

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 2

Hiring and Training Observers

Version 1.00 (April 2012)

Revision History Log:

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

This SOP explains the qualifications needed for permanent and seasonal field personnel and procedures for training vegetation and geomorphology sampling technicians. Accurate, consistent data collection begins with the hiring process, followed by a rigorous training program. Technicians must also be prepared, both mentally and physically, for the extreme weather and difficult terrain of NCPN parks.

Hiring Field Technicians

Staffing requirements

Big river monitoring requires geomorphic and vegetation expertise. A permanent or term subject-to-furlough biological or physical science technician (GS-6/7) leads a crew responsible for vegetation and geomorphology sampling. Three seasonal crew members (NPS, volunteer, intern, or cooperator) comprise the riparian vegetation crew.

Qualifications and attributes

In addition to the technical skills, experience, and knowledge listed below, certain qualities are necessary for all NCPN field personnel. To maintain data quality, all staff should have the ability to successfully engage in repetitive, detail-oriented work. Technicians must be in excellent physical condition and able to thrive in difficult field conditions. Certification as a Wilderness First Responder (or Wilderness First Aid) and CPR is also an asset. Employees must expect to work away at parks for periods up to 8 consecutive days and, in many instances, to camp in backcountry situations.

Technical Skills, Experience, and Knowledge

The Riparian Crew Leader can be either a Biological or Physical Science Technician. Since it is unlikely that NCPN will be able to recruit a candidate with the technical expertise needed for both vegetation and geomorphology sampling, NCPN is committed to train the selected

candidate in the skill that they are lacking. The technical skills, experience, and knowledge required for all integrated riparian field positions is detailed below.

Lead Biological Science Technician (Crew Leader)

- Ability to identify common riparian genera and species.
- Ability to key plants to species using floras and technical keys.
- Experience leading a field crew to collect biological data in remote field settings.

Lead Physical Science Technician (Crew Leader)

- Experience using a total station and post processing total station data.
- Ability to identify bankfull and channel thalweg.
- Experience leading a field crew to collect physical data in remote field settings.

Seasonal Biological Science Technicians (or interns or volunteers)

The most essential element for the collection of quality data is well-trained, experienced field crews. Given the variability of plant community types across NCPN parks, it is necessary to hire highly skilled botanists with experience working throughout the region. The importance of hiring and training well-qualified observers cannot be overemphasized. In order to accurately detect trend across sampling periods, it is imperative that observers record vegetation and geomorphology data using the same methods and level of precision year after year. While not imperative, experience conducting quantitative vegetation sampling is a valuable skill in any employee. During the applicant review process, it will be important to give priority to those candidates with considerable experience conducting vegetation surveys and, secondly, to candidates with (1) experience conducting any type of field work that involves data collection, (2) extensive experience backpacking and hiking, and/or (3) an academic degree related to vegetation or ecology. Particular attention should be paid to the experience of the observer, his/her ability to learn new plants, physical abilities to withstand difficult field conditions, and overall attitude. NCPN will train biological science technicians in geomorphology survey techniques.

Training Seasonal Vegetation Observers

To promote accuracy and consistency in data collection among data collectors, training should be designed to calibrate data collectors so that they have comparable skills in identifying species and are recording data in a consistent format. For data collectors who are already competent at identifying plants by sight and taxonomic keying, the need for training in plant identification may be minimal. If the program is fortunate enough to hire all experienced personnel for a season, then the proposed training program will improve their skills. No data collector is exempt from the training program.

1. Prepare for the training program. The project manager or crew leader acts as the primary instructor; however, experts in various aspects of the protocol (such as First Aid/CPR) should be scheduled to assist in training as necessary. The instructor must prepare training materials, itineraries, and field gear before the training program begins.

2. Issue field gear before training begins. See SOP #1 for a list of field equipment. Provide a copy of this protocol to all trainees, along with a list of recommended personal field and camping

equipment, before training begins. Ensure that observers examine the list of necessary personal gear (see SOP #1) and that they have all the appropriate equipment by the time field work starts. It is highly recommended to check a weather forecast and ensure that all observers have appropriate clothing and equipment for the conditions. Make sure that trainees are informed and prepared for the training and survey events. Have the field technicians read the relevant riparian SOPs prior to field training.

3. Have all vegetation crew members participate in Riparian Vegetation Reach

Establishment, Navigation and Safety training. Crew members from previous seasons normally do not need as much training in plant-identification skills as new crew members; however, all data collectors must attend the entire training course each year. In these cases, it will be important to specifically point out any changes to the protocol. Experienced crew members can assist with training less-experienced data collectors. Experienced crew members will also continue practicing plant identification skills, navigational abilities, and data collection methods. All procedures will be exercised to the full extent, including actual recording of observations on data sheets.

4. Focus on navigation and reach set-up. Training should be given in both general navigation techniques using traditional maps and compass, as well as handheld GPS units. All technicians should practice recording spatial data using a GPS unit.

6. Emphasize field safety procedures and issues. Discuss emergency safety procedures and important safety issues for the NCPN region, notably, rafting safety, heat exposure, flooding, and driving on rough roads. Training includes a one-day CPR/First Aid course and a review of the NCPN Backcountry Safety Plan. The crew leader or project manager will also review low impact and Leave-No-Trace camping procedures.

7. Review dominant plant species. 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.

Suggested topics for training:

Program overview – introduction to NCPN goals and projects

Administrative responsibilities and policies – timesheets, travel, work hours, leave policies, and equipment care

Safety – NCPN Backcountry Safety Plan, Job Hazard Analysis, first aid kits, satellite phone use, specific safety concerns

Government vehicles – proper use and care, vehicle inspection, tire changing

Rafting safety – overview of hazards of working in big rivers, safety signals, etc.

Park etiquette – biological soil crust, visitor interactions, low impact practices

GPS – navigation, logging points, data dictionaries

Reach establishment – measuring active riparian zone width, identifying the channel thalweg, taking bearings using a compass, transect set up

Vegetation measures – Includes all methods in SOPs # 15, 102, 103, 104. Pay particular attention to training observers in identifying the greenline, tagging trees, and measuring DBH.

Photos – taking good reference photos, appropriate camera orientations for monitoring photos, checking time and date settings

Plant identification – making plant collections, using available plant references, review of common species with particular attention to difficult groups including grasses, sedges, rushes and willows, plant walks in the field

Geomorphology surveys – proper extension of the rod and positioning of the prism, identifying geomorphic surface breaks

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #7

Transducers and Hydrologic Monitoring

Version 1.00 (July 2015)

Revision History Log:

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

This SOP describes installation techniques, instrument set up, and monitoring measurements for transducers. An equipment list is provided in SOP #1, 105, 106. The initial site visit includes transducer installation; programming and installing dataloggers; and taking initial water level measurements. Monitoring revisits include water level measurements, downloading transducers, and casing and transducer maintenance, if needed.

A three-person team comprised of one installation specialist and two assistants is required to effectively complete the installation tasks described below. All crew members should have good physical endurance and be capable of heavy lifting. Revisits can be completed by one person.

1. Installation Procedure

1.1 Preparing transducers

There are two types of transducers, water transducers that are installed upstream and downstream of the sentinel site and an air transducer that is installed on land in the vicinity of the water transducers.

The settings on the pressure transducer need to be adjusted before it can be installed. These procedures are specific to the manufacturer and the type of logger used. For detailed instructions on settings, refer to the instrument's user manual (i.e., Solinst Levellogger User Manual) and software (Solinst Levellogger 4.0.3).

- A. Electronically label each pressure transducer with the site and upstream or downstream location, and any well-specific identification information, e.g. DINO_DL_us, DINO_DL_air, etc.
- B. Set the logging interval to 60 minutes.
- C. Change the units to centimeters, and adjust the site elevation so that they are at the testing elevation.
- D. Synchronize the logger time to your computer's time. If needed, adjust the logger time to Mountain Standard Time, and set a future launch date and time.
- E. Before employing transducers in the field, it is important to test them to insure they are accurately reading pressure. The easiest way to do this is to put them through an air test. Gather the transducers to be installed at a park on the next monitoring visit. Keep the groups as large as possible to support as many "should be the same" comparisons as possible. The minimum number of transducers should be a set of three transducers that will be used at one site (one upstream water, one downstream water, and one air). The transducers to be tested should be placed in a stable environment (desk) after synchronizing time and initiating a common start time for at least a 24 hour period and ideally for up to

a week of exposing the transducers to an identical environment. This data will support identification of potential fixed offsets among transducers which will then be used in analysis or effects showing the transducers are no longer operational.

- F. Stop the test and download the transducers using Solinst Software (see Section 2.0 Return Visits below for information on how to download the transducers).
- G. If the transducers air tests are successful, store the test data on X and reset the loggers using the elevation of the site where they are to be deployed. Elevations acquired from online mapping applications such as Google Maps are sufficient for this setting. It is fine to just keep them recording through transport and deployment.

1.2 Preparing the transducer casing



Figure 1. Example of an air transducer casing. A water transducer casing would not have a cap on the bottom.

- A. Cut 1 1/4" inside diameter schedule 80 slotted PVC well casing (Eagle Pacific PVC 1120 SCH.80 ASTM is the current brand being used) into 5 foot lengths. This well casing is compatible with 1 1/4" PVC pipe.
- B. Glue a threaded PVC sleeve to the top of the piece of casing using PVC glue (Fig. 1). Allow to dry.
- C. Drill a hole in the threaded PVC cap for a 3/8" diameter eyebolt. Leaving space for the eyebolt to be assembled with a washer and nut, drill additional smaller holes in the cap to allow water and air to flow through the casing when assembled (Fig. 2).
- D. Thread a nut and washer onto the eyebolt to the top of the threads. Put the eyebolt through the hole in the threaded PVC cap. Put another washer and nut on the eyebolt on the outside of the cap. Adjust the

nuts and washers on both sides of the cap so that the very tip of the eyebolt is showing above the nut on the outside of the cap (Fig. 3). This will allow the surveyors to survey from the top of the eyebolt and know the elevation of the pressure transducer without opening the casing.

- E. If the casing is for an air transducer (deployed in the air), glue an unthreaded PVC cap to the bottom of the casing (Fig. 1). Drill several holes in the cap to vent the casing and allow rain to flow through. The holes should be small to deter insects from building a nest in the casing. If the casing is for a water transducer, leave the bottom uncapped.
- F. The transducer needs to be attached to the eyebolt on a line that will not kink or change in length. The Solinst loggers are about 5” long, and they shouldn’t be resting too close to the bottom of the casing or protruding out the bottom of the casing.
- G. Air transducer casings should be spray painted brown or green to blend into the trees where they will be mounted. Water transducer casings can remain unpainted, these will be painted on site to match the surrounding substrate.



Figure 2. Ventilation holes drilled in cap with eyebolt.



Figure 3. Threaded cap with eyebolt and threaded sleeve.

1.3 Mounting air transducers

- A. Select a branch on a tree that is well above the high water line. Use two heavy duty zip ties or two hose clamps to mount the casing on the branch so that it hangs vertically (Figure 4).



Figure 4. Air transducer attached to a tree.

1.4 Mounting water transducers

- A. On a large boulder or cliff wall, select a location that should be inundated during higher flows and still can capture low base flows (Figure 5).
- B. Hold the logger casing up to the rock, and put a $\frac{3}{4}$ " wide, U-shaped pipe mounting bracket (Figure 6) snug against the lip of the threaded PVC sleeve on the casing. Mark where the bracket holes are on the rock. Using a generator-powered hammer drill, drill a hole big enough for a $\frac{3}{8}$ " expansion bolt (Figure 7) in each desired spot.
- C. Work the expansion bolt with the nut attached through the hole in the bracket into the drilled hole in the rock. Drive the pin and back off the nut.
- D. Determine how long the casing should be to extend the transducer into the water at low base flows. Cut the casing appropriately.
- E. Place the bracket on the bolt and casing, and deploy the expansion bolt by hitting the pin with a hammer. If necessary, before deploying the expansion bolt, use additional washers to make sure that the casing is held snugly to the rock.
- F. Tie a piece of Kevlar cord to the transducer so that it is hanging approximately two inches below the bottom of the casing for maximum recording of the hydrograph.
- G. Chisel/cut a Reference Mark (RM) or "x" directly, and at least 1 m above the eyebolt on the pressure transducer. IMAGINE extending the line/chord/wire suspending the transducer up through the casing and eyebolt STRAIGHT UP to the RM (Figure 8).
- H. Then measure and record the vertical distance from the RM to the top of the eyebolt; and measure and record the distance from the RM to the water surface. These measurements will allow you to:

1. During a subsequent visit determine if the logger has moved or shifted by simply measuring the distance from RM to eyebolt – no surveying required (Assumes the RM was scribed on a solid, immovable rock during install;
 2. During a subsequent visit – when the pressure transducer is under water – obtain a calibration stage measurement by measuring distance from RM to water surface (then, later, back in the office, this measurement can be compared to the recorded stage reading from the transducer for that date/time.
- I. For water and air transducers, record a GPS waypoint for each site. If the GPS is not able to take an accurate point, measure distance and bearing from a reference point so that loggers can be re-located. Take reference photos that show the location of each set up and reference marks with distinctive landmarks such as large boulders or cliff lines. Make sure your landmarks will be visible during high water. Take whatever notes you can to help you relocate loggers and interpret data.



Figure 5. Water transducers attached to boulders and painted to match surroundings.



Figure 6. Pipe mounting bracket.

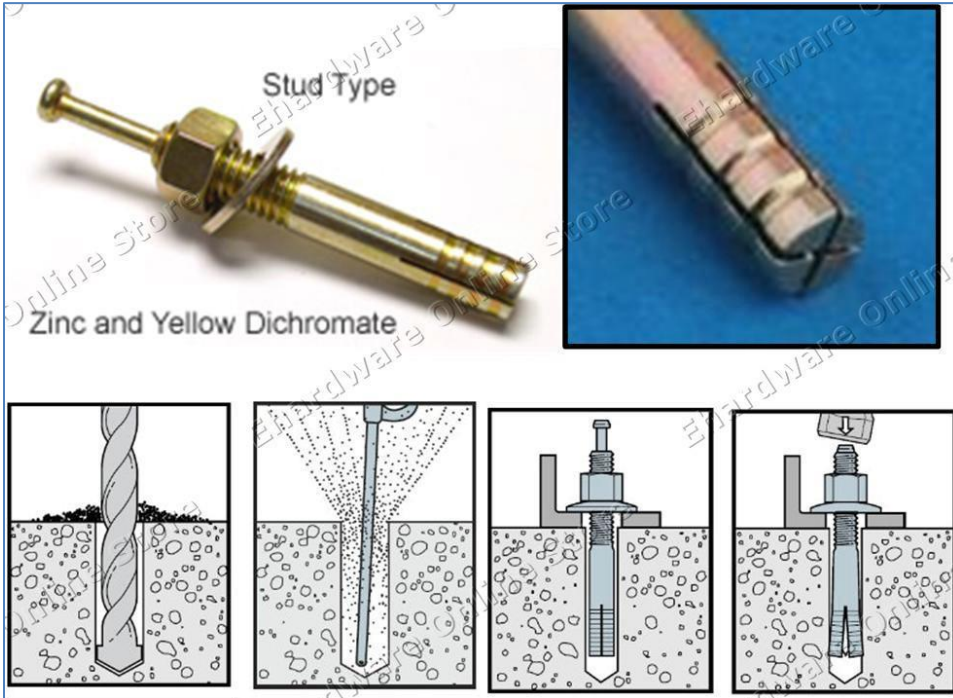


Figure 7. Expansion bolt.



Figure 8. Example of transducer placed in the water with the reference mark noted by the person pointing at the reference mark.

- J. To install the pressure transducer in the well, attach one end of the cord to the eyebolt on the casing. Lay the Kevlar cord and transect tape on the ground and measure the appropriate length of cord. Align the appropriate measurement line on the bottom of the transducer with the casing so that the transducer is approximately 5-6 cm up from the bottom of the casing.
- K. Cut the Kevlar cord at the mark you just created.
- L. Attach the end of the Kevlar cord to the hanger on the pressure transducer.
- M. Carefully measure the distance between the pressure transducer sensor scribe line and the tip of the eye bolt (Figure 10) with the meter tape to the nearest 0.1 cm. *All subsequent data analysis relies on an accurate measurement of the sensor deployment depth.* Record this number on the Transducer data sheet (Appendix 1).
- N. Record the serial number of the transducer and the following additional measurements:
1. Reference mark to top of eyebolt
 2. Reference mark to water line
 3. Eyebolt to water line
- Note that at some times the measurement to water may be negative if the reference mark or eyebolt is under water.
- O. Lower the pressure transducer into the casing, and tighten the well cap with pipe wrenches.

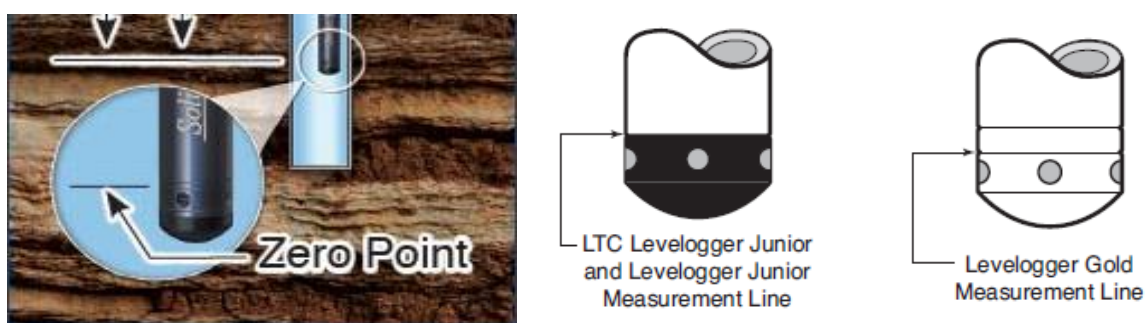


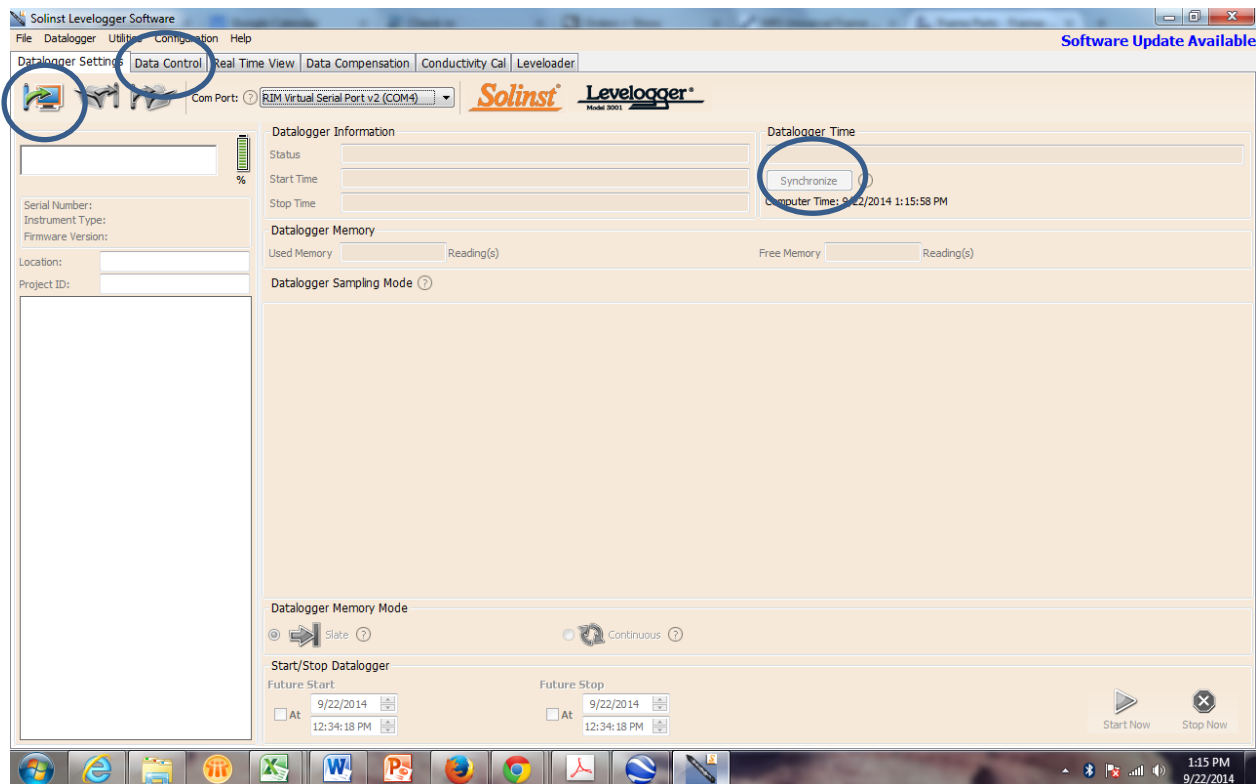
Figure 10. Pressure transducer measurement line. The sensor is located in the bottom of the pressure transducer underneath a protective plastic covering with four holes in it. To determine the depth of the pressure transducer sensor to top of eyebolt, align the meter mark on the tape with the appropriate measurement line on the pressure transducer and measure the length of the rope to the tip of the eye-bolt. Levellogger edge is on the left, junior in the middle and Gold on the right.

2. Return Site Visits

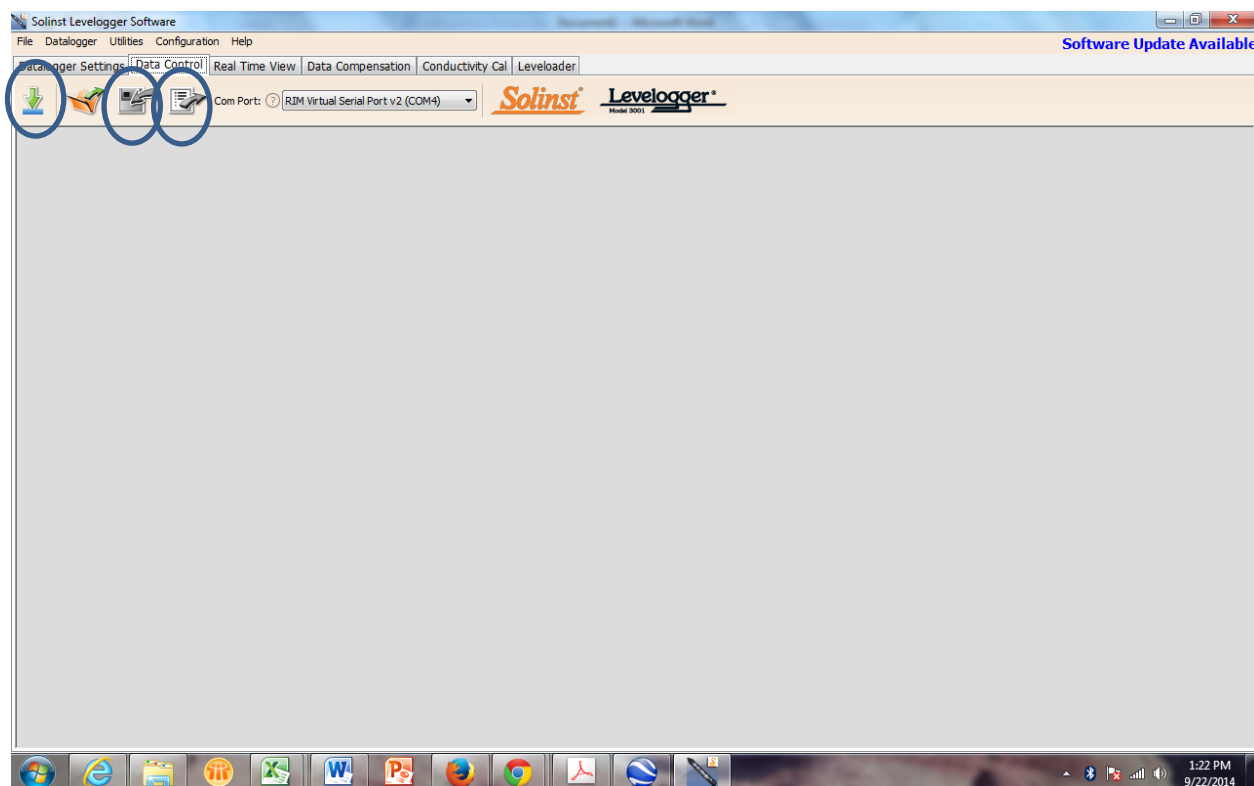
Each set of transducers monitoring wells is visited at a minimum of once a year from March through November. On each visit to the transducers the following procedures should be performed. Record measurements on the Transducer Revisit data sheets.

1. Before unscrewing the casing take the following measurements – reference mark to eyebolt, eyebolt to water, and reference mark to water. Note that at some times the measurement to water may be negative if the reference mark or eyebolt is under water. If you cannot get a good reading on one of these two measurements, you can record reference mark to water as well. Record on the transducer data sheet. When possible it is best to make these measurements as close to the top of the hour as possible when the transducer will also be taking a measurement. Record the time of the measurements.
2. Unscrew the cap, remove the instrument, and measure and record Eyebolt to Scribe line (Figure 10).
3. Unscrew the black top (carabeener is attached to this top) to the transducer.
4. Turn on computer

5. Start Solinst Software 4.0.3
6. Unscrew the cap on the transducer and plug into USB the connector that will download the transducer to the laptop.
7. Insert transducer into connector.
8. Press the “Retrieve Logger Settings” button in the top left. This should download the information and serial number. Make sure you record the serial number with the transducer. If there are difficulties reading, then make sure to change to the correct port. A driver is also needed to be downloaded from Solinst.



9. If it allows you to do so, press the “Synchronize” button to get the times the same.
10. Then press the “Data Control” tab.
11. On the Data Control, press the “Download All Data” button. You will see the downloading start. Don’t overwrite data.



12. Once the downloading has been completed, press the “Save File As” button. Save the file as a graph and as data. Use the following naming conventions with date – BrownsParkUS071515, BrownsParkDS071515, BrownsParkAir071515, etc.
13. Now export the data by pressing the “Export Data” button. Export the file as a .csv file with the same naming convention as above. To double check to see if the data has downloaded, open Excel and open the .csv file.
14. When possible (staying overnight on sight), take all three transducers out of there casings and place them in a stable environment (i.e. tent) for as long as possible. Then repeat steps 2-12 except naming this as a test. If there is no apparent drift, proceed to step 14. If there is obvious drift, replace the entire set of transducers with a set that has gone through air tests in the office as outlined in section 1.1 above.
15. You are done, take out the transducer, put the cap back on, retake the following measurements – Eyebolt to measuring scribe line, reference mark to eyebolt, eyebolt to water, and Reference Mark to water. Note that at some times the measurement to water may be negative if the reference mark or eyebolt is under water. Record on the transducer data sheet. Make sure to record the time and when possible make these measurements as close to the top of the hour as possible.
16. If transducers are removed for the winter, conduct the air test as outlined in section 1.1. when you have returned to the office.
17. Surveyors will survey in the top of the eyebolt and the reference mark during the visit. If the rod cannot be placed on top of the reference mark or eyebolt and kept level, then take a picture of the rod on top of the eyebolt in the position that was done while surveying so that there is no question where the rod was. If the rod cannot be placed on top of the eyebolt, measurements must be taken to describe where the rod was relative to the top of the eyebolt.
18. Surveyors will also survey the water surface as close to the transducer as possible. Times must be recorded with these measurements.

3. Hydrologic Data Processing

Detailed methods for data archiving and processing are provided in Appendix 2. Upon returning from a field visit, field measures are entered into an electronic datasheet, and datalogger files are uploaded to the NCPN server. Water stage data are barometrically compensated, and all data are visually reviewed for gaps or errors. Data are inspected for error or drift, and relevant corrections are applied. Derived datasets convert the raw data to data referenced to a permanent datum, referenced to the ground surface, and referenced to a stage-discharge rating curve. Finally, daily mean datasets are derived from approved data for data summary and analysis.

Appendix 1 – Data Sheets

CANY 2015 - TRANSDUCERS - BEFORE DOWNLOADING

Transducer	Serial #	Date Pulled/ Downloaded	Time Pulled/ Downloaded	Distance (cm): Refer Mark to Waterline	Distance (cm): Refer Mark to Eyebolt	Eyebolt to Waterline	Distance (cm): Eyebolt to Scribe Line	Surveyed? (Y/N...preferably on the hour)
Millard US								
Millard DS								
Queen Anne								
Bonita Bend								
Bonita Bend Air								
Holeman Canyon US								
Holeman Canyon DS								
Sphinx								
Upper Tuxedo								
Upper Tuxedo Air								

CANY 2015 - TRANSDUCERS - AFTER DOWNLOADING

Transducer	Serial #	Date Pulled/ Downloaded	Time Pulled/ Downloaded	Distance (cm): Refer Mark to Waterline	Distance (cm): Refer Mark to Eyebolt	Eyebolt to Waterline	Distance (cm): Eyebolt to Scribe Line	Surveyed? (Y/N...preferably on the hour)
Millard US								
Millard DS								
Queen Anne								
Bonita Bend								
Bonita Bend Air								
Holeman Canyon US								
Holeman Canyon DS								
Sphinx								
Upper Tuxedo								
Upper Tuxedo Air								

DINO 2015 - TRANSDUCERS - BEFORE DOWNLOADING

[illegible]

DINO 2015 - TRANSDUCERS - AFTER DOWNLOADING

Site	Transducer	Serial #	Date Pulled/ Downloaded	Time Pulled/ Downloaded	Distance (cm): Refer Mark to Waterline	Distance (cm): Refer Mark to Eyebolt	Distance (cm): Eyebolt to Waterline	Distance (cm): Eyebolt to Scribe Line	Surveyed? (Y/N...preferably on the hour)
Browns Park	US								
Browns Park	DS								
Browns Park	Air								
Winnie's	US								
Winnie's	DS								
Winnie's	Air								
Limestone	US								N
Limestone	DS								N
Limestone	Air								N
Echo	US								N
Echo	DS								N
Echo	Air								N
Seacliff	US								
Seacliff	DS								
Seacliff	Air								

Appendix 2 - Hydrologic Data Processing

Hydrologic data collection methods are detailed in SOP #7. Upon returning from a field visit, field measures are entered into an electronic datasheet, and datalogger files are uploaded to the NCPN server. Water stage data are barometrically compensated, and all data are visually reviewed for gaps or errors. Data are inspected for error or drift, and relevant corrections are applied. Derived datasets convert the raw data to data referenced to a permanent datum, referenced to the ground surface, and referenced to a stage-discharge rating curve. Finally, daily mean datasets are derived from approved data for data summary and analysis.

Acronyms and Naming Conventions

For naming purposes, the following codes should be used:

Park Code	Park
BLCA	Black Canyon of the Gunnison National Park
CANY	Canyonlands National Park
DINO	Dinosaur National Monument

Dates use Year-Month-Day (YYYYMMDD) format, e.g., 20120514

Firmware and Software Deployment History

Logger	Compatible software
Solinst Levellogger Gold	Solinst Levellogger v.4.0.3
Solinst Barologger Gold	Solinst Levellogger v.4.0.3
Solinst Levellogger Edge	Solinst Levellogger v.4.0.3
Solinst Barologger Edge	Solinst Levellogger v.4.0.3

Temporary data storage

Upon completing a field visit, data are uploaded to the NCPN server at
X:\Active_Monitoring_Projects\Big_Rivers\Data\Hydro Data.

Scan the datasheet and upload to X:\Active_Monitoring_Projects\Big_Rivers\Data\Hydro Data\Field Forms in the appropriate park, stream reach and date (YYYY) folder.

Upload photos to X:\Archive\NCPN Photos\Incoming\Monitoring\Big_Rivers to the appropriate year and project folder. Leave photo names as produced by the camera.

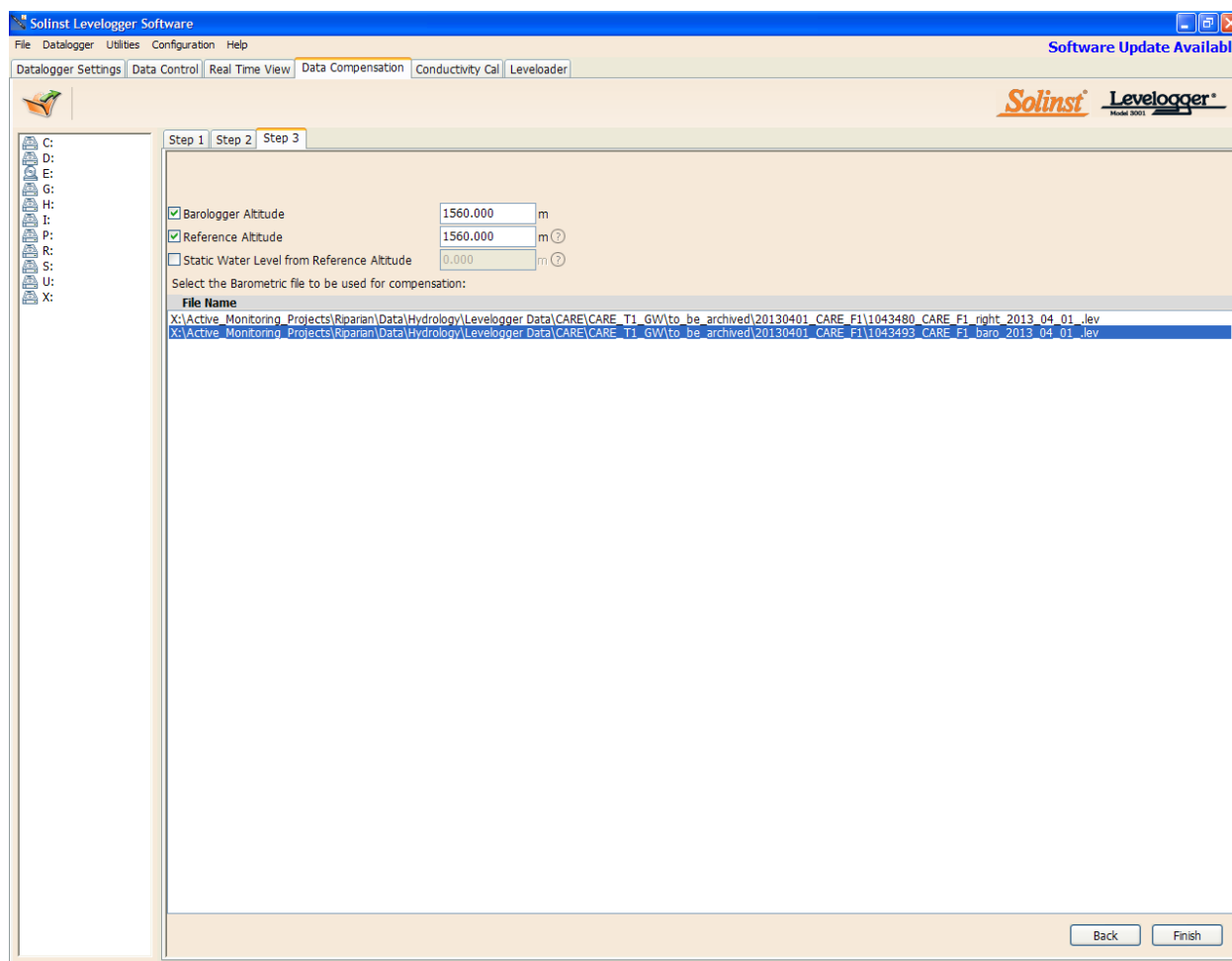
Barometric Pressure Compensation of Water Level Logger Data

All water transducer data must be barometrically compensated by subtracting the barometric pressure recorded by the air transducer from the water stage recorded by each water transducer. Barometric pressure compensation can be completed using Solinst Levellogger software. Compensated data are then adjusted to the manual water level measurement taken during the field visit at the beginning of the logger record using Solinst Levellogger software.

Software compensation

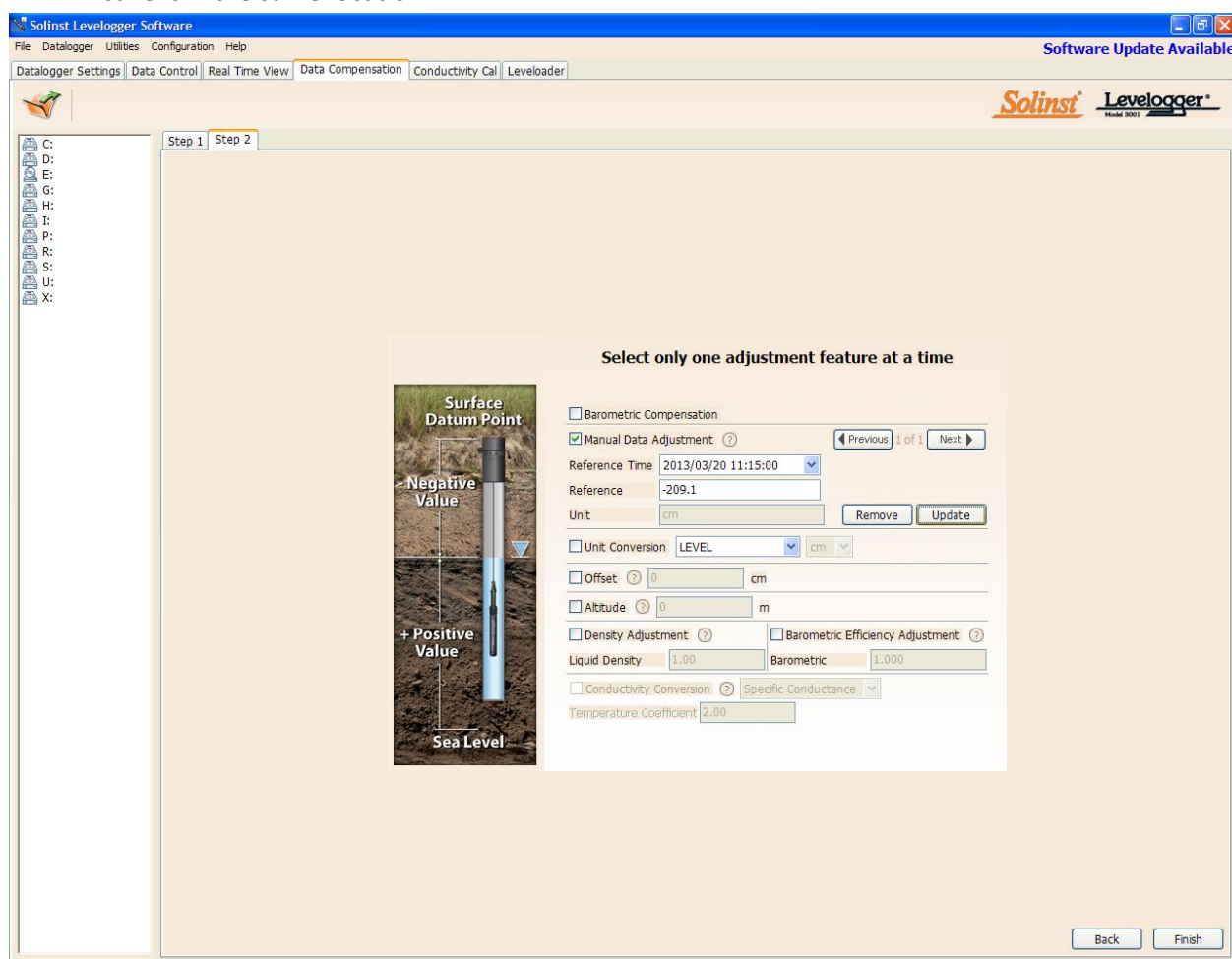
These instructions are written for Solinst Levellogger Software v. 4.0.3 for use with the Levellogger Edge series.

1. Open Solinst Levellogger Software.
2. Open groundwater or surface water data file.
3. Select Data Compensation tab.
 - a. Make sure submerged levellogger file toggle is active, then click next .
 - b. Check Barometric Compensation, then click next.
 - c. Open and select the barologger file that is associated with the levellogger file that you are compensating.
 - d. Add the elevations of the submerged levellogger and the barologger.
 - e. Click Finish. The software will automatically add the word COMPENSATED to the original levellogger file name and save it in the same location.



4. Open the compensated levellogger file you just created.

- Look at the dataset to determine the earliest date and time closest to the field visit measurement time that shows the datalogger is correctly deployed in the water (look for changes in temperature and stage).
- Select the Data Compensation tab and the compensated dataset, then click next.
- Select Manual Data Adjustment. Choose the date and time corresponding to the equilibrated datapoint noted above.
- In the Reference cell, enter the negative value of the manual depth to water measurement (to the -0.1 cm) recorded at the field visit that corresponds to the beginning of the test. For example, if the measured depth to water on 2/14/13 at 11:45 MST was 125.3 cm from the top of the eyebolt, enter (-125.3) as the Reference for 2/14/13 at 12:00 MST on the logger file. Click Add, then Finish.
- The software will automatically add the word COMPENSATED to the original levellogger file name and save it in the same location.



- Open the adjusted levellogger file you just created (filename_compensated_compensated.lev). Export the adjusted and compensated levellogger file as a comma separated value (filename.csv) file. All files should be saved in the same folder on X (original, compensated, and exported .csv files).
- Open the .csv file and delete any measurements taken prior to the equilibrated measurement. Round the level measurement column to the nearest 0.1 cm and the temperature measurement column to the nearest 0.01°C.
- Repeat steps 2-6 for each levellogger file (riparian groundwater and instream levelloggers).

Adjusting for sensor drift

To check for and offset drift, compare the levellogger readings with the derived manually measured elevation above the sensor.

In the Data Correction toolbox, open the logger (Stage.compensated logger) time series as the Target and the derived field visit stage (Stage. calculated manual) time series as the Surrogate. If field visit values are offset from the time series, check for possible user errors such as: an offset of one hour due to differences between Daylight Savings and Standard time, an offset of 6 cm due to incorrectly entering measured instead of calculated manual stage data, etc. If no user errors are apparent, select the appropriate period of record, and select “Drift Correction”.

Click on the hand icon and select the crosshairs at the end of the selected region. Drag the crosshairs to the manual water level reading data point. Note the calibration drift offset, and click Apply. When prompted, add a note indicating the series was adjusted to the manual water level reading and the level of offset, e.g., “adjusted to manual water level reading, offset =- 1.2 cm.” Save.

Interpolating missing data

Missing data can occur due to equipment failure, staff turnover, ice, flooding, siltation or other causes. Gaps of less than two hours may be filled using linear interpolation, although caution should be used during flood events. Open the time series of interest in the Data Correction toolbox. Select the gap of interest, and choose “Fill Data Gaps” and “Linear Interpolation.” Apply and save.

Other data corrections

No other routine data corrections are anticipated at this time. However, should the need for additional data corrections arise, make sure each correction is documented using an explanatory note in Aquarius.

Approving the time series for data summary and analysis

Once the data have been corrected and edited and are ready for use in derived datasets, data summary and analysis, select the appropriate period of record, and select “Set Approval.” Select “Approved,” and apply it to the time series. Save and close.

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #8

Surveying

Version 1.00 (April 2012)

Revision History Log:

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

This SOP gives detailed instructions for surveying the stream channel using a total station and post-processing survey data after returning from the field. A list of necessary equipment for these procedures can be found in SOP #1.

A three-person team comprised of a survey lead and two rod persons can efficiently complete the tasks described below. The survey lead should be skilled in total station operation at remote field sites and have experience with rod duties (i.e. running rod) and post-processing survey data.

1. Surveying

1.1 Establishing the survey layout

- A. Locate headpins (BLCA only) for all transects, control points and benchmarks (DINO only). Mark with pin flags and flagging.
- B. Identify potential instrument setup locations, including occupied points and backsight positions. The survey lead should determine these locations with the help of one of the other crew members to check lines-of-sight. Make sure to describe these locations in the field notes.

Survey field notes (see Figure 1 for an example)

- Record the date, park unit, ReachID, field crew members and their duties (i.e. total station operator or rod crew), scale factor, and general notes (foliage present, weather conditions, etc.).
- Record all rod heights before the survey begins.
- Make a list of surveyed control points including detailed descriptions of all occupied points, backsights, and reference marks shot during the survey.
- Document instrument and backsight heights for each occupied position.
- Record the numbers of the photos taken at each control point and reference mark.

- Record stub transects and stream profile points. These may be grouped in your notes since details of every point are stored in the datalogger.
- List all errors made during the survey so they can be corrected later (e.g. mis-naming of points and rod height errors).
- Define all codes that are not established in Table 1 of this SOP.
- Sketch the reach including relative locations of transects, reference marks, instrument setups, and the riparian corridor.

Table 1. Definitions and abbreviations for survey terminology.

Survey terminology	Code	Definition
Occupied point	OP	Points occupied by the total station during a survey
Backsight position	BS	A measurement taken back towards a point of known elevation (or arbitrary elevation entered in the total station), or a point previously occupied by the total station used to maintain survey control
Control point	CP	Monumented occupied point, backsight location, or a monumented point used to maintain control in survey
Reference marks	RM	Other points used as controls that are not monumented or used as instrument setups (e.g., bedrock, boulder, benchmark, etc.)
Instrument height	HI	Height of the total station above the top of the rebar marking an occupied point
Rod height	HR	Height of prism rod from the bottom of the rod to the center of the prism (to the nearest millimeter)
Top of headpin	XSTOP	Shot taken with the rod on top of the headpin. For BLCA, include feature letter, transect number, RHP or LHP (right or left headpin) and number on rebar in description.
Headpin ground surface	XSGS	Shot taken with the rod on the ground surface next to each headpin. For BLCA, include feature letter, transect number, RHP or LHP (right or left headpin) and number on rebar in description.
Bankfull elevation	BF	Shot taken with the rod at bankfull elevation
Edge of water	W	Shot taken with the rod at the edge of flowing water
Cross-section transect points	XS	All other points shot along each transect, including shots taken at 1-m intervals and at surface breaks. Include feature letter and transect number in code (BLCA).
Thalweg length	TL	Shots of the thalweg
Channel Unit Perimeter	U	Point describing channel unit perimeter within the wetted channel, also describes the wetted channel topography.
Channel Topography	TOPO	Points describing the channel topography.
Maximum Depth	MAX	Points describing the maximum depth of slow-water channel units.
Tail Crest Depth	TC	Points describing the tail-crest depth of slow-water channel units.
Toe of Bank Line	TOE	Points making lines describing the toe of bank line, or the line separating the flood zone from the beginning of the

		bank.
Flood zone	FZ	Boundary of the flood zone
Active Floodplain	AFP	Boundary of the active flood plain
Inactive Floodplain	IFP	Boundary of the inactive flood plain.
Extent of survey	BIFP	Points making lines describing extent of the survey, beyond inactive floodplain.
High Water	HW	High water mark when it can be determined for the year that the survey is occurring.

- C. Monument the initial occupied point and backsight position. Flag the area around the instrument setup for easy visibility while surveying. The initial backsight will ideally be the second occupied point.

Monuments

All permanent monuments must be cleared ahead of time with the park unit. Check to see what is permitted before you leave for the field. Permanent monuments are typically established with 0.5-m lengths of 3/8” rebar. Place an aluminum cap on top of the rebar stamped with NCPN, the FeatureID, and the appropriate code for the control point.

Date:	Park:	ReachID:	Crew:	Scale factor:	Conditions:
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Point no.	OP	BS	Notes	# of rods	RHs (m)
1	CP 1		rebar with aluminum cap "CP1", HI = 1.452 m	1	1.853
2		CP2	high point on boulder ~210 m DS of CP1; valley left; 4 m up on bench	2	3.054
			(photos- P8090402, P8090403, P8090404) --shot with rod	3	etc.
3			RM 1 is the obvious knob on a grayish 10-ft boulder on valley right	4	
			~60 m US of CP1 (photos- P8090405, P8090406, P8090407)	5	
100-152			XS1 starting at left pin	6	
153-206			profile from DS of XS 1 through XS2		
TURN TO CP3					
4	CP3		high point on reddish, flat 12 ft x 5 ft x 8 ft boulder, valley left, at base of bluff		
			(photos- P8090408, P8090409, P8090410, P8090411), HI = 1.530 m		
2		CP2	setup tripod BS; RH = 1.278 m		
5			re-shot RM 1		
6			RM 2 is the high point on oblong reddish boulder, valley right, ~120 m DS of CP3. Boulder is ~4 ft x 4 ft x 6 ft, near bases of 3 much larger, whiter boulders (photos- P8090412, P8090413, P8090414). HI = 1.530 m		
210-264			profile from XS2 through XS4		
260			2 RH not 4		
265-304			XS2 starting at right pin		
305-348			XS3 starting at right pin; incomplete; flagged for completion from CP4		
TURN TO CP4...					

Codes

DS = downstream
US = upstream

Figure 1. Example of survey field notes. Codes are defined in Table 1.

- D. Locate control points that will be monumented with rebar and a stamped cap. These are best located so at least two (preferably 3) can be seen from multiple instrument locations with at least one (preferably 2-3) points in common. Any benchmarks located near the reach should be used as control points. Make sure to describe these in the field notes.
- E. Locate at least two reference marks. These are best located on natural features (i.e. highpoint of very stable boulders, bedrock, etc.). Reference marks provide a control on survey precision and are used to triangulate positions if control points are lost. Make sure to describe these in the field notes.
- F. Take reference photos of each control point and reference marker looking upstream and downstream. The photos should include 1) a few shots with enough background topography for anyone returning to the reach to find the approximate location, and 2) at least one close-up of the precise position of the point.
- G. Record the location of each control point and reference mark using the highest grade GPS unit available at the highest precision possible. These will be used to translate and rotate the survey data into real-world coordinates.

The next section describes steps to set up the total station, datalogger, and backsight. Most of these steps are performed by the survey lead while the rod crew members run the tagline (BLCA) or lay out plots (DINO and CANY) (see SOP#15, 102, 103, 104 for instructions), install monuments, take photos, and hold the rod for any control shots.

- A. Set up the total station at the initial occupied point, using standard leveling procedures. Measure the height of the instrument (HI), to the nearest millimeter, from the top of the permanent rebar to the horizontal axis indicator mark on the side of the instrument. Document how the measurement was obtained in the field notes.
- B. Measure the height of each rod, to the nearest millimeter, from bottom of rod to center of prism. Make sure that prisms are set so that the heights of both rods are identical. Always raise the rod from the top section (the smallest rod), followed by the next-to-top section, etc. Document rod heights in the field notes (e.g., 1HR = 1.768 m, 2HR = 2.987 m, 3HR = 4.151 m...6HR = 7.680 m). If rod heights are changed during survey, the rod person will immediately notify the survey lead.
- C. Set up the backsight in the initial position. If the backsight will be established with a tripod/tribrach/prism, set up the tripod and tribrach using standard leveling methods. Measure the height, to the nearest millimeter, from top of the permanent rebar to the center of the prism. If the backsight will be established using a rod and prism, make sure it can be shot at a single rod since higher rods are less precise.
- D. Turn on the datalogger and open Survey Pro. Turn off all unnecessary features in the datalogger and make sure it is set to automatically shut off. You may run the Spectra Precision Ranger datalogger until it runs out of power since it automatically saves and backs up the data. Losing power will not impact saved data or configurations other than the real time clock.

- E. Set the initial parameters for the survey. In File, select Open to open a file from a previous survey or New to begin a new survey. Enter the following information:
- Default units
 - Azimuth Type: North Azimuth
 - Units for Distances: Meters
 - Units for Angles: Degrees
 - Do not check Adjust for Earth Curvature / Refraction
 - Do not check Use Scale Factor.
 - Make sure prism constant in datalogger matches prism (our's is -30mm; printed on the actual prism). Do not set prism constant in gun.
 - Click Next.
 - Enter First Point
 - Point Name: 1
 - Northing: 5000.0 m (Y coordinate)
 - Easting: 5000.0 m (X)
 - Elevation: 1000.0 m (Z). *Note: the initial survey at each reach establishes an arbitrary coordinate system that is translated and rotated into UTM coordinates during post-processing in the office.*
 - Description: Enter code/description of point you're shooting (i.e., CP1).
- F. Go to Job to adjust additional settings. Under Settings, choose between Bluetooth (wireless option) or using the manual cord to connect to the total station. If you need to look at a point later in the survey, you can also do this under Jobs, Edit Points.
- G. Enter the instrument location set up information. Go to Survey, then Station Setup, and enter the following:
- Setup Type
 - Known Point: Setup at a point with known or assumed coordinates.
 - Unknown Point/Resection: Setup at an unknown location by observing 2 or more known points.
 - Occupy Point: Enter the code for this point.
 - Do not check the 2D survey box.
 - Enter HI (Instrument Height)
 - Do not click Remote Elevation.

The Information Box displays previously entered assumed coordinates. Click Next after you finish entering the information.

- H. Enter the backsight settings in the datalogger.
- Select one of the following:
 - New Point: Observe and store a new reference point for orientation
 - BS Point: Use an existing point for a reference. This is generally used after starting the survey and backsighting to a known location that was already shot.

- BS Azimuth: Orient along an assumed reference azimuth. This is generally used when shooting the first backsight at the beginning of the survey. A compass is used to get the general bearing (i.e., 0, 90, 180, etc. degrees).
 - Choose one of the following:
 - Fixed Target: Use a dedicated target for the backsight, usually on a tripod.
 - Roving Target: Use a single target for both the backsight and the foresight, usually a rod and prism.
 - Enter the rod height (HR).
- I. Perform the backsight circle. **The total station needs to be on the record screen (not the bubble screen) to take readings. Use the yellow REC/ENT button on the instrument to go to the correct screen.** Sight the backsight prism precisely on the center. If a rod is used to shoot in the backsight, use the total station crosshair to ensure that the prism is on a precise vertical line above the backsight point and a rod level to ensure front-to-back leveling. Make sure that the crosshairs visible through the total station sight are sharp and dark to reduce parallax.
- In the datalogger, click Read Circle. An acceptance sound indicates that this is complete.
 - Click Send Circle. Wait for the acceptance sound.
 - Click Next.
 - Station Check: Use this to check errors before continuing with survey.
 - Choose from three options: By Distance, By Angle, or By Point to check for errors and double-check the station set-up. Do not continue if errors are outside the acceptable range. Stop and remedy the problem.

Acceptable errors

Horizontal (includes the northing and easting): 0.000 - 0.030 (3 cm).

Ideally, it is best to have < 0.020 (2 cm) error.

Vertical (includes elevation): 0.000-0.010 (1 cm).

Ideally, it is best to have <0.005 (0.5 cm) error.

This is the process for setting the total station angle to zero (i.e., zeroing the instrument).
Make no changes along the horizontal axis once the total station has been zeroed.

- J. Now the actual location of the backsight can be established. Go to the "Traverse/Sideshot" menu. The foresight number should automatically be set to "3." Make sure that the height shown on the screen is the same as the tripod or rod height at the backsight. Enter a description (e.g., BS1 = CP2), and shoot the point as a sideshot. Return to the backsight setup screen. Change the backsight point to "3." Rerun the two backsight checks described above. Both the horizontal and vertical distance errors should now be 0.000.
- G. Shoot all the control points or reference markers next. Make sure that all control shots are documented in detail in the field notes.
- H. Begin the rest of the survey.

1.2 Surveying transects - BLCA

Shots along each transect are taken at 1) one-meter intervals marked on the tagline, 2) slope break points that provide an accurate depiction of topography (see Figure 2), and 3) the edge of the water.

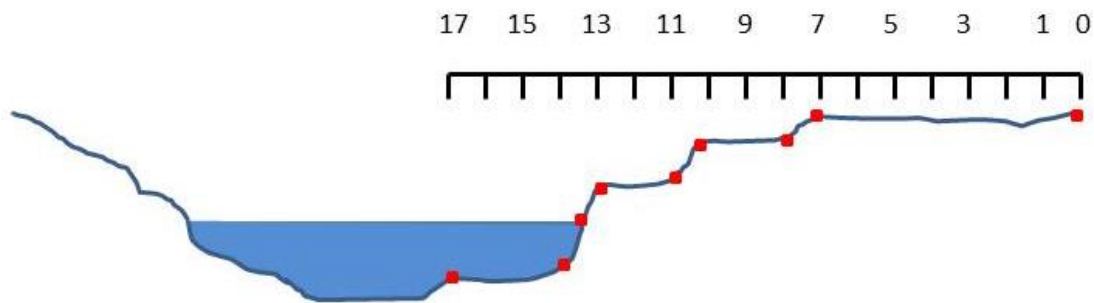


Figure 2. Example of slope breaks points (red) and one-meter intervals (black) surveyed.

- A. Begin at one end of the tagline. Shoot as much of the transect as possible from initial instrument setup. Use codes in Table 1 to name shots in the datalogger and field notes (see Figure 1). Code names for each point should include the transect number, but there is no need to distinguish between 1-m interval shots and slope break shots along the transect.

Rod technique

Raising the rod – Shots are generally taken at the lowest rod height (1 rod) unless there is an obstruction. If the total station does not have a clear line of sight to the prism, try raising the rod, one section at a time, until the shot is successful. Always raise the rod from the top section (the smallest rod), followed by the next-to-top section and so forth. Make sure each time you raise a rod that it snaps into place before the shot.

Rod positioning - Each shot should be taken with the rod flush against the downstream side of the tagline. Use the rod level to make sure that you are holding the rod precisely vertical. When two crew members are running rod, they should "leapfrog" across the tagline or down the profile for the greatest efficiency.

Communication - Use radios to communicate. The survey lead uses an ear piece and microphone attached to the radio to free their hands for operating the total station and datalogger. The rod person should always let the total station operator know how many rods are up before the shot is taken. The total station operator will let the rod person

know when the shot has been successfully completed. When two rods are being used to survey a transect, only the prism of the current shot should be facing the total station operator. Crew members running rod need to make sure their prisms are facing away from the total station while setting up for their next shot. Any shot errors (e.g. rod not raised to full height, incorrect rod height relayed to survey lead) should be relayed to the survey lead immediately, documented, and corrected by re-taking the shot, if necessary.

Shooting through dense vegetation

If you are unable to get a shot at any of the standard rod heights, the following alternatives may be attempted.

- Move the rod slightly upstream or downstream while keeping the bottom of the rod on the same geomorphic surface. The rod person will need to estimate the distance upstream or downstream of the tagline and relay this to the total station operator to document in the field notes. Make sure to level the rod in the new location.
 - Use an alternative rod height. The total station operator finds a section of the rod that is visible and sets the crosshairs to the elevation shown on the rod face (e.g. 1.5 m). The rod person then adjusts the rod so that the prism is at this height. The total station operator instructs the rod person to raise or lower the prism until it is centered in the pre-set crosshairs, takes the shot, and enters the appropriate rod height.
 - Take a shot using the horizontal or vertical offset functions in Survey Pro (see instructions for the software).
- B. Rod crew members should alert the total station operator when they reach a headpin. If it has a permanent monument, set the rod on top of the rebar, notifying the total station operator that the shot is “Top of Pin.” The next shot should be on the ground surface next to the rebar. If endpoints are not monumented, shoot the ground surface at the pin flag. Note that both headpins on a transect are coded with the same name.
- C. After surveying transects along the tagline, use the data in the total station to extend the transects beyond the headpins onto the upland terrace. Points should be surveyed at approximately 1-m intervals and all surface breaks until you reach a very stable upland surface, even when this surface is located behind the permanent transect headpin.
- ### **Woody debris and other obstacles along the survey transect**
- Where large woody or other debris precludes placing the base of the rod on the ground surface, the rod person should place it on the object for the shot, and relay to the total station operator the height of the debris above the ground surface. This can be measured using the increments marked on the face of the rod. The total station operator should document this information in the field notes in order to make later adjustments to the survey data.
- D. If you can shoot additional transects from the existing instrument setup, perform the following checks before beginning the next transect.
- Check the backsight and correct any errors reported by the datalogger.

- Re-shoot any reference marks.
- E. If the total station must be moved to accommodate the next transect, shoot as much of the stream profile as possible before moving the instrument.
- F. If a transect needs to be shot from two different instrument setups, mark the location where you stopped surveying with flagging so that you can begin surveying at the correct location from the new instrument setup.

1.3 Surveying – DINO and CANY

Shots are taken at each vegetation plot and then follow the CHaMPs methodology (Bouwes et al. 2011) to create a continuous surface of topography for the feature. These methods are taken with minor modification from (Bouwes et al. 2011). Features such as edge of water, the spatial arrangement and perimeter of channel units, top and bottom of banks, and topographic points are used to capture the shape and gradient breaks during the survey. A 3-dimensional topographic surface of the feature is created by connecting a series of points that have X, Y, and Z coordinates. During the survey of a site, the job of the person operating the rod is to effectively and efficiently survey points and lines that will collectively represent the feature as accurately as possible. The points selected by this person determine the ultimate utility of the site survey and should be done carefully.

- A. Locate benchmarks (rebar with labeled caps/tags) at the sentinel site. Mark with pinflags. Survey these first when instrument is set-up.
- B. Survey in all vegetation plots as described in SOP 15, 102, 103, 104 (Figure 3).

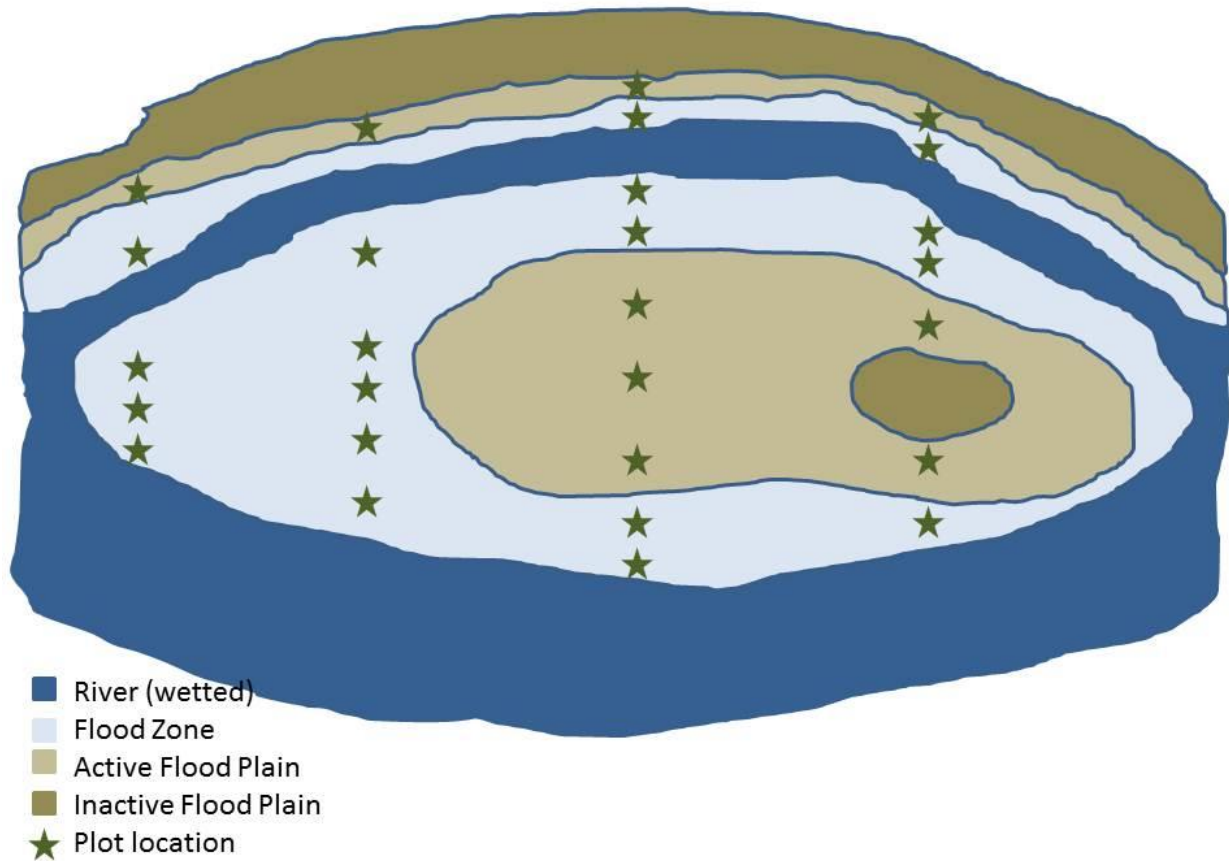


Figure 3. Locations of vegetation plots to be surveyed in. The topographic survey should also capture the boundaries of the geomorphic surfaces shown here.

C. Survey using CHaMPS methodology:

- a. Determine the channel units that will be surveyed and number these (Fig. 4).
- b. Collect points defining the perimeters of channel units. Figure 4 shows the different points taken to define the plan form view of channel units and bars. Table 1 defines the codes used to delineate the survey points (i.e. W, FZ, AFP, IFP, etc.).
 - i. Beginning with the most downstream channel unit collect points along the edge of water of the unit in a manner that characterizes the plan form view of the unit. Label these wetted perimeter points with a W followed by the channel unit number.
 - ii. Where the perimeter of a channel unit is within the wetted channel, label the point U followed by the channel unit number.
- c. Survey high water (HW) points when conditions are appropriate.
- d. Collect points defining the perimeters of mid-channel bars. A mid channel bar is completely surrounded by a wetted perimeter. Label these edge of water points as B followed by the channel unit number.
- e. Perimeter points that are shared by multiple channel units or bars require additional coding. Some perimeter points of channel units and bars will require

additional coding to represent the perimeters of two or possibly three channel units or bars.

- f. Locate and collect points at the maximum depth and tail crested depth of pools. Label maximum depth points as MAX followed by the channel unit number. Label crested depth points as PTC followed by the channel unit number. Pool crested depth points also define the perimeter of multiple channel units and should be additionally coded to reflect the perimeters of these units. These measurements should only be done up to a safe wadeable distance and the surveyor shall have a life jacket on.
 - g.
 - h. Topographic shots (TOPO): Survey enough TOPO shots to capture the shape of the feature. The channel topography survey captures the gradient changes of the flood zone. These topographic points should describe all features of the channel up to and at least 1 m horizontally beyond the first flat floodplain found at or above the bankfull elevation. Label these points TOPO.
 - i. TOPO points should be distributed longitudinally throughout the length of the site, and extend laterally to the survey extent.
 - ii. Spacing of topo points will depend on the complexity of a stream. A stream with more gradient breaks or inflexion points will require a higher density of topo points. The density and distribution of topo points will determine the quality of the survey.
 - iii. Side channels will be surveyed using the same set of procedures as the main channel.
 - iv. It is not necessary to label thalweg points (TL) in non-primary sections of channel; however the deepest points should be surveyed using TOPO points.
- D. Survey as much as the topography of the flood zone at a safe wadeable depth. Figure 2 or 7 shows how points (red dots) are selected that represent changes in gradient in the cross-sectional view. Gradient changes in the longitudinal view must be captured as well.
- E. Survey breakline features (i.e. FZ-AFP boundary; AFP-IFP boundary, etc.) and the extent of the flood zone . Figures 4 and 5 show the importance and placement of these breaklines.
- a. Breakline features are changes in the gradient of the cross-sectional profile along the streambank. Figure 5 shows how surveying a series of breaklines that run parallel to the streambanks are essential for effectively representing these topographically complex areas of channel. Also include shots of the water's edge.
 - b. There are six types of breaklines that need to be surveyed if present (Figures 6, 7):
 - i. Toe-of-bank (TOE): The first break line encountered working toward the bank is the toe-of-bank. This breakline, if present, is a change in cross-sectional gradient below the bankfull elevation. Toe-of-bank points may be in the wetted channel but must be near the bank and represent the beginning of the bank. Toe-of-bank is where the streambed meets the streambank and is often marked by a transition from streambed material to streambank material. Label toe of bank breakline points TOE.

- ii. Flood zone (FZ): The second breakline encountered working toward the bank is the flood zone (FZ) breakline. Points along this breakline should be spaced in order to capture significant gradient breaks or nick points in this breakline. Flood zone in a constrained stream is identified as changes in substrate or vegetation.
- iii. Active floodplain-Inactive floodplain (AFP-IFP): The breaklines of the active floodplain (AFP) and inactive floodplain (IFP) (Figures 2, 7) will also be surveyed in a similar manner as the FZ breakline.
- iv. Top-of-bank (TOB): Beyond the bankfull a breakline must be surveyed that represents the extent of the survey. This breakline is called top of bank and is labeled TOB.
- v. Beyond Inactive Floodplain (BIFP): Alternatively, the extent of the survey in constrained reaches requires a point beyond the IFP. There is not necessarily a feature to determine where this breakline is. Locate these points 1 m beyond the IFP elevation. Label these points beyond inactive floodplain points as BIFP.

Tips for breaklines:

- At a minimum 2 breakline features need to be sampled at any given cross-section. Breaklines can change within a survey but at least two breaklines must be present and continuous from top to bottom of the reach for each side of the channel.
- Breaklines should be composed of enough intermediate points to capture the general shape or any TOB or TOE of bank features (Figures 6, 7).
- It is not necessary to survey breaklines along sections of streambank that lack an apparent TOB or TOE.

Survey in upland boundary.

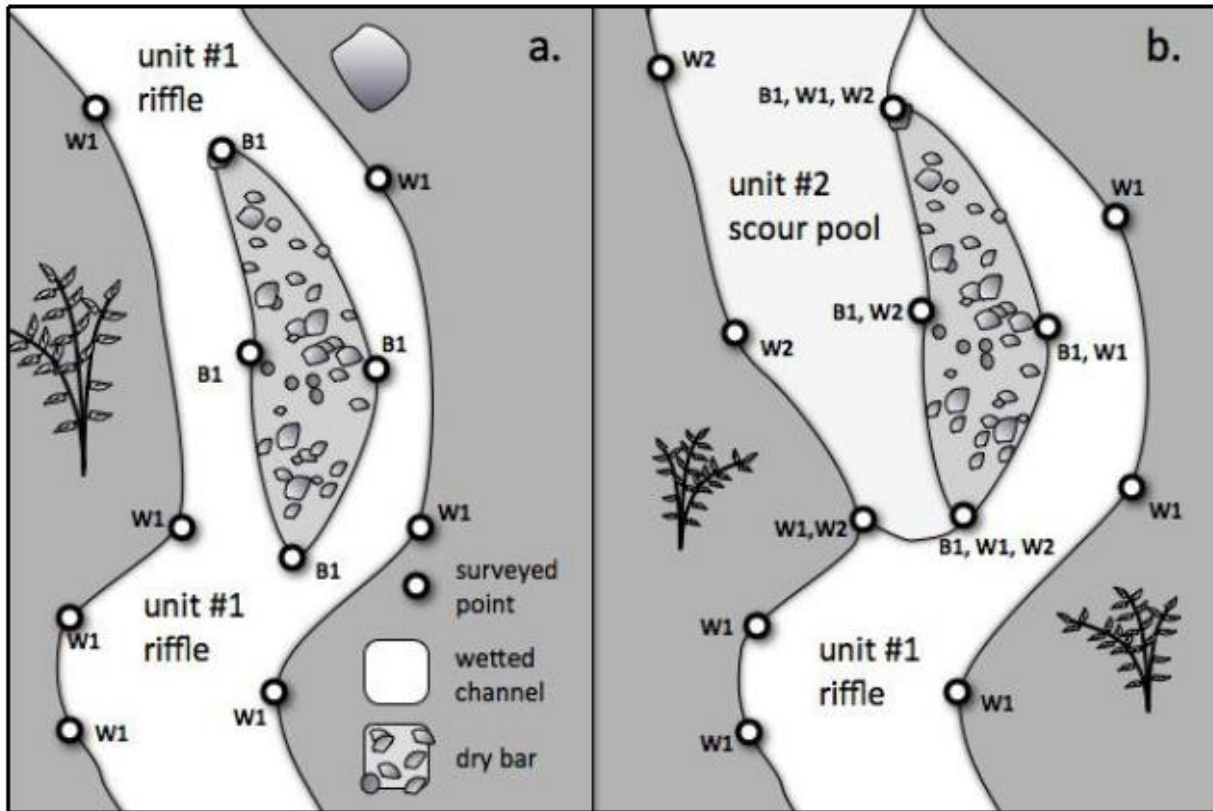


Figure 4. Example of coding points to describe the perimeters of channel units and bars showing which points require multiple codes.

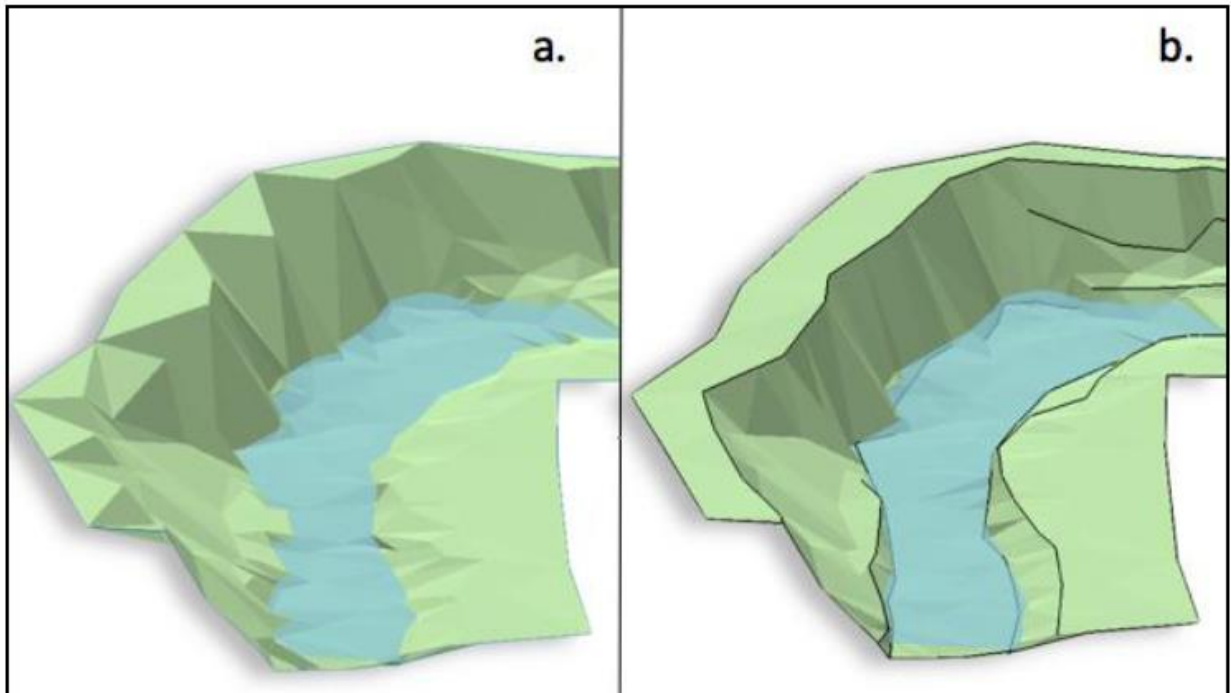


Figure 5. Example of streambank surfaces rendered a) without, and b) with breaklines surveyed at the TOB and TOE of the bank.

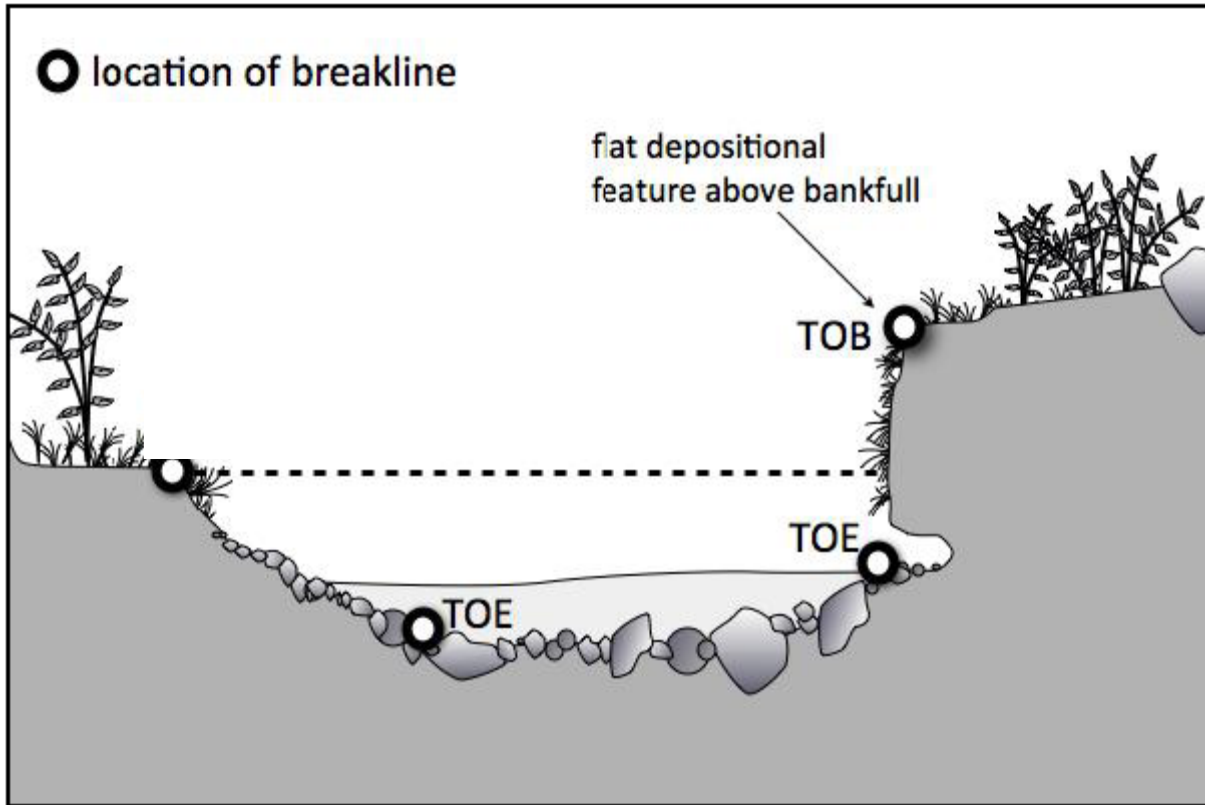


Figure 6. Cross-sectional view of a stream channel demonstrating the appropriate placement of TOB, and TOE breaklines.

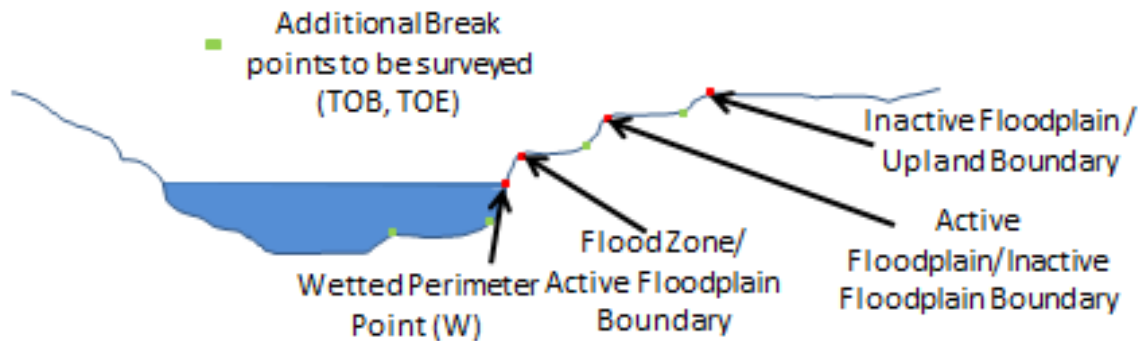


Figure 7. Cross-sectional view of a stream channel demonstrating the wetted perimeter, flood zone, active floodplain, inactive floodplain, upland, and break points.

1.4 Establishing a new instrument setup

Make as many shots as possible from each instrument setup, including transects, stream profile, and hydrologic instrumentation. Follow the instructions below to establish a new instrument setup.

- A. Move the total station to the backsight location, and use the previous occupied point as the new backsight. Adjust the appropriate settings in the datalogger, and shoot the

backsight and reference marks from the new location. Shoot as many transect and stream profile points from this location as possible.

- B. Shoot in a new instrument setup location (CP3). Use one of the existing controls (CP1 or CP2), an existing reference mark, or any headpin that has already been surveyed as the new backsight. Monument, flag, and photograph the new instrument setup as described in section 1 above, and shoot in the new point before moving the total station. Make sure to document any additional instrument locations and backsights used in the field notes.
- C. Shoot in additional instrument setup locations as necessary to complete the survey. In dense vegetation, you may need as many as 4 or 5 instrument setup locations.

1.5 Collecting waypoints

In order to transform the survey data into real-world coordinates, GPS data are collected at all instrument setups and reference marks. In the field notes, record the time GPS waypoints are collected for each occupied point or reference mark.

1.6 Locating positions and lines from previous surveys

Follow instructions in the Survey Pro documentation to locate positions and lines from previous surveys.

2. After the field visit

2.1 Downloading total station survey data

Survey data should be downloaded as soon you return from the field.

- A. Make a copy of the original data and paste it into the corrected data folder. Rename the file so that it begins with “corr” and ends with the extension .txt (see Figure 3). Make sure to keep a copy of the original data for the archives.
- B. Open the copied coordinate file (corrFremont01crd.txt in Figure 3) in Excel. The file should have five columns: point number, x, y, and z coordinates, and point description. Save the file as an .xls file using the naming convention in Figure 3.
- C. Make corrections from field notes in the Excel file. For example, where an incorrect rod height is documented in the field notes, locate the appropriate point number in the Excel file, and make the needed correction to the elevation recorded for the shot. Notes describing each correction can be made to the coordinate and raw data files in the corrected data folder. When all corrections are complete, save the worksheet as a comma-delimited file (.csv) in the corrected folder.

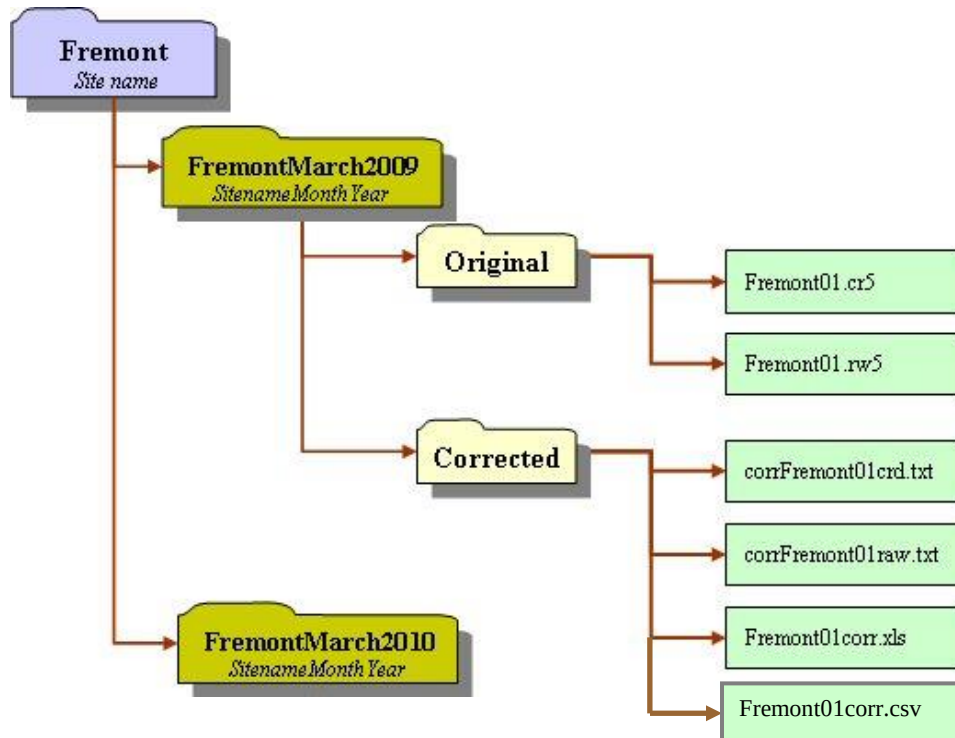


Figure 3. Folder and file naming conventions for survey data.

2.2 Downloading waypoints

Each GPS waypoint should be downloaded and differentially corrected as soon as you return from the field.

2.3 Post-processing survey data

Using Traverse PC software, survey data are converted to UTM coordinates, and profiles are created for each transect and feature.

- A. Convert total station survey data to UTM coordinates.
 - a) Import the corrected .csv file into Traverse PC.
 - b) Obtain differentially-corrected data for all instrument setup and reference mark points. Examine the GPS report to identify points with the lowest PDOP values and reported errors. Select the most accurate point, and move all surveyed points so that coordinates of the selected point match the GPS data.
 - c) Modify the elevations of all points so that this point's elevation is the same as that reported by GPS. This change is to modify the surveyed elevations to within ~1 m of real world elevations. It is the only change to surveyed elevations that should be made, as the relative elevations recorded by the total station will be more accurate than elevations collected by GPS.
 - d) Reproject all survey data to UTM coordinates. Use NAD83 for the datum and the zone appropriate for the reach.

- e) Select the second-most accurate GPS point. Rotate all survey data around the initial point so that the coordinates of this second point are as close as possible to those reported by GPS. Check the northing and easting coordinates for the remaining setup locations and reference marks to make sure that they are within a few centimeters to those reported by GPS. If the error is greater than this, check all transformations and rotations to identify any errors and correct them.
 - f) Separate all control shots from transect and profile shots. Export all control point coordinates into the “final control” worksheet in your Excel file. Repeat for all transect and profile shots and label this one “final topography.” These coordinate values will be used to overlay the transect and profile points on aerial photos.
- B. Obtain detailed cross-sections for each transect and exporting the coordinate values for all points along each transect into the Excel file. Use a separate worksheet for each transect and label each by its transect number. The Pythagorean theorem equation can be used to translate x,y coordinates into stationing values. The left endpoint should be considered the “100” station. Generate cross-section drawings in the Excel file, using uniform scales for the x and y axes.
- C. Export the thalweg profile shots into a separate Excel worksheet. Transform into stationing values, from downstream-most to upstream-most point. The downstream point should be labeled as station “0.” Generate a profile drawing in Excel using an appropriate vertical exaggeration.
- D. In the Traverse PC file, appropriately label control shots (distinguish between occupied points and reference marks), transects, and the points shot along the thalweg profile. Label the drawing with survey dates and other appropriate information for the archive.

2.4 Archiving

Create shape files and the accompanying metadata for the finalized survey data. The following should be archived:

- 1) Traverse PC file.
- 2) Shape files of all spatial data.
- 3) Metadata file.
- 4) Excel file consisting of transect worksheets with finalized survey coordinates, transformed stationing/elevation values, and drawing; 1 profile worksheet with finalized survey coordinates, transformed stationing/elevation values, and drawing; 1 control point and 1 topography worksheet with coordinate values and descriptions, and the original coordinate correction worksheet.
- 5) Field notes with sketch of reach.
- 6) Photographs of all control points and reference marks.
- 7) Original coordinate and raw data files.

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 9

After each Field Visit

Version 1.00 (May 2012)

Revision History Log:

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

This SOP details procedures performed at the end of each field trip, including equipment maintenance, data management, and trip reports.

Procedures

1. Follow check-out procedures with Glen Canyon dispatch detailed in the NCPN Backcountry Safety Plan.
2. Report all broken or missing equipment to the field crew coordinator. Repair equipment if possible or indicate if new equipment needs to be purchased before the next field hitch.
3. Check-in cameras, lasers, satellite phones, and GPS units. Also check-in lasers, total station, data logger, water level meter, and/or PDA if used.
4. Remove plant collections from the press or cooler, and store them in a secure location where they will not be damaged.
5. If boating equipment was used, make sure it is clean and dry before putting away.
6. Complete data entry and verification. Resolve any questions with the crew members who collected the data.
7. Organize and file datasheets.
8. Download photos and organize by park code and reach name.
9. Download data from total station surveys (see SOP #8) and perform any post-processing.

10. The crew leader should complete a trip report detailing the dates of field work, crew members participating, work completed, travel and housing availability, safety concerns and how they were accommodated, weather conditions, any equipment problems or needs, and any other pertinent information. Also note any interesting or unusual findings, observations of disturbance, human or animal activity, deviations from the SOP, or access issues.
11. Organize monitoring boxes for the next hitch.
12. Charge camera and satellite phone batteries. Also charge batteries for the total station, data logger, PDA, and field laptop if these electronics were used.
13. Return GPS units to the GIS technician for downloading and charging.
14. Clean the insides of vehicles. Especially dirty or muddy vehicles may be washed as often as monthly when needed. Report vehicle repair needs to the field crew coordinator.
15. Decontaminate all equipment, personal items, and clothing that have come into contact with water or mud. The following procedures are to be used to prevent the spread of exotic invasive organisms.
 - Remove all mud and debris using a scrub brush.
 - Spray with 5% Quat solution and allow to rest 10 minutes.
 - Rinse with water.
 - When feasible, allow to dry completely before entering another body of water.
16. Tidy the conference room before leaving for multiple days off.

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 10

After the Field Season

Version 1.00 (December 2011)

Revision History Log:

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

This SOP details procedures performed at the end of the field season, including equipment maintenance and data management.

Procedures

1. Equipment maintenance. Inspect all equipment for damage and note any missing equipment. Clean and repair all equipment prior to returning it to the project leader.
2. Equipment inventory. Ensure that adequate supplies are on hand for the next field season and create a list of supplies that need to be ordered.
3. 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.
4. New species follow-up. 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 mounting, labeling, and preparing voucher specimens for any new species collected in a park unit. Update park plant species lists and the species list in the database.
5. Field herbaria. The field crew leader mounts and labels appropriate specimens for the field herbarium.
6. Data management. The field crew leader is responsible for ensuring that all data sheets are completed properly.

7. Data entry. The field crew leader is responsible for ensuring that all data are entered and verified according to procedures outlined in SOP #12. Also download all photographs to the X:\ drive and make sure they are correctly labeled.
8. Field season review procedures. Prior to the departure of the field crew, the project manager will query the field crew for issues with existing monitoring protocols and field logistics and will seek recommendations for improvements.
9. Logistics. The field crew leader updates access documents with new and updated access and logistical information, such as road closures, park personnel turnover, etc.

Big River Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 12

Data Analysis and Reporting

Version 1.00 (December 2011)

Revision History Log:

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

This SOP provides an overview of analysis and reporting procedures. After raw data from the field season are quality checked and certified, they are then summarized to the feature level. Additional QAQC is performed comparing these data to previously collected data to catch misidentified species and values that represent unlikely amounts of change between years. Once data quality issues are resolved, analyses can be conducted. Two general types of analyses are performed: 1) annual reporting of the most recent monitoring observations (annual reports and briefs), and 2) comprehensive assessments of the long term data set (variance estimation of the overall sampling design, evaluation of status and trends, and correlations with other vital signs).

1.0 Data Summary

The sampling unit for all big river analyses is the feature, and sub-samples recorded on plots must be scaled to this level. Vegetation and geomorphology data may be integrated at the transect level, but ultimately need to be summarized to the feature level. Summary queries should be created in Access to expedite this process.

Vegetation Summaries

Richness

Data from the 1-m belt transect (BLCA) and 1-m plots (DINO and CANY) are used to calculate species richness, or the number of unique species encountered. For each reach, calculate richness of all species and of native species.

Percent Cover

Percent cover is calculated for each species, life form, wetland status group, ground cover attribute, and disturbance using data from 1-m belt transects and 1 m plots. It is derived by summing the percent cover from each plot and dividing by the total number of plots, times 100 (eq. 1, Table 1).

Exotic frequency

Exotic frequency is derived from the number of detections of each exotic species in the 1-m² quadrats, and reported as the percent of detections.

Geomorphology Summaries

After total station survey post processing, relevant geomorphic surfaces are delineated by elevation or abrupt surface breaks on each transect. The data can then be integrated with other measurements or summarized to the reach-level.

Channel morphology

The mean active channel width and depth in meters (eq. 2, Table 1) and the channel gradient in percent slope are calculated for the feature using data from the geomorphology survey transects. The distribution of particle sizes in the channel bed is derived from the modal particle size.

Flood plain morphology

The mean flood plain width and elevation in meters is calculated for the reach using data from the geomorphology survey transects. The delineation of the flood plain will be estimated until enough hydrologic data are collected to determine this.

Integrated Summaries

Vegetation data are integrated with the geomorphology survey transects to derive mesic to xeric plant cover by surface elevation and species richness and percent cover by geomorphic surface elevation.

Inundation duration of the floodplain (% of growing season) will be determined using geomorphology surveys and hydrologic data, and will be more meaningful as additional floods are recorded. Inundation frequency of the floodplain (return frequency in years) requires multiple years of hydrologic data in addition to a survey of the flood plain.

Table 1. Formula for deriving reach-level measures.

Percent Cover

$$PC = (h / n) * 100 \quad (1)$$

where PC = percent cover
h = percent cover of each species by plot
n = the total number of plots per feature by geomorphic surface

Mean (channel width, etc.*)

$$M = \left(\sum_{i=1}^v c_i \right) / v \quad (2)$$

where M = mean channel width in m
c_i = channel width in m for transect i in a reach
v = the total number of transects in the reach

* channel width shown in this example, but this formula is also used for channel depth, flood plain width and elevation, annual and growing season stream stage, annual and growing season stream discharge, annual flood stage, and depth to ground water.

2.0 Data Quality Assessment

Before data analysis and reporting, reach-level data should be additionally evaluated for reasonable levels of change based on historical conditions at each reach. For instance, a measure may appear to be valid based on the database domain, but represent an unreasonable (and unlikely) change in reach conditions since the last field visit. Summarized attributes should be compared between years, and all suspect values (large increases or decreases) should be flagged and resolved before the data are analyzed. In addition, data should be evaluated for the omission of historically dominant species or the appearance of dominant species not detected in previous years. New occurrences of a species should be compared with the park-level species list and species-range limits.

Suspect measures or species should be evaluated by field crew members and by field verification if possible. Any corrections made to the database should be recorded in the QAQC log. Suspect data that are not resolved should also be flagged in the QAQC log so that it can be excluded from analyses, if appropriate. Suspect data that cannot be resolved in the office should be brought to the attention of the field crew at the next monitoring visit so that they may eventually be resolved.

3.0 Annual Reporting

Annual Reports

The primary objectives of the annual report are to 1) document monitoring activities for the year, 2) summarize annual data and describe the current condition of resources, and 3) provide information to park managers in a timely manner that increases data utility and communication. A separate annual report is completed for each NCPN park unit with riparian monitoring. Existing NCPN annual reports should be consulted for formatting.

Annual Briefs

Each year, information from annual reports and other analyses is further summarized in 1-2 page briefs that provide resource managers with a concise summary of issues of concern. NCPN produces two types of briefs: vital signs briefs and park briefs. The riparian vital signs brief summarizes findings from riparian monitoring in all NCPN parks. Park briefs are produced for each NCPN park unit and contain a section on riparian monitoring. Existing vital signs briefs and park briefs should be consulted for formatting.

4.0 Comprehensive Assessments

Comprehensive analyses and reports are completed periodically on the long term data set. Comprehensive reports should be structured like typical scientific manuscripts (introduction, methods, results, discussion, and literature cited sections) and may include any of the analyses described in this section.

Sampling-Design Variance Assessment

The sampling design for riparian monitoring at each stream is documented in a separate report that outlines specific sampling objectives. Periodic checking of the assumptions of the sampling design affords timely opportunities to invoke enhancements to meet the original monitoring and sampling objectives. Sampling designs are evaluated by calculating variance and power for trend, and assessments are recommended every 5-7 years.

Variance estimates are derived from all years of monitoring data, not just observations from the current field season. Where necessary, alternative survey designs are evaluated to determine appropriate enhancements, such as an increase in sample size or more frequent visits to established reaches, to achieve the original sampling objective. Power-for-trend is evaluated with alternative numbers of panels, sample sizes, and re-visit schemes. A trend may be reported as a yearly rate or a rate over a set number of years. This conversion is outlined for increasing (eq. 3, Table 2) and decreasing (eq. 4, Table 2) rates of trend. Results are then used to determine which survey designs best meet the original sampling objectives.

Table 2. Formula for converting a yearly rate of trend to a rate of trend over a set number of years.

Conversion for rate of trend

$$I = e^{rt} \quad (3)$$

$$D = 1 - e^{-rt} \quad (4)$$

where;

I = % increase over t years

D = % decrease over t years

r = the yearly rate of increase or decrease

t = the total time period of increase or decrease

Status and Trend Assessments

The underlying motivation for using survey designs to monitor big rivers is the ability to make inferences to a finite, target population. Alternatively, model-based designs and assessments rely on modeled relationships, and thus tend to have inherent assumptions, and in some cases, limitations in terms of the scope of inference. However, model-based assessments may be useful to help explain reasons for trends observed in survey-design efforts, and information from other vital signs monitoring (e.g., climate, air quality, land use, land condition) or other sources may prove critical to interpreting observed riparian trends. Bayesian methods may detect trends earlier than frequentist methods and should be developed over time.

Status and trend analyses are performed after at least 5 years of monitoring data are collected. When significant trends are detected, reasons for these trends should be evaluated by literature reviews, comparison with similar data sets, and additional assessments using ancillary information. When unidirectional trends are not detected, correlations may help us understand system drivers.

Frequentist Methods

Frequentist trend assessments of complex survey designs are performed using a mixed-effects model (Larsen et al. 1995). Reach-scale measures are used in the model and evaluated on the basis of time. The output from this model is a measure of the intercept and slope, the significance of the slope and intercept being different from zero, and measures of the variance and covariance of the regression parameters. A significant slope indicates a significant trend at the alpha level used to assess significance or below.

Status is the condition of the attribute and is derived in two ways. If the trend slope is not significantly different from zero, mean and variance of status is simply the mean and variance of all measures of the attribute up to the current time period. If the slope is significant, then status is the solution of the regression model for the latest time period of the data used to generate the trend line (eq. 5 in Table 3). Variance measures of mean status are derived from the covariance matrix of the regression coefficients (eq. 6 in Table 3).

Table 3. Formula for deriving status and trend estimates.

Mean Status From a Trend Line

$$ST_t = b_0 + b_1 * t \quad (5)$$

where;

ST_t = estimate of mean status at time = t

b_0 = the estimated intercept parameter

b_1 = the estimated slope parameter

t = the most recent time period of the data (in the same units used to generate b_0 and b_1)

Standard Error of Status

$$SeST_t = \sqrt{(\sigma_{b_0}^2 + 2t \sigma_{b_0b_1} + \sigma_{b_1}^2 t^2)} \quad (6)$$

where;

$SeST_t$ = the standard error of the mean-status estimate at time = t

$\sigma_{b_0}^2$ = the variance of the intercept parameter

$\sigma_{b_0b_1}$ = the covariance of the regression parameters

$\sigma_{b_1}^2$ = the variance of the slope parameter

t = the most recent time period of the data

Model-Based Methods

Model-selection procedures consider a range of potential factors influencing directional change in resource conditions. Even if a significant trend occurs as a function of time, the relationship between other explanatory variables and riparian measures should be evaluated to determine potential ‘causal’ factors of trends. These other explanatory variables can include biophysical features of the reaches as well as measures from other vital signs monitoring (e.g., climatic conditions).

Model selection methods (Burnham and Anderson 1998) evaluate the explanatory power of different models of trends in big river measures. Multiple models are considered, each with different combinations of independent variables and interaction terms. All models should be based on hypothesized, ecologically meaningful relationships. Adjusted AIC (Akaike’s Information Criterion) values generated with a mixed-effects model are used to determine the best predictive model as well as the importance of independent variables.

The primary model in this model-selection procedure is the response of interest vs. time (see frequentist methods above). Alternative models can be based on measures of climate, air quality, land use, and land condition, as well as other measures that may be considered important. When evaluating other variables, they are either included in an interaction with time or time is replaced with the variable.

The result of the model-selection procedure is the selection of the model (i.e., set of independent variables) which best predicts the trend of the response variable. This, in turn, aids in explaining reasons for the observed trend. For instance, if alternative models with one or more driver attributes (e.g., drought days) accounted for more variance than just using time, trends may be attributed to these attributes in a correlational relationship, but not necessarily a causal relationship. If alternatives to time account for less variance, other avenues of investigation should be considered to explain reasons for observed trends.

Bayesian Methods

Bayesian methods for trend assessment identify the probability of different slope-parameter values (Gelman et al. 2000, Wade 2000) given the observed data. This differs from frequentist methods which calculate the probability of observing data given a specific value for a parameter, such as the null hypothesis. Assessing the probability of different slope values is potentially important for various reasons. First, sampling designs are largely based on a few key features. The minimum detectable trend at a reasonable power level for many of the other responses will likely be much higher. Estimating the probability of slope values may be the best way to provide insight into trends for these attributes. Second, even for the key features around which sampling designs were based, Bayesian methods may reveal the potential of declining trends before rejecting the null hypothesis that the regression slope equals 0 with conventional statistics.

Bayesian methods use a likelihood distribution generated from the sample data that provides the probability of observing the data for every possible parameter value. Combining this with a prior distribution produces a posterior distribution which is used to make inference about parameters. The prior distribution reflects previous knowledge about the distribution of parameters. In the absence of such knowledge, a non-informative distribution can be used, which essentially is a uniform distribution across the range of the likelihood distribution. In subsequent analyses, the posterior distribution of previous assessments is used as the prior distribution. The posterior distribution allows assessments of the probability of user-selected parameter values. The probability of various increasing and decreasing slopes should be evaluated based on the posterior distribution and the consequences of not alerting management of a potential trend. The result of this assessment is the derivation of the probability of different levels of decline/increase. Even though conventional statistics may not reveal a significant trend, relatively high probabilities (e.g., ≥ 0.70) of trends with a Bayesian method may warrant special attention.

Correlations

There will be instances where a monitored attribute fails to exhibit a trend (i.e., a direction change), but instead may have periods of decline followed by recovery. In other words, natural variation may be more evident than a precipitous decline or increase, and it may mirror the variation in a key driver attribute. Discerning this variation and reasons for it can involve many complex procedures. As a first step, however, correlational methods can provide useful insight and are relatively simple.

For attributes that fluctuate between declines and increases, correlations with climate, air quality, land cover/use, land condition, and other potential drivers should be considered. Strong correlations between a response and driver may be sufficient to understand reasons for the observed variation over time (e.g., strong correlation between shrub cover and annual precipitation).

Another type of correlation assessment is path analysis (Lindquist 2000). This method accounts for the inter-correlated structure among factors by decomposing correlations to direct and indirect effects. For instance, changes in grass cover in a shrub-steppe system may be influenced by shrub cover alone or by climate alone or by the influence of climate on shrub cover. A path analysis would decompose the effects of climate and of shrubs on grass cover, while considering the combined influence of climate and shrubs. The result of a path analysis is the indication of the strength of direct and indirect factors on a response, thus providing insight into reasons for the observed changes in a response. Path analysis is based on correlation values and the simultaneous solution of structural equations. Simple examples of the construction and use of path analysis are provided in Lindquist (2000) and Van Bruggen and Arneson (1986); details of path analysis are provided in Pugeseck et al. (2003).

5.0 References

- Burnham, K. P. and D. R. Anderson. 1998. Model selection and inference: a practical information-theoretic approach. Springer-Verlag, NY
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Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 13

Revising the Protocol Narrative and SOPs

Version 1.04 (January 2015)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	1/1/2012	H. Thomas	Updated master version table.	To reflect new versions of SOPs.	1.01
1.01	1/1/2013	H. Thomas	Updated master version table.	To reflect new versions of SOPs.	1.02
1.02	1/1/2014	H. Thomas	Updated master version table.	To reflect new versions of SOPs.	1.03
1.03	1/1/2015	H. Thomas	Updated master version table.	To reflect new versions of SOPs.	1.04

This Standard Operating Procedure (SOP) explains how to make and track changes to the protocol narrative and SOPs for the Northern Colorado Plateau Network (NCPN) big river monitoring protocol. Following these guidelines ensures that data collection and processing procedures are documented and retained for use and interpretation of historical data sets. Project staff should refer to this SOP when any changes to an approved protocol document are necessary. The procedures in this SOP are based on the NCPN Protocol Versioning Guidance Document (NCPN 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 (NPS) and experts outside of the NPS with familiarity in geomorphology, hydrology, vegetation monitoring, and data analysis will be used to review major changes.
2. Record all changes to a protocol document (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 the big rivers database and is reported in this document (SOP #13). Any time a narrative or an SOP version change occurs, the MVT is updated to reflect the date of the change and the versions of the narrative and SOPs in effect. *The protocol narrative, SOPs, and data should not be distributed independently of this table.*
4. The current version of the protocol narrative and SOPs will be posted on the NCPN web site. Previous versions of the protocol narrative and SOPs will be archived in the NCPN Big River Protocol Library (R:\Monitoring_Archive\Big_Rivers\Protocol) and in the NPS Data Store (<https://irma.nps.gov/DataStore>).

Big River Monitoring, Northern Colorado Plateau Network Master Version Table

SOPs that are numbered 100 or higher are ones that have been retired for various reasons. In some cases, SOPs were retired because the methods were not suitable. In other cases, SOPs were split into park-specific SOPs that ultimately did not work as well as expected. The park-specific SOPs were subsequently combined again and the individual park SOPs were retired. A dash (“-”) in a cell indicates that the narrative or SOP is not applicable during the corresponding time period.

Effective Date	Narrative	1-Prep. for field season & equip. lists	2-Hiring & training observers	3-Using GPS units	4-Sentinel site setup	5-Photographs	6-Measuring vegetation	7-Hydrologic monitoring	8-Surveying	9-After each field visit	10-After the field season	11-Data management	12-Data analysis & reporting	13-Revising the protocol	14-Facies mapping & grain size dist.	15-CURE non-survey field methods	16-Trimble RTK field operating instructions	17-Trimble Business Center QA/QC	18-Vegetated vs. non-vegetated mapping	100-Rapid assessment	101-CURE non-survey field methods	102-BLCA non-survey field methods	103-CANY non-survey field methods	104-DINO non-survey field methods	105-CANY field prep. & equip. list	106-DINO field prep. & equip. list	107-DINO sentinel site setup	108-DINO photographs	109-DINO measuring vegetation	110-DINO facies mapping & grain size dist.
1/1/2011	-	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	-	-	-	1.00	-	-	-	-	-	-	-	-	-	-
1/1/2012	-	1.00	1.00	-	1.00	1.00	1.01	-	1.00	1.00	1.00	-	1.00	1.01	1.00	-	-	-	-	1.00	1.00	-	-	-	-	-	-	-	-	-
1/1/2013	-	1.00	1.00	-	1.01	1.11	1.02	-	1.00	1.00	1.00	-	1.00	1.02	1.01	-	-	-	-	2.00	-	-	-	-	-	-	-	-	-	-
1/1/2014	-	1.01	1.00	-	-	-	-	-	1.00	1.00	1.00	-	1.00	1.03	-	2.00	-	-	-	-	-	2.00	2.01	2.00	-	-	-	-	-	-
1/1/2015	-	-	1.00	-	-	-	-	1.00	1.00	1.00	1.00	-	1.00	1.04	-	2.00	-	-	-	-	-	2.01	2.10	-	1.01	1.00	1.00	2.10	2.11	1.00

References

Northern Colorado Plateau Network (NCPN). 2009. Protocol versioning guidance document, version 1.0. National Park Service, Inventory and Monitoring Program, Northern Colorado Plateau Network, Moab, UT.

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 15

Field Methods (Non-Survey) for Curecanti NRA

Version 2.00 (June 2014)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	6/5/2014	D. Perkins	Major change in numbering of SOPs and in field methods. Methods used previously (2012) are in SOP #101 (retired).	Clarity and simplicity in the field for crew; previous methods did not work well.	2.00

This SOP describes the methods for conducting monitoring at Curecanti NRA. A list of necessary equipment for these procedures can be found in SOP #1.

1. Measuring Vegetation

1.1 Sentinel Site Establishment

Record directions to the transects

Write directions to the transect and include sufficient detail for someone who has never been there to relocate it. Begin with road travel from a designated location (such as Neversink Parking Area, Cooper Ranch West Parking Area) and the route used. Describe (and photograph) landmarks used to navigate to the reach. 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.” You may also GPS the route (see SOP #3).

1.2 Vegetation and Geomorphology Transects

Vegetation transects will be established and conducted exclusively using GPS units and iPads. NCPN sampling will be done along transects that span the entire riparian bottom. Dominant geomorphic and vegetation types will be recorded along the entire transect using GPS or iPad. These transects have been pre-determined and will be programmed into iPads and GPS units

(Figure 1). In 2014 we will determine how many transects are appropriate and feasible to do in a field hitch. The seven primary transects will be done first with the secondary transects as replacements or to be done time permitting.

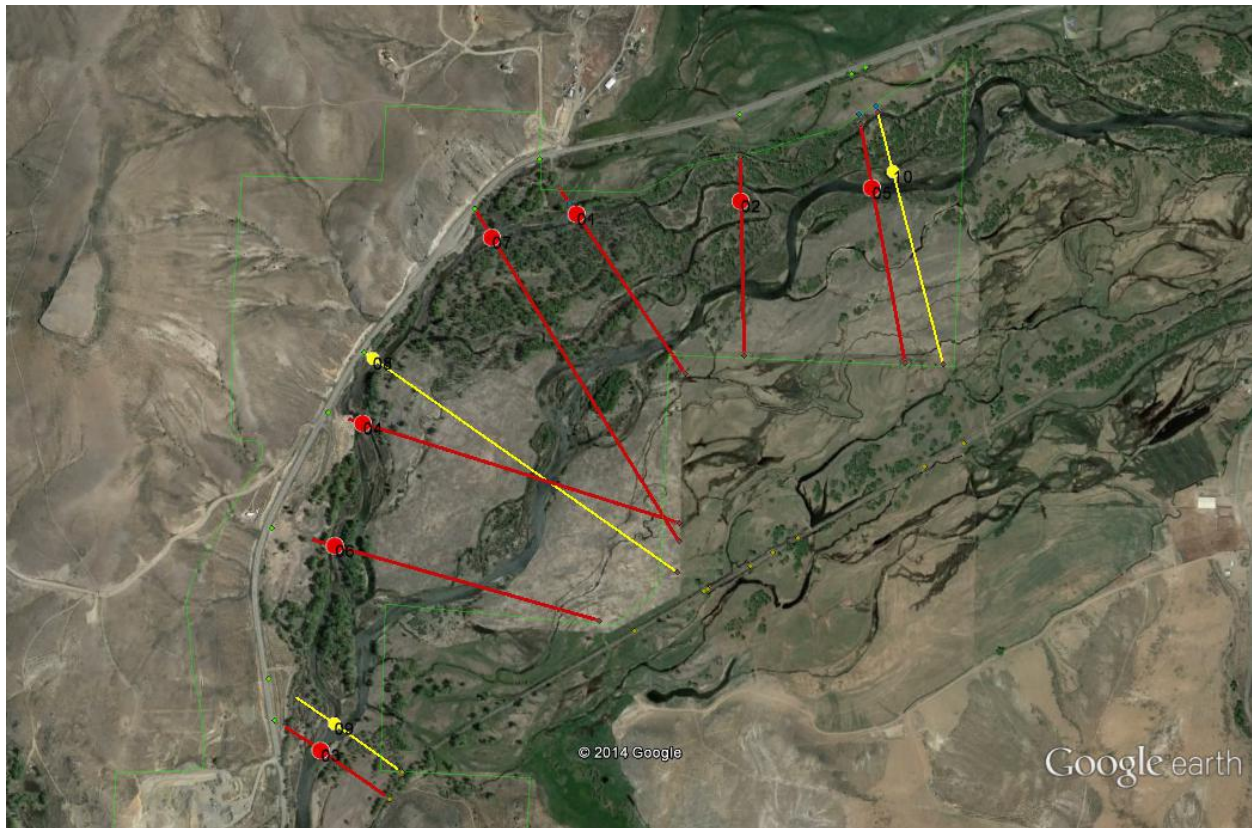


Figure 1. Primary (transects 1-7) and secondary (transects 8-10) transects established at Curecanti NRA.

- A. While walking along the transect the observer will record breaks in vegetation, cottonwood size classes, and geomorphology (see below). The data dictionary will consist of Starts and Stops for each type. It is essential that the observer remembers to record a separate start AND a stop point for each geomorphic and vegetation type.
- B. The observer will walk the transects with a GPS beginning at one edge of the transect. Start and stops (lines) of the following vegetation and geomorphic types will be recorded:
 - a. Water's edge
 - b. Active channel - unvegetated channel. This is the area that is flooded every 1-2 years. Usually with very low vegetation cover.
 - c. Vegetated flood plain (presence of indicator species can be used to mark this line (*Elymus spp.*, *Populus angustifolia*, *Phalaris arundinacea*, *Salix spp.*, *Alnus spp.*). This area is flooded every 2-15 years and is dominated by species that can withstand flooding. Vegetation cover is usually more than 40% and sediment is dominated by fines.
 - d. Inactive flood plain (presence of indicator species can be used to mark this line – *Conyza candensis*, *Distichlis spicata*, *Pascopyrum smithii*). This area is rarely flooded, usually every 15-25 years and often looks like an alluvial terrace.

- e. Uplands (one point; no start/stop unless it is an intervening uplands like an island)
 - f. Abandoned meander or channel
- C. The observer will also record start and stop locations of size classes of narrow-leaf cottonwood (*Populus angustifolia*):
- a. Seedlings (<0.25 m in height) – this could be recorded as a point as well if it is less than 5 m in length.
 - b. Saplings (0.5 m to 1.37 m in height or <5 cm DBH)
 - c. Poles (>1.37 m and 5 to 25 cm DBH)
 - d. Mature cottonwoods (>25 cm DBH)
- D. The observer will record start and stop locations of reed canary grass (*Phalaris arundinacea*)

1.3 Wetted Channel Location

Prior to the field hitch, the wetted channel will be delineated using the most recent imagery. This will be loaded onto GPS units, iPads and hard copy aerial maps. Crew members will walk the wetted channel as noted on the imagery and verify the current channels or make note with GPS where there current wetter channel does not match the pre-determined line.

In future years, the previous year's location of the wetted channel will be loaded onto GPS units and hard copy maps, instead of aerial imagery. The observer will then walk the wetted channel to determine if an avulsion has occurred. The observed will update the area that remains wetted channel during summer base flow.

2. Photos

2.1 Photo Points

These photos are taken from above the feature.

- A. Initial Visit - The observer selects points where the large portions of the study area can be seen from one picture. The best place for this to occur will be on NPS land north and west of Highway 50. Multiple locations may be necessary to capture the monitoring site.
- B. Take photo and GPS photo location.
- C. Take reference photos (see section 2.2 below) of the location where the photographer was located.
- D. Repeat visits. Print out the overall feature photos as well as the reference photos that showed the location of the photographer. Use the GPS and reference photos to get to the location.
- E. Use the previous year's photo to center the photo on the same place. When possible the same time of day is desired.

2.1 Reference Photos

Take reference photos to document locations of all survey control, headpins, or other specific features or items that need to be located in the future. Include the cliff line, surrounding perennial vegetation, and/or other recognizable landmarks in the background to help the returning field crew relocate these points.

- A. Label a chalkboard with the park code, site ID, specific description of what is being photographed (i.e. CP1, G2LHP, etc.), river right or left, and direction facing (upstream [US], downstream [DS], right to left [R -> L], or left to right [L->R], etc.) (e.g., BLCA, EP, G1RHP, US). The date does not need to be included.
- B. Place the chalkboard in a location where it will be easy to read in the photo.
- C. Clearly mark the location of the control, headpin, etc. in relation to recognizable landmarks. This location should be marked by bright-colored pin flags, placed either in the soil at the point or held above the point where they will be visible in the photo. Unlike repeat photos, you may include anything in reference photos that may assist with re-locating the point (i.e., crew members, bright-colored flagging, etc.).
- D. Take a photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one.
- E. Record the specific description, direction (facing), digital file name, photographer, and any comments on the Reference Photos data sheet.

2.3 Photosynth

These directions are modified from directions found on at www.photosynth.net (last accessed 12/14/2011) and will create a synth - stitched together photos by Photosynth.

- A. Take a photosynth from as close to the thalweg of the main channels as is safely possible.
- B. Standing in the thalweg of the feature with your camera zoomed wide. Spin around, taking overlapping shots as you go. Make sure successive photos are overlapped by at least 50%. Depending on how wide your lens goes, you'll probably need to take 15-30 photos to go all the way around (Figure 2). Repeat the rotation at different levels so to get a complete rotation at 3 or 4 different angles getting from the ground to the sky.

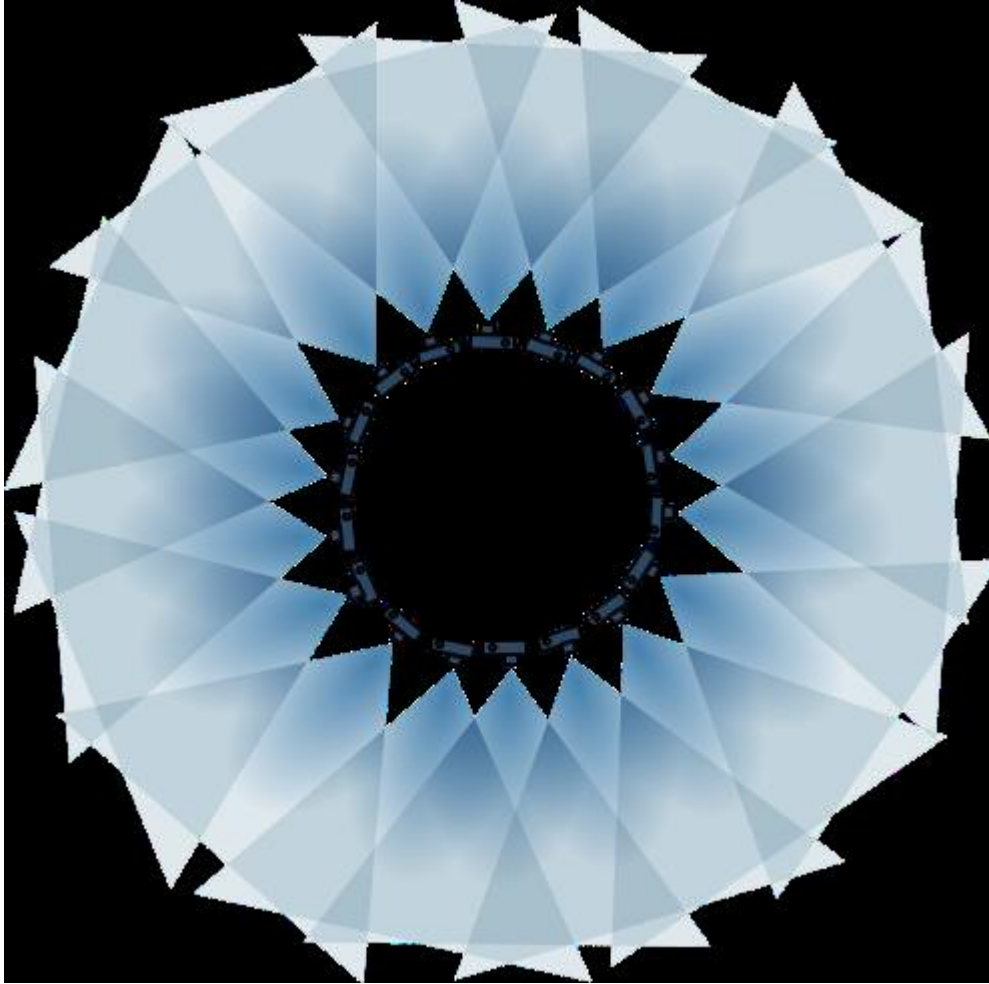


Figure 2. Pictures taken from the center of the feature.

Tips:

- Remember the “Rule of 3”. Each part of the feature you’re shooting should appear in at least three separate photos taken from different locations. This rule means that you are going to shoot a lot more photos for a synth than you would for any other purpose.
- Have lots of overlap when shooting panoramas. Try for at least 50% overlap between photos.
- Limit the angles between photos. When moving around objects, try to get one photo every 25 degrees or so. That will make the synth work better. Larger angle differences on a subject won’t match up.
- Don’t crop images. It confuses Photosynth.
- Shoot wide shots. Wide angle shots (photos taken from farther away, or with your camera’s lens zoomed all the way out) reconstruct more reliably than closer shots. It’s good to have close-ups, too, but you’ll want to have good coverage of your subject with

lots of nice overlapping wide shots.

- Orientation. Make sure your photos are all right-side-up before you start synthing.

2.4 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 or Facebook. This information can be filled out on the bottom of the Transect and Feature Photo data sheets.

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

Transect Photos

NCPN Big River Monitoring

Date:

[illegible]

Other photos

Type	Photo #	Photographer	Description

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

Reference Photos

Data entered
by:

NCPN Big River Monitoring

Park:

Site ID:

Date:

[illegible]

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 102

Vegetation Measurement and Photos for Black Canyon of the Gunnison NP

Version 2.01 (September 2015)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	8/15/12	H. Thomas	Updated BLCA vegetation sampling instructions and data sheet.	To reflect new version of vegetation sampling data sheet.	1.01
1.01	10/1/12	D. Perkins	Updated BLCA vegetation sampling instructions and data sheet.	To reflect changes in vegetation sampling. For BLCA, plot size changed from 1 x 1 m to 2 x 0.5 m.	1.02
1.02	7/16/13	D. Perkins	Minor editorial	Clarity	1.03
1.03	6/5/14	D. Perkins	Major change in numbering of SOPs to make them specific to a park.	Clarity and simplicity in the field	2.00
2.00	9/30/15	D. Perkins	Plot size, percent cover of species, new photo data sheet	Minor changes to reflect what was done in 2015	2.01

This SOP describes the methods for establishing a new monitoring sentinel site, setting up and relocating transects for vegetation monitoring and geomorphic surveying, conducting vegetation monitoring at sentinel and rapid sites, taking photos, and mapping facies. A list of necessary equipment for these procedures can be found in SOP #1.

1. Sentinel Site Establishment

Sentinel Site Establishment

Record directions to the feature

Write directions to the feature (beach-eddy, lateral bar, tip of debris fan, etc.) and include sufficient detail for someone who has never been there to relocate it. Begin with road travel from a designated location (such as the Red Rocks trailhead, East Portal hand cart) and the route used. Describe (and photograph) landmarks used to navigate to the reach. 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.” You may also GPS the route (see SOP #3).

1.1 Establishing a monitoring feature and vegetation transects

Geomorphic features are classified using a lettering system from downstream to upstream (i.e. Feature A, B, C...A being the furthest downstream). Three to four one-bank stub transects are placed on each feature for vegetation sampling purposes (Figure 1). A stub transect is one where the transect ends in the water and does not span the entire river, referred to as “transect” from now on. Transects are numbered in sequential order, from downstream to upstream. Transects are spaced equally throughout the feature. For East Portal, all transects are on the river right side, at Red Rocks they are on both sides of the river.

- A. Establish three survey control points that are permanent and elevationally stable that will be visible from multiple instrument locations.
- B. For each transect, establish a head pin and an additional orientation pin. A transect needs to be perpendicular to the channel.
 - a. A headpin consists of a rebar with an inscribed tag or cap. Tags or caps can be prepared beforehand in the office or in camp. The labeling system is the following:
 - feature letter,
 - transect number,
 - RHP or LHP (right/left headpin),
 - Three digit number,
 - Example: “G2RHP203” is the right headpin #203 on the second transect on Feature G.
 - b. An orientation pin is generally a 6” galvanized nail hammered into ground level with a flexible metal tag. The labeling system for orientation points is the following:
 - feature letter,
 - transect number,
 - P (for orientation point),
 - two digits (distance in meters away from the headpin),
 - three digits of the headpin number
 - Example: “G2P15203” is the orientation pin that is 15m away from the #203 headpin at the second transect on feature G).
- C. Try to use as little metal as possible. Hammer the headpin rebar to within 5 cm of the ground surface. 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. If on bedrock, mark the location with chalk and place a headpin in line with the transect in the nearest possible stable location.
- D. Record the distance and bearing (compass declination should be set; 10 degrees for BLCA) from the head pin to the orientation pin in a field notebook.
- E. Survey the locations of the headpins, orientation pins and control points according to SOP #8. Document the locations with notes and sketch maps. GPS these locations with the highest precision possible.
- F. Take reference 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. These are to assist future crew members in finding the headpins and are not used for monitoring purposes.
 - a. Label a chalkboard with the park code, site, feature letter, transect number, R or L for right head pin or left head pin, direction looking (US=upstream, DS=downstream) and date (e.g., BLCA, EP, G2R-US, 14 Oct 2008).
 - b. Prop the chalkboard by the rebar and pin flag.
 - c. Take photos showing the rebar, chalkboard, and recognizable landmarks looking both upstream and downstream.

- d. Record the photo information on the photo data sheet (see Section 4 below).
- e. Photograph the control points using the same methods.

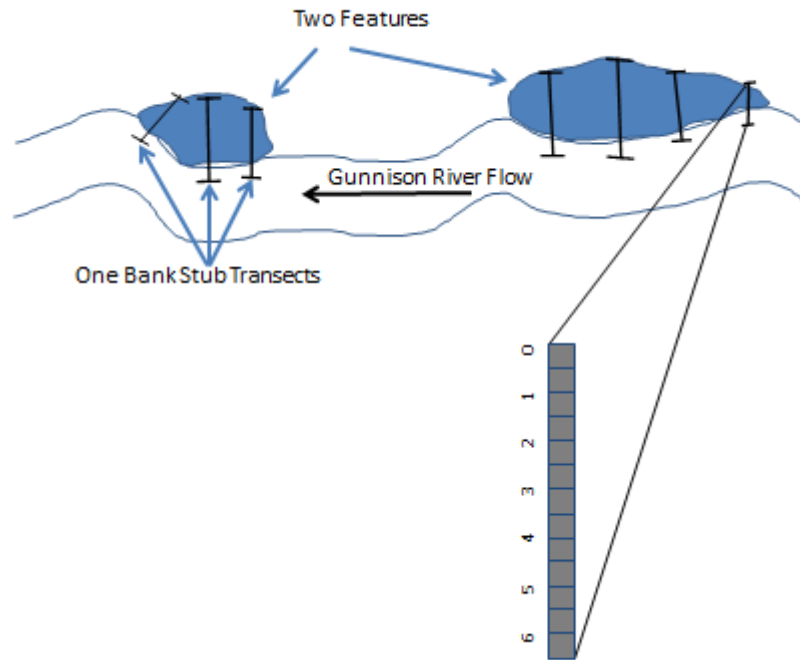


Figure 1. Two features and associated one bank stub transects with plot layout along continuous belt transect.

1.1.2 Setting up a transect

- A. Have one person stand at the 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.
- B. Drive a piece of temporary rebar into the ground on the upland side of the transect headpin.
 - Use the recorded azimuth to make sure the temporary rebar/stake is in line with the permanent transect and place an orientation pin (nail), when possible. There may be times when there is no suitable location to put the rebar on the upland side in line with the transect – getting the rebar into the ground is more important than being in line with the transect. Leave adequate space above ground on the temporary rebar for attaching the tagline and/or transect tape.
- C. Attach the Kevlar tagline and/or the transect tape to the temporary rebar on river right as you face downstream.
 - 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.
- D. Run the tagline and/or transect tape from permanent upland head pin, in line with orientation pin, to another temporary pin located at a safe wadeable distance into the river (usually about thigh deep, although it could be less if the current is fast, hopefully this is 5 m farther than the 300 cfs flow line). Life jackets shall be worn while establishing this pin.
 - 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.
 - Whenever possible, the line should not rest against any tree trunks or other obstacles such as boulders or debris.
 - Obstructing branches can be moved or tied back with flagging.

- If using both a tagline and a transect tape, run the tagline first, make any necessary adjustments, and then run the transect tape. Take up any slack in the tape by tying it to the tagline with flagging at regular intervals. This step is especially important in windy conditions.
- A longer piece of rebar works well for the temporary end in the water.

E. Attach the tagline and/or transect tape to the temporary rebar in the water.

2. Revisiting a Sentinel Site

Relocating the transects

- A. Before leaving the office, upload establishment survey data (control points, headpins, etc.) into datalogger.
- B. Use the site description, topographic maps, GPSed coordinates and routes, and reference photographs to navigate to the sampling feature.
- C. Use UTM's, azimuths, and reference photographs to locate the control points, transect headpins and associated orientation pins.
 - If the rebar is missing, use the total station and the establishment data to relocate the precise location rebar (stakeout to point).
 - If the headpin/control point/orientation point location is no longer available or has become unstable (e.g., active erosion zone, tree fall, etc.), establish a new location along the same azimuth as the previous headpin. If a headpin is moved, remove and relocate witness tree markers as needed.
 - Document the new headpin/control point/orientation point using the guidelines in Section 1.1.1F above.
- D. Place a pin flag or flagging at the control points and headpins.
- E. Check the length of the transect at establishment to make sure you are within 0.1 m of the original length during a re-visit.

3. Measuring Vegetation

3.1 Vegetation Quadrats

At BLCA vegetation sampling includes cover of indicator species along permanent repeated cross-sections and plant walks to develop a species list.

After transect and plot establishment, vegetation sampling can generally be done by one person in an equivalent time to geomorphology surveying by three people. If available, a two-person team comprised of a data recorder and an observer skilled in plant identification can efficiently complete the tasks described below.

Canopy cover is done by visually estimating the percentages of vegetation within a 2 x 0.5m plot that is centered on the tagline. Train crew members on visual estimation techniques and calibrate everyone together frequently to ensure data consistency.

Visual estimation is based on a plan view projection of outline polygon of plant subtracting the open spaces within the polygon. Imagine if the sun were directly overhead, what percentage is shaded. Stand over the plot to get a proper view of the species within a plot.

For all vegetation sampling, record the full Latin name of each species the first time it is encountered at a reach. Any additional times the species is encountered, use the six-letter code composed of the first three letters of the genus and specific epithet.

When filling out the data sheet, if you make a mistake, do not erase, simply draw a line through the erroneous information and write in the correct information.

A. Fill out the top of the data sheet including:

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

Site ID: A pre-assigned, unique code provided for each site (i.e. EP for East Portal).

Date: mm/dd/yyyy

Feature: the letter of the geomorphic feature

Transect: 1-4, downstream to upstream.

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

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

B. Fill out the Tag Line Measurements at the top of the data sheet:

Height above head pin at 0: Record the the distance the tagline is suspended above or below the top of the headpin.

Height above water at river stake: the distance the tagline is above the surface of the water where it is anchored to the rebar set in the river. Both these measurements can be positive (above the headpin / water) or negative (below headpin /water).

Line distance of river stake: Record the total length of the tag line; this measurement is made with a carpenter ruler to measure the distance between the last known meter mark to the river stake.

Line distances at slope changes: Record the line distances (m) of any sharp changes in slope. Line distance at slope changes is the distance from the headpin where the tagline bends. Usually the tagline is set such that it is a straight line from headpin to river stake. At times, however, the line bends over vegetation or ground surfaces, particularly over sections of steep slope. These bends “stretch out” the tagline over a flat line distance. To normalize this stretched out line distance to a flat line distance, we measure not only the line distance at all slope changes, but also how far the tagline is from the ground at this slope change.

C. Line Distance: The 2-m belt transect is surveyed in a series of 2m by 0.5 m plots centered on the transect. Starting at the headpin (0m), place the plot frame on the upstream side of the tagline, moving from uplands towards the stream. Record the line distance of the plot location by documenting the starting distance along the transect tape (“DistUp (small)”) and ending distance (“DistRiv (Large)”) on the datasheet.

Modal Sediment Size (SedMode): Record the modal particle size (Wentworth scale) by visually estimating a plan view projection of substrate within the plot. Estimate the substrate size with the largest fraction of plot by area, not average (e.g. if plot has 25% sand, 30% gravel, and 45% boulder, the modal particle size would be boulder). Look at the diameter of the intermediate axis of the particles. Do not include litter or organic matter. Write down the corresponding code based on the Modified Wentworth Scale. If there is a veneer of silt over an outline of another substrate, i.e. cobbles, call it cobbles. Only call it silt if you cannot recognize the substrate underneath (no longer veneer). If water is turbid, use your hand to feel the bottom of the plot.

Modified Wentworth Scale		
Class Size range	Code	Diameter (mm)
Sand, silt, clay	S	<=2
Fine Gravel	FG	>2 to 4

Medium Gravel	MG	>4 to 8
Coarse Gravel	CG	>8 to 16
Small Pebble	SP	>16 to 32
Large Pebble	LP	>32 to 64
Small Cobble	SC	>64 to 128
Large Cobble	LC	>128 to 256
Boulder	B	>256 to 512
Bedrock, Hardpan	BED	>512

- D. Percent Sand (% sand or finer): Record the percent cover of the plot that is sand (<2 mm) or smaller.
- E. Understory (Rooted) Cover: Record the percentage of total plant cover rooted in the plot (any species below 1.5 m), regardless of species, to nearest 5%. Record a “T” for trace percentage. Visually estimate a plan view projection from 1.5 m down of outline polygons of plants. Pool all live plant species. Cover includes plants that are alive and that were alive earlier this year. Do not double-count overlapping areas of cover below 1.5 m (i.e., 100% is max overall plot cover below 1.5 m). Leave and count plants as you found them (i.e., if a plant is rooted and lying on its side, don't stand it up). Roots and exposed rhizomes do not count as canopy cover. This measurement will continue into the inundated channel recording total plant cover of rooted or attached macrophytes and filamentous algae (long enough to move with current, about ½ cm).
- F. Plot Density (1/4, 1/2, 1/1) at Beginning and End of Zone: Record the fraction of plots sampled (1/4, 1/2, 1/1). To avoid bias in sample size of vegetation plots that experience inundation under a range of flow rates, we adjust plot density along transects. Without a variable plot density, flatter areas, which represent a narrow range of flow rates, would be sampled more heavily than steeper areas, which experience a wider range of flow rates per linear distance. We use three different plot densities: 1/1 is one plot every half-meter, 1/2 is one plot every meter, and 1/4 is one plot every two meters. Elevation and slope are the primary factors to consider when choosing the appropriate plot density for a plot along a transect. We use a plot density of 1/1 on steep slopes to capture more plots at these different elevations; this would be slopes approximately greater than 20-25%. 1/2 plot density can be considered the standard plot density, which would be used for slopes between 2% and 20-25%. On terrain with a slope of 2% or less, we can use 1/4 plot density. For example if you did every plot, then record 1/1. If you did every other plot, then you would record 1/2.
- G. Woody Canopy Cover: Record the percentage of live woody canopy cover by species (above 1.5m) to the nearest 5%. Record a “T” for trace percentage. Record an “R” in the Woody Canopy Cover % box if the specimen is rooted in the plot. Visually estimate plan view projection of outline polygon of plant regardless of where plant is rooted. Record by 6-letter code for the species on data form. Each unique species should be recorded separately. Be sure to look overhead for tall vegetation that might be present. Do not count dead woody canopy. Do not double-count overlapping areas of a single species (i.e., 100% is max for an individual species). Filamentous algae cover (code FA) is recorded as if it were a canopy woody species.
- H. Understory (Rooted) Species Percent Cover in Vegetation Plots: Record the percent cover of indicator species presence to the nearest one percent. Make a definitive entry in row **None** if none of the indicator species are present (to distinguish from a missed plot). List of indicator species is:

Acer negundo

Agrostis stolonifera

Artemisia ludoviciana

Cirsium arvense
Eleocharis palustris
Epilobium ciliatum
Equisetum hyemale-laevigatum
Euthamia occidentalis
Filamentous Algae (FA)
Melilotus alba-officinale
NONE
Phalaris arundinacea
Rhus trilobata
Salix exigua
TRAIL
Verbena bracteata
Veronica anagallis-aquatica
Verbascum thapsus

- I. If there are more than 2 botanists, at least once per day cross calibrate on cover and particle size estimates including some recorded replicate measurements.
- J. Using the plant walk data sheet, record all plant species observed in bottomland of site (e.g., East Portal), noting date and approximate time spent looking. The objective of the plant walk is to record as many species as possible. This can be done in increments as the work schedule allows.

3.2 Unknown Plants

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

- A. 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).
- B. 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 reach (e.g., unkZION-P1-ST1). Record this code in the appropriate column on your vegetation sampling datasheet instead of the species name.
- C. Take a photograph of the unknown plant.
- D. As you proceed through the reach, continue to attempt to find identifiable specimens of unknowns.
- E. 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. Record the full Latin name of the genus followed by “sp.” (e.g., *Opuntia* 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.

- A. Collect specimens from outside of the monitoring transects whenever possible.
- B. 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.
- C. If you must collect from a monitoring feature, remove only a minimal amount of plant material. Do not remove roots of perennial species that are collected within the transect.
- D. Wrap a piece of masking tape around the plant and use a fine-point Sharpie to label it with the unknown species code.
- E. Carefully place the specimen inside a resealable plastic bag labeled with the reach number, unknown species code, date, and collector.
- F. Place the sample in your backpack and in a shady spot until you get back to camp. Attempt to identify the plants when you return to camp.
- G. 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.
- H. 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. Fill in the top of the data sheet and record the following information:

- **Unknown Code:** unk + 4 letter park code + reach number + your initials + collection number for the plot (e.g. unkZION-P1-ST1).
- **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 data sheets 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.

4. Photos

4.1 Transect Photos

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

- A. Place pin flags at the ends of all transects. For the water's transect end, place the pinflag at the water's edge along the transect at a designated meter mark from last year's photo.
- B. Label the chalkboard with the information below and lean it next to the rebar marking the end of a transect.

Feature and Transect # – The feature letter (e.g. A, B, C...etc.), #1-4

Direction Facing – RR $\Rightarrow$ RL would mean the photographer is looking from RR to RL, US $\Rightarrow$ DS would mean the photographer is looking from upstream to downstream

Date – mm/dd/yyyy, e.g., 08/22/2010

Site – Park code and Site ID number (e.g., BLCA-EP)

If you are having difficulty propping up the chalkboard, use additional objects behind it rather than including field crew members or their body parts in the photos. You can also hang the chalkboard on vegetation.

- C. Stand at the headpin of a transect, set the camera body on top of a fully extended laser monopod (1.5 m in height) or a 1.5m reference height on your body and point the camera down the transect.
- D. Orient the camera so that it is rotated 90° and takes a vertical (portrait) format photo.
- E. Check to ensure that the chalkboard is visible at the bottom of the field of view and the tape or tagline is visible in the middle of the photo. If a transect ends in the water, take photo from the temporary rebar location in the water with the chalkboard propped on the downstream side of the transect. Photographer shall have lifejacket on while in the water.
- F. Take a photo and record the photo information on the Photo data sheet (Figure 2):
 - Site ID** – Circle EP or RR for East Portal or Red Rocks
 - Date** – Date(s) of photographs
 - Camera Date/Time Checked** – check box after ensuring that you have gone into the camera settings and ensured that the date and time matches reality
 - Photo type** – Circle “T” for transect
 - Direction (facing)** – Circle the photographer is looking, either RR for river right or RL for river left for transect photos
 - Photographer location** - Record the location of the photographer, i.e. A1 at RHP (0 m), A1 at 25m
 - Subject location** – Record what the photo was centered on, i.e. A1RHP, G1LP
 - Photographer** – use first name initial and full last name
 - Photo #** - see directions below
 - Close-Up and Replacement Boxes** - not recorded for transect photos
 - Comment** – Record any comments unique to that photo

Recording the Digital File Name

- a. While the camera is in “play” mode, you will be able to view the number assigned to the photo. *Do not record this number.* This number changes when the photos are downloaded from the camera. Instead, use the following instructions to record the digital file name on the data sheet.
- b. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.

- c. The template for the number you will record is *Pmdd9999*, where P=photos, *m* = month (Jan – Sept are coded 1-9, Oct = A, Nov = B, Dec = C); *dd* = day (01-31); and 9999 = the unique number of the photo. For example, photo 0300 taken on October 1 would be recorded as PA010300.

4.2 Feature Photos

These photos are to monitor the overall geomorphic feature (Figure 3).

- A. Make sure there are still pin flags at a meter mark near the water's edge of the most upstream transect and the most downstream transect. This meter mark should be the same as was used in previous years if possible. Remove the pin flags on all other transects.
- B. On the furthest downstream end of the feature, stand at the pin flag on the streamward-end of the downstream-most transect. Looking upstream, center the camera on the pin flag at the streamward-end of the upstream -most transect. Photo needs to be taken at 1.5m height; can use a folding engineer ruler, an extended monopod, or a 1.5m reference height on your body. Orient the camera so that it takes a horizontal (landscape) format photo.
- C. On the furthest upstream end of the feature, stand at the streamward-end of the upstream- most transect and center the camera on the pin flag at the streamward end of the downstream -most transect. Set the camera body on top of a folding engineer ruler or monopod extended to 1.5 m high, and point the camera downstream (Figure 2). Orient the camera so that it takes a horizontal (landscape) format photo.

- D. Record the photo information on the Photo data sheet:

Site ID – Circle EP or RR for East Portal or Red Rocks

Date – Date(s) of photographs

Camera Date/Time Checked – check box after ensuring that you have gone into the camera settings and ensured that the date and time matches reality

Photo type – Circle “F” for feature

Direction (facing) – Circle the photographer is looking, either US for upstream or DS for downstream for feature photos

Photographer location - Record the location of the photographer, i.e. A1 at 15 m,

Subject location – Record what the photo was centered on, i.e. A3 at 25 m

Photographer – use first name initial and full last name

Photo # - see directions below

Close-Up and Replacement Boxes - not recorded for feature photos

Comment – Record any comments unique to that photo

Recording the Digital File Name

- a. While the camera is in “play” mode, you will be able to view the number assigned to the photo. *Do not record this number.* This number changes when the photos are downloaded from the camera. Instead, use the following instructions to record the digital file name on the data sheet.
 - b. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
 - c. The template for the number you will record is *Pmdd9999*, where P=photos, *m* = month (Jan – Sept are coded 1-9, Oct = A, Nov = B, Dec = C); *dd* = day (01-31); and 9999 = the unique number of the photo. For example, photo 0300 taken on October 1 would be recorded as PA010300.
- E. If the feature has changed and the picture cannot obtain an adequate picture of the feature go to a meter

mark that is closest to the river and take the picture. Record the meter mark and take all future pictures from this location.

4.3 Overview Photos

These photos are taken from above the feature.

- A. Initial Visit - The observer selects points where multiple features can be seen from one picture.
- B. Take photo and GPS photo location.
- C. Take reference photos (see section 4.4 below) of the location where the photographer was located.
- D. Repeat visits. Print out the overall feature photos as well as the reference photos that showed the location of the photographer. Use the GPS and reference photos to get to the location.
- E. Use the previous year's photo to center the photo on the same place. When possible the same time of day is desired.
- F. Record the information below on the photo data sheet

Site ID – Circle EP or RR for East Portal or Red Rocks

Date – Date(s) of photographs

Camera Date/Time Checked – check box after ensuring that you have gone into the camera settings and ensured that the date and time matches reality

Photo type – Circle “O” for overview

Direction (facing) – Circle the photographer is looking, US for upstream, DS for downstream, RR for river right, RL for river left. More than thing can be circled, if US and RR was circled it would meant that the photographer was looking upstream and river right.

Photographer location - Record the photo point location, i.e. PP1, PP3

Subject location – Record the feature(s) that the photo captures

Photographer – use first name initial and full last name

Photo # - see directions below

Close-Up and Replacement Boxes - not recorded for overview photos

Comment – Record any comments unique to that photo

Recording the Digital File Name

- a. While the camera is in “play” mode, you will be able to view the number assigned to the photo. *Do not record this number.* This number changes when the photos are downloaded from the camera. Instead, use the following instructions to record the digital file name on the data sheet.
- b. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
- c. The template for the number you will record is *Pmdd9999*, where P=photos, *m* = month (Jan – Sept are coded 1-9, Oct = A, Nov = B, Dec = C); *dd* = day (01-31); and 9999 = the unique number of the photo. For example, photo 0300 taken on October 1 would be recorded as PA010300.

4.4 Reference Photos

Take reference photos to document locations of all survey control, headpins, orientation pins, or other specific features or items that need to be located in the future. Include the cliff line, surrounding perennial vegetation, and/or other recognizable landmarks in the background to help the returning field crew relocate these points.

- A. Label a chalkboard with the park code, site ID, specific description of what is being photographed (i.e. CP1, G2LHP, etc.), river right or left, and direction facing (upstream [US], downstream [DS], right to

left [R -> L], or left to right [L->R], etc.) (e.g., BLCA, EP, G1RHP, US). The date does not need to be included.

- B. Place the chalkboard in a location where it will be easy to read in the photo.
- C. Clearly mark the location of the control, headpin, etc. in relation to recognizable landmarks. This location should be marked by bright-colored pin flags, placed either in the soil at the point or held above the point where they will be visible in the photo. Unlike repeat photos, you may include anything in reference photos that may assist with re-locating the point (i.e., crew members, bright-colored flagging, etc.).
- D. Take a photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one.
- E. Record the information below on the Photo data sheet.

Site ID – Circle EP or RR for East Portal or Red Rocks

Date – Date(s) of photographs

Camera Date/Time Checked – check box after ensuring that you have gone into the camera settings and ensured that the date and time matches reality

Photo type – Circle “R” for reference

Direction (facing) – Circle the photographer is looking, US for upstream, DS for downstream, RR for river right, RL for river left. More than thing can be circled, if US and RR was circled it would meant that the photographer was looking upstream and river right.

Photographer location - Record the photographer location, i.e. 10 m upstream of EP water transducer 7

Subject location – Record what the photo captures, i.e. A1RHP, EP water transducer 7

Photographer – use first name initial and full last name

Photo # - see directions below

Close-Up and Replacement Boxes - Check the box if it is a close-up photo or replaces a previous reference photo

Comment – Record any comments unique to that photo

Recording the Digital File Name

- a. While the camera is in “play” mode, you will be able to view the number assigned to the photo. *Do not record this number.* This number changes when the photos are downloaded from the camera. Instead, use the following instructions to record the digital file name on the data sheet.
- b. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
- c. The template for the number you will record is *Pmdd9999*, where P=photos, *m* = month (Jan – Sept are coded 1-9, Oct = A, Nov = B, Dec = C); *dd* = day (01-31); and 9999 = the unique number of the photo. For example, photo 0300 taken on October 1 would be recorded as PA010300.



Figure 2. Example transect photo taken from the transect end in the water looking towards the upland end of the transect.



Figure 3. Example feature photo taken from the upstream most transect with the pin flag placed at the water's edge of the downstream most transect being the center of the photo.

4.5 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 or Facebook. Fill in the category, photographer, photo# and description on the bottom of the photo data sheet.

BLCA Vegetation Data Sheet

Park: _____	Date: _____	Feature: _____	Page _____ of _____
SiteID: _____	Observer: _____	Recorder: _____	XS: _____ within this XS-Feature
Tag Line	Height above head pin at 0: _____	Line distances at slope changes	
Measurements	Height above water at river stake: _____	_____	_____
	Line distance of river stake: _____	_____	_____
DistUp (small)			
DistRiv (Large)			
SedMode			
% sand or finer			
Understory (rooted) cover			
Plot density (1/4, 1/2, 1/1) at beginning and end of zone			
Woody Canopy Cover by sp and Filamentous Algae			
filamentous algae (FA)			
NONE			
Understory (rooted) SPP Presence			
ACENEG			
<i>Agrostis stolonifera</i>			
<i>Artemisia ludoviciana</i>			
CIRARV			
<i>Eleocharis palustris</i>			
<i>Epilobium ciliatum</i>			
<i>Equisetum hyemale-laevigatum</i>			
<i>Euthamia occidentalis</i>			
Filamentous Algae (FA)			
<i>Melilotus alba-officinale</i>			
NONE			
PHAARU			
<i>Rhus trilobata</i>			
SALEXI			
TRAIL			
<i>Verbena bracteata</i>			
<i>Veronica anagallis-aquatica</i>			
VERTHA			

DistUp = distance in m along transect of upland (smallest) edge of plot within XS
DistRiv = distance in m along transect of streamward (edge) edge of plot within XS

SedMode = modal (by plan view area) diameter of surficial sediment in plot coded as character where,

S = (<=2 mm), Sand, silt, clay
 FG = 2-4 mm, Fine Gravel
 MG = 4-8 mm, Medium Gravel
 CG = 8-16 mm, Coarse Gravel
 SP = 16-32 mm, Small Pebble
 LP = 32-64 mm, Large Pebble
 SC = 64-128 mm, Small Cobble
 LC = 128-256 mm, Large Cobble
 B = 256-512 mm, Boulder
 BED = (>512) mm, Bedrock, Hardpan

Understory cover=

Understory (< 1.5 m tall) cover in percent to nearest 5 %. Values are 0, 5, 10, 15 ... 90, 95, 100 with the addition of 1 and 99. A 0 is the complete absence of cover, whereas a 1 (or field entry of T for Trace to be edited to 1 in data file) is a trace amount of cover greater than 0, but less than 2.5 %. The value of 99 represents the symmetric situation at the top of the scale. 100 is complete cover whereas 99 is less than complete but greater than 97.5 (probably less recognizable and used than trace cover at the low end).

Canopy Cover

Canopy (occurring above 1.5 m) cover in percent to nearest 5 percent parallel to Ucover. Values are 0, 5, 10, 15 ... 90, 95, 100 with the addition of 1 and 99. Cover is determined within vertical (looking up) projection of plot boundaries above 1.5 m, including parts of plants rooted outside plot. A value of 0 is entered for the SPP value of NONE when there is no canopy cover at the plot. The SPP value of FA refers to attached filamentous algae and is recorded as percent cover as if it were a canopy tree above 1.5 m.

SPP Codes

ACENEG	Acer negundo	Box elder	HESMAT	Hesperis	
		Russian		matronalis	Dame's rocket
ACRREP	Acropton repens	knapeweed	HYONIG	Hyoscyamus	
				niger	Black henbane
ANTHEM	Anthemis spp.	Chamomile	JUNSCO	Juniperus	
		Common		scopulorum	R. Mt. juniper
ARCMIN	Arctium minus	burdock	LEPLAT	Lepidium	
		Absinth		latifolium	Peren. pepperweed
ARTABS	Artemisia absinthium	wormwood	LINDAL	Linaria	
				dalmatica	Dalmatian toadflax
BASSCO	Bassia scoparia	Kochia	LINVUL	Linaria	
		Hoary		vulgaris	Yellow toadflax
CARDARIA	Cardaria draba	cross/Whitetop	MATPER	Matricaria	
				perforata	Scentless chamomile
CARNUT	Carduus nutans	Musk thistle	NONE	NONE	NONE
		Common		Onopordum	
CELOCC	Celtis occidentalis	hackberry	ONOACA	acanthium	Scotch thistle
		Diffuse		Phalaris	
CENDIF	Centaurea diffusa	knapeweed	PHAARU	arundinacea	Reed canary grass
		Spotted		Populus	
CENMAC	Centaurea maculosa	knapeweed	POPANG	angustifolia	narrowleaf cottonwood
	Chrysanthemum leucanthmum			Potentilla	
CHRLEU		Ox-eye daisy	POTREC	recta	Sulfur cinquefoil
				Pseudotsuga	
			PSEMEN	menziesii	Douglas-fir
CIRARV	Cirsium arvense	Canada thistle	QUEGAM	Gambel oak	Quercus gambelii
				Rubus	
CIRVUL	Cirsium vulgare	Bull Thistle	RUBARM	ameniacus	Himalayan blackberry
CYNOFF	Cynoglossum officinale	Houndstongue	SALEXI	Salaix exigua	Sandbar willow
ELAANG	Elaeagnus angustifolia	Russian-olive	SALSOLA	Salsola spp.	Russian thistle
ELESPP	Eleocharis	Elecharis	TAMCHI	Tamarix	
				chinensis	Salt cedar

EUPESU	Euphorbia esula	Leafy spurge filamentous algae	TRAIL	TRAIL	TRAIL
FA	Algae		ULMPUM	Ulmus pumila Verbascum thapsus	Siberian elm
FRAPEN	Fraxinus pennsylvanica	Green ash	VERTHA		Common mullein

Plant Walk

Data entered by: _____ Data verified by: _____

NCPN Big River Monitoring

Park Code: _____

Site ID: _____

Date: ____/____/____

Feature: _____

Observer: _____ Recorder: _____

Start Time: _____

End Time: _____

Species found:

Unknown Plant Species

Data entered by:

Data verified by:

NCPN Riparian Monitoring

Park Code:

Reach ID:

Date:

Recorder:

Transect: 1 2 3 4 5 6 7

Position on transect (m) / method:

Photo #s:

Unknown species code (e.g., unkZION-P02-KL1): _____

Plant Type & General Description: *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 Collected by:

Best Guess:

Confirmed to be:

Identified by:

Date:

BLCA Photos

Photos downloaded by: _____

Date downloaded: ____/____/____

Data entered by: _____

Date entered: ____/____/____

Data verified by: _____

Date verified: ____/____/____

Page ____ of ____

NCPN Big River Monitoring

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River: **Gunnison** Site ID (circle): **EP RR** Date: ____/____/____  Camera date/time checked? ☐ 

EXAMPLES	
LOCATION	PHOTOGRAPHER: F → F transect #(s) - order # (F 3/4 – 2) T → T transect # - order # (T 2 – 1) O → PP1, PP2, PP3 R → from river, 10m upstream, etc.
	SUBJECT: Location being photographed O → O1, O2, O3 R → CP1, RM2, etc.

KEY	T	F	O	R
Photo Type	Transect	Feature	Overview	Reference
Direction Facing	RR RL	US DS	US DS RR RL	US DS RR RL

P A 01 03 00
1 2 3

① Month: Jan-Sep = 1-9, Oct -Dec = A - C
② Day: 01-31 ③ 4-digit Camera Photo Sequence #

Photo Type ➡	ALL	ALL	O R	ALL	ALL	R		ALL
Photo Type (circle one)	Direction facing (circle)	 Photographer Location	 Subject Location	Photographer (first initial, last name)	Photo #	Close Up?	Replacement?	Comments
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	

OTHER PHOTOS:

Category (select one)				Photographer	Photo #	Description
Animals	Cultural	Disturbance	Field work			
Plants	Scenic	Weather	Other			
Animals	Cultural	Disturbance	Field work			
Plants	Scenic	Weather	Other			

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 103

Sentinel Site Set Up, Vegetation and Photo Methods for Canyonlands NP

Version 2.10 (September 2015)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	08/08/13	K. Lund	Edited data sheets & content regarding recording on photo data sheets	Clarification & efficiency of photo data sheets	1.1
1.1	6/3/2014	D. Perkins	Clarity and added overall feature photo section	This was not in the SOP before	1.11
1.11	6/5/2014	D. Perkins	Major change in numbering of SOPs to make them specific to a park.	Clarity and simplicity in the field for crew	2.00
2.00	11/20/14	D. Perkins, K. Lund	Major clarity changes.	Reflect changes that were made in the field what was actually done in 2014	2.1
2.1	9/10/2015	D. Perkins	Changes due to RTK	RTK altered methods	2.10

This SOP describes the methods for monitoring sentinel sites on the Green and Colorado Rivers in CANY, including sentinel site selection, transect information, establishment and set-up, vegetation sampling, and photographing. Revisiting instructions are also presented. A list of necessary equipment for these procedures can be found in SOP #105.

1. Sentinel Site Selection and Transects Information, Establishment and Set-Up

1.1 Sentinel Site Selection

Six geomorphic features were selected along the lower Green River as sentinel sites (also called features). These sites were chosen via analysis of change through aerial images and discussion with experts: Millard Canyon, Queen Anne Bottom, Bonita Bend, Holeman Canyon, Sphinx, and Upper Tuxedo (Figure 1). Future sites will be established in a similar manner.



Figure 1. Location of sentinel monitoring sites in 2014 along the Green River in Canyonlands National Park. Flow is from top to bottom of the figure.

1.2 General Transect Information and Establishment

Three to eight one-bank stub transects are placed on each sentinel site for monitoring purposes. A stub transect is one where the transect ends in the water and does not span the entire river, referred to as “transect” from now on.

- A. Transects are permanent, but do not have any permanent rebar, headpins, or markers. Transects will be relocated using real-time kinetic (RTK) surveying based on established control points (using stakeout functions; see Surveying SOP #8).
- B. Permanent transect locations will be established and surveyed in on the first visit. Transects are perpendicular to the valley floor and may not be perpendicular to flow as the channel changes.
- C. Transects are numbered in sequential order, from upstream to downstream (i.e. 1 is the most upstream transect).
- D. Transects are spaced equidistant throughout the feature. The total feature length is measured via pacing and the transects are spaced out according to the number of features. For example if we have a 100 m sentinel site and want 4 transects on it, we would divide the total feature length (100 m) by 5 (1 more than the number of transects) to get transect spacing of 20 m.
- E. The number of transects may change from year to year, based on erosion or deposition of the sentinel site. Transects may be added or eliminated in future years.
- F. Transect length may change from year to year, depending on the water level, and safety while wading.
- G. Transect ends are marked with pin flags. Right/left head pin (RHP/LHP) refers to the transect end furthest away from the water, towards the upland. The RHP/LHP is a permanent location, although the transect is not always extended to the RHP/LHP if the water level does not allow it to be done safely. Right/left pin (RP/LP) refers to an end of the transect that is not a permanent location. This is always the case for the transect end that is in the main river channel, but a transect may also have an RP and an LP and no RHP/LHP in cases where the sentinel site is an island and the transect cannot extend safely

across the back channel. Right and left are determined by facing downstream, commonly referred to as “river right” and “river left”. Transects do not extend beyond the headpin/river pin.

- H. Transects will be set up differently depending on type of geomorphic feature (i.e. attached bar or island sentinel sites) and amount of active floodplain. The same feature may change from year to year. For example Holeman Canyon was an island attached bar in 2013, but was an island in 2014. The surfaces on the sentinel site may consist of the following:
1. AC = active channel
 2. AFP = active floodplain
 3. IFP = inactive floodplain
 4. UP = uplands
- I. Transect labeling system is as follows and will be used on pin flags and paper data sheets:
1. MC = Millard Canyon
 - i. Transect number
 - ii. Right/Left headpin (RHP/LHP) or right left pin (RP/LP)
 2. QA = Queen Anne
 3. BB = Bonita Bend
 4. HC = Holeman Canyon
 5. SP = Sphinx
 6. UT = Upper Tuxedo

Examples: “MC2RHP” is the temporary right headpin on the second transect on the Millard Canyon sentinel site; QA3LP is the temporary left pin in the water on the third transect on the Queen Anne Bottom sentinel site.

1.3 Attached Bar Sentinel Sites

1.3.1 Transect Establishment, Set-Up, & Revist on Attached Bar Sentinel Sites

Attached bar sentinel sites are geomorphic features attached to a bank of the river and there is no water flowing between the bar and main channel during low flow (Figure 2). All transects are continuous. In 2014 on the lower Green River the attached bar sentinel sites were Upper Tuxedo, the lower part of Millard Canyon and lower part Holeman Canyon. However it is possible that the upper parts of Millard Canyon and Holeman Canyon as well as Sphinx and Bonita Bend could become attached bars at lower flow.

- B. For each transect, stakeout the headpin location using survey equipment (see Surveying SOP #8). Label place a pin flag at the headpin.
- C. Stakeout plots from the previous year if the feature has not changed. If the feature has dramatically changed, new plots will be placed by the surveyor. The surveyor will also do the recording for water plots with no vegetation.
- D. For subsequent years, new methods of plot selection are necessary, so that plots are not continually added.
 - 1. If there are new breaklines in year 2, re-measure the old breaklines from year 1, and add plots at the new breaklines. In year 3, do not re-survey the breaklines from year 1.
 - 2. For plots that were on land in year 1 and were under water in year 2, survey them in year 2. If in year 3 the plots are still under water they do not need to be surveyed.
 - 3. For plots that were wet in year 1 and are dry in year 2, survey the plots in subsequent years unless they become covered in water again, then survey for one year and discontinue.

1.4 Island Sentinel Sites or Locations with Extensive Active Floodplain in the Middle of Transect

Island features have a back channel separate from the main channel. Water flows on both sides of these types of features. Island features can be exceedingly dynamic and these transects will reflect that. Most likely, the transects will vary from year to year, due to size of the sentinel site and water depth in the back channel (Figure 3).

For the lower Green River in 2014, island sentinel sites include the upper portion of Millard Canyon, Queen Anne Bottom, Bonita Bend, the upper portion of Holeman Canyon, and Sphinx.

Transects may be continuous or discontinuous, depending on two separate or combined factors:

- if the back channel is safe to wade across,
- how much active floodplain (and/or inactive floodplain and uplands) the island has (Figure 3).

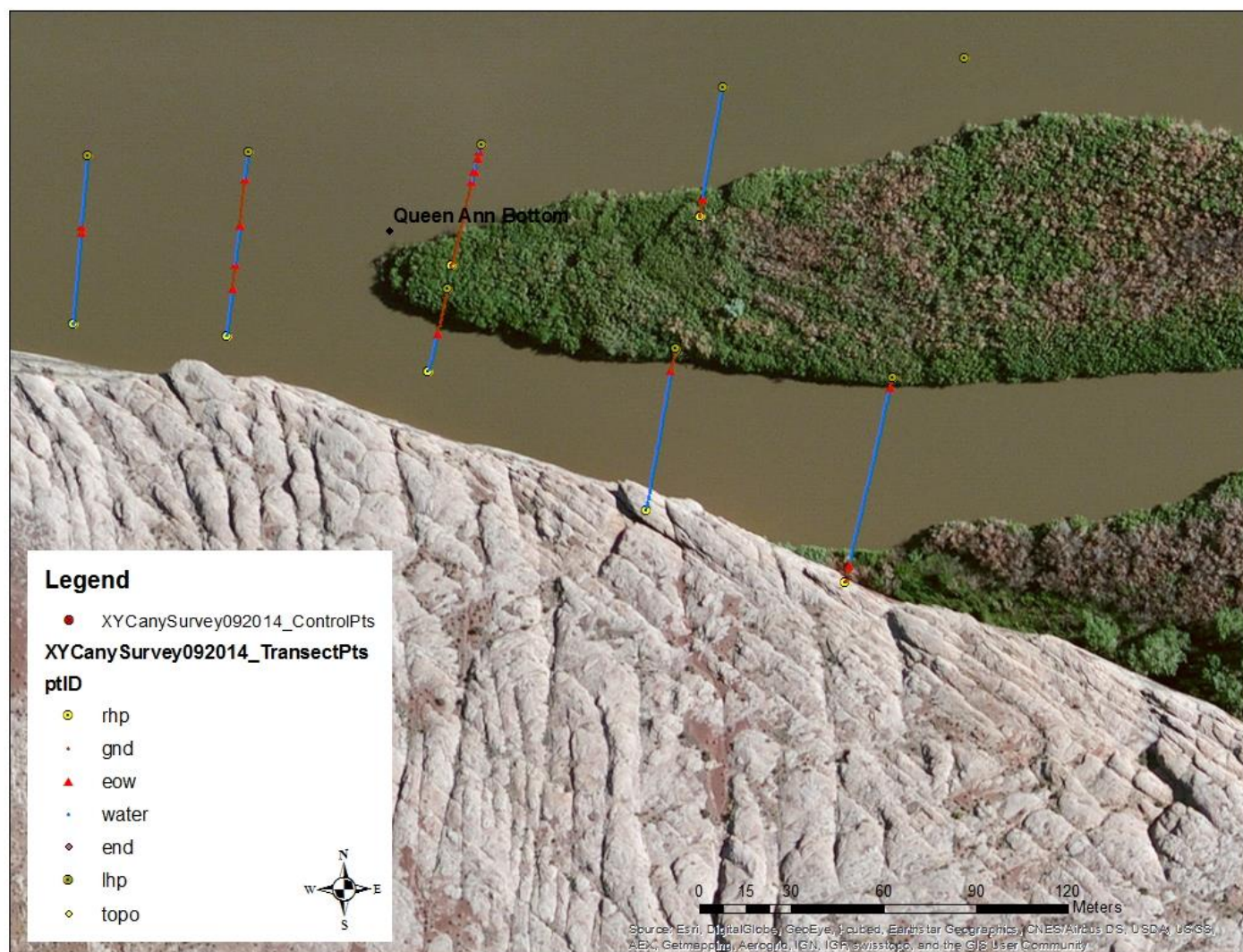


Figure 3. Transect layout at Queen Anne site. Flow is from the left to right. This is an island feature. Blue denotes that the transect was in the water, while red notes that the transect was on land. Note that three upstream most transects extend from a safe wadeable spot in the back channel to a safe wadeable spot in the main channel, while the downstream most transects extend all the way across the back channel. The downstream most three transects also stop when the transect goes into the active and inactive floodplain on the island. The downstream most transect had no safe wadeable portion of the transect on the main channel side of the island.

1.4.1 Transect Establishment on Island Sentinel Sites or Locations with Extensive Active Floodplain in the Middle of Transect

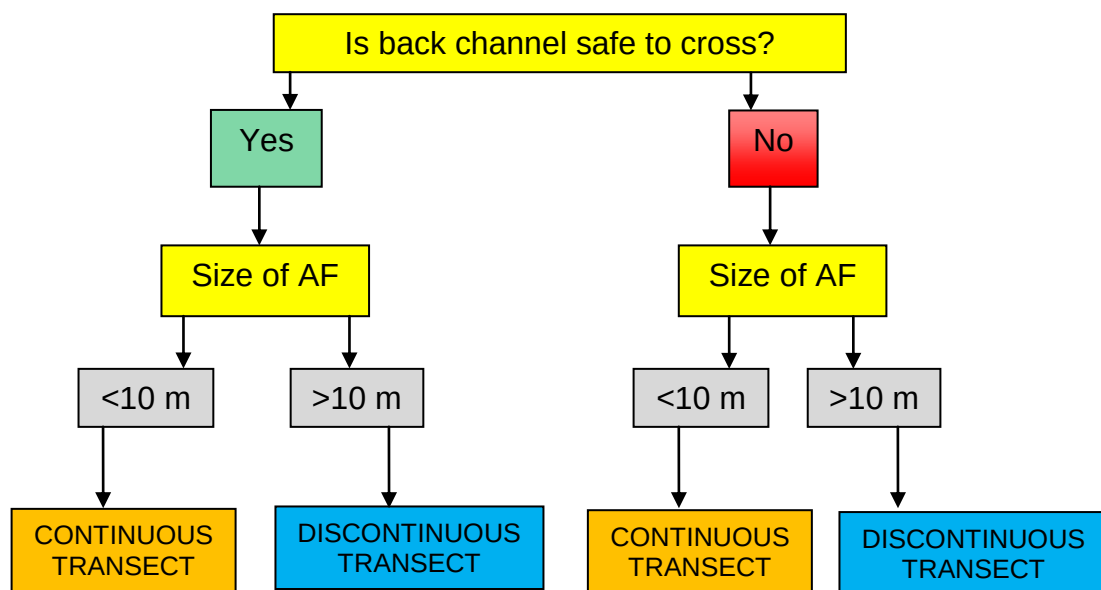
1.4.1 For Establishment On Island Sentinel Sites:

On all transects, follow general transect set-up directions in Section 1.3.1 using these specific rules (Figure 4):

- A. If the back channel can be safely waded across and the island has <10m AF, then the transect will be continuous from main land to main channel:
 1. On the main land (not the island), place headpin 5m into the AF further past the AF/AC boundary, lining up perpendicular to the valley floor. Place the headpin.
 2. Place plot flags where necessary.
 3. Wade into the main channel to a safe wadeable distance while surveying the plots.

- *Note: these transects will have one RHP/LHP and one RP/LP.*

- B. If the back channel can be safely waded across and the island has >10m AF, then the transect will be discontinuous:
1. On the main land (not the island), place headpin 5m into the AF further past the AF/AC boundary, lining up perpendicular to the valley floor. Place one headpin (RHP/LHP).
 2. Place plot flags where necessary.
 3. On the island, stop the transect 5 m further into the AF from the AC/AF boundary, placing a LP/RP.
 4. On the other side of the island, use survey equipment to stakeout the line to continue the transect. Start the transect 5 m further into the AF from the AC/AF boundary on the transect line. Place a second RP/LP.
 5. Wade into the main channel to a safe distance and place a third RP/LP.
- *Note: these transects will have 1 RHP/LHP and 3 RP/LPs.*
- C. If the back channel is too deep to wade across and the island has <10m AF (**NO** IFP and/or uplands), then the transect will span across the island and be continuous:
1. Begin on the island.
 2. Wade into the back channel to a safe wadeable distance and place a river pin.
 3. Place plot flags where necessary, lining up perpendicular to the valley floor.
 4. Wade into the main channel to a safe distance and place a second river pin.
- *Note: these transect will have 2 RP/LPs and no headpins.*
- D. If the back channel is too deep to wade across and the island has >10m AF (and/or IFP/ uplands), then the transect will be discontinuous:
1. Begin on the island.
 2. Wade into the back channel to a safe distance and place a LP/RP.
 3. Place plot flags where necessary, lining up perpendicular to the valley floor.
 4. Stop the transect 5 m further into the AF from the AC/AF boundary. Place a second LP/RP.
 5. On the other side of the island, use survey equipment to stakeout the line to continue the transect. Start the transect 5 m further into the AF from the AC/AF boundary on the transect line. Place a third LP/RP.
 6. Wade into the main channel to a safe distance and place a fourth river pin.
- *Note: these transects will have 4 RP/LPs and no headpins (RHP & LHP).*



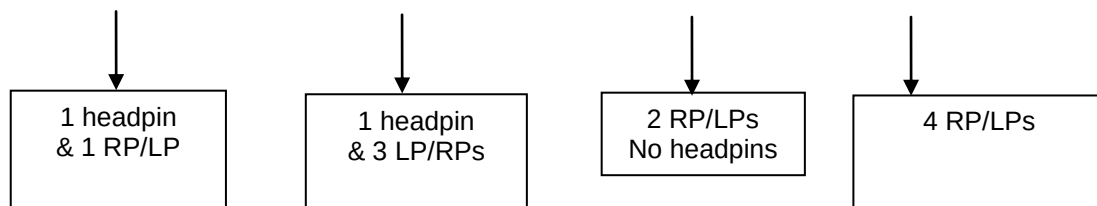


Figure 4. Summary flowchart of transect set-up on island sentinel sites.

1.4.2 For Revisits on Island Sentinel Sites:

As was previously stated, island sentinel sites can vary tremendously year to year and transects will reflect this. The number and length of transects on these features may change depending on the size of the feature and water depth of the back channel. If the feature has dramatically changed, new plots will be placed by the surveyor. If there are only new breaklines, repeat the old breaklines, and add plots at the new breaklines. The surveyor will also do the recording for water plots with no vegetation.

- If the sentinel site increased in size, add as many transects as needed with the same spacing.
- If the sentinel site decreased in size, revisit as many transects as possible. Any transects that are completely underwater do not need to be sampled.
- If the active floodplain on the island changed in size, change the transect length based on the rules in Section 1.4.1. If RP/LPs are no longer in the appropriate location, move them to the correct location.
- For subsequent years, new methods of plot selection are necessary, so that plots are not continually added.
 - a. If there are new breaklines in year 2, re-measure the old breaklines from year 1, and add plots at the new breaklines. In year 3, do not re-survey the breaklines from year 1.
 - b. For plots that were on land in year 1 and were under water in year 2, survey them in year 2. If in year 3 the plots are still under water they do not need to be surveyed.
 - c. For plots that were wet in year 1 and are dry in year 2, survey the plots in subsequent years unless they become covered in water again, then survey for one year and discontinue.

2. Measuring Vegetation

Vegetation sampling consists of sampling 1m² plots along each transect and conducting a plant walk to develop a species list of the sentinel site.

When filling out the data sheet, if you make a mistake, do not erase, simply draw a line through the erroneous information and write in the correct information.

2.1 Plant Walk

Conduct a Plant Walk recording all unique plant species observed in the sentinel site and beyond in the overall bottomland (e.g., Holeman Canyon). Consider conducting the plant walk before beginning plot monitoring as a means of vegetation team calibration. There is no minimum or maximum time to spend on this.

A. Fill out the top of the Timed Plant Walk data sheet including:

Park Code: Use the standard 4-letter code to indicate the park unit (e.g., CANY).

Sentinel Site: Use two-letter abbreviations for the sentinel sites.

MC = Millard Canyon

QA = Queen Anne
BB = Bonita Bend
HC = Holeman Canyon
SP = Sphinx
UT = Upper Tuxedo

Date: mm/dd/yyyy

Start Time: use military time

End Time: use military time

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

Recorder: Record the initials of the person recording the data, if applicable.

Species found: Record the full latin name of each unique plant species encountered.

2.2 Vegetation Plots

Vegetation sampling includes cover of species in 1m² plots placed along upstream side of the transect. For all transects, move from uplands to active channel. Starting location for vegetation sampling depends on the type of sentinel site:

- for Attached Bar sentinel sites, begin at the headpin,
- for Island sentinel sites, begin at the RP/LP closest to the uplands.

Species cover is visually quantified. Visual estimation is based on a plan view projection of outline polygon of plant subtracting the open spaces within the polygon. Imagine if the sun were directly overhead, what percentage is shaded. Stand over the plot to get a proper view of the species within a plot.

Train crew members on visual estimation techniques and calibrate everyone together frequently to ensure data consistency. If there are more than 2 botanists, at least once per day, cross calibrate on cover and particle size estimates including some recorded replicate measurements.

For all vegetation data documentation, record the full Latin name of each species the first time it is encountered at a reach. This can be done in the margin of the paper data sheet. Any additional times the species is encountered, use the six-letter code composed of the first three letters of the genus and specific epithet.

When recording on paper data sheets, do not erase any mistakes. Draw a line through the mistake, record the correct data above along with your initials and date.

A. Fill out the top of the vegetation data sheet including:

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

Recorder: Record the initials of the person recording the data, if applicable.

River: Circle one: GAC (Green above confluence), CAC (Colorado above confluence), CBC (Colorado below confluence)

Sentinel Site: Use two-letter abbreviations as shown above

Transect: Record the transect number

Date: mm/dd/yyyy

Page ____ of ____: Note current page number of total pages for that feature.

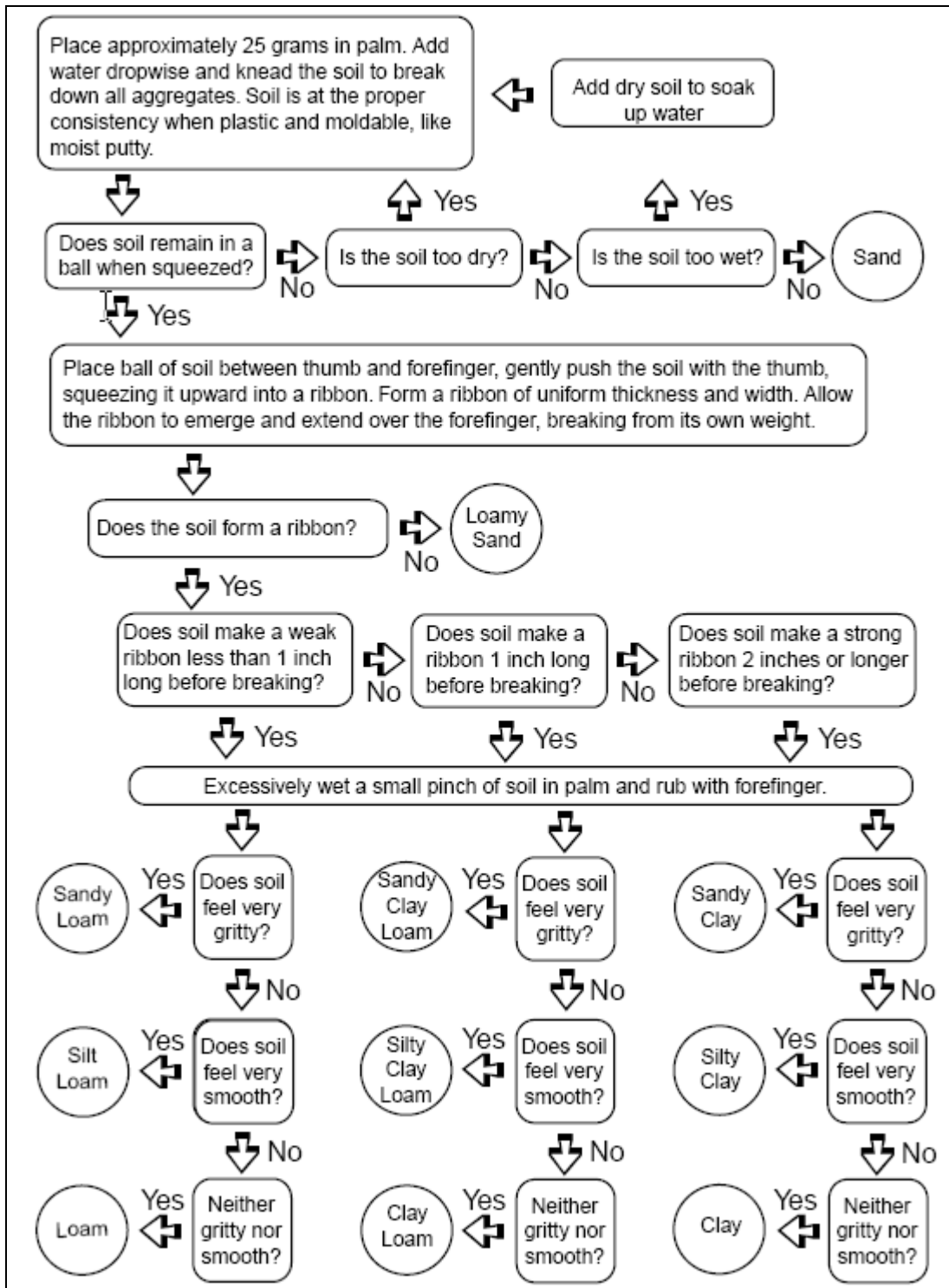
- B. **Dist Up (DU)/Dist Riv (DR):** Record the plot location by the starting distance (“Dist UP” or “DU”) and ending distance (“Dist Riv” or “DR”) along the transect. This will correspond to flags laid out by surveyors.

For example, the first plot along the transect at an attached bar sentinel site will have a Dist Up of 0 and a Dist Riv of 1. A plot in the middle of a transect will have a Dist Up of 100 and a Dist Riv of 101.

- C. Dominant Particle Size (DPS):** Record the dominant particle size using the modal particle size (Modified Wentworth scale) by visually estimating a plan view projection of substrate within the plot. Estimate the substrate size with the largest fraction of plot by area, not average (e.g. if plot has 25% sand, 30% gravel, and 45% boulder, the modal particle size would be boulder). For particles larger than sand, look at the diameter of the intermediate axis of the particles. Do not include litter or organic matter. Brush this matter away if necessary. For particles finer than sand conduct surface soil texture test. Collect a small amount of soil in your hand and add water slowly using a spray bottle or dropper. Mix the water and soil in your hand and use the key in Figure 5 to determine the soil texture. If you have never textured soil, practice this technique with the guidance of an experienced co-worker before the beginning of the field season. The texture triangle (Figure 6) is also helpful for understanding the relationship between different soil particle sizes in determining soil texture. Soil texture tests do not need to be done in every plot, but should be done when the modal sediment size makes a change.

If you cannot see ground surface (due to turbid water), use your hand to feel the bottom of plot to determine dominant particle size. If necessary, randomly select and measure several particles to determine a dominant measurement. For soils that are saturated with water, if the sediment is smaller than sand, simply record as (F) for fines. If there is a veneer of silt over an outline of another substrate, i.e. cobbles, call it cobbles. Only call it silt if you cannot recognize the substrate underneath (no longer veneer).

Modified Wentworth Scale		
Class Size range	Code	Diameter (mm)
Fines	F	For classes finer than sand in saturated sediment, simply record as fines.
Clay	CL	For classes finer than sand, please see figures 5 and 6.
Loam/Clay	LC	
Loam (left most column in Figure 5)	LO	
Sand	SA	0.5 micrometers to 2 millimeters
Gravel (medium, fine, and very fine gravel)	GR	>2 to 16
Pebble (course to very course gravel)	PE	>16 to 64
Cobble	CO	>64 to 256
Boulder	BL	>256 to 512
Bedrock, Hardpan	BR	>512



(Herrick et al. 2005)

Figure 5. Soil texture key. Begin in the top left corner and answer the yes/no questions to determine soil texture.

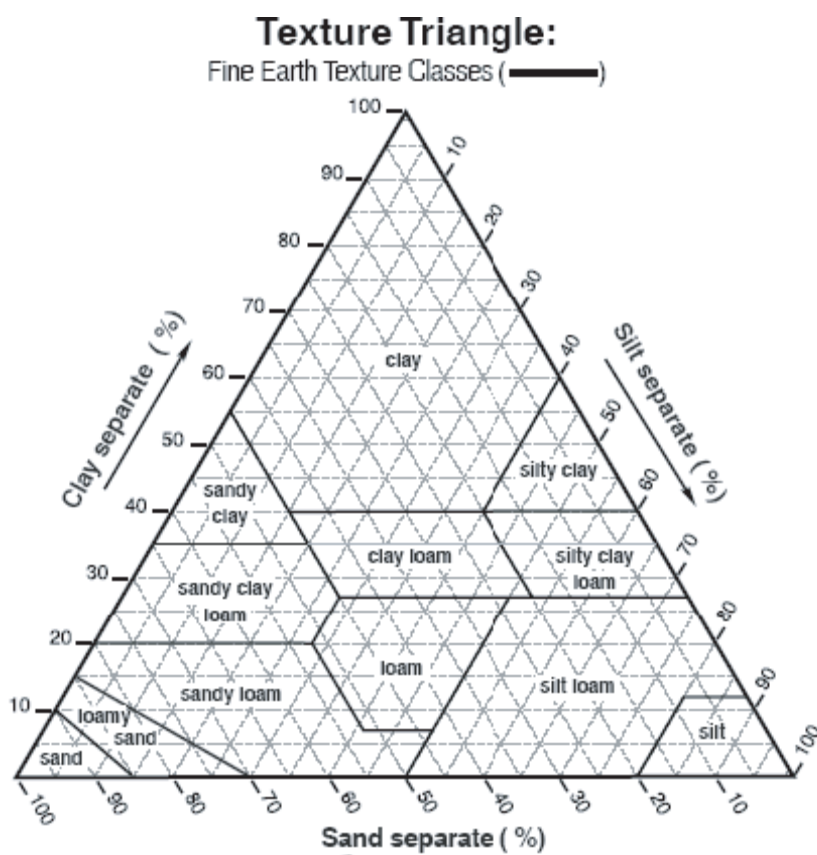


Figure 6. Soil texture triangle (Schoeneberger et al. 2002)

- D. **Percent Sand or Finer (PSF):** Visually estimate the percent cover of the plot that is characterized by particles that are sand (<2 mm) or smaller. Record to the nearest 1%.
- E. **Plot Density (PD):** To avoid bias in sample size of vegetation plots that experience inundation under a range of flow rates, we adjust plot density along transects. Without a variable plot density, flatter areas, which represent a narrow range of flow rates, would be sampled more heavily than steeper areas, which experience a wider range of flow rates per linear distance.

We use three different plot densities:

- 1/1 is one plot sampled every meter,
- 1/2 is one plot sampled every 2 meters,
- 1/4 is one plot sampled every four meters.

Elevation and slope are the primary factors to consider when choosing the appropriate plot density for a plot along a transect. Use the following guidelines:

- 1/1 on steep slopes to capture more plots at these different elevations; this would be slopes approximately greater than 20-25%, the presence of a geomorphic break, or where the slope is flat for <10m,
- 1/2 plot density can be considered the standard plot density, which would be used for slopes between 2% and 20-25% and where the vegetation is similar,
- 1/4 on terrain with a slope of 2% or less, or where the slope is flat for >20 m.

Woody Canopy Cover (WCC): Visually estimate the percentage of total live woody canopy cover (>1.5 m height, rooted and unrooted) in the plot. The vegetation can be rooted inside or outside of the plot. Be sure to look overhead for tall vegetation that might be present. Visualize the plan view projection of outline polygon of plant within the plot, regardless of where plant is rooted. Do not count dead woody canopy. Do not double-count overlapping areas of a single species (i.e., 100% is max for an individual species). Leave and count plants as you found them (i.e., if a plant is rooted and lying on its side, don't stand it up). Roots and exposed rhizomes do not count as canopy cover. Record to the nearest 1%. Record a "T" for trace percentage (<0.5%). Record by 6-letter code for the species on data form (writing in the margin full latin name for each first encounter).

- F. **No Rooted Veg?:** Check this box if the plot has no vegetation rooted inside the plot and draw a line across the vegetation boxes to ensure that you skip that line when recording the next plot.

Understory Plant Cover [% cover by species (0.5-100)]: Visually estimate the percentage of live understory plant cover (<1.5 m height) rooted in the plot. Visually estimate a plan view projection of outline polygons of each plant species within the plot. Cover includes plants that are alive and that were alive earlier this year. Do not double-count overlapping areas of cover below 1.5 m (i.e., 100% is max overall plot cover below 1.5 m).

Record the 6-letter code for each species on data sheet (writing in the bottom of the sheet the full latin name for each first encounter on each transect). Record the percentage of each unique species plant species cover to nearest 1%. Record a "T" for trace percentage (<0.5%).

This measurement will continue into the inundated channel recording plant cover of rooted or attached macrophytes and filamentous algae (long enough to move with current, about ½ cm) if present.

Separate seedlings (<1.5m tall) from adults (>1.5m tall) for *Acer negundo*, *Celtis reticulata*, *Populus sp.*, *Salix sp.*, and *Tamarix sp.* species. If a plant is longer than 1.5 m in length, but no part of plant is above 1.5 m in height (i.e. the plant is leaning), then the plant is considered a seedling and gets recorded here.

2.3 Unknown Plants

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

- A. 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).
- B. If an identifiable specimen cannot be found, create a unique name using the following code: unk + 4 letter park code + sentinel site ID + your initials + collection number for the reach (e.g., unkCANY-HC-ST1). Record this code in the appropriate column on your vegetation sampling datasheet instead of the species name.
- C. Take a photograph of the unknown plant.
- D. As you proceed through the reach, continue to attempt to find identifiable specimens of unknowns.

- E. 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. Record the full Latin name of the genus followed by “sp.” (e.g., *Opuntia* 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.

- A. Collect specimens from outside of the monitoring transects whenever possible.
- B. 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.
- C. If you must collect from a monitoring feature, remove only a minimal amount of plant material. Do not remove roots of perennial species that are collected within the transect.
- D. Wrap a piece of masking tape around the plant and use a fine-point Sharpie to label it with the unknown species code.
- E. Carefully place the specimen inside a resealable plastic bag labeled with the reach number, unknown species code, date, and collector.
- F. Place the sample in your backpack and in a shady spot until you get back to camp. Attempt to identify the plants when you return to camp.
- G. 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.
- H. 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 unknown plant datasheet, give a detailed description of each characteristic. This allows greater potential for future identification when crews return to the site. Fill in the top of the data sheet and record the following information:

- **Unknown Code:** unk + 4 letter park code + reach number + your initials + collection number for the plot (e.g. unkZION-P1-ST1).
- **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 data sheets 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.

3. Photos

Four types of photos are taken at each sentinel site: transect, feature, overview, and reference. Reference photos are used solely for future crews to locate things and may not be taken each year. All other photo types are considered repeat photos for monitoring changes to the sentinel site and will be taken every year.

One photo data sheet can be filled out for all photo types. Fill out the top portion of the data sheet:

Park Code: Use the standard 4-letter code to indicate the park unit (e.g., CANY).

Feature: Use two-letter abbreviations for the feature sentinel sites.

Date: mm/dd/yyyy

Camera date/time checked: Go to the settings and date on the camera to ensure that the date on the camera matches today's date. Check the box after doing so.

3.1 Transect Photos

The goal is to capture the entire transect within the context of the sentinel site. Transect photos are only taken in two directions, river right and river left. At minimum there will be a picture taken from both ends of the transect, if the transect is heavily vegetated, additional photos may be placed along the tagline at vegetated/unvegetated boundaries. The complete set of transect photos are taken in the initial year. In subsequent years, transect photos only need to be taken if there are dramatic changes, for example a sand bar disappears or appears, and island is ripped out. Transect photos should be re-taken every 5 years if they are not taken more frequently.

For Establishment:

A. Go to transect photo location flags established by the survey crew.

B. Check that the date/time is correct in the camera.

C. Label the chalkboard with the information below and lean it against the transect end rebar:

Site: park code (e.g., CANY)

Sentinel Site ID and Transect End: transect end where photographer is standing. Use transect end label (e.g., MC2RHP, see Section 1.2.J).

Direction Facing: The photographer was standing with an arrow to direction facing (e.g., RR→RL which means the person was standing river right and facing river left).

Date – mm/dd/yyyy, e.g., 08/22/2010

D. If you are having difficulty propping up the chalkboard, use additional objects behind it rather than including field crew members or their body parts in the photos. You can also hang the chalkboard on vegetation.

- Take transect photos from each end of the transect with the tagline is stretched out along the transect. Stand directly over the transect end. Camera should be approximately 1.5m in height and pointed down the transect, centering on the opposite transect end with the tagline in the middle of the frame.

- If dense vegetation is blocking the headpin photo, take the photo on the other side of the vegetation along the transect.
- If the transect is heavily vegetated, additional photos may be placed along the tagline at vegetated/unvegetated boundaries, which can be looking either direction. The goal is to have photo documentation of all of entire transect (Figures 7 & 8).
- Stand in the water for the river pin location photo.

E. Orient the camera so that it is rotated 90° and takes a vertical (portrait) format photo.

F. Check to ensure that the chalkboard is visible at the bottom of the field of view.

For Transect Photo Revisits:

During a revisit, follow the above guidelines for taking transect photos with these few specifics:

- Stand at previous year's meter mark to ensure repeatability. Use the 2014 photos to do your best to match the photo. If vegetation has grown so that the photo no longer captures the transect, take the photo, and then establish a new transect photo location at a more suitable location. Explain why it was necessary in the comment section of the data sheet,
- It is highly likely the river pin will not be at the same location due to differing water levels, but the observer should still attempt to take the picture at the previous year meter mark (when safe) rather than a new meter mark at the end of the transect.

G. Record the photo information on the Photo data sheet:

Photo Type – Circle “T”

Direction Facing – Circle the direction the photographer is facing. RL (river left), RR (river right), US (upstream), DS (downstream). In some cases it is appropriate to circle two abbreviations.

Photographer Location – Location of photographer. Use digits and not the transect end label. Record to nearest whole m) (e.g., 54 m).

Subject Location – record what the photo is of.

Photographer – use first name initial and full last name

Photo # - Digital file name (see instructions below; e.g., P7251234)

Close Up? – Check this box if it is a close-up photo and a direction cannot be noted. Usually only used for reference mark or rebar photos.

Replacement – Check this box if the photo is to replace a previously taken photo. This is usually only used for reference photos

Comment - Any useful comments

Recording the Digital File Name

- a. While the camera is in “play” mode, you will be able to view the number assigned to the photo. *Do not record this number.* This number changes when the photos are downloaded from the camera. Instead, use the following instructions to record the digital file name on the data sheet.
- b. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
- c. The template for the number you will record is *Pmdd9999*, where P=photos, *m* = month (Jan – Sept are coded 1-9, Oct = A, Nov = B, Dec = C); *dd* = day (01-31); and 9999 = the unique number of the photo. For example, photo 0300 taken on October 1 would be recorded as PA010300 and photo 1234 taken on July 25 would be recorded as P7251234.



Figure 7. Transect photos from transect 7 at Holeman Canyon. On left, photo from headpin taken at the 8 m (due to dense vegetation in front of headpin) facing river left. On right, photo from river pin at 42 m facing river right. Total transect length was 42 m.

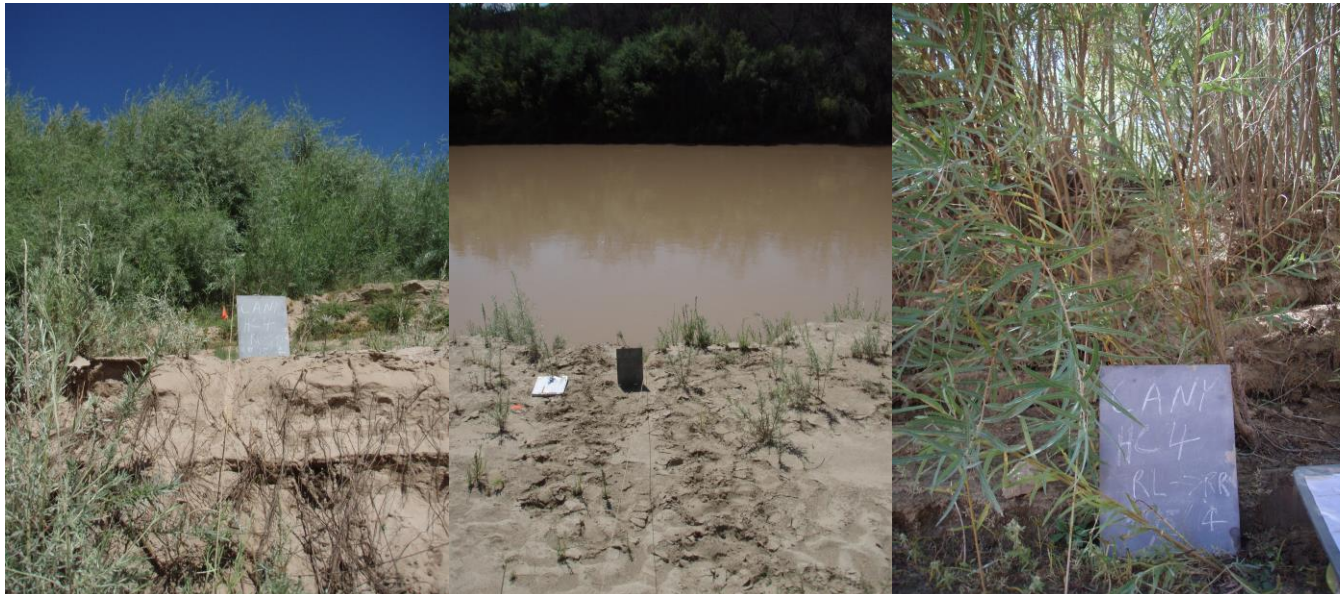


Figure 8. Transect 4 at Holeman Canyon required three photos to document the transect as the transect went through a dense willow island. Pictures were taken at the 100 m (RP start of transect) mark facing river left, 108 m mark (middle of transect at dense willow vegetation) facing river right, and 120 m (LP end of transect) mark facing river right.

3.2 Feature Photos

These photos are to monitor the overall geomorphic feature (Figures 9, 10). Feature photos are only taken in two directions, upstream and downstream. Feature photos are taken every year.

- A. **For Establishment:** Set up target pin flags at both ends of the upstream most and downstream most transects so that two flags are on each transect. These flags could be placed at 2 of the following locations near the ends of the transect: a meter mark closest to the water's edge (without being in the water); with flagging tied around the RP/LP in the river or back channel, at the RHP/LHP, or at the dense vegetation line closest to the upland end of the transect. Alternatively if the transect is not the best place to capture the feature, choose another location on the feature for the feature photo. Choose whichever locations best show the feature.
- B. Walk to the furthest downstream transect of the sentinel site. Stand at the target pin flag.
- C. Label the chalkboard with the information below and lean it against a chaining pin for support. Keep the chalkboard a short enough distance from the photographer to be legible in the photo:

Park: Park code (e.g., CANY)

Sentinel Site ID: Two-letter abbreviation for sentinel site

Direction Facing: direction the photographer is facing. US = upstream, DS=downstream

Date – mm/dd/yyyy, e.g., 08/22/2014

If you are having difficulty propping up the chalkboard, use additional objects behind it rather than including field crew members or their body parts in the photos. You can also hang the chalkboard on vegetation.

- D. Looking upstream, center the camera on the target pinflag at the most upstream transect. Photo should be taken with the camera at approximately 1.5m height.
- E. Orient the camera so that it takes a horizontal (landscape) format photo and take photo.
- F. Walk to the other target pin flag on the downstream transect and take the photo as in D looking US
- G. Repeat steps B-F so that photos are taken from the upstream transect looking downstream.
- H. For larger features, there are two methods to capture the entire sentinel site. Use one or both of them:
 - 1. If the sentinel site is very long, additional photos can be taken from the middle of the feature. Place more target pinflags in the middle of the feature. Continue to use target the same target pin flag located on the most upstream or downstream transect and take upstream and downstream photos from the middle transect (Figure 9).
 - 2. If the sentinel site is very wide, photos can be taken from multiple locations across the feature (e.g., if BB1 is 50 m long, stand at 10 m and 40 m). Use multiple target pin flags to maintain an upstream-downstream orientation (e.g., for the first photo, the photographing will be standing at BB1 at 10m photographing pinflag at BB5 at 15m; the second photo will be the photographer standing at BB1 at 45m photographing pinflag at BB5 at 47m).
- I. Record the photo information on the Photos data sheet:

Photo Type – Circle “F” for feature photo

Direction Facing – Circle the direction the photographer is facing. US (upstream), DS (downstream). In some cases it is appropriate to circle two abbreviations.

Photographer Location – Location of photographer. Use digits and not the transect end label. Record to nearest whole m) (e.g., 54 m).

Subject Location – record what the photo is of.

Photographer – use first name initial and full last name

Photo # - Digital file name (see instructions below; e.g., P7251234)

Close Up? – Check this box if it is a close-up photo and a direction cannot be noted. Usually only used for reference mark or rebar photos.

Replacement – Check this box if the photo is to replace a previously taken photo. This is usually only used for reference photos

Comment - Any useful comments

For Feature Photo Revisits:

During a revisit, follow the above guidelines for taking feature photos with these few specifics:

- Make sure photo is taken as the same location as previous years.
- Stand at the same location of previous year’s meter mark to ensure repeatability. Use 2014 photos to match the photos. If vegetation has grown so that the location no longer effectively captures the feature, take the photo, and then establish a new feature location that has a better view of the feature. Explain why it was necessary in the comment section of the data sheet,
- Consult revisit sheet to see if middle transects or multiple locations along the transect were used.



Figure 9. Examples of upstream-facing feature photos from Transect 7 at Holeman Canyon, a very long sentinel site, using middle transects to capture the feature. In the left photo, the photographer was standing at the 10 m on Transect 7 and photographed a pin flag at the 15 m on Transect 5. In the right photo, the photographer then moved to 47 m on Transect 7 and photographed a pin flag at the 42 m on Transect 5



Figure 10. Examples of downstream-facing feature photos from Transect 5 at Holeman Canyon, a very long sentinel site, using middle transects to capture the feature. In the left photo, the photographer was standing at the 15 m on Transect 5 and photographed a pin flag at 10 m on Transect 7. In the right photo, the photographer was standing at 41 m on Transect 5 and photographed on a pin flag at 47 m on Transect 7.

3.3 Overview Photos

Overview photos are taken from above the sentinel site from “photo point” (PP) locations and will be used to monitor changes (Figure 11). Overview photos are taken every year.

For Establishment:

- A. Select 1+ photo point(s) where all or most of the sentinel site can be seen from one location. Usually a high point across the river from the sentinel site offers the best vantage. Pick a place with unique characteristics for future crews to easily locate (e.g., high point of large boulder, unusual rock outcropping, etc.). Sometimes multiple photo points may need necessary. Photo points will receive number for the order they were used (e.g., PP1, PP2, etc.).
- B. Do not use a chalkboard for these photos.
- C. Take photo(s) that capture the sentinel site. If possible one photo should be taken with the sentinel site in the center of the frame. Ideally orient the camera in horizontal (landscape) view, however, sometimes vertical (portrait) orientation works better. If multiple photos are needed, overlap the photos with at least 50% of the frame (see Figure 11).
- D. Record on the Photos datasheet:

Photo Type – Circle “O” for overview photo

Direction Facing – Circle the direction the photographer is facing. RL (river left), RR (river right), US (upstream), DS (downstream). In some cases it is appropriate to circle two abbreviations.

Photographer Location – Location of photographer. Use digits and not the transect end label. Record to nearest whole m) (e.g., 54 m).

Subject Location – record what the photo is of.

Photographer – use first name initial and full last name

Photo # - Digital file name (see instructions below; e.g., P7251234)

Close Up? – Check this box if it is a close-up photo and a direction cannot be noted. Usually only used for reference mark or rebar photos.

Replacement – Check this box if the photo is to replace a previously taken photo. This is usually only used for reference photos

Comment - Any useful comments

E. GPS the photo point location.

F. Take reference photos of the location where the photographer was located (see Section 3.4).

For Revisits:

- A. Before leaving the office, print out previous year's overview photos and reference photos of the photo point(s).
- B. Use the GPS and reference photos to get to the location.
- C. Use the previous year's photo to center the photo on the exact same place. When possible the same time of day is desired.



Figure 11. Example of overview photos for the Holeman Canyon.. Three photos were necessary to capture the entire sentinel site. Note the overlap of the photo frames.

3.4 Reference Photos

Reference photos are to document locations of all survey control, headpins, or other specific items that need to be located in the future. These are solely used for future crews and not used for monitoring purposes (Figure 12).

A. Label a chalkboard with the following information:

Park: Park code (e.g., CANY)

Sentinel Site ID: Two letter abbreviation for sentinel site (e.g., HC)

Item: description of subject of photograph (e.g., CP1, CP2, etc.)

Direction Facing: The photographer was standing with an arrow to direction facing (e.g., RR→RL which means the person was standing river right and facing river left.

The date does not need to be included.

- B. Place the chalkboard in a location where it will be easy to read in the photo and the item is clearly visible (e.g., not against rebar if rebar is the item being photographed).
- C. Clearly mark the location of the control, headpin, etc. in relation to recognizable landmarks. This location should be marked by bright-colored pin flags, placed either in the ground at the point or held above the point where they will be visible in the photo. Unlike repeat photos, you may include anything in reference photos that may assist with re-locating the point (i.e., crew members, bright-colored flagging, etc.).

- D. Take a far-away photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one. Include the cliff line, surrounding perennial vegetation, and/or other recognizable landmarks in the background to help the returning field crew relocate these points. Camera orientation does not matter. Multiple photos from different perspectives can be taken to help with future finding.
- E. Take a close-up photo of the item, including any perennial vegetation nearby or distinctive rocks.
- F. Take any intermediate distance photos or photos from another direction – i.e. upstream and downstream locations.
- G. Record this data on a Reference Photos datasheet.

Photo Type – Circle “R” for reference photo

Direction Facing – Circle the direction the photographer is facing. RL (river left), RR (river right), US (upstream), DS (downstream). In some cases it is appropriate to circle two abbreviations.

Photographer Location – Location of photographer. Use digits and not the transect end label. Record to nearest whole m) (e.g., 54 m).

Subject Location – record what the photo is of.

Photographer – use first name initial and full last name

Photo # - Digital file name (see instructions below; e.g., P7251234)

Close Up? – Check this box if it is a close-up photo and a direction cannot be noted. Usually only used for reference mark or rebar photos.

Replacement – Check this box if the photo is to replace a previously taken photo. This is usually only used for reference photos

Comment - Any useful comments



Figure 12. Example of reference photos of the location of Holeman Canyon Photopoint #1. The left photo is a close-up photo accompanied with notes that state the photopoint is at the tip of the rock, while the right photo is the same rock with the photo taken at a downstream location looking upstream.

3.5 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 or Facebook. Photo number, photographer, and a description can be filled out on the bottom margin of the Photo data sheet.

Timed Plant

Walk

Data entered by: _____

Data verified by: _____

**NCPN Big River
Monitoring**

Park Code: _____

Sentinel
Site: _____

Date: ____/____/____

Observer: _____ Recorder: _____

Start Time: _____

End
Time: _____

Species found:

CANY Veg Plots

Observer: Recorder:

Data entered by: Data verified by:
Date entered: ____/____/____ Date verified: ____/____/____

Page ____ of ____

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#103 – Version 2.10 – Sep 2015

River (circle): GAC CAC CBC Sentinel Site: _____ Transect: _____ Date: ____/____/____

Modified Wentworth Scale					
Class Size	Code	Diameter (mm)	Class Size	Code	Diameter (mm)
Fines	F	< 0.5	Pebble	P	>16-64
Sand	S	0.5 – 2	Cobble	C	>64-256
Gravel	G	>2-16	Boulder	BL	>256-512
			Bedrock, Hardpan	BR	>512

Plot Density	1/1	1/2	1/4
Plots	Every 1 m	Every 2 m	Every 4 m

Continuation Sheet Used? ☐

Distance (nearest m)		Dominant Particle Size (F S G P C BL BR)	% Sand & Finer (nearest 1%)	Plot Density 1/x (1, 2, or 4)	Woody Canopy % Cover Rooted & Unrooted nearest 1%, T ≤ 0.5	No Rooted Veg?	Understory Rooted Plant % Cover																				Tree Seedling?																																																																																																																																																																																																																																																																																																																																																																															
Upland	River						< 1.5m height • to nearest 1% • T (trace) ≤0.5																																																																																																																																																																																																																																																																																																																																																																																																			

CANY Veg Plots

Continuation

Observer:

Recorder:

Data entered by:

Data verified by:

Date entered: ____/____/____

Date verified: ____/____/____

Page _____ of _____

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#103 – Version 2.10 – Sep 2015

River (circle):

GAC CAC CBC

Sentinel Site: _____

Transect: _____

Date: ____/____/____

[illegible]

Unknown Plant Species

Data entered by:

Data verified by:

NCPN Big River Monitoring

Park Code:

Reach ID:

Date:

Recorder:

Transect: 1 2 3 4 5 6 7

Position on transect (m) / method:

Photo #s:

Unknown species code (e.g., unkZION-P02-KL1): _____

Plant Type & General Description: *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* Collected by:

Best Guess:

Confirmed to be:

Identified by:

Date:

CANY Photos

Photos downloaded by:

Data entered by:

Data verified by:

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#103 – Version 2.10 – Sep 2015

Park: CANY River: Green Feature: __ Date: __/__/__  Camera date/time checked? ☐

LOCATION	PHOTOGRAPHER:	F → F transect #(s) - order # (F 3/4 – 2)	T → T transect # - order # (T 2 – 1)
		O → PP1, PP2, PP3	R → from river, 10m upstream
	SUBJECT:	Location being photographed	

KEY	T	F	O	R
Photo Type	Transect	Feature	Overview	Reference
Direction Facing	RR RL	US DS	US DS RR RL	US DS RR RL

P A 0 1 0 3 0 0			1 Month: Jan-Sep = 1-9, Oct-Dec = A - C
1	2	3	2 Day: 01-31 3 4-digit Camera Photo Sequence #

Photo Type	ALL	ALL	O R	ALL	ALL	R		ALL
Photo Type (circle one)	Direction facing (circle)	 Photographer Location	Subject Location	Photographer (first initial, last name)	Photo #	Close Up?	Replacement?	Comments
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	
T F O R	US DS RR RL					☐	☐	

OTHER PHOTOS:

Category (select one)	Photographer	Photo #	Description
Animals Plants	Cultural Scenic	Disturbance Weather	Field work Other
Animals Plants	Cultural Scenic	Disturbance Weather	Field work Other

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 105

Preparations for the Field Season and Equipment Needed, Canyonlands NP

Version 1.01 (April 2014)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	April 2014	K. Lund	Updated equipment list	Purchased more equipment	1.01

This SOP describes how to prepare for the field season, including a list of field equipment and tasks that are performed before each field trip.

1. Before the Field Season

The following tasks should be completed by the project manager or field crew leader well before the arrival of seasonal field crew members.

1. Post positions for seasonal employees or student interns 3-4 months prior to scheduled field work. Riparian monitoring requires four field crew members for vegetation sampling and geomorphology work. Hiring must be completed at least six weeks prior to the beginning of the field season to allow time for federal background check procedures.
2. Review the entire protocol. Understand the goals and procedures of the monitoring program before beginning other preparations. Discuss any proposed or recent changes to the sampling design or protocol with appropriate I&M personnel. If a change has been implemented since the last field season, make sure that all field forms, databases, and relevant SOPs have been updated.
3. Compile a list of sentinel and rapid sites that will be monitored. Discuss the season's objectives with appropriate I&M personnel to develop a field schedule.
4. Schedule field work. Use the guidelines below to develop a field schedule that meets the objectives for the field season and maintains some flexibility for unforeseen events.

Seasonality of sampling

Vegetation is sampled during the growing season, when the summer low flows have been reached, typically between late July and mid- September. Sampling visits should be scheduled to optimize phenology for the group of NCPN park units included in big river monitoring. Park units should be visited at approximately the same time each year to maximize repeatability.

Field crew schedule

Crew members typically work 8 consecutive 10-hour days, followed by 6 days off, especially when working at distant park units or in the backcountry. Field work that does not require travel and camping has more flexibility. Driving to the launch site, rigging boats, and getting to the first campsite usually takes close to one full day. Similarly getting to the take out, de-rigging, and driving back to Moab takes another day.

Therefore field hitches at DINO and CANY should plan for actual data collection to be implemented in 6 day stretches. There may be some additional time for hitches at BLCA and CURE where a raft is not required. Office work at the beginning and end of the field season is scheduled for 8 hour days Monday through Friday, and additional office days throughout the field season may be scheduled for trainings, field preparation, or data management.

5. Request research permits. Begin the process at least 10 weeks before the start of the field season to allow ample time for processing.
6. Request river permit for big river sections (DINO & CANY). Specific dates are usually required. Campsites, number of people, number of boats, etc. is usually required as well. Contact the river office of the specific park for requirements. We have a long term permit for BLCA and CURE.
7. Plan travel logistics. Notify appropriate park personnel of the dates the big river field crew will be in their park unit. Discuss housing availability and needs with appropriate parks, and acquire backcountry camping permits.
8. Organize and check all equipment. Equipment is usually tested and inventoried at the end of the field season. Review this list to make sure that you have adequate supplies and that all replacement equipment is ordered and will be available before the field season begins. Tables 1-4 list equipment needed for each SOP.
9. Review plant species lists for each park unit, and update them with new species detected in the previous field season. Print additional copies, if necessary, so that each 2-person team has a copy for the field. Review the species most likely to be encountered in each park and assemble relevant flora, keys, and field herbaria.

2. A few weeks before each field visit

The following tasks should be completed by the field crew leader in the weeks before a scheduled field visit.

1. Review existing maps for each park, and request additional maps from the GIS technician if necessary. Make sure that the locations of existing benchmarks are added to maps for surveying trips.
2. Pack and review relevant information for each sentinel and rapid sites to be monitored.

All visits

Access document – contains useful information for navigating to remotes areas of park units.

Trip reports - from the previous field season. At the end of each field trip, the crew leader writes a brief report describing general field conditions, access issues, logistical

challenges, safety concerns, equipment problems, and suggestions for improving efficiency.

Monument photos – photos used to help relocate each headpin, total station instrument setup, or reference mark for surveying.

Vegetation sampling

Revisit data sheets – provides directions to the reach, coordinates of monuments, and any other specific information from the previous visit.

Reach species list - list of species detected during previous monitoring visits.

Surveying

Field notes – a copy of notes from the previous survey.

3. Print and copy the field data sheets, at least 1/4 of the data sheets should be on Rite-in-the-Rain® paper. Copies of each form are found at the end of the appropriate SOP. Data sheets for field measures are listed below with the minimum number needed to sample a reach.

Vegetation sampling

Sentinel site Quadrats/Transects

Rapid assessment sites

Photos

Point-intercept

Site assessment

Geomorphology sampling

4. Coordinate with the GIS technician to reserve GPS units and load UTM coordinates for the reaches to be sampled.
5. Load data from the previous total station survey on the datalogger.
6. Contact parks and provide detailed trip information. Contact the resource staff and chief ranger and provide dates the crew will be working in the park, names of field crew members, vehicle descriptions, and approximate locations of monitoring activity.
7. Check stream flows and weather forecasts. Stream flows can be referenced at usgs.waterdata.gov. Applicable gages include:

BLCA

09128000 Gunnison River below Gunnison Tunnel, CO for BLCA

CURE – Sum of these two sites

09119000 Tomichi Creek at Gunnison, CO

09114500 Gunnison River near Gunnison, CO

CANY

09180500 Colorado River near Cisco, UT

09315000 Green River near Green River, UT

DINO

09260050 Yampa River at Deerlodge Park, CO

09234500 Green River near Greendale, UT

09261000 Green River near Jensen, UT

3. Immediately before each field visit

The following tasks should be completed by the field crew leader immediately before each field visit.

1. File a backcountry safety plan. The day the crew leaves for a multi-day field trip, the crew leader should fax a backcountry safety plan to Glen Canyon dispatch. Crew leaders should review the NCPN Backcountry Safety Plan for specific procedures.
2. Check for satellite phone availability using the Globalstar Call Times Tool at <http://calltimes.globalstarusa.com/>.
3. Perform a vehicle safety inspection and replace any necessary fluids.
4. Check out cameras, GPS units, and satellite phones to crew members. Depending on the type of field trip, also check out lasers, total station, data logger, water level meter, peristaltic pump, PDA, field laptop, and/or cordless drill. **Make sure that the batteries are fully charged for all rechargeable equipment.**

Table 1. Equipment needed for CANY

Item	Number needed	Description	Notes
General Equipment			
GPS with extra batteries	3	Trimble GeoXM or more accurate	main unit and backup
CANY Permit	2		
River Shuttle Agreement	1 per vehicle		If using a private shuttle company
Maps	variable		Of each sentinel site
Belnap River Guide	1		Waterproof map with river miles
SOPs	1 per 2 people		
Clipboard	1 per 2 people		
Field notebook	1 per person	small, Rite-in-the-Rain®	field notes
Pencils & permanent markers	5 – 10 each		
2-way radios	1/person + 2 extras		crew communication
Extra radio batteries	many	AA alkaline	radios require 3 per unit
Magnetic Locator	1	Metal detector in hard case	Magna-Trak brand
Safety Equipment			
<i>Check with CANY River Shop to see what equipment they're providing (river major first aid kit?)</i>			
Satellite phone	1 per 2 people		
Satellite phone charger	1 per phone		
NCPN Backcountry Safety Plan	1 per 2 people		
NCPN Accident Report Logs	1 per 2 people		found in NCPN Backcountry Safety Plan
NCPN Medical Information Forms	1 per person		found in NCPN Backcountry Safety Plan
Transect, Photo and Vegetation Monitoring Equipment			
100-m Kevlar taglines	7	Kevlar string with meter markings	set up transects
Rebar	Transects: min. 18 short & 8 long <u>Control (if est):</u> 6 med pieces	3/8" diameter cut into 18" and ~36" lengths	For <u>transects</u> , use short ones to secure taglines on land and longer ones for in water. Includes spare. <u>Control</u> pieces are for establishing survey control points.
Sledgehammer	1		Placing rebar
Clawhammer	2		Placing rebar, includes spare
Compass	2	with declination setting	set declination, take transect bearings
Pin flags	100+	narrow steel pins with flag top	mark locations. Need 4 different colors.

Item	Number needed	Description	Notes
Pin flag holder	2	So that surveyors can hold flags while laying out plots, belt attachment or shoulder strap	
Permanent markers	6		Sharpie brand for marking pinflags & unknown plant collections
Flagging	4 rolls	brightly colored	mark locations
Digital camera	3		
Extra battery for digital camera	3		
Chalkboard	2	5 x 7"	label photos
Chalk	2		
1 x1 m quadrat frames	2	Pvc pipe	Use for veg plots
Folding carpenter rulers	6	2m	Use for veg plots
Hand lenses	2		
2-gallon resealable plastic bags	min. 6	2- gallon or larger	collect plants
Masking tape	2		label plant collections
Trowel	2	small garden tool	extract specimen roots
Plant press in dry bag	1	field press with card, blotter, and paper	store plant collections for identification
Relevant floras and park species lists		various by park	
Previous plant walk lists for each sentinel site	2	species previously recorded at sentinel site plant walks	
Datasheets: - CANY Establishment/Revisit - CANY Vegetation Plots (Keyed & Continuation) - CANY Timed Plant Walk - Unknown plants - CANY Photos			
Boating Gear Necessary – CANY will provide most of boating gear			
<i>Check with CANY River Shop to see if NCPN needs to bring any boating equipment</i>			
PFD	One per person		Personal Floation Devices
Small dry bags	One each per person		Used as day bags
Large dry bags	One each per person		Used for overnigher gear
Carabiners	One each per person		Clearly labeled NCPN. Clip gear into boat.
Rocket boxes	4		Store science gear
Inflatable kayak ("Duckie")	2		NCPN 2-person inflatable kayak
Duckie seats	4		Back support; fits inside boat

Item	Number needed	Description	Notes
Paddles	4		
Duckie repair kit	2		In small blue box
Throw bag	2 small		
Alpaca packraft	1		In duffel bag
Airbag	1		Used to inflate boat
Packraft paddle	1		
Packraft repair kit	1		In small blue repair box
Surveying Equipment			
RTK base	1		In yellow Pelican case including Trimble R6 receiver, 2 batteries, 1 antennae, 1 tribrach with optical plummet, 1 extender, 1 battery charging cradle, 1 charging power cord, 1 tape measure. Make sure batteries are fully charged before leaving
Base Battery	1		Small yellow jug Trimble battery. Make sure batteries are fully charged before leaving.
Container of cords	1		3 cords for RTK base (2 black, 1 yellow). 1 black cord for RTK rover.
Tripod	2		For base radio. In orange canvas cases.
Base Radio	1		In yellow Pelican case, including cord to connect to base and battery
Base Radio antennae	1		35 Watt high-powered radio antennae
Base Radio battery	1		Usually a motorcycle or car battery
RTK rover	1		In yellow Pelican case, including Trimble R6 receiver, 2 batteries, 1 antennae, 1 battery charging cradle, 1 charging power cord
Seco carbon rod	1		For rover. Comes with quick-release attachment for receiver and flat topo boot
Data collector	1		Trimble TSC 3 with all the necessary files uploaded before leaving
Data collector holder	1		Attaching to rod. Two pieces.
Data collector charger	1		Power cord
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety

Item	Number needed	Description	Notes
Stamp kit	1		Label rebar caps
Sledgehammer	1		Placing rebar
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
10-m engineer's tape or rolling metric tape (>5m)	1 per surveyor + 2 spares		measure instrument and rod heights
Survey notebook	1		
Field notes from previous survey			Includes files to be uploaded to data collector
Reference geomorphology photos	R -2	reference photos taken during survey control establishment	
Generator	1	Honda EU1000i	Used to recharge batteries
Gas & oil for generator	one 5 gallon + enough oil		
Chisel	1		Marking control points in rocks
White marker	1		Marking control points in rocks
Transducer Equipment- All Trips (Establishment & Revisit)			
Spare well casing or PVC in 5 foot length	1		1 ¼" diameter. Spare
PVC couplers	A few		1 ¼" diameter
PVC primer & glue	1 can each		In case PVC needs to be glued in field
3'-5' Well casing	1-5		Dependent on how many transducers are being put in
Hack saw	1		For cutting PVC
Hammer	1		
Spare Kevlar line	A bunch		To adjust height of transducer in casing
Plumber's tape	1 roll		
Wrench	3		Includes 2 spares. Tightening nuts. 7/16", ¼", 5/16"
PVC wrench	1		
Crescent wrench	1		
Plumber's grease	1 tube		
Zip ties	1 small bag		For attaching barologger
Hose clamps	2 per site		For attaching barologger. Includes one spare.
Level	1		
Carpenter rulers	2		
Measuring tape	1		Rolling metric tape
Transducer Datasheet	1		Checking reference mark measurements
Transducer Equipment- Establishment Only			

Item	Number needed	Description	Notes
Hammer Drill	1		Charge batteries before leaving
Hammer Drill charger	1		
Eye protection	1		
Drill bits	3		¼" bit (eyebolt) and 1/8" bit (extra holes)
Transducers	3 per site		2 levelloggers and 1 barologger
Casing	1 per transducer		Pre-Assembled (see "Big River logger deployment" document for full list)
Paint	2-3 cans		Match the rock color (tan, black, rust, gray)
Expanding anchor bolts	10 per site		Mostly ¼" x 2 ¼" and a few ¼" x 1 ¾". Includes 6 spares
Brackets	6 per site		U-shaped; single side-mount clasp. Includes spares
Washers	10 per site		¼". Includes 6 spares
Nuts	10 per site		¼" Includes 6 spares
Transducer Equipment- For Revisit Only			
Laptop computer	1		With Solinst 4.0.3 software loaded and a working USB port
Solinst shuttle device	1		
Reference photos of transducer locations	1		
GPS with transducer locations	1		
Spare transducers	3		Should have a minimum of one set – 2 levelloggers and one barologger
Spare Brackets	6 per site		U-shaped; single side-mount clasp. Includes spares
Spare Washers	10 per site		¼". Includes 6 spares
Spare Nuts	10 per site		¼" Includes 6 spares

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 106

Preparations for the Field Season and Equipment Needed - Yampa and Green Rivers, Dinosaur NM

Version 1.00 (July 2015)

Revision History Log:

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

This SOP describes how to prepare for the field season, including a list of field equipment and tasks that are performed before each field trip.

1. Before the Field Season

The following tasks should be completed by the project manager or field crew leader well before the arrival of seasonal field crew members.

1. Post positions for seasonal employees or student interns 3-4 months prior to scheduled field work. Riparian monitoring requires four field crew members for vegetation sampling and geomorphology work. Hiring must be completed at least six weeks prior to the beginning of the field season to allow time for federal background check procedures.
2. Review the entire protocol. Understand the goals and procedures of the monitoring program before beginning other preparations. Discuss any proposed or recent changes to the sampling design or protocol with appropriate I&M personnel. If a change has been implemented since the last field season, make sure that all field forms, databases, and relevant SOPs have been updated.
3. Compile a list of sentinel and rapid sites that will be monitored. Discuss the season's objectives with appropriate I&M personnel to develop a field schedule.
4. Schedule field work. Use the guidelines below to develop a field schedule that meets the objectives for the field season and maintains some flexibility for unforeseen events.

Seasonality of sampling

Vegetation is sampled during the growing season, when the summer low flows have been reached, typically between late July and mid- September. Sampling visits should be scheduled to optimize phenology for the group of NCPN park units included in big river monitoring. Park units should be visited at approximately the same time each year to maximize repeatability.

Field crew schedule

Crew members typically work 8 consecutive 10-hour days, followed by 6 days off, especially when working at distant park units or in the backcountry. Field work that does not require travel and camping has more flexibility. Driving to the launch site, rigging boats, and getting to the first campsite usually takes close to one full day. Similarly getting to the take out, de-rigging, and driving back to Moab takes another day.

Therefore field hitches at DINO and CANY should plan for actual data collection to be implemented in 6 day stretches. There may be some additional time for hitches at BLCA and CURE where a raft is not required. Office work at the beginning and end of the field season is scheduled for 8 hour days Monday through Friday, and additional office days throughout the field season may be scheduled for trainings, field preparation, or data management.

5. Request research permits. Begin the process at least 10 weeks before the start of the field season to allow ample time for processing.
6. Request river permit for big river sections (DINO & CANY). Specific dates are usually required. Campsites, number of people, number of boats, etc. is usually required as well. Contact the river office of the specific park for requirements. We have a long term permit for BLCA and CURE.
7. Plan travel logistics. Notify appropriate park personnel of the dates the big river field crew will be in their park unit. Discuss housing availability and needs with appropriate parks, and acquire backcountry camping permits.
8. Organize and check all equipment. Equipment is usually tested and inventoried at the end of the field season. Review this list to make sure that you have adequate supplies and that all replacement equipment is ordered and will be available before the field season begins. Tables 1-4 list equipment needed for each SOP.
9. Review plant species lists for each park unit, and update them with new species detected in the previous field season. Print additional copies, if necessary, so that each 2-person team has a copy for the field. Review the species most likely to be encountered in each park and assemble relevant flora, keys, and field herbaria.

2. A few weeks before each field visit

The following tasks should be completed by the field crew leader in the weeks before a scheduled field visit.

1. Review existing maps for each park, and request additional maps from the GIS technician if necessary. Make sure that the locations of existing benchmarks are added to maps for surveying trips.
2. Pack and review relevant information for each sentinel and rapid sites to be monitored.

All visits

Access document – contains useful information for navigating to remotes areas of park units.

Trip reports - from the previous field season. At the end of each field trip, the crew leader writes a brief report describing general field conditions, access issues, logistical

challenges, safety concerns, equipment problems, and suggestions for improving efficiency.

Monument photos – photos used to help relocate each headpin, total station instrument setup, or reference mark for surveying.

Vegetation sampling

Revisit data sheets – provides directions to the reach, coordinates of monuments, and any other specific information from the previous visit.

Reach species list - list of species detected during previous monitoring visits.

Surveying

Field notes – a copy of notes from the previous survey.

3. Print and copy the field data sheets, at least 1/4 of the data sheets should be on Rite-in-the-Rain® paper. Copies of each form are found at the end of the appropriate SOP. Data sheets for field measures are listed below with the minimum number needed to sample a reach.

Vegetation sampling

Sentinel site Quadrats/Transects

Rapid assessment sites

Photos

Point-intercept

Site assessment

Geomorphology sampling

4. Coordinate with the GIS technician to reserve GPS units and load UTM coordinates for the reaches to be sampled.
5. Load data from the previous total station survey on the datalogger.
6. Contact parks and provide detailed trip information. Contact the resource staff and chief ranger and provide dates the crew will be working in the park, names of field crew members, vehicle descriptions, and approximate locations of monitoring activity.
7. Check stream flows and weather forecasts. Stream flows can be referenced at usgs.waterdata.gov. Applicable gages include:

DINO

09260050 Yampa River at Deerlodge Park, CO

09234500 Green River near Greendale, UT

09261000 Green River near Jensen, UT

3. Immediately before each field visit

The following tasks should be completed by the field crew leader immediately before each field visit.

1. File a backcountry safety plan. The day the crew leaves for a multi-day field trip, the crew leader should fax a backcountry safety plan to Glen Canyon dispatch. Crew leaders should review the NCPN Backcountry Safety Plan for specific procedures.
2. Check for satellite phone availability using the Globalstar Call Times Tool at <http://calltimes.globalstarusa.com/>.
3. Perform a vehicle safety inspection and replace any necessary fluids.
4. Check out cameras, GPS units, and satellite phones to crew members. Depending on the type of field trip, also check out lasers, total station, data logger, water level meter, peristaltic pump, PDA, field laptop, and/or cordless drill. **Make sure that the batteries are fully charged for all rechargeable equipment.**

Table 1. Equipment needed for all big river monitoring.

Item	Number needed	Description	Notes
General Equipment - necessary for all SOPs			
GPS with extra batteries	3	Trimble GeoXM or more accurate	main unit and backup
GPS car charger	1		
iPad	1		For data collection. In waterproof Pelican case.
iPad charger	1		
Digital camera	3		transect headpins and mid-channel, survey monuments and reference marks, wells and piezometers
Extra battery for digital camera	3		
Permit	2		one with crew leader, one with a crew member
SOPs	1 per person		
Maps	Variable		Created by GIS tech for each site
Datasheets:			
1. Est/Revisit	Variable		
2. Veg Plots (keyed)			
3. Veg Plot Continuation			
4. Timed plant walk			
5. Facies & Grain Size			
6. Photo			
7. Unknown plants			
Clipboard	1 per person	lightweight with interior storage	
Field notebook	1 per person	small, Rite-in-the-Rain®	field notes
Pencils & permanent markers	5 – 10 each		
Magnetic Locator	1	Metal detector in hard case	Magna-Trak brand
2-way radios	1 per person + 3 spare		crew communication; with cord to hang around neck
Extra radio batteries	lots	AA alkaline	radios require 3 per unit. In Good/Bad baggie system.
Radio harness	2		
Waders	1 per person	3 mm neoprene	optional during hot or cold weather
Wader repair kit	1	Includes Aquaseal and patches	Fix holes in waders
Safety Equipment - necessary for all SOPs			

Item	Number needed	Description	Notes
River major first aid kit	1	In clearly marked ammo can.	Content list in NCPN Backcountry Safety Plan. Use if rafting
Backcountry first aid kit	1 per 2 people		Use if not rafting. Content list in NCPN Backcountry Safety Plan
Satellite phone	1 per 2 people		
Satellite phone charger	1 per phone		
NCPN Backcountry Safety Plan	1 per 2 people		
NCPN Accident Report Logs	1 per 2 people		found in NCPN Backcountry Safety Plan
NCPN Medical Information Forms	1 per person		found in NCPN Backcountry Safety Plan
DINO Vegetation Monitoring			
1 x 1 m quadrat frames	2	PVC pipe	Use for veg plots
Folding carpenter rulers	6	2m	Use for veg plots
Pin flags	100+	narrow steel pins with flag top	mark veg plot locations
Permanent markers	6		Sharpie brand
Hand lenses	2		
2-gallon resealable plastic bags	min. 6	2- gallon or larger	collect plants
Masking tape	2		label plant collections
Permanent marker	2		label plant collections
Trowel	2	small garden tool	extract specimen roots
Field plant press	1	field press with card, blotter, and paper	store plant collections for identification
Relevant floras and park species lists		various by park	
Sentinel site species list	1 per botanist	species previously recorded at reach	
DINO Plant Synonyms Sheet	1 per botanist		Utah & Colorado names
DINO Facies & Grain Size Mapping			
Sieves	1 set		In gray bag. Used to sample substrate
Foldable shovel	1		
Scale	1		In orange stuff sack
Bucket	1		5 gallon. To measure substrate
DINO Photos			
Chalkboard	2	5 x 7"	label photos
Chalk	2		
Compass	2	with declination setting	set declination, take transect bearings
Repeat Photo Binder	1 per site		Compiled overview photos

Item	Number needed	Description	Notes
------	---------------	-------------	-------

Table 2. Camping Equipment

<i>Group Camping Equipment – Necessary for all field work that requires car camping</i>			
Stove	1-2		Include spare, if available
Propane	1-2		Ideally full containers
Kitchen box	1	Includes pots, pans, plates, bowls, silverware	
Tarp / rain shelter	1		If available. For tarp, bring ropes necessary to put it up.
Roll-a-table	1		If available when the crew is not camping in a campground
Water jugs	1 gal/person/day		
Tent repair	1	Tent tape and zipper wax	
Duct tape	1		
<i>Backpacking Equipment – Necessary for backpacking when flows are too low to raft</i>			
Water filters	2	MSR Sweetwater	Hand pump
Bucket	1		For settling water
Alum	1	Spice used to help settle particles out of water	
Water bladders	2		For water storage
Backpacking stoves	2		One that attaches to canister fuel bottle; one that attaches refillable fuel bottle
Fuel	various	White gas for refillable fuel bottle or canister fuel bottles	Bring extra
Lighters	2		For stoves
Cook set	2		Includes pots of various sizes
Trowel/shovel	1		
Wagbags	1/person/day		Use if camping in main basecamp
Spare tent	1		If available. Works out well to store extra equipment and use as back-up.

Table 3. Rafting Equipment.

Rafting equipment, <i>Necessary for all multi-day rafting trips.</i>		
River Shuttle Agreement	1	For all rafting trips requiring a separate company to do the shuttle
River Map	1 per boat	Belnap's Waterproof Dinosaur River Guide
Raft	1-2	Including bowlines and chicken lines
Frame, including floor	1 per raft	
Frame straps	Four 2"-wide cam straps/frame	Attaching frame to boat
Aluminum dry box	1 per raft	Currently on long-term loan from CANY river office
Floor	1 per raft	Wooden pieces that attaches to the frame or solid metal floor
Floor straps	4 for wooden-floored frame	Two 3 ft cam straps & two 1 ft cam straps. Attaches floor to frame.
Cooler	1 per raft	80 qt
Table	1 per raft	Fits on frame over drop bag bay. Needs two 6' cam straps
Drop bag	1 per raft	
Beaver Tail	1 per raft	Cargo floor for stern
Beaver Tail straps	3 per beaver tail	Two 4 ft cam straps & one 6 ft cam straps. Attaches cargo floor to raft.
Oars	3 per raft	Includes one spare
Oar locks	3 per raft	Two on frame + 1 spare in Repair Kit
Oar leashes	2 per raft	Cord attached from oar to frame
Oar counterbalances	2	Optional. Helps with rowing heavy oars.
Flip lines	2 per raft	Attaches to frame
Raft Repair kit	1 per raft	Includes spare oarlock. Double-check equipment list in repair kit. In designated red ammo can.
Hand pump	1	NRS barrel pump
Electric pump	1	Attaches to vehicle battery
Throw bag	1 big per raft	

Wrap Kit	1	In designated dry bag
PFD	One per person + one spare per raft	Personal Floation Devices
Helmets	One per person + spare	
Small dry bags	One each per person	Used as day bags
Large dry bags	One each per person	Used for overnighter gear
Cargo strap bag	~21 per raft	Various cam straps (2 of 15 ft, 2 of 10 ft, 5 of 8ft, 3 of 6 ft, 6 of 4 ft, 2 of 1 ft)
Water jugs	3 or more	Heavy-duty 5 gallon. General formula is 1 gal/person/day.
Stove	1	4 burner Partner stove
Propane	Enough for trip	Double-check stove fittings
Kitchen box	1	Double-check for necessary kitchen equipment, including bleach for dishes
Firepan	1	
Fire blanket	1	In the Firepan bag
Kitchen floor	1	Mesh floor to put under tables
Bucket for charcoal	1	Used for straining ashes
Strainer	1	Used for straining dishwater
Hand Wash & hand soap	1	In designated blue bag
Dishtubs	4	Washing dishes with 4 tub system.
Dish drying mesh	1	Attaches to Roll-a-table
Dish washing accessories	Variable	Dish soap, sponges, brushes
Bleach	1 small bottle	Water sanitation
Groover	1	Necessary if on backcountry stretches. In designated rocket box
Groover seat & accessories	1	Includes seat, gloves, bleach, soap, spray bottle, brush. In designated rocket box.
Toilet paper	Necessary amount	In designated ammo can
Groover hand wash	1	Take every time we take the groover
Sandstake	1/raft	
Mallet	1/raft	Pounding in sandstake
Brush	1/raft	Used for cleaning raft
Sponge	1/raft	Used for cleaning raft

Buckets	3	5-gallon buckets. Two have screw-on lids.
Carabiners	7	Clearly labeled NCPN
Rocket boxes	4	
Roll-A-Table	optional	
Rain shelter	1	NRS River Wing
Small Boat Equipment		
Inflatable kayak (“Duckie”)	2	NCPN 2-person inflatable kayak
Duckie seats	4	Back support; fits inside boat
Paddles	4	
Duckie repair kit	2	In small blue box
Throw bag	2 small	
Alpaca packraft	1	In duffel bag
Airbag	1	Used to inflate boat
Packraft paddle	1	
Packraft repair kit	1	In small blue repair box

Table 4. Survey equipment needed (RTK and Total Station).

Item	Number needed	Description	Notes
RTK Surveying			
RTK base	1		In yellow Pelican case including Trimble R6 receiver, 2 batteries, 1 antennae, 1 tribrach with optical plummet, 1 extender, 1 battery charging cradle, 1 charging power cord, 1 tape measure. Make sure batteries are fully charged before leaving
Base Battery	1		Small yellow jug Trimble battery. Make sure batteries are fully charged before leaving.
Container of cords	1		3 cords for RTK base (2 black, 1 yellow). 1 black cord for RTK rover.
Tripod	2		For base radio. In orange canvas cases.
Base Radio	1		In yellow Pelican case, including cord to connect to base and battery
Base Radio antennae	1		35 Watt high-powered radio antennae

Item	Number needed	Description	Notes
Base Radio battery	1		Usually a motorcycle or car battery
RTK rover	1		In yellow Pelican case, including Trimble R6 receiver, 2 batteries, 1 antennae, 1 battery charging cradle, 1 charging power cord
Seco carbon rod	1		For rover. Comes with quick-release attachment for receiver and flat topo boot
Data collector	1		Trimble TSC 3 with all the necessary files uploaded before leaving
Data collector holder	1		Attaching to rod. Two pieces.
Data collector charger	1		Power cord
Rebar	variable		To establish new survey control
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety
Stamp kit	1		Label rebar caps
Sledgehammer	1		Placing rebar
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
10-m engineer's tape or rolling metric tape (>5m)	1 per surveyor + 2 spares		measure instrument and rod heights
Survey notebook	1		
Field notes from previous survey			Includes files to be uploaded to data collector
Laminated survey code cheatsheet	1 per surveyor		
Reference geomorphology photos	R -2	reference photos taken during survey control establishment	
Generator	1	Honda EU1000i	Used to recharge batteries
Gas & oil for generator	one 5 gallon + enough oil		
Chisel	1		Marking control points in rocks
White marker	1		Marking control points in rocks
Total Station Surveying			
Total station with 6 batteries	1		make sure batteries are fully charged before leaving
Charger for total station	2		use when electricity is available. Includes battery cradle and power cord.
Battery charger for total station	2		Battery cradle
Power cords for total station charger	2		

Item	Number needed	Description	Notes
12V battery total station & datalogger charger	1		Attaches directly from battery and does not need the inverter
Datalogger with Survey Pro software	1		make sure batteries are fully charged before leaving
Charger for datalogger	1		
Hand-held weather unit	1		Highgear brand, WeatherPort model. Used for calibrating temperature & pressure in total station. Stored in total station case.
Tripod	2	1 wooden and 1 metal with screw-mount adjustable legs	to mount total station, includes spare & carrying cases
Prism poles	3	identical	includes attached levels and both flat foot and a point on the end
Prism poles extenders	3	orange & white stripe sections	good for visibility in thick vegetation
Leveling rod	3	identical, telescoping to 5 m	with adapters to mount prisms
Levels for leveling rods	3		need to attach to rods before surveying
Bipods	2		used to turn a prism pole into a free-standing tripod
Prisms	4	identical	for rods and backsight, includes spare & padded cases for each prism
10-m engineer's tape or rolling metric tape (>5m)	4		measure instrument and rod heights; one for each person, includes spare
Tool pouch	1		holds equipment for survey lead
Survey notebook	1		
2-way radios	1/person + 1 spare		
Extra radio batteries	many		For 2-way radios
Ear piece with microphone	1	compatible with radios	for person running total station
Survey umbrella	1		
Umbrella stand	1	separate tripod to support the umbrella	
Rebar	I - min. 12, R - 4	3/8" diameter cut in 0.5 m lengths	permanent survey markers
Survey rebar caps	I - 12	1 1/2" pre-stamped with NCPN and dot in center	label rebar and cover top for safety
Stamp kit	1		Label rebar caps
Sledgehammer	1		Placing rebar

Item	Number needed	Description	Notes
Screwdriver, pliers, and allen wrench set	1 each		attach prisms, tighten rods, troubleshoot equipment
Flagging	4 rolls	brightly colored	mark locations
GPS	2	survey grade with horizontal accuracy < 0.1 m	includes spare
Field notes from previous survey			Includes files to be uploaded to datalogger
Reference geomorphology photos	R -2	reference photos taken during survey control establishment	
Total station & Survey Pro manuals	1 each		
Marine battery (12 V)	1		charging electronic equipment on raft trips
Multimeter	1		checking charge of batteries
Battery Inverter	1	plugs into marine battery	charge electronic equipment
Car Inverter	2	Plugs into car	charge electronic equipment

Table 5. Transducer Equipment

Transducer Equipment- All Trips (Establishment & Revisit)			
Spare well casing or PVC in 5 foot length	1		1 ¼" diameter. Spare
PVC couplers	A few		1 ¼" diameter
PVC primer & glue	1 can each		In case PVC needs to be glued in field
Hack saw	1		For cutting PVC
Hammer	1		
Spare Kevlar line	A bunch		To adjust height of transducer in casing
Plumber's tape	1 roll		
Wrench	3		Includes 2 spares. Tightening nuts. 7/16", ¼", 5/16"
PVC wrench	1		
Crescent wrench	1		
Vise Grip			
Plumber's grease	1 tube		
Epoxy	1		
Zip ties	1 small bag		For attaching barologger
Hose clamps	2 per site		For attaching barologger. Includes one spare.

Level	1	
Carpenter rulers	2	
Measuring tape	1	Rolling metric tape
Transducer Datasheet	1	Checking reference mark measurements
Transducer Reference Photos	1 per site	
Spare Ziplocks	3	
Transducer Equipment- Establishment Only		
Hammer Drill	1	Charge batteries before leaving
Hammer Drill charger	1	
Eye protection	1	
Drill bits	3	¼" bit (eyebolt) and 1/8" bit (extra holes)
Transducers	3 per site	2 levelloggers and 1 barologger
Casing	1 per transducer	Pre-Assembled (see "Big River logger deployment" document for full list)
Paint	2-3 cans	Match the rock color (tan, black, rust, gray)
Expanding anchor bolts	10 per site	Mostly ¼" x 2 ¼" and a few ¼" x 1 ¾". Includes 6 spares
Brackets	6 per site	U-shaped; single side-mount clasp. Includes spares
Washers	10 per site	¼". Includes 6 spares
Nuts	10 per site	¼" Includes 6 spares
Transducer Equipment- For Revisit Only		
Laptop computer	1	With Solinst 4.0.3 software loaded and a working USB port
Solinst shuttle device	1	
Reference photos of transducer locations	1	
GPS with transducer locations	1	
Spare transducers	3	Should have a minimum of one set – 2 levelloggers and one barologger
Spare casings	1-2	
Spare Brackets	6 per site	U-shaped; single side-mount clasp. Includes spares
Spare Washers	10 per site	¼". Includes 6 spares
Spare Nuts	10 per site	¼" Includes 6 spares

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #107

Sentinel Site Set Up for Dinosaur NM

Version 1.00 (July 2015)

Revision History Log:

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

This SOP describes the methods for monitoring a sentinel site in Dinosaur National Monument, including sentinel site establishment and revisiting, including transect and vegetation plot set up. These were the methods used at Dinosaur along the Yampa River from 2011 to 2015 and along the Green River from 2011 to 2014. After these times, methods were adjusted due to the RTK survey equipment.

1. Sentinel Site Establishment *(note: still under construction, Est sheet still needs to be created, KL)*

Sentinel Site Establishment

Record directions to the feature

Write directions to the feature (beach-eddy, lateral bar, tip of debris fan, etc.) and include sufficient detail for someone who has never been there to relocate it. Begin with nearest river mile and describe (and photograph) landmarks used to navigate to the feature. 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.” You may also GPS the route (see SOP #3). On the Yampa River, directions may also include hiking in from the Yampa Bench road for the Harding Hole and Laddie Park sentinel sites.

1.1 Establishing Survey Control

At DINO there are permanent control points. In 2015 we began a transition to repeat earlier plot locations. In 2015 we resampled plot locations at Seacliff. Prior to 2015, we had new plots every year. With the purchase of RTK repeat of plots became possible.

- A. Establish three control points that are permanent and elevationally stable that will be visible from multiple instrument locations. Try to use as little metal as possible. Hammer the rebar to within 5 cm of the ground surface.
- B. Inscribe the feature and control point number on a metal tag or rebar cap. Tags can be prepared beforehand in the office or in camp.
- C. 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.
- D. Survey the locations of the control points according to SOP #8. Document the locations with notes and sketch maps. GPS the control point locations with the highest precision possible.
- E. Take reference photographs to document the location of the control points, including the cliff line or other recognizable landmarks in the background.
 - a. Label a chalkboard with the park code, site, reach, control point number, and date (e.g., DINO, HH, CP-01, 14 Oct 2008).
 - b. Prop the chalkboard by the rebar and pin flag.
 - c. Take photos showing the rebar, chalkboard, and recognizable landmarks.
 - d. Record the photo information on the photo data sheet (see below Section 4).

1.2 Establishing Transects & Vegetation Plots

- A. Walk around the entire sentinel site to get a feel for the geomorphic zones consisting of the active channel (AC), active floodplain (AF), and inactive floodplain (IF) while studying the vegetation and geomorphology. The zones are often wider at the middle and narrower at the upstream and downstream ends.
- B. Place temporary pin flags at the boundary of the active channel and the active flood plain.
- C. The goal is to place 50-100 vegetation randomly placed plots in the active channel, active flood plain, and the boundary between the two. Pace (in meters) the sentinel site along the length of the approximate center of sentinel site.
- D. Determine how many evenly-spaced transects would be necessary with an average number of plots per transect to achieve 50-100 plots. Also, determine the transect spacing necessary.
- D. While walking the boundary of the active channel and the active flood plain, pace off the transect spacing number (determined above) and mark with a pin flag.

- E. The transect originates in the inactive floodplain or uplands (UP) 5 m from the boundary of the AF and IF/UP. Determine the proportion of each riverine zone in each transects and how many plots will be necessary in each zone along the transect.
- F. Use a random number table for pacing steps to determine the locations of the AC and AF veg plots in each zone. The goal is to place plots roughly proportionate to the width of the sentinel site at the different transect spacing numbers. There may also be a few plots in the AC/AF transition. Pace steps are determined from the transect origination or from the zone boundary.
- G. Label a pin flag with the zone (AC, AF, or AC/AF) and a unique number (e.g., AC1, AF2, AC/AF3, etc.). Each zone has its own numbering (e.g., AC1, AC2, AC3; AF1, AF2, AF3, etc.). Place the pinflag at each veg plot location.
- H. While laying out plots, create a cheatsheet that has the list of transects and the plots that are on each transect for the veg and survey crew to ensure data completeness and efficiency. For example, transect 1 has AC1-5, AF1-4, and AC/AF1-2.

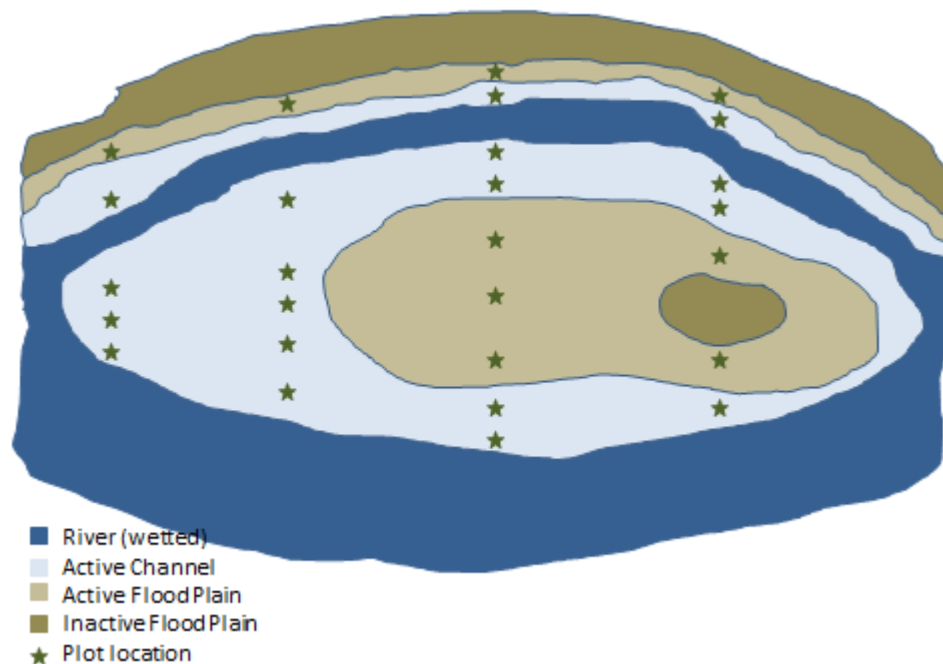


Figure 1. One sentinel site feature with the riverine zones and plot locations (actual feature would have more plots).

2. Revisiting a Sentinel Site

- A. See list of pre-trip office duties necessary for a revisit (*still need to make, KL*).

- B. Navigate to the sentinel site using the site description, topographic maps, GPSed coordinates, and photographs.
- C. Use the Revisit sheet for important tasks, comments, and to ensure all tasks get completed for each sentinel site.
- D. Locate all survey control points using GPS units, survey equipment, and reference photographs and mark with highly visible pin flag(s) or flagging.
 - If the rebar is missing, use the information provided by the sources above to relocate and replace the control point as accurately as possible.
 - If the control point location is no longer available or has become unstable (e.g., active erosion zone, tree fall, etc.), document this and establish a new control point with a new name.
 - Document the new control point using the guidelines in Section 1.1 above.
- E. Transect & veg plot set up: because the veg plots are not permanent, new transects and veg plots will be established every year based on the current geomorphology of the feature. In 2015 we began a transition to repeat earlier plot locations. In 2015 we resampled plot locations at Seacliff. Prior to 2015, we had new plots every year. With the purchase of RTK repeat of plots became possible. From the Revisit sheet and/or map, study the previous years' transects and plot numbers, locations, and distribution. Follow steps 1.2 above for instructions to place approximately the same number of transects and plots as previous years.

BIG RIVERS REVISIT SHEET

Park: DINO

River: Yampa

Sentinel Site: **Deerlodge Park**

Crew:

Original Establishment Date: 09/02/2011 Revisit Date: ____/____/____ Recorder: _____

ESTABLISHMENT COMMENTS: This site is the extensive sandbar ~250 m downstream of the campsite and boat ramp. It is on river left. A large dead *Populus fremontii*, engraved the “Wisdom Tree” is usually on the site.

REVISIT COMMENTS:

There is no 2014 plant list for Deerlodge.

TASK LIST OF TO DO'S FOR 2015:

- ☐ Evaluate new location for upstream transducer since it is on movable boulders.
- ☐ Replace DLCP1 (was missing in 2014).
- ☐ Fill in missing types of rebar (e.g., stamped, capped, unmarked) in control table below
- ☐ Get close up reference photo of CPDL22
- ☐ Evaluate status of both US and DS transducers. See if a longer casing could extend the period of measurements. Investigate adding additional

reference marks so that checks can be made in high water

- ☐ Figure out best times to take all overview photos to minimize shadows (original photos taken on cloudy day).
- ☐ Get reference photos of DL_BASE

TASK LIST FOR NEXT REVISIT:

☐ _____

☐ _____

☐ _____

☐ _____

☐ _____

☐ _____

☐ _____

☐ _____

1. **VEGETATION:**

- ☐ All veg plots got completed?
- ☐ Timed plant walk got completed for the sentinel site?

	2011	2012	2013	2014	2015
AC	65	59	54	46	
AC/AF	0	0	1	0	
AF	32	26	28	25	
TOTAL	97	85	83	71	
# transects	14	14	14	9	

2. **PHOTOS:**

- ☐ All overview photos got taken?
- ☐ Photosynth taken from center of sentinel site?
- ☐ Photosynth taken from edge of sentinel site?

Overview Photos				Comments
Photo point Locations		Photos	Best Time of Day	
1	PP1	O1	Taken at 13:30	PP1=CP DL 02. Figure out best times to take.
2	PP2	O2	Taken at 14:49	PP2=CP DL 22. Figure out best times to take.
	PP2	O3	Taken at 14:49	PP2=CP DL 22. Figure out best times to take.
	PP2	O4	Taken at 14:49	PP2=CP DL 22. Figure out best times to take.
	PP2	O5	Taken at 14:49	PP2=CP DL 22. Figure out best times to take.
TOTAL	2	5		

- 3. SURVEYING:** ☐ All surveying got completed?
- All control points?
 - All veg plots?
 - All CHaMP points?
 - All edge of water shots?
 - All transducers? (minus the air)

- ☐ Surveying data got backed up?
- ☐ Transducer shots were photographed?

POINTID	DESCRIPTION	CP_FROM	COMMENT
DL_BASE	Base station. On small knoll in field south of boat ramp.	NCPN-2014	

USGS_BM	1/2" rebar, under tree	USU	Previously DP1BM1
CP DL 01	1/2" rebar with redcap, marked USU-CNR. Downstream of site; 195 m upstream of USGS gage.	USU	
CP DL 02	1/2" rebar with redcap, marked USU-CNR. Downstream of site; 112 m upstream of USGS gage.	USU	
CP DL 03	USGS Brass Reference Mark in Rock. Next to USGS gage.	USU	
CPDL 20	1/2" rebar with redcap, marked USU-CNR. "T" fencepost close by.	USU	
CPDL 21	1/2" rebar with redcap, marked USU-CNR. "T" fencepost close by.	USU	
DL_6RHP		USU	Original transects established in the 1980s
DLCP1	Rebar; next to trail & close to sandbar.	NCPN-2012	dlcp1, deerlodge site, next to trail, Est in 2012, updated 2013. Missing in 2014 and on task list to be replaced in 2015.
DL_6LHP	Close to campsite. Unmarked rebar next to brown campsite sign & close to POPFRE.	NCPN-2013	Original transects established in the 1980s
DL_6LHP2	10.3 m west (away from river) from DL6LHP.	NCPN-2013	
CPDL22	On high knoll on river right.	NCPN-2013	

4. TRANSDUCERS:

- ☐ All transducers got downloaded?
- ☐ Transducer data sheet filled out?

☐ Ground-truthing measurements taken?

	TYPE (water or air)	Location (brief description)	What Was Surveyed? (e.g., top of eyebolt, top of casing without the cap, etc.)	Comments/Survey Special Notes (e.g., in overhang, cannot get rod plumb; use the top of casing, not the top of eyebolt, etc.)	Survey Shot Photographed This Year?
1	Water-US	Next to boat ramp on movable boulders.		Super crappy location. See if there is anything better (which there isn't).	☐ Y N
2	Water-DS	3m east of USGS brass benchmark (CP DL 03). Can drive to (?).			☐ Y N
3	Air	~19 m upslope from DS transducer	NA		NA

5. **FACIES MAPPING & GRAIN SIZE DISTRIBUTION:**

☐ Facies mapping & grainsize completed?

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #108

Photos for Dinosaur NM

Version 2.10 (September 2015)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	May 2013	D. Perkins, K. Lund, A. Wight	Edited section on belt transect	Making sure transects and plot numbers would correlate with size of feature	1.01
1.01	6/3/14	D. Perkins/ K. Lund	Major change in numbering of SOPs to make them specific to a park. Minor edits to datasheets.	Clarity and simplicity in the field for crews. Data entry/proofing documentation	2.00
2.00	9/30/15	K. Lund/D. Perkins	Separate SOPs into separate photo SOP. Represents what occurred in 2015 field season.	Clarity for field crew.	2.10

This SOP provides instructions for taking photos at sentinel sites in Dinosaur National Monument. Photos can be one of the most effective methods of showing long-term change at a site. Four types of photos are taken for each sentinel site:

1. Overview repeat photos taken from Photo Point locations. Record on *DINO Photos* data sheet. Mandatory.
2. Reference photos, which are for anything necessary for future crews to find. Record on *DINO Photos* data sheet. Optional.
3. Other photos. Record on *DINO Photos* data sheet. Optional.
4. Photosynth photos, taken on the iPad. No paper data sheet is used for Photosynth. Mandatory.

1.1 For Overview, Reference, and Other Photos

A. Fill out the top portion of *DINO Photos* data sheet:

River: Circle either Green or Yampa.

Sentinel Site: Record the pre-assigned, 2-letter code for each sentinel site

DL=Deerlodge

HH=Harding Hole

LP=Laddie Park

BP=Brown's Park

WN=Winnie's

LS=Limestone

EP=Echo Park

SC=Seacliff

IP=Island Park

Date: mm/dd/yyyy

Camera date/time checked?: check this box after the correct date and time have been set in the camera.

Photo #: This is necessary for all photographs and is *not* intuitive. Please follow directions carefully:

1. While the camera is in “play” mode, you will be able to view the number assigned to the photo. *Do not record this number.* This number changes when the photos are downloaded from the camera. Instead, use the following instructions to record the digital file name on the data sheet.
2. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
3. The template for the number you will record is *Pmdd9999*, where P = photos, *m* = month (Jan – Sept are coded 1-9, Oct = A, Nov = B, Dec = C); *dd* = day (01-31); and 9999 = the unique number of the photo. For example, photo 0300 taken on October 1 would be recorded as PA010300.

B. Overview Photos

Overview photos are repeat photos that are taken from Photo Point locations which are generally high locations above the sentinel site with good visibility. Record this photo data on the *DINO Photos* datasheet, direction in Section 4.3.

A. Establishment:

- a. Select a best time of day that minimizes shadows on the sentinel site.
- b. The observer selects Photo Point location where the entire sentinel site can be seen.

- c. Take repeat photo(s) of sentinel site
- d. GPS Photo Point location
- e. Take reference photos (see section 4.2 below) of the location where the photographer was located.

B. Revisits:

- a. Use the Revisit sheet for total Photo Point locations, total number of photos, and best times of day needed to repeat photos.
- b. Use maps, GPS units, and reference photos to get to the Photo Point location.
- c. Carefully repeat the photos using the Repeat Photos binder to match photographs in the field. When possible, use the same time of day or best times when shadows are minimized.

C. Fill out the remaining *DINO Photos* data sheet with the following:

Photo Type: circle O for overview

Direction Facing: circle US for upstream, DS for downstream, RR for river right, or RL for river left for the direction the photographer is facing. One or more directions can be circled.

Photographer Location: record the Photo Point location (e.g., PP1, PP2, etc.).

Subject Location: this is what the photographer is taking a photo of. If establishing overview photos, use O1, O2, O3, etc. If repeating overview photos, use the same nomenclature as the original photograph (e.g., O1, O2, O3, etc.).

Photographer: record the first initial and full last name of the photographer

Photo number: Record the Digital File Name using the above procedures (e.g., P7241234, P8176789)

Comments: Record any pertinent comments for the photograph.

C. Reference Photos

Take reference photos to document locations of all survey control, headpins, or other specific features or items that need to be located in the future. Include the cliff line, surrounding perennial vegetation, and/or other recognizable landmarks in the background to help the returning field crew relocate these points. Record this photo data on the *DINO Photos* datasheet, direction in Section 4.3.

- A. Label a chalkboard with the park code, site ID, specific description of what is being photographed (i.e. CP1, G2LHP, etc.), river right or left, and direction facing (upstream [US], downstream [DS], right to left [R -> L], or left to right [L->R], etc.) (e.g., BLCA, EP, G1RHP, US). The date does not need to be included.
- B. Place the chalkboard in a location where it will be easy to read in the photo.
- C. Clearly mark the location of the control, headpin, etc. in relation to recognizable landmarks. This location should be marked by bright-colored pin flags, placed either in the soil at the point or held above the point where they will be visible in the photo.

Unlike repeat photos, you may include anything in reference photos that may assist with re-locating the point (i.e., crew members, bright-colored flagging, etc.).

D. Take a photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one.

E. Fill out the remaining *DINO Photos* data sheet with the following:

Photo Type: circle R for reference

Direction Facing: circle US for upstream, DS for downstream, RR for river right, or RL for river left for the direction the photographer is facing. One or more directions can be circled.

Photographer Location: record a general description (e.g., from the river, 10 m upstream from HHCP1, etc.).

Subject Location: this is what the photographer is taking a photo of (e.g., CP1, RM2, etc.)

Photographer: record the first initial and full last name of the photographer

Photo number: Record the Digital File Name using the above procedures (e.g., P7241234, P8176789)

Close Up?: check only for a Reference Photo that is a close-up.

Replacement?: check only if the Reference photo being taken is to replace an already existing reference photo. This should help make it easy to update reference photos in the office afterwards.

Comments: Record any pertinent comments for the photograph.

D. 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 or Facebook.

A. Fill out the remaining *DINO Photos* data sheet with the following:

Category: circle one

Photographer: record the first initial and full last name of the photographer

Photo #: Record the Digital File Name using the above procedures (e.g., P7241234, P8176789)

Description: record a short description of the photograph

1.2 Photosynth

Photosynth is taken with the iPad and nothing is recorded on paper data sheets. Photosynth software stitches together photographs to form a complete picture. Directions can be found at www.photosynth.net (last accessed 12/14/2011) and are modified for our needs here.

A. GPS a location that gets a good view of the feature and label as Photosynth on iPad. Sometimes 2 or 3 locations may be necessary to adequately capture the feature.

B. Standing at the photosynth location, use the iPad to spin around, taking overlapping shots as you go. Make sure successive photos are overlapped by at least 50%. Depending on

how wide your lens goes, you'll probably need to take 15-30 photos to go all the way around (Figure 2).

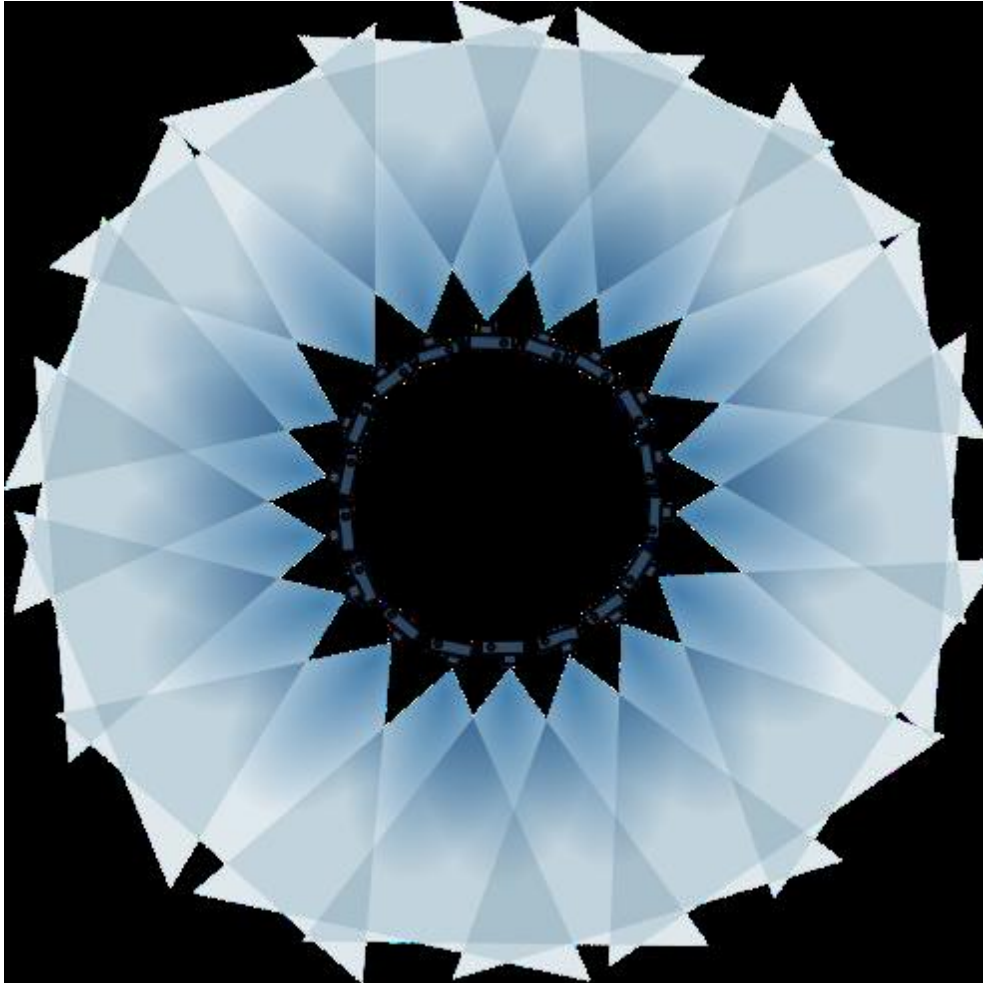


Figure 2. Pictures taken from the center of the feature.

DINO Photos

Photos downloaded by: _____
Date downloaded: ____/____/____

Data entered by: _____
Date entered: ____/____/____

Data verified by: _____
Date verified: ____/____/____

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River: Green Yampa **Sentinel Site:** _____ **Date:** ____/____/____ ➡ Camera date/time checked? ☐ ➡

KEY	O	R
Photo Type	Overview	Reference
Direction Facing	US DS RR RL	US DS RR RL

1 Month: Jan-Sep = 1-9, Oct -Dec = A - C
2 Day: 01-31 **3** 4-digit Camera Photo Sequence #

LOCATION	E X A M P L E S	
	PHOTOGRAPHER:	O → PP1, PP2, PP3 R → from river, 10m upstream, etc.
	SUBJECT:	Location being photographed O → O1, O2, O3 R → CP1, RM2, etc.

[illegible]

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #109

Vegetation Sampling for Dinosaur NM

Version 2.11 (September 2015)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.00	May 2013	D. Perkins, K. Lund, A. Wight	Edited section on belt transect	Making sure transects and plot numbers would correlate with size of feature	1.01
1.01	6/3/14	D. Perkins/ K. Lund	Major change in numbering of SOPs to make them specific to a park. Minor edits to datasheets.	Clarity and simplicity in the field for crews. Data entry/proofing documentation	2.00
2.0	9/30/15	K. Lund, D. Perkins	Split into separate SOP for measuring vegetation. Methods represent 2015 field season for the Yampa river.	Clarity for field crew	2.10
2.10	9/30/15	D. Perkins	Changes reflecting new set up of vegetation plots reflecting the use of RTK	Efficiency in field and increase statistical power	2.11

This SOP describes the methods for monitoring vegetation at sentinel sites in Dinosaur National Monument. After transect and plot establishment, vegetation sampling can generally be done by one person in an equivalent time to geomorphology surveying by three people. If available, a two-person team comprised of a data recorder and an observer skilled in plant identification can efficiently complete the tasks described below.

For each sentinel site, vegetation monitoring consists of sampling 1 m² vegetation plots and a timed veg walk to develop a species list. Four vegetation monitoring data sheets:

1. DINO Veg Plots, which includes keys and cheatsheets. Mandatory for all sentinel sites.

2. DINO Veg Plots Continuation, which does not have keys or cheatsheets. Optional and is provided for additional plots and/or species.
3. Unknown Plants. Optional, but highly encouraged if unknown plants are encountered.
4. DINO Veg Walk. Done for all sentinel sites as time permits. Occasionally this list is not collected if time is short.

1.0 Vegetation Plots

Vegetation surveying will consist of relocating previously plots (originally randomly located along systematic transects) 50 to 100 permanent 1x1 m plots at each site. In 2015 this was only done at Seacliff, all other sites had the old methods of new plots each year.

Veg plots will be marked with pinflags that are put out by the surveyors, which will be labeled with the zone and a unique number (e.g., 1, 2, 3, 4, etc.). The pinflag will be the center of the plot. Care needs to be taken to ensure that plots are not missed as the surveyors will take measurements at plots that are completely submerged.

For each veg plot, canopy cover is done by visually estimating the percentages of vegetation rooted within a 1x1m plot. Train crew members on visual estimation techniques. It is very important to calibrate everyone together frequently to ensure data consistency.

When filling out the data sheet, if you make a mistake, do not erase, simply draw a line through the erroneous information and write in the correct information.

Fill out the *DINO Veg Plots* data sheet:

Observer: Record the first initial and full last name of the person calling out the plot data if applicable.

Recorder: Record the first initial and full last name of the person recording the data.

River: Circle either Green or Yampa.

Sentinel Site: Record the pre-assigned, 2-letter code for each sentinel site:

DL=Deerlodge

HH=Harding Hole

LP=Laddie Park

EP=Echo Park

BP=Browns Park

WN=Winnies Rapid

LS=Limestone

SC=Seacliff

IP=Island Park

Date: mm/dd/yyyy

Plot: Record the veg plot label, which is written on the pinflag (e.g., 1, 2, 3, etc.)

Dominant Particle Size: Record the modal particle size by visually estimating a plan view projection of substrate within the plot. Estimate the substrate size with the largest fraction of plot by area, not average (e.g. if plot has 25% sand, 30% gravel, and 45% boulder, the modal particle size would be boulder). Look at the diameter of the intermediate axis of the particles. Do not include litter or organic matter. If there is a veneer of silt over an outline of another substrate, i.e. cobbles, call it cobbles. Only call it silt if you cannot recognize the substrate underneath (no longer veneer). If water is turbid, use your hand to feel the bottom of the plot. Record the corresponding code based on the Modified Wentworth Scale:

Modified Wentworth Scale		
Class Size range	Code	Diameter (mm)
Fines	F	<0.5
Sand, silt, clay	S	0.5 to 2
Gravel	G	>2 to 16
Pebble	P	>16 to 64
Cobble	C	>64 to 256
Boulder	BL	>256 to 512
Bedrock, Hardpan	BR	>512

% Sand & Finer: record to the nearest 1% the amount of the plot that is sand or less than <2mm (includes clay & silt).

% inundation (water): record to the nearest 1% the amount of that plot that is inundated by water.

No Rooted Veg: only check if the plot does not contain any rooted vegetation.

All Rooted Species % Cover: for each understory and overstory unique species, record the 6-letter species code composed of the first three letters of the genus and specific epithet vertically in the column. If a specific epitaph is not known, use the genus name as the code. Count only species rooted within the plot. Cover includes plants that are alive and that were alive earlier this year. Leave and count plants as you found them (i.e., if a plant is rooted and lying on its side, don't stand it up). Roots and exposed rhizomes do not count as canopy cover.

Visually estimate the percentage of each unique species' canopy cover rooted within a 1x1m plot to the nearest 1%. Record T if trace percentage ($\leq 0.5\%$). Visual estimation is

based on a plan view projection of outline polygon of plant subtracting the open spaces within the polygon. Imagine if the sun were directly overhead, what percentage is shaded. Stand over the plot to get a proper view of the species within a plot.

For *Acer negundo*, *Celtis reticulata*, *Populus fremontii*, *Salix exigua*, and *Tamarix sp.* we are distinguishing between adults (>1m tall) and seedlings (<1m tall). Check the Tree Seedling box if the specimen is <1m tall for these three tree species.

If an unknown plant is encountered, fill out an Unknown Plant data sheet (see section 3.2) and record the unknown species code in the column.

Full Latin Names: For the first time a unique species is encountered at a sentinel site, record the full Latin, including the 6-letter species code.

Continuation Sheet Used?: The *DINO Veg Plots Continuation* data sheet is optional and provides more space for additional veg plots at a sentinel site or additional species per veg plot. Check the “Continuation Sheet Used?” box if this data sheet is used to supplement the *DINO Veg Plots* data sheet.

If there are more than 2 botanists, at least once per day cross calibrate on cover and particle size estimates including some recorded replicate measurements.

1.1 Unknown Plants

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

- A. 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).
- B. 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 reach (e.g., unkDINO-HH-ST1). Record this code in the appropriate column on your vegetation sampling datasheet instead of the species name.
- C. Take a photograph of the unknown plant.
- D. As you proceed through the reach, continue to attempt to find identifiable specimens of unknowns.
- E. 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. Record the full Latin name of the genus followed by “sp.” (e.g., *Opuntia 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.

- A. Collect specimens from outside of the monitoring transects whenever possible.
- B. 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.
- C. If you must collect from a monitoring feature, remove only a minimal amount of plant material. Do not remove roots of perennial species that are collected within the transect.
- D. Wrap a piece of masking tape around the plant and use a fine-point Sharpie to label it with the unknown species code.
- E. Carefully place the specimen inside a resealable plastic bag labeled with the reach number, unknown species code, date, and collector.
- F. Place the sample in your backpack and in a shady spot until you get back to camp. Attempt to identify the plants when you return to camp.
- G. 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.
- H. 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.

Data sheets

When filling out the data sheet, give a detailed description of each characteristic. This allows greater potential for future identification when crews return to the site. Fill in the top of the data sheet and record the following information in its entirety if possible:

- **Unknown Code:** unk + 4 letter park code + reach number + your initials + collection number for the plot (e.g unkDINO-HH-ST1).
- **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 data sheets 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.

2.0 Timed Veg Walk

On each sentinel site, conduct a search for the presence of all species anywhere on the sentinel site. If time is running short, this step may be skipped.

Fill out the *DINO Veg Walk* data sheet:

River: Circle either Green or Yampa

Sentinel Site: Record the pre-assigned, 2-letter code for each sentinel site

Observer: Record the first initial and full last name of the person

Recorder: Record the first initial and full last name of the person

Date: mm/dd/yyyy

Time: record the **Start** and **End** time using military 12:00 time

Species Found: record the full Latin name of each unique species found on the sentinel site

DINO Veg Walk

Data entered by:

Data verified by:

Page _____ of _____

Date entered: / /

Date verified: / /

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**River
(circle):**

Green

Yampa

KEY :

suspected = *
species = sp.

unknown = UNK + CODE

CODE = *park* + *site* + 2 letter initials + 1 digit

Example unknown: UNK-CANY-HC-KL-3

[illegible]

DINO Veg Plots

Observer:

Recorder:

Data entered by:

Data verified by:

Date entered: ____/____/____

Date verified: ____/____/____

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River (circle):

Green

Yampa

Sentinel Site:

Date: ____/____/____

Modified Wentworth Scale

Class Size	Code	Diameter (mm)	Class Size	Code	Diameter (mm)
Fines	F	< 0.5	Pebble	P	>16-64
Sand	S	0.5 – 2	Cobble	C	>64-256
Gravel	G	>2-16	Boulder	BL	>256-512
			Bedrock, Hardpan	BR	>512

Plot	AC#	AC/AF#	AF#	IF#
	Active Channel # (e.g., AC1)	Active Channel / Active Floodplain Interface (e.g., AC/AF2)	Active Floodplain (e.g., AF3)	Inactive Floodplain (e.g., IF4)

Continuation Sheet Used? ☐[illegible]

FULL LATIN NAMES

Latin Name	6 letter code		Latin Name	6 letter code

DINO Veg Plots

Continuation

Recorder:

Data verified by:

Date verified: ____/____/____

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Green↓

Yampa

Sentinel Site: _____

Date: ____/____/____

[illegible]

Unknown Plant Species

Data entered by:

Data verified by:

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Park Code:

Reach ID:

Date:

Recorder:

Transect: 1 2 3 4 5 6 7

Position on transect (m) / method:

Photo #s:

Unknown species code (e.g., unkZION-P02-KL1): _____

Plant Type & General Description: *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 Collected by:

Best Guess:

Confirmed to be:

Identified by:

Date:

Big River Monitoring Protocol for Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) #110

Facies Mapping & Grain Size Distribution for Dinosaur NM

Version 1.00 (July 2015)

Revision History Log:

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

This SOP describes the methods for facies mapping and grain size distribution sampling at sentinel sites in Dinosaur National Monument. Facies is defined as “the character of a rock expressed by its formation, composition, and fossil content.” Facies mapping takes place on each sentinel site along with measuring grain size distributions at each facie and is recorded either on the iPad or on the *Facies Mapping and Grain Size Distribution* paper data sheet.

1.0 Facies Mapping

A. After completing the vegetation work, a person should have a good idea of how the sentinel site is laid out. Begin by mapping the most dominant facie (e.g., sand) and proceed to the less dominant facies (e.g., gravel). The mapping is done either on an iPad or on a hard copy map of the sentinel site. At each facie:

1. Record the primary attribute name by dominant size – Boulder, cobble, pebble, gravel, sand, fines. If bimodal add a modifier – Bouldery, cobbly, pebbly, gravely, sandy, silty, non. The first modifier is the more dominant. For example Bouldery cobble would indicate that the site had more boulders than cobbles. Boulder (>256 mm); Cobble (64-256 mm); Pebble (16-64 mm); Gravel (2-16 mm); Sand (1-2 mm); Fines (<1mm). Name the features with a number in sequential order, i.e., Cobble 1, Pebbly cobble 2, Sand 3....
2. How is the facie vegetated (bare to sparse <5%, sparse 5-25%, becoming vegetated 26-50%, vegetated >50%)?

3. Are there wake or shadow deposits downstream of sparse individual plants or stands?
 - i. Are the wake or shadow deposit sedimentologically different than the rest of the facie?
 - ii. Are ridges forming (>30 cm) in wake/shadow deposits?
 4. Is there any large woody debris?
 - iii. Are wake or shadow deposits associated with these?
 - iv. Are the wake or shadow deposit sedimentologically different than the rest of the facie?
 - v. Are ridges forming (>30 cm) in wake/shadow deposits?
 5. Is there any fine woody debris?
- B. If wake or shadow deposits are sparse (<5) and have a different grain size distribution than surroundings, consider mapping as an individual facie.
- C. Take Photosynth from center of facie (see section 4.4).

2.0 Grain Size Distributions

Grain size distributions do not need to be taken every year, but should be done a minimum of once every 5 years or if a state change is observed, for example a cobble bar is now covered with sand. For each facie at a sentinel site, record grain size distributions at two sites with sieves and scales for finer textured surfaces. For boulder bars we will not do a grain size distribution. At each site record a surface and sub-surface grain size distribution on the *Facies Mapping and Grain Size Distribution* data sheet.

- A. Draw a sketch of the facies on the feature and label each facies.
- B. Surface Grain Size Distribution
1. Take 2-5 shovelfuls from the surface and place them in a 5-gallon bucket. It is important to take a representative sample. On fine textured surfaces (sand) two shovelfuls will likely be sufficient, but if the surface material is made of small boulders or large cobbles, 3-5 shovelfuls would be needed.
 2. Place material from the bucket into the sieves. Shake vigorously to ensure that all smaller sediment has made it to the next sieve. Remove 63 mm sieve with any material and place to the side.
 3. Shake vigorously to ensure that all smaller sediment has made it to the next sieve. Remove 16 mm sieve with any material and place to the side.
 4. Shake vigorously to ensure that all smaller sediment has made it to the next sieve. Remove 2 mm sieve with any material and place to the side.
 5. Any remaining material should be in the bottom bucket and is finer than 2 mm.
 6. Weigh all buckets. Be sure to account for weight of sieves. Record weights on data sheet.
 7. Take photo of sample location.

- Data entered by:

Data proofed by:

DINO-Site:

Observer:

Recorder:

[illegible]

Sketch of Feature with Facies and Locations Labeled

