

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

Standard Operating Procedure (SOP) # 1

Preparations and Equipment Setup Prior to the Field Season

Version 1.00 (July 2010)

Revision History Log:

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

This SOP provides information on how to prepare for the field season, including a list of field equipment needed. This SOP was adopted with modifications from the Vegetation Community Monitoring Protocol For the Heartland I&M Network and Prairie Cluster Prototype Monitoring Program Standard Operating Procedure (SOP) # 1 - Preparations and Equipment Setup Prior to the Field Season Version 1.0 (December 2004).

I. General Preparations

Prior to the field season each year, all field crew members should review the entire protocol, including SOPs. The following list includes key points to consider in preparing for the upcoming field season.

1. Acquire a list of reaches to be monitored in the upcoming field season from the project manager. Some reaches may be first-time visits and require establishment. Others may already exist and just require re-measurement. The UTM coordinates of all reaches should be acquired from the project manager, entered into a GPS unit for navigational purposes, and used in planning the logistics of the upcoming field season.
2. For each reach to be re-measured, a reach report should be acquired from the project manager which will indicate travel directions to a reach, coordinates of transect ends (which are monumented with re-bar), and anomalies related to transect monuments. For instance, if a monument could not be located exactly at the end of a transect, the report will indicate the displacement (distance and direction) of the monument from transect end.
3. Species lists from previous years should be reviewed, if available, to identify any unique plants that may be encountered. Prior knowledge of species most likely to be encountered in a park will aid botanists in preparing for the sampling season. Therefore, species lists from previous community monitoring efforts in a park should be compiled and compared to reference manuals to identify species likely to be present in the area. Primary sources are certified species lists from NPSpecies, available from the NCPN data management staff

and/or the project manager, and published floras. Copies of these combined species lists should be carried into the field as quick references.

4. Research permits should be requested 10 weeks before the start of the field season. Geomorphology surveying will occur during leaf off, generally in late fall or early winter for perennial streams and in late winter or early spring for intermittent and ephemeral streams. Well installation can theoretically occur at any time, but likely will occur in spring or fall to avoid weather extremes. Vegetation monitoring will be conducted during the period coinciding with the growing season across the Colorado Plateau, from late May to early October. Sampling dates should be scheduled and logistics organized prior to the start of each field season. Logistics include scheduling park housing, where possible, and the acquisition of back-country camping permits, where necessary. A preliminary schedule should be approved by the project manager. Upon approval, resource staff of park units being visited should be notified (via an email message) of the dates the riparian field crew will be in their parks. Just prior to the time the field crew enters a park unit, the resource staff and chief ranger of the park are to be provided with the actual dates field crew members will be working in the park, a list of their names, and approximate locations of monitoring activity. Crew leaders should review the NCPN Backcountry Safety Plan for procedures for filing an itinerary with GLCA dispatch.
5. All equipment should be organized and made ready for the field season a month in advance of the field season. This allows time to make needed repairs and order equipment. The following are lists of field equipment needed for each crew (Tables 1, 2, 3, 4). Equipment specified for Reach Establishment should be prepared and taken into the field even if all reaches are to be re-measured, to replace any monuments removed since the last visit. However, at most, four pieces of rebar should be carried to existing reaches. This should be sufficient to cover replacement needs without undue burden to field crews.

Table 1. Equipment needs associated with all integrated riparian sampling

Activity	Equipment
General Equipment <i>Necessary for all SOPs</i>	GPS with extra batteries GPS car charger Digital camera with extra batteries Inverter Permit Maps Data sheets SOPs Clipboard Pencils Waders
Safety Equipment <i>necessary for all SOPs</i>	First aid kit Satellite phone NCPN Backcountry Safety Plan NCPN Accident Report Logs NCPN Medical Information Forms Quat Pump Sprayer Rubber gloves Scouring brush Throw bag
General Personal Equipment	Sunscreen

Activity	Equipment
<i>necessary for all SOPs</i>	Water Snacks

Table 2. Equipment needed for riparian vegetation sampling using a four person crew. Some equipment is used for more than one SOP but is listed under the most appropriate SOP in this table.

Activity	Equipment
Reach Establishment and Re-visits SOPs #4, 5 <i>Necessary for all visits unless noted with an E = establishment or R = re-visit.</i>	Compass with declination (2) Rangefinder (<i>E only</i>) Pin flags (minimum 21) 3/8" rebar (<i>E</i> - minimum 14, <i>R</i> - 4) Sledgehammer Pre-stamped rebar caps (<i>E only</i> , 14) Protective leather for hammering caps (old belt; <i>E only</i>) 2-way radios (4) Extra radio batteries (AA; minimum 12) Reach species list (<i>R only</i>)
Transect set-up and Point-Intercept Sampling SOPs #5, 6 <i>Necessary for all visits.</i>	100-m Kevlar taglines (2) 100-m transect tapes (2) 10-m transect tapes (2) Chaining pins (minimum 6) Point-Intercept lasers (2 plus spare) Extra laser batteries (1.5V silver oxide; 6 minimum) Screwdriver for changing batteries Laser monopods (2) Densitometer (2) Transect relocation photos (<i>R only</i>)
5-m Belt Transects SOP #8 <i>Necessary for all visits.</i>	2.5-m poles (2) Modified concave spherical densiometer (2) 15-cm DBH calipers (2) DBH tape (2)
Reach Tree Census SOP #9 <i>Necessary for all visits.</i>	Pre-stamped round aluminum tree tags (<i>E</i> - minimum 200 per reach; <i>R</i> - 50) Galvanized steel nails (<i>E</i> - minimum 200 per reach; <i>R</i> - 50) Clawhammer Tool pouch (2) List of previously tagged trees (<i>R only</i>)
Plant Identification and Unknown Plants SOP #10 <i>Necessary for all visits.</i>	2-gallon resealable plastic bags Masking tape Sharpie Trowel Plant press Newspaper for press Relevant floras and species lists
Photographs SOP #11 <i>Necessary for all visits.</i>	Digital camera (2) Extra battery for digital camera Chalkboard (2) Chalk (2)
Site Assessment SOP #12 <i>Necessary for all visits.</i>	Watch
Pebble Count SOP #13	Metric rulers (2)

<i>Necessary for all visits.</i>	
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Table 3. Equipment needed for geomorphology surveys.

Table 4. Equipment needed for hydrology sampling.

II. Field Data Sheets

Sufficient copies of all data sheets should be generated for each reach. For riparian sampling, at least half of the datasheets should be printed on rite-in-the-rain paper. All greenline and pebble count datasheets should be on rite-in-the-rain paper. Data sheets used in field measures are referenced below and can be found in Appendix A at the end of the appropriate SOP. The numbers listed are the minimum needed for each reach.

Vegetation Sampling

Reach establishment or re-visit – 1 per reach

Point-intercept – 14 per reach

Greenline – 7 per reach (perennial streams only)

5-m belt – 4 per reach

Reach census – 4 per reach

Photos – 2 per reach

Site Assessment – 1 per reach

Pebble count – 2 per reach

Unknown Plants – 10 per reach

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

Standard Operating Procedure (SOP) # 2

Training Observers

Version 1.00 (July 2010)

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

This SOP provides information to train field personnel at the beginning of the field season.

Procedures

Monitoring must be conducted in a reliable and repeatable manner. Therefore, every effort must be made to hire and retain well-qualified staff to conduct this work. Necessary skills to be acquired or honed before beginning each season's field data collection are reviewed below.

- I. Knowledge of GPS is essential. GPS units are used to navigate to reaches and to record key site information. SOP #3 should be thoroughly reviewed, and any questions should be directed to the NCPN GIS expert. Training sessions described below require field crew members to use GPS units.
- II. Plant identification skills are critical for the biological science technicians. Only field crew members with demonstrated plant identification skills should be hired. Even so, fine-tuning identification skills for NCPN plant species is still important. The NCPN Vegetation Ecologist or a field crew leader will provide training for all crew members. Training will consist of field-based identification of plants likely to be observed during the field season, with emphasis on difficult-to-identify species. Additionally, field crews will be instructed on the use of available taxonomic keys and reference materials.
- III. Permanent NCPN staff will train the biological science technicians on how to conduct geomorphic surveys as it is unlikely NCPN can reliably hire technicians with both surveying and plant identification skills.
- IV. Reach establishment and measurement procedures will be practiced prior to operational monitoring efforts. The project manager and field crew leaders will provide instruction

covering all field-based procedures. Reach establishment, site measurement methods, and site-impact procedures will be explained and demonstrated. For each of these activities, field crew members will be paired and required to exercise all procedures under the critical eye of the project manager or a field crew leader. All procedures will be exercised to the full extent, including actual recording of observations on data sheets.

- V. The permanent hydrologic technician must have demonstrated skills in installing monitoring wells and piezometers, cleaning and maintaining this infrastructure, and downloading stage data.
- VI. The crew leader or project manager will review low impact camping procedures and discuss the inherent dangers of working in remote areas on the Colorado Plateau.
- VII. Safety is a top priority for monitoring crews. Permanent crew leaders should have Wilderness First Responder or Wilderness Advanced First Aid certifications. Safety training for the crew should include reviewing the NCPN Backcountry Safety Plan and First Aid/CPR.

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

Standard Operating Procedure (SOP) # 3

Using Global Positioning System (GPS) Units

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This Standard Operating Procedure (SOP) explains the procedures and considerations that all observers should follow when navigating to and/or collecting geospatial data at riparian monitoring locations.

This SOP assumes that each observer is familiar with the operation and function of the GPS unit to be used for this project. This SOP is intended to complement, not replace, the operations manual accompanying the GPS unit. Each observer should be familiar with the use of their particular GPS unit before entering the field to collect data or navigate to points.

This SOP is divided into two main sections: 1) Riparian Site Characterization and Riparian Reach Establishment, and 2) Riparian Site Revisit. Each main section contains minimum GPS receiver requirements, followed by brand-specific instructions. The intent is to maintain a high quality of GPS spatial accuracy and collection capabilities

This SOP does not require the use of a specific brand of GPS unit; however, the unit is required to meet the minimum standards listed below.

1 Definitions and Acronyms

<i>NPS</i>	National Park Service
<i>NCPN</i>	Northern Colorado Plateau Network
<i>I&M</i>	Inventory & Monitoring Program of the National Park Service
<i>SOP</i>	Standard Operating Procedure
<i>GIS</i>	Geographic Information Systems – A computerized system used to input, manage, manipulate, analyze and display geographic data in digital form.
<i>GPS</i>	Global Positioning System (unit/receiver/datalogger) – A three part system of 1) 25+ Department of Defense satellites 2) Control segment 3) Users with receivers

<i>Coordinate system</i>	Any three-dimensional reference frame that locates objects in space.
<i>FGDC</i>	Federal Geographic Data Committee, the interagency committee that promotes the coordinated development, use, sharing, and dissemination of geographic data.
<i>Feature</i>	A physical object or location of an event. A feature can be a point, line or polygon (area).
<i>Data Dictionary</i>	Information (data) that describes features that will be located in the field.
<i>Tabular dataset</i>	A dataset organized in a table or group of tables where each column and row has a specific interpretation; often produced by Microsoft (MS) Excel, MS Access, database, or statistical software, and managed as text, spreadsheet, or relational databases.
<i>Spatial dataset</i>	A dataset that is natively read by mapping software; often produced by mapping software, such as ESRI ArcMap and ArcInfo; also includes georeferenced imagery, geodatabases, as well as hardcopy aerial photographs, satellite imagery and maps.
<i>Raw data</i>	Data that have not been subjected to either quality control or documentation procedures; includes data recorded by hand on hard-copy forms, digital files from handheld devices, GPS receivers, telemetry data loggers, etc.
<i>Certified data</i>	Finalized project data, i.e., data that have undergone thorough quality assurance and screening as well as complete documentation.
<i>Working database</i>	A project-specific database for entering and processing data for the current season (or other logical period of time). This might be the only database for short-term projects where there is no need to distinguish working data for the current season from the full set of validated project data.
<i>Master database</i>	Project-specific database for storing the full project data set, used for viewing, summarizing, and analysis. Only used to store certified data.

2 Site Verification and Reach Establishment

The NCPN ecologist predetermines riparian reach monitoring locations (specific XY coordinates in UTM NAD83). The NCPN requires the use of a mapping grade GPS unit to record these plot locations.

2.1 Minimum GPS Receiver Requirements

- Capable of uploading pre-determined riparian monitoring locations
- Capable of utilizing data dictionary utilities (NCPN Riparian Data Dictionary, see section 2.3)
- Capable of utilizing park-specific background GIS data layers
- Capable of navigation
- Capable of maintaining 4 or more satellites

- Capable of maintaining horizontal errors of less than 5 meters (PDOP (or equivalent error reading) of less than 6)
- Capable of post data collection correction (differential correction)
- Capable of storing date, time, elevation and coordinates of features collected (in addition to data dictionary items)
- Capable of exporting features collected to a GIS data format

2.2 GPS Unit Setup

The NCPN currently uses the Trimble line of mapping grade GPS units and TerraSync software to capture the spatial data for the riparian monitoring reach locations. The requirements should be transferable to other mapping grade GPS receivers (such as Leica etc.).

Positional accuracy can be affected by several factors which mapping-grade GPS units can track and to some extent, compensate for. Table 1 lists these functions, their definitions, and the standard settings.

Table 1 Minimum GPS Receiver Settings Standards

Name	Definition	Standard
Almanac	GPS unit collects data containing estimated position of satellites, time corrections, and atmospheric delay parameters.	The unit will automatically collect the almanac. Acquire within 10 days prior to data collection or navigating, download to computer.
Altitude reference	Ellipsoid model	Height Above Ellipsoid (HAE)
Antenna heights	GPS unit height above the ground (average).	1.0 – 1.5 meters
Coordinate System	A reference system consisting of a set of points, lines, and/or surfaces, and a set of rules, used to define the positions of points in space in either two or three dimensions.	Universal Transverse Mercator (UTM)
Datum	Geodetic model designed to fit a point on the earth's surface to the ellipsoid.	NAD 1983 (Conus)
Elevation mask	The minimum angle at which a GPS receiver will track satellite vehicles.	15 degrees
Logging intervals	Time interval between positions gathered.	Point: 1 second Line and Polygon: 5 seconds
Minimum number of positions for a point feature	Number of positions received then averaged to create a point feature.	10
Mode	2-Dimensional or 3-Dimensional	3-Dimensional (4 satellites)
PDOP Mask	Positional Dilution of Precision is a measurement of the geometry of the satellites.	6.0 or less
Satellite vehicles	Number of satellites, currently a constellation of 28 DOD satellites.	4

Name	Definition	Standard
SNR Mask	Signal-to-Noise Ratio is a measure of the strength of the satellite signal relative to background noise.	4.0
Unit of Measure	Units of measure.	Meters
Zone	In UTM coordinate system, the globe is divided into 60 north-south zones.	Zone 12 North (N)* *Black Canyon & Curecanti are Zone 13 N

2.3 Data Dictionary

A data dictionary should be utilized to facilitate field data collection as well as assuring necessary data items are (correctly) collected. The minimum elements necessary for the riparian data dictionary are shown below. Once the project lead has given the GIS technician all potential riparian points for a given park in a given year, those points are then imported with the Riparian data dictionary (using Pathfinder Office), creating a data file for Reach Establishment ([park_est.imp](#)). All point features in the Riparian Data Dictionary should have the default feature settings of:

Logging Interval	Time = 1 second
Minimum Positions	3
Accuracy	Code
Label 1	ReachID

The following data dictionary digital file (.ddf) can be obtained by contacting the NCPN Data Management staff.

Reach Establishment Center Point Feature

The reach establishment point should be used to locate the center point of the riparian monitoring reach. Once the location has been evaluated as an acceptable or rejected riparian monitoring reach (see SOP #4), fill in the S_Action as “Accept” or “Reject.”

EstPlotCenter Attributes	Attribute Explanation	Entry	Type
ReachID	Numeric unique ID from Project Lead	Entry not permitted in the field	Numeric
S_Action	- Accept – decision to accept the site as an acceptable riparian monitoring location - Reject – decision to reject the site as an acceptable riparian monitoring location	Entry permitted in the field	Menu
StreamName	Displays the stream/canyon name. This is pre-populated.	Entry not permitted in the field	Text
Comments	Any comments regarding the site	Entry permitted in the field	Text – Optional

Transect Start and End Points Feature

For riparian monitoring, there are seven transects per monitoring plot. Each transect beginning and end point needs to be GPSed and identified.

Transects Attributes	Attribute Explanation	Entry	Type
ReachID	Numeric unique ID from NCPN ecologist	Entry permitted in the field	Numeric
Trans_Point	- T1_Left (Transect 1, river Left) - T1_Right (Transect 1, river Right) - T2_Left (Transect 2, river Left) - T2_Right (Transect 2, river Right) - T3_Left (Transect 3, river Left) - T3_Right (Transect 3, river Right) - T4_Left (Transect 4, river Left) - T4_Right (Transect 4, river Right) - T5_Left (Transect 5, river Left) - T5_Right (Transect 5, river Right) - T6_Left (Transect 6, river Left) - T6_Right (Transect 6, river Right) - T7_Left (Transect 7, river Left) - T7_Right (Transect 7, river Right)	Entry required in the field	Menu
RebarMeters	Distance, in meters, from the right transect point to the left transect end point.	Entry permitted in the field	Numeric
Comments	Any comments regarding the site	Entry permitted in the field	Text – Optional

Other Optional Point Locations (incidental observations worth recording) Feature:

This point feature is for incidental observations the monitoring crews may encounter. For example, if you found lithic scatter or invasive exotic plant community or wanted to mark

a particularly good way to get to the reach, you may want to mark that location with this point feature, briefly commenting why you marked the location.

OtherPt Attributes	Attribute Explanation	Entry	Type
Comment	Incidental observation comment	Entry permitted in the field	Text – Optional
Comment2	Incidental observation comment	Entry permitted in the field	Text – Optional

Routes to Reaches

This line feature is for mapping routes to riparian monitoring reaches that seem somewhat difficult to locate. Once all data collection is complete, on the hike out from the reach, this feature can create a route or trail for future field crews to easily locate the monitoring reach.

Route Attributes	Attribute Explanation	Entry	Type
ReachID	unique ReachID	Entry permitted in the field	Text – Optional
Comments	Incidental observation comment	Entry permitted in the field	Text – Optional

All other data required from the GPS unit can be automatically downloaded from the GPS unit (see section 2.6).

2.4 Uploading possible monitoring locations

Mapping grade GPS units have the ability to upload data points to be used in concert with the data dictionary. The (potential) riparian monitoring points are imported with the Riparian Data Dictionary by the NCPN GIS technician. Importing points (uploading) to the GPS unit eliminates possible reach mis-identification in the field, as well as allowing the user to navigate more easily to a riparian reach.

Also, background data layers can be used to assist with navigation. The two GIS data layers found most useful as background layers have been 1) roads and trails and 2) hydrography, both combined with the park boundary.

2.5 Collecting data

Once you've navigated to the reach (or potential reach), it's time to collect the GPS locations necessary. Appendix A contains detailed instructions for use with the Riparian data dictionary and various files. Open the file necessary, and begin logging the point and any required data. Each point collected should be allowed to receive 10 positions before ending data collection and moving onto collecting another type of point. Given the terrain of many of the riparian monitoring locations, the liberal use of the offset feature is recommended.

2.6 Downloading

When data collection is finished, the GPS data needs to be downloaded. The NCPN GIS technician downloads the data from the GPS unit(s) after each field excursion, and then differentially corrects the data, using the appropriate (closest) base station. The corrected GPS files are then exported to a GIS data format. Table 2 indicates the attributes to capture while exporting the corrected GPS data into a GIS data format ("turn on" in Pathfinder Office).

Table 2 GPS Auto-generated Attributes to Capture

PDOP	Update Status	Height
Correction Status	Data File Name	Vertical Precision
Receiver Type	Total Positions	Horizontal Precision
Date Recorded	Filtered Positions	Standard Deviation
Time Recorded	Data Dictionary Name	Position

Data should be exported using the same coordinate system used in the field (UTM, NAD83 Conus, Zone 12 or 13, meters).

2.7 Uploading to the master Riparian Database

Once the GPS field data are validated & verified (GPS points given a visual review, compared to GRTS coordinates, transect plot ID attributes verified) in ArcMap, the data are ready to be uploaded into the working Riparian Database. The GPS data are exported from ArcMap into an Excel spreadsheet for importing into the Riparian Database (see [SOP #13, section 3.1](#)).

3 Riparian Reach Revisit

Once reaches are established, no new data will be collected with a GPS unit when the site(s) are revisited. GPS units will be used primarily for relocation of and navigation to and from the riparian transects. This allows for the use of recreational grade GPS units (Garmins, Magellans, etc.) rather than the sometimes heavier and larger mapping grade GPS units. Mapping grade units certainly can be used to navigate to plots ready to be revisited; however, the following steps demonstrate how one could utilize a recreational GPS unit.

If it becomes necessary to physically move a transect endpoint, the field crew should GPS the endpoint with the Garmin (or other recreational) GPS unit. In addition, a distance (in meters) and bearing should be taken from the old endpoint to the new endpoint. Both data sets should be given to the GIS technician, who will determine the new coordinates for the plot, and pass those updated coordinates to the Data Manager for incorporation into the Riparian database.

3.1 Minimum GPS Receiver Requirements

- Capable of uploading previously visited riparian monitoring transect locations (XY points)
- Capable of storing date and coordinates of features collected.
- Capable of exporting features collected to a format that can be used by GIS
- Capable of maintaining an EHE (Estimate of Horizontal Error) of less than or equal to 12 meters. Maintaining an EHE (or EPE – Estimate of Positional Error) of 12 meters or less meets the National Map Accuracy Standard.
- Capable of tracking a minimum of 4 satellites
- Capable of collecting real-time differentially-corrected positions (DGPS)

3.2 GPS Unit Setup

The riparian monitoring reaches which are to be revisited in a given year will be given to the NCPN GIS technician. These locations (XYs of the plot centroid as well as all fourteen transect beginning and end points) will then be uploaded into any recreational grade GPS unit for relocation purposes. If using a Garmin GPS, data transfer is enhanced by utilizing the freeware DNRGarmin (<http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions.html>). Background maps of the area(s) to be visited should be uploaded from Map Source as well. Once the data are transferred to the GPS unit, the GPS unit is ready for field use.

The GPS unit should be configured with the settings in Table 3.

Table 3 Minimum GPS Receiver Settings

Name	Standard
Projection (displayed coordinates)	UTM
Datum	NAD 83
WAAS	Enabled (on)

Attachment A

File Explanations:

Existing Data Files on GPSes:

- *Park_est* – (Park Reach Establishment) This file also contains potential center points of riparian monitoring reaches.

Background Layers (Files):

- *PARK_RdsTrls* – This file contains the roads and trails for PARK, and the park boundary.
- *PARK_Strms* – This file contains the “streams” (hydrography) for PARK, and the park boundary.

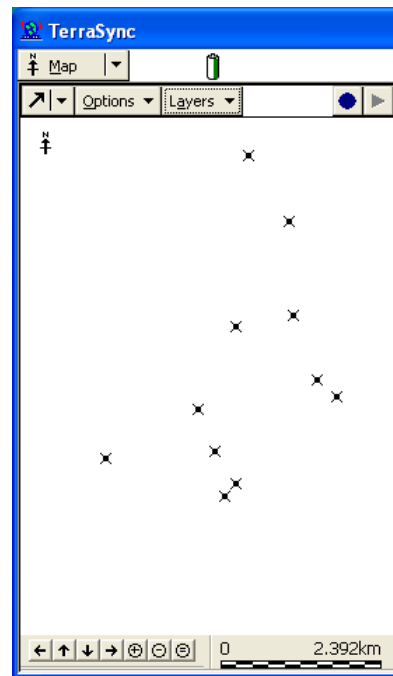
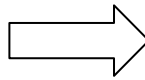
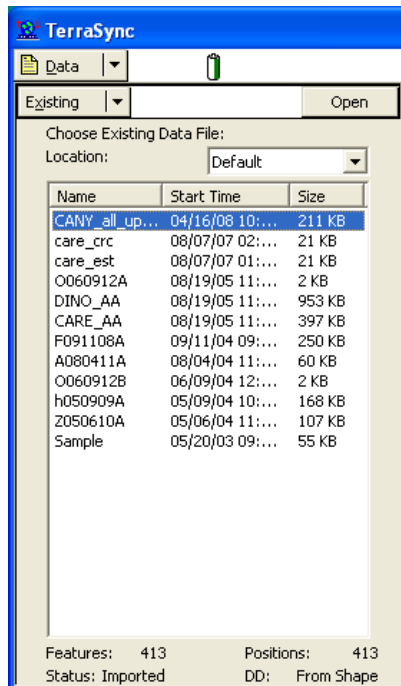
Basic instructions:

The following instructions are based on using a Trimble GPS unit with TerraSync Professional GPS software loaded.

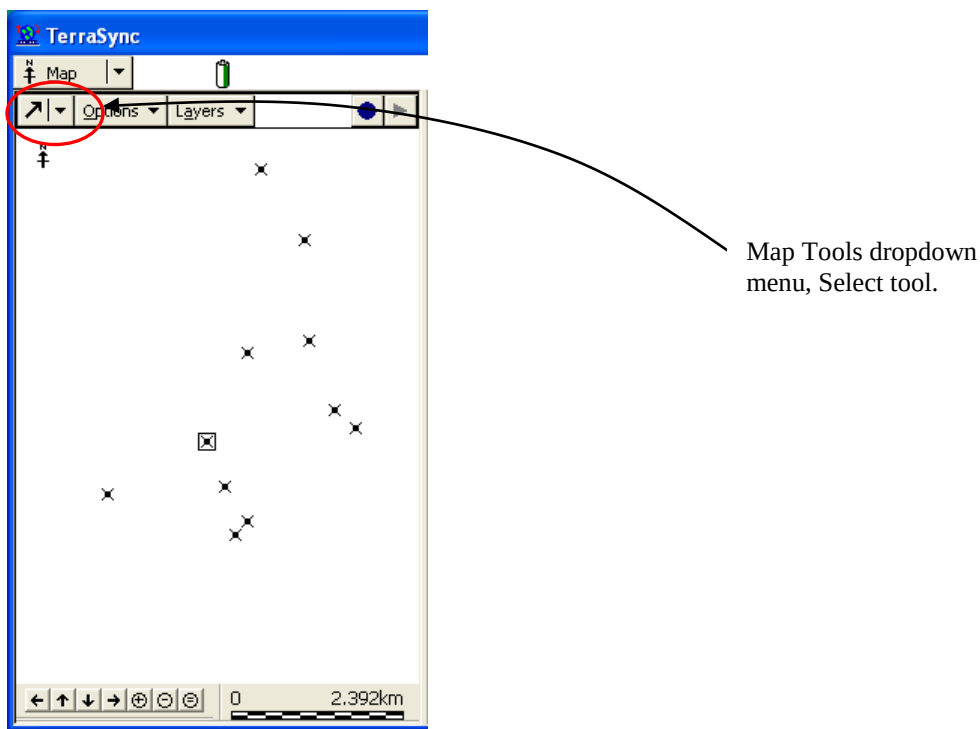


Navigation:

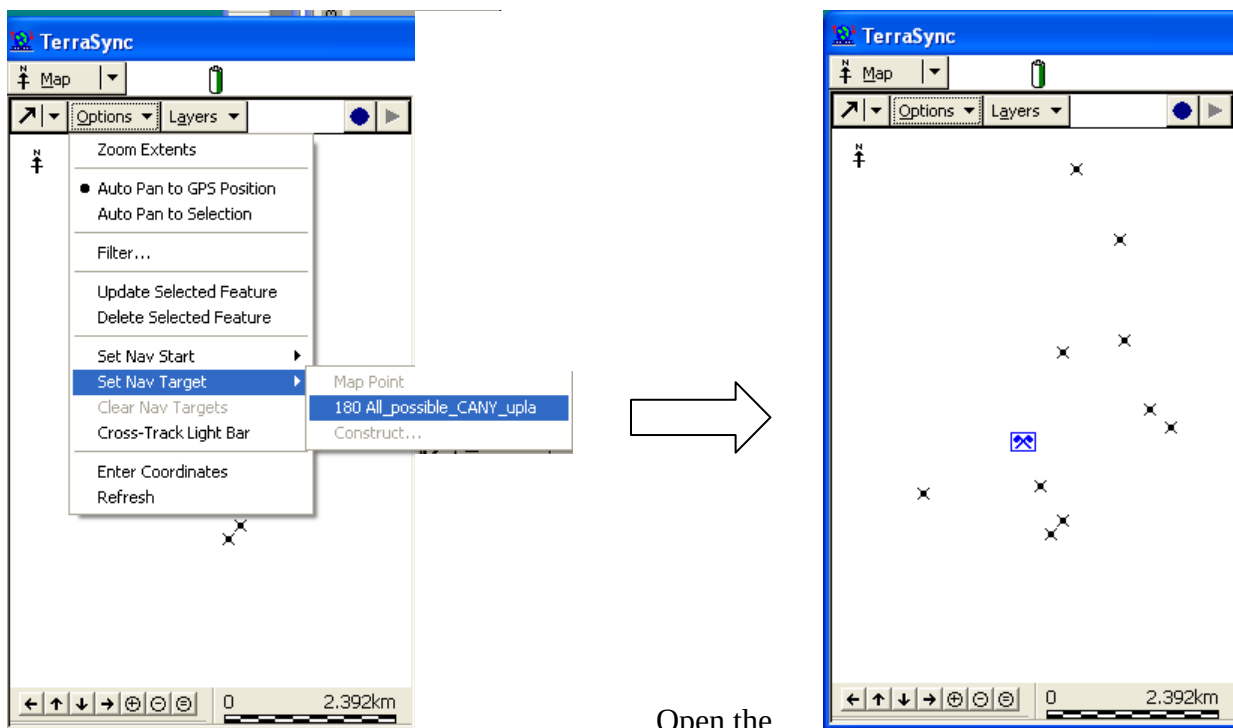
To navigate to a point, open the file which contains the point you want to update. Change the screen to the Map View (click on the Data drop down, and choose Map).



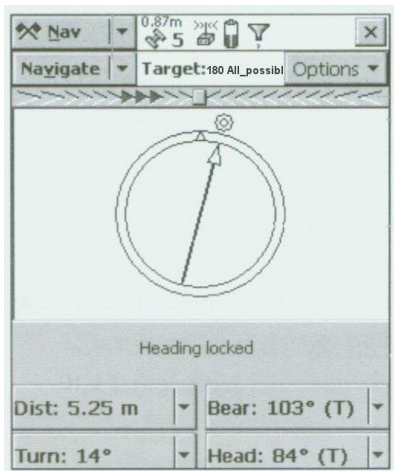
Using the Tools (the down menu directly underneath Map), use the Select tool to select the point to which you wish to navigate. A box will display around the point. Map drop



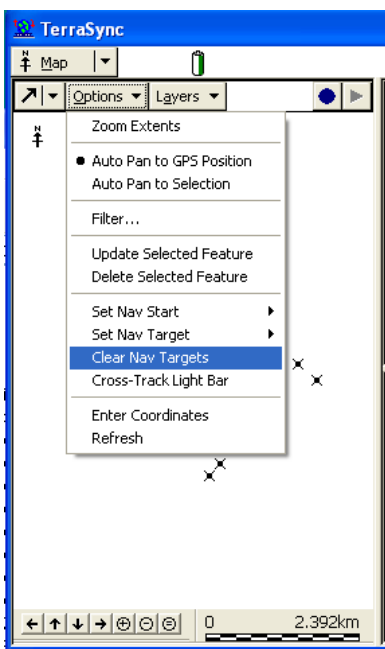
Click on the Options button, then Set Nav Target, then the point file name. The selected point will then be displayed with the target icon.



Open the Navigation section (click on Map and chose Navigation). This will open the navigation screen. As you move, this screen will display the information needed to navigate to the point.

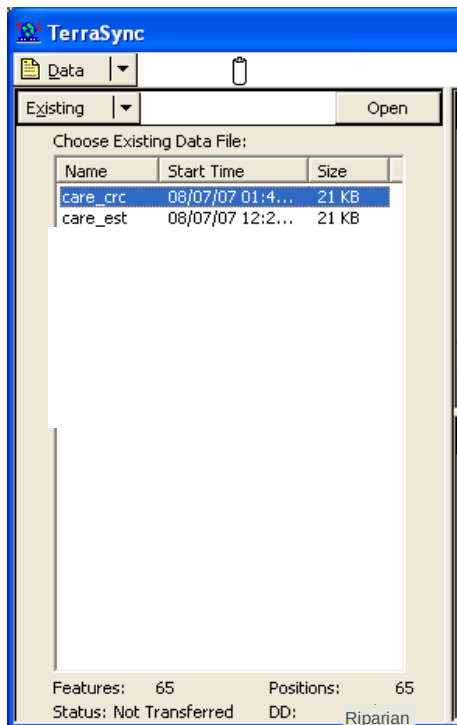


When you've reached your point and/or no longer need to navigate, select the Map screen, then go to Options and select Clear Nav Targets.

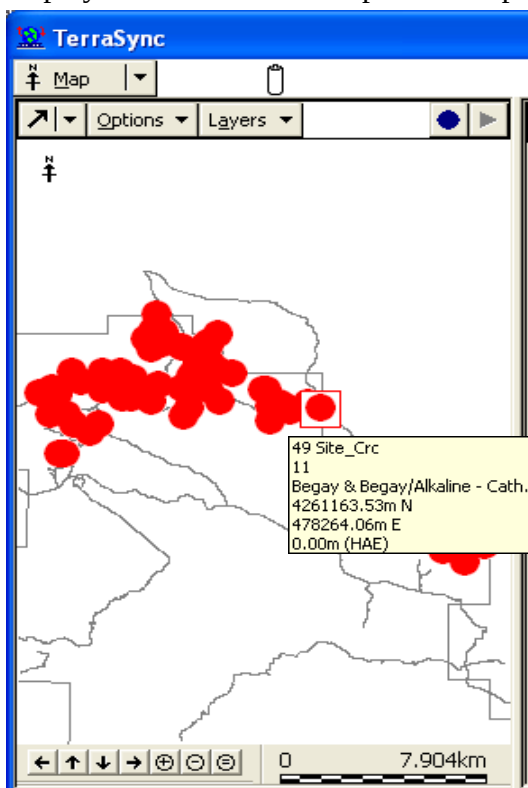


Data Collection:

For site recon and/or navigation, open up park_crc:



Change the view from the Data view to the Map view (upper left dropdown menu). In this example, the background file is “CARE_RdTrls”, so all the roads and trails are displayed in addition to the potential riparian monitoring reaches.



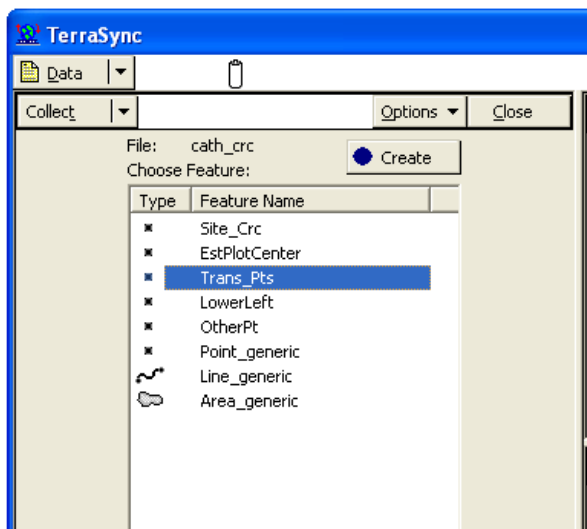
Note that the PlotID (11) and ecosite/allotment (Begay & Begay/Alkaline – Cath) are displayed. The second label (ecosite/allotment) does not always have data displayed.

Double click on a point from the map screen

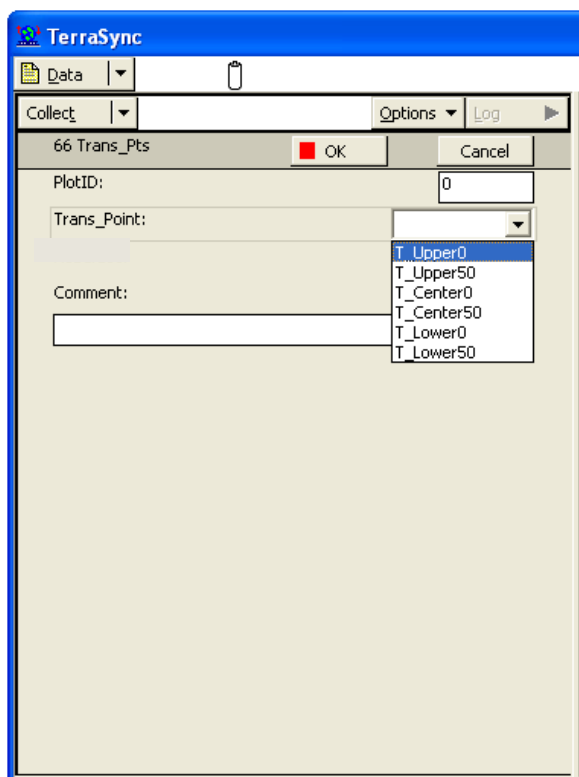
to bring up the data dictionary. You'll notice the only field to fill in is the S_Action field (either Accept or Reject).

If you are **establishing** a monitoring reach (after you've navigated to the location), under Data and then Update, choose Collect Features.

This will put you into the data dictionary, where you can log the Trans_Pts (transect beginning and end points).



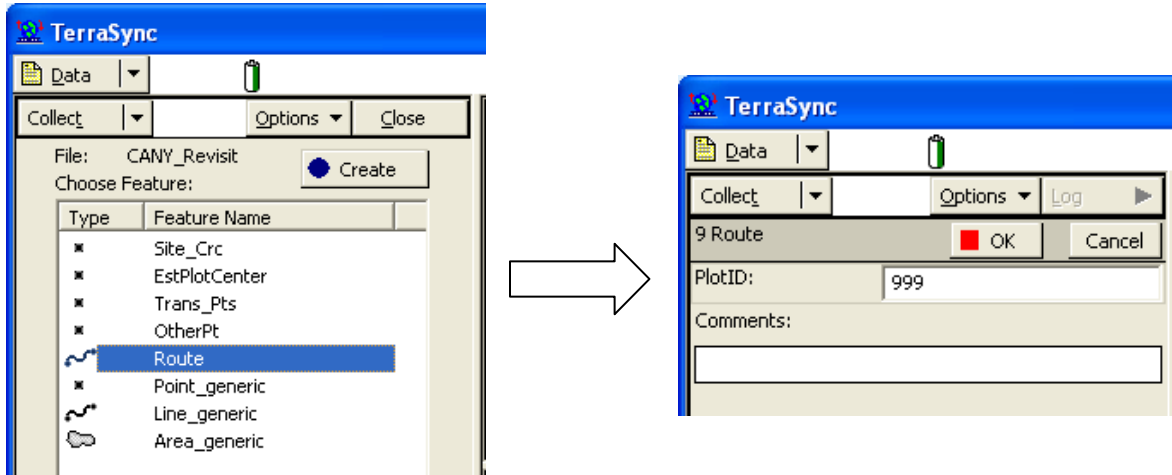
For the Transect points, you'll need to enter both the ReachID and which transect point it is. Per reach, you need to take fourteen transect beginning / end points.



Creating Trails/Routes:

If you feel that the reach you've visited is difficult to navigate to and/or hard to find, you may want to GPS the route you take out. This route can then be shown to future field crews to enable them to get to the reach efficiently.

To map the route (trail) from the reach, click on Data/Collect and click on Route, which will bring up a field to fill in the ReachID and any brief comments you'd like to add:



As you walk along, the GPS unit will collect a point every 3 seconds. You don't need to do anything until you get to the end (as in, back to the paved road or trail or whatever). At that point, just click OK to end, close and save the feature.

Hints for Trimble units:

- Log a point for a minimum of 10 “hits” (about 10 seconds).
- Holding the power button down for 30 seconds will soft re-boot the XM GPS. Holding the power button down for 60 seconds will hard re-boot the XM GPS. Neither of these re-boots will loose any data, but you should recheck the coordinate system.
- To re-boot the Junos, there is a little hole on the top left side (next to the expansion card). Push that with the tip of the stylus to re-boot the Juno.
- To conserve on battery life (generally 8 hours on XMs and 4+ hours on Junos), turn the unit off if you aren’t using it to navigate. It is recommended that TerraSync be closed *prior* to turning off the unit.
- The NCPN has a copy of the TerraSync Guide, which goes into more detail about the many functions of TerraSync. Please contact the GIS technician if you would like to take a look at it.
- Report any idiosyncrasies with the Trimble GPSes to the NCPN data management staff.

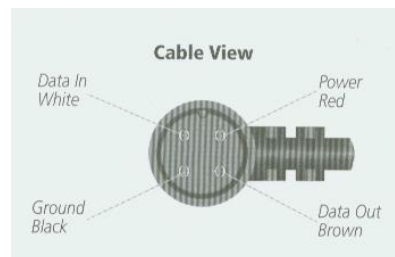
Attachment B



This graphic demonstrates the keys of a Garmin 76 GPS unit, and their functions. These keys are referred to in the following instructions.

1. To Connect GPS to Computer

- Either a serial or USB port cable will accompany the GPS unit. This is the cable that connects the GPS receiver to your workstation computer, allowing the uploading and downloading of waypoints.
- The serial or USB end of the cable attaches to your workstation computer. The other cable end (below) inserts into the Garmin GPS unit (lift bottom of black flap on the back of the GPS unit)



2. To change the displayed map projection:

- Turn on the unit by depressing the POWER key
- Set Projection
 1. Access the Main Menu (press the MENU key twice)
 2. Using the rocker key, scroll down to Setup and press the ENTER key
 3. There are several tabs listed (General, Time, Units, Location, Alarms & Interface) – using the rocker key, scroll over to the Location tab. Scroll down with the rocker key to Location Format and press the ENTER key.
 4. Scroll down the list of formats to UTM UPS, make sure this choice is highlighted, and press the ENTER key.
 5. Scroll down to Map Datum, press the ENTER key. Scroll down through the Map Datum choices, press the ENTER key when NAD 83 is highlighted.
 6. Press the PAGE key to get back to the “GPS Information” screen. (If the GPS Information screen is not showing, press the PAGE key; it will cycle through the screens). The bottom of the screen should now be displaying coordinates as UTM.

3. Set GPS to log differentially correct data

- If not already on, power up the GPS
- Enable WAAS
 1. Access the Main Menu (press the MENU key twice)
 2. Using the key, scroll down to Setup and press the ENTER key
 3. There are several tabs listed (General, Time, Units, Location, Alarms & Interface) – using the rocker key, scroll over to the Location tab. Scroll down with the rocker key to General and press the ENTER key.
 4. Scroll down to WAAS, press ENTER, highlight Enabled, and press ENTER
 5. Press the PAGE key to exit Setup

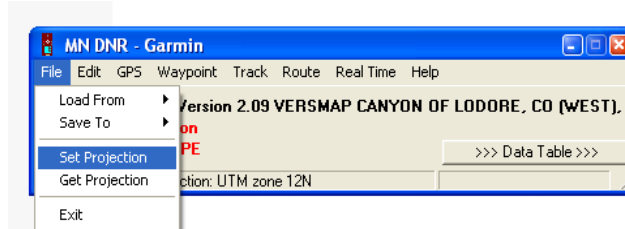
4. In the Field - optional

- Collect (or mark) a waypoint
 1. When at the observation location, check the GPS Information page for number of satellites (4 or more needed) and accuracy (12 meters or less)
 2. Press and hold the ENTER/MARK key until the Mark Waypoint Page is displayed.
 3. Using the Rocker key, change the waypoint ID.
 4. Using the Rocker key, highlight “OK” and press ENTER
- Navigation
 1. Press the NAV key
 2. Select ‘Go To Point’ then press the ENTER key
 3. Select ‘Waypoints’ then press the ENTER key
 4. Select ‘your point’ then press the ENTER key

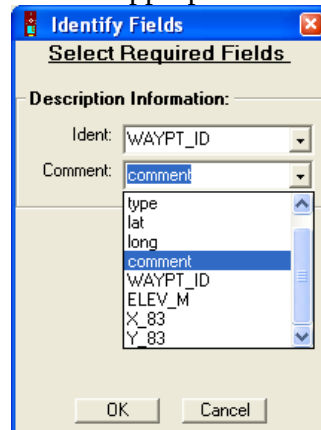
5. Highlight the 'GoTo' button, press ENTER
6. As you start walking, the Pointer will point to your destination

5. Upload Background Data

- Upload background maps from MapSource (proprietary software) if needed
- Upload waypoints using DNR Garmin
 1. Connect GPS to the computer
 2. Turn GPS on, then open DNR Garmin, it will connect to the computer
 3. When the MN DNR – Garmin window opens, make sure that the projection is set to UTM, NAD 83, zone 12N (unless at CURE or BLCA, which are zone 13N). Go to File, then Set Projection to change projection.

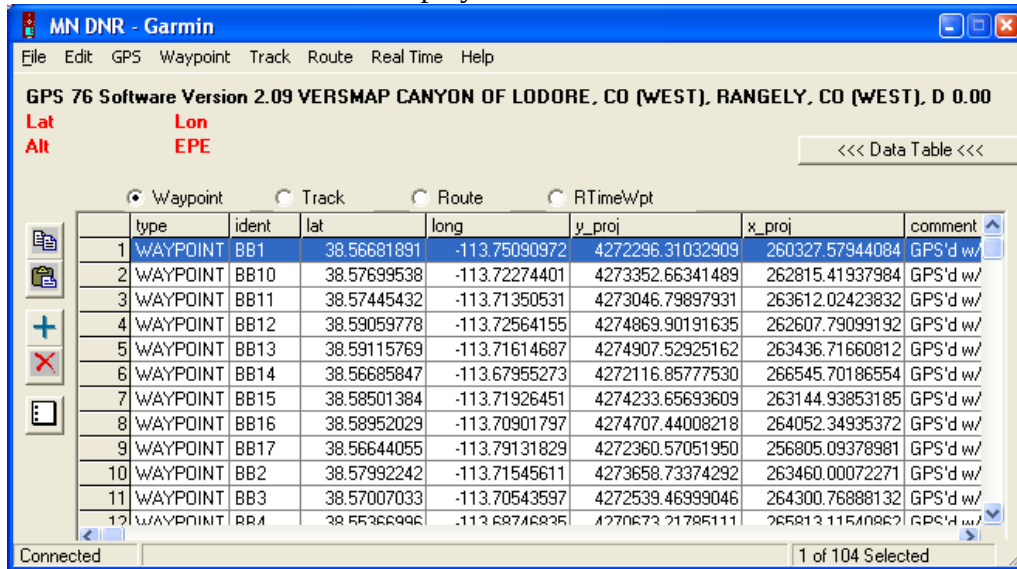


4. Click on File, then Load From. You can upload a .txt file, .dbf file or a shapefile. Navigate to the file you wish to upload and click Open.
5. A window will open prompting you select description information. Choose appropriate fields for Ident (ID) and Comment and click OK.



6. A window will open stating "File was loaded successfully from...", click OK

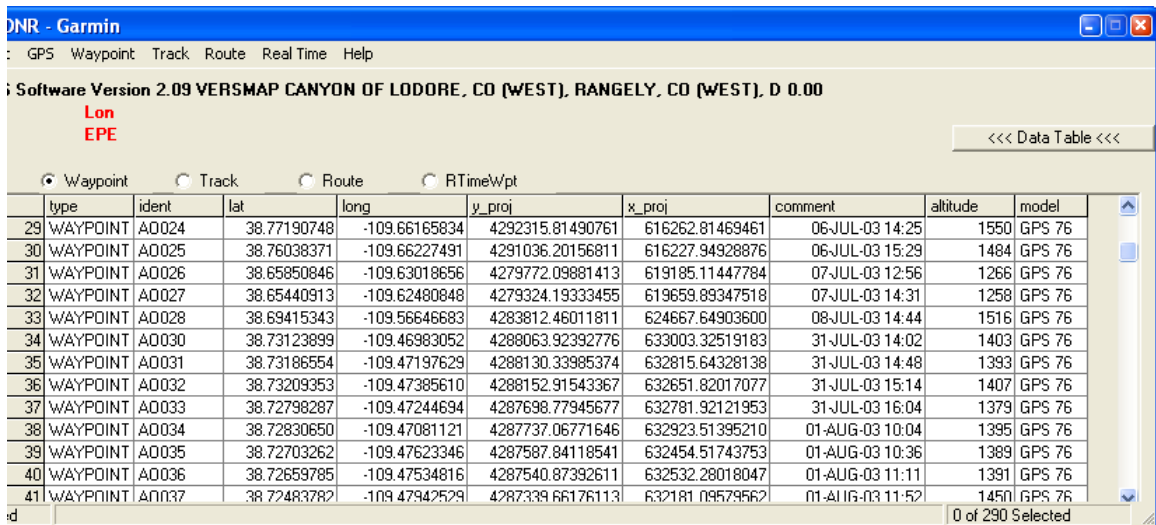
7. Points will be displayed in the MN DNR – Garmin window.



8. If the points are correct, click on WAYPOINT on the top menu, then Upload
9. A window will pop up stating “Transfer Complete. # points uploaded”

6. Downloading Waypoints

- Download waypoints using MN DNR Garmin freeware
 1. Connect the GPS to the computer and turn on the GPS unit, then open the program DNR Garmin on the computer
 2. From the DNR Garmin main menu, click on Waypoint, then Download. Your data will appear in the MN DNR Garmin window (see below). Elements to be included in the downloading process are: type, ident, lat, long, y_proj, x_proj, comment, altitude & model. These fields can be chosen by choosing Waypoint from the main menu, then Waypoint Properties and checking only those fields.



3. Click on File, and then Save To. Navigate to the proper folder on the computer where GPS files are stored.
4. There are several file types which you can save the file as. The NCPN recommends saving the data as a projected shapefile (*.shp) file.
5. Name the file with the date of download in the file name (example: Riparian_June10_09.shp) and click the Save button. A window will display “File successfully written to ...”

NCPN Integrated Riparian Monitoring Protocol**SOP #4 Establishing the Sample Reach
Version 1.0 (November 2008)****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 #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 with declination
- Range finder
- Pin flags (minimum 21)
- 100 m Kevlar tagline
- 100 m tape
- Rebar (14, minimum; ½ inch (1.25 cm))
- Sledgehammer
- Rebar tags marked with transect numbers
- Galvanized 12 gauge wire
- Wire cutters
- Tree tags
- Galvanized steel nails
- DBH tape
- Clawhammer
- Field note books
- Datasheets
- Pencils/ extra pencil lead/ erasers/ pens/ sharpies
- Camera
- Chalkboard
- Chalk

Sampling Teams

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

Procedures:

Site Verification

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 whenever possible. On longer streams, multiple random, spatially balanced points will be generated using a Generalized Random Tessellation Stratified design (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.
 - Good indicator species of the active riparian zone include *Salix exigua* and *Baccharis* spp.
 - 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.
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. 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.

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.

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.

3. No 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 GRTS point for evaluation.

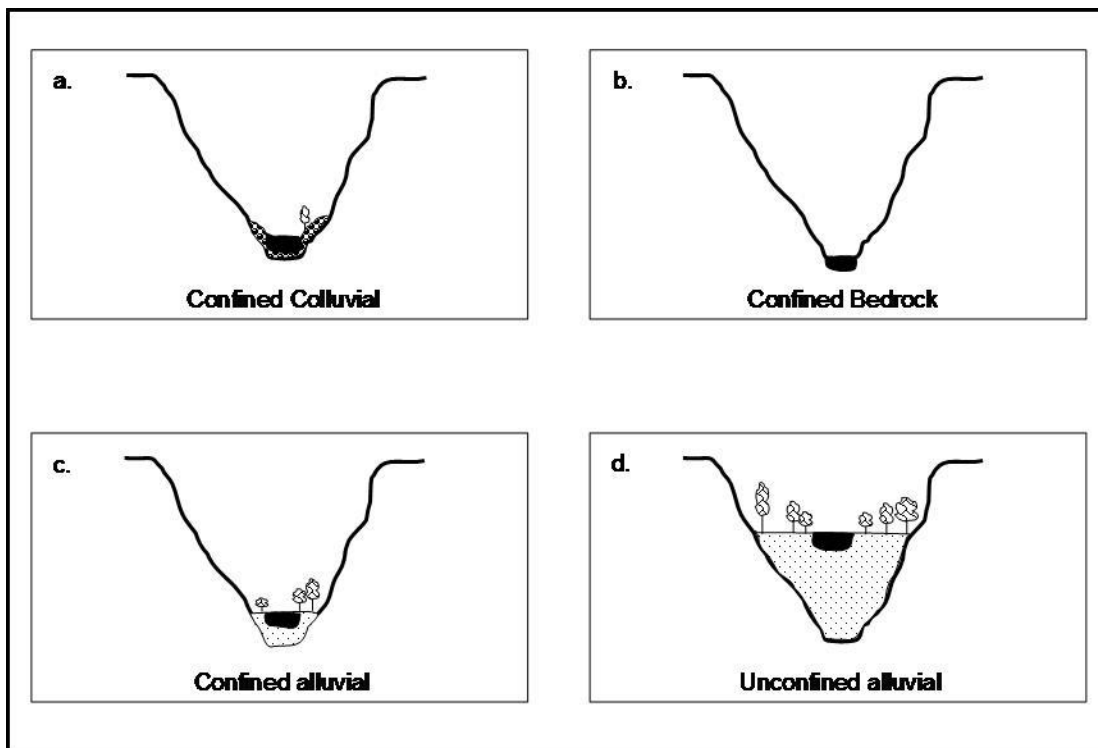


Figure 1. Idealized stream channel valley settings, including (a) colluvial, (b) bedrock, (c) confined alluvial, and (d) alluvial or unconfined alluvial. Colluvial material is

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

Record directions to the reach.

Write directions assuming that they will be used to relocate the site by someone who has never been to the reach before. Begin with road travel from a designated location (such as the park's visitor's center), where to park, and the route used. Describe (and photograph) landmarks used in navigating to the reach centroid. Note particular obstacles or hazards to be avoided at and en route to this particular site. Use specific language such as "southwest" and "downslope" rather than ambiguous terms such as "left" or "below."

Establishing a monitoring reach

A confirmed monitoring reach consists of 7 transects with a maximum length of 100 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 or the stream bank 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.

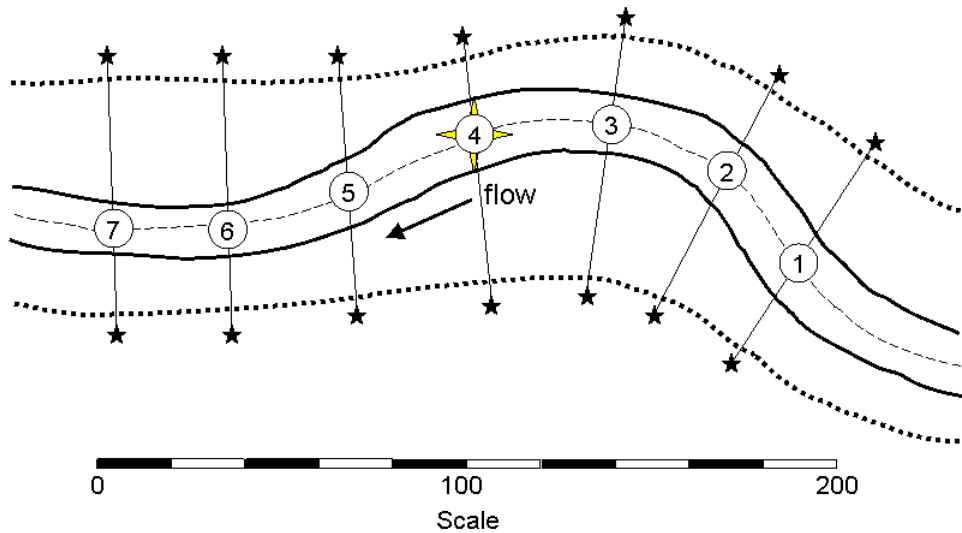


Figure 2. Features of an established sampling reach. “4” is the centroid, star symbols indicate locations of headpins, and the dotted line represents the upland-riparian zone boundary.

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. Starting at the center of the transect, have two crew members walk in opposite directions perpendicular to the channel setting (Fig. 2). 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.
2. 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 (landslides, slumps, rockfalls, gullying, etc.).
 - If stable surfaces are >100 m apart, headpins may be located on relatively stable surfaces (e.g., 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, documenting with witness trees (see below).
3. Mark the location with an appropriately numbered pin flag. If on bedrock, make a 2-rock cairn or stand in place.
4. Stand over the pin flag, and confirm with the other crew members that the transect line is still perpendicular to the channel setting.

5. 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 5 cm of the ground surface.
- If on bedrock, mark the location with chalk and place a headpin in line with the transect in the nearest possible stable location. The two pieces of rebar should be a minimum of 20 m apart. Document the distance from the rebar to the end of the transect to the nearest 0.5 m.

6. Inscribe the reach number and transect number (e.g., 1-4 for Reach 1, Transect 4) on a metal tag or rebar cap. Tags can be prepared beforehand in the office or in camp.

7. Attach the metal tag to the rebar using galvanized wire or gently hammer the cap onto the rebar, protecting the cap with a leather strip.

8. Record the location of the permanent headpin using a mapping grade GPS unit (Trimble XM). Record 10 points for each headpin (see SOP #3).

- 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.
- If the headpin is more than 5-m away from the actual transect origin or end due to unstable surfaces or bedrock, also record points for the unmarked origin or end.

9. Record the bearing of the transect in degrees (from right headpin to left headpin). Use true north (i.e., set declination).

10. Take photographs to document the location of the headpins and unmarked origin or end (if necessary), including the cliff line or other recognizable landmarks in the background.

- Label a chalkboard with the park code, reach 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 recognizable landmarks.
- 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.

- Drive a nail into the tree at BH, so that the aluminum tree tag hangs down and away from the tree and several centimeters of nail remains exposed, leaving ample space for tree growth.
- 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.

- If channel sinuosity is such that adjacent transects cross, establish the transects as described above. Sampling proceeds as usual with the exception of collecting belt transect data (SOP #8).

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 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. 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.

Setting up long transects and/or transects through thick brush

On many occasions, it may not be possible to align the headpins and transect center from one 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, etc.). In cases where it is impossible to see the entire transect by any means, use a compass to proceed at the proper bearing, leapfrogging with crew members in visible positions until you reach the transect headpin. It is helpful in these situations to tie flagging tape to properly aligned vegetation as you go.

Appendix A.

Reach Establishment Datasheet

Reach Establishment Datasheet

Data entered by: _____

Data verified by: _____

NCPN 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
 other (describe): _____

Centroid UTM's: Zone _____ N _____ E

Active Riparian Zone Width (m): _____

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

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

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

Directions to Reach: _____

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

Transect

Coordinates

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

Reach Establishment Datasheet

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Witness Trees

Monument	Tag #	Species	DBH (cm)	Bearing (°)	Distance to rebar (m)
T1 - La					
T1 - Lb					
T1 - Lc					
T1 - Ra					
T1 - Rb					
T1 - Rc					
T2 - La					
T2 - Lb					
T2 - Lc					
T2 - Ra					
T2 - Rb					
T2 - Rc					
T3 - La					
T3 - Lb					
T3 - Lc					
T3 - Ra					
T3 - Rb					
T3 - Rc					
T4 - La					
T4 - Lb					
T4 - Lc					

Monument	Tag #	Species	DBH (cm)	Bearing (°)	Distance to rebar (m)
T4 - Ra					
T4 - Rb					
T4 - Rc					
T5 - La					
T5 - Lb					
T5 - Lc					
T5 - Ra					
T5 - Rb					
T5 - Rc					
T6 - La					
T6 - Lb					
T6 - Lc					
T6 - Ra					
T6 - Rb					
T6 - Rc					
T7 - La					
T7 - Lb					
T7 - Lc					
T7 - Ra					
T7 - Rb					
T7 - Rc					

NCPN Integrated Riparian Monitoring Protocol

SOP #5 Relocating and Setting Up Vegetation Transects Version 1.0 (November 2008)

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

Sampling Teams

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

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 5 cm of the surface. Each headpin has a tag 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 UTM's, 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 right as you face downstream.
 - 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 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.
 - Check the length of the transect at establishment to make sure you have the correct length during a re-visit.
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 (Fig. 1).
 - Obstructing branches can be moved or tied back with flagging.
7. Attach the tagline and/or transect tape to the temporary rebar on river left.
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.

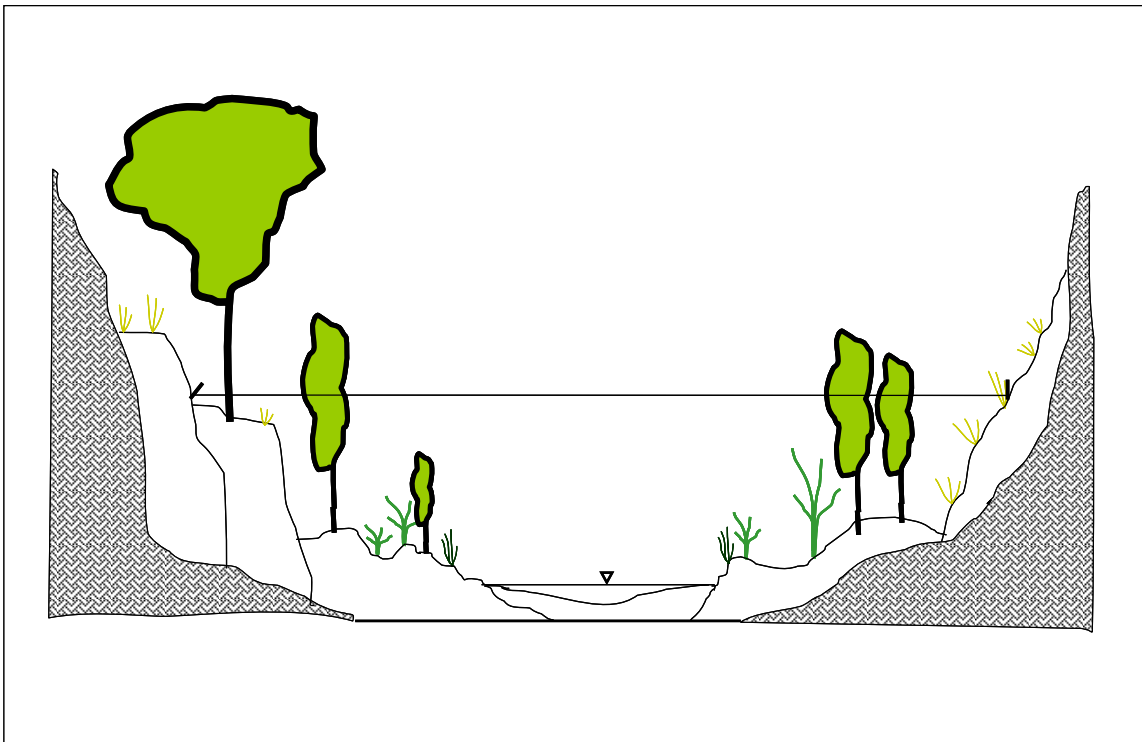


Figure 1. Diagram of Kevlar tagline established between two rebar headpins. Always establish taglines as taut as possible. If the line runs through vegetation, make sure that branches do not cause the line to bend. Vertical elevations are exaggerated in this diagram.

NCPN Integrated Riparian Monitoring Protocol

SOP #6 Measuring Understory and Surface Features Using a Point Intercept Transect

Version 1.0 (November 2008)

Revision History Log:

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

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. Point intercept methods are adapted from Herrick et al. (2005a, b).

Equipment

- Point-Intercept Laser
- Point Intercept Datasheets
- Clipboard
- Pencils, extra pencil lead, and erasers
- Plant press
- Hand lenses
- Plant species list for ecological site or park
- Plant identification keys as needed
- Write-In-Rain blank data sheets (to avoid confusion with regular paper, keep labeled)
- 2.5 m pole
- Pinflag

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.

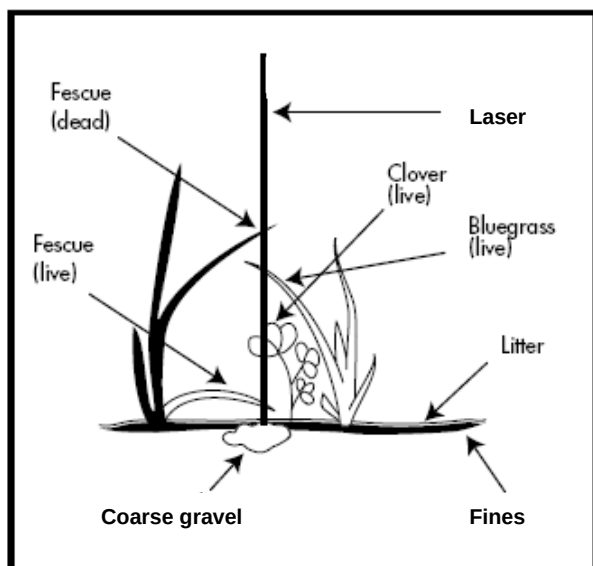
Date: mm/dd/yyyy

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

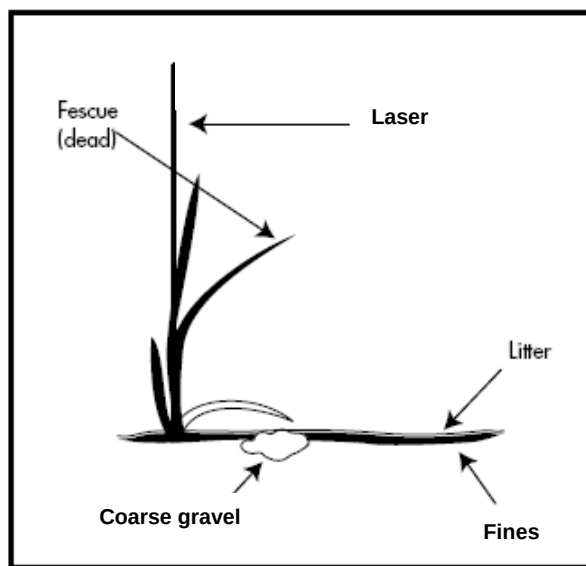
- A. Stand on the downstream side of the transect and work from river right to river left.
- B. Start at 0.5 m on the tape and move forward 0.5 m for each consecutive point. The final point sampled is the last half meter interval before the transect endpoint.
- C. Position a fully extended monopod (1.5 m tall) at the correct point on the tape with the laser extending out perpendicular to the tape on the upstream 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 no more than twice, a maximum of one live hit and one dead hit, 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 can be identified only to genus, use the first four letters of the genus followed by “sp.”. If a plant is not intercepted, leave this column blank. After the species code, write “-D” 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 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 on the back of the datasheet. 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 laser is touching dead fescue (*Festuca arundinacea*), bluegrass (*Poa pratensis*), clover (*Melilotus officinalis*), live fescue, litter, and a rock. Record fescue only once, even though it intercepts the pin twice, because it is the same individual. 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	Fes aru	Poa pra	Mel off	L	GC	
2	Fes aru - D	L			Fes aru	
3	Bac vim - D	Poa pra	L		F	ant mound
etc.						



Point 1



Point 2

Figure 1. Points along a transect associated with the example in Table 1 (adapted from Herrick et al. 2005a).

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 elevated above the soil surface
WD	Woody debris	Detached woody plant material that is greater than 2.5 cm in diameter that is elevated above the soil surface

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.

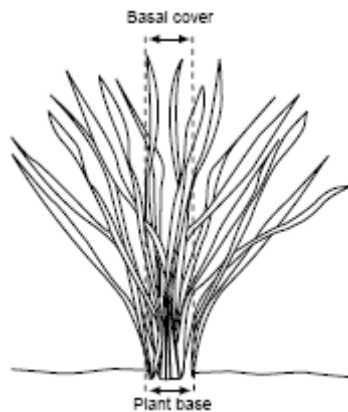


Figure 2. Area defined as plant base and included as basal cover (from Herrick et al. 2005a).

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 dead plant 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 from wildlife, livestock or humans
Camp	Campsite	Bare ground associated with camping
Auto	Motor vehicle	Disturbances caused by any motorized vehicle, including two tracks and roads
Flood	Recent flooding	Recent flooding indicated by flattened vegetation and mud and debris lines
Graze	Grazing	Grazing or browsing by wildlife or livestock
Other	Other	Any other disturbance

Sampling Procedure – Greenline transects

Greenline transects are performed at perennial streams only.

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 (see below and Fig. 5). Move the tape while sampling to follow the rooted edge.
 - 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.
2. Use the directions above to sample vegetation 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 (Fig. 4).

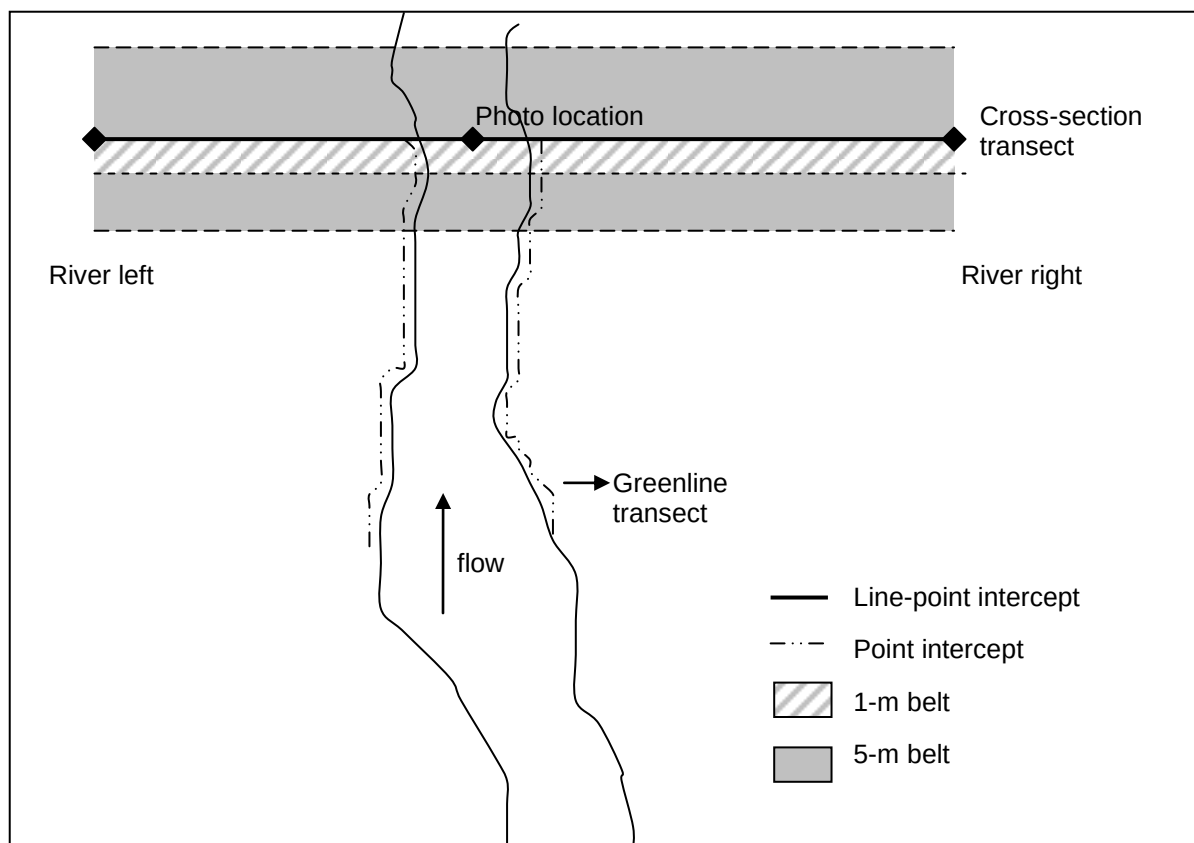


Figure 4. Example of greenline transect set-up in relation to a cross-section transect.

Identifying the Greenline

The greenline is the rooted line of perennial vegetation closest to the stream, according to the following criteria:

- At least 25% cover of live, rooted perennial species.
- Indicators that a plant is perennial: woody tissue, leaves/stems present from previous year; roots stained brown rather than white.
- The greenline may be in the water at high flows and when bank building is occurring.
- Emergent aquatic species (e.g., *Typha*, *Carex*, *Eleocharis*, etc.) are used to define the greenline, but floating aquatic species (e.g., *Lemna*, *Rorippa*, etc.) are not.
- Islands in the channel are not part of the greenline.
- The greenline may be discontinuous and include patches of vegetation on depositional bars or slump blocks on the channel margins, as long as the bars and slumps are not separated from the bank by part of the channel.

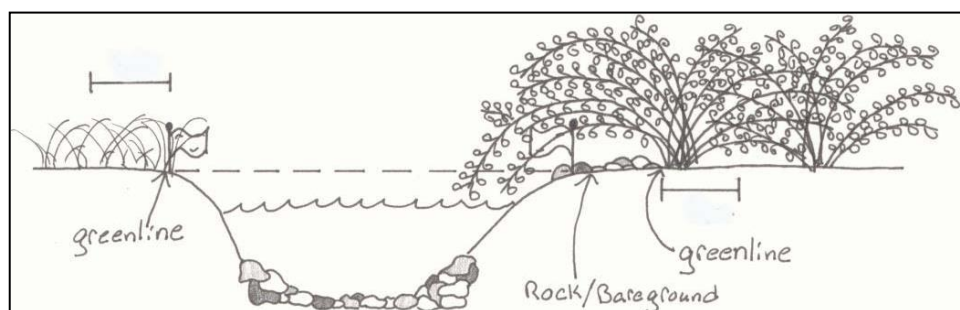


Figure 5. Location of greenline data collection for herbaceous vegetation (left) and shrubs (right). Note that the rooted point is where the transect is placed, not necessarily at the canopy of the woody vegetation. Figure adapted from Coles-Ritchie 2006.

Reference

- Coles-Ritchie, M. 2006. Effectiveness monitoring for streams and riparian areas in the Upper Columbia basin: sampling protocol for vegetation parameters. USDA Forest Service, PIBO Effectiveness Monitoring Program, Logan, Utah.
- Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005a. *Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick start*. USDA-ARS Jornada Experimental Range, Las Cruces, NM. 36 pp. [available online at http://usda-ars.nmsu.edu/jer/monit_assess/monitoring.htm]
- Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005b. *Monitoring manual for grassland, shrubland and savanna ecosystems. Volume II: Design, supplementary methods and interpretation*. USDA-ARS Jornada Experimental Range, Las Cruces, NM. 200 pp.

Appendix A.

Point-Intercept and Greenline Transect Datasheets

Point Intercept Datasheet p.1

Point Intercept Data Sheet

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code:

Reach ID:

Date:

Page

Observer:

Recorder:

Transect:

1 2 3 4 5 6 7

Point (m)	Top Canopy	Lower canopy		Surface	Disturb.
		1	2		
0.5					
1					
1.5					
2					
2.5					
3					
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9					
9.5					
10					
10.5					
11					
11.5					
12					
12.5					

Point (m)	Top Canopy	Lower canopy		Surface	Disturb.
		1	2		
13					
13.5					
14					
14.5					
15					
15.5					
16					
16.5					
17					
17.5					
18					
18.5					
19					
19.5					
20					
20.5					
21					
21.5					
22					
22.5					
23					
23.5					
24					
24.5					
25					

Additional canopy layers can be added on other side

Point Intercept Datasheet p.2

Point (m)	Top Canopy	Lower canopy		Soil Surface	Disturb.
		1	2		
25.5					
26					
26.5					
27					
27.5					
28					
28.5					
29					
29.5					
30					
30.5					
31					
31.5					
32					
32.5					
33					
33.5					
34					
34.5					
35					
35.5					
36					
36.5					
37					
37.5					

Point (m)	Top Canopy	Lower canopy		Soil Surface	Disturb.
		1	2		
38					
38.5					
39					
39.5					
40					
40.5					
41					
41.5					
42					
42.5					
43					
43.5					
44					
44.5					
45					
45.5					
46					
46.5					
47					
47.5					
48					
48.5					
49					
49.5					
50					

Additional canopy layers

Point (m)	Lower Canopy		
	3	4	5

Point (m)	Lower Canopy		
	3	4	5

Greenline Datasheet

Greenline Data Sheet

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code:

Reach ID:

Date:

Observer:

Recorder:

Transect:

1 2 3 4 5 6 7
L R

Point (m)	Top Canopy	Lower canopy	
		1	2
0.25			
0.5			
0.75			
1			
1.25			
1.5			
1.75			
2			
2.25			
2.5			
2.75			
3			
3.25			
3.5			
3.75			
4			
4.25			
4.5			
4.75			
5			

Point (m)	Top Canopy	Lower canopy	
		1	2
5.25			
5.5			
5.75			
6			
6.25			
6.5			
6.75			
7			
7.25			
7.5			
7.75			
8			
8.25			
8.5			
8.75			
9			
9.25			
9.5			
9.75			
10			

Additional canopy layers

Point (m)	Lower Canopy		
	3	4	5

Point (m)	Lower Canopy		
	3	4	5

NCPN Integrated Riparian Monitoring

SOP # 8 Measuring Exotic Perennial Density, Tree Density and Canopy Closure in a 5-m Belt Transect Version 1.01 (November 2008)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	11/2008	R. Weissinger	Remove 1-m belt and take all measures in 5-m belt	Simplify sampling	1.01

Equipment

- 2.5 m pole
- Concave modified spherical densiometer
- 15-cm DBH calipers
- DBH tape

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

- a. Expand the laser monopod so that 3 of the 4 segments are extended (height is approximately 1.25 m). Place the densiometer on top of the laser monopod over the correct 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 live or dead vegetation above the V (maximum is 17). Do not count canyon walls or cutbanks.
- 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 as you rotate it and yourself for each reading. It does not matter in which order you take the readings.

Occasionally, you may not be able to take the measurement at one of the standard locations because a tree trunk is blocking that location. If this occurs, move down the transect 0.5 m (i.e. move to 5.5 m) until you can hold the densiometer in the correct location. Do not move the location of the densiometer along the transect for branch obstructions. You should be able to move the densiometer up or down a centimeter or so in order to take the measurement.

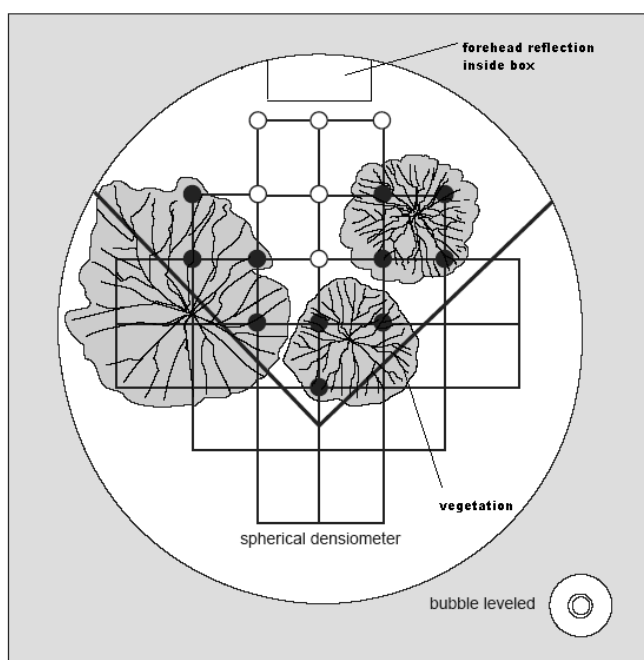
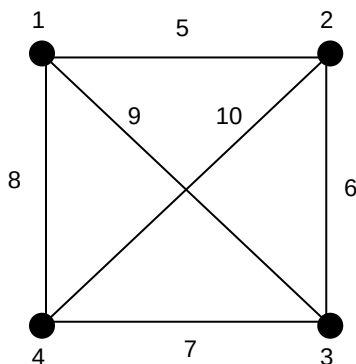


Figure 1. A modified concave spherical densiometer. Note the bubble level, tape marking right angle (above which points are counted), and 17 points of intersection. Closed circles represent line intersections where vegetation is present and consequently counted in measurement of canopy closure (example shows 11 out of 17 points) (from Fitzpatrick et al. 1998).

2. Sample exotic perennial and live tree seedling density.

- A. Use a 2.5 meter pole to determine the boundaries of the 5-m belt on each side of the cross-section transect.
- B. Use a dot tally to record the density of exotic grass, shrubs, vines, and forbs and all exotic and native tree seedlings up to 1.37 m in height or ≤ 2.5 cm DBH. A dot tally is created by forming the following figure as you count stems:



- C. For rhizomatous species, count the number of emergences (defined as spatially separated clumps of the plant species) instead of the number of stems.
- D. Multiple “suckers” that originate from the same location, and stump sprouts are considered one seedling. Do not tally or count “layers” (undetached branches partially or completely covered by soil, usually at the base) as seedlings. Do not tally any seedlings that sprout from a live tally tree.
- E. At sites with high densities, estimate density using the following categories: 100-250, 250-500, 500-1000, and >1000 individuals.
- F. After completing a belt, add up the dot tally marks for each species and write in the numeric total in the “Total” row.

3. Record DBH of live and dead tree saplings and mature trees >2.5 cm DBH.

A. 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.

B. 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. Use “-D” to denote dead individuals.
- Record unknown specimens using the guidelines in SOP#10 (Unknown Plants).

C. Measure the diameter at breast height (DBH) using the guidelines in SOP #9 (Reach Census). Trees greater than 15 cm DBH will be measured in both methods.

- If using the 15-cm plastic calipers, record to the nearest 0.5 cm.
- If using the DBH tape, record to the nearest 0.1 cm.
- If multiple suckers or sprouts occur from a single stump, measure the largest diameter sprout only.

Sampling adjustment if two transects cross

If two transects cross, do not sample the higher numbered transect's belt area where it overlaps with the lower numbered transect. Note on the datasheet where tallying stops, and at what point it restarts if necessary.

References

Fitzpatrick, F.A., I.R. Waite, P.J. D'Arconte, M.R. Meador, M.A. Maupin, and M.E. Gurtz. 1998. Revised methods for characterizing stream habitat in the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 98-4052, 67 p.

Appendix A.

5-m Belt Transect Datasheet

5-m Belt Transect Datasheet

Data entered by:

Data verified by:

NCPN Riparian
Monitoring

Park Code:

Reach ID:

Date:

Observer:

Recorder:

Transect: 1 2 3 4 5 6 7

Spherical Densiometer

5-m	_____	_____	_____	_____	55-m	_____	_____	_____	_____
15-m	_____	_____	_____	_____	65-m	_____	_____	_____	_____
25-m	_____	_____	_____	_____	75-m	_____	_____	_____	_____
35-m	_____	_____	_____	_____	85-m	_____	_____	_____	_____
45-m	_____	_____	_____	_____	95-m	_____	_____	_____	_____

Exotic Perennial Species (excluding trees)

Species	Tally	Total

Tree Seedlings (<1.37 m tall or ≤2.5 cm DBH)

Species	Tally	Total

Trees (>2.5 cm DBH)

Species	DBH	

Density Classes: 100-250, 250-500, 500-1000, 1000+

NCPN Integrated Riparian Monitoring

SOP # 9 Measuring Trees in a Reach Census Version 1.02 (April 2010)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	11/2008	R. Weissinger	Do not sample trees beyond the headpins	Not connected to active riparian zone	1.01
1.01	4/2010	R. Weissinger	Added crown health class 6 and instructions	Standardize with upland methods	1.02

Equipment

- DBH tape
- Pre-numbered tree tags
- Galvanized steel nails
- Clawhammer
- Orthorectified aerial photograph (DOQQ)

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 – Reach Census

All woody species greater than 15 cm DBH within the reach are tagged and measured. This includes large individuals of species that are considered shrubs in other parts of the protocol.

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 woody species have been measured, sample the other side of the channel.
 - The reach includes the area between Transect 1 and Transect 7.
 - The reach includes the active riparian zone and any surfaces between the transect headpins.
2. Locate a woody species, hereafter referred to as tree, with a diameter at breast height of >15 cm.
 - A. If the tree is not tagged, affix a pre-numbered tag to the tree using a nail.
 - a. When establishing a reach, tag trees in numeric order.
 - b. When revisiting a reach, use tree tags from a different numeric series. For example, if tags 1-80 were used during establishment, use tags 100-199 during the subsequent visit.

- c. Place the nail so that the top of the nail is at breast height (1.37 m). If the tree forks below breast height, both forks should be tagged.
 - d. 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 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 (-“D”) after the species name. If the species is unknown, write UNKT -D.
- C. Record the location of the tree in the DOQQ and make a note about its location on the datasheet.
- D. Measure DBH using the notes below.
- Measure just above the nail.
 - Measure to the nearest 0.1 cm, making sure to read the correct side of the DBH tape.
3. E. Record Crown Health

Crown Health: Evaluate the density of each tree’s crown in relation to crowns of the same species located in a similar position within the canopy, and from a similar habitat. Crown health codes are defined in Table 1 and listed at the bottom of the data sheet. Classes 1 through 4 refer to the estimated amount of the foliage that is intact, expressed as a percent. Class 5 is used to designate standing dead trees with an overall height greater than 1.37 meters that are still rooted to the ground.

Class 6 should only be used to record trees that were previously tagged and standing but have fallen down since the last plot visit. This class is used in order to not confuse fallen trees with missing data. After a tree has been recorded once as class 6, it does not need to be recorded on the data sheet in subsequent plot visits.

Standing dead trees whose diameters fall below 15 cm since the last plot visit (usually due to decay) should be recorded as class 5. A comment should also be included in the Notes/Conditions field explaining why a tree < 15 cm dbh was recorded on the data sheet. After a tree has been recorded once as class 5 and < 15 cm dbh, it does not need to be recorded on the data sheet in subsequent plot visits.

Table 1. Crown health classes for forest species

Crown Health Class	Description
1	90-100% live foliage
2	50-89% live foliage

3	16-49% live foliage
4	0.1 – 15% live foliage
5	standing dead
6	dead and down

F. Record Conditions/Notes: Any significant damage to a living tree should be recorded. Scan each tree carefully for signs of damage, including but not limited to beaver browsing, recent fire scars, lightning strike scars, mistletoe infestation, bark beetles, cankers, stem decays, woodboring insects, tent caterpillars, or broken or dead top.

Measuring DBH:

- Use the 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. Hook 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. Bowed tapes 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 1).
- 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 1. The proper method for securing a DBH tape.

Common stem irregularities (Fig. 2):

- *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.
- *Trees with a shrubby, clumped or clonal growth form* - Measure only the five largest stems.

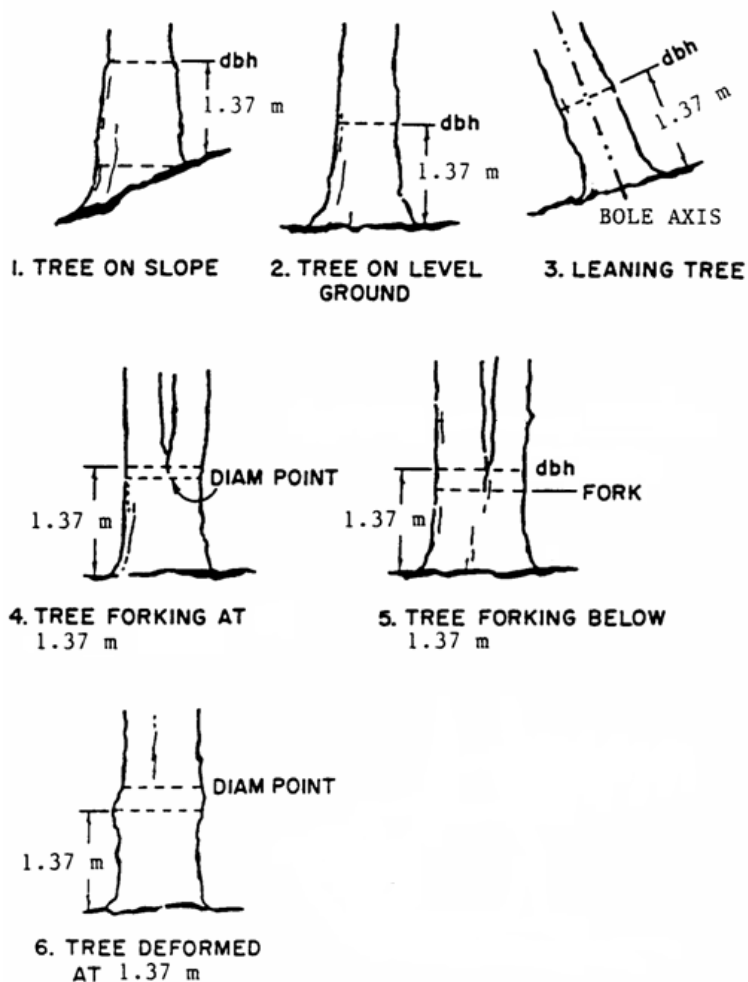


Figure 2. Locations of diameter at breast height (DBH) measurements for a variety of bole form situations. DBH measurements will always be taken perpendicular to the bole axis as illustrated (modified from USDA Forest Service 2005).

References

USDA Forest Service. 2005. Forest Inventory and Analysis National Core Field Guide, Vol. 1: Field Data Collection Procedures for Phase 2 Plots, Version 3.0. Available online at: http://fia.fs.fed.us/library/field-guides-methods-proc/docs/2006/core_ver_3-0_10_2005.pdf

Appendix A.

Reach Census Datasheet

Reach Census

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code:

Reach ID:

Date:

Observer:

Recorder:

[illegible]

NCPN Integrated Riparian Monitoring

SOP # 10 Unknown Plants Version 1.0 (November 2008)

Revision History Log:

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

Equipment

- Resealable 2-gallon-sized plastic bags
- Masking tape
- Sharpie
- Trowel
- Plant press
- Newspaper for press

Procedure

Sometimes it may be difficult or impossible to determine the specific identity of individual plants encountered during sampling. Crews may be unfamiliar with a plant or unable to distinguish one species from other similar species at the time of sampling. Before sampling, review previously collected unknown species from the stream and use existing unknown names whenever possible.

When an unknown plant is encountered:

1. Search the immediate area surrounding the point or transect, looking for specimens of the unknown plant that are more readily identifiable (i.e., due to the presence of flowers or fruits from current or previous seasons).
2. If an identifiable specimen cannot be found, create a unique name using the following code: unk + 4 letter park code + reach number + your initials + collection number for the plot, e.g. unkZION-P1-ST1.
3. Record this code in the appropriate column on the datasheet instead of the species name.
4. Take a photograph of the unknown plant.
5. As you proceed through the reach, continue to attempt to find identifiable specimens of unknowns.

6. It is permissible to identify a plant only to the genus level if no identifiable parts are present for keying, or if hybridization makes species delineation difficult (e.g., *Opuntia* sp., *Yucca* sp., *Tamarix* sp., etc.).

Collecting unknown plants

Once it has become apparent that no identifiable plants can be found or that a plant with identifiable features cannot be keyed out in the field, a collection of the plant should be made.

1. Collect specimens from outside of the monitoring transects whenever possible.
 2. Attempt to collect as many identifiable parts as possible, including flowers, fruits, leaves, and roots. It is especially important to collect roots of forbs and grasses. You may need to collect from more than one plant to achieve this goal.
 3. If you must collect from inside a monitoring reach, remove only a minimal amount of plant material. Do not remove roots of perennial species that are collected within the transect.
 4. Wrap a piece of masking tape around the plant and use a fine-point Sharpie to label it with the unknown species code. If the sample is very small, put it in a small, labeled resealable plastic bag.
 5. Carefully place the specimen inside a resealable plastic bag labeled with the reach number, unknown species code, date and collector.
 6. Put the samples in your bag and in a shady spot until you get back to camp. Attempt to identify the plants when back at camp.
 7. If the specimen cannot be identified right away, preserve the bag in a cooler as soon as possible. Make sure the specimen does not get wet. If a cooler is not available, press the plant between two sheets of newspaper.
6. Fill out an unknown species datasheet for each specimen. It is especially important to fill out datasheets for specimens that do not have identifiable characteristics in this sampling year, but may be identified in future years.

Datasheets

When filling out the datasheet, give a detailed description of each characteristic. This allows greater potential for future identification when crews return to the site. Complete the following information on the data sheet:

- **Park:** A four letter code unique to a particular park
- **Reach ID:** The pre-assigned plot ID
- **Transect #:** 1-7
- **Position on Transect:** The point along a transect (e.g., 0 m, 10 m, 6.4 m, etc.).
- **Unknown Code:** unk + 4 letter park code + reach number + your initials + collection number for the plot (e.g. unkZION-P1-ST1).

- **Date:** Use the format mm/dd/yyyy.
- **Collected by:** Initials of person collecting sample.
- **Photos:** Yes or No
- **Plant type and General Description:** Circle the appropriate categories and provide a succinct description of the overall appearance, e.g. tiny *Eleocharis*.
- **Most Salient Feature:** A unique characteristic that identifies the plant from others.
- **Leaf Characteristics (optional):** Describe the leaf type, leaf margin, leaf surface, petiole, etc.
- **Stem Characteristics (optional):** Describe the shape, pubescence, markings, and color of the stem, as well as the bud characteristics.
- **Flower Characteristics (optional):** Describe the floral formula, location (axillary or terminal), habit (indeterminate or determinate), pubescence, and color.
- **Microhabitat Characteristics:** Describe the microhabitat in which it was found if unique on the plot (e.g., wash bottom, limestone outcrop, etc.).
- **Collected:** Circle yes or no, whether a specimen was collected.
- **Best Guess:** Preliminary guess about species in field.

Annotating datasheets

When updating data collection datasheets with identified plants, draw a line through the unknown code and write in the correct species code in the nearest available space. Initial and date the change on the datasheet.

Appendix A.

Unknown Plant Species Datasheet

Unknown Plant Species Data Sheet

Park: _____ Unknown Code: _____
Reach ID: _____ Date: _____
Transect #: _____ Position on transect (m): _____
Collected by: _____ Photos: _____

Plant Type: *tree shrub grass forb other* _____
Forbs and grasses: *annual perennial*
Perennial Grasses: *bunchgrass rhizomatous*

General Description:

Most salient feature:

Leaf Characteristics (optional):
Leaf Type: (compound/simple, arrangement, etc.)

Margin:

Other: (pubescence, sap, stipules, etc)

Stem Characteristics (optional): (shape, pubescence, bud)

Flower Characteristics (optional): (color, location, floral formula)

Microhabitat Characteristics:

Collected: *Yes No*

Best Guess:

Confirmed to be:

Identified by: _____ Date: _____

NCPN Integrated Riparian Monitoring

SOP # 11 Repeat Photographs Version 1.0 (November 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. Monitoring photos are taken at each transect headpin and at mid-channel. Reference photos are taken as part of the reach establishment (SOP #4).

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. You can also hang the signboard on vegetation.

B. Stand at the headpin of a transect, set the camera body on top of a fully extended laser

monopod (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 of the photo.

E. Take a photo and record the photo information on the Photo Data Sheet. Record the location of the photo point as 0 m on river right or as the meter location to the nearest 0.1 m of the transect end on river left.

2. Mid-Channel Photos

Because the signboard can not be placed in these photos, always take the photo facing upstream first, followed by the downstream-facing photo.

A. Stand 3-m downstream from the tagline at mid-channel, set the camera body on top of a folding engineer ruler or monopod extended to 1.5-m in height, and point the camera upstream.

B. Orient the camera so that it takes a horizontal (landscape) format photo.

C. Take a photo and record the photo information on the Photo Data Sheet. Record the approximate location of the photo point along the transect tape, rounding to the nearest 0.5 m.

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.

Appendix A.

Photo Datasheet

Photopoints

Data entered by:

NCPN Riparian Monitoring

Park

Code:

Reach ID:

Date:

Transect Photos

Transect	Direction	Photo #	Photographer	Location (m)
1	Left Pin			
1	Facing Upstream			
1	Facing Downstream			
1	Right Pin			
2	Left Pin			
2	Facing Upstream			
2	Facing Downstream			
2	Right Pin			
3	Left Pin			
3	Facing Upstream			
3	Facing Downstream			
3	Right Pin			
4	Left Pin			
4	Facing Upstream			
4	Facing Downstream			
4	Right Pin			
5	Left Pin			
5	Facing Upstream			
5	Facing Downstream			
5	Right Pin			
6	Left Pin			
6	Facing Upstream			
6	Facing Downstream			
6	Right Pin			
7	Left Pin			
7	Facing Upstream			
7	Facing Downstream			
7	Right Pin			

Other photos

Type	Photo #	Photographer	Description

Type = archeology, disturbance, fauna, fieldwork, flora, scenic, other

Transect Establishment Photos

Transect	Direction	Photo #	Photographer
1L	Upstream		
1L	Downstream		
1R	Upstream		
1R	Downstream		
2L	Upstream		
2L	Downstream		
2R	Upstream		
2R	Downstream		
3L	Upstream		
3L	Downstream		
3R	Upstream		
3R	Downstream		
4L	Upstream		
4L	Downstream		
4R	Upstream		
4R	Downstream		
5L	Upstream		
5L	Downstream		
5R	Upstream		
5R	Downstream		
6L	Upstream		
6L	Downstream		
6R	Upstream		
6R	Downstream		
7L	Upstream		
7L	Downstream		
7R	Upstream		
7R	Downstream		

NCPN Integrated Riparian Monitoring

SOP # 12 Site Assessment Version 1.01 (November 2009)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	11/2009	R. Weissinger	Added timed walk for exotic species presence	Increase reporting to managers	1.01

This SOP provides instructions for qualitatively detecting and describing on-site and off-site impacts on long term ecological monitoring reaches, and for filling in the “Site Assessment Datasheet”. This assessment is conducted every site visit.

Procedures

If this SOP can not be accomplished during other reach measurements, the Site Assessment should be completed after all other measurements.

1) Fill out the information at the top of the datasheet including:

- **Park Code** – Standard 4-letter code.
- **Reach ID** – Pre-assigned, unique number.
- **Recorder** – Record the initials of the person(s) recording data.
- **Date** – mm/dd/yyyy.

While sampling the transects and walking in the stream, observe signs of disturbance within the reach.

- If a significant disturbance not found on the lists below is present, it should be recorded.
- If there is no disturbance to report, enter “none”.

2) In-stream disturbances

A list of common in-stream disturbances can be found in Table 1.

Table 1. Common in-stream disturbance types on the Colorado Plateau.

Disturbance Type	Description
Channel modification	Anthropogenic modification such as a dam, structure, or diversion
Road crossing	
Beaver dam	
Recent flooding	Indicated by flattened vegetation, turbidity, and debris lines. Only record flooding that appears to have occurred in the previous several days.
Crayfish	All crayfish species in this region are exotic. They look like little lobsters.

3) Terrestrial disturbances

A list of potential disturbances is given in Table 2.

Table 2. Common riparian disturbance types on the Colorado Plateau.

Disturbance Type	Description
Road	Paved, dirt, or two-track. Note whether it is presently open or closed.
Trail	Livestock or human trail, whether it is maintained or social.
Campsite	Denoted by compacted areas devoid of vegetation, fire rings, etc.
Beaver browsing	Chewed and/or felled trees.
Livestock trampling/grazing	Indicated by the presence of livestock or livestock scat.
Wildlife trampling/grazing	Significant impacts due to native ungulates.
Insect infestation	
Fire	Indicated by fire scars on trees, charred vegetation. Note whether the fire is old or recent.
Exotic plant removal	Indicated by cut stumps, debris piles, etc.

4) Exotic plant species present

Do a timed 30-minute walk through the reach and record all annual and perennial exotic species present. Pay particular attention to rare species that were not recorded during the vegetation sampling. It is the park's responsibility to remove invasive exotics, but the crew may decide to pull exotics if very few plants are present and if the time needed to access a population is great. Record if they were pulled by the crew and their general location.

5) Other notes

Record any other notes that may assist in interpreting results for the reach or describe interesting features of the reach, such as amphibians or fish species seen, management activities noted, etc.

Appendix A

Site Impact Assessment Datasheet

Site Assessment

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code:

Reach ID:

Date:

In-Stream Disturbance

Channel Modification	Yes	No
Road Crossing	Yes	No
Beaver Dam	Yes	No
Recent Flooding	Yes	No
Crayfish Present	Yes	No
Other	Yes	No

Describe all:

Terrestrial Disturbance

Road	Yes	No
Trail	Yes	No
Campsite	Yes	No
Beaver Browsing	Yes	No
Livestock Grazing	Yes	No
Wildlife Trampling/Grazing	Yes	No
Insect Infestation	Yes	No
Fire	Yes	No
Exotic Plant Removal	Yes	No
Other	Yes	No

Describe all:

Site Assessment

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code:

Reach ID:

Date:

Exotic Plant Species Present:

Other Notes:

NCPN Integrated Riparian Monitoring

SOP # 13 Assessing channel substrate size using a pebble count Version 1.0 (April 2009)

Revision History Log:

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

This SOP provides instructions for conducting a pebble count at each riparian monitoring site. Sixty pebbles are measured at each cross-section.

Equipment

- Metric ruler
- 10m transect tape
- 2 chaining pins

I. Fill out the datasheet

Park Code – The four letter park code

Reach ID – The reach ID number

Date – Use the format mm/dd/yyyy

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

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

II. Conduct the Pebble Count

- Begin at Transect 7 (the downstream end of the reach) at the edge of the water or at the edge of the scoured channel in a dry channel.
- Stake out the transect tape from wetted width to wetted width perpendicular to flow. In a dry channel, stake out the scoured channel bottom.
- Record the wetted width or channel width in m.
- Divide the width by 60 to determine the sampling interval. The minimum sampling interval is 0.1 m.
- Without looking at the channel bottom, plunge your index finger into the water at the first sampling point.
- Pick up the first pebble that you touch. If there is silt or sand on top of a rock or bedrock, you should record the silt or sand.
- Measure the intermediate axis (not the shortest or longest) using a ruler (Fig. 1) and record the length to the nearest 0.1 cm on the field sheet. The intermediate axis corresponds to the axis that determines the sieve size through which a particle can fall.
- If a pebble is <0.2 cm, record as “F” for fines. Enter as 0.1 in the database.
- If you touch bedrock, record as “BR.” Enter as XXX in the database.
- Continue across the cross-section, sampling at the pre-determined interval.
- After recording 60 pebbles, move to Transect 6.

L. Continue recording pebbles at each cross-section in the same manner.



Fig. 1. Measuring the intermediate axis. Note its position relative to the longest axis (the vertical axis in this image) and the shortest axis (pebble depth in this image).

Rules for Pebble Counts

- If the minimum sampling interval of 0.1m does not allow 60 pebbles to be sampled in one pass, move upstream one foot and do a second pass parallel to the cross-section. Sample equally across the channel (i.e., if only 20 pebbles are needed, sample them at equidistant intervals such that the entire channel is sampled)
- Do not count a pebble twice. If a large rock is intercepted multiple times, record the rock once and move on to the next location that intercepts a new pebble.
- If a rock is too large to pick up, measure the smaller of the two available axes.

References

Gordon N.D., T.A. McMahon, and B.L. Finlayson. 1992. *Stream hydrology. An introduction for ecologists*. John Wiley & Sons, Chichester. 526 pp.

Appendix A.

Pebble Count Datasheet

Pebble Count Datasheet

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code: Reach ID:

Date:

Observer:

Recorder:

Minimum sampling interval is 0.1m. Measure to nearest 0.1 cm.

Width T7(m):

Width/60:

1	7	13	19	25	31	37	43	49	55
2	8	14	20	26	32	38	44	50	56
3	9	15	21	27	33	39	45	51	57
4	10	16	22	28	34	40	46	52	58
5	11	17	23	29	35	41	47	53	59
6	12	18	24	30	36	42	48	54	60

Width T6(m):

Width/60:

1	7	13	19	25	31	37	43	49	55
2	8	14	20	26	32	38	44	50	56
3	9	15	21	27	33	39	45	51	57
4	10	16	22	28	34	40	46	52	58
5	11	17	23	29	35	41	47	53	59
6	12	18	24	30	36	42	48	54	60

Width T5(m):

Width/60:

1	7	13	19	25	31	37	43	49	55
2	8	14	20	26	32	38	44	50	56
3	9	15	21	27	33	39	45	51	57
4	10	16	22	28	34	40	46	52	58
5	11	17	23	29	35	41	47	53	59
6	12	18	24	30	36	42	48	54	60

Width T4(m):

Width/60:

1	7	13	19	25	31	37	43	49	55
2	8	14	20	26	32	38	44	50	56
3	9	15	21	27	33	39	45	51	57
4	10	16	22	28	34	40	46	52	58
5	11	17	23	29	35	41	47	53	59
6	12	18	24	30	36	42	48	54	60

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

Standard Operating Procedure (SOP) # 14

After the Field Season

Version 1.00 (July 2010)

Revision History Log:

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

This SOP provides information to close out the field season, assuring that equipment maintenance, data management, and reporting procedures are followed.

Procedures

I. Equipment maintenance. Make certain that all equipment is in good working order. Repair or replace if necessary.

II. Supplies inventory. Ensure that adequate supplies are on hand for the next field season and order supplies if needed.

III. Complete identification of unknown plants. The field-crew leader is responsible for ensuring complete resolution of all unknown plants. Plants are identified to species, family, or at least life form. Annotate the data sheets with the correct identifications and ensure that species are entered correctly in the database.

IV. Data management. The field-crew leader is responsible for ensuring that all data sheets are completed properly and that all photographs are downloaded and labeled on the NCPN common drive.

V. New Species. The field-crew leader is responsible for ensuring that plant species not on current park lists are submitted for NPSpecies updates. The field-crew leader is also responsible for collecting the required voucher specimen for a new species.

VI. Data entry. The field-crew leader is responsible for ensuring that all data are entered and verified.

VII. Field season review procedures. Prior to the departure of the field crew, the project manager will implement the annual Field Season Review procedures, which queries the field crew for problems, issues, and recommendations regarding the extant upland protocols and field logistics.

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

Standard Operating Procedure (SOP) # 15

Revising the Protocol Narrative and SOPs

Version 1.02 (April 2010)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	4-1-2009	H. Thomas	Updated master version table (MVT)	To reflect protocol changes based on field work.	1.01
1.01	4-1-2010	H. Thomas	Updated MVT	To reflect protocol changes based on field work.	1.02

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. The procedures in this SOP are based on the NCPN Protocol Versioning Guidance Document (NCPN-NPS 2009).

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.
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. An “x” indicates that an SOP has been discontinued.

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
1/1/2009	-	1.00	-	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.00	1.00	1.00	1.00	-	1.01
1/1/2010	-	1.00	1.00	1.00	1.00	1.00	1.00	x	1.01	1.02	1.00	1.00	1.01	1.00	1.00	1.02

References

NCPN-NPS 2009. Protocol Versioning Guidance Document, Version 1.0. National Park Service, Inventory and Monitoring Program, Northern Colorado Plateau Network, Moab, UT.