

NCPN Riparian Monitoring Protocol

Standard Operating Procedure #1: Preparation for the Field Season

Revision History Log

New version number	Revision date	Author	Changes made	Reasons for change
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Only changes in this specific SOP will be logged here. Version numbers increase incrementally by hundredths (e.g., version 1.01, version 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0). Record the previous version number, date of revision, author of the revision; identify paragraphs and pages where changes are made, who approved the revision, and the reason for making the changes along with the new version number.

This Standard Operating Procedure (SOP) describes pre-season procedures for monitoring riparian resources in NCPN parks. The procedures described here are primarily the responsibility of the crew leader, who should be familiar with the monitoring protocol narrative before initiating this and subsequent SOPs. Included in SOP #1 are a description of general preparations, field season scheduling considerations, and a list of necessary supplies and equipment for sampling. The procedures described here should begin no later than three months prior to the field season.

2.1 General Preparations and Review

1. **Review monitoring narrative and all SOPs.** The crew leader should be thoroughly familiar with the objectives described in the NCPN integrated riparian monitoring protocols. This person should also have a solid working knowledge of the conceptual models that summarize existing knowledge and hypotheses concerning the structure and functioning of riparian and aquatic ecosystems of the Colorado Plateau (Scott et al. 2005).
2. **Identify season-specific plans.** The crew leader should discuss specific sampling goals, including scheduling and crew member responsibilities, with the program manager and project manager. Goals for the upcoming season and a realistic timeline to meet the goals

should be established. Finally, the crew leader should review notes from previous seasons and be familiar with any unique conditions (i.e., hazardous routes, missing markers) that were encountered during that season.

3. **Prepare the field folders.** The crew leader should be familiar with the field folder for each site and should check each folder to make sure that all of the listed items are included (Table SOP1.1).
4. **Obtain permits.** The crew leader should work with the NCPN project manager to obtain all necessary permits. These include Scientific Research and Collecting Permits as well as backcountry hiking and camping permits. Scientific Research and Collecting Permits should be obtained for each park using the National Park Service Research Permit and Reporting System website, <http://science.nature.nps.gov/research>. These permits include a sub-section on sample collection and vouchering that must be completed for all vegetation sample sites. Backcountry hiking and camping permits or specific permission must be obtained for each park where samples will be collected. This should be done through park backcountry offices, park resource managers, law enforcement rangers, or other designated park staff.
5. **Prepare supplies and equipment.** All of the necessary field equipment and supplies for the season should be inventoried and inspected. Equipment should be checked to ensure that it is in optimum working condition. In addition to sampling equipment, additional items that should be available include species lists, floras, datasheets, field notebooks, GPS units, maps, and safety equipment. For a complete list of supplies and equipment, see Table SOP1.1 (below) and associated data collection SOPs (SOPs 4-10).
 - a) Equipment and supplies should be grouped together in containers according to sampling activity, and each container should have an attached checklist of all of the necessary supplies.
 - b) All field equipment should be available and organized at least one month before field work is scheduled to begin. All equipment should also be examined for functionality and completeness before field work begins. For example, a sufficient supply of replacement batteries and pencils should be available.
6. **Confirm site locations.** Prior to the field season, the crew leader should check all GPS units to ensure that the location coordinates of all sampling sites have been uploaded to each unit. A print out of all sampling location coordinates should be included in the field folder as a back-up reference for crew members. Topographic maps with sampling locations marked on them should also be included in the field folder. Access points of difficult to reach areas should be marked on the maps and if possible, the coordinates of these points should be saved in the GPS units. Road or trail logs, in addition to site descriptions and contact information for landowners, park managers, etc. should be maintained in the field folder.

2.2 Scheduling Field Work

Sampling schedule outline. Sampling for integrated riparian resources will be conducted during established sampling windows (typically during leaf-off for surveying and during the growing season for riparian vegetation), depending on the specific site. A tentative schedule should be constructed for the entire field season, taking into account all logistical considerations. This sampling schedule should provide an initial plan for the entire season but allow flexibility for unforeseen circumstances. Potential reasons for schedule changes include weather (spring run-off and snow melt dates, monsoon rainstorms), road conditions, backcountry permits, travel time

between sites and other, sometimes unpredictable, accessibility issues. The number and distribution of sites being sampled and number of field crew members will also determine the schedule.

Table SOP1.1. List of field equipment and supplies.

Field Folder
Site description
Topographic site map with locations marked
Site coordinates
Road log
All necessary permits (research, backcountry, and camping)
Equipment list
Park contact information
Emergency contact information
Photographs
Copies of previous sampling efforts' field notes and year end summaries
Site annotated plant species list
Park plant species list
Field Office
Waterproof pens
Pencils
Permanent Markers (e.g., Sharpies)
Field datasheets on regular and waterproof paper
Clipboards
Integrated Riparian Monitoring Protocol
Reach Layout
Flagging tape
Surveyor pin flags
Rangefinder
200-m Kevlar taglines
100-m transect tapes
Metal detector
Rebar – ½" diameter, 4 ft. long
Pre-stamped rebar caps for marking transects and control points
Stamp kit
Hammer
Leather or other protective material for rebar caps
Vegetation Sample Collection
Point-intercept laser
2-m folding rulers
30-m transect tape
Chaining pins
DBH tape (minimum 244 cm diameter, prefer metal, auto-rewind)
50 cm calipers
15 cm calipers
Pre-stamped tree tags
4" rust-resistant steel nails
Modified concave spherical densiometer
Hand lens
Relevant floras

Plant press
Newspaper
Key to geomorphology surfaces

Geomorphology Sample Collection

Total station
25-m fiberglass survey rods
Prisms
Survey rod levels
Data logger
Extra batteries for data logger
Extra battery for total station
Battery charger
Hand held radios

Basic Field Supplies

Digital Camera

Chalkboard

Chalk
GPS (mapping grade)
Extra batteries for all equipment
Tool set (it is recommended that each crew member have personal multi-tool)
Compass
Watch

Personal and Group Safety

First aid kit
Satellite phone (cell phone or park radio may be adequate)
Insect repellent
Alcohol based hand-wash

Personal Items

Rain gear
Sunhat
Sandals (or other water shoes)
Hiking boots
Drinking water
Sunscreen

NCPN Riparian Monitoring Protocol
SOP #4 Establishing the Sample Reach

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) describes the methods for establishing a monitoring reach for park units in the NCPN. Here, we provide detailed instructions for (1) assessing the suitability of a new monitoring site, including rejection criteria; and (2) establishing a sample reach, including sampling design for setting up transects. Detailed information on setting up transects with a Kevlar tagline and meter tape is available in SOP #4.5 (Relocating and Setting Up Transects). This SOP was modified from the Environmental Monitoring and Assessment Program, Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams (Peck et al. XXXX).

Equipment List:

- GPS
- Compass
- Range finder (2)
- Pin flags (minimum 33)
- 50 m tape
- 100 m tape
- Rebar (14, minimum; ½ inch (1.25 cm), 4-ft (120 cm)long)
- Sledgehammer
- Rebar tags marked with transect numbers (14)
- Tree tags (42)
- 4” galvanized steel nails
- DBH tape
- Field note books
- Datasheets
- Pencils/ extra pencil lead/ erasers/ pens/ sharpies
- Camera
- Chalkboard
- Chalk

Procedures:

Site Verification

Potential monitoring locations will be selected based on the length of the stream within park boundaries using GIS technology. On longer streams, multiple random, spatially balanced points will be generated using a Generalized Random Tessellation Stratified desing (GRTS). GRTS points will be assigned sequential numbers and should be assessed in numerical order.

Assessing suitability of a new monitoring site:

Locating the centroid

1. Use topographic maps, aerial photographs, and a GPS unit to navigate to the monitoring location.
2. Mark the point with a pin flag or flagging tape. This point is the center of the reach.

Determining reach length

1. Use a range finder or meter 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.
 - Legacy riparian species may be present beyond the active riparian zone, but they will not dominate the surface.
 - In some instances, this boundary may be between a riparian surface and a bedrock valley wall or colluvial deposit.
2. 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 at a 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.
3. Average the five measurements and multiply by 6. This number is the length of the monitoring reach.
 - Minimum reach length is 180 m.
 - Maximum reach length is 300 m.

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.

1. No more than 25% of the reach:
 - Is confined by bedrock or colluvium (Fig. 1)

- Lies within a different stream type (perennial, intermittent, ephemeral)
- Is influenced by side canyon springs

2. No major tributary junctions occur 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 GRTS point for evaluation.

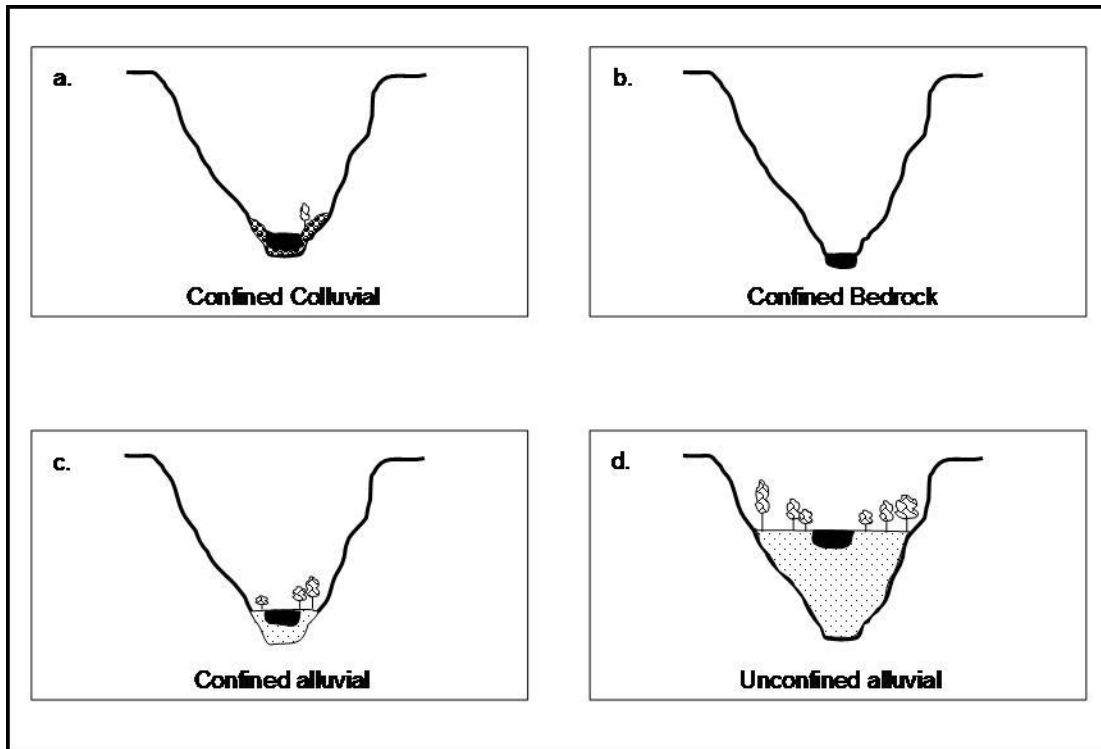


Figure 1. Idealized stream channel valley settings, including (a) colluvial, (b) bedrock, (c) confined alluvial, and (d) alluvial or unconfined alluvial. Colluvial material is typically found at the foot of a slope and is deposited as a result of gravitational action. Alluvium is material deposited by 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).

Site Establishment

Establishing a monitoring reach

A confirmed monitoring reach consists of 7 transects with a maximum length of 200 m each along which sampling is conducted (Fig. 2). Transects are numbered 1 through 7, in order, from upstream to downstream. Transects are spaced equally throughout the reach at a distance of the reach length divided by 6.

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

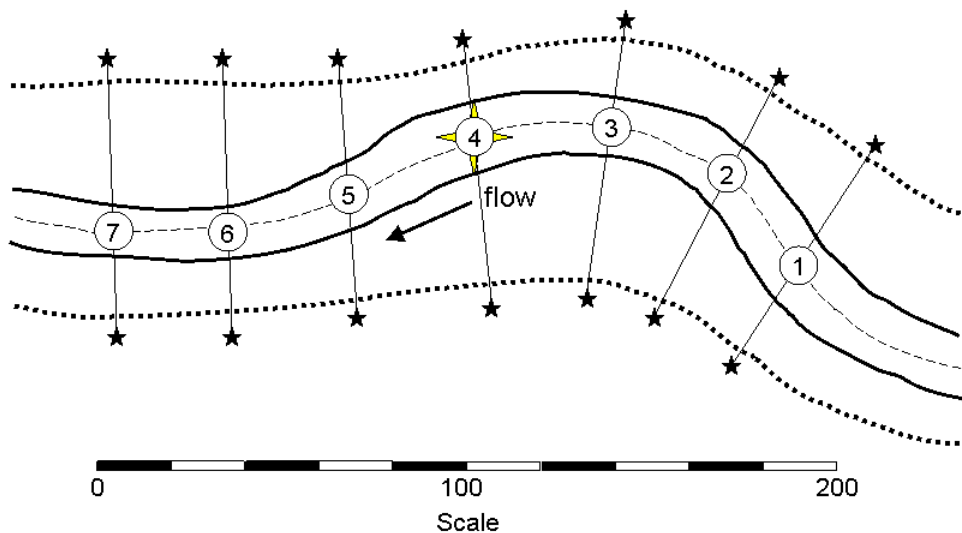


Figure 2. Features of an established sampling reach. “4” is the centroid, star symbols indicate locations of headpins, and the dotted line represents the upland-riparian zone boundary.

Establishing transects

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

1. Start at a transect at one end of the reach. Make sure the center of the transect is visible from a distance.
2. Starting at the center of the transect, have two crew members walk in opposite directions perpendicular to the valley setting (Fig. 1). It is helpful to have a crew member remain at the centroid to assist in lining up the transect.
3. Walk until you have arrived 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 (landslides, slumps, rockfalls, gullying, etc.).
 - If stable surfaces are >200 m apart, headpins may be located on relatively stable surfaces (e.g., abandoned 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 >200 m wide, place one of the headpins in a stable upland area, and the other in the floodplain.
4. Mark the location with an appropriately numbered pin flag. If on bedrock, make a 2-rock cairn or stand in place.
5. Stand over the pin flag, and confirm with the other crew members that the transect line is still perpendicular to the valley setting.
6. Once the line has been confirmed, pound in a piece of rebar to mark the location of the permanent headpin.
 - Select a stable location.
 - Hammer the rebar to within 2.5 cm of the ground surface.
7. Place an aluminum cap with the transect number on top of the rebar. Shield the cap with a piece of leather; then gently hammer the cap onto the rebar until it is stable.
8. Record the location of the permanent headpin using a mapping grade GPS (Trimble XMs). Record 10 points for each headpin.
 - If there is no satellite coverage at the headpin, move to a location with coverage and offset the point.
 - If no satellite coverage is available within 10 m of the headpin, mark the location of the headpin on an aerial photo or topographic map.
9. Record the bearing of the transect in degrees (from headpin to headpin). Use magnetic north (i.e., do not set declination).
10. Take photographs to document the location of the headpin, including the cliff line or other recognizable landmarks in the background.
 - Label a chalkboard with the park code, site code, transect number, river right or left, and date (e.g., ZION, P-01, T3R, 14 Oct 2008).

- Prop the chalkboard by the rebar and pin flag.
- Take photos showing the rebar, chalkboard, and landmarks facing upstream and downstream.
- Record the photo information on the photo datasheet.

11. 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 #9 for methods to measure DBH.
- Tag the tree just below breast height using a numbered aluminum tree tag. Angle the nail downward, with the head pointing in the direction of the rebar.
- Leave 1" of nail exposed to allow the tree to expand.
- Record the tag number, bearing in degrees from the tree to the rebar, and distance (m) from the tree to the rebar.

12. Continue throughout the reach, establishing headpins in the same manner for the remaining six transects.

Transect troubleshooting

Under certain scenarios, some transects may need to be repositioned as you are establishing the sample reach. The distance a transect is repositioned depends on the scale of the sample reach and the situation which requires it to be moved. Always slide transects away from the centroid. After repositioning or sliding a transect, each subsequent transect should be located using the original spacing. Situations in which a transect may need to be repositioned include:

- If stream sinuosity causes any portion of a transect to come within 15 m of an adjacent transect (Fig. 2, Transect 5), increase the spacing of that transect along the centerline of the stream to ensure that the alignment of that transect is farther than 15 m to the adjacent transect.
- 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, slide the location of the transect beyond the 90° bend such that the transect is oriented more or less perpendicular to the axis of the 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, slide the transect beyond the confluence until the headpin location is a minimum 20 m from the mouth of the tributary.

NCPN Riparian Monitoring Protocol

SOP #5 Relocating and Setting Up Transects

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) provides step-by-step instructions for relocating and setting up transects for vegetation monitoring and surveying.

Equipment List:

- GPS
- Compass
- Metal detector
- Pin flags (minimum 18)
- Flagging
- Stream site folder
- 200 m Kevlar tag line
- 50 m tape
- 100 m tape
- Level
- Rebar (2, minimum)
- Hammer or hand sledge to drive in rebar

Sampling Procedures:

Details on reach establishment are described in SOP 4, “Establishing the sample reach.” Each monitoring reach consists of 7 transects along which vegetation sampling is conducted. Transects are numbered 1 through 7, in order from upstream to downstream. The ends of each transect are marked with rebar, called headpins, that are driven into the ground to within 2.5 cm of the surface. Each headpin has an aluminum cap marked with the transect number.

Relocating the transects

1. Use the site folder information, including site description, coordinates, topographic maps, and photographs to navigate to the sampling reach.

2. Use UTMs, witness trees, azimuths, and photographs to locate the transect headpins.
 - If the rebar is missing, use the information provided by the sources above to relocate the headpin as accurately as possible.
 - 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 SOP #4 to select a headpin location.
 - If a headpin is moved, remove and relocate witness tree markers as needed.
 - Document the new headpin using the guidelines in SOP #4.
3. Place a pin flag or flagging at the headpins and mid-stream of each transect.

Setting up a transect

1. 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.
2. Drive a piece of rebar into the ground behind each transect headpin.
 - Use the recorded azimuth to make sure the temporary rebar is in line with the permanent transect.
 - Leave adequate space above ground on the temporary rebar for attaching the tagline and/or transect tape.
3. Attach the Kevlar tagline and/or the transect tape to the temporary rebar on river left.
 - Attach the tagline at a point so that one of the marked meters falls over the permanent headpin.
 - Use a cord to extend the transect tape such that the 0 m mark falls over the permanent headpin.
 - Do not attach to the permanent headpins, as this may cause the headpins to move.
4. Run the tagline and/or transect tape from river right to river left as you face downstream.
 - To avoid trampling vegetation sampling areas, walk on the upstream 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.
5. Tighten the tagline and/or transect tape.
6. 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. 1).
 - Obstructing branches can be moved or tied back with flagging.
 - Use the level to make the tagline as level as possible.

7. Attach the tagline and/or transect tape to the temporary rebar on river right.
8. If using both a tagline and a transect tape, take up any slack in the tape by using flagging to tie the transect tape to the tagline at regular intervals. This step is especially important in windy conditions.
9. Begin sampling.

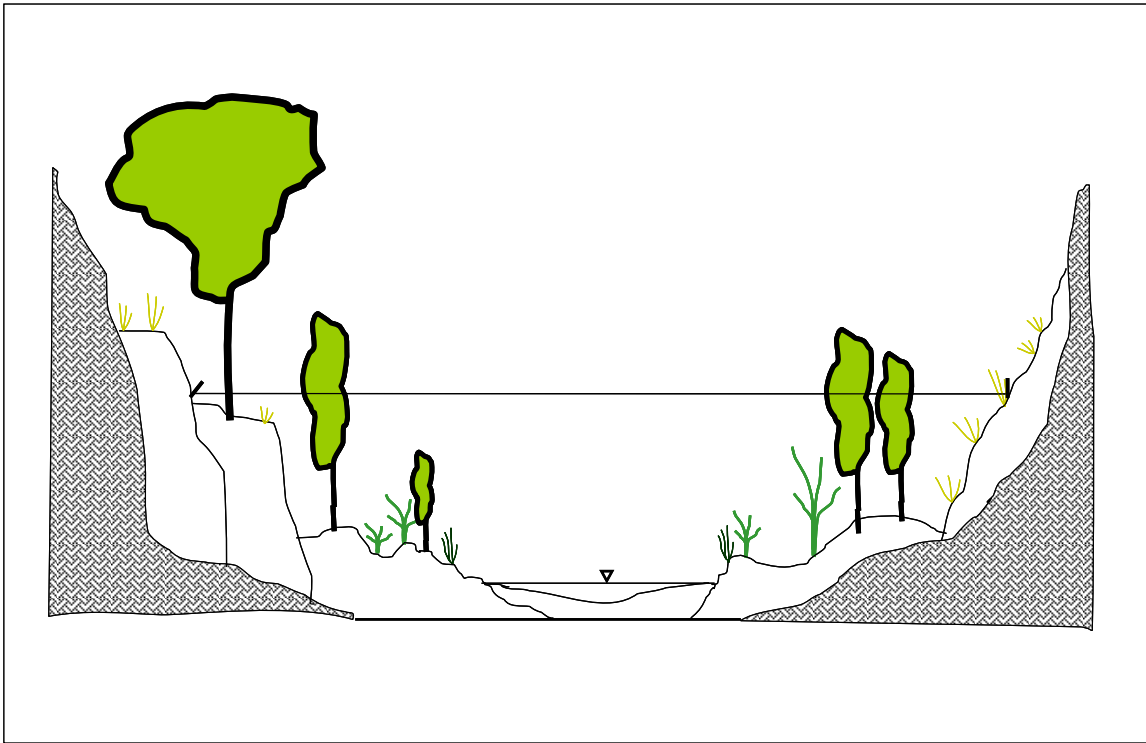


Figure 1. Diagram of Kevlar tagline established between two rebar headpins. Always establish taglines as taut as possible. If the line runs through vegetation, make sure that branches do not cause the line to bend. Vertical elevations are exaggerated in this diagram.

References

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Standard Operating Procedure (SOP) #6

Measuring Understory and Surface Features Using a Point Intercept Transect

Version 1.0 (August 2008)

Revision History Log:

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Point-intercept sampling is used to sample understory vegetation on seven cross-section transects of varying length and on fourteen 10-m long greenline transects. Cross-section transects are sampled at a 0.5 m interval, and greenline transects are sampled at a 0.25 m interval.

Equipment

- Point-Intercept Laser
- Point Intercept Data Sheets (1 per transect; Appendix A)
- Unknown Plant Data Sheets
- Clipboard
- Pencils, extra pencil lead, and erasers
- Plant press
- Hand lenses
- Plant species list for ecological site or park
- Unknown specimen book
- Plant identification keys as needed
- Write-In-Rain blank data sheets (to avoid confusion with regular paper, keep labeled)
- Field notebook

Sampling Teams

A two-person team comprised of a data recorder and an observer skilled in plant identification can complete the tasks described below efficiently.

Sampling Procedure – Cross-section transects

1. Fill out relevant information at the top of the “Point Intercept Data Sheet” including:

Park: Use the standard 4-letter code to indicate the park unit.

Site: A pre-assigned, unique code provided for each stream reach.

Transect #: 1-7, upstream to downstream

Observer: Record the initials of the person calling out the intercept data.

Recorder: Record the initials of the person recording the data.

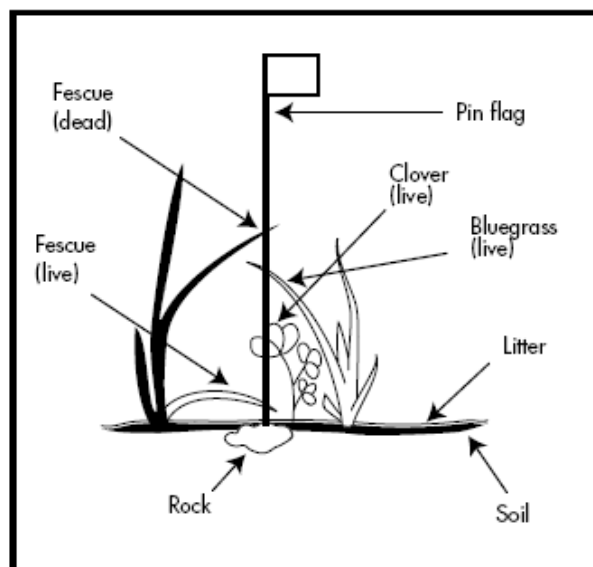
Date: mm/dd/yyyy

2. Record point intercept data for understory species (<2m).

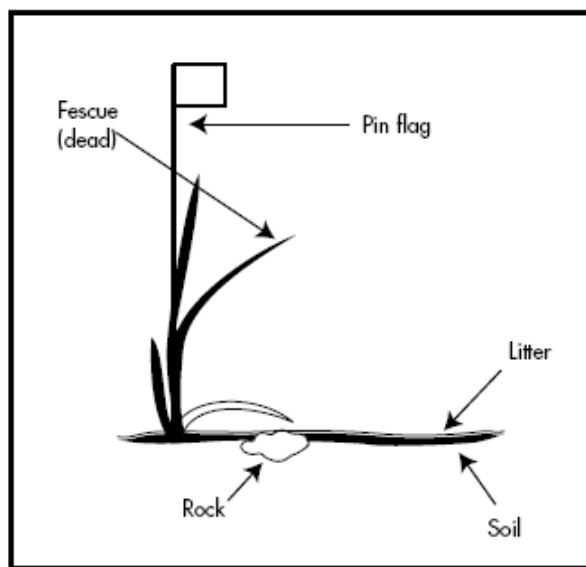
- A. Stand on the upstream side of the transect and work from river right to river left.
- B. Start at 0.5 m on the tape and move forward 0.5 m for each consecutive point. The final point sampled is the last half meter interval before the transect endpoint.
- C. Position the monopod at the correct point on the tape with the laser extending out perpendicular to the tape on the downstream side.
- D. Use the bubble on the monopod to level the laser. With the laser leveled, push the button to take a point.
- E. Once you have recorded a point, move the uppermost vegetation away so that you can take subsequent hits for lower canopy and surface layers. If it is difficult to keep the monopod level and record hits, have one person hold the monopod level while a second person reads and records hits. On a windy day, it is important to turn the laser on for just a second to record a hit.
- F. Once the laser is leveled, record every plant species it intercepts. Record each canopy species only once, even if it is intercepted several times. Record the following information for each point:
 - A. Top Canopy** - Record the species of the top plant intercepted in the “Top canopy” column using a six letter code composed of the first three letters of the genus and specific epithet (Table 1 & Fig. 1). If a plant is not intercepted, leave this column blank. After the species code, write “-dead” if the part of the plant intercepted by the laser is dead.
 - B. Lower canopy layers**- From the top canopy species, move down the laser and record species intercepted in the order that they occur. Use the “Lower canopy” columns (Table 1 & Fig. 1) to record all additional species intercepted by the laser. Record the plant as dead following the guidelines above. You may also intercept litter and woody debris, but it must not be embedded or it must be elevated above the soil surface to be considered a lower canopy layer (Table 2). If you hit more than two lower canopy layers, be sure to record them even though the data sheet only provides space to record two. If you do not encounter lower canopy layers leave these columns blank.

Table 1. Sample data sheet for examples illustrated below in Figure 1. Points 1 and 2 show the first two points on a transect. In Point 1, the pin flag is touching dead fescue (*Festuca octoflora*), bluegrass (*Poa secunda*), clover (*Trifolium gymnocarpon*), live fescue, litter, and a rock. Record fescue only once, even though it intercepts the pin twice. In Point 2, the flag touches dead fescue, then touches litter, and finally the fescue plant base. The table below shows how to record these two points on the data sheet. Notice that all plants are recorded using six-character abbreviations.

Pt.	Top canopy	Lower canopy layers			Soil surface	D.*
		1	2	3		
1	FESOCT	POASEC	TRIGYM	L	SR	
2	FESOCT	L			FESOCT	
3	ATRCAN - dead	FESOCT	L		S	ant mound
etc.						



Point 1



Point 2

Figure 1. Points along a transect associated with the example in Table 1 (from Herrick et al. 2005a). Although the pin drop method is shown in this example, sampling is performed in the same way using the laser.

Table 2 Abbreviations and definitions of litter and woody debris as lower canopy layer classes for point intercept sampling.

Code	Lower canopy cover type	Definition
L	Litter	Detached dead plant material less than 2.5 cm in diameter that is not embedded in the soil surface
WD	Woody debris	Detached woody plant material that is greater than 2.5 cm in diameter and not in direct contact with soil

C. Surface Features - In the “Surface” column record whether the laser intercepts a plant base (Fig. 2) or a surface feature. Use the appropriate six letter code to identify plant bases. Use the abbreviations of surface features defined in Table 3 to record all other surface features.

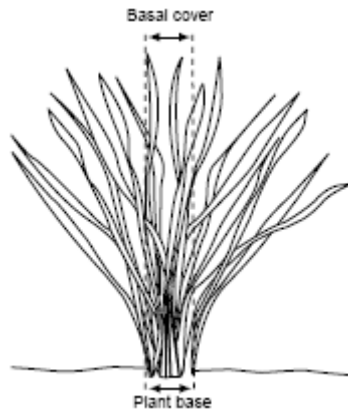


Figure 2. Area defined as plant base and included as basal cover (from Herrick et al. 2005a).

Table 3 Abbreviations and definitions of surface feature classes for point intercept sampling.

Code	Surface Feature	Definition
F	Fines	Loose mineral particles 0-2 mm in diameter
GF	Gravel, Fine	Particles 2-16 mm in size; ant to beetle-sized
GC	Gravel, Coarse	Particles 16-64 mm in size; beetle to baseball-sized
CB	Cobble	Particles 64-256 mm in size; baseball to basketball-sized
BL	Boulder	>256 mm in size; larger than a basketball
BR	Bedrock	Exposed bedrock
WA	Water	Flowing or pooled water
BSC	Biological soil crust	Cyanobacterial crust, sometimes in community with mosses and lichens
L	Litter	Detached organic material that is less than 2.5 cm in diameter
WD	Woody debris	Detached woody plant material that is greater than 2.5 cm in diameter and in direct contact with soil
SL	Scat, livestock	Any type of livestock scat
SW	Scat, wildlife	Any type of wildlife scat

D. Disturbance - Record whether the laser intercepts a disturbance on the soil surface in the “D.*” column (Table 1 & Fig. 2). Use abbreviations from Table 4 to label the type of disturbance. Leave this column blank if there is no disturbance.

Table 4. Abbreviations and definitions of soil-surface disturbance classes for line-point intercept sampling.

Code	Disturbance type	Definition
Ant	Ant mound	Holes and mounds created by ants
Bike	Bicycle	Disturbances caused by non-motorized bicycles
Trail	Trail	Defined tracks or trails
Camp	Campsite	Bare ground associated with camping
Auto	Motor vehicle	Disturbances caused by any motorized vehicle
Flood	Recent flooding	Recent flooding indicated by flattened vegetation and mud and debris lines
Graze	Grazing	Grazing or browsing by wildlife or livestock
Insect	Insect damage	Insect herbivory, galls, etc.
Other	Other	Any other disturbance

Sampling Procedure – Greenline transects

3. Fill out relevant information at the top of the “Greenline Data Sheet” including:

Park: Use the standard 4-letter code to indicate the park unit.

Site: A pre-assigned, unique code provided for each stream reach.

Transect #: 1-7, upstream to downstream; R = river right, L = river left when facing downstream

Observer: Record the initials of the person calling out the intercept data.

Recorder: Record the initials of the person recording the data.

Date: mm/dd/yyyy

1. Run a transect tape along the greenline for 10-m upstream of where the cross-section transect intercepts the greenline (Fig. 4).
 - The greenline is the first rooted line of perennial vegetation adjacent to the channel.
 - Typical greenline genera in a riparian setting include *Scirpus*, *Juncus*, *Carex*, *Salix*, and *Baccharis*.
 - If the channel is incised or is bordered by a cutbank, the greenline may be formed by upland species.
 - See Appendix A for more details on identifying the greenline.
2. Use the directions above to sample vegetation, surface features, and disturbances at 0.25-m intervals along the transect, starting at 0.25-m and ending at 10-m.
 - Place the laser along the tape, and shoot the laser on the upslope side of the tape (away from the channel).
3. Run greenline transects on river right and river left for each cross-section transect.

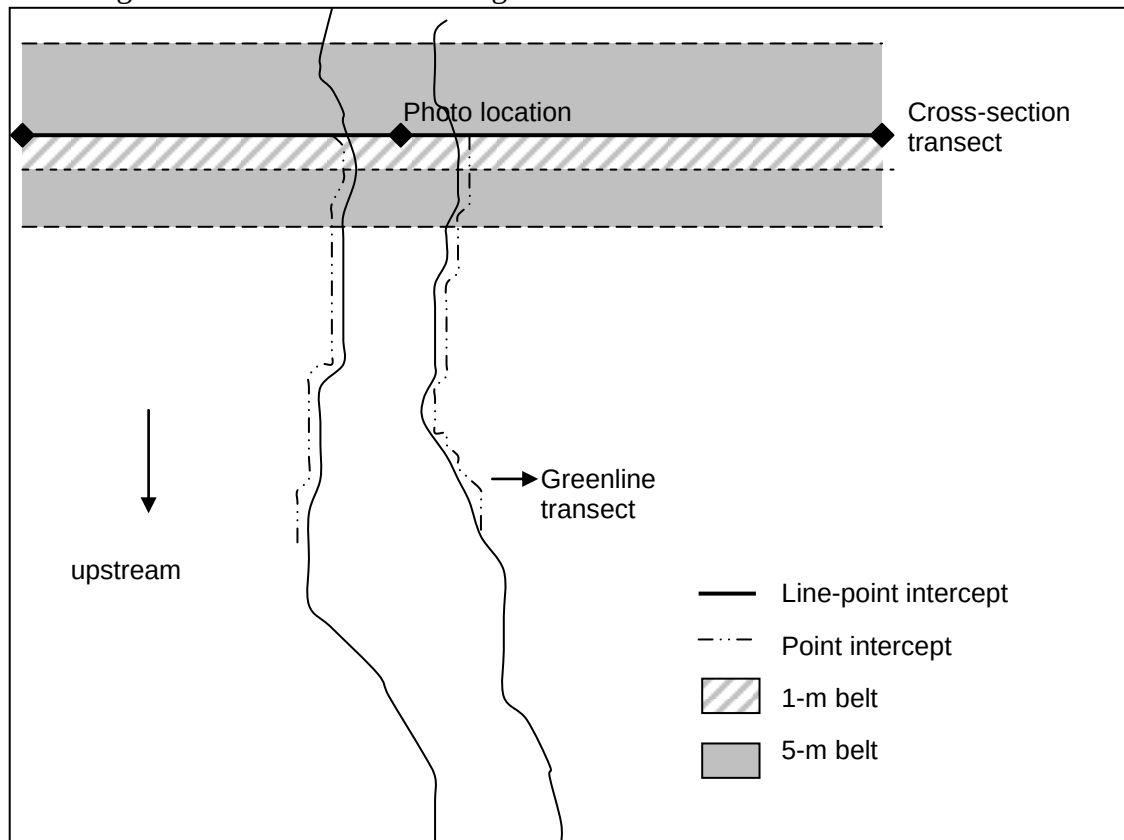


Figure 4. Example of greenline transect set-up in relation to a cross-section transect.

Standard Operating Procedure (SOP) #7

Measuring Shrubs and Geomorphology Using a Line Intercept Transect

Version 1.0 (August 2008)

Revision History Log:

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

Sampling Teams

A two-person team comprised of a data recorder and an observer skilled in plant identification can complete the tasks described below efficiently.

Sampling Procedure

1. Fill out relevant information at the top of the “Line Intercept Data Sheet” including:

Park: Use the standard 4-letter code to indicate the park unit.

Site: A pre-assigned, unique code provided for each stream reach.

Transect #: 1-7, upstream to downstream

Observer: Record the initials of the person calling out the intercept data.

Recorder: Record the initials of the person recording the data.

Date: mm/dd/yyyy

2. Record line intercept data for shrub species.

A. Stand on the downstream side of the transect.

B. Record the species and location where the first shrub canopy intercepts the transect.

C. Record the location where that species canopy ends along the transect.

D. Record each shrub species, but do not record the start and stop locations of individual plants within a species. Different shrub species may have overlapping start and stop locations.

E. Canopy occurs any time 50% of any 3 cm segment of tape edge intercepts live or dead plant canopy based on a vertical projection from canopy to ground.

3. Record geomorphic surfaces along the transect.

A. Geomorphic Surface – Record the intercepts for each geomorphic surface you encounter, using the definitions in Table 1 and Fig. 1.

- Note that not all geomorphic surfaces may be present at every transect.
- If more than one terrace is present, number the terraces, with the lower terrace beginning at 1.
- Consult Appendix B for more information on geomorphic surfaces.

Table 1. Description of geomorphic surfaces.

Code	Geomorphic Surface	Description
CH	Channel	Active channel denoted by flowing water and a scour zone
CR	Channel riser	Sloping surface between the channel and the floodplain
FL	Floodplain	Flat, usually relatively wide, surface adjacent to the channel showing active recruitment of riparian tree species
FR	Floodplain riser	Sloping surface between the floodplain and a terrace
TE	Terrace	Elevated, generally flat, alluvial surface that no longer shows active recruitment of riparian species, although mature riparian trees may be present.
TR	Terrace riser	Sloping surface between a terrace and upland areas or between two terraces.
UP	Upland	Elevated or sloping colluvial surface with only upland plant species.
BR	Bedrock	Exposed bedrock surfaces

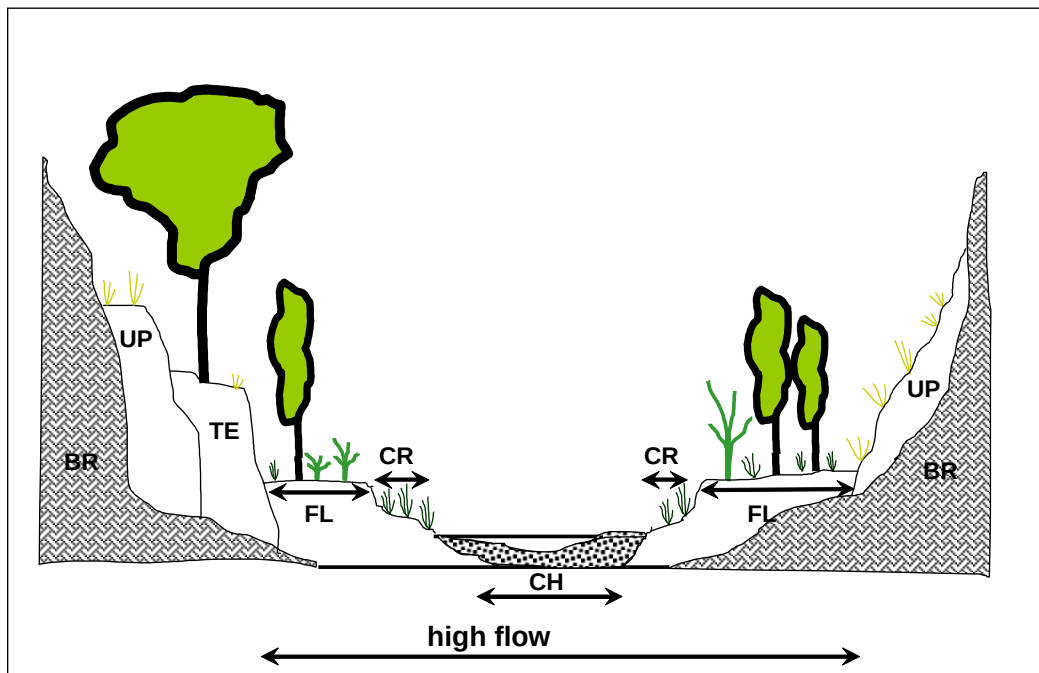


Figure 1. Illustration of geomorphic surfaces. Symbols represent the following geomorphic features: BR = bedrock; UP = upland; TE = terrace; FL = flood plain; and CR = channel riser, and CH = channel. Physiographic descriptions of surfaces are presented in Table 1 based on the following sources: Hupp and Osterkamp (1985), Graff 1987, Hupp 1988, Everett 1995 and Birkeland (1996). It should be noted that at any particular channel cross-section, not all surfaces would be expected to occur.

Standard Operating Procedure (SOP) # 8

Measuring Exotic Perennial and Tree Seedling/Sapling Density in a 1-m Belt Transect

Version 1.0 (August 2008)

Revision History Log:

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

Equipment

- 2 m folding engineer's ruler

Sampling Teams

A two-person team comprised of a data recorder and an observer skilled in plant identification can complete the tasks described below efficiently.

Sampling Procedure

1. Fill out relevant information at the top of the “Belt Transect Data Sheet” including:

Park: Use the standard 4-letter code to indicate the park unit.

Reach ID: A pre-assigned, unique code provided for each reach.

Transect #: 1-7.

Observer: Record the initials of the person calling out the data.

Recorder: Record in the initials of the person recording the data.

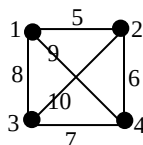
Date: mm/dd/yyyy

2. Sample exotic perennial and tree seedling and sapling density

A. Unfold a ruler to 1-m in length and use the ruler and the transect tape to determine whether exotic perennials and tree seedlings and saplings are rooted within the belt transect.

B. Record the entire Latin name of each species encountered on the belt transect.

C. Use a dot tally to record the density of exotic plants and tree seedlings and saplings. A dot tally is created by forming the following figure as you count stems:



- D. At sites with high levels of density, estimate density using the following categories: 100-250, 250-500, 500-1000, and >1000 individuals.
- E. After completing a belt, add up the dot tally marks for each species and write in the numeric total in the “Total” row.

Standard Operating Procedure (SOP) # 9

Measuring Trees in a 5-m Belt Transect and a Reach Census

Version 1.0 (August 2008)

Revision History Log:

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

Equipment

- DBH calipers
- DBH tape
- Tree tags
- 4” galvanized steel nails
- Hammer
- 5-m long measuring tape
- Graphing paper

Sampling Teams

A two-person team comprised of a data recorder and an observer skilled in plant identification can complete the tasks described below efficiently.

Sampling Procedure – 5-m Belt Transect

Trees >2.5 cm DBH are measured in a 5-m belt transect centered on the line-point intercept transect. Densiometer readings are taken every 10-m starting at the 5-m mark to record canopy closure.

1. Fill out relevant information at the top of the “5-m Belt Transect Data Sheet” including:

Park: Use the standard 4-letter code to indicate the park unit.

Reach ID: A pre-assigned, unique code provided for each reach.

Transect #: 1-7.

Observer: Record the initials of the person calling out the line-point intercept data. .

Recorder: Record in the initials of the person recording the data.

Date: mm/dd/yyyy

2. Take a modified concave spherical densiometer reading every 10-m, starting at the 5-m mark (i.e., 5, 15, 25-m, etc.)

- a. Place the densiometer on top of the laser monopod over the meter mark. Level the densiometer using the bubble level. Position your body so that your forehead is visible at the top of the mirror as you make the reading (Fig. 1).
- b. Count the number of point intersections covered by vegetation above the V (maximum is 17).
- c. Four measurements are made, (1) facing downstream; (2) facing the right bank; (3) facing upstream and, (4) facing the left bank. Keep the densiometer in the same place for each reading as you rotate around it.

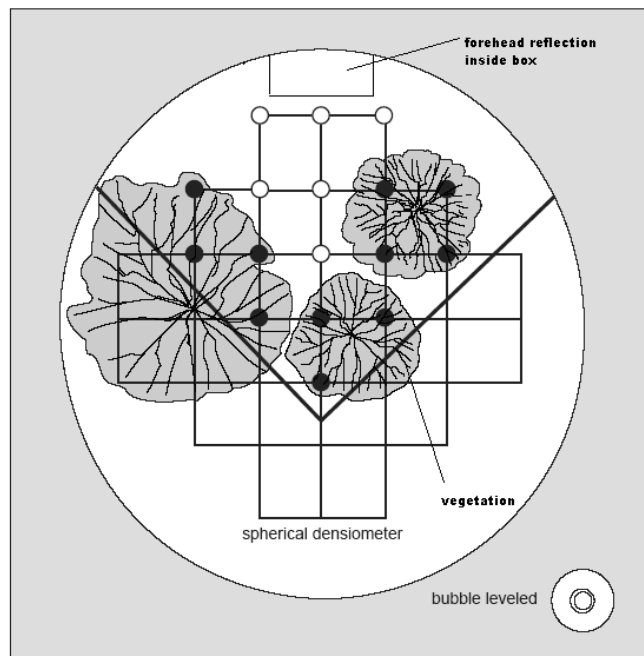


Figure 3. A modified concave spherical densiometer. Note the bubble level, tape marking right angle (above which points are counted), and 17 points of intersection. Closed circles represent line intersections where vegetation is present and consequently counted in measurement of canopy closure (example shows 11 out of 17 points) (from Fitzpatrick et al. 1998).

3. Record all individuals greater than 2.5 cm diameter at breast height that fall within 2.5 m downstream or upstream of the transect.
 - Individuals >15 cm DBH are tagged as part of the reach census and are measured as part of both efforts.
4. Measure all individuals rooted more than 50% within the 5-m belt. If a tree is rooted near the belt transect boundary, use a tape or pole to measure the perpendicular distance between the tree and the transect line.

5. Record the geomorphic surface for each individual (Table 1).

Table 1. Description of geomorphic surfaces.

Code	Geomorphic Surface	Description
CH	Channel	Active channel denoted by flowing water and/or a scour zone
CR	Channel riser	Sloping surface between the channel and the floodplain
FL	Floodplain	Flat, usually relatively wide, surface adjacent to the channel showing active recruitment of riparian tree species
FR	Floodplain riser	Sloping surface between the floodplain and a terrace
TE	Terrace	Elevated, generally flat, alluvial surface that no longer shows active recruitment of riparian species, although mature riparian trees may be present.
TR	Terrace riser	Sloping surface between a terrace and upland areas or between two terraces.
UP	Upland	Elevated or sloping colluvial surface with only upland plant species.
BR	Bedrock	Exposed bedrock surfaces

6. Record the tree species.

- The first time a species is encountered within a reach, record the entire Latin name. After the first occurrence, record the species name using a six-character code consisting of the first three letters each of genus and specific epithet.
- Record unknown specimens using a code including the park code, reach number, and a descriptive note about the plant, e.g., ZION_P01_serrate_Salix. See SOP 12 for naming and collecting conventions for unknown plant specimens.

7. Record DBH to the nearest 0.1 cm.

Measuring DBH:

- Use the calipers or a DBH tape to measure the diameter of the tree at 1.37 m above the ground surface (breast height).
- Round DBH measurements to the nearest 0.1 cm.
- If the tree is on a slope, stand on the uphill side of the tree to measure DBH.
- When using a DBH tape, take care to keep it straight and perpendicular around the entire stem.

A. Using the DBH tape.

- a. Press the hook at the end of the tape into the bark and then run the tape around the trunk, ensuring that the tape is straight and pulled perpendicular to the axis of the trunk. Tapes not run straight will give an overestimate for the trunk diameter.

b. Wrap the tape tightly around the tree and read the number where the tape crosses the zero mark at the beginning (hook end) of the tape (See Figure 2).

c. Make certain that you are reading the correct side of the DBH tape; often one side has standard centimeters and the other side has units calibrated to give the diameter in centimeters when wrapped around the circumference of the tree. Read off of the calibrated side of the tape.



Figure 2. The proper method for securing a DBH tape.

Common stem irregularities (Fig. 3):

- *Trees with swellings, bumps, depressions, and branches at breast height* - Measure diameter immediately above the irregularity at the place it ceases to affect normal stem form.
- *Trees missing bark or wood at breast height* - Record diameter of the wood and bark that is still attached to the tree.
- *Curved, leaning, or flood-trained trunks* - Find the point equivalent to breast-height (1.37 m) by measuring along the curvature of the bole on the upper surface (i.e., the short side) of the tree.
- *Trees that fork at breast height* - If forking influences DBH, the diameter should be measured below the fork.
- *Trees that fork below breast height* – Measure the DBH of each fork. Circle the two measurements on the datasheet to indicate they are from the same tree.

- *Trees with a shrubby, clumped or clonal growth form* - Measure only the five largest stems. Circle the five measurements on the datasheet to indicate they are from the same tree.

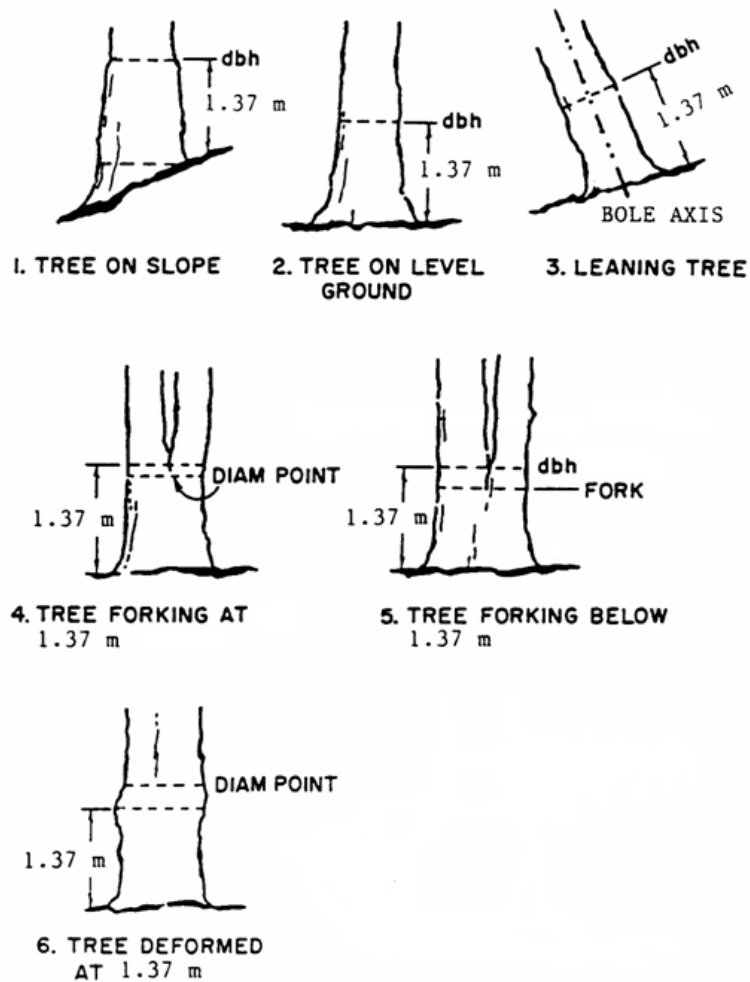


Figure 3. Locations of diameter at breast height (DBH) measurements for a variety of bole form situations. DBH measurements will always be taken perpendicular to the bole axis as illustrated (modified from USDA Forest Service 1985).

Sampling Procedure – Reach Census

All trees greater than 15 cm DBH within the reach are tagged and measured.

1. Start at one end of the reach and work your way to the other end, sampling on one side of the channel. Once all trees have been measured, sample the other side of the channel.
 - The reach includes the area between 2.5-m upstream of Transect 1 and 2.5-m downstream of Transect 7.
 - The reach includes the active riparian zone and the entire first terrace surface, even if this surface is beyond the transect headpins (i.e., include legacy riparian trees).

- Exclude trees associated with water sources other than the stream, such as tributaries, side springs, residential areas, or landscaping.
 - Record all tree species between the headpins and only riparian species beyond the headpins (Table 2).
2. Locate a tree with a diameter at breast height of >15 cm.
- A. If the tree is not tagged, affix a tag to the tree using a 4” nail.
- a. For trees measured at breast height (1.37 m), place the nail so that the top of the nail is at breast height. If the tree forks below breast height, both forks should be tagged.
 - b. Pound in the nail so it slants downward, and leave approximately 1” of the nail exposed so that the tree trunk has room to expand.
- B. Record the geomorphic surface (Table 1), tag number and Latin name of the tree.
- a. Record the full Latin name the first time a species is encountered, and record subsequent occurrences using a six-letter code comprised of the first three letters of the genus and specific epithet.
 - b. If a tree is dead, write (dead) after the species name. If the species is unknown, write UNKT (dead).
- C. Measure DBH using the notes above.
- a. Measure just above the nail.
 - b. Measure to the nearest 0.1 cm, making sure to read the correct side of the DBH tape.
3. After systematically sampling the reach, draw a scale replica of the reach and tree locations as part of the Site Assessment (SOP #12).

Table 2. Tree and shrub species with facultative or obligate wetland indicator status in western Colorado and Utah according to the USDA PLANTS database (plants.usda.gov). Wetland indicator status is as follows: OBL - obligate always found in wetland setting; FACW – facultative wetland species with 67-99% of occurrences in a wetland setting; FAC – equally likely to be found in a wetland or upland setting; FACU – facultative upland; UPL – upland; NI – insufficient information.

Family	Latin name	Common name	CO, UT
Aceraceae	<i>Acer negundo</i>	boxelder	FACW*
Betulaceae	<i>Alnus incana</i>	gray alder	FACW
	<i>Alnus incana ssp. tenuifolia</i>	thinleaf alder	FACW
	<i>Betula occidentalis</i>	water birch	FACW
Caprifoliaceae	<i>Sambucus nigra ssp. canadensis</i>	common elderberry	FACW
	<i>Sambucus racemosa var. melanocarpa</i>	black elderberry	FACU-
Cornaceae	<i>Cornus sericea ssp. sericea</i>	redosier dogwood	FACW
Elaeagnaceae	<i>Elaeagnus angustifolia</i>	Russian olive	FAC

Family	Latin name	Common name	CO, UT
Fabaceae	<i>Prosopis pubescens</i>	screwbean mesquite	FAC
Oleaceae	<i>Fraxinus pennsylvanica</i>	green ash	FACW*
Rhamnaceae	<i>Frangula betulifolia</i> ssp. <i>betulifolia</i>	beechleaf frangula	FAC
Rubiaceae	<i>Cephalanthus occidentalis</i>	common buttonbush	OBL
Salicaceae	<i>Populus ×acuminata</i>	lanceleaf cottonwood	FAC+
	<i>Populus angustifolia</i>	narrowleaf cottonwood	FAC*
	<i>Populus balsamifera</i>	balsam poplar	FACW
	<i>Populus deltoides</i>	eastern cottonwood	FACW*
	<i>Populus fremontii</i>	Fremont cottonwood	FACW*
	<i>Salix amygdaloides</i>	peachleaf willow	FACW
	<i>Salix bebbiana</i>	Bebb willow	FACW+
	<i>Salix eriocephala</i>	Missouri River willow	OBL
	<i>Salix exigua</i>	narrowleaf willow	OBL
	<i>Salix glauca</i>	grayleaf willow	FAC*
	<i>Salix gooddingii</i>	Goodding's willow	FACW
	<i>Salix lasiolepis</i>	arroyo willow	FACW
	<i>Salix lucida</i> ssp. <i>lasiandra</i>	Pacific willow	OBL
	<i>Salix lutea</i>	yellow willow	OBL
	<i>Salix melanopsis</i>	dusky willow	FACW+
	<i>Salix monticola</i>	park willow	OBL
	<i>Salix nigra</i>	black willow	OBL
	<i>Salix planifolia</i>	diamondleaf willow	OBL
Tamaricaceae	<i>Tamarix aphylla</i>	Athel tamarisk	FACW
	<i>Tamarix chinensis</i>	five-stamen tamarisk	FACW
	<i>Tamarix parviflora</i>	smallflower tamarisk	FACW
	<i>Tamarix ramosissima</i>	saltcedar	FACW

Standard Operating Procedure (SOP) # 11

Repeat Photographs

Version 1.0 (August 2008)

Revision History Log:

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

This SOP provides instructions for taking photographs at each riparian monitoring site. Photos are taken at each transect headpin and at mid-channel

Equipment

- Digital camera
- Chalkboard
- Chalk
- Monopod or 2 m folding ruler

I. Fill out the datasheet

1. **Park Code** – The four letter park code
2. **Reach ID** – The reach ID number
3. **Date** – Use the format mm/dd/yyyy

II. Photo Points

Photos are to be taken using a digital camera. If a film camera must be used, procedures are the same, but the film-roll information is also recorded in the photo # column on the datasheet.

1. Transect Photos

Take transect photos from each end of each transect while the meter tape or tagline is stretched out along the transect.

A. Label photo point ID board and lean it next to the rebar marking the end of a transect.

Site – Park code and Reach ID number (e.g., ZION-P1)

Date – mm/dd/yyyy, e.g., 08/22/2010

Transect # and side - i.e., #1-7 and R = river right, L = river left when facing downstream

- If you are having difficulty propping up the ID board, use additional objects behind it rather than including field crew members or their body parts in the photos.

- B. Stand 3 meters back from the end of a transect, set the camera body on top of a folding engineer ruler extended to 1.5-m in height, and point the camera down the transect.
- C. Orient the camera so that it is rotated 90° and takes a vertical (portrait) format photo.
- D. Check to ensure that the sign board is visible at the bottom of the field of view and the tape or tagline is visible in the middle.
- E. Take a photo and record the photo information on the Photo Data Sheet. Record the location of the photo point as -3 m or as the transect end +3 m.

2. Mid-Channel Photos

- A. Stand 3-m downstream from the tagline at mid-channel, set the camera body on top of a folding engineer ruler extended to 1.5-m in height, and point the camera upstream.
- B. Orient the camera so that it is rotated 90° and takes a vertical (portrait) format photo.
- C. Take a photo and record the photo information on the Photo Data Sheet. Record the location of the photo point along the transect tape.
- D. Go 3-m upstream of the tagline and take a photo facing downstream using the same methods.

3. Other Photos

Crew members are encouraged to take other photos to document specific aspects of a reach or to provide scenic or fieldwork photos for publications.

- A. Write the type of photograph: archeology, disturbance, fauna, fieldwork, flora, scenic, or other.
- B. Record the photo number and a description of the photo.

NCPN Riparian Monitoring Protocol
Standard Operating Procedure (SOP) # 12
Site Impact Assessment
Version 1.0 (August 2008)

Revision History Log:

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

This SOP provides instructions for recording in-stream and terrestrial impacts within the reach and for drawing a reach map.

Equipment

Site Impact Assessment Datasheet

Procedures

At the end of a site visit, record all disturbances or impacts found within a reach.

- A. In-stream disturbances: Examples include channel modifications, road crossings, beaver dams, recent flooding and presence of crayfish.
- B. Terrestrial disturbances: Examples include roads, trails, campsites, beaver damage to trees, livestock grazing, wildlife trampling and/or grazing, insect infestations, fire, etc.

Riparian Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 15

Revising the Protocol Narrative and SOPs

Version 1.00 (August 2008)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains how to make and track changes to the Narrative and Standard Operating Procedures for the Northern Colorado Plateau Network (NCPN) Riparian Monitoring Protocol. Individuals editing the Protocol Narrative or any one of the SOPs need to follow these procedures in order to eliminate confusion on how data are collected and analyzed. All observers conducting the monitoring should be familiar with this SOP in order to identify and use the most current methods.

Procedures:

1. Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by NCPN Inventory and Monitoring staff. An outside review is required for substantive changes in methods. Regional and national staff of the National Park Service and experts outside of the Park Service with familiarity in vegetation monitoring, hydrology, geomorphology, and data analysis will be used to review major changes.
2. Record all changes to a protocol document (Protocol Narrative or SOP) in the document's revision history log, even minor edits like fixing typos or formatting changes. It is not necessary to record the specific edits made, rather just the fact that typos were fixed or formatting changes were made. For minor edits, record the same document version number in the revision history log. For actual protocol changes (e.g., changes in methods, equipment), assign a new version number in the revision history log. Depending on the significance of the changes, it may be okay to combine multiple changes in the same entry in the revision history log. Version numbers increase incrementally by hundredths (e.g. version 1.01, version 1.02, etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). Record the previous version number, date of revision, author of the revision, and the reason for the changes along with the new version number (if applicable).

3. Narrative and SOP updates may occur independently. That is, a change in one SOP will not necessarily invoke changes in other SOPs; a narrative update may not require SOP modifications. The NCPN tracks the narrative and SOP version numbers in a Master Version Table (MVT), which is maintained in this document (SOP #15). Any time a narrative or an SOP version change occurs, a new Version Key number (VK#) must be created and recorded in the MVT, along with the date of the change and the versions of the narrative and SOPs in effect. The VK number increments by whole integers (e.g., 1, 2, 3, 4, 5). Updates to the MVT also must be provided to the NCPN Data Manager for inclusion in the master version table database. *The protocol narrative, SOPs, and data should not be distributed independently of this table.*
4. New versions of the protocol narrative and SOPs must be posted on the NCPN web page. Older versions of the Protocol Narrative and SOPs must be archived in the NCPN Riparian Protocol Library: (R:\Monitoring_Archive\Riparian\Protocol).

Riparian Monitoring, Northern Colorado Plateau Network Master Version Table

A dash (“-”) in a cell indicates that the narrative or SOP is not applicable during the corresponding time period.

Effective Date	Narrative	1-Preparations for the Field Season	2-Hiring & Training Field Technicians	3-Using GPS Units	4-Reach Establishment	5-Transect Setup	6-Point Intercept Transect	7-Line Intercept Transect	8-Belt Transect	9-Measuring Trees	10-Unknown Plants	11-Repeat Photos	12-Site Impact Assessment	13-Pebble Count	14-After the Field Season	15-Revising the Protocol
1/1/2008	-	1.00	-	-	1.00	1.00	1.00	1.00	1.00	1.00	-	1.00	1.00	-	-	1.00