Greater Yellowstone Network Upland Vegetation Monitoring Protocol

*Standard Operating Procedures, Version 1.0*

Natural Resource Report NPS/GRYN/NRR—2013/624
ON THE COVER
(Clockwise starting in upper left): Juniper-mountain mahogany woodland, sample quadrat, juniper woodland, and sagebrush steppe shrub and grassland
Photograph by (clockwise starting in upper left): Ryan E. Baum and Charles Peterson, NPS, NPS, Ryan E. Baum and Charles Peterson
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Standard Operating Procedures, Version 1.0

Natural Resource Report NPS/GRYN/NRR—2013/624

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January 2013

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado
The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This protocol uses methods based on an established peer-reviewed protocol. Additional formal peer review was received by a subject-matter expert not directly involved in the development of the sample design and sample size analysis, and whose background and expertise put them on par technically and scientifically with the authors.

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Please cite this publication as:

## Contents

<table>
<thead>
<tr>
<th>Standard Operating Procedure (SOP) 1: Field Safety</th>
<th>SOP 1-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change History</td>
<td>SOP 1-1</td>
</tr>
<tr>
<td>Required Reading</td>
<td>SOP 1-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 1-1</td>
</tr>
<tr>
<td>Risks Inherent in Upland Vegetation Monitoring</td>
<td>SOP 1-2</td>
</tr>
<tr>
<td>Procedures</td>
<td>SOP 1-2</td>
</tr>
<tr>
<td>Safety Cautions</td>
<td>SOP 1-4</td>
</tr>
<tr>
<td>Reference Materials</td>
<td>SOP 1-4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard Operating Procedure (SOP) 2: Field Preparation and Season Close-Out</th>
<th>SOP 2-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change History</td>
<td>SOP 2-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 2-1</td>
</tr>
<tr>
<td>Procedures</td>
<td>SOP 2-2</td>
</tr>
<tr>
<td>List of Field Equipment</td>
<td>SOP 2-5</td>
</tr>
<tr>
<td>Field Reference Manual</td>
<td>SOP 2-6</td>
</tr>
<tr>
<td>File Storage Box</td>
<td>SOP 2-6</td>
</tr>
<tr>
<td>Vehicle Safety Binder</td>
<td>SOP 2-6</td>
</tr>
<tr>
<td>Reference Materials</td>
<td>SOP 2-10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard Operating Procedure (SOP) 3: Training Observers</th>
<th>SOP 3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change History</td>
<td>SOP 3-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 3-1</td>
</tr>
<tr>
<td>Procedures</td>
<td>SOP 3-2</td>
</tr>
</tbody>
</table>
# Contents (continued)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training</td>
<td>SOP 3-3</td>
</tr>
<tr>
<td>Sample Training Agenda</td>
<td>SOP 3-4</td>
</tr>
<tr>
<td>Training Procedures</td>
<td>SOP 3-5</td>
</tr>
<tr>
<td>Taxonomic and Other Reference Materials</td>
<td>SOP 3-10</td>
</tr>
<tr>
<td><strong>Standard Operating Procedure (SOP) 4: Locating and Establishing Sampling Quadrats</strong></td>
<td>SOP 4-1</td>
</tr>
<tr>
<td>Change History</td>
<td>SOP 4-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 4-1</td>
</tr>
<tr>
<td>Procedures</td>
<td>SOP 4-2</td>
</tr>
<tr>
<td>Reference Materials</td>
<td>SOP 4-4</td>
</tr>
<tr>
<td><strong>Standard Operating Procedure (SOP) 5: Measuring Plant Community Attributes</strong></td>
<td>SOP 5-1</td>
</tr>
<tr>
<td>Change History</td>
<td>SOP 5-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 5-1</td>
</tr>
<tr>
<td>Procedures for Measuring Ground and Vegetation Cover</td>
<td>SOP 5-2</td>
</tr>
<tr>
<td>Procedures for Photography</td>
<td>SOP 5-3</td>
</tr>
<tr>
<td>Reference Materials</td>
<td>SOP 5-6</td>
</tr>
<tr>
<td><strong>Standard Operating Procedure (SOP) 6: Data Management</strong></td>
<td>SOP 6-1</td>
</tr>
<tr>
<td>Change History</td>
<td>SOP 6-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 6-1</td>
</tr>
<tr>
<td>Data Management Tasks in the Project Information Life Cycle</td>
<td>SOP 6-2</td>
</tr>
<tr>
<td>Project Stage: Preparation</td>
<td>SOP 6-5</td>
</tr>
<tr>
<td>Project Stage: Data Acquisition, Entry, and Processing</td>
<td>SOP 6-23</td>
</tr>
<tr>
<td>Project Stage: Quality Review</td>
<td>SOP 6-31</td>
</tr>
<tr>
<td>Project Stage: Metadata</td>
<td>SOP 6-34</td>
</tr>
<tr>
<td>Contents (continued)</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Project Stage: Data Certification and Delivery</td>
<td>SOP 6-37</td>
</tr>
<tr>
<td>Project Stage: Data Delivery</td>
<td>SOP 6-38</td>
</tr>
<tr>
<td>Project Stage: Product Development</td>
<td>SOP 6-41</td>
</tr>
<tr>
<td>Project Stage: Posting and Distribution</td>
<td>SOP 6-42</td>
</tr>
<tr>
<td>Project Stage: Archival and Records Management</td>
<td>SOP 6-45</td>
</tr>
<tr>
<td>Reference Materials</td>
<td>SOP 6-45</td>
</tr>
<tr>
<td>Standard Operating Procedure (SOP) 7: Data Analysis and Reporting</td>
<td>SOP 7-1</td>
</tr>
<tr>
<td>Change History</td>
<td>SOP 7-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 7-1</td>
</tr>
<tr>
<td>Procedures</td>
<td>SOP 7-2</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>SOP 7-2</td>
</tr>
<tr>
<td>Step by Step instructions for using R-code for annual data analysis</td>
<td>SOP 7-5</td>
</tr>
<tr>
<td>Sample Design Analysis Techniques</td>
<td>SOP 7-7</td>
</tr>
<tr>
<td>Reporting</td>
<td>SOP 7-8</td>
</tr>
<tr>
<td>Annual Report</td>
<td>SOP 7-8</td>
</tr>
<tr>
<td>Resource Briefs</td>
<td>SOP 7-10</td>
</tr>
<tr>
<td>Trend Report</td>
<td>SOP 7-11</td>
</tr>
<tr>
<td>Weed Location Data</td>
<td>SOP 7-11</td>
</tr>
<tr>
<td>Reference Materials</td>
<td>SOP 7-12</td>
</tr>
<tr>
<td>Standard Operating Procedure (SOP) 8: Protocol Revision</td>
<td>SOP 8-1</td>
</tr>
<tr>
<td>Change History</td>
<td>SOP 8-1</td>
</tr>
<tr>
<td>Overview</td>
<td>SOP 8-1</td>
</tr>
<tr>
<td>Procedures</td>
<td>SOP 8-2</td>
</tr>
</tbody>
</table>
Figures

Figure SOP 3-1. Visual cover estimation guide. ................................................................. SOP 3-8

Figure SOP 3-2. A calibration tool for estimating cover classes. In this example, species 1 (red hexagons are 0.0078 m²) has a known cover of 3.1% and should be placed in Daubenmire class 1. In a lab setting such as is shown here, cover of exposed bare ground can be determined by subtracting the three non-overlapping red, two green, and one blue shapes with known cover from 1. In this case, bare cover is 80%. This subtraction method cannot be used in the field, however, because of overlapping plants, but may be helpful during training. ............................................................................ SOP 3-9

Figure SOP 3-3. Another configuration of cover cutouts. In this example, species 1 has a known cover of 3.1%. Species 2 (black rectangle) has a known cover of 20% and should be placed in Daubenmire class 2. .................................................................. SOP 3-9

Figure SOP 4-1. One meter square quadrat frame with dashed lines showing 25% and 5% coverages. .......................................................... ............................................................. SOP 4-3

Figure SOP 6-1. Annual Project Information Cycle (Courtesy of North Coast and Cascades Inventory and Monitoring Network, NPS Inventory and Monitoring Division.) .......................................................... SOP 6-1

Figure SOP 7-1. The percent (or frequency) of Daubenmire cover classes for bare ground in seven sample frames monitored at Bighorn Canyon in 2011. Error bars show one standard error, calculated from the local variance estimator associated with GRTS samples (Stevens and Olsen 2003). .......................................................... SOP 7-3

Figure SOP 7-2. Two alternative ways of frequency data are shown. In the upper panel, percents are stacked in a bar chart; in the bottom panel, sample frames are grouped according to plant community type before charting and percents are presented as a 3D column. .......................................................... SOP 7-3

Figure SOP 7-3. Example input file for data analysis. Note that response variables start in column H and continue. .......................................................... SOP 7-5

Figure SOP 7-4. Annual report for 2011 (Tercek 2012) cover page. ......................... SOP 7-10

Figure SOP 7-5. The 2011 upland vegetation monitoring resource brief for Bighorn Canyon. .......................................................... SOP 7-10

Figure SOP 7-6. Example map showing locations of toadflax discovered in Bighorn Canyon during 2012. In addition to the map, the exact coordinates are provided to park managers to aid locations using a GPS device. .................. SOP 7-11
### Tables

**Table SOP 1-1.** Topics addressed in the Upland Vegetation Monitoring and Driving Safety JHAs. .......................................................................................................................... SOP 1-3

**Table SOP 3-1.** Important field definitions for upland vegetation in Bighorn Canyon.....SOP 3-6

**Table SOP 3-2.** Inventory of cardboard cutouts used for training observers in ocular cover class estimation in 1 m² quadrats. .......................................................... SOP 3-10

**Table SOP 4-1.** Quadrat reject criteria........................................................................... SOP 4-4

**Table SOP 5-1.** Daubenmire’s cover classes to be used for visually estimating vegetation cover in 1 m² or 3.16 m² quadrats. ............................................................. SOP 5-2

**Table SOP 6-1.** Tasks covered in this SOP are shown in bold text that hyperlinks to the task details in this document. SOP numbers for prerequisite and related information life cycle tasks are listed here for reference.................................................... SOP 6-2

**Table SOP 7-1.** Data dictionary showing database and .csv field names.................... SOP 7-4

**Table SOP 7-2.** A pre-built MS Word Styles template for tables are shown below. ........SOP 7-6

**Table SOP 7-3.** Primary protocol deliverables, their destination and responsibility........ SOP 7-9

**Table SOP 8-1.** Master Version Table............................................................................. SOP 8-4
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Standard Operating Procedure (SOP) 1: Field Safety

Version 1.0, January 2013

Change History

<table>
<thead>
<tr>
<th>Original Version #</th>
<th>Date of Revision</th>
<th>Revised By</th>
<th>Changes</th>
<th>Justification</th>
<th>Pages Affected</th>
<th>New Version #</th>
</tr>
</thead>
</table>

Required Reading
Driving Safety Job Hazard Analysis V2.0


Vegetation Monitoring Job Hazard Analysis V2.0

Overview
A primary goal of the Greater Yellowstone Network (GRYN) is to ensure the safety of its staff and partners while conducting inventory and monitoring activities in parks. The safety plan for the GRYN (GRYN 2012) is the foundation document for conducting safe field work and includes both action plans and reference materials for NPS personnel and partners. Encountering hazardous situations is inherent in outdoor monitoring activities, and all staff persons need to be aware of the risks and take adequate precautions.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Risks Inherent in Upland Vegetation Monitoring
A. A Job Hazard Analysis (JHA) has been completed for the GRYN vegetation monitoring program at Bighorn Canyon National Recreation Area following procedures in the NPS Reference Manual #50B, Occupational Safety and Health Program (NPS 2008). The JHA identifies potential hazards for each task, and procedures on how to reduce or abate the hazard. This JHA and the Driving Safely JHA are fundamental to safe field operations. See Table 1 for the list of topics addressed by the upland vegetation monitoring protocol JHA.

B. Upland habitats in Bighorn Canyon can be in remote and rugged areas. Steep slopes and cliffs are routinely encountered when traveling to and from sampling frames and between quadrats within a frame. Field work at Bighorn Canyon can bring with it challenging weather extremes; cold rainy weather can be encountered in July, and extremely hot weather encountered in May. More commonly, heat is a problem and temperatures may frequently be above 80°F with limited to no shade available. In addition, long days in the field followed by camping outdoors increases exposure to ticks, mosquitoes, and mice that may carry zoonotic diseases. Other risks, described in the JHA include working alone in rugged and isolated environments, long driving trips between parks and network offices, extreme weather, and hazardous fire conditions.

Procedures
1. A safety orientation program will be provided to each new and returning employee to learn about procedures that safeguard each person in the performance of their assigned tasks.

2. Each year the Upland Vegetation JHA and Driving Safety Job Hazard Analysis are be reviewed and updated if necessary. All crew members must review the Job Hazard Analysis during staff training. The JHA follows procedures in the NPS Reference Manual #50B, Occupational Safety and Health Program (NPS 2008). The JHA identifies potential hazards for each task, and procedures on how to reduce or abate the hazard. See Table SOP 1-1 for the list of topics addressed by the upland vegetation monitoring protocol JHA.

3. Tailgate safety sessions will be held to regularly communicate safety and any emerging concerns, such as inclement weather, road conditions, and fire hazards.

4. Specific park hazards, emergency contact information, and procedures should be reviewed with park staff at the start of each park sampling session. Park safety protocols must be reviewed and adhered to.

5. Each crew will be provided a personal locating beacon (PLB), a radio, and cellular or satellite phone depending on the location and signal availability. Crews are required to check in with the park resource manager upon arrival in the park and when they leave at the end of the hitch.

6. Daily check-ins with the GRYN staff take place morning and night using the PLB and when cell phone coverage is available, crews check-in by phone to obtain any needed situational updates and to affirm that travel continues as planned. Having established lines of communication and a Check-in/Check-out procedure are essential to ensure timely assistance can be provided in case of a mishap or delay. These procedures are described in the GRYN Safety Plan (2012).
Table SOP 1-1. Topics addressed in the Upland Vegetation Monitoring and Driving Safety JHAs.

<table>
<thead>
<tr>
<th>General Job Activity</th>
<th>Basic Job Step</th>
<th>Potential Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>2 daily check-ins with GRYN Field Coordinator or designee</td>
<td>PLB does not work; cannot make verbal contact with coordinator (Search and Rescue initiated when not needed if forget to check in two times in a row)</td>
</tr>
<tr>
<td>Communication</td>
<td>Communication with work partner when working independently</td>
<td>Loss of contact with field partner(s)/team member(s) Unable to reach a radio repeater in a remote location</td>
</tr>
<tr>
<td>All Field Activities</td>
<td>Hiking</td>
<td>Steep, rugged and slippery terrain Undergrowth Rocks/climbing Crossing fences Bad footwear lead to sprains/twists to knees and ankles; blisters to feet</td>
</tr>
<tr>
<td></td>
<td>Encountering noxious plants, animals, disease and people</td>
<td>Bees/wasps, hornets Ticks Mosquitoes Rattlesnakes Mountain lions Bears (Black) Disease (bubonic plague and Hanta virus) Poison ivy/stinging nettles Encounters with strangers</td>
</tr>
<tr>
<td></td>
<td>Exposure to environment</td>
<td>Hypothermia Hyperthermia Giardia caused by drinking water Sunburn Dehydration</td>
</tr>
<tr>
<td>Accessing Sites</td>
<td>Highway Driving</td>
<td>Varied Road Conditions Fatigue Behavior of other Drivers Animals and other Obstructions</td>
</tr>
<tr>
<td></td>
<td>Driving on Unimproved Roads</td>
<td>Rough and Vegetated Roads Muddy Roads Fire Ignition During Dry Weather Narrow Roads with Poor Visibility</td>
</tr>
</tbody>
</table>

7. The team must check in with park points of contact periodically during park sampling season to keep abreast of developing safety information, and to provide park staff with locations of operation. Cellular phones can be used depending on signal availability.

8. Field technicians will work in teams of two, and each team will be provided a two-way radio.

9. Each team member must know where vehicle keys are to be stored during field operations, the location of the nearest pay phone and cellular phone signal availability, and emergency contact and operation procedures for each park.

10. The minimum crew size is two people and working alone in the field is allowed only with advance permission from the program manager. When permission is granted, a team of two may split up and work independently and by doing so, must pay particular attention to safety.
communication. Regular radio checks with one another are required and when this is not feasible, team members must make an extra effort to work within sight and earshot of one another.

11. Agency driving regulations must be followed. Field crews will depart the office (or the field) with plenty of time left in the workday to arrive without exceeding the 10-hour work day limit unless prior approval by the program manager and a GAR (Green Amber Red) has been completed. Travel between the south district in Bighorn Canyon and network headquarters normally takes 4½ hours but could take longer under changing weather and road conditions.

12. The recommended footwear for traversing rugged and steep terrain is a hiking boot, 6-8” in height, with slip-resistant heels and soles with firm, flexible support to help reduce chances of slips, trips, and falls. Recommended clothing in the field is long-sleeved shirts and long pants to guard from brush, insect and snake bites. Wide-brimmed hats are recommended to protect from sun exposure, along with sunscreen. Although temperatures can be warm, precautionary clothing will help reduce risks such as sun exposure, cuts, and scratches from environmental exposure while conducting field work.

Safety Cautions
While an effort has been made to reduce exposure to unsafe terrain, it is incumbent upon field personnel to make conservative decisions and choose the safest routes possible to access sampling areas. This may require longer travel times in order to circumvent risky terrain and may reduce the number of quadrats sampled in a day. Safety is more important than productivity, and the GRYN does not want the drive to complete quadrats to cloud good judgment. In other words, stay alert and take it easy out there! Of the several safety procedures described in the GRYN safety plan, some are more relevant to this project and described in more detail below.

Reference Materials

Standard Operating Procedure (SOP) 2: Field Preparation and Season Close-Out

Version 1.0, January 2013

Overview
This SOP describes the step-by-step procedures for preparing for field work and for constructing, preparing, and organizing field equipment prior to the initiation of personnel training and entry into the field. Field time is expensive in time as well as money, so adequate field and equipment preparation is crucial to a cost-effective monitoring program.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Procedures

I. Pre-Season Tasks
   A. Review protocol and close-out notes; respond to lessons learned from the previous year (Protocol Lead).

       Review the close-out checklist, data summary report, and certification from the previous year and address all identified issues and tasks. Refer to SOP 6: Data Management and SOP 7: Data Analysis and Reporting.

   B. Adjust sample frame boundaries if needed.

       It is important that sample frame boundaries and sampling effort have been considered, and any changes to sampling design have been made before new points are generated. This is particularly true during the first few years of testing and implementation. Changes to sampling frames are complex decisions with potentially serious statistical implications.

   C. Review and update target species list and concurrent field forms.

       The master plant species list is a comprehensive list of plants targeted for this protocol by survey year. If a plant is to be added or dropped, open, edit, and save the species list.

       \Monitoring\Active_Vital_Signs\BICA_Uplands\Sampling_Design\Master_Files\BICA_UplandVeg_Monitoring_MASTER_SpeciesList_and_AnnualFieldDataCollectionSheets.xlsx.

   D. Advertise and hire qualified field technicians (Field Coordinator).

       Begin the hiring process for field technicians in December. The GRYN Field Coordinator initiates the personnel process for seasonal biological technicians based on GRYN’s overall needs for the year. A minimum of two dedicated field technicians are required to complete sampling. As appropriate, announcements may be done in conjunction with other NPS Inventory and Monitoring networks such as the Rocky Mountain Network in Colorado. The Field Coordinator should refer to SOP 3: Training Observers to make sure skills needed to perform the monitoring are considered during the hiring process.

   E. Apply for or renew the NPS Scientific Research and Collecting Permit (Field Coordinator).

       1. A Scientific Research and Collecting Permit is required to ensure that GRYN monitoring activities are documented within the official NPS Research Permitting and Reporting System. Research permit applications and renewals are submitted in February to allow sufficient time for processing. Applications in parks where monitoring occurred in previous years should be registered as “continuing research projects” to ensure continuous tracking information.

       2. Log on to web site (http://science.nature.nps.gov/research) and follow the instructions for submitted an application for a Scientific Research and Collecting Permit.
F. Schedule field itinerary (Field Coordinator).

1. The Field Coordinator works with the Protocol Lead to schedule and address all the logistical details. Close coordination with park resource staff is absolutely essential.

2. Vegetation surveys can begin after the middle of May in Bighorn Canyon and normally end no later than mid-July. This covers the period when most target plants are identifiable to the species level, often in their vegetative form, and are neither too immature nor too senesced for identification. Sampling periods must include a sufficiently flexible window of dates to accommodate variation in the timing of warm weather and drought, and some last-minute adjustment of sampling dates may be required during years with unusual weather events and altered phenology. Utilizing MODIS–NDVI tools to measure green up and narrow down sampling windows will be useful in future planning efforts.

   a. Training requires one week, and five additional weeks are allotted for sampling. About 40 samples should be scheduled for completion in each 10-hour field day by each field crew of two persons. This schedule allows for approximately 500-600 sample locations to be surveyed and provides extra time to accommodate unanticipated problems and contingencies. Allow time at the end of each sampling session to pick up oversample points if quadrats were rejected earlier in the season.

   b. Determine which quadrat locations will be sampled each day and order them to avoid unnecessary travel time. Anticipate that some quadrat points will be rejected during the first few years of implementation when sampling frame errors have not been resolved.

   c. Reserve lodging and camp sites for field crews.

   d. Prepare and distribute field itinerary with park staff. Before each season a field itinerary defining the time period, geographic location of planned work, field crew names, contact information, vehicle information, and camp or lodging locations is distributed to park contacts (usually by email) and shared with network staff. The itinerary may include multiple trips as long as the itinerary is updated and re-distributed to park and network staff (GRYN 2012).

G. Prepare field equipment (Field Coordinator).

1. Each independent field team needs a full set of equipment. Inventory existing equipment, identify and make needed repairs, and construct or purchase new and replacement equipment.

2. Each tent should be fully checked over and repaired. Examine the tents to determine whether they require additional seam sealer on the fly and around the bottom of the tent. Test the camping stoves to make sure they are in working order. Be sure that enough new white gas is on hand to cover the crews for the field season.
3. Inspect and clean the five-gallon water jugs and the bear-resistant food containers.

4. Charge all batteries that will be used in the field, including batteries for the GPS unit, the digital camera, and the satellite phone.


1. Provide each field technician with a sturdy, ring-bound Field Reference Manual that includes the items listed below. The Field Reference Manual must fit easily into a daypack.

2. Assemble packets for each sample frame that include instructions for repeat photography and stock imagery, route maps, access locations, and other key field and safety information.

3. Laminate a complete set of the digital repeat photography and include in packet. These images are crucial resources for accurate duplication of repeat photography.

4. Prepare and print hard copy field data collection sheets following procedures in SOP 6: Data Management. Print a reasonable number (45) and print at least ten copies on Rite-in-the-Rain paper.

5. Maps of park sampling frames must be prepared in advance of field work with sample points organized and color coded by proximity in order to guide efficient field travel.

I. Prepare navigation and field data management equipment.

1. Prepare and test tablet computers following SOP 6: Data Management.

2. Upload sample points to each GPS unit following SOP 6: Data Management.

3. Review GPS signal strength for each planned survey day using this online tool: http://www.trimble.com/GNSSPlanningOnline/

   Use a single point in the approximate center of the entire sampling area (e.g., N 45.0650 degrees, W 108.2570 degrees). It isn’t necessary or useful to determine signal strength for each and every sample frame. To account for the mountainous terrain due west of the areas where sampling occurs, consider using a terrain mask, or “curtain,” of approximately 25 degrees in height from approximately 220 degrees to 330 degrees azimuth. Based on the forecast signal strength for each day, try to schedule survey activities when the Position Dilution of Precision (PDOP) is less than 6 in order to achieve consistently accurate quadrat placement.


5. Before each field trip charge batteries for all GPS units, two-way radios, digital cameras, and field computers. Carry spare batteries where possible and as needed.

SOP 2-4
## Greater Yellowstone Network Upland Vegetation Monitoring Protocol

### List of Field Equipment
- Plastic file box for storage of data sheets (in vehicle) and supplies
- Photo log book
- Rite-in-the-Rain note paper
- Clipboard with mechanical pencils and extra lead
- Backup paper data forms (some printed on Rite-in-the-Rain paper)
- Trowel (for collecting unknown plant specimens) with labeled plastic Ziploc bags
- Plant press
- Two 2-m folding rulers (fiberglass Rhino rulers)
- Four 3.16-m or longer poles (layout 10 square meter quadrat)
- 10x (or larger) hand lens (e.g., Loupe)
- Weatherized data entry field computer
- GPS, preloaded with sample location waypoints
- Compass
- Digital camera and spare back-up memory cards
- Field Reference Manual (see next page)
- Wire brush for cleaning tires, boots, and trousers of weed seeds

### Other Equipment
- First Aid Kit
- Snake gators
- Spare batteries for GPS, field computer and camera
- Car battery charging cables for equipment as available
- Hand-held radio plus batteries (two extra sets)
- Satellite phone with extra battery, in crush-proof case
- Cooking stove
- White gas
- Cook set (including two pots)
- Large bear-proof can to hold cooking gear and other items
- Five-gallon water jugs
- Large-capacity backpack
- Daypack
- Tent, with ground footprint and fly
- Sleeping bag
- Water bottles
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Field Reference Manual
— Field navigation maps
— SOP 3: Training Observers
— SOP 4: Locating and Establishing Sampling Quadrats
— SOP 5: Measuring Plant Community Attributes
— Tablet computer quick reference guide
— Plant identification keys and descriptions
— Field data entry forms with target plant species and plant codes
— Tablet computer quick reference guide
— Plant identification keys and descriptions

File Storage Box
— Sampling frame name, code and quadrat coordinates and sampling order
— Field data collection sheets
— Sample Frame Packets
— Maps

Vehicle Safety Binder
— GRYN_Park_Safety_Contact_information_<year>
— Upland Vegetation Monitoring and Driving Safety JHAs
— Radio Repeater and Frequency Guide
— Safety Plan: Check-in/Check-out Procedures
II. Generate GRTS draw of sample locations for the year (Protocol Lead).
This task requires ESRI ArcMap software and the R System for Statistical Analysis and Graphics, including installation of the \textit{spsurvey} package.

Sample quadrats are determined for each sample frame using the \textit{spsurvey} package (Kincaid 2008) in R (R Development Core Team 2012). This algorithm generates an ArcGIS point shapefile containing the quadrats for each frame and a table of x-y coordinates in UTM NAD 83 format that can be uploaded to the GPS units used by the field crew.

The R code for drawing a GRTS sample location is available in the protocol “tool box,” under the file name \texttt{BICA\_LTM\_Veg\_RCode\_GRTS\_unstratified\_eqprob\_<year>.txt}. The sample frame boundaries must be represented as polygon features in ESRI Shapefile format. Details for modifying this script can be found in Kincaid (2008).

A. Install \textit{spsurvey}. The latest version of this R package can be installed by issuing \texttt{\texttt{install.packages()}} on the R command line.

B. Draw GRTS survey site locations.

1. Establish a working directory (e.g., C:\GRTS\temp).

2. In ArcMap, open the master project Geodatabase from the project’s data folder on the GRYN server: NPS\_BICA\_Uplands\_Monitoring\_MASTER\_Geodatabase.gdb

   a. Select the features for every sample frame scheduled for survey in the current year from the feature class named BICA\_Master\_LTM\_Sample\_Frame.

   b. Export the selected features to create a shapefile in the local working directory. Shapefile naming convention:

      \texttt{BICA\_LTM\_Veg\_SampleFrames\_<current\_YEAR>.shp}

3. In a text editor, open the basic GRTS script from the GRYN SharePoint:

   \url{http://imnetsharepoint/gryn/product_dev/BICA\%20Uplands/BICA\_LTM\_Veg\_Rcode\_GRTS\_unstratified\_eqprob\_2012.txt}

C. Edit the script to specify or confirm the input shapefile name, the output shapefile names, the values for panel one and oversample output points, the design type, and any other required parameters.

D. Save the script to the working directory with a name such as:

\texttt{BICA\_LTM\_Veg\_Rcode\_GRTS\_unstratified\_eqprob\_<current\_YEAR>.txt}

E. In R, set the working directory to the location established in the previous step.

1. Open the current year script saved in the previous step or copy the commands from the text editor and paste into R.

2. Run the script.
F. In Windows Explorer, make a copy of each .dbf file generated from running the R script.

G. Open each copied .dbf file in Microsoft Excel. DO NOT open the original .dbf file(s) that are part of the shapefile(s) because doing so can corrupt the shapefile. An alternative is to open the output shapefiles(s) in ArcMap to review both the spatial and attribute properties.

H. Review the content of each copied .dbf file (or the attribute tables for each shapefile in ArcMap) to confirm that each contains all expected records, fields, and values. Double check weight calculations (sampling location selection probabilities) by dividing sampling frame or stratum area by the number of sample size (excluding oversamples). Keep in mind that if sample quadrat point locations are rejected or added during the field season, the weight values listed in these pre-season tables may need to be updated at the end of the season after all surveys are completed. Checking and adjusting the weight values prior to data analysis is covered in SOP 6: Data Management.

1. Copy the edited R script and the R output files from the local folder to this folder on the GRYN Server:

   \Monitoring\Active_Vital_Signs\BICA_Uplands\Sampling_Design\<current_YEAR >\<current_YEAR>_BICA_GRTS_sample_points\n
2. Notify the data manager that the sample point source data for the current year is ready to use for updating the master project databases.

III. Season Close-Out.

A. Check in and inventory equipment (Field Coordinator).

   1. Clean, organize, and store all non-electronic equipment at the GRYN office. Wash sleeping bags and store them loosely in large storage bags. Clean out all the backpacks and tents; hang them to dry thoroughly before storing.

   2. Inventory and inspect all equipment. Make arrangements to repair or replace required items before the start of the next field season. (Some equipment is used for other projects during the year.)

   3. Remove any remnant gas from the camp stoves before placing them in storage.

   4. Check in electronic equipment with the data manager.

   5. Check in all other equipment with the Field Coordinator.

B. Prepare trip report (Field Crew Lead).

   1. At the end of the season, one technician, usually the lead, will write a single trip report describing each field visit that took place that season. These reports provide general information about each sample frame visited, in three broad categories:

   a. Logistical information that will be helpful to future crews in planning and executing repeat visits. For example, details about routes, camping, and sources of water.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

b. Natural history observations that help round out our understanding of the ecological conditions at each grid. For example, observations of birds and mammals.

c. Indices of data sheets, collections, photos, and other materials as a method of keeping track of the “official data.”

2. All crew members are responsible for contributing to the contents of the trip reports. The lead technician will take field notes in addition to the standard data that are recorded on data sheets to report on categories a-c described above.

C. Label photographs (Field Crew Lead).
Refer to SOP 5: Measuring Plant Community Attributes

D. Meet to discuss the recent field season and begin planning data analysis and reporting (Protocol Lead).

1. Document any needed changes to field sampling protocols or the working database.

2. Discuss and document needed changes to analysis and reporting procedures.

E. Update project GIS datasets, layers, and associated metadata records (Data Manager).

GRTS sampling site selection probabilities (weight values) are initially assigned to each quadrat location in R. The weight values must be checked and adjusted as necessary following the field survey season and before the data are used. Refer to SOP 7: Data Analysis and Reporting for computation procedures required to update GRTS sample site selection weights. Refer to SOP 6: Data Management for adjusting the original attribute table(s).

F. Review data quality following SOP 6: Data Management.

G. Update metadata including identification and documentation of sensitive information following SOP 6: Data Management.

H. Certify data prior to use following SOP 6: Data Management.
Notify team that uploaded data are ready for analysis and reporting.

I. Review, clean up, and store or dispose of project files according to NPS Director’s Order 19, Records Management (NPS 2001). Refer to SOP 6: Data Management.

J. File an Investigator Annual Report (IAR) after the field season is complete (Field Coordinator).

Scientists issued a NPS Scientific Research and Collecting Permit are required to provide an Investigator’s Annual Report (IAR) before March 31 of each calendar year. IARs are used to document accomplishments of research conducted in parks.

1. Log onto web site (http://science.nature.nps.gov/research) and follow the instructions for submitted an Investigator’s Annual Report.

SOP 2-9
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

2. Prepare the “Findings and Status” section of the report in a separate word processing document that can be pasted into the IAR form. The report should provide readers with a basic understanding of the protocol objectives (<4,000 characters) and accomplishments (<4,000 characters).

3. Submit a copy of the report, journal articles, and other products as required in the Scientific Research and Collecting permit.

Reference Materials


Standard Operating Procedure (SOP) 3:
Training Observers

Version 1.0, January 2013

Overview
This SOP describes the step-by-step procedures for training field personnel to accomplish stated objectives for this monitoring project. These instructions do not replace the thorough documentation available from other sources for GPS use and field botany techniques. Personnel should follow this SOP, and seek out and use additional information in the suggested references and through related training resources provided by NPS and outside vendors.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Procedures
This SOP explains the procedures for training field crew members to implement the upland vegetation monitoring protocol. As a result of training, field technicians should be capable of the following prior to initiation of formal sampling:

- Use a GPS to navigate to and locate sample sites.
- Objectively place sample quadrats and measure indicators of community condition—cover of exposed soil (bare ground) and key native and non-native plant species.
- Identify principal plants to genera and species, both in flower and in vegetative form.
- Resolve sampling frame boundary decisions and sampling frame errors encountered in the field, drop and pick up points from the GRTS list as necessary.
- Enter data clearly and correctly onto data forms and hand-held computers.
- Awareness and general understanding of the NPS Directors Order 79, Integrity of Scientific and Scholarly Activities (NPS 2012).

Use of the GPS to locate waypoints and to otherwise navigate in field sites should be practiced before beginning field work. Procedures for locating and establishing sample quadrats are detailed in SOP 4: Locating and Establishing Sampling Quadrats and procedures for measuring plant community attributes are detailed in SOP 6: Data Management. Data entry instructions, using the field tablet computer, are explained in the field supplement titled BICA_Uplands_<current_YEAR>_Data_Entry_Instructions, which is normally filed in the project folder at:

\\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<current_YEAR>\Field_Prep\.

Field technicians must be capable of learning the sampling methods, quickly learning or already knowing dozens of plant species, and have experience working independently outdoors all day in remote and sometimes arduous conditions. The monitoring supervisor should seek individuals with the following capabilities:

- Some college-level training in plant taxonomy or systematic botany.
- Previous experience working at least seasonally under remote and rugged field conditions and in group living situations.
- Evidence of personal initiative and an independent, self-starter work ethic.
- Meticulous attention to details and demonstrated interest in natural resource conservation.

A detailed list of technical references for plant identification, including regional floras, are provided at the end of this SOP. The plant species targeted for monitoring are located in the master plant species list data file at:

\\Monitoring\Active_Vital_Signs\BICA_Uplands\Sampling_Design\Master_Files\BICA_UplandVeg_Monitoring_MASTER_SpeciesList_and_AnnualFieldDataCollectionSheets.xlsx

Up-to-date and certified park species lists are maintained at the NPSpecies website at: https://irma.nps.gov/App/Species/Welcome.

It is important to identify a lead trainer, typically the project lead, if present, or the designated field lead. This person should be well versed in the protocol and SOPs, and have considerable experience both conducting field work and in training and directing technicians. Hired field
technicians should also be provided with a copy of the narrative and SOPs prior to arriving on site for training, and should be familiar with program objectives, ecological context, and field methods. Field measurement operations are best taught outdoors. Be sure not to conduct training in or near sampling locations in order to avoid trampling vegetation. Personnel should already have basic GPS navigation and data entry skills, but additional training on those topics can be provided in the field as well. Practice sample points can be included in the waypoint list in an anticipated training area, enabling participants to practice GPS navigation.

Training

Goals:

- Develop a general understanding of the NPS Directors Order 79, Integrity of Scientific and Scholarly Activities (NPS 2012).
- Review plant identification terminology.
- Review use of plant identification manuals, keys, and photos.
- Acquire proficiency in identification of principal native and invasive plants (genera and species) targeted in this protocol.
- Acquire confidence and consistency in visually estimating cover in sample quadrats.
- Acquire proficiency in use of GPS equipment and navigation to sampling points.
- Acquire proficiency in use of a tablet computer, including troubleshooting and procedures for backing up data.
- Demonstrate appreciation of overall program monitoring goals and competence in all field skills, including meticulous data entry and attention to detail in the field environment.
- Understand procedures for sample frame boundary decisions, sampling frame errors, and dropping and adding sites.
- Understand importance of value-added comments in the event field.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, safety procedures including regular communication with park points of contact and GRYN headquarters.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, weed spread prevention procedures during field work.

Materials:

- Protocol narrative and SOPs for each participant
- Field Reference Manual for each participant
- GPS units
- Tablet computers
- Digital cameras
- Quadrat folding rulers
- Backup data sheets
- Hand lens
- Plant keys and other key references
Sample Training Agenda

Day 1: Arrival and Orientation
- Get acquainted, backgrounds of participants, team building
- Upland Vegetation Monitoring Protocol orientation
- Review of sample design and sample plans for season

Day 2: Field Methods—Structured Training
- Using the Field Reference Manual
- Field demonstration of all field methods, including use of the tablet computer and GPS
- Cover estimation practice and calibration
- Plant identification

Day 3: Field Methods—Practice
- Practice cover estimation and calibration
- Practice using Field Reference Manual
- Field walk practicing target plants identification

Day 4: Field Data Collection—at park location
- Familiarization with park terrain, safety, and general travel and hazard issues
- Group field methods practice, visual estimate calibration, and plant identification
- Review of boundary decision, add/drop procedures

Day 5: Field Data Collection—at park location
- Group practice—completion of actual quadrats
- Troubleshooting, GRTS, and field decisions
- Review and solve outstanding issues
Training Procedures

1. Definitions for key field terms are presented in table SOP 3-1 and should be reviewed during training. The size of sampling quadrats is scaled depending on the plant species encountered. If any one of these four larger tree species are encountered (Utah juniper, Rocky Mountain juniper, limber pine, curl-leaf mountain-mahogany), *regardless of size*, then these species are measured within a 3.16 m² quadrat. All other plant species and ground cover attributes are measured within a 1 m² quadrat. In practice, this is accomplished by first setting up the 1 m² quadrat next to the surveyor’s pin and then visually determining whether any of the four larger tree species occur within range of the larger quadrat, which has its lower right corner in the same location as the corner of the 1 m² quadrat. (In the following text, we refer to “quadrats” generically, assuming that the reader will know that different quadrat sizes will be used depending on the species being measured.)

2. Field measurement techniques are best taught outdoors. Indoor lab environments with sufficient space to set up dissecting scopes and plant materials for identification practice may also suffice. Be sure not to conduct training in or near sampling locations in order to avoid trampling vegetation. Personnel should already have basic GPS navigation and data entry skills, but additional training in those topics can be provided in the field as well. Practice sample points can be included in the waypoint list in an anticipated training area, enabling participants to practice GPS navigation.

3. During training, adequate time must be given to properly set up quadrats, and for decision-making associated with sampling frame boundaries and sampling frame errors encountered in the field. While efforts have been made to minimize errors (e.g., 10 m buffers within park boundaries), problems will inevitably be encountered. Each technician should understand the implications of dropping sites, and that in order for the GRTS sample to remain valid, sequential selection of new sites off the GRTS sample list is essential, regardless of where that next site is located. Quadrats that originate within the sampling frame but cross fence lines, roads, cliffs, or are otherwise clearly outside of the target population may be moved using a 5 m offset in a random direction. If offsetting does not resolve the problem, the quadrat location should be rejected from the sample. Rejected quadrats and the associated quadrat number must be entered in the Access database with a note describing the reason why. The criteria and procedures for rejecting and adding quadrats are located in SOP 4: Locating and Establishing Sampling Quadrats. Added sites must come from the oversample list, which are included in the GPS and maps for each sampling frame. Oversample sites are numbered in sequential order, starting with the next quadrat after the sample size (quadrat n+1). For example, if a sample size for a given frame is 84, the first replacement site should be quadrat #85.
# Greater Yellowstone Network Upland Vegetation Monitoring Protocol

## Table SOP 3-1. Important field definitions for upland vegetation in Bighorn Canyon.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Ground</td>
<td>Cover of bare ground should include only bare soil (mineral soil) not covered by plant canopies. Gravel greater than ¼”, litter, cryptogamic crust, and rock should be excluded from bare ground cover estimates.</td>
</tr>
<tr>
<td>Cover</td>
<td>The percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. Openings within an individual plant’s foliar canopy are included in cover estimation. Recorded in percent (%) units. Can be visualized as a bird’s-eye view over the quadrat. Plants rooted outside the quadrat but that project foliage into quadrat area contribute to cover and are included in estimates.</td>
</tr>
<tr>
<td>Cryptogams</td>
<td>Cryptogams include cryptobiotic soils crusts and/or other non-vascular plants including mosses, lichens, and fungi growing on the soil surface. Lichen growing on rock is not included in cryptogam cover estimates.</td>
</tr>
<tr>
<td>Litter</td>
<td>Detached dead stems, leaves, and other woody debris that is in contact with the ground. Litter cover estimates do not include litter present beneath the canopy of other plants.</td>
</tr>
<tr>
<td>Perennial Forbs</td>
<td>Forbs that live two or more years with aerial stems that die back each year while underground parts remain alive. Plants re-sprout from the root each year. In contrast, annual forbs grow from seed each year and biennial forbs produce leaves in the first year (usually a basal rosette) and flower in the second year.</td>
</tr>
<tr>
<td>Plant cover</td>
<td>Current year’s growth including senescent annual grasses of the current sampling year that are included in the visual cover estimates (see definition of cover).</td>
</tr>
<tr>
<td>Quadrat</td>
<td>The defined unit of measurement, with boundaries framed by two 2-m folding rulers, bent at right angles to form a 1 m² square. The quadrat frame is positioned on the lower right corner at the sample point UTM coordinates. The quadrat is oriented in the direction of travel.</td>
</tr>
<tr>
<td>Recruitment</td>
<td>A measure of small (younger) trees (juniper spp. and limber pine) and/or mountain mahogany plants in the sample frame is determined by counting and recording the number of individual plants present in the 10 meter square quadrat.</td>
</tr>
<tr>
<td>Sampling Frame</td>
<td>An area designated by geographical boundaries within which the sampling units are placed and evaluated. This is always imperfect and sampling frame errors and procedures for addressing them must be addressed in training.</td>
</tr>
<tr>
<td>Target Vegetation Community</td>
<td>The predetermined collection of plant communities of interest for monitoring in Bighorn Canyon (e.g., sagebrush steppe; juniper-mountain mahogany, and juniper communities). In Bighorn Canyon, many of the sampling frames were chosen because they have a known history (e.g., cattle pastures) and park staff are interested in measuring recovery trajectories from these human disturbances and responses to management treatments.</td>
</tr>
</tbody>
</table>
4. Objective positioning of quadrats within sampling frames is essential for unbiased estimates of plant cover that represent their current year status. In particular, observers need to avoid ease of quadrat placement such as inadvertent inclusion or exclusion of rooted plants due to the rigidity of the ruler frames (e.g., excluding a shrub because the woody stem obstructs the sampling frame). Rulers can be opened and slid through vegetation to position around shrub bases. Placement of the frame is described in SOP 4: Locating and Establishing Sampling Quadrats.

5. Visual cover estimation should be practiced repeatedly as a group throughout the sampling season to maintain visual calibration among individuals who then compare results among group members. Repeatability (by and among observers) is an important issue and needs to be assessed throughout the field season. Evaluation of repeatability should be done as part of the training and calibration in cover estimation. Visual cover estimation guide (Figure SOP 3-1) and laminated cards of varying shapes and sizes are used during training to calibrate the observer. Laminated cards with known proportional coverage of both the 1 m² and 3.16 m² quadrats have been prepared for use in practice and calibration. These are stored at the GRYN headquarters. Emphasize use of visual cue cards and the 25% and 5% cues marked on rulers (see Figure SOP 4-1). Table SOP 3-2 provides the areas of cards currently in use by the GRYN.

6. Plant identification should be practiced throughout the training week in both a lab and field setting, and must include inspection of above-ground vegetative and reproductive plant parts. The list represents the principal species of current emphasis for this program, and should be the priority during training. In addition, it is highly recommended that the field crew visit the herbarium in Bighorn Canyon at the start of the field season, where preserved specimens of all the target species can be examined. Hand lens use should be practiced in the lab and field setting. While proficiency in the use of technical floral keys is desirable, it is not essential, but technicians should be familiar with technical key characteristics that differentiate principal species from similar species that may cause confusion.

7. Use of the tablet computer must be practiced and thoroughly understood by all field personnel. Practice with a stylus is required to gain proficiency in moving through screens and selecting options and keyboard use. Allow time for field practice as a group in data entry and in post-field backup procedures. Troubleshooting tips, including procedures for deleting quadrat records, should be reviewed. Using the Review Data Quality section of SOP 6: Data Management, explain and emphasize the responsibilities each person has to ensure data quality throughout the project. Data entry instructions using the tablet computer are explained in the field supplement titled BICA_Uplands_<current_YEAR>_Data_Entry_Instructions filed on the GRYN server in the project folder.

8. Safety procedures are outlined in SOP 1: Field Safety. This must be reviewed as a group in a focused session, and the Job Hazard Analysis worksheet must be reviewed, and signed by all field personnel.

SOP 3-7
Figure SOP 3-1. Visual cover estimation guide for increasing levels of vegetative cover.
**Figure SOP 3-2.** A calibration tool for estimating cover classes. In this example, species 1 (red hexagons are 0.0078 m²) has a known cover of 3.1% and should be placed in Daubenmire class 1. In a lab setting such as is shown here, cover of exposed bare ground can be determined by subtracting the three non-overlapping red, two green, and one blue shapes with known cover from 1. In this case, bare cover is 80%. This subtraction method cannot be used in the field, however, because of overlapping plants, but may be helpful during training.

**Figure SOP 3-3.** Another configuration of cover cutouts. In this example, species 1 has a known cover of 3.1%. Species 2 (black rectangle) has a known cover of 20% and should be placed in Daubenmire class 2.
Table SOP 3-2. Inventory of cardboard cutouts used for training observers in ocular cover class estimation in 1 m² quadrats.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Color</th>
<th>Size</th>
<th>Area (m²)</th>
<th>No. of Cutouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle</td>
<td>Green/Red</td>
<td>Large</td>
<td>0.24630</td>
<td>12</td>
</tr>
<tr>
<td>Circle</td>
<td>Green/Red</td>
<td>Small</td>
<td>0.02270</td>
<td>12</td>
</tr>
<tr>
<td>Hexagon</td>
<td>Green/Red</td>
<td>Small</td>
<td>0.00786</td>
<td>42</td>
</tr>
<tr>
<td>Waffle Rectangle</td>
<td>Light Green</td>
<td>Medium</td>
<td>0.09450</td>
<td>2</td>
</tr>
<tr>
<td>Waffle Rectangle</td>
<td>Dark Green</td>
<td>Medium</td>
<td>0.09450</td>
<td>2</td>
</tr>
<tr>
<td>Rectangle</td>
<td>Orange/Fl. Orange</td>
<td>Large</td>
<td>0.39760</td>
<td>1</td>
</tr>
<tr>
<td>Rectangle</td>
<td>Blue/Violet</td>
<td>Small</td>
<td>0.04200</td>
<td>2</td>
</tr>
<tr>
<td>Square</td>
<td>Blue/Violet</td>
<td>Medium</td>
<td>0.07840</td>
<td>4</td>
</tr>
<tr>
<td>Rectangle</td>
<td>Orange/Black</td>
<td>Medium</td>
<td>0.19880</td>
<td>2</td>
</tr>
<tr>
<td>Rectangle</td>
<td>Tan/Grey</td>
<td>Large</td>
<td>0.39760</td>
<td>10</td>
</tr>
</tbody>
</table>

9. Prevention of spreading invasive plants and weeds is a critical issue during all field activities. The old adage “first do no harm” used in medicine applies to ecological monitoring as well. A wire brush should be kept in project vehicles at all times, and tires, undercarriage (do not scratch paint!), boots and clothing should be cleaned of as much weedy debris and seed as possible, as often as possible. It is particularly important that attention is given to travel from infested to uninfested park areas. Regular practice should include brushing down vehicles, boots, and trouser legs at arrival and departure for each field jump-off point. This should only require a few minutes of extra time and is an important gesture of care and stewardship. Periodically, vehicles should be hosed down as an extra measure of prevention. Park-specific procedures should be followed when provided, and this topic should be discussed with park staff at the beginning of each park sampling session.

Taxonomic and Other Reference Materials


Greater Yellowstone Network Upland Vegetation Monitoring Protocol


SOP 3-11
Standard Operating Procedure (SOP) 4:
Locating and Establishing Sampling Quadrats

Version 1.0, January 2013

Overview
This SOP describes the step-by-step procedures for locating and establishing non-permanent quadrats for purposes of long-term monitoring of Bighorn Canyon upland vegetation.
Procedures
Review and discuss the sampling plan each day. Discuss safety and all emerging and potential concerns and risks, such as inclement weather, road conditions, and fire hazards. Discuss weed spread prevention procedures. *Don’t forget to clean vehicles, boots, and clothing of weeds before heading into a new area.*

In order to maintain the spatial balance of the GRTS sample, quadrats must be sampled following their sequential order, which follows the numeric name on the GPS device and as displayed on the field map and in the sample point list. A panel consists of the minimum number of quadrats to be sampled. If a quadrat is rejected for any reason, then use the first or next available over-sample quadrat in its place. Panel one quadrats and over-sample quadrats are clearly identified on the GPS device, the field map, and the sample point list.

I. **Prior to field work each day, plan a safe and efficient sampling route.**
   A. Locate and refer to the sample frame map provided in the field packet that shows all sample points.
   B. Consider the time of day, terrain factors, and other current conditions and circumstances.
   C. Write down an ordered list of 20-30 target quadrat points to start within the sample area. The planned route should not pass over or through one point to reach another. Survey each point as it is reached. The route can be marked on the field map or created as route on the GPS device if desired.

II. **To begin or continue sequential point sampling:**
   A. Select a target GPS waypoint that matches the first (or next) point in the planned sampling route.
   B. Use the GPS navigation functions to travel directly to the point (avoid obvious hazards).
      1. Since recreation-grade GPS units normally provide position accuracy between 2 and 5 meters, the distance to the target point tends to “drift” as the user gets close to the destination waypoint.
      2. In order to eliminate bias in the sample, ignore the vegetation and rely only on the direct line of travel using the GPS unit to reach each new point. This rule applies only if the direct line of travel is safe (e.g., do not walk over a rattlesnake or off a cliff).
      3. Immediately stop walking the first time the GPS unit indicates that the distance to the target is 1 m (3 ft) or less. This distance guideline is based on prior experience, and since GPS signal strength varies continuously, your GPS receiver may not always display a minimum distance to the target of 1 meter or less. In these cases use your best judgment to stop and locate the quadrat.
   C. Update and adjust the route list throughout the day as progress is made and conditions change, making sure to include all sequential sample points within the current and forecast operational period.
   D. As quadrat surveys are completed, keep track of progress by marking a slash directly through the point on the map (point labels should be left visible for future reference). A
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

a separate list of sample sites is also available in the field packet for reference and tracking progress.

E. To establish a quadrat origin, carefully mark the lower right corner and direction of the 1 square meter quadrat with the folded ruler. The middle (1 m mark) of the ruler should be bent at 90° and placed on the lower right corner. Ruler ends can be threaded through vegetation to seat correctly as close to the ground as possible. Match the other ruler accordingly to make a square (Figure SOP 4-1). Pay careful attention not to unintentionally avoid shrubs because they don’t easily fit into the quadrat.

F. If any of Bighorn Canyon’s four large tree species (Utah juniper, Rocky Mountain juniper, limber pine, or mountain mahogany) are within the area encompassed by a 10 square meter quadrat, the technician should place the larger quadrat (3.16 m²) in the same origin and oriented in the same direction as the 1 meter rulers. Only these four large species, regardless of their size, will be measured in the larger quadrat. All other plant species and observational categories are measured within a 1 m² quadrat.

G. If a quadrat falls across a sampling frame boundary, fence line, or other area that cannot be adequately/entirely sampled or that clearly is outside of the target vegetation community (e.g., roadside ditch), a five meter offset using a random compass bearing, is randomly selected and paced.

H. Add a short entry in the Event Note field to record the offset. If this offset fails to resolve the issue then record the quadrat as rejected in the data entry form’s Event Note field and include the next point on the GRTS over sample list in its place. Only use criteria and codes from Table SOP 4-1 below. Photograph the site for later reference.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Table SOP 4-1. Quadrat reject criteria.

<table>
<thead>
<tr>
<th>Reject Code</th>
<th>Reject Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>bndry</td>
<td>Outside park boundary</td>
</tr>
<tr>
<td>unsafe</td>
<td>Dangerous/prohibitive difficulty to access (e.g., slope &gt;30°, talus or rimrock, rattlesnake present in area, etc.)</td>
</tr>
<tr>
<td>road or trail</td>
<td>Road or improved trail</td>
</tr>
<tr>
<td>veg</td>
<td>None of the vegetation belongs to the target population (e.g., not juniper woodland, juniper-mountain mahogany woodland or sagebrush steppe; an example would be riparian vegetation)</td>
</tr>
<tr>
<td>other</td>
<td>Human disturbance (e.g., roadside ditch, abandoned mining lands, or developed features)</td>
</tr>
</tbody>
</table>

Reference Materials

SOP 4-4
Overview
This SOP describes how to measure attributes of vegetation and ground cover while in the field. It explains the methods for repeat photography and provides instruction on organizing, labeling and filing repeat and stock imagery. The following are the goals of this SOP.

- Objectively position quadrat frames as described in SOP 4: Locating and Establishing Sampling Quadrats.
- Open the Microsoft Access Database on the tablet computer.
- Estimate ground cover and foliar cover of principal genera and species.
- Take photographs and record image metadata in the event notes field or in the Vegetation Monitoring Photo Log.
- Add relevant comments in notes field.
- Review data entry and be sure that all fields are filled appropriately, unambiguously, and clearly before moving to the next sample location.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Procedures for Measuring Ground and Vegetation Cover

A. For each distinct sample quadrat, select the frame ID number, date, and observer names on the “Defaults” tab of the data entry application. Follow the separate Data Entry Instructions in the Field Reference Manual for specific procedures.

B. Visual cover estimation of ground cover and vegetation is quick but should be conducted methodically, and field personnel must be trained to use consistent techniques for cover estimation (SOP 3: Training Observers). Cover is estimated in categories following Daubenmire (1959; Table SOP 5-1). A cover class pick list is available in the data entry form.

Table SOP 5-1. Daubenmire’s cover classes to be used for visually estimating vegetation cover in 1 m² or 3.16 m² quadrats.

<table>
<thead>
<tr>
<th>Cover Class</th>
<th>Range</th>
<th>Midpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>1</td>
<td>&gt;0-5%</td>
<td>2.50%</td>
</tr>
<tr>
<td>2</td>
<td>&gt;5-25%</td>
<td>15%</td>
</tr>
<tr>
<td>3</td>
<td>&gt;25-50%</td>
<td>37.50%</td>
</tr>
<tr>
<td>4</td>
<td>&gt;50-75%</td>
<td>62.50%</td>
</tr>
<tr>
<td>5</td>
<td>&gt;75-95%</td>
<td>85%</td>
</tr>
<tr>
<td>6</td>
<td>&gt;95%</td>
<td>97.50%</td>
</tr>
</tbody>
</table>

C. Ground cover and vegetation attributes are defined in SOP 3-1: Training Observers. There is a tab on the data entry form for each of the major attribute groups. Bare ground includes only soil and fine gravels smaller than one-quarter inch that are not covered by vegetation, litter, or cryptogams. Plant cover includes current year’s growth, including senescent annual grasses of the current year, measured as the vertical projection of the outermost perimeter of the natural spread of foliage of plants. The portion of plant foliage that fall within the quadrat from a plant rooted outside the quadrat area contributes to cover and is included in plant cover estimates. Cryptogams include cryptobiotic soils crusts and other non-vascular plants including mosses, lichens, and fungi growing on the soil surface. Lichen growing on rocks is not included in cryptogam cover estimates.

D. If a target plant species that is known to occur somewhere in a sample frame but is not present in a quadrat, DO NOT enter a record for that species. Data analysis procedures will address these situations. Bare ground includes only soil and fine gravels smaller than one-quarter inch that are not covered by vegetation, litter, or cryptogams. There is a tab on the data entry form from non-vascular plants, lichens, and cryptogams.

E. Estimate cover by following these steps:
1. Select one of the plant species for estimation; usually it is best to select one of the plant species that has obvious and fairly high cover values (e.g., sagebrush cover or key bunchgrass cover).

2. Estimate cover by sequentially reducing the visual space the vegetation occupies in the quadrat.

3. First, decide whether cover is >50% or <50%. Use the markers along the sides of the 1 m² quadrat sampling frame to visually quarter the quadrat into areas equaling 25% of the quadrat (see Figure SOP 4-1 in SOP 4: Locating and Establishing Sampling Quadrats). If cover is <50%, then determine whether cover is > or <25%. If cover is >25% then the cover rank is 3.

4. If cover is <25%, then determine whether cover is >5% or <5%. If cover is >5% then cover rank is 2. Five percent markers are placed along the ruler edges as a visual cue.

5. In a similar fashion, if cover is >50%, keep splitting between the largest next cover division until a rank is assigned.

F. The visual cover estimation guides (Figures SOP 3-1 and 3-2, SOP 3: Training Observers) also can be used to aid cover class determination.

G. If larger tree species are present (Utah juniper, Rocky Mountain juniper, limber pine or curl-leaf mountain-mahogany) then estimate their cover in the 3.16 m² quadrat following the same methods. Note that the 1 m² quadrat, which has already been established in the corner of the 3.16 m² quadrat, can be used as a visual guide for cover estimation because it represents 10% of the larger quadrat area.

H. Continue estimating cover for each indicator present in the quadrat until finished. Total vegetation and ground cover could exceed 100% or be less than 100%.

I. As necessary, enter concise, relevant, and objective information in the “Event Notes” field about the quadrat, including the reason for rejecting a quadrat, issues with species identification, photographs taken at or from the site, and other helpful information.

J. Before leaving the data entry system, carefully review all entries and notes on each data entry form and tab for completeness. Take care to double check that entries are correct and all principal species are accounted for.

Procedures for Sample Frame Photography

Repeat photos for each overall sample frame are extremely valuable for documenting changes in vegetation and landscape attributes over time. Landscape photo-pairs repeated from identical points provide a way to visually demonstrate vegetation change and can be used to augment the visual cover estimates described above.

A. Establishing permanent photo points for each sample frame.

1. One permanent photo point depicting the vegetation composition and structure at the landscape scale will be established for each permanent, long-term, vegetation monitoring sample frame.
2. The time of year that the photograph is taken should coincide, as closely as possible, with anthesis of the principle grass species.

3. The location for the photo point will be decided by the Protocol Leader who will consider the objective of capturing a photograph that represents the overall vegetation composition and structure, site condition and also the ease of relocating for future repeat photography. The photo point does not need to be taken from a quadrat sampling point.

4. The direction of the photo point will be dependent upon what aspect gives the best overall picture of the area. Ideally, each photo point will include a conspicuous landmark or panoramic vista. (Photos should not be taken into the glaring sun.)

5. Consider time of day to optimize the quality of the photograph. On sunny days, earlier or later is best. Overcast skies are good as they reduce shadows.

6. To shoot the photo, position the camera to maximize the resolution of the vegetation in the sample frame.

7. Use a medium resolution format for photos. The typical file size of photos ranges between 400 kb-1 MB; rarely will you need to store images in the highest resolution format for routine photo-documentation.

B. Documenting photos in the photo log.
   Each photo that is taken must be recorded in a small Rite-in-the-Rain notebook labeled “Vegetation Monitoring Photo Log” and a place to record the Start and End dates. (The photo log is not for quadrat-level photos. Quadrat photos are normally documented in the “Event Notes” field in the data entry system.) Each photo log entry requires the following information:
   1. Camera make
   2. Camera model
   3. Image number (unique ID assigned by the camera)
   4. GPS location (x and y coordinates)
   5. Date of acquisition (month/day/year)
   6. Time of acquisition (hours:minutes AM/PM)
   7. Sample frame name
   8. Azimuth direction of photo in degrees, using a compass on which declination is set correctly for the current year
   9. A brief description of the photograph’s subject/intent
   10. Name of the person taking the photo

SOP 5-4
C. Office processing after each field trip.
   1. Create or use a subfolder in the project’s existing directory structure that is named with the year the photographs were taken: \Monitoring\Active_Vital_Signs\BICA_Uplands\Resources\Images\Unrestricted\2012fieldImagesInbox.
   2. Download photographs from the camera to the Inbox folder. Note that the Inbox folder may include photographs from multiple frames which will need to be named accordingly.
   3. Examine the newly transferred photos and delete those that are blurry, corrupted, or otherwise not useful.
   4. Rename each photo file using the following syntax:

   **SampleFrame_Quadrat_Year_Subject.jpg**

   a) Sample frame ID (BICA_LTM_Veg10)

   b) Quadrat number (numeric if taken at a quadrat, omit if the photograph is more general in nature)

   c) Year the photo was taken (four digits)

   d) Subject (PermPhotoPoint)

   Examples:

   BICA_LTM_Veg10_2012_PermPhotoPoint.jpg

   BICA_LTM_Veg10_15_2012_bareground.jpg

   5. Move the named images from the Inbox folder to a permanent storage folder named for the sample frame where they were taken, for example:

   BICA_Uplands/Resources/Images/Unrestricted/2012fieldImages/LTM_Veg10/BICA_LTM_Veg10_2012_NA_PermPhotoPoint.jpeg

   6. Each year that the sample frame is revisited, another photograph is added to this folder, with the date portion of the file name distinguishing the two sets.

D. Repeat photography.

   1. Once the initial photo point and photograph is established, repeat photographs of each monitored sample frame are taken annually, from the same location, by the technicians completing the vegetation monitoring field work.

   2. Before the field season, the field reference manual will be updated to include the exact coordinates of the photo point, the azimuth direction the original photographer faced when the photo was taken, and a printed copy of the original photograph. In addition, the photo point coordinates will be loaded into the project GPS unit to help with relocation.

SOP 5-5
3. Taking the repeat photograph:
   a. Try to take repeat photos on or near the same day each year while also making
      necessary adjustments for taking photos that coincide with anthesis of the
      principle grass species.
   b. If sunny, take the photo early in the morning or later in the afternoon.
   c. Navigate to the permanent photo point location using a GPS system.
   d. Use a compass to orient towards the direction the photograph faces.
   e. Stand and look into the camera view lens and compare with past photos and adjust
      as needed using available land mark and horizon-profile references.
   f. Take three or four pictures and log each into the photo log.

E. Stock imagery.
   Obtain photographs for stock imagery suitable for reports, management briefs and other
   publications. Photographs should illustrate:
   1. Representative habitat and environment for each sample frame.
   2. Target species and/or features that help tell a story (patches of weedy invasive plants,
      bare soil).
   3. The layout of the 10 square meter quadrat in woodland habitats.
   4. Field crew working—especially if in uniform and/or with protective clothing (snake
      gaiters, long sleeves).

Reference Materials

York, NY.

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Chapters 8 and 9 in Measuring and
Monitoring Plant Populations. U.S. Department of Interior, Bureau of Land Management,
Denver, CO.


health, version 4. USDI Bureau of Land Management Technical Reference 1734-6. Denver,
CO.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Standard Operating Procedure (SOP) 6: Data Management

Version 1.0, January 2013

Change History

<table>
<thead>
<tr>
<th>Original Version #</th>
<th>Date of Revision</th>
<th>Revised By</th>
<th>Changes</th>
<th>Justification</th>
<th>Pages Affected</th>
<th>New Version #</th>
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<td></td>
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</tr>
</tbody>
</table>

Overview

This SOP specifies data management practices, responsibilities, and schedules following the annual project information cycle shown in Figure 6-1. The survey database for this project was adopted from one developed by the Upper Columbia Basin Network using the NPS Natural Resource Database Template (NRDT). A separate ESRI Geodatabase is kept for the project to store sample frame polygons and sample points. The monitoring protocol narrative provides additional overview information about data handling.

![Annual Project Information Cycle](image)

Figure SOP 6-1. Annual Project Information Cycle (Courtesy of North Coast and Cascades Inventory and Monitoring Network, NPS Inventory and Monitoring Division.)
Data Management Tasks in the Project Information Life Cycle
Table SOP 6-1 provides a summary of the data management tasks and timeline that are further described in this SOP.

Table SOP 6-1. Tasks covered in this SOP are shown in bold text that hyperlinks to the task details in this document. SOP numbers for prerequisite and related information life cycle tasks are listed here for reference.

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Task Description</th>
<th>SOP</th>
<th>Responsibility</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Review and update the target species list for the current year</td>
<td>2</td>
<td>Project Lead</td>
<td>March 1</td>
</tr>
<tr>
<td></td>
<td>Generate GRTS sample point layer(s) for the upcoming field season and notify the</td>
<td>2</td>
<td>Project Lead</td>
<td>March 1</td>
</tr>
<tr>
<td></td>
<td>data manager.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Notify data manager of needs (field maps, GPS support, training, etc.)</td>
<td>2</td>
<td>Project Lead</td>
<td>by March 1</td>
</tr>
<tr>
<td></td>
<td><strong>Update the master Geodatabase</strong> (page SOP 6-5)</td>
<td></td>
<td>Data Manager; Project Lead</td>
<td>By April 1</td>
</tr>
<tr>
<td></td>
<td><strong>Update the survey database for field use</strong> (page SOP 6-6)</td>
<td></td>
<td>Data Manager</td>
<td>By April 1</td>
</tr>
<tr>
<td></td>
<td><strong>Prepare and test field computers</strong> (page SOP 6-11)</td>
<td></td>
<td>Data Manager</td>
<td>May</td>
</tr>
<tr>
<td></td>
<td><strong>Create and print field maps</strong> (page SOP 6-13)</td>
<td></td>
<td>Data Manager; Project Lead</td>
<td>by May 1</td>
</tr>
<tr>
<td></td>
<td><strong>Prepare hard copy field data collection sheet</strong> (page SOP 6-15)</td>
<td></td>
<td>Data Manager; Project Lead</td>
<td>by May 1</td>
</tr>
<tr>
<td></td>
<td><strong>Prepare a reference list of target sample points</strong> (page SOP 6-16)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>by May 1</td>
</tr>
<tr>
<td></td>
<td><strong>Prepare and load GPS waypoints</strong> (page SOP 6-18)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>May</td>
</tr>
<tr>
<td></td>
<td><strong>Prepare and load GPS tracks showing sample frame boundaries</strong> (page SOP 6-21)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>May</td>
</tr>
<tr>
<td></td>
<td><strong>Update the Data Entry Instructions document</strong> (page SOP 6-22)</td>
<td></td>
<td>Data Manager; Project Lead</td>
<td>May</td>
</tr>
<tr>
<td></td>
<td>Provide database and GPS training</td>
<td>3</td>
<td>Data Manager</td>
<td>May</td>
</tr>
<tr>
<td></td>
<td>Train field crew in sampling protocols</td>
<td>3</td>
<td>Project Lead; Field</td>
<td>May-June</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Coordinator</td>
<td></td>
</tr>
</tbody>
</table>
## Greater Yellowstone Network Upland Vegetation Monitoring Protocol

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Task Description</th>
<th>SOP</th>
<th>Responsibility</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data acquisition, entry, and processing</strong></td>
<td>Enter survey values directly into the field database on a tablet computer. If survey values are recorded on paper, enter these as soon as possible during or following the current field trip. Print, carry, and follow the latest instructions for data entry and backup (page SOP 6-23)</td>
<td>4,5,6</td>
<td>Project Lead; Field Coordinator; Field Tech</td>
<td>May-July</td>
</tr>
<tr>
<td></td>
<td>Archive data at the GRYN Office between field trips (page SOP 6-24)</td>
<td></td>
<td>Data Manager; Project Leader; Field Tech</td>
<td>Between each field trip</td>
</tr>
<tr>
<td></td>
<td>Merge field data with the master project database (page SOP 6-25)</td>
<td></td>
<td>Data Manager</td>
<td>Within a week following the last field trip</td>
</tr>
<tr>
<td></td>
<td>Update sample frame weight values to reflect actual samples collected (page SOP 6-30)</td>
<td></td>
<td>Project Lead; Data Analyst; Data Manager</td>
<td>August</td>
</tr>
<tr>
<td><strong>Quality review</strong></td>
<td>Review Data Quality (page SOP 6-31)</td>
<td></td>
<td>Project Lead; Data Manager; All staff</td>
<td>August-September</td>
</tr>
<tr>
<td><strong>Metadata</strong></td>
<td>Review data for sensitive information annually: (page SOP 6-34)</td>
<td></td>
<td>Project Lead</td>
<td>August-September and before using or sharing data</td>
</tr>
<tr>
<td></td>
<td>Review and maintain data documentation (metadata) (page SOP 6-34)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>August-September</td>
</tr>
<tr>
<td><strong>Data certification</strong></td>
<td>Certify data prior to use or distribution (page SOP 6-37)</td>
<td></td>
<td>Project Lead; Data Manager; Program Manager</td>
<td>August-September</td>
</tr>
<tr>
<td><strong>Data delivery</strong></td>
<td>Confirm all project data files are organized and documented on GRYN server (page SOP 6-38)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>August-September</td>
</tr>
<tr>
<td></td>
<td>Test and execute data output functions in the master database to generate data sets for analysis (page SOP 6-39)</td>
<td></td>
<td>Data Manager; Project Lead</td>
<td>August-September</td>
</tr>
<tr>
<td></td>
<td>Notify analysts and others as needed that data are ready for analysis and reporting (page SOP 6-40)</td>
<td></td>
<td>Project Lead</td>
<td>August-September, and after data certification documentation is complete</td>
</tr>
</tbody>
</table>

SOP 6-3
## Greater Yellowstone Network Upland Vegetation Monitoring Protocol

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Task Description</th>
<th>SOP</th>
<th>Responsibility</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data analysis</td>
<td>Analyze data as described in the monitoring protocol and specified in standard operation procedures</td>
<td>7</td>
<td>Data Analyst</td>
<td>October-November</td>
</tr>
<tr>
<td>Product development</td>
<td>Prepare report(s) as specified in the monitoring protocol</td>
<td>7</td>
<td>Project Lead; Data Analyst</td>
<td>October-November</td>
</tr>
<tr>
<td></td>
<td>Screen all reports and data products for sensitive information</td>
<td>7</td>
<td>Project Lead; Data Analyst</td>
<td>October-November</td>
</tr>
<tr>
<td></td>
<td>Submit draft report to Program Manager for review</td>
<td>7</td>
<td>Project Lead</td>
<td>October-November</td>
</tr>
<tr>
<td></td>
<td>Review report for formatting and completeness, notify Project Lead of approval or need for changes</td>
<td>7</td>
<td>Program Manager</td>
<td>October-November</td>
</tr>
<tr>
<td></td>
<td>Acquire and apply the proper report template from the NPS publications website</td>
<td>7</td>
<td>Writer/Editor</td>
<td>October-November</td>
</tr>
<tr>
<td></td>
<td>Store completed reports and related products in the appropriate location(s) on the GRYN server (page SOP 6-41)</td>
<td>6,7</td>
<td>Project Lead</td>
<td>December</td>
</tr>
<tr>
<td>Posting &amp; distribution</td>
<td>Deliver reports and other products according to the delivery schedule and instructions (page SOP 6-42)</td>
<td>6,7</td>
<td>Project Lead</td>
<td>December</td>
</tr>
<tr>
<td></td>
<td>Create records and upload data sets, reports, and other pertinent project resources to national database/clearinghouse (page SOP 6-43)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>December</td>
</tr>
<tr>
<td></td>
<td>Update records in the national species database (page SOP 6-44)</td>
<td></td>
<td>Data Manager</td>
<td>December</td>
</tr>
<tr>
<td>Archival &amp; records management</td>
<td>Review and manage electronic and physical project records according to NPS policy (page SOP 6-45)</td>
<td></td>
<td>Project Lead; Data Manager</td>
<td>December</td>
</tr>
<tr>
<td>Season close-out</td>
<td>Meet to discuss the recent field season. Develop action plans to address any required improvement to the monitoring protocol, SOPs, the project databases, and products.</td>
<td>2</td>
<td>Program Manager; Project Lead; Park Resource Managers; Data Manager; Crew members</td>
<td>December</td>
</tr>
</tbody>
</table>
Project Stage: Preparation  
Task: Update the master Geodatabase  
Responsibility: Data Manager

The project’s master Geodatabase contains feature data sets for sample frame polygons, sample points, and reference layers. A new feature class is generated for sample points each year based on the target quadrat locations generated using the R System for Statistical Analysis and Graphics (for details see SOP 2: Preparation for the Field Season).

In ArcGIS:

Open ArcCatalog

Locate ‘NPS_BICA_Uplands_Monitoring_MASTER_Geodatabase.gdb’ in the project’s ‘Data’ folder.

Create a new point feature class in the master Geodatabase named ‘BICA_<YEAR>_UplandsMonitoringSites’.

Load the new feature class with data from the R output file or files available from the project leader or designated contact (see SOP 2: Preparation for the Field Season).

Review the other feature classes in the Geodatabase and make any required adjustments.

Review and if necessary update the metadata for the Geodatabase components (see the ‘metadata’ task later in this document for complete instructions).
Project Stage: Preparation
Task: Update the survey database for field use
Responsibility: Data Manager

In the office before each field season the data manager prepares and transfers the field database application to each field computer and enters a few test records to make sure the application functions correctly on each computer. The Microsoft Access database application includes a data file to hold new survey values, a user interface file with forms and functions to guide data entry and control data quality, and a data dictionary file of commonly used reference values. The data file contains a table of sample locations populated before the field season with records generated from the random sample draw for that year, lookup tables for target species, sample frames, and other established values, along with empty tables to hold new survey and cover type records collected in the field that year.

Set up the data file for the current-year field database:

In Windows Explorer:

Navigate to the project data folder on the GRYN server:
\\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\

Copy the master database file ‘NPS_BICA_LTM_Veg_MASTER_Data_FILE.mdb’ to a folder on the local drive of the data manager’s computer, such as c:\BICA_LTM
This file will be prepared on the data manager’s computer and transferred to each field computer later.

Rename the local copy of the data file with a descriptive name:
‘NPS_BICA_LTM_Veg_FIELD_Data_FILE_<YEAR>.mdb’
Example: ‘NPS_BICA_LTM_Veg_FIELD_Data_FILE_2013.mdb’

Prepare the data file to record current year data:

This multi-step task involves ‘cleaning out’ prior-year location and other data records from the local copy of the current year field data file, loading new target location records and updating the link values for the new location records to their site (sample frame) records in a related table.

In Microsoft Access:

Open the newly named field data file from the local computer.
Open ‘tbl_Locations’ and examine the records to get a sense of which fields are populated with what kinds of entries to prepare for the next step.

In ArcGIS:

Open the attribute table for the current year’s sample points created previously as a feature class in ‘NPS_BICA_Uplands_Monitoring_MASTER_Geodatabase.gdb’.
Write on a piece of scratch paper the total record count in the attribute table and make sure the count remains the same as the records are passed through the next few steps.
Export the records to a text file stored temporarily in a local working folder.

**In Microsoft Excel:**

Open the text file exported from ArcGIS in the previous step.

Make sure the total record count matches from the previous step.

Save the file in MS Excel format in the project folder on the GRYN server:

customary location:
```
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<YEAR>\Field_Prep\customary_file_name:
```

BICA_<current_YEAR>_Uplands_MonitoringPoints_forListPrinting_GPSloading_DBloading.xlsx

Rename the current worksheet as ‘input from R’.

Copy the worksheet and name the copy ‘formatted for DB’.

In the worksheet ‘formatted for DB’ adjust the column names and format cell values to match the structure and format of ‘tbl_Locations’ in Access (example pictured on the right; check the table design each year to stay current with any changes). Add empty columns where needed to match the columns in ‘tbl_Locations’. Note that some NPS Natural Resource Database Template fields in the table do not require values and may remain blank. As pictured below, the column names do not have to match in this temporary data migration table but the data values must correctly line up with the matching columns in ‘tbl_Locations’.

Save the file temporarily in text format (csv) in a local working folder.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

In Microsoft Access:

Select and delete all existing records from ‘tbl_Locations’ in the local data file (never do this in the master data file on the server). Due to table relationship properties that enforce cascading deletes of related records in other tables, this will automatically remove the records in tbl_Events, tbl_EvData_BareGrdCover, and tbl_EvData_SpeciesCover.

Import the text file saved from Excel in the previous step into a new table (to be removed shortly) called ‘tbl_Sites2013_forDB’ (or something similarly descriptive). In the import wizard be sure to choose the option ‘No Primary Key’.

Open the newly imported table and check the record count – it should match the count of records in the feature class attribute table in the master Geodatabase.

Select and copy the records in the newly imported table.

Paste the records into empty table, ‘tbl_Locations’. If paste errors occur check and fix the column order and try again.

Review and resolve any automatically generated tables containing import errors or paste errors.

Delete ‘tbl_Sites2013_forDB’ after confirming that all records and values from ‘tbl_Sites2013_forDB’ now exist in ‘tbl_Locations’.

Populate the Site_ID_F field for all records in ‘tbl_Locations’:

First apply a select query like the one pictured here to tbl_Locations with criteria for the field ‘Loc_Name’ to filter records for a single sample frame.

Example criteria expression: ‘Loc_Name’ Like "*Veg10**".

View the selected records to confirm they are the correct set and that the record count is correct for the sample frame.

Once confirmed, change the select query to an update query.

In tbl_Sites copy the entire ReplicateID value from the Site_ID field for the selected sample frame.

Paste the copied Site_ID value in to the ‘Update to’ row in the ‘Site_ID_F’ field of tbl_Locations (example shown in the figure below).

Run the update query.

Repeat the steps in this section for each remaining sample frame to select, verify, and update the ‘Site_ID_F’ values for the selected records in tbl_Locations with the corresponding ‘Site_ID’ value from tbl_Sites.

SOP 6-8
Double-check the results in tbl_locations for the ‘Site_ID_F’ field values to confirm the correct Site ID value for each set of location records.

Close tbl_Locations

Open tlu_Contacts.

Delete records from tlu_Contacts for individuals who won’t be collecting data during the current year.

Add records to tlu_Contacts for new individuals who will collect data during the current year. If the names of one or more individuals won’t be available until hiring is completed closer to field season, remember to edit tlu_Contacts at a later date and deploy the updated table to the field computers as needed.

Close tlu_Contacts.

Delete temporary tables in MS Access, such as tables showing import errors and paste errors (assuming any such errors have already been addressed – otherwise determine the cause and address the issue(s) before deleting such tables).

Perform the ‘Compact and Repair Database’ function.

Close the data file and MS Access.

In Windows Explorer:

Delete all temporary working files used to populate tbl_Locations, including those generated from Excel and/or ArcGIS. This prevents future confusion about which file contains what version of data.

Copy the local field data file to the project folder on the GRYN server:

```
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<YEAR>\Field_Prepare\`
```

Prepare the user interface file to record current year data:

The user interface file may not require annual updates. If the data entry forms and functions worked as intended throughout the previous field season and no adjustments are needed, then simply make sure the latest user interface file is copied to each field computer along with the field data file, and that the table links between these files are correct. If user interface adjustments are required then follow all of the procedures listed in this section.

In Windows Explorer:

Navigate to the project data folder on the GRYN server:

```
\Monitorings\Active_Vital_Signs\BICA_Uplands\Data\`
```

Copy the master user interface file ‘NPS_BICA_LTM_Veg_MASTER_User_Interface.mdb’ to the archive folder as a backup before making changes to the master file, customary archive folder:

```
\Monitorings\Active_Vital_Signs\BICA_Uplands\Data\Archive\`
```

Rename the archive copy of the user interface file to include the backup date:

SOP 6-9
Example: ‘NPS_BICA_LTM_Veg_MASTER_User_Interface_BU_March13_2013.mdb’

In Microsoft Access:

Open the master user interface file on the GRYN server:
\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\NPS_BICA_LTM_Veg_MASTER_User_Interface.mdb

Perform the necessary adjustments to the objects, properties, and code for the file, and document significant changes in the table ‘tbl_Db_Revisions’. Use best judgment in what to document. For example, improving the arrangement of existing elements on a form probably doesn’t require documentation, but adding a new form, a new query, or procedure in code should be described in ‘tbl_Db_Revisions’

Perform the ‘Compact and Repair Database’ function.

Close the data file and MS Access.
Project Stage: Preparation
Task: Prepare and test field computers
Responsibility: Data Manager

Required files are normally transferred to non-networked field computers using a USB memory device. Do not connect a field computer to the DOI or NPS network unless all security requirements and mandatory licensed software applications, including the operating system, are installed and up-to-date. Consult with your office’s Organizational Unit Administrator (computer support person) to find out whether a field computer can be connected to the network. For GRYN this is the Data Manager.

On each field computer:

  Locate existing project files on the local drive (customary location is `c:\BICA_LTM` or similar).

  Remove all outdated and unnecessary files from the previous period of use.

  Transfer and archive any remaining useful files from the local project folder(s) to the master project folders on the GRYN server.

  Confirm that the local project folder is empty and ready for new files for the current year.

  Perform necessary hardware, operating system, or other software updates. If necessary obtain assistance from an IT Specialist/computer support person. If the device is not permitted on the DOI/NPS network, download required updates to a USB memory device or memory card on another computer and securely transfer and apply the updates to the standalone field computer.

Copy the **field data file** for the current year from the GRYN server to the local drive

  **customary source folder:**
  
  `::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<YEAR>\Field_Prep`

  **customary destination folder:** `c:\BICA_LTM`

Copy the **user interface file** from the GRYN server to the local drive in the same folder as the field data file –

  **customary source:**
  
  `\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\NPS_BICA_LTM_Veg_Master_User_Interface.mdb`

A note about the data dictionary file in the following step – this file generally does not need to be opened or adjusted in any way on a regular basis, but it is a required element of the database application. The data dictionary file contains a table of enumeration values that is required by the user interface file and a table of contacts that is not required by the user interface file.

Copy the **data dictionary file** from the GRYN server to the local drive in the same folder as the field data file

  **customary source:**
  
  `\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\NPS_BICA_Uplands_Monitoring_Master_DataDictionary.mdb`

SOP 6-11
Set up or update the desktop shortcut to the user interface file. The customary name for the shortcut is ‘BICA Uplands Data Entry’.

Double-click the shortcut to test that it opens the user interface file.

With the database application open in MS Access, select ‘Connect data tables’ and follow the on-screen instructions to update links.

Enter several test records using sample frame ‘BICA_TEST’ and verify that all the data entry forms and functions work correctly.

After testing is complete, close the user interface file.

Open the data file.

Select and delete all the test records from tables ‘tbl_Events’ and ‘xref_Event_Contacts’. Note that related records in the bare ground and species cover data tables will be removed automatically as a function of the their table relationship settings with ‘tbl_Events’.

Close the data file and MS Access.
Project Stage: Preparation
Task: Create and print field maps
Responsibility: Data Manager; Project Leader

This task requires intermediate ArcGIS skills to use data driven pages and advanced labeling. These relatively large scale maps provide a planning, orientation, and progress-tracking tool for survey crew members by showing the sample frame boundary and the labeled target sample points with a true-color aerial image background. The map template and base layers are already established in ArcGIS map documents used to create the maps in prior years. Printed maps from previous years are filed with other project materials in the GRYN office, and these can be used as a reference for producing current-year maps. In addition to the 11 by 17 inch sample frame maps, an overview map, designed for 17 by 22 inches or larger, is also produced each year, or as needed, to show all sample frame map tiles within BICA.

**In Windows Explorer:**
Open the folder on the GRYN server that stores ArcGIS documents for this project
*customary_location: ::\General_Library\GIS_projects\BICA_Veg*

In this folder create a copy of the ArcGIS Map Document file used for creating prior year field maps – customary file name:
* BICA_Uplands_<prior_YEAR>_Sampling_Sites_11x17_DataDrivenMaps.mxd

Rename the new file:
* BICA_Uplands_<current_YEAR>_Sampling_Sites_11x17_DataDrivenMaps.mxd

**In ArcMap:**
Open the copied and renamed ArcGIS map document file created above.
Add the current year sample points as a map layer.

Use ArcMap labeling and symbolization tools with the layer of sample points to generate the required visual presentation. Make sure that each and every ‘panel-one’ and ‘over-sample’ point feature is distinctly symbolized and labeled (no overlaps, omitted labels, etc.).

Check and replace (if available) the background aerial image with the most current data source. Normally an online base map is used to provide reasonably current imagery.

Use the Data Driven Pages extension to control map production and output for all sample frames. The index layer for Data Driven Pages is stored in the master project Geodatabase. Basic settings for Data Driven Pages are shown on the right. If necessary open ArcGIS Help for Data Drive Pages.

SOP 6-13
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Make any other necessary adjustments to the map template.

Instead of (or in addition to) printing the map pages directly from ArcMap, use Export from the File menu to create a PDF containing all the maps in the series. Save the PDF with a customary name to a customary location, e.g.:
\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<current_YEAR>\Field_Prep\BICA_Uplands_<current_YEAR>_Sampling_Sites_11x17_DataDrivenMaps.pdf

Save and exit ArcMap when finished.

Update the Overview map if new data sources are available for layers already shown on the map, or new layers need to be added, the scale and/or page size needs to be changed, or other improvements would help make the map more useful. The ArcMap document file for the overview map can be copied from a previous version, saved and renamed as a new version, and then opened, edited, and saved. Before closing the overview map document create a PDF to enable anyone to easily print or view a copy of the overview map. The customary location and name for the overview map document on the GRYN server is:
::\General_Library\GIS_projects\BICA_Veg\BICA_Uplands_Master_LTM_Sampling_Frame_Overview.mxd

**In Adobe Reader:**

Any project staff can open the PDF file containing all the maps for the current year and print/reprint as needed.

Remember to select the correct printer and load paper for printing 11 by 17 inch output.

**In Windows Explorer:**

Copy current year maps to the project folder on each field computer – customary destination folder: c:BICA_LTM

SOP 6-14
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Project Stage: Preparation
Task: Prepare hard copy field data collection sheet
Responsibility: Data Manager; Project Leader

In Windows Explorer:
Open the folder on the GRYN server that stores master sampling design files for this project,
customary location:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Sampling_Design\Master_Files\n
In Microsoft Excel:
Open the master file containing the field data sheet:
customary file name:
BICA_UplandVeg_Monitoring_MASTER_SpeciesList_and_AnnualFieldDataCollectionSheets.xlsx

Create a copy of the worksheet named ‘Data Sheet <previous_YEAR>’.
Rename the copied worksheet as ‘Data Sheet <current_YEAR>’.

In the renamed worksheet change the date, the list of observers, and any other required elements. The sheet is set up to print double-sided by having an exact copy of the sheet sitting directly below itself. Make sure to update both copies in exactly the same way. Alternatively the ‘lower’ copy in the worksheet can be removed and replaced with the final ‘upper’ copy using copy/paste.

Use Print Preview to make sure the worksheet will print as planned – make any necessary adjustments to fit the form to the page.

Save the Excel file.

Use ‘Save As’ to create a PDF file of the data sheet,
customary location on the GRYN server:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\2013\Field_Preparation

customary file name:
BICA_<current_YEAR>_Uplands_Monitoring_FieldDataCollectionSheet.pdf

Close MS Excel

In Adobe Reader:
Any project staff can open the PDF file containing field data collection sheet and print/reprint as needed.

In Windows Explorer:
Copy current year data sheets to the project folder on each field computer,
customary destination folder: c:\BICA_LTM\
Project: Preparation
Task: Prepare a reference list of target sample points
Responsibility: Project Leader or Data Manager

In Microsoft Excel:

Open the Excel file from the GRYN server that contains the monitoring points for the current year, this file was created in the ‘update the survey database’ task describe previously in the SOP.

customary location:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<YEAR>\Field_Prepi

customary file name:
BICA_<current_YEAR>_Uplands_MonitoringPoints_forListPrinting_GPSloading_DBloading.xls

Copy one of the existing worksheets and name the copy ‘formatted for printing’.

Adjust and format the new worksheet to approximate the image shown below. Be sure to leave a blank column on the left as a place for crew members to track progress or make other marks. The design and layout shown below and used in prior years is a general guide that can be adjusted to meet current needs. Note that every other row is shaded to enhance readability.

Set up the worksheet to fit on a single page and edit the header properties with descriptive title information. Edit the footer to print page numbers, e.g., Page x of x.

Use Print Preview to make sure the worksheet will print as planned – make any necessary adjustments to fit the list to the page.

Save the Excel file.

Use ‘Save As’ to create a PDF file of the data sheet,

customary location on the GRYN server:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<current_YEAR>\Field_prep

customary file name:
SOP 6-16
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

BICA_<current_YEAR>_Uplands_Monitoring_SamplePointsList.pdf
Close MS Excel

**In Adobe Reader:**
Any project staff can open the PDF file containing the list of target sample points and print/reprint as needed.

**In Windows Explorer:**
Copy the PDF file of target sample points for the current year to the project folder on each field computer,
customary destination folder: c:\BICA_LTM\
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

**Project Stage: Preparation**  
**Task: Prepare and load GPS waypoints**  
**Responsibility: Project Leader or Data Manager**

**In Microsoft Excel:**

Open the Excel file from the GRYN server that contains the monitoring points for the current year; this file was created in the ‘update the survey database’ task described previously in the SOP.

- Customary location:  
  \::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<YEAR>\Field_Prep\  
- Customary file name:  
  BICA\_<current_YEAR>_Uplands_MonitoringPoints_forListPrinting_GPS\loading_DB\loading\ng.xlsx

Copy one of the existing worksheets and name the copy ‘formatted for GPS’.

Adjust and format the new worksheet for input into DNR GPS version 6 by carefully matching the column names and cell value formats shown in this image:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>WAYPOINT</td>
<td>BICA10-001</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>3</td>
<td>WAYPOINT</td>
<td>BICA10-002</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>4</td>
<td>WAYPOINT</td>
<td>BICA10-003</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>5</td>
<td>WAYPOINT</td>
<td>BICA10-004</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>6</td>
<td>WAYPOINT</td>
<td>BICA10-005</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>7</td>
<td>WAYPOINT</td>
<td>BICA10-006</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>8</td>
<td>WAYPOINT</td>
<td>BICA10-007</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>9</td>
<td>WAYPOINT</td>
<td>BICA10-008</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>10</td>
<td>WAYPOINT</td>
<td>BICA10-009</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
<tr>
<td>11</td>
<td>WAYPOINT</td>
<td>BICA10-010</td>
<td>lat</td>
<td>long</td>
<td>x_proj</td>
<td>y_proj</td>
<td>comment</td>
</tr>
</tbody>
</table>

Select Save As from the File menu.

Save the file as Type = ‘CSV (Comma delimited) (*.csv)’ with file name =  
‘BICA\_<current_YEAR>_Uplands_MonitoringPoints_forGPS.csv’ to folder:  
\::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<YEAR>\Field_Prep\  

**In Windows Explorer:**

Change the extension of the file from .csv to .txt.

**In DNR GPS:**

DNRGPS, released in 2012 by the Minnesota Department of Natural Resources, is an Open Source update to the popular DNRGarmin application. It provides users the ability to transfer data between handheld GPS receivers and GIS software.

Select ‘Set Projection’ from the File menu, choose ‘UTM Zone 12N’, and click Ok.

Open File → Load From → File

SOP 6-18
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Change the File Type filter to ‘Text file (comma delimited)’.

Navigate to the folder holding the new text file of GPS waypoints.

Load the file.

Review the results of the loaded values. Make sure all records are present compared to the total number of sample points in sample point feature class in the master Geodatabase. Before proceeding make any necessary adjustment or corrections, including reformating the source file and reloading if necessary.

From the Edit menu select ‘Unproject Coordinates’. This populates the lat and long columns, which is required in order to save the waypoints in GPX format.

Open File → Save To → File

Set ‘Save as Type’ to ‘GPS Exchange Format (*.gpx)’

Set the file name to BICA_<current_YEAR>_Uplands_MonitoringPoints_forGPS.gpx.

Save the file to the current year’s ‘Field-Prep’ folder.

When prompted select ‘Waypoints’ as the GPS type.

In Garmin BaseCamp:

From the File menu select ‘Import into my collection’.

Locate and load the GPX file saved from DNR GPS in the previous step.

For each sample frame select all panel one waypoints from the list and set the symbol color to Green. The default flag symbol for waypoints is normally a good choice but can be changed if another symbol is preferred.

Select all remaining waypoints (representing over-sample points) and set the symbol color to Red. This helps differentiate panel one and over-sample points on the GPS screen while navigating in the field.

Connect a GPS device to the computer.

Check for existing data on the connected GPS device.

If data exist on the device then contact the previous user(s) of the device to determine if the data are already transferred and saved. If in doubt and/or the previous user isn’t available, go ahead and transfer the data to Garmin BaseCamp from the device and export the transferred data to this folder on the GRYN server in GPX format:

::\General_Library\GPS_Data_Unclaimed\

After reviewing and saving what is needed, remove all waypoint, track, image, and other data from the GPS unit.

Send the current year waypoints to the device. If the device has limited memory and only some of the waypoints fit in memory then select and send only the waypoints required for the upcoming field trip.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Select the device from the list in Garmin BaseCamp Library and view the loaded waypoints to confirm the device contains what you need. Make any required adjustments.

Disconnect the device and close Garmin BaseCamp.

**On the GPS device:**

After disconnecting the device and before leaving the computer for the field trip, turn on the GPS unit and open the list of loaded waypoints to confirm the required waypoints are loaded, correctly symbolized, named, and commented for use in the field. (For assistance refer to the device’s operating manual and consult program staff.)

Make any necessary adjustment and then turn off the GPS unit.

**In Windows Explorer:**

Copy the GPX file containing waypoints of sample points from the current year’s ‘Field-Prep’ folder to the project folder on each field computer customary destination folder: c:\BICA_LTM\
Project Stage: Preparation
Task (optional): Prepare and load GPS tracks showing sample frame boundaries
Responsibility: Project Leader or Data Manager

This is an optional task. Instructions will be added in a future version of the SOP.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Project Stage: Preparation
Task: Update the Data Entry Instructions document
Responsibility: Data Manager; Project Leader

In Windows Explorer:
Open the folder on the GRYN server that stores field preparation files for the prior year.

customary location:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<prior_YEAR>\Field_Prep\n
Create a new folder to hold current year files, e.g.:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<current_YEAR>\Field_Prep\n
Copy the file ‘BICA_Uplands_<prior_YEAR>_Data_Entry_Instructions’ from the older folder to the new folder.
Rename the copied file to:
‘BICA_Uplands_<current_YEAR>_Data_Entry_Instructions’

In Microsoft Word:
Open the renamed file, update the dates and make any other useful and necessary changes.
Save the Word file.
Save As a PDF file in the same location.

In Windows Explorer:
Copy the PDF file for data entry instructions for the current year to the project folder on each field computer,
customary destination folder: c:\BICA_LTM\
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Project Stage: Data Acquisition, Entry, and Processing
Task: Print, carry, and follow the latest instructions for data entry and backup
Responsibility: Project Leader, Field Technicians

Obtain current, printed data entry instructions before the first field trip:

In Windows Explorer:

Open the folder on the GRYN server that stores field preparation files for the current year.

\::\Monitoring\Active_Vital_Signs\BICA_Uplands\Projects\BICA_LTM_Veg\<current_YEAR>\Field_Prep\n
Open the document with data entry instructions for the current year.

\‘BICA_Uplands_<YEAR>_Data_Entry_Instructions’

Print, carry, and follow the data entry and data backup instructions.

Provide feedback to the project leader and/or data manager during or after each field trip about issues with the instructions and suggestions for improvement.
Project Stage: Data Acquisition, Entry, and Processing
Task: Archive data at the GRYN Office between field trips
Responsibility: Data Manager, Project Leader, Field Technicians

The data manager normally performs this task because it is a good opportunity to check computer hardware and software in addition to reviewing the content and completeness of each data file transferred to the server. If the data manager is unavailable then the project leader or a field crew member performs this task.

Field technician(s):

Upon arriving at the GRYN office after each field trip deliver the field computer and/or a memory card or USB device with the latest data file to the desk of the GRYN data manager.

Data Manager:

Before the crew depart for the next field trip, copy the latest data file from the field computer or memory device to the project folder on the GRYN server

\U:\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\Archive\<current_YEAR>\field_data_archive\

If no direct communication takes place between the data manager and the field crew between field trips then the data manager should leave a note on the field computer stating that the data transfer is complete.

Field technician(s):

Pick up the field computer and/or memory device before leaving the GRYN office for the next field trip. If there is no direct or written notice that the data file has been copied to the GRYN server then perform this task before leaving for the field.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Project Stage: Data Acquisition, Entry, and Processing
Task: Merge field data with the master project database
Responsibility: Data Manager

The complex nature of this task is due to the use of replication ID values in Microsoft Access. Replication ID values ensure completely unique records within this database and with records from any other database. The use of replication ID fields and values ensures long-term, big picture data integrity at the cost of dealing with the somewhat demanding format and function of replication ID fields during local data management and processing.

One cycle through these steps merges data from two separate files. If data are collected separately on two field computers, both of which need to be merged with a master database that already contains data, then merge the two field data sources first, and then follow these steps a second time to merge that result with the master data file. If project data are entered on three computers then it takes three cycles through these steps to combine all the data, and so forth.

**In Windows Explorer:**
- Make a copy of the destination data file that will become the new master data file and name it appropriately.
  e.g. NPS_BICA_Uplands_Monitoring_MASTER_Data_File_NewMaster.mdb
- Archive a copy of the source data file to preserve the original content.

**In Microsoft Access:**
- Open the source data file. If the source data file contains records from previous surveys that are already in the destination (master) data file, then open the Events table, sort by date, select the duplicate records from prior surveys, and delete those records, which will also delete associated records in the bare ground and species data tables. The remaining records should be distinct from those in the destination table, so these are the records that will be transferred in the following steps.
- Identify and delete any TEST records from the Events table since these shouldn't be retained.
- Create copies of the three key tables in the source data file:
  (Copied files are named to distinguish the user and month/day.)
  Copy ‘tbl_Events’ to ‘tbl_Events_User2_0613’
  Copy ‘tbl_EvData_BareGrdCover’ to ‘tbl_EvData_BareGrdCover_User2_0613’
  Copy ‘tbl_EvData_SpeciesCover’ to ‘tbl_EvData_SpeciesCover_User2_0613’
- Leave the source data file open - it will be used again soon.

Typically the separate data files deployed for field data collection contain the same set of Locations and Sites, and have identical data in the lookup tables (e.g. Species, Contacts). In that case the data in these tables don’t need to be merged, but watch for and address cases where a Location was added, or Species list modified. Address differences in the location/sites and species list data before processing the data for events and event data. Only if necessary, follow similar procedures to those outlined below to move records from
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

tbl_Locations and tbl_Sites with a join on field ‘Site_ID’, and/or the required species tables.

Open the destination data file.
Import the source tables renamed above from the source data file.

**To create Event records from the imported Events table:**

Open both the destination and source Events tables.
Select all data in all columns from the source Events table except Event_ID.
Copy the selected records.

*When executing the next step in June, 2012 a Microsoft Access message appeared saying the paste operation couldn't be completed. Getting it to work required selecting the Event_ID column as well as all other columns in the source Events table, then pasting into the destination table and working through the subsequent message(s) that appear. In this case one record copied from the source table didn’t paste to the destination table and had to be added to the destination Events table by copying the Location_ID value, pasting it directly in the destination cell of the new record row, then manually entering the remaining values for that record. Messages kept appearing, but eventually the record count in the destination Events table was correct.*

Highlight the New Record row in the destination Events table and paste the copied records.

**Create a query to join Event tables:**

Create a new query and add the destination (master) Events table and the source Events table.
Join the two tables using the Location_ID field.
To the query design grid add the Event_ID field from the destination Events table and establish an alias called “ValidEventID”.
Add the Event_ID field from the source Events table with alias “OrigEventID”.
Add all fields (*) from the destination Events table.
Save the query as a temporary working query (e.g. Qry_Events_User2_0613_wOrigEventID)
Open and inspect the query. It should contain all the pertinent data for the newly created Events (i.e., the records from Events_User2_0613), including the Original Event_ID replication values from the copied/renamed table.
Leave the destination data file open.

**To transfer records for the observer (contact) for each event:**

In the source data file create and view a select query in the source table with tbl_Events and tbl_xref_Event_Contacts.

SOP 6-26
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Change the query type to Make Table and select ‘Another Database’ (specify the new master data file) to create a table and assign a useful name such as ‘tbl_EventContacts_Jun25source’.

Execute the Make Table query to generate the new table in the destination data file.

Close the source data file.

In the destination data file create a query like the one pictured here:

Select and copy the results of this query.

Paste the results to tbl_xref_Event_Contacts.

To create the new records in the bare ground data table:

Create a query using the above saved query and the EvData_BareGrd_User2_0613 table, joining between OrigEventID (in Qry_Events_User2_0613_wOrigEventID) and Event_ID (in EvData_BareGrd_User2_0613).

Design this new query to display ValidEventID and CoverClass_Code.

Add an empty first column called 'Bare' as a placeholder, as shown:

Save this query with an appropriate name and keep it open.

Open the destination EvData_BareGrd table.

Select and copy columns ValidEventID and CoverClass_Code.

If this message appears when highlighting the New Record row in the destination EvData_BareGrd table, and pasting the copied records:

“The field is too small to accept the amount of data you attempted to add. Try inserting or pasting less data. (Error 3163)’’.

Then confirm that most records were successfully pasted, and then check the Paste Errors table for those that didn’t paste.

Copy and paste or manually enter the record(s) from the Paste Errors table to complete the transfer.
To create the new records in the species cover data table:

Create a query using the above saved query and the EvData_SpeciesCover_User2_0613 table, joining between OrigEventID (in Qry_Events_User2_0613_wOrigEventID) and Event_ID (in EvData_SpeciesCover_User2_0613).

Design this new query to display ValidEventID and the fields from EvData_SpeciesCover_User2_0613 (SppGroup, SpName, CoverClass).

Save this query with an appropriate name and keep it open.

Select and copy columns.

Highlight the New Record row in the destination EvData_SpeciesCover table, and paste the copied records.

View and verify the results of the paste and address any issues.

Close all open tables and queries.

The data merge process is now complete, but there are a few more things to do.

Compact and Repair the database.

Close MS Access.

In Windows Explorer:

Copy the new master data file to the archive folder. This file includes the tables containing both the original source records for Events, bare ground cover and species cover, along with the final merged records for the same groups.

customary location:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\Archive\n
customary file name:
NPS_BICA_Uplands_Monitoring_MASTER_Data_File_Archive_<mm_dd_yyyy>.mdb

In Microsoft Access:

Open the new master data file containing the complete, merged data set.

Delete the data processing queries used to merge data.

Delete the imported data tables whose records were merged in the master data tables.

Check for, address, and delete any table containing paste errors or other data processing objects generate by the data merging procedures.

Compact and Repair the database.

Close MS Access.

In Windows Explorer:

Rename the master data file:

Old name:
NPS_BICA_Uplands_Monitoring_MASTER_Data_File_NewMaster.mdb

SOP 6-28
New name:
NPS_BICA_Uplands_Monitoring_MASTER_Data_File.mdb
Project Stage: Data Acquisition, Entry, and Processing  
Task: Update sample frame weight values to reflect actual samples collected  
Responsibility: Project Leader; Data Analyst; Data Manager

Using values from the attribute table of the ‘BICA_Master_LTM_Sample_Frame’ feature class in the master project Geodatabase, create and save a file in Microsoft Excel using the example shown below as a guide, and using the current year in columns C and D for weight values.

customary location:  
U:\Monitoring\Active_Vital_Signs\BICA_Uplands\Data_Analysis\<current_YEAR>\  

customary file name:  
BICA_<current_YEAR>_Uplands_SampleFrameWeights.xlsx

<table>
<thead>
<tr>
<th></th>
<th>SampleFrame</th>
<th>FrameAreaSqmMeters</th>
<th>Weight2013_PreSeason</th>
<th>Weight2013_PostSeason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BICA_LTM_Veg10</td>
<td>947555</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>BICA_LTM_Veg20</td>
<td>274979</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>BICA_LTM_Veg30</td>
<td>782197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>BICA_LTM_Veg40</td>
<td>404191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>BICA_LTM_Veg50</td>
<td>605940</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>BICA_LTM_Veg60</td>
<td>356111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>BICA_LTM_Veg70</td>
<td>372545</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>BICA_LTM_Veg80</td>
<td>159360</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>BICA_LTM_Veg90</td>
<td>18979</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>BICA_LTM_Veg100</td>
<td>330147</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>BICA_LTM_Veg110</td>
<td>847534</td>
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<td>BICA_LTM_Veg120</td>
<td>287778</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>BICA_LTM_Veg130</td>
<td>603602</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>BICA_LTM_Veg140</td>
<td>495577</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>BICA_LTM_Veg150</td>
<td>518667</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Populate the pre-season weight values (column C) in the Excel file based on the original output from the pre-season GRTS draw of target sampling points for each sample frame (See SOP 2: Field Season Preparation and Close Out).

Confirm or adjust post-season weight values (Column D) in the Excel file using the results of Step 1 from section ‘Step by Step instructions for using R-code for annual data analysis’ in SOP 7: Data Analysis and Reporting.

Populate the post-season weight values in the Excel file using the original pre-season values if they didn’t change, or the adjusted values from the previous step.

Save and close the Excel file.

Tell the data manager that the Excel file is ready to incorporate into the master survey database for use in data output for analysis and for updating attribute tables in the master Geodatabase.

SOP 6-30
Project Stage: Quality Review  
Task: Review Data Quality  
Responsibility: Project Leader and all project personnel  

Everyone working on the project is responsible for collecting, managing, and reporting high quality data. Following each field season a subject matter expert performs and documents an assessment of all data collected for the period in order to certify (or deny if necessary) the qualification of the data for use in analysis, reporting, and distribution. The post-season data review is normally done concurrently with data documentation and certification (instructions for which follow in this document).

Responsibilities of all personnel:

Remember that data quality review is ongoing throughout annual and overall project implementation.

Become familiar with data quality standards and objectives in the monitoring protocol’s objectives, sample design, database design and documentation, analytical specifications, and reporting requirements.

Obtain, read, and use reference documentation to support data quality throughout all project operations, including pre-season training materials, field operation guides, standard operating procedures, and data entry and handling instructions.

Always prioritize and focus on collecting, managing, delivering, and using high quality data.

Follow and provide constructive feedback on data input and output procedures that are designed to be as simple and streamlined as possible in order to match field work flow and directly support analytical and reporting needs.

Learn and use controls on data recording and data entry tools that prevent anomalous entries and maintain data integrity.

During electronic data entry:

*Make sure the computer screen is clearly visible.* When natural lighting and environmental conditions in the field make this challenging, use and create shaded areas, turn your back to the sun, work in the shadow of another person, or find some way to make sure you can clearly see what you’re entering on the computer screen.

*Don’t hurry data entry.* Carefully and deliberately choose the correct row from the pick lists in each data field. It’s always better to have less data that are better, than more data that don’t accurately record field observations and measurements.

*Check and double-check each entered data value.* Immediately look at the value that appears in the data field after selecting an intended row from a pick list. If the field value is not correct then open the pick list for that field again and carefully select the intended value. Check again that the correct value shows up in the data field. This requires you to be meticulous.

*Take notes and tell someone in charge about anomalies, issues, and suggestions for improvement.*
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

During data recording on paper if direct computer entry isn’t possible:

Always write neatly and legibly.

Write a value in every data field because blank fields either mean an effort was made to collect a data value with no result, or no attempt was made due to laziness, indifference, or distraction. These two outcomes are impossible to differentiate after the fact if nothing is written down. Therefore, surveyors must write a value in every data field unless specifically instructed to leave a field empty, which happens only in cases where an empty data field has a clear and specific meaning, and it saves time and effort during the survey. *When in doubt, write it out.*

If a mistake is made, don’t erase. Instead, put a single line through the incorrect entry, clearly write the correct value, and initial and date the change.

For data fields with pre-defined values or ranges, only record values from the approved or referenced list. In some cases you may have to look up these values in separate documents.

Make notes about question, issues, and suggestions for improvement.

Review all entries before putting away the current data sheet; make sure everything written is complete and is legible (clearly readable) to someone other than you.

Slow down - as already stated above, it’s always better to have less data that are better, than more data that don’t accurately record field observations and measurements.

Post-season Data Review by subject matter expert(s):

Do this data review in conjunction with the next two tasks, data documentations and certification.

Refer to the data review and certification template document (see the “Certify Data . . .” task below) for a list of questions to answer about data quality.

Perform any and all activities required to comprehensively examine the data from the survey period in ways that allow identification of errors, anomalies, issues, or any factor affecting the utility of the data for both planned and unplanned summarization, analysis, and reporting.

Suggested review activities:

Open data tables in the master data file and scroll, filter, and query to look at original data in a variety of ways;

Summarize data in various ways using standard tools in Microsoft Access and/or Microsoft Excel (e.g. sorting, filtering, pivot tables, crosstab queries, etc.);

Apply *ad hoc* preliminary and exploratory analytical procedures to generate and assess outputs that reflect the validity and utility of the original data.

Evaluate the data for consistency with project data collected before the period under review, and document any differences.

Validate the following data quality elements during review activities:

The correct and expected numbers of records are present.
The correct data fields are present.
Data values fall within expected and allowed ranges or categories.
No extra or unnecessary values exist.
Data field and values have the correct format.
No inexplicable blank or null values exist.
Data fields and values are completely described in a format and location that all users can easily identify and read.
Project Stage: Metadata
Task: Review and maintain data documentation (metadata)
Responsibility: Project Leader and Data Manager

Documentation for this protocol’s data includes descriptions of site, survey, and cover type parameters/variables in the monitoring protocol document, database object descriptions in the project database, a data dictionary file for the master survey database, and data field/variable descriptions in standard operating procedures, field manuals, and training materials. Geospatial data for the protocol, consisting of sample frame polygons and a different layer of sampled points each year, are described in geospatial metadata within the project’s master Geodatabase that meet Federal Geographic Data Committee (FGDC) and NPS standards.

Review data for sensitive information annually:
While sensitive information is not expected to be part of these protocol data sets, the project leader evaluates this annually by working with park resource managers to determine whether or not the project’s databases include any sensitive information, such as specific locations of rare, threatened, or endangered species.

Enter explanatory text in the ‘Use Limitations’ field in the metadata record to describe whether and how data are restricted for use and distribution based on sensitive content.

Work with the data manager to ensure that sensitive records in project data sets are appropriately restricted, secured, and prevented from distribution.

Update the documentation for the master Geodatabase:
For reference, open these comprehensive metadata instructions prepared by the NPS Intermountain Region Geographic Resources Program for use in ArcGIS 10, Service Pack 3 or greater (location last checked 12/7/2012):

The user interface for geospatial metadata in ESRI GIS products tends to evolve as new versions are released. If these instructions do not reflect current user interface options and tools then please consult the ESRI Help system and online resources to determine how best to review and update the geospatial data documentation. Please also advise the GRYN data manager to update these instructions as needed.

In ArcGIS:
Open ArcCatalog
Locate ‘NPS_BICA_Uplands_Monitoring_MASTER_Geodatabase.gdb’ in the project’s ‘Data’ folder.
Expand the feature data set named ‘Sample Points’.
Right click on the feature class containing the sample points for the current year.
Select Item Description from the right-click menu to open the metadata record for the feature class.
Select the Edit button to open the metadata record for editing.
Review, update, and enter a value in every possible field in each of the content areas in the left navigation pane.

Repeat these steps with other feature classes as necessary to review, update, and add documentation for each feature class in the master Geodatabase.

**Update field descriptions for tables in the master survey database**

**In Microsoft Access:**

Open the master data file:

`customary location:`
`:\\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\`

`customary file name:`
`‘NPS_BICA_LTM_Veg_MASTER_Data_File.mdb’`

For every table in the master database:

Open the table in Design View.

Using the NPS Naturel Resource Database Template documentation as a guide, review and update the description for each field in the table. Leave NRDT description in place, but include additional information pertaining to the monitoring project to help other users understand the purpose of each data field. Since there is a limit to the total number of characters allowed for field description, be creative but clear when constructing field descriptions.

Use caution to avoid changing the table design while in Design View.

Save and close the table.

Perform the ‘Compact and Repair Database’ function.

Close the data file and MS Access.

**Review and update the data dictionary file for the master survey database**

**In Windows Explorer:**

Open the master data dictionary document:

`customary location:`
`:\\Monitoring\Active_Vital_Signs\BICA_Uplands\Data\`

`customary file name:`
`NPS_BICA_Uplands_Monitoring_MASTER_Data_File_Data_Dictionary.docx`

**In Microsoft Word:**

Review and if necessary edit the content of the database field names, descriptions, etc. to reflect the current structure and content of each table in the master survey database. Field
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

descriptions should include, and if necessary further describe for the benefit of users, the field descriptions directly from the table properties in the master survey database.

Save and close the data dictionary file.
Project Stage: Data Certification and Delivery
Task: Certify data prior to use or distribution
Responsibility: Project Leader; Data Manager; Program Manager

Open the read-only data review and certification template document from the GRYN server:
::\Monitoring\Active_Vital_Signs\BICA_Uplands\Products\Reports_Data_Quality\BICA_veg_monitoring_data_quality_review_certification_TEMPLATE.docx

Use Save As to establish a file in the same folder with a name that includes the current year and, if necessary, an indication of the completion status of the certification report:
BICA_veg_monitoring_data_quality_review_certification_<current_YEAR>_InProgress.docx

Based on the associated post-season data quality review and documentation tasks covered above, complete each field in the certification document. The project leader is responsible for getting input and signatures from other project and program staff.

Multiple sessions could be required to work through the data review, documentation, and certification. Save the ‘InProgress’ version of the file during and after each session. When the certification report is complete and all required signatures are in place, rename the saved file as the final report for the current year:
BICA_veg_monitoring_data_quality_review_certification_<current_YEAR>_FinalReport.docx
**Project Stage: Data Delivery**

**Task:** Confirm all project data files are organized and documented on GRYN server

**Responsibility:** Project Leader; Data Manager

Open the folder and file naming convention document from the GRYN server for guidance:

::\Data_Info_Management\Standard_Operating_Procedures\NPS_GRYN_Folder_File_Conventions_Version1.4.doc

Follow the conventions in the above document to name and file project data files.

For additional guidance contact the GRYN data manager.
Project Stage: Data Delivery
Task: Test and execute data output functions in the master database to generate data sets for analysis
Responsibility: Data Manager; Project Leader

Open SOP 7: Data Analysis and Reporting and locate the section that describes the data output(s) and format(s) required for analysis.

Discuss data output and formatting needs with the data analyst.

Open the master survey database.

Incorporate final sample frame weight values from the previous task ‘Update sample frame weight values to reflect actual samples collected’. The method for incorporating final weight values may vary and improve each year, so performing this task is left to the discretion of the data manager. Specific instructions may be added to these procedures in the future.

Execute existing data summary and output functions present in the master database application. These are buttons in the data interface with descriptive names and/or descriptively named query objects saved in the database.

If necessary, create new output from the master data file using queries, functions, and procedures to meet the data content and format required for input into analytical routines and applications.

Save new output objects and functions with descriptive names for future use.

Generate the output files required for analysis (as specified in SOP 7: Data Analysis and Reporting) and save each file with a descriptive name in an appropriate location.

Customary location: U:\Monitoring\Active_Vital_Signs\BICA_Uplands\Data_Analysis\<current_YEAR>\ Example file name: ‘NPS_BICA_2012_VegData_qry_xtab_SpeciesCover_ForInternalReview.xlsx’

Close the master survey database.
Project Stage: Data Delivery
Task: Notify analysts and others as needed that data are ready for analysis and reporting
Responsibility: Project Leader

Inform the analyst(s) directly or via email that data are certified for use in analysis and reporting.

Provide specific file locations, file names, and helpful instructions to the analyst.
Project Stage: Product Development
Task: Store completed reports and related products in the appropriate location(s) on the GRYN server
Responsibility: Project Leader

Open the most recent file naming convention document from the GRYN server for guidance:
::\Data_Info_Management\Standard_Operating_Procedures\NPS_GRYN_Folder_File_Conventions_Version<X>.doc

Follow the instructions and conventions in the above document to name and file project reports and related files.

All or most reports and products will already be filed in the correct locations based on the instructions in this and other SOPs.

For additional guidance contact the GRYN data manager.
Project Stage: Posting and Distribution
Task: Deliver reports and other products according to the delivery schedule and instructions
Responsibility: Project Leader

Provide preliminary information, completed reports, and other projects to park and program staff as requested or as scheduled in the monitoring protocol.

Delivery may include sending printed material, posting files on web sites, transferring files via email, etc.
Project Stage: Posting and Distribution

Task: Create records and upload data sets, reports, and other pertinent project resources to national database/clearinghouse

Responsibility: Project Leader; Data Manager

Open the NPS resource management applications web site: https://irma.nps.gov.

Open and use the online Help documentation for creating records and uploading files. These instructions change frequently with new versions of the online application and user interface.

Create and update records in the online database for completed reports and annual certified data sets.

Upload corresponding files for these project records. The schedule for distributing data from the current year is at the discretion of the project leader and program manager based on reporting and publishing requirements.

Review and update the overall ‘project’ record that brings together individual records for the project.

Contact the GRYN data manager for additional guidance if necessary.
Project Stage: Posting and Distribution  
Task: Update records in the national species database  
Responsibility: Data Manager; Project Leader

Open the NPS resource management applications web site: https://irma.nps.gov.

Locate and open the web page for the species database.

Open and use the online Help documentation for adding or editing species records. These instructions change frequently with new versions of the online application and user interface.

Make necessary changes or additions to the species database using documented species information in project reports and certified data sets.

Contact the GRYN data manager for additional guidance if necessary.
Project Stage: Archival and Records Management
Task: Review and manage electronic and physical project records according to NPS policy
Responsibility: Project Leader; Data Manager

Using Director’s Order 11, Records and Electronic Information Management as a guide, review and process physical and electronic records for the project after all data management, analysis, and reporting requirements have been met for the year. This includes deleting intermediate electronic files that are not required for the permanent record. If there is concern about needing an intermediate file in the future, then move the files identified for deletion to a folder named ‘delete_when_ready’ in the project’s electronic library on the GRYN server. Then, while performing this task the following year, permanently delete all the files remaining in the ‘delete_when_ready’ folder from the previous year.

File all paper data sheets and other physical project materials for the year in labeled folders within the existing filing system at the GRYN office.

Paper materials for the project are stored in a filing system at the GRYN offices. Following procedures in the overall GRYN Data Management Plan these materials will eventually and periodically receive permanent accessions and archival at a facility approved by the National Archives and Records Administration.

Reference Materials

NRDT Web site (accessed 9/6/2012):
http://science.nature.nps.gov/im/datamgmt/applications/template/index.cfm
Standard Operating Procedure (SOP) 7: Data Analysis and Reporting

Version 1.0, January 2013

Overview
This SOP describes the recommended analytical approaches and reporting guidelines for the GRYN Upland Vegetation monitoring program. Many different types of analysis will be conducted over the life cycle of this project and choosing the appropriate analysis method will be dependent on the purpose of the analysis. Code written for the R statistical software and language environment referenced in this SOP is available on the GRYN server at: Monitoring\Active_Vital_Signs\BICA_uplands\Resources\Analysis_tools.
Procedures

Data Analysis

Routine Summary Statistics

Routine summary statistics will be performed after each year of data collection and the results presented in graphical, spatial, and tabular formats. The primary monitoring metric is estimated canopy cover for each species, analyzed by estimating the proportion of sampling quadrats within each Daubenmire cover class and trends in those proportions over time. As discussed in the sample design chapter, it is best to present annual status in terms of the proportions of quadrats in each cover class rather than using more traditional methods (e.g., Daubenmire 1959, Bureau of Land Management 1992) that substitute the median for each Daubenmire class and then calculate a single value for each frame by averaging the median-replaced values.

Calculating proportions with the local variance estimator

Since the quadrats in this protocol are distributed within each sample frame by the GRTS algorithm, it is possible to calculate a confidence interval around each cover class frequency with the “local variance estimator” that is associated with GRTS samples (Stevens and Olsen 2003, Stevens and Olsen 2004). Refer to SOP 7.1 for example graphic showing percent (or frequency) of Daubenmire cover classes for bare ground in seven sample frames monitored at Bighorn Canyon in 2011. Error bars show one standard deviation, calculated from the local variance estimator associated with GRTS samples.

The statistical methods outlined below are based on the statistical freeware R, an open source version of S-Plus. R is a powerful system for statistical computations and graphics, which runs on Windows, Unix, and Mac computers. R is a combination of a statistics package and a programming language. It can be downloaded for free from http://www.r-project.org/. The R Wiki provides an online forum http://wiki.rproject.org/rwiki/doku.php and documentation.

Analysis for routine annual status reports is performed with the spsurvey library for R. Before using the scripts provided in the digital toolbox, it would be worth the reader’s time to scan through the spsurvey documentation by Kincaid (2008) and develop an understanding of what each function in the code does.

The analytical code (script) used to derive the proportion of quadrats by cover class is available in the protocol ‘tool box’, under the file name BICA_LTM_Veg_RCode_proportion_of_plots_by_coverclass<year_date>. Direct references to R commands in the text are distinguished by Courier New Font rather than Times New Roman, with arguments for the commands noted by closed parentheses (). The example script in the protocol toolbox was prepared for a single species of interest (cheatgrass), but the proportion of quadrats for each cover class can be calculated for any response variable of interest.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

**Figure SOP 7-1.** The percent (or frequency) of Daubenmire cover classes for bare ground in seven sample frames monitored at Bighorn Canyon in 2011. Error bars show one standard error, calculated from the local variance estimator associated with GRTS samples (Stevens and Olsen 2003).

**Figure SOP 7-2.** Two alternative ways of frequency data are shown. In the upper panel, percents are stacked in a bar chart; in the bottom panel, sample frames are grouped according to plant community type before charting and percents are presented as a 3D column.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

The script used to derive the proportion of quadrats by cover class will result in a table showing the proportion of quadrats in each cover class and the GRTS-derived local variance estimator (stdError.P) for the species of interest. Data values from the table are then exported to MS Excel or other analysis packages for graphing. Graphs styles may vary over time depending on what receives the best response from park management. Several alternative ways of presenting the same data are shown in Figures SOP 7-1 and 7-2 above.

Data analysis prerequisites
Input files for data analysis

Data stored in the project database will be exported following the data delivery steps in SOP 6. Data Management. Only certified data ready for analysis should be used.

Add a worksheet for the sample frame weight values

In order to maintain the spatial balance of the GRTS sample, sample frames are assigned a weight (wgt), which appears in the original, unsorted ArcGIS .dbf file(s). This weight must be added to the data analysis file before analysis.

Before using the data analysis script in the digital toolbox, it may be necessary to adjust the sample weights to reflect the actual number of samples collected in each frame. This can be done with the adjwgt() command (Kincaid 2008), or in the case of the equal probability design used in this protocol, a simpler approach is to change the weights in the data analysis file before analysis.

To make this adjustment, multiply the weights in the wgt column for each frame by the quantity \( \frac{n_0}{n_1} \), where \( n_0 \) is the initial sample size designated for the sample frame, taken from the sample design, and \( n_1 \) is the actual number of samples collected including all over-sample quadrats. When the adjustment has been made, add a column to the data file named ‘Weight<year>_PostSeason’ with the adjusted weights for each sample frame added to the quadrat_ID cell.

Make a copy of the original data file

Preserve the original data file by making a copy for data analysis purposes, save to the same workbook and rename the worksheet “<year>_data_analysis_input_file”.

Confirm and rename column headers to match the data dictionary naming conventions below

For analysis with the R statistical package, the order of the columns in the input file does not matter, but all the fields shown in Table SOP 7-1 and Figure SOP 7-1 below should be present.

Table SOP 7-1. Data dictionary showing database and .csv field names.

<table>
<thead>
<tr>
<th>Database field name</th>
<th>Value</th>
<th>.csv field name</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>4 digit year e.g. 2012</td>
<td>Year_Sampled</td>
</tr>
<tr>
<td>Sample_Frame</td>
<td>A unique code for each sample frame e.g. BICA_Juniper08</td>
<td>Sample_Frame</td>
</tr>
<tr>
<td>Plot_Name</td>
<td>A unique code for each sample quadrat</td>
<td>Plot_Name</td>
</tr>
<tr>
<td>X_Coor</td>
<td></td>
<td>UTMx</td>
</tr>
<tr>
<td>Y_Coor</td>
<td></td>
<td>UTMy</td>
</tr>
<tr>
<td>Weight&lt;year&gt;PostSeason</td>
<td>GRTS weight adjusted post field season</td>
<td>wgt</td>
</tr>
</tbody>
</table>

SOP 7-4
### Greater Yellowstone Network Upland Vegetation Monitoring Protocol

For analysis with the R statistical package, the order of the columns in the input file does not matter, but all the fields shown in Figure SOP 7-3 below should be present. For the power analysis scripts available in the digital toolbox, the data should be arranged exactly as shown in the figure, with the quadrat name appearing in the third column and the species data in the 7th and later columns. The file does not need to be sorted in numerical quadrat order.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>452</td>
<td>2012</td>
<td>BICA_Sage05</td>
<td>71906</td>
<td>498172</td>
<td>13107.7736</td>
<td>6/7/2012</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>453</td>
<td>2012</td>
<td>BICA_Sage05</td>
<td>71906</td>
<td>498317</td>
<td>13107.7736</td>
<td>6/7/2012</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>454</td>
<td>2012</td>
<td>BICA_Sage05</td>
<td>71827</td>
<td>498205</td>
<td>13107.7736</td>
<td>6/7/2012</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>455</td>
<td>2012</td>
<td>BICA_Sage05</td>
<td>719648</td>
<td>498563</td>
<td>13107.7736</td>
<td>6/8/2012</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>456</td>
<td>2012</td>
<td>BICA_Sage05</td>
<td>718565</td>
<td>498519</td>
<td>13107.7736</td>
<td>6/20/2012</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Figure SOP 7-3.** Example input file for data analysis. Note that response variables start in column H and continue.

*Export data and save as a comma delimited (.csv) file.*  
Once the column names have been edited, make a copy of the data analysis worksheet and save as a comma delimited (.csv) file. Store in a location where the results from running the R script are also stored.

**Step by Step instructions for using R-code for annual data analysis.**  
Note: before analysis, complete all the prerequisites described above.

The R scripts provided in the digital toolbox will likely need to be edited each year in response to changes in data or analysis techniques and are presented here only as guidelines. At a minimum, the user of the scripts should verify that the variable names imported correctly into R by issuing the `names(data)` command and comparing the output to the variable names in the script. Quite often spaces or other formatting characters will be transformed into periods or other nulls, necessitating changes in the names used.

**Step 1.** Download the R program for statistical computing by following the instructions at [http://cran.r-project.org](http://cran.r-project.org).

**Step 2.** Open the R program and install the spsurvey package.

As written, the first line of the script will allow you to choose the analysis file with your file browser, so you don’t need to change the working directory.

**Step 3.** Open the R script in a text editor like notepad or Gedit. For the annual data analysis reports, use the script titled `BICA_LTM_Veg_Rcode_proportion_of_quadrats_by_coverclass`.

**Step 4.** Edit the R script by removing lines of programming code based on desired outcome. As written, the script as will calculate the proportion of quadrats by cover class that include cheatgrass and the variance estimate. Alternately, it will calculate the proportion of quadrats with cheatgrass >0 and the variance estimate.

SOP 7-5
Step 5. Edit the R script by changing the species (e.g., substitute another plant name) and the criteria, if calculating the proportion of quadrats meeting a certain criteria (substitute another value such as >3). If the weight column is named anything other than wgt, edit the R script to replace wgt with the exact name of the column heading.

Step 6. Copy and paste the commands from the R script into the R command either one at a time or as a block. If you get errors, you will want to enter the commands singly, making edits as needed.

Step 7. View the results by typing at the command line >cheatgrass_estimates.

Step 8. Select the results and save by choosing ‘save to file’ from the file drop down menu. Save as a .txt file that can later be imported into an Excel file. Note that the local variance estimator is labeled ‘stdError.P’ and displayed in the right hand column of the results.

Step 9. To re-run the analysis for a new species, edit the code to include the variable of interest and repeat step 7 and 8.

Step 10. Import the text file into excel, or other stat package, for graphing. Save the file to the project folder on the GRYN server–customary location: \products\annual_reports\<year>\pre_publication\tables.

Using Excel
To calculate the proportion of sampling quadrats within each Daubenmire cover class, begin by counting the number of quadrats in each cover class and then divide this number by the total number of quadrats sampled in the frame. One way to do this is by using the CountIf function in Excel (e.g. =COUNTIF(V2:V101,$C102). Once the count is complete, use the Sum function to divide the total number of quadrats sampled in each cover class by the total number of quadrats sampled in the frame. These values are then added to the pre-built table template below (Table SOP 7-2). These data may also be represented graphically as shown in Figure SOP 7-2.

Table SOP 7-2. A pre-built MS Word Styles template for tables are shown below.

<table>
<thead>
<tr>
<th>BICA LTM_Veg_110: Juniper woodland</th>
<th>0%</th>
<th>&gt;0-5%</th>
<th>&gt;5-25%</th>
<th>&gt;25-50%</th>
<th>&gt;50-75%</th>
<th>&gt;75-95%</th>
<th>&gt;95-100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bare ground</td>
<td></td>
<td>1</td>
<td>65</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Litter</td>
<td>0</td>
<td>68</td>
<td>8</td>
<td>9</td>
<td>4</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Cryptogams</td>
<td>5</td>
<td>62</td>
<td>22</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utah juniper (Juniperus osteosperma)</td>
<td>26</td>
<td>10</td>
<td>33</td>
<td>20</td>
<td>8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Mountain mahogany (Cercocarpus ledifolius)</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sage brush (Artemisia tridentata spp.)</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Black sage brush (Artemisia nova)</td>
<td>94</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Step Change Analysis
After several years of data have been collected, measurements of step-change, which examine differences in plant cover measured during two different years, can be performed with a proportion test (Sheskin 2007). Although more advanced statistical methods may be used, the proportion test is a simple way to compare the frequencies of a cover class measured during two different years and determining if there is a significant difference to report.

When trends are analyzed it may be desirable to divide the sample frames into strata according to known physical gradients. For example, there is a strong north-south precipitation gradient in Bighorn Canyon that has strong effects on the composition of vegetation communities (Singer and Schoenecker 2000, Tercek 2010).

Sample Design Analysis Techniques
For the sample design of this protocol, sample size estimates and power analysis for a step-change comparison between two years was completed and the results described in chapter 2 of the protocol narrative. Readers should refer to this chapter for details pertaining to how these analytical methods were used in the sample design. In general we do not anticipate having to conduct this analysis again, however if the need arises, the analytical codes for these analyses are available in the protocol tool box on the GRYN server at: \Monitoring\Active_Vital_Signs\BICA_uplands\Resources\Analysis_tools.

The file named BICA_LTM_Veg_PythonCode_Status_estimates<year_date>.txt is the python code used to iteratively calculate status estimates for subsets of the GRTS sample and was used to guide sample size requirements for this protocol.

The file name BICA_LTM_Veg_RCode_Step_Change_Proportion_test<year_date>.txt is the R-Code used to determine power for a “step-change” comparison between two years.
Reporting
Reporting will take place each year of data collection and will routinely include a data summary report and a resource brief. On occasion, the protocol leader may need to immediately report a result, e.g. when the invasive plant on the park ‘watch list’ is discovered. A more in-depth trend report will be produced every six years. Table SOP 7-3 list the reporting products, their destination and the primary person responsible.

Annual reports and six-year analyses of status and trend will use the NPS Natural Resource Publications series template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Template guidelines and documentation of the NPS publication standards (NPS 2006) are available at the following address: [http://www.nature.nps.gov/publications/NRPM/index.cfm](http://www.nature.nps.gov/publications/NRPM/index.cfm). These reports are described in more detail below.

Annual Report
A data summary report (Figure SOP 7-4) will be produced after each year of data collection, and will:

- Provide a summary history of the samples taken during each year of the study, tabulating numbers of samples for each sampling frame and showing these locations on maps of the parks
- Provide summary status statistics and interpretation of the biological meaningful results
- Evaluate data quality and identify any data quality concerns and/or deviations from protocols that affect data quality and interpretation.
- Evaluate and identify suggested or required changes to the protocol.

The annual report outline will include the following sections:

1. Introduction
2. Study Area and Methods
3. Results and Discussion
   a. Sample frame results
   b. Key findings
   c. Table: Percent of quadrats within each cover class for exposed soils and principle plant species
   d. Map showing all sample points – emphasis on select plant(s) of interest
   e. Yearly park wide results
   f. Key findings
   g. Figure(s) showing the percent of each cover class for ‘select’ attributes across all sample frames
4. Literature Cited
### Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Table SOP 7-3. Primary protocol deliverables, their destination and responsibility.

<table>
<thead>
<tr>
<th>Deliverable Product</th>
<th>Primary Responsibility</th>
<th>Destination(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed location data (priority species)</td>
<td>Protocol Lead</td>
<td>Park Resource Manager</td>
</tr>
<tr>
<td>Raw data files</td>
<td>Field Lead</td>
<td>GRYN Server¹</td>
</tr>
<tr>
<td>Photographs (select, quality images for long-term storage)</td>
<td>Protocol Lead</td>
<td>GRYN Server¹</td>
</tr>
<tr>
<td>Certified working database and geospatial data with draft metadata</td>
<td>Protocol Lead with Data Manager assistance</td>
<td>Master project database and GIS data sets, copy to GRYN Server¹, and NR-GIS Metadata and Data Store²</td>
</tr>
<tr>
<td>Annual report (NRDS publication)</td>
<td>Protocol Lead</td>
<td>IRMA³, GRYN Server¹, printout to local park collections, NRPS website⁵</td>
</tr>
<tr>
<td>Resource Brief</td>
<td>Protocol Lead</td>
<td>Park superintendent, resource staff and interpreters; GRYN Website</td>
</tr>
<tr>
<td>6-year analysis report</td>
<td>Protocol Lead</td>
<td>IRMA³, GRYN Digital Library³, printout to local park collections, NRPS website⁵</td>
</tr>
<tr>
<td>Other publications</td>
<td>NPS Lead, Protocol Lead, Data Manager</td>
<td>IRMA³, GRYN Digital Library³, printout to local park collections</td>
</tr>
<tr>
<td>Other records</td>
<td>NPS Lead and Protocol Lead</td>
<td>Retain according to NPS Director’s Order #19⁶</td>
</tr>
</tbody>
</table>

¹ The GRYN Server is a hierarchical digital filing system stored on the GRYN server in Bozeman MT. Network users have access to these files, except where information sensitivity may preclude general access.  
² NR-GIS Metadata and Data Store is a clearinghouse for natural resource data and metadata ([http://science.nature.nps.gov/nrdata](http://science.nature.nps.gov/nrdata)). Only non-sensitive information is posted to NR-GIS Metadata and Data Store. Refer to the protocol section on sensitive information for details.  
³ IRMA is the NPS Integrated Resource Management Applications database ([https://irma.nps.gov/App/Portal/Home](https://irma.nps.gov/App/Portal/Home)). This application has the capability of storing and providing public access to digital files associated with each record.  
⁴ NPS Director’s Order #19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: [http://www.nps.gov/refdesk/DOrders/DOrder19.html](http://www.nps.gov/refdesk/DOrders/DOrder19.html)  
Resource Briefs
A resource brief will also be prepared to highlight the key results for superintendents, park interpretive staff, and resource managers (Figure SOP 7-5). This brief is completed concurrent with or following the completion of the annual report. It is small enough to be sent to park management as an attachment, posted to the web site, and printed for distribution.

Figure SOP 7-5. The 2011 upland vegetation monitoring resource brief for Bighorn Canyon.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Trend Report
This report will provide greater analytical and interpretive detail, and will evaluate the relevance of findings to long-term management and restoration goals. The report will review operational aspects of the monitoring program, such as whether sample frame boundaries need to be changed or whether the sampling period remains appropriate (the optimal sampling season could conceivably change over time in response to climate change). The report will also evaluate if there is new management concerns that might dictate some reallocation of effort or additions to the indicator metrics that are routinely examined annually.

Current versions of the protocol, resource briefs, and annual and six-year technical reports will be made available on the GRYN website (http://science.nature.nps.gov/im/units/gryn/index.cfm). The protocol and technical reports will also be available from the national NRPM website (http://www.nature.nps.gov/publications/nrpm/nrr.cfm). All NPS protocols are available from (http://science.nature.nps.gov/im/monitor/protocoldb.cfm).

Weed Location Data
Invasive weed locations (Figure SOP 7-6) for high-priority species should be reported to the park resource managers immediately following completion of field activities or sooner if the plant is a new record for the park. Reported information should include GPS locations and maps of locations with weeds present both within quadrats and as noted during travel between sampling locations. Include a photo if taken of the weed.

![Weed Location Data](image)

**Figure SOP 7-6.** Example map showing locations of toadflax discovered in Bighorn Canyon during 2012. In addition to the map, the exact coordinates are provided to park managers to aid locations using a GPS device.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Reference Materials


Tercek, M. T. 2010. Climate zonation analysis for Bighorn Canyon National Recreation Area. Report delivered in March 2010 as partial fulfillment of MSU-186 task agreement between the Greater Yellowstone Network and Big Sky Institute, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, Montana.

SOP 7-12
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Standard Operating Procedure (SOP) 8: Protocol Revision

Version 1.0, January 2013

Change History

<table>
<thead>
<tr>
<th>Original Version #</th>
<th>Date of Revision</th>
<th>Revised By</th>
<th>Changes</th>
<th>Justification</th>
<th>Pages Affected</th>
<th>New Version #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overview

This SOP describes how to revise the protocol. The protocol narrative, appendices, SOPs, and data sheets are managed to ensure that only authorized and approved modifications are made to these documents and to maintain a complete version history of this protocol to ensure all data can be synthesized, analyzed, and reported.
Greater Yellowstone Network Upland Vegetation Monitoring Protocol

Procedures

I. Review and if necessary revise the protocol narrative document:

A. Each year, evaluate the monitoring protocol narrative document during field close-out activities and continuing throughout the data analysis and reporting period in order to identify issues.

B. If changes are necessary perform all edits in a copy of the original (or latest) protocol narrative document well before the start of the upcoming field season to allow time for internal review and approval of minor changes, and possibly additional, lengthier reviews if there are major changes.

C. Make minor updates to clarify or further describe objectives and/or methods that will help readers and users understand the purpose and methods for monitoring. Consult with the program manager to resolve questions about minor versus major changes. Minor updates are those that do not change the underlying objectives, methods or outputs. For example:
   1. Correcting spelling and grammatical errors in existing text.
   2. Adding descriptive detail to an existing section to improve clarity and promote understanding.
   3. Updating a graphic to better reflect existing methods or outputs.
   4. Improving the layout and design of a data collection form for existing (not new) parameters.

D. Record every minor change in the revision history log located at the beginning of the monitoring protocol narrative. Follow the instructions that accompany the log.

E. Consult with the program manager if major adjustments are necessary that involve existing objectives, sample design, parameter values, data management, analytical formulas or procedures, or report content.

F. If approved by the program manager, make the required major updates to the monitoring protocol narrative. Examples of changes that could represent major updates:
   1. Changing (as opposed to clarifying) monitoring objective(s).
   2. Including additional sampled parameters/variables.
   3. Discontinuing existing sampled parameters/variables.
   4. Changing the sample population spatially or otherwise.
   5. Changing the sampling approach to sample more, less, or differently.
   6. Changing the sampling schedule such that the volume and distribution of data in a given time period changes, which could affect the precision or timing of status and trend estimates.
   7. Changing the existing method(s) for collecting data in ways that make previously collected data inherently different from data collected using revised methods, for
example, increased or decreased precision or a different domain of allowed values for
a parameter.

G. Record every major change in the revision history log located at the beginning of the
monitoring protocol narrative. Follow the instructions that accompany the log.

H. If changes were made to the protocol narrative document, update the version number and
the current date at the beginning of the document and everywhere else the version
number and/or date are used, e.g. in document headers or footers. Use the next sequential
tenth of an integer only if all of the changes were minor (i.e., Version 1.0 changes to 1.1).
Use the next whole integer with zero in the tenths place if one or more major changes
were made (i.e., Version 1.3 changes to 2.0).

I. Save the updated document, with the latest version number in the file name, in the
project’s protocol folder on the GRYN server.

II. Review and if necessary revise Standard Operating Procedure (SOP) documents:

A. Evaluate every SOP associated with the monitoring protocol each year, in conjunction
with the evaluation and possible update of the protocol narrative. If the protocol narrative
received a major revision then one or more SOPs must also receive a major revision that
reflects the new information in the narrative. If the protocol narrative was not changed or
changed only in minor ways that aren’t directly linked to SOP content, then it may not be
necessary to revise SOPs. In general, however, SOPs are revised more frequently (often
annually) than the protocol narrative.

B. Perform all SOP edits in a copy of the original (or latest) version of the SOP document.

C. Use lessons learned and latest information from the most recent survey period to make
SOPs more helpful to future users.

D. Incorporate instructions for new equipment such as cameras and GPS devices, and to
reflect improvements in data collection systems and tools.

E. Assign a new version number to the front page of each changed SOP, along with the
current date. Use the next sequential tenth of an integer only if all of the changes were
minor. Use the next whole integer with zero in the tenths place if one or more major changes
were made. In general, if a major change occurs to one or more SOPs then the
protocol narrative receives a corresponding major revision. Remember to communicate
and coordinate all major revisions in SOPs and the protocol narrative with the program
manager.

F. Record all changes in the revision history log located at the beginning of the SOP. Follow
the instructions that accompany the log for updating the version number. If there are none
described follow the guidance for updating the narrative version number described above.

G. Save the updated document, with the latest version number in the file name, in the
project’s protocol folder on the GRYN server.

SOP 8-3
III. Share updates and archive previous versions:

A. Archive previous versions of the narrative and each SOP on the GRYN server in the archive folder under the project’s protocol folder.

B. If major revisions require additional peer-review and/or approval, the program manager coordinates this with the regional I&M program manager.

C. Update the Master Version Table (MVT) (Table SOP 8-1) by keeping track of current and historic versions of the protocol narrative and Standard Operating Procedures (SOPs), associated with the monitoring protocol.

D. Update records and content in the NPS online resource information database following instructions in SOP 6: Data Management.

E. Inform users of the monitoring protocol about updates, and provide instructions on how to reach the updates online.

Table SOP 8-1. Master Version Table.

<table>
<thead>
<tr>
<th>Version Key #</th>
<th>Date of Change</th>
<th>Narrative</th>
<th>SOP #1</th>
<th>SOP #2</th>
<th>SOP #3</th>
<th>SOP #4</th>
<th>SOP #5</th>
<th>SOP #6</th>
<th>SOP #7</th>
<th>SOP #8</th>
</tr>
</thead>
<tbody>
<tr>
<td>VK1</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>
The Department of the Interior protects and manages the nation’s natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 960/119678, January 2013