

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

### **Standard Operating Procedure (SOP) # 1**

#### **Preparations for the Field Season and Equipment Needed**

##### **Version 1.02 (December 2015)**

###### **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          |
| 1.01               | December 2015 | D. Perkins | Updated equipment list | Changes to needs         | 1.02          |
|                    |               |            |                        |                          |               |
|                    |               |            |                        |                          |               |
|                    |               |            |                        |                          |               |

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. Big river 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 July and late- 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 are often planned 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 needs with appropriate parks, and acquire backcountry camping permits, if necessary.
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.

**Data sheets**

Refer to appropriate SOPs for data sheets for vegetation, transducers, grain size distributions and photos.

**Photos**

Refer to appropriate SOPs for park specific photo data sheets.

**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.
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](http://usgs.waterdata.gov). This information is also quickly available at the NCPN Climate Analyzer (<http://www.climateanalyzer.org/NCPN/map.html>) Applicable gages include:

BLCA

09128000 Gunnison River below Gunnison Tunnel, CO

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

09328920 Green River at Mineral Bottom, 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. **Make sure that the batteries are fully charged for all rechargeable equipment.**

## BLACK CANYON OF THE GUNNISON EQUIPMENT LIST

Equipment needed to bring to BLCA is listed first (what goes in the vehicle), followed by a concise list of what to backpack into the Red Rocks site.

| Item                                                     | Number needed  | Description                       | Notes                                                                                          |
|----------------------------------------------------------|----------------|-----------------------------------|------------------------------------------------------------------------------------------------|
| <b>General Equipment - necessary for all SOPs</b>        |                |                                   |                                                                                                |
| GPS with extra batteries                                 | 2              | Trimble GeoXM or more accurate    | main unit and backup                                                                           |
| GPS car charger                                          | 1              |                                   |                                                                                                |
| Digital camera                                           | 3              |                                   | transect headpins and mid-channel, survey monuments and reference marks, wells and piezometers |
| Extra battery for digital camera                         | 2              |                                   |                                                                                                |
| Permit                                                   | 2 per vehicle  |                                   | one on dashboard, one with crew                                                                |
| Maps                                                     | 1 per 2 people |                                   |                                                                                                |
| SOPs                                                     | 1 per 2 people |                                   |                                                                                                |
| Clipboard                                                | 1 per 2 people | lightweight with interior storage |                                                                                                |
| Field notebook                                           | variable       | small, Rite-in-the-Rain®          | field notes                                                                                    |
| Pencils & permanent markers                              | 5 – 10 each    |                                   |                                                                                                |
| 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                                                                            |
| Magnetic Locator                                         | 1              | Metal detector in hard case       | Magna-Trak brand                                                                               |
| <b>Safety Equipment - necessary for all SOPs</b>         |                |                                   |                                                                                                |
| Backcountry first aid kit                                | 1 per 2 people |                                   | Use if not rafting.<br>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                                                          |
| <b>Equipment Necessary for ALL Vegetation Monitoring</b> |                |                                   |                                                                                                |

| Item                                   | Number needed               | Description                                 | Notes                                      |
|----------------------------------------|-----------------------------|---------------------------------------------|--------------------------------------------|
| Compass                                | 2                           | with declination setting                    | set declination, take transect bearings    |
| Pin flags                              | 30                          | narrow steel pins with flag top             | mark locations                             |
| Flagging                               | 3 rolls                     | Fluorescent                                 | Mark 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                    |
| Trowel                                 | 2                           | small garden tool                           | extract specimen roots                     |
| Plant press                            | 1                           | field press with card, blotter, and paper   | store plant collections for identification |
| Relevant floras and park species lists |                             | various by park                             |                                            |
| Chalkboard                             | 2                           | 5 x 7"                                      | label photos                               |
| Chalk                                  | 2                           |                                             |                                            |
| 2-way radios                           | One per person plus 4 extra |                                             | crew communication                         |
| Extra radio batteries                  | min. 24                     | AA alkaline                                 | radios require 3 per unit                  |
| Reach species list                     | 2                           | species previously recorded at reach        |                                            |
| BLCA Vegetation Monitoring             |                             |                                             |                                            |
| 100-m Kevlar taglines                  | 6                           | Kevlar string with meter markings           | set up transects                           |
| Rebar                                  | min. 6 short & 6 long       | 3/8" diameter cut into 18" and ~36" lengths | secure taglines on uplands and in water    |
| Sledgehammer                           | 1                           |                                             | Placing rebar                              |
| Clawhammer                             | 2                           |                                             | Placing rebar, includes spare              |
| Cam straps                             | 6                           | 6 footers                                   | Tighten taglines                           |
| Stakes                                 | 6                           | Heavy duty                                  | Tighten taglines                           |
| 100-m transect tapes                   | 3                           | fiberglass reel tapes                       | cross-section transects. Includes spare.   |
| Chaining pins                          | min. 6                      | striped metal pins                          | secure tapes                               |
| 0.5 x1 m quadrat frames                | 2                           | Pvc pipe                                    | Use for veg plots                          |
| Folding carpenter rulers               | 6                           | 2m                                          | Use for veg plots                          |
| Transect relocation photos             | R - 2                       | reference photos taken during establishment |                                            |
| Compass                                | 2                           | with declination setting                    | set declination, take transect bearings    |

| Item                                                                 | Number needed | Description | Notes                                                               |
|----------------------------------------------------------------------|---------------|-------------|---------------------------------------------------------------------|
| Datasheets:                                                          |               |             |                                                                     |
| - Vegetation                                                         |               |             |                                                                     |
| - Photos (feature & reference)                                       |               |             |                                                                     |
| - Timed Plant Walk                                                   |               |             |                                                                     |
| Unknown plants                                                       |               |             |                                                                     |
| <b>Small Boat Equipment,</b>                                         |               |             |                                                                     |
| 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                                            |
| <b>Transducer Equipment- All Trips (Establishment &amp; Revisit)</b> |               |             |                                                                     |
| Spare well casing or PVC in 5 foot length                            | 2             |             | 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 and attach air transducers |
| 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        |             |                                                                     |
| 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                                     |
| <b>Transducer Equipment- Establishment Only</b> |                  |                                                                          |
| 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 claspings. Includes spares                   |
| Washers                                         | 10 per site      | ¼". Includes 6 spares                                                    |
| Nuts                                            | 10 per site      | ¼" Includes 6 spares                                                     |
| <b>Transducer Equipment- For Revisit Only</b>   |                  |                                                                          |
| Laptop computer                                 | 1                | With Solinst 4.0.3 software loaded and a working USB port                |
| HOB0 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 claspings. Includes spares                   |
| Spare Washers                                   | 10 per site      | ¼". Includes 6 spares                                                    |
| Spare Nuts                                      | 10 per site      | ¼" Includes 6 spares                                                     |

Equipment to Backpack into Red Rocks (a subset of equipment listed above)

NOTE: Stashed gear: sledgehammer, 7 rebar (4 long and 3 short). The gear is stashed downstream of the fin just downstream of Feature C. It is on a shelf.

|        |            |  |
|--------|------------|--|
| Radios | 1.5/person |  |
|--------|------------|--|

|                         |                |                                        |
|-------------------------|----------------|----------------------------------------|
| Radio batteries         | 3 sets/radio   |                                        |
| GPS                     | 1              |                                        |
| Maps                    | 5              |                                        |
| Pinflags                | ~20            |                                        |
| Chaining Pins           | 6              |                                        |
| Pencils                 | 2/person       |                                        |
| Sharpies                | 5              |                                        |
| Sunscreen               | 2              |                                        |
| Tecnu                   | 2              |                                        |
| Flagging                | 3 rolls        |                                        |
| Packraft                | 1 (2 is ideal) | Includes paddles, repair kit, air bag  |
| Camera                  | 2              | Includes spare battery for each camera |
| Chalkboard              | 1              |                                        |
| Chalk                   | 1 pack         |                                        |
| Reference photos        | 1 set          |                                        |
| Photo Datasheet         | 6              | Printed 2-sided on Rite in Rain paper  |
| Taglines                | 7              |                                        |
| Stakes & Cams           | 7              | Same number as taglines                |
| Survey Rods             | 4              |                                        |
| Bipods                  | 2              |                                        |
| Prisms                  | 4              |                                        |
| Small Aluminum Tripod   | 1              |                                        |
| Tripod                  | 1              | For Total Station                      |
| Total Station           | 1              |                                        |
| Controller              | 1              |                                        |
| Total Station Batteries | 6              |                                        |
| Survey Notebook         | 1              | Rite in the Rain                       |
| Tape Measures           | 4              |                                        |
| Metal Detector          | 1              |                                        |
| Turning Pins            | 20             | Large nails                            |
| Metal Number Tags       | 20             | Attach to Turning Pins                 |
| Chisel                  | 1              |                                        |
| White Paint Marker      | 2              |                                        |
| Transducer Datasheets   | 2              | Printed 2-sided on Rite in Rain paper  |
| Levels                  | 2              | 1 large, 1 small                       |
| Grip-It Strap Wrench    | 1              |                                        |

|                                   |                |                                       |
|-----------------------------------|----------------|---------------------------------------|
| Channellock Tongue & Groove Plier | 1              |                                       |
| Binder/Clipboard                  | 1/botanist     |                                       |
| Folding Ruler                     | 2/botanist     |                                       |
| Unknown Plant Kit                 | 1/botanist     |                                       |
| Veg Plot Datasheet                | 25             | Printed 2-sided on Rite in Rain paper |
| Veg Walk Datasheet                | 8              | Printed 2-sided on Rite in Rain paper |
| Small Drybags or Bear Cans        | 0.5-1/person   | For bear-hanging food                 |
| Rope/Cord                         |                | For bear-hanging food                 |
| Small Carabiners                  | 1/Small Drybag | For bear-hanging food                 |
| Water Filters                     | 2              |                                       |
| Stoves                            | 2              |                                       |
| Stove Fuel                        | 2              |                                       |
| Pot Sets                          | 2              |                                       |
| Wag Bags                          | 2/person       |                                       |
| Trowel                            | 1              |                                       |

## CANYONLANDS EQUIPMENT LIST

| Item                        | Number needed       | Description                    | Notes                                          |
|-----------------------------|---------------------|--------------------------------|------------------------------------------------|
| General Equipment           |                     |                                |                                                |
| GPS with extra batteries    | 3                   | Trimble GeoXM or more accurate | main unit and backup                           |
| CANY Permit                 | 2                   |                                | May not be needed if trip is organized by SEUG |
| 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            |                     |                                |                                                |

| Item                                                                                                   | Number needed                                                                        | Description                                                                                | Notes                                                                                                                                                                               |
|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <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                                                                                                                                               |
| <b>Transect, Photo and Vegetation Monitoring Equipment</b>                                             |                                                                                      |                                                                                            |                                                                                                                                                                                     |
| Rubber bands                                                                                           | Bag                                                                                  |                                                                                            | Used for grouping pin flags in 10s                                                                                                                                                  |
| 100-m Kevlar taglines                                                                                  | 7                                                                                    | Kevlar string with meter markings                                                          | set up transects                                                                                                                                                                    |
| Rebar                                                                                                  | <u>Transects:</u><br>min. 18 short & 8 long<br><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.<br><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.                                                                                                                                            |
| 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                                                                                                                                                                   |

| Item                                                                                                                                                                                                                                     | Number needed       | Description                                              | Notes                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------|--------------------------------------------|
| 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: <ul style="list-style-type: none"> <li>- CANY Establishment/Revisit</li> <li>- CANY Vegetation Plots (Keyed &amp; Continuation)</li> <li>- CANY Timed Plant Walk</li> <li>- Unknown plants</li> <li>- CANY Photos</li> </ul> |                     |                                                          |                                            |
| 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 Floatation Devices                |
| Small dry bags                                                                                                                                                                                                                           | One each per person |                                                          | Used as day bags                           |
| Large dry bags                                                                                                                                                                                                                           | One each per person |                                                          | Used for overnighner 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             |
| 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                                                                                                                                                                                                                      |                     |                                                          |                                            |

| Item                   | Number needed | Description                                    | Notes                                                                                                                                                                                                                                              |
|------------------------|---------------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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      | 1 - 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                                                                                                                                                                                                                                   |

| Item                                                                 | Number needed             | Description                                                | Notes                                                               |
|----------------------------------------------------------------------|---------------------------|------------------------------------------------------------|---------------------------------------------------------------------|
| 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                                     |
| <b>Transducer Equipment- All Trips (Establishment &amp; Revisit)</b> |                           |                                                            |                                                                     |
| Spare well casing or PVC in 5 foot length                            | 2                         |                                                            | 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 and attach air transducers |
| 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                    |                                                            |                                                                     |
| Hose clamps                                                          | 2 per site                |                                                            | For attaching barologger. Includes one spare.                       |
| Level                                                                | 1                         |                                                            |                                                                     |

| Item                                            | Number needed    | Description | Notes                                                                    |
|-------------------------------------------------|------------------|-------------|--------------------------------------------------------------------------|
| Carpenter rulers                                | 2                |             |                                                                          |
| Measuring tape                                  | 1                |             | Rolling metric tape                                                      |
| Transducer Datasheet                            | 1                |             | Checking reference mark measurements                                     |
| <b>Transducer Equipment- Establishment Only</b> |                  |             |                                                                          |
| 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 claspings. Includes spares                   |
| Washers                                         | 10 per site      |             | ¼". Includes 6 spares                                                    |
| Nuts                                            | 10 per site      |             | ¼" Includes 6 spares                                                     |
| <b>Transducer Equipment- For Revisit Only</b>   |                  |             |                                                                          |
| 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 claspings. Includes spares                   |
| Spare Washers                                   | 10 per site      |             | ¼". Includes 6 spares                                                    |
| Spare Nuts                                      | 10 per site      |             | ¼" Includes 6 spares                                                     |

## CURECANTI EQUIPMENT LIST

| Item                                              | Number needed                      | Description                       | Notes                                                 |
|---------------------------------------------------|------------------------------------|-----------------------------------|-------------------------------------------------------|
| General Equipment - <i>necessary for all SOPs</i> |                                    |                                   |                                                       |
| GPS with extra batteries                          | 5+                                 | Trimble GeoXM or more accurate    | main unit and backup                                  |
| GPS car charger                                   | 1                                  |                                   |                                                       |
| Ziploc bags                                       | 6+                                 | For GPS                           |                                                       |
| Digital camera                                    | 3                                  |                                   | Transect, reference and overview photos               |
| Chalkboards and chalk                             | 3                                  |                                   |                                                       |
| DBH tapes                                         | 3                                  |                                   |                                                       |
| 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:<br>1. Photo                           | Variable                           |                                   |                                                       |
| 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                        |                                   |                                                       |
| 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. |
| 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                                   |
| Duckies                                           | 2                                  |                                   |                                                       |
| Alpacka                                           | 1                                  |                                   |                                                       |
| Vehicles                                          | 2+                                 | For shuttling duckies             |                                                       |
| Paddles                                           | 5                                  |                                   |                                                       |
| PFDs                                              | 1 per person, 1 spare for 3 people |                                   |                                                       |
| Throw bags                                        | 2                                  |                                   |                                                       |
| Electric pump                                     | 1                                  |                                   |                                                       |
| Barrell pump                                      | 1                                  |                                   |                                                       |
| Ducky repair kit                                  | 1                                  |                                   |                                                       |

[illegible]

## DINOSAUR EQUIPMENT LIST

| Item                                              | Number needed          | Description                       | Notes                                                                                          |
|---------------------------------------------------|------------------------|-----------------------------------|------------------------------------------------------------------------------------------------|
| General Equipment - <i>necessary for all SOPs</i> |                        |                                   |                                                                                                |
| 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:                                       |                        |                                   |                                                                                                |
| 2. Est/Revisit                                    |                        |                                   |                                                                                                |
| 3. Veg Plots (keyed)                              |                        |                                   |                                                                                                |
| 4. Plant walk                                     |                        |                                   |                                                                                                |
| 5. Facies & Grain Size                            | Variable               |                                   |                                                                                                |
| 6. Photo                                          |                        |                                   |                                                                                                |
| 7. Transducers                                    |                        |                                   |                                                                                                |
| 8. 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                                                                            |

| Item                                             | Number needed  | Description                               | Notes                                                            |
|--------------------------------------------------|----------------|-------------------------------------------|------------------------------------------------------------------|
| <b>Safety Equipment - necessary for all SOPs</b> |                |                                           |                                                                  |
| 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                            |
| <b>DINO Vegetation Monitoring</b>                |                |                                           |                                                                  |
| Rubber bands                                     | Bag            |                                           | Used for getting pin flags in groups of 10                       |
| 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                           |                                                                  |
| Flagging                                         | 2 rolls        | Neon color                                | For flagging plots in dense vegetation                           |
| Sentinel site species list                       | 1 per botanist | species previously recorded at reach      |                                                                  |
| DINO Plant Synonyms Sheet                        | 1 per botanist |                                           | Utah & Colorado names                                            |
| <b>DINO Facies &amp; Grain Size Mapping</b>      |                |                                           |                                                                  |
| Sieves                                           | 1 set          |                                           | In gray bag. Used to sample substrate                            |
| Foldable shovel                                  | 1              |                                           |                                                                  |
| Scale                                            | 1              |                                           | In orange stuff sack                                             |

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

## Camping Equipment

|                                                                                  |                  |                                                               |                                                                                     |
|----------------------------------------------------------------------------------|------------------|---------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Group Camping Equipment – Necessary for all field work that requires car camping |                  |                                                               |                                                                                     |
| 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                |                                                               |                                                                                     |
| Backpacking Equipment – Necessary for backpacking when flows are too low to raft |                  |                                                               |                                                                                     |
| 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. |

### Rafting Equipment.

Rafting equipment, *Necessary for all multi-day rafting trips.*

|                         |                               |                                                                      |
|-------------------------|-------------------------------|----------------------------------------------------------------------|
| 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                                   | Only needed if fires intended                                                                  |
| 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                                                                      |
| <b>Small Boat Equipment</b> |                  |                                                                                     |
| 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                                                            |

**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                                                                                                                                                                                                                |
| 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                         | 1 - 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                                                                                                                                                                                                |

| Item                                              | Number needed             | Description                                                | Notes                                                                                                                          |
|---------------------------------------------------|---------------------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| 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                                                                                                |
| <b>Total Station Surveying</b>                    |                           |                                                            |                                                                                                                                |
| 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                         |                                                            |                                                                                                                                |
| 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                                                                                        |

| Item                                              | Number needed         | Description                                                | Notes                                                                   |
|---------------------------------------------------|-----------------------|------------------------------------------------------------|-------------------------------------------------------------------------|
| 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,<br>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                                                           |
| 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                                             |

## 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 and for barologgers             |
| 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 clasping. 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) # 2**

#### **Hiring and Training Observers**

#### **Version 1.01 (December 2015)**

##### **Revision History Log:**

| Previous Version # | Revision Date | Author     | Changes Made                  | Reason for Change                                       | New Version # |
|--------------------|---------------|------------|-------------------------------|---------------------------------------------------------|---------------|
| 1.00               | 12/17/15      | D. Perkins | Editing for current practices | Previous version was largely a copy of wadeable streams | 1.01          |
|                    |               |            |                               |                                                         |               |
|                    |               |            |                               |                                                         |               |
|                    |               |            |                               |                                                         |               |
|                    |               |            |                               |                                                         |               |

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 to five 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), CPR and/or Swift Water Rescue are assets. 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 Big River 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/RTK and post processing survey data.
- 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. Due to the differences in measuring vegetation on the different rivers, all training is done in the field as part of the scheduled field hitch.** Crew members from previous seasons normally do not need as much training in plant-identification skills as new crew members. 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.

**4. 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. A river talk (hand signals, what to do in the water, proper positioning for rapids, sunburn, etc.) is given by an experience boater prior to the boats launching. In addition, safety talks are given prior to the first big rapid and are repeated and reviewed depending on the day's plans and conditions.

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

### **Standard Operating Procedure (SOP) # 3**

### **Using Global Positioning System (GPS) Units**

### **Version 1.02 (December 2016)**

#### **Revision History Log:**

| Prev. Version # | Revision Date | Author     | Changes Made                                                                          | Reason for Change                               | New Version # |
|-----------------|---------------|------------|---------------------------------------------------------------------------------------|-------------------------------------------------|---------------|
| 1.0             | 1/4/16        | D. Perkins | Editorial and due to methods changes in other SOPs. Removed rapid assessment portion. | Clarity. Currently not doing rapid assessments. | 1.01          |
| 1.01            | 12/2016       | A. Wight   | Rewrote SOP to reflect Big Rivers methods                                             | To capture updated protocol changes             | 1.02          |
|                 |               |            |                                                                                       |                                                 |               |
|                 |               |            |                                                                                       |                                                 |               |
|                 |               |            |                                                                                       |                                                 |               |

This SOP explains the procedures and considerations that all observers should follow when navigating to and/or collecting geospatial data at big river monitoring locations.

This SOP assumes that each observer is familiar with the operation and function of the GPS unit to be used for this project. This SOP is intended to complement, not replace, the operations manual accompanying the GPS unit. Each observer should be familiar with the use of their particular GPS unit before entering the field to collect data or navigate to points. This SOP does not require the use of a specific brand of GPS unit; however, the unit must meet the minimum standards listed below.

#### **Definitions and Acronyms**

|                   |                                                                                                                                                             |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accepted data     | Data that have undergone all QA and QC procedures as defined in the published protocol and associated SOPs.                                                 |
| Coordinate system | Any three-dimensional reference frame that locates objects in space.                                                                                        |
| Data dictionary   | Information (data) that describes features that will be located in the field.                                                                               |
| Feature           | A physical object or location of an event. A feature can be a point, line, or polygon (area).                                                               |
| FGDC              | Federal Geographic Data Committee. The interagency committee that promotes the coordinated development, use, sharing, and dissemination of geographic data. |
| GIS               | Geographic Information Systems. A computerized system used to input, manage,                                                                                |

|                                   |                                                                                                                                                                                                                                                  |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                   | manipulate, analyze and display geographic data in digital form.                                                                                                                                                                                 |
| GPS                               | Global Positioning System (unit/receiver/datalogger). A three part system of 1) 25+ Department of Defense satellites, 2) Control segment, 3) Users with receivers.                                                                               |
| I&M                               | Inventory & Monitoring Program of the National Park Service                                                                                                                                                                                      |
| Master database                   | Project-specific database that stores the full project dataset and is used for viewing, summarizing, and analysis. Contains only accepted data.                                                                                                  |
| NCPN                              | Northern Colorado Plateau Network                                                                                                                                                                                                                |
| NPS                               | National Park Service                                                                                                                                                                                                                            |
| Quality assurance (QA) procedures | Procedures used to ensure collection of data with minimal errors.                                                                                                                                                                                |
| Quality control (QC) procedures   | Procedures used to flag or modify data to ensure that data meet established data quality standards.                                                                                                                                              |
| Raw data                          | Data that have not been subjected to either quality control or documentation procedures; includes data recorded by hand on hard-copy forms, digital files from handheld devices, GPS receivers, telemetry data loggers, etc.                     |
| SOP                               | Standard Operating Procedure                                                                                                                                                                                                                     |
| Spatial dataset                   | A dataset that is natively read by mapping software; often produced by mapping software, such as ESRI ArcMap and ArcInfo; also includes georeferenced imagery, geodatabases, as well as hardcopy aerial photographs, satellite imagery and maps. |
| Tabular dataset                   | A dataset organized in a table or group of tables where each column and row has a specific interpretation; often produced by MS Excel, MS Access, database, or statistical software, and managed as text, spreadsheet, or relational databases.  |
| Working database                  | A project-specific database for entering and processing data for the current season (or other logical period of time).                                                                                                                           |

## 1. GPS overview

The primary role of GPS for Big Rivers Monitoring is to get an idea of the layout of the sentinel site (monitoring location), and what features are there as well as their relation to each other. Minimal, if any, data are collected with GPS, as most locational data is collected during the survey part of the monitoring of each sentinel site. The NCPN requires the use of a mapping grade GPS unit to navigate to and record any data.

### 1.1 Minimum GPS Receiver Requirements

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

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

## 1.2 GPS Unit Setup

The NCPN currently uses the Trimble line of mapping grade GPS units and TerraSync Professional software to capture minimal spatial data for the Big Rivers Protocol. The requirements should be transferable to other mapping grade GPS receivers (such as Leica, etc.).

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

**Table 1 Minimum GPS Receiver Settings Standards**

| Name                                            | Definition                                                                                                                                                                       | Standard                                                                                                                              |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Almanac                                         | GPS unit collects data containing estimated position of satellites, time corrections, and atmospheric delay parameters.                                                          | The unit will automatically collect the almanac. Acquire within 10 days prior to data collection or navigating, download to computer. |
| Altitude reference                              | Ellipsoid model                                                                                                                                                                  | Height Above Ellipsoid (HAE)                                                                                                          |
| Antenna heights                                 | GPS unit height above the ground (average).                                                                                                                                      | 1.0 – 1.5 meters                                                                                                                      |
| Coordinate System                               | A reference system consisting of a set of points, lines, and/or surfaces, and a set of rules, used to define the positions of points in space in either two or three dimensions. | Universal Transverse Mercator (UTM)                                                                                                   |
| Datum                                           | Geodetic model designed to fit a point on the earth's surface to the ellipsoid.                                                                                                  | NAD 1983 (Conus)                                                                                                                      |
| Elevation mask                                  | The minimum angle at which a GPS receiver will track satellite vehicles.                                                                                                         | 15 degrees                                                                                                                            |
| Logging intervals                               | Time interval between positions gathered.                                                                                                                                        | Point: 1 second<br>Line and Polygon: 5 seconds                                                                                        |
| Minimum number of positions for a point feature | Number of positions received then averaged to create a point feature.                                                                                                            | 10 - 20                                                                                                                               |
| Mode                                            | 2-Dimensional or 3-Dimensional                                                                                                                                                   | 3-Dimensional (4 satellites)                                                                                                          |
| PDOP Mask                                       | Positional Dilution of Precision is a measurement of the geometry of the satellites.                                                                                             | 6.0 or less                                                                                                                           |
| Satellite vehicles                              | Number of satellites, currently a constellation of 28 DOD satellites.                                                                                                            | 4                                                                                                                                     |

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

### 1.3 Data Dictionary

A data dictionary should be utilized to facilitate field data navigation and collection. The minimum elements necessary for the Big Rivers data dictionary are shown below. Once the project manager has given the GIS technician all (RTKed) data for a given park, those points are then imported with the Big Rivers data dictionary (using Pathfinder Office), creating a data file for use in the field (*PARK\_BigRiv.imp*). All point features in the Big River Data Dictionary should have the default feature settings of:

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

The following data dictionary digital files (.ddf) can be obtained by contacting the NCPN Data Management staff. Since each park with Big River monitoring has slightly different SOPs, each park has a unique data dictionary, although there are many same features throughout all data dictionaries.

#### Black Canyon of the Gunnison National Park Big Rivers Data Dictionary

Before each field hitch, the following data dictionary, populated with existing data of the 2 sentinel sites, will be loaded onto several GPS units. The data is primarily to help the field crew locate existing (established) locations, not to collect new locations, as the survey team will do the spatial data collection. If a spatial feature is collected via GPS (such as a photo point), allow the point to collect 10+ satellites hits, fill in the appropriate attributes, then save the feature. Given the terrain in Black Canyon, marking the location on a paper map as well is encouraged.

| ControlPt Feature – This feature identifies locations where the tripod or RTK base are located within the sentinel site. |                       |                              |                 |
|--------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------|-----------------|
| Attributes                                                                                                               | Attribute Explanation | Entry                        | Type            |
| POINTID                                                                                                                  | Unique ID             | Entry permitted in the field | Numeric         |
| Site                                                                                                                     | Sentinel site name    | Entry permitted in the field | Text - Optional |

| PT_TYPE                                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>Control point</li> <li>Occupy point</li> <li>Base setup point</li> <li>Temp base setup</li> <li>Future control</li> <li>Other</li> </ul>                  | Entry permitted in the field | Menu            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| Comments                                                                                                                                                                                                        | Any comments regarding the control point                                                                                                                                                         | Entry permitted in the field | Text – Optional |
| <b>Headpin Feature</b> – This feature delineates where the headpins for each transect within the feature are located.                                                                                           |                                                                                                                                                                                                  |                              |                 |
| Attributes                                                                                                                                                                                                      | Attribute Explanation                                                                                                                                                                            | Entry                        | Type            |
| ID                                                                                                                                                                                                              | Coded unique identifier. Feature Letter, Transect number, Right or Left HeadPin, number. Example: “G2RHP203” is Feature G, Transect 2, Right head pin, 203.                                      | Entry permitted in the field | Text – Optional |
| Descriptio                                                                                                                                                                                                      | Description                                                                                                                                                                                      | Entry permitted in the field | Text – Optional |
| SiteName                                                                                                                                                                                                        | Name of the sentinel site                                                                                                                                                                        | Entry permitted in the field | Text – Optional |
| Comments                                                                                                                                                                                                        | Any comments/notes regarding this headpin                                                                                                                                                        | Entry permitted in the field | Text – Optional |
| <b>Orientation Feature</b> - This feature delineates where the orientation pin is located within the feature. Once an observer has found the head pin and the orientation pin, the transect can be established. |                                                                                                                                                                                                  |                              |                 |
| Attributes                                                                                                                                                                                                      | Attribute Explanation                                                                                                                                                                            | Entry                        | Type            |
| ID                                                                                                                                                                                                              | Coded unique identifier. Feature Letter, Transect number, Distance from headpin to orientation pin, Pin number. Example “G2D6P203” is Feature G, Transect 2, Distance 6 meters from headpin 203. | Entry permitted in the field | Text – Optional |
| Descriptio                                                                                                                                                                                                      | Description                                                                                                                                                                                      | Entry permitted in the field | Text – Optional |
| SiteName                                                                                                                                                                                                        | Name of the sentinel site                                                                                                                                                                        | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                                           | Any comments/notes regarding this orientation pin                                                                                                                                                | Entry permitted in the field | Text – Optional |
| <b>Transducer Feature</b> - This feature locates where transducers were placed, both water and air transducers.                                                                                                 |                                                                                                                                                                                                  |                              |                 |
| Attributes                                                                                                                                                                                                      | Attribute Explanation                                                                                                                                                                            | Entry                        | Type            |
| ID                                                                                                                                                                                                              | Unique identifier of the transducer. Site name, Air or Water, number. Example: “EPW6” is East Portal, Water, #6.                                                                                 | Entry permitted in the field | Text – Optional |
| Transducer                                                                                                                                                                                                      | Transducer type: <ul style="list-style-type: none"> <li>Air</li> <li>Water</li> <li>Other</li> </ul>                                                                                             | Entry permitted in the field | Menu            |
| River                                                                                                                                                                                                           | Side of river: <ul style="list-style-type: none"> <li>Right</li> <li>Left</li> <li>NA</li> </ul>                                                                                                 | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                                                                         | Any comments/notes regarding this transducer                                                                                                                                                     | Entry permitted in the field | Text – Optional |

| LocationNotes                                                                                                                                                                             | Specific notes about the location. Example: “btn D1 & D2” | Entry permitted in the field | Text – Optional |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------------------------|-----------------|
| <b>PhotoPt Feature</b> - This feature maps the location where repeat overview photographs are taken.                                                                                      |                                                           |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                     | Entry                        | Type            |
| SiteName                                                                                                                                                                                  | Name of sentinel site                                     | Entry permitted in the field | Text – Optional |
| PhotoNum                                                                                                                                                                                  | Unique photo number                                       | Entry permitted in the field | Text – Optional |
| LocationNotes                                                                                                                                                                             | Specific notes about the location of the photo point      | Entry permitted in the field | Text – Optional |
| Comment                                                                                                                                                                                   | Any comments/notes regarding this photo point             | Entry permitted in the field | Text – Optional |
| <b>Other Feature</b> – This feature is for incidental observations, such as a gear cache or invasive plant location or some other item for which a location is helpful.                   |                                                           |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                     | Entry                        | Type            |
| Comment                                                                                                                                                                                   | Any comments about the other feature point                | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                     | Any additional notes about the other feature point        |                              |                 |
| <b>Route Feature</b> – This feature creates a line, or route, should such a feature be helpful. Generally, use this feature on the way back from the sentinel site or geomorphic feature. |                                                           |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                     | Entry                        | Type            |
| Comment                                                                                                                                                                                   | Any comments about the route feature                      |                              |                 |
| Notes                                                                                                                                                                                     | Any additional notes about the route feature              |                              |                 |

### Canyonlands National Park Big Rivers Data Dictionary

Prior to the field hitch, the following data dictionary, populated with existing data, will be loaded onto several GPS units. The data is primarily to help the field crew locate existing (established) locations, not to collect new locations, as the survey team will do the spatial data collection. If a spatial feature is collected via GPS (such as an invasive point), allow the point to collect 10+ satellites hits, fill in the appropriate attributes, then save the feature.

| <b>BaseLocation Feature</b> – This feature identifies locations where the RTK base stations are located within the sentinel site. |                                                                                                                                                                                 |                              |                 |
|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| Attributes                                                                                                                        | Attribute Explanation                                                                                                                                                           | Entry                        | Type            |
| POINTID                                                                                                                           | Unique ID                                                                                                                                                                       | Entry permitted in the field | Numeric         |
| PT_TYPE                                                                                                                           | <ul style="list-style-type: none"> <li>Control point</li> <li>Occupy point</li> <li>Base setup point</li> <li>Temp base setup</li> <li>Future control</li> <li>Other</li> </ul> | Entry permitted in the field | Menu            |
| SiteName                                                                                                                          | Name of the sentinel site                                                                                                                                                       | Entry permitted in the field | Text – Optional |

| Comment                                                                                                                                                                 | Any comments regarding the control point                                                                                                 | Entry permitted in the field | Text – Optional |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| <b>Transducer Feature</b> - This feature locates where transducers were placed, both water and air transducers.                                                         |                                                                                                                                          |                              |                 |
| Attributes                                                                                                                                                              | Attribute Explanation                                                                                                                    | Entry                        | Type            |
| SiteName                                                                                                                                                                | Name of the sentinel site                                                                                                                | Entry permitted in the field | Text – Optional |
| ID                                                                                                                                                                      | Unique identifier of the transducer. Site name, Location (upstream or downstream). Example: “HCUS” is Holeman Canyon, (Water), upstream. | Entry permitted in the field | Text – Optional |
| Transducer                                                                                                                                                              | Transducer type: <ul style="list-style-type: none"> <li>• Air</li> <li>• Water</li> <li>• Other</li> </ul>                               | Entry permitted in the field | Menu            |
| River                                                                                                                                                                   | Side of river: <ul style="list-style-type: none"> <li>• Right</li> <li>• Left</li> <li>• NA</li> </ul>                                   | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                                 | Any comments/notes regarding this transducer                                                                                             | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                   | Any other notes/comments about the transducer                                                                                            | Entry permitted in the field | Text – Optional |
| <b>PhotoLocation Feature</b> - This feature maps the location where repeat photographs are taken.                                                                       |                                                                                                                                          |                              |                 |
| Attributes                                                                                                                                                              | Attribute Explanation                                                                                                                    | Entry                        | Type            |
| PhotoNum                                                                                                                                                                | Photo number by site                                                                                                                     | Entry permitted in the field | Text – Optional |
| Type                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• Overview photo</li> <li>• Transect photo</li> <li>• Feature photo</li> <li>• Other</li> </ul>   | Entry permitted in the field | Text – Optional |
| SiteName                                                                                                                                                                | Name of sentinel site                                                                                                                    | Entry permitted in the field | Text – Optional |
| Comment                                                                                                                                                                 | Comment about photo location point                                                                                                       | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                   | Any comments/notes regarding this photo point                                                                                            | Entry permitted in the field | Text – Optional |
| <b>Other Feature</b> – This feature is for incidental observations, such as a gear cache or invasive plant location or some other item for which a location is helpful. |                                                                                                                                          |                              |                 |
| Attributes                                                                                                                                                              | Attribute Explanation                                                                                                                    | Entry                        | Type            |
| Comment                                                                                                                                                                 | Any comments about the other feature point                                                                                               | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                   | Any additional notes about the other feature point                                                                                       | Entry permitted in the field | Text – Optional |
| <b>Invasive Feature</b> – This feature is to note any populations of invasive (trees) noted along the river.                                                            |                                                                                                                                          |                              |                 |
| Attributes                                                                                                                                                              | Attribute Explanation                                                                                                                    | Entry                        | Type            |
| Species                                                                                                                                                                 | <ul style="list-style-type: none"> <li>• Russian olive</li> <li>• Elm</li> <li>• Catalpa</li> <li>• Tree of heaven</li> </ul>            | Entry permitted in the field | Text – Optional |

|                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>Other</li> </ul> |                              |                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------|-----------------|
| Notes                                                                                                                                                                                     | Any comments/notes regarding the invasive point taken.  | Entry permitted in the field | Text – Optional |
| <b>Route Feature</b> – This feature creates a line, or route, should such a feature be helpful. Generally, use this feature on the way back from the sentinel site or geomorphic feature. |                                                         |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                   | Entry                        | Type            |
| Comment                                                                                                                                                                                   | Any comments about the route feature                    | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                     | Any additional notes about the route feature            | Entry permitted in the field | Text – Optional |

### Dinosaur National Monument Big Rivers Data Dictionary

Before each field hitch, the following data dictionary, populated with existing data, will be loaded onto several GPS units. The data is primarily to help the field crew locate existing (established) locations, not to collect new locations, as the survey team will do the spatial data collection. If a spatial feature is collected via GPS (such as a photo point), allow the point to collect 10+ satellites hits, fill in the appropriate attributes, then save the feature.

| <b>ControlPt Feature</b> – This feature identifies locations where the tripod or RTK base are located within the sentinel site. |                                                                                                                                                                          |                              |                 |
|---------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| Attributes                                                                                                                      | Attribute Explanation                                                                                                                                                    | Entry                        | Type            |
| POINTID                                                                                                                         | Unique ID                                                                                                                                                                | Entry permitted in the field | Text – Optional |
| PT_TYPE                                                                                                                         | <ul style="list-style-type: none"> <li>Control point</li> <li>Occupy point</li> <li>Base setup point</li> <li>Temp base setup</li> <li>O'Brien</li> <li>Other</li> </ul> | Entry permitted in the field | Menu            |
| Site                                                                                                                            | Name of the sentinel site                                                                                                                                                | Entry permitted in the field | Text – Optional |
| Comment                                                                                                                         | Any comments regarding the control point from years past.                                                                                                                | Entry permitted in the field | Text – Optional |
| NewNotes                                                                                                                        | Any comments/notes noted during this field visit                                                                                                                         | Entry permitted in the field | Text – Optional |
| <b>Transducer Feature</b> - This feature locates where transducers were placed, both water and air transducers.                 |                                                                                                                                                                          |                              |                 |
| Attributes                                                                                                                      | Attribute Explanation                                                                                                                                                    | Entry                        | Type            |
| SiteName                                                                                                                        | Name of the sentinel site                                                                                                                                                | Entry permitted in the field | Text – Optional |
| ID                                                                                                                              | Unique identifier of the transducer. Site name, Location (upstream or downstream), # if applicable. Example: "IPUS1" is Island Park, (Water), upstream, #1.              | Entry permitted in the field | Text – Optional |
| Transducer                                                                                                                      | Transducer type: <ul style="list-style-type: none"> <li>Water</li> <li>Air</li> <li>Other</li> </ul>                                                                     | Entry permitted in the field | Text – Optional |

| River                                                                                                                                                                                     | Side of river: <ul style="list-style-type: none"> <li>• Right</li> <li>• Left</li> <li>• NA</li> </ul>                                                                                                                                                                                                          | Entry permitted in the field | Menu            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| Comment                                                                                                                                                                                   | Any comments/notes regarding this transducer                                                                                                                                                                                                                                                                    | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                     | Any other notes/comments about the transducer                                                                                                                                                                                                                                                                   | Entry permitted in the field | Text – Optional |
| <b>PhotoPt Feature</b> - This feature maps the location where repeat sentinel site overview photographs are taken.                                                                        |                                                                                                                                                                                                                                                                                                                 |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                                                                                                                                                                                                                                                                           | Entry                        | Type            |
| SentinelSi                                                                                                                                                                                | Sentinel site name: <ul style="list-style-type: none"> <li>• Deerlodge</li> <li>• Laddie Park</li> <li>• Browns Park</li> <li>• Seacliff</li> <li>• Winnies</li> <li>• Other</li> <li>• Harding Hole</li> <li>• Echo Park</li> <li>• Limestone</li> <li>• Island Park</li> <li>• New (name in Notes)</li> </ul> | Entry permitted in the field | Menu            |
| PhotoNum                                                                                                                                                                                  | Photo number by site                                                                                                                                                                                                                                                                                            | Entry permitted in the field | Text – Optional |
| Comment                                                                                                                                                                                   | Comment about photo location point                                                                                                                                                                                                                                                                              | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                     | Any comments/notes regarding this photo point                                                                                                                                                                                                                                                                   | Entry permitted in the field | Text – Optional |
| <b>PhotoSynth Feature</b> – This feature contains the location where photo synth photos were/are taken.                                                                                   |                                                                                                                                                                                                                                                                                                                 |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                                                                                                                                                                                                                                                                           | Entry                        | Type            |
| SentSite                                                                                                                                                                                  | Sentinel site name: <ul style="list-style-type: none"> <li>• Deerlodge</li> <li>• Laddie Park</li> <li>• Browns Park</li> <li>• Seacliff</li> <li>• Winnies</li> <li>• Other</li> <li>• Harding Hole</li> <li>• Echo Park</li> <li>• Limestone</li> <li>• Island Park</li> <li>• New (name in Notes)</li> </ul> | Entry permitted in the field | Menu            |
| Code                                                                                                                                                                                      | Identifier of Photosynth location                                                                                                                                                                                                                                                                               | Entry permitted in the field | Text – Optional |
| Year                                                                                                                                                                                      | The year the point was established                                                                                                                                                                                                                                                                              | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                     | Any additional notes about the photosynth feature point                                                                                                                                                                                                                                                         | Entry permitted in the field | Text – Optional |
| <b>Route Feature</b> – This feature creates a line, or route, should such a feature be helpful. Generally, use this feature on the way back from the sentinel site or geomorphic feature. |                                                                                                                                                                                                                                                                                                                 |                              |                 |
| Attributes                                                                                                                                                                                | Attribute Explanation                                                                                                                                                                                                                                                                                           | Entry                        | Type            |
| Comment                                                                                                                                                                                   | Any comments about the route feature                                                                                                                                                                                                                                                                            | Entry permitted in the field | Text – Optional |

## 1.4 Collecting data

Once you've arrived to the sentinel site, it's time to collect the GPS locations necessary. Appendix A contains detailed instructions for use with the big river data dictionary and various

files. Open the necessary file, and begin logging the point and any required data. Each point collected should be allowed to receive 10 positions before ending data collection and moving onto collecting another type of point.

### 1.5 Downloading

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

**Table 2.** GPS Auto-generated attributes to capture.

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

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

### 1.6 Uploading to the master Big River Database

Generally any collected GPS data will serve as a placeholder until the location can be obtained from survey data. When a GPS location, such as a photo point, is to be placed in the Big Rivers database, it first needs to be validated and verified (GPS points given a visual review and attributes verified) in ArcGIS. The GPS data is then exported from ArcMap into an Excel spreadsheet for importing into the Big Rivers Database.

## Appendix A

### File explanations:

Existing Data Files on GPSes:

- *1PARK\_BigRiver* – This file will contain all the surveyed features for each feature in the park. There will be two files, *1PARK\_BigRiver* and *2PARK\_BigRiver* in case one file times out while in the field. The two files are identical.

Background Layers (Files):

- *PARK\_Roads* – This file contains the roads for the park.
- *PARK\_Trails* – This file contains the trails for the park.
- *PARK\_bnd* – This file contains the park boundary.
- *PARK\_Drainages* – This file contains the “streams” (hydrography) for the park.
- 

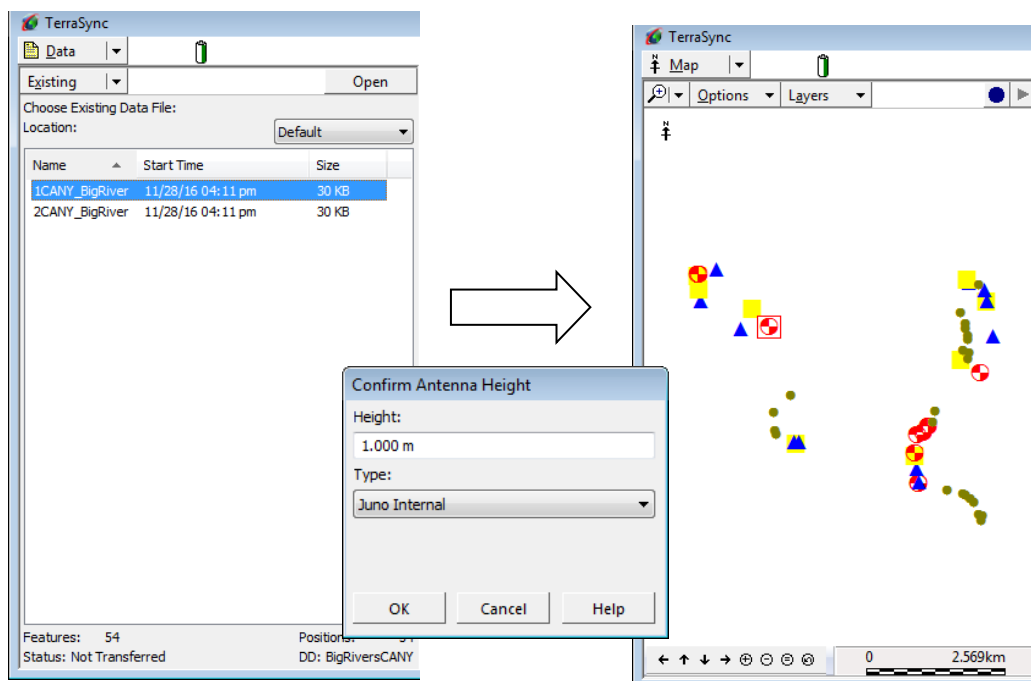
### Basic instructions:

The following instructions are based on using a Trimble GPS unit with TerraSync Professional GPS software loaded. The directions below demonstrate one way of recording and navigating through the screens and options in TerraSync, not the only way to GPS data needed for monitoring points. Big River monitoring does not require much, if any, collecting of new GPS data, rather, the data provided in the files is primarily there to assist the field crew in finding general location of features.

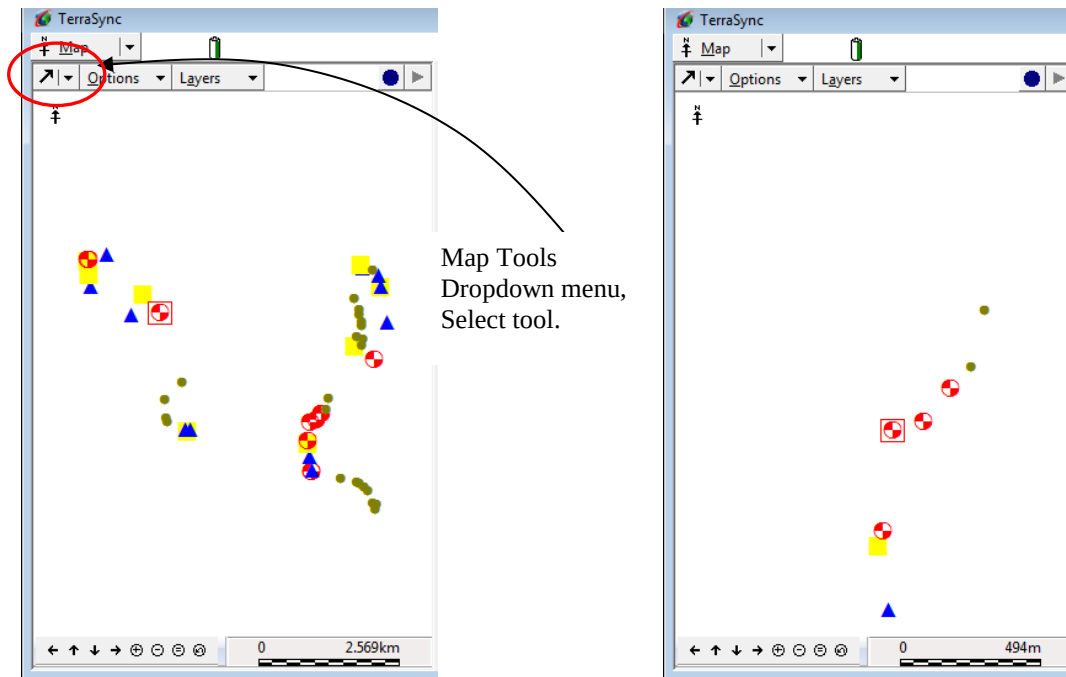


### Navigation:

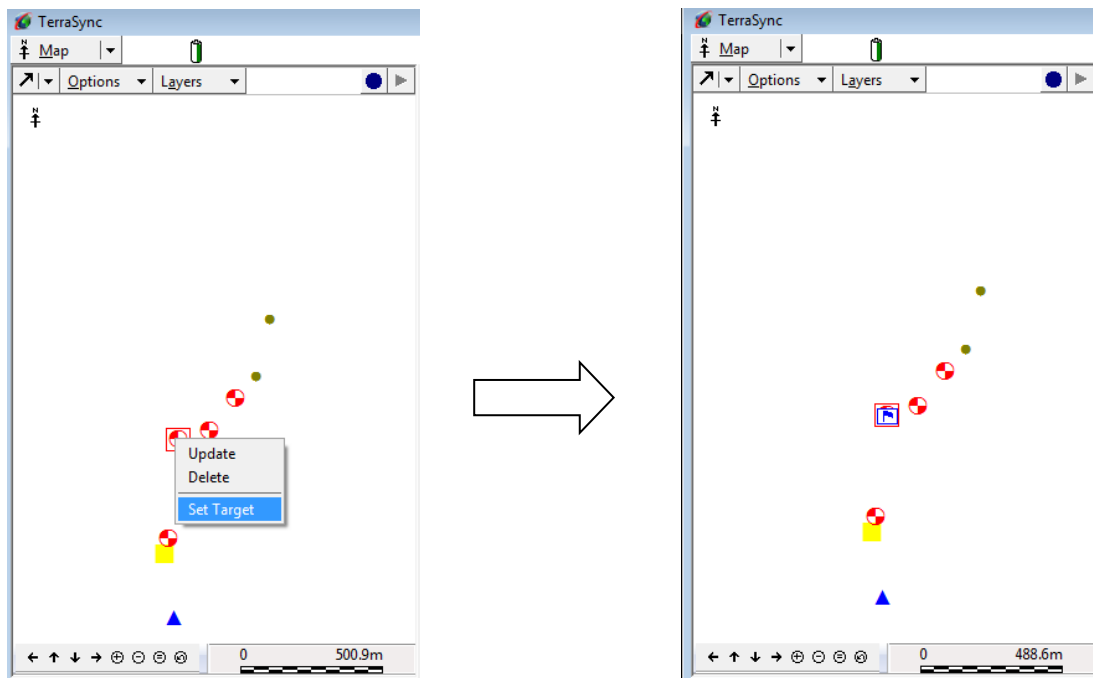
To navigate to a point, open the file which contains the point you want to update. Change the screen to the Map View (tap on the Data drop down, and choose Map).



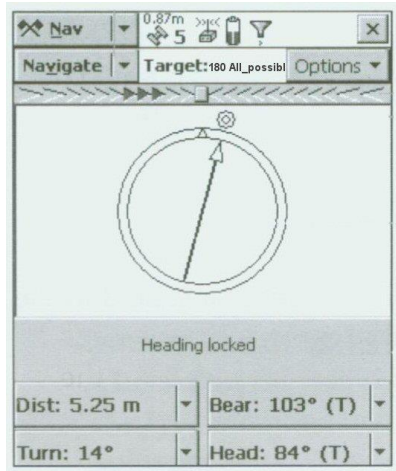
Using the Map Tools (the drop down menu directly underneath Map), use the Select tool to select the point to which you wish to navigate. A box will display around the point.



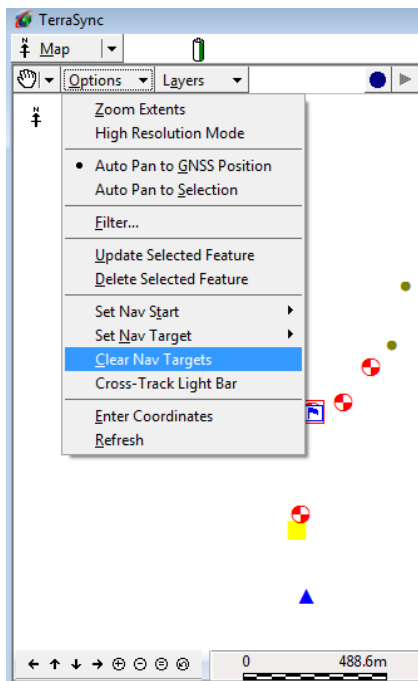
Tap and hold on the point to which you would like to navigate, and a popup menu will popup, choose Set Target. A navigation symbol will appear over your point.



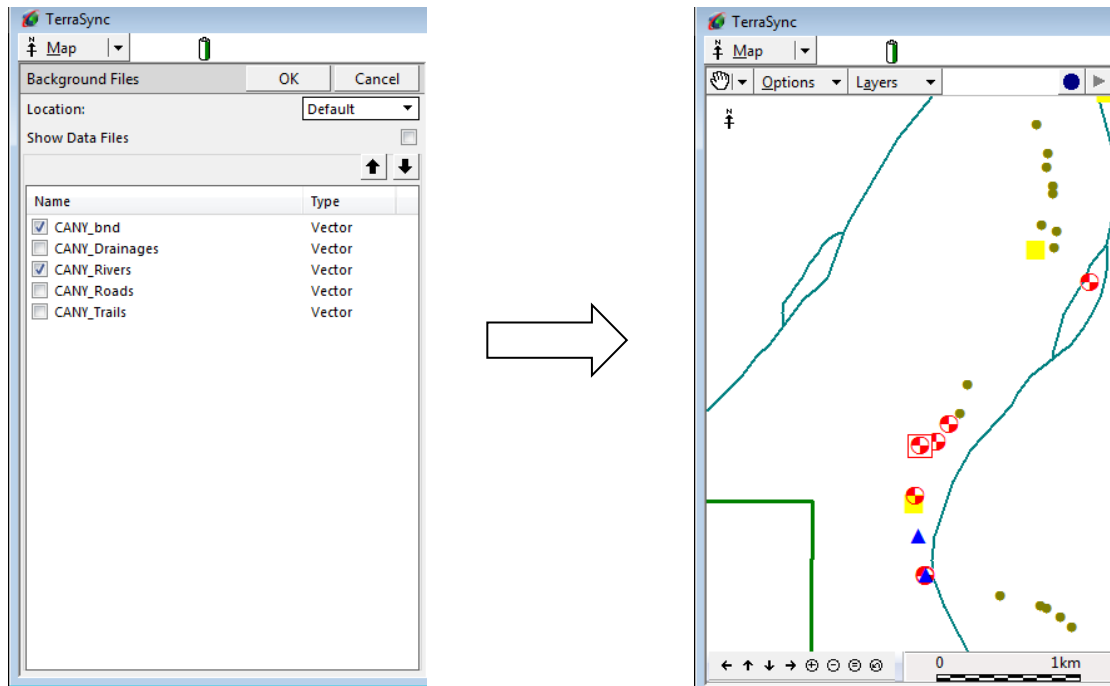
Open the Navigation section (click on Map and choose Navigation). This will open the navigation screen. As you move, this screen will display the information needed to navigate to the point.



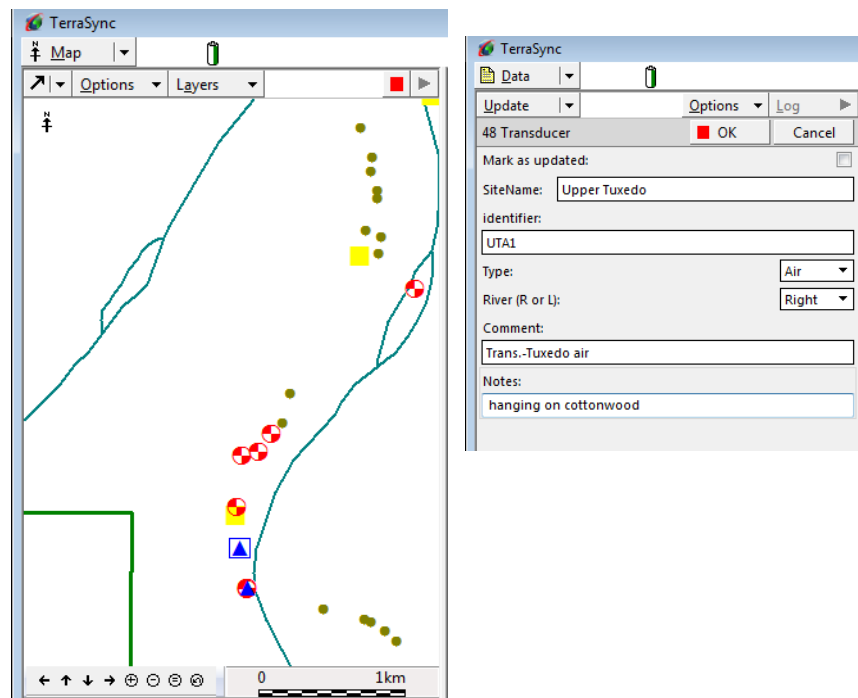
When you've reached your point and/or no longer need to navigate, select the Map screen, then go to Options and select Clear Nav Targets.



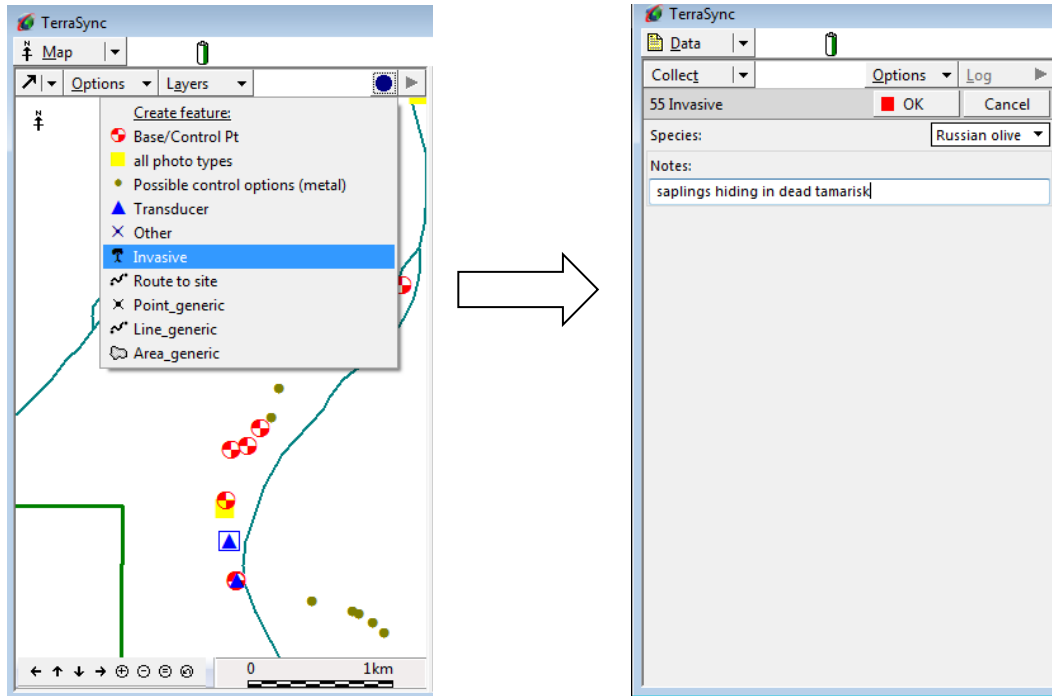
To bring in some background layers, tap the Layers button, then choose Background Files. You can select one or more to display on the Map view (be aware all background files will display as one color). Tap OK.



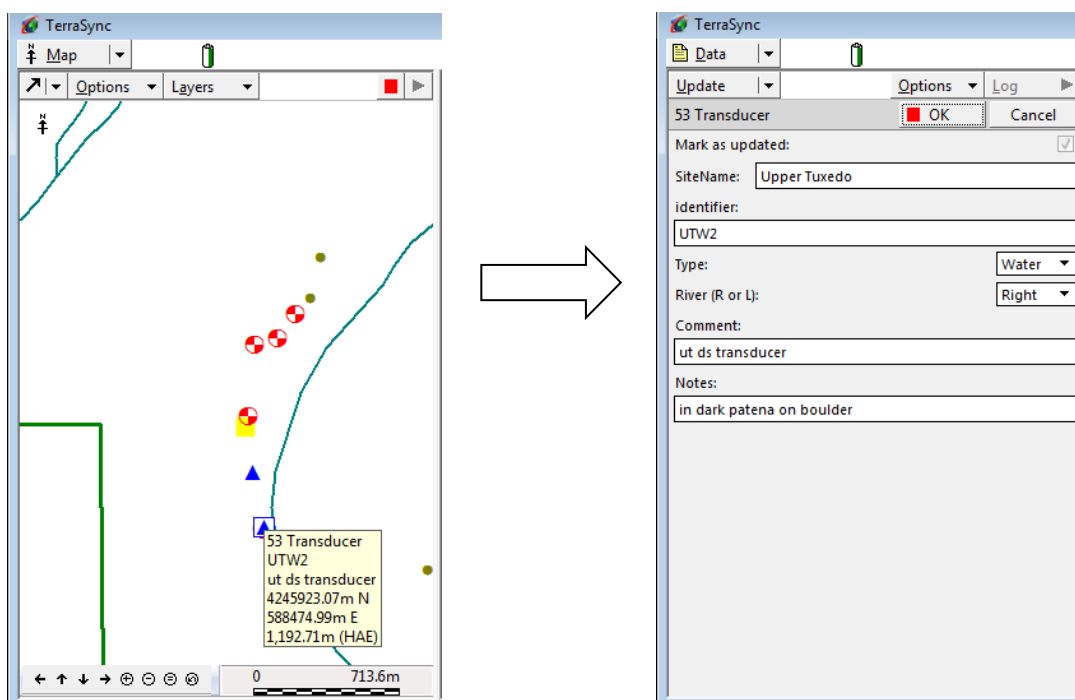
To GPS (locationally update) any of the points within the open TerraSync file, merely double tap the point from the map screen, and the data dictionary fields for the point will open (Transducer displayed). Add any attributes necessary, add just let the GPS unit obtain 10 or so “hits” from the satellites, and tap OK.



If you need GPS a new point, the data dictionary can be accessed using the little blue dot in the upper right of the map screen. Merely tap it, and choose the feature type you'd like to GPS, fill in any attribute information, let the unit collect 10 satellite "hits", and save and close the feature.

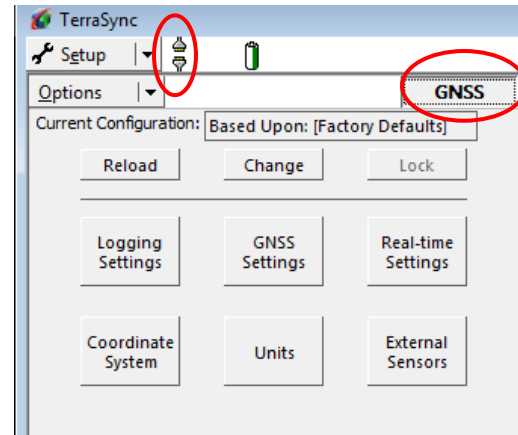


You can select (tap) a feature from the Map Screen and limited data will display in the Identity box. However, you can display more data about each feature by double-tapping to access the data dictionary attributes in their entirety. If necessary, you may update both the location and attributes.



### Hints for Trimble units:

- Log a point for a minimum of 10 (to 20) “hits” (about 10 seconds).
- To re-boot the Junos, there is a little hole on the bottom left side (nestled in with the various buttons). Push that with the tip of the stylus to re-boot the Juno.
- To conserve on battery life (generally 8 hours on XMs and 4+ hours on Junos), turn the unit off if you aren’t using it to navigate. It is recommended that TerraSync be closed *prior* to turning off the unit.
- While carrying extra batteries in the soft GPS cases, face the GPS unit screen to the opposite of the battery to prevent cracked screens.
- If the GPS gets disconnected, go to the Setup screen and tap the GNSS button on the upper right side. A little connecting icon will appear as the unit reconnects to the GPS. A satellite icon will replace the connecting icon when TerraSync is reconnected to the GPS.



- The NCPN has a copy of the TerraSync Users Guide, which goes into more detail about the many functions of TerraSync. Please contact the GIS technician if you would like to take a look at it.
- Report any idiosyncrasies with the Trimble GPSes to the NCPN data management staff.

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

### Standard Operating Procedure (SOP) # 4

#### Sentinel Site Set Up – BLCA, CANY, and DINO

#### Version 3.0 (January 2016)

##### Revision History Log:

| Previous Version # | Revision Date | Author     | Changes Made                                                                                                | Reason for Change                            | New Version # |
|--------------------|---------------|------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------|
| Varied             | 01/16         | D. Perkins | SOPs from DINO, BLCA, CURE, and CANY were combined. See SOPs from each park from 2015 for previous changes. | Combine into one SOP for easier organization | 3.0           |
|                    |               |            |                                                                                                             |                                              |               |
|                    |               |            |                                                                                                             |                                              |               |
|                    |               |            |                                                                                                             |                                              |               |
|                    |               |            |                                                                                                             |                                              |               |

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.

# **I - BLACK CANYON OF THE GUNNISON NP**

## **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) (Figure 1). Three to four one-bank stub transects are placed on each feature for vegetation sampling purposes (Figure 2). 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.

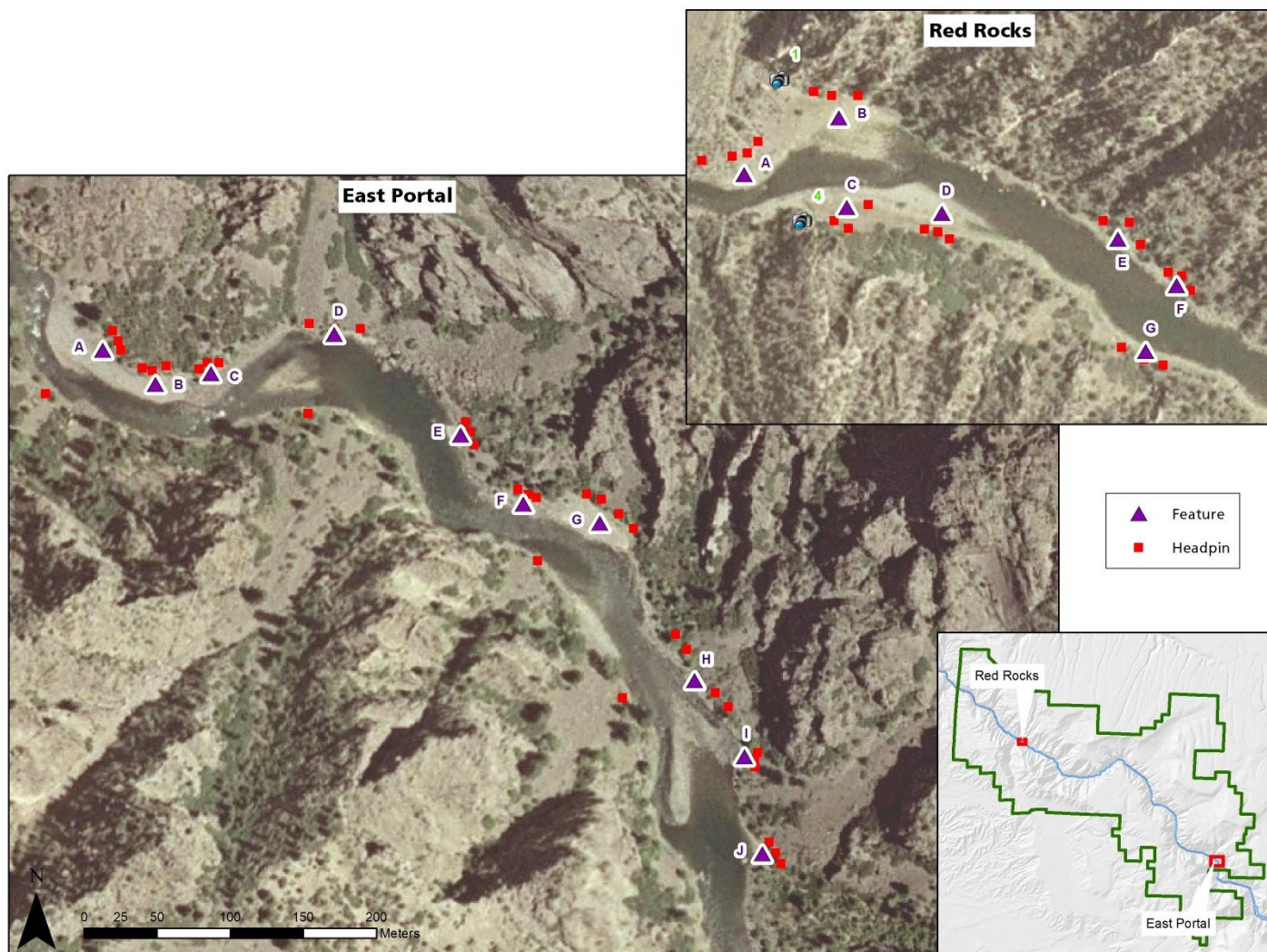


**Figure 1.** Location of sentinel monitoring sites at Black Canyon of the Gunnison National Park. Flow is from right to left of the figure.

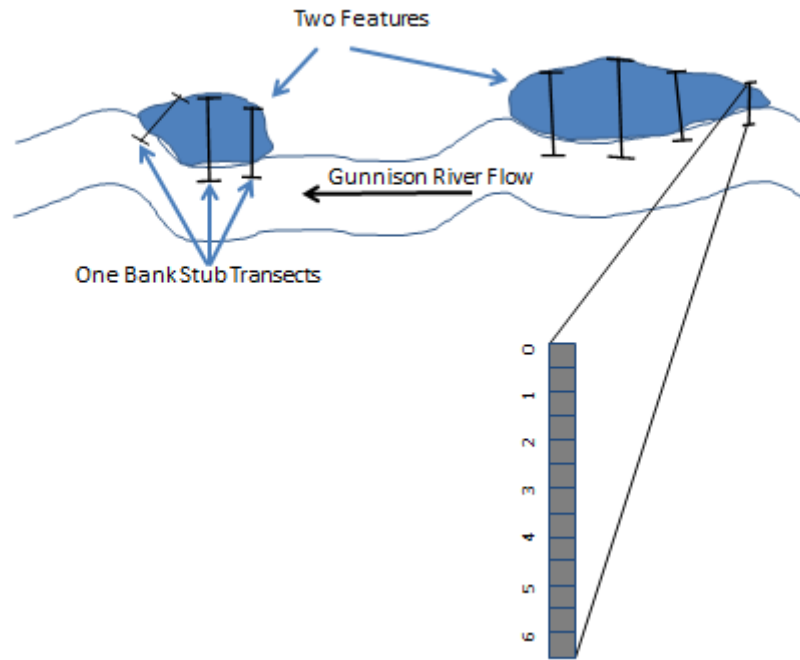


Figure 2. Two features and associated one bank stub transects with plot layout along continuous belt transect.

- 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.

### **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).
  - 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.

## II - CANYONLANDS NP

### 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 3). Future sites will be established in a similar manner.

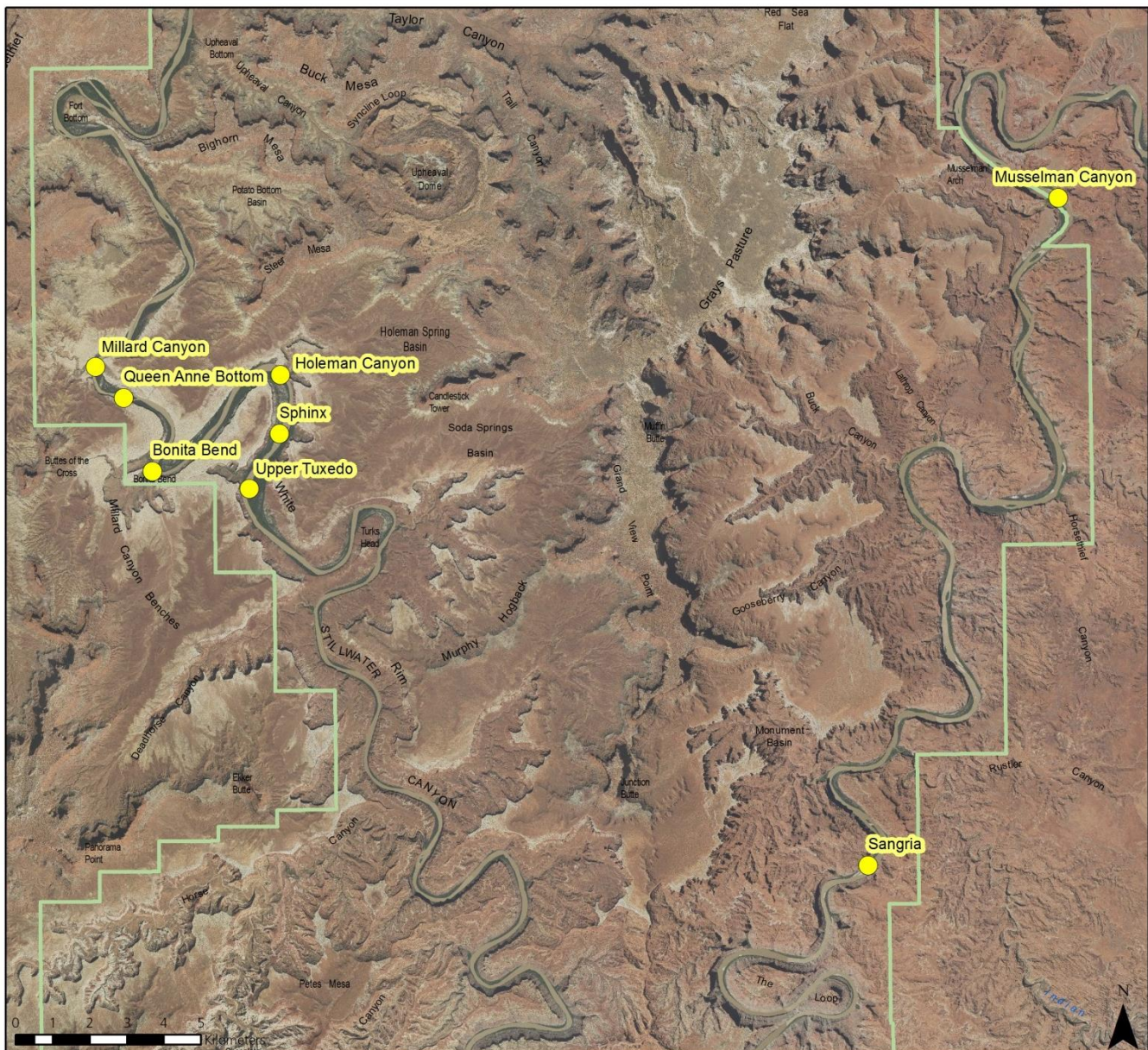


**Figure 3.** Location of sentinel monitoring sites in Canyonlands National Park. Flow is from top to bottom of the figure.

## 1.2 General Transect Information and Establishment

Three to twelve 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 and plots have been established. 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 movement of the active floodplain, water level, and safety while wading.
- G. Plots are permanent and are placed every 3 m along each transect. The surveyor will establish the plots to be recorded. The surveyor will extend plots to a safe wading distance (waist deep in slow water, less deep in faster water) and will extend the plots to at least 2 plots in the active flood plain. At CANY the AF boundary is generally noted by a change to dense (>75%) vegetation, often dominated by *Salix*, and fine sediment.
- 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

## 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 4). 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.

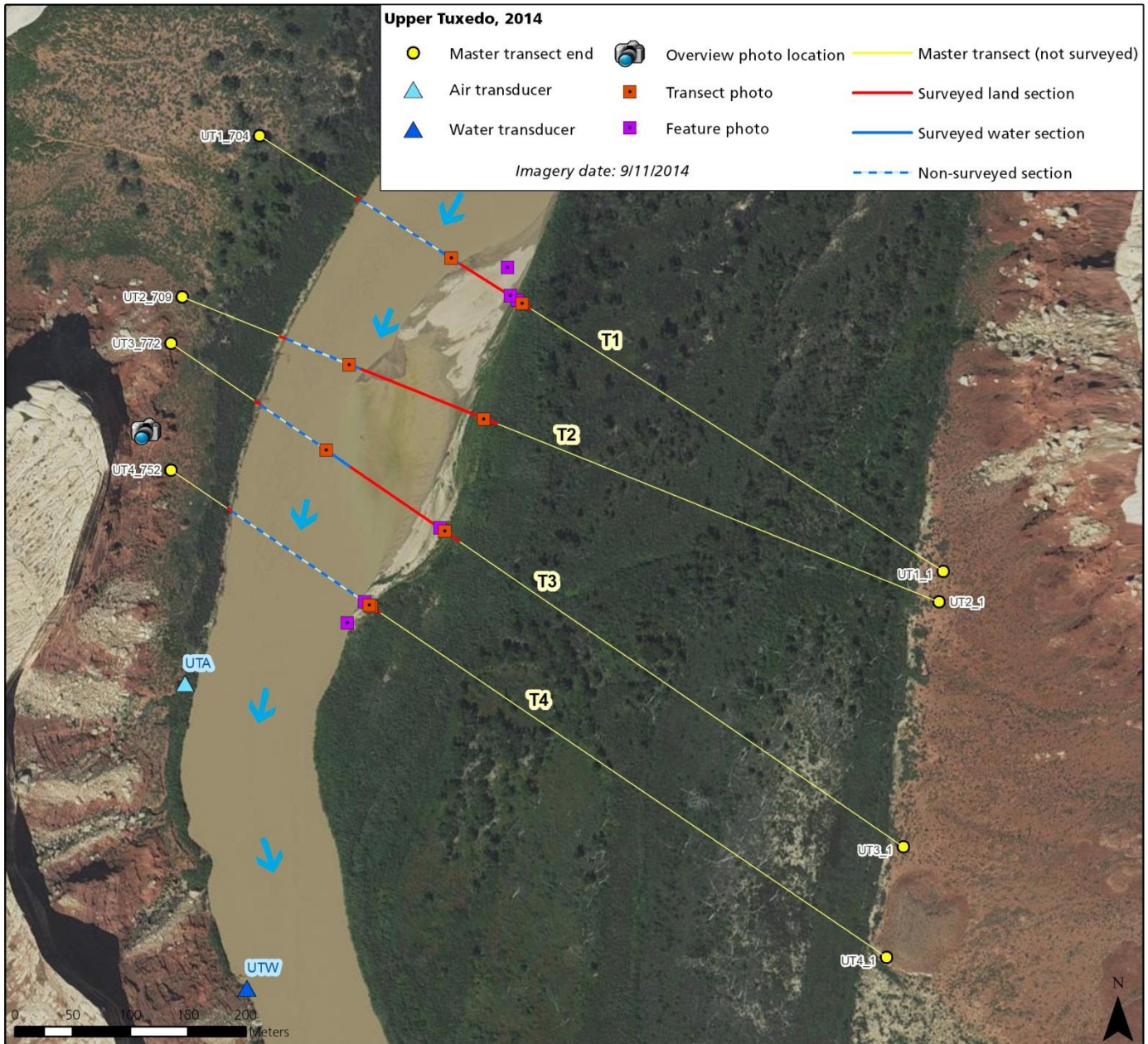


**Figure 4.** Transect layout at Upper Tuxedo site. Flow is from the top of the page to the bottom. This is an attached bar feature. Note that all transects are continuous transects that go from the inactive flood plain out to a safe wadeable distance in the river channel. The transect was also surveyed at the edge on the river right side by extending the transect with an RTK to note any future bank trimming or aggradation, no photos or vegetation work was done on this far river right side.

#### 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 5).

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 5).

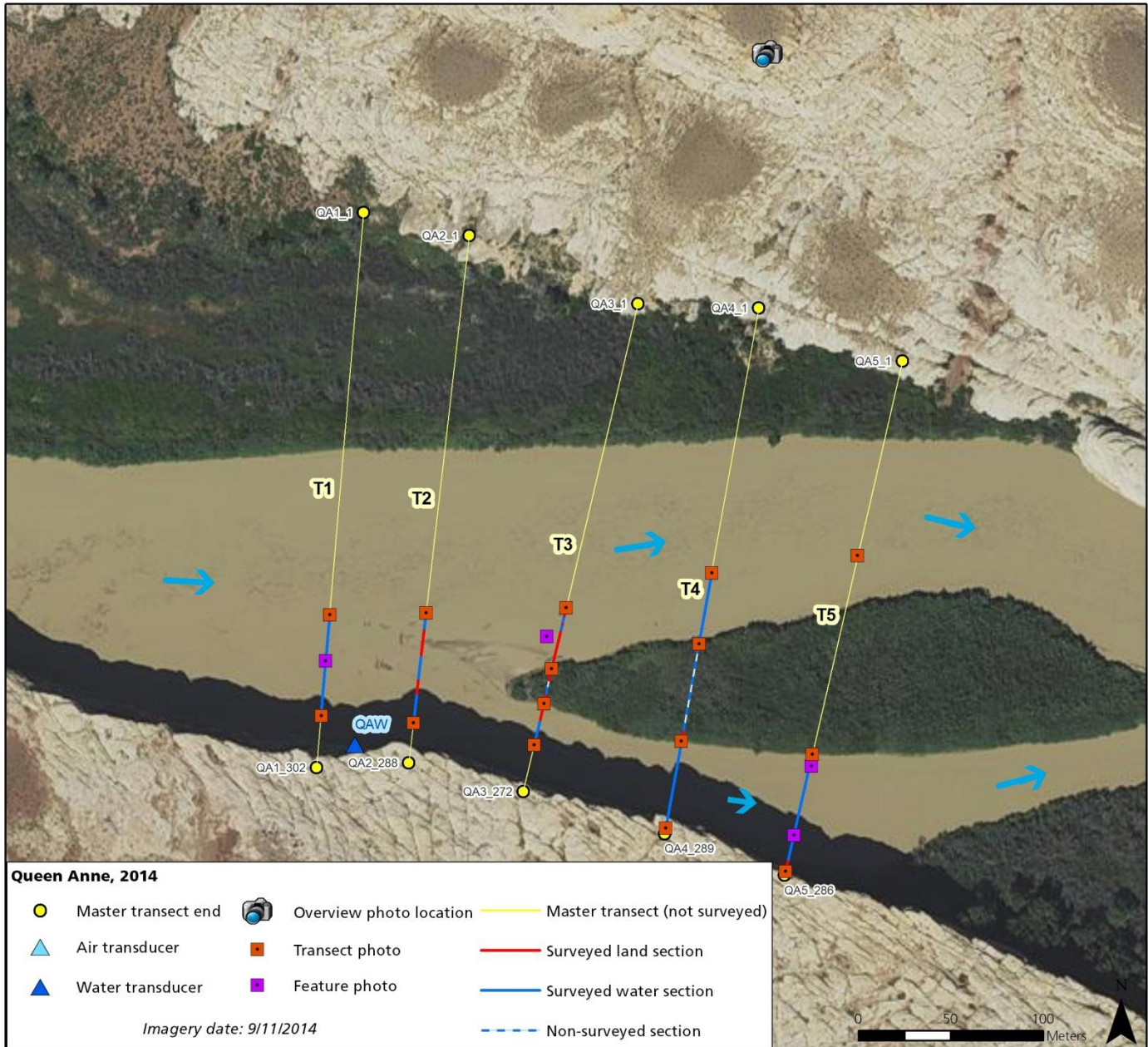


**Figure 5.** Transect layout at Queen Anne site. Flow is from the left to right. This is an island feature. Blue denotes that the transect was in the water, while red notes that the transect was on land. Note that three upstream most transects extend from a safe wadeable spot in the back channel to 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.

## III – DINOSAUR NM

### 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 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 (Figure 6).

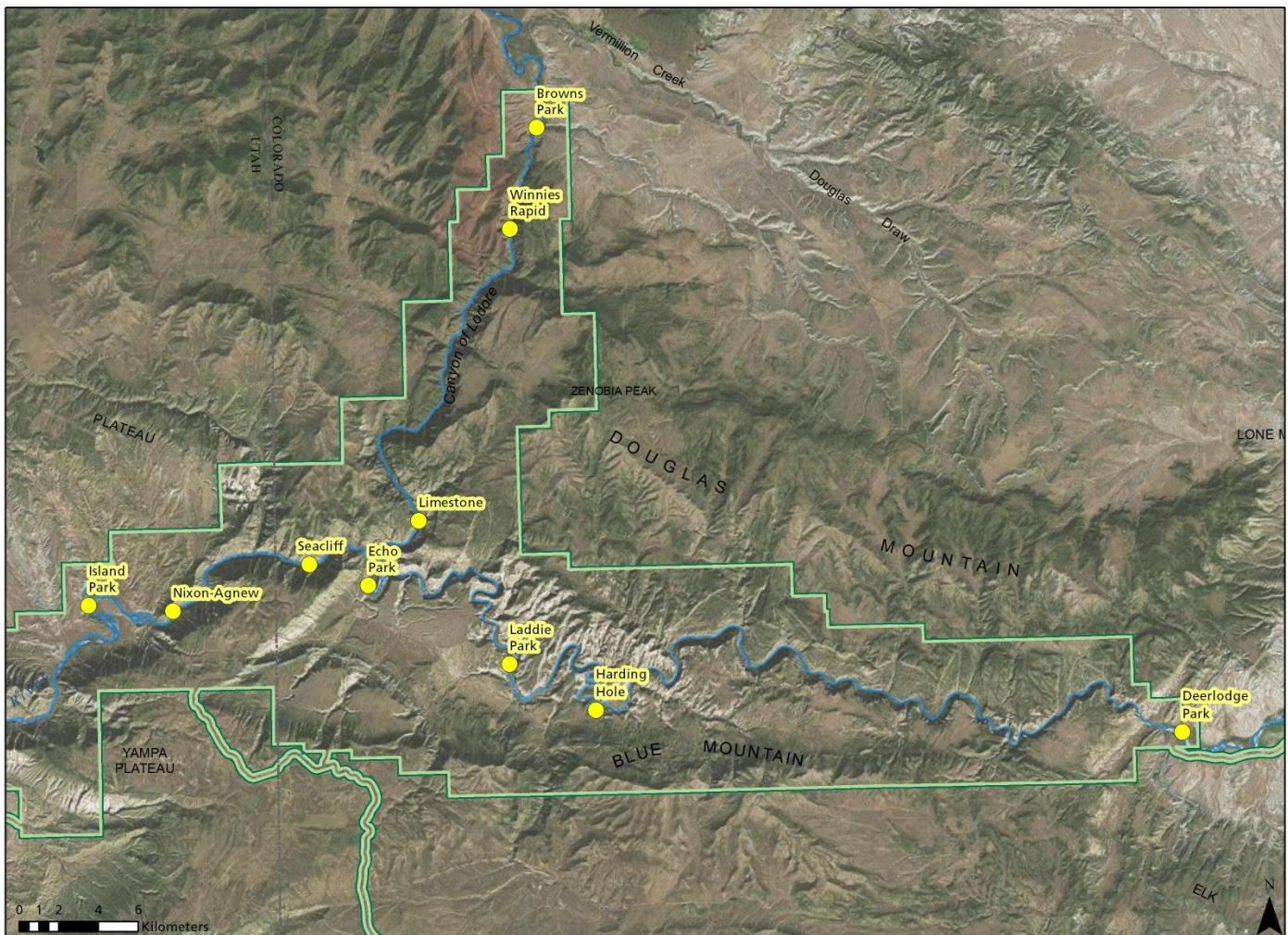


**Figure 6.** Location of sentinel monitoring sites at Dinosaur National Monument. Flow is from right to left of the figure.

#### 1.1 Establishing Survey Control

Beginning in 2015 on the Green River and 2016 on the Yampa River, there are now a permanent set of “master” plots based on the 2011 plots plus the “extension” of plots that was possible in 2012 due to lower water levels. The extension using the 2012 plots was done by looking at the spatial extent that was completed in 2012, but placing the extent in line with the 2011 transects. If a site was not done in 2011, 2012-13 was used as the master set of plots, whichever was earlier. Prior to 2015 on the Green and 2016 on the Yampa, there are no permanent vegetation (or “veg”) plots or transects. There are permanent control plots at all sites.

- A. Establish at least three control points that are permanent and elevationally stable. 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. The goal is to place 50-100 vegetation randomly placed at each site. Pace (in meters) the sentinel site along the length of the approximate center of sentinel site.
- B. There should be 7-10 transects per sentinel site depending on the size. Determine how many evenly-spaced transects would be necessary with an average number of plots per transect to achieve 50-100 plots (Figure 1). Also, determine the transect spacing necessary.
- D. The transect originates in the IF or 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.
- E. Use a random number table for pacing steps to determine the locations of the veg plots. 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.
- F. Label a pin flag in the center of the plot with a unique plot number in sequential order, starting upstream and closest to the water’s edge.

- G. 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 plots 1-13, transect 2 has plots 13-25, etc.

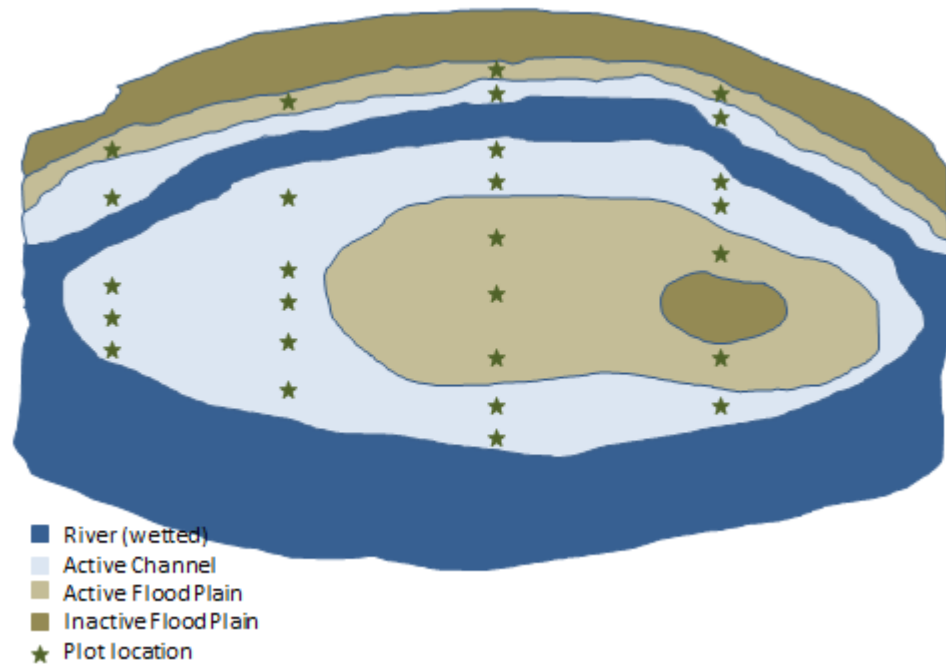


**Figure 3.** One sentinel site feature with the riverine zones and plot locations (actual sentinel site would have more plots).

## 2. Revisiting a Sentinel Site

- A. 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.
- B. The master set of plots will be pre-loaded on to the RTK survey gear for each site.
- C. A surveyor and an assistant will use the RTK equipment to re-locate each plot.
- D. Upon locating a plot, the center of the plot will be marked with a temporary pin flag and plot number.
- E. For plots that are completely submerged, the surveyor will tell the assistant that the plot is completely submerged and will note the modal particle size (see SOP 6 for details).
- F. Based on geomorphic and vegetative characteristics, the surveyor will also note whether the geomorphic surface of the plot (active channel [AC], active floodplain [AF], inactive floodplain [IF], uplands [UP]) has

changed from the previous designation. The surveyor can also note a transitional plot, for example AC/AF. If there is no one qualified to make this designation on a trip, it is acceptable to skip this step.

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

### **Standard Operating Procedure (SOP) #5**

#### **Photos for Black Canyon of the Gunnison NP, Canyonlands NP, and Dinosaur NM**

#### **Version 3.00 (December 2015)**

##### **Revision History Log:**

| Prev. Version # | Revision Date | Author     | Changes Made                                                                                  | Reason for Change        | New Version # |
|-----------------|---------------|------------|-----------------------------------------------------------------------------------------------|--------------------------|---------------|
| 1.00            | 12/17/15      | D. Perkins | Minor wordsmithing and renumbering. SOPs for BLCA, CANY, and DINO were combined into one SOP. | Clarity, new SOP numbers | 3.00          |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |
|                 |               |            |                                                                                               |                          |               |

This SOP provides instructions for taking photos at sentinel sites. 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. Photos can be one of the most effective methods of showing long-term change at a site. This SOP covers BLCA, CANY, and DINO from the start of monitoring in 2011 to present.

# I - BLACK CANYON OF THE GUNNISON NP

One photo data sheet (Appendix 1) can be filled out for all photo types. Fill out the top portion of the data sheet:

**Site ID:** Circle RR (Red Rocks) or EP (East Portal).

**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.

## 1.1 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 (Figure 1).

- 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⇒RL would mean the photographer is looking from RR to RL,  
US⇒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.
- F. Take a photo and record the photo information on the Photo data sheet:
  - 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 (right head pin) (0 m), A1 at 25m

**Subject location** – Record what the photo was centered on, i.e. A1RHP (right head pin), G1LP (left pin)

**Photographer** – use first name initial and full last name

**Photo #** - see directions below

**Close-Up and Replacement Boxes** - not recorded for transect photos

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**Comment** – Record any comments unique to that photo

### Recording the Digital File Name

- 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.
- The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
- 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.

## 1.2 Feature Photos

These photos are to monitor the overall geomorphic feature (Figure 2).

- 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.
- 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.
- 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 (Figure 2). Orient the camera so that it takes a horizontal (landscape) format photo.
- 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

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**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.

## **1.3 Overview Photos**

These photos are taken from above the feature Figure 3.

1. Initial Visit - The observer selects points where multiple features can be seen from one picture.
2. Take photo and GPS photo location, this is the photopoint. More than one overview photo can be taken from a single photopoint.
3. Take reference photos (see section 4.4 below) of the photopoint where the photographer was located.
4. Repeat visits. Print out the overall feature photos as well as the reference photos that showed the photopoints. Use the GPS and reference photos to get to the location.
5. Use the previous year’s photo to center the photo on the same place. When possible the same time of day is desired.

6. 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 overview number, followed by the feature(s) that the photo captures (i.e., O3-A, O3-B, O4-B, O5-BCD)

**Photographer** – use first name initial and full last name

**Photo #** - see directions below

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

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**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.

**1.4 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 (Figure 4). Include the cliff line, surrounding perennial vegetation, and/or other recognizable landmarks in the background to help the returning field crew relocate these points.

1. 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.
2. Place the chalkboard in a location where it will be easy to read in the photo.

3. 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.).
4. Take a photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one.
5. 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

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**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 1. Example transect photo taken from the transect end in the water looking towards the upland end of the transect.



Figure 2. 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.



Figure 3. Example overview photo taken from a location above the sentinel site.



Figure 4. Example reference photo of a headpin.

### **1.5 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.

## II - CANYONLANDS NP

One photo data sheet (Appendix 1) 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).

**River:** Use Green, CAC (Colorado Above Confluence), or CBC (Colorado Below Confluence)

**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.

### 1.1 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 (Figures 5, 6). 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 8 & 9).
  - 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:

- The previous transect photo location will be marked with a flag by the surveyor. 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 possible that the river pin will not be at the same location due to erosion or accretion of sediment and differing water levels, but the observer should still take the picture at the same x, y, location.

- 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. The surveyor will have pre-labeled flags, using the following naming convention T2-1, T3-1, where the number after the T corresponds to the transect where the photo is taken. Numbers generally go from lowest on river left to highest on river right.

**Subject Location** – Leave blank for transect photos.

**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

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**Comment** - Any useful comments

**Recording the Digital File Name**

- d. 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.
- e. The last 4 digits of the number displayed on the camera (those following the dash) represent a unique photo number.
- f. 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 5.** 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.

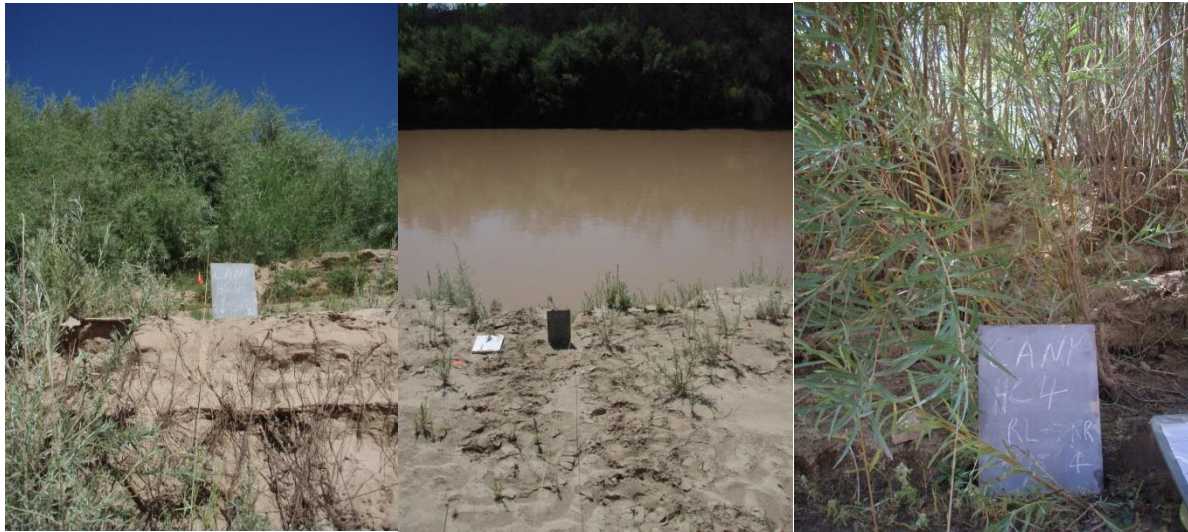


**Figure 6.** Transect 4 at Holeman Canyon required three photos to document the transect as the transect went through a dense willow island. Pictures were taken at the 100 m (RP start of transect) mark facing river left, 108 m mark (middle of transect at dense willow vegetation) facing river right, 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 7, 8). 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 8).
  - 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. The surveyor will have pre-labeled flags, using the following naming convention F2-1, F3-1.
  - Subject Location** – Leave blank for feature photos.
  - 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
  - Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field
  - Comment** - Any useful comments

**For Feature Photo Revisits:**

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

- The previous transect photo location will be marked with a flag by the surveyor. 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 7.** 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 8.** 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 9). Overview photos are taken every year.

#### For Establishment:

7. 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 are the location. Multiple overview photos can be taken from one photopoint.
8. Do not use a chalkboard for these photos.
9. 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).
10. 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, PP1, PP2, etc. 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, O1, O2, O3.

**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

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**Comment** - Any useful comments

11. GPS the photo point location.
12. 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 9. 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 10).

- 6. 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.

**Date:** mm/dd/yyyy, e.g., 08/22/2014

- 7. 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).
- 8. 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.).
- 9. 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.

10. Take a close-up photo of the item, including any perennial vegetation nearby or distinctive rocks.
11. Take any intermediate distance photos or photos from another direction – i.e. upstream and downstream locations.
12. 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. These will not be any set location, but would be in reference to the subject of the photo, i.e located 10 m upstream of Upper Tuxedo water transducer.

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

**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

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**Comment** - Any useful comments



Figure 10. 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 photon point 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.

### III - DINOSAUR NM

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 (Appendix 1). 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.

### 1. 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.

### 2. 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.

### 3. 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)

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**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.

1. 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.
2. Place the chalkboard in a location where it will be easy to read in the photo.
3. 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.).
4. Take a photo and check the quality. If the photo is blurry or otherwise not acceptable, delete it and take another one.
5. 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.

**Skipped Box** – Check if photo deliberately not taken and enter a reason for skipping photo in the comment field

**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](http://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 photosynthlocation, 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 11).

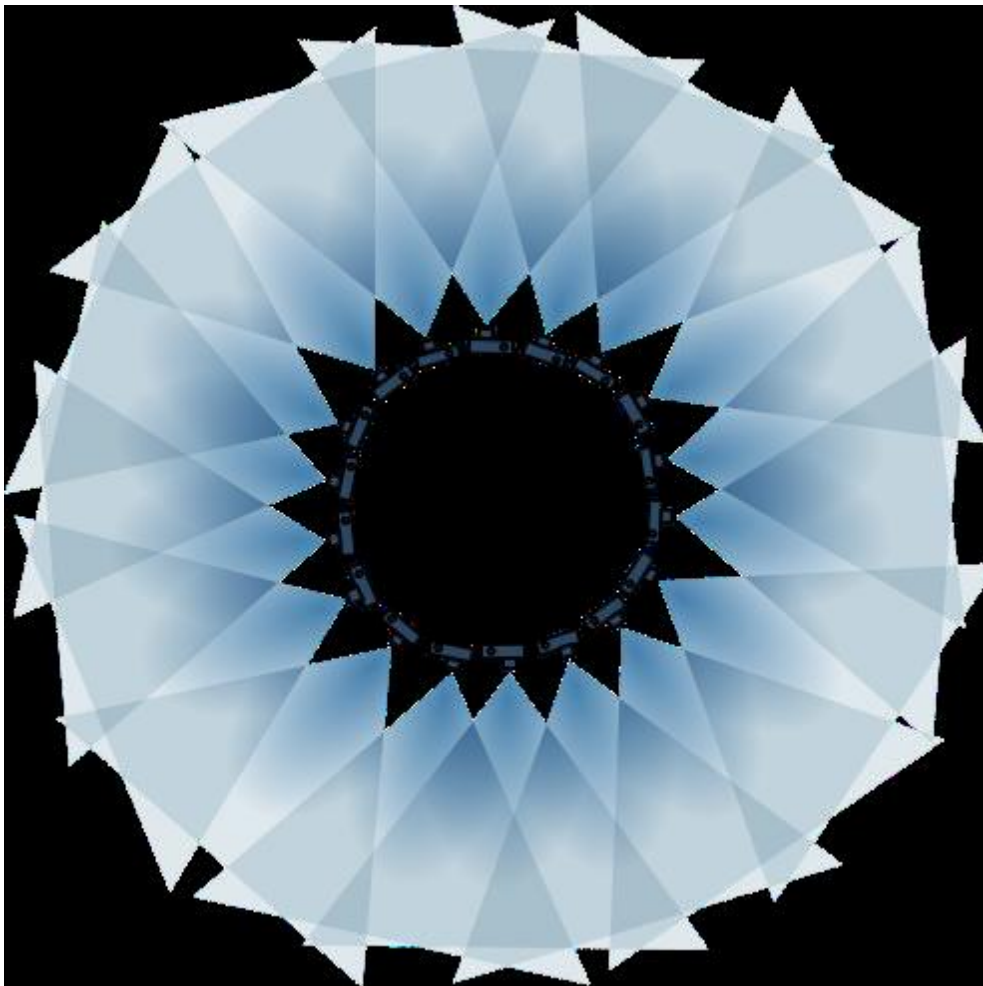


**Figure 11.** Pictures taken from the center of the feature.

## Appendix 1. Data Sheets

### BLCA Photos

Photos downloaded by: \_\_\_\_\_  
Date downloaded: \_\_\_\_/\_\_\_\_/\_\_\_\_

Data entered by: \_\_\_\_\_  
Date entered: \_\_\_\_/\_\_\_\_/\_\_\_\_

Data verified by: \_\_\_\_\_  
Date verified: \_\_\_\_/\_\_\_\_/\_\_\_\_

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#5 – Version 3.00 – December 2015

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

| LOCATION                    |                                  | EXAMPLES                                |  |
|-----------------------------|----------------------------------|-----------------------------------------|--|
| PHOTOGRAPHER:               | F → Feature letter transect #(s) | T → Feature letter transect # - tagline |  |
|                             | @ tagline distance in m (J1@20)  | dist. in m (G1LHP, G1LP@26)             |  |
|                             | O → PP1, PP2, PP3                | R → from river, 10m upstream, etc.      |  |
| SUBJECT:                    | F → Feature letter transect #(s) | T → Feature letter transect # - tagline |  |
|                             | @ tagline distance in m (J1@20)  | dist. in m (G1LHP, G1LP@26)             |  |
|                             | O → O # - feature(s) O1-GH       | R → CP1, RM2, etc.                      |  |
| Location being photographed |                                  |                                         |  |

| KEY              | T        | F       | O                  | R                  |
|------------------|----------|---------|--------------------|--------------------|
| Photo Type       | Transect | Feature | Overview           | Reference          |
| Direction Facing | RR   RL  | US   DS | US   DS<br>RR   RL | US   DS<br>RR   RL |

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

| Photo Type ➡               | ALL                             | ALL                                                                                                        | ALL                                                                                                   | ALL                                           | ALL     | R                        |                          | ALL                                              |
|----------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------|--------------------------|--------------------------|--------------------------------------------------|
| Photo Type<br>(circle one) | Direction<br>facing<br>(circle) |  Photographer<br>Location |  Subject<br>Location | Photographer<br>(first initial,<br>last name) | Photo # | Close Up?                | Replacement?             | Comments<br><br>Skipped?<br>(if so, give reason) |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |

#### 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      |              |         |             |

## CANY Photos

Photos downloaded by: \_\_\_\_\_  
Date downloaded: \_\_\_\_/\_\_\_\_/\_\_\_\_

Data entered by: \_\_\_\_\_  
Date entered: \_\_\_\_/\_\_\_\_/\_\_\_\_

Data verified by: \_\_\_\_\_  
Date verified: \_\_\_\_/\_\_\_\_/\_\_\_\_

### NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#5 – Version 3.00 – December 2015

River: **Green CAC CBC** Sentinel Site: \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_ ☐ Camera date/time checked? ☐

| LOCATION                    |                                           | EXAMPLES                             |                    |
|-----------------------------|-------------------------------------------|--------------------------------------|--------------------|
| 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 |                                           | F → N/A                              | T → N/A            |
|                             |                                           | 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<br>RR   RL | US   DS<br>RR   RL |

|                              |                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------|
| <b>P A 01 03 00</b><br>① ② ③ | ① Month: Jan-Sep = 1-9, Oct -Dec = A - C<br>② Day: 01-31    ③ 4-digit Camera Photo Sequence # |
|------------------------------|-----------------------------------------------------------------------------------------------|

| Photo Type ➡               | ALL                             | ALL                                                                                                        | O R                                                                                                   | ALL                                           | ALL     | R                        |                          | ALL                                              |
|----------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------|--------------------------|--------------------------|--------------------------------------------------|
| Photo Type<br>(circle one) | Direction<br>facing<br>(circle) |  Photographer<br>Location |  Subject<br>Location | Photographer<br>(first initial,<br>last name) | Photo # | Close Up?                | Replacement?             | Comments<br><br>Skipped?<br>(if so, give reason) |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| T F O R                    | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |

### 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             |              |         |             |

## DINO Photos

Photos downloaded by: \_\_\_\_\_  
Date downloaded: \_\_\_\_/\_\_\_\_/\_\_\_\_

Data entered by: \_\_\_\_\_  
Date entered: \_\_\_\_/\_\_\_\_/\_\_\_\_

Data verified by: \_\_\_\_\_  
Date verified: \_\_\_\_/\_\_\_\_/\_\_\_\_

### NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#5 – Version 3.00 – December 2015

River: GAC GBC Yampa

Sentinel  
Site:

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Camera date/time  
checked? ☐

| LOCATION                                       | EXAMPLES                                             |                                               |
|------------------------------------------------|------------------------------------------------------|-----------------------------------------------|
|                                                | <b>PHOTOGRAPHER:</b><br>F → N/A<br>O → PP1, PP2, PP3 | T → N/A<br>R → from river, 10m upstream, etc. |
| <b>SUBJECT:</b><br>Location being photographed | F → N/A<br>O → O1, O2, O3                            |                                               |
|                                                | T → N/A<br>R → CP1, RM2, etc.                        |                                               |

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

|                                    |                                                                                               |
|------------------------------------|-----------------------------------------------------------------------------------------------|
| P A <u>01</u> <u>0300</u><br>① ② ③ | ① Month: Jan-Sep = 1-9, Oct -Dec = A - C<br>② Day: 01-31    ③ 4-digit Camera Photo Sequence # |
|------------------------------------|-----------------------------------------------------------------------------------------------|

| Photo Type ➡               | ALL                             | ALL                                                                                                        | O R                                                                                                   | ALL                                           | ALL     | R                        |                          | ALL                                              |
|----------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------|--------------------------|--------------------------|--------------------------------------------------|
| Photo Type<br>(circle one) | Direction<br>facing<br>(circle) |  Photographer<br>Location |  Subject<br>Location | Photographer<br>(first initial,<br>last name) | Photo # | Close Up?                | Replacement?             | Comments<br><br>Skipped?<br>(if so, give reason) |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |
| O R                        | US DS<br>RR RL                  |                                                                                                            |                                                                                                       |                                               |         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>                         |

### 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) #6**

#### **Measuring Vegetation for Black Canyon of the Gunnison NP, Canyonlands NP, and Dinosaur NM**

#### **Version 3.00 (January 2016)**

##### **Revision History Log:**

| Prev. Version # | Revision Date | Author     | Changes Made                                  | Reason for Change     | New Version # |
|-----------------|---------------|------------|-----------------------------------------------|-----------------------|---------------|
| Varies          | 1/04/16       | D. Perkins | Combine BLCA, CANY, and DINO veg into one SOP | Clarity, organization | 3.00          |
|                 |               |            |                                               |                       |               |
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This SOP describes the methods for conducting vegetation monitoring at sentinel sites. A list of necessary equipment for these procedures can be found in SOP #1.

# I - BLACK CANYON OF THE GUNNISON NP

## 1. Measuring Vegetation

### 1.1 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 conduct 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 (Appendix 1), 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:

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

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

**Site ID:** Circle RR (Red Rocks) or EP (East Portal).

**Feature:** the letter of the geomorphic feature

**Transect:** 1-4, record the transect, downstream to upstream.

**Date:** mm/dd/yyyy

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

**Height above head pin at 0:** Record 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), center the plot frame on 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 (“Upland (smaller number)”). For a plot located between the 10 and 10.5 m mark, the observer would mark 10 on the distance row of the datasheet.
- A. **Modal Particle Size:** Record the modal particle size (Wentworth scale) (see Appendix 2) 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. 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). If water is turbid, use your hand to feel the bottom of the plot. 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 1 (in Appendix 2) 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 2 in Appendix 2) 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.
- D. **Percent Sand (% sand or finer):** Record the percent cover to the nearest 1% of the plot that is sand (<2 mm) or less.
- E. **% inundation (water):** record to the nearest 1% the amount of that plot that is inundated by water.
- 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 1%. Record a “T” for trace percentage (<0.5%). 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. If there is no woody canopy, check the box for that plot.
- H. If there are no indicator species present, check the box for that plot.
- I. 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 1%. Record a “T” for trace percentage (<0.5%). Visually estimate a plan view projection from 1.5 m down of outline polygons of plants. 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).
- J. Understory (Rooted) Species Presence in Vegetation Plots: Record the percent cover of indicator species presence to the nearest one percent. Filamentous algae cover is recorded as understory. 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*  
*Apocynum cannabinum*  
*Artemisia ludoviciana*  
*Cirsium arvense*  
*Eleocharis palustris*  
*Elymus repens*  
*Epilobium ciliatum*  
*Equisetum hyemale-laevigatum*  
*Euthamia occidentalis*  
Filamentous Algae (FA)  
*Heterotheca villosa*  
*Mellilotus alba-officinale*

*Phalaris arundinacea*  
*Populus angustifolia*  
*Rhus trilobata*  
*Salix exigua*  
TRAIL  
*Verbena bracteata*  
*Veronica anagallis-aquatica*  
*Verbascum Thapsus*

- K. 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.

## 1.2 Plant Walk

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. At each site (RR and EP), 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 *BLCA Veg Walk* data sheet (Appendix 1):

**River:** Circle either Green or Yampa

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

## 1.3 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 + 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 (Appendix 1), 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.

## II - CANYONLANDS NP

### 1. Measuring Vegetation

Vegetation sampling consists of sampling 1m<sup>2</sup> plots along each transect and conducting a plant walk to develop a species list of the sentinel site.

When filling out the data sheet (Appendix 1), if you make a mistake, do not erase, simply draw a line through the erroneous information and write in the correct information.

#### 1.1 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:

**River**                      Green = Green  
                                  CAC = Colorado above confluence  
                                  CBC = Colorado below confluence

**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

**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:** Place a check mark next to any species found that has been pre-written on the data sheet. If a species is not pre-written, record the full latin name of each unique plant species encountered.

#### 1.2 Vegetation Plots

Vegetation sampling includes cover of species in 1m<sup>2</sup> plots placed every 3 m along the transect. The plots are permanent locations but may they will not all be surveyed every year. Plots will extend at least one plot into the inactive floodplain and will extend into the water to a safe distance (waist deep in slow water, less deep as the current picks up). Plots will be loaded into the RTK units and will be laid out by the surveyors. Plots where the water is too deep to place a pin flag will be recorded by the surveyors.

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.

**B. 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**                      Green = Green  
                                 CAC = Colorado above confluence  
                                 CBC = Colorado below confluence

**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  
MM = Musselman Canyon  
SG = Sangria

**Transect:** Record the transect number

**Date:** mm/dd/yyyy

**Page \_\_\_\_ of \_\_\_\_:** Note current page number of total pages for that feature.

**C. Lay out the plot frame:** The surveyors mark the center of the plot, so the plot should be laid out centered on the flag and perpendicular to the flow of the main river.

**D. Plot location:** Record the plot location as shown on the pin flag laid out by the surveyors.

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

- F. **Modal Particle Size:** Record the modal particle size using the modal particle size (Modified Wentworth scale – see Appendix 2) 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 1 in Appendix 2 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 2 in Appendix 2) 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).

- G. **Percent Sand or Finer:** Visually estimate the percent cover of the plot that is characterized by particles that are sand (<2 mm) or smaller.

- H. **No Canopy Veg?** If there is no woody canopy, check the box for that plot.

- I. **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). 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).

- J. **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.

- K. **Total Plant Cover %:** Visually estimate the percentage of live understory plant cover (<1.5 m height) rooted in the plot.

- L. **Understory Plant Cover [% cover by species (0.5-100)]:** Visually estimate a plan view projection of outline polygons of each plant species (<1.5m) 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). 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 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.

### 1.3 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.

### III - DINOSAUR NM

For each sentinel site, vegetation monitoring consists of sampling 1 m<sup>2</sup> vegetation plots and a timed veg walk to develop a species list. Three vegetation monitoring data sheets (Appendix 1):

1. DINO Veg Plots, which includes keys and cheatsheets. Mandatory for all sentinel sites.
2. Unknown Plants. Optional, but highly encouraged if unknown plants are encountered.
3. 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 150 permanent 1x1 m plots at each site.

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.)

**Modal Particle Size:** Record the modal particle size (Appendix 2) 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. Record the corresponding code based on the Modified Wentworth Scale. For soils finer than fines, see Figures 1 and 2 in Appendix 2. 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). If water is turbid, use your hand to feel the bottom of the plot.

**% 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 ( $\leq 0.5\%$ ), 1% if 0.5-1%. 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 (>1.5m tall) and seedlings (<1.5m tall). Be sure to either place the seedling cover in the pre-written seedling row, or if the species is not written be sure to write "Seedling" after the species name.

If an unknown plant is encountered, fill out an Unknown Plant data sheet (see section III.1.1) 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.

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***

- F. 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).
- G. If an identifiable specimen cannot be found, create a unique name using the following code: unk + 4 letter park code + sentinel site + 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.
- H. Take a photograph of the unknown plant.
- I. As you proceed through the reach, continue to attempt to find identifiable specimens of unknowns.
- J. 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.

- I. Collect specimens from outside of the monitoring transects whenever possible.
- J. 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.
- K. 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.
- L. Wrap a piece of masking tape around the plant and use a fine-point Sharpie to label it with the unknown species code.
- M. Carefully place the specimen inside a resealable plastic bag labeled with the reach number, unknown species code, date, and collector.

- N. 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.
- O. 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.
- P. 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 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

# Appendix 1. Data Sheets

## BLCA Veg Plots

Data entered by:

Data verified by:

Date entered: / /

Date verified: / /

Page \_\_\_\_ of \_\_\_\_

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

River: **Gunnison** Site: \_\_\_\_\_ Feature: \_\_\_\_\_ Transect: \_\_\_\_\_ Observer: \_\_\_\_\_ Recorder: \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

| NCPN Modified Wentworth Scale |      |                    |                  |      |               | Tagline Measurements |             |                   |
|-------------------------------|------|--------------------|------------------|------|---------------|----------------------|-------------|-------------------|
| Class Size                    | Code | Diameter (mm)      | Class Size       | Code | Diameter (mm) | DESCRIPTION          | HEIGHT (cm) | LINE DISTANCE (m) |
| Fines                         | F    | See SOP definition | Gravel           | GR   | > 2 – 16      | Above Headpin @ 0    |             | 0                 |
| Clay                          | CL   |                    | Pebble           | PE   | > 16 – 64     | Above Water @ RS     |             |                   |
| Loam/Clay                     | LC   |                    | Cobble           | CO   | > 64 – 256    |                      |             |                   |
| Loam                          | LO   |                    | Boulder          | BL   | > 256 – 512   |                      |             |                   |
| Sand                          | SA   | 0.5µm – 2mm        | Bedrock, Hardpan | BR   | > 512         |                      |             |                   |

|                                                                                                                                                        |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Plot Location (m) plot centered on transect                                                                                                            |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| % Inundation (Water)                                                                                                                                   |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Modal Particle Size { F CL LC LO SA GR PE CO BL BR }                                                                                                   |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| % Sand & Finer (nearest 1%)                                                                                                                            |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| % Litter (nearest 1%)                                                                                                                                  |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| % Woody Debris (nearest 1%)                                                                                                                            |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Plot Density 1/x (1, 2, 4, or 8)                                                                                                                       |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| R = rooted in plot      Woody Canopy % Cover      Rooted & Unrooted > 1.5m • nearest 5% • T ≤ 0.5                                                      |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| No Canopy Veg?                                                                                                                                         |           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| <i>Acer negundo</i>                                                                                                                                    | ACENEG    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Juniperus osteosperma</i>                                                                                                                           | JUNOST    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Juniperus scopulorum</i>                                                                                                                            | JUNSCO    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Salix exigua</i>                                                                                                                                    | SALEXI    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Filamentous Algae<br>incl. attached macrophytes & FA < 0.5 cm long                                                                                     |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Understory Rooted Plant % Cover                                                                                                                        |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| ≤ 1.5m height • to nearest 5% • T (trace) ≤ 0.5 • No dead plants/parts • No double-counting overlapping areas of cover • max overall plot cover = 100% |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Total Plot Cover % (< 1.5m in height)                                                                                                                  |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Herbaceous Indicator Species      ≤ 1.5m • % Cover                                                                                                     |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| No Rooted Veg?                                                                                                                                         |           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| <i>Acer negundo</i>                                                                                                                                    | ACENEG    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Agrostis stolonifera</i>                                                                                                                            | AGRSTO    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Apocynum cannabinum</i>                                                                                                                             | APOCAN    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Artemisia ludoviciana</i>                                                                                                                           | ARTLUD    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Cirsium arvense</i>                                                                                                                                 | CIRARV    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Eleocharis palustris</i>                                                                                                                            | ELEPAL    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Elymus repens</i>                                                                                                                                   | ELYREP    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Epilobium ciliatum</i>                                                                                                                              | EPICIL    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Equisetum hyemale/laevigatum</i>                                                                                                                    | EQUHYELAE |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Euthamia occidentalis</i>                                                                                                                           | EUTOCC    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Heterotheca zionensis</i>                                                                                                                           | CHRZIO    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Melilotus sp.</i>                                                                                                                                   | MELILOTUS |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Phalaris arundinacea</i>                                                                                                                            | PHAARU    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Populus angustifolia</i>                                                                                                                            | POPANG    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Rhus aromatica</i>                                                                                                                                  | RHUARO    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Salix exigua</i>                                                                                                                                    | SALEXI    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Verbascum thapsus</i>                                                                                                                               | VERTHA    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Verbena bracteata</i>                                                                                                                               | VERBRA    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| <i>Veronica anagallis-aquatica</i>                                                                                                                     | VERANA    |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Filamentous Algae<br>incl. attached macrophytes & FA < 0.5 cm long                                                                                     |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
| Social Trails                                                                                                                                          |           |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |

# BLCA Veg Walk

Data entered by:

Data verified by:

Date entered: \_\_\_\_/\_\_\_\_/\_\_\_\_

Date verified: \_\_\_\_/\_\_\_\_/\_\_\_\_

Page \_\_\_\_ of \_\_\_\_

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

River (circle): **Gunnison**

Sentinel Site: \_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Observer: \_\_\_\_\_

Recorder: \_\_\_\_\_

| ✓ | Species Found                   |              |
|---|---------------------------------|--------------|
|   | <b>Aceraceae</b>                |              |
|   | <i>Acer negundo</i>             | ACENEG       |
|   | <i>Acer negundo</i> SEEDLING    | ACENEG       |
|   | <b>Anacardiaceae</b>            |              |
|   | <i>Rhus aromatic</i>            | RHUARO       |
|   | <b>Apocynaceae</b>              |              |
|   | <i>Apocynum</i> sp.             | APOCYNUM     |
|   | <i>Apocynum cannabinum</i>      | APOCAN       |
|   | <b>Asteraceae</b>               |              |
|   | <i>Ambrosia acanthicarpa</i>    | AMBACA       |
|   | <i>Ambrosia tomentosa</i>       | AMBTOM       |
|   | <i>Artemisia biennis</i>        | ARTBIE       |
|   | <i>Artemisia dracuncululus</i>  | ARTDRA       |
|   | <i>Artemisia ludoviciana</i>    | ARTLUD       |
|   | <i>Artemisia tridentata</i>     | ARTTRI       |
|   | <i>Aster ascendens</i>          | ASTASCENDENS |
|   | <i>Carduus nutans</i>           | CARNUT       |
|   | <i>Centaurea repens</i>         | ACRREP       |
|   | <i>Chrysanthemum linifolius</i> | CHRLIN       |
|   | <i>Chrysanthemum nauseosus</i>  | CHRNAU       |
|   | <i>Chrysopsis villosa</i>       | CHRVIL       |
|   | <i>Cirsium arvense</i>          | CIRARV       |
|   | <i>Cirsium undulatum</i>        | CIRUND       |
|   | <i>Conyza Canadensis</i>        | CONCAN       |
|   | <i>Euthamia occidentalis</i>    | EUTOCC       |
|   | <i>Gaillardia</i> sp.           | GAILLARDIA   |
|   | <i>Gnaphalium palustre</i>      | GNAPAL       |
|   | <i>Grindelia squarrosa</i>      | GRISQU       |
|   | <i>Gutierrezia sarothrae</i>    | GUTSAR       |
|   | <i>Helenium autumnale</i>       | HELAUT       |
|   | <i>Helianthus</i> sp.           | HELIANTHUS   |
|   | <i>Iva axillaris</i>            | IVAAXI       |
|   | <i>Solidago</i> sp.             | SOLIDAGO     |
|   | <i>Solidago missouriensis</i>   | SOLMIS       |
|   | <i>Taraxacum officinale</i>     | TAROFF       |
|   | <i>Tragopogon dubius</i>        | TRADUB       |
|   | <i>Xanthium strumarium</i>      | XANSTR       |
|   | <b>Brassicaceae</b>             |              |
|   | <i>Alyssum desertorum</i>       | ALYDES       |
|   | <i>Descurainia</i> sp.          | DESCURAINIA  |
|   | <i>Lepidium densiflorum</i>     | LEPDEN       |
|   | <i>Lepidium latifolium</i>      | LEPLAT       |
|   | <i>Sisymbrium altissimum</i>    | SISALT       |

| ✓ | Species Found                       |            |
|---|-------------------------------------|------------|
|   | <b>Capparaceae</b>                  |            |
|   | <i>Cleome lutea</i>                 | CLELUT     |
|   | <i>Cleome serrulata</i>             | CLESER     |
|   | <b>Chenopodiaceae</b>               |            |
|   | <i>Chemopodium fremontii</i>        | CHEFRE     |
|   | <i>Chemopodium glaucum</i>          | CHEGLA     |
|   | <i>Cycloloma atriplicifolia</i>     | CYCATR     |
|   | <i>Salsola tragus</i>               | SALTRA     |
|   | <b>Cupressaceae</b>                 |            |
|   | <i>Juniperus osteosperma</i>        | JUNOST     |
|   | <i>Juniperus scopulorum</i>         | JUNSCO     |
|   | <b>Cyperaceae</b>                   |            |
|   | <i>Carex</i> sp.                    | CAREX      |
|   | <i>Carex emoryi</i>                 | CAREMO     |
|   | <i>Eleocharis palustris</i>         | ELEPAL     |
|   | <i>Scirpus pungens</i>              | SCIPUN     |
|   | <b>Equisetaceae</b>                 |            |
|   | <i>Equisetum arvense</i>            | EQUARV     |
|   | <i>Equisetum hyemale</i>            | EQUHYE     |
|   | <i>Equisetum hyemale/laevigatum</i> | EQUHYELAE  |
|   | <i>Equisetum</i> sp.                | EQUISETUM  |
|   | <b>Euphorbiaceae</b>                |            |
|   | <i>Chamaesyce</i> sp.               | CHAMAESYCE |
|   | <i>Euphorbia esula</i>              | EUPESU     |
|   | <b>Fabaceae</b>                     |            |
|   | <i>Astragalus</i> sp.               | ASTRAGALUS |
|   | <i>Astragalus mollissimus</i>       | ASTMOL     |
|   | <i>Glycyrrhiza lepidota</i>         | GLYLEP     |
|   | <i>Melilotus officinalis</i>        | MELOFF     |
|   | <i>Melilotus</i> sp.                | MELILOTUS  |
|   | <i>Psoralea lanceolata</i>          | PSOLAN     |
|   | <b>Fagaceae</b>                     |            |
|   | <i>Quercus gambelii</i>             | QUEGAM     |
|   | <b>Hydrangeaceae</b>                |            |
|   | <i>Philadelphus microphyllus</i>    | PHIMIC     |
|   | <b>Juncaceae</b>                    |            |
|   | <i>Juncus arcticus</i>              | JUNARC     |
|   | <b>Lamiaceae</b>                    |            |
|   | <i>Mentha arvensis</i>              | MENARV     |
|   | <b>Oleaceae</b>                     |            |
|   | <i>Fraxinus anomala</i>             | FRAANO     |

| ✓ | Species Found                   |        |
|---|---------------------------------|--------|
|   | <b>Onagraceae</b>               |        |
|   | <i>Epilobium ciliatum</i>       | EPICIL |
|   | <i>Oenothera biennis</i>        | OENBIE |
|   | <i>Oenothera elata</i>          | OENELA |
|   | <i>Oenothera pallida</i>        | OENPAL |
|   | <b>Pinaceae</b>                 |        |
|   | <i>Pseudotsuga menziesii</i>    | PSEMEN |
|   | <b>Poaceae</b>                  |        |
|   | <i>Agrostis stolonifera</i>     | AGRSTO |
|   | <i>Bromus inermis</i>           | BROINE |
|   | <i>Bromus japonicus</i>         | BROJAP |
|   | <i>Bromus tectorum</i>          | BROTEC |
|   | <i>Cryptantha alopecuroides</i> | CRYALO |
|   | <i>Distichlis spicata</i>       | DISSPI |
|   | <i>Elymus</i> sp.               | ELYMUS |
|   | <i>Elymus canadensis</i>        | ELYSAN |
|   | <i>Elymus cinereus</i>          | ELYSIN |
|   | <i>Elymus elymoides</i>         | ELYELY |
|   | <i>Elymus lanceolatus</i>       | ELYLAN |
|   | <i>Elymus repens</i>            | ELYREP |
|   | <i>Elymus smithii</i>           | ELYSMI |
|   | <i>Elymus trachycaulus</i>      | ELYTRA |
|   | <i>Hordeum jubatum</i>          | HORJUB |
|   | <i>Muhlenbergia asperifolia</i> | MUHASP |
|   | <i>Phalaris arundinacea</i>     | PHAARU |
|   | <i>Poa pratensis</i>            | POAPRA |
|   | <i>Poa secunda</i>              | POASEC |
|   | <i>Spartina pectinata</i>       | SPAPEC |
|   | <i>Sporobolus cryptandrus</i>   | SPOCRY |
|   | <i>Stipa comata</i>             | STICOM |
|   | <i>Stipa hymenoides</i>         | STIHYM |
|   | <b>Plantaginaceae</b>           |        |
|   | <i>Plantago major</i>           | PLAMAJ |
|   | <b>Polygonaceae</b>             |        |
|   | <i>Polygonum amphibium</i>      | POLAMP |
|   | <i>Polygonum lapathifolium</i>  | POLLAP |
|   | <b>Portulacaceae</b>            |        |
|   | <i>Portulaca oleracea</i>       | POROLE |
|   | <b>Rosaceae</b>                 |        |
|   | <i>Amelanchier utahensis</i>    | AMEUTA |
|   | <i>Potentilla anserina</i>      | POTANS |
|   | <i>Rosa woodsii</i>             | ROSWOO |

## BLCA Veg Walk

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Page \_\_\_\_\_ of \_\_\_\_\_

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

**River (circle):**      **Gunnison**

Sentinel Site:

Date:     /     /

Observer:

**Recorder:**

[illegible]

## CANY Veg Plots

Data verified by:

Date verified:     /     /

Page of

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

Observer:

Date:     /     /

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Page \_\_\_\_\_ of \_\_\_\_\_

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

River (circle): ☒ Green ☐ CAC ☐ CBC Sentinel Site: \_\_\_\_\_ Observer: \_\_\_\_\_ Recorder: \_\_\_\_\_ Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

| ✓                     | Species Found                       |             |
|-----------------------|-------------------------------------|-------------|
| <i>Amaranthaceae</i>  |                                     |             |
|                       | <i>Amaranthus albus</i>             | AMAALB      |
| <i>Anacardiaceae</i>  |                                     |             |
|                       | <i>Rhus aromatica</i>               | RHUARO      |
| <i>Apocynaceae</i>    |                                     |             |
|                       | <i>Apocynum cannabinum</i>          | APOCAN      |
| <i>Asclepladaceae</i> |                                     |             |
|                       | <i>Asclepias subverticillata</i>    | ASCSUB      |
| <i>Asteraceae</i>     |                                     |             |
|                       | <i>Artemisia biennis</i>            | ARTBIE      |
|                       | <i>Artemisia dracunculus</i>        | ARTDRA      |
|                       | <i>Artemesia ludoviciana</i>        | ARTLUD      |
|                       | <i>Aster frondosus</i>              | ASTFRO      |
|                       | <i>Baccharis salicina</i>           | BACSAL      |
|                       | <i>Baccharis viminea</i>            | BACVIM      |
|                       | <i>Bidens cernua</i>                | BIDCER      |
|                       | <i>Bidens frondosa</i>              | BIDFRO      |
|                       | <i>Cirsium sp.</i>                  | CIRSIUM     |
|                       | <i>Conyza canadensis</i>            | CONCAN      |
|                       | <i>Euthamia occidentalis</i>        | EUTOCC      |
|                       | <i>Gnaphalium palustre</i>          | GNAPAL      |
|                       | <i>Gnaphalium stramineum</i>        | GNASTR      |
|                       | <i>Helenium autumnale</i>           | HELAUT      |
|                       | <i>Sonchus asper</i>                | SONASP      |
|                       | <i>Viguiera multiflora</i>          | VIGMUL      |
|                       | <i>Xanthium strumarium</i>          | XANSTR      |
| <i>Brassicaceae</i>   |                                     |             |
|                       | <i>Lepidium latifolium</i>          | LEPLAT      |
| <i>Chenopodiaceae</i> |                                     |             |
|                       | <i>Bassia sp.</i>                   | BASSIA      |
|                       | <i>Chenopodium sp.</i>              | CHENOPODIUM |
|                       | <i>Chenopodium fremontii</i>        | CHEFRE      |
|                       | <i>Chenopodium rubrum</i>           | CHERUB      |
|                       | <i>Salsola tragus</i>               | SALTRA      |
| <i>Cyperaceae</i>     |                                     |             |
|                       | <i>Carex sp.</i>                    | CAREX       |
|                       | <i>Cyperus erythrorhizos</i>        | CYPERY      |
|                       | <i>Eleocharis palustris</i>         | ELEPAL      |
| <i>Equisetaceae</i>   |                                     |             |
|                       | <i>Equisetum hyemale/laevigatum</i> | EQUHYELAE   |
| <i>Euphorbiaceae</i>  |                                     |             |
|                       | <i>Chamaesyce glyptosperma</i>      | CHAGLY      |

| ✓                                  | Species Found |            |
|------------------------------------|---------------|------------|
| <b><i>Fabaceae</i></b>             |               |            |
| <i>Astragalus</i> sp.              |               | ASTRAGALUS |
| <i>Melilotus officinalis</i>       |               | MELOFF     |
| <b><i>Lamiaceae</i></b>            |               |            |
| <i>Mentha arvensis</i>             |               | MENARV     |
| <b><i>Onagraceae</i></b>           |               |            |
| <i>Oenothera</i> sp.               |               | OENOTHER   |
| <i>Oenothera biennis</i>           |               | OENBIE     |
| <b><i>Poaceae</i></b>              |               |            |
| <i>Crypsis alopecuroides</i>       |               | CRYALO     |
| <i>Distichlis spicata</i>          |               | DISSPI     |
| <i>Echinochloa crus-galli</i>      |               | ECHCRU     |
| <i>Eragrostis hypnoides</i>        |               | ERAHYP     |
| <i>Leptochloa fascicularis</i>     |               | LEPFAS     |
| <i>Panicum capillare</i>           |               | PANCAP     |
| <i>Phragmites australis</i>        |               | PHRAUS     |
| <i>Sporobolus cryptandrus</i>      |               | SPOCRY     |
| <b><i>Plantaginaceae</i></b>       |               |            |
| <i>Plantago major</i>              |               | PLAMAJ     |
| <b><i>Polygonaceae</i></b>         |               |            |
| <i>Polygonum lapathifolium</i>     |               | POLLAP     |
| <i>Rumex maritimus</i>             |               | RUMMAR     |
| <b><i>Portulacaceae</i></b>        |               |            |
| <i>Portulaca oleracea</i>          |               | POROLE     |
| <b><i>Ranunculaceae</i></b>        |               |            |
| <i>Ranunculus cymbalaria</i>       |               | RANCYM     |
| <b><i>Rosaceae</i></b>             |               |            |
| <i>Potentilla</i> sp.              |               | POTENTILLA |
| <b><i>Salicaceae</i></b>           |               |            |
| <i>Populus fremontii</i>           |               | POPFRE     |
| <i>Populus fremontii</i>           | SEEDLING      | POPFRE*    |
| <i>Salix exigua</i>                |               | SALEXI     |
| <i>Salix exigua</i>                | SEEDLING      | SALEXI*    |
| <i>Salix lucida</i>                |               | SALLUC     |
| <i>Salix lucida</i>                | SEEDLING      | SALLUC*    |
| <b><i>Scrophulariaceae</i></b>     |               |            |
| <i>Veronica anagallis-aquatica</i> |               | VERANA     |
| <b><i>Tamaricaceae</i></b>         |               |            |
| <i>Tamarix</i> sp.                 |               | TAMARIX    |
| <i>Tamarix</i> sp.                 | SEEDLING      | TAMARIX*   |
| <b><i>Typhaceae</i></b>            |               |            |
| <i>Typha</i> sp.                   |               | TYPHA      |

[illegible]

Data verified by:

Date verified:        /        /

Page \_\_\_\_\_ of \_\_\_\_\_

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

River (circle): ☐ Green ☐ CAC ☐ CBC Sentinel Site: \_\_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_ Observer: \_\_\_\_\_ Recorder: \_\_\_\_\_

|             |                                |                                                                          |                                          |
|-------------|--------------------------------|--------------------------------------------------------------------------|------------------------------------------|
| <b>KEY:</b> | suspected = *<br>species = sp. | unknown = UNK + CODE<br>CODE = park + site + 2 letter initials + 1 digit | <b>Example unknown:</b> UNK-DINO-BP-BG-3 |
|-------------|--------------------------------|--------------------------------------------------------------------------|------------------------------------------|

✓ Species Found ☐ ✓ Species Found ☐ ✓ Species Found

[illegible]

Data entered by:

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Data verified by:

Date verified:     /     /

Page \_\_\_\_\_ of \_\_\_\_\_

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

Sentinel Site: \_\_\_\_\_

Observer:

Recorder:

Date:      /      /     [illegible]

## Date verified:     /     /

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

Date:        /        /

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# DINO Veg Walk

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Date verified: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Page \_\_\_\_ of \_\_\_\_

NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

River (circle): **GAC** **GBC** **Yampa** Sentinel Site: \_\_\_\_\_ Observer: \_\_\_\_\_ Recorder: \_\_\_\_\_ Date: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

| ✓ | Species Found                    |              |
|---|----------------------------------|--------------|
|   | <b>Aceraceae</b>                 |              |
|   | <i>Acer negundo</i>              | ACENEG       |
|   | <i>Acer negundo</i> SEEDLING     | ACENEG       |
|   | <b>Anacardiaceae</b>             |              |
|   | <i>Rhus aromatica</i>            | RHUARO       |
|   | <b>Apocynaceae</b>               |              |
|   | <i>Apocynum</i> sp.              | APOCYNUM     |
|   | <i>Apocynum cannabinum</i>       | APOCAN       |
|   | <b>Asclepiadaceae</b>            |              |
|   | <i>Asclepias</i> sp.             | ASCLEPIAS    |
|   | <i>Asclepias speciosa</i>        | ASCSP        |
|   | <b>Asteraceae</b>                |              |
|   | <i>Ambrosia acanthicarpa</i>     | AMBACA       |
|   | <i>Ambrosia tomentosa</i>        | AMBTOM       |
|   | <i>Artemisia biennis</i>         | ARTBIE       |
|   | <i>Artemisia dracunculifolia</i> | ARTDRA       |
|   | <i>Artemisia ludoviciana</i>     | ARTLUD       |
|   | <i>Artemisia tridentata</i>      | ARTTRI       |
|   | <i>Aster ascendens</i>           | ASTASCENDENS |
|   | <i>Carduus nutans</i>            | CARNUT       |
|   | <i>Centaurea repens</i>          | ACRREP       |
|   | <i>Chrysanthemum linifolium</i>  | CHRLIN       |
|   | <i>Chrysanthemum nauseosum</i>   | CHRNAU       |
|   | <i>Chrysopsis villosa</i>        | CHRVIL       |
|   | <i>Cirsium arvense</i>           | CIRARV       |
|   | <i>Cirsium undulatum</i>         | CIRUND       |
|   | <i>Conyza canadensis</i>         | CONCAN       |
|   | <i>Euthamia occidentalis</i>     | EUTOCC       |
|   | <i>Gaillardia</i> sp.            | GAILLARDIA   |
|   | <i>Gnaphalium palustre</i>       | GNAPAL       |
|   | <i>Grindelia squarrosa</i>       | GRISQU       |
|   | <i>Gutierrezia sarothrae</i>     | GUTSAR       |
|   | <i>Helenium autumnale</i>        | HELAUT       |
|   | <i>Helianthus</i> sp.            | HELIANTHUS   |
|   | <i>Iva axillaris</i>             | IVAAXI       |
|   | <i>Solidago</i> sp.              | SOLIDAGO     |
|   | <i>Solidago missouriensis</i>    | SOLMIS       |
|   | <i>Taraxacum officinale</i>      | TAROFF       |
|   | <i>Tragopogon dubius</i>         | TRADUB       |
|   | <i>Xanthium strumarium</i>       | XANSTR       |

| ✓ | Species Found                       |             |
|---|-------------------------------------|-------------|
|   | <b>Brassicaceae</b>                 |             |
|   | <i>Alyssum desertorum</i>           | ALYDES      |
|   | <i>Descurainia</i> sp.              | DESCURAINIA |
|   | <i>Lepidium densiflorum</i>         | LEPDEN      |
|   | <i>Lepidium latifolium</i>          | LEPLAT      |
|   | <i>Sisymbrium altissimum</i>        | SISALT      |
|   | <b>Capparidaceae</b>                |             |
|   | <i>Cleome lutea</i>                 | CLELUT      |
|   | <i>Cleome serrulata</i>             | CLESER      |
|   | <b>Chenopodiaceae</b>               |             |
|   | <i>Chenopodium fremontii</i>        | CHEFRE      |
|   | <i>Chenopodium glaucum</i>          | CHEGLA      |
|   | <i>Cyclolooma atriplicifolia</i>    | CYCATR      |
|   | <i>Salsola tragus</i>               | SALTRA      |
|   | <b>Cupressaceae</b>                 |             |
|   | <i>Juniperus osteosperma</i>        | JUNOST      |
|   | <b>Cyperaceae</b>                   |             |
|   | <i>Carex</i> sp.                    | CAREX       |
|   | <i>Carex emoryi</i>                 | CAREMO      |
|   | <i>Eleocharis palustris</i>         | ELEPAL      |
|   | <i>Scirpus pungens</i>              | SCIPUN      |
|   | <b>Equisetaceae</b>                 |             |
|   | <i>Equisetum arvense</i>            | EQUARV      |
|   | <i>Equisetum hyemale</i>            | EQUHYE      |
|   | <i>Equisetum hyemale/laevigatum</i> | EQUHYELAE   |
|   | <b>Euphorbiaceae</b>                |             |
|   | <i>Chamaesyce</i> sp.               | CHAMAESYCE  |
|   | <i>Euphorbia esula</i>              | EUPESU      |
|   | <b>Fabaceae</b>                     |             |
|   | <i>Astragalus</i> sp.               | ASTRAGALUS  |
|   | <i>Astragalus mollissimus</i>       | ASTMOL      |
|   | <i>Glycyrrhiza lepidota</i>         | GLYLEP      |
|   | <i>Melilotus officinalis</i>        | MELOFF      |
|   | <i>Psoralea lanceolata</i>          | PSOLAN      |
|   | <b>Juncaceae</b>                    |             |
|   | <i>Juncus arcticus</i>              | JUNARC      |
|   | <b>Lamiaceae</b>                    |             |
|   | <i>Mentha arvensis</i>              | MENARV      |
|   | <b>Onagraceae</b>                   |             |
|   | <i>Oenothera biennis</i>            | OENBIE      |
|   | <i>Oenothera elata</i>              | OENELA      |
|   | <i>Oenothera pallida</i>            | OENPAL      |

| ✓ | Species Found                     |         |
|---|-----------------------------------|---------|
|   | <b>Poaceae</b>                    |         |
|   | <i>Agrostis stolonifera</i>       | AGRSTO  |
|   | <i>Bromus inermis</i>             | BROINE  |
|   | <i>Bromus japonicus</i>           | BROJAP  |
|   | <i>Bromus tectorum</i>            | BROTEC  |
|   | <i>Cryptis alopecuroides</i>      | CRYALO  |
|   | <i>Distichlis spicata</i>         | DISSPI  |
|   | <i>Elymus</i> sp.                 | ELYMUS  |
|   | <i>Elymus canadensis</i>          | ELYSAN  |
|   | <i>Elymus cinereus</i>            | ELYSIN  |
|   | <i>Elymus elymoides</i>           | ELYELY  |
|   | <i>Elymus lanceolatus</i>         | ELYLAN  |
|   | <i>Elymus repens</i>              | ELYREP  |
|   | <i>Elymus smithii</i>             | ELYSMI  |
|   | <i>Elymus trachycaulis</i>        | ELYTRA  |
|   | <i>Hordeum jubatum</i>            | HORJUB  |
|   | <i>Muhlenbergia asperifolia</i>   | MUHASP  |
|   | <i>Phalaris arundinacea</i>       | PHAARU  |
|   | <i>Poa pratensis</i>              | POAPRA  |
|   | <i>Poa secunda</i>                | POASEC  |
|   | <i>Spartina pectinata</i>         | SPAPEC  |
|   | <i>Sporobolus cryptandrus</i>     | SPOCRY  |
|   | <i>Stipa comata</i>               | STICOM  |
|   | <i>Stipa hymenoides</i>           | STIHYM  |
|   | <b>Plantaginaceae</b>             |         |
|   | <i>Plantago major</i>             | PLAMAJ  |
|   | <b>Polygonaceae</b>               |         |
|   | <i>Polygonum amphibium</i>        | POLAMP  |
|   | <i>Polygonum lapathifolium</i>    | POLLAP  |
|   | <b>Portulacaceae</b>              |         |
|   | <i>Portulaca oleracea</i>         | POROLE  |
|   | <b>Rosaceae</b>                   |         |
|   | <i>Potentilla anserina</i>        | POTANS  |
|   | <i>Rosa woodsii</i>               | ROSWOO  |
|   | <b>Salicaceae</b>                 |         |
|   | <i>Populus fremontii</i>          | POPFRE  |
|   | <i>Populus fremontii</i> SEEDLING | POPFRE  |
|   | <i>Salix exigua</i>               | SALEXI  |
|   | <i>Salix exigua</i> SEEDLING      | SALEXI  |
|   | <b>Scrophulariaceae</b>           |         |
|   | <i>Verbascum thapsus</i>          | VERTHA  |
|   | <b>Tamaricaceae</b>               |         |
|   | <i>Tamarix</i> sp.                | TAMARIX |
|   | <i>Tamarix</i> sp. SEEDLING       | TAMARIX |

## DINO Veg Walk

Data entered by:

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Date entered: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Date verified: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Page \_\_\_\_\_ of \_\_\_\_\_

## NCPN Big River Monitoring

Big River Monitoring Protocol – SOP#6 – Version 3.00 – January 2016

**River (circle):**

GAC GBC Yampa

Sentinel Site:

Date:     /     /

Observer:

Recorder:

**KEY :**

suspected = \*  
species = sp.

unknown = UNK + CODE

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

**Example unknown:** UNK-DINO-BP-BG-3

[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:

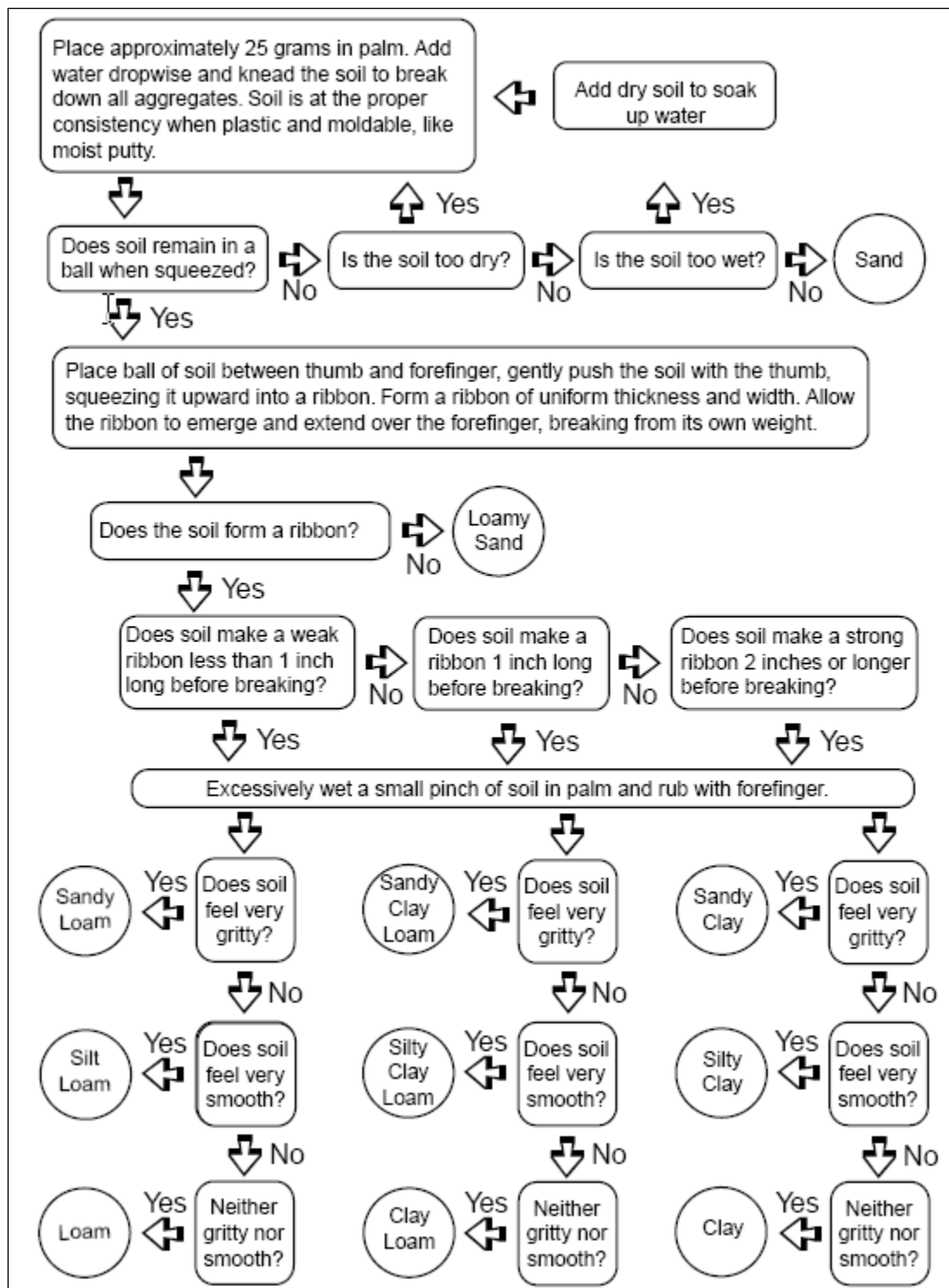
Confirmed to be:

Identified by:

Date:

## Appendix 2. Modal sediment table and soil texture figures

| 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 1 and 2.                   |
| Loam/Clay                                   | LC   |                                                                            |
| Loam (left most column in Figure 1)         | 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 1.** Soil texture key. Begin in the top left corner and answer the yes/no questions to determine soil texture.

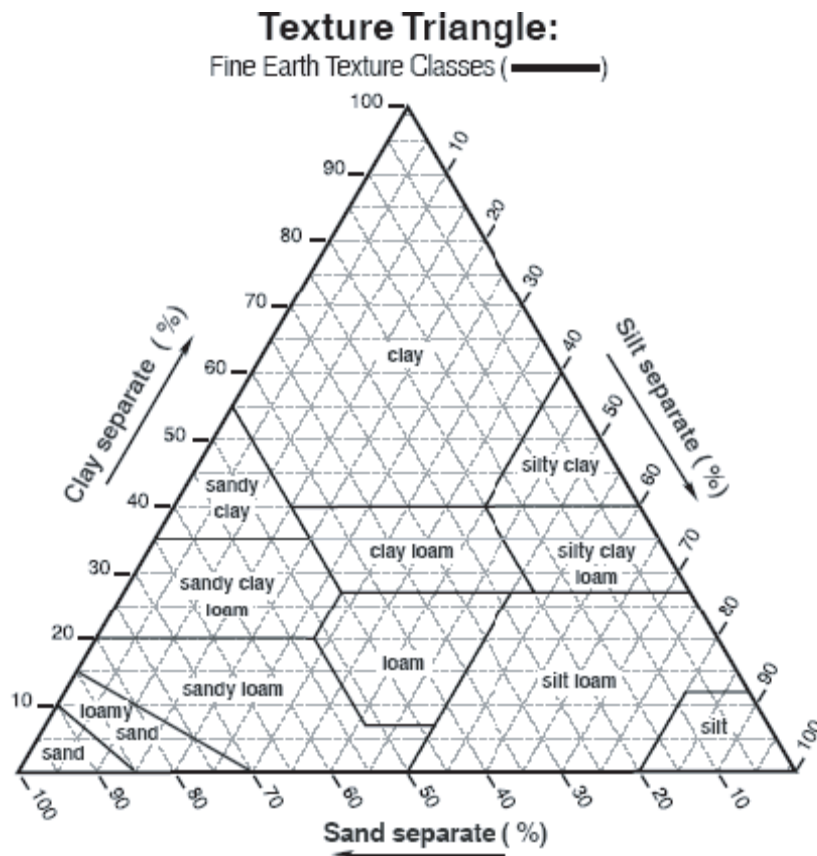


**Figure 2.** Soil texture triangle (Schoeneberger et al. 2002)

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

## Standard Operating Procedure (SOP) # 7

### Transducers and Hydrologic Monitoring – BLCA, CANY, and DINO

#### Version 1.01 (August 2015)

#### Revision History Log:

| Previous Version # | Revision Date | Author     | Changes Made                                 | Reason for Change          | New Version # |
|--------------------|---------------|------------|----------------------------------------------|----------------------------|---------------|
| 1.0                | 8/2015        | D. Perkins | Added software instructions relevant to BLCA | BLCA was not in SOP before | 1.01          |
|                    |               |            |                                              |                            |               |
|                    |               |            |                                              |                            |               |
|                    |               |            |                                              |                            |               |
|                    |               |            |                                              |                            |               |

This SOP describes installation techniques, instrument set up, and monitoring measurements for transducers and covers field work done from 2013 to present. This SOP is relevant to BLCA, CANY, and DINO. An equipment list is provided in SOP #1.

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 so that the slope of the water can be drawn across the sentinel sites 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 or HOBOWare User's Guide) and software (Solinst Levellogger 4.0.3 and Hoboware Pro).

- 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, CANY\_BB etc.
- Set the logging interval to 60 minutes.
- 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 (two water and one air). The transducers to be tested should be placed in a stable environment (office desk). Synchronize the time and program a common start time for all transducers. Let the transducers run 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 may show a transducer is no longer operational.
- F. Stop the test and download the transducers using Solinst or Hobo Software (see Section 2.0 Return Visits below for information on how to download the transducers).
- G. If the transducers air tests are successful (<5 cm deviation, see Figure 1), store the test data on X and reset the loggers using the elevation of the site where they are to be deployed. NOTE that when comparing data from barologgers (air transducers) to levelloggers (water transducers) the barologgers must be multiplied by 1.01702 for the graphing operations. It is fine to just keep them recording through transport and deployment.

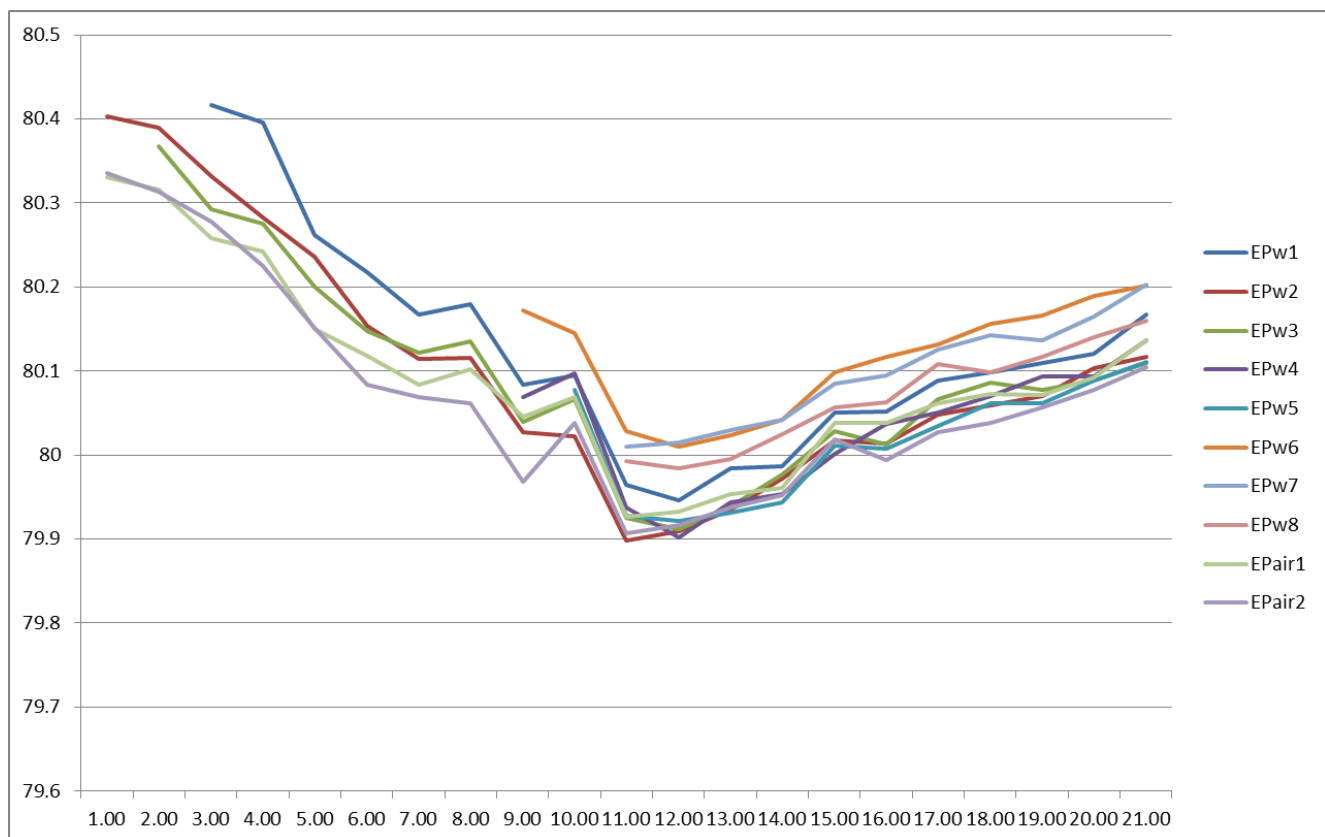


Figure 1. Example of a successful air test.

## 1.2 Preparing the transducer casing

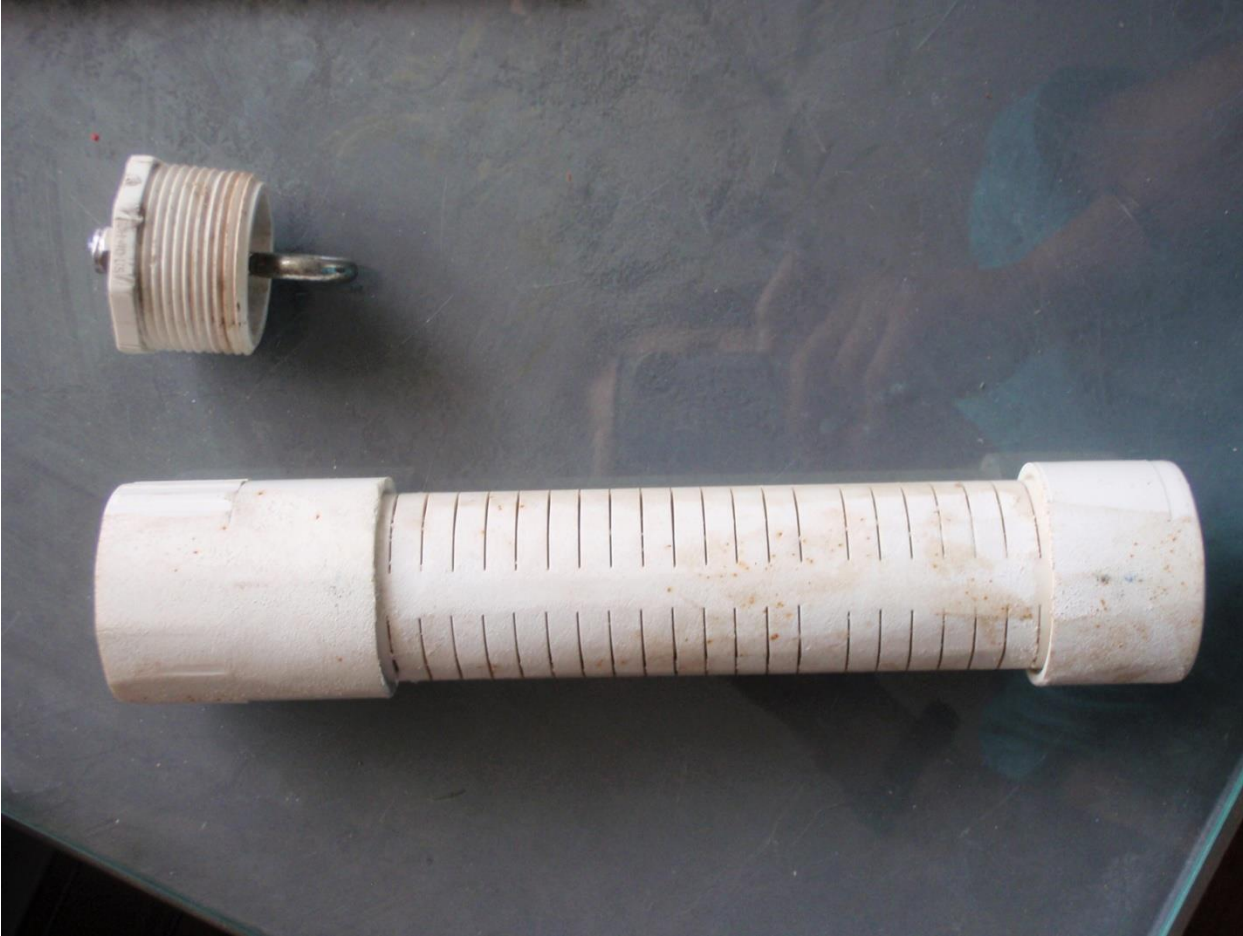


**Figure 2. Example of an air transducer casing. A water transducer casing would not have a cap on the bottom. Many of the water transducer casings will be considerably longer than shown.**

- 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. 2). 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. 3).
- 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. 4). 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. 2). 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 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 3. Ventilation holes drilled in cap with eyebolt.**



**Figure 4. 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 5).



Figure 5. 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 6). Consideration should also be given to taking survey measurements with a rod (can a rod be placed straight up on the eyebolt and reference mark), protection of the transducers from debris, and effects that could result in water being higher at the transducer (circling eddy) than the rest of the river channel.
- B. Hold the logger casing up to the rock, and put a  $\frac{3}{4}$ " wide, U-shaped pipe mounting bracket (Figure 7) snug against the lip of the threaded PVC sleeve on the casing. Mark where the bracket holes are on the rock. Drill a hole big enough for a  $\frac{3}{8}$ " expansion bolt (Figure 8) 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 9). In some cases it may be necessary to have two reference marks, one for easy measurement at low flows and one that is higher for use during peak flows.

- 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. 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 6. Water transducers attached to boulders and painted to match surroundings.



Figure 7. Pipe mounting bracket.

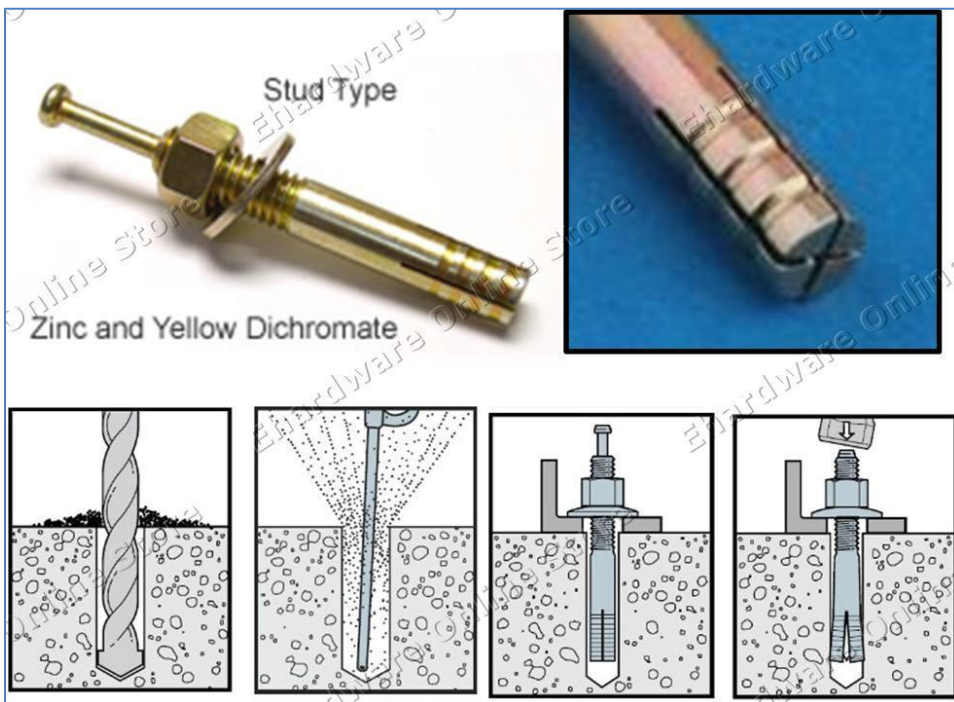


Figure 8. Expansion bolt.



Figure 9. 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.
- N. Record the serial number of the transducer and the following additional measurements on the datasheet (Appendix 1):
  - 1. Reference mark to top of eyebolt
  - 2. Eyebolt to water line
  - 3. Reference mark to water lineNote that at some times the measurement to water may be negative if the reference mark or eyebolt is under water. These three numbers are recorded even though they are somewhat redundant – measurements #1 + #2 = #3. So if these numbers are way off (>1-2 cm), measure again.
- O. Lower the pressure transducer into the casing, and tighten the well cap with pipe wrenches.

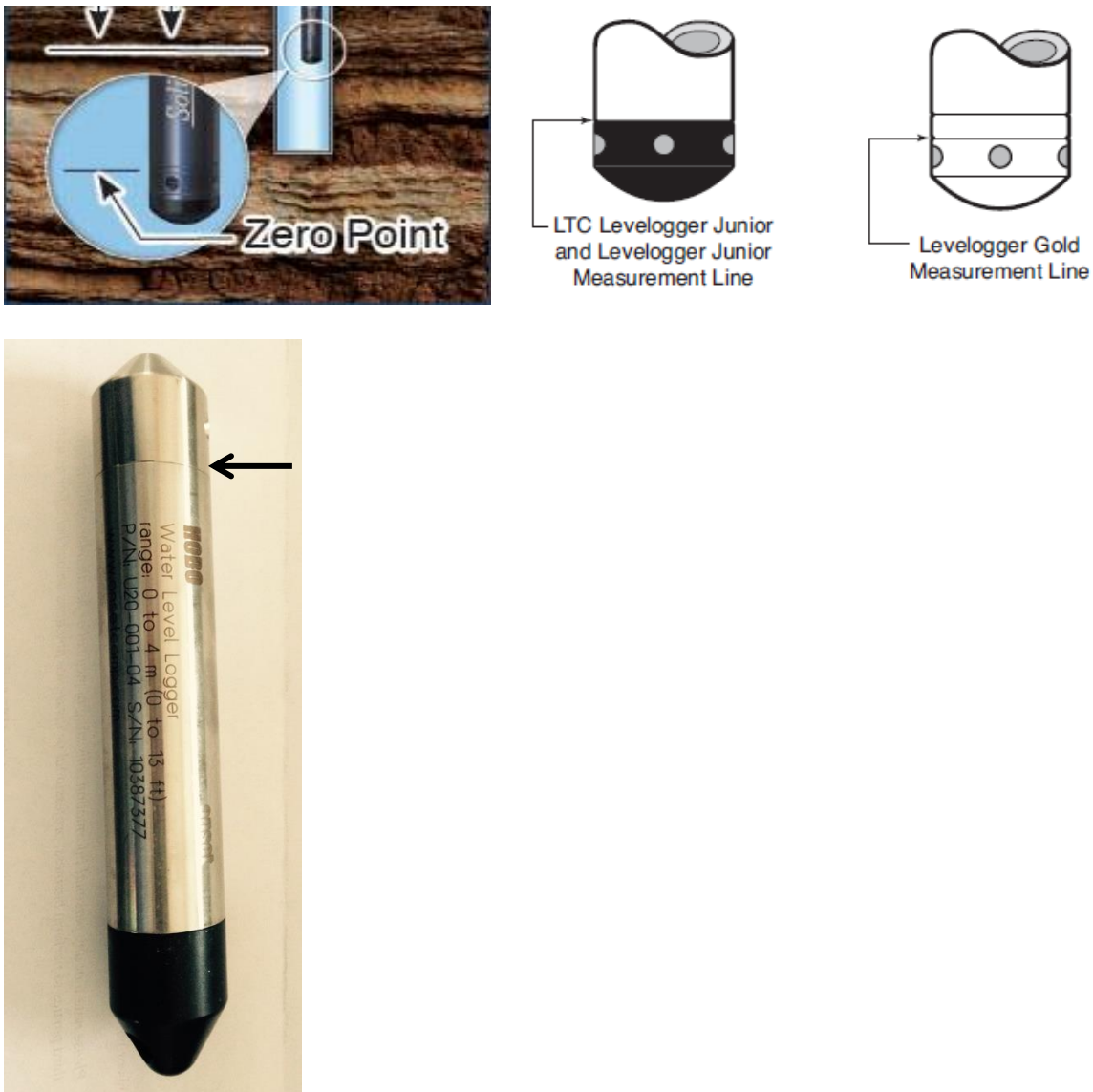


**Figure 10.** Pressure transducer measurement line. The sensor is located in the bottom of the pressure transducer underneath a protective plastic covering with four holes in it. To determine the depth of the pressure transducer sensor to top of eyebolt, align the meter mark on the tape with the appropriate 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 top left, junior in the top middle and Gold on the top right and Hobo on the bottom. The measurement lines are denoted by black arrows.

## 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 data sheets in Appendix 1.

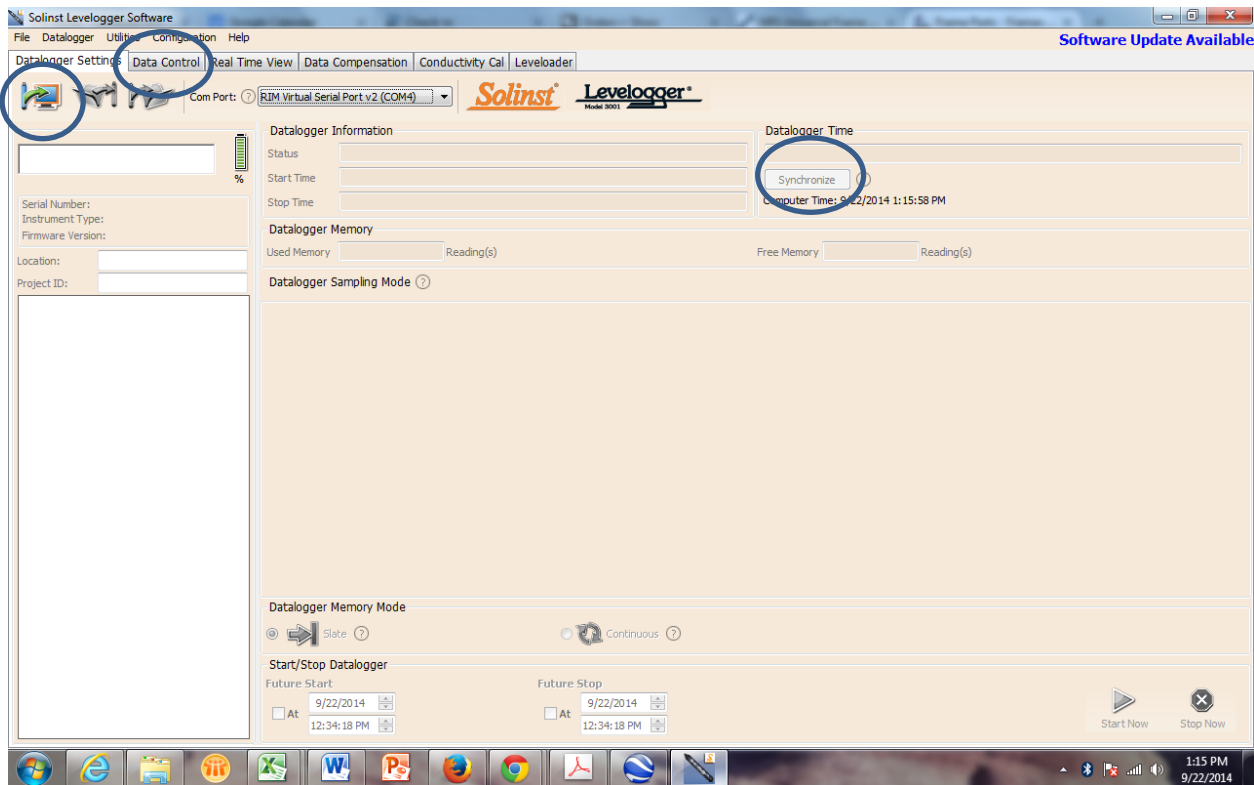
1. Before unscrewing the casing take the following measurements – reference mark to eyebolt, eyebolt to water, and reference mark to water. Note that at some times the measurement to water may be negative

if the reference mark or eyebolt is under water. 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. These three numbers are recorded even though they are somewhat redundant – measurements #1 + #2 = #3. So if these numbers are way off (>1-2 cm), measure again.

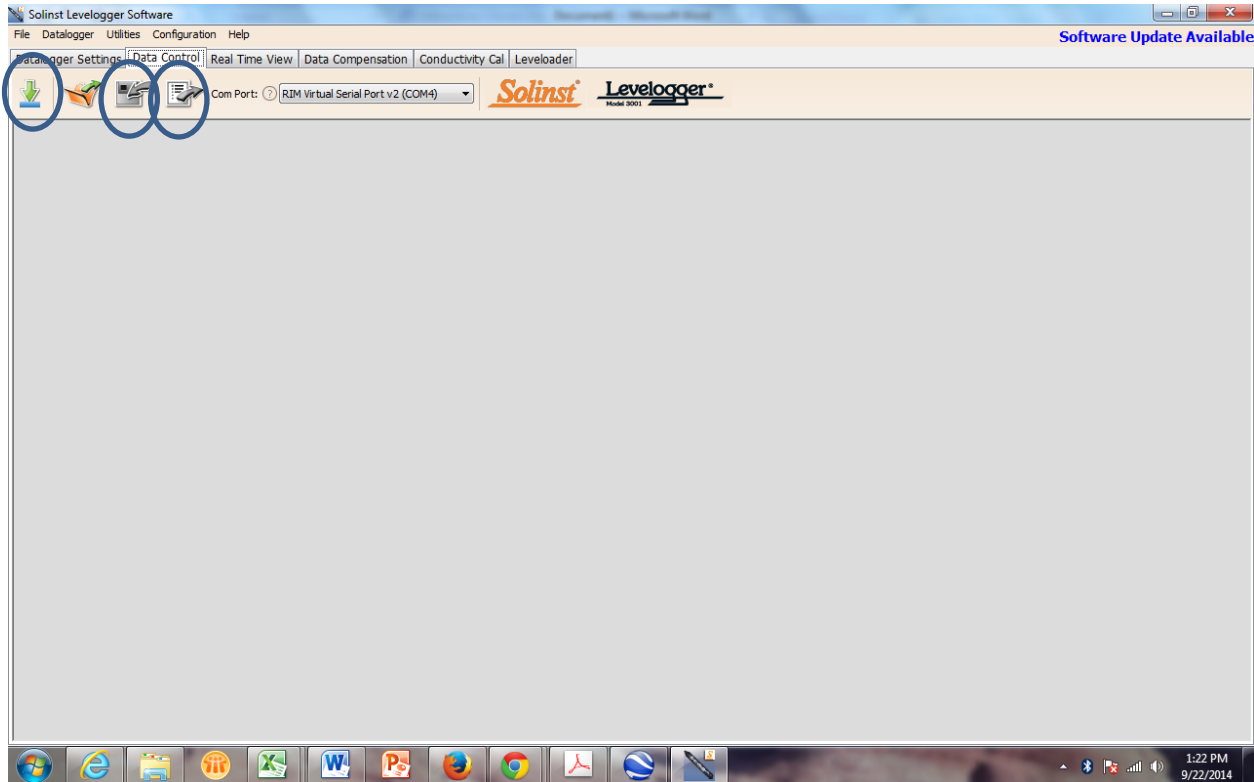
2. Unscrew the cap, remove the instrument, and measure and record Eyebolt to Scribe line (Figure 10).
3. Unscrew the black top (carabeener is attached to this top) to the transducer.
4. Turn on computer.
5. Refer to Solinst Software instructions for CANY and DINO and Hobo software instructions for BLCA.

## Solinst Software – CANY and DINO.

1. Start Solinst Software 4.0.3
2. Unscrew the cap on the transducer and plug into USB the connector that will download the transducer to the laptop.
3. Insert transducer into connector.
4. 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.



5. If it allows you to do so, press the “Synchronize” button to get the times the same.
6. Then press the “Data Control” tab.
7. On the Data Control, press the “Download Data” button. Select “All Data” from the drop down menu. You will see the downloading start. Don’t overwrite data.



8. Once the downloading has been completed, press the “Save File As” button. Save the file as a .xle file. Use the following naming conventions with date – BrownsParkUS071515, BrownsParkDS071515, BrownsParkAir071515, BB091515etc.
9. Now export the data by pressing the “Export Data” button. Export the file as a data (.csv) file and graph (.bmp) 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.
10. 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 1-9 except naming this as a test. If all water transducers are recording within 3 cm, proceed to step 11. 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.
11. 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.
12. 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.
13. Surveyors will also survey the water surface as close to the transducer as possible. Times must be recorded with these measurements.

## **Hobo Software – BLCA. From HOBO Waterproof Shuttle (U-DTW-1) Manual**

1. Start HOBOWare Pro Software 2.2 or greater.
2. Make sure the shuttle's large cap and center cap are closed securely. Tighten the center cap until it is just flush with the large cap, or until the O-ring is no longer visible.
3. Make sure the communication end of the shuttle is clean. Attach the U-20 Water Level coupler for the logger, and ensure that it is seated properly.
4. Insert the logger into the coupler. Make sure groove drops down into coupler.
5. Momentarily press the coupler lever (pressing hard enough so the lever bends). Readout should begin immediately. The amber LED blinks continuously while readout and relaunch are in progress. Do not remove the logger when the amber LED is blinking.
6. After reading out the logger, the shuttle synchronizes the logger's clock to the shuttle's internal clock and relaunches the logger, using the description, channels to log, logging interval, and other settings that are already in the logger. (If the logger was launched with multiple logging intervals, the final defined logging interval will be used.)
7. When the relaunch has completed, the green LED blinks for 15 minutes, or until you momentarily press the coupler lever to stop it (press hard enough so the lever bends). If the red LED blinks instead, there was an error, and the logger may have stopped.
8. Remove the logger from the coupler. The shuttle's memory has 63 "banks." One logger readout can be stored in each bank. To check the shuttle's memory and batteries in the field, remove the logger and press the coupler's lever for at least three seconds (pressing hard enough so the lever bends). When you release the lever, the green LED blinks once for each unoccupied bank in the shuttle's memory. (Press the lever momentarily to stop the blinking, pressing hard enough so the lever bends.) If the shuttle's batteries are running low, all of the shuttle banks are full, or the clock has not been set, the red LED blinks. (Press the lever momentarily to stop the blinking, pressing hard enough so the lever bends) Use HOBOWare to check the shuttle's battery level, available memory, and clock. You may need to change the batteries, or offload the datafiles to the host computer and delete them from the shuttle to free up memory before you can continue reading out loggers.

### **Always check the shuttle batteries prior to going in the field.**

The shuttle's batteries should last about one year or at least 50 complete memory fills in typical conditions. When the shuttle's batteries run low (2.2 V or less), any logger data that is already in the shuttle will remain safe, but the shuttle will not read out another logger until its batteries are replaced. To avoid battery problems, always check the shuttle's batteries in HOBOWare before going into the field, and replace them if needed. If you cannot replace the bad batteries right away, you should remove them as soon as possible to ensure that they do not leak and damage the shuttle.

To change the shuttle's batteries:

1. Work over a clean surface to provide a safe platform for the disassembly.
2. Unscrew the center cap on the shuttle. If the cap is too tight to loosen by hand, insert a screwdriver through the lanyard hole and rotate counterclockwise until the cap is loosened.

3. Use the center cap to help you carefully pull the rubber loop free of the large cap. The large cap cannot be removed while the rubber loop is in place.
4. Turn the large cap counter-clockwise slightly, then pull it off. Turn the shuttle over and tap it gently. The circuit board should slide into your hand.
6. Remove the old batteries and install two new ones in the correct orientation. Both batteries should be turned the same way, with their positive ends facing the USB port on the board. (When the second battery makes contact, all of the shuttle's LEDs will blink in unison.)
7. Put the board back into the case, taking care not to bend the communication LEDs. Align the circuit board with the runners in the case. The USB port should face the open end of the shuttle, and the LEDs should show through the window on the label.
8. Close the shuttle's case. Line up the tabs on the large cap with the slots on the case, press gently, and turn slightly clockwise until the large cap is closed securely.
9. Replace the rubber loop and center cap. Tighten the center cap until it is just flush with the large cap, or until the O-ring is no longer visible.
10. Using HOBOWare, offload any datafiles that are on the shuttle and launch the shuttle before going into the field again. The shuttle will not read out and relaunch loggers until the clock has been synchronized.

**In order to conduct air tests, the data needs to be downloaded to a computer. It is recommended that this be done in the field when possible.**

To offload datafiles from a shuttle to a computer:

1. Connect the shuttle to the computer.
2. Choose Manage Shuttle from the Device menu. Alternate Method: To quickly offload all of the new datafiles that are on the shuttle, choose Readout from the Device menu.
3. Choose files to offload: Waterproof Shuttle - Only the files that have not previously been offloaded and saved are selected by default. To check or uncheck individual files, click the checkbox next to each file. Use the Check All and Uncheck All buttons next to Previously Offloaded Files and New Files (Not Offloaded) to control the selection of these groups of files. To automatically delete files from a Waterproof Shuttle after you offload and save them, enable the Delete Contents Upon Offload option. Files will be automatically deleted only after you successfully save them to the host computer.
4. Offload Files. Click the Offload Checked button to begin offloading the datafiles. Once offloading begins, the Offload Checked button will change to Cancel Offload. When offloading is complete, the Files on Shuttle panel on the Shuttle Management window will change to a Files Offloaded From Shuttle panel. You can now save the files to your computer.

5. Save Folder. The default location for the save is indicated in the Save Folder box. To change to another location, click Choose and browse to the location.
2. Automatically Open Files. To have the folder automatically open on the desktop after the files are saved, check: Open Folder in Windows Explorer after Save.
3. Choose files to save. By default, all of the files you offloaded will be selected for saving. To uncheck individual files, click the checkbox next to each file. To uncheck all files, click the Uncheck All button. To save all files (if you have already unchecked a few), click the Check All button.
4. Datafile Name. Enter a new name if desired.
5. Cancel Save. To exit without saving any files, click Cancel Save.
6. Save Checked. Click this button to save all checked files. The files are saved to the specified folder.
7. To automatically delete files after you offload and save them, enable the Delete Contents Upon Offload option before clicking Offload Checked. Files will be automatically deleted only after you save them. To select specific files to delete, click the checkbox for each unwanted file on the Shuttle Management window. To select all of the files that have already been offloaded, click the Check All button next to Previously Offloaded Files. Then click Delete Checked. To delete all files from a Waterproof Shuttle, whether they have been offloaded or not, click the Launch Shuttle button on the Shuttle Management window to launch the shuttle. This will also reset the shuttle's clock and its Last Launched time.

### **3. Hydrologic Data Processing**

Detailed methods for data archiving and processing are provided in Appendix 2. While in the field, measurements are made on a paper data sheet and entered into the big river database when back from the field. 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.





Page \_\_\_\_ of \_\_\_\_

Date verified:

Big River Monitoring - SOP #7 - Version 1.01 - Aug 2015

Date:     /     /

**Reference Mark** ----> **Waterline**

[illegible]











## 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 |
| Hobo Level Logger 0 to 4 m | HOBOWare 2.2 or greater     |

### 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.

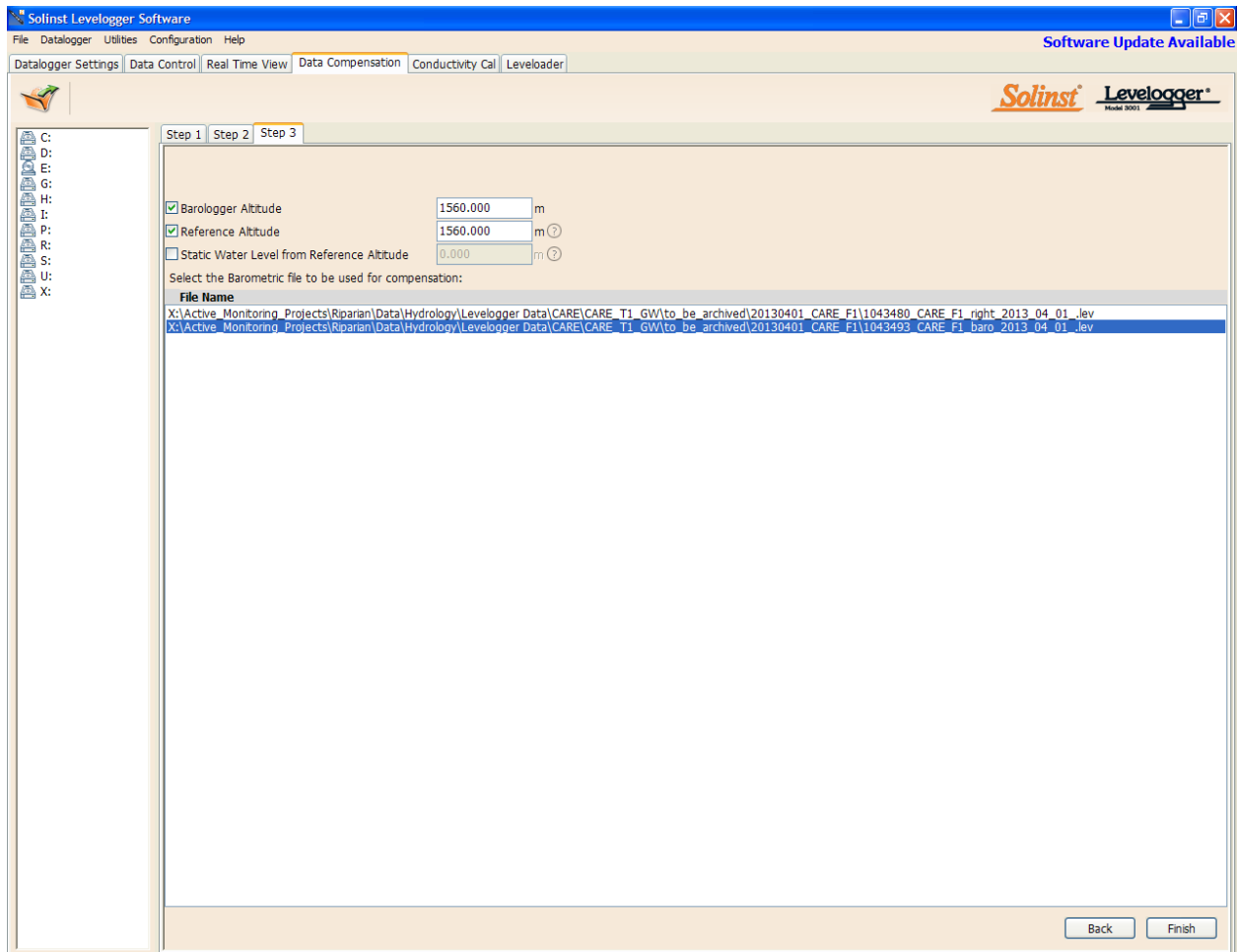
## Barometric Pressure Compensation of Water Level Logger Data

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 or Hobo software depending on transducer type. 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.

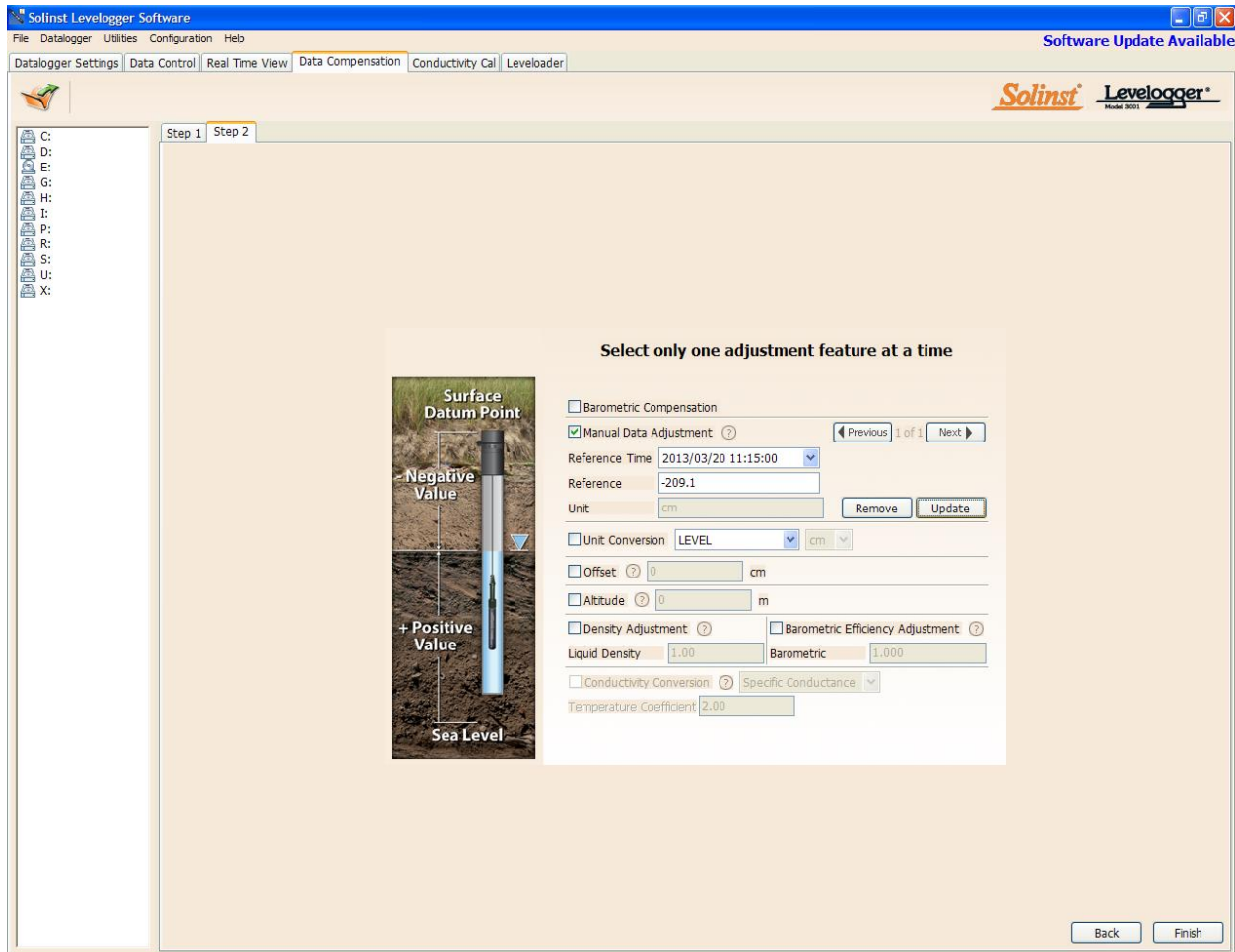
### Software compensation - Solinst

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 appropriate 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.
  - a. 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).
  - b. Select the Data Compensation tab and the compensated dataset, then click next.
  - c. Select Manual Data Adjustment. Choose the date and time corresponding to the equilibrated datapoint noted above.
  - d. 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.
  - e. The software will automatically add the word COMPENSATED to the original levellogger file name and save it in the same location.



5. 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).
6. 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.
7. 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*

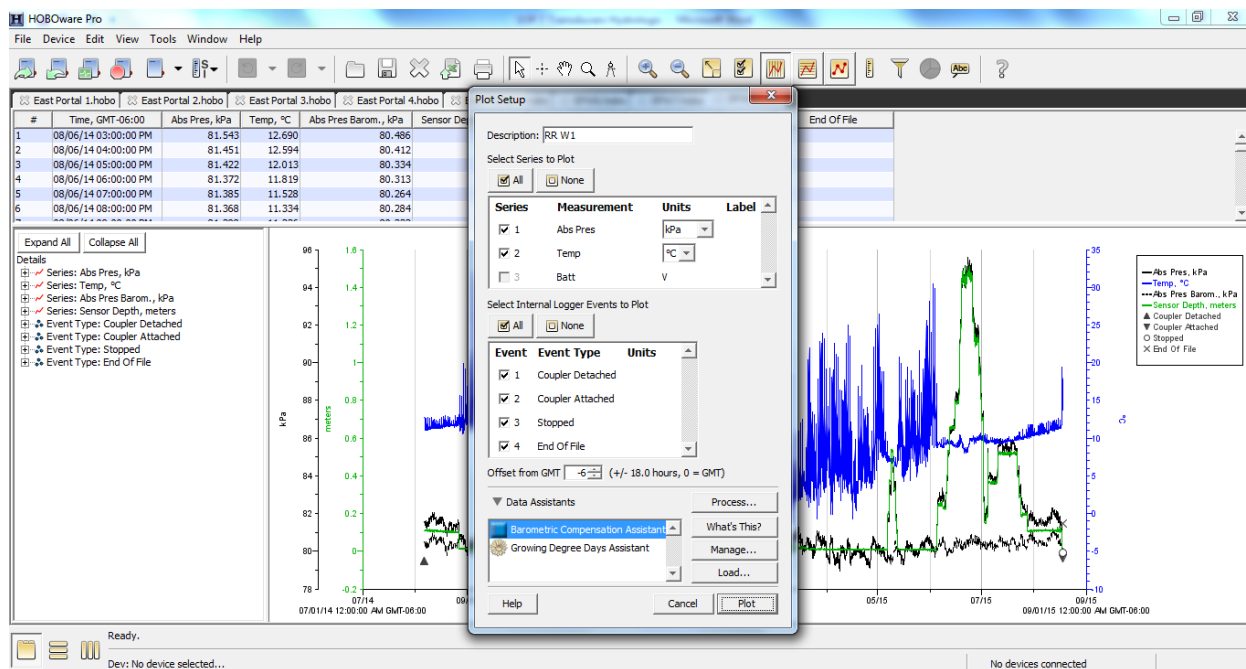
No other routine data corrections are anticipated at this time. However, should the need for additional data corrections arise, make sure each correction is documented using an explanatory note in Aquarius.

### *Approving the time series for data summary and analysis*

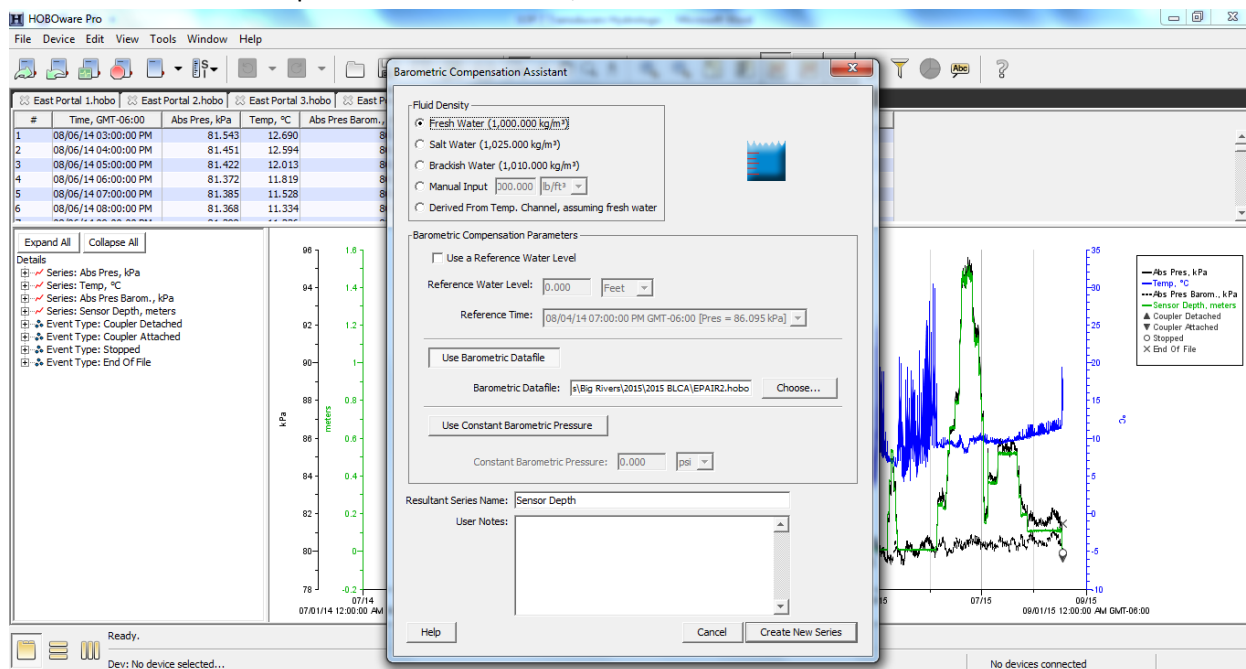
Once the data have been corrected and edited and are ready for use in derived datasets, data summary and analysis, select the appropriate period of record, and select “Set Approval.” Select “Approved,” and apply it to the time series. Save and close.

## Software compensation - Hoboware

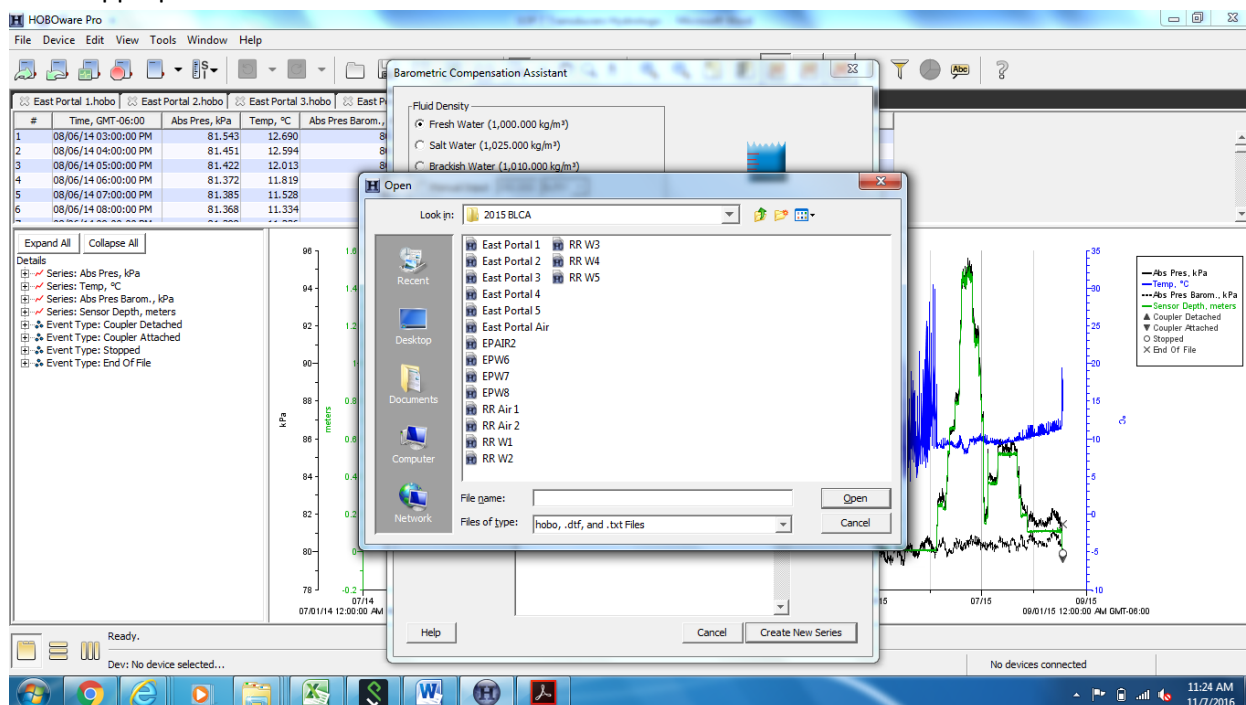
1. Open Solinst Hoboware Software.
2. Open appropriate data file.
3. When Plot Setup window opens, in the “Data Assistants” section select “Barometric Compensation Assistant”, then select “Process”



4. Select “Fresh Water” under “Fluid Density”
5. Under “Barometric Compensation Parameters”, select “Use Barometric Datafile” and “Choose”

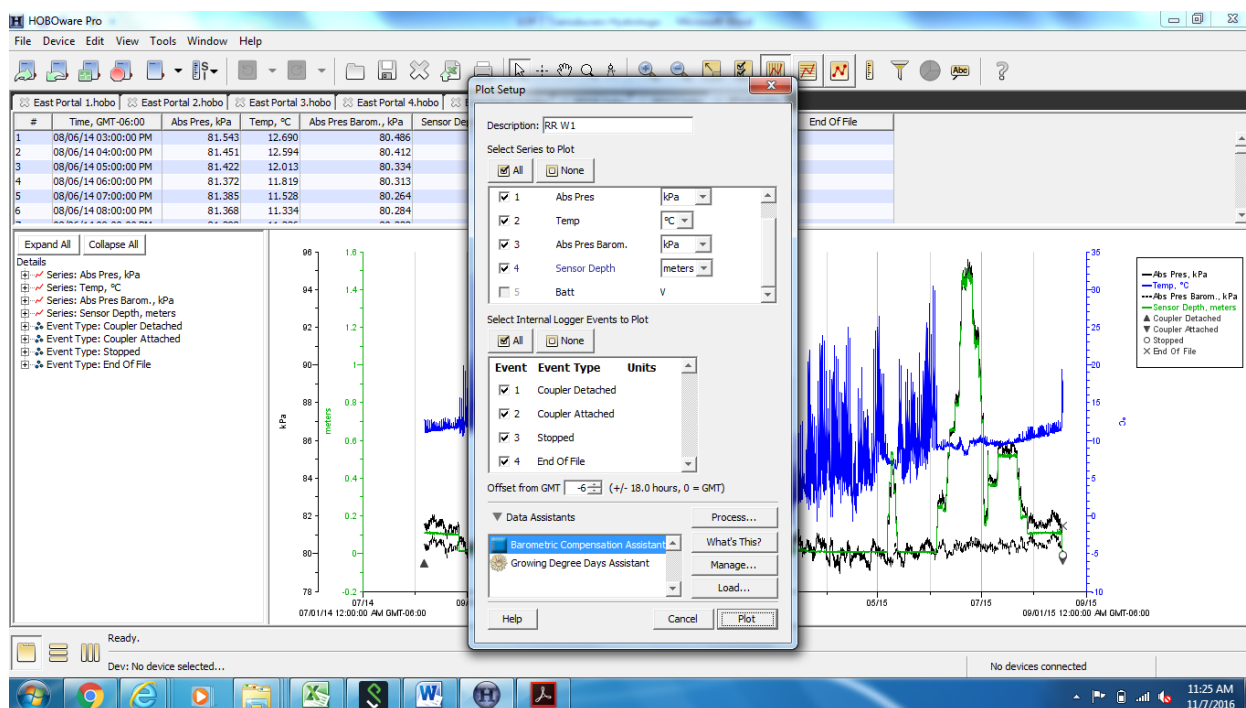


6. Select appropriate air transducer file



7. Select “Create New Series”

8. Select “Plot”



9. Save project file with the following nomenclature, two letter code for site (EP for East Portal or RR for Red Rocks), water or air transducer (W or A), number of transducer (1-8), underscore, and year. For example EPW1\_2015 or RRA2\_2015.

10. Export project as a .csv file with the following nomenclature, two letter code for site (EP for East Portal or RR for Red Rocks), underscore, number of water transducer (W1-8), underscore, compensated, underscore, and year. For example EP\_W1\_compensated\_2015 or RRA\_W2\_compensated\_2015.

## **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 # |
|--------------------|---------------|--------|--------------|-------------------|---------------|
|                    |               |        |              |                   |               |
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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: |
|-------|-------|----------|-------|---------------|-------------|
|-------|-------|----------|-------|---------------|-------------|

| 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.

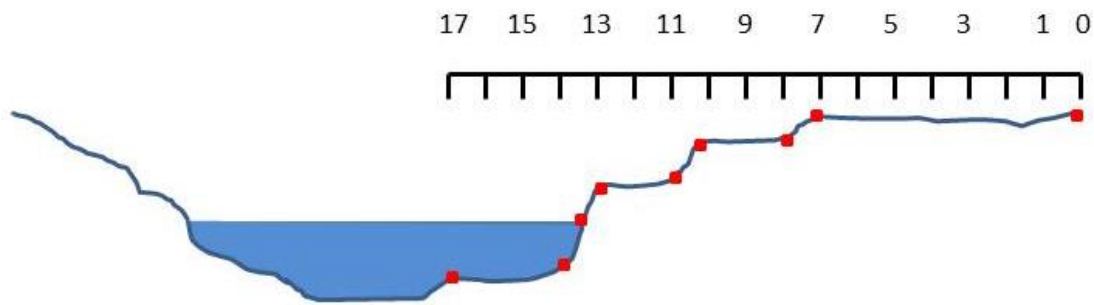


**Figure 2.** Example of slope breaks points (red) and one-meter intervals (black) surveyed.

- 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).

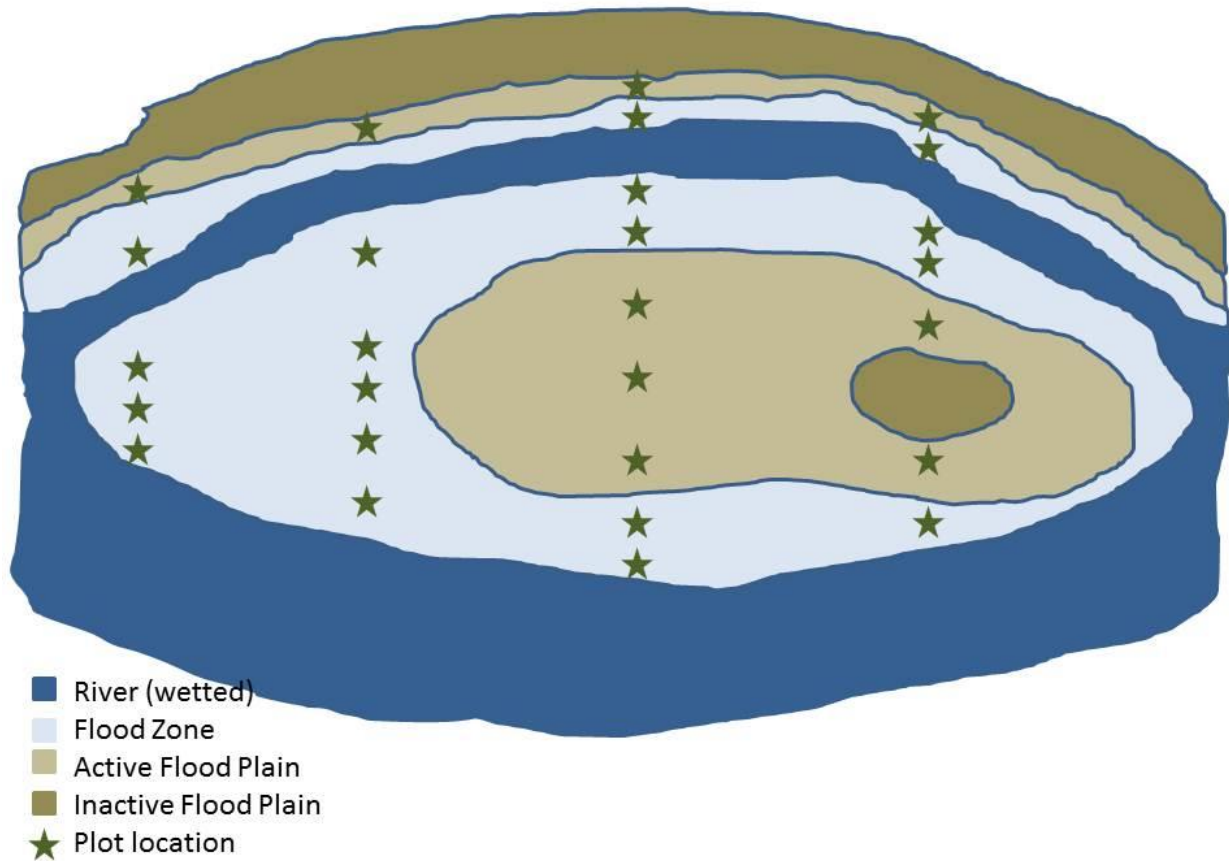


Figure 3. Locations of vegetation plots to be surveyed in. The topographic survey should also capture the boundaries of the geomorphic surfaces shown here.

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.

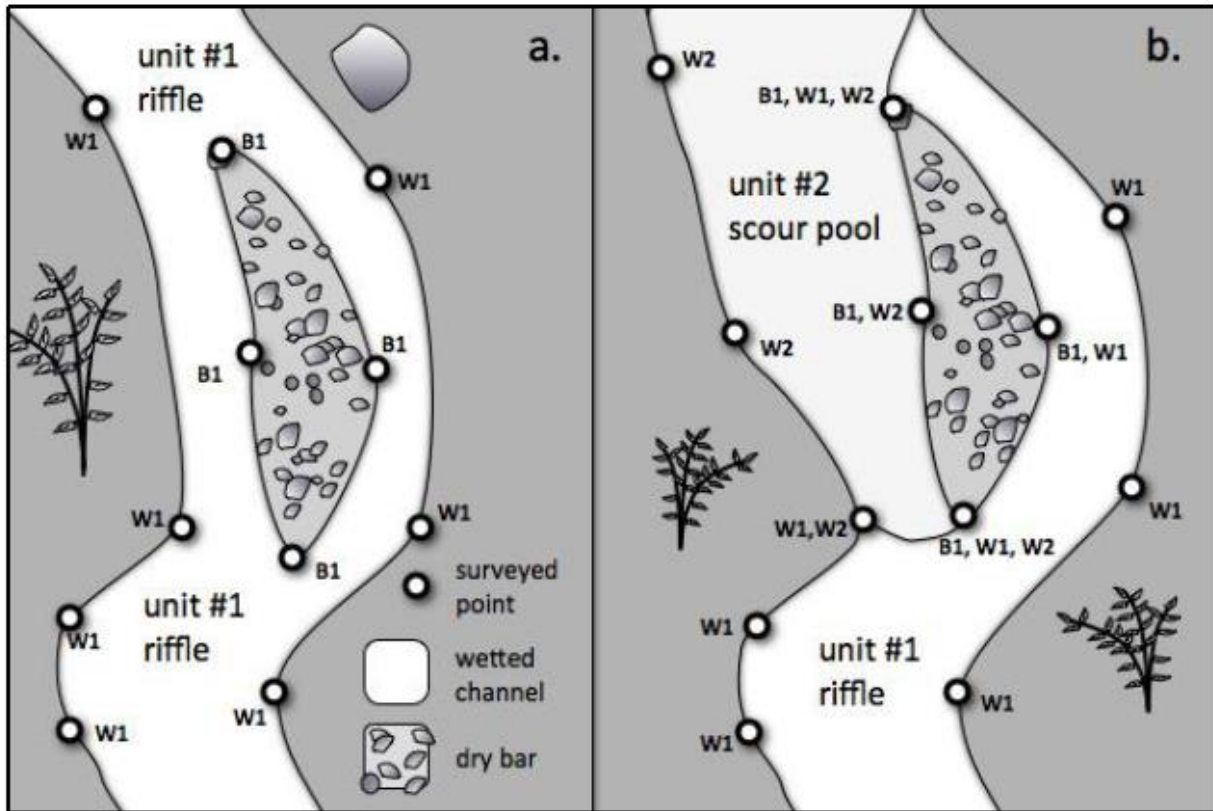


Figure 4. Example of coding points to describe the perimeters of channel units and bars showing which points require multiple codes.

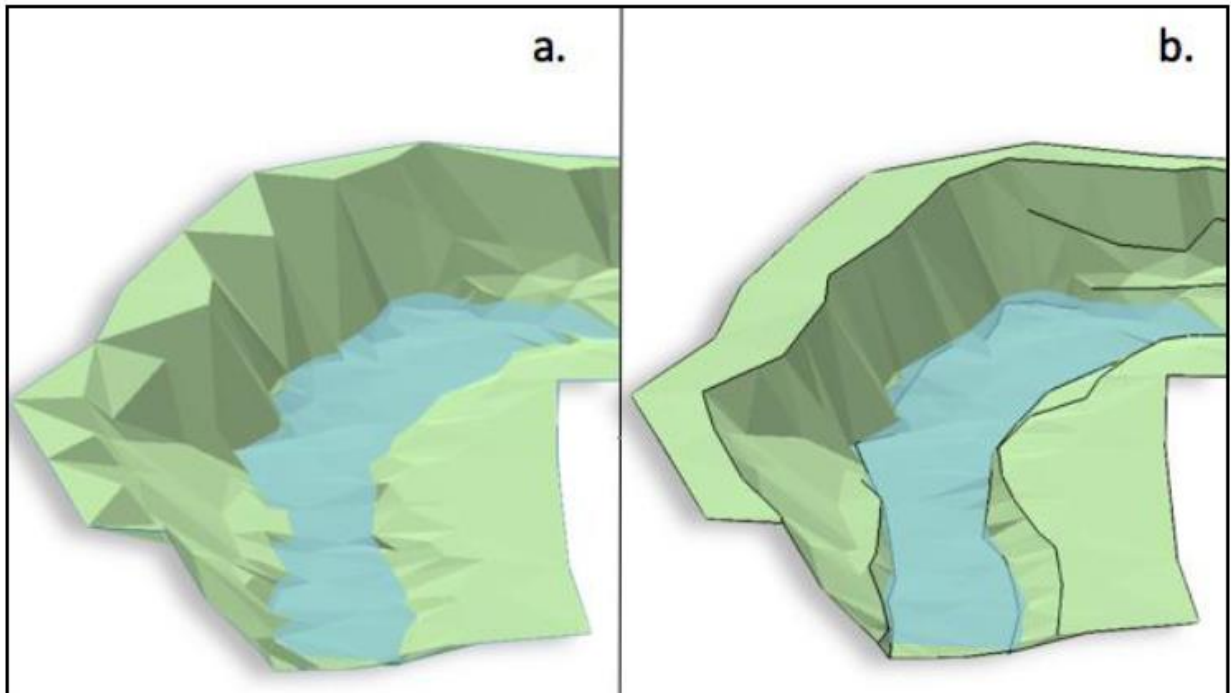


Figure 5. Example of streambank surfaces rendered a) without, and b) with breaklines surveyed at the TOB and TOE of the bank.

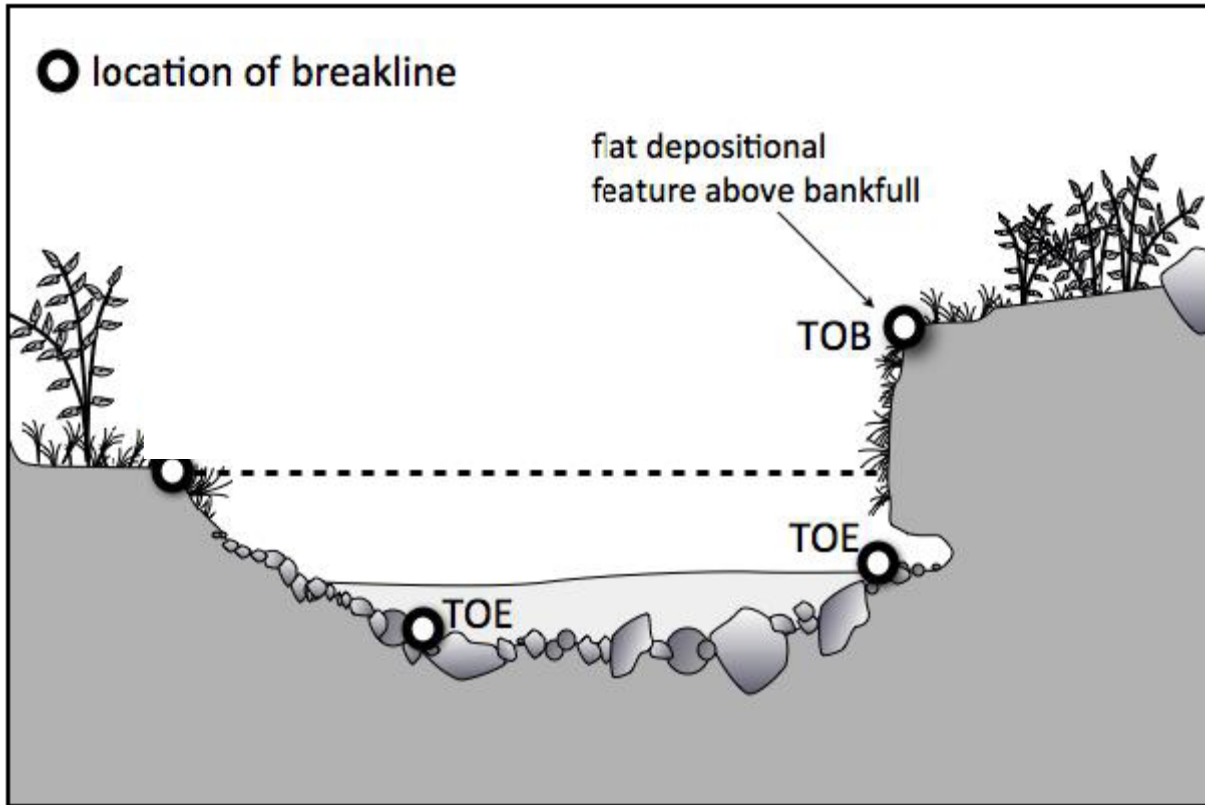


Figure 6. Cross-sectional view of a stream channel demonstrating the appropriate placement of TOB, and TOE breaklines.

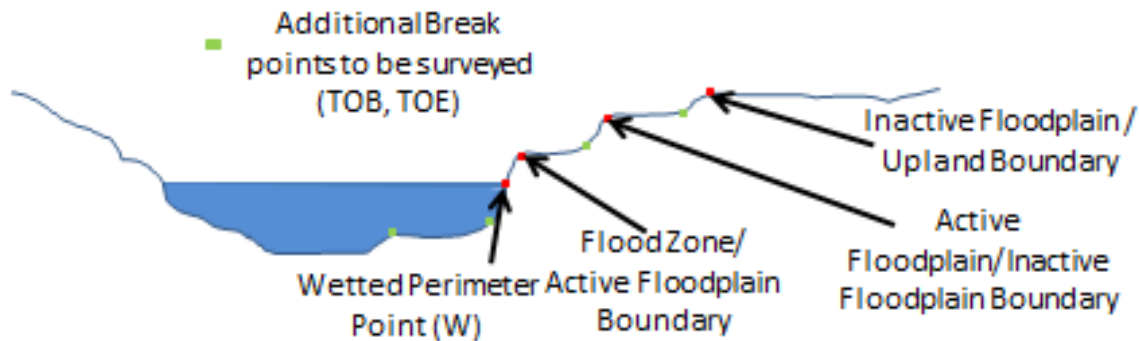


Figure 7. Cross-sectional view of a stream channel demonstrating the wetted perimeter, flood zone, active floodplain, inactive floodplain, upland, and break points.

#### 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.

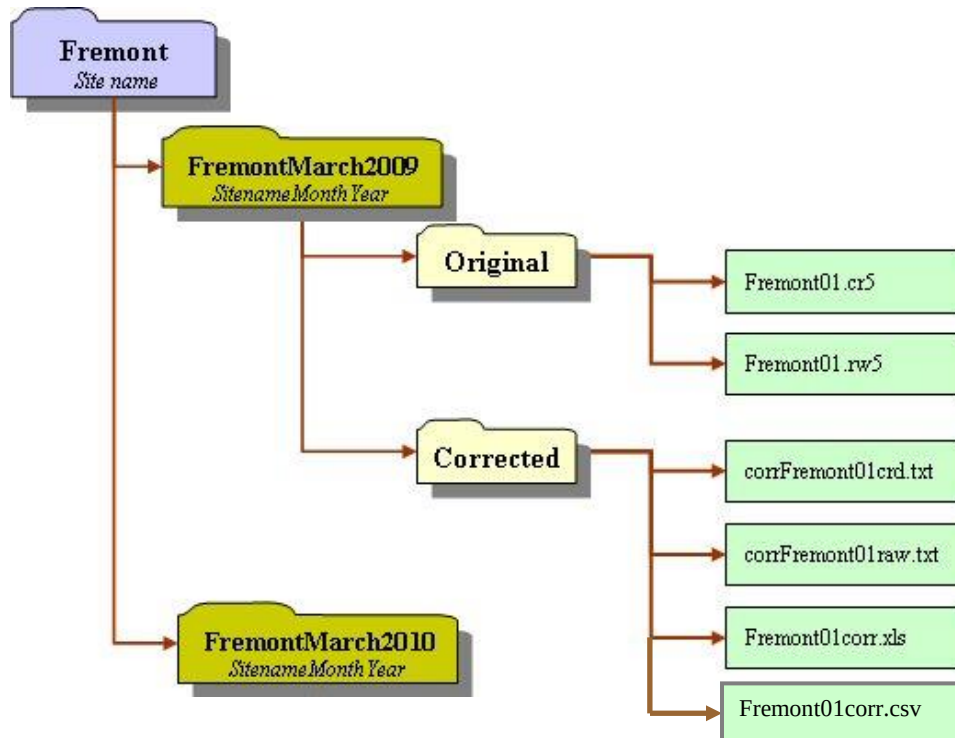


**Figure 3.** Folder and file naming conventions for survey data.

## 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 1.01 (December 2015)**

##### **Revision History Log:**

| Previous Version # | Revision Date | Author     | Changes Made | Reason for Change | New Version # |
|--------------------|---------------|------------|--------------|-------------------|---------------|
| 1.0                | 12/17/15      | D. Perkins | Editorial    | Clarity           | 1.01          |
|                    |               |            |              |                   |               |
|                    |               |            |              |                   |               |
|                    |               |            |              |                   |               |
|                    |               |            |              |                   |               |

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 and RTK 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. Charge RTK equipment.
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 # |
|--------------------|---------------|--------|--------------|-------------------|---------------|
|                    |               |        |              |                   |               |
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|                    |               |        |              |                   |               |
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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 #11. 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.<br>Version # | Revision<br>Date | Author | Changes Made | Reason for Change | New<br>Version # |
|--------------------|------------------|--------|--------------|-------------------|------------------|
|                    |                  |        |              |                   |                  |
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|                    |                  |        |              |                   |                  |

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 or site 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 or site, and sub-samples recorded on plots must be scaled to this level. Vegetation and geomorphology data may be integrated at the transect level, flow level (flow at which the plot inundated), or geomorphic surface (active channel, active floodplain, etc.). Summary queries should be created in Access to expedite this process.

### **Vegetation Summaries**

#### **Richness**

Data from the 1-m plots 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-m<sup>2</sup> quadrats, and reported as the percent of detections.

### **Geomorphology Summaries**

After 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.

#### **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 indicators of active channel, active floodplain, and inactive floodplain plant cover by surface elevation and species richness and percent cover by geomorphic surface and flow 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<sub>i</sub> = 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.

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## **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 Reporting**

### **Annual Briefs**

Each year, information from 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.

### **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.

### **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 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 2).

Table 2. 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.,  $\geq 0.70$ ) 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

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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 1.05 (January 2016)**

##### **Revision History Log:**

| Prev.<br>Version # | Revision<br>Date | Author    | Changes Made                     | Reason for Change                   | New<br>Version # |
|--------------------|------------------|-----------|----------------------------------|-------------------------------------|------------------|
| 1.00               | 1/1/2012         | H. Thomas | Updated master<br>version table. | To reflect new versions<br>of SOPs. | 1.01             |
| 1.01               | 1/1/2013         | H. Thomas | Updated master<br>version table. | To reflect new versions<br>of SOPs. | 1.02             |
| 1.02               | 1/1/2014         | H. Thomas | Updated master<br>version table. | To reflect new versions<br>of SOPs. | 1.03             |
| 1.03               | 1/1/2015         | H. Thomas | Updated master<br>version table. | To reflect new versions<br>of SOPs. | 1.04             |
| 1.04               | 1/1/2016         | H. Thomas | Updated master<br>version table. | To reflect new versions<br>of SOPs. | 1.05             |

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.

[illegible]

## **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) #14

#### Facies Mapping & Grain Size Distribution for Dinosaur NM

##### Version 1.01 (December 2015)

###### Revision History Log:

| Prev. Version # | Revision Date | Author     | Changes Made                       | Reason for Change        | New Version # |
|-----------------|---------------|------------|------------------------------------|--------------------------|---------------|
| 1.0             | 12/17/15      | D. Perkins | Minor wordsmithing and renumbering | Clarity, new SOP numbers | 1.01          |
|                 |               |            |                                    |                          |               |
|                 |               |            |                                    |                          |               |
|                 |               |            |                                    |                          |               |
|                 |               |            |                                    |                          |               |
|                 |               |            |                                    |                          |               |
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|                 |               |            |                                    |                          |               |
|                 |               |            |                                    |                          |               |

This SOP describes the methods for facies mapping and grain size distribution sampling at sentinel sites in Dinosaur National Monument. It covers the years from 2013 to present. 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. Facies mapping should be done towards the end of the sentinel site visit. 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 and proceed to the less dominant facies. The mapping is done either on an iPad or on a hard copy map of the sentinel site. All data is recorded in the description field for the mapped facie on the iPad. 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. In other years, it can be done time permitting. 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. This sketch will correspond with the way the facies were mapped on the iPad.
- 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 will 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.

- Data proofed by:

**Recorder:**

[illegible]

Sketch of Feature with Facies and Locations Labeled



## **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 from 2014 to present. 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**

Ten vegetation transects were randomly placed and are established and surveyed exclusively using GPS units. 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. These transects have been pre-determined and will be programmed into GPS units (Figure 1).

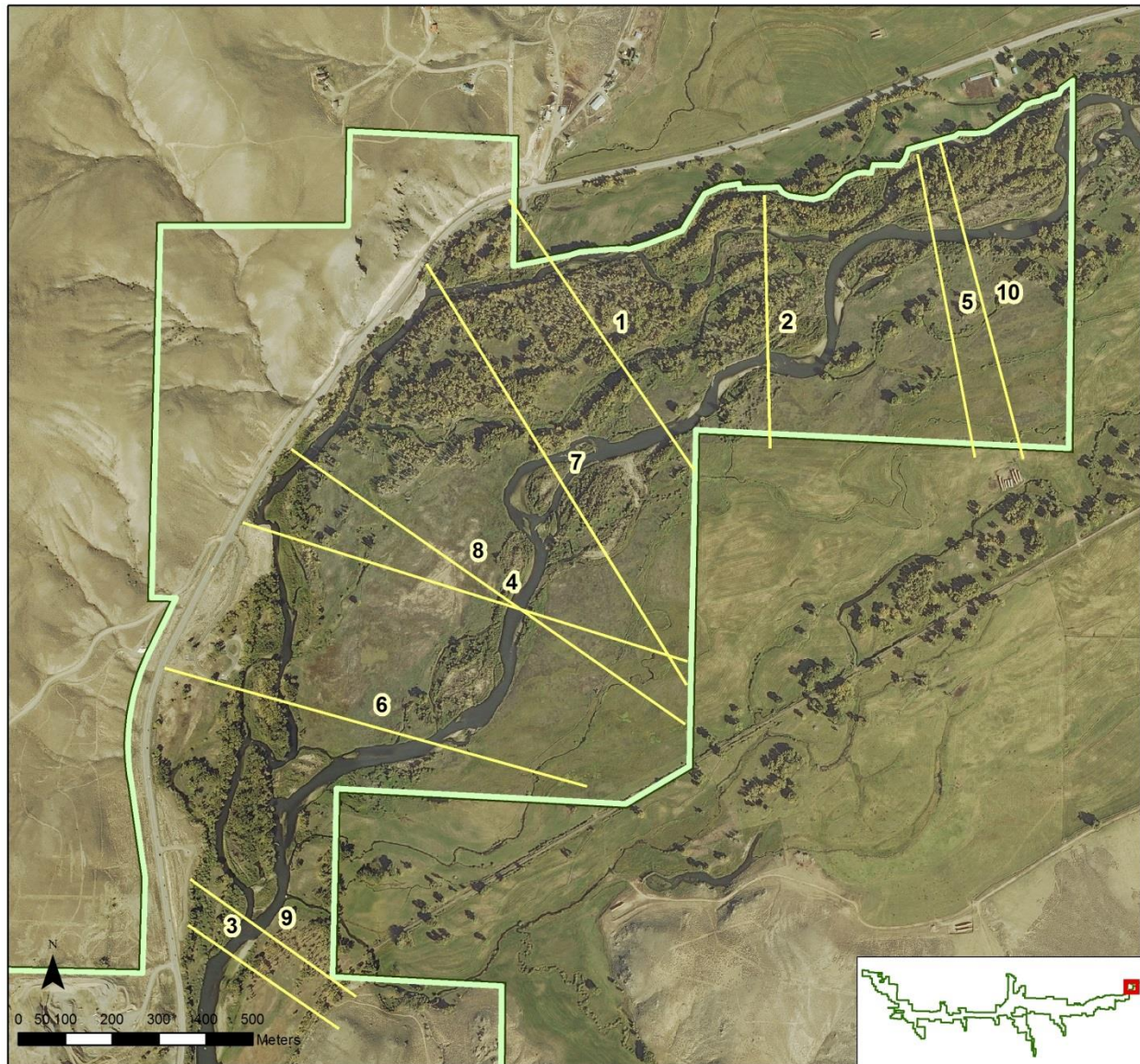


Figure 1. Transects established at Curecanti NRA.

- A. While walking along the transect the observer will record breaks in vegetation, cottonwood size classes, and geomorphology (see below) (Figure 2). The data dictionary will consist of marking the transition zones between each geomorphic surface.
- B. The observer will walk the transects with a GPS beginning at one edge of the transect. Transition zones of the following geomorphic types (Appendix 1) will be recorded as points:
  - a. Water's edge
  - b. Active channel - unvegetated channel/Active flood plain transition. The active channel area that is flooded every 1-2 years. Usually with very low vegetation cover. The active flood plain can be noted by the 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.

- c. Active flood plain/Inactive flood plain transition. The inactive floodplain can be noted by the presence of indicator species (*Conyza canadensis*, *Distichlis spicata*, *Pascopyrum smithii*). This area is rarely flooded, usually every 15-25 years and often looks like an alluvial terrace.
- d. Inactive flood plain/Uplands transistion. Uplands can be noted by the change in vegetation and lack of flooding effects.
- e. Abandoned meander or dry water channel
- f. If there are areas where an abrupt transition (i.e. between active channel and active floodplain) is not evident (the transition area occurs over a larger area), place the point in the middle of this transition area.

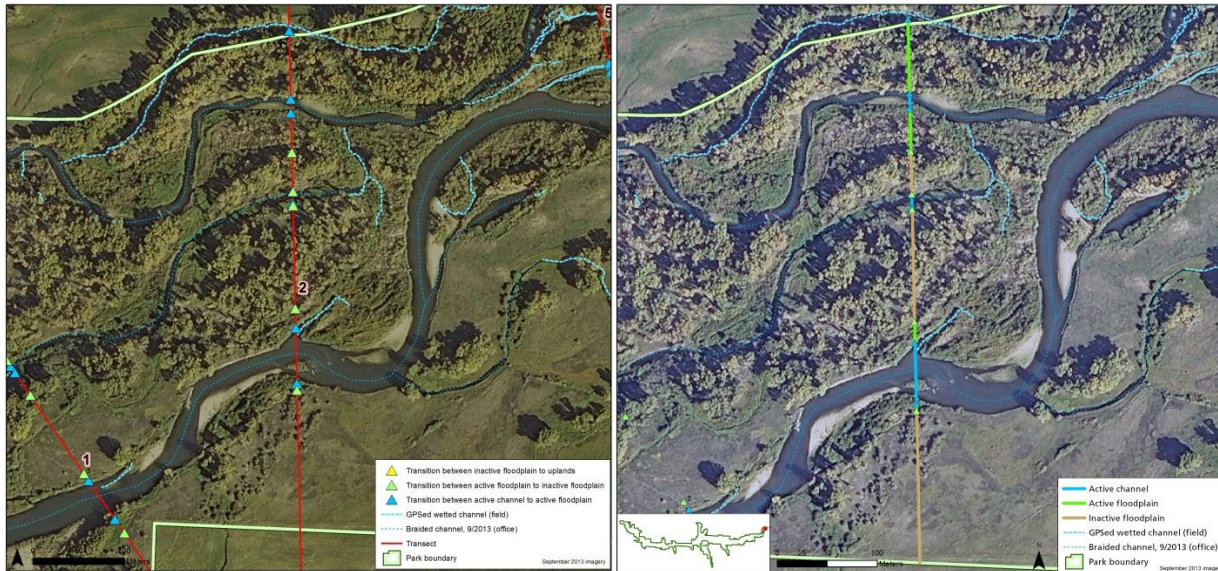


Figure 2. On the left is how geomorphic surfaces are recorded in the field, on the right is the result with the delineations of the geomorphic surfaces.

C. The observer will also record start and stop locations of size classes of narrow-leaf cottonwood (*Populus angustifolia*) (Figure 3). Observers are looking for cohorts in these size classes, not individual trees. Seedlings and saplings arising from beaver-browsed stumps do not count, but if beaver browsing results in any poles, these do count. Only live trees are counted.

- a. Seedlings (<0.25 m in height). There must be at least 5 seedlings within a 10m x 10 m area to mark this as a start of seedlings. This area includes 5m either side of this person while standing on the transect and 10 m in front of them. It is constantly moving with the observer. So if there is >10m without at least 5 seedlings, this is considered a gap and a stop point is established. For seedlings a density measure is applied to the area that is in between the start and stop: “low” is 1-25 individuals/sq m; “medium” is 26-100 individuals/sq m; and “high” is >100 individuals/sq m.

- b. Saplings (0.25 m to 1.37 m in height or <10 cm DBH). The same density rules for starting and stopping seedlings apply to saplings.
- c. Poles (>1.37 m and 10 to 20 cm DBH). Poles are marked when the canopy crossed a transect line. We would imagine a bird's eye view and stand directly below the canopy edge on the transect to mark the point. In order to record a stop, there must be a gap of 25 m. Canopy is started if there is canopy within 5 m of the transect.
- d. Mature cottonwoods (>20 cm DBH). Mature cottonwoods are marked the same as poles.

The above categories are not exclusive, so more than one size class can be recorded at the same point along a transect.

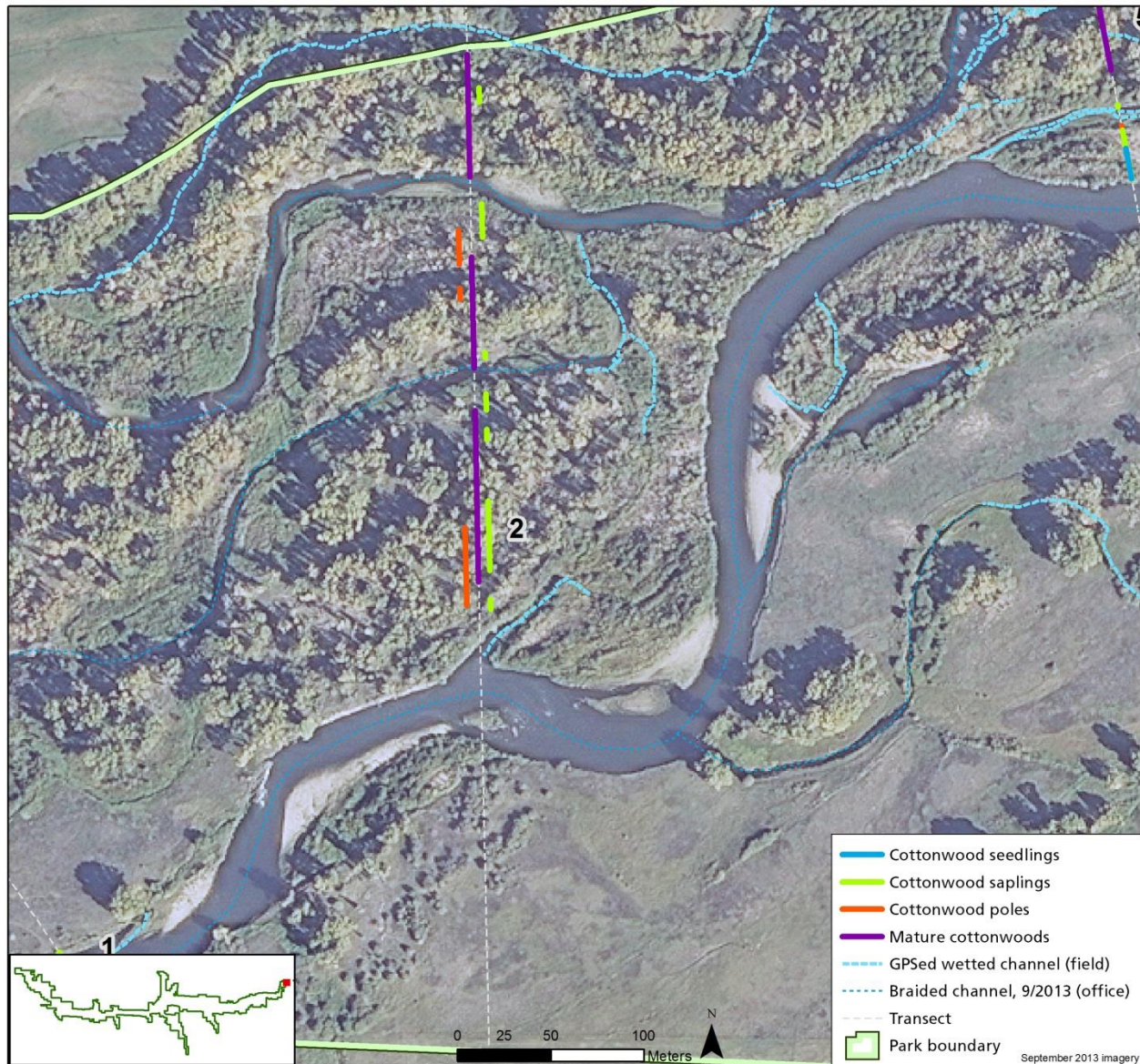


Figure 3. Results of cottonwood size class sampling along transect 2 at Curecanti NRA.

### **1.3 Wetted Channel Location**

Prior to the field hitch, the wetted channel will be delineated using the most recent imagery or the most recent visit. This will be loaded onto GPS units, iPads and hard copy aerial maps. Crew members will verify the current channels or make note with GPS where there current wetted channel does not match the pre-determined line either by drying up or where an avulsion has occurred. When the wetted channels peter out to damp mud depressions with lots of vegetation, note that it is “not wetted”. Intermittent wetted areas along the channel can also be marked. If the area remains wetted and matches the data loaded onto GPS and hard copy maps, nothing needs to be noted.

## **2. Photos**

### **2.1 Overview Photos**

These photos are taken from above the feature.

- A. 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 for repeat visits.
- 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.

### **2.2 Transect photos**

- A. Transect photos are taken along the transects at any river channels, abandoned meanders, secondary channels, or anywhere else we found had a high density of seedlings/saplings. At each point, 4 photos are taken. A chalkboard is included in in the photo (usually someone has to hold the chalkboard to make it visible). Chalkboard is labeled with CURE/T#-PP#/direction/date.
- B. The photo directions are based on the transect line. Upstream (US)/downstream (DS) is perpendicular from the transect line and river right (RR)/river left (RL) is in line with the transect. The direction on the chalkboard also relates to where the photographer was standing and facing (e.g., US ->DS means that photographer was standing on the transect line and facing downstream, RR -> RL means that the photographer was facing river left). Most of the photos are portrait orientation. Occasionally, a photo was taken slightly off the transect line in order to better capture a feature.
- C. GPS the photo location.

- 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 with pre-loaded points 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.

## 2.3 Reference Photos

Take reference photos to document locations of 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), and date.
- 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 subject, direction (facing), digital file name, photographer, and any comments on the Reference Photos data sheet (Appendix 2).

## 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 social media. This information can be filled out on the bottom of the Photo data sheets.

- A. Fill in the type of photograph: Animals, Plants, Cultural, Scenic, Disturbance, Weather, Field Work, other.
- B. Record the photo number, photographer, and a description of the photo.

## Appendix 1 Big Rivers Data Dictionary for Curecanti National Recreation Area

| <b>Observer Feature</b> – This feature identifies who the observer is for the transect. An Observer point should be taken at the beginning of a transect or when the observer and recorder switch positions. |                                                                                                                     |                              |                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| Observer                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>NCPN field crew name</li> <li>NCPN field crew name</li> <li>Other</li> </ul> | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                                                                      | Any comments regarding the observer.                                                                                | Entry permitted in the field | Text – Optional |
| <b>WaterEdge Feature (Water's edge)</b> - This feature maps the start and stop of the water's edge.                                                                                                          |                                                                                                                     |                              |                 |
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| StartStop                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                               | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                                                                      | Any comments/notes regarding this transducer                                                                        | Entry permitted in the field | Text – Optional |
| <b>AFP_AC Feature (Active floodplain/Active channel)</b> - This feature maps the boundary of inactive vs active floodplain zone (or vice versa)                                                              |                                                                                                                     |                              |                 |
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| Comment                                                                                                                                                                                                      | Comments about the AFP_AC transition point                                                                          | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                                        | Any comments/notes regarding this point                                                                             | Entry permitted in the field | Text – Optional |
| <b>IFP_AFP (Inactive floodplain/active fp) Feature</b> – This feature maps the boundary of the transition between inactive and active floodplain (or vice versa)                                             |                                                                                                                     |                              |                 |
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| Comment                                                                                                                                                                                                      | Comments about the IFP_AFP transition point                                                                         | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                                                                        | Any additional notes about the transition point                                                                     | Entry permitted in the field | Text – Optional |
| <b>IFP_Upland (Inactive floodplain/uplands) Feature</b> – This feature maps the transition zone between inactive floodplain and upland zone. (or vice versa)                                                 |                                                                                                                     |                              |                 |
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| Comment                                                                                                                                                                                                      | Any comments about the route feature                                                                                | Entry permitted in the field | Text – Optional |
| <b>DryChannel (Dry water channel (Abandoned meander))</b> – This feature maps the start and stop when a dry channel bed is crossed by the transect. GPS both a start and stop for this feature.              |                                                                                                                     |                              |                 |
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| StartStop                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                               | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                                                                      | Any comments about the start or stop of the dry channel point.                                                      | Entry permitted in the field | Text – Optional |
| <b>SeedlingCottonwood (Seedlings(&lt;.25m in height))</b> - This feature maps the start and stop of a population of seedling cottonwoods.                                                                    |                                                                                                                     |                              |                 |
| Attributes                                                                                                                                                                                                   | Attribute Explanation                                                                                               | Entry                        | Type            |
| StartStop                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                               | Entry permitted in the field | Menu            |

|                                                                                                                                                         |                                                                                                                                  |                              |                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|
| Comment                                                                                                                                                 | Any comments about the start or stop of the cottonwood seedling population.                                                      | Entry permitted in the field | Text – Optional |
| <b>SaplingCottonwood (Sapling(.25 – 1.37m in height or &lt;5cm DBH))</b> - This feature maps the start and stop of a population of sapling cottonwoods. |                                                                                                                                  |                              |                 |
| <b>Attributes</b>                                                                                                                                       | <b>Attribute Explanation</b>                                                                                                     | <b>Entry</b>                 | <b>Type</b>     |
| StartStop                                                                                                                                               | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                                            | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                 | Any comments about the start or stop of the cottonwood sapling population.                                                       | Entry permitted in the field | Text – Optional |
| <b>PolesCottonwood (Sapling(&gt;1.37m in height, 5-25cm DBH))</b> - This feature maps the start and stop of a population of pole cottonwoods.           |                                                                                                                                  |                              |                 |
| <b>Attributes</b>                                                                                                                                       | <b>Attribute Explanation</b>                                                                                                     | <b>Entry</b>                 | <b>Type</b>     |
| StartStop                                                                                                                                               | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                                            | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                 | Any comments about the start or stop of the cottonwood pole population.                                                          | Entry permitted in the field | Text – Optional |
| <b>MatureCottonwood (Mature (&gt;25cm DBH))</b> - This feature maps the start and stop of a population of mature cottonwoods.                           |                                                                                                                                  |                              |                 |
| <b>Attributes</b>                                                                                                                                       | <b>Attribute Explanation</b>                                                                                                     | <b>Entry</b>                 | <b>Type</b>     |
| StartStop                                                                                                                                               | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                                            | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                 | Any comments about the start or stop of the cottonwood mature population.                                                        | Entry permitted in the field | Text – Optional |
| <b>ReedCanaryGrass (Phalaris arundinacea)</b> - This feature maps the start and stop of a population of mature cottonwoods.                             |                                                                                                                                  |                              |                 |
| <b>Attributes</b>                                                                                                                                       | <b>Attribute Explanation</b>                                                                                                     | <b>Entry</b>                 | <b>Type</b>     |
| StartStop                                                                                                                                               | <ul style="list-style-type: none"> <li>Start</li> <li>Stop</li> </ul>                                                            | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                 | Any comments about the start or stop of the cottonwood mature population.                                                        | Entry permitted in the field | Text – Optional |
| <b>PhotoPt</b> - This feature maps the locations where photos were taken along the transects and site overview photos.                                  |                                                                                                                                  |                              |                 |
| <b>Attributes</b>                                                                                                                                       | <b>Attribute Explanation</b>                                                                                                     | <b>Entry</b>                 | <b>Type</b>     |
| PhotoNum                                                                                                                                                | Unique photo number. Transect # - Photo number (example: T3-PP2)                                                                 | Entry permitted in the field | Text – Optional |
| PhotoType                                                                                                                                               | <ul style="list-style-type: none"> <li>Transect photo</li> <li>Overview photo</li> <li>Reference photo</li> <li>Other</li> </ul> | Entry permitted in the field | Menu            |
| Comment                                                                                                                                                 | Any comments about the photo location                                                                                            | Entry permitted in the field | Text – Optional |
| Notes                                                                                                                                                   | Any other addition notes about the photo location                                                                                | Entry permitted in the field | Text – Optional |
| <b>Other</b> – This feature can be used to map any incidental observations.                                                                             |                                                                                                                                  |                              |                 |
| <b>Attributes</b>                                                                                                                                       | <b>Attribute Explanation</b>                                                                                                     | <b>Entry</b>                 | <b>Type</b>     |
| Comment                                                                                                                                                 | Any comments about the photo location                                                                                            | Entry permitted in the field | Text – Optional |

|                                                                                                                                                                               |                                                   |                              |                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|------------------------------|-----------------|
| Notes                                                                                                                                                                         | Any other addition notes about the photo location | Entry permitted in the field | Text – Optional |
| <b>WettedChannel (wetted channel)</b> – This line feature is to be used to map channels containing water that are not already displayed on the GPS unit.                      |                                                   |                              |                 |
| <b>Attributes</b>                                                                                                                                                             | <b>Attribute Explanation</b>                      | <b>Entry</b>                 | <b>Type</b>     |
| Not Wetted                                                                                                                                                                    | Channel is no longer wetted                       | Not wetted                   | Text – Optional |
| Comments                                                                                                                                                                      | Comments about the channel line                   | Entry permitted in the field | Text – Optional |
| <b>Route</b> – This line feature is to be used to map routes to/from a site that would aide future field crews through the easiest path. Generally, GPS this on the way back. |                                                   |                              |                 |
| <b>Attributes</b>                                                                                                                                                             | <b>Attribute Explanation</b>                      | <b>Entry</b>                 | <b>Type</b>     |
| Comments                                                                                                                                                                      | Comments about the route                          | Entry permitted in the field | Text – Optional |

## Transect Photos

## NCPN Big River Monitoring

Date:

## Other photos

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

Data entered  
by:

NCPN Big River Monitoring

Date:

[illegible]