



Mojave Desert Network I&M Program

Desert Spring Vegetation Monitoring Protocol

Standard Operating Procedures v 1.0



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ON THE COVER

Photo of Saratoga Spring in Death Valley National Park in spring 2017.
Photograph courtesy of the National Park Service (Nicole Hupp)

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Background

This document provides detailed information on how to monitor desert spring vegetation in five parks in the Mojave Desert Network Inventory & Monitoring Program: Joshua Tree National Park (JOTR), Death Valley National Park (DEVA), Lake Mead National Recreation Area (LAKE), Mojave Nation Preserve (MOJA), and Grand-Canyon Parashant National Monument (PARA). This Protocol is designed to work in coordination with MOJN's hydrology protocol, the Selected Large Spring Protocol (Moret et al. 2016). The standard operating procedures documented here and the methods described in the associated Desert Springs Vegetation Monitoring Protocol (DSVMP) narrative will be used to monitor a subset of MOJN springs on a three-year revisit cycle.

Acknowledgments

Parks in the Mojave Desert Network contributed many hours to visiting sites, refining goals, and proofreading many versions of this protocol. We would like to acknowledge all of the personnel in MOJN parks that contributed to this, particularly members of the MOJN Technical Committee, Neil Frakes (JOTR), Josh Hoines and Kirsten Lund (DEVA), Gretchen Baker and Meg Horner (GRBA), Jennifer Fox (PARA), and Drew Kaiser and Debra Hughson (MOJA). MOJN staff worked diligently to write and test these SOPs including Carolyn Mills, Logan Combs, and others.

List of Acronyms and Abbreviations

BLM: Bureau of Land Management

DEVA: Death Valley National Park

DPL: Data Processing Levels provide a standardized way of defining the degree of data verification that has been performed on a dataset.

DS: Desert Springs Monitoring Protocol; Moret et al. 2018 is a long-term monitoring protocol implemented in MOJN parks that inventories and monitors the status and trends at smaller and less-persistent MOJN springs.

DSVMP: Desert Spring Vegetation Monitoring Protocol, Hupp et al. *in review*

GRBA: Great Basin National Park

I&M: Inventory and Monitoring

IPSED: Invasive Plant Species Early Detection Monitoring Plan; Hupp et al. 2017 is a monitoring plan MOJN developed to assist parks with identifying species of concern, detecting them, and outlines a plan to have those species treated.

JOTR: Joshua Tree National Park

LAKE: Lake Mead National Recreation Area

LAKE-EPMT: Lake Mead Exotic Plant Management Team

LPI: Line Point Intercept sampling is a vegetation monitoring method that collects data at points along a transect line. It is a rapid, accurate method for quantifying soil cover, including vegetation, litter, rocks and biotic crusts.

MANZ: Manzanar National Historic Site

MOJA: Mojave National Preserve

MOJN: Mojave Desert Network Inventory and Monitoring Program

NPS: National Park Service

PARA: Grand Canyon-Parashant National Monument

‘R’: an open source software used for statistical analysis and creating graphical representations of data.

SLS: Selected Large Spring Protocol; Moret et al. 2016 is the MOJN protocol that measures water quality, quantity, and other hydrology elements at large, persistent springs of interest in MOJN parks.

SOP: Standard Operating Procedure

TUSK: Tule Springs Fossil Beds National Monument

US EPA: United States Environmental Protection Agency

USGS: United States Geological Survey

WRD: Water Resources Division

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

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes

This SOP describes the step-by-step procedures for preparing for fieldwork 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.

Annual Review

Key network and park staff should conduct an annual review of the protocol and SOPs prior to spring preparations. This is a central element to season closeout procedures. Review should include training and field procedures, recruitment of participating field technicians, data management, analysis, and reporting, as well as fundamental design issues. Most importantly, careful consideration should be made of the resulting analyses. The adequacy of sampling effort must be evaluated before going to the field. Any necessary changes should be made to the protocol and SOPs with enough time to circulate updated material to key staff.

Scheduling and Organizing Fieldwork

MOJN and its constituent parks are unable to maintain a large field staff for financial and logistical reasons. This combined with the remote and widely dispersed nature of the network, as well as the demands from other vital signs monitoring efforts requires that the field portion of the DSVMP will likely be sustained by temporary employees. The fieldwork should be scheduled in winter of the previous calendar year, and scheduling efforts should begin no later than the previous November/December. The Project Lead will coordinate this planning with the DEVA, JOTR, LAKE, MOJA, and PARA natural resource staff. A team of three people working for three weeks each sampling season must be available in order to complete the field data collection.

If necessary, the Field Lead or Protocol Lead will contact administrative staff at the park to reserve a fee-waived campsite permit or backcountry camping permit for the duration of the trip.

The Protocol Lead will send a brief email to relevant park personnel with a reminder of the dates that field crews will be working in the park, the names of the field crewmembers, their vehicle

descriptions and license plate numbers, and the locations of the springs, parking spots, and campsites that the field crews will be visiting.

Site Information Packet

Field crews will assemble site information packets for their trips into the field before the season begins. Though time consuming to create, these packets guide the entire week in the field and should be created carefully. Site information packets include:

- Backcountry travel plan (see Mojave Desert Network Inventory & Monitoring Field Safety Plan [Tallent et al. 2017]) for each day of the trip
- Driving and hiking route maps to each stand being visited
- List of UTM coordinates for spring locations, permanent transect markers, and permanent photo points.
- Field data sheets (see Appendix B)
- Emergency contact information, and the locations and phone numbers of local services, such as hospitals.

Equipment Preparation

Equipment List: The following equipment should be assembled each spring, and sufficient time allowance must be made to construct or order replacement equipment. The amounts of individual items required are not included here, as they change according to the number of field participants and teams available.

Measuring Equipment

- Steel chaining pins (14" red and white painted)
- Meter tapes
- Measuring rod: A repurposed metal-ended broomstick 1.5 m in length. Mark 1 m and 1.5 m on the stick.
- Pin flags
- Orienteering compass, with moveable housing and adjustable declination
- Clinometer
- Plant identification material
- Hard copies of relevant SOPs for field reference
- Plant press for in the field
- Plant press for in the truck

Navigation and Recording Equipment

- GPS unit with pre-loaded sampling location waypoints (MOJN supplied, or comparable unit)
- Tablet with data collection software (if used by this team) and AC/DC converter for charging batteries.
- Weatherized field data sheets (Appendix B)
- Backup copies of field data sheets
- Mechanical pencils and clipboards

Miscellaneous Field Equipment

- Digital camera

- Rebar and MOJN engraved aluminum caps (if installing or replacing transect markers)
- Cleaning supplies for decontamination

Preparation of Navigation and Field Data Management Equipment

- Charge all GPS units, Tablets and digital cameras, as well as backup batteries, prior to departure for the field. Bring extra AA batteries during fieldwork.
- Paper data sheets should be prepared and printed on to Rite-in-the-Rain paper if rain is likely to occur. A copy of the field data sheet is provided in Appendix B

Miscellaneous Preparatory Notes

- Analysis and reporting of previous year's data is necessary before starting a new field effort. This is covered in *SOP 12 Data Management*, and *SOP 13 Data Summary, Analysis, and Reporting*. It is particularly important that adequacy of population boundaries and sampling effort has been considered, and any changes to sampling design have been made before new points are generated.
- Prepare a realistic schedule of events in advance of group arrival, and circulate to team leaders and organizers ahead of time to manage expectations and ensure timely arrival
- Apply for a research permit (<http://science.nature.nps.gov/research/ac/ResearchIndex>) well ahead of the field season, as early as February/March. Arrange with the staff at Parks for your arrival and stay during field season. The research cabins or bunkhouses are occasionally available for MOJN research teams and campgrounds or housing can be reserved at other Parks.
- Make all crewmembers read the MOJN Field Safety Plan (Tallent et al., 2017) before going into the park.
- Make sure all team leaders know 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 Park staff.
- Hard copies of all field-relevant SOPs and sampling point location maps should be prepared and made available to the field team for the duration of the survey period.

Season Closeout

After the field season, clean and organize all non-electronic equipment and store in well-labeled plastic bins in MOJN ready-room. Non-electrical equipment, including wire ropes, stakes, rulers, and compasses should be stored in well-marked plastic bins. Some of this equipment may be used by other MOJN protocols, so thorough organization and documentation of equipment is important. Electronic equipment, including GPS units, should be stored in the MOJN headquarters. Batteries should be removed during the winter months to prevent corrosion and leaking. Make sure any specimens collected are properly prepared, protected, identified, and the data are applied to appropriate field data sheets and office databases.

Standard Operating Procedure (SOP) 2: Training Observers and Plant Identification

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes

This SOP describes the training of the field crew prior to field sampling including navigation with a compass, overview of field data collection, data recording, and the importance of repeatability and identification of trees and shrubs that occur in the parks.

The goals of training are:

1. Ensure all field crews collect data in the same way, every time.
2. Make sure all technicians understand that identifying a species as an “unknown” is preferable to identifying something as their “best guess”.
3. Confirm that all field crewmembers understand that safety is the most important element of fieldwork. Make sure they all feel empowered to choose not to do any task that feels unsafe.
4. Guarantee that data management is emphasized to the point that crews understand it is a vital element of this (and all) protocols.

Procedures

Field Crew Organization

Field crews for this protocol can be kept to one crew, or if there are abundant staff, crews can break into two. Two persons per crew is a minimum, three is ideal, and four is acceptable. Larger team sizes are inefficient. Once the team is established, it should be maintained throughout the duration of training and sampling in order to maintain consistency.

Safety

Safety procedures include formal and on-the-job training in communications devices, radio etiquette, and 4-wheel drive vehicles. New field crewmembers will read about previous incidents and accidents in the field that have been reported by the NPS and other agencies. They will discuss with their peers and supervisors the lessons learned from these incidents as well as specific hazards they may encounter while working in backcountry desert and mountainous environments. All crewmembers must review the MOJN Safety Plan (Tallent et al. 2017) and receive at least a one-day overview training on Operational Leadership.

In addition, ideally, field crewmembers will take a 16-hour wilderness first aid course, either through a certified organization (e.g., Red Cross, NOLS). All permanent and term NPS staff are required to

complete the 16-hour Operational Leadership course before participating in field activities, which covers situational awareness and good decision making skills.

Equipment Operation

Operation of GPS units is outlined in MOJN general SOP “Using Garmin 76CSx GPS Devices” (Lehman, 2017). Teach compass use to field crewmembers outside. Compasses should be held flat, on an open palm, in front of and close to the user’s body. To move the compass around for alignment of arrows and determination of a bearing, or azimuth, the user should move with the whole body rather than just the arm or hand. Use the mnemonic “put red in the shed”, where “red” is the magnetic arrow that always points to magnetic north, and the “shed” is the fixed north arrow inscribed on the bottom of the moveable housing (See Figure 2.1).



Figure 2.1. Compass displaying components used to find a bearing.

Once the “shed” is set to accommodate the magnetic declination and the “red” is in the “shed,” the compass directional arrow that is inscribed on the outside of the compass housing along the end of the base plate will always point to a true bearing or azimuth. Align this line on an object ahead of you and walk towards the object. Transects should be oriented along the pre-assigned azimuth by turning the compass housing to the desired number, and then turning the body until “red is in the shed”.

Plant Identification Training

Before going to the field, all crewmembers must receive formal training on how to identify parts of grasses, sedges, forbs, shrubs, and tree species. This process should take 3 days or a full week. This training will take place partially in the office, but can take field trips outside and to the LAKE herbarium depending on the level of training required by each staff person. Additional days in the field are required. For example, if DEVA will be monitored in a certain sampling year, crews must be trained in DEVA that year for plant identification.

Field crews must review the floral parts of relevant taxa in detail. The lead trainer must have skills in identifying Mojave Desert plants. The trainer can use plant keys relevant to the park that crews will be working in, and use dry samples from previous years to explain key features flora.

Field Training Operations

1. Designate a lead trainer. This leader must know the answers to nuanced protocol questions. This will typically be the Project Lead or the designated Field Lead. This person should be available to troubleshoot and reassign new equipment as needed.
2. Have all crewmembers read the entire DSVMP narrative (Hupp et al. 2018) and SOPs, and the MOJN Safety Plan (Tallent et al. 2017) before going outside to train.
3. All field crewmembers will require one full week of in-office plant identification training which includes a full refresher on grass parts, characteristics of herbaceous plants, tree identification, and other plant identification topics. Crewmembers should review any plant lists already created for the field sites. Ask vegetation experts at each park for any resources, just in case they have extra information that might be useful for plant ID.
4. Teach field measurements outside at the park site.
5. Allot time to learn MOJN data entry skills. Although most crewmembers have experience in this, additional training on those topics must be provided in the field to ensure accuracy.
6. On-site training can be accomplished in one full field day. The team should be assembled at the beginning for a review of concepts and techniques. Basic plant identification should be reviewed, and plant specimens should be assembled and presented to the group.
7. Following group introductory material, assemble teams and practice calibration. Team members should practice locating transect start locations with GPS, maps, and compass. The team should practice taking measurements and performing data entry. To facilitate this, extra field data entry sheets should be made available. **Emphasize clear communication practices between team members during data entry.**
8. Once teams are comfortable with basic operations, have teams switch roles to re-measure the plots and compare results. If disparity is high, have groups repeat counting and observe closely how this is done. Identify sources of disparity. Have teams establish transects nearby and repeat calibration exercises. Once this portion of training is complete, reassemble into the full group and review questions and concerns. Each crewmembers must be comfortable and confident in the methods.

Standard Operating Procedure (SOP) 3: Locating Springs

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes
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This SOP provides general information about locating each of the springs monitored in the DSVMP. The sites in this protocol are not difficult to find, but each crew sent to a spring should have at least one member who has monitored the spring previously. GPS points and site photographs should be taken into the field to ensure that the correct locations are being visited.

Specific access directions and spring descriptions are omitted from this SOP; instead, they are maintained and updated in the DSVMP database as part of the data entry process. This prevents redundancy and ensures that site information is updated in a timely manner. Storing site information in the database also saves time, since up-to-date site information sheets will be automatically generated from the database at the start of each field season. These sheets include driving and hiking directions and waypoints, spring-specific safety instructions, and maps. An example site information sheet can be found in Appendix C. Table 3.1 lists the coordinates that are used to locate each spring. For a general description of each spring monitored in the DSVMP, including flora, fauna, and cultural history, refer to the Monitoring Sites sections of the DSVMP narrative (Hupp et al. 2018).

Table 3.1. UTM (11N NAD83) coordinates for springs monitored in the DSVMP.

Park	Spring	Code	Easting (m)	Northing (m)
DEVA	Mound	DEVA_P_MOUN0	465822	4097484
DEVA	Nevares	DEVA_P_NEVA0	516020	4040821
DEVA	Saratoga	DEVA_P_SARA0	552272	3948893
DEVA	Texas	DEVA_P_TEXA0	514434	4034676
DEVA	Travertine	DEVA_P_TRAV0	515431	4033086
JOTR	Cottonwood	JOTR_P_COT0235	610356	3733409
JOTR	Fortynine Palms	JOTR_P_FORT0	582544	3774260
JOTR	Smith Water	JOTR_P_SMIT0	566556	3765674
LAKE	Horsethief Canyon	LAKE_P_HOR0042	713412	3986425
LAKE	Blue Point	LAKE_P_BLUE0	730244	4030199
LAKE	Grapevine	LAKE_P_GRA0058	767934	3992987
LAKE	Rogers	LAKE_P_ROGE0	729321	4028754
MOJA	Cornfield	MOJA_P_COR0060	630442	3870714
MOJA	MC Spring	MOJA_P_MCSP0	581628	3889017
MOJA	Piute	MOJA_P_PIU0161	682615	3887196
PARA	Chill Heal	PARA_P_CHI0190	770662	4012186
PARA	Pakoon	PARA_P_PAKO0	772891	4034242
PARA	Tassi	PARA_P_TASS0	773311	4016710

Standard Operating Procedure (SOP) 4: Site Establishment

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes

This SOP describes how to establish transects at a spring. These steps will typically be followed only at the first monitoring visit to each spring, but will also be applicable at subsequent spring visits in the event that new transects need to be added or markers for existing transects need to be replaced. This SOP defines two types of springs, and the type of spring determines the layout of the transects (Table 4.1). One type of spring consists series of pools or a wash that flow downslope into streams (“stream dominated” rheocrenes; Figure 4.1). The other type are springs that consist of standing water or wetlands, but do not terminate in streams (“pool dominated” limnocrenes or mound springs; Figure 4.2; Springer and Stevens 2009). For stream-dominated springs, transects are located at evenly spaced intervals along the spring and are centered on the streambed (Figure 4.1). Transects for pool-dominated springs are located along midpoint lines, the number of which depends on the spring (Table 4.4).

Table 4.1. Springs in this protocol are grouped into two classes for sampling design purposes: stream dominated or pool dominated.

Park	Stream Dominated	Pool Dominated
PARA	Tassi, Chill Heal*	Pakoon
JOTR	49 Palms, Smithwater, Cottonwood	-
DEVA	Nevares, Travertine, Texas	Mound, Saratoga
MOJA	Piute*, Cornfield*	MC
LAKE	Blue Point, Rodgers, Grapevine*, Horsethief*	-

*All springs are also included in the Selected Large Springs protocol (SLS; Moret et al 2016), except five springs denoted with an asterisk.

Office Tasks

Stream Dominated Springs

These springs emerge in canyons or washes. The spring vegetation is typically found in the lowest parts of canyons, often with steep walls. There are 14 springs in this category (Table 4.1). Vegetation at these springs is measured along transects that are centered on the streambed.

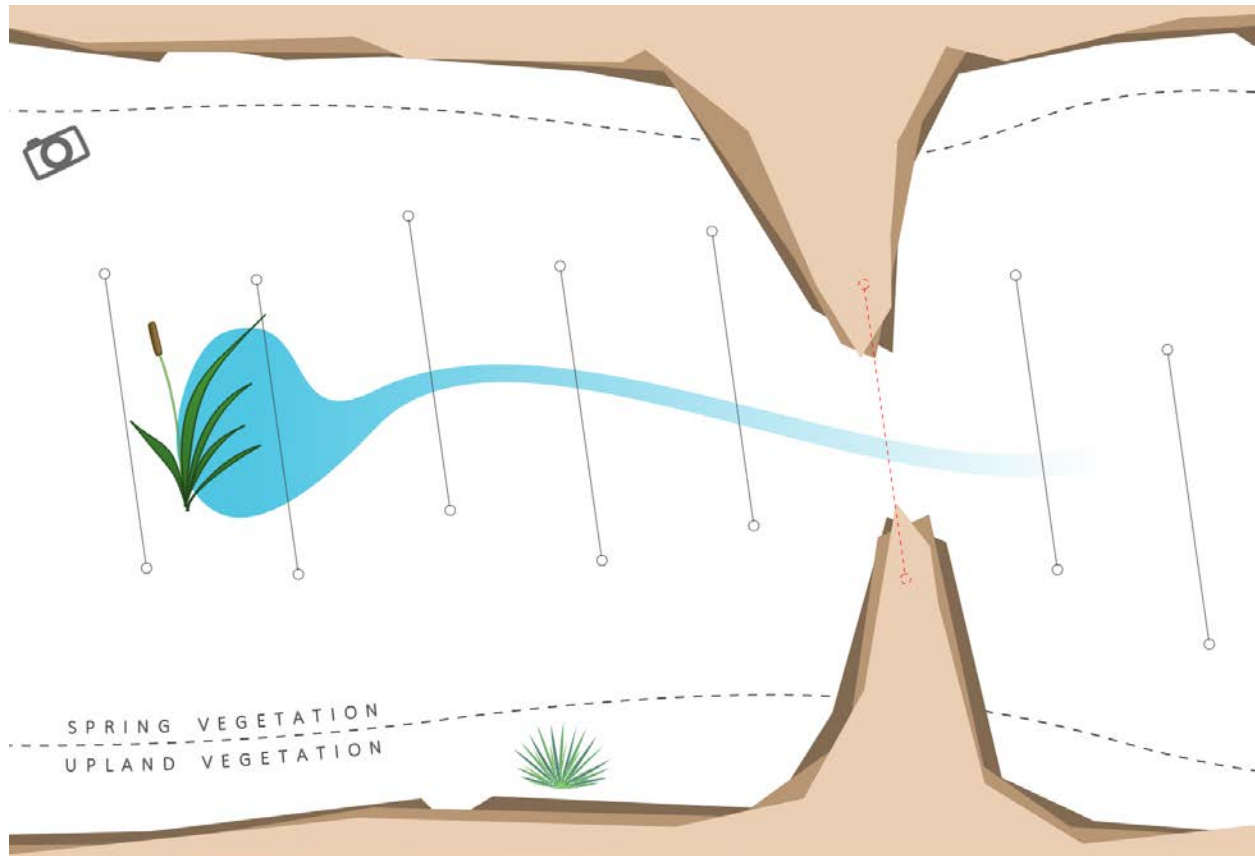


Figure 4.1. Example layout of transects and photo point for “stream-like” springs. The camera icon indicates a photo point location. The red dotted transect is one that has to be skipped because it is in a canyon too narrow for a 15 m transect.

Determine Transect Midpoints for Stream Dominated Spring

Before going to the field, the Protocol Lead or Field Lead must determine the midpoint of the streambed using spatial imagery or GIS tools and make a list of locations to use in the field.

1. Navigate to the spring source coordinates stored in the Spring Vegetation database using spatial imagery or GIS tools.
2. From the spring source, use the measuring tool to mark the location 20 m upstream of the spring source, at the lowest elevation point upstream (i.e. in the bottom-most point of the canyon or drainage). This location is the midpoint of transect 1.
3. From the midpoint of transect 1, measure downstream of this point for the distance specified in Table 4.2, depending on which stream is being sampled (Table 4.3).
4. Mark the second point at the predetermined distance at the lowest elevation point (in the bottom-most point of the canyon or drainage).
5. Repeat steps 2-4 until the appropriate number of transects are marked with a center point. Select 5 additional midpoints beyond the number specified in Table 5.3 in the event that transects might be rejected at the site.
6. Draw a line that connects all points together. Using the GIS tools, estimate the average direction that the spring slopes. Add 90 degrees to this number. This will be used as the

bearing for all transects at the spring. Enter this information into the database and include it in the site information packet.

Table 4.2. For stream dominated springs, the total number of transects and the distance between those transects is a function of the length of the spring. Since the actual length of the riparian vegetation zone is dynamic, the spring lengths are placed in classes. Regardless of the number of transects and the distance between them, transects are always 15 m long.

Length Class	Estimated Spring Length	# of Transects at Spring	Distance Between Transects
1	501 m-1000 m	8	30 m
2	100 m-1.5 km	10	30 m
3	>1.5 km	12	40 m

Table 4.3. The springs included in this protocol are monitored using the same sampling design however the number of sampling units within a spring is a function of the springs' length, therefore calculated uniquely for each spring. Longer springs often have greater species diversity therefore to capture that variation it is required to have a larger sample. Due to the dynamics of spring vegetation and seasonal variation, the length of springs is estimated here from aerial imagery.

Park	Spring	Length Class
JOTR	Fortynine Palms	1
	Smith Water	3
	Cottonwood	3
LAKE	Blue Point	1
	Rodgers	1
	Grapevine	2
	Horsethief	2
DEVA	Texas	2
	Travertine	2
	Nevares	3
	Tassi	2
	Chill Heal	1
PARA	Piute Spring	3
	Cornfield	2

Pool Dominated Springs

These limnocene spring vegetation areas are often wider than they are long. These springs are usually in basins or flat locations where surface water remains in standing pools or creates wetlands. There are four springs that are in this category (Table 4.3).

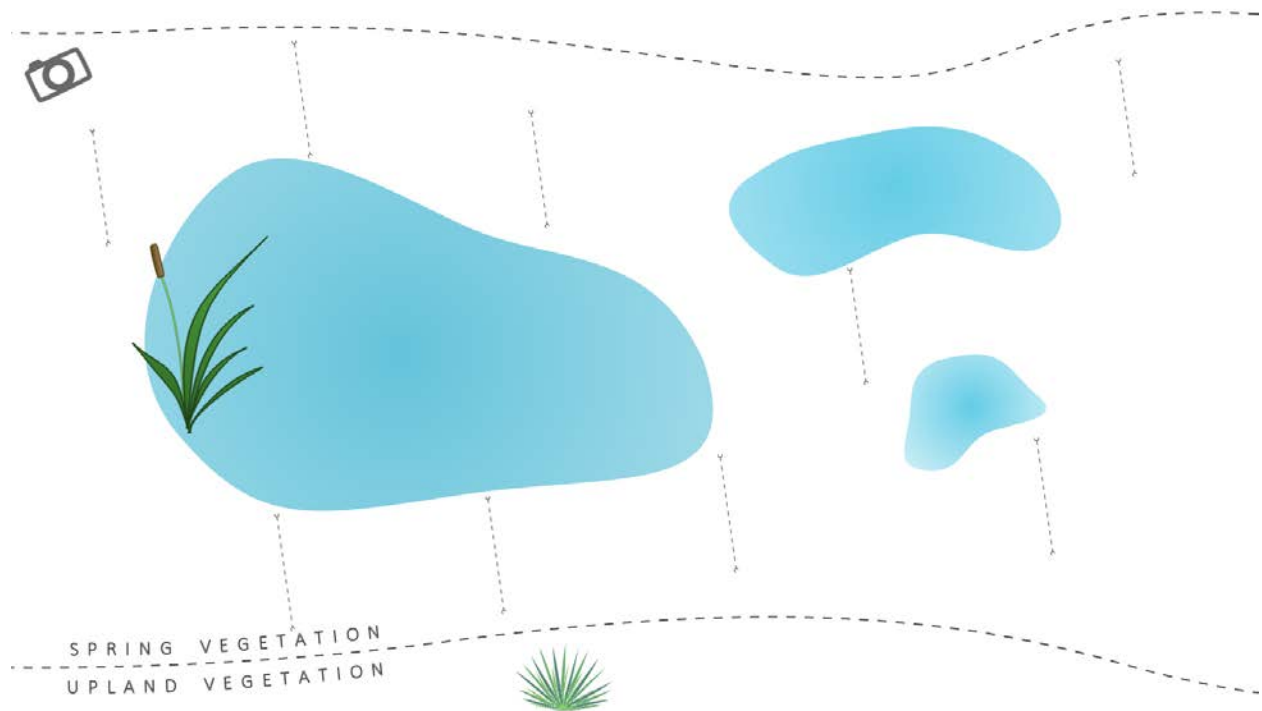


Figure 4.2. Example layout of transects and photo point for “pool like” springs.

Determine Transect Midpoint for Pool Dominated Spring

Before going to the field, the Protocol Lead or Field Lead must determine midpoint lines at the spring using spatial imagery or GIS tools, and make a list of locations to use in the field. Since pool dominated springs don’t have an obvious center (such as the middle of the streambed for the stream dominated springs described above), midpoint lines are used to establish transects in linear and systematic way. Since each of these springs have different amounts of surface water (e.g. Saratoga is lake-like where Mound has intermittent pools) and total area, the number of midpoint lines varies.

Determine transect locations following these steps:

1. Navigate to the spring source coordinates stored in the SLS database or the Desert Springs database, depending on which protocol monitors the spring, using spatial imagery or GIS tools.
2. Draw a polygon around the spring area including all riparian vegetation.
3. Determine if the spring has an elevational gradient and choose appropriate bearing for midpoint lines.
 - a. If it does have a gradient, midpoint lines begin upslope and end downslope. In this case, the midpoint lines will run perpendicular to the gradient, starting at the highest point and ending at the lowest point for the entire riparian area.

- b. If the spring does not have a gradient, midpoint lines begin on the northern side of the spring, and end on the southern end. If the spring is flat, the midpoint lines start at the northern most end of the spring and extend south for the entire length of the riparian area.
4. Mark the starting points for the midpoint lines either at the highest upslope point or on the northernmost end of the polygon. These points are evenly spaced (Table 4.4).
5. Project the appropriate bearing (step 3) from each of the midpoint lines to the edge of the polygon (i.e. the edge of the riparian vegetation). Mark the end points for the midpoint lines at this location. Midpoint lines must be parallel, but they will likely be different lengths since the polygon will not have straight edges.
6. Determine the length of each midpoint line.
7. Divide the length of each midpoint line by the number of transects (Table 4.4); this is how far apart transects will be established along each midpoint line.
8. Add 90 degrees to the midpoint bearing. This will be used as the bearing for all *transects* at the spring (transects are perpendicular to the midpoint lines).
9. Include the midpoint start and end points, the midpoint bearing, the distance between transects at each midpoint line, and the transect bearing information in the site information packet.

Table 4.4. For pool dominated springs, the number of transects is based on the total area of the spring, since these springs are more round-shaped than linear. The estimated area of each spring was calculated using spatial imagery in Google Earth. The number of transects per spring are divided among the midpoint lines (e.g. in Saratoga, each of the 3 midpoint lines has 4 transects, at Pakoon both midpoint lines have 4 transects)

Park	Spring	Estimated Area (m2)	# of Transects	# of Midpoint Lines	Dist. Between Midpoint Lines
MOJA	MC	956	7	1	-
DEVA	Mound	872	7	1	-
DEVA	Saratoga	75709	12	3	50 m
PARA	Pakoon	2045	8	2	60 m

Field Tasks

Before going to the field, download all of the predetermined transect midpoints into the GPS.

Establishing Transects

The instructions below provided the step-by-step process to establish transects in the first sample year. In subsequent years, these transects will be revisited and the steps for revisiting springs is described in the next section.

Stream Dominated Springs

Upon arrival at the spring, follow these steps to establish transects:

1. Using your GPS, navigate to the midpoint of transect 1.

2. Mark the midpoint of the transect using the Bad Elf GPS unit.
3. At the midpoint of the transect, set your compass (that has been set to the proper declination) to the predetermined bearing that will be used at the given spring (step 6 above).
4. Use the meter tape to extend 7.5 m on either side of the midpoint following the predetermined bearing. The transect is 15 m long.
5. Mark the ends of the meter tape with either rebar, photo points, and or a GPS point following the procedures below.
6. Once the transect has been established, measure the vegetation at the transect.
7. Repeat steps 1-5 for subsequent transects.

Specific Rules and Exceptions for Narrow Canyons:

If you get to a narrow canyon at the spring and the 15 m transect will not fit on level ground within the canyon, then reject this midpoint and move to the next. At each spring, there are 5 additional predetermined midpoints in the event that transect locations are rejected.

Pool-Dominated Springs

Upon arrival at the spring, follow these steps to establish transects:

1. Using your GPS, navigate to the start of midpoint line 1. If this point is in the middle of the pool, using waders, attempt to navigate to the start of midpoint line 1. If it can't be safely approached, then the transect will be skipped (but attempted to establish in the subsequent year).
2. At the start of midpoint line 1, set your compass (that has been set to the proper declination) to the predetermined bearing that will be used at the given spring.
3. Extend the meter tape between the start and end points of midpoint line 1.
4. Establish transect 1 at the start of midpoint line 1.
5. Use the meter tape to extend 7.5 m on either side of the midpoint line following the predetermined bearing. The transect is 15 m long. (note: there may be years where the entire transect is in the water; in this scenario crews should attempt to run the transect line anyway if safe; if unsafe, data can still be collected, but mark the "estimated" box on the data sheets.)
6. Mark the ends of the meter tape with either rebar, photo points, and or a GPS point following the procedures below.
7. Once the transect has been established, measure the vegetation at the transect.
8. Measure the predetermined distance between transects at that midpoint line to the center of transect 2.
9. Repeat steps 4-8 for the total number of transects required at the midpoint line.
10. Repeat steps 1-9 for the appropriate number of midpoint lines (Table 4.4).

Installing Permanent Markers

The permanent markers used in this protocol will be made of rebar. These can only be installed at certain sites due to special requirements at some sites (e.g. sites that are in Wilderness areas, those that are of cultural importance, etc.). At locations where permanent markers are not allowed, all transect start or end points must be thoroughly documented with photos. For springs where it is appropriate to install permanent markers, field crews should either determine if the location is

appropriate for rebar. Rebar markers are appropriate in places fully described below. If rebar markers are used, the observer must follow these steps:

1. Stamp the cap with the site name
2. Place the marker
3. Record the GPS location
4. Document the location with GPS coordinates and photos

Placing the Marker

- Place at least 18 in rebar in locations where it appears the metal will not move in at least 3 years. Use an alternative marking method if rebar must be placed in loose sand, within boulders that appear to be dynamic, or other locations that appear to be unstable.
- All rebar should be marked at the time site locations are established.
- If the study type and site number are known, the markers can be stamped prior to going into the field.

Recording Location

1. Record the marker location with a waypoint (saved on the GPS unit).
2. Record UTM coordinates on the field data forms.
3. Photograph the marker and the surrounding area from upstream of the marker, downstream of the marker, and in-line with the marker (i.e. the observer continues in the trajectory of the transect line a few meters beyond the transect and takes the photo facing the marker). For each photo, record the photo number, the photo bearing to the transect endpoint, distance from the photo location to the transect endpoint, and if the photo is upstream, downstream, or in-line with the transect.

Standard Operating Procedure (SOP) 5: Measuring Vegetation Using the Line Point Intercept Method

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes

This SOP details methods for estimating cover of vegetation using point-intercept sampling. A list of plant species for each park will be provided based on designation in the USDA Plants database and Calflora. For identifying unknown plant species, refer to SOP 11.

This SOP was adapted from *SOP 8 – Measuring Cover of Vegetation and Soil Surface Features Using a Point-Intercept Transect* from the Northern Colorado Plateau Inventory and Monitoring Network (NCPN) Integrated Upland protocol.

Point-Intercept for Cover Estimates

Point-intercept is used to sample vegetation on multiple, 15 meter transects at 0.5 meter intervals. A crew of two is expected to conduct this SOP, with one member the observer and the other the recorder.

Filling Out the Field Data Sheet

For each transect, fill out relevant information at the top of the Point-Intercept Field Data Sheet (Appendix B) including:

- *Park* – Use the standard 4-letter code to indicate the park unit.
- *Spring* – The name of the spring.
- *Date* – mm/dd/yyyy
- *Transect* – The number assigned to the current transect.
- *Start Time* – The time at which the field crew began reading the current transect (hh:mm, 24h).
- *End Time* – The time at which the field crew finished reading the current transect (hh:mm, 24h).
- *Observer* – Record the three initials (first, middle, and last name initials) of the observer.
- *Recorder* – Record the three initials of the recorder.

Point-Intercept Data Collection Procedure

1. Stand on the downstream side of the transect and work from the start marker toward the end marker (river right to river left).

2. Start at 0 m on the tape and move forward 0.5 m for each consecutive point. You will sample 30 points on each transect starting at 0.5 m and ending at 15 m.
3. Record the location along the meter tape on the field data sheet.
4. Record the data accuracy at that point using the abbreviations defined in Table 5.1.
5. Record data for **Stratum 1** (<1 m):
 - a. Place the base of the pin flag on top of the soil as close to the point on the transect as possible. Do not bias placement of the flag by trying to intercept or hit vegetation. Do not force the pin flag into the ground, as this will bias placement of the pin flag on impenetrable materials.
 - b. Record each plant species or canopy cover type that the pin flag intercepts, starting from the top of the pin flag. Next to the code, circle “B” for bottom stratum.
 - c. Record what the pin flag intercepts at the soil surface using the abbreviations defined in Table 5.4.
 - d. If the pin flag intercepts a disturbance on the soil surface, record it using the codes in Table 5.5.
 - i. If no disturbance is present, record it as a “0”.
 - ii. If multiple disturbances are present (e.g., wash with wildlife track), record them all. On the field data sheet, use a comma to separate the disturbance types.
 - iii. If the pin flag intercepts a plant base (Figure 5.2), record the USDA Plants code.
6. Record data for **Stratum 2** (1 m – 1.5 m)
 - a. Hold a depth rod against the pin flag so that it extends at least another half meter from the top of the pin flag. Try not to create additional soil disturbance with the end of the depth rod.
 - b. Record each plant species or canopy cover type that the depth rod intercepts, starting at a height of 1.5 m from the ground and ending at the top of the pin flag (1 m from the ground). For plant species and cover types already recorded in Stratum 1, do not write the code again; instead, circle “M” for middle stratum next to the existing code.
7. Record data for **Stratum 3** (>1.5 m)
 - a. Hold the moosehorn directly above the pin flag at a height of 1.5 meters from the ground. Use the levels inside of the tool to make sure it is perfectly vertical. Record each tree species observed through the moosehorn. Do not record non-tree species for this stratum. For tree species already recorded in Stratum 1 and/or 2, do not write the code again; instead, circle “T” for top stratum next to the existing code.
8. Proceed to the next point on the transect and repeat steps 3 – 7. Continue until all 30 points are completed.

Specific Rules and Exceptions for Point-Intercept

- **If an unknown plant species is encountered, refer to SOP 11** for instructions on recording it on the datasheet and collecting a sample for office identification.

- **If the intercepted plant is dead, write its code on the datasheet as the USDA species code with a “-D” appended to the end (e.g. LATR2-D).** This applies to any plant code recorded as part of this SOP, including plants that are recorded as soil surface.
- **If any part of a plant is alive, then the whole plant is considered alive,** even if the pin flag/depth rod/moosehorn intercepts a dead branch.
- **There is no need to report multiple occurrences of the same plant species or cover type within a stratum at a point,** even if it is intercepted several times. If the same plant species or cover type occurs across multiple strata, simply circle the letter of each stratum in which it appears. However, **live and dead plants of the same species must be recorded separately.** See Table 5.2 for stratum codes and definitions. See Figure 5.1 for an example of how to fill out the field data sheet.
- **Only litter and woody debris elevated above the soil surface and not embedded in the surface are considered canopy** (Table 5.3).
- Soil surface features are in direct contact with the soil or part of the soil; **removal of a soil surface feature would disturb or leave an indentation in the ground.**
- If a soil surface feature (e.g. scat, plant base, woody debris, large rock, bedrock) prevents determination of disturbance by covering up the area to be assessed, then record “0” for disturbance. Washes, human, livestock, and wildlife trails may be discerned by looking around the point of interest. That is, if a cow pie is in the middle of a livestock trail, it is reasonable to determine that the trail continues under the cow pie.
- **If you cannot safely measure the point on the line, or if it is impossible to drop the pin at the appropriate location, mark the appropriate accuracy code on the data sheet (Table 5.1).** For example, if the transect must span a steep or loose bank and the observer can’t stand next to the transect line, do your best to estimate what the flag would likely touch. But if you estimate in this way ensure that the datasheet reflects the estimation.

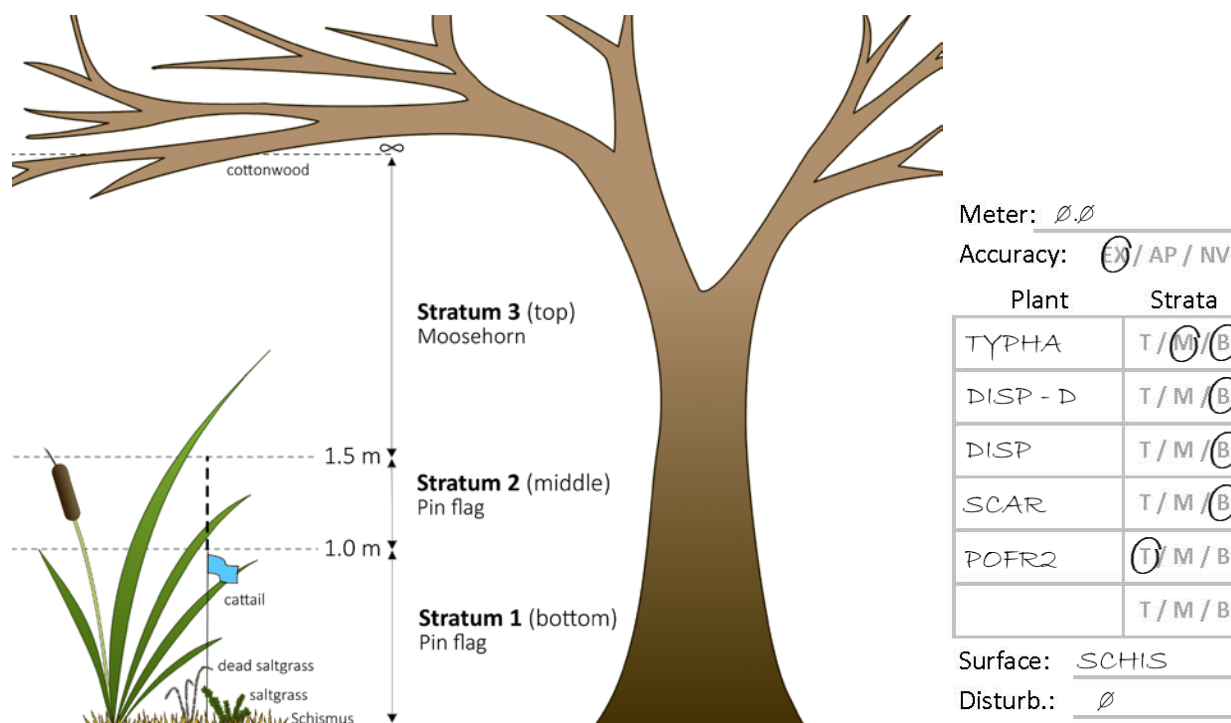


Figure 5.1. Example of a transect point with sample data and illustration of the three strata.

Table 5.1. Data accuracy codes and definitions. Occasionally crews may not be able to safely access transect locations. In those instances, mark the appropriate data accuracy code on the data sheet.

Code	Data Accuracy	Definition
EX	Exact	Field crew was able to access the specified transect location
AP	Approximate	Field crew could see specified transect location but could not access it; data are approximate
NV	Not visible	Field crew could not see or access specified transect location; data are an educated guess or omitted entirely

Table 5.2. Stratum codes and definitions.

Code	Stratum	Definition
B	Bottom	Bottom stratum; below 1 m.
M	Middle	Middle stratum; between 1 m and 1.5 m.
T	Top	Top stratum; above 1.5 m.

Table 5.3. Canopy cover type codes and definitions.

Code	Canopy cover type	Definition
L	Litter	Detached dead plant material less than 2.5 cm in diameter that is not embedded in the soil surface
W	Woody debris	Detached woody plant material that is greater than 2.5 cm in diameter and not in direct contact with soil
SL	Scat, livestock	Any type of livestock scat that does not serve as soil surface and can roll away
SW	Scat, wildlife	Small scat droppings that do not serve as a soil surface, e.g., rabbit, mouse, and can roll away.

Table 5.4. Soil surface codes and definitions.

Code	Soil surface type	Definition
S	Bare Soil	Loose soil particles (0-2 mm diameter) not protected from wind erosion by any type of crust or any other soil surface feature
C	Crust	Darkened cyanobacterial soil crust, typically black in color
LC	Lichen	Lichen crust on soil (lichen on rock is recorded as the appropriate rock type)
M	Moss	Moss on soil (moss on rock is recorded as the appropriate rock type)
D	Duff	Embedded litter that is less than 2.5 cm in diameter, where removal of the litter would leave an indentation in the soil surface or would disturb the soil surface
W	Woody debris	Detached woody plant material that is greater than 2.5 cm in diameter and in direct contact with soil
SR	Small rock	Rock fragments 2 mm-10 cm in diameter
LR	Large rock	Rock fragments >10 cm in diameter
BR	Bedrock	Exposed bedrock
SL	Scat, livestock	Any type of livestock scat that sits on or is embedded into the soil or does not easily roll away
SW	Scat, wildlife	Any type of wildlife scat that sits on or is embedded into the soil or does not easily roll away
[USDA plant code]	Plant base	See Figure 5.2.



Figure 5.2. Area defined as a plant base (from Herrick et al. 2005).

Table 5.5. Disturbance codes and definitions.

Code	Disturbance Type	Definition
ANT	Ant mound	Holes and mounds created by ants
BK	Bicycle	Disturbances caused by non-motorized bicycles
HMT	Human track/trail	Tracks or trails created by humans
LT	Livestock track/trail	Tracks, marks, or trails created by livestock
MV	Motor vehicle	Disturbances caused by any motor vehicle
WSH	Drainage area	Small to large eroded areas caused by (temporary) flowing water
WLE	Wildlife excavation	Holes and mounds created by wildlife
WLT	Wildlife track	Tracks, marks, or trails created by wildlife
HMO	Other anthropogenic	Any human disturbance other than tracks and trails
UNK	Unknown	Any disturbance of indeterminate origin or not classified as one of the other categories

Standard Operating Procedure (SOP) 6: Species Inventory

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes
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The species inventory is conducted in belt transects that center on the permanent transect line and extend 1.5 m on either side. Along these transects, observers record all species present. This systematic approach increases the probability of detecting rare or unique species at desert springs and will provide a more complete estimate of the number of species present at a spring. However, since this measurement will be time consuming, it will only be conducted every third visit to a spring (every 9 years) and will enlist the help of park natural resource staff when possible.

The time it takes to look for species along the transect will vary depending on species diversity (where the amount of time it takes to look for species is a function of the overall species diversity at the spring). Crews may choose to spend more time on the species inventory if an experienced botanist is present.

Species Inventory Procedure

1. Begin at the start marker (river right) on the downstream side of the meter tape (have the measuring rod and a few pin flags in hand).
2. Begin walking towards the far end of the transect. Use the 1.5 m measuring rod to ensure that you are only observing species within a 1.5 m belt on the side of the transect where you are walking. As you walk, move carefully and delicately; be sure to not step directly under the transect tape since this area is the focus of the LPI measurements.
3. As you progress along the transect, carefully search the ground for all plant species that have not yet been encountered on the current transect. Record the USDA plant code on the datasheet. Species codes are only recorded once per transect.
4. When an unknown plant species is encountered, mark it with a pin flag and continue conducting the species inventory. When the species inventory is complete, follow the instructions in SOP 11 to document and collect unknowns.
5. When you reach the end of the transect, turn around and repeat steps 2 – 4 on the upstream side of the transect, working back towards the start marker.
6. Repeat steps 1 – 5 for each permanent transect at the spring.

Specific Rules and Exceptions for Species Inventory

- If any part of a rooted plant falls inside the belt transect, include it in the inventory. This includes plants that are overhanging the belt transect, whether or not they are rooted

- inside the transect. For example, in Figure 6.1 below, the cottonwood tree is not rooted in the belt transect but it does hang over the transect, and is therefore counted.
- For statistical purposes, the sample unit for this variable is the entire belt transect. However, the time spent looking for plants should also be recorded accurately on the datasheet in order to obtain an accurate measure of effort. Do not include the time spent trying to identify unknown species after they have been marked with a pin flag.
 - If a species occurs multiple times within a given transect, only record it once for that transect.
 - If a species occurs on more than one transect, record it for each transect on which it occurs.
 - Be cautious of trampling! This protocol requires visiting very sensitive areas and our footprints matter. Follow the rules for “Crust Friendly Procedures”, as they are also useful for reducing trampling in dense vegetation.

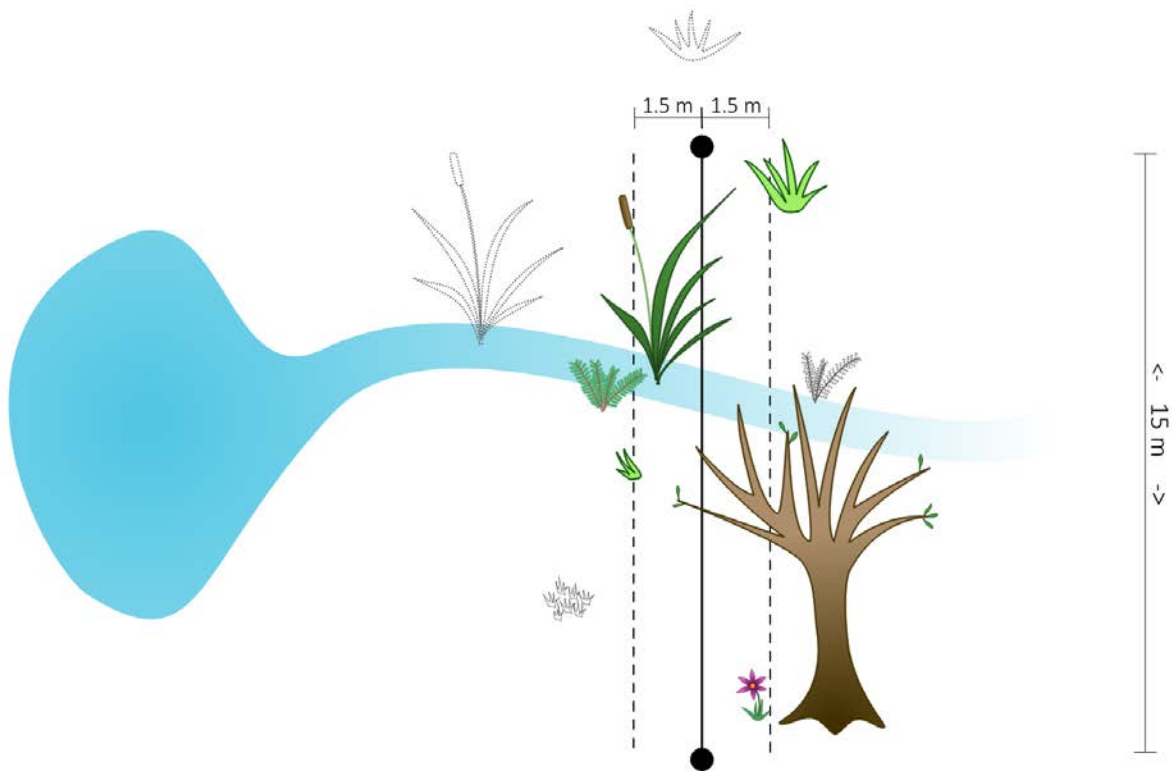


Figure 6.1. Species inventory belt transect example. Grayed out plants with a dotted outline are not included in the inventory.

Version 1.0

Version #	Date of Revision	Revised By	Changes
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Overstory Composition Survey Procedure

- ### ***Specific Rules and Exceptions for Overstory Composition***

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Version 1.0

Version #	Date of Revision	Revised By	Changes

This SOP was adapted from *SOP 4 – Crust Friendly Procedures* from the Northern Colorado Plateau Inventory and Monitoring Network (NCPN) Integrated Upland protocol and describes general procedures for minimizing BSC and soil disturbance during monitoring. All crewmembers must learn and follow the procedures below when visiting monitoring sites.

Footprints last a long time in desert systems. Walking the same route from a road or trail to a monitoring location can quickly create the appearance of an ‘established’, or ‘social’, trail. Because park visitors tend to gravitate to such trails, the access route can become heavily trampled over time and the chances of unwanted site disturbance may increase. Therefore, crews should:

- To minimize impact on the monitoring site, crews should adhere to the following guidelines:

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- Leave only one set of footprints by walking in existing footprints, especially when walking in areas with crust.
- Trails might eventually form below each transect in springs with well-developed crust. Be extra cautious to walk only in these trails and to avoid trampling any additional crust.
- Place packs, equipment, or anything that needs to be set down on bedrock or in a wash *outside* of the monitoring location.
- If these options do not exist, minimize disturbance as much as possible and use previously disturbed areas *outside* of the monitoring transects during revisits.
- To minimize the number of people trampling a given area, avoid huddling with other crewmembers to look at the Global Positioning System (GPS) unit, unknown plant species, etc.
- Stand outside of the transects when taking any breaks.
- Minimize unnecessary trips across plots by carrying water bottles and other necessities with you.
- In areas with well-developed crusts and very shallow soils, use shorter pieces of rebar (no less than 9 inches) to mark transect ends. If this is not possible, then use rocks (if available) to hold standard lengths of rebar in place.

Standard Operating Procedure (SOP) 10: Disinfecting Gear

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes

Field personnel have the potential to introduce and spread parasites and non-native organisms. Therefore, MOJN personnel will sterilize equipment prior to sample collection. MOJN personnel will use the decontamination techniques developed by Michael Bower (Bower 2009) for the Devils Hole Ecosystem Monitoring Plan (Wilson et al. 2009). Bower (2009) states:

“As the golden rule, if there is any doubt about the potential contamination of a piece of equipment or its history of use in other aquatic ecosystems, avoid its use in Devils Hole until it can be properly decontaminated.”

This principle should be followed by personnel working at any of the springs in the MOJN parks.

Priority of Park Procedures

Some of the MOJN parks have disinfection procedures in place that vary from water body to water body, and may vary from year to year. These procedures take priority over the MOJN disinfection procedures described below. In all cases, park staff should be consulted regarding the appropriate disinfection procedures. The procedures described below should be used when they are approved by the park or when the equipment is being moved between parks.

Difficult-to-Disinfect Equipment

Equipment that is difficult to disinfect properly, such as felt-soled waders, should not be used. If no substitute for difficult-to-disinfect equipment can be found, the Protocol Lead should research the best possible disinfection procedures and discuss them with park managers well ahead of the scheduled fieldwork. At all times, MOJN personnel should remember that it is preferable to miss a monitoring cycle rather than risk introducing an invasive species to a spring.

Water quality sensors are a special case for disinfection because the pH and DO electrodes would be destroyed by the processes described in this SOP. The steps for disinfecting water quality instruments are as follows:

- Use quaternary ammonium and extended desiccation to disinfect the cable as described below.
- Before use, rinse the sensor probe three times with clean water (not spring water), taking care that ALL sediment, algae, etc. is washed away. Use a small soft brush if necessary. Capture the rinsate in a bottle and pack it out.

- To the extent possible, avoid fouling the sensor probe in sediment, algae, etc. during use.
- Immediately after use, rinse the sensor probe three times with clean water again.

Disinfection

[The following text is taken directly from Bower (2009), with minor changes in wording]

There are two steps to the decontamination procedure, an initial cleaning and chemical disinfection followed by a physical disinfection treatment. This protocol is only effective when BOTH steps are followed. Step 1 below will not suffice to decontaminate equipment. Several known threats, such as the red-rim melania (*Melanoides tuberculatus*), an exotic operculated snail, are extremely tolerant of chemical disinfectants (e.g. Mitchell et al. 2007) and will require one of the physical disinfection treatments described in Step 2 for eradication. Conversely, the physical disinfection treatment options described in Step 2 below are not effective against many potential pathogens. Both steps, in combination, are necessary to ensure adequate decontamination of equipment.

Following completion of Steps 1 and 2, equipment should be stored in a cool and dry central location where there is no potential for cross-contamination by equipment used in other aquatic ecosystems.

STEP ONE: Cleaning and Chemical Disinfection

Option 1. Quaternary ammonium detergent disinfectant

This technique includes the dual benefits of cleaning equipment of chemical residues and killing many pathogens that are intolerant of quaternary ammonium. This chemical has also been shown to kill NZ mudsnails in 5 min (Hosea and Finlayson 2005).

- 1) Dilute quaternary ammonium detergent disinfectant per label directions.
- 2) Using detergent, thoroughly wash all equipment surfaces, internal and external, making sure to remove all organic matter and soil that could retain contaminants, invasive organisms, or residual moisture.
- 3) Thoroughly rinse all equipment surfaces in fresh water.

STEP TWO: Physical Disinfection

Option 1. Extended desiccation

This option requires minimal effort and works equally well for sturdy field gear and sensitive electronic instruments. Thoroughly drying equipment should kill most aquatic organisms, though desiccation-resistant invasive species are well established in the area. For this reason, it is imperative that a THOROUGH drying of equipment be extended for a minimum of 14 days after complete drying prior to use in a spring.

- 1) Complete Step One.
- 2) Thoroughly rinse equipment and place in a well-ventilated and secure area.
- 3) Drying racks or hangers can help to speed the drying process.
- 4) Occasionally check equipment to see if internal surfaces, fabrics, or pores are drying or if they continue to retain moisture.

- 5) Where necessary, utilize drying aids such as fans and boot dryers to initially dry equipment.
- 6) Continue the desiccation treatment for 14 days following the complete drying of ALL surfaces.
- 7) If personnel are unable to document the complete drying of ALL equipment surfaces, internal and external, prior to and during the treatment, this technique should not be used.

Option 2. Freezing

This is a convenient technique for gear that is easily cleaned and can be subjected to freezing conditions without sustaining damage. Most aquatic organisms, particularly those living in thermal springs, are not tolerant of freezing conditions.

- 1) Complete Step 1.
- 2) Thoroughly rinse all equipment and let drip dry.
- 3) Adjust temperature within the freezer to -10°C (14°F) prior to placement of equipment.
- 4) Maintain equipment in the freezer at -10°C (14°F) overnight.
- 5) If personnel are unable to document that air temperature reaches and maintains -10°C (14°F) overnight, this technique should not be used.

Option 3. Superheated water bath

This technique can be used to easily disinfect equipment that can be subjected to intense heat without sustaining damage.

- 1) Complete Step 1.
- 2) Establish and maintain a 50°C (120°F) hot water bath. This can be accomplished in several ways, including use of a home water heater and bathtub, use of a metal trough and propane blaster, or use of a laboratory autoclave.
- 3) After a sufficient heating period, check water temperature with a mercury thermometer.
- 4) Place equipment into hot water bath for a minimum of one hour.
- 5) If personnel are unable to document that water temperature reaches and maintains 50°C (120°F), the technique should not be used.

Version 1.0

Version #	Date of Revision	Revised By	Changes
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This SOP was adapted from *SOP 16 – Unknown Plant Species* from the Northern Colorado Plateau Inventory and Monitoring Network (NCPN) Integrated Upland protocol.

Follow the procedures below when you encounter a species that you cannot identify.

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- b. Fill out the Unknown Plant Species datasheet, making sure to take photographs of the unknown plant if you think important features of the plant may be difficult to see after it is collected. Take additional photos if the unknown is not collected due to its rarity at the spring.
- c. Continue looking for identifiable specimens of unknowns as you sample the rest of the plot, but be aware of how much time you have already invested trying to key out the plant.
- d. Use the same unknown code each time you encounter the unknown species.
- e. Even if it is possible to identify the plant to genus, follow steps a – d if there is a chance that it can be identified to species later. It is permissible to identify a plant only to the genus level if no identifiable parts are present for keying, or if hybridization makes species delineation difficult (e.g. *Quercus* sp.).

Collecting unknown plants

After it becomes apparent that you will not be able to identify the plant to species in a timely manner at the plot (less than 5 minutes), make a collection. To complete this process you will need a field plant press, small sheets of newspaper, a hori hori garden tool, and paper slips to include with the sample (slips available in Appendix B).

1. Collect specimens from outside of the monitoring plots whenever possible. Do not collect the plant if there are fewer than 20 individuals on the plot. Do not collect specimens from the sampling area within 1 m of the meter-tape.
2. Attempt to collect identifiable parts including flowers, fruits, and leaves. Collect roots of forbs and grasses. You may need to collect from more than one plant to get enough identifiable material, but don't be excessive.
3. Wrap the sample with the paper ID slips to label it with the unknown species code, basic information, and characteristics that will fade. Basic information includes if the sample is annual vs. perennial or rhizomatous vs. bunchgrass, color of flowers (this will fade over time!), and obvious odors.
4. Carefully place the specimen inside the small field plant press, and label the newspaper containing the sample with the unknown species code, date, location, and collector.
5. With assistance from the other field crewmembers, attempt to identify the plant when you are back at camp.
6. If the specimen cannot be identified right away, carefully transfer the sample to the larger plant press (usually located in the vehicle). Be careful with plant presses because they are holding data. They are fragile, the samples within them are fragile, and MOJN roads are bumpy! They should ride in the cab.
7. After returning to the office, organize all samples in the in-office MOJN plant presses.
8. Plants should be identified at the end of field hitches if possible. If the identity of the plant can't be determined, crews should consult experts from the park they are working in as soon as possible.
9. Once plants have been identified, the database must be updated with the species name.

10. All plants must be identified by the end of the field season, or permanently recorded in the database as “unknown”.

Although everyone is encouraged to learn new plants while in the field, please do not make excessive collections of plants. Remember, we are working in National Parks, and the vegetation is protected.

The form for recording unknown plants is presented with the full suite of field data sheets in Appendix B.

Standard Operating Procedure (SOP) 12: Data Management

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes

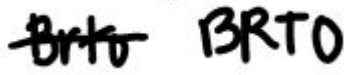
This SOP describes the data management procedures used for the data collected during spring vegetation monitoring. The database model is described in detail, including definitions of all input and computed data fields. Procedures for data certification, data archiving, QA/QC, and handling of sensitive information are provided. A list of the yearly spring vegetation monitoring data management tasks is included, including timing for execution of various data management steps.

Data Collection

Collecting and Managing Data

Data collected in the field will be recorded on paper datasheets until an electronic data collection system is deemed practical. To minimize potential ambiguity of field data sheets, MOJN has established handwriting best practices which are summarized in Table 12.1.

Table 12.1. Handwriting best practices.

Description	Correct Method
Use a line through the 7	
Use a line through the 0 (zero)	
Single line through mistakes Never erase Never scribble out	
Never use "ditto" marks	Line with arrow through the column or row where data is repeated
Clear distinction between P and D	
Date format	mm/dd/yyyy
Time format	24 hour, hh:mm (e.g. 13:00)
Fill in every field	use a line through it or N/A (not applicable)
Decimal points	Points should be distinct and unmistakable for commas or dashes
Park or Park Code is always four alpha characters	DEVA, GRBA, JOTR, LAKE, MANZ, MOJA, PARA

Before leaving a spring, the crew leader is responsible for ensuring that all forms – whether digital or electronic - have been filled out completely and that the information on each form is logical and legible. Upon returning from each field trip, datasheets will be filed in the incoming data file cabinet. After data have been entered into the database, the field data sheets will be scanned to 300 dpi or greater PDF files. When retroactive changes are made to paper datasheets, they must be re-scanned. The Protocol Lead is responsible for safekeeping and organization of the datasheets until data entry and verification procedures have been completed, at which point the datasheets are stored, and eventually archived, by the network Data Manager.

Importing and managing photographs

To import photographs from a MOJN camera memory card, insert the card into a USB card reader and plug the reader into a computer that has access to the MOJN shared drive (M:\). Open Windows Explorer and navigate to the memory card. Run the script titled TransferPhotos.bat and follow the prompts. For devices without a memory card (e.g. phone camera) or memory cards without the TransferPhotos.bat script, consult the Data Management team.

All incoming photos can be found in M:\MONITORING_FieldPhotoOriginals_DoNotModify. The photos in this folder are organized by memory card ID and date and should never be renamed or edited. Pine monitoring photos should be copied into M:\MONITORING\SpringVeg\Data\Images and organized by park, at which point they may be renamed according to the following convention:

SpringID_YYYYMMDD_description

Where *SpringID* is the unique spring ID code spring ID code, including the “PARK_P_” prefix (e.g., LAKE_P_AZT0072).

The *description* should adhere to the following standard, where ##### is a four digit number corresponding to the last four digits of the original photo filename:

Repeat Photos

REPEAT_####

Marker Photos (Upstream and Downstream)

UPST_####

DNST_####

Project File Storage Conventions

All of the files associated with the development and implementation of this protocol will be stored on the MOJN server under the folder \Monitoring\SpringVeg.

The SpringVeg folder will contain at a minimum the following folders:

- **Analyses** (Contains R scripts and results)
- **Data**
 - **Database** (Contains the database front-end and backups of previous database versions. The database backend is hosted on MOJN’s SQL server instance.)
 - **FieldData** (Contains a scan of all field data sheets grouped in folders by park and field season.)
 - **Images** (Contains all photographs taken at a site grouped in folders by park and field season.)
- **Implementation**
 - **FieldDataForms** (Contains blank field data sheets and lookup code “cheat sheets”)
 - **GIS_Basedata** (Contains spatial data for navigation and simple map making)
 - **SitePackets** (Contains a Word file for each spring including navigation waypoints and a map with the suggested access route)
- **ProjectFiles**
 - **Permits** (Contains copies of permits for conducting fieldwork)
 - **Protocol** (Contains folders for the published DSVMP narrative and SOPs, draft revisions of the narrative and SOPs, and files documenting the protocol development process)
 - **SampleDesign** (Contains information about the sample frame)
- **Reports** (Contains data and trends reports)

Other parts of this SOP will contain additional information on required file naming procedures that are specific to this protocol. Where file naming procedures are not defined it should be assumed the MOJN general SOP “MOJN File Naming Conventions” is applicable.

Database Design

Data will be stored in a SQL Server relational database with a Microsoft Access front-end for data entry and QA/QC processes. The database design is inspired by the Inventory and Monitoring (I&M) program’s Natural Resources Database Template (NRDT) but with modifications which bring it in line with the 2015 Inventory and Monitoring Division database standards (Frakes, 2015), and the 2017 IMD Minimum Implementation Standards (Frakes, 2017). The database will track the quality control and quality assurance processes (data processing level) that have been applied to each site visit activity, and will store a “line of sight” to the full package of protocol materials that were in place at the time that the data was collected. The database will store metadata for photographs taken as part of each site visit. A data model showing the relationships among the core data tables, lookup tables, and cross reference tables is included below (Figure 12.1).

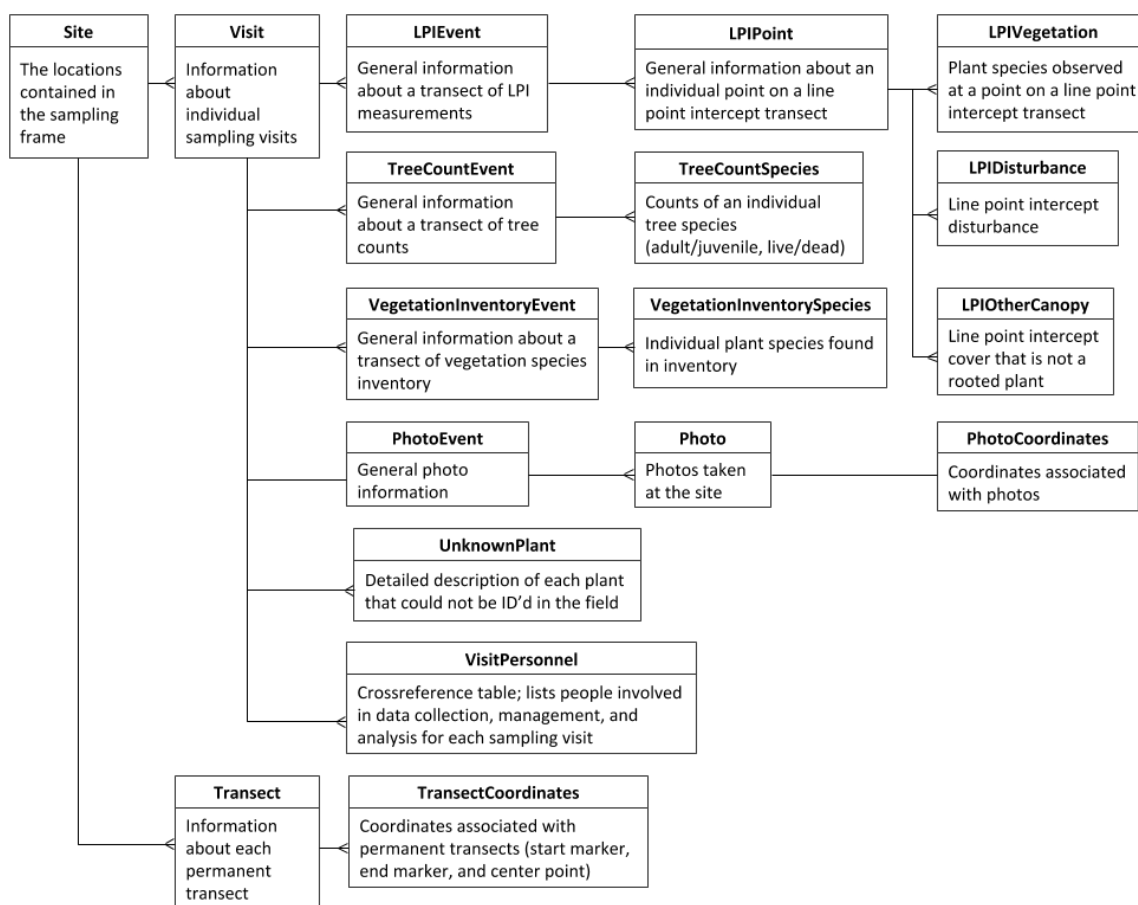


Figure 12.1 Data model of the core tables in the MOJN Spring Vegetation database

Data Dictionary

This data dictionary provides a description for every table in the SQL “back-end” database, and for each table, lists the field names and their associated field type, size, and description.

Table 12.2 Data Dictionary

TableName	ColumnName	ColumnDescription
LPIDisturbance	ID	Primary key for this table Foreign key to data.LPIPoint (general information about an individual point on a line point intercept transect)
LPIDisturbance	LPIPointID	Foreign key to lookup.DisturbanceType (indicates type of disturbance found at a point)
LPIDisturbance	DisturbanceTypeID	
LPIDisturbance	DateCreated	Date the record was created
LPIEvent	ID	Primary key for this table Foreign key to data.Visit (information about individual sampling visits)
LPIEvent	VisitID	Foreign key to data.Transect (information about each permanent transect)
LPIEvent	TransectID	
LPIEvent	StartTime	Time of day that data collection on the LPI transect began
LPIEvent	EndTime	Time of day that data collection on the LPI transect was completed
LPIEvent	Notes	Notes regarding the site visit
LPIEvent	DataProcessingLevelID	Foreign key to lookup.DataProcessingLevel (indicates level of QA/QC that has been applied to data in a given table)
LPIEvent	DataProcessingLevelDate	Date the Data Processing Level was changed
LPIEvent	DataProcessingLevelNote	Notes for Data Processing Level Status
LPIEvent	DateCreated	Date the record was created
LPIOtherCanopy	ID	Primary key for this table Foreign key to data.LPIPoint (general information about an individual point on a line point intercept transect)
LPIOtherCanopy	LPIPointID	
LPIOtherCanopy	CoverTypeID	Foreign key to lookup.CoverType (indicates type of overstory that is not a rooted plant)
LPIOtherCanopy	DateCreated	Date the record was created
LPIPoint	ID	Primary key for this table Foreign key to data.LPIEvent (general information about a transect of LPI measurements)
LPIPoint	LPIEventID	
LPIPoint	LocationOnTape_m	Location of LPI point on meter tape
LPIPoint	SoilSurfaceClassID	Foreign key to lookup.SoilSurfaceClass (type of soil surface found at a point)
LPIPoint	DataAccuracyID	Foreign key to lookup.DataAccuracy (indicates accuracy of LPI data)
LPIPoint	DateCreated	Date the record was created
LPIVegetation	ID	Primary key for this table Foreign key to data.LPIPoint (general information about an individual point on a line point intercept transect)
LPIVegetation	LPIPointID	
LPIVegetation	TaxonID	Foreign key to ref.Taxon (lookup of MOJN species)

LPIVegetation	UnknownPlantCodeID	Foreign key to lookup.UnknownPlantCode (temporary codes assigned to unknown plants)
LPIVegetation	LayerID	Foreign key to lookup.Layer (canopy layer (overstory, understory, surface, etc.))
LPIVegetation	IsDeadID	Foreign key to lookup.IsDead (indicates whether plant is dead)
LPIVegetation	DateCreated	Date the record was created
Photo	ID	Primary key for this table
Photo	PhotoEventID	Foreign key to data.PhotoEvent (general photo information)
Photo	PhotoShortDescriptionID	Foreign key to ref.PhotoShortDescription (short descriptions of photos (used in photo file naming))
Photo	IsLibraryPhotoID	Foreign key to lookup.IsLibraryPhoto (indicates whether photo may be a good candidate for inclusion in newsletters or other communication products)
Photo	OriginalFilePath	File path to the original photo on the shared drive
Photo	RenamedFilePath	File path to the photo once it has been copied to the appropriate monitoring folder and renamed
Photo	Notes	Notes about the photo
Photo	DateCreated	Date the record was created
PhotoCoordinates	ID	Primary key for this table
PhotoCoordinates	GPSUnitID	Foreign key to ref.GPSUnit (GPS units, each with a unique identifier)
PhotoCoordinates	PhotoID	Foreign key to data.Photo (photos taken at the site)
PhotoCoordinates	HorizontalDatumID	Foreign key to lookup.HorizontalDatum (horizontal datum of UTM coordinates)
PhotoCoordinates	UTMZoneID	Foreign key to lookup.UTMZone (zone associated with UTM coordinates)
PhotoCoordinates	UtmX_m	UTM X coordinate
PhotoCoordinates	UtmY_m	UTM Y coordinate
PhotoCoordinates	DateCreated	Date the record was created
PhotoEvent	ID	Primary key for this table
PhotoEvent	VisitID	Foreign key to data.Visit (information about individual sampling visits)
PhotoEvent	CameraID	Foreign key to ref.Camera (all cameras used for monitoring, each with a unique identifier)
PhotoEvent	CameraCardID	Foreign key to ref.CameraCard (lookup of camera memory cards)
PhotoEvent	DataProcessingLevelID	Foreign key to lookup.DataProcessingLevel (indicates level of QA/QC that has been applied to data in a given table)
PhotoEvent	DataProcessingLevelDate	Date the Data Processing Level was changed
PhotoEvent	DataProcessingLevelNote	Notes for Data Processing Level Status
PhotoEvent	DateCreated	Date the record was created
Site	ID	Primary key for this table

Site	ParkID	Foreign key to lookup.Park (park unit)
Site	Name	Site name
Site	Code	Unique code assigned to each site
Site	AccessDirections	Directions to the site
		Foreign key to lookup.SpringCategory (indicates spring category as used to determine transect layout (does not reflect ecology or hydrology of spring))
Site	SpringCategoryID	
Site	TransectLength_m	Length in meters of transects at this spring
		Distance in meters between point-intercept points
Site	PointInterceptSpacing_m	
Site	Lat_WGS84	Site latitude (WGS84)
Site	Lon_WGS84	Site longitude (WGS84)
Site	X_UTM_NAD83_11N	UTM X coordinate (NAD83, zone 11N)
Site	Y_UTM_NAD83_11N	UTM Y coordinate (NAD83, zone 11N)
Site	X_UTM_NAD83_12N	UTM X coordinate (NAD83, zone 12N)
Site	Y_UTM_NAD83_12N	UTM Y coordinate (NAD83, zone 12N)
Site	DateCreated	Date the record was created
Transect	ID	Primary key for this table
		Foreign key to data.Site (the locations contained in the sampling frame)
Transect	SiteID	
		Number assigned to transect (only unique within a site)
Transect	TransectNumber	
Transect	DateInstalled	Date permanent transect was installed
		Indicates whether permanent transect is being used for ongoing monitoring
Transect	IsActive	
		Distance in meters from spring source to middle of transect
Transect	DistanceFromSource_m	
		Label stamped on permanent transect start marker
Transect	StartMarkerLabel	
		Location on meter tape at which permanent transect start marker is installed
Transect	StartMarkerLocationOnTape_m	
		Location of thalweg along the meter tape when the transect was established
Transect	ThalwegLocationOnTape_m	
		Label stamped on permanent transect end marker
Transect	EndMarkerLabel	
		Location on meter tape at which permanent transect end marker is installed
Transect	EndMarkerLocationOnTape_m	
Transect	DateCreated	Date the record was created
Transect	Notes	Notes about permanent transect
TransectCoordinates	ID	Primary key for this table
		Foreign key to data.Transect (information about each permanent transect)
TransectCoordinates	TransectID	
		Foreign key to ref.GPSUnit (GPS units, each with a unique identifier)
TransectCoordinates	GPSUnitID	

TransectCoordinates	PointTypeID	Foreign key to lookup.PointType (indicates the position (start, center, end) of a coordinate point along a transect)
TransectCoordinates	HorizontalDatumID	Foreign key to lookup.HorizontalDatum (horizontal datum of UTM coordinates)
TransectCoordinates	UTMZoneID	Foreign key to lookup.UTMZone (zone associated with UTM coordinates)
TransectCoordinates	UtmX_m	UTM X coordinate
TransectCoordinates	UtmY_m	UTM Y coordinate
TransectCoordinates	DateCreated	Date the record was created
TreeCountEvent	ID	Primary key for this table
TreeCountEvent	VisitID	Foreign key to data.Visit (information about individual sampling visits)
TreeCountEvent	TransectID	Foreign key to data.Transect (information about each permanent transect)
TreeCountEvent	StartTime	Time of day that data collection on tree count belt transect began
TreeCountEvent	EndTime	Time of day that data collection on tree count belt transect was completed
TreeCountEvent	Notes	Notes regarding the site visit
TreeCountEvent	DataProcessingLevelID	Foreign key to lookup.DataProcessingLevel (indicates level of QA/QC that has been applied to data in a given table)
TreeCountEvent	DataProcessingLevelDate	Date the Data Processing Level was changed
TreeCountEvent	DataProcessingLevelNote	Notes for Data Processing Level Status
TreeCountEvent	DateCreated	Date the record was created
TreeCountSpecies	ID	Primary key for this table
TreeCountSpecies	TreeCountEventID	Foreign key to data.TreeCountEvent (general information about a transect of tree counts)
TreeCountSpecies	TaxonID	Foreign key to ref.Taxon (lookup of MOJN species)
TreeCountSpecies	UnknownPlantCodeID	Foreign key to lookup.UnknownPlantCode (temporary codes assigned to unknown plants. unique only within a single spring visit.)
TreeCountSpecies	LiveAdultCount	Number of live adult trees of a given species
TreeCountSpecies	DeadAdultCount	Number of dead adult trees of a given species
TreeCountSpecies	LiveJuvenileCount	Number of live juvenile trees of a given species
TreeCountSpecies	DeadJuvenileCount	Number of dead juvenile trees of a given species
TreeCountSpecies	Notes	Notes about the tree count for a given species
UnknownPlant	ID	Primary key for this table
UnknownPlant	VisitID	Foreign key to data.Visit (information about individual sampling visits)
UnknownPlant	IsCollectedID	Foreign key to lookup.IsCollected (indicates whether an unknown plant sample was collected)
UnknownPlant	UnknownPlantCodeID	Foreign key to lookup.UnknownPlantCode (temporary codes assigned to unknown plants. unique only within a single spring visit.)

UnknownPlant	GeneralDescription	General description of unknown plant
UnknownPlant	MostSalientFeature	Description of most definitive feature(s) of unknown plant
UnknownPlant	LeafType	Description of leaf type
UnknownPlant	LeafMargin	Description of leaf margin
UnknownPlant	LeafOther	Other leaf information
UnknownPlant	StemCharacteristics	Description of unknown plant stem
UnknownPlant	PhenologyID	Foreign key to lookup.Phenology (phenologic stage of unknown plant)
UnknownPlant	PhenologyDescription	Description of unknown plant phenology
UnknownPlant	HabitatCharacteristics	Description of unknown plant's habitat
UnknownPlant	IdentifierID	Foreign key to ref.Personnel (lookup of MOJN personnel (temporary))
UnknownPlant	ConfirmedTaxonID	Foreign key to ref.Taxon (lookup of MOJN species)
VegetationInventoryEvent	ID	Primary key for this table
VegetationInventoryEvent	VisitID	Foreign key to data.Visit (information about individual sampling visits)
VegetationInventoryEvent	TransectID	Foreign key to data.Transect (information about each permanent transect)
VegetationInventoryEvent	StartTime	Time of day that data collection on vegetation inventory transect began
VegetationInventoryEvent	EndTime	Time of day that data collection on vegetation inventory transect was completed
VegetationInventoryEvent	Notes	Notes regarding the site visit
VegetationInventoryEvent	DataProcessingLevelID	Foreign key to lookup.DataProcessingLevel (indicates level of QA/QC that has been applied to data in a given table)
VegetationInventoryEvent	DataProcessingLevelDate	Date the Data Processing Level was changed
VegetationInventoryEvent	DataProcessingLevelNote	Notes for Data Processing Level Status
VegetationInventoryEvent	DateCreated	Date the record was created
VegetationInventorySpecies	ID	Primary key for this table
VegetationInventorySpecies	VegetationInventoryEventID	Foreign key to data.VegetationInventoryEvent (general information about a transect of vegetation species inventory)
VegetationInventorySpecies	TaxonID	Foreign key to ref.Taxon (lookup of MOJN species)
VegetationInventorySpecies	UnknownPlantCodeID	Foreign key to lookup.UnknownPlantCode (temporary codes assigned to unknown plants. unique only within a single spring visit.)
VegetationInventorySpecies	Notes	Notes about an individual species found in the vegetation inventory
Visit	ID	Primary key for this table
Visit	SiteID	Foreign key to data.Site (the locations contained in the sampling frame)
Visit	ProtocolID	Foreign key to ref.Protocol (reference to each version of the monitoring protocol)

Visit	VisitDate	Date monitoring visit occurred
Visit	StartTime	Time monitoring visit began
Visit	WindID	Foreign key to lookup.Wind (wind speed (Beaufort scale))
Visit	SkyConditionID	Foreign key to lookup.SkyCondition (amount of cloud cover observed)
Visit	Notes	Notes regarding the site visit
Visit	DataProcessingLevelID	Foreign key to lookup.DataProcessingLevel (indicates level of QA/QC that has been applied to data in a given table)
Visit	DataProcessingLevelDate	Date the Data Processing Level was changed
Visit	DataProcessingLevelNote	Notes for Data Processing Level Status
Visit	DateCreated	Date the record was created
VisitPersonnel	VisitID	Foreign key to data.Visit (information about individual sampling visits)
VisitPersonnel	PersonnelID	Foreign key to ref.Personnel (lookup of MOJN personnel (temporary))
VisitPersonnel	PersonnelRoleID	Foreign key to lookup.PersonnelRole (data management roles, from collection to QA/QC and certification)
VisitPersonnel	DateCreated	Date the record was created

Data Entry, Verification, and Validation

Data Entry

Data from paper data sheets will be entered into the MOJN Spring Vegetation database as soon after data collection as possible through an MS Access front-end. Ideally, this will be undertaken throughout the field season. Otherwise, it should occur in less than 2 months following the field season. Data entry should be completed by someone who participated in data collection, or is familiar with the project and data. The primary goal of data entry is to transfer the data from paper into the database with 100% accuracy. The database will be backed up regularly to maximize the ability to recover should irreversible errors or problems occur during the data entry session.

When the person entering the data finds a correctable error or omission on the field data sheet, this correction should be entered in the database and recorded on the field data sheet along with the correction date and the initials of the person who made the correction. Data entry should be viewed as an important step in the overall QA/QC process.

Data Verification

The Spring Vegetation database application will incorporate quality assurance/quality control (QA/QC) strategies to ensure data quality. The database design and the allowable value ranges assigned to individual fields within the data tables help to minimize the potential for data entry errors and/or the transcription of erroneously recorded data.

After the initial data entry process for a spring is completed, all of the records will be reviewed for consistency with hard-copy datasheets. This task should be completed by someone other than the person who completed the original data entry. The completion of data entry and data verification will

be tracked in the database. Any outstanding discrepancies between the database and the field data sheet should be clearly documented in the appropriate comments field in the database.

The data manager will supervise the verification of the geospatial component of the field data each season by completing a proximity analysis of any newly collected coordinates against the known stand and photo point coordinates.

When data verification is complete, the dataset is considered to have reached the “provisional” data processing level. The data processing levels referred to in this document are more fully described in “Certification Guidelines for Inventory and Monitoring Data Products” (National Park Service 2016).

Data Validation

The Protocol Lead and Data Management Team will collaboratively validate a given season’s dataset (i.e., ensure that the data make sense). Some validation methods have been incorporated into the database as queries or views. Other, more specific, validation routines are developed in collaboration with the Protocol Lead and will be executed in batch from the ‘R’ statistical software platform. The Data Management Team will work closely with the Protocol Lead to provide any needed database queries, reports, graphs, ‘R’ scripts or export file formats to assist with the overall validation.

Data Certification and Documentation

Once the data have undergone QC procedures, the Data Manager and Protocol Lead will complete the necessary accompanying metadata. Metadata are defined as structured information about the content, quality, condition, and other characteristics of a given dataset. Additionally, metadata provide the means to catalog and search among datasets, thus making them available to a broad range of potential data users.

The Protocol Lead and Data Manager will work collaboratively to fill out the MOJN Metadata Interview form (Appendix D). Any records that did not meet the documented quality standards in the validation process must be clearly identified in the metadata, which will be an FGDC and NPS compliant metadata record in XML format.

When data has undergone all QC procedures and metadata are complete, the dataset is considered to have reached the “accepted” data processing level. This is the highest data processing level that can be achieved until the approval of the full Quality Assurance Plan for this protocol.

Data Distribution

Prior to publication of any reports or data, MOJN staff will work with a staff member from each park represented in the dataset to complete a data sensitivity assessment. The results of this assessment will dictate the appropriate audience for the data: Park only, NPS only, or public. Redacted datasets and reports may be created when it is deemed that sensitive information should be obscured for one or more of these audiences. The sensitivity or “protected status” of species and location data will be tracked in the database following the guidance in the IMD document Minimum Standards for Network Projects (Frakes, 2017).

As part of the reporting cycle, summary reports and derived data products will be made available on the IRMA website Data Store (<http://irma.nps.gov/DataStore/>).

Data Maintenance and Archiving

Secure data archiving is essential for protecting data files from loss or corruption. Once the master project dataset and metadata are considered final for a field season, the Data Manager will place a copy of the dataset and the metadata record into the appropriate folder within the archive directory on the network server. These archived files will be stored in read-only format. Any subsequent changes made to this database must be documented in an edit log and in the metadata. In addition to the database copy in its native format, all tables will be archived in a comma-delimited ASCII format that is platform-independent. Additionally, a full copy of the project master dataset will be uploaded to the IRMA DataStore on an annual basis to ensure compliance with the Application Inventory Registry (AIR) requirements. This upload will be consistent with the guidance in *Loading/Linking Data for Application Inventory Registry (AIR) Compliance* (Dratch, 2017), including the creation of a link to the data in the NPS Protocol Tracking Tool (<https://irma.nps.gov/protocoltracking>).

Additional digital files to be archived include all digital photos associated with that field season, and any digital files associated with data analysis products and project reporting.

Hard-copy materials (e.g., datasheets, field notebooks) are scanned and will be stored in the network office for at least four years, and will eventually be moved to an NPS-approved repository for permanent storage.

Any editing of archived data must be documented in an edit log and accompanied by an explanation that includes pre-and post-edit data descriptions. This ensures that there are no unexplained discrepancies between the original datasheets and the archived data, or between different versions of archived datasets.

Prior to any changes to the database structure, a copy is stored with the appropriate version number to allow for tracking changes over time. Each additional version will be assigned a sequentially higher number. Frequent users of the data are notified of the updates and provided with a copy of the most recent version.

Revising the Protocol

The following guidelines ensure that changes to data collection and processing procedures are documented and retained throughout the entire lifespan of the long-term dataset, thus maintaining “line of sight”. Project staff should refer to these instructions when any changes to an approved protocol document are necessary.

Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by MOJN Inventory and Monitoring staff. An outside review is required for substantive changes in methods. Regional and national staff of the NPS and experts outside of the NPS with familiarity in vegetation monitoring and data analysis will be used to review major changes.

Record all changes to a DSVMP document (protocol narrative or SOP) in the document's revision history log, even minor edits like fixing typos or formatting changes. It is not necessary to record the specific edits made, rather just the fact that typos were fixed or formatting changes were made. For minor edits, record the same document version number in the revision history log. For actual protocol changes (e.g., changes in methods, equipment), assign a new version number in the revision history log. Depending on the significance of the changes, it may be okay to combine multiple changes in the same entry in the revision history log. Version numbers increase incrementally by tenths (e.g., version 1.1, version 1.2, etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). Record the previous version number, date of revision, author of the revision, and the reason for the changes along with the new version number (if applicable).

Data Management Task Timetable

Table 12.3. The yearly Spring Vegetation monitoring 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
	Ensure that project workspace is ready for use and GPS download software is loaded	Data Manager	by May 1
	Prepare and print field maps and data sheets	Project Lead /Data Management Team	by May 1
	Update and load data dictionary, background maps, and target coordinates into GPS units	Project Lead/Data Manager	by May 1
	Provide database/GPS training as needed	Data Management Team/Project Lead/Field Lead	May
	Train field crew in plant identification and field sampling protocols	Project Lead and/or Field Lead	May
	Examination and certification of field observer qualifications	Project Lead and/or Field Lead	May
Data acquisition	Collect field observations and position data during field trips	Technicians/ Volunteers	May-Jul
	Review data sheets after each day	Field Lead	daily
Data entry & processing	Enter data into working copy of the database	Technicians	after each tour
	Verification of accurate transcription as data are entered	Technicians	after each tour
	Periodic review of database entries for completeness and accuracy	Field Lead	As needed
Product development	Complete field season report	Project Lead / Field Lead	Jul-Aug
Product delivery	Send field season report to Data Manager	Project Lead / Field Lead	by Sep 1
Quality review	Quality review and data validation using database tools and R; Set DPL to "accepted" in database	Project Lead/Data Management Team	Jul-Oct
	Prepare coordinate summaries and/or GIS layers and data sets as needed for spatial data review and reports	Data Manager	by Sep 15
Metadata	Identify any sensitive information contained in the data set	Project Lead and Park Resource Manager	Aug-Oct
	Update project metadata records	Project Lead	Aug-Sept

Standard Operating Procedure (SOP) 13: Data Analysis and Reporting

Version 1.0

Revision History

Version #	Date of Revision	Revised By	Changes
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Reporting Overview

Three types of reporting are associated with the MOJN Spring Vegetation protocol: annual status reports, data trends reports, and resource briefs. All analysis and reporting of this protocol should be directly linked back to monitoring questions and the four long-term monitoring objectives of this protocol (the abbreviated objectives are monitor: status and trends of vegetation community, status and trends of invasive plants, status and trends of overstory, and status and trends of disturbance). While incorporating supplementary analysis that has ecological relevance is encouraged, the protocol objectives must be adequately addressed.

Annual Status Reports

Since field data collection occurs every year, we anticipate that MOJN will produce at least one annual status for this protocol each year. This means each park will receive a park-specific Annual Status Report for each year that monitoring occurs in the park. This will typically be at the 3 year interval described in the monitoring calendar (DSVMP Narrative Table 6), but may be more frequent if supplemental monitoring has occurred. The Analysis Reports will be published in the NPS Natural Resource Data Series (NRDS), and the certified data that are reported on will be made available to the parks through the [IRMA Data Store](#).

The Annual Status Report will include the following:

- A description of the fieldwork, including documentation of any deviations from the protocol, such as missed sites or measurements.
- General summary statistics and graphs for the core components of the protocol
- Quality assurance and quality control analyses

Trends Reports

Once all springs in a park have been sampled three times (9 years as scheduled), MOJN will prepare a Trends Report for that park. These reports will synthesize the information presented in the Annual Data Summary Reports and provide statistically rigorous assessments of trends in the data. After the first report, they will be prepared every 9 years. In other words, since the monitoring schedule specifies that all springs will be visited every 3 years, and those undergoing monitoring will be monitored every year, we will have at least 3 years of new monitoring data to create a long-term

trend report. The Trends Reports will be published in the peer-reviewed NPS Natural Resource Report (NRR) series.

In addition to summarizing the collected data, the Data Synthesis Reports will include the following information:

- An overview of the protocol status and major accomplishments
- The status and trend analysis results
- A summary of relevant MOJN data from related protocols such as Selected Large Springs
- A discussion of results, including management implications
- An in depth discussion and analysis of quality assurance and quality control
- Recommendations for future improvements to the protocol or data management strategies if needed (e.g. update sampling schedule based on actual trends, add GIS tools that were not developed at time of protocol development, and new analytical procedures that we deem relevant after initial trends are detected).

Resource Briefs

Along with Status Reports, MOJN will prepare a 1-2 page resource brief that will provide a concise summary of the status of the protocol. These resource briefs will be provided to parks and written in a style that will allow interpretative staff to directly use relevant sections to tell accurate, science-based stories about the parks. Associated electronic materials, such as figures, can also be made available to parks, if needed.

Resource Briefs may also be created to accompany Annual Status Reports when there is a story that merits quicker and broader distribution than it would otherwise receive.

Status Analysis

Status analysis is used in this protocol to describe the current state of the spring vegetation and may be obtained for all parameters of interest in this protocol. Status analysis will be contained in the Annual Status Reports and are included in Resource Briefs when appropriate. Status analyses include, at the minimum, basic summary statistics such as the calculation of the mean, median, variance, minimum, maximum, sample size, and range, as well as appropriate exploratory analysis. Standard summary statistics should be presented in figures and tables, and should include measures of central tendency and spread.

In addition to summary statistics, the Protocol Lead will conduct exploratory analysis to share relevant findings with the parks, and to conduct a basic check-in with the protocol. These procedures are important to ensure our data meet the underlying assumptions of statistical techniques (e.g. assumption of normality), help reduce type I and II errors, and minimize the risk of formulating incorrect ecological conclusions. Exploratory data analyses should be used to refine existing hypotheses and they can help generate new hypotheses about patterns and processes. Some examples of parameters that should be investigated in status analysis and exploratory analysis include:

- Mean % cover across transects of each species grouped by stratum (bottom, middle, top) and live/dead status.

- % cover of any species of interest, total % veg cover, % soil cover
- % cover of each disturbance class, total % cover of disturbance
- Species richness (total # of species), native species presence/absence, community diversity indices (such as Shannon Diversity Index)
- Total tree species richness; total tree species diversity; abundance of a particular tree species, abundance of tree age classes, proportion live and dead, summarize for all species, and each species
- Presence/absence and abundance of invasive species

To understand if the sample effort adequately estimates the actual species richness at a spring, data should be displayed using species accumulation curves (see example Figure 13.1). This is particularly true in the implementation years when the first full species inventory is conducted. These figures can be interpreted to determine if the sampling effort is sufficient to capture the estimated species diversity at each spring. Also, if this curve saturates before the currently required sample effort, then the sample size can be reduced and sampling resources can be reallocated elsewhere. For example, if the species accumulation curve begins to asymptote at $n_t = 7$ transects, and the protocol requires that we sample vegetation at 10 transects, we can reduce the number of transects to $n_t = 7$.

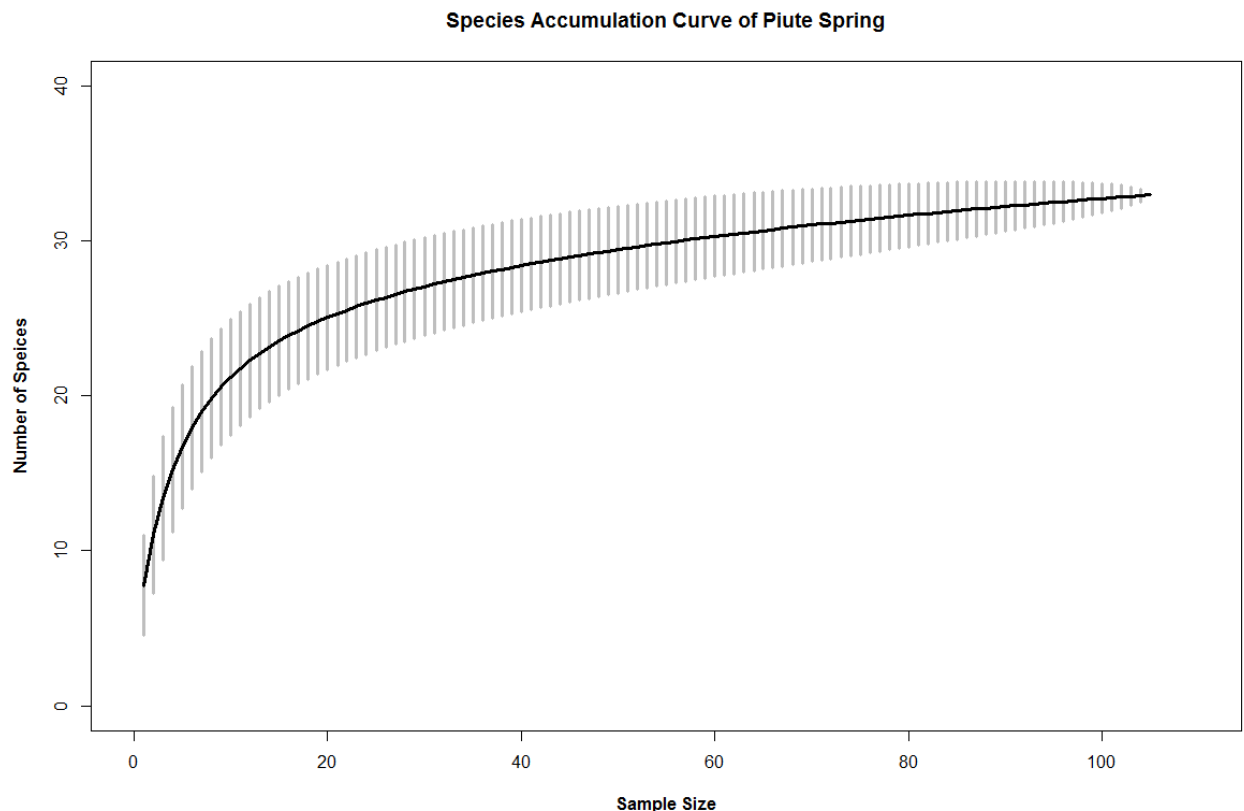


Figure 13.1. Example figure (using simulated data) of a species accumulation curve that will be created in the summary statistics. Species accumulation curves are useful figures to estimate the number of species detected per sampling effort. In this case, sampling effort is the number of samples. As the

number of samples increases, the species richness increases asymptotically. As the curve levels off (in this example, around 25 samples), the observers can be confident that their sampling effort sufficiently captures the species diversity at the sample location. The Y axis can use any measurement of sample effort, including amount of time invested sampling, or the sample size (the Project Lead should consider both of these units).

Sample R code to create a species accumulation curve using the vegan package in R is provided below. PIUTE data below is a “.csv” file where the columns are species names, the rows are transect numbers, and the cells are the abundance of each species at a transect.

```
Library(vegan)
```

```
PIUTE.rare<-specaccum(PIUTE,"rarefaction",permutations=1000)
```

```
plot(PIUTE.rare, lwd=3,xlab="Sample Size", ylab="Number of  
Speices",main="Species Accumulation Curve of Piute Spring")
```

Trend Analysis

Trend analyses show how vegetation at springs are changing through time. These analyses are in-depth and will be conducted once sufficient data has accumulated to estimate trends. Trends results are summarized after 3 or more years of data collection (9 calendar years). Trend analyses will be presented in figures and modeling output; raw data is available for park managers to view. Data are analyzed by species and spring. Trend analyses will be included in the Trends Reports and Resource Briefs when appropriate.

Trend analysis will directly address the four measurable objectives: trends of the vegetation community, trends of invasive plants, trends of overstory, and trends of disturbance (see Background section for expanded definitions). We suggest conducting mixed effects models to address the measureable objectives.

Mixed effect models are useful to determine if and to what extent they are changing over time. Mixed effect models allow both fixed effects (things that affect all samples consistently; for example in this case, time) and random effects (factors that vary from sample to sample; for example in this case, transect number). Using a mixed effects model, the Project Lead can use relevant temperature, precipitation, and other climatic variables, as well as data collected in SLS. The usefulness of these variables should be determined using backwards elimination and only relevant predictors (and with the appropriate transformations) should be included in the model.

For each vegetation variables of interest, the null hypothesis is the same. The null hypothesis (H_0) that there is no difference in [the vegetation variable of interest] within individual springs will be tested with a repeated measures nested analysis of variance (ANOVA). Initially the trend analyses will be performed on data from only two points in time, however as more data becomes available (i.e. after three sampling periods) the trend analyses will be conducted using a mixed effects model designed to evaluate trajectories. All analyses will be performed in the statistical analysis freeware program R.

The following mixed model was derived based on van Leeuwen et al. (1996)

$$y_{ij} = \mu + w_j \beta_i + a_{j(i)} + \gamma_i + w_j t_{k(i)} + e_{j(ik)}$$

where:

y = the vegetation variable of interest (e.g. species richness at a spring, the overstory composition at a spring....)

$i = 1, \dots, 1$ indexes the transects within a spring

$j = 1, \dots, j_i$ indexes the j^{th} survey year within the i^{th} transect

μ = fixed intercept of the linear time trend

w_j = constant representing the j^{th} year (covariate) which is centered such that the year of least variation occurs at $w_j = 0$

β_i = the fixed slope of the i^{th} transect within a spring

$a_{j(i)}$ = random effect of the j^{th} year in the i^{th} transect, assumed independent and identically

distributed as $\text{IID } N(0, \sigma_\alpha^2)$

γ_i = fixed effect of the i^{th} transect

$e_{j(i)}$ = unexplained error, assumed independent and identically distributed as

distributed as $\text{IID } N(0, \sigma_\varepsilon^2)$

An example of how to run a similar mixed model in R is provided in the code below using the package *lmer*.

```
library(lmer)

trendfit.BySpring<-lmer(Y ~ wYear * Spring + (-1+Spring
Spring:wYear|Transect) + (-1+ Spring|Year), data= SpRichnessMean)

summary(trendfit.BySpring)
```

If disturbance events occurred at springs, data will be modeled before and after the disturbance using repeated measures ANOVA to understand how the plant community changed before and after the disturbance event. This method is useful for sites that are permanent where measures are taken at the sample place using the same methods over time. Using repeated measures ANOVA, the Project Lead can use relevant temperature, precipitation, and other climatic variables, as well as data collected in SLS. The usefulness of these variables should be determined using backwards elimination and only relevant predictors should be included.

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Appendix A: Status and Trend Invasive Species for the MOJN Parks

Table A.1. Invasive plant species for status and trends monitoring at Death Valley National Park.

Species	Common name	Invasion phase	MOJN rating	Habitat of concern
<i>Bromus rubens</i>	Red brome	Equilibrium	High	Upland and Riparian
<i>Bromus tectorum</i>	Cheatgrass	Spread/Equilibrium	High	Upland and Riparian
<i>Erodium cicutarium</i>	Redstem filaree	Equilibrium	Medium	Upland and Riparian
<i>Phoenix dactylifera</i>	Date palm	Spread	Medium	Riparian
<i>Salsola</i> spp. (<i>S. tragus</i> and <i>S. paulsenii</i>)	Russian thistle	Spread/Equilibrium	Medium	Upland and Riparian
<i>Schismus</i> spp. (<i>S. arabicus</i> and <i>S. barbatus</i>)	Mediterranean grass	Equilibrium	Medium	Upland and Riparian
<i>Sisymbrium irio</i>	London rocket	Spread	Medium	Upland and Riparian
<i>Tamarix</i> spp. (<i>T. ramosissima</i> , <i>T. chinensis</i> , <i>T. aphylla</i> , <i>T. parviflora</i>)	Saltcedar	Spread/Equilibrium	High	Riparian

Table A.2. Invasive species for status and trends monitoring at Great Basin National Park.

Species	Common name	Invasion phase	MOJN rating	Habitat of concern
<i>Bromus inermis</i>	Smooth brome	Spread	Medium	Riparian
<i>Bromus tectorum</i>	Cheatgrass	Equilibrium	High	Upland and Riparian
<i>Cirsium</i> spp. (<i>C. arvense</i> , <i>C. vulgare</i>) and <i>Carduus nutans</i>	Thistles	Spread	High	Riparian
<i>Erodium cicutarium</i>	Redstem filaree	Equilibrium	Medium	Upland and Riparian
<i>Melilotus</i> spp. (<i>M. officinale</i> , <i>M. albus</i>)	Sweetclovers	Spread	Medium	Upland and Riparian
<i>Salsola</i> spp. (<i>S. tragus</i> and <i>S. paulsenii</i>)	Russian thistle	Spread/Equilibrium	Medium	Upland and Riparian
<i>Sisymbrium altissimum</i>	Tumble mustard	Spread	Medium	Upland and Riparian

Table A.3. Invasive species for status and trends monitoring at Joshua Tree National Park.

Species	Common name	Invasion phase	MOJN rating	Habitat of concern
<i>Brassica tournefortii</i>	Sahara mustard	Spread	High	Upland and Riparian
<i>Bromus rubens</i>	Red brome	Equilibrium	High	Upland and Riparian
<i>Bromus tectorum</i>	Cheatgrass	Spread/Equilibrium	High	Upland and Riparian
<i>Erodium cicutarium</i>	Redstem filaree	Equilibrium	Medium	Upland and Riparian
<i>Schismus</i> spp. (<i>S. arabicus</i> and <i>S. barbatus</i>)	Mediterranean grass	Equilibrium	Medium	Upland and Riparian
<i>Sisymbrium irio</i>	London rocket	Spread	Medium	Upland and Riparian
<i>Tamarix</i> spp. (<i>T. ramosissima</i> , <i>T. chinensis</i> , <i>T. aphylla</i> , <i>T. parviflora</i>)	Saltcedar, tamarisk	Spread/Equilibrium	High	Riparian

Table A.4. Invasive species for status and trends monitoring at Lake Mead National Recreation Area.

Species	Common name	Invasion phase	MOJN rating	Habitat of concern
<i>Brassica tournefortii</i>	Sahara mustard	Spread	High	Upland and Riparian
<i>Bromus rubens</i>	Red brome	Equilibrium	High	Upland and Riparian
<i>Bromus tectorum</i>	Cheatgrass	Spread/Equilibrium	High	Upland and Riparian
<i>Erodium cicutarium</i>	Redstem filaree	Equilibrium	Medium	Upland and Riparian
<i>Schismus</i> spp. (<i>S. arabicus</i> and <i>S. barbatus</i>)	Mediterranean grass	Equilibrium	Medium	Upland and Riparian
<i>Sisymbrium irio</i>	London rocket	Spread	Medium	Upland and Riparian
<i>Tamarix</i> spp. (<i>T. ramosissima</i> , <i>T. chinensis</i> , <i>T. aphylla</i> , <i>T. parviflora</i>)	Saltcedar	Spread/Equilibrium	High	Riparian

Table A.5. Invasive species for status and trends monitoring at Mojave National Preserve.

Species	Common name	Invasion phase	MOJN rating	Habitat of concern
<i>Brassica tournefortii</i>	Sahara mustard	Spread	High	Upland and Riparian
<i>Bromus rubens</i>	Red brome	Equilibrium	High	Upland and Riparian
<i>Bromus tectorum</i>	Cheatgrass	Equilibrium	High	Upland and Riparian
<i>Erodium cicutarium</i>	Red stem filaree	Equilibrium	Medium	Upland and Riparian
<i>Salsola</i> spp. (<i>S. tragus</i> and <i>S. paulsenii</i>)	Russian thistle	Spread/Equilibrium	Medium	Upland and Riparian
<i>Schismus</i> spp. (<i>S. arabicus</i> and <i>S. barbatus</i>)	Mediterranean grass	Equilibrium	Medium	Upland and Riparian
<i>Sisymbrium irio</i>	London rocket	Spread	Medium	Upland and Riparian
<i>Tamarix</i> spp. (<i>T. ramosissima</i> , <i>T. chinensis</i> , <i>T. aphylla</i> , <i>T. parviflora</i>)	Saltcedar	Spread/Equilibrium	High	Riparian

Table A.6. Invasive species for status and trends monitoring at Grand Canyon-Parashant National Monument.

Species	Common name	Invasion phase	MOJN rating	Habitat of concern
<i>Bromus rubens</i>	Red brome	Equilibrium	High	Upland and Riparian
<i>Bromus tectorum</i>	Cheatgrass	Equilibrium	High	Upland and Riparian
<i>Erodium cicutarium</i>	Red stem filaree	Equilibrium	Medium	Upland and Riparian
<i>Schismus</i> spp. (<i>S. arabicus</i> and <i>S. barbatus</i>)	Mediterranean grass	Equilibrium	Medium	Upland and Riparian
<i>Tamarix</i> spp. (<i>T. ramosissima</i> , <i>T. chinensis</i> , <i>T. aphylla</i> , <i>T. parviflora</i>)	Saltcedar	Spread/Equilibrium	High	Riparian

Appendix B: Field Data Sheets

Site Overview

Spring Vegetation

Start Time (24H):

GPS Unit:

Sky Condition:

Spring Category:

General site notes:

End Time (24H):

Zone:

Wind (0 - 10):

Transect Length (m):

15

Observer:

Datum:

Weather Notes:

LPI Distance Between Points (m):

Park:

Spring:

Date:

Updates/corrections to access directions:

Camera ID #:

Memory Card #:

Repeat Photos

Photo	File #	UTM X	UTM Y	Notes
Overview				

Site Overview Spring Vegetation

Park: _____ Spring: _____
Date: _____

Transect Number	Location	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					
Transect Number	Coordinates	UTM X	UTM Y	Label	Location on Tape (m)	Notes
Meters from Source	Start Marker					
	Thalweg					
	End Marker					

Line Point Intercept

Spring Vegetation

Park: _____ Spring: _____

Date: _____ Transect: _____

Start Time (24H): _____ End Time (24H): _____ Observer: _____ Recorder: _____

Meter: _____	Meter: _____	Meter: _____	Meter: _____	Meter: _____					
Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV					
Plant	Strata	Plant	Strata	Plant	Strata	Plant	Strata	Plant	Strata
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B

Surface: _____ Surface: _____ Surface: _____ Surface: _____ Surface: _____
Disturb.: _____ Disturb.: _____ Disturb.: _____ Disturb.: _____ Disturb.: _____

Meter: _____	Meter: _____	Meter: _____	Meter: _____	Meter: _____					
Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV					
Plant	Strata	Plant	Strata	Plant	Strata	Plant	Strata	Plant	Strata
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B

Surface: _____ Surface: _____ Surface: _____ Surface: _____ Surface: _____
Disturb.: _____ Disturb.: _____ Disturb.: _____ Disturb.: _____ Disturb.: _____

Meter: _____	Meter: _____	Meter: _____	Meter: _____	Meter: _____					
Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV					
Plant	Strata	Plant	Strata	Plant	Strata	Plant	Strata	Plant	Strata
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B
	T / M / B		T / M / B		T / M / B		T / M / B		T / M / B

Surface: _____ Surface: _____ Surface: _____ Surface: _____ Surface: _____
Disturb.: _____ Disturb.: _____ Disturb.: _____ Disturb.: _____ Disturb.: _____

Soil surface codes

S: bare soil
SA: sand
P: playa
C: crust
LC: lichen
M: moss
D: duff
W: woody debris
SR: sm. rock (2mm-10cm)
LR: large rock
BR: bedrock
SL: scat, livestock
SW: scat, wildlife
VM: vegetative mat

Disturbance codes

ANT: ant mound
BK: bicycle
HMT: human track/trail
LT: livestock track/trail
MV: motor vehicle
WSH: drainage area
WLE: wildlife excavation
WLT: wildlife track
TR: trash
HMO: other anthropogenic
UNK: unknown

Strata

T: top strata ()
M: middle strata ()
B: bottom strata ()

Accuracy

EX: exact
AP: approximate
NV: not visible

Spring Vegetation

Date: _____
Transect: _____

Recorder: _____

If tallying, write and circle total counts when finished.

[illegible]

Spring Vegetation

Start Time (24H): _____

End Time (24H): _____

Observer: _____

Recorder: _____

[illegible]

Unknown Plant Species

Spring Vegetation

Park: _____ Spring: _____

Date: _____

Start Time (24H): _____ End Time (24H): _____ Observer: _____ Recorder: _____

Identification Info

Collected? ☐ Y / ☐ N Best guess: _____ Scale (in.)

Unknown plant code: UNKS - _____ 0—

The format for the unknown plant code is: UNKS-[collection letter] where collection letter starts at "A" and increments for each different unknown species within a site. For example, the first unknown species found at a site would be UNKS-A, and the second would be UNKS-B. When recording plant codes on datasheets, use this code in place of the USDA plants code.

General Description: _____ Most salient feature: _____

Leaf: Type (compound/simple, arrangement, etc.): _____ 1—

Margin: _____ 2—

Other (pubescence, sap, stipules, etc.): _____

Stem characteristics (shape, pubescence, bud): _____ 3—

Phenology stage (circle one): _____ Phenology description: _____

- 1 leaf buds formed/ leafing out
- 2 fully open leaves
- 3 reproductive/flowering
- 4 fruit formation/ripening
- 5 dead/senescent

General- and microhabitat characteristics: _____ 5—

Photos (use scale on right side of page if needed)

Camera ID #: _____ Memory Card #: _____

Transect	Point (m)	File #	Notes
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			
1 / 2 / 3			

Unknown Plant Slips

Spring Vegetation

Park: _____ Spring Name: _____ Date (mm/dd/yyyy): _____
Unk. plant code: UNKS - _____ Best guess: _____ Collected by: _____
Notes: _____



Park: _____ Spring Name: _____ Date (mm/dd/yyyy): _____
Unk. plant code: UNKS - _____ Best guess: _____ Collected by: _____
Notes: _____



Park: _____ Spring Name: _____ Date (mm/dd/yyyy): _____
Unk. plant code: UNKS - _____ Best guess: _____ Collected by: _____
Notes: _____



Park: _____ Spring Name: _____ Date (mm/dd/yyyy): _____
Unk. plant code: UNKS - _____ Best guess: _____ Collected by: _____
Notes: _____



Park: _____ Spring Name: _____ Date (mm/dd/yyyy): _____
Unk. plant code: UNKS - _____ Best guess: _____ Collected by: _____
Notes: _____



Park: _____ Spring Name: _____ Date (mm/dd/yyyy): _____
Unk. plant code: UNKS - _____ Best guess: _____ Collected by: _____
Notes: _____



Spring Vegetation

Spring: _____

Date: _____

Photographer: _____

Photo Types:

M: Monitoring photo. Anything that is of potential scientific value, even if it is fairly anecdotal.

L: Library photo. Any photos that might be worth including in the MOJN photo library for use in newsletters, powerpoints, slideshows. Photos of field crew, nice nature shots, etc. Monitoring photos and library photos are not mutually exclusive.

[illegible]

Point Intercept (Extra)

Spring Vegetation

Park: _____ Spring: _____
Date: _____

Transect: _____	Transect: _____	Transect: _____	Transect: _____	Transect: _____
Meter: _____	Meter: _____	Meter: _____	Meter: _____	Meter: _____
Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV
Plant	Plant	Plant	Plant	Plant
Strata	Strata	Strata	Strata	Strata
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
Surface: _____	Surface: _____	Surface: _____	Surface: _____	Surface: _____
Disturb.: _____	Disturb.: _____	Disturb.: _____	Disturb.: _____	Disturb.: _____

Transect: _____	Transect: _____	Transect: _____	Transect: _____	Transect: _____
Meter: _____	Meter: _____	Meter: _____	Meter: _____	Meter: _____
Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV	Accuracy: EX / AP / NV
Plant	Plant	Plant	Plant	Plant
Strata	Strata	Strata	Strata	Strata
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
T / M / B	T / M / B	T / M / B	T / M / B	T / M / B
Surface: _____	Surface: _____	Surface: _____	Surface: _____	Surface: _____
Disturb.: _____	Disturb.: _____	Disturb.: _____	Disturb.: _____	Disturb.: _____

Appendix C: Example Site Information Sheet

GRBA 204

Site Location Coordinates: 11S

Easting	733842	Northing	4309963
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Latitude	38°54'26.80"N	Longitude	114°18'11.54"W
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Map Name	Mt. Washington Area D / GRBA 204
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Directions:

1) From Mt.Washington A Parking, follow the road/ trail north for 0.48 miles, then turn east and travel for 0.81 miles until you reach Intersection 1.

Intersection 1	Easting	733291	Northing	4308960
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2) From Intersection 1, travel north for 0.71 miles until you reach Intersection 2.

Intersection 2	Easting	733383	Northing	4310006
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3) From Intersection 2, travel east for 0.14 miles until you reach Mt.Washington D2 Trailhead 204.

Mt.Washington D2 Trailhead 204	Easting	733582	Northing	4309990
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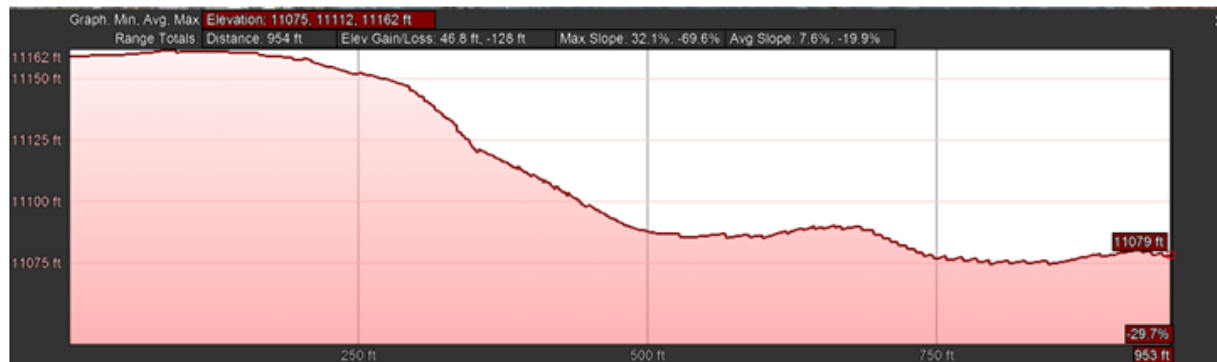
4) From Mt.Washington D2 Trailhead 204, travel east 0.17 miles (downhill) to GRBA 204.

GRBA 204	Easting	733842	Northing	4309963
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Estimated Walking Distance: **0.27 km / 0.17 mi** **Gain: 50 ft.**

Point Name	Type	EASTING	NORTHING
Mt.Washington A Parking	Start Point/ Parking Area	732158	4308622
Intersection 1	Intersection	733291	4308960
Intersection 2	Intersection	733383	4310006
Mt.Washington D2 Trailhead 204	Trailhead	733582	4309990
GRBA 204	Site Location	733842	4309963

Trail Topography: From Mt. Washington C3 Trailhead to GRBA 204.



Appendix D: Metadata Interview Form



Project Metadata Interview (v 1.0)

- 1) Title of the project or dataset:
- 2) Creator of the dataset:
- 3) Who else should be credited as a contributor to the dataset:
- 4) Brief description or abstract for the dataset:
- 5) Time period represented in the dataset
- 6) Is it expected that this dataset will be updated, and if so, how frequently?
- 7) Keywords for this dataset:

Thematic	
Place	
Temporal	
Taxonomic	

- 8) List any related datasets that should be cross-referenced to this dataset:
- 9) If species information was collected, what taxonomic authority or field guide was used for identification?:
- 10) If any voucher specimens were collected, please describe:
- 11) If the dataset was developed using an analytical tool or model, please provide a reference or url.
- 12) Describe the FIELD METHODS used in collecting this data, or reference a published protocol or SOP
- 13) Describe the LABORATORY METHODS used in collecting this data, or reference a published protocol or SOP
- 14) Describe the STATISTICAL AND ANALYTICAL METHODS used in preparing this data, or reference a published protocol or SOP
- 15) Describe the QUALITY ASSURANCE AND QUALITY CONTROL MEASURES taken to ensure that the data are accurate, or reference a published protocol or SOP
- 16) if spatial data is included in this dataset, describe the geospatial data collection and processing steps, or reference a published protocol or SOP
- 17) Describe the fields in each file or table including field size, data type, and domain (enumerated, range, codeset) or reference a published data dictionary
- 18) Additional advice or caveats for potential users of this dataset

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS, October 2018

National Park Service
U.S. Department of the Interior



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