National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Upper Columbia Basin Network
Sagebrush Steppe Vegetation Monitoring Protocol

Standard Operating Procedures Version 1.0
(Appendix to Narrative Version 1.0)

Natural Resource Report NPS/UCBN/NRR—2009/142

ON THE COVER
Sagebrush steppe vegetation in City of Rocks National Reserve
NPS Photograph, courtesy of Upper Columbia Basin Network

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Natural Resource Report NPS/UCBN/NRR—2009/142

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Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 1: Preparation for the Field Season

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: 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, both in time as well as in money. Adequate field and equipment preparation is crucial to a successful monitoring program.

Suggested Reading

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Appendix 12 *in* Measuring and Monitoring Plant Populations. US Department of Interior, Bureau of Land Management, Denver, CO.

Kincaid, T. 2008. User guide for spsurvey, version 1.6 probability survey design and analysis functions. Version 2.0 June 16, 2008. Available at: http://www.epa.gov/nheerl/arm/documents/design_doc/UserGuide%20for%20spsurvey%202.0.pdf.

Maindonald, J., and W. J. Braun. 2007. Data analysis and graphics using R – an example-based approach. Cambridge University Press, UK.

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99: 262–278.

Theobald, D. M., D. L. Stevens, D. White, N. S. Urquhart, A. R. Olsen, J. B. Norman. 2007. Using GIS to generate spatially-balanced random survey designs for natural resource applications. Environmental Management 40:134-146.

Annual Review

Prior to the field season each year, beginning in December and January, the project lead should review the entire protocol, including SOPs, and should plan the field season. The season close-out checklist (SOP # 6) from the previous year should also be reviewed for any outstanding tasks that need to be completed. Planning includes advertising for and hiring qualified field technicians, checking and testing field equipment (e.g., GPS, cameras), mapping of new sampling locations, and revising the protocols in response to lessons learned from the previous sample year. Review of technician training including plant identification is particularly important. The Field Reference Manual (SOP # 10) should be reviewed and updated if necessary. SOP # 1 gives a brief description of how sagebrush steppe vegetation monitoring should be scheduled at the 5 parks that are included in the sampling design. Lodging and camping sites for field crews will need to be reserved with the separate parks or other local facilities. All of the equipment and supplies listed in this SOP should be organized and made ready for the field season, and copies of the field data form in SOP # 10 should be made. The Field Reference Manual and approximately 25% of the field data forms should be copied to all-weather "Rite-in-the-Rain" paper. Paper data sheets are used only as a back-up for PDA digital entry.

Procedures

Generating Spatially-balanced Sample Locations in R and ArcGIS 9.2 using GRTS

Important Note: In order to generate a Generalized Random Tessellation Stratified (GRTS) sample, ArcView or ArcGIS must be installed and running, as well as R statistical software. The *spsurvey* and *sp* packages must be downloaded from the EPA EMAP website (http://www.epa.gov/nheerl/arm/analysispages/software.htm) and installed in the appropriate R library. The *Tinn-R* text editor available from this same website can be used for manipulating the R scripts, or the script feature available in R can be used (File > New script).

New sample sites for the year that each park unit is visited need to be selected using the GRTS spatially balanced sampling method as described in the narrative. A new sample of locations must be drawn for each park sampling frame in advance of each new biennial sampling event. Waypoints need to be loaded into the GPS unit prior to the start of the field season. Waypoints are the X and Y coordinates (in Universal Transvere Mercator [UTM] coordinate system) for each sample location along with a unique point identifier. This process is described in SOP # 3.

1) Begin by organizing a working directory (e.g., C:\GRTS\temp), and placing the target park sample frame polygon shapefile (all associated files including .shp,.dbf, and .prj extensions) in the appropriate subfolder. The sample frame shapefile should be accurate and projected in UTM NAD 83. Be careful to account for park boundaries and non-NPS in-holdings. Complete sampling frame GIS coverages for UCBN sagebrush steppe parks are in stored on the Network's network attached storage (NAS) server located at UCBN headquarters in the following sagebrush steppe project directory: Sage\3_Implement\GIS_Data_Working\Features\Sample_Frames.

2) In the RGui screen, change the working directory to C:\GRTS\temp (or an appropriate alternative). Open an existing GRTS script in R (or *Tinn-R*). If no GRTS script is available, the example in step 4 below can be copied and saved into the text editor and edited as necessary. Examples are also available from the EPA EMAP website.

3) In RGui, load the *spsurvey* package (Packages > Load Package).

4) R code example for drawing a GRTS sample. This sample can be copied and saved directly into the R script text editor, modified as necessary, and executed by highlighting desired sections of code, and keying "ctrl-shift" and then "r" on the computer keyboard. Note that stratified code is used for JODA.

```
**************************************************************
# File: UCBNsage_Rcode_GRTS_unstratified_eqprob_20071227.txt
# Purpose: Example area unstratified equal probability GRTS survey
# designs for Painted Hills Unit, JODA
# Contact: Tom Rodhouse, UCBN Ecologist, Tom_Rodhouse@nps.gov
# Date: December 27, 2007

# Load the spsurvey library

library(spsurvey)

# Equal probability GRTS survey design, example sample size = 100,
# example oversample = 50

# Create the design list

Equaldsgn <- list(None=list(panel=c(Panel_1=100), seltype="Equal",over=50))

# Create the GRTS survey design

Equalsites <- grts(design=Equaldsgn,
                   DesignID="Site",
                   type.frame="area",
                   src.frame="shapefile",
                   in.shape="phills_bndry",
                   prjfilename="phills_bndry",
                   out.shape="phills_grts150_NAD83_2008")

print(dsgnsum(Equalsites))
**************************************************************
```

5) In ArcGIS (or ArcView), add the output file (e.g., SheepRockWest_grts150_NAD83_2009.shp) to an open park map project to display the sample locations. View the associated .dbf table to ensure everything worked as expected. Double check weight calculations (sampling location selection probabilities) by dividing sampling frame or stratum area by the number of sample size (excluding oversamples). Note that UTM coordinates are already included in the dbf. Note that these weights will need to be updated at the end of each sampling session once the total number of sampled quadrats have been determined (i.e., after dropping and adding new locations).

   Note: In order to maintain the desirable properties of the GRTS sample (e.g., spatial balance), sites need to be included in the sample in the same order as is presented in the

.dbf list. The points are also given a site ID as a feature of the `grts()` function in R, and the ID order should be followed. For example, if 10 sites are needed for a sample, but the 2nd and 3rd sites are inaccessible, then sites 1, 4-12 should be used (Figure 1). If additional sites are needed in the future, then site 13 should be the first choice, followed by 14, 15, and so on.

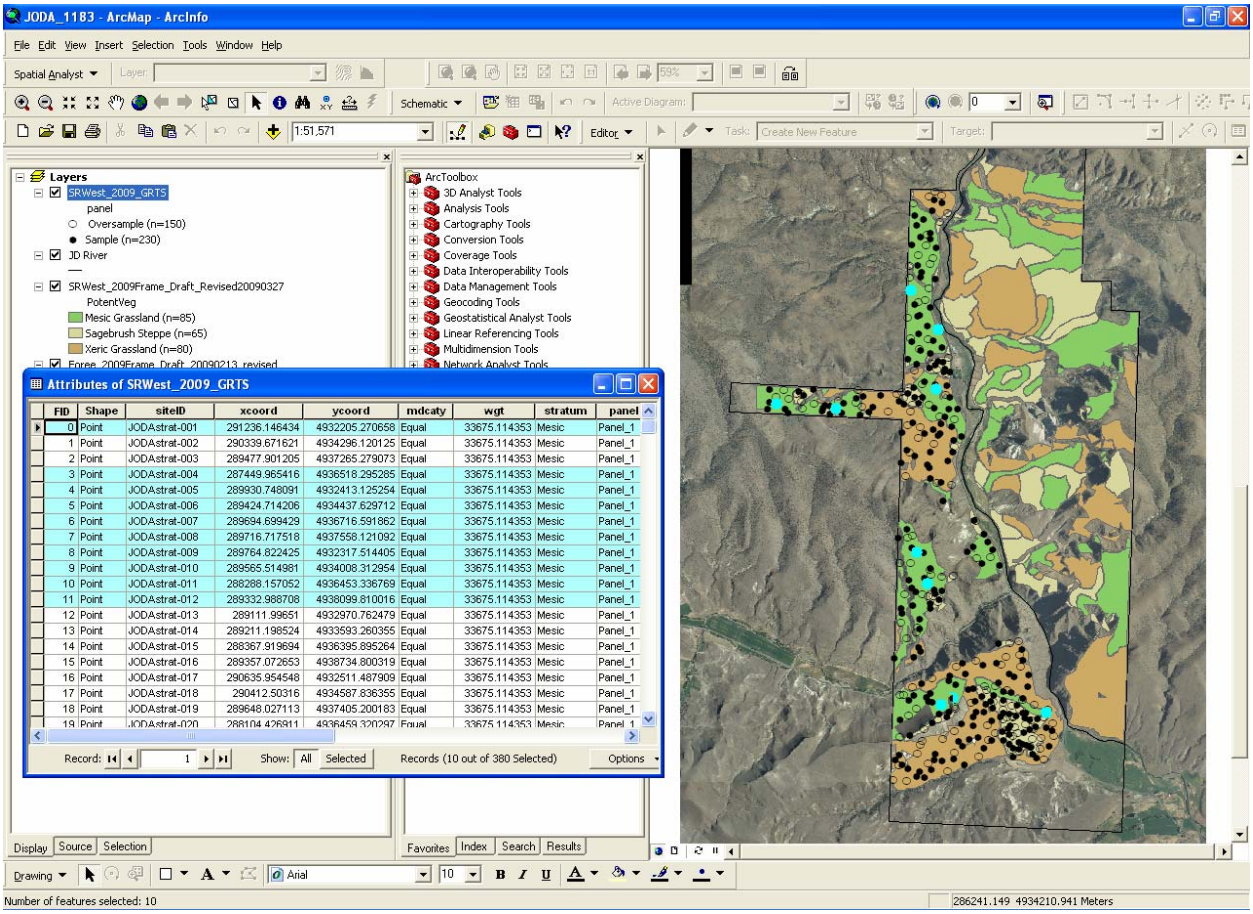

Figure 1. An ArcGIS screenshot illustrating the SheepRockWest_grts150_NAD83_2009 shapefile for JODA with sites 1 and 4-12 selected.

6) Note that NPS and UCBN standards require that spatial data be projected in the North American Datum 1983 (NAD 83). However, the native datum for GPS satellites is the World Geodetic Survey 1984 (WGS 84), and coordinates output for uploading into GPS units should be in this datum. This requires that the shapefile be reprojected and X and Y coordinates added again (a second step), or that the data frame environment for the .mxd is in WGS 84 to begin with. Note that the example output shapefile name in step 5 above specifies the datum. Careful attention should be paid to this issue to avoid confusion. Fortunately there is very little difference between the two projections. Spatial data and maps produced for archiving, analysis, and reporting should be projected in NAD 83. Care should also be taken with careful tracking of each unique annual sample for each frame. In this example, the year is added to the shapefile name.

7) Export the output table (e.g., SheepRockWest_grts150_NAD83_2009.dbf) and update the sagebrush steppe monitoring project Access database.

8) Finally, import the master sampling location list, as a text file (e.g., SheepRockWest_grts150_NAD83_2009.txt), to GPS waypoints following procedures outlined in SOP # 3, Finding GPS Waypoints.

9) Once samples have been drawn for each park sampling frame, maps with labels and color codes for optimal routes of travel must be created. Organize proximal clusters of 50 sites into discrete daily "sets", and account for impassable barriers such as cliffs and private land. Identify key park roads, trails, and other access points. Figure 17 in SOP # 10 illustrates an example for the western portion the Sheep Rock Unit of JODA.

Scheduling and Organizing Field Work

Hiring of field technicians should begin in December of the preceding year. The UCBN project lead should send advertisements and job descriptions to the Student Conservation Association (www.thesca.org) and/or work with the UCBN Network Coordinator to advertise for field technicians through other channels (e.g., an NPS STEP hire). It is important to generate interest in UCBN field technician positions among advanced undergraduate or post-baccalaureate students with training in botany from the Pacific Northwest. A minimum of two dedicated field technicians are required each season to complete sampling. Past job descriptions and announcement documentation is stored in the following UCBN NAS share folder directory: UCBN_NPSonly\Personnel.

Scheduling of fieldwork also needs to begin as early as possible, and no later than January of the sampling event year. The UCBN sagebrush steppe project lead has primary responsibility for ensuring that all hiring, schedules, and logistical details are addressed. Close coordination with park resource staff is absolutely essential. Vegetation surveys will begin no sooner than late April or early May in the lower elevation parks (LARO, JODA, and HAFO) and extend no later than mid July in the northern portions of CIRO and CRMO. This period includes the times during which most sagebrush steppe plants are identifiable to species, and are neither too immature nor too senesced and dried. 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 shuffling of park sampling dates may be required during years with unusual weather events and altered phenology.

Each park will be sampled in an alternating biennial pattern with even years (e.g., 2010, 2012) at CIRO, JODA, and LARO, and odd years in CRMO and HAFO. Training will require 1 week and ten weeks should be allotted for sampling. This schedule allows for approximately 2000 sample locations to be visited comfortably and provides extra time to accommodate unanticipated problems and contingencies. About 50 samples should be scheduled for completion in each 8-hour field day by each field crew, where both crew members work independently but in close proximity (each team member completes approximately 25 quadrats per day). Field routes will be established prior to field work, and will be based on past experience traversing park terrain and the particular arrangement of sample locations (Figure 17 SOP # 10). Determine which quadrat locations will be sampled each day and order them so as to avoid unnecessary travel

time. Access roads may need to be loaded into the GPS to aid in efficient orientation to sample sites. Camping sites should be planned for CRMO (and perhaps for JODA) to avoid unnecessary and unproductive travel to and from areas to be sampled. Anticipate that some sites will be dropped, particularly during the first few years of implementation when sampling frame errors have not been resolved. Allow time at the end of each sampling session for each park or park area to pick up replacement points. Because of the GRTS spatially-balanced design, replacement points will not necessarily be near dropped sites.

Equipment Preparation

Equipment List: Each independent field observer will need a full set of equipment. An inventory of existing equipment, needed repairs identified, and construction or purchases of additional equipment must be made well in advance of the approaching field season. The required equipment is as follows:

Measuring Equipment:

- 2 two-meter folding rulers (fiberglass Rhino rulers)
- Surveyor's pin or screwdriver for anchoring quadrats
- Plant ID references and software
- Field Reference Manual with sample route maps (SOP # 10)
- 10x (or larger) hand lens (e.g., Loupe)

Navigation and Recording Equipment:

- Weatherized data entry PDA with DataPlus software (e.g. Juniper Systems Archer Unit)
- GPS, preloaded with sample location waypoints
- Clipboard with mechanical pencils and extra lead
- Backup paper data forms (weatherized Rite-in-the-Rain paper; SOP # 10)
- Compass with inclinometer for estimating slopes

Miscellaneous Field Equipment:

- Plastic file box for storage of data sheets (in vehicle) with folders and extra forms, mechanical pencils, and rite-in-the-rain note paper
- Trowel (for collecting unknown plant species) with labeled plastic ziploc bags
- Wire brush for cleaning tires, boots, and trousers of weed seeds
- Daypack
- Sunscreen
- Water bottles
- First Aid kit
- 2-way handheld radio
- Digital camera
- Spare batteries for GPS, PDA, and camera

A sturdy ring-bound Field Reference Manual that easily fits into a daypack will be provided to each field technician (SOP # 10). The Field Reference Manual includes the following:

- Field data entry form
- Sampling frame/photo coding reference guide
- Sampling route maps identifying clusters of proximal sample points, access locations, and other key travel information (e.g., Figure 17)
- Visual cover estimation guide

- DataPlus quick reference guide
- Quadrat add/drop procedures
- Park sagebrush steppe monitoring plant species lists
- Emergency contact information
- Field-relevant SOPs (SOP # 1-5)
- Rite-in-the-Rain note paper

SOP # 10 lists the plants and plant codes that are principal species targeted for status and trend monitoring, and that have been encountered in quadrats in 2008-2009 pilot sampling quadrats (as dominant species). Hard copies of manuals are stored along with field equipment at the UCBN headquarters.

Preparation of Navigation and Field Data Management Equipment:

1) Development of a new set of randomly generated sampling points must be conducted following the procedures described at the beginning of this SOP, and a digital text file (.txt) created with the Quadrat ID and UTM coordinates. This list will then be uploaded to each GPS unit following procedures outlined in SOP # 3. GPS preplanning also includes review of satellite availability for the duration of the scheduled sampling window, and is described in SOP # 3. Park sites are typically open shrub land, and typically have good satellite coverage, but this should be double-checked. Some sites near cliffs in CIRO and JODA can have poor satellite coverage. Make necessary schedule changes if an unusually poor arrangement of satellites is scheduled during the sampling window. Data entry forms should be revised and printed, with extra copies available for each team. At least one back-up GPS unit should also be available and have all necessary files pre-loaded.

2) Be sure to completely charge all GPS units, radios, and digital cameras, as well as backup batteries, prior to departure for the field.

3) Paper data sheets should be prepared and at least 25% printed to Rite-in-the-Rain paper for each field team. 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.

Miscellaneous Preparatory Notes:

1) Analysis and reporting of previous year's data is necessary before starting a new field effort. This is covered in SOP # 6, data management, and SOP # 7, data summary and analysis. It is particularly important that sampling frame boundaries and sampling effort has 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. Consult with a statistician before making any changes.

2) UCBN sagebrush steppe parks are large, rugged, and remote. Toilets will be unavailable during the day. Personal effects carried in daypacks should include toilet paper and a Ziploc plastic bag for packing out garbage. **The UCBN insists that its field crew members adopt a "leave no trace" ethic during all park visits.**

3) Safety is an important, but easily overlooked consideration. Each year the project Job Hazard Analysis should be reviewed and updated if necessary. All crew members must review the Job Hazard Analysis during staff training. The general safety plan (SOP # 9) should be reviewed during training, and specific park hazards, emergency contact information and procedures should be reviewed with park staff at the start of each park sampling session. A park debriefing should occur with park points-of-contact at this time to review any emerging developments, such as fire hazard conditions. Park safety protocols must be reviewed and adhered to. For CRMO and JODA, a park-issued radio may be provided in order for back-country emergencies to be reported via radio repeater towers. Cell phones can be used but coverage is spotty at best. The team must check in with park points of contact periodically during park sampling sessions to keep abreast of developing safety information, and to provide park staff with locations of operation. With team members operating independently in the field, communication can be difficult. Efforts should be made to work within eyesight and shouting distance whenever possible. Provide two-way radios to each team member. Make sure each team member knows where vehicle keys are to be stored during field operations, the location of the nearest pay phone and/or cellular phone coverage opportunity, and emergency contact and operation procedures for each park.

4) After the field season be sure to clean and organize all non-electronic equipment and store in well labeled plastic bins in the UCBN headquarters. Some of this equipment will be used by other UCBN monitoring projects so a well organized and well stored collection of equipment is essential. Remove batteries from GPS units requiring long-term winter storage. PDAs need to remain charged to prevent loss of programs such as ArcPad, so these are typically stored by the UCBN under the direction of the data manager in the central office. All equipment should be checked in with the UCBN staff person responsible for equipment inventories.

5) Finally, quadrat UTM coordinates and updated GRTS sampling location selection probabilities need to be provided to the UCBN data manager for uploading to the project database. This will typically occur with final migration of DataPlus files immediately after the end of field sampling, as the final step in monthly data entry and processing tasks (see Table 5 in SOP # 6). GRTS sampling site selection probabilities are initially assigned to each quadrat location in R, but after some sites have been dropped and replaced with oversamples, these probabilities will have changed and need to be updated and permanently archived with each quadrat. See SOP # 7 for computation procedures required to update GRTS sample site selection probabilities (weights).

Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 2: Training Observers

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes the step-by-step procedures for training field personnel. Note that none of these SOPs are meant to be stand-alone training manuals replacing the thorough documentation available for GPS and field botany techniques. Training personnel should refer to these SOPs as a guide and seek out additional information in the suggested references and through hands-on training course provided by NPS and outside vendors.

Suggested Reading

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Chapter 8 *in* Measuring and Monitoring Plant Populations. US Department of Interior, Bureau of Land Management, Denver, CO.

Garmin. 2005. GPSMAP 76CSx Owner's Manuel. Garmin International, Olathe, KS. Available online at http://www.garmin.com/products/manual.jsp?product=010-00469-00

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. USDI Bureau of Land Management Technical Reference 1734-6. Denver, CO.

Procedures

This SOP explains the training procedures for sagebrush steppe monitoring crew members. 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 and sample quadrats in the field for 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, for each park.
- Resolve 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/or handheld computers.

Use of the GPS to locate waypoints and to otherwise navigate in field sites is discussed in SOP # 3, and this should be reviewed and practiced before beginning field work. Procedures for quadrat set-up and sampling sagebrush steppe indicators are detailed in SOPs # 4 and # 5. Procedures for operating DataPlus software on handheld PDAs is reviewed in SOP # 6 and in the Field Reference Manual (SOP # 10).

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

- College-level training in plant taxonomy or systematic botany.
- Previous experience working at least seasonally under 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.

Additional details of required and desired qualifications are available from past job announcements and descriptions in the following UCBN NAS share folder directory: UCBN_NPSonly\Personnel. A detailed list of technical references for plant identification, including regional floras as well as park plant species lists, is provided at the end of this SOP. Up-to-date and certified park species lists are maintained at the NPSpecies website (http://science.nature.nps.gov/im/apps/npspp/) and passwords can be obtained through the UCBN Data Manager.

The following outline has been developed to guide training in spring 2010. This will be updated periodically as needed. The Field Reference Manual, frequently cited in this SOP and placed in SOP # 10, will be revised as necessary prior to each subsequent field season.

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 as well as 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 outside, at the park site or another analogous sagebrush steppe location. In even years in which JODA is part of the park tour, the Oregon Museum of Science and Industry's (OMSI) Hancock Field Station, located within the Clarno Unit of the park, is an ideal place to train for a week during early spring. Arrangements with OMSI must be made well in advance (phone: 541-763-4691). HAFO, another low elevation park, is likely the best location for training during odd years. 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 Outline

Goals:

- 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 1 m^2 quadrats.
- Acquire proficiency in use of GPS equipment and navigation to sampling points.
- Acquire proficiency in use of a PDA and DataPlus software, including troubleshooting and procedures for backing up data onto project laptops.
- 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 boundary decisions, sampling frame errors, and dropping and adding sites.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, safety procedures including regular communication with Park points of contact and UCBN 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 Manuals for each participant
- GPS units
- PDA units
- Compasses with inclinometers
- Digital cameras
- Quadrat folding rulers
- Backup data sheets
- Project laptops and peripheral equipment (e.g., flash drives)
- Plant keys, plant identification software, UCBN park plant lists, other key references

Agenda:

Day 1

- Morning
  - Arrival and orientation
  - Get acquainted, backgrounds of participants, team building
  - Individual protocol study
- Afternoon
  - Group program orientation and protocol discussion
  - Data management and QA/QC
  - Review of safety procedures and contact information
  - Review of weed spread prevention procedures

Day 2

- Morning
  - Field demonstration of all field methods, including use of PDA/DataPlus
  - GPS practice
  - Review of boundary decisions, add/drop criteria, procedures, and documentation
- Afternoon
  - Plant identification
  - Cover estimation practice and calibration

Day 3

- Morning
  - Practice use of Field Reference Manual materials
  - Field walk identifying plants
  - Familiarization with park terrain, safety, and general travel and hazard issues, and weed spread prevention procedures
- Afternoon
  - Group field methods practice and calibration

Day 4

- Morning
  - Group practice – completion of 1-2 real quadrats
- Afternoon
  - Group practice – completion of 1-2 real quadrats

Day 5

- Morning
  - Group practice, troubleshooting, GRTS and field decisions
- Afternoon
  - Review, scheduling, planning
  - Outstanding issues

Training Procedures

1) Definitions for key field terms are presented in Table 1 and should be reviewed during training.

Table 1. Important field definitions for monitoring sagebrush steppe vegetation in the UCBN.

Term	Definition
Cover	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.
Bare Ground	Cover of bare ground should include only bare soil (mineral soil) not covered by plant canopies. Gravel greater than ¼", litter, and rock should be excluded from bare ground cover estimates.
Perennial Forbs	Forbs that live 3 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.
Quadrat	The defined unit of measurement, with boundaries framed by two 2-m folding rulers, bent at right angles to form a 1 m^2 square. The quadrat frame is anchored by a survey pin in the lower right corner at the sample point UTM coordinates. The quadrat is oriented in the direction of travel.
Target Population	The predetermined collection of plant communities (sagebrush steppe; bunchgrass communities in JODA) within UCBN parks for which statistical inference is desired.
Sampling Frame	The physical representation of the target population. This is always imperfect and sampling frame errors and procedures for addressing them must be addressed in training.

2) Field measurement techniques are best taught outside, at the park site or another analogous sagebrush steppe location. Indoor lab environments with sufficient space to set up dissecting scopes and plant materials for identification practice, is also very helpful. In years in which JODA is part of the park tour, the Oregon Museum of Science and Industry's (OMSI) Hancock Field Station, located within the Clarno Unit of the park, provides these spaces, and is an ideal place to train for a week during early spring. Arrangements with OMSI must be made well in advance (phone: 541-763-4691). 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.

3) Adequate time must be given to properly set up quadrats, and for decision-making associated with boundary decisions and sampling frame errors encountered in the field. While efforts have been made to minimize these (e.g., 10 m buffers within park boundaries), problems will inevitably be encountered. Each technician should understand the implications of dropping sites, and understand 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 dropped from the sample. Dropped locations and the associated quadrat number must be entered in DataPlus and in the Access database with a note describing met criteria. The criteria and procedures for dropping and adding quadrats are located in SOP # 4 and SOP # 10. 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.

4) Objective positioning of the quadrat frames is essential for unbiased parameter estimates. In particular, observers need to avoid the 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.

5) Visual cover estimation should be practiced repeatedly as a group and as individuals who then compare results among group members. Repeatability 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. Laminated cards of varying shapes and sizes and with known proportional coverage of the 1 m^2 quadrat have been prepared for use in practice and calibration. These are stored at the UCBN headquarters. Emphasize use of visual cue cards and the 25% and 5% cues marked on rulers (Figures 2 and 3). Table 2 provides the areas of cards currently in use by the UCBN.

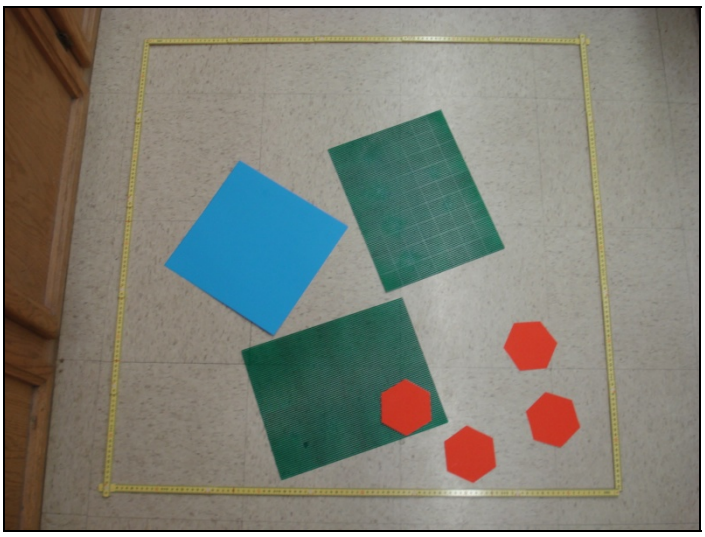

Figure 2. A calibration tool for estimating cover classes. In this example, species 1 (red hexagons are .0078 m^2) has a known cover of 3.1% and should be placed in Daubenmire class 1. In a lab setting such as is shown here, cover of exposed bare ground can be determined by subtracting the three non-overlapping 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.

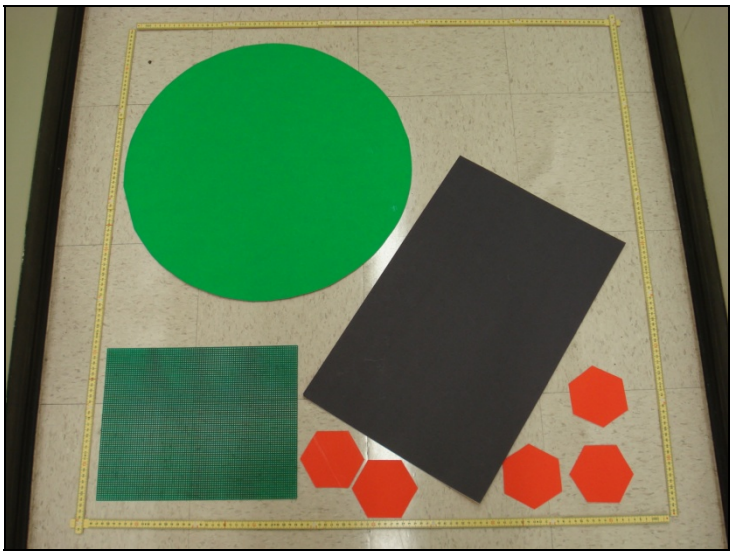

Figure 3. Another configuration of cover cutouts. In this example, species 1 has a known cover of 3.9%. Species 2 (black rectangle) has a known cover of 20% and should be placed in Daubenmire class 2.

Table 2. Inventory of cardboard cutouts used for training observers in ocular cover class estimation in 1 m^2 quadrats.

Shape	Color	Size	Area (m^2)	No. of Cutouts
Circle	Green/Red	Large	0.2463	12
Circle	Green/Red	Small	0.0227	12
Hexagon	Green/Red	Small	0.00786	42
Waffle Rectangle	Light Green	Medium	0.0945	2
Waffle Rectangle	Dark Green	Medium	0.0945	2
Rectangle	Orange/Fl. Orange	Large	0.3976	1
Rectangle	Blue/Violet	Small	0.042	2
Square	Blue/Violet	Medium	0.0784	4
Rectangle	Orange/Black	Medium	0.1988	2
Rectangle	Tan/Grey	Large	0.3976	10

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 parts. The list in SOP # 10 represents the principal species of current emphasis for this program, and should be the priority during training. In some cases, species will not be encountered at a training site and the field leader must provide additional training at the start of sampling at each park. Typically this will occur during the first morning of field work at each park, and will provide an opportunity for the team to re-calibrate to the new surroundings and vegetation. Dissecting scopes are available at Hancock Field Station. 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. Training should include use of the quasi-technical key FloraID Northwest (www.xidservices.com, Pendleton, OR), which will be loaded on laptops for use throughout the season.

7) Use of the handheld PDA and DataPlus must be practiced and thoroughly understood by all field personnel. PDAs currently in use by the UCBN use Windows Mobile CE operating systems, and are intuitively like desktop PCs with Windows operating systems. Practice with a stylus is required to gain proficiency in moving through screens and selecting options and keyboard use. Use the DataPlus quick reference guide located in the Field Reference Manual and additional instructions located in SOP # 6 on backing up data from DataPlus to project laptop computers and for updating species picklists. Allow time for field practice as a group in data entry and in post-field backup procedures. Troubleshooting tips, including the use of <escape> in DataPlus, should be reviewed.

8) Safety procedures are outlined in SOP # 9. 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.

9) Weed spread prevention is a critical issue in all UCBN 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. At JODA, puncture vine (*Tribulus terrestris*) seeds are picked up in tires and boots and should be removed before moving to new locations. It is particularly important that attention is given to travel from infested to uninfested Park areas. For example, the JODA Clarno Unit is infested with medusahead (*Elymus caput-medusae*), and equipment and clothing should be cleaned of medushead seeds (evident from the distinctive long awns) before traveling to other areas of the Park. 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 for our parks. Periodically, vehicles should be hosed down as an extra measure of prevention. Opportunities for this exist at the end of each day when passing through park headquarters. 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.

Reference Materials

Taxonomic References:

Hitchcock, C. L., and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, WA.

Hitchcock, C. L., A. Cronquist, M. Ownbey, J. W. Thompson. 1955. Vascular plants of the Pacific Northwest, Part 5: Compositae. University of Washington Press, Seattle, WA.

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Hitchcock, C. L., A. Cronquist, M. Ownbey, J. W. Thompson. 1964. Vascular plants of the Pacific Northwest, Part 2: Salicaceae to Saxifragaceae. University of Washington Press, Seattle, WA.

Hitchcock, C. L., A. Cronquist, M. Ownbey, J. W. Thompson. 1969. Vascular plants of the Pacific Northwest, Part 1: Vascular Cryptogams, Gymnosperms, and Monocotyledons. University of Washington Press, Seattle, WA.

Rosentreter, R. 2005. Sagebrush identification, ecology, and palatability relative to sage-grouse. General Technical Report PNW-GTR-385. US Forest Service, Rocky Mountain Research Station, Fort Collins, CO. available at: http://www.fs.fed.us/rm/pubs/rmrs_p038/rmrs_p038_003_016.pdf)

USDA, NRCS. 2006. The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. (available at: http://plants.usda.gov)

Welsh, S. L., N. D. Atwood, S. Goodrich, and L. C. Higgins. 2003. A Utah flora. 3rd edition. Brigham Young University, Provo, UT.

Plant Identification Software:

Flora of the Pacific Northwest. CD-ROM Version 1.0. University of Washington Press.

Flora ID Northwest. Interactive plant keys and color photos for the Pacific Northwest. All known native and naturalized vascular plants. Version 4.1. available at: www.xidservices.com/FID.

Aids to Terminology and Structures Important in Plant Identification:

Harrington, H. D. and L. W. Durrell. 1957. How to identify plants. Ohio University Press, Athens, OH.

Harris, J. G. and M. W. Harris. 2001. Plant identification terminology, an illustrated glossary. 2nd edition. Spring Lake Publishing, Spring Lake, UT.

Other Useful References:

Prather, T. S., S. S. Robins, D. W. Morishita, L. W. Lass, R. H. Callihan, and T. W. Miller. 2002. Idaho's noxious weeds. University of Idaho Extension, Moscow, ID.

Taylor, R. J. 1990. Northwest weeds: the ugly and beautiful villains of fields, gardens, and roadsides. Mountain Press Publishing Company, Missoula MT.

Taylor, R. J. 1992. Sagebrush country: a wildflower sanctuary. Mountain Press Publishing Company, Missoula MT.

Whitson, T. D. 2000. Weeds of the west. 9th edition. The Western Society of Weed Science, Newark, CA.

Park Plant Lists:

NPSpecies website: http://science.nature.nps.gov/im/apps/npspp/. This cite requires an active user account and password, which can be requested through the UCBN Data Manager.

Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 3: Finding GPS Waypoints

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: The purpose of this SOP is to describe the procedures necessary to navigate to sampling locations using GPS units, particularly the Garmin Map 76CSx. Information on GPS specifications and settings are also included. This SOP is not intended as a substitute user's guide for GPS units. Please consult the appropriate user's guide for more detailed information on unit functionality.

Suggested Reading

Garmin. 2005. GPSMAP 76CSx Owner's Manuel. Garmin International, Olathe, KS. Available online at http://www.garmin.com/products/manual.jsp?product=010-00469-00

Before the Field

Preparation is essential to successful field work, particularly when that field work relies on GPS data collection or navigation. The baseline GPS constellation consists of 24 satellites that orbit the earth approximately every 12 hours. The position and time signals transmitted by these satellites are used by GPS receivers to triangulate a location on Earth. While this process is subject to various sources of error, pre-planning can minimize the impacts. For the sagebrush steppe monitoring protocol, objective placement of the sampling frame is more critical than the precision of the location. Sample locations are not permanent so the GPS unit will be used as a tool for objective quadrat placement although the precision of the location may vary within the limits of the GPS. However, the precision of the GPS unit should be consistent among all units used for monitoring, and within the limitations of the capabilities of the GPS units based on satellite locations and terrain.

Setting GPS Specifications

Verify Time: Time synchronization of the GPS receiver and GPS satellites is critical for the most accurate data collection and navigation. With the Garmin MAP76CSx, use the Time Setup Menu to set the time format, zone, and to conform to Daylight Savings Time.

Verify Projection and Datum: All GPS positioning information is referenced to the World Geodetic System 1984 (WGS84) datum (Figure 4). While the difference between WGS84 and NAD83 is minimal (<1 m), best practice is to navigate and collect data in WGS 84. For the five UCBN parks being monitored for sagebrush steppe, select the appropriate projection and datum listed in Table 3. With the Garmin MAP76CSx, use the Units Setup Menu to select the position format and map datum.

Table 3. Map datum and Transverse Mercator projection for each park unit in the UCBN sagebrush steppe monitoring program.

Park	Datum	Projection
CIRO	WGS 84	UTM Zone 12N
CRMO	WGS 84	UTM Zone 12N
HAFO	WGS 84	UTM Zone 11N
JODA: Clarno	WGS 84	UTM Zone 10N
JODA: Painted Hills	WGS 84	UTM Zone 10N
JODA: Sheep Rock	WGS 84	UTM Zone 11N
LARO	WGS 84	UTM Zone 11N

Enable WAAS: Enabling WAAS (Wide Area Augmentation System) allows for real-time correction of GPS coordinates as long as the WAAS satellites are in view. Due to the fixed position of these satellites over the equator, signal reception is best in open areas with a clear view of the southern sky. With the Garmin MAP76CSx, use the System Setup Menu to enable WAAS.

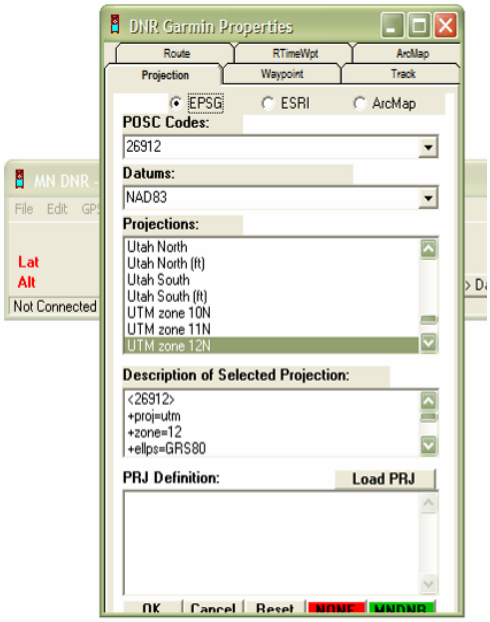
Calibrate the Compass: The internal compass in the Garmin MAP76CSx should be calibrated prior to each use for increased accuracy in navigation. Use the Calibration Setup Menu to calibrate the compass. Follow the directions on screen.

Batteries: Lastly, fully charge the batteries and remember to take spares! The Garmin Map76 units tend to fail on battery power quickly and without warning.

Loading Waypoints: Sample points are generated using ArcGIS 9.1 and exported to a shape or dBase file for each park. Uploading these locations to the Garmin Map76CSx as waypoints is simplified by using DNRGarmin, a freeware program developed and maintained by the Minnesota Department of Natural Resources. The program can be downloaded from http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions/DNRGarmin/DNRGarmin.html. The site has information on the application including installation guidelines and documentation.

To upload waypoints to the Garmin Map76CSx, connect the GPS unit to the PC and open DNRGarmin. DNRGarmin should display your GPS unit and say connect. If it does not, go to GPS and open port.

Use the File Menu to set the correct projection (Table 3 and Figure 5). Next go to 'Load Data' in the File Menu and select your shapefile or dBase file of interest. You can delete and or edit points, add comments, etc. if necessary. Use the GPS Menu to open the port to the GPS unit. Then, use the Waypoint Menu to upload the points to the GPS unit.



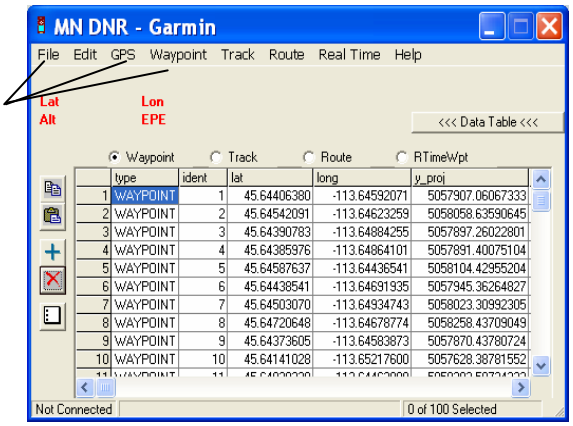


Figure 4 (left). Screenshot from DNRGarmin used to set the correct map projection.

Figure 5 (right). Screenshot from DNRGarmin used to view and upload selected waypoints.

In the Field

Monitoring Location Error

Ideally, you would be able to set thresholds for the maximum PDOP (Position Dilution of Precision) allowed as well as the minimum number of satellites. While you cannot set these values in the Garmin MAP76CSx, you can monitor the satellite strength and relative location error by using the Satellite Main Page (Figure 6).

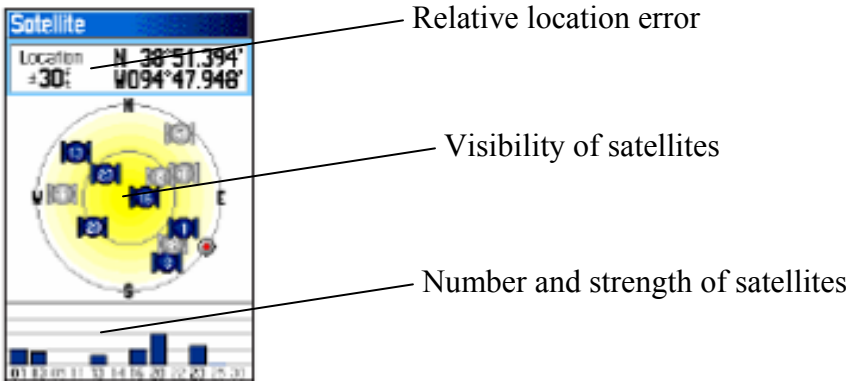


Figure 6. Screenshot from GPS unit for satellite information.

The maximum relative location error allowed should be set prior to beginning field work. For the sagebrush steppe monitoring protocol, the maximum location error allowed is 30 ft (10 m). If a GPS unit is used that allows for user-defined PDOP thresholds, the maximum should be set at 6.

Selecting and Navigating to Waypoints

With Garmin Map76CSx, use the Find Menu to search for a waypoint of interest. Select 'Find by Name' and scroll to the point ID of interest. Conversely, you can select the waypoints icon and scroll to the Point ID of interest. Note that often the menu is set to 'Find by Nearest' and if no point are near, no points will be displayed (although because sample locations are clustered in a spatially balanced design this may be the most efficient setting for locating sample points). To change this setting, go to the waypoint menu, push the menu button, and select 'Find by Name.'

Once selected, the items information page for the waypoint opens, allowing you to show the item on the map (by selecting Map) or create a route to the point (select GoTo). Select 'GoTo' to navigate to the point. You can use the 'Page' button to switch through various pages, select the Compass page (Figure 7) and, holding the GPS level, walk in the direction indicated by the compass until the 'Dist to Dest' window reads zero.

When the person, navigating with the GPS unit, first approaches the waypoint location, the person will focus on the coordinates and ignore the vegetation. Once the GPS unit registers "zero" (or otherwise shows that the coordinates have been reached exactly), the person stops immediately. The location is marked with a chaining pin/screwdriver midway between the locator's boots. This will fix the lower right-hand corner of the quadrat. The quadrat will be oriented along the line of travel to avoid trampling vegetation in that area before the quadrat frame is established.

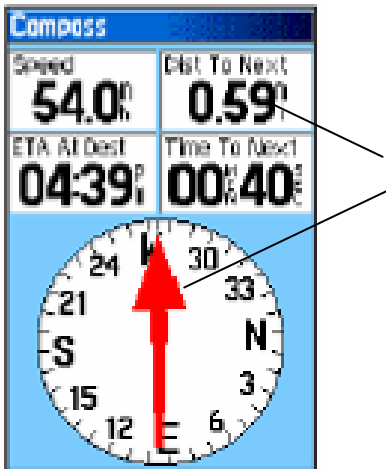


Figure 7. Screenshot from GPS unit compass page for navigation to a waypoint.

After the Field

Deleting Waypoint

After completion of fieldwork, delete any waypoints on the GPS units. Go to the Find Waypoints page, select Menu – Delete – All waypoints. Remove batteries from units before any long-term winter storage to prevent corrosion and leakage.

Sagebrush Steppe Monitoring Protocol

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

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes the step-by-step procedures for locating and establishing non-permanent quadrats for purposes of long-term monitoring of UCBN park sagebrush steppe vegetation.

Suggested Reading

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Chapter 8 *in* Measuring and Monitoring Plant Populations. US Department of Interior, Bureau of Land Management, Denver, CO.

Driving Directions

City of Rocks National Reserve and Castle Rocks State Park

CIRO is located near the town of Almo, Idaho, near the Utah border, approximately 3 hours from Salt Lake City, 3½ hours from Boise, Idaho, and 2½ hours from Pocatello, Idaho. Access from the north is from Interstate 84 at exit 216 south along Highway 77 through the town of Albion and Elba. Alternatively, the park can be accessed from the Malta Interchange along Interstate 84 south of the junction with interstate 86. From Salt Lake City, the park can also be accessed from Interstate 84 to Highway 81 to the town of Strevell, just over the state border, and then west along the Yost-Strevell Road, north to Yost Road, and then west again into Almo along Narrows Road. The park headquarters is located in Almo, and the park entrance to City of Rocks National Reserve is only a few hundred yards away and well marked. Castle Rocks State Park is located three miles northwest of town and is also well-marked. The Castle Shadows bed and breakfast, frequently used by UCBN field crews for housing during park visits, is conveniently located along road 750 E between the two park units. The UCBN travel trailer can be used in park campsites. However, campsite reservations must be made months in advance because of the popularity of the Reserve for rock climbing. Field crews will always check in with park staff at the visitor center or at the Castle Rocks State Park office before proceeding into the park. There are few park roads, but several short spurs behind gates will be convenient for accessing sampling areas and keys must be obtained from park staff upon check-in at the headquarters. Park road maps will be provided upon check-in and are available in the UCBN office.

Craters of the Moon National Monument and Preserve

CRMO is a vast park that spans over 500,000 acres between Highway 93 and the Snake River north of Interstate 86. The park headquarters is located along Highway 93 on the north end of the Monument and Preserve, approximately 30 miles northeast of Carey, Idaho, and 18 miles west of Arco, Idaho. Park visits should always begin at the headquarters unless otherwise arranged with park staff. Remote camping is necessary during work in southern portions of the Preserve. Arrangements must be made with Park staff. Check-in with park staff is essential before accessing the park to begin work, and daily when feasible. There are considerable challenges to driving and accessing areas of this large and rugged park. There are two main access roads into the interior of the Park: Laidlaw Park Rd., and the Minidoka-Arco Rd. sampling frames have been grouped according to access from these roads, or Highway 93. The Laidlaw Park Rd. is accessed north of the town of Carey and from the southern end of the Preserve is also referred to as the Carey-Kimama Rd., eventually connecting to highway 24 between the towns of Shoshone and Minidoka. The Minidoka-Arco Rd. also connects to highway 24, and can be used to access sampling frames on the Wapi Flow (e.g., sand kipuka).

Hagerman Fossil Beds National Monument

HAFO is located near the town of Hagerman, Idaho, along Highway 30 along the Snake River, south of Interstate 84 approximately 1½ hours from Boise, Idaho. The park headquarters are located in Hagerman, and all park sampling visits should begin here with a check-in with park staff. A small portion of NPS property is located below Hagerman along the Snake River but the majority of the park, and the entire sampling frame for sagebrush steppe monitoring, is located across the river along the escarpment visible from Hagerman. To access this portion, drive south along Highway 30 to the bridge over the river above the power plant and dam associated with Upper Salmon Falls, and then proceed west and north into the park. Park lands are located on

both sides of this road and several convenient access points and pull outs are available. An unpaved road into the fossil-bearing escarpment area is also an important access into sampling areas. A convenient park road map can be obtained upon check-in or from the UCBN office.

John Day Fossil Beds National Monument

Clarno Unit: The Clarno Unit of JODA is located along Highway 218 between the towns of Antelope and Fossil, Oregon, and approximately 3 miles from the John Day River at Clarno. The unit is approximately 1½ hours drive from the Sheep Rock Unit headquarters north along Highway 19. All sampling visits should begin at the park kiosk where a ranger is stationed much of the time. Contact with park staff at headquarters in the Sheep Rock Unit should be established ahead of time, and the Clarno ranger duty schedule should by obtained. Vehicle access to the park is along Highway 218, at the Indian Canyon Picnic Area, the Palisades Trailhead, and the Oregon Museum of Science and Industry Hancock Field Station. Permission to use the Hancock Field Station (541-763-4691) must be obtained prior to arrival and can be facilitated by the NPS Clarno ranger. A private short access road into "Lee's Canyon", terminating approximately ¼ mile north of Highway 218, is a convenient access point to the western portion of the Unit and permission can be facilitated by the Clarno ranger. Do not use this road without obtaining prior permission.

Painted Hills Unit: The Painted Hills Unit is located approximately 10 miles north of Highway 26 just west of Mitchell, Oregon. The unit is approximately 45 minutes drive from the Sheep Rock Unit headquarters west along Highway 26. There is one primary unpaved road that bisects the unit and provides access to sampling areas. As with the Clarno Unit, the Painted Hills ranger schedule should be obtained prior to scheduling visits, and check-in is required.

Sheep Rock Unit: The Sheep Rock Unit contains the park headquarters and is located along Highway 19 beginning at the junction with Highway 26 12 miles west of Dayville, Oregon, and extending north almost to Kimberley, Oregon. The Foree and Cathedral Rock subunits are located north of the main portion of Sheep Rock (referred to as "Sheep Rock") and are disjunct parcels. No sampling is planned for Cathedral Rock but Foree is an important area for sagebrush steppe monitoring. The Foree area is well signed and easily located approximately 7 miles north of the headquarters along Highway 19. There is a short park access road into a picnic area. Several unpaved park service roads, behind gates, are useful points of access in the main Sheep Rock area of the unit, and keys can be obtained at check-in, but must be requested in advance. A map of these roads can be provided upon check-in. Importantly, access to areas east of the John Day River can also be made by using one of three cable cars crossing the river. These are locked and keys will be provided by park staff upon request.

Lake Roosevelt National Recreation Area

LARO encompasses the southern half of the 150-mile Columbia River reservoir behind Grand Coulee dam, and includes a significant amount of forest land that is not part of the sagebrush steppe monitoring program. The southern portion of the lake contains sagebrush steppe, and several specific areas that overlap with high priority park management areas are targeted for monitoring. Access to this area is from Highway 174 east of Electric City, Washington and Grand Coulee. Park headquarters are located in Coulee Dam, Washington on the north side of the dam. As with the other parks, check-in with park staff is required. Access to specific sampling areas is challenging and may require park assistance. Crescent Bay requires driving

through a densely populated neighborhood. Take Hwy 174 (Grand Coulee Ave.) north. Turn left on Martin Ave. at the top of the hill past the landfill. Immediately turn right on Wetzel Ave., from Martin Ave. Take Wetzel Ave. to Garner Ave. Garner Ave. runs along the south edge of the Crescent Bay sampling frame. A 2-track parking spot with a cable gate and NPS boundary marker is a convenient place to park. To access Neal Canyon and the Ponderosa frame, take Spring Canyon Rd to Neal Canyon Rd, turn right, and head around the broad point (arm in the lake). The Spring Canyon Frames are easily accessed off of Hwy 174, and the Spring Canyon campground and boat launch is well-marked with NPS signs.

Procedures

1) Prior to entry into the field, pre-determined sampling points should be organized into routes for each field team member. For example, if two observers are available for sampling, points should be organized into efficient clusters of 50 such that one cluster can be completed in one day by one team. Rugged areas with extensive travel should include fewer sites per daily cluster. Follow SOP # 3 "Finding GPS Waypoints" for instructions on pre-loading sampling point coordinates for field navigation.

2) Arrange a debriefing meeting with park points-of-contact (e.g., park Science Advisory Committee [SAC] members, typically the park chief of resources). Review the sampling plan and discuss daily schedules and check-in/check-out procedures. Discuss safety and any emerging concerns, such as inclement weather, road conditions, and fire hazards. Discuss weed spread prevention procedures and arrange for hose access at a park maintenance building. **Don't forget to clean vehicles, boots, and clothing of weeds before heading into a new park area!**

3) To locate a new sampling point, go through the steps outlined in SOP # 3 "Finding GPS Waypoints" to initiate navigation to a waypoint. Ensure that you are navigating to the correct point, according to the Quadrat ID #. Once the GPS unit registers "zero" distance to the waypoint or otherwise indicates the point has been reached exactly, stop immediately and establish the quadrat origin. It is crucial that navigators ignore the vegetation and rely on the GPS unit in order to eliminate selection bias.

Figure 8. 1 m^2 quadrat frame with dashed lines showing 25% and 5% coverages

Figure 9. Placing the corner pin.

4) To establish a quadrat origin, place a steel chaining pin into the soil between the feet of the navigator while standing exactly on the point location as indicated by the GPS unit (see Figures 8 and 9).

5) The lower right corner of the 1 m^2 quadrat should be placed at the survey pin, and the quadrat should be oriented in the direction of travel. The middle (1 m mark) of the ruler should be bent at 90^o and placed against the pin. 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. Pay careful attention not to unintentionally avoid shrubs because they don't easily fit into the quadrat.

6) It is very helpful to approach a sampling point with an idea of the approximate orientation of the quadrat (direction of travel), and to avoid trampling vegetation inside the quadrat during set up.

7) In the event that a particular quadrat falls across a sampling frame boundary, fence line, or other area that cannot be adequately sampled or that clearly is outside of the target population (e.g., roadside ditch), a 5 m offset direction should be randomly selected and paced. If this offset is insufficient to resolve the drop criteria, the quadrat should be removed from the sample and the next point on the GRTS sample list should be included instead. Because of the spatially-balanced natured of GRTS samples, an added site will not necessarily be near a dropped site, and typically will be sampled later, possibly by another team member on another day. Record the decision making criteria met and the quadrat number, and photograph the site for later reference. Refer to the add/drop procedures in the Field Reference Manual for guidance on decision making and drop procedures (SOP # 10).

   Quadrat drop criteria:

   - Outside park boundary
   - Dangerous/prohibitively difficult to work on (e.g., slope $>30^o$, talus or rimrock).
   - Road or improved trail
   - Vegetation is completely other than sagebrush steppe or potential sagebrush steppe (e.g., riparian aspen, no species representative of sagebrush steppe, a roadside ditch)

Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 5: Measuring Sagebrush Steppe Community Attributes

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes how to measure attributes of UCBN sagebrush steppe community health with cover of principal species and genera, as well as bare ground. Associated tasks include photographing quadrats, if necessary, and collecting plants as needed for identification (temporary collection – no vouchering), and quality control checking of dropped quadrats in the field.

Suggested Reading

Bonham, C. D. 1989. Measurements for terrestrial vegetation. John Wiley & Sons, Inc. New York, NY.

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

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. USDI Bureau of Land Management Technical Reference 1734-6. Denver, CO.

Procedures

The sequence of steps for sampling sagebrush steppe indicators of community condition is as follows:

- Objectively position quadrat frames as described in SOP # 4
- Open DataPlus on the handheld PDA (see the DataPlus quick reference in the Field Reference Manual SOP # 10)
- Enter sample site information – park, observer, date, and temporary quadrat ID
- Estimate cover of bare ground and foliar cover of principal genera and species
- Add 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

1) Once the quadrat is established observers begin first with entering basic site information into DataPlus, following steps outlined in the DataPlus quick reference guide (SOP # 10), including park frame, temporary quadrat ID, observer name, and date. Pick lists and correct date default settings should expedite this step. UTM coordinates will have already been entered into the project database and given that these are temporary quadrats, there is no need to record the actual UTM coordinates. Temporary quadrat IDs are the ID numbers (1-*n*, for each frame) generated during the GRTS random sampling draw and used on maps and in GPS units. These temporary quadrat IDs will be linked to permanent globally unique identifiers (GUIDs) in the project Access database.

2) Visual cover estimation of bare ground and vegetation is quick but should be conducted methodically and care should be taken to double check that entries are correct. Cover is estimated in categories following Daubenmire (1950; Table 4). A cover class pick list is available in DataPlus to expedite data entry. There are seven vegetation cover indicator categories: sagebrush shrubs (*Artemisia spp*.); other shrubs; principal native perennial grasses; principal persistent native forbs (to genera or species); other native forbs that may be ephemeral and less consistently present, depending on weather and phenology; invasive grasses (e.g., *Agropyron cristatum*, *Bromus tectorum*, *Elymus caput-medusae*), non-native invasive forbs, including noxious weeds. The use of two native forb categories helps maintain shorter pick lists, which can be difficult to navigate through in a PDA with a stylus. It is important that field personnel be trained to use consistent techniques for cover estimation (SOP # 2). Principal species absent from quadrats but that are present (or have been in the past) in a sampling frame will be given a "0", representing 0% cover, in the data analysis stage. This is not done in the field, and principal species missing from a quadrat should not have any value entered during field data entry. However, it is important to recognize that these absent values will be interpreted as zeros and care should be taken not to erroneously miss principal species. Bare ground includes only soil and fine gravels smaller than ¼" not covered by vegetation, litter, or cryptogams.

Table 4. Daubenmire's cover classes to be used for visually estimating vegetation cover in 1 m^2 square quadrats.

Cover Class	Range	Midpoint
(0	0%	0%)
1	1-5%	2.50%
2	>5-25%	15%
3	>25-50%	37.50%
4	>50-75%	62.50%
5	>75-95%	85%
6	>95%	97.50%

The recommended steps for estimating cover visually are as follows:

- First, select one of the indicators for estimation; usually it is best to select one of the indicators which have obvious and fairly high cover values (e.g., sagebrush cover or key bunchgrass cover).
- Decide whether cover is > or <50% cover. Use the markers along the sides of the 1 m^2 quadrat to visually quarter the quadrat into areas equaling 25% of the quadrat (Figure 18 in SOP #10).
- If cover is less than 50%, then determine whether cover is > or <25%. If cover is >25% then the cover rank is 3.
- If cover is <25% then determine whether cover is >5% or <5%. If cover is >5% then cover rank is two. 5% markers are placed along the ruler edges as a visual cue.
- In a similar fashion, if cover is >50%, keep splitting between the largest next cover division until a rank is assigned.
- The visual cover estimation guides (Figures 19 and 20 in SOP #10) also can be used to aid cover class determination.

3) Any additional information, including information that might assist sampling frame refinement, identification of unidentified species, or photographs taken should be included in notes. Photographs should be numbered according to the camera auto numbering system, however, this should be updated to include park, frame, quadrat, and year immediately upon downloading to the project laptop computer. Photographs should be numbered as follows: JODA-Clarno-Mesic-2009-03 or CIRO-Bath-2009-15.

4) Clerical and operational errors are costly and potentially disastrous. Upon completion of all required and optional measures and notes, review all pages of the site record in DataPlus for clarity and completeness. Be sure that all necessary sample site identification information is filled in and that the entries in the data columns are consistent. **Double check the quadrat ID!**

Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 6: Data Management

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP provides documentation for the sagebrush steppe monitoring database and provides instructions for the development, maintenance, archiving, and distribution of the database or datasets. It also includes instructions for using DataPlus for data entry in the field, and for backing up field data to project PCs and, eventually, to the working project database.

Suggested Reading

Dicus, G. H. and L. K. Garrett. 2007. Upper Columbia Basin Network Data Management Plan. National Park Service Upper Columbia Basin Network Inventory and Monitoring Program. Moscow, ID

Garrett, L. K., T. J. Rodhouse, G. H. Dicus, C. C. Caudill, and M. R. Shardlow. 2007. Upper Columbia Basin Network vital signs monitoring plan. Natural Resource Report NPS/ UCBN/NRR—2007/002. National Park Service, Fort Collins, CO.

National Park Service. 2006. Natural Resource Database Template Version 3.1 documentation. Natural Resource Program Center, Office of Inventory, Monitoring, and Evaluation, Fort Collins, CO.

Database Model

The UCBN Sagebrush Steppe database has been developed within Microsoft Access. The database structure conforms to the standards of version 3.2 of the Natural Resource Database Template (NRDT), and consists of a user interface front-end (holding user forms for data import, entry, review, and export) that is linked to a back-end database file (holding the core sagebrush steppe data tables), an integrated UCBN data dictionary database file (holding various lookup tables shared across all UCBN protocols), and an integrated UCBN species database file (holding UCBN species data, from the NPSpecies database, also shared across all UCBN protocols). The general data management strategy will employ both a "working copy" of the database (used to import/enter the current season's data, then conduct error-checking and validation) and a "master version" of the database (used to store all validated data, to facilitate multi-year analyses, and to provide specific data report and export formats). A logical data model for the sagebrush steppe monitoring protocol shows the primary data tables and the general flow of data collection and data storage (Figure 10). The sagebrush steppe protocol database can also be depicted as a physical data model of linked core data tables, lookup tables, and cross reference tables (Figure 11).

The primary core tables in the UCBN Sagebrush Steppe database are the tbl_Locations and tbl_Events tables and two quadrat data tables (tbl_EvData_SpeciesCover and tbl_EvData_BareGrdCover). These core tables are supported by a set of lookup tables that hold codes and definitions (e.g., cover class codes, species groups, protocol versions, etc.). The locations table stores the unique physical location information for each sagebrush steppe vegetation sampling quadrat. The events table, storing information about sampling visits to a given vegetation quadrat, links to all involved field observers (via the xref_Events_Contacts table) and to all of the sampling data (via the tbl_EvData_BareGrdCover and tbl_EvData_SpeciesCover tables). The protocol version in use at the time of data import or entry is also linked to tbl_Events, and revisions to the sagebrush steppe monitoring database will be captured in two metadata tables, tbl_Db_Meta and tbl_Db_Revisions.

The UCBN employs generic lookup tables that can be incorporated across all monitoring protocols. The sagebrush steppe database will make use of tlu_Parks_UCBN, tlu_UCBN_Contacts, and tlu_LocalSppList_UCBN as generic lookup tables. The most important generic lookup table will be tlu_LocalSppList_UCBN, as it will represent the most current UCBN species list drawn from the NPSpecies database for the purpose of populating the tbl_EvData_SpeciesCover table. Generic lookup tables will be managed in one or more separate MS Access files that will be linked to protocol-specific databases, allowing for updates to generic lookup tables without disruption to the functionality and use of protocol-specific database applications.

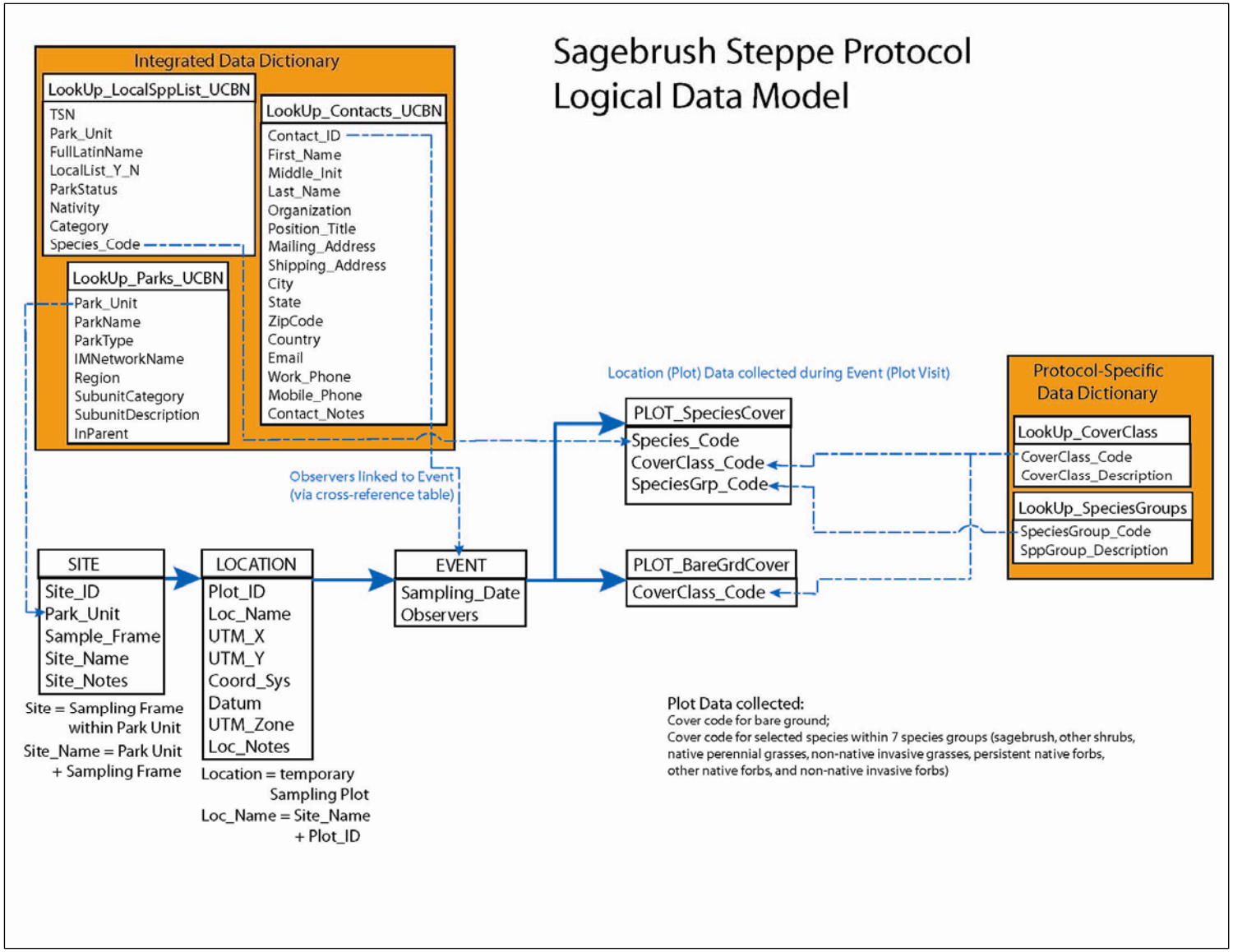


Figure 10. A logical data model for the UCBN Sagebrush Steppe monitoring protocol.

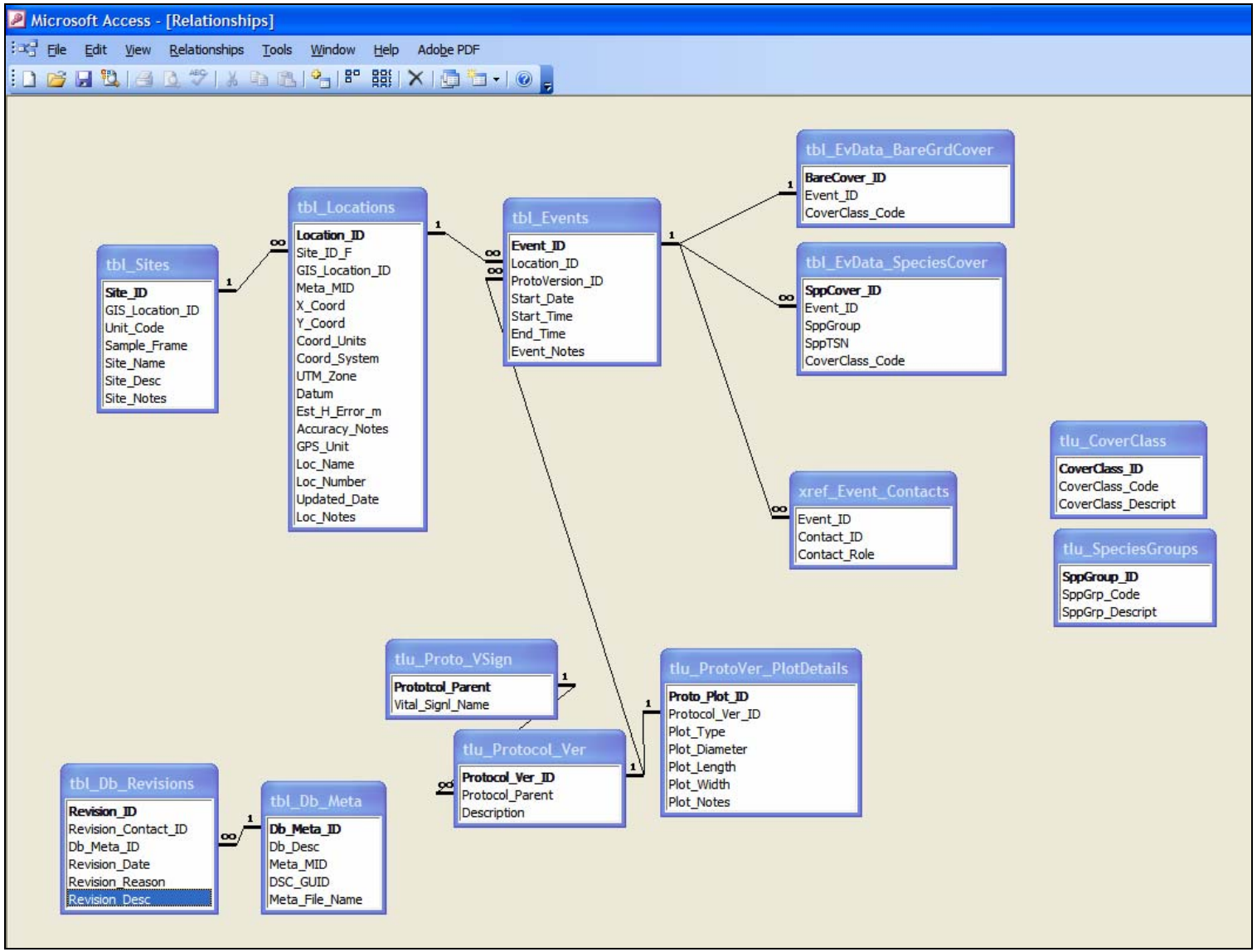


Figure 11. A physical data model for the UCBN Sagebrush Steppe monitoring protocol.

Data Dictionary

The following data dictionary provides a table description for every table contained in the UCBN Sagebrush steppe database back-end file. For each table, a field name, type, size, and description in provided.

Table: tbl_Sites

Description: Table stores descriptive data for Sites. Sites are sampling frames within Park units. Linked 1:Many to tbl_Locations.

Field Name	Field Type	Size	Field Description
Site_ID	ReplicationID	16	Primary key, uniquely identifying each tbl_Sites record
GIS_Location_ID	ReplicationID	16	Link to GIS feature, if applicable
Unit_Code	Text	12	Park unit code (Park or Park sub-unit code)
Sample_Frame	Text	50	Sampling frame in which quadrats are located
Site_Name	Text	70	Unique name for a site (constructed from UnitCode and SampleFrame)
Site_Desc	Text	255	Description for a site, if applicable
Site_Notes	Text	255	General notes on the site, if applicable

Table: tbl_Locations

Description: Table stores sampling Location data. Locations are quadrats where sagebrush steppe vegetation is sampled. Linked 1:Many to tbl_Sites, and linked to tbl_Events.

Field Name	Field Type	Size	Field Description
Location_ID	ReplicationID	16	Primary key, uniquely identifying each tbl_Locations record
Site_ID	ReplicationID	16	Link to tbl_Sites (foreign key)
GIS_Location_ID	ReplicationID	16	Link to GIS feature, if applicable
Meta_MID	ReplicationID	16	Link to Metadata record
X_Coord	Double	8	X coordinate of quadrat corner (lower left corner)
Y_Coord	Double	8	Y coordinate of quadrat corner (lower left corner)
Coord_Units	Text	10	Coordinate distance units (e.g., meters)
Coord_System	Text	50	Coordinate system
UTM_Zone	Text	50	UTM Zone
Datum	Text	50	Datum of mapping ellipsoid
Est_H_Error_m	Single	8	Estimated horizontal accuracy in meters
Accuracy_Notes	Text	255	Positional accuracy notes, if applicable
GPS_Unit	Text	80	GPS unit used to collect Location coordinates, if applic
Loc_Name	Text	80	Name of the location (constructed from SiteName [tbl_Sites] and LocNumber)
Loc_Number	Long Integer	4	Location (quadrat) number
Updated_Date	Date/Time	10	Date of entry or last change
Loc_Notes	Text	255	General notes on the location

Table: tbl_Events

Description: M. Table stores sampling Event data. Linked 1:Many to tbl_Locations, and linked to all field data tables (Bareground cover, Species cover, Forb group cover, Forb diversity, Dominant species, and Erosion).

Field Name	Field Type	Size	Field Description
Event_ID	ReplicationID	16	Primary key, uniquely identifying each tbl_Events record
Location_ID	ReplicationID	16	Link to tbl_Locations (foreign key)
Protocol_Version_ID	Text	10	Link to tlu_Protocol_Ver (indicates the Protocol version in use at time of Event)
Start_Date	Date/Time	10	Date of sampling Event
Start_Time	Date/Time	6	Start time (24 hour format) of sampling Event
End_Time	Date/Time	6	End time (24 hour format) of sampling Event
Event_Notes	Text	255	Event notes, if applicable

Table: xref_Event_Contacts

Description: Cross-reference table between tbl_Events and tlu_Contacts (stored in UCBN_Data_Dictionary backend file), allowing one or more contact persons to be associated with a given sampling Event.

Field Name	Field Type	Size	Field Description
Event_ID	ReplicationID	16	Link to tbl_Events
Contact_ID	ReplicationID	16	Link to tlu_Contacts (in UCBN Data Dictionary file)
Contact_Role	Text	50	The contact's role in collection of field data

Table: tbl_EvData_BareGrdCover

Description: Table stores bare gound cover data. Uses cover class codes from tlu_CoverClass. Linked 1:1 to tbl_Events.

Field Name	Field Type	Size	Field Description
BareCover_ID	ReplicationID	16	Primary key, uniquely identifying each tbl_EvData_BareGrdCover record
Event_ID	ReplicationID	16	Link to tbl_Events (foreign key)
CoverClass_Code	Text	10	Percent Cover class for bare ground within quadrat (from tlu_CoverClass pick-list)

Table: tbl_EvData_SpeciesCover

Description: Table stores species cover data. Uses species TSNs from UCBN_NPSpp_Module linked back-end file, and cover class codes from tlu_CoverClass. Linked 1:Many to tbl_Events.

Field Name	Field Type	Size	Field Description
SppCover_ID	ReplicationID	16	Primary key, uniquely identifying each tbl_EvData_SpeciesCover record
Event_ID	ReplicationID	16	Link to tbl_Events (foreign key)
SppGroup	Text	50	Species group (from tlu_SpeciesGroups pick-list)
SppTSN	Long Integer	4	Species TSN (from xref_Spp_Protocol table in linked UCBN_NPSpp_Module backend file)
CoverClass_Code	Text	10	Percent Cover class for bare ground within quadrat (from tlu_CoverClass pick-list)

Table: tlu_CoverClass

Description: Lookup table storing cover class codes and definitions of the cover class codes.

Field Name	Field Type	Size	Field Description
CoverClass_ID	ReplicationID	16	Primary key, uniquely identifying each tlu_CoverClass record
CoverClass_Code	Text	10	Code used for Cover Class
CoverClass_Descript	Text	255	Definition of Cover Class

Table: tlu_SpeciesGroups

Description: Lookup table storing native forb species group codes and definitions of the groups.

Field Name	Field Type	Size	Field Description
SppGroup_ID	ReplicationID	16	Primary key, uniquely identifying each tlu_SpeciesGroups record
SppGrp_Code	Text	25	Code used for Species Group
SppGrp_Descript	Text	255	Description of Species Group

Table: tlu_Proto_VSign

Description: Lookup table of Vital Sign and Protocol. Linked 1:Many to tlu_Protocol_Ver.

Field Name	Field Type	Size	Field Description
Prototcol_Parent	Text	10	Primary key. Four letter code to identify each vital sign protocol (i.e., CAMA for Camas Lily Vital Sign).
Vital_Signl_Name	Text	150	Full Name of associated Vital Sign

Table: tlu_Protocol_Ver

Description: Lookup table of Protocol versions, linked to tbl_Events in order to associate a Protocol version with each individual sampling Event.

Field Name	Field Type	Size	Field Description
Protocol_Ver_ID	Text	10	Primary key. Four letter Protocol Parent code plus version (e.g., CAMA_1_0, SAGE_2_3, etc.).
Prototcol_Parent	Text	10	Link to tlu_Proto_VSign (foreign key). Protocol

			four letter abbreviation (e.g., CAMA for Camas Lily).
Description	Memo	NA	Description of this Protocol Version

Table: tlu_ProtoVer_PlotDetails

Description: Lookup table storing details on quadrat size for a given Protocol version. Linked 1:1 to tlu_Protocol_Ver.

Field Name	Field Type	Size	Field Description
Proto_Plot_ID	ReplicationID	16	Primary key, uniquely identifying each tlu_ProtoVer_PlotDetails record
Prototcol_Ver_ID	Text	10	Link to tlu_Protocol_Ver (foreign key). Four letter Protocol Parent code plus version (e.g., CAMA_1_0, SAGE_2_3, etc.).
Plot_Type	Text	50	Type of sampling plot, if applicable (e.g., Circular, Rectangular, etc.)
Plot_Diameter	Text	50	Diameter of circular plot, if applicable (include units)
Plot_Length	Text	50	Length of plot, if applicable (include units)
Plot_Width	Text	50	Width of pplot, if applicable (include units)
Plot_Notes	Memo	NA	Notes about plot, if applicable

Table: tbl_DB_Meta

Description: Database description and links to I&M metadata tools.

Field Name	Field Type	Size	Field Description
DB_Meta_ID	ReplicationID	16	Local primary key
Db_Desc	Memo	NA	Description of database purpose
Meta_MID	ReplicationID	16	Link to Metadata record
Meta_File_Name	Text	255	Filename of Metadata record

Table: tbl_DB_Revisions

Description: Database revision history data.

Field Nam	Field Type	Size	Field Description
Revision_ID	Text	50	Database revision (version) number or code
Revision_Contact_ID	ReplicationID	16	Link to tlu_Contacts
DB_Meta_ID	ReplicationID	16	Link to tbl_DB_Meta
Revision_Date	Date/Time	8	Database revision date
Revision_Reason	Memo	NA	Reason for the database revision
Revision_Desc	Memo	NA	Revision description

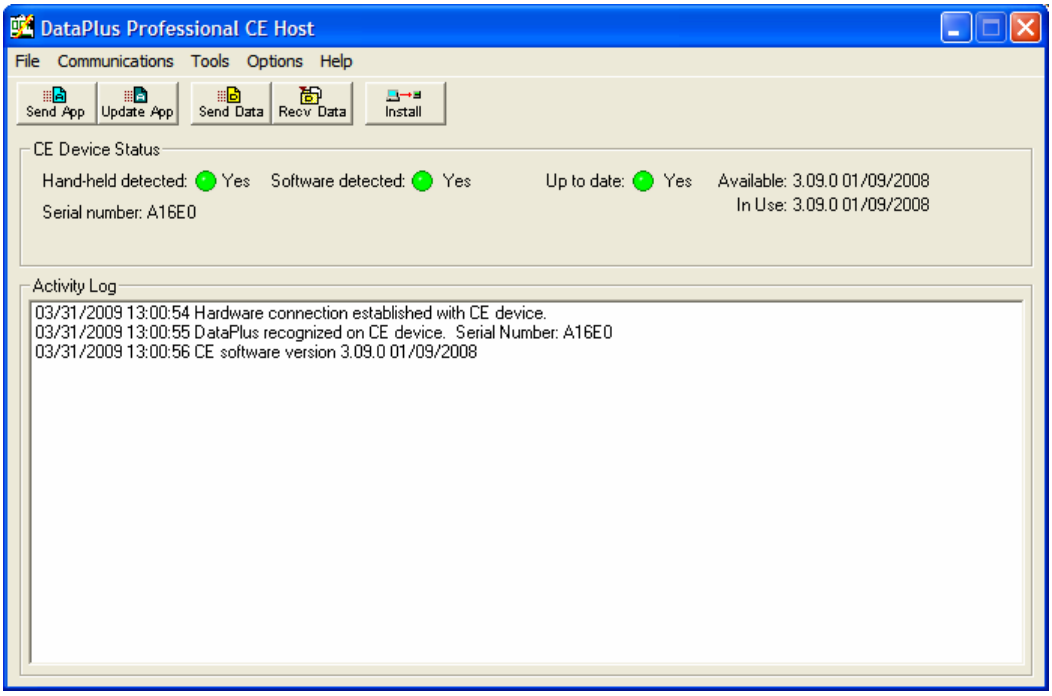
Data Collection and Import

Digital collection of field data uses PDA devices loaded with data entry forms developed with DataPlus software. Import of PDA data files into the UCBN Sagebrush Steppe database will be accomplished as soon after completion of field work as possible. Data entry/review forms within

both the UCBN Sagebrush Steppe database, a Microsoft Access application, and, to the greatest extent feasible, the PDA devices are patterned after the structure of the basic sagebrush steppe monitoring paper data sheet, and use built-in quality assurance components such as pick lists and validation rules to minimize data quality problems. The UCBN Sagebrush Steppe database uses a main switchboard menu form that allows the user to manage links to back-end files, set default values for certain fields, backup the database to a selected file directory, access data entry/review forms, and open or export data summary and analysis queries. The UCBN Sagebrush Steppe database will also include automated routines for importing PDA files. Data entry is a critical component in the overall QA/QC process, and great care should be taken to review the data input to PDA devices prior to leaving the sampling location. Step-by-step instructions for entering data into DataPlus are included in a quick reference guide in the Field Reference Manual (SOP # 10).

Procedures for uploading sage application to PDA device

1. Install the Data Plus software package on the field leader's laptop computer, using the installation CD provided by the UCBN Data Manager, and accepting all default installation settings.
2. Copy the latest digital directory folder (provided by UCBN Data Manager, and named according to the current version [e.g., Sage_vX] of the Data Plus application for the Sage protocol) into the C:\DataPlus Professional\APPS folder that was created on the field leader's laptop computer upon installation of the Data Plus software.
3. Turn on the Archer Field PC unit, and connect it to the field leader's laptop computer using the USB cable included with the Archer unit.
4. On the field leader's laptop computer, open the Data Plus CE Host application (available via Start → Programs → DataPlus Professional → DataPlus CE Host), and wait for the DataPlus Professional CE Host to detect the Archer unit (as evidenced by green-light buttons under the CE Device Status heading, refer to screen shot).



5. If Data Plus CE Host fails to detect the Archer unit, ensure that the appropriate software applications for the laptop's operating system are functioning. The WindowsXP operating system uses Microsoft ActiveSync to communicate with PDA devices, while the WindowsVista operating system uses the integrated Microsoft Windows Mobile Device Center. (Note that, when using Microsoft ActiveSync, it is not necessary to establish a Sync Partnership; a Guest Connection is sufficient.)
6. If the Data Plus software has not yet been installed on the Archer unit, then click the Install button within the Data Plus CE Host dialog box on the laptop, and when prompted, enter the serial number and license code (provided by UCBN Data Manager).
7. To upload the latest Data Plus application for the Sage protocol, click the Send App button within the Data Plus CE Host dialog box on the laptop. Then select the appropriate Sage application (the name of the folder copied to the laptop's C:\ drive in Step 2), and click OK. (Important NOTE – If you already have field data on the Archer unit, you should always backup that data before uploading a Data Plus application!)

Procedures for backing up field data from PDA device

1. Turn on the Archer Field PC unit, and connect it to the field leader's laptop computer using the USB cable included with the Archer unit.
2. On the field leader's laptop computer, open the Data Plus CE Host application (available via Start → Programs → DataPlus Professional → DataPlus CE Host), and wait for the DataPlus Professional CE Host to detect the Archer unit (as evidenced by green-light buttons under the CE Device Status heading).
3. If Data Plus CE Host fails to detect the Archer unit, ensure that the appropriate software applications for the laptop's operating system are functioning. The WindowsXP operating system uses Microsoft ActiveSync to communicate with PDA devices, while the WindowsVista operating system uses the integrated Microsoft Windows Mobile Device Center. (Note that, when using Microsoft ActiveSync, it is not necessary to establish a Sync Partnership; a Guest Connection is sufficient.)
4. To backup the field data held on the Archer unit, click the Recv Data button within the Data Plus CE Host dialog box on the laptop. Highlight the appropriate Sage application (the name of the folder copied to the laptop's C:\ drive in Step 2 of the "Procedures for uploading Sage application to PDA device"). Next, highlight the Datasets to be transferred (use the Control and Shift keys to highlight all Datasets), then click the Receive Data button.
5. The Data Plus CE Host will transfer all files associated with your selected Datasets into a "MMDDYYYY" folder in C:\DataPlus Professional\Data\Sage_vX\ on the laptop, then display a notification of the number of files transferred. Click OK. This new folder within the laptop's directory is named with the date of your file transfer. (Important NOTES – following the General Recommendations provided in the DataPlus QuickRef field sheet [see SOP 10, Field Reference Manual], you should NOT check the "Delete data after successful transfer" checkbox within the Data Plus CE Host dialog box on the laptop, and you should always highlight ALL of the available Datasets so that each successive MMDDYYYY folder can serve as your latest full backup of Archer unit field data. Also, if you use the Receive Data function more than once on a given day *for the same Archer*

unit, then the previous data files [*for that Archer unit*] within that day's MMDDYYYY folder will be overwritten.)

Procedures for updating DataPlus picklists

There are several Pick Lists within the Sage Protocol Data Plus application for collecting field data. Many of these Pick Lists (e.g., for the Park and Frame fields on the PkFrame Form, for the Observer field on the Plots Form, and for Cover field on the various Species Cover Forms) will not need any updates during the field season. Some of these Pick Lists (e.g., for each Species Code field on the various Species Cover Forms) will need to be periodically updated.

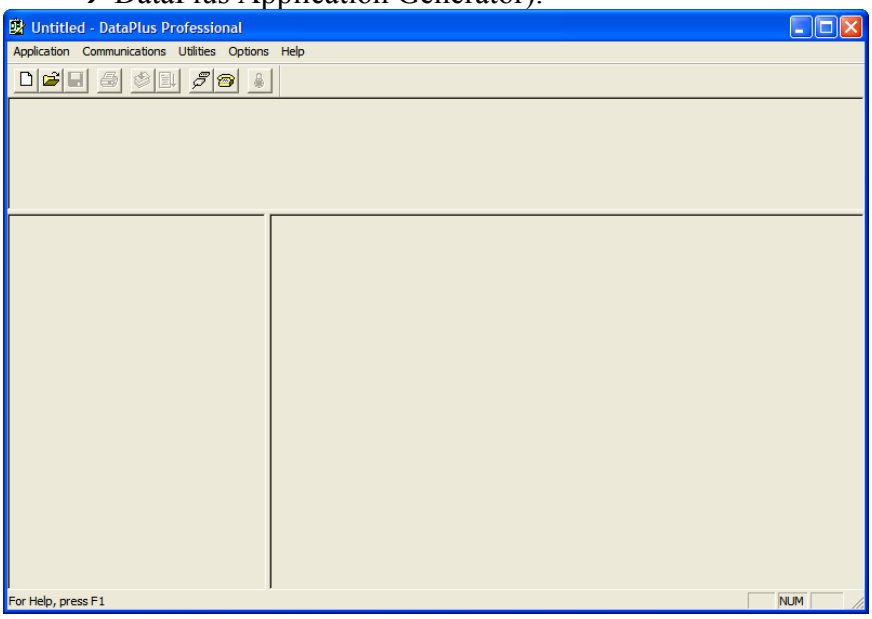
Here is a list and description of all of the Pick Lists in the Sage Data Plus application:

Form Level	Form Name	Field Name	Relate File (.RCL)	PickList File (.CL)	PickList Description
1	PkFrame	Park		PARKLIST	UCBN Parks with Sage Monitoring
		Frame	FRAMESEL	FRM_CIRO	CIRO Frames (includes CRSP)
				FRM_CRMO	CRMO Frames
				FRM_HAFO	HAFO Frames
				FRM_JODA	JODA Frames
				FRM_LARO	LARO Frames
2	Plot_Basics	Observer		OBS_LIST	List of Observers
3	Cover	BareG_Covr		BGCVRCAT	BareGround Cover Categories
4	Sage_Spp	Sage_Sp	PK_SGSP	SAGE_CI	CIRO Sage spp
				SAGE_CR	CRMO Sage spp
				SAGE_HA	HAFO Sage spp
				SAGE_JO	JODA Sage spp
				SAGE_LA	LARO Sage spp
		SgSp_Cover		COVERCAT	Spp Cover Categories
4	Shrub_Spp	Shrub_Sp	PK_SHRB	SHRB_CI	CIRO Shrub spp
				SHRB_CR	CRMO Shrub spp
				SHRB_HA	HAFO Shrub spp
				SHRB_JO	JODA Shrub spp
				SHRB_LA	LARO Shrub spp
		ShbSp_Covr		COVERCAT	Spp Cover Categories
4	PerGrs_Spp	PerGr_Sp	PK_PGSP	PERG_CI	CIRO PerenGrass spp
				PERG_CR	CRMO PerenGrass sp
				PERG_HA	HAFO PerenGrass spp
				PERG_JO	JODA PerenGrass spp
				PERG_LA	LARO PerenGrass spp
		PGrSp_Covr		COVERCAT	Spp Cover Categories
4	InvGrs_Spp	InvGras_Sp	PK_IGSP	INVG_CI	CIRO InvGrass spp
				INVG_CR	CRMO InvGrass sp
				INVG_HA	HAFO InvGrass spp
				INVG_JO	JODA InvGrass spp
				INVG_LA	LARO InvGrass spp
		InvGr_Covr		COVERCAT	Spp Cover Categories
4	PersFrb_Spp	PersFrb_Sp	PK_PFSP	PSFB_CI	CIRO PersistForbs
				PSFB_CR	CRMO PersistForbs
				PSFB_HA	HAFO PersistForbs
				PSFB_JO	JODA PersistForbs
				PSFB_LA	LARO PersistForbs

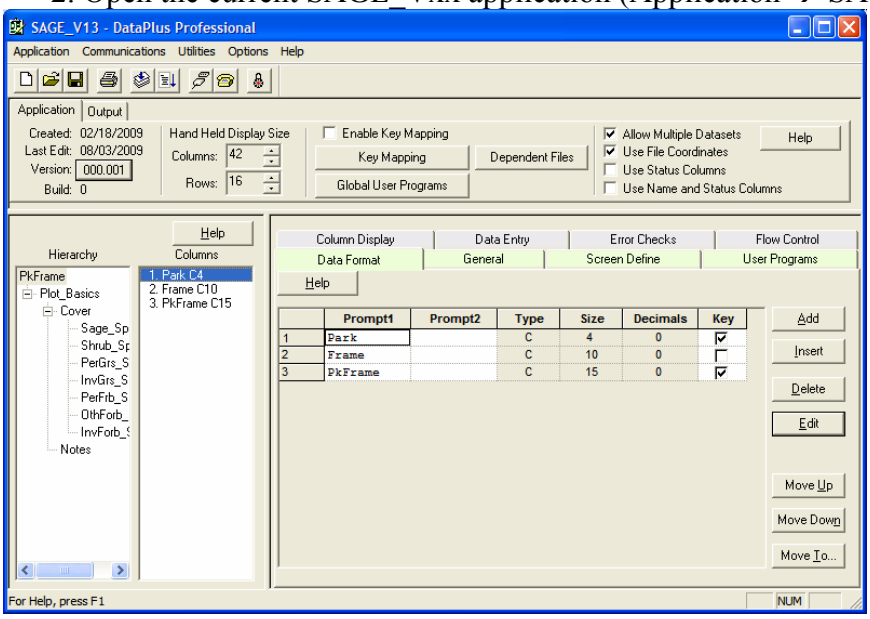
Form Level	Form Name	Field Name	Relate File (.RCL)	PickList File (.CL)	PickList Description
		PsFb_Cover		COVERCAT	Spp Cover Categories
4	OthForb_Spp	OthForb_Sp	PK_OFSP	OTFB_CI	CIRO OtherForbs
				OTFB_CR	CRMO OtherForbs
				OTFB_HA	HAFO OtherForbs
				OTFB_JO	JODA OtherForbs
				OTFB_LA	LARO OtherForbs
		OthFb_Covr		COVERCAT	Spp Cover Categories
4	InvForb_Spp	InvForb_Sp	PK_IFSP	INVF_CI	CIRO InvForb spp
				INVF_CR	CRMO InvForb spp
				INVF_HA	HAFO InvForb spp
				INVF_JO	JODA InvForb spp
				INVF_LA	LARO InvForb spp
		InvFb_Covr		DOMRANKS	Spp Cover Categories

Step by Step Procedures for updating a Pick List:

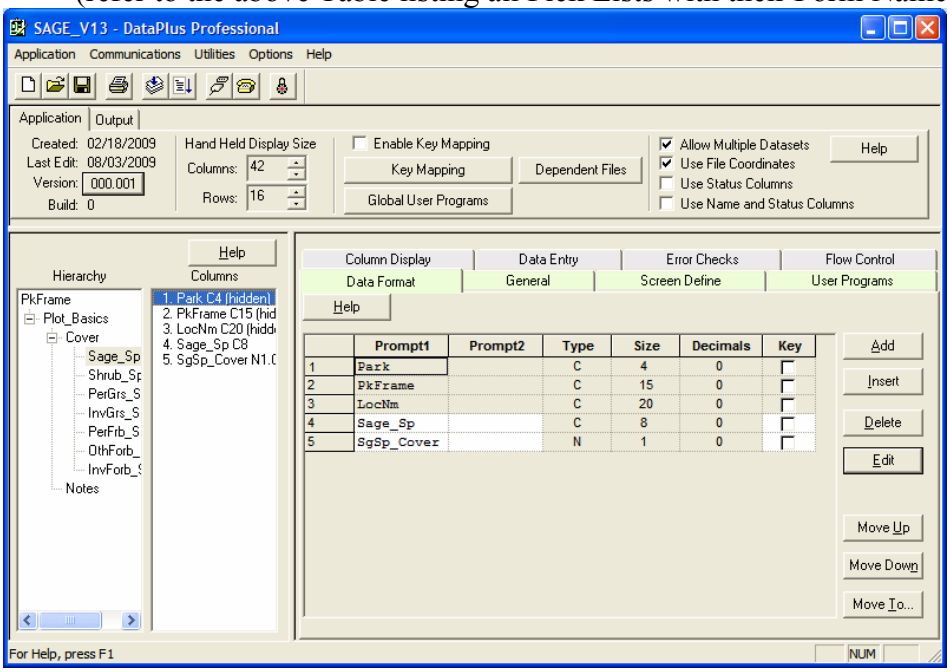
1. Open the DataPlus Application Generator (Start → All Programs → DataPlus Professional → DataPlus Application Generator).



2. Open the current SAGE_Vxx application (Application → SAGE_Vxx).

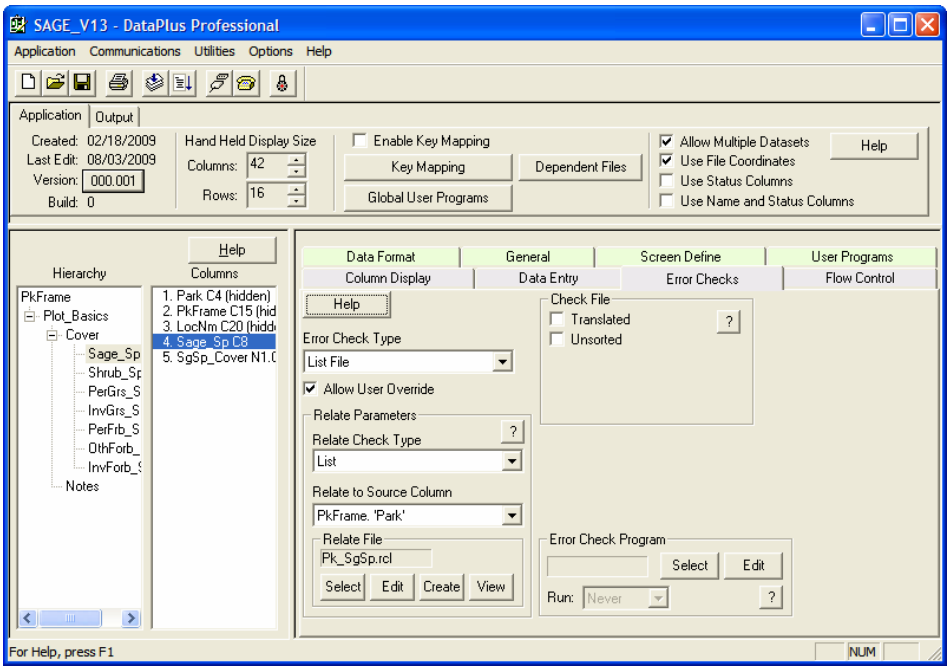


3. Within the Hierarchy window, Highlight the Form that contains the Pick List to be updated (refer to the above Table listing all Pick Lists with their Form Name and Field Name).



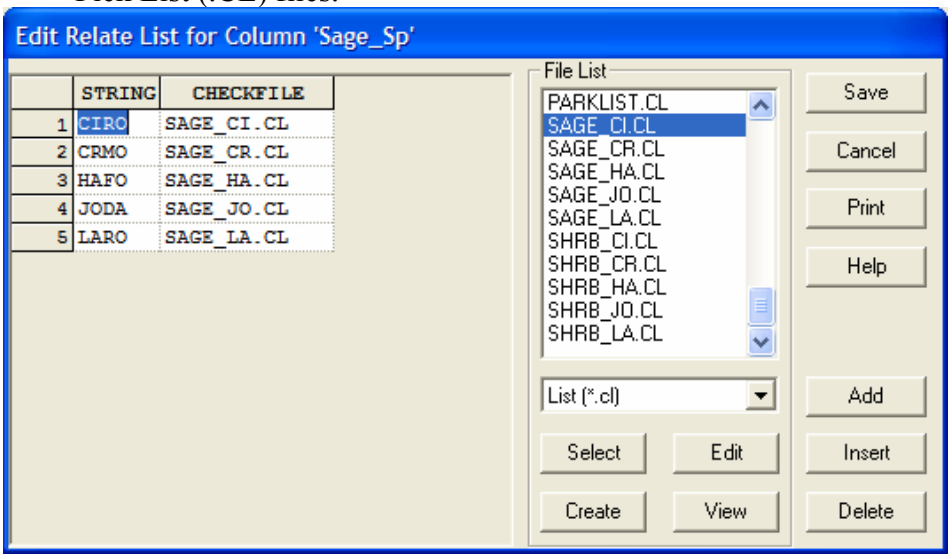
4. Within the Columns window, Highlight the Field associated with the Pick List (see Table).

5. Click on the Error Checks tab to make it the active tab.

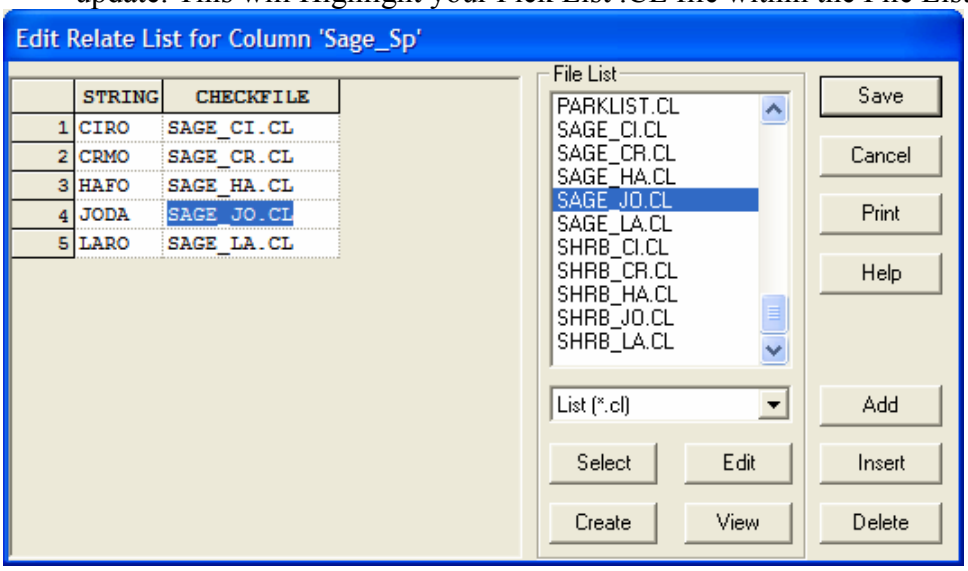


6. If your Pick List does not involve a Relate File (see above Table), then the Pick List .CL file will appear within the Check File box on the Error Checks tab. You can edit the Pick List by clicking the Edit button immediately below the .CL file name in the Check File box (this opens an Edit List Check dialog window, as shown in Step 9, and you can proceed with Steps 10-12). The Pick Lists most likely to need updating, however, involve a Relate File (see Step 7).

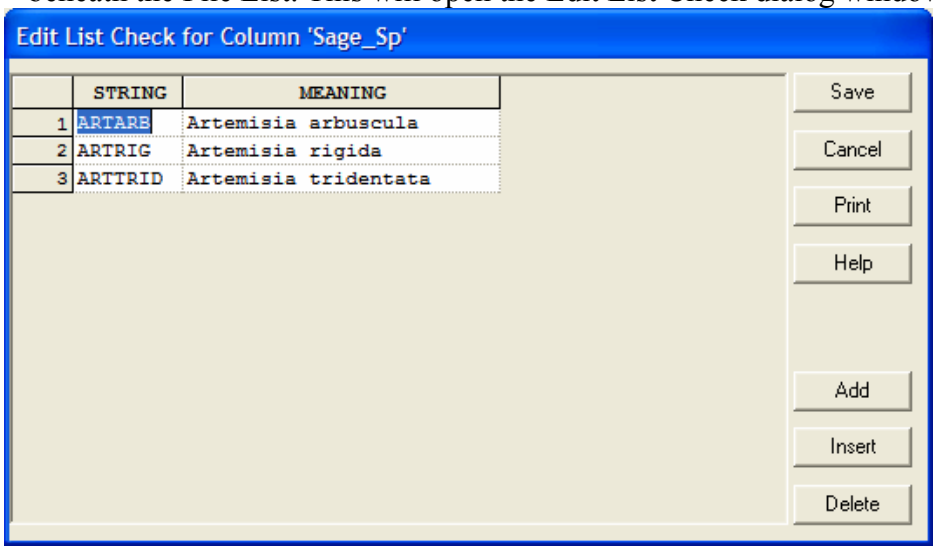
7. If your Pick List involves a Relate File, then the Relate File (a .RCL file) will appear within the Relate Parameters box on the Error Checks tab, as shown in Step 5. To update an individual Pick List (.CL file), you must click the Edit button immediately below the Relate File. This will open the Edit Relate List dialog window, which shows the Pick Lists (or Check Files) included in your open Relate File and provides Edit access to the individual Pick List (.CL) files.



8. Within the CheckFile column, find and Highlight the Pick List .CL file that you wish to update. This will Highlight your Pick List .CL file within the File List box.



9. With the Pick List .CL file that you wish to update Highlighted, click the Edit button beneath the File List. This will open the Edit List Check dialog window.



10. Notice that the list is ordered alphabetically by Species Code. **IMPORTANT NOTE** – it is imperative that, when entering or editing a list, the values in the "String" column must be Unique Values. You must check carefully that your entries or edits do NOT create Duplicate Values within the "String" column. If you do create Duplicate Values, there will be no reliable way to later deduce which list item was intended for a particular Data record (since it is the "String" column value that gets saved within the Data Plus data files).

11. The Edit List Check dialog window allows you to Add and Delete list items. The updated list will automatically sort in alphabetical order on the "String" column, either when the Pick List is re-opened within the Data Plus Application Generator (following the above steps) or when the Pick List is viewed on your Handheld device.

IMPORTANT NOTE – all of the Species Code fields (Sage_Sp, Shrub_Sp, PerGr_Sp, InvGras_Sp, PersFrb_Sp, OthForb_Sp, and InvForb_Sp) are limited to 8 characters. Most of the Species Codes are comprised of the first 3 letters of the Genus name and the first 3 letters of the Species name. In cases where that generates duplicate values, then a fourth letter (usually from the Species name) is added (for example, see ARTTRI and ARTTRID in the Sage Species pick lists).

12. When finished editing the Pick List, click the Save button at top right of the Edit List Check dialog window. If you decide to make no edits, you can simply click the Cancel button.

    Transfer your updated Pick List(s) to your ArcherPC handheld:

    Open DataPlus CE Host (Start → All Programs → DataPlus Professional → DataPlus CE Host).

    Click the Update App button, then Select the current SAGE_Vxx application within the

    Update Application dialog window, and click OK. If successful, you will see an "Application SAGE_Vxx updated successfully" message; click OK. You will also see a full list, within the DP CE Host's Activity Log box, of the files that were sent to your ArcherPC handheld.

    IMPORTANT – Do NOT use the Send App button! (Sending an App that already exists on your ArcherPC requires that all existing Data files, within that App on your ArcherPC, be deleted!)

    Update App does not affect existing Data files on the handheld; it only replaces supporting files.

    You can now close DataPlus CE Host. And you are ready to collect data, using your updated Pick List(s), on your ArcherPC.

Quality Review

The review of data quality is accomplished using the UCBN Sagebrush Steppe database. Once the PDA data files (containing plot data recorded using the Data Plus digital data forms) have been imported into the UCBN Sagebrush Steppe database and/or data from paper data sheets have been entered into the database, the records will be reviewed by the Project Lead for quality, completeness, and logical consistency. The "working copy" of the database, containing the current year data, facilitates this review by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. The Project Lead may then fix and document any problem data. If all errors and inconsistencies cannot be fixed, the resulting errors will be documented and included in the metadata and certification report.

Metadata Procedures

Data documentation is a critical step toward ensuring that datasets are useable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, and condition of data. Additionally, metadata provide the means to catalog datasets within intranet and internet systems, making data available to a broad range of potential users. Metadata for all UCBN monitoring data will conform to Federal Geographic Data Committee (FGDC) and NPS guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed, and synthesized. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years will need to be updated to reflect current publications, references, taxonomic conventions, contact information, data disposition and quality, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for metadata development and posting are outlined in the UCBN Data Management Plan. In general, the Project Lead and the Data Manager (or Data Technician) will work together to create and update an FGDC- and NPS-compliant metadata record in XML format. The Project Lead should update the metadata content as changes to the protocol are made, and each year as additional data are accumulated. Edits within the document should be tracked so that any changes are obvious to those who will use it to update the XML metadata file. At the conclusion of the field season, the Project Lead will be responsible for providing a completed, up-to-date metadata interview form to the Data Manager. The Data Manager will facilitate metadata development by creating and parsing metadata records, and by posting such records to national clearinghouses as described below.

Sensitive Information

Part of metadata development includes determining whether or not the data include any sensitive information, which includes specific locations of rare, threatened, or endangered species. Prior to completing metadata, the Project Lead and Park Resource Manager should work together to identify any sensitive information in the data. Their findings should be documented and communicated to the Data Manager. We do not anticipate that sensitive information will be present in the sagebrush steppe program at this time.

Data Certification and Delivery

Data certification is a benchmark in the project data management process that indicates that 1) the data are complete for the period of record; 2) they have undergone the quality assurance checks, with all problem data either corrected or documented; and 3) that they are appropriately documented and in a condition for archiving, posting, and distribution. Certification is not intended to imply that the data are completely free of errors or inconsistencies which may not have been detected during quality assurance reviews.

To ensure that only data of the highest possible quality are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Project Lead is primarily responsible for completing certification. The completed form,

certified data, and updated metadata should be delivered to the Data Manager as outlined in the following steps and in Table 5. A Season close-out checklist should be completed and provided to the Data Manager at this time.

Data certification steps

To package the certification materials for delivery, the Project Lead should follow these steps:

1) After the quality review has been completed, open the back-end working database file and compact it (in Microsoft Access, Tools >Database Utilities >Compact and Repair Database). This will make the file size much smaller.

2) Create a compressed file (using WinZip® or similar software) and add the back-end database file to that file. Note: The front-end application does not contain project data and as such should not be included in the delivery file.

3) Add the completed metadata to the compressed file.

4) Add the completed certification report to the compressed file.

5) Add any geospatial data files that aren't already in the possession of the Data Manager.

6) All file names – except for image files and geospatial data files – should include the assigned UCBN project code, in addition to the year or span of years for the data being certified. For example: SAGE_2008_certified.mdb, SAGE_2008_cert_report.doc.

7) The compressed file may then be uploaded to the new submissions folder of the UCBN Digital Library. The Data Manager should be notified of this submission by email.

Upon receiving the certification materials, the Data Manager will check them in, upload the certified data to the master project database, and update the project GIS data sets with any geospatial data that are submitted. Upon notification that the year's data have been uploaded and processed successfully, the Project Lead may then proceed with data summarization, analysis and reporting.

Season Close-out Checklist

Project Lead: _____ Monitoring Year: _____

Parks Involved: _____

Checklist Submitted to Network Coordinator and Data Manager on: _____ (mm/dd/yyyy)

Deliverable Product	Notes:	Completion Date
Tabular Data		
Data entry completed?		
Data quality verified?		
Certified data submitted?	This includes: ☐ Project Access dB ☐ Excel spreadsheets generated from dB	
Spatial Data		
Waypoints submitted	This includes: ☐ 2010 sampling locations for next year ☐ All 2009 locations sampled	
GIS data status		
GIS metadata created?		
Photos		
Photos	☐ Photos in UCBN photo db ☐ Other photo repositories (directory and content)	

Reporting		
Revised Protocol/SOPs submitted?		
Annual report submitted?		
Resource briefs submitted?		
Has the above information been posted on the website?		
Data Storage		
Final project directory on NAS?	UCBN_Root:\VitalSign_Protocols\Sage	

Data Archiving

Paper data sheets will be archived for three years, which allow ample time to complete QA/QC and certification steps for digital data. Long-term archiving will only be used for digital data. Upon certification, data and reports will be archived on the UCBN Network Attached Storage (NAS) unit, posted to the UCBN website, and posted to the national web-accessible secure databases hosted by the NPS Washington Areas Support Office (WASO) or National I&M program. These include:

- *NatureBib* – the master database for natural resource bibliographic references
- *NPSpecies* – the master database for biodiversity information including species occurrences and physical or written evidence for the occurrence (i.e., references and observations)
- *NPS Data Store* – a centralized data repository with a graphical search interface

A review of archive and expendable data products will be undertaken by the Project Lead and Data Manager during season close-out each year. An example of an expendable data product is an intermediate draft of an annual report that was saved during report preparation.

Directory Structure

The following directory structure will be used to store and archive all information related to the sagebrush steppe monitoring project on the UCBN NAS drive. This is a generic structure that should provide a foundation and a minimum standard of organization and consistency. The goal is to organize all project materials in an efficient hierarchical structure that reflects the life cycle and workflow of the project. Toward this goal, all subfolders are organized into four primary project folders that reflect life cycle stages (initiate, plan, implement, and close). Additional subfolders may be added as needed, but a strong emphasis must be placed on keeping the structure as simple and logical as possible. The four primary project folders and their standard subfolders are presented below.

\Initiate – Store information about the initiation of the project here, including proposals, contract agreements, relevant e-mails, etc.

\Agreements_Contracts
\Meetings_Correspondence
\Proposals

\Plan – Store information about the planning phase of the project here, including monitoring objectives, protocol development summaries, conceptual models, protocol and SOP drafts, study plans, and research permits.

\Conceptual_Models
\Data_Mng_Models
\Equipment
\Meetings_Correspondence
\Monitoring_Objectives
\Protocol_Develop_Summary
\Protocol_SOP_Drafts
\Research_Permits

\Study_Plans

\Implement – Store information about the implementation phase of the project here, including data management documents and draft products, data analysis documents and draft products, project photos, and relevant correspondence.

\Data_Analysis

\Data_Management

\Data_Dictionary

\PDA_Forms

\Database_Working

\Download_Files

\GPS_Files

\Datalogger_Files

\GIS_Data_Working

\Map_Products

\Templates

\Features

\Geodatabases

\Meetings_Coorespondence

\Photos

\Final

\Originals

\Working

\Close – Store finalized documents and products from the close-out phase of the project (on either an annual basis or a final project close-out basis) here, including final reports, certified data and GIS products, and presentations.

\Certified_Data_GIS_Metadata

\Final_Reports

\Annual_Reports

\Investigator_Annual_Reports

\Protocol_SOP_Final

\Other_Final_Deliverables

\Presentations

Schedule for Data Management Tasks

Table 5. Yearly sagebrush steppe data management task list. This table identifies tasks by project stage, indicates who is responsible for the task, and establishes the timing for its execution.

Project Stage	Task Description	Responsibility	Timing
Preparation	Notify Data manager of needs (field maps, GPS support, training)	Project Lead	ASAP, before Feb 1
	Prepare field maps and field forms	Project Lead/Data Manager	by April 1
	Provide database/GPS training as needed	Data Manager	Mid April
	Train field crew in sampling protocols	Project Lead/Field Lead	Late April/Early May
Data acquisition	Collect plot data	Project Lead and/or Field Lead	May-July
Data entry & processing	Enter data into protocol database, and review data entry accuracy	Data Technician and Data Manager	Monthly
Quality review	Quality review and data validation using database tools	Project Lead/Data Manager	Aug/Sept
Metadata	Identify any sensitive information contained in the dataset	Project Lead	After each season
	Update project metadata records	Project Lead/Data Manager	November
Data certification	Certify the season's data	Project Lead/Data Manager	November
Data delivery	Deliver certified data and updated metadata to data manager	Project Lead	November
	Upload certified data into master project database, store data files in UCBN Digital Library[1]	Project Lead	November
	Notify Project Lead of uploaded data ready for analysis and reporting	Data Manager	November
	Update project GIS datasets, layers and associated metadata records	Data Manager	November
	Finalize and parse metadata records, store in UCBN Digital Library[1]	Data Manager	By Dec 1
Data analysis	Status and trend analyses	Project Lead/Data Analyst	December

Table 5. Yearly sagebrush steppe data management task list. This table identifies tasks by project stage, indicates who is responsible for the task, and establishes the timing for its execution (continued).

Project Stage	Task Description	Responsibility	Timing
Product development	Acquire the proper report template from the NPS website, create annual report	Data Analyst	Dec – Jan
	Screen all reports and data products for sensitive information	Data Manager / Data Analyst	Dec – Jan
	Submit draft report to Network Coordinator for review	Data Analyst / Data Manager	Jan
	Review report for formatting and completeness, notify Project Lead of approval or need for changes	Network Coordinator	Jan
	Upload completed report to UCBN Digital Library[1] submissions folder, notify Data Manager	Project Lead	Feb
	Deliver other products according to the delivery schedule and instructions	Project Lead	Feb
Posting & distribution	Submit metadata to NR-GIS Data Store[2]	Data Manager	Feb
	Create NatureBib[3] record, post reports to NPS clearinghouse	Data Manager	Feb
	Update NPSpecies[4] records according to data observations	Data Manager	Feb
	Submit certified data and GIS data sets to NR-GIS Data Store[2]	Data Manager	Feb
Archival & records management	Store finished products in UCBN Digital Library[1]	Data Manager	Feb
	Review, clean up and store and/or dispose of project files according to NPS Director's Order #19 [5]	Project Lead	Feb
Season close-out	Meet to discuss the recent field season, and document any needed changes to field sampling protocols or the working database	Project Lead, Park Resource Managers, and Data Manager	Jan – Feb
	Discuss and document needed changes to analysis and reporting procedures	Project Lead, Park Resource Managers, and Data Manager	Jan - Feb

[1] The UCBN Digital Library is a hierarchical digital filing system stored on the UCBN file server. Network users have read-only 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). Only non-sensitive information is posted to NR-GIS Metadata and Data Store. Refer to the protocol section on sensitive information for details.
[3] NatureBib is the NPS bibliographic database (http://www.nature.nps.gov/nrbib/index.htm). This application has the capability of storing and providing public access to image data (e.g., PDF files) associated with each record.
[4] NPSpecies is the NPS database and application for maintaining park-specific species lists and observation data (http://science.nature.nps.gov/im/apps/npspp/index.htm).

[5] 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.

Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 7: Data Analysis and Reporting

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP provides details of the recommended analytical approaches and reporting guidelines for the UCBN sagebrush steppe monitoring program. Code written for the R statistical software and language environment is included in the accompanying CD and in the project directory of the UCBN network attached storage drive.

Suggested Reading

Agresti, A. 2007. An introduction to categorical data analysis. 2nd Edition. John Wiley and Sons, New York, NY.

Crawley, M. J. 2005. Statistics: an introduction using R. John Wiley and Sons, Ltd. West Sussek, England.

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Chapter 11 *in* Measuring and Monitoring Plant Populations. US Department of Interior, Bureau of Land Management, Denver, CO.

Garrett, L. K., T. J. Rodhouse, G. H. Dicus, C. C. Caudill, and M. R. Shardlow. 2007. Upper Columbia Basin Network vital signs monitoring plan. Natural Resource Report NPS/ UCBN/NRR—2007/002. National Park Service, Fort Collins, CO.

Guisan, A., and F. E. Harrell. 2000. Ordinal response regression models in ecology. Journal of Vegetation Science 11:617-626.

Kincaid, T. 2008. User guide for spsurvey, version 1.6 probability survey design and analysis functions. Version 2.0 June 16, 2008. Available at:

http://www.epa.gov/nheerl/arm/documents/design_doc/UserGuide%20for%20spsurvey%202.0.pdf.

Lyles, R. H., H. M. Lin, and J. M. Williamson. 2007. A practical approach to computing power for generalized linear models with nominal, count, or ordinal responses. Statistics in Medicine 26:1632-1648.

McCune, B., and J. B. Grace. 2002. Analysis of ecological communities. MJM Software Design, Gleneden Beach, OR.

Maindonald, J., and W. J. Braun. 2007. Data analysis and graphics using R – an example-based approach. Cambridge University Press, UK.

National Park Service. 2006. Instruction to authors—Natural Resource Report and Natural Resource Technical Report. Natural Resource Report NPS/NRPC/NRR—2006/001. National Park Service, Fort Collins, CO.

Rodhouse, T. J. 2009. Monitoring sagebrush-steppe vegetation in the Upper Columbia Basin Network: 2008 annual monitoring report for City of Rocks National Reserve, Hagerman Fossil Beds National Monument, and John Day Fossil Beds National Monument. Natural Resource Technical Report NPS/UCBN/NRTR—2009/182. National Park Service, Fort Collins, CO.

Stevens, D. L., and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. Environmetrics 14:593-610.

Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99:262-278.

Theobald, D. M., D. L. Stevens, D. White, N. S. Urquhart, A. R. Olsen, J. B. Norman. 2007. Using GIS to generate spatially-balanced random survey designs for natural resource applications. Environmental Management 40:134-146.

Thompson, S. K. 2002. Sampling. 2nd Edition. John Wiley and Sons, New York, NY.

Analytical Procedures

The statistical methods outlined below are described for implementation with 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. R is one of the analytical environments of choice for the Upper Columbia Basin Network. Computational code for procedures outlined in this SOP written for R statistical language and environment (http://www.r-project.org/) are provided on the CD that accompanies this manual or by request from the UCBN. All analytical code is stored on the UCBN NAS drive under Sage/Implement/Data_Analysis/RCode. 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 `()`.

We developed the following sampling objectives to guide sample size decisions:

- Estimate the proportion of sampling strata and frames covered by principal plant species and exposed soil, for each Daubenmire category, within 15% of true proportion values with 90% confidence.
- Detect differences of >25% in the proportion of quadrats assigned to a given cover class or classes between any two sampling periods for each stratum or frame during the first 10 years of the monitoring program (five biennial samples per park sampling frame) with $\geq$ 90% power and $\leq$ 10% false-change error (type I or α).
- Detect linear trends in cover proportions $\geq$ 50% after 10 years (five biennial samples per park frame), and $\geq$ 25% after 20 years (10 biennial samples per park) for each sampling stratum with $\geq$ 90% power and $\leq$ 10% false-change error.

These objectives are expressed in terms of cover, our principal monitoring metric, which will be collected in cover classes and analyzed as ordinal categories. Specifically, we will estimate the proportion of sampling quadrats within each Daubenmire cover class and trends in those proportions over time. These objectives serve as guidelines for ensuring that this monitoring effort has the capability to detect ecologically meaningful status and trends in core cover metrics for discrete areas of management interest and across ecological sites within parks. These objectives include both short-term and long-term status and trend monitoring goals, and address the statistical reality that many years of sampling are required before trends, if present, can be detected. It is important to underscore that considerable status information of importance will be available to park managers immediately after the first year of sampling, as has already been demonstrated with the sagebrush vegetation monitoring annual report following 2008 pilot sampling (Rodhouse 2009). Changes will be detected long before 20 years of sampling have elapsed, particularly if evidence of change with lower confidence levels (e.g., 80%) will be accepted (a lower "conservationist's risk" and higher "polluter's risk", Morrison 2007, Irwin 2006)

The values for change between years were arrived at through review of the literature, consideration of the magnitude of change meaningful to park management, and consideration of the cost-benefit tradeoffs inherent in these decisions. The sampling objectives capture conservative yet biologically meaningful management thresholds or "assessment points" (Bennetts et al. 2007). We believe that a 25% difference in cover is biologically meaningful and will reflect more than just the "noise" inherent in fluctuations of steppe vegetation abundances. The threshold for irreversible change from native rangeland to cheatgrass dominance is not known (Pellant 1999), but a shift to ≥ 25% cover (Daubenmire class 3 or more) summed across a sample frame likely indicates greater risk to the stability (integrity) of the sagebrush steppe community because of increased risk of fire, and loss of native plants. Van Haveren (2001) suggested that > 30% cover of bare ground is detrimental to soil stability in xeric sagebrush steppe, which is represented in our cover class scheme by class 3. A change from class 2 (5-25% cover) to class 3 (25-50% cover) would indicate a substantial increase of bare ground and increased risk of soil instability. Similarly, a decline to < 25% cover (classes 1 and 2) for *Artemisia* shrubs and native bunchgrasses certainly warrants attention and represents an important *a priori* assessment point. We anticipate that as information from monitoring is gained and as further research clarifies the disturbance ecology of sagebrush steppe, that these assessment points will be revised.

Power Analysis

We considered sample sizes for both status and for a 2-sample comparison of proportions (e.g., proportion of quadrats with cover class 1) between years ("step trend"). Because GRTS sampling allows for a more efficient variance estimator (Stevens and Olsen 2004), a simple random sampling formula for sample size to achieve a desired confidence interval will be conservative. For status, we used the simple random sampling formula, $n_0 = 1.64^2/(4e^2)$, to determine the sample size required for a specific margin of error (confidence interval half-width), where 1.64 is the 90% confidence interval multiplier from a standard normal distribution, e is the margin of error, and ¼ (4 in the denominator) is the binomial variance when the estimated proportion is 0.5. Sample size is maximized when the estimated proportion is 0.5. A sample size of 50 yields a 90% confidence interval with margin of error (confidence interval half-width) approximately 0.11 when $p = 0.5$, but a margin of error of 0.093 when $p = 0.2$. A minimum sample size of 50 will allow us to meet our first sampling objective identified in the protocol narrative and obtain adequate precision within years. Figure 12 shows margins of error over a range of sample sizes when $s^2 = 0.25$ and $p = 0.5$. The vertical lines in Figure 12 represent sample sizes of 50 and 100, respectively.

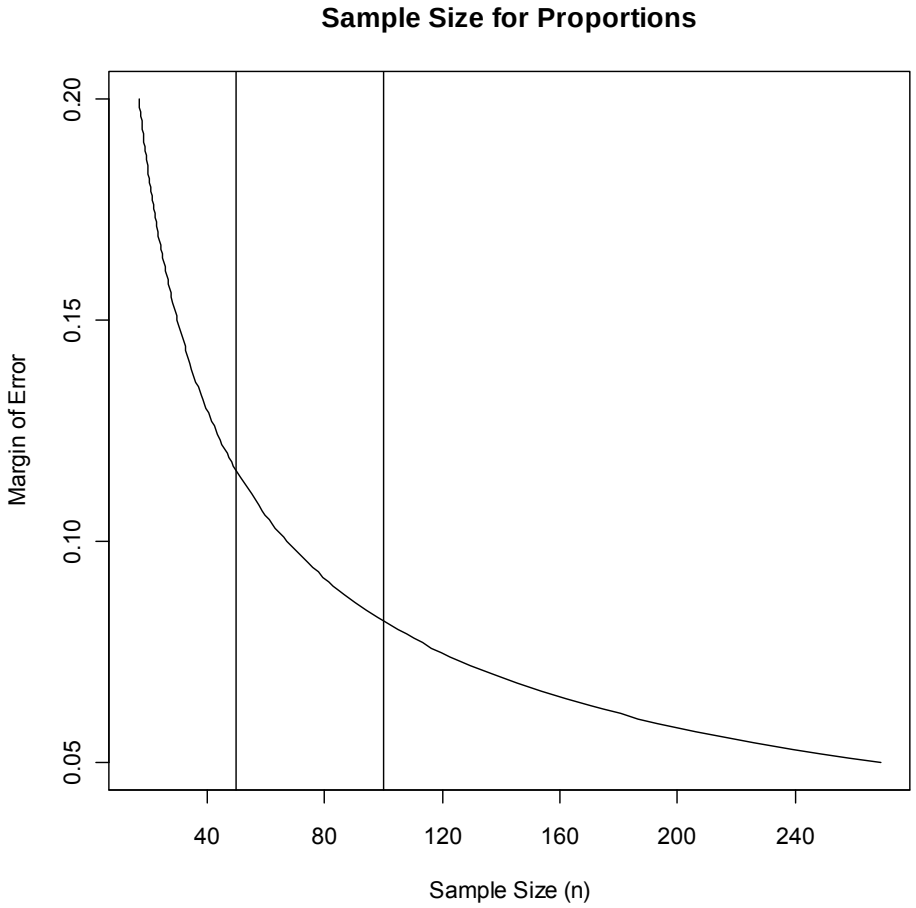


Figure 12. Margins of error over a range of sample sizes for proportions when the estimate π is 0.5, which is the most conservative estimate.

We followed methods outlined by Ramsey and Schafer (1997) to determine sample sizes for comparing two proportions or odds estimated from categorical data. We used pilot cover class estimates from 2008 sampling in the Clarno Unit of JODA and from 2009 sampling in the Foree Unit of JODA to provide the necessary proportion inputs to the formula (Rodhouse 2009). We included estimates of cover for bare ground, annual grass, bunchgrass, and shrub group data from 2008 and for *Artemisia tridentata*, *Gutierrezia sarothrae*, *Pseudoeregneria spicata*, and *Bromus tectorum* species-specific cover data from 2009, which provided a wide range of skewed and relatively symmetric empirical distributions to consider. Sample size estimates ranged from 18-69 for a fixed effect size of ±25% cover (multiplicative change) and an α level (type I error) of 10%. For the species data, a 25% increase in *Bromus tectorum* cover classes $\geq$ 3 resulted in the highest sample size estimate of 49.

The step trend calculation is as follows: for sampling period 1 denote the proportion of quadrats with, for example, bare ground cover within Daubenmire class i as p_i, and q_i for sampling period 2. For a question concerning the proportion of quadrats within cover classes $\geq$ 3, let $\pi_0 = p_3+p_4+p_5+p_6$ and $\pi_1 = q_3+q_4+q_5+q_6$. To detect an increase from π_0 to π_1 of $\geq$ 25%, let $\pi_1 = 1.25*\pi_0$

be the practically significant difference (Ramsey and Schafer 1997), estimated from the pilot data. Sample size is calculated from equation 1, where R is the odds ratio for the two years and $z_{1-\alpha/2}$ is the multiplier from the standard normal distribution (i.e. 1.64 for $\alpha = 0.1$).

$$n = \frac{z^2_{1-\alpha/2}}{\log(R)^2}\left\{\frac{1}{\pi_0(1-\pi_0)} + \frac{1}{\pi_1(1-\pi_1)}\right\} \quad (1)$$

Sample size is sensitive to the starting baseline probability π_0 (Figure 13). We can address this by rephrasing the assessment as whether the proportion of quadrats within cover classes ≤ 2, for example, has *decreased* between the two sampling periods when most of the quadrats are classified in the lower classes initially (i.e., quadrats are "migrating" to higher cover classes). The sensitivity to initial probabilities is a function of multiplicative change and having an initial probability close to zero; for example, 25% of .08 is much smaller compared to 25% of .80.

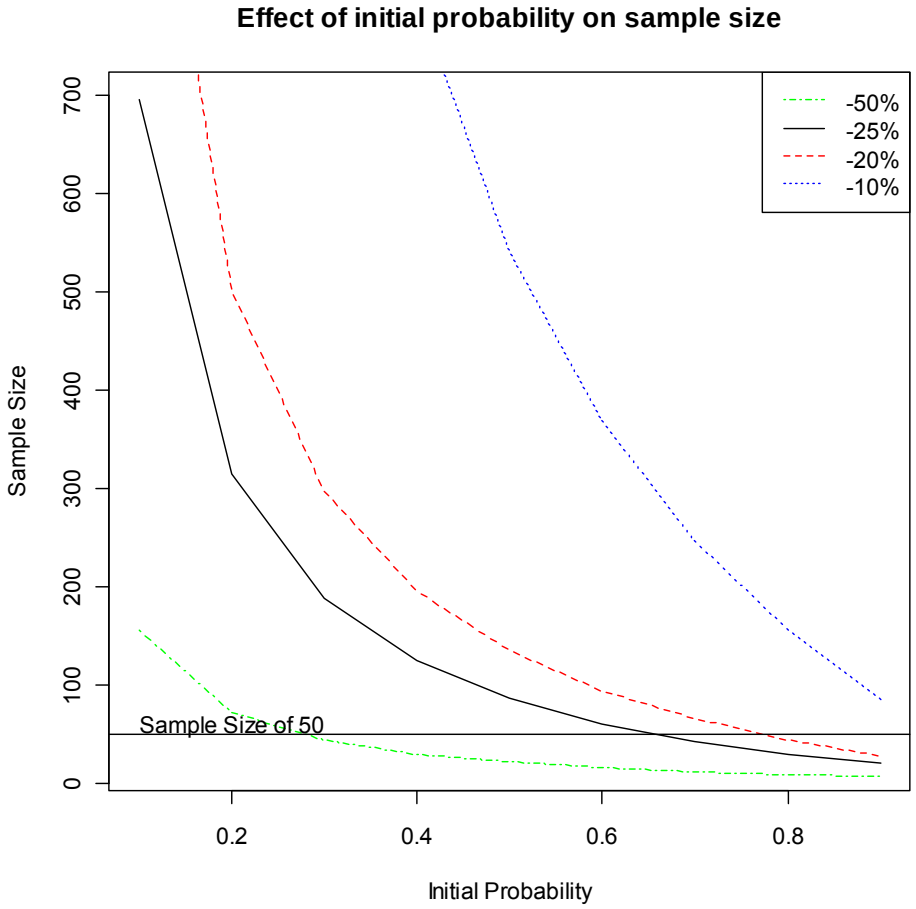


Figure 13. The effect of initial probabilities (π_0) on required sample sizes.

Based on these two exercises, we settled on 50 as a minimum sample size for 2009, but adjusted sample sizes upward proportionally for larger strata and frames, with an upper limit of 100 (Thompson 2002). Sample sizes for each park stratum are presented in Table 6. We will re-

estimate sample size requirements and address power to detect long-term trends with generalized linear models after 3 years of data have been collected.

Table 6. Sample sizes and estimated time to sample each park unit (based on two 2-person teams). A 2-person team can complete approximately 50 quadrats in a day. Approximately 5 days are required to sample 250 quadrats.

Park Unit	Sample Size	Sample Days
CIRO TOTAL	600	15
CIRO-Bath Rock	55	1
CIRO-Circle Cr. South	55	1
CIRO-Circle Cr. North	65	2
CIRO-Emery Cyn.	75	2
CIRO-Tracy Lane	55	1
CIRO-Kempton	60	2
CIRO-Trail Cyn.	65	2
CRSP-West	55	1
CRSP-North	60	2
CRSP-South	55	1
CRMO TOTAL	1750	35
Hwy 20 (13 frames)	650	13
Laidlaw Park Rd. (12 frames)	600	12
Minidoka-Arco Rd. (7 frames)	350	7
Wapi Flow (3 frames)	150	3
HAFO TOTAL	300	7
North	50	1
South	65	2
Upper Bench	55	1
Pump Station	55	1
Oregon Trail	75	2

Table 6. Sample sizes and estimated time to sample each park unit (based on two 2-person teams; continued). A 2-person team can complete approximately 50 quadrats in a day. Approximately 5 days are required to sample 250 quadrats. Total number of days required for CRMO were inflated by 15% to account for to extensive travel times (continued).

Park Unit	Sample Size	Sample Days
JODA TOTAL	1070	25
Clarno	215	5
Painted Hills	210	5
Sheep Rock East	250	5
Sheep Rock West	230	5
Foree	165	5
LARO TOTAL	260	5
Crescent Bay	55	1
Spring Cyn. West	50	1
Spring Cyn. East	50	1
Neil Cyn.	55	1
Ponderosa	50	1

Status Analysis

Cover (Ordered Multinomial Proportions): Categorical data analysis for cover can be accomplished in at least two ways. The median of cover class mid-points, `median()`, rather than the mean, is the most widely used approach to summarize cover class data, and median values can be readily reported in summary tables. An alternative approach, and one that is more appropriate for ordinal data, is to summarize the proportions of quadrats in each cover class or classes (e.g., proportion of quadrats with annual grass cover classes ≤ 2) in the same way as frequency is estimated in the preceding paragraph, drawing on the fact that cover classes follow a multinomial distribution. Means, standard errors, and confidence intervals can be easily computed using the same frequency formulas (binomial estimators) for each of *j* cover classes, and interpreted directly with no untenable distributional assumptions. Cover class proportions can be graphically displayed as was illustrated in Figure 14 of the protocol narrative using the `barplot()` graphical command. Error bars can be added to bar charts to indicate confidence intervals using the `errbar()` command found in the *Hmisc* R library package. Estimating cover class proportions naturally addresses thresholds that were discussed in the sampling objectives and sample size section of the narrative. Proportions also extend easily to odds ratios involved in the various methods for estimating trends with categorical data, discussed in the next section, and in the preceding step trend power analysis section.

Note that these estimation procedures assume a simple random sample rather than a spatially-balanced GRTS sample. An efficient alternative based on the Horvitz-Thompson estimator for categorical data is available for GRTS sample data using function `cat.analysis ()` from the *spsurvey* R library package developed by the EPA EMAP program (Stevens and Olsen 2003, Kincaid 2008). Using the standard estimators based on a simple random sample is conservative, but probably only slightly so given the unstructured equal probability design used for this protocol (Theobald et al. 2007). R code for estimating means, standard errors, total sample frame area within cover classes, and confidence intervals using the GRTS local variance estimator is available on the CD that accompanies this protocol or by request from the UCBN. The approach first requires an adjustment of the sample selection probabilities (weights) generated during the initial GRTS sample draw for the actual number of sites evaluated, which includes both the sites actually sampled (including sites off of the oversample list) and dropped sites. Typically this will be a number n_0' larger than initial n_0, because of the addition of sites from the oversample list. The initial weights, w_i for site *i,* are calculated as A/n_0, where n_0 is the desired sample size and A is the area of the sample frame. The selection probalities are the inverse, n_0/A. These initial weights are provided in the output produced by the `grts()` function in *spsurvey*. The `adjwgt()` function can be used to adjust the weights, and for equal probability samples such as are used for this protocol, is simply $w_i' = A/n_0'$, where n_0' is the adjusted sample size. To estimate the proportion of quadrats in class *j*, $\hat{\pi}_j$, using adjusted weights, denote $Y_{ij} = 1$ if site *i* is classified in class *j*, or $Y_{ij} = 0$ otherwise and use equation 2.

$$\hat{\pi}_j = \frac{\hat{N}j}{\hat{N}} = \frac{\sum Y_{ij} w_i'}{\sum w_i'} \qquad (2)$$

The estimate of the total area within class j (e.g., class 2, 5-25% cover) within a sample frame is simply calculated as $\hat{\tau} = \hat{\pi}_j * \hat{N}$. Note that the total frame area $\hat{N}$ is adjusted by the adjusted weights w_i'.

Trend Analysis

The detection of change between 2 sample periods will be evaluated by comparing odds ratios from categorical cover estimates (Ramsey and Schafer 1997, Elzinga et al. 2001, Higgins 2004). As an accumulation of results from 5 or more sampling periods (10 years) become available for each park, we will evaluate trend through the use of the generalized linear model for trends of the form $g(\mathbf{X})=\beta_0+\beta_1*(year_j)+\beta_2*(x_{1ij})+...+\beta_k*(x_{kij})+\varepsilon_{ij}$, for site *i* in year *j*, where $g(\mathbf{X})$ represents an appropriate link function (e.g., logit for species frequency and proportional odds logit for ordinal cover class data) for the response, x_{kij} denotes the value x of covariate k at site i in year j, and ε represents residual error. The hypothesis test for linear trend in this model is H_0: $\beta_1 = 0$ and H_a: $\beta_1 \neq 0$, using the Wald's test. Covariates may include year, precipitation, management "treatment", and other site- and sample event-specific ancillary data. The use of ordinary least squares using cover category midpoints has been shown to be effective and is generally common practice (Peet et al. 1998, McCune and Grace 2002). However, categorical approaches, such as a proportional odds logistic regression model, may prove more efficient and would be more consistent with the status and step-trend procedures previously outlined (Ananth and Kleinbaum

1997, Agresti 1999, 2007, Guisan and Harrell 2000, McCune and Grace 2002). This is a mathematically more appropriate use of cover class data (rather than as continuous, or when collapsed as binary), particularly when unequal cover class intervals are used, and can effectively summarize threshold or assessment point changes between ranks. The proportional odds model uses a logit link, and is based on the cumulative probabilities of each of the *j* ordinal classes (e.g., *j* = 6 ranks in Daubenmire's cover class scheme) and the *j*-1 subsequent classes. This model takes the form as shown in equation 3.

$$g_j = \Pr(Y \geq j \mid yr_i) = \log\left(\frac{\pi_j(yr_i)}{1-\pi_j(yr_i)}\right) = \alpha_j + \beta(yr_i) \qquad (3)$$

for each of *j* classes, where the probability of the response *Y* (e.g., bare cover) greater than or equal to rank *j* (e.g., rank 3) is estimated using the logit link as a linear function of an intercept α_j plus an effect for year $\beta(yr_i)$. Note that this results in a series of *j* models each with a unique intercept and a common slope. The proportional odds model provides a flexible approach to evaluate the third sampling objective of this protocol for ordinal assessment points of interest. In R, proportional odds `polr()` is available through the MASS library package.

This model-based approach provides considerable flexibility and the ability to include informative explanatory variables will reduce the uncertainty of β_1 estimates for temporal trend. Regression coefficients that are obtained from models fit to frequency or cover class data using the logit link will be back-transformed ("exponentiated") and interpreted in terms of a percent change in the odds of species occurrence or of quadrats being within cover class(es) for 1 year increases (or decreases). Fitted probabilities can easily be obtained, and when site-specific covariates are accounted for, will provide spatially-explicit estimates that will be very helpful to park managers both in terms of interpretation of trends as well as in localized management decision-making. Trend analysis methods will be further developed following collection of three years of data (from one park), first projected to be available for JODA in 2012 (pilot data from 2009, plus 2-year alternating samples beginning 2010).

Precipitation and Temperature

Controlling for the effects of precipitation and temperature on sagebrush steppe condition indicator trends will be important in the future. These two variables can also be tested using the generalized linear model framework. For this protocol version, analysis of precipitation and temperature is considered only in a preliminary manner. Weather effects will require several years of data before they become detectable. More in depth treatment will be provided in a future SOP. Currently, it is hypothesized that available moisture, particularly during the winter months (dormant period) and during spring growth is the most significant seasonal precipitation driver. Accounting for the effects of precipitation and temperature (i.e., evapotranspiration) will be important, as gross precipitation may mask real effects on vegetation. Figure 14 illustrates one approach to graphically displaying available moisture over time, and effectively displays prolonged droughts that will strongly influence observed patterns in UCBN plant communities.

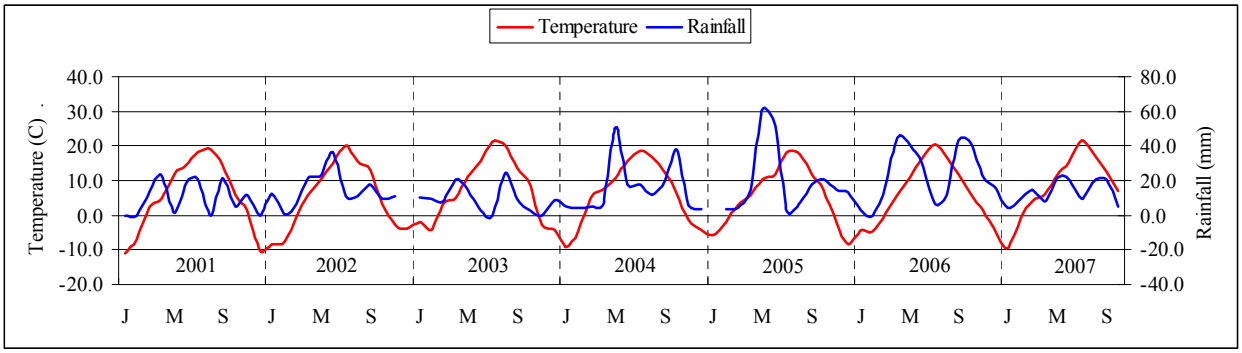
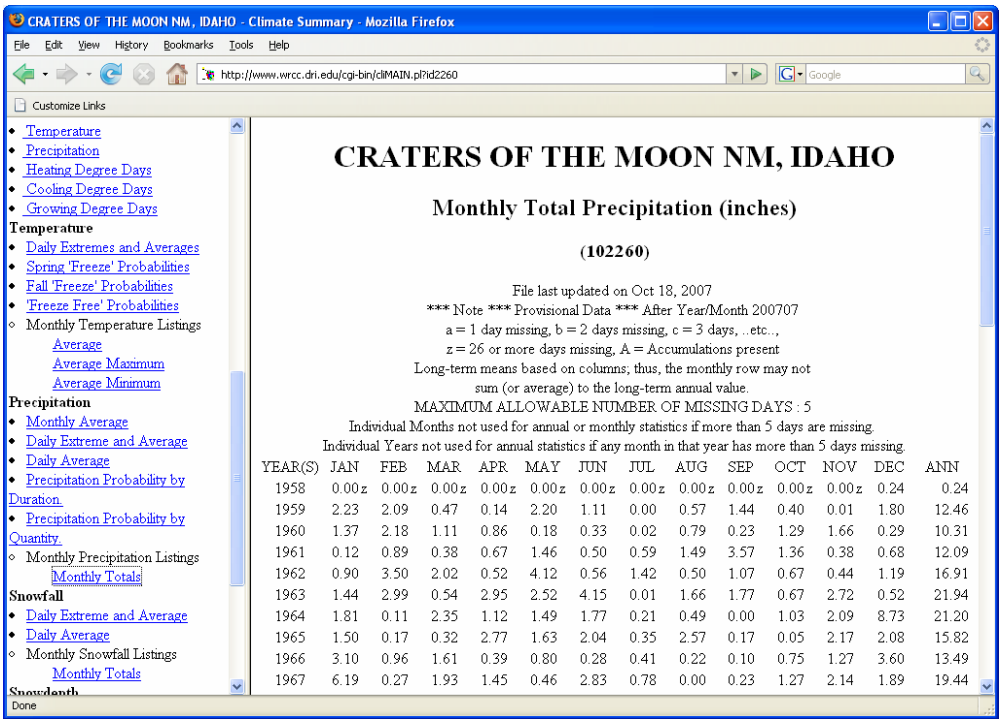


Figure 14. Continuous climate diagrams using the methods of Walter et al. (1975). Within each year, those intervals when the temperature (red line) exceeds rainfall (blue line) indicate arid periods. The horizontal extent of the arid period signifies the time when water is not available for plant growth, and the vertical extent of the arid period signifies the severity of the drought period. For example, 2001 and 2003 had lengthy arid periods that extended from early spring through late fall while 2005 and 2006 had much shorter arid periods centered in summer. The severity of drought appeared greatest during 2003 and 2007.

Precipitation and temperature data will be retrieved from the Western Regional Climate Center at http://www.wrcc.dri.edu/Climsum.html (Figure 15). Click on the link to S. Idaho stations (or Oregon or Washington) and then navigate to the appropriate station (e.g., Craters of the Moon station; Station 102260) and click on the "monthly totals" hyperlink under precipitation and/or temperature. Right click on the data and save as a text file (.txt) to the appropriate directory and folder. This file can be imported into Microsoft Excel and prepared for analysis. Monthly totals with more than 4 days missing (coded as e or greater by WRCC) should be treated as missing values and coded as NA in Excel. Summations of precipitation during the dormant period (Oct-Mar), peak precipitation period (Nov-May), and annual total preceding the current growing season (June-May) can all be considered for analysis, as can synthetic variables for available moisture that account for evapotranspiration, as is illustrated in Figure 15.



CRATERS OF THE MOON NM, IDAHO

Monthly Total Precipitation (inches)

(102260)

File last updated on Oct 18, 2007
*** Note *** Provisional Data *** After Year/Month 200707
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1958	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.00z	0.24	0.24
1959	2.23	2.09	0.47	0.14	2.20	1.11	0.00	0.57	1.44	0.40	0.01	1.80	12.46
1960	1.37	2.18	1.11	0.86	0.18	0.33	0.02	0.79	0.23	1.29	1.66	0.29	10.31
1961	0.12	0.89	0.38	0.67	1.46	0.50	0.59	1.49	3.57	1.36	0.38	0.68	12.09
1962	0.90	3.50	2.02	0.52	4.12	0.56	1.42	0.50	1.07	0.67	0.44	1.19	16.91
1963	1.44	2.99	0.54	2.95	2.52	4.15	0.01	1.66	1.77	0.67	2.72	0.52	21.94
1964	1.81	0.11	2.35	1.12	1.49	1.77	0.21	0.49	0.00	1.03	2.09	8.73	21.20
1965	1.50	0.17	0.32	2.77	1.63	2.04	0.35	2.57	0.17	0.05	2.17	2.08	15.82
1966	3.10	0.96	1.61	0.39	0.80	0.28	0.41	0.22	0.10	0.75	1.27	3.60	13.49
1967	6.19	0.27	1.93	1.45	0.46	2.83	0.78	0.00	0.23	1.27	2.14	1.89	19.44

Figure 15. Screenshot of the monthly precipitation totals for the Craters of the Moon weather station, retrieved from the Western Regional Climate Center website.

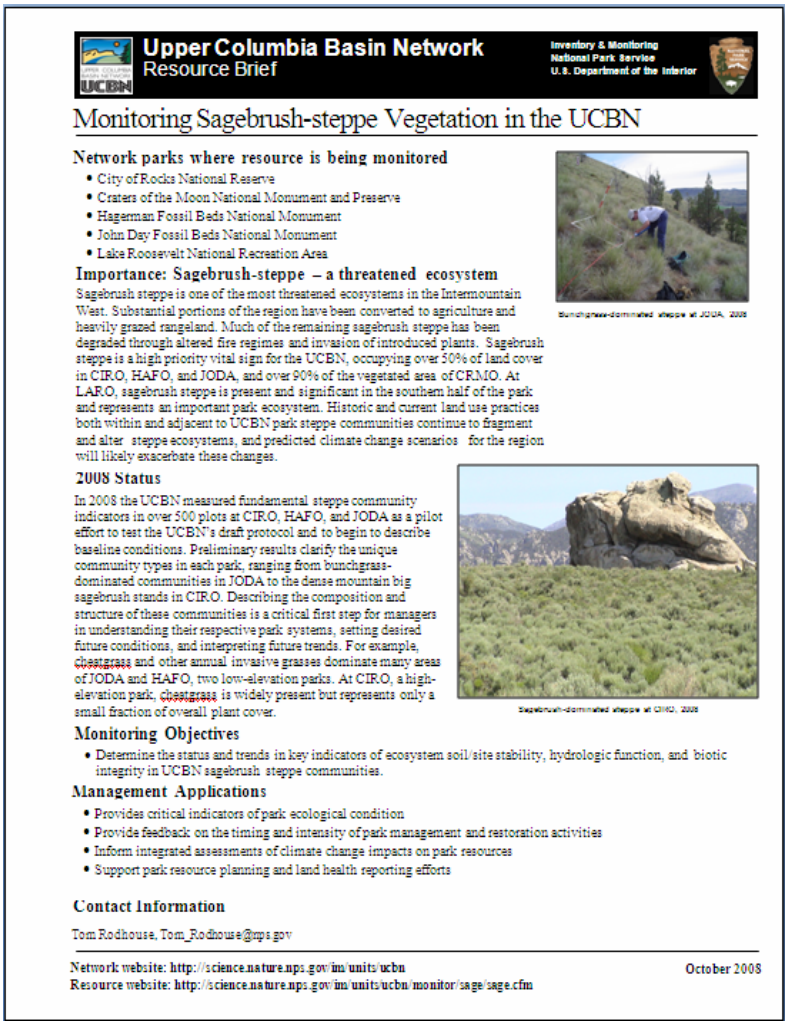
Reporting

A summary report will be produced after each year of data collection, with a more detailed report produced every 5 years. The annual report 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 results relative to management goals.
- Provide a summary table or "scorecard" for use in park reporting and resource stewardship strategies.
- 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.

An annual report was produced following the 2008 pilot season and can be used as a template to guide future reports (Rodhouse 2009). A 1-2 page resource brief will also be prepared from this annual report that will be provided to superintendents, park interpretive staff, and resource managers (Figure 16). The 2008 sagebrush monitoring resource brief can be used as a template

and is available at http://science.nature.nps.gov/im/units/ucbn/. A template for the resource brief is included in Figure 16. An NPS template for producing maps with ESRI ArcGIS or ArcView software is available at http://imgis.nps.gov/templates.html. Information from the annual summary report will also be provided to parks in time for park Government Performance Results Act (GPRA) goals reporting and for informing and evaluating park resource stewardship strategies. Table 7 presents an example status summary report of indicators for the Oregon Trail frame within HAFO from 2009 sample data. Figure 14 in the protocol narrative illustrates a graphical approach for displaying status estimates. Finally, invasive weed locations should be reported to the UCBN park resource managers immediately following completion of field activities. Reported information should include GPS locations and maps of locations with weeds present both within quadrats and as noted during travel between sampling locations.



Upper Columbia Basin Network
Resource Brief

Inventory & Monitoring
National Park Service
U.S. Department of the Interior

Monitoring Sagebrush-steppe Vegetation in the UCBN

Network parks where resource is being monitored

- City of Rocks National Reserve
- Craters of the Moon National Monument and Preserve
- Hagerman Fossil Beds National Monument
- John Day Fossil Beds National Monument
- Lake Roosevelt National Recreation Area

Importance: Sagebrush-steppe – a threatened ecosystem

Sagebrush steppe is one of the most threatened ecosystems in the Intermountain West. Substantial portions of the region have been converted to agriculture and heavily grazed rangeland. Much of the remaining sagebrush steppe has been degraded through altered fire regimes and invasion of introduced plants. Sagebrush steppe is a high priority vital sign for the UCBN, occupying over 50% of land cover in CIRO, HAFO, and JODA, and over 90% of the vegetated area of CRMO. At LARO, sagebrush steppe is present and significant in the southern half of the park and represents an important park ecosystem. Historic and current land use practices both within and adjacent to UCBN park steppe communities continue to fragment and alter steppe ecosystems, and predicted climate change scenarios for the region will likely exacerbate these changes.

2008 Status

In 2008 the UCBN measured fundamental steppe community indicators in over 500 plots at CIRO, HAFO, and JODA as a pilot effort to test the UCBN's draft protocol and to begin to describe baseline conditions. Preliminary results clarify the unique community types in each park, ranging from bunchgrass-dominated communities in JODA to the dense mountain big sagebrush stands in CIRO. Describing the composition and structure of these communities is a critical first step for managers in understanding their respective park systems, setting desired future conditions, and interpreting future trends. For example, cheatgrass and other annual invasive grasses dominate many areas of JODA and HAFO, two low-elevation parks. At CIRO, a high-elevation park, cheatgrass is widely present but represents only a small fraction of overall plant cover.

Monitoring Objectives

- Determine the status and trends in key indicators of ecosystem soil/site stability, hydrologic function, and biotic integrity in UCBN sagebrush steppe communities.

Management Applications

- Provides critical indicators of park ecological condition
- Provide feedback on the timing and intensity of park management and restoration activities
- Inform integrated assessments of climate change impacts on park resources
- Support park resource planning and land health reporting efforts

Contact Information

Tom Rodhouse, Tom_Rodhouse@nps.gov

Network website: http://science.nature.nps.gov/im/units/ucbn
Resource website: http://science.nature.nps.gov/im/units/ucbn/monitor/sage/sage.cfm

October 2008

Figure 16. The 2008 sagebrush steppe vegetation monitoring resource brief.

A more in-depth trend report will be produced every 5 years. 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 also evaluate 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 the monitoring protocol. For instance, does allocation of samples among parks appear to be adequate for all parks, are there new management concerns that might dictate some reallocation of effort or additions to the indicator metrics that are routinely examined annually, is the sampling time still appropriate, etc.

Annual reports and 5-year analyses of status and trend will use the NPS Natural Resource Publications Natural Resource Technical Report series template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Template guidelines and documentation of the NPS publication standards are available at the following address: http://www.nature.nps.gov/publications/NRPM/index.cfm.

Current versions of the protocol, resource briefs, and annual and 5-year technical reports will be made available on the UCBN website (http://science.nature.nps.gov/im/units/UCBN/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).

Table 7. Summary information for the sagebrush steppe vital sign in the Oregon Trail sampling frame of Hagerman Fossil Beds National Monument, 2009.

Current Condition - % Cover of Principal Species			
Species	Cover Range	Proportion (%)	± margin of error (%)
Artemisia tridentata (Big sagebrush - a principal native shrub)	0	81.3	±7.2
	1-5%	1.3	±2.2
	>5-25%	9.3	±5.8
	>25-50%	4.0	±3.9
	>50-75%	1.3	±2.1
	>75-95%	2.7	±3.2
Bromus tectorum (Cheatgrass – an invasive annual grass)	0	6.7	±4.9
	1-5%	2.7	±3.1
	>5-25%	16.0	±7.5
	>25-50%	20.0	±7.4
	>50-75%	21.3	±8.3
	>75-95%	29.3	±8.3
	>95%	4.0	±4.0
Poa secunda (Steppe bluegrass – a principal native grass)	0	38.7	±9.6
	1-5%	33.3	±9.1
	>5-25%	16.0	±7.1
	>25-50%	9.3	±5.6
	>50-75%	2.7	±3.2
Sisymbrium altissimum (Tumble mustard – an invasive annual forb)	0	70.7	±8.7
	1-5%	16.0	±7.4
	>5-25%	9.3	±5.6
	>25-50%	2.7	±3.3
	>50-75%	1.3	±2.2

Schedule for Sagebrush Steppe Monitoring Project Deliverables

Table 8. Schedule for sagebrush steppe monitoring project deliverables.

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Weed location data	Project Lead	Immediately and no later than 2 weeks after completion of field work	CIRO, CRMO, HAFO, JODA, LARO, UCBN Digital Library[1]
Raw data files	Field Lead	July 15 of the same year	UCBN Digital Library[1]
Photographs (select, quality images for long-term storage)	Project Lead	October 1	UCBN Digital Library[1]
Certified working database and geospatial data with draft metadata	Project Lead with Data Manager assistance	September 15	Master project database and GIS data sets, copy to UCBN Digital Library [1], and NR-GIS Metadata and Data Store[2]
Full metadata (parsed XML)	Data Manager	December 15	NR-GIS Metadata and Data Store[2], UCBN Digital Library[1]
Resource Brief	Project Lead	October 1	CIRO, CRMO, HAFO, JODA, LARO, UCBN Website
Annual report (NRTR publication)	Project Lead	January 15, following year	NatureBib[3], UCBN Digital Library [1], printout to local park collections, NRPS website[5]
Season close-out checklist	Project Lead	January 15, following year	Data Manager, Coordinator, and project directory
5-year analysis report	Project Lead	Every 5 years by January 15	NatureBib[3], UCBN Digital Library [1], printout to local park collections, NRPS website[5]
Other publications	NPS Lead, Project Lead, Data Manager	As completed	NatureBib[3], UCBN Digital Library [1], printout to local park collections

Table 8. Schedule for sagebrush steppe monitoring project deliverables (continued).

Deliverable Product	Primary Responsibility	Target Date	Destination(s)
Other records	NPS Lead and Project Lead	Review for retention every December	Retain according to NPS Director's Order #19 [4]

[1] The UCBN Digital Library is a hierarchical digital filing system stored on the UCBN file server. Network users have read-only 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). Only non-sensitive information is posted to NR-GIS Metadata and Data Store. Refer to the protocol section on sensitive information for details.
[3] NatureBib is the NPS bibliographic database (http://www.nature.nps.gov/nrbib/index.htm). This application has the capability of storing and providing public access to image data (e.g., PDF 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
[5] NPS Natural Resource Publication Management Website, available at: http://www.nature.nps.gov/publications/nrpm/.

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Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 8: Protocol Revision

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes the recommended protocol revision practices and provides a history and documentation of the protocol development and revision process.

Procedures

This monitoring protocol is an actively evaluated and updated document that reflects the latest procedures of the monitoring program. Revisions are expected, and can involve only minor changes with little overall impact or occasional major revisions and course corrections. Evaluation and revision of the protocol is directed by the project leader on an annual basis in association with season close-out. The narrative as well as each SOP has a revision history log whereby changes can be recorded. Older versions of the narrative and SOPs should be archived to ensure proper legacy of past work is maintained. Each revision will require the updating of the version number. Minor changes are recorded as decimal numbers (e.g. 1.0, 1.1, 1.2, etc…). Major changes are recorded as a change in the primary number of the protocol version (e.g. 1.0, 2.0, 3.0, etc…). In some cases, major revisions to the protocol may prompt the need for additional peer-review. The project lead and Network Coordinator will coordinate this with the Regional I&M Program Coordinator.

Development and Revision History Log

Table 9. Protocol development and revision history log. This table summarizes the major events leading to the development and revision of the UCBN sagebrush steppe vegetation monitoring protocol (version 1.0).

Date	Development Step	Documentation
February 2006	Begin protocol development with Dr. Nancy Huntly, though a CESU task agreement between NPS and Idaho State University	Task agreement available from UCBN
February 2006	Protocol Development Summary included with task agreement	PDS available from UCBN
March 2007	Incomplete protocol draft submitted	Huntly draft available from UCBN
May 2007	Receive unsolicited proposal from Dr. Jeff Yeo, consultant and former Idaho TNC science director, for development of long-term sagebrush steppe monitoring	Proposal available from UCBN
July 2007	Yeo contract initiated, and protocol development reinitiated	Contract information available from UCBN
Aug-Sept 2007	Field reconnaissance with Jeff Yeo, Tom Rodhouse, and Park resource staff	

Table 9. Protocol development and revision history log. This table summarizes the major events leading to the development and revision of the UCBN sage monitoring protocol (version 1.0) (continued).

Date	Development Step	Documentation
Sept-Dec 2007	Protocol development team assembled and contributes to protocol development; Yeo leads development	
January 2008	Revised protocol development summary completed	Attached to SOP # 8
January 2008	Final draft of CRMO photo plant ID guide provided by Nancy Huntly, Huntly task agreement completed	ID guide included in accompanying CD
January 2008	Complete draft protocol version 1.0, including SOPs 1-5, provided to UCBN by Jeff Yeo for review and revision	Draft available from UCBN
February 2008	Complete draft protocol version 1.0, including all SOPs, submitted for peer review to Drs. Penny Latham and Jim Agee.	Final draft available from UCBN
June 2008	Peer review comments provided to UCBN by Jim Agee	Comments available from UCBN
July 2008	Revision “roadmap” detailing proposed revisions provided to Jim Agee by UCBN	Roadmap available from UCBN
May 2009	Revised final draft protocol narrative and SOPs provided to Jim Agee for final review/approval	Final draft available from UCBN
June 2009	A protocol approval decision temporarily deferred until authors address an additional set of concerns presented by Jim Agee and Penny Latham	Comments available from UCBN
July 2009	An authors response to final comments provided to Jim Agee and Penny Latham	Response document available from UCBN
August 2009	Revised final protocol narrative and SOPs, formatted for publication in the NRR series, provided to Jim Agee and Penny Latham for final review/approval	Final draft available from UCBN

UCBN Protocol Development Summary

Protocol: Sagebrush-steppe Vegetation

Parks Where Protocol will be Implemented: JODA, CRMO, CIRO, HAFO, LARO

Justification/Issues being addressed:
The sagebrush-steppe region has undergone radical and extensive changes during the last 150 years (USDA Forest Service 1996, West and Young 2000, Bureau of Land Management 2002, Reid et al. 2002). Prior to European colonization, sagebrush-steppe covered approximately 44 million hectares of the intermountain west (West and Young 2000). Significant portions of the region have since been converted to agriculture and heavily grazed rangeland (West and Young 2000, Bunting et al. 2002). Much of the remaining sagebrush-steppe has been degraded through altered fire regimes and invasion of introduced plants (Reid et al. 2002). These changes have had significant impacts on the ecological condition of the sagebrush-steppe, including a decline in native flora and fauna, decreased soil stability, and reduced hydrologic function (Mack and D'Antonio 1998, Wisdom et al. 2000, Keane et al. 2002).

In the Upper Columbia Basin Network, sagebrush-steppe is the most extensive ecosystem type, occupying over 50% of land cover in CIRO, HAFO, and JODA. At CRMO, where bare lava rock comprises 81% of the total land cover, sagebrush-steppe represents over 90% of the existing vegetation cover. Sagebrush-steppe covers most of the southern half of LARO. The degradation of sagebrush-steppe resulting from biological invasion, altered fire regimes, and other stressors so widespread throughout the intermountain west has also occurred within UCBN parks. Historic and current land use practices both within and adjacent to UCBN parks continue to fragment and alter steppe ecosystems, and predicted climate change scenarios for the region will likely exacerbate these stressors (Smith et al. 2000, Wagner et al. 2003). Long-term vegetation trends from the Idaho National Engineering and Environmental Laboratory (INL) near CRMO provide substantial evidence of the importance of climate patterns on sagebrush-steppe vegetation dynamics (Anderson and Inouye 2001). Monitoring on the INL has demonstrated a multi-decadal plant community response to prolonged drought during the mid- 20th century that has important implications for management within the context of a changing climate.

The heterogeneity of sagebrush community types (i.e. alliances and associations defined by *Artemisia* subtaxa) in the UCBN present management challenges because community response to fire and drought, vulnerability to invasion, and potential for restoration and recovery can differ significantly between them (Reid et al. 2002; Bureau of Land Management 2002). Understanding these differences at the park level is critical for effective management strategies to be developed. This underscores the need for a long-term monitoring program that provides for periodic evaluation of the status of UCBN steppe communities and for identification of trends over time both within parks and across the network.

Tying network monitoring objectives to park management objectives is important to ensure that the monitoring program provides relevant information to managers. Specific management objectives related to sage-steppe plant communities have not been explicitly articulated at this

time. However, all of the parks addressed by this protocol share a common overarching management goal to maintain and restore native ecosystems and ecological processes. Plant invasion and shifting community composition and species abundance is the overarching concern for UCBN park managers. This protocol will be focused on this concern and will provide managers with the information necessary to evaluate progress in their activities related to maintaining and restoring native plant communities. However, it is equally important to recognize that shifting park management priorities and unanticipated ecological change over the life of the monitoring program require a generalized and flexible protocol with a design that can accommodate these changes. This protocol will attempt to balance these potentially competing short-term and long-term needs.

Specific Monitoring Questions and Objectives to be Addressed by the Protocol:

Monitoring questions that will be addressed by this protocol include:

- What are the status and trends in abundance of principal native plant species in UCBN sagebrush steppe communities?
- What are the status and trends in abundance of principal invasive plant species in UCBN sagebrush steppe communities?
- Do status and trends differ among community types?
- What are the trends in the fundamental rangeland health indicators of soil/site stability?
- How is the composition of principal plant species changing over time in UCBN sagebrush steppe communities?
- Are the trends observed in sagebrush steppe communities principally correlated with trends in weather and climate?

Monitoring objectives that will be addressed by this protocol include:

- Determine the status and trends in key indicators of ecosystem soil/site stability, hydrologic function, and biotic integrity in UCBN sagebrush steppe communities.
- Determine the status and trends in the frequency of occurrence and cover of principal native and exotic grasses, forbs, shrubs, and conifer trees in UCBN sagebrush steppe communities.

The following sampling objectives have been developed to guide power analyses and focus attention on desired programmatic capabilities:

- Detect a $\pm$ 35% multiplicative change over 10 sampling events (20 years; approximately 4% per event rate of change) in the frequency of occurrence of target plant species for each discrete UCBN sagebrush steppe monitoring study area with 90% power and 10% acceptable false change (α) error.
- Detect a non-trivial change (i.e., when $\pi > 0.5$) over 10 sampling events (20 years) in the likelihood (probability) of ordinal cover, forb richness, and soil/site stability indicators shifting between ranks ≤ 2 and ≥ 3 with 90% power and 10% acceptable false change (α) error.

- Detect a 25% increase over 10 sampling events (20 years) in the density of juniper and pinyon pine with 90% power and 10% acceptable false change (α) error.

Basic Approach:
Monitoring large landscapes poses unique challenges that require compromises among (1) the accuracy and precision of measurements needed to detect meaningful change, (2) the large sample sizes and extensive sampling required to reflect the high natural variability found across these ecosystems, and (3) the logistical constraints posed by rugged and often inaccessible terrain. As a result, our criteria for selecting a design for long-term monitoring are:

- An efficient response design that permits rapid measurements thus allowing for large sample sizes and good dispersion of sample units.
- Rapid quantification of principal indicators of rangeland health with sufficient precision to detect meaningful community change.
- Accessible and easily learned field methods that will be consistently applied among observers.

Peet et al. (1998) also identify several additional criteria that we also subscribe to, including one of "open architecture". We think this is particularly important for long-term studies subject to unanticipated future uses and modifications, and will be a hallmark of our particular design approach. This protocol is intended to provide park managers with "actionable intelligence" on the status and trends in park sagebrush steppe ecosystem conditions, and early warning of large and potentially catastrophic functional changes. Sampling design development is an exercise in cost-benefit trade-offs, and given the large and highly variable steppe landscapes in the UCBN, we will place a premium on obtaining large and truly representative samples and accept trade-offs in terms of precision and detectable effect size.

The protocol will be based on well recognized models of sagebrush steppe responses to disturbances, such as fire, grazing, invasive species, and drought. The National Research Council (1994) recommended key attributes of rangelands that should be the basis for monitoring rangeland condition and trend. Subsequent to these recommendations, Pellant et al. (2005), Pyke et al. (2002), O'Brien et al. (2003), and Herrick et al. (2005) developed assessments using specific attributes that are key indicators of rangeland condition. This protocol will monitor the core suite of those attributes:

- Ordinal ranked soil surface indicators of erosion: soil movement, surface litter movement, soil pedestals, rills, and gullies
- Cover of bare ground
- Frequency and cover of *Artemisia* species
- Frequency and cover of key native bunchgrasses
- Frequency and cover of native forbs in 2 categories: upright perennials and cushion perennials
- Native forb richness and dominant native forb species
- Frequency and cover of cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*)

- Frequency and cover of crested wheatgrass (*Agropyron cristatum*)
- Frequency and cover of established non-native invasive forbs
- Density of single-leaf pinyon pine (*Pinus monophylla*) and juniper (*Juniperus spp.*)

These indicators are readily measured and address our objectives for monitoring soil stability, biotic integrity, and hydrologic function.

No existing sagebrush-steppe monitoring protocol is currently available for adoption from the NPS or other relevant organizations. The UCBN sagebrush-steppe vegetation monitoring protocol will be developed following NPS I&M standards as outlined by Oakley et al. (2003). A probabilistic sampling design will be developed that balances the need for maximum scope of inference and statistical power with logistical and financial efficiency. Sampling methods will be adopted that support these criteria, following techniques established in the literature (Herrick et al. 2005; Elzinga et al. 2001). Power analysis and sample size requirements will be calculated *a priori* for frequency trend using an approach for generalized linear models developed by Lyles et al. (2007). Lessons learned from long-term monitoring at the INL and other programs underscore the need for an efficient and flexible protocol that will accommodate the revisions and adjustments necessary to sustain this program over many decades. It is expected that the protocol sampling design and field methods will be refined during several years of implementation and protocol testing following peer-review.

Principal Investigators and NPS Lead:
Principal Investigator: Dr. Jeff Yeo, consultant and former Idaho science director for TNC, 208-544-7616; NPS Project Lead: Tom Rodhouse, UCBN Ecologist, 541-318-3726.

Development Schedule, Budget, and Expected Interim Products:
The P.I. and NPS UCBN staff will produce a draft monitoring protocol ready for external peer review by February 2008. After peer review and revision, the protocol will by tested in 2008-2009 and a final protocol will be complete by November 1, 2009. We have budgeted $16,000 for FY 2007 for protocol development and $42,500 for FY 2008 for protocol testing and revision. The annual operating budget for sage monitoring in the UCBN is estimated to be $49,000 beginning in 2009. This figure includes UCBN staff time and travel, as well as field personnel, equipment, housing, and vehicles.

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Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 9: Field Safety

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This SOP describes recommended safety practices and emergency contact information.

Introduction and Objectives

Encountering hazardous situations is inherent in sagebrush steppe vegetation monitoring activities, and all staff persons need to be aware of these risks and take adequate precautions. A primary goal of the UCBN is to ensure the safety of its staff and associates while conducting inventory and monitoring activities in parks. Risks include working alone in rugged and isolated environments, long driving trips between Parks and Network offices, backcountry roads and trails, hiking over rough terrain, extreme weather and hazardous fire conditions, and traversing steep slopes and cliffs. Job Hazards Analyses have been prepared for driving and for sagebrush steppe vegetation monitoring field work, and these will be updated and reviewed each year by all field staff. This is a fundamental step in building operational leadership capacity in the UCBN I&M Program. Emergency contact information is provided in the Field Reference Manual, and first aid kits and 2-way radios are provided to field teams. Cell phones should be carried in vehicles, when available, although coverage is spotty in most UCBN park areas. UCBN evacuation instructions and medical information for each UCBN staff person and associate conducting field work will be provided to field leads and carried in the primary field vehicle along with the vehicle first aid kit.

Risks Inherent in Sagebrush Steppe Vegetation Monitoring

Inherent risks associated with monitoring sagebrush steppe vegetation in the UCBN include:

Working alone – Field staff will often work alone when traveling to and from remote sites and when sampling vegetation in the field. Field staff will operate in teams of two whenever possible, but will sample locations independently. As a result, particular attention must be given to safety and communication. Team members must make an extra effort to work within sight and earshot of one another. Regular radio checks are required when this is not feasible.

Long road trips – Travel between parks will require long road trips under varied weather and road conditions. It is incumbent upon field staff to drive responsibly, and to monitor fatigue while driving. Pull over to rest when necessary!

Backcountry roads and trails – Accessing sample sites will require travel on secondary roads that are graveled or dirt, and some sites require hiking. In CRMO, access to sample sites is extremely difficult, remote, and requires overnight camping. Many CRMO roads are not maintained. High vegetation growing up through roads can block view of lava rocks which can damage vehicles. A damaged vehicle could lead to a life-threatening situation if the vehicle cannot be driven out and no communication to call for help is available (e.g., no cell phone coverage, no radio contact). Vegetated jeep roads can also pose serious fire hazards when driving over them with hot vehicles. Late season access, which could begin as early as June in some drought years, may be prohibited if fire risk is too high. Fire protection equipment must be maintained in working condition and be available in work vehicles at all times. It is incumbent upon field staff to maintain regular contact with Park staff to review developing hazards.

Activities during sampling – Vegetation sampling will require hiking over rugged and steep terrain. While an effort has been made to reduce exposure to unsafe terrain with restricted sampling frames, exposure to some unsafe terrain is unavoidable. It is incumbent upon field

personnel to make conservative decisions and choose safest routes possible to access sampling areas. This may require longer travel times in order to circumvent risky terrain. This may reduce the number of quadrats sampled in a day. Safety is more important than productivity, and the UCBN does not want the drive to complete plots to cloud good judgement. In other words, stay alert and take it easy out there! Proper field gear, including good footwear, long pants, sun and rain protection, adequate food and water, will help mitigate many of the risks encountered in the field.

Varied weather conditions – The UCBN region is characterized by weather conditions that vary considerably through the seasons, day-to-day, and even hour-by-hour. Snow and rain, wind and freezing temperatures can occur during field operations, particularly during early spring sampling. More commonly, heat is a problem and temperatures may frequently be above 100°F. As a result, field work requires preparation for this range of conditions. Hypothermia and heat-related injury are possible and occasional discomfort is certain. Extreme weather can contribute to fatigue and increase the risk of injury from falls.

Weather and Field Gear

Field work in UCBN parks can bring with it challenging weather extremes. Cold rainy weather can be encountered in July, and extremely hot weather encountered in May. It is essential to the success of the program that all UCBN staff persons and associates working on sagebrush steppe monitoring projects are well prepared for weather extremes. Good rain gear, warm clothes, sunhats, sunscreen, and mosquito repellant are essential. In 2006, Idaho emerged as a "hot spot" for West Nile Virus, and numerous cases of human infection and illness caused by this mosquito-borne virus were reported. The U.S. Center for Disease Control website for this disease contains up-to-date information on location of outbreaks and prevention tips. The web address is as follows:
http://www.cdc.gov/ncidod/dvbid/westnile/
Lightweight long-sleeve clothing can be helpful, and mosquito repellant is a must!

Safety Precautions

UCBN sagebrush steppe parks are extremely rugged and remote. Steep slopes and cliffs, and broken lava expanses are routinely encountered. While sampling frames exclude slopes over 30^{o}, these areas will need to be traversed when traveling between sites. Conservative decision making is imperative. An injury, even a minor one, could cause a substantial interruption in field schedules and overall monitoring program progress. Minor injuries can become serious life-threatening incidents if complications such as cold weather and long distances back to a vehicle are present. Be prepared! Field schedules, particularly when long travel distances are involved, often end after normal working hours. Upon arrival and check-in at each park, establish a clear procedure of communication between UCBN teams and park staff. Cell phone coverage at park sites is intermittent and should not be relied upon in case of an emergency. Arrange to call a primary park contact, even at home, upon safe return in the evening, particularly at Craters of the Moon, where extreme distances, the remoteness of the park, and hazardous terrain combine into a serious safety issue. Park radios may be issued, particularly at CRMO and JODA, as a means for field personnel to be able to contact the park, or, after hours, a BLM or Forest Service dispatch office in case of serious emergency. Check with park contacts for radio availability and use procedures.

Emergency Contact Information

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. This will be particularly important since UCBN field staff will often work alone. A routine will be established where UCBN field staff will contact park staff to notify them of the time and location of work in each park using email or other written forms of communication. In addition, it is advisable to leave a written travel plan with UCBN staff or other NPS staff. This plan should include the time and location of work and return times. National Park Service park managers and UCBN staff should be notified if plans have been modified. Table 10 contains emergency and field operations contact information for each park; a similar list will be included in the Field Reference Manual. UCBN field staff may obtain a field radio programmed for the applicable radio frequencies used by each park and BLM/USFS district where they will be working. Cell phones should be carried when working in parks with adequate cell phone coverage.

Table 10. List of park contacts and emergency information for field operations.

Park		Name	Telephone
CIRO			
	CIRO Visitor Center		208-824-5519
	Resource Manager – CRSP Office	Vacant	208-824-5757
	Superintendent	Wallace Keck	208-824-5519 X 101
	Park Climbing Ranger – CRSP Office	Brad Shilling	208-824-5757
	Emergency		
		Cassia Regional Medical Center	208-678-4444 Or 911
		Cassia County Sheriff's Office	208-878-1107 Or 911
CRMO			
	Integrated Resource Program Manager	John Apel	208-527-3257 X 501
	Ecologist	Steven Bekedam	208-527-3257 X 505
	Superintendent	Doug Neighbor	208-527-3257
	Emergency		
		Lost Rivers District Hospital - Arco	208-527-8206 Or 911
		Butte County Sheriff's Office	208-527-8553 Or 911
HAFO			
	Superintendent	Wendy Janssen	208-837-4793 X 5222
	HAFO Geologist / Paleontology	Phil Gensler	208-837-4793 X 5237
	Park Ranger	Stephanie Martin	208-837-4793 X 5227
	Emergency		
		Gooding County Mem. Hospital	208-934-4433
		Gooding County Sheriff's Office	208-934-4421 Or 911
		Hagerman Police Department	208-934-4421 Or 911
JODA			
	Integrated Resource Manager	Shirley Hoh	541-987-2333
	Clarno Ranger	John Laing	541-763-2203
	Painted Hills Ranger	Scott Ritner	541-462-3961
	JODA Superintendent	Jim Hammett	541-987-2333 X xxx
	Emergency		
	Sheep Rock Unit-John Day River and Rock Creek	Blue Mountain Hospital	541-575-1311
	Painted Hills – Bridge Creek	Pioneer Memorial Hospital	541-447-6254
	Sheep Rock Unit-John Day River and Rock Creek	Grant County Sheriff's Office	541-575-1131
	All Units	Wheeler County Sheriff's Office	541-763-4101

Table 10. List of park contacts and emergency information for field operations. (continued).

Park		Name	Telephone
LARO			
	Chief Of Compliance and Natural Resource Management	Jerald Weaver	509-633-9441 X 128
	Chief Ranger	Margaret Goodro	509-633-9441 X 123
	District Ranger	Chris Rugel	509 633-3830 X32
	Emergency		
	Stevens County		
		Stevens County Sheriff's Office	509-684-5296 Or 911
		Kettle Falls Police Department	509-738-6700 Or 911
		Mount Carmel Hospital - Colville	509-684-2561
		St Joseph's Hospital - Chewelah	509-935-8211
	Lincoln County		
		Lincoln County Sheriff's Office	509-725-3501 Or 911
		Lincoln Hospital - Davenport	509-725-7101
	Ferry County		
		Ferry County Sheriff's Office	509-775-3136 Or 911
		Coulee Community Hospital-Grand Coulee	509-633-1753
	Okanogan County		
		Coulee Dam Police Department	509-633-1234 Or 911
		Okanogan County Sheriff's Office	509-422-7200 Or 911
		Coulee Community Hospital-Grand Coulee	509-633-1753
	Grant County		
		Grand Coulee Police Department	509-633-1411 Or 911
		Grant County Sheriff's Office	509-754-2011 Or 911
		Coulee Community Hospital-Grand Coulee	509-633-1753

Job Hazard Analysis

The UCBN sagebrush vegetation monitoring project lead will, in conjunction with his/her supervisor (and, if appropriate, other knowledgeable persons), develop a Job Hazard Analysis (JHA) of the task to be performed within each park. At the beginning of each sampling season all personnel will review the appropriate JHA and make modifications as necessary. The procedure to be used for writing a JHA is presented in NPS Reference Manual #50B, Occupational Safety and Health Program. (NPS 1999).

Table 11. Suggested topics to be addressed in the Sagebrush Steppe Vegetation Monitoring Job Hazard Analysis.

General Job Activity	Basic Job Step	Potential Hazards
All Field Activities	Environmental Conditions	Temperature and Sun Exposure
		Adverse Weather (rain, snow, lightning and wind)
		Hazardous Animals, Plants, People
Accessing Sites	Highway Driving	Varied Road Conditions Fatigue Behavior of other Drivers Animals and other Obstructions
	Driving on Unimproved Roads	Rough and Vegetated Roads
		Muddy Roads
		Fire Ignition During Dry Weather
		Narrow Roads with Poor Visibility
	Hiking	Steep/Slippery Terrain, Rocky Slopes

2009 Job Hazards Analysis for UCBN Sagebrush Steppe Vegetation Monitoring

Job Hazard Analysis

UCBN Sagebrush Steppe Vegetation Monitoring Program

U.S. Department of Interior National Park Service	**WORK PROJECT/ACTIVITY UCBN Sagebrush Steppe Vegetation Monitoring**	**LOCATION: Upper Columbia Basin Network**	**UNIT: CIRO, CRMO, HAFO, JODA, LARO**
JOB HAZARD ANALYSIS (JHA)	**DEVELOPED BY Tom Rodhouse**	**JOB TITLE UCBN Ecologist/Sage Project Lead**	**DATE PREPARED 21 April 2009**

APPROVED BY:
DATE:

Required and/or Recommended Personal Protective Equipment:

Sturdy hiking boots
Long pants
Warm clothing / hat
Rain gear
Sun hat
Sunscreen
Sunglasses
Personal water bottles
Food
First Aid Kit
Park radio
Compass / GPS Unit
Maps
Emergency contact information/Field Reference Manual

TASKS/PROCEDURES	HAZARDS	ABATEMENT ACTIONS
		All people (permanent, seasonal, VIPs) involved in any project should receive a general orientation and tailgate safety session specific to the task prior to beginning of work.
1. Driving to and from remote field sites	1a. Narrow roads with bumpy or "washboard" surfaces	WEAR SEATBELTS AT ALL TIMES WHEN VEHICLE IS MOVING 1a. Maintain a safe speed (this if often below the legal speed limit) for the road conditions; stay clear to the right, especially on curves, drive with headlights on at all times; when turning around on mountain roads always "face the danger"(versus backing toward the cliff edge, e.g.); the passenger should get out and spot for driver when backing up.
	1b. Driving with limited visibility	1b. Maintain windshield cleaner fluid level and clean both sides of windows regularly (remember back window); slow down; if blinded by sun or dust, proceed slowly or pullover and wait for hazard to pass; keep to the right hand side of the road and drive with your lights on.

TASKS/PROCEDURES	HAZARDS	ABATEMENT ACTIONS
	1c. Sharp rocks on edge or in middle of road	1c. Get out and move sharp rocks out of the way, reduce speed substantially in places with large amounts of rockfall; make sure tires are properly inflated and check tread and walls regularly for damage; make sure tire jack fits the vehicle and all parts are in the vehicle.
	1d. Large animals crossing or standing in roads	1d. Slow down where animals might be present to allow for reaction time; do not swerve abruptly to avoid hitting an animal, if necessary it's better to ride out the impact.
	1e. Fatigue at night and after a long shift in the field	1e. Be aware of signs of fatigue- pull over and rest! Take a short nap, eat a snack or have a partner drive; do not take chances by continuing to drive; communicate with your field partner.
	1f. Storm conditions – wind, lightning, muddy/ slippery roads	1f. Keep informed on the current weather- check www.weather.com or www.wrh.noaa.gov; if winds exceed 15 mph, or the excessive wind category on Beaufort scale (tree tops swaying, twigs and leaves falling, etc.), do not travel into the field; avoid going to the field if lightning is present and avoid using radios; drive slowly when roads are muddy and slippery or snow covered, check with park staff if you are uncertain of back road conditions; avoid wet clay roads as much as possible, these roads can fail after storms, especially in spring, maintain a slow speed when driving on these roads!; if you damage waterbars make sure you repair them immediately.
	1g. Fallen trees on road	1g. For small trees, try and remove tree or cut with a handsaw and remove portion of tree; for large trees, notify support crew to remove tree.
	1h. Others driving on the road	1h. Do not assume you are the only one on the road behind locked gates(day or night), people from other agencies use these roads; be alert to the idea that others may be coming in from the field in the early a.m. - drive slow and keep right!; if you encounter an unusual situation, contact your partner to inform and notify the supervisor or park ranger- avoid confrontational situations with visitors- let the proper authorities handle it!

TASKS/PROCEDURES	HAZARDS	ABATEMENT ACTIONS
	1i. Wildfire ignition from vehicle undercarriage/catalytic converter	1i. Track fire hazard warnings from Park and other agencies; Obey road closures, such as occur in late summer at CRMO when fire hazards are extreme; Avoid driving over vegetated two-track roads whenever possible; constantly monitor accumulated vegetation underneath, and watch behind for smolder; ALL UCBN VEHICLES MUST HAVE BASIC FIRE PREVENTION AND EXTINGUISHING EQUIPMENT AT ALL TIMES!
2. Communication	2a. Loss of contact with field partner(s)/team member(s)	2a. Make sure radios are charged and on the correct channel. Use cell phone (if available and coverage), as this may be more reliable for communication in remote locations. Establish regular contact/meeting times where failure to contact triggers emergency procedures. Clearly establish triggers for emergency procedures, avoid false alarms.
	2b. Unable to reach a radio repeater in a remote location	2b. Make sure radio is charged- try to contact someone on the radio to inform him/her of your predicament; if you are unable to reach a repeater from your location climb upslope toward a ridgetop or knoll and try again; try at regular intervals, meandering around may help in getting a signal; Use cell phone in vehicle (if available), as this may be more reliable for communication in remote locations.
3. Hiking	3a. Steep, rugged, and slippery terrain	3a. Assess terrain conditions to find safe route and modify sampling plans to avoid unsafe areas; proper footwear is VERY important- wear boots with slip-resistant soles with tops well above the ankle, broken in before the field season, plus extra socks, NO TENNIS SHOES or open toed sandals; maintain an erect posture when contouring steep slopes; avoid walking below another person due to the potential for rocks to dislodge from above
	3b. Undergrowth	3b. Wear safety glasses (or other glasses) when hiking in brushy areas to protect eyes from protruding objects.
	3c. Rocks/climbing	It is likely that hiking may occur over large or steep rocks, broken lava terrain. Vertical climbing should be avoided unless outfitted with proper rock climbing gear. Follow procedures in 3a. for travel across lava.
	3d.Crossing fences	It is likely that multiple fences will be crossed during the course of work. When possible use gates (leave them open or closed depending on how you find them) if no gate is available cross under or over with caution.

TASKS/PROCEDURES	HAZARDS	ABATEMENT ACTIONS
4. Encountering noxious plants, animals, disease, and people	4b. Bees/Wasps/Hornets	4b. Determine if any field crew are allergic to bee stings. Notify other crew members and the supervisor if you know you are allergic to bee stings; ensure that individual carries prescribed medication to prevent anaphylactic shock; carry a bee sting kit or Benadryl or other antihistamine; be aware of the ground where you step- some hornets build nests in the ground at the base of trees or shrubs, or in rotten logs- watch for bees buzzing in and out of holes or around ground level; if possible, flag a nest so future surveyors won't run into it;
	4c. Ticks	4c. If bitten by a tick, remove it (grasp tick with tweezers at head and pull straight out); fill out an accident report in the event that symptoms of Lyme disease appear (red bull's eye rash);
	4d. Scorpions	4d. Inspect items left lying on the ground, e.g., clothing, for scorpions prior to putting them on, especially after camping
	4e. Mosquitoes	4e. Wear bug repellent and long sleeve shirt to prevent bites; be aware of West Nile Virus symptoms.
	4f. Rattlesnakes	4f. Avoid rattlesnakes by inspecting the ground near logs before stepping over them; avoid placing hands on rock ledges or other natural hoists without visually inspecting them first; in the unlikely event you're bitten by a rattlesnake, stay calm, sit still, and call and wait for help.
	4g. Mountain lions	4g. Avoid mountain lions; if you encounter a lion that doesn't run from you- leave the area; if attacked- fight back!
	4h. Disease (bubonic plague and Hanta Virus)	4h. Stay away from dead rodents and rodent feces, especially in closed buildings.
	4i. Encounters with strangers	4i. Report uncomfortable encounters with strangers in the park to a supervisor as soon as possible; report apparent illegal activity to a park ranger, do not get into a confrontation with visitors in the park.
5. Exposure to environmental variables	5a. Treatment of general injuries	5a. All NPS field staff and contractors should have current first aid and CPR certification.

TASKS/PROCEDURES	HAZARDS	ABATEMENT ACTIONS
	5b. Hypothermia	5b. Always anticipate bad weather and dress accordingly, or carry warm clothes with you; keep clothing as dry as possible; use synthetic fleece and non-cotton outdoor clothing in inclement weather; eat high energy nutritional supplements between meals; cover the head and neck to prevent heat loss; keep active to maintain the body's metabolism; drink plenty of liquids to prevent dehydration, although an individual does not "feel" thirsty; drink warm liquids not cold; understand the effects of cold and wind; most hypothermia cases develop between 30°F and 50°F.
	5c. Hyperthermia	5c. Hyperthermia may occur during high temperatures, monitor for dehydration, heat exhaustion, heat cramps, and heat stroke; symptoms include nausea, headache, and flushed, red skin; drink plenty of water (even when you are not thirsty); as heat increases, take frequent breaks in cool locations; wear a light shirt.
	5d. Giardia	5d. Giardia is caused by drinking contaminated water- carry plenty of water on outings; also carry water treatment tablets; consider all streams contaminated.
	5e. Sunburn	5e. Field work takes place in full sunlight so use 30+ or greater SFP sunscreen and lip balm; and wear a hat, sunglasses, and shirt.

HA Instructions

The JHA shall identify the location of the work project or activity, the name of employee(s) involved in the process, the date(s) of acknowledgment, and the name of the appropriate supervisor approving the JHA. The supervisor acknowledges that employees have read and understand the contents, have received the required training, and are qualified to perform the work project or activity.

Identify all tasks and procedures associated with the work project or activity that have potential to cause injury or illness to personnel and damage to property or material. Include emergency evacuation procedures (EEP).

Identify all known or suspect hazards associated with each respective task/procedure listed. For example:

a. Research past accidents/incidents.
b. Research the Health and Safety Code, or other appropriate literature.
c. Discuss the work project/activity with participants.
d. Observe the work project/activity.
e. A combination of the above.

Emergency Evacuation Instructions

Work supervisors and crewmembers are responsible for developing and discussing field emergency evacuation procedures (EEP) and alternatives in the event a person(s) becomes seriously ill or injured at the worksite.

Be prepared to provide the following information:

a. Nature of the accident or injury (avoid using victim's name).
b. Type of assistance needed, if any (ground, air, or water evacuation).
c. Location of accident or injury, best access route into the worksite (road name/number), Identifiable ground/air landmarks.
d. Radio frequencies.
e. Contact person.
f. Local hazards to ground vehicles or aviation.
g. Weather conditions (wind speed & direction, visibility, temperature).
h. Topography.
i. Number of individuals to be transported.
j. Estimated weight of individuals for air/water evacuation.

The items listed above serve only as guidelines for the development of emergency evacuation procedures.

Identify appropriate actions to reduce or eliminate the hazards identified. **Abatement measures listed below are in the order of the preferred** **abatement method:** **a. Engineering Controls (the most desirable method of abatement).** **For example, ergonomically designed tools, equipment, and Furniture.** **b. Substitution. For example, switching to high flash point, non-toxic** **solvents.** **c. Administrative Controls. For example, limiting exposure by reducing** **the work schedule; establishing appropriate procedures and practices.** **d. PPE (least desirable method of abatement). For example, using hearing** **protection when working with or close to portable machines (chain saws, rock drills, and portable water pumps).** **e. A combination of the above.** **Copy of the JHA as justification for purchase orders when procuring PPE.**	**JHA and Emergency Evacuation Procedures Acknowledgment** **We, the undersigned work leader and crewmembers, acknowledge participation in the development of this JHA (as applicable) and accompanying emergency evacuation procedures. We have thoroughly discussed and understand the provisions of each of these documents:** **PRINT NAME** **SIGNATURE** **DATE** _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

Sagebrush Steppe Monitoring Protocol

Standard Operating Procedure (SOP) 10: Field Reference Manual

Version 1.0, August 2009

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	Page #'s affected	New Version #

Note: This frequently updated SOP serves as the location and assembly mechanism for developing Field Reference Manuals for each UCBN sagebrush steppe crew member. It includes current field form, sample maps, UTM coordinates for sampling locations in the GRTS sequential order, ocular cover guides, plant lists, and other vital information not already presented in previous SOPs. While plant lists exist for each park in the NPSpecies database, we have used results from 2008 and 2009 to develop focused species lists based on actual encounters in quadrats. Contents of the manual should include:

A sturdy ring-bound Field Reference Manual that easily fits into a daypack will be provided to each field technician with the following:

- Field data entry form
- Sampling frame/photo coding reference guide
- Sampling route maps identifying clusters of proximal sample points, access locations, and other key travel information (e.g., Figure 17)
- Visual cover estimation guide
- DataPlus quick reference guide
- Quadrat add/drop procedures
- Park sagebrush steppe monitoring plant species lists
- Emergency contact information
- Field-relevant SOPs (SOP # 1-5)
- Rite-in-the-Rain note paper

UCBN Sagebrush Steppe Monitoring Field Form – 2010

Park Unit:_____ Sample Frame ID:_____ Quad ID No (000):_____

Observer:_____ Date (mmddyyyy):_____

Indicator:	**Cover:**
Bare Ground	
Big Sagebrush	
Other Sagebrush:_____	
Other Shrubs:_____	
Other Shrubs:_____	
Other Shrubs:_____	
Perennial Native Grass:_____	
Perennial Native Grass:_____	
Perennial Native Grass:_____	
Perennial Native Grass:_____	
Persistent Native Forb:_____	
Persistent Native Forb:_____	
Persistent Native Forb:_____	
Persistent Native Forb:_____	
Persistent Native Forb:_____	
Persistent Native Forb:_____	
Other Native Forb:_____	
Other Native Forb:_____	
Other Native Forb:_____	
Other Native Forb:_____	
Other Native Forb:_____	
Invasive Grass:_____	
Invasive Grass:_____	
Invasive Grass:_____	
Non-native Forb:_____	
Non-native Forb:_____	
Non-native Forb:_____	
Non-native Forb:_____	
Non-native Forb:_____	

0 = 0% cover
1 = 1 – 5% cover
2 = >5 – 25% cover
3 = >25 – 50% cover
4 = >50 – 75% cover
5 = >75 – 95% cover
6 = >95% cover

Comments:

Sampling Frame/Photo Coding Reference Guide

Refer to Table 12 for sampling frame names and codes for DataPlus datasets (frames). CRMO frames currently number from 1-35, and should be coded as shown in Table 12. Quadrats with photos should have the auto-generated camera number entered in the Notes field. Upon downloading photos to the project laptop, photos files should be named as follows: Park_Frame_Year_Quadrat.

Table 12. Sampling frames and DataPlus codes.

Park/Frame	Frame Code		
CIRO	Sage	Mesic Grass	Xeric Grass
CIRO-Bath Rock	CIROBR		
CIRO-Circle Cr. South	CIROCS		
CIRO-Circle Cr. North	CIROCN		
CIRO-Emery Cyn.	CIROEC		
CIRO-Tracy Lane	CIROTL		
CIRO-Kempton	CIROKE		
CIRO-Trail Cyn.	CIROTC		
CRSP			
CRSP-West	CRSPWE		
CRSP-South	CRSPSO		
CRSP-North	CRSPNO		
CRMO*	CRMO1-CRMO35		
HAFO			
HAFO-North	HAFONO		
HAFO-South	HAFOSO		
HAFO-Upper Bench	HAFOUP		
HAFO-Pump Station	HAFOPS		
HAFO-Oregon Trail	HAFOOT		
JODA			
Clarno	CLASAG	CLAMES	CLAXER
Painted Hills	PHSAG	PHMES	PHXER
Foree	FORSAG	FORMES	FORXER
Sheep Rock East	SRESAG	SREMES	SREXER
Sheep Rock West	SRWSAG	SRWMES	SRWXER
LARO			
Coulee Dam	LARCD		
Spr Cyn West	LARSCW		
Spr Cyn East	LARSCE		
Point	LARPT		
Bay	LARBAY		
Ponderosa	LARPON		

Park Sampling Frame Map and Sample Routes

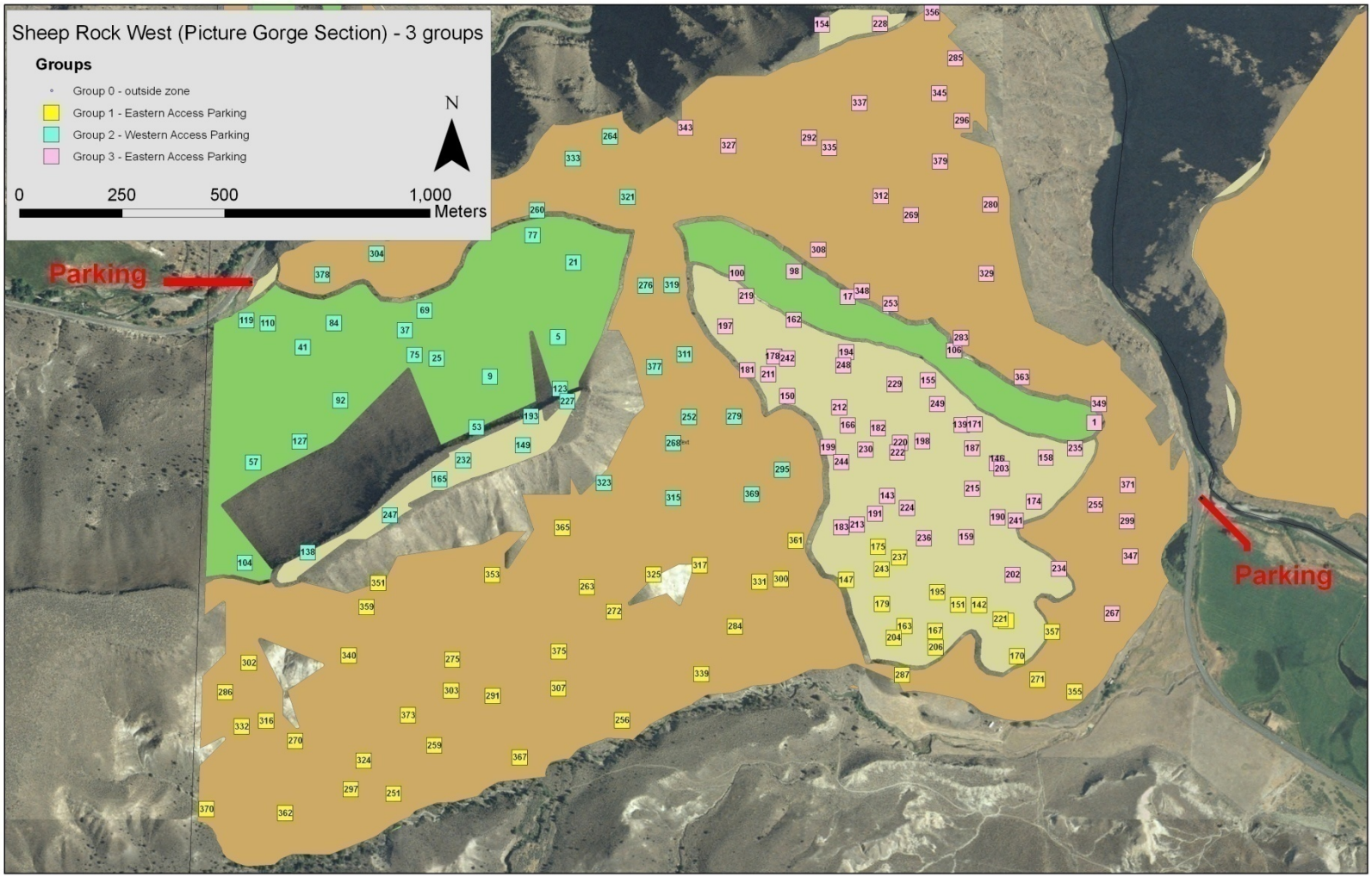

Figure 17. 2009 Sample route map for southern section of Sheep Rock West with 3 groups (approximately 2.5 days of sampling for 2 observers).

Cover Estimation Guide

Quadrat Layout and Cover Cues:

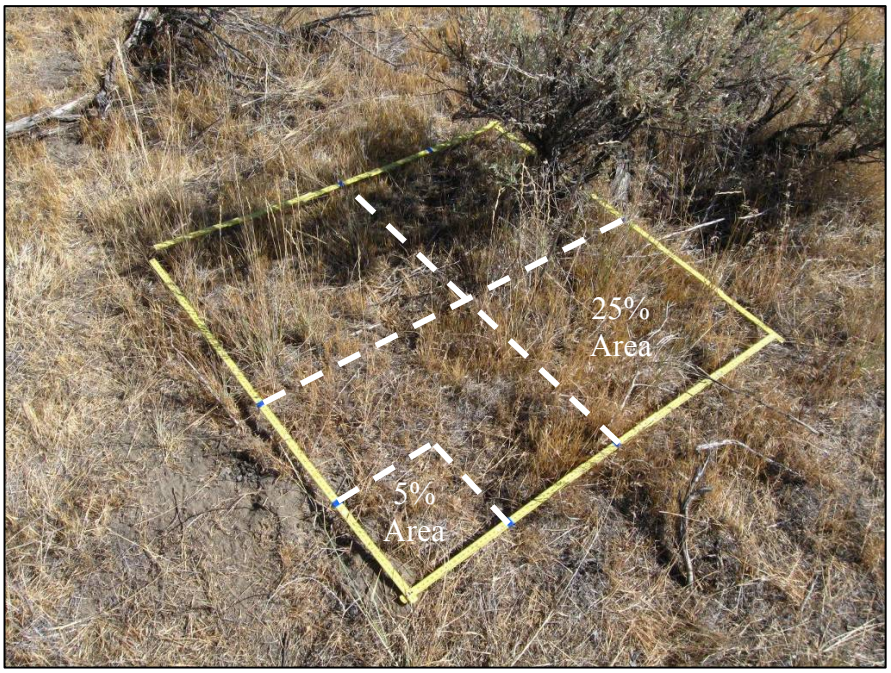

Figure 18. Layout of cover estimation quadrat using folding 2-m rulers. Markers on the rulers provide visual cues delineating 5% and 25% of the quadrat area (white dashed lines).

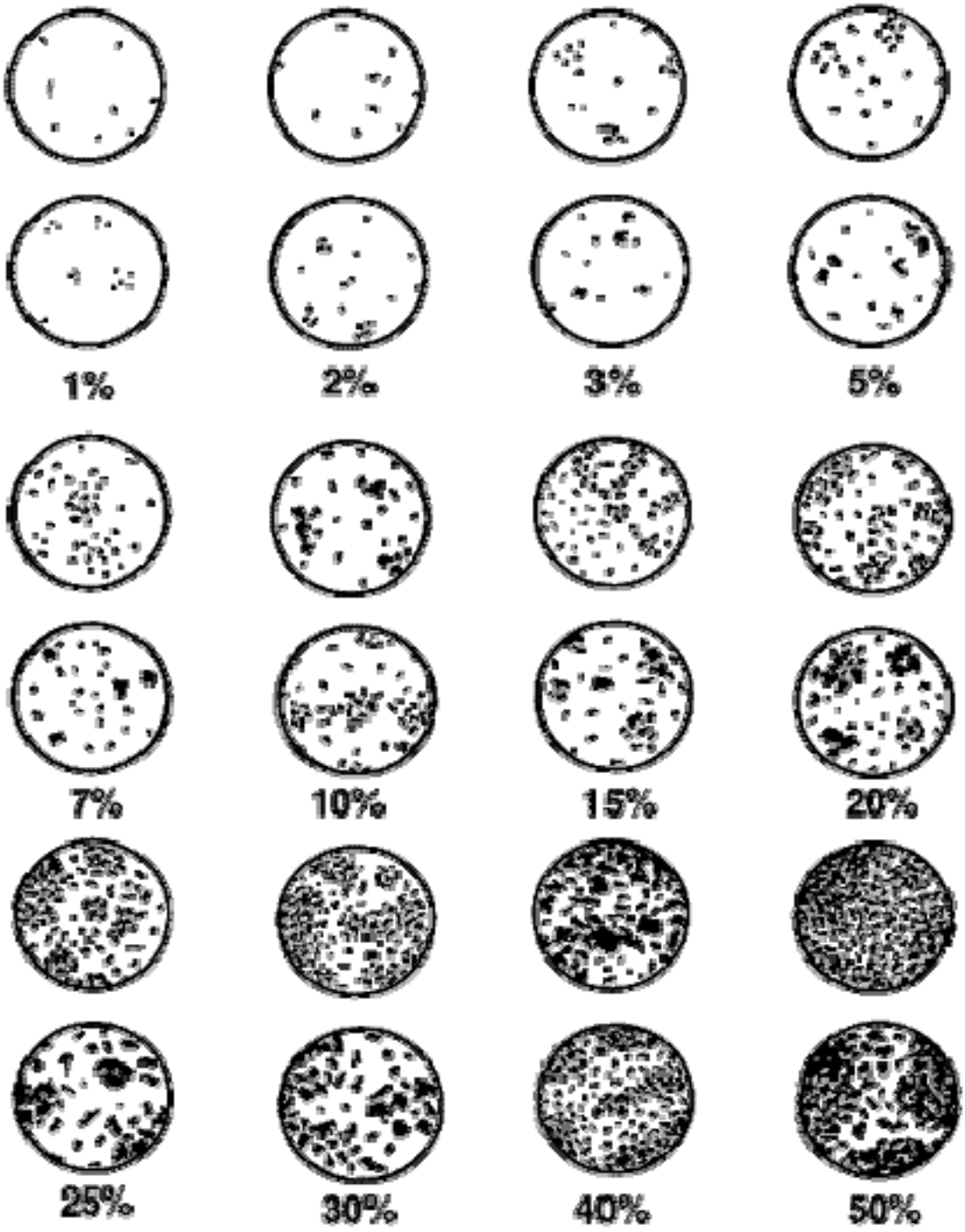

Figure 19. Visual cover estimation guide version 1.

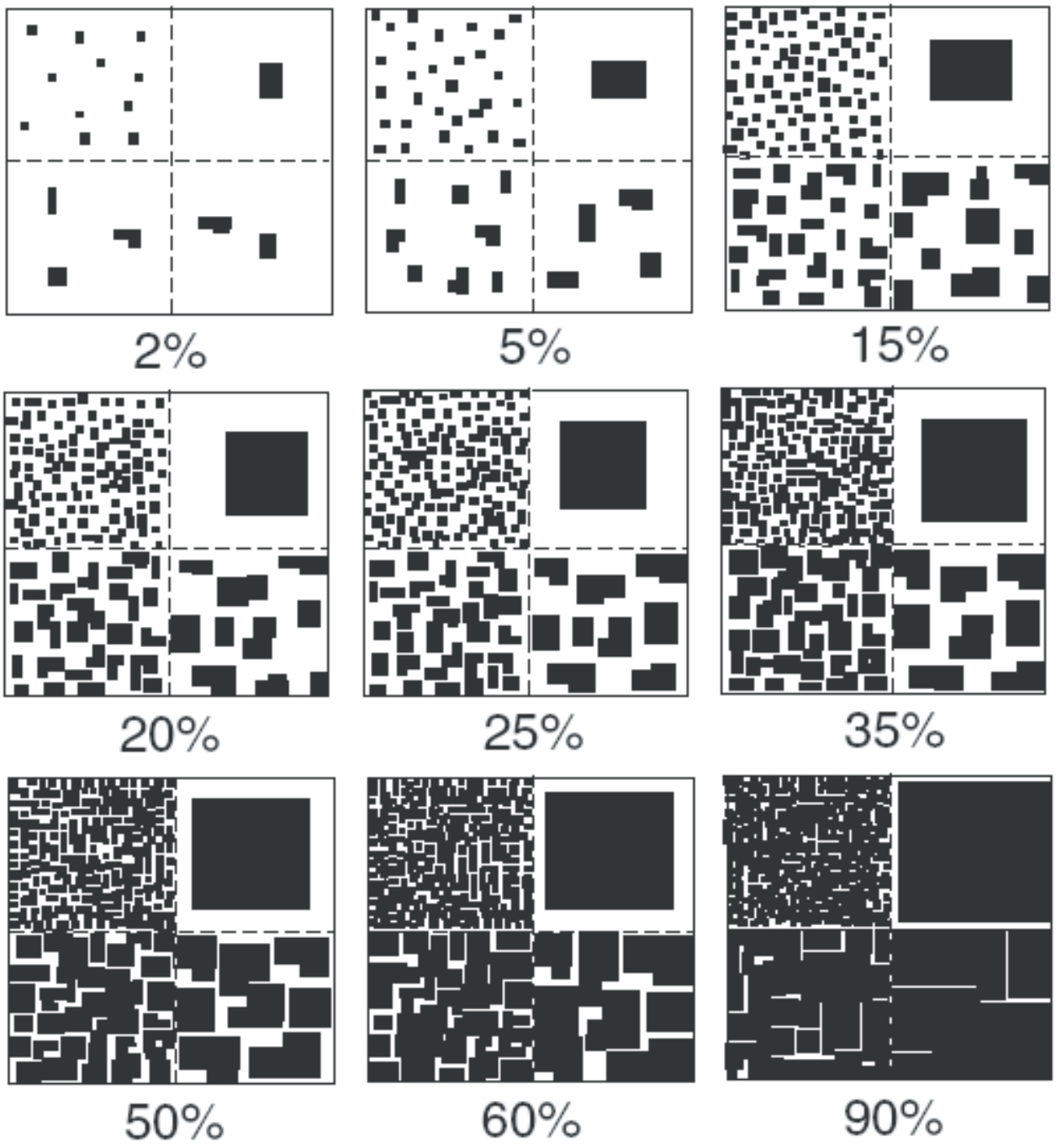

Figure 20. Visual cover estimation guide version 2.

DataPlus Quick Reference Guide

SAGE Protocol – DataPlus QUICK REF 1 (DataEntry)

Using the ArcherPC to collect field data

1. Turn on ArcherPC, then use stylus to click Start, Programs, DataPlus CE.

If DataPlus Application not already selected:

2. Use stylus to click Menu, App, Select Application
3. Use stylus to select current SAGE_Vxx application, click OK

Once SAGE_Vxx Application has been selected:

4. Use stylus to click Menu, Data, Collect Data

IMPORTANT DATASET NAMING CONVENTION:

5. When Creating a New Dataset (i.e., a new SampleFrame record) – use keyboard to name Dataset as a sensible 6-letter abbreviation of the Sample Frame (e.g., CIROCS, LARSCW, CRMO17, etc.)
6. When Opening an existing Dataset: Select Dataset, click Open Selected.

You can STORE UP TO 26 DATASETS (SampleFrames), and EACH SAMPLE FRAME can HAVE UP TO 1295 PLOTS.

To Enter/Edit Plot data:

1. Open correct SampleFrame (Dataset) and Advance(F5) to Plots form (Level 2); 2. Enter a new Plot or highlight existing Plot; 3. Adv(F5) along the Dir Tree (i.e., bare ground cover, species cover, and Notes) to enter Level 3-4 data; 4. Retreat(F4) as needed to reach the various Level 4 forms; 5. When done, Ret(F4) to Plots form or Exit [Ret(F4) to DataPlus Pro screen].

To move between data fields, use arrow buttons on body of ArcherPC unit, or StylusClick on-screen keyboard arrow keys.

IMPORTANT TIPS: To create a New Line (e.g., new Plot record, or new Cover Species record), Use the Down Arrow (on either ArcherPC body or on-screen keyboard) to access a New Line below last existing record. The F3 Key allows a Search for a value (e.g., PlotNum on Plots form); enter value, click F5 [seePg2].

To open a data field Pick List, use stylus to double click in that data field or to click the F2 Key, then select a value by double clicking w/stylus. To Adv(F5) to a "Child" data form, double click the desired form name. All Forms display current SampleFrame and PlotNumber at the top of the Form.

DATAPLUS FORMS ARE ORGANIZED IN DIRECTORY TREE

Level 1	Park-SampleFrame	
Level 2	Plot Basics	
Level 3	*[Cover]*	*[PlotNotes]*
	BareGnd	Notes
Level 4	Sage_Spp	*NA*
	Shrub_Spp	
	PerGr_Spp	
	InvGras_Spp	
	PersFrb_Spp	
	OthForb_Spp	
	InvForb_Spp	

StylusClick F5 KEY to ADVANCE from LEVEL 1 TO 2 TO 3 TO 4
StylusClick F4 KEY to RETREAT from LEVEL 4 TO 3 TO 2 TO 1

SAGE Protocol – DataPlus QUICK REF 1 (DataEntry)

General Guidance for collecting field data with ArcherPC

All Forms display the current SampleFrame and PlotNumber at the top of the Form. In addition, DataPlus generates automatic warnings if data rules are violated – these may consist only of an audial warning (a Beep if, for example, you try to Advance or Retreat from a Plot record where PlotNum = 0) or an on-screen error message. If you accidently create a record you do not actually want, then you may need to DELETE the Record before you can move on – you DELETE a Record by using the F10 Key. Make certain the record you wish to Delete is the Current Record (StylusClick on any field in the Record line so that the flashing cursor is in the Record line to be Deleted). You will be prompted to Confirm the Deletion and, for Level 1, 2, and 3 Forms, you'll also be prompted to Acknowledge that all existing "Child" data [lower Level data] will also be Deleted. Needless to say, Use CAUTION!

Custom warnings alert you if Child data has not been entered. When you see these warnings, StylusClick anywhere on the ArcherPC screen to continue.

If a SELECTION SCREEN FREEZES, StylusClick the "AK" KEY, then
StylusClick "ESCAPE" to RETURN to LAST DATAPLUS FORM. Sometimes the ArcherPC unit may Freeze and the "Escape" button will not UnFreeze it. Usually, if you use the F4 (Retreat) Key to Back All the Way Out to the DataPlus Pro screen (without attempting to use any other Keys), then you'll be able to re-open the Dataset (SampleFrame) and return to your current Plot record (with no loss of data). If neither the F4 nor the Escape Keys will work, then you have to PowerOff the unit, then restart (usually with no data loss).

Another useful Function Key is F3(Search) – it's dialog box will allow you to search for an existing value in the main data field of the current form (e.g., an existing PlotNum entry on Plots form, an existing SpCode entry on a Cover form); enter the search value, then click F5 (if no match, you'll get a warning message). To exit the Search dialog box, click AK then "Escape" button.

The "AK" KEY allows you to open a Full List of FUNCTION BUTTONS.

You can SUSPEND the ArcherPC by pressing the POWER button. If, returning from Suspend mode (press Power button again), the SCREEN is BLANK, tap the screen with Stylus to refresh the current DataPlus Form.

SPECIAL CAUTIONS:
Do NOT edit/change the Park or Frame values for an existing Dataset (SampleFrame) for which you've already entered Plot records. Doing so will change the Park and Frame to which your Plot records are associated!
If need to enter new Plots for a new SampleFrame, then create a New Dataset.

In the unlikely event that you run low on ArcherPC storage capacity [you can check memory space by going to Start → Settings → System → Memory], you will need to delete older Datasets to free up storage capacity. [Please see the DataPlus QUICK REF 2 on Data Backups, and ensure that the older Dataset records are fully backed up before deleting them from the ArcherPC!]

SAGE Protocol – DataPlus QUICK REF 2 (Data Backups)

Installing DataPlus on laptop and copying Sage_Vxx applic to laptop

1. Install DataPlus software from installation CD, accepting all default settings.

2. When you connect the ArcherPC to the laptop [see below], it should be automatically detected after a few moments. The Windows XP operating system uses Microsoft ActiveSync (if not already installed, a free download is at www.microsoft.com/windowsmobile/en-us/help/synchronize/device-synch.mspx). The Windows Vista operating system uses Windows Mobile Device Center.

3. Copy the latest SAGE folder (SAGE_Vxx, from UCBN DM) to your laptop's hard drive (into the C:\DataPlusPro\APPS folder created at DataPlus install).
NOTE – UNINSTALL DataPlus software from laptop when no longer needed!

Transferring Sage_Vxx application to your ArcherPC unit

1. With ArcherPC unit powered On, plug it into laptop using Archer USB cord. On your laptop screen (if using MS ActiveSync), ActiveSync should startup and recognize your mobile device (ArcherPC); if not, then start ActiveSync using Start Menu → Programs → MS ActiveSync. (Ignore/Cancel any ActiveSync messages about Office Outlook profiles.) You do not need to set up a Sync Partnership (you can Cancel the Sync Wizard); ActiveSync's default Guest Connection will suffice.

2. DataPlus Pro CE Host should also auto start once your laptop has recognized your ArcherPC. If not, start it using Start Menu → Programs → DataPlus Pro → DataPlus CE Host. After a min, DataPlus CE Host should show that your Handheld and Software are detected (will display green 'Yes' buttons under CE Device Status). If not, temporarily unplug Archer and/or restart your laptop.

3. IF the current SAGE_Vxx application is NOT already on your ArcherPC, then Click the 'Send App' button, Select the latest SAGE_Vxx application and Click OK to send the application to your ArcherPC. IMPORTANT NOTE – If the current SAGE_Vxx application is already on the ArcherPC, a DPP CE Host dialog window will ask if you wish to Delete All applic Data in order to send the application. Obviously, you do NOT wish to do so! (In the unlikely event that replacement of the SAGE_Vxx application is required, then please consult with the UCBN Data Manager, and ensure that all existing ArcherPC Data is Backed Up to your laptop.)

4. Unplug your ArcherPC from laptop. (If using WinXP, can close ActiveSync.)

Your ArcherPC is now ready to collect field data. The first time you use the current SAGE_Vxx application on ArcherPC, you'll need to Select the applic prior to collecting data [see the DataPlus QUICK REF 2 on Data Entry].

Backing Up your ArcherPC field data to your laptop

1. With ArcherPC powered On, plug it into laptop with Archer USB cord. On laptop screen (if WinXP), ActiveSync should startup and recognize ArcherPC; if not, start ActiveSync from Start Menu. (Cancel messages on Office Outlook profiles, and cancel the Sync Wizard; default Guest Connection will suffice.)

SAGE Protocol – DataPlus QUICK REF 2 (Data Backups)

Backing Up your ArcherPC field data (Continued…)

2. DataPlus Pro CE Host should also auto start once your laptop has recognized your ArcherPC; if not, start DP CE Host from Start Menu. DP CE Host should show that Handheld and Software are detected (green 'Yes' buttons displayed). If not, temporarily unplug Archer and/or restart your laptop.
3. Click the Receive Data button in DP CE Host. Highlight the SAGE_Vxx application and the Dataset(s) to be transferred to laptop [see Gen Rec below]. This will place all files for the selected Dataset(s) in a folder on your laptop (C:\DataPlusPro\Data\SAGE_Vxx\mmddyyyy, with the folder named using the Date on which you Click Receive Data to transfer the ArcherPC files).
4. Unplug your Archer from laptop. (If using WinXP, can close ActiveSync.)

GENERAL RECOMMENDATIONS: KEEP ALL your DATA on ArcherPC (by NOT checking the "Delete data after transfer" checkbox at the top of the Receive Data dialog window). Doing so will allow each successive C:\DataPlusPro\Data\SAGE_Vxx\mmddyyyy folder to serve as the latest FULL BACKUP of ALL your DATA.
If you run low on ArcherPC storage capacity, you'll need to delete older Datasets from the ArcherPC (using Menu → Data → Erase Data, then selecting the SampleFrame Datasets to be deleted). In this case, since subsequent ..\SAGE_Vxx\mmddyyyy folders will no longer constitute Full Backups, you will need to organize your ..\SAGE_Vxx\mmddyyyy folders on your laptop so it's clear which SampleFrame Datasets are saved in which folders. (Please Consult with UCBN DM if this unlikely action becomes necessary.)

IMPORTANT NOTE – if you use Receive Data more than once on a given day for the *same ArcherPC unit*, data files (for *that Archer UnitID*) in that day's ..\SAGE_Vxx\mmddyyyy folder will be overwritten.

Reviewing your ArcherPC field data on your laptop

To review field data on laptop, you need to convert it to .dbf format. In DP CE Host, click Tools, then Data Converter. Then click File, Convert. Highlight SAGE_Vxx applic, and Sage_DC conversion file. Click DBF Convert. Highlight the mmddyyyy folder, and ALL of the Files (use Shift+Click), and ENSURE ALL 3 CHECKBOXES are CHECKED. Then Click OK twice. Your .dbf files will be in same ..\SAGE_Vxx\mmddyyyy folder as transferred files, and a Zip "archive" of transferred files will be in C:\DataPlusPro\Convert\.

REVIEWING .DBF FILES: The .dbf files in your ..\SAGE_Vxx\mmddyyyy folder are named by the Level 1,2,3,4 form names (PkFrame, Plot_Basics, Cover, Dominance, Erosion, Notes, Sage_Spp, Shrub_Spp, etc.). All Level 2,3,4 files show ParkFrame and LocName so that PlotNumber (at end of LocName) assoc with each record is obvious when viewing files in MS Excel.

IMPORTANT NOTE – if you use Data Converter more than once for given mmddyyyy folder, then you will be prompted to Overwrite or Append existing files. You want to select Overwrite, otherwise you will get duplicate records.

Quadrat Add/Drop Procedures

Refer to the following checklist below for determining whether a quadrat should be dropped. If a quadrat meets one or more of these criteria, the quadrat should be offset 5 m in a random direction. If it still meets the rejection criteria, the quadrat should be dropped. To drop a quadrat, enter the plot record into DataPlus. Reference the coding below (bold font in parentheses), and enter DROP_code (e.g., DROP_bndry for a quadrat that falls outside of a Park fenceline) into the Notes field. If a quadrat is dropped, a replacement must be drawn off of the GRTS oversample list, in consecutive order, and sampled, beginning with quadrat number n+1 (i.e., the first quadrat # after the last number corresponding with the desired sample size). Because sampling frame errors will persist during the first few years of protocol implementation, anticipate some drops. Allow time for site pickups on the last day of sampling for each park area. To add a new site off the GRTS oversample list, simply choose the next site on the list, and navigate to it using the GPS. Oversample sites will be included in the list of locations loaded to the GPS unit before the field season begins (SOP # 3).

Do not drop a quadrat if it can be offset a distance of 5 m in a random direction (compass bearing) and not meet the following criteria

Rejection Criteria:

- Outside park boundary (**bndry**)
- Dangerous/prohibitively difficult to work on (e.g., slope >30^{o}, talus or rimrock; **unsafe**).
- Road or improved trail (**road** or **trail**)
- Vegetation is completely other than sagebrush steppe or potential sagebrush steppe (e.g., riparian aspen, no species representative of sagebrush steppe, a roadside ditch; **veg**)
- Other circumstances – detail this in the notes (**other**)

Plant Lists

*These lists represent principal species targeted for cover estimation. Lists for dominant forbs and grasses are not included here due to length, but are included in DataPlus picklists and in printed Field Reference Manuals. DataPlus picklists include entries for both species and genera (e.g., ASTSPP for Astragalus spp). New species should be entered with up to 8 letters (typically with 6, for the first three letters of the genus and species). Follow instructions in SOP # 6 and in the DataPlus quick reference guide for instructions on updating picklists with new species.

Table 13. Principal sagebrush shrub species.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
ARTARB	**Low sagebrush***	*Artemisia arbuscula*	X	X	X	X	
ARTCAN	**Silver sagebrush**	*A. cana*		X			
ARTRIG	**Stiff sagebrush**	*A. rigida*				X	X
ARTTRID	**Big sagebrush**	*A. tridentata*	X	X	X	X	X
ARTTRIP	**Threetip sagebrush**	*A. tripartita*		X	X		X

**A. arbuscula*, *A. nova*, and *A. longiloba* commonly lumped as *A. arbuscula*.

Table 14. Principal invasive non-native grasses.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
AGRCRI	**Crested wheatgrass**	*Agropyron cristatum*	X	X	X	X	X
BROTEC	**Cheatgrass**	*Bromus tectorum*	X	X	X	X	X
ELYCAP	**Medusahead**	*Elymus caput-medusae*	X	X	X	X	X
POAPRA	**Kentucky bluegrass**	*Poa pratensis*	X	X	X	X	X
POABUL	**Bulbous bluegrass**	*Poa bulbosa*	X	X	X	X	X

Table 15. Other shrubs.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
ATRCAN	**Four-winged saltbrush**	*Atriplex canescens*			X	X	X
ATRCON	**Shadscale**	*Atriplex confertifolia*			X	X	X
SARVER	**Greasewood**	*Sarcobatus vermiculatus*			X	X	X
ERIMIC	**Slender buckwheat**	*Eriogonum microthecum*	X		X	X	X
ERISPH	**Rock buckwheat**	*Eriogonum sphaerocephalum*				X	X
CERLED	**Mountain mahogany**	*Cercocarpus ledifolius*	X			X	
PURTRI	**Bitterbrush**	*Purshia tridentata*	X	X	X	X	X
SALDOR	**Purple sage**	*Salvia dorrii*				X	X
ERINAU	**Rubber rabbitbrush**	*Ericameria nauseosus*	X	X	X	X	X
CHRVIS	**Green rabbitbrush**	*Chrysothamnus viscidiflorus*	X	X	X	X	X
GUTSAR	**Broom snakeweed**	*Gutierrezia sarothrae*	X	X	X	X	X
EURLAN	**Winterfat**	*Eurotia lanata*	X		X		
RIBSPP	**currant**	*Ribes spp*	X	X			
PRUVIR	**Chokecherry**	*Prunus virginiana*	X	X			
LEPPUN	**Prickly phlox**	*Leptodactylon pungens*	X	X	X		X
SYMORE	**Mountain snowberry**	*Symphoricarpos oreophilus*	X	X			
TETCAN	**Horsebrush**	*Tetradymia canescens*		X		X	X
CHAMIL	**Fernbush**	*Chamaebatiaria millefolium*		X			

Table 15. Other shrubs (continued).

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
ERINAN	**Dwarf goldenbush**	*Ericameria nana*		X			
LONINV	**Twinberry honeysuckle**	*Lonicera involucrata*	X				
AMESPP	**Serviceberry**	*Amerlanchier spp.*	X				
ROSWOO	**Woods' rose**	*Rosa woodsii*	X				
ROSSPP	**Rose**	*Rosa spp.*					

Table 16. Principal native perennial grasses.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
PSESPI	**Bluebunch wheatgrass**	*Pseudoroegneria spicatum*	X	X	X	X	X
AGRSMI	**Western wheatgrass**	*Agropyron smithii*	X	X	X		
AGRSPP	**Wheatgrass**	*Agropyron spp.*	X	X	X	X	X
ELYCIN	**Basin wildrye**	*Elymus cinereus*	X	X	X	X	X
FESIDA	**Idaho fescue**	*Festuca idahoensis*	X	X		X	X
ORYHYM	**Indian ricegrass**	*Oryzopsis hymenoides*	X	X	X	X	X
MELBUL	**Bulbous oniongrass**	*Melica bulbosa*	X	X			
POASEC	**Steppe bluegrass**	*Poa secunda*	X	X	X	X	X
POASPP	**Bluegrass**	*Poa spp.*	X	X	X	X	X
SITHYS	**Bottlebrush Squirreltail**	*Sitanion hystrix*	X	X	X	X	X
SPOCRY	**Sand dropseed**	*Sporobolus cryptandrus*	X	X	X	X	X
STISPP	**Needlegrasses***	*Stipa comata*	X	X	X	X	X
		Stipa lettermanii	X				
		Stipa occidentalis	X				X
		Stipa nevadensis	X	X			
		Stipa thurberiana		X	X	X	X

*Needlegrasses lumped as single indicator.

Table 17. Principal, persistent native perennial forbs.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
ACHMIL	**Yarrow**	*Achillea millefolium*	X	X	X	X	X
ANTSPP	**Pussytoes**	*Antennaria spp*	X	X		X	X
ARESPP	**Sandwort**	*Arenaria spp*		X			
ASTSCO	**Lava aster**	*Aster scopulorum*	X	X	X	X	X
ARTDRA	**Tarragon**	*Artemisia dracunculus*					X
ASTSPP	**Locoweed**	*Astragalus spp*	X				
BALSAG	**Arrowleaf balsamroot**	*Balsamorhiza sagittata*	X	X	X	X	X
CASSPP	**Paintbrush**	*Castilleja spp*	X	X	X	X	X
CHADOU	**Douglas' chaenactis**	*Chaenactis douglasii*	X	X	X		x
CIRSPP	**Native thistle**	*Cirsium spp **	X	X	X	X	X
COMUMB	**Bastard toadflax**	*Comandra umbellata*	X				X
CREACU	**Tapertip hawksbeard**	*Crepis acuminata*	X	X	X	X	X
DALORN	**Prairie clover**	*Dalea ornata*			X		
ERISPP	**Daisy**	*Erigeron spp*	X	X	X	X	X
ERIOSPP	**Desert buckwheat**	*Eriogonum spp*	X	X	X	X	X
ERILAN	**Woolly sunflower**	*Eriophyllum lanatum*	X	X			X
GERVIC	**Stickseed geranium**	*Geranium viscosissimum*	X				
HAPACA	**Glodenweed**	*Haplopappus acaulis*	X	X			
HYMFIL	**Fineleaf hymenopappus**	*Hymenopappus filifolius*					X
LINLEW	**Lewis' flax**	*Linum lewisii*	X				
LITRUD	**Western stoneseed**	*Lithospermum ruderale*	X	X	X	X	X
LOMSPP	**Desert parsley**	*Lomatium spp*	X	X	X	X	X
LUPSPP	**Lupine**	*Lupinus spp*	X	X	X	X	X
MERSPP	**Bluebells**	*Mertensia spp*	X				
OPUPOL	**Prickly pear cactus**	*Opuntia polyacantha*	X	X	X	X	X

Table 17. Principal, persistent native perennial forbs (continued).

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
OSMOCC	**Sweet cicely**	*Osmorhiza occidentalis*	X	X			
PENSPP	**Beardtongue**	*Penstemon spp*	X	X	X	X	X
PHAHAS	**Silverleaf phacelia**	*Phacelia hastata*	X	X	X	X	X
PHASPP	**Phacelia**	*Phacelia spp*				X	X
PHLSPP	**Phlox**	*Phlox spp*	X	X	X	X	X
POTGLA	**Sticky cinquefoil**	*Potentilla glandulosa*	X				
SEDLAN	**Spearleaf stonecrop**	*Sedum lanceolatum*	X				
SENSPP	**Groundsel**	*Senecio spp*	X	X	X		X
SPHMUN	**Orange globemallow**	*Sphaeralcea munroana*	X	X	X	X	X

Table 18. Other principal native forbs.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
AGOSPP	**False dandelion**	*Agoseris spp*	X	X	X	X	X
ALLSPP	**Onion**	*Allium spp*	X	X	X	X	X
ARASPP	**Rock cress**	*Arabis spp*	X	X	X	X	X
BRODOU	**Douglas' brodiaea**	*Brodiaea douglasii*				X	X
CALSPP	**Mariposa/ Sego lily**	*Calochortus spp*	X	X	X	X	X
CRYSPP	**Cryptantha**	*Cryptantha spp*	X	X	X	X	X
CYMSPP	**Spring parsley**	*Cymopterus spp*	X	X			
DELSPP	**Larkspur**	*Delphinium spp*	X	X	X	X	X
FRIPUD	**Yellow fritillary**	*Fritillaria pudica*	X	X			
GILSPP	**Gilia**	*Gilia spp*	X	X			
LEWRED	**Bitterroot**	*Lewisia rediviva*	X	X	X	X	X
LITSPP	**Starflower**	*Lithophragma spp*	X	X	X	X	
MIMNAN	**Dwarf monkeyflower**	*Mimulus nanus*	X	X			
SEDLAN	**Spearleaf stonecrop**	*Sedum lanceolatum*		X	X	X	X
STETEN	**Wire lettuce**	*Stephanomeria tenuifolia*		X			
VIOSPP	**Violet**	*Viola spp*		X	X		
ZIGSPP	**Death camas**	*Zigadenus spp*		X	X		X

Table 19. Principal non-native invasive forbs.

Code	Name	Species	CIRO	CRMO	HAFO	JODA	LARO
CIRARV	**Canada Thistle**	*Cirsium arvense*	X	X	X		X
CENMAC	**Spotted Knapweed**	*Centaurea maculosa*	X	X	X	X	X
CENDIF	**Diffuse Knapweed**	*Centaurea diffusa*		X	X	X	X
ACRREP	**Russian Knapweed**	*Acroptilon repens*		X		X	X
CHOJUN	**Rush Skeletonweed**	*Chondrilla juncea*		X	X		X
ONOACA	**Scotch Thistle**	*Onopordum acanthium*	X	X	X	X	X
CENSOL	**Yellow Starthistle**	*Centaurea solstitialis*				X	X
EUPESU	**Leafy Spurge**	*Euphorbia esula*		X			X
LINDAL	**Dalmation Toadflax**	*Linaria dalmatica*	X	X	X	X	X
CARDRA	**Whitetop**	*Cardaria draba*		X		X	
DESSPP	**Tansy mustard**	*Descurainia spp.*	X	X	X	X	X
SYSALT	**Tumble mustard**	*Sisymbrium altissimum*	X	X	X	X	X
ERICIC	**Filaree**	*Erodium cicutarium*	X	X	X	X	X
ISATIN	**Dyer's woad**	*Isatis tinctorum*	X	X			

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