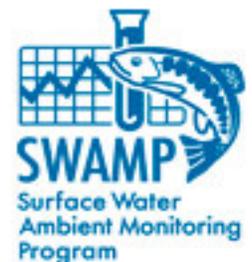
Transect Description
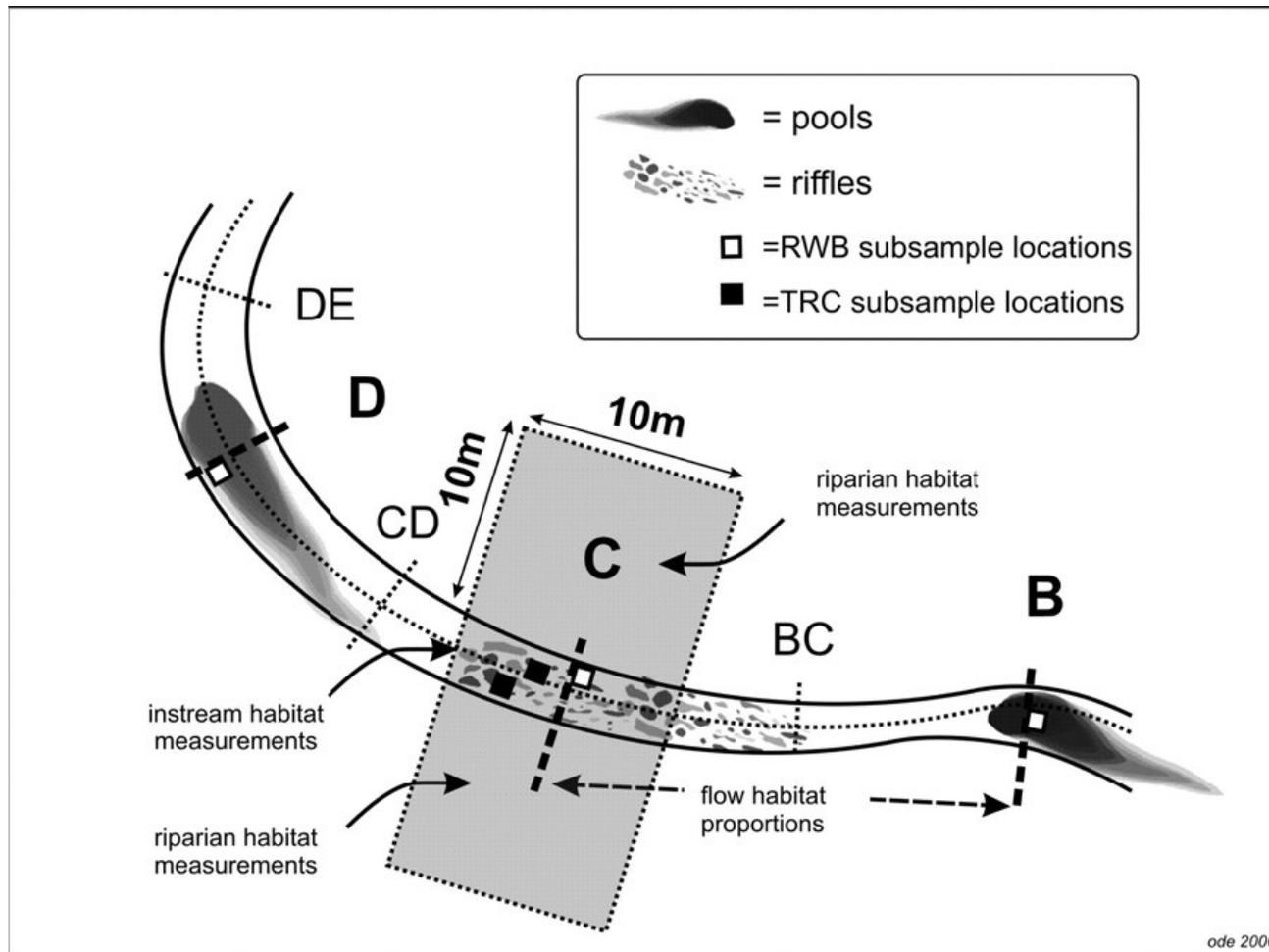
Reachwide Benthos (Multihabitat) Procedure (RWB)

The RWB procedure employs an objective method for selecting subsampling locations that is built upon the 11 transects used for physical habitat measurements. The RWB procedure can be used to sample any Wadeable stream reach since it does not target specific habitats. Because sampling locations are defined by the transect layout, the position of individual sub-samples may fall in a variety of erosional or depositional habitats.

Note: Sampling locations should be displaced one meter downstream of the transects to avoid disturbing substrates for subsequent physical habitat assessments.
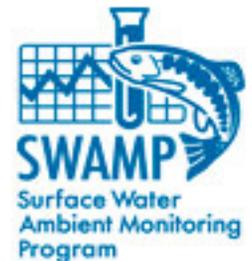
RWB Step 1

Step1. The sampling position within each transect is alternated between the **left, center and right** positions along a transect (**25%, 50% and 75% of wetted width**, respectively) as you move from upstream transect to transect. Starting with the downstream transect (Transect A), identify a point that is 25% of the stream width from the right bank (note that the right bank will be on your left as you face upstream). If you cannot collect a sample at the designated point because of deep water obstacles or unsafe conditions, relocate the point as close as possible to the designated position.

Note: The first transect's benthos sample is taken at 25% from the left bank. If a replicate sample is to be obtained, the replicates sample is taken at 50% from the left bank.
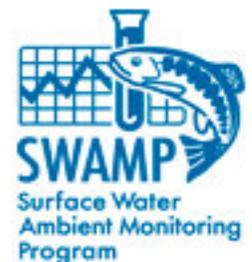
RWB Step 2

Step 2. Place a 500 μ D-net net in the water so the mouth of the net is perpendicular to and facing into the flow of the water. If there is sufficient current in the area at the sampling point to fully extend the net, use the normal D-net collection technique to collect the sub-sample (TRC-Step 3 through TRC-Step 6 above). If flow volume and velocity is not sufficient to use the normal collection technique, use the sampling procedure for "slack water" habitats (RWB -Step 3 through RWB -Step 7 below).

SWAMP
Surface Water
Ambient Monitoring
Program

RWB Step 3

Step 3. Visually define a 1 ft (0.09 m) quadrat that is one net width wide and one net width long at the sampling point.
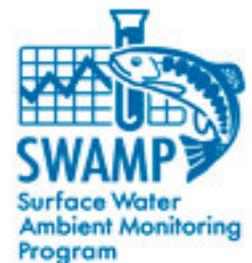
RWB Step 4

Step 4. Working from the upstream edge of the sampling plot backward, check the quadrat for heavy organisms such as mussels and snails. Remove these organisms from the substrate by hand and place them into the net. Carefully pick up and rub stones directly in front of the net to remove attached animals. Remove and clean all of the rocks larger than a golf ball within your sampling quadrat such that all the organisms attached to them are washed downstream into your net. Set these rocks outside your sampling quadrat after you have cleaned them. Large rocks that are less than halfway into the sampling area should be pushed aside. If the substrate is consolidated or comprised of large, heavy rocks, use your feet to kick and dislodge the substrate to displace BMIs into the net. If you cannot remove a rock from the stream bottom, rub it (concentrating on cracks or indentations) thereby loosening any attached insects.

SWAMP
Surface Water
Ambient Monitoring
Program
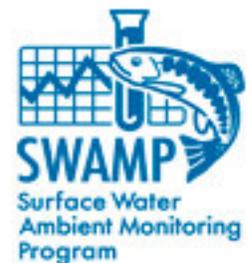
RWB Step 5

RWB -Step 5. Vigorously kick the remaining finer substrate within the quadrat with your feet while dragging the net repeatedly through the disturbed area just above the bottom. Keep moving the net all the time so that the organisms trapped in the net will not escape.
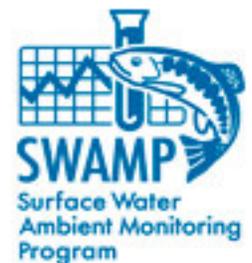
RWB Steps 6 and 7

Step 6. After 30 seconds, remove the net from the water with a quick upstream motion to wash the organisms to the bottom of the net.

Step 7. PROCEED to Filling and Labeling BMI Sample Jars

Latitude: N_____W_____   circle one:
                                                    NAD27
Longitude: N_____W_____   NAD83

Stream Name: _____

Site Name/ Code: _____

County: _____ Jar #: _____ of _____

Date: _____ Time: _____

Collector: _____ BMI Method: circle one:
                                         TRC RWB

SWAMP
Surface Water
Ambient Monitoring
Program

MAIN CROSS-SECTIONAL TRANSECT MEASURES

Physical Measures

The majority of physical habitat measurements in this protocol are made relative to the main cross-sectional transects (Figure 5). All the measures taken relative to each transects are recorded on forms specific to that transect. Start with the downstream transect (Transect A) and repeat steps six through 15 for all 11 main transects.
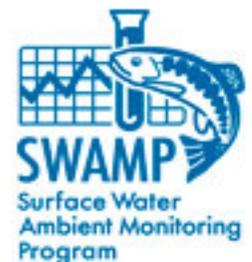
Transect Dimensions- Wetted Width

Transect Dimensions: Wetted Width

Wetted Width~ The wetted channel is the zone that is inundated with water and the wetted width is the distance between the sides of the channel at the point where substrates are no longer surrounded by surface water. Measure the wetted stream width and record this in the box at the top of the transect form.
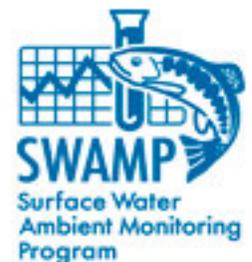
Transect Dimensions- Bankfull Dimensions
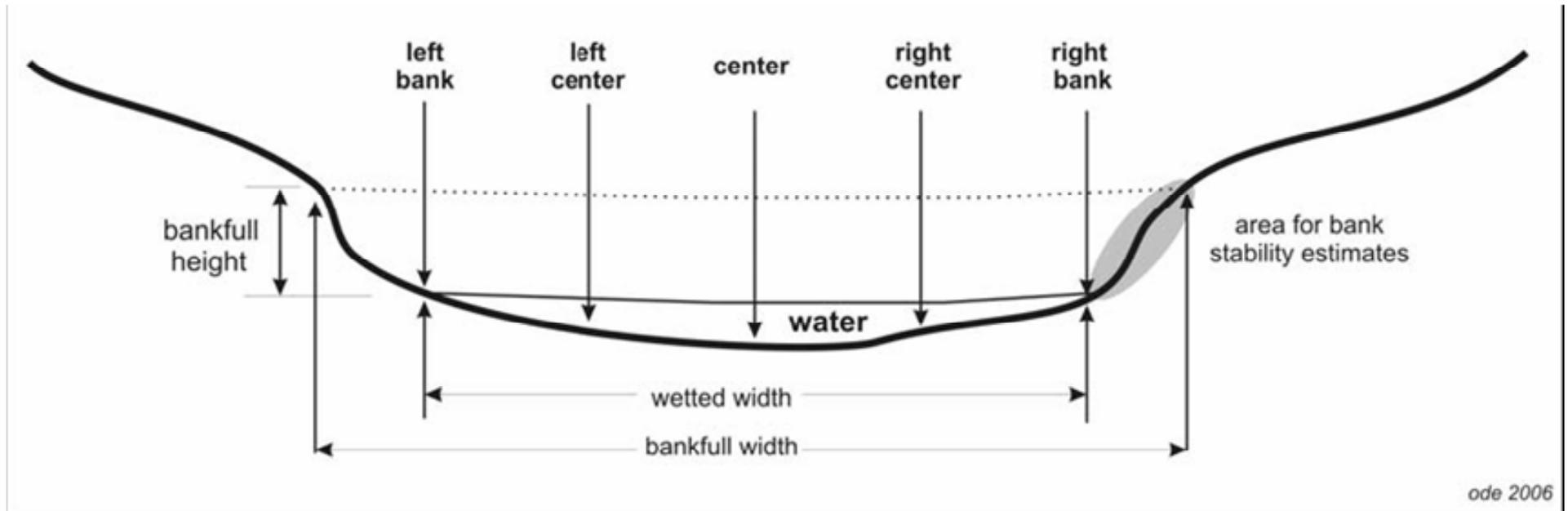
Bankfull Width and Depth~ The bankfull channel is the zone of maximum water inundation in a normal flow year (one to two year flood events). Since most channel formation processes are believed to act when flows are within this zone (Mount 1995), bankfull dimensions provide a valuable indication of relative size of the waterbody.
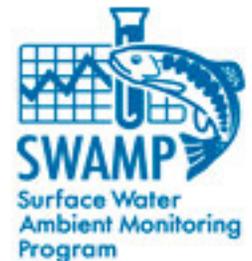
Bankfull Step 1

Step 1. Scout along the stream margins to identify the location of the bankfull margins on either bank by looking for evidence of annual or semi-annual flood events.

Examples of useful evidence includes topographic, vegetative or geologic cues (changes in bank slope, changes from annual to perennial vegetation, changes in the size distribution of surface sediments). While the position of drift material caught in vegetation may be a helpful aid, this can lead to very misleading measurements.

SWAMP
Surface Water
Ambient Monitoring
Program

Bankfull Steps 2 and 3

Alder

Young salmonberry shrub < 6 ft. high

Fir 2nd terrace

Fern

Floodplain

flood channel

soil

Bank shape

Sand

Gravel

Bankfull is probably here

Slumping hillslope — difficult ID on this bank

Best Indicators on this bank
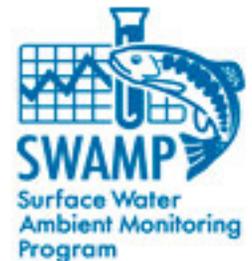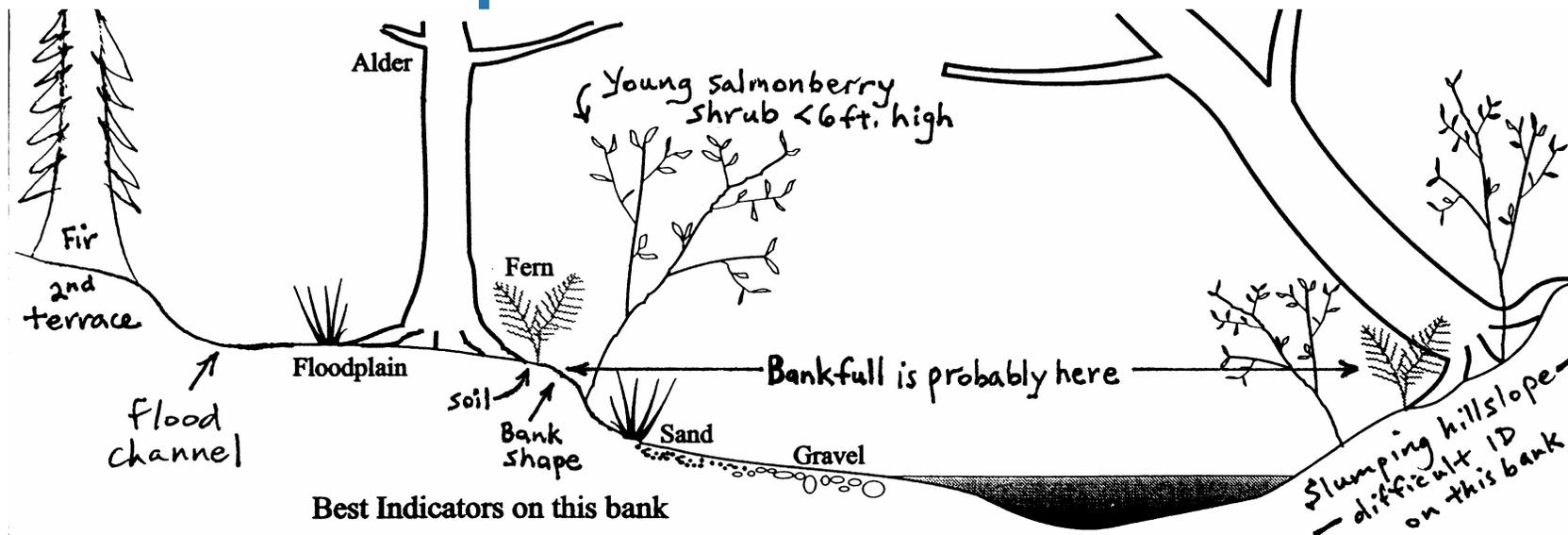
Step 2. Stretch a tape from bank to bank at the bankfull position. Measure the width of the bankfull channel from bank to bank at bankfull height and perpendicular to the direction of stream flow.

Step 3. Measure bankfull height (the vertical distance between the water height of the water and the height of the bank, Figure 5) and record.

SWAMP
Surface Water
Ambient Monitoring
Program
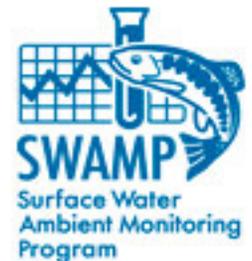
Canopy Cover

This method uses the Strickler (1959) modification of a convex spherical densiometer to correct for over-estimation of canopy density that occurs with unmodified readings. Read the densiometer by counting the number of line intersections that are obscured by overhanging vegetation (see Figure 7). Taping off the lower left and right portions of the mirror emphasizes overhead vegetation over foreground vegetation (the main source of bias in canopy density measurements). All densiometer readings should be taken with the bubble leveled and 0.3 m (1ft) above the water surface.

SWAMP
Surface Water
Ambient Monitoring
Program
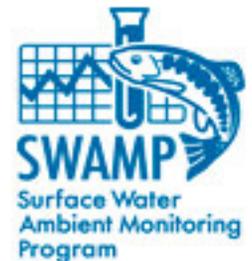
Canopy Cover Step 1
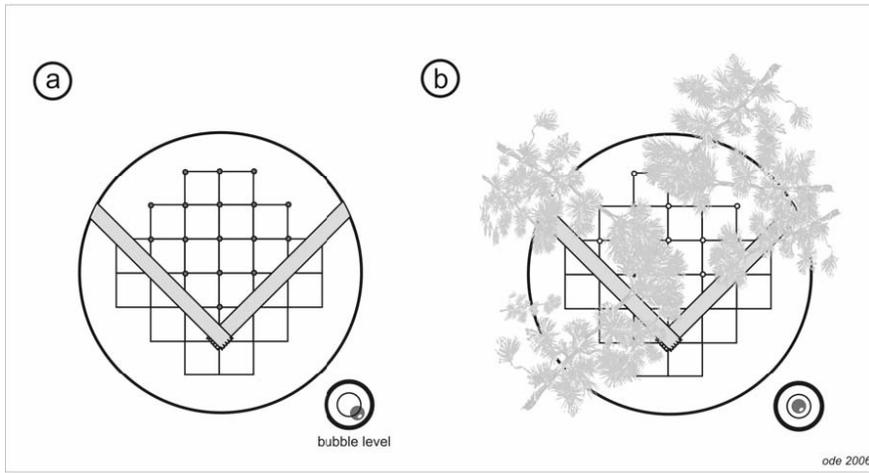
Step 1. Using a modified convex spherical densitometer, take and record four 17 point readings all taken from the center of each transect: a) facing upstream, b) facing downstream, c) facing the left bank, d) facing the right bank.

SWAMP
Surface Water
Ambient Monitoring
Program
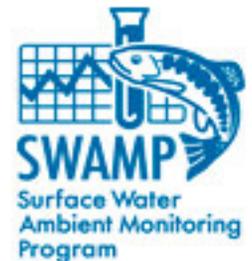
Bank Stability

The vulnerability of stream banks to erosion is often of interest in bioassessments because of its direct relationship with sedimentation.

SWAMP
Surface Water
Ambient Monitoring
Program

Bank Stability Step 1

Step 1. For each transect, record a visual assessment of bank vulnerability in the region between the wetted width and bankfull width of the stream margins and between the upstream and downstream inter-transects.

Choose one of three vulnerability states:
- **Eroded** (evidence of mass wasting)
- **Vulnerable** (obvious signs of bank erosion or unprotected banks),
- **Stable** (no obvious signs of bank erosion or unprotected banks),

Flow Habitats

Side view

(A) *Run*   (B) *Riffle*   (C) *Pool*

(A) *Run*   (B) *Riffle*   (C) *Pool*

Top view
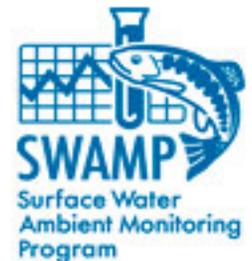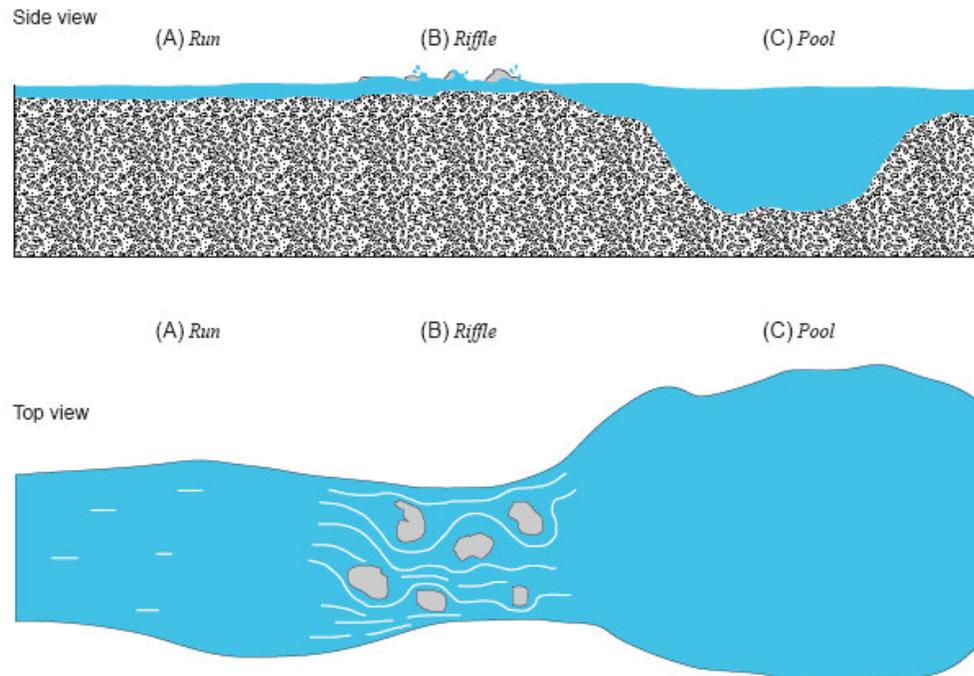
Figure 4. Diagram of the three main geomorphic channel units. (A) Run—A slow moving, relatively shallow body of water with moderately low velocities and little or no surface turbulence; (B) Riffle—A part of the stream where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation; (C) Pool—A part of the stream with reduced velocity, commonly with deeper water than surrounding areas (modified from Bisson and others, 1982).

Because many benthic macroinvertebrates prefer specific flow and substrate microhabitats, the proportional representation of these habitats in a reach is often of interest to bioassessments. There are many different ways to quantify the proportions of different flow habitats (for example, see text on EMAP's "thalweg profile" below). Like the riparian and instream measures listed above, this is a semi-quantitative measure consisting of 10 transect-based visual estimates.

SWAMP
Surface Water
Ambient Monitoring
Program

Flow Habitats Step 1

Step 1. At each transect, identify the proportion of 6 different habitat types in the region between the upstream inter-transect and downstream inter-transect. Record percentages to the nearest 5%; the total percentage of surface area for each section must total 100%. At transects A and K, include area immediate upstream and downstream of the reach in the habitat estimates.

Referencing the CWT Fish Habitat document may be useful.

Flow Habitat Type	Description
Cascades	Short, high gradient drop in stream bed elevation often accompanied by boulders and considerable turbulence
Falls	High gradient drop in elevation of the stream bed associated with an abrupt change in the bedrock
Rapids	Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles
Riffles	Shallow sections where the water flows over coarse stream bed particles that create mild to moderate surface turbulence; (< 0.5 m deep, > 0.3 m/s)
Step-Runs	A series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope
Runs	Long, relatively straight, low-gradient sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool; (> 0.5 m deep, > 0.3 m/s)
Glides	A section of stream with little or no turbulence, but faster velocity than pools; (< 0.5 m deep, < 0.3 m/s)
Pools	A reach of stream that is characterized by deep, low-velocity water and a smooth surface ; (> 0.5 m deep, < 0.3 m/s)

SWAMP
Surface Water
Ambient Monitoring
Program
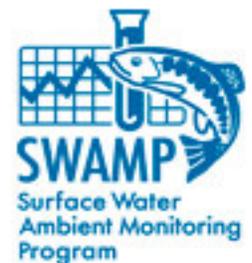
Discharge

Stream discharge is the volume of water that moves past a point in a given amount of time and is generally reported as either cubic meters per second (cms) or cubic feet per second (cfs). Because discharge is directly related to water volume, discharge affects the concentration of nutrients, fine sediments and pollutants, and discharge measurements are critical for understanding impacts of disturbances such as impoundments, water withdrawals and water augmentation. Discharge is also closely related to many habitat characteristics including temperature regimes, physical habitat diversity and habitat connectivity. As a direct result of these relationships, stream discharge is often also a strong predictor of biotic community composition. Since stream volume can vary significantly on many different temporal scales (diurnal, seasonal, inter-annually), it can also be very useful for understanding variation in stream condition.

SWAMP
Surface Water
Ambient Monitoring
Program
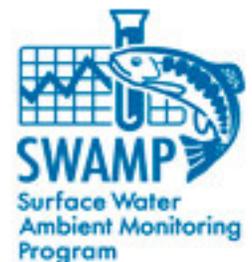
Neutrally Buoyant Object Method (NBO):

If streams are too shallow to use a flow velocity meter, the neutrally buoyant object method should be used to measure flow velocity. However, since this method is less precise than the flow velocity meter it should only be used if absolutely necessary. A neutrally buoyant object (one whose density allows it to just balance between sinking and floating) will act as if it were nearly weightless, thus it's movement will approximate that of the water it floats in better than a light object. To estimate the flow velocity through a reach, three transects are used to measure the cross-sectional areas within the test section sub-reach and three flow velocity estimates are used to measure average velocity through the test reach. To improve precision in velocity measurements, the reach segment should be long enough for the float time to last at least 10-15 seconds.

SWAMP
Surface Water
Ambient Monitoring
Program
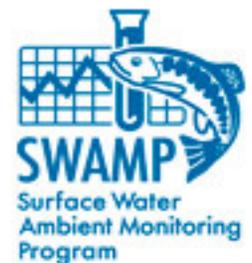
NBO Step 1

NBO-Step 1. The position of the discharge sub-reach is not as critical as it is for the velocity-area method, but the same criteria for selection of a discharge reach apply to the neutrally buoyant object method. Identify a section that has relatively uniform flow and a uniform cross sectional shape.
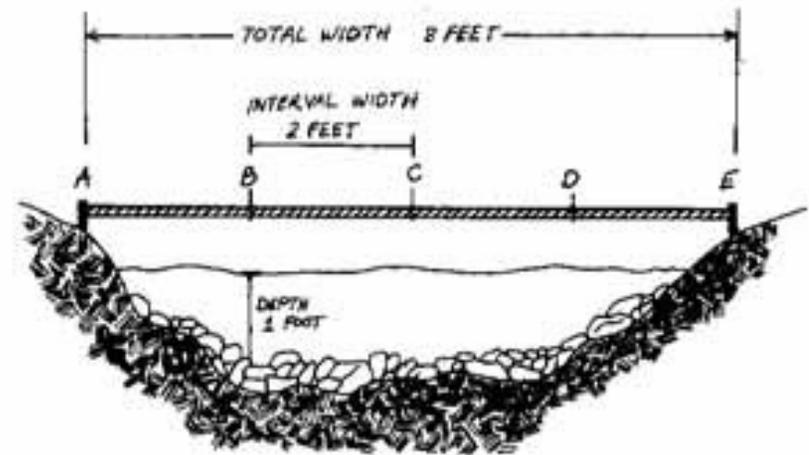
NBO Step 2 and 3
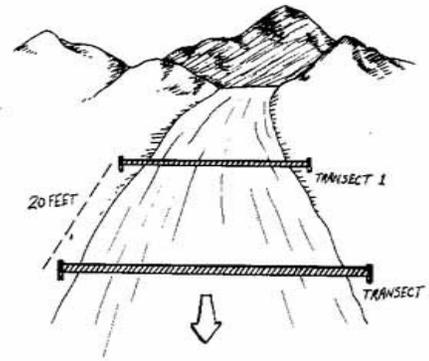
NBO-Step 2. The cross sectional area is estimated in a manner that is similar but less precise than that used in the velocity area method. Measure the cross sectional area in one to three places in the section designated for the discharge measurement (three evenly spaced cross sections are preferred, but one may be used if the cross section through the reach is very uniform). Record the width once for each cross section and measure depth at five equally-spaced positions along each transect.

NBO-Step 3. Record the length of the discharge reach.
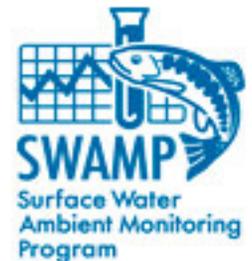
NBO Step 4
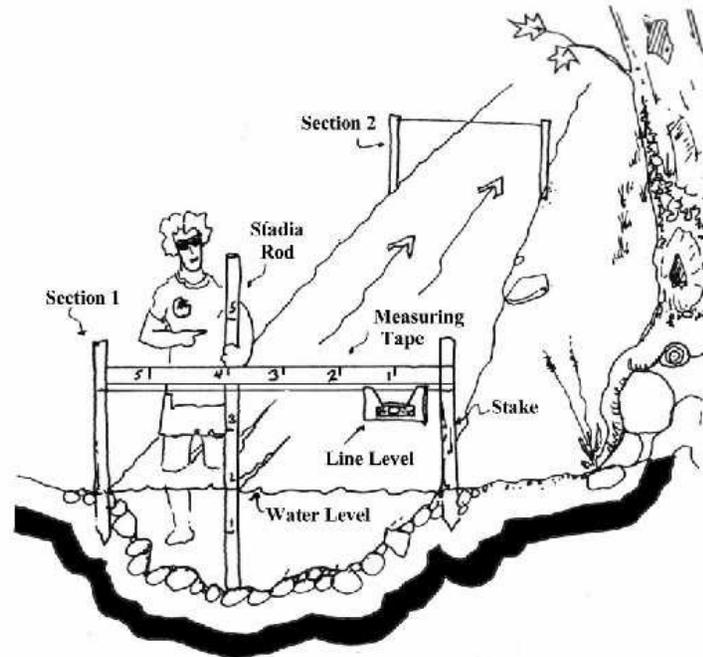
NBO-Step 4. Place a neutrally buoyant object (e.g., orange, rubber ball, heavy piece of wood, etc.) in the water upstream of the discharge reach and record the length of time in seconds that it takes for the object to pass between the upstream and downstream boundaries of the reach. Repeat this timed float three times.

RBP Visual Assessment Scores

The EPA's Rapid Bioassessment Procedures (Barbour et al. 1999) include a set of 10 visual criteria for assessing instream and riparian habitat. The RBP has been used in the CSBP since its first edition (1995) and thus, this information is often valuable for comparison to legacy datasets. The criteria also have a useful didactic role since they help force the user to quantify key features of the physical environment where bioassessment samples are collected.

Note: The CWT has a separate document/presentation on this procedure.

SWAMP
Surface Water
Ambient Monitoring
Program
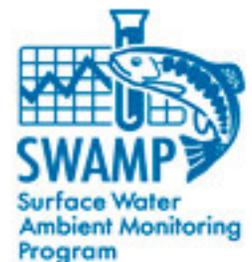
RBP Visual Assessment Field Data Sheets

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: _____ DATE/ TIME: _____
COMPANY/ AGENCY: _____ SAMPLE ID NUMBER: _____
SITE DESCRIPTION: _____

Circle the appropriate score for all 20 habitat parameters. Record the total score on the front page of the CBW.

| HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
1. Epifaunal Substrate/ Available Cover	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/ Depth Regimes (deep<0.5 m, slow<0.3 m/s)	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Parameters to be evaluated within the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	SUBOPTIMAL	MARGINAL	POOR
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Parameters to be evaluated in an area longer than the sampling reach

SWAMP
Surface Water Ambient Monitoring Program
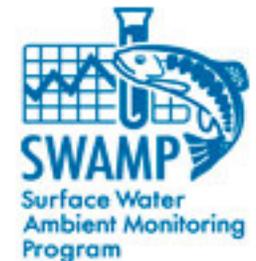
Reach Slope

Reach slope should be recorded as percent slope (%) as opposed to degrees slope to avoid confusion. Slope measurements work best with two people, one taking the readings at the upstream transect and the other holding a stadia rod at the downstream transect. If you cannot see the mid point of the next transect from the starting point, use the supplemental sections (indicating the proportion of the total length represented by each section).

An auto level (with a tripod) should be used for reaches with a percent slope of less than or equal to 1%. All methods (clinometer, hand level, or auto level) may be used for reaches with a percent slope of greater than 1%. In reaches that are close to 1%, you will not know whether you are above or below the 1% slope cutoff. In these cases, default to use of the autolevel.
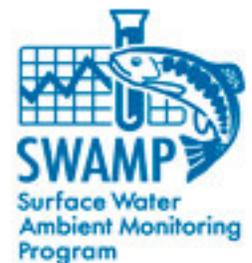
Reach Slope Step 1
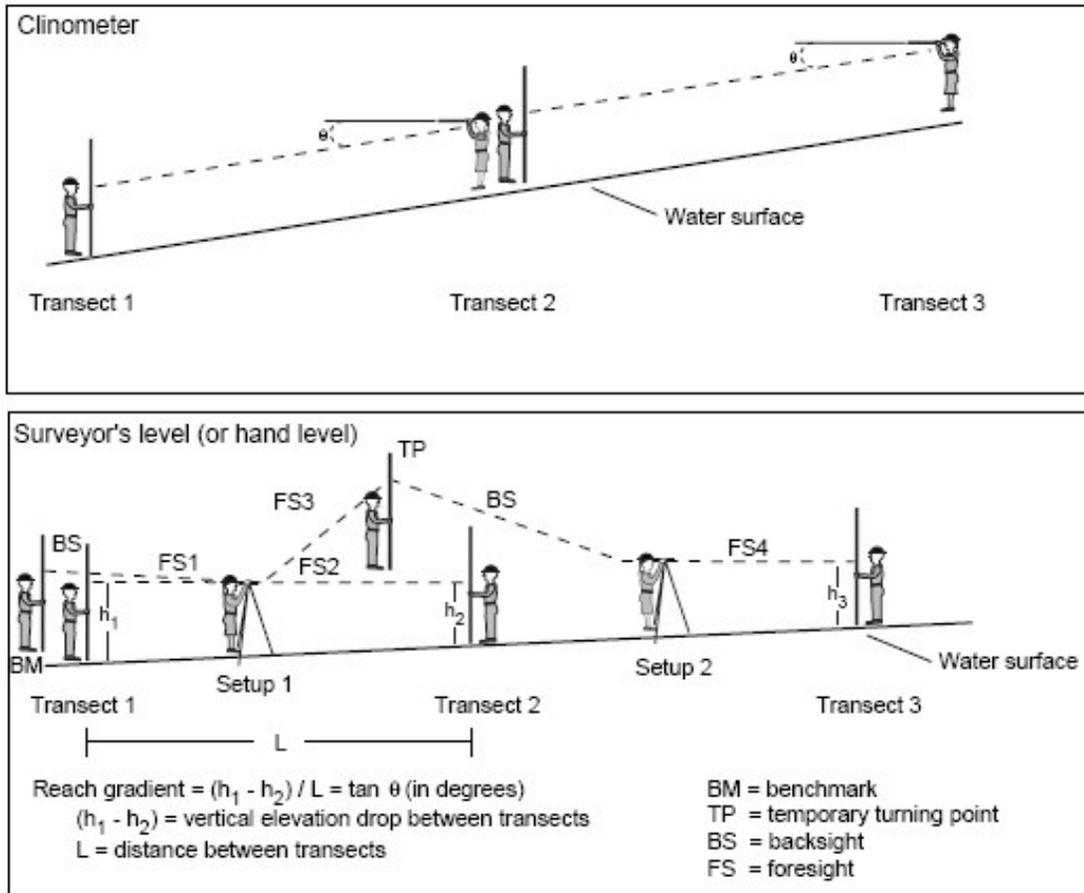
Figure 6. Diagram of how to measure water-surface gradient with a clinometer or surveyor's level.

Labels in figure: Clinometer; θ; Water surface; Transect 1; Transect 2; Transect 3; Surveyor's level (or hand level); TP; FS3; BS; BS; FS1; FS2; FS4; h_1; h_2; h_3; BM; Setup 1; Setup 2; Water surface; Transect 1; Transect 2; Transect 3; L

Reach gradient = $(h_1 - h_2)$ / L = tan θ (in degrees)
$(h_1 - h_2)$ = vertical elevation drop between transects
L = distance between transects

BM = benchmark
TP = temporary turning point
BS = backsight
FS = foresight

Step 1. Divide the reach into multiple segments such that stadia rod markings can be easily read with the measuring device to be employed (this is especially a factor for clinometer and hand level readings).

SWAMP
Surface Water
Ambient Monitoring
Program

Photo Monitoring

Take a minimum of four (4) photographs of the reach at
the following locations:

     a) Transect A facing upstream

     b) Transect F facing upstream

     c) Transect F facing downstream

     d) Transect K facing downstream.

It may also be desirable to take a photograph at Transect A facing
downstream and Transect K facing upstream to document conditions
immediately adjacent to the reach.

Digital photographs should be used when possible.

Record the image numbers on the front page of the field form.

SWAMP
Surface Water
Ambient Monitoring
Program

END

http://www.waterboards.ca.gov/nps/volunteer.html