

Riparian Monitoring of Wadeable Streams Protocol Implementation Plan for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 2

Establishing the Reach and Setting up Transects

Version SCPN_Riparian_SOP2_20180930

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP is adopted from the Northern Colorado Plateau Network's SOP #4 Establishing the reach and setting up transects, Version 1.05 (August 2016) in Weissinger, R., D. Witwicksi, H. Thomas, A. Wight, K. Lund, and M. Van Grinsven. 2018. Riparian monitoring of wadeable streams protocol for park units in the Northern Colorado Plateau Network: Version 1.05. Natural Resource Report NPS/NCPN/NRR—2018/1636. National Park Service, Fort Collins, Colorado.

And

SOP#5 Sentinel site set up, Version 3.0, January 2016 in Perkins, D. W., M. Scott, G. Auble, M. Wondzell, C. Holmquist-Johnson, E. Wahlig, H. Thomas, and A. Wight. 2018. Big River Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network, Version 1.00. Natural Resource Report NPS/NCPN/NRR—2018/1707. National Park Service, Fort Collins, Colorado.

This SOP describes the methods for (1) assessing the suitability of a new monitoring reach, (2) establishing a sampling reach, and (3) setting up and relocating transects for vegetation monitoring and surveying. A list of necessary equipment for these procedures can be found in SOP #1.

A minimum of a three-person team is needed to establish and set up the monitoring transects.

1. Reach Establishment

1.1 Assessing suitability of a new monitoring reach

Potential monitoring locations will be selected based on the length of the stream within park boundaries using GIS technology. Reaches of the stream that are confined by

bedrock or colluvium, or that are affected by a major tributary, will be buffered out of the potential monitoring areas in advance whenever possible. On longer streams, multiple random, spatially-balanced points are generated using a Generalized Random Tessellation Stratified (GRTS) design. These points are assigned sequential reach identification numbers and should be assessed in ascending order.

Locating the centroid

- A. Use topographic maps, aerial photographs, and a GPS unit to navigate to the monitoring reach.
- B. Mark the point with a pin flag or flagging tape. This point is the center of the reach. In perennial streams, you can mark either side of the channel.

Determining reach length

- A. Use a range finder or transect tape to measure the width of the active riparian zone at the centroid, rounding to the nearest 1 m.
 - The active riparian zone boundary is defined as the intersection of surfaces dominated by riparian vegetation with surfaces dominated by upland vegetation.
 - Good indicator species of the active riparian zone include *Salix exigua* and *Baccharis* species.
 - Legacy riparian species, especially mature cottonwood trees, may be present beyond the active riparian zone, but they will not dominate the surface or have active regeneration (i.e., seedlings or saplings) on the surface.
 - In some instances, this boundary may be between a riparian surface and a bedrock valley wall or colluvial deposit.
- B. Re-measure the width of the riparian zone at four additional locations, two upstream and two downstream from the centroid.
 - Separate each additional width measurement using spacing equal to the width of the riparian zone at the centroid.
 - Measure the spacing between additional width measurements along the thalweg or lowest point along the stream bed.
- C. Average the five measurements and multiply by 6. This number is the estimated length of the monitoring reach. If the reach length falls outside of the desired range of 180 – 360 m, default to the minimum or maximum reach length.
 - Minimum reach length is 180 m.
 - Maximum reach length is 360 m.
- D. Determine the actual reach length after establishing all of the transects. Sometimes this will be different than the estimated calculation when transects are moved, altering the distance between transects (see Transect Troubleshooting in section 1.2). Record the actual reach length on the Reach Establishment datasheet.

Evaluating the sampling reach

Walk the entire length of the reach to determine if the reach meets the acceptance criteria described below. An acceptable monitoring reach contains riparian vegetation and remains relatively homogenous throughout its entire length.

A. No more than 25% of the reach:

- Is confined by bedrock or colluvium.
- Has a bedrock channel.
- Lies within a different stream type (perennial, intermittent, ephemeral).
- Is influenced by side canyon springs.

B. No major tributary junctions occur within the reach.

Major tributaries are indicated by either of the following:

- Perennial flow.
- Deposition areas that visibly affect the main channel, such as cobble bars or boulder deposits, even if flow is ephemeral.

C. No significant archeological sites exist within the reach.

If a reach is rejected for any of the above reasons, be sure to collect the centroid pin flag and move on to the next consecutively numbered reach for evaluation.

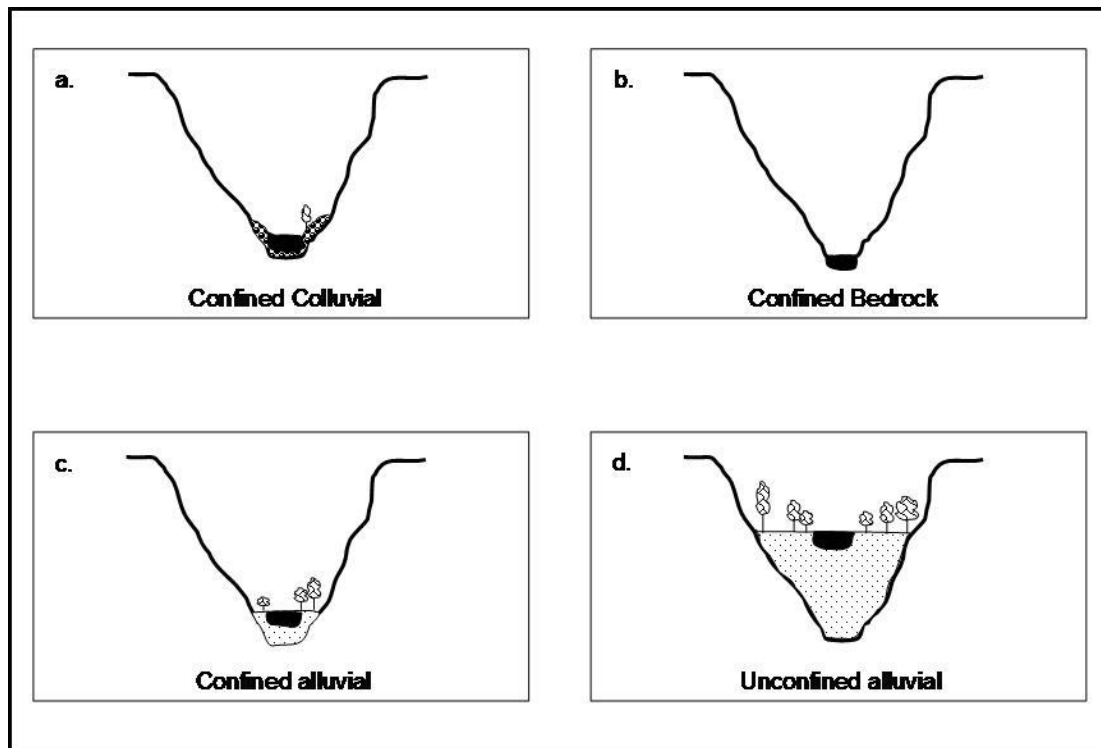


Figure 1. Idealized stream channel valley settings, including (a) colluvial, (b) bedrock, (c) confined alluvial, and (d) alluvial or unconfined alluvial. Colluvial material is typically found at the foot of a slope and is deposited as a result of gravitational action. Alluvium is material deposited by running water. The active channel is represented as solid black. Confined here refers to a channel where the valley width is less than two active channel widths. Adapted from Montgomery and Buffington (1993).

1.2 Site Establishment

Record directions to the reach

Write directions to the reach and include sufficient detail for someone who has never been there to relocate it. Begin with road travel from a designated location (such as the park's visitor center), where to park vehicles, and the route used. Describe (and photograph) landmarks used to navigate to the reach centroid. Note obstacles or hazards to be avoided at and en route to this particular site. Use specific language such as "southwest" and "downstream" rather than ambiguous terms such as "left" or "below." You may also GPS the route (see SOP #3).

Establishing a monitoring reach

A monitoring reach consists of 7 transects where the majority of sampling is conducted (Figure 2). Transects are numbered 1 through 7, in order, from upstream to downstream and have a maximum length of 100 m. Transects are spaced equally throughout the reach at a distance of the reach length divided by 6.

- A. Mark the centroid flag as Transect 4.
- B. From the centroid flag, walk downstream along the thalweg, or lowest part, of the channel. Use a rangefinder, RTK, or transect tape to walk the distance determined above (total reach length divided by 6).
- C. Mark the middle of the stream or the stream bank with a pin flag or flagging tape labeled "5."
- D. Proceed downstream in the same manner, marking the location of Transects 6 and 7 along the stream.
- E. Return to the centroid and walk upstream along the thalweg. Mark the locations of Transects 1-3 along the stream.

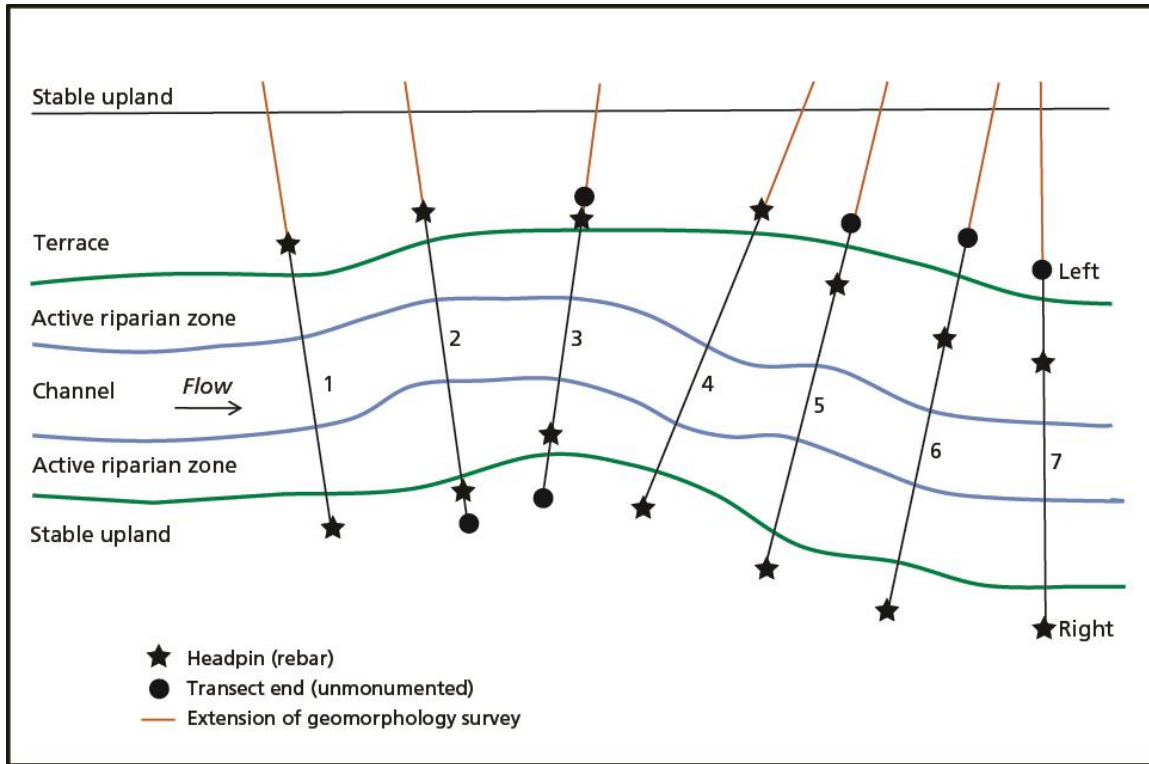


Figure 2. Features of an established sampling reach. “4” is the centroid, star symbols indicate locations of headpins, black circles indicate the locations of transect end points that cannot be monumented due to bedrock or highly unstable surfaces, and the green line represents the upland-riparian zone boundary. Geomorphology transects extend to a stable upland surface.

Establishing transects for Surveying with Total Station

When all transect locations have been determined, flagged mid-stream, and labeled with the appropriate transect number, you are ready to install permanent headpins.

- A. Starting at the center of the transect, have two crew members walk in opposite directions perpendicular to the channel (Figure 2). In braided channels, set up transects perpendicular to the entire channel area. It is helpful to have additional crew members remain at the centroid or position themselves along the desired line to assist in lining up the transect.
- B. Walk until you arrive at a stable surface, upslope of surfaces that are flooded frequently.
 - The most stable surface is dominated by upland plant species and does not show active erosion such as landslides, slumps, rockfalls, gullyng, etc.
 - If stable surfaces are >100 m apart, headpins may be located on relatively stable surfaces such as terraces, indicated by legacy riparian species that show no recruitment (i.e., no seedlings or saplings are present, only mature trees).

- If the active riparian zone is >100 m wide, place one of the headpins in a stable area and the other in the floodplain. Document the headpin in the floodplain using witness trees (see below).
- C. Mark the location with an appropriately numbered pin flag. If on bedrock, make a 2-rock cairn or stand in place.
- D. Stand over the pin flag, and confirm with the other crew members that the transect line is still perpendicular to the channel.
- E. Once the line has been confirmed, pound in the rebar used to mark the locations of the headpins.
- Whenever possible, headpins are located at the ends of a transect.
 - In places where a transect end is on an unstable surface or bedrock, the headpin is installed at a different location along the transect. Select the most stable ground along the transect in the general vicinity of the transect end. The two headpins on a transect should be a minimum of 10 m apart.
 - Hammer the rebar to within 15 cm of the ground surface.
- F. Inscribe the reach number, transect number, and river right or left (e.g., C-01, T4L for Reach 1, Transect 4 river left) on a rebar cap or metal tag. Right and left are determined while facing downstream. If using a rebar cap, stamp a dot or “x” in the center of the cap as well. This is used to align the point of the survey rod during geomorphic surveying (see SOP #9). Caps or tags can be prepared beforehand in the office or in camp.
- G. Gently hammer the cap onto the rebar, protecting the top of the cap with a leather strip, or attach the metal tag to the rebar using galvanized wire.
- H. Set up the transect following the detailed instructions in Section 2. If an unmonumented transect end is on bedrock or an unstable surface, end the transect in a location that gives you an approximately level tagline.
- I. Unless the total station or RTK survey will be completed concurrently with transect establishment, record the location of the headpins and transect ends using a mapping grade GPS unit (see SOP #3) or with an RTK. Be sure to take a waypoint for each headpin and each transect end when they are located in different places. Also record UTM coordinates of each headpin and transect end on the paper data sheet.
- If there is no satellite coverage at the point, move to a location with coverage and offset the point.
 - If offsetting is not possible, mark the location of the headpin or transect end on an aerial photo or topographic map. This will be used to derive coordinates in the office.
- J. Record the location of the headpins along the transect and the total transect length to the nearest 0.1 m. Remember to also record the location of the headpins along each

transect in the data dictionary. This is especially important when headpins are not located at the ends of the transect.

- K. Record the bearing of the transect (from right headpin to left headpin) in degrees. Use true north (i.e., compass declination should be set and recorded on the data sheet).
- L. Take reference photos to document locations of all headpins and any unmonumented transect ends. Include the cliff line, surrounding perennial vegetation, and/or other recognizable landmarks in the background to help the returning field crew relocate these points.
- Label a chalkboard with the park code, reach code, transect number, river right or left, and direction facing (upstream [US], downstream [DS], right to left [R -> L], or left to right [L->R], etc.) (e.g., ZION, P-01, T3R, US).
 - Place the chalkboard in a location near the headpin or transect end where it will be easy to read in the photo.
 - Clearly mark the location of the headpin or unmonumented transect end in relation to recognizable landmarks. This location should be marked by bright-colored pin flags, placed either in the soil at the point or held above the point where they will be visible in the photo. Alternatively, a crew member may hold a survey rod on the point for the photo. Unlike repeat photos, you may include anything in reference photos that may assist with re-locating the point (i.e., crew members, bright-colored flagging, etc.).
 - Take a photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one.
 - Record the digital file name and photographer on page 2 of the photo data sheet (see SOP #3).
- M. If the headpin is located in dense vegetation or on an unstable surface, establish three witness trees.
- Select three healthy trees within 20 m of the headpin. If possible, use different species of trees.
 - Record the diameter at breast height (DBH) and species of each tree. See SOP #4 for methods to measure DBH.
 - Align the nail so that it enters the tree at breast height (1.37 m) facing the headpin. Drive the nail into the tree at an angle, so that the tag hangs down and away from the tree. Leave several centimeters of nail exposed so the tree has ample space for growth.
 - Record the tag number, bearing in degrees from the tree to the headpin, and distance in meters from the tree to the headpin.
- N. Continue throughout the reach, establishing headpins in the same manner for the remaining six transects.
- If channel sinuosity is such that adjacent transects cross, establish the transects as described above. Sampling proceeds as usual with the exception of collecting 5-

m belt data (SOP #6). Be sure to note which transects cross in the comments section of the data sheet.

Establishing transects for Surveying with RTK real-time kinetic

1.2 General Transect Information and Establishment

Seven transects are placed on each sentinel site for monitoring purposes.

- A. Transects are permanent, but do not have any permanent rebar, headpins, or markers. Transects will be relocated using RTK surveying based on established control points (using stakeout functions; see Surveying SOP #6).
- B. Permanent transect locations have been established in the office and loaded onto the RTK. Transects are perpendicular to the valley floor and may not be perpendicular to flow as the channel changes.
- C. The surveyor finds the headpins and marks it with a pin flag. Depending on the length of the transect and amount of vegetation, the crew can either string a tagline the length of the transect or flags can be placed by the surveyor every 3-10m from upland boundary to upland boundary.
- D. Record the location of the headpins along the transect and the total transect length to the nearest 0.1 m. Remember to also record the location of the headpins along each transect in the data dictionary. This is especially important when headpins are not located at the ends of the transect.
- E. Record the bearing of the transect (from right headpin to left headpin) in degrees. Use true north (i.e., compass declination should be set and recorded on the data sheet).

Transect troubleshooting

Under certain scenarios, some transects may need to be repositioned as you are establishing the reach. The distance a transect is repositioned depends on the scale of the reach and the situation which requires it to be moved. Always slide transects away from the centroid in 10-m increments until a suitable location is reached. After repositioning or sliding a transect, each subsequent transect should be located using the original spacing between transects. For example, a reach that is 180 m long should have all transects spaced at least 30 m apart. If you need to slide transect 6 ten meters downstream due to one of the situations below, you will then measure 30 m down the thalweg from the shifted transect 6 location to determine the location of transect 7. Situations in which a transect may need to be repositioned include:

- If a transect location falls immediately upstream from a sharp, 90° bend in the channel and valley axis, causing the transect to run parallel to the channel and valley.
- If a transect location intersects a tributary, and as a result the transect extends up a side canyon instead of intersecting an upland terrace or colluvial surface of the main stream.
- If crew safety is endangered by a permanent, fast-flowing deep section of river or other safety concern.

Any time a transect is repositioned during reach establishment, record the distance that the transect was shifted and the reasons for doing this in the reach establishment comments. You will also need this information to calculate the actual reach length (in this case of the example above, it would be 190 m). Be sure to record this on the data sheet.

Setting up long transects and/or transects through thick brush

On many occasions with total station establishment, it may not be possible to align the headpins and transect center from a vantage point in the channel. One crew member may be able to direct the others by going to a higher vantage point (e.g., on top of a bedrock rim). In cases where it is impossible to see the entire transect by any means, use a compass to proceed at the proper bearing, leap-frogging with crew members in visible positions until you reach the headpin. It is helpful in these situations to tie flagging tape to properly aligned vegetation as you go.

2. Setting up transects

Relocating the transects with Total Station

- A. Use the site description, topographic maps, GPSed coordinates and routes, and photos to navigate to the reach.
- B. Use a GPS, witness trees, azimuths, reference photos, and a metal detector to locate the transect headpins.
 - If the headpin is missing, use the information provided by the sources above to relocate the headpin as accurately as possible. Whenever possible, missing headpins will be relocated ahead of time using surveying equipment.
 - If the headpin location is no longer available or has become unstable (e.g., active erosion zone, tree fall, etc.), establish a new headpin location along the same azimuth as the previous headpin. Use the guidelines in Section 1.2 above to select a headpin location.
 - If a headpin has moved, remove and relocate witness tree markers as needed.
 - Document the new headpin using the guidelines in Section 1.2 above.
- C. Place a pin flag or flagging at the headpins and mid-stream of each transect.

Relocating and setup up transects with RTK

Transects will be loaded into the RTK units and will be laid out by the surveyors. Pin flags are place at the headpins. A tagline is then strung from headpin to headpin, or if the transect is too long or has dense vegetation the surveyor can place pin flags every 3-10 me along the transect.

Setting up a transect with total station

- A. Check the data sheet to see where the headpins are located relative to the transect ends.

- B. Have one person stand at each headpin location. On transects with thick vegetation, additional people may be needed to stand in line with the headpins to provide an accurate line of sight.
- C. Drive a piece of rebar into the ground at each transect end point.
 - If the headpin is located at the transect end point, place the temporary rebar behind the headpin.
 - Leave adequate space above ground on the temporary rebar for attaching the tagline and/or transect tape.
 - Use the recorded azimuth to make sure the temporary rebar is in line with the permanent transect.
- D. Attach the Kevlar tagline and/or the transect tape to the temporary rebar on river right. Remember that river right and left are determined while facing downstream.
 - Attach the tagline so that one of the marked meters falls over the permanent headpin.
 - Use a chaining pin to align the transect tape such that the 0 m mark falls over the permanent headpin.
 - Do not attach the tagline or transect tape to the permanent headpins, as this may cause the headpins to move.
- E. Run the tagline and/or transect tape from river right to river left.
 - To avoid trampling vegetation sampling areas, walk on the downstream side of the transect whenever possible.
 - Keep the tagline and/or transect tape as straight as possible, both vertically and horizontally. Thread through vegetation as necessary.
- F. Tighten the tagline and/or transect tape.
- G. Adjust the tagline and/or transect tape as needed.
 - Whenever possible, the line should not rest against any tree trunks or other obstacles such as boulders or debris (Figure 3).
 - Obstructing branches can be moved or tied back with flagging.
- H. Attach the tagline and/or transect tape to the temporary rebar on river left.
- I. If using both a tagline and a transect tape, run the tagline first, make any necessary adjustments, and then run the transect tape. Take up any slack in the tape by tying it to the tagline with flagging at regular intervals. This step is especially important in windy conditions.
- J. On a revisit, check the length of the transect at establishment to make sure you are within 0.5 m of the original length.
 - Small changes in transect length occur over time due to changing vegetation and geomorphology along the transect. It is highly unlikely that any of the headpins have been moved when there are small changes in transect length.

- If the difference in transect length is more than 0.5 m, check to make sure that the tagline/transect tape is straight and aligned correctly with the headpins, especially in cases where headpins are not located at transect end points. If this and any additional troubleshooting does not resolve the issue, record the new transect length and document the issue in the visit comments. Do not move the headpin.

K. Begin sampling. Use the Visit Comments section of the data sheet to record any general comments relevant to the current monitoring visit.

Transect end point located on bedrock

If a transect end point is located on bedrock, you will not be able to place the temporary rebar at the transect end. Place the temporary rebar as close to the transect end as possible, and secure the tagline and/or transect tape to this point following the instructions above. To sample the transect beyond the temporary rebar, you will need to extend the transect tape using other methods. If possible, use a rock cairn to hold the transect tape in place. If this is not possible, have a crew member hold the transect tape in place while you are sampling.

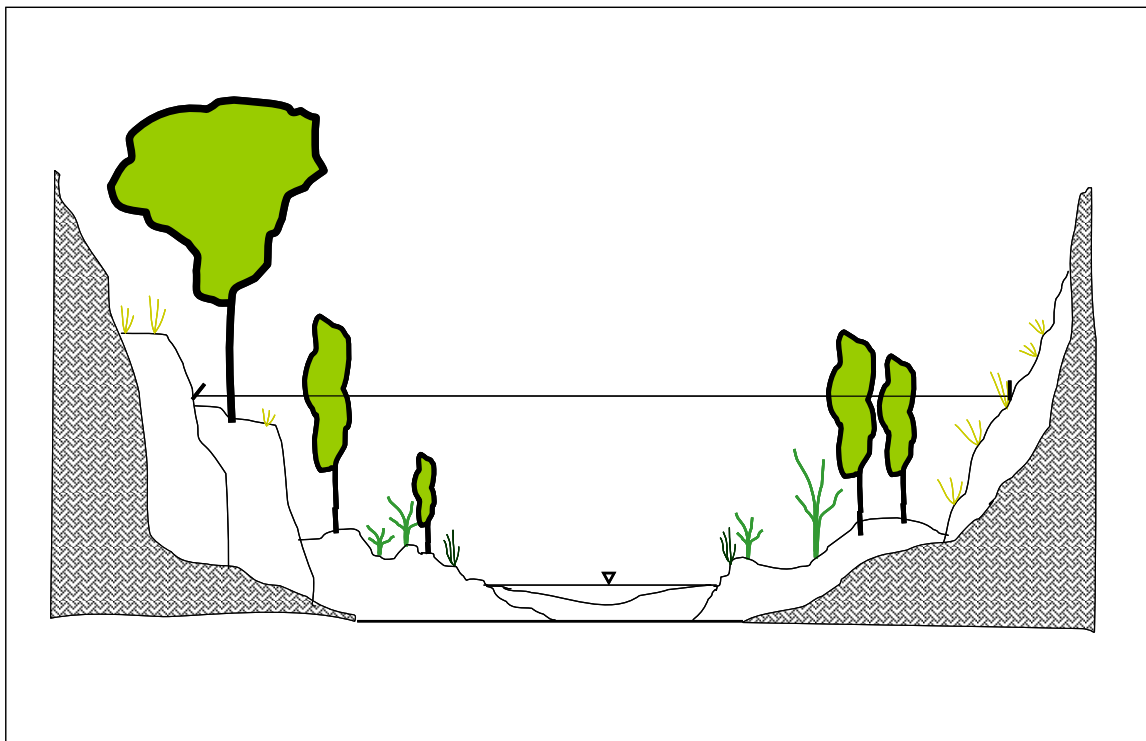


Figure 3. Diagram of Kevlar tagline established between two rebar headpins. Always establish taglines as taut as possible. If the line runs through vegetation, make sure that

branches do not cause the line to bend. Vertical elevations are exaggerated in this diagram.

References

Montgomery, D.R. and J.M. Buffington. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Report prepared for the SHAMW committee of the Washington State Timber/ Fish/ Wildlife Agreement. Report TFW-SH10-93-002.

Reach Establishment

Data entered by: _____

Data verified by: _____

p.1

SCPN Riparian Monitoring

Park Code: _____ Stream Name: _____ Reach ID: _____

Accept

Reject

Observers: _____ Date: _____

Rejection criteria (circle appropriate):

>25% confined

>25% different stream types

>25% spring-influenced

major tributary present

archeological site present

Centroid UTM's: Datum: _____ Zone _____ N _____ E

Active Riparian Zone Width (m): _____

Average Reach Width (m): _____ x 6 = _____ Est. Reach Length: _____ Min. 180m Max. 360m

other (describe):

% Valley Setting: Confined colluvial _____% Confined bedrock _____% Confined alluvial _____% Unconfined alluvial _____%

% Stream Type: Perennial _____% Intermittent _____% Ephemeral _____%

Actual Reach Length: _____

Reach Establishment Comments:

Directions to Reach:

Visit Comments:

Reach Establishment

Data entered by:

Data verified by:

p.2

SCPN Riparian Monitoring

Headpin Coordinates

Compass declination _____

Headpin	Right			Left			Transect Length (m)	Bearing (R to L)
	Easting	Northing	Location (m)	Easting	Northing	Location (m)		
T1 (upstream)								
T2								
T3								
T4								
T5								
T6								
T7 (downstream)								

Transect End Point Coordinates

Transect	Right		Left	
	Easting	Northing	Easting	Northing
1				
2				
3				
4				
5				
6				
7				

Establish transects from downstream (7) to upstream (1) and from right (R) to left (L) when facing downstream.

Witness Trees

Monu-ment*	Tag #	Species	DBH (cm)	Bearing (°)	Distance to rebar (m)

*Include the transect number, river right or left, and a letter to identify witness trees (e.g., T1-Ra, T1-Rb, T1-Rc, T1-La, etc.)

Example Data Sheet:

Reach Establishment

Data entered by: A. Jones Data verified by: C. Whitford

p.1

NCPN Riparian Monitoring

Park Code: ARCH Stream Name: Courthouse Wash Reach ID: C-03

Observers: A. Jones, C. Whitford, S. Smith, K. Spears Date: 6/5/2013

Centroid UTM's: Datum: NAD83 Zone 12 4274199.99 N 623324.80 E

Active Riparian Zone Width (m): 20 25 24 37 32 = 138

Average Reach Width (m): 28 x 6 = Est. Reach Length: 168 Min. 180m Max. 360m

% Valley Setting: Confined colluvial % Confined bedrock 5% Confined alluvial % Unconfined alluvial 95%

% Stream Type: Perennial % Intermittent 100% Ephemeral %

Actual Reach Length: 192 m

Reach Establishment Comments: T1 was slid 10 m upstream because of a tributary on river right & safety concerns where the transect would be (i.e., a steep colluvial slope).

Directions to Reach:

Park at the Courthouse Wash trailhead on Hwy. 191. Walk south on the paved bike path to the Courthouse Wash trail. Follow the trail for about 50m then head west towards the wash.

Visit Comments:

- There are many slash piles throughout the reach (*Elaeagnus angustifolia* & *Tamarix* sp.) from exotic plant removal crews. They were recorded as "other" disturbance in Point-Intercept. Beware of thorns hiding in grassy areas.
- Beware of biting ants near large *Populus fremontii* trees and litter near T1L.

Accept Reject

Rejection criteria (circle appropriate):

>25% confined

>25% different stream types

>25% spring-influenced

major tributary present

archeological site present

other (describe):

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Compass declination 11°

*Include the transect number, river right or left, and a letter to identify witness trees (e.g., T1-Ra, T1-Rb, T1-Rc, T1-La, etc.)