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Natural Resource Stewardship and Science

Terrestrial Vegetation Monitoring Protocol for the Mediterranean Coast Network—Cabrillo National Monument, Channel Islands National Park, and Santa Monica Mountains National Recreation Area

Standard Operating Procedures, Version 1.0

Natural Resource Report NPS/MEDN/NRR—2016/1296.1



ON THE COVER
Field technician recording data on a line-point transect for Terrestrial Vegetation monitoring. (T. Sagar)

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Overview

These Standard Operating Procedures are one part of a two-part protocol for monitoring terrestrial vegetation in the Mediterranean Coast Network. The second part of the protocol is the narrative:

Tiszler, J., D. Rodriguez, K. Lombardo, T. Sagar, L. Aguilar, L. Lee, T. Handley, K. McEachern, L. Starcevich, M. Witter, T. Philippi, and S. Ostermann-Kelm. 2016. Terrestrial vegetation monitoring protocol for the Mediterranean Coast Network—Cabrillo National Monument, Channel Islands National Park, and Santa Monica Mountains National Recreation Area: Narrative, version 1.0. Natural Resource Report NPS/MEDN/NRR—2016/1296. National Park Service, Fort Collins, Colorado.

National parks in the Mediterranean Inventory and Monitoring Network:

Cabrillo National Monument (CABR)

Channel Islands National Park (CHIS)

Santa Monica Mountains National Recreation Area (SAMO)

SOP 1: Preparations for the Field Season

Version 1.0 (September 2016)

1.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 1 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

1.2 Overview

This SOP describes tasks that need to be completed prior to each season's hiring, training, and field work. Table 1.1 shows the annual cycle of activities.

Table 1.1. Annual cycle of activities.

		Responsible Party			
Month	**Activity**	**CHIS**	**SAMO**	**CABR**	**SOP**
January–February	Prepare field equipment, datasheets, and site visit information packages	M	B	P, S	1
	Coordinate planned field work with cooperating land mgmt. agencies	M	B	P	1 (15)
	Recruit Interns, complete training and safety documents	M	B, E, R	P	1,2,3,4
	Establish new plots	M	B, E	P, S	4,5
	Monitor vegetation plots	M	B Interns		4,6,7,8
March–June (July)	Monitor vegetation plots	M Intern	B, E, Interns	P, S	4,6,7,8
July	Data entry and verification	M Intern	B, E, Interns	P, S Vols.	9,10
August	Prepare internal logistics report, plan staffing requirements and budget for new fiscal year, and revise SOPs as needed	M	B, E	P, S	11,16
September	Data certification and archiving, metadata production	D	B, D	P, D	12,13
October	Data analysis of current year's results	D	B, E, D	P, D	14
November	Prepare annual report	D	B, E, D	P, D	Protocol Narrative App. E
	Submit research permit requests		B, E		15

CHIS M = Monitoring Botanist
SAMO B = MEDN/SAMO Botanist, E = Plant Ecologist, R = Restoration Ecologist
CABR P = Plant Biologist, S = Other Natural Resource Staff (Vols. = volunteers)
All Parks D = MEDN Database Manager

1.3 General Preparation and Review

The program leader at each MEDN park will be responsible for all aspects of preparation for the field season at his/her park. Preparations include:

1. **Recruit interns to assist with field sampling.** Recruitment will be done through the park Volunteer Coordinator as well as through contacts at local universities and community colleges. If funding is available, Student Conservation Association or seasonal employees may be hired.
2. **Review protocol narrative and all SOPs.** Understand the goals and procedures of the monitoring program and begin preparations for training and field surveys. Discuss with other personnel involved in monitoring any recent changes to the sampling design or protocol. If a change has been implemented since the last field season, confirm that all field forms, databases, and appropriate sections in relevant SOPs have been updated. Changes to the procedures described in the approved protocol should be discussed with the I&M Program Manager and the Program Lead at each park before being implemented.
3. **Begin preparations.** Discuss the season's objectives and schedules with I&M Program Manager and Data Manager. Develop a timeline and field schedule based on the current year's needs and outline responsibilities of individual crew members.
4. **Contact partner agencies and parks.** Contact appropriate land managers and 'sister' agencies to discuss any changes in their policy for researchers or specific conditions that may have changed since the last field season (e.g., sites or areas that may have been closed). Process permit requests, if needed, or locate and copy existing research permits for cooperating land manager, if they are current. For permit process, see SOP 15.
5. **Check on housing for field staff**. Discuss availability of intern dormitory space or park housing with the park housing manager. It is best to make transportation/housing and vehicle reservations as soon as the field schedule is known, as the earlier the reservation, the better the chance that space will be available.
6. **Review field notes, reports, and project log from previous sampling season. For each of the plots to be sampled, review available documents.** At the end of each park sampling effort, the Project Lead will write a brief (3–5 page) internal logistics report, to include a discussion on the general field conditions of the period, access issues, and possible suggestions for improving the efficiency of the program. When plot locations are resampled, refer to the plot's original "Transect Establishment/Revisit" form, which contains useful relocation details and orientation specifics.
7. **Print and review the park specific plant species list.** The park-specific list can be printed from the database. Review the species that were previously encountered at each sampling location, and collect relevant floras, guidebooks, and keys for the area.
8. **Identify a list of point coordinates for all plots to be sampled.** The beginning point (A) and the bearing to the end point (B) of the existing transect will be available in shapefile format and should be loaded onto GPS units.
    - At CHIS, additionally, print a paper list of the actual marker coordinates for previously sampled sites, as well as any new sites to be added during any particular island tour.
    - At SAMO/CABR, transect points will be loaded and deleted onto GPS unit daily.

9. **Prepare site reference packets.** Site reference packets are prepared for each plot. Each packet includes pertinent general information as well as information specific to each plot, as described below.

   General information

   - Pertinent SOPs. These include SOPs 3–8, which outline safety concerns, establishing and relocating plots, vegetation community type assessment protocol, monitoring protocol, and necessary information to record for voucher collection.
   - Map (Datum NAD83) that shows the transect points in landscape context as well as roads and trails travelled to the plot.
   - Field forms.

   Transect establishment/revisit

   - Transect schematic
   - Complete species list with codes
   - Species list from the most recent visit to the transect
   - Emergency contact information (Emergency/Assistance Contacts form)
   - Random number table

   Site reference packet for plots also includes the following forms:

   - Line-point intercept
   - 1 × 5 m belt plot
   - 1 × 30 m belt plot

   Site-specific information

   - Directions to the plot, including cross-country route taken to the plot.
   - SOP 7 explains data collection (plot reading) and SOP 8 explains how to collect vouchers.

10. **Print and copy the field data forms.** The field data forms are included in Appendix A. Print enough field datasheets for the number of transects to be read during the day or in the case of CHIS, for a complete island tour. If the forecast is for substantial rainfall during the dates of scheduled island visit, consider delaying the trip.
11. Print approximately 5% of the data forms onto Rite-in-the-Rain paper. Print the transect diagram sheet and the transect checklist, as well as a cumulative species list from previous years for each transect.
12. Make sure to bring out also the paper datasheets for both the shrub and tree protocol monitoring, if those protocols are being done in addition to the basic monitoring protocol. Even when you are planning on entering monitoring data into a handheld computer, bring paper datasheets with you as a backup in case the handheld computer fails or rain precludes the use of the handheld computer.

13. **Checklist from the previous year transect stakes.** Review the transect checklists from the previous year for the sites you are visiting. On the Transect Establishment/Revisit datasheet, you will see notes regarding the condition of the stakes marking the transect. At times, due to deterioration, human intervention, or erosion, the stakes marking the end points of each transect may need to be replaced. If noted on the transect revisit datasheet that a stake needs to be replaced, stamp one of the replacement angle aluminum stakes kept at the storage with the proper transect number and A (begin transect) or B (end transect) designation. For example the replacement end stake for transect 35 on Santa Cruz Island would be stamped SCI VT35B. A die set is kept in each MEDN park's headquarters for such a purpose. Remember to include the replacement stake in the assembled gear, along with a 2 ½ lb sledgehammer.
14. **Calibrate instruments and check for integrity.** Equipment, such as tapes, tripods, and measuring cylinders should be checked for structural integrity and replaced, if necessary. Check radios and GPS units, and replace batteries if needed.
15. **CHIS gear transport.** At CHIS, once the gear has been gathered and inspected, place it in a plastic cargo box or tote with locking lid for transport to the backcountry entry point. If going by boat, use a thick garbage bag as a liner to prevent water from getting on to the field equipment.
16. **Reserve training facilities and equipment.** Reserve training room, power point projector, and laptop computer for the week of orientation and training.

1.4 Scheduling Field Work

- **Field crew**

  CABR: Monitoring efforts in CABR will require one crew (team lead/reader and scribe), with possible assistance from CABR or SAMO for 1–3 tours. Typically, four to five transects can be completed in a day. Crew members will work normal park hours.

  CHIS: Monitoring efforts will require one field crew (team lead/reader and scribe), with possible assistance from CABR or SAMO for 1–3 tours. Typically, four to five transects can be completed in a day. Crew members will be asked to work the island schedule as determined by the crew lead (see Preliminary field schedule and CHIS transportation schedule below).

  SAMO: Monitoring efforts will require two field crews of one team lead/reader and one observer each. Each crew will consist of one experienced park employee and one intern. Typically, one to two transects at SAMO, can be completed by a crew in a day, depending on travel time. Crew members will be asked to work a schedule consisting of four consecutive 10-hour days, followed by 3 days off. However, this may change as needs dictate.

- **Vehicles**

  CHIS: One 4X SUV vehicle is needed on each island for the monitoring work.

  SAMO: Two 4X SUV vehicles are needed for the vegetation monitoring.

  CABR: One vehicle of any type is occasionally needed. Plots can either be reached by walking or by a short drive.

- **Preliminary field schedules will be drawn up prior to the start of sampling.** Surveys at different park lands will be timed to best capture optimal phenology (i.e., when most annual species are flowering or in fruit). Schedules will include days for crews to conduct data management and to arrange logistics and scheduling.
- **CHIS transportation schedule.** Because Channel Islands National Park has islands, field work travel arrangements and logistics are different from the Mediterranean network mainland parks. The length of an island visit or tour is predicated on the availability of transportation to each of the islands. Through the park's transportation division there is a park sponsored trip to each island once a week. This park travel is usually by boat. However, access to San Miguel Island (SMI) is typically by plane through the park's concessionaire for air travel, Channel Islands Aviation (CIA), or less frequently, Aspen Helicopter, Inc.

  Because of the normal once-a-week transportation schedule, the normal tour on an island is usually one week. This is especially true for the outermost islands within the park: Santa Barbara Island (SBI), Santa Rosa Island (SRI), and San Miguel Island. For the islands closer to Ventura—Anacapa Island (ANI) and Santa Cruz Island (SCI)—there are greater opportunities for shorter length stays due to a higher frequency of visits to each of those islands through the public boat concessionaire, Island Packers (IPCO).
- **CHIS transportation reservation.** No matter which of the avenues used to access any of the islands, reservations must be made through park dispatch to secure a place either on a park boat, concessionaire boat, or on a concessionaire plane. Travel on a park boat on a regularly scheduled run is paid through the park's general transportation account, but air travel or use of a park boat outside the normal travel schedule will require funding from a separate account or outside funding source.

  To make a transportation reservation, the field crew lead must call, visit, or email dispatch and provide them with information regarding the island that the crew will visit, the dates of travel to and from the island, and if required, an account code. For all travel beyond the normally scheduled park transportation, the crew will need to fill out the proper travel form (D-I1) and submit that along with the travel request. Note that there are separate D-I1s for travel through IPCO or with CIA.
- **CHIS housing and vehicle availability.** When making travel arrangements, the crew lead must make sure that park housing or camping sites are available on the island. Additionally, for the two largest islands—Santa Cruz and Santa Rosa—the lead must ensure that there is a vehicle available for use. Vehicles may not be available because they have been reserved by other people, road conditions may be poor (not uncommon during the spring), or one or more vehicles may be down for repairs. In such cases, the crew lead will need to evaluate whether the island visit is still worthwhile regardless of the increased travel time to monitoring sites associated with hiking. It may be preferable to rearrange the island field schedule to better accommodate completion of all work associated with vegetation monitoring.

1.5 Organizing Supplies and Equipment

At least one month prior to the beginning of each season, the team lead should inventory, inspect, test, and calibrate all equipment. Perform necessary repair or replacement.

Equipment needed for field work

Each field crew will have the following equipment:

Measuring equipment

- 50 m monitoring tape × 2
- Measuring rod (see SOP 7)
- Chaining pins for anchoring tapes
- Periscope densitometer
- DBH tape (for tree measurements)
- Plant ID references (including site-specific species lists based on previous observations)

Navigation and recording

- Route maps (see site reference packet)
- Site Reference Packet that easily fits into a daypack.
    a. Field data entry form (at CHIS some printed on Rite-in-the-Rain paper)
    b. Sampling route maps identifying groups of proximal sample points, access locations
    c. Transect add/drop procedures
    d. Plant species checklist, including plant codes
    e. Emergency contact information
    f. SOPs for field work (SOPs 3–9)
- GPS, preloaded with sample location waypoints and shapefiles
- At CHIS, laptop computer
- Clipboard and pencils, markers
- Data forms (including weatherized Rite-in-the-Rain paper)
- Compass
- Clinometer
- Digital camera

Equipment for setting up transect

- 2 end point markers

    CHIS: ¾” × 45” aluminum angle stakes with 4” metal rods that can be located with metal detector.

SAMO: 4’ long #3 rebar with PVC sleeve. Optional: additional center point 4’ long #3 rebar marker with PVC sleeve for use as midpoint marker in dense chaparral.

CABR: 9” nails

- Metal tags with transect numbers
- 1 die set consisting of letters and numbers
- 2 ½ or 5 lb sledgehammer
- Flagging tape (orange or red)
- Random number table (see SOP 5)

Safety equipment

- 2-way handheld radio (make sure battery is fully charged)
- Satellite tracking device / emergency beacon:
- CHIS: Spot Tracker
- SAMO/CABR: Delorme “inReach”
- Spare batteries for satellite tracking device
- Drinking water adequate for day’s work (anticipated need plus extra for emergency)
- Snake gaitors
- Insect repellent and tweezers for tick removal
- First aid kit
- Sunscreen

Miscellaneous field equipment

- Action packer (to hold field equipment for travel to CHIS)
- Metal detector for relocating plots where aluminum angle bar at CHIS has been removed (this very rarely happens)
- Plastic file box for storage of datasheets, extra forms (including checklists of species that were encountered in previous seasons’ sampling), and pencils
- 2-way handheld radio
- Spare batteries for GPS unit, camera, and laptop if laptop is used
- Trowel and plastic ziploc bags (for collecting unknown plant species)
- Wire brush for cleaning tires, boots, and trousers of weed seeds
- Daypack
- Water bottles

SOP 1a: Preparations for the Post-Fire Field Season

Version 1.0 (September 2016)

1a.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 1a only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

1a.2 Overview

This SOP lists additional preparations for the field season needed for more intensive Post-Fire monitoring of Terrestrial Vegetation plots. It describes tasks that need to be completed prior to each season's hiring, training, and field work. Pre-season planning, such as creating schedules and organizing equipment, facilitates the completion of monitoring work and allows for budget planning. For timeline of the annual cycle of the monitoring activities, see SOP 1.

Additional materials needed for post-fire plot establishment (modifying existing / establishing new)

In addition to the Terrestrial Vegetation field equipment and materials for plot installation (SOP 1), each field crew will require additional equipment to establish fire monitoring plots. See SOP 5a, section 5a.4 for details.

Equipment needed for monitoring

Post-fire monitoring will require additional equipment to that needed for Terrestrial Vegetation monitoring. For details, including needed datasheets, see SOP 5a, section 5a.5, and Appendix B.

Site reference packet for fire monitoring plots includes the following datasheets:

- MEDN Terrestrial Vegetation Transect Establishment/Revisit
- Terrestrial Vegetation 30-m Transect Data Form [line-point intercept]
- Terrestrial Vegetation Species Richness (1m × 30m belt) datasheet (1 m^2) [1-m belt transect, 1 × 1 m nested plots in 1× 5 m belt segments along 30-m line transect]
- Shrub Density 30 m Belt Transect in 1m × 5 m^2 Subplots
- Fire Monitoring 10 × 10 Density and Mortality (Year 1 only)
- Fire Species Richness (three 100m^2 subplots) [10-m belt transect in three 10 × 10 m quadrats, for species richness and cover estimates]

SOP 2: Recruitment and Observer Training

Version 1.0 (September 2016)

2.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 2 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

2.2 Overview

This SOP explains the procedures for hiring and training vegetation sampling personnel. Training should ensure that all crew leaders are able to identify, by sight and through the use of technical floras and keys, at least 95% of all plant species known to occur in each park's public land. It is also essential that field technicians are able to accurately and consistently follow standard operating procedures to assure data quality across time. Technicians must also be prepared, both mentally and physically, for the considerable heat and difficult terrain of MEDN parks. Note that none of these SOPs are meant to be stand-alone training manuals replacing the thorough documentation available for GPS and field botany techniques. Training personnel should refer to these SOPs as a guide and seek out additional information in the suggested references and through hands-on training courses provided by National Park Service (NPS) and outside vendors.

2.3 Recruiting Field Technicians

1. **Qualifications and attributes.** Recruitment of field technicians (interns, seasonals, and volunteers) should begin in January of the sampling year. Each park project lead should send advertisements and job descriptions to the Volunteer/Intern coordinator as well as directly to key professors in local universities and community colleges. A concerted effort is made to generate interest in Mediterranean Network field internships among advanced undergraduate or post-baccalaureate students with training in botany.
2. In addition to their skill, experience, and knowledge in college level plant taxonomy and systematic botany, interns must be in excellent physical condition and able to thrive in difficult field conditions. The physical and psychological demands of sampling in high temperatures, negotiating ticks, poison oak, and rattlesnakes should not be underestimated. Certification as a First Responder (or Wilderness First Aid) and CPR is an asset.
3. **Hiring process.** It is assumed that each park will have one permanent botanist (GS-09 at minimum) in place to lead the terrestrial vegetation sampling effort. Two other permanent staff members, Plant Ecologist and Restoration Ecologist, will contribute time for the project. In addition, at least two but preferably three botany interns need to be recruited annually through the park volunteer/internship or other programs.
4. Hiring personnel should interview all well-qualified candidates at least once and call three references. Particular attention should be paid to the observer's experience, ability to learn new plants, ability to pay meticulous attention to detail, demonstrated interest in natural resource conservation, physical ability to withstand difficult field conditions, and overall attitude. Data collectors with positive and enthusiastic attitudes make better crew members and are the most adaptable to challenging field conditions.

2.4 Training Observers

The Program Lead for the respective park, together with the designated staff who are well versed in the protocol and SOPs and have considerable experience both conducting field work as well as in training and directing technicians, will conduct the training. Field technicians will also be provided

with a copy of the narrative and SOPs prior to arriving on site for training, so that they will be familiar with program objectives, ecological context, and field methods.

Field measurement operations will be taught outside, at a park site, away from predetermined transect locations in order to minimize trampling at permanent sampling sites. Practice sample points will be included in the waypoint list in an anticipated training area, enabling participants to practice GPS navigation.

2.5 Training Outline

Goals:

- Demonstrate appreciation of overall program monitoring goals and competence in all field skills, including meticulous data entry and attention to detail in the field environment.
- Review field and vehicle safety concerns and practices, including use of handheld radios.
- Acquire proficiency in use of GPS equipment and navigation to sampling points.
- Acquire proficiency in use of Pathfinder software, including troubleshooting.
- Understand procedures for boundary decisions, sampling frame errors, and dropping and adding sites.
- Acquire confidence and consistency in recording plot data.
- Acquire proficiency in identification of principal native and non-native plant genera and species targeted in this protocol.
- Review use of plant identification manuals, keys, and photos.
- Review plant identification terminology.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, safety procedures, including regular communication with park points of contact.
- Understand and demonstrate a sincere appreciation for, and commitment to follow, weed spread prevention procedures during field work.

Materials:

- Protocol narrative and SOPs for each participant
- Radios
- GPS units
- Satellite tracking device / emergency beacon (1 per crew)
- Compasses
- Digital cameras
- Transect measuring equipment
- Datasheets
- Park plant list and key

Agenda:

Day 1

Morning

Arrival and orientation

Get acquainted, backgrounds of participants, team building

Individual protocol study

Afternoon

Group program orientation and protocol discussion

Data management and QA/QC

Review of safety procedures and contact information

Review of weed spread prevention procedures

Day 2

Morning

Field demonstration of all field methods, including use of Pathfinder

GPS practice

Review of boundary decisions, add/drop criteria, procedures, and documentation

Afternoon

Plant identification

Field methods

Day 3

Morning

Practice use of Field Reference Manual materials

Field walk identifying plants

Familiarization with park terrain and general travel

Familiarization of safety, hazard issues, and weed spread prevention procedures

Afternoon

Group field methods practice and calibration

Day 4

Morning

Group practice – completion of 1–2 real transects/plots

Afternoon

Group practice – completion of 1–2 real transects/plots

Day 5

Morning

Group practice, troubleshooting, GRTS and field decisions

Afternoon

Review, scheduling, planning; outstanding issues

Training procedures

1. Definitions for key field terms are presented below and should be reviewed during training.

   Term Definitions

   Bare Ground

   Cover of bare ground should include only bare soil (mineral soil) not covered by plant canopies. Gravel greater than ¼", litter, and rock should be excluded from bare ground cover estimates.

   Annual/Perennial Forbs

   Annual forbs grow from seed each year and biennial forbs produce leaves in the first year (usually a basal rosette) and flower in the second year. Forbs live three or more years with aerial stems that die back each year while underground parts remain alive. Plants re-sprout from the root each year.

   Belt Plot

   The defined unit of measurement, with boundaries framed by 30 m transect tape, and in 1 × 5 m increments with the help of Rhino rulers.

   Target Population

   The predetermined collection of plant communities within MEDN parks for which statistical inference is desired. This includes all native and non-native vegetation and areas of disturbed vegetation that are otherwise unmaintained. Excluded is vegetation associated with development and areas that are perpetually disturbed or maintained. Also excluded are areas adjacent to roads, trails, and other development, as well as slopes greater than 40 degrees.

   Sampling Frame

   The physical representation of the target population. This is always imperfect and sampling frame errors and procedures for addressing them must be addressed in training.

2. Field measurement techniques are best taught outside at the park site or another analogous location. Be sure not to conduct training in or near sampling locations to avoid trampling vegetation. Personnel should already have basic GPS navigation and data entry skills, but additional training on those topics will be provided in the field as well. Practice sample points will be included in the waypoint list in an anticipated training area, enabling participants to practice GPS navigation. See SOP 4 for topics and content covered in GPS training.

17. Indoor lab environment with space to set up dissecting scopes and plant materials to practice plant identification will be provided in the mainland offices.

3. Adequate time must be given to properly set up transects, and for decision-making associated with boundary decisions and sampling frame errors encountered in the field. While efforts have been made to minimize these (e.g., 5 m buffers within park boundaries), problems will inevitably be encountered. Each technician should understand the implications of dropping sites, and understand that in order for the GRTS sample to remain valid, sequential selection of new sites off the GRTS sample list is essential, regardless of where that next site is located. Transects that originate within the sampling frame but cross fence lines, roads, cliffs, or are otherwise clearly outside of the target population may be moved using a 5 m offset in a random direction. If offsetting does not resolve the problem, the transect location should be dropped from the sample. Dropped locations and the associated quadrat number must be entered in the Access database with a note describing criteria met. The criteria and procedures for dropping and adding quadrats are located in SOP 5. Added sites must come from the oversample list, which is included in the GPS and maps for each sampling frame. Oversample sites are numbered in sequential order, starting with the next transect after the sample size (transect n + 1). For example, if a sample size for a given frame is 84, the first replacement site should be transect number 85.
4. Objective positioning of the belt transect tapes is essential for unbiased parameter estimates. In particular, observers need to avoid the inadvertent inclusion or exclusion of rooted plants due to the difficulty in placing the tape straight under dense chaparral (e.g., including a shrub or tree because it is easier to pull the tape around them on the outside of the plot). The tape can be pulled out and redirected by one crew member crawling under the shrubs while the other calls out directions from a better view point.
5. Plant identification will be practiced throughout the training week in both a lab and field setting, and must include inspection of above ground vegetative and reproductive parts. Shrubs and common perennial forbs for this program will be the priority during training. In some cases, species will not be encountered at a training site and the field leader must provide additional training at the start of sampling at each park. Typically this will occur during the first morning of field work at each park, and will provide an opportunity for the team to recalibrate to the new surroundings and vegetation. Hand lens use should be practiced in the lab and field setting. While proficiency in the use of the Jepson Manual (2nd Edition) technical floral keys is desirable, it is not essential. However, the technicians should be familiar with technical key characteristics that differentiate principal species from similar species that may cause confusion.

18. The interns will assist in collecting plant specimens to complete a park's voucher collection. Proper collection and documentation of the vouchers will be reviewed in the lab following instructions in SOP 8.

6. Creating waypoints, making background images, and transferring data from the GPS unit must be practiced and thoroughly understood by all field personnel. Allow time for field practice as a group in data entry and in post-field backup procedures. Troubleshooting tips will be reviewed. See instructions for navigation tools in SOP 4.
7. Safety procedures are outlined in SOP 3. This must be reviewed as a group in a focused session, including review of driving on- and off-road, use of handheld radios, wildfire safety procedures, and health concerns such as heat exposure, ticks, rattlesnakes, and poison oak.

8. Weed spread prevention is a critical issue in all MEDN network field activities. A wire brush should be kept in project vehicles at all times, and tires, undercarriage (**do not scratch paint!**), boots and clothing should be cleaned of as much weedy debris and seed as possible, as often as possible. It is particularly important that attention is given to travel from infested to uninfested park areas. Regular practice should include brushing down vehicles, boots, and trouser legs at arrival and departure for each field jump-off point. This should only require a few minutes of extra time and is an important gesture of care and stewardship for our parks. Periodically, vehicles should be hosed down as an extra measure of prevention. Opportunities for this exist at the end of each day when passing through park headquarters. Park-specific procedures should be followed when provided, and this topic should be discussed with park staff at the beginning of each park's sampling session.

SOP 3: Safety

Version 1.0 (September 2016)

3.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 3 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

3.2 Overview

This SOP explains what cautions to take to avoid accidents and what behaviors to adopt to ensure safety of all crew members. Regardless of the relative nearness of urban areas, the backcountry conditions in SAMO are often inclement and strenuous. Awareness of the common hazards and preparedness in meeting them will ensure that any field work is completed successfully without interruptions from carelessness or unnecessary risk taking.

3.3 Protocol Readiness Review

Before beginning the field season, a Protocol Readiness Safety Review must be performed and certified by the Program Lead, I&M Program Manager, and the Superintendent at each park. For this protocol, three separate Protocol Readiness Safety Review forms must be submitted prior to beginning field work. The review is a way to ensure that all field staff have read and understood the safety documents associated with this monitoring program and the park in which they will perform field work. The review includes the safety information listed below, and the GREEN-AMBER-RED (GAR) hazard analysis and risk assessment developed by the United States Coast Guard and adopted by the NPS. Instructions on performing the analysis and required documentation can be obtained from Operational Leadership Training, which is required for all NPS employees in the Pacific West Region. An example of a GAR analysis and supporting documents, along with a Protocol Readiness Safety Review form, is provided at the end of this SOP.

3.4 CHIS Boat and Air Transportation Safety

Channel Islands National Park is unique in that to actually enter the park to conduct field work, one must travel by either boat or small aircraft. As these are not typical modes of transportation, extra safety precautions must be adhered to.

Boat transportation: Prior to first boarding a park service boat to any island within the park, employees, researchers, and volunteers must undergo three annual safety steps: 1) view several park service boating safety videos at the following link (http://www.nps.gov/chis/boatsafety.htm), 2) read the park service boating travel guide concerning procedures for boarding and unboarding from the boat, and 3) fill out a self-assessment questionnaire pertaining to personal health and fitness. This questionnaire must be submitted to the park at least 24 hours in advance of the travel date.

In addition, on the morning of travel, there are two safety briefings that must be attended. The first concerns risk and how we may overlook it in our daily lives. The second briefing is conducted by the boat captain, who will update all the passengers on the expected weather, the location of life vests and the life boats, and the safest way to move about the boat. All passengers must wear life vests when boarding and unboarding from the boat and when outside the main the boat cabin.

Air transportation: Travel to San Miguel Island (SMI) (Santa Rosa Island (SRI) can be accessed by aircraft or boat) is usually by a small plane operated by a park concessionaire. When flying out to SMI (or SRI), passengers should wear trousers and boots that cover the ankle. Prior to departure the pilot will conduct a safety briefing showing the location of the exits and life jackets. Employees of Channel Islands National Park must also undergo an annual online safety course, and every 3 years, practice what to do in the event the aircraft ditches into the water.

3.5 CHIS Unexploded Ordnance

San Miguel Island is unique among the islands within the park in that, while administered by CHIS, it is owned by the US Navy. From the 1940s through the Vietnam War era, the Navy used the island as a bombing range and an unknown amount of explosives were dropped on the island. A 2014 survey of locations on the island that were "high use" bombing areas found several practice bombs and flare canisters and one item that was identified as unexploded ordnance. As a result the potential exists for those working on the island to encounter exposed munitions that, if disturbed, could explode and cause serious injury. To prevent this from happening, the park, in conjunction with the US Navy, has implemented the following safety measures:

- Prior to traveling to SMI, park service employees, researchers, and volunteers must watch an unexploded ordnances training video.
- All researchers and volunteers must undergo a safety briefing by the chief of the law enforcement division or the island ranger.

All researchers and volunteers must be accompanied by a park service employee when working out in the field on SMI.

3.6 Required and/or Recommended Personal Protective Field Equipment:

- Back pack
- Sturdy hiking boots
- Long pants
- Long sleeved shirt (ticks)
- Tall socks (ticks)
- Insect repellent (ticks)
- Warm clothing / hat
- Rain gear
- Sun hat
- Sunscreen
- Sunglasses
- Personal water bottles
- Food
- First Aid Kit
- Park radio
- List of radio call numbers for park law enforcement and pertinent staff
- Compass / GPS Unit

- Maps
- Emergency contact information/Field Reference Manual

3.7 Hazard Abatement Actions

All people (permanent, seasonal, VIPs) involved in any project will receive a general orientation and tailgate safety session specific to the task prior to beginning of work.

1. **Driving to and from remote field sites.**
   a. **Seat belts. WEAR SEATBELTS AT ALL TIMES WHEN VEHICLE IS MOVING.**
   b. **Safe speed.** Maintain a safe speed (this if often below the legal speed limit) for the road conditions; stay clear to the right, especially on curves; drive with headlights on at all times; when turning around on mountain roads always "face the danger"(versus backing toward the cliff edge); the passenger should get out and spot for driver when backing up.
   c. **Driving with limited visibility.** Maintain windshield cleaner fluid level and clean both sides of windows regularly (remember back window); slow down; if blinded by sun or dust, proceed slowly or pull over and wait for hazard to pass; keep to the right hand side of the road and drive with your lights on.
   d. **Wildfire.** Wildfire ignition from vehicle undercarriage/catalytic converter. Track fire hazard warnings from park and other agencies. Obey road closures, which occur during fire season when hazards are extreme. Avoid driving over vegetated two-track roads whenever possible. Constantly monitor accumulated vegetation underneath the vehicle, and watch behind for smolder.
2. **Communication—Maintaining contact with field, supervisory, and emergency staff.**
   a. **Radios.** Make sure radios are charged and on the correct channel. On the mainland, use cell phone (if available and there is coverage), as this may be more reliable for communication in remote locations. Establish regular contact/meeting times where failure to contact triggers emergency procedures. This is particularly important in the Channel Islands—be sure to sign up on the vehicle sign-up board, let at least one other person know which parts of the range you will be in, and when you expect to be back.

      Make sure that field pack includes a list of radio call numbers for park law enforcement and pertinent staff. The list must include cell phone numbers for Angeles Dispatch and park visitor center.

      The Team Lead and/or park Plant Ecologist will go over radio protocol for the assigned park.

      - How to use the type of radio assigned (with handout)
      - How to maintain radios and batteries (if replaceable) with specifics about battery life on the shelf and in the backcountry
      - How to contact dispatch
      - Which repeater to use in each region of the park
      - Appropriate topics and terminology for radio communication

- Who to contact if radio malfunctions

b. **Unable to reach a radio repeater in a remote location.** Make sure radio is charged. Try to contact someone on the radio to inform him/her of your predicament. If you are unable to reach a repeater from your location, climb upslope toward a ridgetop or knoll and try again. Try at regular intervals—meandering around may help in getting a signal. Use cell phone in vehicle (if available), as this may be more reliable for communication in remote locations.

c. **Tracking location and safe return of crews.**

Field Location & Contact Information (see form in Appendix A). Prior to departing for the field, each crew will complete a field information sheet that describes the location to be visited (including UTM) and the access route to be taken. Members of the crew should be listed with their cell phone numbers along with the license plate number of the vehicle driven and name of the InReach GPS device carried by the crew.

Headquarters Monitors. The field crew must identify two monitors at headquarters or other office who will track their field activities. At least one of these monitors must remain at the office until the crew has returned or checked in as departing the backcountry. The names of these monitors will be written on the field information sheet.

Satellite Tracking Device / Emergency Beacon. Each crew will carry a Personal Beacon or InReach tracking GPS unit. Before going out in the field, all crew members must familiarize themselves with the operation of the tracking devices currently in use at the park. For example, SAMO uses the Delorme InReach beacon while CHIS provides their employees with a Spot tracker device. CABR is so small that field crews can rely on radios.

At CHIS and SAMO, the crews' movements out in the field will be monitored via internet in the park headquarters by two staff members available to be contacted at all times while the crews are out in the field. Before departure, crew will post its assigned locations together with routes taken and description of their vehicle on the emergency contact board in headquarters, and at its return, notify staff tracking the crew.

3. **Hiking.**

a. **Steep, rugged, and slippery terrain.** Assess terrain conditions to find safe route and modify sampling plans to avoid unsafe areas. Proper footwear is VERY important—wear boots with slip-resistant soles with tops well above the ankle, broken in before the field season, plus extra socks. NO TENNIS SHOES or open toed sandals are allowed in the field. Maintain an erect posture when contouring steep slopes. Avoid walking below another person due to the potential for rocks to dislodge from above.

b. **Eye protection.** Wear safety glasses (or other glasses) when hiking in brushy areas to protect eyes from protruding objects.

c. **Rocks/climbing.** It is likely that hiking may occur over large or steep rocks. Vertical climbing should be avoided.

d. **Crossing fences.** It is likely that a fence will be crossed occasionally during the course of work. When possible, use gates—leave them open or closed depending on how you find them. Do not go through an open gate unless you have the key or code to get back out in case the gate is closed before you return. If no gate is available, cross fence, barbwire or other, under or over with caution.

4. **Encountering noxious plants, animals, diseases, people, and marijuana farms.**

   a. **Bees/Wasps/Hornets.** Determine if any field crew are allergic to bee stings. Notify other crew members and the supervisor if you know you are allergic to bee stings. Ensure that individual with allergy carries prescribed medication to prevent anaphylactic shock. Crew First Aid kit should include a bee sting kit, and Benadryl or other antihistamine. Be aware of the ground where you step—some hornets build nests in the ground at the base of trees or shrubs, or in rotten logs—and watch for bees buzzing in and out of holes or around ground level. If possible, flag a nest so future surveyors won't run into it.

   b. **Ticks.** If bitten by a tick, remove it—grasp tick with tweezers at head and pull straight out. Store the tick in a small glass vial, and when back at the office, send it out to be tested for Lyme disease. Fill out an accident report in the event that symptoms of Lyme disease appear (red bull's eye rash).

   c. **Scorpions.** Inspect items (e.g., clothing) left lying on the ground for scorpions prior to putting them on.

   d. **Mosquitoes**. Wear insect repellent and long sleeve shirt to prevent bites. Be aware of West Nile Virus symptoms.

   e. **Rattlesnakes**. Avoid rattlesnakes by inspecting the ground near logs before stepping over them. Avoid placing hands on rock ledges or other natural hoists without visually inspecting them first. In the unlikely event you're bitten by a rattlesnake, stay calm, draw a visible circle around the bite mark with ballpoint pen or marker, write down the time it occurred, sit still, call, and wait for help.

   f. **Mountain lions.** Avoid mountain lions. If you encounter a lion that doesn't run from you, leave the area. If attacked, fight back!

   g. **Disease (bubonic plague and Hanta Virus).** Stay away from dead rodents and rodent feces, especially in closed buildings.

   h. **Encounters with strangers.** Report uncomfortable encounters with strangers in the park to a supervisor as soon as possible. Report apparent illegal activity to a park ranger. Do not get into a confrontation with visitors in the park.

   i. **Encounters with marijuana farms.** Check in with law enforcement prior to going out to the field to get clearance for areas with potential for marijuana farms. If you encounter marijuana plants or suspicious setups, such as make-shift water collection ponds with garden hoses, take a photo and collect a GPS point if you can safely do so, and leave the area. Report to law enforcement. Do not pull up or destroy the plants or attempt to do a thorough investigation. It would only interfere with a proper investigation.

5. **Exposure to environmental dangers.**
    a. **Treatment of general injuries.** All NPS field staff should have current first aid and CPR certification.
    b. **Hypothermia.** Always anticipate bad weather and dress accordingly, or carry warm clothes with you. Keep clothing as dry as possible. Use synthetic fleece and non-cotton outdoor clothing in inclement weather. Eat high energy nutritional supplements between meals. Cover the head and neck to prevent heat loss. Keep active to maintain the body's metabolism. To prevent dehydration, drink plenty of liquids even when you don't "feel" thirsty. Drink warm liquids, not cold. Understand the effects of cold and wind; most hypothermia cases develop between 30°F and 50°F.
    c. **Hyperthermia (heat exhaustion).** Hyperthermia may occur during high temperatures. Monitor for dehydration, heat exhaustion, heat cramps, and heat stroke. Symptoms include irritability, nausea, headache, and flushed, red skin. Drink plenty of water even when you are not thirsty. As heat increases, take frequent breaks in cool locations. Wear a light shirt. When temperatures climb above 100˚F, return to the office and attend to office duties.
    d. **Giardia.** Giardia is caused by drinking contaminated water. Carry plenty of water on outings—consider all streams contaminated.
    e. **Sunburn.** Field work takes place in full sunlight, so use 30+ or greater SPF sunscreen and lip balm, and wear a hat, sunglasses, and shirt.
6. **What to do if injured.**
    a. Keep CA-1 form (Notice of Traumatic Injury), a vehicle accident report form, and a disposable camera for photographing vehicle accidents, in the glove box of your vehicle at all times.
    b. If injured, treat promptly. If immediate medical attention is required, go directly to a hospital emergency room. Try to make contact with your supervisor or the office to get instructions and assistance. Make sure the doctor fills out his/her part on the CA-1 form.
    c. Inform your supervisor of all injuries and ask which, if any, forms need to be filled out.
    d. Supervisors must complete the accident reporting forms as promptly as possible (e.g., within 24 hours).
    e. Fill out federal accident forms completely with signatures. ALWAYS make a copy for your personal records. Give the completed forms to your supervisor. Have the supervisor check your entries for mistakes, fill out his/her section, and forward the completed forms to the appropriate person.
    f. Gather information. If you are in a multivehicle accident, provide the other parties with enough written information so that they can easily get in touch with you, your crew supervisor, and the office. In turn, you must get the following information from all involved parties and witnesses: names, addresses, phone numbers, vehicle license numbers, driver's license numbers, insurance company names, policy numbers, and police report numbers. If possible, do not admit responsibility without first contacting your supervisor.

3.8 Example of Green-Amber-Red (GAR) Analysis and Field Readiness Certification Forms

Following are example documents showing a GREEN-AMBER-RED hazard risk and mitigation analysis performed for the SAMO Terrestrial Vegetation monitoring program with the two required readiness certification forms (Figures 3.1 through 3.4). Instructions, templates and forms can be obtained from the I&M Program Manager.

PREPARATION / HAZARD MITIGATION FOR TERRESTRIAL VEGETATION TRANSECT INSTALLATION AND MONITORING

[Operational Risk Management Analysis (GAR) Components]

February 2015 (Not changed from May 2014 analysis)

SUPERVISION

Present, qualified, accessible & effective? Clear chain of command?

- Each two-person crew has an experienced crew leader; a staff person or partner with several years' experience working in the SMM backcountry.
- Prior to departing for the field, additional supervisory personnel, two monitors, and other support staff are identified. Monitors are provided with the information necessary to locate and track crews in field.

PLANNING

SOPs, pre-plans, briefs, team input, availability of information

- Approach to each site is analyzed and preplanned by project lead and/or field leads. Field assistants either participate in planning or are fully briefed.
- The day's work is reviewed prior to departure. Crews consult checklist for necessary safety and field equipment and steps to be taken / notifications provided before departing for field. Monitors are provided with field info.
- SOPs for avoiding, responding to, and reporting hazards and accidents are followed (Includes protocol SOPs and park safety SOPs). Copies of SOPS are available in binder by vehicle keys. PDF files are available for download onto smart phones.
- GAR analysis is performed when arriving at trailhead.

CONTINGENCY RESOURCES

Do you have backup resources? Plans in place with cooperators? Shared communication plans and frequencies?

- Emergencies reported to Angeles Dispatch, Rangers, Local Police (911), and/or dispatch of agency on whose land the work is being performed. Can also use InReach emergency reporting service.
- Problems (less than emergencies) can be reported to project lead, office monitors, and/or Rangers.

COMMUNICATION

Do radio and phone work? Does everyone know how to use them? Is everyone speaking up?

- Teams provide notification /contact sheets to two staff in office who monitor crew activities. Teams carry phone numbers of office staff , emergency personnel, and supervisors.
- Teams carry radio, cell phone & InReach GPS tracking device. All team members trained in their use. Communication equipment is checked before departure.
- Teams notify NPS, CDPR, MRCA dispatch as necessary.
- Crews phone designated monitor when leaving and returning to vehicle

TEAM SELECTION

Level of training and experience. Atmosphere open to dialog?

- Team leads all have been at the park several years and have experience navigating off-trail in SMM and in using GPS to navigate. They are well aware of backcountry hazards.
- Team assistants may have limited experience, but are fit and have previous outdoor hiking experience. Team assistancts fully trained in use of GPS, radio, and inReach. Assistants are encouraged to monitor mental and physical condition of leads.
- All decisions related to activities in field.

TEAM FITNESS

Physical and mental state of the team? Rest, fatigue, morale, outside distractions?

- Team leads are fit and have experience navigating under difficult backcountry conditions. They know when to back-off. Team leads are responsible for monitoring mental and physical condition of team assistants.
- Team assistants are fit and have been fully briefed on what to expect in field.
- Field work is begun as early as possible after beginning the day, after crews have had a night's rest. Crews are provided with emergency and other assistance numbers
- Field work is planned to be completed in 8.5 hours, allowing time and sufficient physical reserves to manage mishaps or exceptionally difficult situations.

Figure 3.1a. Example hazard mitigation analysis, page 1. All eight elements must be addressed.

ENVIRONMENT

Threats, time of day, winds, temperature, difficulty of terrain, remoteness of monitoring location?

Work is off-trail, involving strenuous cross country travel (sometimes more than a kilometer) over rough terrain and through extremely dense brush.

- Difficult environmental conditions are mitigated by the fact that the work performed is not time-critical. Crews can take whatever time required to assess each situation encountered.
- Field work is planned to be completed in 8.5 hours including drive time, allowing sufficient time and sufficient physical reserves to manage mishaps or exceptionally difficult situations. Crews monitor their time and if it becomes clear that a site cannot be accessed and monitored within the specified time frame, the site is rejected.
- Field work is begun early to take advantage of cooler conditions.
- On days of extreme environmental conditions (e.g. high temperatures), sites are chosen that are easily accessible. Or field work is cancelled.
- While sites may be difficult to reach, it is also difficult to get lost in the SMM. Even if one does not return by route entered, a trail or road can be reached in a reasonable time traveling downhill. Crews carry local topographic maps to assist them in such situations.

INCIDENT COMPLEXITY

Amount of exposure, potential for fatigue? Stability of conditions?

Work is off-trail, involving strenuous cross country travel (sometimes more than a kilometer) over rough terrain and through extremely dense brush. There is exposure and potential for fatigue, particularly on hot, dry days.

- Crews may encounter unstable terrain or extreme conditions. However, because the work to be accomplished in any given day is not time-critical, crews can take the time to assess the environment and potential for incident and back off their approach if necessary
- Field work is planned to be completed in 8.5 hours including drive time, allowing sufficient time and sufficient physical reserves to manage mishaps or exceptionally difficult situations. Crews monitor their time and if it becomes clear that a site cannot be accessed and monitored within the specified time frame, the site is rejected.
- Field work is begun early to take advantage of cooler conditions.
- On days of extreme environmental conditions (e.g. high temperatures or high fire danger), sites are chosen for that are easily accessible or field work is cancelled for that day.
- While sites may be difficult to reach, it is difficult to get lost in the SMM. Even if one does not return by route entered, a trail or road can be reached in a reasonable time by traveling downhill. Crews carry local topographic maps to assist them in such situations.
- Crew leaders assure sufficient water and food is carried by each team member.

Figure 3.1b. Example hazard mitigation analysis, page 2. All eight elements must be addressed.

February 5, 2015

GAR Risk Assessment Model for Vegetation Monitoring

Participants: Crystal Anderson, Luis Aguilar, Brendan Clarke, Tarja Sagar, Mark Mendelsohn, John Tiszler, Marti Witter

Mission: Establish randomly chosen vegetation monitoring transects (25) and collect field data (90)

	Defined Threats	Risk Factor: Supervision	Risk Factor: Planning	Risk Factor: Contingency Resources	Risk Factor: Communication	Risk Factor: Team Selection	Risk Factor: Team fitness	Risk Factor: Environment	Risk Factor: Incident Complexity	Total Risk Score
1	Driving - public roads	5	1	1	1	1	2	7	5	23
2	Driving - dirt roads	2	1	1	2	1	2	4	5	18
3	Hiking on trail - slips and falls.	2	1	2	2	1	2	2	3	15
4	Hiking off trail - rough uneven terrain, steep slopes, loose rock.	2	1	5	3	1	2	8	7	29
5	Hiking off trail - possibility of getting lost.	2	1	1	2	1	2	5	7	21
6	Moving through dense shrubs - sharp branches & plant parts can cause scratches & puncture wounds	2	1	5	2	1	2	5	7	25
7	Encountering marijuana gardens - physical violence, booby traps	5	5	5	2	5	2	7	8	39*
8	Encountering dangerous people - physical violence	5	9	5	2	5	3	1	8	38*
9	Installing Plots & Monitoring - trips and falls, sharp branches	1	1	1	1	1	1	5	2	13
10	Exhaustion, dehydration or heat stroke	3	2	3	2	1	2	5	5	23
11	Poison oak / Mountain Mahogony - allergic reaction	2	2	1	1	1	2	5	1	15
12	Phacelia in Fire Plots – allergic reaction	2	1	1	1	1	1	3	1	12
13	Rattlesnakes - venomous bite	2	7	5	1	1	2	7	9	34
14	Ticks - allergic reaction, disease	2	5	1	1	1	2	9	5	26

*Mitigation: 1) Held group discussion of early recognition and communication & retreat strategies

Figure 3.2. Example of threat summary and rating for a GREEN-AMBER-RED risk assessment. Threats are rated from 1 (no risk) to 10 (maximum risk). Total risk scores greater than 25 must be mitigated.

Mediterranean Coast Network Inventory & Monitoring Program

2015 Long-term and Post- fire Vegetation Monitoring Protocol Readiness Document Review Certification

This form must be completed for each field crew member

Date_____

We certify that _____ has carefully reviewed and discussed the following documents in preparation for conducting fieldwork in collaboration with MEDN I&M:

___ Protocol and safety SOP(s)

___ Park safety directives or safety plan (if available)

___ Green Amber Red (GAR) risk assessment for this protocol

___ Park operations plan (emergency phone numbers, where to go if you're injured, etc.)

___ Radio and inReach operations guides

Employee _____

Name Signature Date

Supervisor _____

Name Signature Date

Figure 3.3. Readiness document that must be completed and signed by each crew member and supervisor.

Pacific West Region Inventory and Monitoring Program
Protocol Readiness Review Certification

Monitoring Protocol: Long-term and Post-fire Vegetation Monitoring

Park and Network: SAMO / MEDN

Date: February - July 2015

We confirm that the above named monitoring protocol has sufficient resources and support to implement with full consideration for safety, field logistics, and supervisory oversight. All relevant Inventory and Monitoring Program and park personnel have been informed of, understand, and concur with safety plans, procedures, and responsibilities, and will effectively communicate, supervise, and execute these measures through the Inventory and Monitoring Program, Inventory and Monitoring Network, and park lines of authority. Park staff and Inventory and Monitoring personnel have jointly identified the key groups and individuals that will contribute and participate to ensure safe implementation of the protocol.

Our Readiness Review assessed the following components of protocol implementation and safety:

- Operations planning and field logistics
- Training requirements
- Risk management
- Awareness of and consistency with park safety protocols and emergency procedures
- Supervisory oversight
- Communications

We certify that each above component has been fully addressed and will be properly implemented and supported prior to initiating and while conducting protocol field work (including pilot data collection or other field work before a protocol is finalized).

Signatures:

	David Szymanski	SAMO/MEDN	
Park Superintendent	Name	Park/Network	Date
	Stacey Ostermann-Kelm	MEDN	
I&M Network Program Manager	Name	Park/Network	Date
	John Tiszler	SAMO/MEDN	
Protocol Field Supervisor/Manager	Name	Park/Network	Date

Copies of this certification must be provided to the I&M Network Board of Directors Chair and to the Regional I&M Program Manager. The signed original is retained by the I&M Network Program Manager.

Figure 3.4. Certification that must be signed by Park Lead, Program Manager, and Park Superintendent.

SOP 4: Field Navigation and GPS Procedures

Version 1.0 (September 2016)

4.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 4 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

4.2 Overview

The purpose of this SOP is to provide step-by-step instructions for planning access and navigating to monitoring sites using GPS, including in-office field preparation and post-field data processing.

4.3 Electronic File Organization of Site Documentation Forms

All document files for each sampling site, including photographs, maps, GPS tracks, and access instructions, are stored in an electronic folder named with the site number. Collected vegetation data are stored in the MEDN Native Vegetation Monitoring Program Database (SOP 9).

The folder naming convention follows the form "MS-####" (Master Sample-###). Descriptive annotations may be added to the name of the folder using an underscore, for example "MS-0002_Rejected," or "MS-0004_Sulphur_Springs_Trail."

Within site folders, all files are named beginning with the site number followed by the year the file was created (e.g., MS-0200_2015). Site photographs are organized into subfolders named for each year the site was visited, e.g., 2015_Photos (SOP 10).

Site folders are stored in the Inventory and Monitoring Native Vegetation directory for each park.

4.4 Daily Field Operations Overview

The following steps outline the necessary procedures associated with a vegetation monitoring session.

1. Create background files for Garmin GPS devices. (Sub-meter Trimble devices are used for recording the location of a plot.)
2. Use Google Earth to determine preferred and alternative access routes.
3. Upload background images to GPS devices.
4. Create an overview map of the area illustrating preferred and alternative access points.
5. Create driving directions.
6. Use Google Earth to conduct a safety assessment of the area and access routes.
7. Complete Field Survey Contact Sheet; post and distribute to office monitors. Take a copy into field.
8. Gather necessary datasheets and materials for site packet.
9. Review the Field Survey Checklist (see forms) to make sure you have everything.
10. Once in the field, navigate to the site using the Garmin unit.
11. Implement transect installation or field monitoring protocol (data collection).
12. Once you have returned from the field, file datasheets in appropriate location.
13. Process Garmin tracks.
14. Enter status of site into the digital record spreadsheet.
15. Charge GPS, inReach, and camera batteries.

4.5 Operations Using Garmin Device for Navigating to Sites

Garmin devices are recommended for navigation. Their small size and ease of use is especially helpful when navigating through dense brush. However, Trimble units must be used for establishing site locations (SOP 5).

Creating and uploading KML background images

Background images for the Garmin units must be created in Google Earth. Striving for perfection may be a bit difficult, but generating a usable product is faster than generating a usable product for the Trimble unit.

1. Launch Google Earth.
2. Zoom to the area you would like to set as your image.
    a. Note that, like Trimble background files, your output will be final. You will not be able to make edits to the background image after it has been saved.
3. If tracks in a KML or KMZ format already exist, load them to Google Earth to use as part of your background image (You can do this by simply double clicking on the file). If there are no associated KML files, you can use the "Add Path" () or "Add Placemarker" () tools to mark any noteworthy markers.
    a. Note that there is a series of existing Google Earth files that may be useful, such as land ownership or trail KMLs. You may find these files in multiple directories. Ask a supervisor or someone in the GIS Lab for any specifics. You can create your own Google Earth files directly from ArcMap, but generally, you will find the standard Google Earth files in the following directory: J:\workspace\LAguilar\KMLs
4. Make sure that the "Terrain" checkbox is unchecked. This is under "Layers" in the bottom left of the Google Earth window. This will make it much easier to project your background image (Step 9).
5. Make sure that the aerial view is directly from above, and north is at the top of the screen. After setting up your background image to the desired specification, click the "U" key. This will shift your image so that you are looking directly over your image and remove any tilt. Click the "N" key. This will orient your image so that north is the top of your screen. This will also help in projecting your background image.
6. Click "File" > "Save" > "Save Image."
    a. If you are given the option in Google Earth Pro, select "Medium (1400x1226)" resolution. High or Premium may produce a file too large for the Garmin device.
7. Click "Save," and navigate to the appropriate MS folder. If one does not exist, create it. Give your file a useful name (ex. MS-0021GE_BG).
8. Click "Save."
9. Without making any adjustments to your Google Earth window, click "Add" > "Image Overlay." This will launch the "Google Earth – New Image Overlay" (GENIO) window.
10. In the GENIO window, make sure that your image has an appropriate name.

11. Click the “Browse…” button, and navigate to your background image. Click “Open”
12. The third item down the GENIO window is the Transparency slider. Slide it back about half way so that you can see both the Google Earth window and your image. This will help you overlay and adjust your image. This will produce a muddy image, and you may have to play with it to understand which image is which, as well as the relationship between the two.
13. Adjust your image to fit the Google Earth window as closely as possible. The crosshairs at the center allow you to move the image around the screen without affecting the location of the Google Earth screen or the proportions of your image. The perimeter of the crosshairs allows you to reshape the image. However, you want to avoid changing any one side or any one corner. This will distort your image overlay. **While holding the SHIFT key**, grab one of the corners and shrink or expand your image. Use the center crosshairs to adjust the image accordingly.
14. When you are satisfied with the location of your background image, click “OK.”
15. Your layer will appear under “Places” in the center-left of the Google Earth window.
16. Right-click on your image, and click “Save Place As…” Navigate to the appropriate folder, and save as a KMZ file.
17. To upload your background file, connect the Garmin unit to the computer.
18. Open the drive for your Garmin unit.
19. Navigate to the “Garmin” > “CustomMaps” folder. Place your background image (in its KMZ format) into this folder.
20. Close the folder and disconnect your unit.
21. Your map will automatically be loaded in the map view when you turn it on. Check to make sure your map loaded properly. If you are not at the current location covered by your background, you can add a placemarker in a random location covered by your background image. You can zoom in to the point and determine if your map loaded properly.
19. If you would like to access another custom map, click the “PAGE” button on your Garmin device to navigate to “Main Menu” > “Setup” > “Map” > “Select Map.”

Creating and processing GPS tracks

Tracks (reusable GPS cookies) should be collected for each site and stored in the appropriate MS folder. The final product should be a Google Earth (KML/KMZ) file. There are two ways of obtaining these tracks. One way is by creating a line feature using a Trimble unit, but the easiest and most efficient way is by using a Garmin GPS unit. To do this, simply turn on your Garmin device and it will automatically start creating tracks. To save your tracks, follow these steps:

1. Connect the Garmin device to the Computer.
2. Open Google Earth.
3. Click “Tools” > “GPS.”
4. This will open the “Google Earth – GPS Import” (GEGI) window.

    a. In the GEGI window, under the “Output:” section, deselect “KML Tracks” and select “KML LineStrings.”
    b. For the “Import:” section, make sure all three options are selected.
5. Click “Import.”
6. You will get a message illustrating the uploaded tracks process. Click “OK.”
7. This will add all tracks associated with your Garmin unit. This will import all of the projects stored in your Garmin. The results may be messy, so you will have to create a stand-alone folder for your specific project.
    a. The tracts will appear in “Temporary Places” under the name “Garmin GPS Device.”
8. Expand the file by clicking on the white triangle next to its name. When the file is expanded, the white triangle rotates 90 degrees clockwise and becomes black. You can close the dropdown by clicking the black triangle.
    a. This will reveal a folder called “Tracks.” Expand that folder by clicking on the white folder next to its name.
        i. You will notice that a project folder has been automatically created for each day the unit has been used.
9. Scroll to your project folder. If there are multiple folders, identify yours by date.
10. Right-click on the folder, and click “Save Place As…” Navigate to the appropriate MS folder, and give it a significant Name.
11. Close and turn off the parent “garmin GPS Device” file.
12. On the Google Earth window, click on “File” > “Open.”
13. Navigate to the file you have just created, and open it.
14. This will add your track to “Temporary Places.”
15. Expand your file, and the folder within. This will reveal a folder called “Points” and a feature called “Path.”
    a. The “Points” folder illustrates all of the points that were used to automatically create the track feature. These points are stamped and can be used for different purposes, but that is beyond the scope of this document.
    b. The Path is a line feature illustrating your tracks.
16. You may have to edit your track. To do so, right-click on the path, and click “Properties.”
17. You will then notice all of the vertices that make up the path. You can click and drag any one of these points, or click a point and hit the “Delete” key.
18. You can only edit one vertex at a time. If there are multiple, consecutive, vertices that need to be deleted, click and hold the “Delete” key.
19. Click “OK.”

20. Right-click on your file and select “Save Place As…” Note that you will have to overwrite your file every time you make an edit in Google Earth.

4.6 Other Field Prep

Driving directions

To be done once. Check the MS point folder (if one has been created) to see if the driving directions have been created.

Using Google Earth, Google Maps, or any other navigation program, get driving directions from headquarters (34.185597, -118.883617) to the closest drivable place along public access roads to the MS point.

Driving directions using Google Earth

1. Set a starting point placemarker.
    a. Simply type “34.185597, -118.883617” into the upper left search bar.
2. Set a destination marker at the neatest drivable place along public access roads to the MS point.
    a. Click on the  (add placemark) button in top left toolbar.
    b. Drag destination placemark to desired location and click ok.
3. Right-click on the (34.185597, -118.883617) headquarters placemark and select “Directions from here.”
4. Right-click on the destination placemark and select “Directions to here.”
    a. This will launch driving directions in the left hand panel.
5. Near the top of the panel, click on the 

link to obtain a print friendly version
    a. Use these directions to create a “Driving Directions” file for the MS point folder using the naming convention “MS-####_DrivingDirections.”
    b. Print the directions and use to navigate to MS point.

Driving directions using Google Maps

1. Zoom to headquarters or enter the coordinates (34.185597, -118.883617) in the search bar on the upper left. Right-click, and select “Directions from here.”
2. Zoom to the nearest drivable location on public access roads to the MS point. Right-click on the desired space, and select “Directions to here.”
3. Extend the directions by hovering over the results located right under the search bar in the upper left corner.

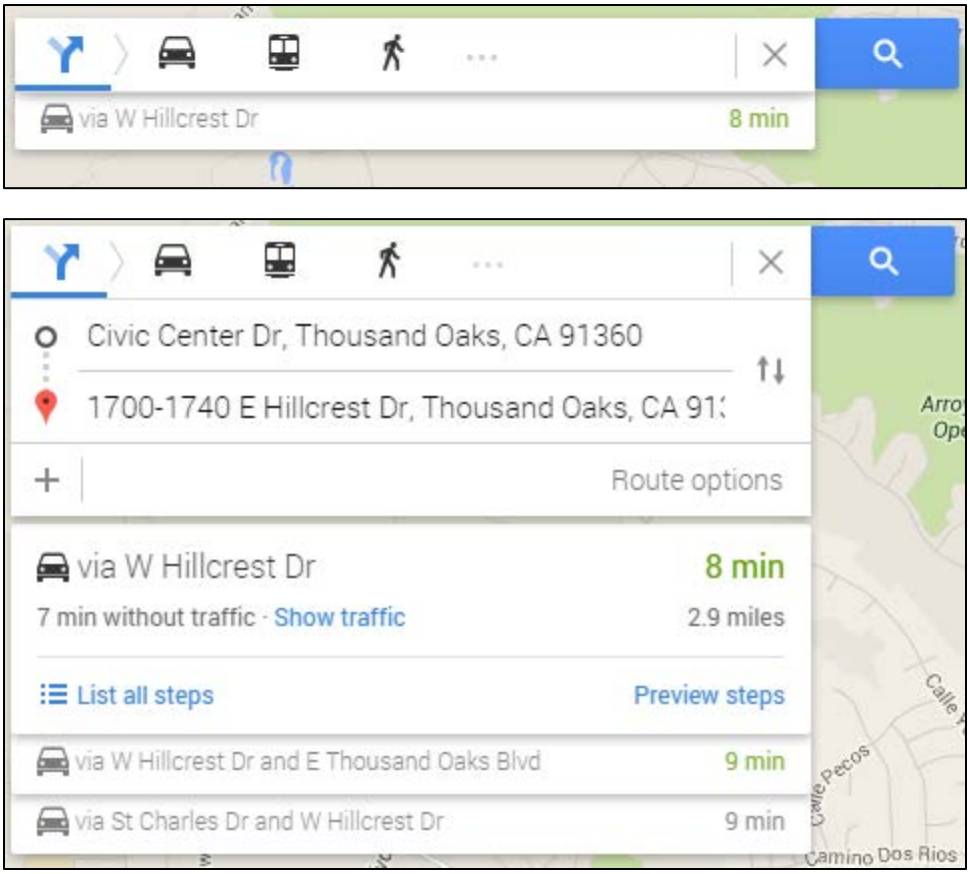


Figure 4.1. Example of driving directions available from Google Maps.

4. Click on List all steps in the drop down to obtain a print friendly version of the directions.
    a. Use these directions to create a "Driving Directions" file for the MS point folder using the naming convention "MS-####_DrivingDirections."
    b. Print the directions and use to navigate to the MS point (Figure 4.1).

Google Earth site overviews

Google Earth will be used to assess field safety and accessibility. It will be used to determine the primary access route, as well as alternative access routes. Access routes can be explored at any time before the field work is conducted, including several days in advance, but the Google Earth safety overview should be conducted on the same day as the day of the field work.

Google Earth for access routes and safety consideration

1. Look at the MS point in Google Earth.
2. Get a general sense of the landscape in the area.
3. Consider the density of the vegetation surrounding the MS point.
4. Assess the best potential access point, and plan at least one alternative route. While Google Earth is a great resource, the resolution is not high enough to account for every obstacle. Poison oak

may not be visible in Google Earth, making the planning of alternative access points a more valuable exercise.

5. Print out an aerial image of the MS point.
    a. To do this, click on “File”>”Save”>”Save Image…”
    b. Note that you may need to make adjustments to your access route, so accommodate for the alternatives in your aerial image, or make multiple maps if necessary.
6. Be sure to include any other layers that may be useful, such as trails or property boundaries.

SOP 5: Establishing Monitoring Plots

Version 1.0 (September 2016)

5.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 5 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

5.2 Overview

This SOP explains the procedure for locating, laying out, and marking permanent 30 m line-point intercept transects. A list of necessary equipment for these procedures can be found in SOP 1.

5.3 Determining Plot Locations

1. **Selecting the new plot locations.** New plot locations are designated from a Generalized Random Tessellation Stratified (GRTS) design. Once selected, transect location coordinates are uploaded into a handheld GPS unit, as well as printed out onto an ArcGis map. At SAMO plots are selected from a subsample of the master draw.
2. **Review map of new plot locations.** Review the ArcGis map to determine the best possible route to access the new transect locations. Note that based on topographical features, the best way to access the new location may not be the shortest. Use your judgment when reviewing the map, taking note of steep slope contour lines. Bring both the GPS unit and the physical map with you to the field when you attempt to reach the new transect location.

5.4 Transect Equipment

A list of necessary equipment for these procedures can be found in SOP 1.

1. **Monument materials.** Different types of stakes are used as permanent transect monuments at each park. These differences reflect a balance of specific park concerns over durability, visibility in relocating the stakes, and mitigating impacts to visitor experience.
    - CABR: 9-in nails with a blue tag.
    - CHIS: 3/4" × 45" aluminum angle stakes with 4" metal rods.
    - SAMO: 4' or 2' long #3 rebar with a PVC sleeve. PVC pipe at point A is 4' tall, while the PVC pipe at point B is 2' tall. The rebar is driven approximately 30 cm into the ground. For safety, the rebar should not extend beyond the PVC sheathing.
2. **Stakes in high public use areas.** For transect site locations that are close to public high use areas, the stakes should be set at such height that they are not at all or only slightly visible. This is to ensure that seeing the transect stakes will not diminish the visitor experience to the park. It will also reduce the likelihood of having to replace the stakes after they have been pulled up by a visitor who does not care to see transect markers. At SAMO, PVC is not used in visible areas and the rebar is bent over for safety.
3. **Stamping the stakes.** The transect end point stakes must be tagged (at SAMO and CABR) or stamped on the interior side of the stake (at CHIS) with the park code, the transect number, and an A (begin transect) or B (end transect) designation. At SAMO each rebar stake is marked with a metal tag. The beginning of transect MS 0200 would read "MS 0200 A" and the stake at the end of the transect would read "MS 0200 B." At CABR a tag with a sequential number is attached to the nail. At CHIS, a stake at the beginning of transect 32 on Santa Cruz Island would read "SCI VT32A." The stake marking the end of the transect would read "SCI VT32B."
4. **Ground level markers.** At CHIS, markers are driven into the ground at the base of each aluminum angle stake. This is done so that if the aluminum stake is lost or pulled up, either end

point can be reliably located with the use of a metal detector. The ground level markers should be fairly substantial and should also be marked with the transect number and A (begin transect) or B (end transect) designation. However, this naming convention for the ground level markers was not always followed for the index sites at CHIS and therefore should not be used to identify the transect itself.

5.5 Navigating to Field Locations

1. **Loading shapefiles onto the GPS.** Pertinent base layers include: park boundary, streams, trails, roads, and transect point locations. Note that different point shapefiles are used when first establishing a transect as opposed to resampling an established transect. For existing transects, merged shapefiles, named by park, are available containing all transect beginning point locations and repeat photo locations. For new transects, only the beginning point A is available, and is located in a different file, ParkCode_Upland_Line-point_Transects. This layer contains all transect locations to be sampled across the 5-year period as well as additional or alternative locations. Other layers, such as satellite imagery, digital orthophoto quarter quads, and other spatially explicit layers, may be useful and also can be loaded onto the GPS units.
2. **Document directions to the transect**. Before leaving for the field, locate the GRTS point on the project map. Review the map for roads and trails that will get you to the backcountry entry point closest to the transect. While doing so, enter road and trail directions onto the "Establishment/Revisit" form (see Appendix A), which will be used in subsequent transect visits.
3. **Use road and topographic maps to travel from park headquarters to the point along road or trail nearest to the transect.** Use the GPS to assist in fine-scale navigation. Note that the GRTS point marks the beginning of the transect, point A. While establishing the transect the first time, take notes and fill in the Transect Establishment/Revisit form to aid in finding the transect in subsequent years.
4. **Navigate to the transect vicinity.** Using a GPS unit with the transect coordinates stored in a shapefile, navigate to the vicinity of the point, staying at least 50 m away from it to avoid trampling. Stay well outside the transect location as you approach to avoid unnecessary trampling in sampling area. Minimize walking through the site prior to establishing the transect monuments. Do not set any tools or packs on the transect line or within 1 m buffer zone on both sides of the transect.
5. **Add/drop decision.** After you are in the plot vicinity, assess whether the plot location can be added to the pool of permanent plots or not. If the plot area is less than 5 m from a road or trail, on a slope that is > 40°, or the area cannot be safely accessed or worked on, the plot must be dropped and the next available GRTS oversample point will replace it.

5.6 Installing the Transect

1. **Navigating to the location and determining the direction of the transect.** Once you have navigated to the transect site location, use the GPS unit to get as close as possible to the marker site. Take in the location of the marker site on the landscape and determine which way to run the transect. There are three general rules to follow to assist you in setting up the transect direction.

a. On slopes >5°, the transect runs left to right, perpendicular to the primary slope, parallel to the contour. Transect is read facing upslope, moving from left to right. This is both for the safety of the monitors, and for minimizing erosion on the site, especially on steep, rocky slopes.
b. For transects on slopes <5°, if no slope is clearly discernable, use a random number table to determine the bearing from the "A" stake to the "B" stake. Read the transect such that the "A" stake is always on your left.

2. **Installing the monuments.**

a. Locate the beginning and end points of the transect and pound in the permanent transect monuments **(**aluminum angle stake and rebar at CHIS; rebar at SAMO; nail at CABR) at both ends of the transect.

   If the substrate is not conducive for driving in the marker (i.e., it is rock), locate a more amenable site as close as possible to the designated location to install the marker. Note any change in the location on the Establishment/Revisit form (see Appendix A).

   CHIS: Orient the stake so that the interior is facing the direction that the transect will run.

   SAMO: In tall, dense chaparral, it is recommended to install an additional rebar marker at the 15 m point to help guide threading of the transect tape in straight line.

b. Attach a metal tag with the transect number on the transect marker rebars. Attach tag with A designation on the rebar in the beginning of the transect and the tag with B designation on the rebar at the end of the transect. Fire-resistant brass tags are to be used for the A corner.

c. Run the 50 m tape out from A to B. Keeping the meter tape taut (for concave slopes use chaining pins to keep to the topography), drive the B (end of transect) angle stake and rebar into the ground at the 30.30 m mark or further if this substrate is not conducive to driving the markers into the ground. In some cases you may have to position the B markers up to 31 or 32 meters away from the A markers. Make sure that this is noted in the Transect Establishment form. Keep trampling of the site to a minimum and do not walk directly on the transect line. Do not place the B stake at the 30 m point, as it is the last point where data are collected.

d. If the beginning A stake had to be moved from the original GRTS location, record a GPS point for the new location. Also, record a GPS point for the B stake. After both stakes are in place, take a bearing direction from the A stake to the B stake. This can aid in ensuring proper relocation of either stake should they go missing.

e. Take photos of the transect in both directions and an overview of the site and complete the Establishment/Revisit form . Step back far enough that the transect monument shows in the photograph.

f. Figure 5.1 shows the Terrestrial Vegetation monitoring plot layout.

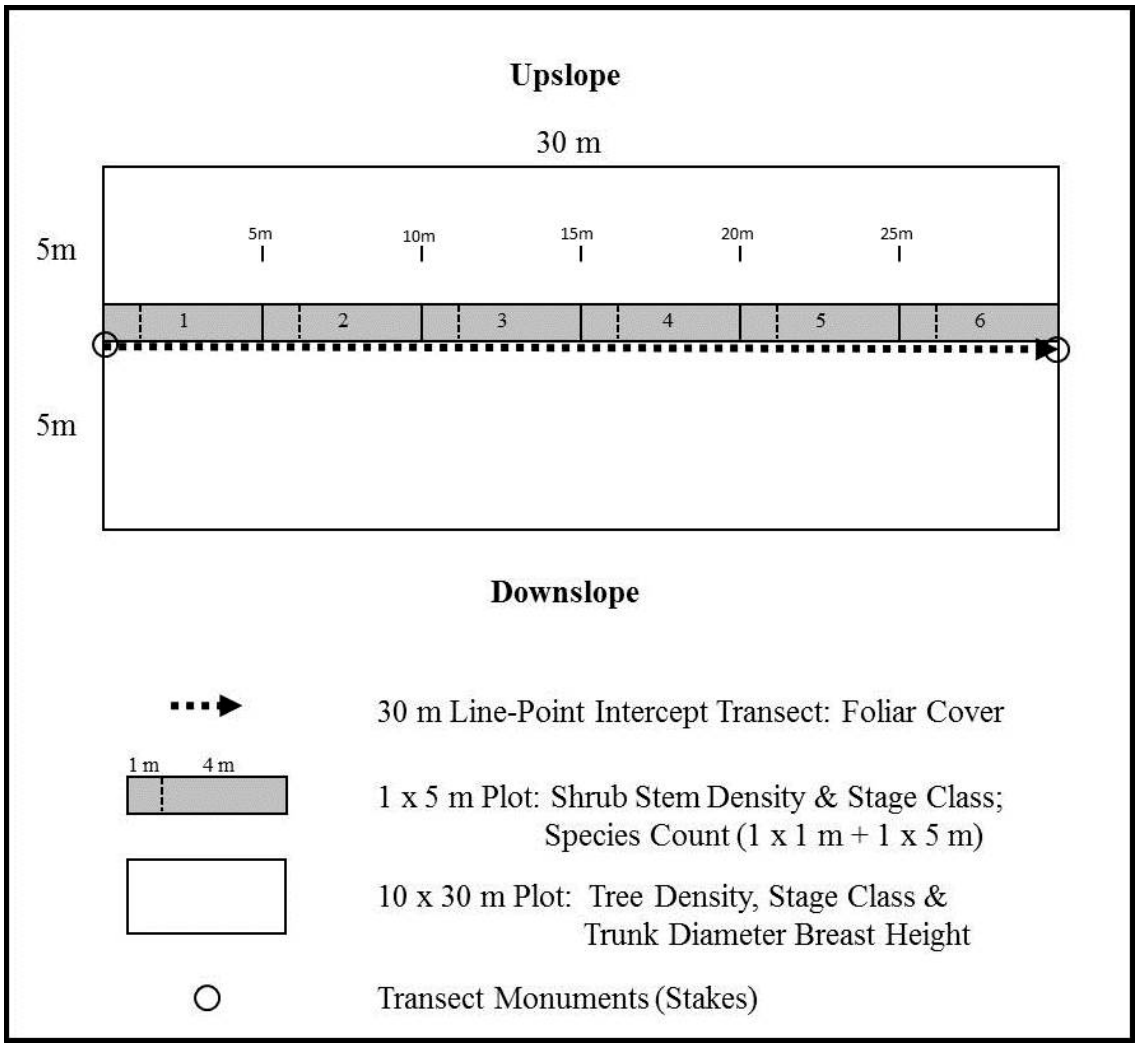


Figure 5.1. Terrestrial Vegetation monitoring plot layout.

SOP 5a: Establishing Post-Fire Monitoring Plots

Version 1.0 (September 2016)

5a.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 5a only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

5a.2 Overview

This SOP explains the procedure for laying out and marking the permanent 30 m line-point transects and 30 m belt 10 × 10 m quadrats for post-fire monitoring. These transects will be used to collect information for vegetation response to fire. A list of necessary equipment for these procedures can be found in SOPs 1 and 1a.

5a.3 Determining Plot Locations

Selecting the new plot locations. New plot locations are those derived from the SAMO Master Sample or the CHIS/CABR supplemental GRTS sampling that are located in burned vegetation within a new wildfire perimeter. Once selected, transect location coordinates are saved as both KMZ and ArcGIS files that are uploaded into a handheld GPS unit, and are printed out as an ArcGIS or Google Earth map.

5a.4 Additional Materials Needed for Post-Fire Plot Establishment (modifying existing / establishing new)

In addition to the normal Terrestrial Vegetation field equipment and materials for plot installation, each field crew will require the following additional equipment to establish fire monitoring plots:

- Additional 2 pieces of 3’ #3 rebar/plot for C and D points – top bent down
- Additional 2 metal tags labeled with plot number (e.g., MS-0390) and C, or D.
- Wire to attach metal tags to rebar (cut to ~ 12”)
- Additional 50 m tape (2 total)

5a.5 Additional Equipment Needed for Post-Fire Plot Establishment and Monitoring

The following additional equipment is required for Post-Fire data collection:

- Additional 50 m tape (2 total)
- Chaining pins
- Pin flags YR01: minimum numbers required for layout and shrub mortality belts.
    - 3 blue
    - 24 yellow
    - 4 red
    - 2 orange
- Pin flags YR02: for marking boundaries of 10 × 10 m species diversity subplots and
- 1 × 5 m Terrestrial Vegetation density plots
    - 4 red
    - 3 orange or yellow
- Datasheets (Appendix B)
    - MEDN Terrestrial Vegetation Transect Establishment/Revisit
    - Terrestrial Vegetation 30m Transect [line-point]

- Terrestrial Vegetation Species Richness (1m x 30m belt) datasheet (1 m^2) [1-m belt transect, 1 × 1 m nested plots in 1× 5 m belt segments along 30-m line transect]
- Shrub Density 30m Belt Transect in 1m x 5m Subplots [1-m belt transect, shrub density, mortality and recruitment]
- Fire Monitoring 10 × 10 Density and Mortality (Year 1 only)
- Fire Species Richness (three 100m^2 subplots) [10-m belt transect in three 10 × 10 m quadrats, for species richness and cover estimates]

5a.6 Installing Post-Fire Monitoring Plots

These instructions are for expanding an existing Terrestrial Vegetation monitoring plot for Post-Fire monitoring and do not include installation of the base transect's (A – B) monuments and tags. If a new plot is being established for Post-Fire monitoring, then the steps described in SOP 5 need to be implemented before employing the steps provided below. These installation instructions also include directions for setting temporary pin flags for measurement, which is integrated into the establishment process for field efficiency.

Installing the monuments and laying quadrat markers (see schematic diagram in SOP 5a)

1. Establish plot origin, A, with rebar to set the plot (belt) origin at (0,0). If the substrate is not conducive for driving in an aluminum angle stake (i.e., it is rock), locate a more amenable site as close as possible to the designated location to install the marker. Note any change in the location on the Transect Establishment/Revisit form. Orient the stake so that the interior is facing the direction that the transect will run. Label as A with metal tag. Fire-resistant brass tags are to be used for the A corner.
2. Using a 50 m tape, one crew member will run the plot baseline out to 30 m and pin it with rebar and label as B with metal tag. As the tape is being laid, the second crew member will help avoid snags to lay the tape in a straight line, and will follow and mark the intermediate 10 m points (10 m and 20 m) with red pin flags, blue pin flag the 5 m, 15 m, and 25 m points, and put yellow flags at any unflagged 2 m interval points.
3. Continue to run the tape at a right angle upslope for another 10 m (to the 40 m mark) to your best estimate of the upper right corner of the 10 × 30 m belt. Temporarily mark it with an orange pin flag and anchor with a chaining pin.
4. Use a second 50 m tape to run the tape 10 m upslope from the plot origin, A, to your best approximation of the upper left corner of the 10 × 30 belt transect and temporarily mark it with a chaining pin and orange pin flag.
5. Continue running the second tape up from the temporary upper left corner along the diagonal down to the baseline to the 10 m pin flag. If your positioning of the lower left corner was square, the tape will read exactly 24.14 m at the 10 m pin flag on the baseline. (The purpose of diagonal is to square the belt transect)
6. If the diagonal does not read 24.14 m, move the upper left corner to the right or left to achieve this reading at the baseline. Mark with rebar. Label as C with metal tag.

7. Reel in the diagonal run of the second tape just back to the upper left corner and then rerun the tape along the upper baseline to the temporary upper right corner, using the distant orange pin flag to assist in laying it straight and true.
8. Set the actual position of the upper right corner using rebar where the 40 m mark on the first tape meets the 40 m mark on the second tape. Label as D with a metal tag. (In the process of this step, ensure that the right boundary of the plot runs straight between the upper right and lower right corners of the plot.)
9. Set red pin flags at the 10 m marks on the upper baseline at 10 and 20 m, blue pin flags at the 15 m, 25 m, and 35 m points, and yellow pin flags at any unflagged 2 m intervals.
10. Complete the Transect Establishment/Revisit form. Take photos at each of the plot corners to capture the long axis of the plot and the diagonal:
    - from A: to B, to D
    - from B: to A, to C
    - from C: to D, to B
    - from D: to C, to A

    Step back far enough that the transect monument shows in the photograph.
11. If the beginning A stake had to be moved from the original GRTS location, record a GPS point for the new location. Also, record a GPS point for the B, C and D stakes. Record the bearing direction from the A stake to the B stake to ensure proper relocation and replacement of either stake should they go missing.
12. Figure 5a.1 shows the layout of the Post-Fire vegetation monitoring plot.

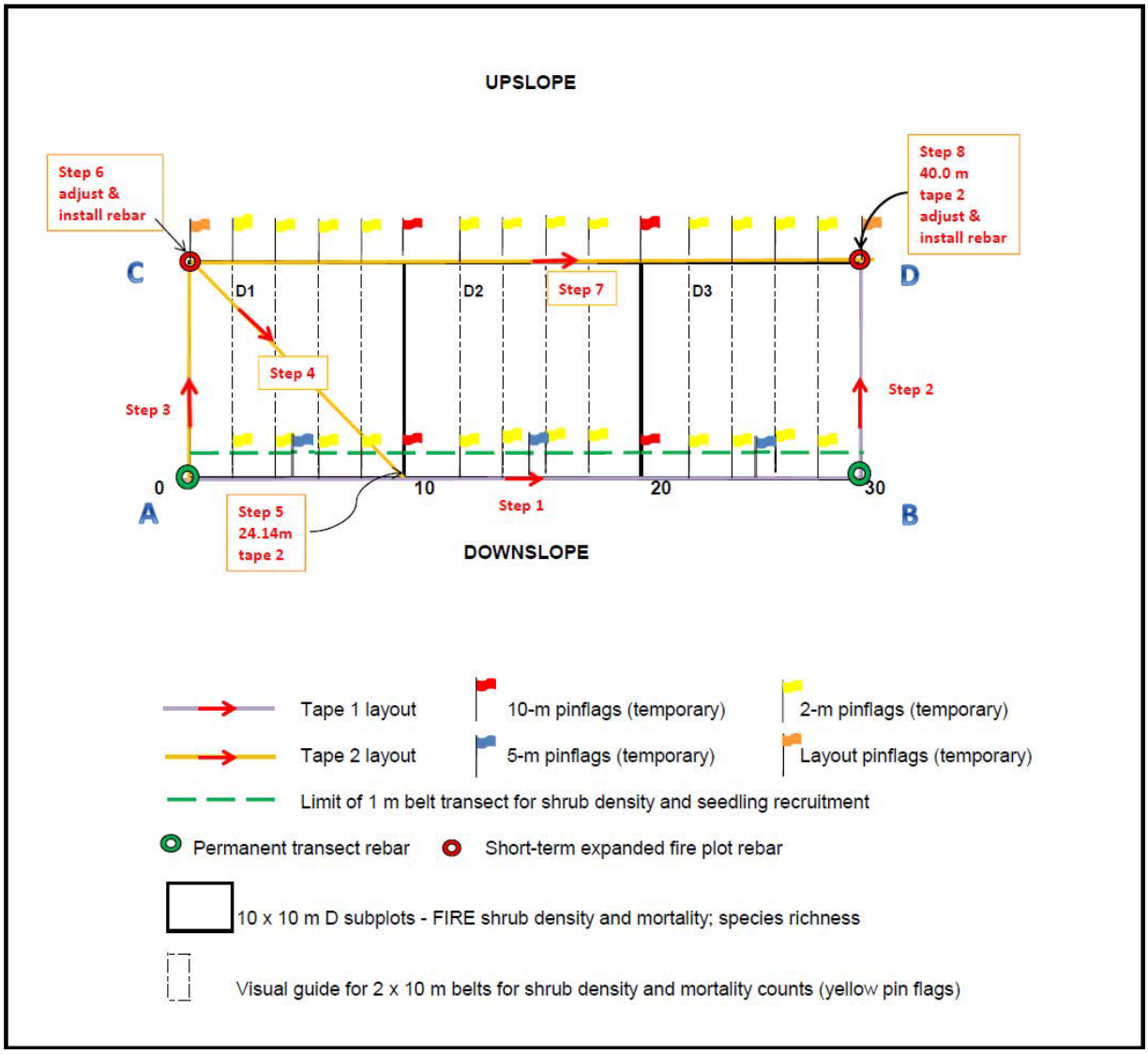


Figure 5a.1. Year 01 installation sequence and pin flag placement for Post-Fire monitoring of the 10 × 30 m belt transect and 10 × 10 m quadrats.

SOP 6: Revisiting Monitoring Plots

Version 1.0 (September 2016)

6.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 6 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

6.2 Overview

This SOP provides instructions on how to relocate transects for monitoring. Transects are resampled on a 4- and 6-year cycle for CHIS and SAMO/CABR respectively. This SOP does not cover logistical practices, such as research permits, housing, or office space.

6.3 In-office Preparation

Information and equipment

1. **Identify which transects are to be sampled during the upcoming period.** Contact the program lead at each park for specific plot locations and associated information.
2. **Generate a database print-out of the transects using the MS Access master database front-end query button, Revisit Print-Out.** This query will generate a list of vital information collected when the plot was first established, such as GPS coordinates, photo point coordinates, directions on how to access the plot, marker descriptions, and a list of species recorded at each transect in previous years. Place the printouts into a 3-ring binder and include it in the action packer with other field equipment to be taken out to the field.
3. **Gather existing topographic map prints of the local plot areas that are filed with previous sampling period datasheets.** If these are no longer in good condition, generate new maps using ArcGIS that show the local terrain to aid in navigation to the plot.
4. **Load GPS units with shapefiles.** Load GPS units with appropriate base layers for the park (boundary, trails, roads, or anything else of use). Load individual plot shapefiles that contain points for the beginning and end of the transects and photo locations. Open these on the unit and ensure that they are all functional and that you have the correct transects loaded.
5. **Reports.** Read the field summary report for the last sampling period for these plots. Read the 3–5 page internal logistics report compiled at the end of the previous sampling period. This report will detail information relevant to field work logistics, prior access issues, safety restrictions, former weather/phenology, and any plot-specific notes. Adjust field plans, if needed.
6. **Review filed copied datasheets for each transect.** Make a two-sided copy of the Establishment/Revisit form for each plot, which will include the original transect diagram. These will be referenced in the field to assist in locating plot monuments and used to compare with current conditions during this new sample period.
7. **Copy SOPs.** Print paper copies of the most recent version of all SOPs and datasheets, including at least three sets of datasheets printed on waterproof paper.
8. **Equipment.** Locate and check the integrity of all equipment listed in SOP 1. Consult the previous year's checklist to see if replacement stakes are needed. Gather together the equipment needed to conduct monitoring. Purchase goods as needed.
9. **Road and trail conditions.** Make inquiries about current road and trail conditions. Adjust the selection of transects to be read if necessary due to access restrictions.
    - CHIS: You may have to consider going to a different island. After arriving at any one of the islands, you will also need to consult on-island staff about the road and trail conditions and make adjustments to your schedule as necessary.

10. **Consult SOPs.** If this is the first monitoring tour of the season, consult SOP 1.
11. **Pack the daypack.** Separate out the field gear and datasheets you will need for the day and place them in your daypack. Be sure to pack spare batteries for any electronic equipment that you will be using as well as a spare battery for the park radio.
12. **Notify other personnel where you will be for the day.** At each park, notify other personnel where you will be for the day by recording your destination and anticipated return time on the daily log located next to the truck sign-up station. At CHIS, notify on-island personnel.
13. **Vehicle safety.** Prior to using a park vehicle, conduct a walk-around inspection of the vehicle, taking a special note of the tire conditions. Open the hood and check oil and radiator water levels. Do not operate a vehicle without having any vehicle operational issues addressed. In case of any issues associated with the operational safety of the vehicle:
    - CHIS: Notify the island ranger or maintenance person immediately.
    - SAMO/CABR: Contact staff in charge of vehicle maintenance.
14. **Routine vehicle maintenance.** To help maintain the vehicles in good working order and as a courtesy for the next user, perform daily and weekly basic maintenance, which includes making sure the vehicle has enough fuel for the next driver, cleaning the interior, and washing the outside of the vehicle at least every other week or more often when field conditions are muddy or dusty.
    - CHIS: The basic maintenance is done weekly at the end of each tour.
15. **New transects.** Regarding the installation of new transects or the monitoring of established transects, see SOP 5 or 7 as needed.

6.4 Conducting Repeat Sampling

The following outlines the steps for completing a single repeat sampling procedure. Note that the sites to be visited must be submitted and approved by law enforcement staff one week prior to the intended visit date.

Transect locations

1. **Locate plot using GPS point location files.**
2. **Locating monuments.** Without trampling the plot, locate both transect monuments as well as the line-point transect center marker where applicable. If one monument is found, utilize the bearings noted on the original plot diagram to shoot a bearing to the other markers. After all monuments are found, verify the recorded bearing and make note on the updated plot diagram (back side of the Establishment/Revisit form) of any discrepancies found between recorded and actual bearing. If no discrepancies are evident, note this on the Establishment/Revisit form notes section.
3. **Verify plot.** Verify that the transect marker tags are labeled and that it is the correct transect.
4. **Missing markers.** If the transect A marker is missing or undetectable, mark the approximate location with pin flags and begin to locate the monument for the B end of the transect. Once one of the markers has been found, follow the bearing recorded during the original plot establishment.

5. **Setting up new marker.** For any transect end markers not found, approximate the location by measuring 30 m at the known bearing from the found monument. Look for the missing monument again within a few-meter radius of the tape end. Be sure to reference the original transect diagram for notes on where the monument was placed.
6. **Missing monument.** If either the A or B monument is not found, secure the 30 m mark with a chaining pin and verify the accuracy of your tape bearing (have two people check each other) by back-shooting to the tape origin as well as based on photos taken during the first visit to the site. Based on the photos and the original GPS point, establish a new monument as close to the original location as possible.
7. **Lay out the tape, pulling it tight between the monuments.** Use extra chaining pins if necessary to follow the topography between the markers. This is usually necessary if the topography is undulating or concave.

SOP 7: Vegetation Plot Monitoring

Version 1.0 (September 2016)

7.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 7 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
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—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

7.2 Overview

This SOP describes the methods used to conduct monitoring of vegetation with a 30 m line-point intercept transect, a 1 × 30 m shrub transect, and a 10 × 30 m tree belt. Vegetation monitoring includes four components: 1) foliar cover, 2) density, 3) frequency, and 4) species richness. When possible, all vegetation is identified to species. Table 7.1 below shows the cycle of the rotating panels and methods.

Table 7.1. Cycle of cover and density monitoring at Channel Islands National Park (CHIS), Santa Monica Mountains National Recreation Area (SAMO), and Cabrillo National Monument (CABR). "C" is foliar cover and richness, "S" is density of shrubs, "T" is density of trees. Species richness is recorded in every monitoring event.

		Year												
Park	**Panel**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
CHIS	Core	CST	C	CS	C	CST	C	CS	C	CST	C	CS	C	CST
	A	CST	—	—	—	CST	—	—	—	CST	—	—	—	CST
	B	—	CST	—	—	—	CST	—	—	—	CST	—	—	—
	C	—	—	CST	—	—	—	CST	—	—	—	CST	—	—
	D	—	—	—	CST	—	—	—	CST	—	—	—	CST	—
SAMO and CABR	A	C	—	—	—	—	C	CST	—	—	—	—	C	CST
	B	C	CST	—	—	—	—	C	CST	—	—	—		C
	C	—	C	CST	—	—	—	—	C	CST	—	—	—	—
	D	—	—	C	CST	—	—	—	—	C	CST	—	—	—
	E	—	—	—	C	CST	—	—	—	—	C	CST	—	—
	F	—	—	—	—	C	CST	—	—	—	—	C	CST	—

7.3 Basic Protocol

All transects are permanently marked at both ends with aluminum angle stakes (CHIS) or rebar (SAMO) or 9" nails (with blue tag, CABR), which are either stamped or marked with A (begin transect) or B (end transect) and transect number. The end points have been recorded by GPS and the coordinates for both stakes can be found in the Site Reference Packet.

1. **Navigating to the transect location.** Use both the maps in the reference packet and the GPS unit to navigate to the transect location. Once you have navigated to the transect site, determine from the transect establishment/revisit form in the reference packet and stake tags which direction the transect runs (i.e., A to B).

2. **Setting up transect.** Use a chaining pin to secure the beginning of the 30 m tape at the A stake and run the tape out to the B stake. Note that the B stake is set at least 20 cm beyond 30 m mark, so that the data for the last monitoring point can be read without obstruction. Do not walk directly between the A and B stakes but rather about arm's length downhill from the transect line. Once you are at the B stake, stand behind it and look back at the A stake to make sure the tape is running as straight and tight along the ground as possible. Extra chaining pins may need to be used to keep the line straight while keeping to the topography. Use 1–4 extra chaining pins to hold the tape in place on windy days. Stands in dense chaparral may have a permanent marker at the 15 m point; this will be noted in the transect establishment form included in the reference packet.

   Having an assistant present to help run a straight transect line—especially on tree or shrub dominated sites—will save time and reduce trampling of the site. In open shrub stands each person can hold up his or her end of the tape and then bring it back down to the ground in as straight a line as possible. In dense shrub stands the tape will have to be threaded under the shrub canopy.

3. **Photo documentation.** Once the tape is in place, document the site photographically by taking a picture of the site looking from the A stake to the B stake and then vice versa. Do not stand at either stake when taking the pictures but rather 1–2 meters behind the stake, if possible. Although the stakes and transect line are in the picture, the focus should not be exclusively on the transect itself, but should incorporate the surrounding near and far landscape as well. On revisits no change may be apparent on the transect site, but the photographs may capture change on the nearby slopes or in the background.

4. **Comments on general condition.** Write down comments on the general condition of the site in the comment section of the establishment/revisit form. These notes should include such observations as which species are blooming or senescing, signs of disturbance, new plant species in the area, or other noteworthy points.

5. **Reading the transect.** Refer to the MEDN vegetation plot schematic in SOP 5. Reading the transect requires two people, with one person being the observer while the other records the data. The reader stands on the downhill side of the transect line. The recorder (if present), can either stand on the downhill side with the reader or on the uphill side but at least one meter away from the transect line. The data are recorded either on the paper Terrestrial Vegetation 30 m Transect Data form - (regular or weatherized) or into an electronic form. The recorder must ensure that the reader does not inadvertently skip a point, the data are written on the correct line, and the correct species code is used.

6. **Species codes.** SAMO/CABR use six-letter species codes and CHIS uses a four-letter code. These codes are specific to each park and are based on, but do not conform to, USDA species codes (there is a crosswalk in the database). Taxonomic nomenclature conforms to the 2nd edition of the Jepson Manual. Unknown plants are recorded as "SP#" (SP1, SP2, etc.).

   Dead Plants. For perennial shrub species, in addition to hits on live tissue, hits on dead plants and dead branches greater than 8 mm diameter on a live plant (the diameter of a wooden pencil) are recorded, even when both are from the same species. Dead grasses and forbs are counted as

litter. On the datasheet, dead branches are distinguished from live branches by placing them in parentheses.

The height of the highest hit of dead plant is recorded (height of the dead branch is not recorded) by placing it in parentheses following the height of the highest live tissue. For example, 50(20) indicates height of highest live tissue intersecting the sampling rod is 50 cm and the height of highest dead tissue (>8 mm) intersecting the sampling rod is 20 cm.

A complete list of species names and codes will be included in the Site Reference Packet (see SOP 1).

7. **Monitoring methods: Line-point Intercept, Density, and Species Richness.**
   - SAMO/CABR: Foliar cover and species richness data are collected every time the plot is visited; shrub and tree data are collected only in the second consecutive year of monitoring at a given site.
   - CHIS: Shrub data are collected for every monitoring event in the rotating panels, but for the core plots, which are monitored annually, shrub data are collected every second year and tree data every fourth year (Table 7.1).
8. **Unknown plants:** Unknown plants are recorded as "SP#" (SP1, SP2, etc.) and then collected or documented. If >20 individuals of a species occur at the site, collect one plant. If possible collect the plant from outside the 1 × 30 m belt transect. If <20 plants occur, photograph the plant and only collect parts (leaves, flowers, branches) so as not to excessively damage the plant. See SOP 8 for full directions on how to collect and/or document.
9. **Line-point intercept cover measurement (30 m line transect).** Keeping the graduated sampling rod vertical (not perpendicular to the slope), record vegetation cover every 30 cm, beginning at 30 cm (by the A stake) and ending at 30 m (by the B stake). Record all species touching the marked line on the rod, proceeding from the bottom to the top of the rod. Walk on the downslope side of the tape so as not to disturb the shrub and diversity monitoring belt. Record the data on the Terrestrial Vegetation 30 m Transect Data form.

   *Substrate***.** Place the rod on the upslope side of the tape. Record the soil surface cover that the sampling rod rests on: biological crust (algal crust/moss/ lichen), litter/thatch, wood, rock, pebbles, bare soil, or sand.

   The soil surface cover types are defined as follows:

   Biological crusts include algal crust (CRST), soil lichen (LICH) and moss (MOSS) on soil. Note that lichen and moss on rock, shrubs, or trees is treated as a plant, and contiguous patches greater than 2.5 cm (1 in) diameter are also treated as plant and recorded as a hit on a plant.

   Litter/thatch (LITT) is loose dead or decaying plant matter, including twigs up to 2.5 cm diameter. Grass thatch is counted as litter.
   - The substrate beneath the litter is not recorded.

- Dead grass from previous years is included as litter. If plant material is this year's growth and still attached to the parent plant, it is not included in litter but recorded as this year's live plant material.

Wood (WOOD) is loose stems or branches >2.5 cm diameter.

Stem (STEM) is the main rooted structure of a shrub or larger herbaceous plant.

Trunk (TRUNK) is the main rooted structure of a tree or large shrub, including basal burls.

Root (ROOT) is the exposed root of shrubs or trees.

Rock (ROCK) is all rock material >7.5 cm diameter. Rock includes cobbles, stones, boulders, and bedrock.

Pebble/Gravel (PEBBLE) is all rock material >2 mm and <7.5 cm diameter.

Soil (SOIL) is fines <2 mm diameter ("bare ground") with no obvious biological crust or loose material covering it.

Sand (SAND) is fines <2 mm diameter composed of silica or carbonate minerals (the latter derived from marine invertebrates).

Vegetation - species. With the sampling rod placed on the upslope side of the tape and the vertical line facing the observer standing on the downslope side of the transect, record all species that touch the line on the front of the sampling rod (Figure 7.1, 7.2). Record "hits" along the line from the lowest to the highest. If the same plant touches the rod more than once at a given sampling point, only record the highest hit.

For woody perennial species (shrubs), in addition to hits on live tissue, hits on dead stems and branches greater than 8 mm (the diameter of a wood pencil) are recorded, even if live tissue of the same species intersects the measuring rod.

See "Species Codes" section above for notation rules.

Herbaceous annual and perennial species that have begun to dry and shrivel are recorded as live for the current year's growth and as litter if last year's growth. The subshrubs listed in Table 7.2 are treated in the same way as herbaceous species (not counted in shrub density measurement).

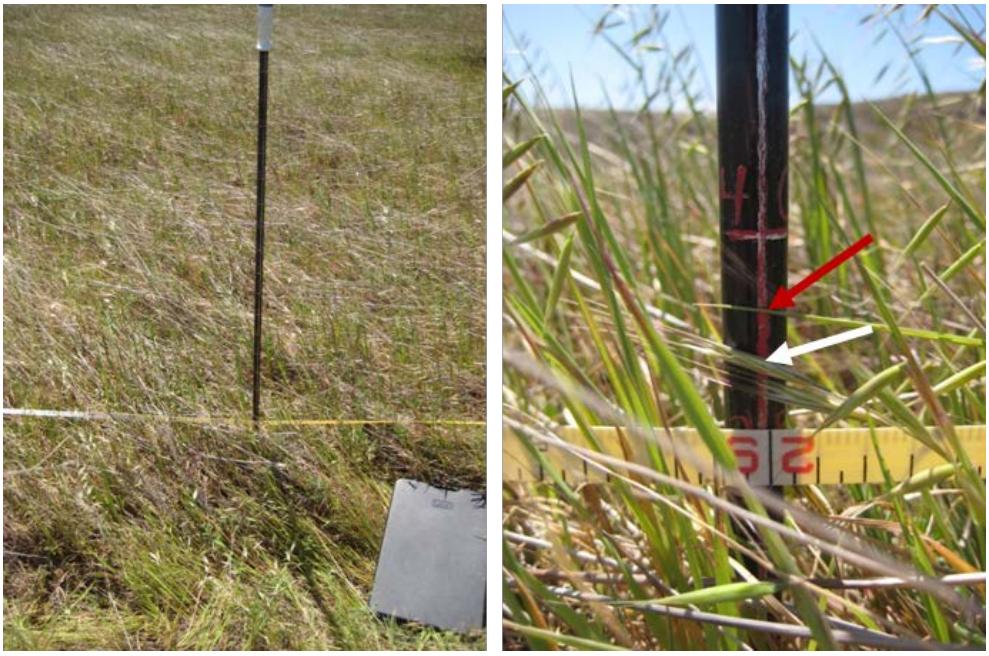


Figure 7.1. Monitoring rod fashioned from a ski pole, employed along a transect in non-native grassland. Species are recorded from the ground up, with each taxon recorded at the lowest point it intersects the 2-mm wide vertical line etched on the rod. In the photograph at right *Bromus diandrus* (white arrow) is recorded before *Avena fatua* (red arrow). Since the latter species is the highest contacted by the line along the rod, its height at contact is also recorded as canopy height, even though surrounding grasses are taller.

Table 7.2. Subshrubs treated as herbaceous species.

Species
Hazardia squarrosa var. *grindelioides*
Lonicera subspicata var. *denudata*
Symphoricarpos mollis
Gutierrezia californica
Keckiella cordifolia
Acmispon glaber
Hoita macrostachya
Lupinus longifolius
Helianthemum scoparium
Hesperoyucca whipplei
Nolina cismontana

Vegetation – height. Record the height of the tallest living and tallest dead plant at the point where each touches the line on the front of the sampling rod. Note that only the height of the highest dead plant is recorded; the height of the highest dead branch is not recorded. The height of the tallest dead plant hit is placed in parentheses. See "Species Codes" section above for notation rules.

Where trees or very tall shrubs are present on the line-point intercept transect, use the periscope densitometer to determine hits up in the canopy. Place the densitometer on top of the sampling rod, and keeping the rod vertical (rely on the densitometer's internal level), look through one end of the densitometer and line up the crosshairs inside the circle imprinted on the lens. Once this is done, look through the crosshairs and see whether they are hitting any part of the tree canopy above. If so, record the species as a hit and include an estimate of the canopy height at that point (to the nearest 0.5 m).

10. **Shrub density measurement (1 × 30 m belt plot).** After completing the line-point intercept measurement, delineate six 1 × 5 m belt subplots on the upslope side of the transect by using a folding engineer's ruler or the measuring rod to identify the uphill limit of the belt. The 1 m width should be measured along the ground. Record the shrubs by species and demographic stage class in each 1 × 5 m subplot on the Terrestrial Vegetation Shrub Density datasheet. The belt may be assessed from whichever direction is most convenient, but if reading the belt from B to A (30 m to 0 m), be aware that the datasheet lists subplots running from A to B.

    The five stage classes recorded under the shrub protocol are:

    Seedling: small plant that germinated from seed; it is not a root sprout.

    - Note that it can be difficult to distinguish seedlings from root sprouts. If the seedling germinated this year, it may still have cotyledons on it. Seedlings will have true roots that narrow and sometimes branch with depth. Sprouts have "roots" that are really stems that maintain a fairly constant thickness down to the connection with the rhizome. In some cases, minor, gentle excavation of the top few centimeters of duff or soil may allow one to see the root area well enough to determine if the plant is a seedling or root sprout. Excavate only when you are sure you won't harm the plant.
    - Shrub root sprouts are recorded as saplings or mature depending on the shrub to which they are attached.

    Juvenile: small, single-stemmed or multi-stemmed individual in which most stems have a diameter of 8 mm or less (the size of a wooden pencil) at ground level.

    Adult: reproductive shrub with any live vegetation on it. Note that a resprouting shrub, where a burl is evident, is recorded as mature.

    Dead: no live vegetation.

    Resprout: plants resprouting after freeze or drought dieback.

In assessing the plants, stand downslope of the transect line and move along the transect, using the measuring rod or a pin flag as a guide to keep track of the plants that have been counted and those that still need to be counted. Note: In most cases the A rebar stake (0 m) will be on your left and the B rebar stake (30 m) will be on your right. In a few cases, because of topographic constraints, these have been reversed. Be sure you have correctly identified your belt transect segments as you record your data.

- At CHIS, record the number of stems per shrub for mature species that can be identified to an individual. For clonal species (Table 7.3), count stems by clone. For stem count, rooted stems include stems that branch off from the main stem at the height of 10 cm or less and are at least 2 cm in diameter.
- At SAMO/CABR only count the number of shrubs, not the number of stems. In certain clonal species, like *Cercocarpus betuloides,* identifying an individual can be difficult. The observer must use their best judgment based on the apparent aggregation of stems.

Within each belt segment the numbers of individuals (whether counting stems or shrubs) in each stage class are counted and recorded. A shrub is counted as within a given 1 × 5 m belt segment when it is rooted within the segment or if it has rooted stems intersecting the downslope or right-hand border of the segment. Shrubs with rooted stems intersecting the upslope and left-hand borders of a given segment are not counted. A shrub is only counted once.

11. **Species richness / species count (1 × 30 m belt plot).** After completing the shrub density measurement, count all species occurring in the same 1 × 30 m belt transect using the Terrestrial Vegetation Species Richness (1m x 30m belt) datasheet..

    For measurement of richness, a species is counted if any part of the plant overhangs the belt plot. The plant does not have to be rooted in the plot (unlike the shrub density protocol, which counts only plants rooted within the plot). Counting the plants overhanging into the plot will ensure that vines, such as wild cucumber and morning glory, are included in the richness measure.

    The count can be done in either direction, but care must be taken to record the information in the correct column for the segment. Each 1 × 5 m segment used in shrub density monitoring is divided into a 1 × 1 m subplot, followed by a 1 × 4 m subplot. For example the 5–10 m segment is divided into 5–6 m and 6–10 m subplots.

    Record all species occurring in the 1 × 1 m subplot at the beginning of each 1 × 5 m belt segment. Then record all <u>additional</u> species occurring in the remainder of the 1 × 5 m segment (the 1 × 4 m subplot). <u>Do not recount</u> species that occur in the 1 × 1 m subplot in the rest of the segment. On the datasheet, enter the name of each species only once and make a checkmark in each belt subplot in which the species occurs. Species are counted only once within a given 1 × 5 m belt segment. For example, if a species occurs in the 5–6 m subplot, it is counted in that subplot, but not within the 6–10 m subplot. If the species reoccurs in the 16–20 m subplot, a checkmark is also placed in that subplot.

Additional species (not found in 1 × 30 m belt plot). Record in the "Outside" column of the Species Richness datasheet any species observed in an approximately 10 × 30 m area centered on the transect that were not recorded in the belt plot.

12. **Tree protocol**

CHIS: The tree protocol is implemented every four years for the tree transects in the core panel. For transects in rotating panels, the protocol is done each time the site is monitored.

SAMO/CABR: The tree protocol is implemented in the second year that a site is monitored.

Where trees are present, the tree protocol is conducted on transects within a 30 × 10 m belt plot centered on the line-point transect, with 5 m above the transect line and 5 m below the transect line. Use the Terrestrial Vegetation Tree Monitoring datasheet.

After the basic line-point intercept monitoring is completed, set up a 10 × 30 m plot on top of the base transect with 5 m on one side of the base line, and 5 m on the other side of the baseline.

Record tree species within the 10 × 30 m plot in four different classes – seedling, resprout, root sprout, sapling, mature, dead (adult). The seedling, sapling, mature, and dead classes are tallied and enumerated in following classes:

<u>The six classes recorded under the tree protocol are:</u>

Seedling: Plants that are clearly of a very young age and have <2.5 cm (1 in) Diameter at Breast Height (DBH, 140 cm).

- Seedlings can often be identified by the presence of dicotyledons. It can be difficult to distinguish seedlings from root sprouts. If a seedling germinated this year, it may still have cotyledons on it. Seedlings will have true roots that narrow and sometimes branch with depth. Sprouts have "roots" (these are really stems) that maintain a fairly constant thickness down to the connection with the rhizome. In some cases minor, gentle excavation of the top few centimeters of duff or soil may be needed to see the root area well enough to determine plant status. Excavate only when you are sure you won't harm the plant.

Resprout: Plants that have sprouted from the base of a damaged or top-killed tree.

Root Sprout: Plants that have sprouted from the roots or base of an apparently healthy tree.

Sapling: Plants that are older than 1 year but have not yet reached sexual maturity or with DBH of 2.5 cm to 12.5 cm.

Mature tree: Plants that are mature enough to reproduce either sexually or asexually, or DBH > 12.5 cm, and with any live tissue.

Dead: Plants with no live tissue. Record the dead in classes of seedling, sapling, or mature.

For convenience, survey the two 5 × 30 m subplots (above and below the line-point transect) separately. Trees are counted as within the 30 × 10 m belt plot when more than one-half of the tree is rooted within the plot.

For the mature trees, record a Diameter at Breast Height (DBH, 140 cm) using a DBH tape. Record by individual for taxa that can be identified to individual, and by trunk for the rhizomatous/clonal species (see Table 7.3 below). For trees with multiple trunks, record the DBH for each trunk.

13. **Review data.** After all protocols have been completed, review data forms to make sure all necessary information has been collected, correct codes have been used, and all notes are legible. Be sure that all required photographs (item #2 above) have been taken.
14. **Record any changes in the transect.** If there have been changes in the transect layout or method**,** draw and annotate a new plot diagram using the Terrestrial Vegetation Establishment/Revisit datasheet notes section. Include new beginning or end points and the new bearing in as much detail as necessary to make the change as clear as possible. Use landmarks, distances from trees, rocks, or large shrubs. Try to improve the diagram's usefulness over and above the original diagram. If there have been no changes, notate that on the transect diagram sheet. Take any additional photos to document disturbance or interesting features that you noticed in the course of monitoring.

7.4 Completing the Transect

Pull up all chaining pins and roll up all the meter tapes. Pack everything away, and before leaving the site, make sure nothing has been left behind. Proceed to the next monitoring site and repeat the necessary protocols.

7.5 Data Review

At the end of the monitoring day, review the data one more time to look for incorrect codes or other errors. If you have entered the data into a handheld computer, download the data onto a laptop computer and then review the data for incorrect codes, missing data, or other errors.

Do your best to allow enough time at the end of the day to identify as many of the collected unknown plants as possible. Either store the unresolved samples in zip lock bags in the refrigerator until they can be processed or press the material for later identification and/or confirmation by an experienced botanist.

Table 7.3. Clonal trees, shrubs, and subshrubs likely to be encountered on transects in Channel Islands National Park, Cabrillo National Monument, and Santa Monica Mountains National Recreation Area. Only total stem count is done for the species on this list; the stems are counted per individual for other trees, shrubs, and subshrubs.

Type	Species	CABR	CHIS	SAMO
Clonal Trees	*Alnus rhombifolia*			X
	Lyonothamnus floribundus ssp. *aspleniifolius*		X	
	Umbellularia californica			X
Clonal/rhizomatous Shrubs and Subshrubs	*Adenostoma fasciculatum* var. *prostratum*		X	
	Adenostoma sparsifolium			X
	Bergerocactus emoryi	X		
	Cercocarpus minutiflorus	X		
	Cercocarpus betuloides var. *betuloides*			X
	Dendromecon rigida			X
	Eriodictyon crassifolium var. *nigrescens*			X
	Glycyrrhiza lepidota			X
	Hazardia squarrosa var. grindelioides	X		X
	Hesperoyucca whipplei [Yucca whipplei]			X
	Holodiscus discolor			X
	Isocoma menziesii var. *decumbens*	X		
	Isocoma menziesii var. *sedoides*	X		
	Isocoma menziesii var. *menziesii*	X		
	Isocoma menziesii var. *vernonioides*		X	X
	Lepidospartum squamatum			X
	Mimulus flemingii		X	
	Nicotiana glauca			X
	Nolina cismontana			X
	Opuntia littoralis	X	X	X
	Rhus integrifolia	X		X
	Rosa californica			X
	Rubus ursinus			X
	Rupertia physodes			X
	Salix exigua var. *hindsiana*	X		X
	Salix lasiolepis			X
	Tamarix ramosissima	X		X
	Vaccinium ovatum		X	

7.6 Design of Measuring Rod

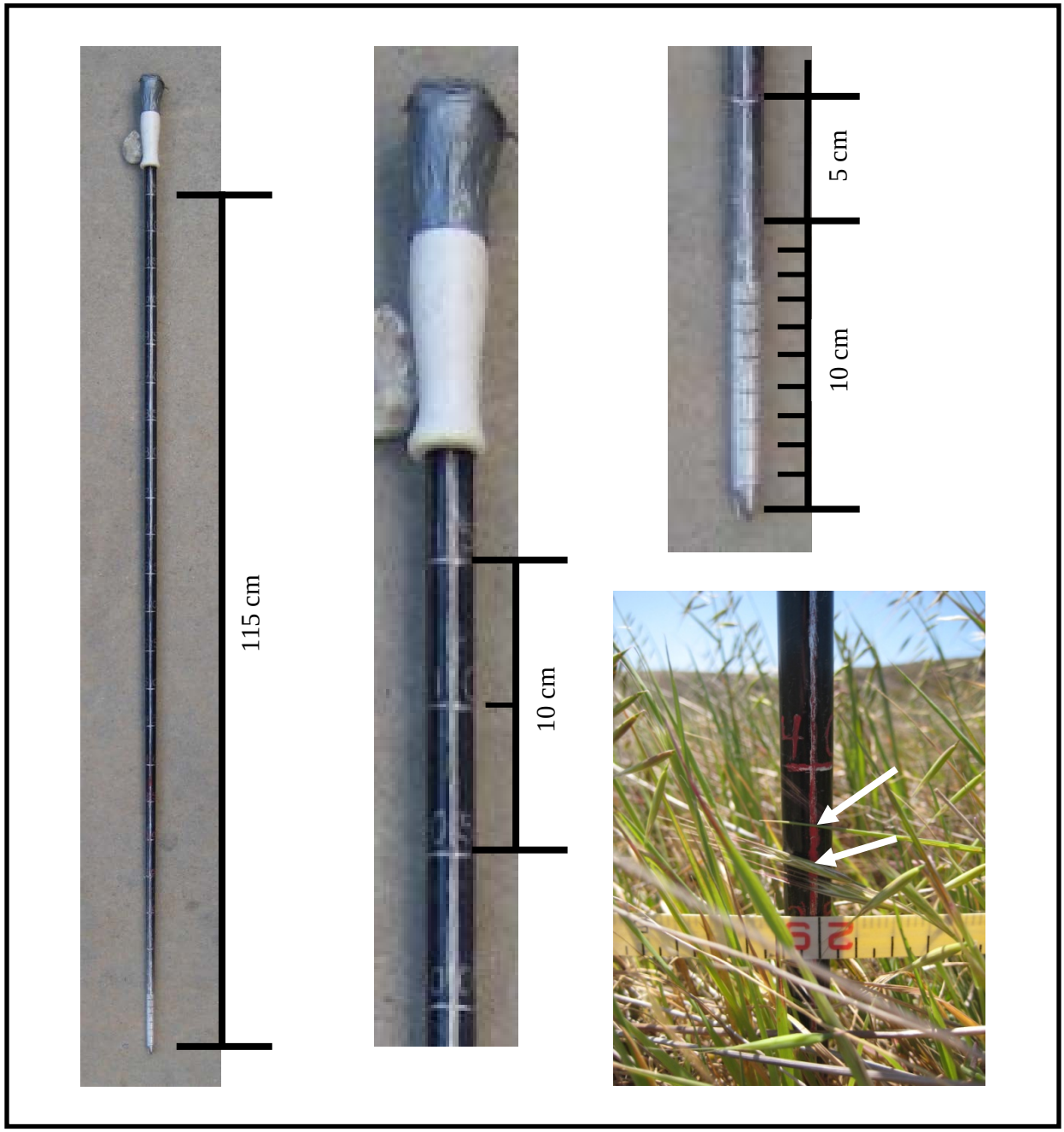


Figure 7.2. Metal monitoring rod used in recording hits of vegetation. Rod is scored in 1 cm increments in the lowest 10 cm and in 5 cm increments from 10 cm to 115 cm. White arrows in the lower right hand picture show points where vegetation is hitting the line on the front edge of the pole. Record the lower plant first, then the upper plant. The upper arrow also records the highest point any plant is hitting.

SOP 7a: Post-Fire Vegetation Plot Monitoring

Version 1.0 (September 2016)

7a.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 7a only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

7a.2 Overview

This SOP describes the methods used to conduct Terrestrial Vegetation and expanded Post-Fire monitoring with a 30 m line-point-intercept transect, 1 × 30 m shrub belt transect, and a 10 × 30 m belt transect with three 10 × 10 m quadrats. Post-Fire vegetation monitoring includes four basic measurements: 1) foliar cover, 2) density and mortality, 3) frequency, and 4) species richness. When possible, all vegetation is identified to species. Fire monitoring occurs in the first two years following fire and then returns to the normal rotation of plot revisits.

7a.3 Basic Protocol

The basic protocol is described below. Additional steps that are required for the Post-Fire protocol modifications are indicated by "[Post-Fire]" at the beginning of each such step. All transects are monumented at both ends with rebar and metal tags that are stamped with A (begin transect) or B (end transect) and transect number. The end points have been recorded by GPS and the coordinates for both stakes can be found in the Site Reference Packet.

1. **Navigating to the transect location.** Use both the maps in the field guide and the GPS unit to navigate to the transect location. Once you have navigated to the transect site, determine from the field guide and marking on the stake which direction the transect runs (i.e., A to B).
2. **Setting up transect.** Use a chaining pin to secure the beginning of the 30 m tape at the A stake and run the tape out to the B stake. Note that the B stake is set at least 20 cm beyond 30 m mark, so that the data for the last monitoring point can be read without obstruction. Do not walk directly between the A and B stakes but rather about arm's length downhill from the transect line. Once you are at the B stake, stand behind it and look back at the A stake to make sure the tape is running as straight and tight along the ground as possible. Extra chaining pins may need to be used to keep the line straight while keeping to the topography. Use 1–4 extra chaining pins to hold the tape in place on windy days.

   Having an assistant present to help run a straight transect line—especially on tree or shrub dominated sites—will save time and reduce trampling of the site. In open shrub stands each person can hold up his or her end of the tape and then bring it back down to the ground in as straight a line as possible. In dense shrub stands the tape will have to be threaded under the shrub canopy.
3. **[Post-Fire] Complete the remainder of the plot.** Follow the instructions described in SOP 5a.
4. **[Post-Fire] Photo documentation.** Once the layout is completed, document the site photographically. Take photos at each of the plot corners to capture the long axis of the plot and the diagonal:
   - from A: to B, to D
   - from B: to A, to C
   - from C: to D, to B
   - from D: to C, to A

   Do not stand at the stakes when taking the pictures but rather 1–2 meters behind the stake, if possible. Although the stakes and transect line are in the picture, the focus should not be

exclusively on the transect itself, but should incorporate the surrounding near and far landscape as well. No change may be apparent directly on the transect site, but the photographs may capture change on the nearby slopes or in the background.

5. **Comments on general condition.** Write down comments on the general condition of the site in the comment section of the establishment/revisit datasheet. These notes should include such observations as which species are blooming or senescing, signs of disturbance, new plant species in the area, or other noteworthy points.
6. **Reading the transect.** Refer to the Post-Fire plot schematic in SOP 5a. Reading the transects requires two people, with one person being the observer while the other records the data. The reader stands on the downhill side of the transect line. The recorder (if present), can either stand on the downhill side with the reader or on the uphill side, but at least one meter away from the transect line. The data are recorded either on paper datasheets (regular or weatherized) or into a handheld computer. The recorder must ensure that the reader does not inadvertently skip a point, the data are written on the correct line, and the correct species code is used.
7. **Species codes.** SAMO/CABR use six-letter species codes and CHIS uses a four-letter code. These codes are specific to each park and are based on, but do not conform to, USDA species codes (there is a crosswalk in the database). Taxonomic nomenclature conforms to the 2nd edition of the Jepson Manual. Unknown plants are recorded as "SP#" (SP1, SP2, etc.).

   Dead Plants. For perennial shrub species, in addition to hits on live tissue, hits on dead plants and dead branches greater than 8 mm diameter on a live plant (the diameter of a wooden pencil) are recorded, even when both are from the same species. Dead grasses and forbs are counted as litter. On the datasheet, dead branches are distinguished from live branches by placing them in parentheses.

   The height of the highest hit of dead plant is recorded (height of the dead branch is not recorded) by placing it in parentheses following the height of the highest live tissue. For example, 50(20) indicates height of highest live tissue intersecting the sampling rod is 50 cm and the height of highest dead tissue (>8 mm) intersecting the sampling rod is 20 cm.

   A complete list of species names and codes will be included in the Site Reference Packet (see SOP 1).

8. **Conduct vegetation monitoring on 30 m line-point intercept transect line, and on 1 × 30 m shrub density belt transect (six 1 × 5 m quadrats).**

   [Post-Fire] Conduct species richness belt transect (six sets of 1 × 1 m and 1 × 4 m quadrats).

   [Post-Fire] Conduct vegetation monitoring on 10 × 30 m belt transect and 10 × 10 m quadrats.

   All measurements, including cover, density, and species richness are done in both the first and second year post-fire, EXCEPT the full mortality count in the 10 × 10 m quadrats, which is only done in the first year.

Line-point intercept cover measurement (30 m line transect). Keeping the measuring rod vertical (not perpendicular to the slope), record vegetation cover every 0.3 m, beginning at 0.30 m (A stake end of the line) and ending at 30 m (B stake end of the line). Using the line-point intercept method, record vegetation hits to species, walking on the downslope side of the tape. First, record the soil surface cover: biological crust (algal crust/moss/ lichen), litter/thatch, wood, pebbles, rock, bare soil, or sand. Record the data on the Terrestrial Vegetation 30 m Transect Data Form.

*Substrate***.** Place the rod on the upslope side of the tape. Record the soil surface cover that the sampling rod rests on: biological crust (algal crust/moss/ lichen), litter/thatch, wood, pebbles, rock, or bare soil.

The soil surface cover types are defined as follows:

Biological crusts include algal crust (CRST), soil lichen (LICH) and moss (MOSS) on soil. Note that lichen and moss on rock, shrubs, or trees is treated as a plant, and contiguous patches greater than 2.5 cm (1 in) diameter are also treated as plant and recorded as a hit on a plant.

Litter/thatch (LITT) is loose dead or decaying plant matter, including twigs up to 2.5 cm diameter. Grass thatch is counted as litter.

- The substrate beneath the litter is not recorded.
- Dead grass from previous years is included as litter. If plant material is this year's growth, and still attached to the parent plant, it is not included in litter but recorded as this year's live plant material.

Wood (WOOD) is loose stems and branches >2.5 cm diameter.

Stem (STEM) is the main rooted structure of a shrub or larger herbaceous plant.

Trunk (TRUNK) is the main rooted structure of a tree or large shrub, including basal burls.

Root (ROOT) is the exposed root of shrubs or trees.

Rock (ROCK) is all rock material >7.5 cm diameter. Rock includes cobbles, stones, boulders, and bedrock.

Pebble/Gravel (PEBBLE) is all rock material >2 mm and <7.5 cm diameter.

Soil (SOIL) is fines <2 mm diameter ("bare ground") with no obvious biological crust or loose material covering it.

Sand (SAND) is fines <2 mm diameter composed of silica or carbonate minerals (the latter derived from marine invertebrates).

Vegetation - species. With the sampling rod placed on the upslope side of the tape and the vertical line facing the observer standing on the downslope side of the transect, record all species that touch the line on the front of the sampling rod. Record "hits" along the line from the lowest to the highest. If the same plant touches the rod more than once at a given sampling point, only record the highest hit.

[Post-Fire] For woody perennial species (shrubs), in addition to hits on live tissue, hits on dead stems and branches greater than 8 mm (the diameter of a wood pencil) are recorded, even if live tissue of the same species intersects the measuring rod.

See "Species Codes" section above for notation rules.

Herbaceous annual and perennial species that have begun to dry and shrivel are recorded as live for the current year's growth and as litter if last year's growth.

Vegetation – height. Record the height of the tallest living and tallest dead plant at the point where each touches the line on the front of the sampling rod. Note that only the height of the highest dead plant is recorded; the height of the highest dead branch is not recorded. The height of the tallest dead plant is placed in parentheses. See "Species Codes" section above for notation rules.

Where trees or very tall shrubs are present on the line-point intercept transect, use the periscope densitometer to determine hits up in the canopy. Place the densitometer on top of the sampling rod, and keeping the rod vertical (rely on the densitometer's internal level), look through one end of the densitometer and line up the crosshairs inside the circle imprinted on the lens. Once this is done, look through the crosshairs and see whether they are hitting any part of the tree canopy above. If so, record the species as a hit and include an estimate of the canopy height at that point (to the nearest 0.5 m).

[Post-Fire] Shrub density, mortality and recruitment (1 × 30 m belt plot). After completing the line-point intercept measurement, begin the first belt plot at the 25–30 m section and work back to the 0–5 m section. Mark out 1 × 5 m belt plots on the upslope side of the transect by using a folding engineer's ruler or the measuring rod to identify the uphill limit of the 1 m wide belt. Record the shrubs species by species and demographic stage class in each 1 × 5 m plot on the I&M Fire Shrub Density datasheet. In assessing the plants, move from right to left, using the measuring rod or pin flags as a guide to keep track of the plants that have been counted and those that still need to be counted. Record shrub density, mortality, and recruitment each year Post-Fire monitoring is done.

Note: In most cases the A rebar stake (0 m) will be on your left and the B rebar stake (30 m) will be on your right. In a few cases, because of topographic constraints, these have been reversed. Be sure you have correctly identified your belt transect segments as you record your data.

The six stage classes recorded under the shrub protocol are:

Seedling (new this year): small plant that germinated from seed, not a root sprout. Note that it can be difficult to distinguish seedlings from root sprouts. If the seedling germinated this year, it may still have cotyledons on it. Seedlings will have true roots that narrow and sometimes branch with depth. Sprouts have "roots" (these are really stems) that maintain a fairly constant thickness down to the connection with the rhizome. In some cases, minor, gentle excavation of the top few centimeters of duff or soil may be needed to see the root area well enough to determine plant status. Excavate only when you are sure you won't harm the plant. In Year 02, first year and second year seedlings are recorded separately if it is possible to distinguish them. Newer seedlings will tend to be malacophyllous (soft leaved).

Seedling (older than current year): older seedlings that germinated in the previous seasons, but are not quite old enough to be considered juvenile. If possible, it is especially important to distinguish Year 02 seedlings from Year 01 seedlings to determine timing and survivorship of post-fire recruitment. Plants will still be very small, but typically have more branching and start to exhibit sclerophylly, glaucousness or one of the many other adaptations characteristic of Mediterranean plants.

Juvenile: small, single-stemmed or multi-stemmed individual in which most stems have a diameter of 8 mm or less (the size of a wooden pencil) at ground level. Juveniles are more mature than seedlings, but not yet reproductive; therefore, to be classed as juvenile, the plant will not have produced any flowers or fruits.

Adult: mature shrub that survived the fire (e.g., live oak) without top-kill; may be scorched or partially burned but some portion of the canopy is alive. Note that a resprouting shrub, where a burl is evident, is recorded as adult.

Resprout: top-killed plant that is resprouting from the ground.

Dead adult/resprout/seedling: no live vegetation present on plant.

Within each belt segment the numbers of individuals in each stage class are counted and recorded. A shrub is counted as within a given 1 × 5 m belt segment when it is rooted within the segment or if it has rooted stems intersecting the downslope or right-hand border of the segment. Shrubs with rooted stems intersecting the upslope and left-hand borders of a given segment are not counted. A shrub is only counted once.

[Post-Fire] Species richness / species count (1 × 30 m belt plot). After completing the shrub density measurement, count all species occurring in the same 1 × 30 m belt transect using the Terrestrial Vegetation Species Richness (1m x 30m belt) datasheet. Record richness each year when post-fire monitoring is done.

For measurement of richness, a species is counted if any part of the plant overhangs the belt plot. The plant does not have to be rooted in the plot (unlike the shrub density protocol, which counts only plants rooted within the plot). Counting the plants overhanging into the plot will ensure that vines, such as wild cucumber and morning glory, are included in the richness measure.

Begin the count at 0 m and work toward 30 m. Each 1 × 5 m segment used in shrub density monitoring is divided into a 1 × 1 m subplot followed by a 1 × 4 m subplot. For example the 5–10 m segment is divided into 5–6 m and 6–10 m subplots.

Record all species occurring in the 1 × 1 m subplot at the beginning of each 1 × 5 m belt segment. Then record all additional species occurring in the remainder of the 1 × 5 m segment (the 1 × 4 m subplot). Do not recount species that occur in the 1 × 1 m subplot in the rest of the 5 m^2 segment. On the datasheet enter the name of each species only once and make a checkmark in each belt subplot in which the species occurs. Species are counted only once within a given 1 × 5 m belt segment. For example, if a species occurs in the 5–6 m subplot, it is counted in that subplot, but not within the 6–10 m subplot. If the species reoccurs in the 16–20 m subplot, a checkmark is also placed in that subplot.

[Post-Fire] Pre-fire shrub density and post-fire mortality (10 × 30 m belt plot; three 10 × 10 m quadrats). YR01 only.

This protocol is for the first year (YR01) Post-Fire monitoring only. It uses the Fire Monitoring 10 × 10 Density and Mortality datasheet. All dead skeletons in three 10 × 10 m quadrats are counted to provide an estimate of mortality and pre-fire shrub density. Resprouting shrubs are counted to provide an estimate of survivorship. This is a time-consuming task best implemented by a second two-person crew (if available) while the first two-person crew performs the preceding measures.

It can be difficult to keep track of which individuals have been counted. Use the pin flags placed at 2-m intervals along the upper and lower boundary lines of the plot to divide the plot visually into smaller, workable areas (see SOP 5a schematic diagram showing installation of pin flags). Walk the 2-m segments in a serpentine pattern. One person walks the first 2-m segment from the lower to upper boundary, then the second segment from upper end to the lower end, etc. The second person spots between the pin flags on opposite tapes. The spotter calls whether plants are "in" or "out" and helps track the count while recording the number of dead skeletons and resprouts. Counting skeletons in each 10 × 10 m quadrat requires five traverses of each quadrat, one for each 2-m band. The recorder can either move with the counter or stay at the baseline, whichever works better for the crew.

[Post-Fire] Species richness / species count (10 × 30 m belt plot; three 10 × 10 m quadrats).

Record each species present in each 10 × 10 m subplot and estimate cover on Fire Species Richness (three 100 m^2 subplots) datasheet.

[Post-Fire] Burn severity (10 × 30 m belt plot; three 10 × 10 m quadrats). YR01. Estimate burn severity using a revised NPS Fire Monitoring Handbook scale:

- 0 Unburned
- 1 Scorched
- 2 Lightly burned

- 3 Moderately burned
- 4 Heavily burned
- 0 Not applicable

See the Revised Scale for FMH Burn Severity table accompanying the Fire Monitoring 10 × 10 Density and Mortality datasheet for a description of each class.

9. **Review data.** After all protocols have been completed, review data forms to make sure all necessary information has been collected, correct codes have been used, and all notes are legible. Be sure that all required photographs (tem #2 above) have been taken.
10. **Record any changes in the transect.** If there have been changes in the transect layout or method**,** draw and annotate a new plot diagram in the notes section of Terrestrial Vegetation Establishment/Revisit datasheet. Include new beginning or end points and the new bearing in as much detail as necessary to make the change as clear as possible. Use landmarks, distances from trees, rocks, or large shrubs. Try to improve the diagram's usefulness over and above the original diagram. If there have been no changes, notate that on the transect diagram sheet. Take any additional photos to document disturbance or interesting features that you noticed in the course of monitoring.

7a.4 Completing the Transect

Pull up all chaining pins and roll up all the meter tapes. Place flagging or other markers necessary to help relocate the site. Pack everything away, and before leaving the site, make sure nothing has been left behind.

7a.5 Data Review

At the end of the monitoring day, review the data one more time to look for incorrect codes or other errors. If you have entered the data into a handheld computer, download the data onto a laptop computer and then review the data for incorrect codes, missing data, or other errors.

Do your best to allow enough time at the end of the day to identify as many of the collected unknown plants as possible. Either store the unresolved samples in zip lock bags in the refrigerator until they can be processed or press the material for later identification and/or confirmation by an experienced botanist.

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SOP 8: Collecting and Identifying Unknown Plants

Version 1.0 (September 2016)

8.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 8 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

8.2 Collecting Vouchers

When an unknown species is encountered, assess first if the plant is mature enough to identify it to genus/species in case it is collected for identification at the office. Use Voucher Specimen Field Documentation Form to record the data for unknown species.

1. Search the area for several more individuals before collecting one sample, using a general rule of allowing a collection of 1 individual from a population of 20 individuals. (For herbs, the "1 to 20" rule applies to individual plants; for shrubs and trees, it applies to shoots removed.)
2. If it is determined critical to make a collection regardless of having less than 19 other individuals (for example, in order to confirm presence of a new native species for the flora inventory or to confirm identity of the plant), and the plant in question is large enough that removing a portion of it will not devastate it, it is allowable to collect a small portion of the plant, provided that there is a strong likelihood for positive identification of the species based on the plant part.
3. If it is unlikely that the plant can be identified to species or even genus (for example, the plant is a seedling with no outstanding characteristics), no collection should be made. In this case, a photo will be taken and the plant will be recorded as "Unknown" with consecutive number attached to it (e.g., Unknown1).
4. If a sample is collected, it is to be labeled "Date, Site Name, Transect#, Unknown 1 [2,3…], Initials of team members."
5. Whether a voucher is collected or not, the unknown plant is to be photographed in the natural habitat. The photos must include both the habit and pertinent details such as flower, fruit, and/or leaf shape.
6. Attempt to collect as many identifiable parts as possible, including flowers, fruits, leaves, and roots.
7. Wrap a piece of masking tape around the plant and use a fine-point Sharpie to label it with the unknown species code. If the sample is very small, place it in a small, labeled resealable plastic bag.
8. Carefully place the specimen inside a resealable plastic bag labeled with the site name, transect number, unknown species code, date and collector. Do not press all air out of the plastic bag in closing it, but leave some in to better retain the architecture of the sample in transit.
9. Keep the sample in your bag and in shade until you can get it to the cooler.
10. Attempt to identify the plant the same day once back in the office.
11. If the specimen cannot be identified right away, preserve the bagged sample in the refrigerator. Unresolved samples will be brought to the attention of the University of California, Los Angeles Herbarium botanists (SAMO), Santa Barbara Botanic Garden Herbarium botanists (CHIS), or San Diego Natural History Museum botanists (CABR) to get help in resolving difficult identities.
12. If population of a species new or uncommon to the park is abundant enough to allow collection of a duplicate voucher to be sent to one of the above mentioned herbaria, do your best to arrange for collection of sufficient additional material for that purpose.

13. Press and label (Date, Site, Transect#, Unknown code, Collector) unidentified specimen (what is left of it) to be retained as a voucher for possible future identification.
14. Press and label specimen (what is left of it) that is identified successfully to be included in the park herbarium collection. All plants to be curated need a more detailed label following instructions below.

8.3 Curation of Vouchers

Any material left from field samples will be pressed, dried, and mounted, with pertinent label information on New York Botanical Garden style or equivalent 100% rag mounting paper with a neutral pH reading of 7.0–8.0. If the species is unique, the voucher will be forwarded to the San Diego Natural History Museum Herbarium (CABR), Santa Barbara Botanic Garden Herbarium (CHIS), or UCLA Herbarium (SAMO).

Label information

1. Date of collection.
2. Country/State/County.
3. Specific locality. Description of the location, include measured or estimated distance on roads or trails for possible future relocation.
4. GPS location. UTM (with datum stated) or latitude and longitude, as well as source of location (e.g., USGS 7.5' quad or GPS device).
5. Elevation. List in units appropriate for source of determination.
6. Landmark information. Describe nearest prominent landmark and distance to it.

Plant information

1. Collection number. A unique number associated with the primary collector. Duplicate specimens of a taxon collected at the same site and time receive the same collection number.
2. Collector (primary).
3. Associated collector(s). Other people present or aiding in collecting; these names are not directly associated with the collection number.
4. Taxon. Scientific name of species (a binomial of genus + specific epithet), including authorship as well as subspecies (ssp.) or variety (var.) name if applicable, including authorship. In final form, the scientific name is underlined or italicized.
5. Duration (annual, biennial, or perennial), habit (forb, shrub, subshrub, vine, tree), height from ground level (not essential if entire plant is collected), and any distinguishing characteristics of the branching pattern not apparent from the specimen.
6. Flower/fruit color or other notes related to phenology. Describe any features that might be lost or distorted in a pressed sample.
7. Physical habitat/substrate. Abiotic features of the plant habitat, such as "moist edge of floodplain" or "in a sandy pocket between boulders." For substrate, list color and basic soil type (e.g., sand, gravel, sandy loam, rock).

8. Slope/Aspect/Exposure. List angle of slope from flat to underhang. Aspect is general compass direction toward which slope is facing. Exposure is full sun, partly shaded, filtered light, or shaded.
9. Community/Vegetation type. Description may be general (e.g., "coastal sage scrub") or precise (e.g., *Salvia leucophylla – Artemisia californica* coastal sage scrub).
10. Associated species. List as many species as is necessary to characterize the collection site.
11. Identified by (I.d. by) / date / source. List the person who identified the specimen, when it was done, and the source that was used to confirm the identity of the plant (e.g., Jepson Manual 1993).

8.4 Taxonomic References

General

Baldwin, B. G., ed. 2012. The Jepson Manual: Vascular plants of California. University of California Press, Berkeley. This is the current authority in California species identification.

Flora of North America North of Mexico. 1993. Oxford University Press, New York.

USDA, NRCS. 2006. The PLANTS Database. National Plant Data Center, Baton Rouge, Louisiana 70874-4490 USA. (available at: http://plants.usda.gov). This site provides information on species occurring in the United States.

Wildflowers of the Santa Monica Mountains National Recreation Area website: http://smmflowers.org/

Aids to terminology and structures important in plant identification

Stern, W. T. 2004. Botanical Latin. Timber Press, Inc., Portland, Oregon.

Simpson, M. G. 2006. Plant Systematics. Elsevier Academic Press, New York.

Park plant lists

NPSpecies website: https://irma.nps.gov/NPSpecies/. This site requires an active user account and password, which can be requested through the MEDN network Data Manager.

SOP 9: Data Entry, QA/QC, and Processing

Version 1.0 (September 2016)

9.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 9 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

9.2 Overview

This SOP outlines specific, daily data management tasks that must be completed for all data collected in the field, including tabular data, spatial data. SOP 10 describes photograph processing. Contact the monitoring leads at each park for any park specific data review and data entry procedures.

9.3 Datasheet Processing

1. **Filing datasheets.** Compile datasheets and place them in a folder labeled by park unit and date.
2. **Electronic data.** If some data were collected electronically, generate paper copies for them and store with other datasheets.
3. **Data completion check.** Verify that all datasheets are complete, and attempt to verify the identity of any unknown plants. Amend datasheets as needed by making all corrections in red ink to distinguish from field collected data.
4. **Copy and scan datasheets.** Store copies separately from originals and place scanned copies in the appropriate project folder on the network.

9.4 Field Datasheet Review and Entry

1. **Review at the end of field day.** Datasheets are reviewed at the end of each field day for their legibility and the correct spelling of species codes and corrected as needed. The person recording the data in the field should not review it for readability.
2. **Data entry by two persons.** One day in each two week period should be dedicated to data entry. When possible, data are entered as partners. One person will read the data out loud and another enters it into the database. Once the data have been entered and saved, they must be checked for inconsistencies or errors.
3. **Opening the database and entering data.** Data for the Terrestrial Vegetation monitoring protocol is entered and stored in an MS Access database. The databases for each park can be found in their respective resource management offices. For specific location of the database, contact the program leader at the respective park.
4. **Forms.** The user interfaces with the database through a series of custom-built forms. The forms have been designed to (1) mimic existing field recording methodology, (2) minimize transcription error (i.e., look-up tables, drop-down menus, auto-filled fields, range limits), and (3) allow users not familiar with MS Access to query the database and export datasets for analysis. Instructional steps are also provided on each form, where applicable, to help guide the user in making the correct selections.

   When the database is first opened, the Main Menu window appears (Figure 9.1).

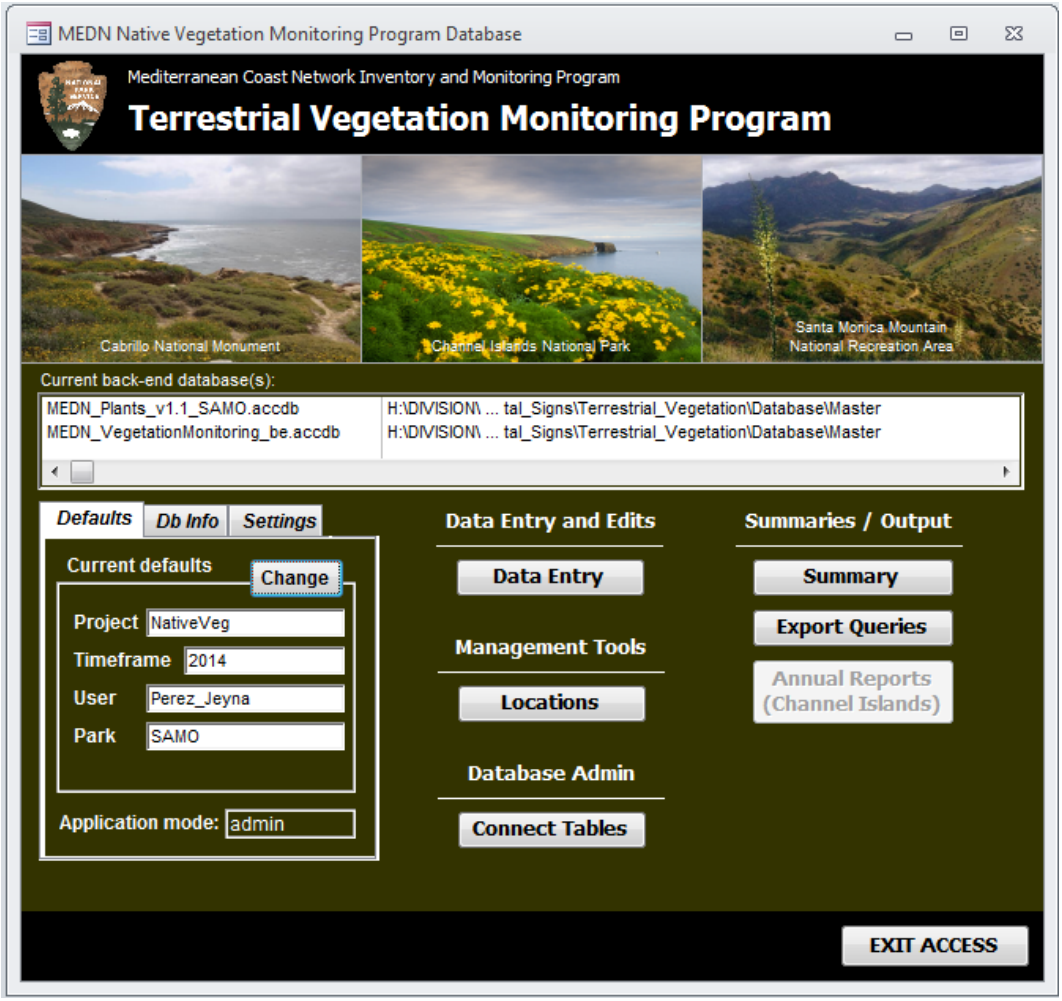


Figure 9.1. Screen shot of the "Main Menu" form window in the MEDN Terrestrial Vegetation Database.

Data entry

The Data Entry Menu allows users to enter field collected data into the database (Figure 9.2). When Data Entry is selected from the Main Menu, the data entry form for the appropriate method (i.e., line-point transect or macroplot) will open to a new record. Plans to include various navigation and records searching functions are in progress and are expected to be completed in 2016.

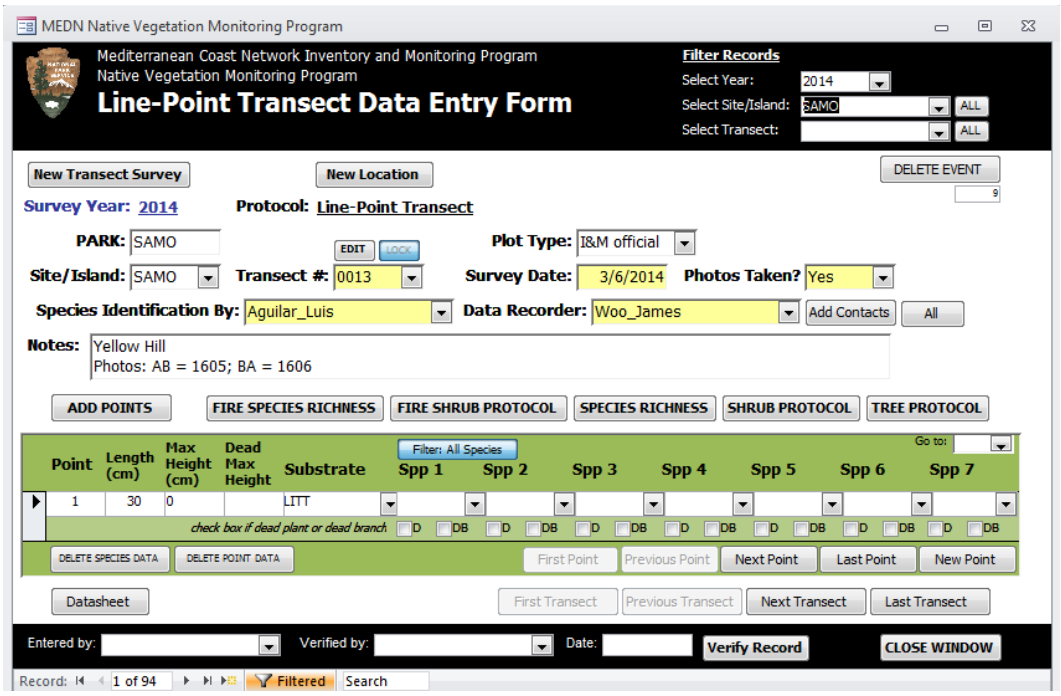


Figure 9.2. Screen shot of the "Line-Point Transect Data Entry" form window in the MEDN Terrestrial Vegetation Database. In this example, since this survey occurs at SAMO, options to enter Fire Species Richness and Fire Shrub surveys are enabled.

9.5 Data QA/QC, Verification, and Validation

The Program Lead for each park oversees the verification and validation process. Automated QA/QC reports are in progress and are expected to be completed in 2016. Two levels of QA/QC are undertaken before data can be distributed or analyzed. First, verification or checks for transcription errors (i.e., data entered incorrectly) should be done immediately after data entry, preferably by a two person team. To do this, after the data have been entered and saved, the digital record is checked against the original datasheet by one partner reading the values on the field form and the other checking the database entries using electronic or printed data verification reports. Even if data are checked by two people, data verification reports should be generated, and if necessary, printed from the database after data entry. These reports are digital outputs of entered data and are formatted to look like the field datasheets. These reports are used to verify entered data with the actual data (field datasheet) and represent a physical hard copy of the entered data. If printed, data verification reports are filed behind the original field datasheet. If errors are found, the user may correct the data and document the corrections in the database.

Following a review of the data, data should be marked as verified by clicking on the Verify button for each survey completed. The database stores the name and date of when the data were verified.

Once verification for transcription errors has been completed, the data are validated by checking for inconsistent or null values by the Program Leader and/or network Data Manager. Automated QA/QC queries (data validation queries) set up in the database will facilitate the flagging of suspect records. Flagged records will need to be rechecked against the original field datasheet, and if applicable,

corrected in the database. If the error cannot be corrected, due to incomplete data collection in the field (e.g., fields not filled out) or incorrect data documentation in the field (e.g., wrong characters entered in the field), the record is to remain flagged with notes on the error detailed in the comments field.

Data should be marked by the Program Lead as validated by clicking on the Validate button for each survey component. The database stores the name and date of when the data were validated.

9.6 Data Analysis

The Data Analysis Menu creates a query based on user-defined parameters. The queried dataset can be exported to a format that can be easily imported into Excel, R, Systat, etc., for analysis. It should be noted that queries and query parameters are not saved to the database. Plans to include other data analysis functions are in progress and are expected to be completed by the end of fiscal year 2016.

9.7 Data Certification

Once data have been checked and verified, the data can be certified for distribution. Data certification assumes all unflagged records have been collected according to the methods stated in the protocol, have been verified by the Program Leader and Network Data Manager, and are approved to be used for analysis. Data ready to be used for analysis should be marked by the Program Lead or MEDN Data Manager as certified by clicking on the Certify button for each survey component. (Note: Results sections of annual and trend reports will include a summary of the data verification and validation steps, the number and nature of the errors found, and how they were corrected.) The database stores the name and date of when the data were certified. Certified data will be posted annually to the NPS IRMA (Integrated Resource Management Applications) data system by the Data Manager.

9.8 Data Documentation (Metadata)

Data documentation or the creation of a metadata report should be completed by the Program Lead(s) and MEDN Data Manager upon season closeout. The development of metadata is defined as structured information about the content, quality, and condition of data. The following information is required for the metadata report for the Terrestrial Vegetation Monitoring Program:

- Specified time period being documented (i.e., season, date range).
- Complete methods (including any deviations from the specified protocol) on field data collection, analysis, and GPS/GIS data layer processing steps.
- References for any models, analytical tools, or statistical procedures used to develop the dataset.
- Data collection forms used.
- Additional contact persons and their contact information.
- Were any sensitive, rare, threatened or endangered species data collected?
    - If yes, what are the access constraints?: Public, NPS Only, MEDN Only, Park Only.
- Verification of the data accuracy and completeness.

    - Have all data been entered?
    - Have all data been verified for accuracy?
    - Have all data been validated for logical errors?
- Related datasets for cross referencing (i.e., temperature or precipitation datasets).

SOP 10: Photograph Processing

Version 1.0 (September 2016)

10.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 10 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

10.2 Overview

This SOP describes management of the digital monitoring photos, including uploading, naming conventions, and storing.

10.3 Camera

Pictures are taken with a Canon PowerShot SX100 digital camera or similar camera with an 8 megapixel file capacity. Any future cameras used in the long-term monitoring program should have at least an 8 megapixel file capacity and be well rated in terms of picture quality and battery usage. Set up the camera so that it displays the photo number, which will be recorded on the plot datasheet.

10.4 Labeling

At the end of the monitoring day, all the monitoring photos taken are downloaded onto a computer in a folder specifically set up to house the monitoring photos. At CHIS, the naming convention for the photo files is island / mainland site code / transect# / transectdirection / year. For example, a monitoring photo taken on Santa Cruz Island, transect 15 in 2012 would have the file name: sci_vt15_a-b_2012. At CABR and SAMO, the naming convention for the photo files is master sample number / AB / date / camera number of the picture (0146_AB_02-25-14_1579). The a-b/AB direction means that the photo was taken from the starting end of the transect (i.e., from the A stake) and is looking toward the end point of the transect line (the B stake). An example photo with the associated file name is shown below at the end of this SOP (Figure 10.1).

10.5 Filing Photos

At CHIS, after returning to the office or at the end of the island tour, the digital photo files are transferred from the laptop to the U drive on RM server. The folders where the digital monitoring files reside are found at U:\NRM\vegetation\veg transect photos. At that location, the photo files are separated into additional folders by island/park site and transect number. At SAMO, digital photos are transferred to the H:\DIVISION\psrm\Plant_Ecology\Inventory and Monitoring_Terrestrial Veg & Weed Monitoring folder. At CABR, photos are stored at U:\VEGETATION\CABR vegetation monitoring\photos. At both parks the photos are saved into folders labeled by transect number.

After the monitoring photos have been transferred into the proper island/park site and transect number folder, they can be printed out or placed in electronic documents as needed. Given the large size of the individual photo files, resize the photos using any standard software program with that capability. At the end of the monitoring season, all the monitoring photos taken for that year are copied onto an external hard drive and stored in the monitoring cabinet with a binder with labeled monitoring photos. This is an added safety measure should the files stored on the server be corrupted or lost, either temporarily or permanently.



CHIS: eai_vt04_b-a_2008



SAMO/CABR:0146_AB_02-25-14_1579

Figure 10.1. Example of transect line photographs and their labeling.

SOP 11: Field Season Closing Activities

Version 1.0 (September 2016)

11.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 11 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
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Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

11.2 Overview

This SOP describes procedures to be followed in closing out the work year.

1. **Equipment inspection.** Inspect all equipment for damage and note any missing equipment for the next field sampling period.
2. **Equipment repair.** Clean and repair all equipment prior to returning it to the Program Leader. Need for any equipment replacement should be brought to the attention of relevant project staff.
3. **Reference manuals.** Reshelve all reference manuals in their appropriate places.
4. **Reference materials.** File other reference materials and extra datasheets in their appropriate filing cabinet.
5. **Vehicles.** Clean the insides and outsides of all vehicles used in the field.
6. **Data.** Enter, verify, and validate all data collected, including spatial files and photographs.
7. **Paper records.** Copy and file paper records in appropriate locations, archiving off-site when possible.
8. **Internal Logistic Report.** Each park should prepare an internal logistics report for park records. This 3–5 page report should detail all the logistical topics relevant to the park year's field sampling effort, for use in updating site reference packets and when the plots are resampled and the data analyzed. The report should include, but is not limited to, information on the following topics:
    - List all plots sampled. For each, note any changes made to location, markers, or photo points; describe any major disturbances on the plots; and describe difficulties in access and changes in access routes.
    - Weather conditions over the period that may have affected phenology or field conditions.
    - Problems encountered (general and protocol-specific), such as missing data.
    - Suggested modifications to SOPs (actual changes require further discussion and potentially meeting with other park program leaders and the I&M program manager and data manager).
    - Crew performance.
    - Safety issues or concerns and how they were accommodated.
    - Problems with travel and housing availability.
    - Any unusual or interesting observations.

SOP 12: Database Structure

Version 1.0 (September 2016)

12.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 12 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

12.2 Overview

This SOP details the database structure for the Terrestrial Vegetation Database.

12.3 Terrestrial Vegetation Database

The MEDN Terrestrial Vegetation Database is a customized relational database developed in Microsoft Access (MS Access, Access) 2010 and is used to store and manipulate the data associated with this project. It is modeled after the Natural Resource Database Template (NRDT) developed by the Natural Resource Inventory and Monitoring Program. The NRDT is a set of relational database tables in MS Access that parks and networks can use as a standardized yet flexible database core for developing natural resource-related applications (National Park Service 2007). This database complies with NRDT standards for core mandatory tables, fields, relations, and naming conventions, where applicable.

The database consists of two linked files, a "front-end" database (MEDN_TerrestrialVegetation_Database_v1.0.accdb) and a "back-end" database (MEDN_TerrestrialVegetationDATA_be.accdb). The front-end database is a series of forms, queries, and reports customized with Visual Basics for Applications (VBA) programming code. The user interfaces with the database through the front-end database. The back-end database contains the data tables. This configuration makes it easier to make changes to the database application without altering the actual data structure or data records. The linked tables are managed by the Linked Table Manager wizard included in the application.

The database is primarily managed by the network Data Manager. Changes to the design or structure of the database can only be made by the network Data Manager or with the approval of the network Data Manager. Changes are documented in the tbl_Db_Meta and tbl_Db_Revisions tables within the database.

Prior to any structural changes to the database, a copy with the most recent version number is stored in the 'Archive' subdirectory. Each new version of the database is assigned a sequentially higher number. Version numbers allow project and Data Managers to track changes to the database over time. Changes to any record in the database are documented in the record itself and must include a description of pre- and post-edit changes, especially changes made to the data post-verification.

Information on data management organization and procedures can be found in SOP 13.

12.4 Tables

The data tables for this project are located in the back-end database (MEDN_TerrestrialVegetationDATA_be.accdb). It consists of three types of tables: standard tables describing the "who, where and when" of data collection, project-specific tables, and lookup tables that contain domain constraints for other tables. Although standard tables are based on the Natural Resource Database Template standards, they may contain fields, domains, or descriptions that have been added or altered to meet project objectives.

The database includes the following standard tables:

tbl_Sites .....List of park-specific geographic areas

tbl_Locations .....Sampling unit locations

tbl_Event_Group.....Description of the sampling period

tbl_Events .....Description of the sampling event

tbl_Event_Details .....Additional details about the sampling event

tbl_Db_UserLog .....Record of users accessing the database

xref_Event_Contacts.....Cross-reference table between events and contacts

The following are project-specific data tables:

tbl_Event_Point .....Point specific information

tbl_Species_Data .....Species specific information collected at the point

tbl_Shrub_Data.....Shrub specific information

tbl_Shrub_Count.....Count of shrubs

tbl_Tree_Data .....Tree specific information

tbl_Tree_Count.....Count of trees

tbl_Tree_DBH .....DBH measurements

The following are a few of the more prominent, standard lookup tables:

tlu_CABR_plants.....Species lookup table for Cabrillo National Monument

tlu_CHIS_plants .....Species lookup table for Channel Islands National Park

tlu_Contacts.....Contact data for project-related personnel

tlu_Enumerations.....Enumerated lookup table

tlu_LocalList_Data .....Species-specific information

tlu_Protocols.....List of protocols

tlu_SAMO_plants.....Species lookup table for Santa Monica Mountains National Recreation Area

Figure 12.1 shows the relationships among the primary tables.

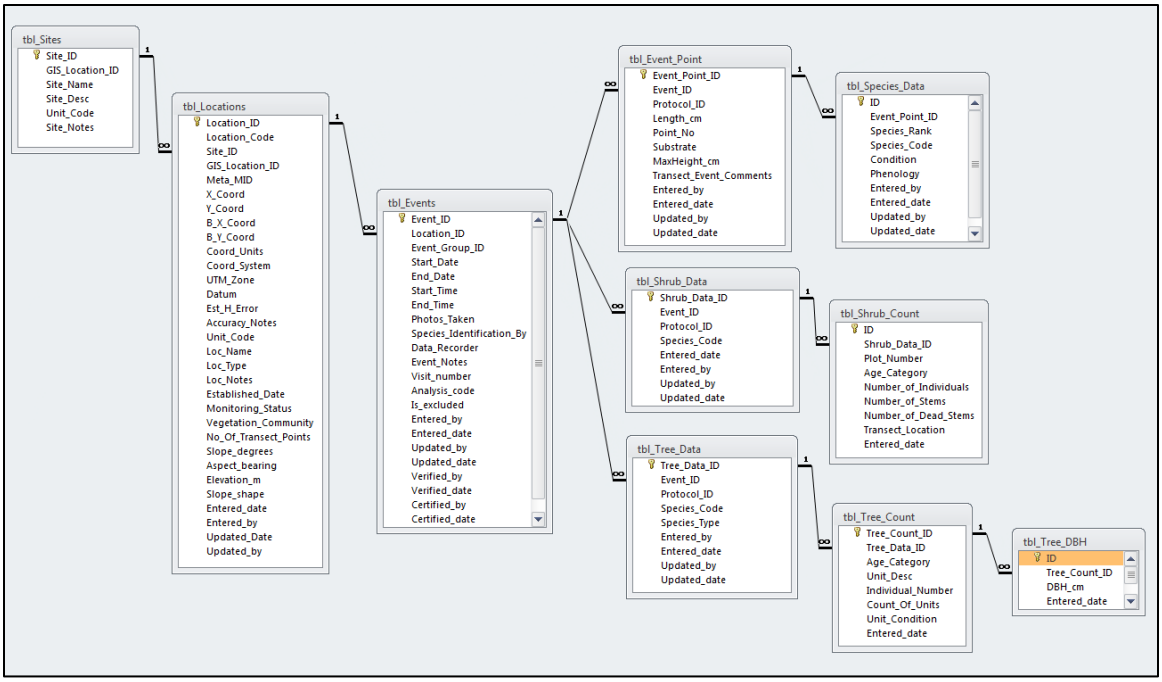


Figure 12.1. Relationship diagram for the primary tables in the MEDN Terrestrial Vegetation Database. Relationships between tables are represented by lines.

The primary table for storing site information (i.e., island, park site) is tbl_Sites (Table 12.1). This is a core mandatory table under the NRDT standard. The table contains one record for each site. A site is defined as a conceptual, and usually, physical area known to researchers and park staff often described by a place name, but is too general to define the position of specific sampling measurements or observations.

Table 12.1. tbl_Sites is the primary table for storing information on park-specific geographic information such as island or park site name.

Field Name	Field Type	Size	Field Description
Site_ID	Long Integer	4	Site identifier (autonumber)
GIS_Location_ID	Text	50	Link to GIS feature, equivalent to NPS_Location_ID
Site_Name	Text	100	Unique name or code for a site
Site_Desc	Text	255	Description for a site
Unit_Code	Text	12	Park, Monument or Network code
Site_Notes	Memo		General notes on the site

The primary table for storing sampling unit location information is tbl_Locations (Table 12.2). This is a core mandatory table under the NRDT standard. The table is linked to tbl_Sites by the Site_ID field. The table contains one record for each location that is monitored and includes data on the location, including coordinate points.

Table 12.2 tbl_Locations is the primary table for storing sampling unit location information, including location name and x- and y-coordinates.There is one record for each sampling unit location.

Field Name	Field Type	Size	Field Description
Location_ID	Long Integer	4	Location identifier (autonumber)
Location_Code	Text	4	Two to four letter code assigned to a location
Site_ID	Long Integer	4	Link to tbl_Sites
GIS_Location_ID	Text	50	Link to GIS feature, equivalent to NPS_Location_ID
Meta_MID	Text	50	Link to NR-GIS Metadata Database
X_Coord	Double	8	X coordinate
Y_Coord	Double	8	Y coordinate
B_X_Coord	Double	8	X coordinate of B point
B_Y_Coord	Double	8	Y coordinate of B point
Coord_Units	Text	50	Coordinate distance units (meters)
Coord_System	Text	50	Coordinate system (UTM)
UTM_Zone	Text	50	UTM Zone (11N)
Datum	Text	50	Datum of mapping ellipsoid (Nad83)
Est_H_Error	Long Integer	4	Estimated horizontal accuracy
Accuracy_Notes	Text		Positional accuracy notes
Unit_Code	Text	12	Park, Monument or Network code
Loc_Name	Text	100	Name of location
Loc_Type	Text	25	Location type category
Loc_Notes	Memo		General notes on the location
Established_Date	Date/Time	8	Date that location was established
Monitoring_Status	Text	10	Current status of location (active, inactive)
Vegetation Community	Text	255	Vegetation community
No_of_Transect_Points	Integer	8	Number of transect points
Slope_degress	Integer	8	Slope in degrees
Aspect_bearing	Integer	8	Aspect in bearing number
Elevation_m	Integer	8	Elevation in meters
Slope_shape	Text	10	Slope shape
Entered_date	Date/Time	8	Date on which data entry occurred
Entered_by	Text	50	Person who entered the data for this event
Updated_Date	Text	50	Date of entry or last change
Updated_by	Text	50	Person who made the most recent updates

The primary table for storing information on the survey event is tbl_Events (Table 12.3). This is a core mandatory table under the NRDT standard. The table is linked to tbl_Locations by the Location_ID field. The table contains one record for each visit made and includes data on the visit such as the date and time, type of survey (line-point intercept, quadrat), and names of the field staff performing species identification and recording data.

Table 12.3. tbl_Events is the primary table for storing event (visit) information, including date and time and field crew. The table contains one record for each survey visit.

Field Name	Field Type	Size	Field Description
Event_ID	Long Integer	4	Event identifier
Location_ID	Long Integer	4	Link to tbl_Locations
Event_Group_ID	Long Integer	4	Link to tbl_Event_Group
Start_Date	Date/Time	8	Starting date for the event
End Date	Date/Time	8	Ending date for the event
Start_Time	Date/Time	8	Starting time for the event
End_Time	Date/Time	8	Ending time for the event
Photos_Taken	Text	5	Were photos taken at the location?
Species_Identification_By	Text	255	Name of individual identifying plants
Data_Recorder	Text	255	Name of individual recording information
Event_Notes	Memo		Notes for the event
Visit_number	Byte	8	Visit number for the season
Analysis_code	Byte	8	Analysis type: 1=I&M official; 2=I&M extra; 3=Fire
Is_excluded	Yes/No	1	Exclude this survey record from analysis?
Entered_by	Text	50	Person who entered the data for this event
Entered_date	Date/Time	8	Date on which data entry occurred
Updated_by	Text	50	Person who made the most recent updates
Updated_date	Date/Time	50	Date of the most recent edits
Verified_by	Text	50	Person who verified accurate data transcription
Verified_date	Date/Time	8	Date on which data were verified
Certified_by	Text	50	Person who certified data for accuracy and completeness
Certified_date	Date/Time	50	Date on which data were certified

Line-point intercept

The primary table for storing information on point data is tbl_Event_Point (Table 12.4). The table is linked to tbl_Events by the Event_ID field. The table contains one record for each point at a transect location and includes data on the point number, length number, substrate, and maximum plant height.

The primary table for storing information on species data for the Line-Point intercept method is tbl_Species_Data (Table 12.5). The table is linked to tbl_Event_Point by the Event_Point_ID field. The table contains one record for each species observed at a point at a transect location and includes data on the species name (4-letter code), species rank, and condition.

Table 12.4. tbl_Event_Point is the primary table for point information including point number, length, substrate, and maximum plant height. The table contains one record for each point at a transect.

Field Name	Field Type	Size	Field Description
Event_Point_ID	Long Integer	4	Event Point identifier
Event_ID	Long Integer	4	Link to tbl_Events
Protocol_ID	Long Integer	4	The ID of the protocol governing the event
Length_cm	Long Integer	4	30 cm measurement increment
Point_No	Long Integer	4	Point number from 1-100
Substrate	Text	10	Substrate type
MaxHeight_cm	Long Integer	4	Height of tallest plant measured in centimeters
Transect_Event_Comments	Memo		Additional comments on the point
Entered_by	Text	50	Person who entered the data for this event
Entered_date	Date/Time	8	Date on which data entry occurred
Updated_by	Text	50	Person who made the most recent updates
Updated_date	Date/Time	50	Date of the most recent edits

Table 12.5. tbl_Species_Data is the primary table for species data information including species rank and code, and condition. The table contains one record for each species on a point at a transect.

Field Name	Field Type	Size	Field Description
ID	Long Integer	4	Species data identifier
Event_Point_ID	Long Integer	4	Link to tbl_Event_Point
Species_Rank	Long Integer	4	Order of species recorded
Species_Code	Text	20	Six to nine-letter species code
Condition	Text	00	Condition of the species
Entered_by	Text	50	Person who entered the data for this event
Entered_date	Date/Time	8	Date on which data entry occurred
Updated_by	Text	50	Person who made the most recent updates
Updated_date	Date/Time	50	Date of the most recent edits

Shrub protocol

The primary table for storing information on the species observed with the shrub protocol is tbl_Shrub_Data (Table 12.6). The table is linked to tbl_Events by the Event_ID field. The table contains one record for each shrub species detected.

The primary table for storing the number of shrubs counted with the shrub protocol is tbl_Shrub_Count (Table 12.7). The table is linked to tbl_Shrub_Data by the Shrub_Data_ID field. The table contains one count for the corresponding species observed at a specific plot location and includes data on the age, number of individuals and stems, and its relative location on the transect.

Table 12.6. tbl_Shrub_Data is the primary table for storing shrub species information. The table contains one record for each species detected in the shrub protocol.

Field name	Field type	Size	Description
Shrub_Data_ID	Long Integer	4	Unique identifier for the table
Event_ID	Long Integer	4	Link to tbl_Events
Protocol_ID	Long Integer	4	The ID of the protocol governing the event
Species_Code	Text	4	Four letter code for species used by the park
Entered_by	Text	50	Person who entered the data for this event
Entered_date	Date/Time	8	Date on which data entry occurred
Updated_by	Text	50	Person who made the most recent updates
Updated_date	Date/Time	50	Date of the most recent edits

Table 12.7. tbl_Shrub_Count is the primary table for the number of shrubs detected for the Shrub protocol. The table contains one record for each age category for a specific plot number.

Field name	Field type	Size	Description
ID	Long Integer	4	Unique identifier for the table
Shrub_Data_ID	Long Integer	4	Link to tbl_Shrub_Data
Plot_Number	Long Integer	4	Plot number
Age_Category	Text	10	Age category
Number_of_Individuals	Long Integer	4	Number of individuals in the plot
Number_of_Stems	Long Integer	4	Number of stems of all individuals in the plot
Number_of_Dead_Stems	Long Integer	4	Number of dead stems of all individuals in the plot
Transect_Location	Text	5	Location of the transect on which the shrubs were
Entered_date	Date/Time	8	Date on which data entry occurred (beginning in 2011)

Tree protocol

The primary table for storing information on the species observed with the tree protocol is tbl_Tree_Data (Table 12.8). The table is linked to tbl_Events by the Event_ID field. The table contains one record for each tree species detected.

The primary table for storing the number of trees counted with the shrub protocol is tbl_Tree_Count (Table 12.9). The table is linked to tbl_Tree_Data by the Tree_Data_ID field. The table contains one count for the corresponding species observed at a specific plot location and includes data on the age, number of individuals and stems, and its relative location on the transect.

Table 12.8. tbl_Tree_Data is the primary table for storing tree species information. The table contains one record for each species detected in the tree protocol.

Field name	Field type	Size	Description
Tree_Data_ID	Long Integer	4	Unique identifier for the table
Event_ID	Long Integer	4	Link to tbl_Events
Protocol_ID	Long Integer	4	Link to tlu_Protocols
Species_Code	Text	10	Four letter code for species used by the park
Species_Type	Text	5	Type of species
Entered_by	Text	50	Person who entered the data for this event
Entered_date	Date/Time	8	Date on which data entry occurred
Updated_by	Text	50	Person who made the most recent updates
Updated_date	Date/Time	50	Date of the most recent edits

Table 12.9. tbl_Tree_Count is the primary table for the number of trees detected for the tree protocol. The table contains one record for each age category for a specific plot number.

Field name	Field type	Size	Description
Tree_Count_ID	Long Integer	4	Unique identifier for the table
Tree_Data_ID	Long Integer	4	Link to tbl_Tree_Data
Age_Category	Text	15	Age category
Unit_Desc	Text	10	Unit description
Individual_Number	Long Integer	4	Number of individual being measured
Count_Of_Units	Long Integer	4	Count of units (see Unit_Desc) in the plot
Unit_Condition	Text	5	Condition of the plant
Entered_date	Date/Time	8	Date on which data entry occurred

The primary table for storing the diameter at breast height (DBH) measured is tbl_Tree_DBH (Table 12.10). The table is linked to tbl_Tree_Count by the Tree_Count_ID field. The table contains one DBH measurement for a corresponding individual.

Table 12.10. tbl_Tree_DBH is the primary table for diameter at breast height measurements for individual trees observed for the tree protocol. The table contains one record for each DBH measurement.

Field name	Field type	Size	Description
ID	Long Integer	4	Unique identifier for the table
Tree_Count_ID	Long Integer	4	Link to tbl_Tree_Count
DBH_cm	Double	8	Diameter at breast height measured in centimeters
Entered_date	Date/Time	8	Date on which data entry occurred

Other tables in the MEDN Terrestrial Vegetation Database

tbl_Db_UserLog – Database description and links to I&M metadata tools

Field name	Field type	Size	Description
Db_UserLog_ID	Long Integer	4	Unique identifier for the table
Db_UserName	Text	50	Windows Active Directory login name
Db_ComputerName	Text	255	Computer name
Start_Date	Date/Time	8	Date of access
Start_Time	Date/Time	8	Time of access
End_Date	Date/Time	8	Date of exited database
End_Time	Date/Time	8	Time exited database
Entered_date	Date/Time	8	Date on which data entry occurred

tbl_Event_Details – Sampling event details

Field name	Field type	Size	Description
Event_ID	Long Integer	8	Unique identifier for the table
Event_Notes	Memo	---	General notes on the event (Ev_Notes)
Entered_date	Date/Time	8	Date on which data entry occurred

tbl_Event_Group – Event aggregations

Field name	Field type	Size	Description
Event_Group_ID	Long Integer	8	Unique identifier for the table
Start_Date	Date/Time	8	Start date of survey event (DD/MM/YYYY)
End_Date	Date/Time	8	End date of survey event (DD/MM/YYYY)
Event_Group_Name	Text	1	Event group (e.g., season, trip) name
Event_Group_Desc	Text	255	Event group description
Event_Group_Notes	Memo	---	Event group notes
Event_Group_Report	Text	255	Trip report, link to trip report or trip report name
DatabaseEntryDate	Date/Time	8	data entry date (beginning in 2011)
LV_SurveyYear	Long Integer	8	Legacy: Survey year
LV_ProjectLeader	Text	3	Legacy: Program leader
legacy_EventNumber	Long Integer	8	Legacy: Event number

tlu_Project_Taxa – Species lookup table for each park

Field name	Field type and Size	Size	Description
Taxon_ID	Long Integer	8	Unique identifier for the table
Unit_code	Text	4	Park, Monument or Network code
Family_name	Text	255	Family name
Sort_order	Double	8	Sort order
Species_code	Text	10	Species code for taxa name
Taxa_rank	Text	20	Taxonomic rank
Scientific_name	Text	255	Scientific Name
Common_name	Text	255	Common Name
USDA_Code	Text	10	USDA Code
TSN	Double	8	ITIS Taxonomic Serial Number (NPSpecies)
LocalAcceptedTSN	Long Integer	8	What is the current name for the species?
Taxon_is_active	Yes/No	1	Indicates that the record is currently available for data entry pick lists
Refers_to	Long Integer	8	Valid taxon the record should refer to for analysis and summaries
Park_List	Yes/No	1	List on official park species list?
Layer	Text	1	Link to tlu_Layer
Native	Yes/No	1	Is the species native to the park?
Perennial	Yes/No	1	Is the species in the park a perennial?
IsEndemic	Yes/No	1	Is the species endemic to the Channel Islands
ParkStatusID	Long Integer	8	NPSpecies park status
AbundanceID	Long Integer	8	NPSpecies abundance
NativityID	Long Integer	8	NPSpecies nativity
CultivationCode	Text	50	NPSpecies cultivation code
IsCultivated	Text	3	NPSpecies is cultivated code
InNPSpecies	Yes/No	1	Is the record in NPSpecies?
Comments	Memo		Additional comments
Created_date	Date/Time	8	Time stamp for record creation
Updated_date	Date/Time	50	Date of the last update to this record
Updated_by	Text	50	Person who made the most recent edits

tlu_CHIS_details – Additional species information for Channel Islands National Park

Field name	Field type	Size	Description
Taxon_ID	Double	8	Unique identifier for the table
AI	Text	1	Species occurs on Anacapa Island
SBI	Text	1	Species occurs on Santa Barbara Island
SCI	Text	1	Species occurs on Santa Cruz Island
SMI	Text	1	Species occurs on San Miguel Island
SRI	Text	1	Species occurs on Santa Rosa Island

tlu_Contacts – Contact data for project-related personnel

Field name	Field type and Size	Size	Description
Contact_ID	Long Integer	8	Contact identifier
Last_Name	Text	50	Last name
First_Name	Text	50	First name
Middle_Init	Text	1	Middle initial
Organization	Text	50	Organization or employer
Position_Title	Text	50	Title or position description
Address_Type	Text	50	Address (mailing, physical, both) type
Address	Text	50	Street address
Address2	Text	50	Address line 2, suite, apartment number
City	Text	50	City or town
State_Code	Text	8	State or province
Zip_Code	Text	50	Zip code
Country	Text	50	Country
Email_Address	Text	50	E-mail address
Work_Phone	Text	50	Phone number
Work_Extension	Text	50	Phone extension
Contact_Notes	Memo	---	Contact notes
Status	Text	10	Employment status
PersonnelTypeCode	Text	1	Code describing the role of the contact
Entered_by	Text	50	Person who entered the data for this event
Entered_date	Date/Time	8	Date on which data entry occurred
Updated_by	Text	50	Person who made the most recent updates
Updated_date	Date/Time	50	Date of the most recent edits

tbl_LocalList_Data – Species-specific information

Field name	Field type	Size	Description
LocalAcceptedTSN	Long Integer	8	Local accepted TSN
Layer	Text	1	Type of vegetation
Native	Text	1	Is the species native to the Channel Islands?
Perennial	Text	1	Is the species perennial?

tlu_Enumerations – Enumerated lookup table

Field name	Field type	Size	Description
Enum_Code	Text	50	Code for lookup values
Enum_Description	Memo	---	Lookup value description
Enum_Group	Text	50	Category for lookup value
Sort_Order	Integer	2	Order in which to sort lookup values

tlu_Protocols – List of Protocols

Field name	Field type	Size	Description
Protocol_ID	Long Integer	8	Unique identifier for the table
Protocol_Name	Text	75	Name of the protocol
Element_Name	Text	25	Name of the measure unit used by the protocol
Element_Count	Byte	1	Number of measure units
Active	Yes/No	1	Is the protocol actively being used?
Form_Name	Text	255	Name of the data entry form name

xref_Event_Contacts – Cross-reference table between events and contacts

Field name	Field type	Size	Description
Event_ID	Long Integer	8	Link to tbl_Events
Contact_ID	Long Integer	8	Link to tlu_Contacts
Contact_Role	Text	50	The contact's role in the protocol
Entered_date	Date/Time	8	Date on which data entry occurred

SOP 13: Data Management, Storage, and Archiving

Version 1.0 (September 2016)

13.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

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—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

13.2 Overview

This Standard Operating Procedure documents data management organization and procedures specific to the Terrestrial Vegetation monitoring protocol for the Mediterranean Coast Network (MEDN). File-naming conventions and storage locations are SAMO-specific. CABR and CHIS will have similar measures in place although the file naming conventions will be different. General procedures on data management procedures are detailed in the network Data Management Plan.

13.3 Data Management

Administration

Administration of all data files and folders associated with the Terrestrial Vegetation monitoring protocol are carried out by the park Program Leads(s), Network Data Manager, and Network Program Manager.

Analog file organization

1. **Field Datasheets.** Field datasheets are kept in the resource management offices at each of the three park's main offices. Contact the monitoring leads at each park for specific on-site locations.
2. **Data Verification Reports.** Data Verification Reports are generated from the database after data entry. Reports can be used to verify entered data with the actual data (field datasheet). Final data verification reports represent a physical hard copy of the entered data and are in the resource management offices at each of the three park's main offices. Contact the monitoring leads at each park for specific on-site locations.
3. **Archives.** Original field datasheets and final data verification reports are archived in the resource management offices at each of the three park's main offices. Contact the monitoring leads at each park for specific on-site locations.

13.4 Digital File Organization

Documents and non-GIS files

All digital documents and non-GIS files associated with the Terrestrial Vegetation monitoring protocol for each park are located on the park's network server.

At SAMO, the data will be located on the "H" drive. The H drive is a mapped directory (\DIVISION\psrm) on the park's server (\\inpsamo-hq1\) and is only accessible to staff within the park's Planning, Science, and Resource Management division. There are several directories within the H drive where files can be located.

- Protocol and annual report documents and data summaries are located in

  H:\!Inventory_and_Monitoring\Vital_Signs\Terrestrial_Vegetation

- The Terrestrial Vegetation Database is located in

  H:\!Inventory_and_Monitoring\Vital_Signs\Terrestrial_Vegetation\Database

  The latest front-end user interface (MEDN_TerrestrialVegetation_Database_v1.0.accdb) is located in this directory. The directory has four subdirectories: Archive, Data, Manuals, Working. Previous versions of the front-end databases are located in the 'Archive' subdirectory. Back-end data tables (MEDN_TerrestrialVegetationDATA_be.accdb) are

located in the ‘Data’ subdirectory. Manuals and SOPs on how to use the database are stored in the ‘Manuals’ subdirectory. Lastly, versions of the front-end database for users to manipulate are located in the ‘Working’ subdirectory. It is assumed work done in this folder is temporary.

- Field and other documents are located in

  H:\!\Inventory_and_Monitoring\Vital_Signs\Terrestrial_Vegetation

At CHIS, the data will be located on the T drive, a mapped directory (\SERVER) on the park’s server (\\inpchis_02). There is one main directory on the T drive where files are located:

- Protocol and annual report documents and data summaries are located in

  \Im\Land_Veg

- The Terrestrial Vegetation Database is located in

  \Im\Land_Veg\Database

  The latest front-end user interface (MEDN_TerrestrialVegetation_Database_v1.0.accdb) is located in this directory. The directory has four subdirectories: Archive, Data, Manuals and Working. Previous versions of the front-end databases are located in the ‘Archive’ subdirectory. Back-end data tables (MEDN_TerrestrialVegetationDATA_be.accdb) are located in the ‘Data’ subdirectory. Manuals and SOPs on how to use the databases are stored in the ‘Manuals’ subdirectory. Lastly, versions of the front-end database for users to manipulate are located in the ‘Working’ subdirectory. It is assumed work done in this folder is temporary.

- Field data and other documents are located in \Im\LandVeg\documents as well as in other subdirectories.

At CABR, the data will be located on the U drive, a mapped directory (\photos) on the park’s server (\\inpcabr-03srv1). There is one main directory on the U drive where files are located:

- Protocol and annual report documents and data summaries are located in

  \VEGETATION\CABR vegetation monitoring

- The Terrestrial Vegetation Database is located in

  \VEGETATION\CABR vegetation monitoring\Data\Database

  The latest front-end user interface (MEDN_TerrestrialVegetation_Database_v1.0.accdb) is located in this directory. The directory has four subdirectories: Archive, Data, Manuals and Working. Previous versions of the front-end databases are located in the ‘Archive’ subdirectory. Back-end data tables (MEDN_TerrestrialVegetationDATA_be.accdb) are located in the ‘Data’ subdirectory. Manuals and SOPs on how to use the databases are stored in the ‘Manuals’ subdirectory. Lastly, versions of the front-end database for users to

manipulate are located in the 'Working' subdirectory. It is assumed work done in this folder is temporary.

- Field data and other documents are located in \VEGETATION\CABR vegetation monitoring\documents as well as in other subdirectories.

GIS data

All GIS data associated with the Terrestrial Vegetation monitoring protocol for SAMO are located on the park's "J" drive. The J drive is a mapped directory (\gis\data) on the park's server (\\inpsamo-hq1\gis) and houses the park's GIS data. This drive is only accessible to staff within the park's Planning, Science, and Resource Management division. GIS data for this protocol are located in

J:\data\plant_eco\vegetation\

All GIS data associated with the Terrestrial Vegetation monitoring protocol for CHIS are located on the park's "T" drive. The T drive is a mapped directory (\SERVER) on the park's server (\\inpchis_02\) and houses the park's monitoring and GIS data. This drive is only accessible to staff within the park's Resource Management division. GIS data for this protocol are located in

T:\Im\Land_Veg

All GIS data associated with the Terrestrial Vegetation monitoring protocol for CABR are located on park's "U" drive. The U drive is a mapped directory (\photos) on the park's server (\\inpcabr-03srv1) and houses the park's monitoring and GIS data. This drive is only accessible to staff within the park's Resource Management division. GIS data for this protocol are located in

U:\VEGETATION\CABR vegetation monitoring\Data

13.5 Maintenance

All files on the parks' servers are backed up nightly. Each server is maintained by the parks' respective Information Technology specialist.

13.6 Data Workflow

It is the responsibility of the Program Lead(s) to make sure data are collected, entered, reviewed and verified in a timely manner.

13.7 Data Collection

Data are collected on field datasheets (see Appendix A). Digital copies of the datasheets can be found in the following SAMO/MEDN folder:

H:\Plant_Ecology\Inventory_And_Monitoring_Terrestrial Veg & Weed Monitoring\Documents\Forms.

13.8 Data Entry

Data are to be entered into the Terrestrial Vegetation Database as soon as possible after completing that season's field surveys. (Section 13.4, above, describes the database locations for each park.) Detailed instructions on data entry can be found in SOP 9.

13.9 Data Review and Verification

Once the data have been entered and saved, the Program Lead and network Data Manager will review the data for quality, completeness, and logical consistency. Automated queries and reports have been built into the database to look for apparent outliers, inconsistencies in entry, null values, or any other anomalous data points. Detailed instructions on data QA/QC can be found in SOP 9. It is the responsibility of the Program Lead to ensure that the inconsistencies and errors are resolved in the database prior to certification.

13.10 Data Certification

Once data have been checked and verified, the data can be certified for use in analysis and for public distribution. Certified data will be posted no later than two years following the end of the field season to the NPS IRMA (Integrated Resource Management Applications) data system by the network Data Manager.

13.11 Data Archive

Once data have been certified, the original field datasheets and final data verification reports for the year are archived. A copy of the field datasheet and data verification report should be made and kept in their respective site folders.

SOP 14: Data Analysis

Version 1.0 (September 2016)

14.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 14 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

14.2 Overview

This SOP provides guidance for the data analysis methods to be used for the periodic trend reports that will be written in CABR, CHIS, and SAMO. The MEDN vegetation monitoring program is structured to examine estimates of both status and trend. Status measures provide indices of the condition of a resource of interest for a given point in time. Trend characterizes the change in the resource over time. Outcomes that provide information on the function, composition, and structure of park ecosystems are chosen for long-term monitoring and include species richness, foliar cover, frequency of observation, and density of individuals.

Estimation methods may include design-based, model-assisted, and model-based approaches. Design-based estimation approaches, which include weighting adjustments and some types of imputation, use the monitoring design as the basis for inference (Lohr 1999; Thompson 2002). Design-based methods treat the outcomes as fixed, but the mechanisms of sample inclusion and response are considered random (Little 1982). Model-assisted estimation augments design-based inference with additional modeling assumptions (Särndal et al. 1992). Model-based nonresponse approaches treat the outcomes as random with specified distributions.

Some nonresponse is expected in the MEDN vegetation surveys. Some sites will be inaccessible due to steep slopes or potential for disturbance of sensitive species (e.g., pelican nesting). Some sites may be inaccessible due to the density of the vegetation itself, especially in areas with old-growth shrub communities.

Status estimation will occur annually and will incorporate design-based estimation from Generalized Random Tessellation Stratified (GRTS) sampling (Stevens and Olsen 2003). Analysis tools from the R package, *spsurvey* (Kincaid et al. 2011), may be used to obtain design-unbiased estimates of population means and totals, cumulative distribution functions, and proportions above/below a threshold for each outcome of interest.

Trend may be expressed as net change over a period of time or as an average annual change (McDonald 2003). Model-based, model-assisted, and nonparametric data analysis approaches will be examined to characterize trend.

This data analysis SOP will address estimation and issues that are anticipated to arise when the monitoring data are available for analysis. However, all possible data analysis issues cannot be foreseen, and analyses should be conducted by personnel familiar with modeling assumptions, model selection, and exploratory data analysis. A simulated dataset is used in this SOP for testing code and to provide templates for data formatting (see Appendix at the end of this SOP). **Neither this simulated dataset nor the resulting data analyses should be used for inference.** This data analysis SOP was developed with R version 2.13.0 and *spsurvey* version 2.2.

14.3 Inter-park Comparisons

The three parks of MEDN use very similar methods for the sampling design and the response design. This was intended to facilitate comparisons of status and trend across parks. Indeed, if one wished, one could carry out an analysis on the combined data from all three parks. However, this would be

unwise. Despite the fact that all three parks share a Mediterranean climate, there remain large differences among them. Each park has some number of unique species, communities, environments, and ecological forces. This should not be surprising, since each park was established in large part because of the fact that it contained some unique natural resources. Given these ecological differences, inter-park comparisons will best be done as a meta-analysis. The data from each park unit should be analyzed in a manner appropriate for the particular unit. When inter-park comparisons are desired, results from park-level analyses should be compared.

14.4 Estimation from a Combination of Subjective Sites and Probabilistic Sites

A subjectively selected sample is fundamentally different from a probabilistically selected sample. Often, the difference may be characterized as one of breadth versus depth. Subjectively selected samples usually have a relatively limited scope of inference, but they can also be relatively sensitive indicators of some types of change (Edwards 1998).

With care and thought, it is sometimes possible to combine information from subjectively selected sites and probabilistically selected sites in such a way as to have valid inference at broad scope with greater sensitivity than would be possible from just the probabilistic sites (e.g., Brus and De Gruijter 2003; Overton et al. 1993; Paul et al. 2008; Schreuder et al. 2001; Stoddard et al. 1998). Research into these methods is ongoing.

The specific methods required to judge whether such a combination is possible or useful depend on the details of the data, and the questions of interest. The best methods for analysis of a combined subjective/probabilistic dataset depend on those same details. Thus, it is not possible to provide detailed directions on those methods before the data have even been collected. However, when it comes time for the initial trend analysis, the investigators may further pursue these issues so as to make maximal fair use of index sites, which were sampled subjectively, to gain the best possible power to estimate status and trends at the scope of our sample frame.

In the remainder of this SOP, we describe procedures appropriate for the analysis of a probabilistic sample, with the understanding that these may later be augmented to allow for analysis of a combined subjective/probabilistic sample.

14.5 Status Estimation

Annual status estimation will reflect the GRTS sampling design (Stevens and Olsen 2003). Data analysis will incorporate the design-based analysis tools from the R package, *spsurvey* (Kincaid and Olsen 2012), which may be used to obtain estimates of population means and totals, cumulative distribution functions, and proportions above/below a threshold for each outcome of interest. Descriptive measures of status may include mean, median, variance, standard deviation, standard error, minimum, maximum, sample size, and range. The statistics may be obtained with the *spsurvey* functions, and these calculations will require the UTM coordinates of each transect and the inclusion probabilities from the sampling design. Standard error estimates for each of these status estimates will reflect the spatial balance of the sites over the population of interest for more precise estimation when the GRTS design is incorporated.

Estimation from the GRTS design

Inclusion probabilities are derived from the sampling design and provide the basis for design-unbiased extrapolation to the sampled population (see Thompson 2002 for more on inclusion probabilities). In some cases, the inclusion probabilities (or their inverse, the design weights) must be adjusted for unbiased inference. When a panel structure is imposed on the sample so that the entire sample is not visited annually, the inclusion probabilities must be weighted to account for this missingness within a given year. When nontarget sites are included in the sample or sites are inaccessible, these missing sites may warrant inclusion probability adjustment. The subsequent analysis code is based on the assumption that the inclusion probabilities have been appropriately adjusted.

The status estimators for GRTS samples are based on the form of the Horvitz-Thompson estimator (Horvitz and Thompson 1952). The population mean is computed as:

$$\hat{\mu} = \sum_{s_j \in R} \frac{z\left(s_j\right)}{\pi\left(s_j\right)},$$

where $\hat{\mu}$ is the estimator of the population mean, μ, $z\left(s_j\right)$ is the indicator of interest measured at site s_j, $\pi\left(s_j\right)$ is the inclusion probability of site s_j, and *R* is the domain of the sampled population defined as a set of points occupied by the population elements. The variance of the mean is calculated using the GRTS neighborhood variance estimator (Stevens Jr. and Olsen 2003; Stevens Jr. and Olsen 2004):

$$\hat{V}_{NBH}\left(\hat{\mu}\right) = \left(\sum_{s_j \in R} \frac{1}{\pi\left(s_j\right)}\right)^2 \sum_{s_j \in R} \sum_{s_i \in D\left(s_j\right)} w_{ij} \left(\frac{z\left(s_j\right)}{\pi\left(s_j\right)} - \sum_{s_k \in D\left(s_i\right)} w_{ik} \frac{z\left(s_k\right)}{\pi\left(s_k\right)}\right)^2,$$

where D (s_i) is the local neighborhood for site *i*, and w_{ij} are weights chosen to reflect the behavior of the pairwise inclusion function for GRTS and are constrained so that $\Sigma_i\, w_{ij} = \Sigma_j\, w_{ij} = 1$. The population total is estimated similarly and the population proportion is estimated as a ratio of two Horvitz-Thompson estimators.

Adjusting sample inclusion probabilities for panel surveys

When estimating status using a panel survey, the overall sample is chosen and then allocated to panels. Therefore, the inclusion probabilities for the overall random sample do not apply directly to a single year. The inclusion probabilities that would be obtained from the survey design and from the GRTS design file are too large and should be reduced for the additional extrapolation to the unsurveyed sample. The sample inclusion probabilities from the GRTS draw must be adjusted with a panel inclusion probability to obtain unbiased estimates of single-year status.

Two methods of weighting the inclusion probability were examined. Define a panel grouping as a set of panels that have the same revisit schedule. Let

N = population size

n = original sample size for all panels combined

n_g = sample size of panel grouping g, where g=1,..,G

n_{gj} = sample size of panel j within grouping g, where j=1,..,J_g

n_t = sample size surveyed in year t, where t = 1,...,T

Assume that a simple random sample of n is drawn from the population of N units for a sample inclusion probability of $\frac{n}{N}$. The panel inclusion probability is calculated conditionally on inclusion in the sample and may be estimated in two ways. Let

$$p_{gj} = \frac{n_{gj}}{n_g} \text{ and } p_t = \frac{n_t}{n}.$$

The panel inclusion probability p_{gj} represents the proportion of each panel grouping surveyed in any given year and p_t is the proportion of sampling units included in the sample in any given year (note that indexing for year is suppressed). The principal difference between the two weights is that p_{gj} weights within a panel grouping and p_t weights across groupings. Note that, when sample sizes are equal across panels within a grouping, the panel inclusion probability can be easily calculated for panels within that grouping as $p_{gj} = \frac{a_g}{a_g + b_g}$ for all j=1,..,J_g where $\left(a_g - b_g\right)$ indexes the revisit pattern within panel grouping g. For example, a [1-0] design has one grouping and a [(1-0),[1-3)] design has two groupings. The panel inclusion probability for grouping 1 would be calculated as $p_{1j} = \frac{1}{1+0}$=1. The panel inclusion probability for grouping 2 would be calculated as $p_{2j} = \frac{1}{1+3}$ = 0.25 for all panels within panel grouping 2. Rotating panels ([1-n], [2-n], etc.) would not be given any weight and would receive a panel probability of 1. Two unbiased estimators of the population mean are considered:

$$\hat{\mu}_1 = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\frac{1}{N}\sum_{\mathrm{g}=1}^{\mathrm{G}}\sum_{\mathrm{j}=1}^{\mathrm{J_g}}\sum_{\mathrm{i}=1}^{\mathrm{n_{gj}}}\frac{\mathrm{Y_i}}{\pi_i'} = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\frac{1}{N}\sum_{\mathrm{g}=1}^{\mathrm{G}}\sum_{\mathrm{j}=1}^{\mathrm{J_g}}\sum_{\mathrm{i}=1}^{\mathrm{n_{gj}}}\frac{\mathrm{Y_i}}{\pi_i p_{gj}} = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\sum_{\mathrm{g}=1}^{\mathrm{G}}\sum_{\mathrm{j}=1}^{\mathrm{J_g}}\sum_{\mathrm{i}=1}^{\mathrm{n_{gj}}}\frac{n_g \mathrm{Y_i}}{\mathrm{n_{gj}} n}$$

$$\hat{\mu}_2 = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\frac{1}{N}\sum_{\mathrm{i}=1}^{\mathrm{n_t}}\frac{\mathrm{Y_i}}{\pi_i'} = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\frac{1}{N}\sum_{\mathrm{i}=1}^{\mathrm{n_t}}\frac{\mathrm{Y_i}}{\pi_i p_t} = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\sum_{\mathrm{i}=1}^{\mathrm{n_t}}\frac{\mathrm{Y_i}}{n_{\mathrm{t}}}$$

Variance estimation

These adjusted inclusion probabilities may be used in a standard Horvitz-Thompson estimator (Horvitz and Thompson 1952). Note that sample sizes within a grouping and panel are planned and sampling units are randomized to panels, so the variance estimator does not need to account for random sample sizes or post-strata as in a post-stratification estimator when status is estimated within a year.

However, when estimates of status are computed over time, panels that are visited more than once during a schedule will be correlated over time when the second method of panel inclusion probability estimation is used. This correlation is likely to be positive and variance estimators will likely underestimate the true variance of multiyear status. When data are collected from GRTS samples, the standard Horvitz-Thompson variance estimator, which is known to be conservative for spatially-balanced data, may be used to offset the bias variance of using the adjusted inclusion probabilities until further work may be done on variance estimation.

Simulations indicate that both methods are unbiased, accurate, and similarly precise. The difference between the two methods is that, in the first method, only the means within a grouping are used to extrapolate to the unsurveyed panels, while in the second method, all sites surveyed within a year contribute to the extrapolation to unsurveyed sites. Confidence interval coverage was found to be about 99% for both methods, indicating that variances may be relatively large. However, the variance estimators are naïve and do not account for the correlation over time, so under-coverage is not an issue. Since both methods are equally accurate and similarly precise, either method of estimating panel inclusion probabilities would be acceptable. Simulations indicate that confidence interval coverage is similar for both estimators.

Nonresponse adjustment

Nonresponse occurs when a complete set of measurements cannot be obtained for the entire sample. Understanding the mechanism that generates the nonresponse helps the data analyst to determine what analysis methods are most appropriate. Nonresponse is categorized into three missingness mechanisms: missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR) (Little and Rubin 2002). MCAR and MAR missingness are also referred to as ignorable nonresponse, while NMAR missingness is called nonignorable nonresponse. Response disposition, defined as an indicator for response (1 if the site is surveyed and 0 otherwise), is provided in the test data for each of the types of missingness. After a brief discussion of the types of missingness mechanisms, status estimation for the three types of nonresponse is examined.

Missing-completely-at-random (MCAR) missingness

When data are MCAR, the missingness mechanism is completely unrelated to the outcome of interest, any covariates, or the sampling design (Lohr 1999). Examples of MCAR missingness might include failed instrumentation so that measurements for a site are unavailable or an early snow that ends the survey year prematurely. If these events can be safely assumed to be unrelated to the outcome of interest, any covariates, or the sampling design, then the sample of respondents may be treated as a random sample of the population. In this case, complete-data analysis methods provided above are used for the reduced sample.

Missing-at-random (MAR) missingness

When data are MAR, the missingness mechanism is related to covariates that are correlated with the outcome of interest. For unbiased estimation, covariates associated with the missingness mechanism are identified and nonresponse adjustment is applied within classes based on these covariates.

Not-missing-at-random (NMAR) missingness

When the missingness mechanism is NMAR (also called nonignorable nonresponse), the missingness is related to the outcome of interest and cannot be explained by covariates alone. Even small proportions of nonresponse can substantially affect inference when the proper adjustments are not made (Lohr 1999). When this occurs, then model-based estimation approaches will be necessary. When data exhibit monotone missingness (once a site is missed, it is always missed), the likelihood may be factored for complete and incomplete data (Little 1982). For general missingness patterns, the EM algorithm may be used with regression imputation and a covariance adjustment to account for imputation variation (Dempster et al. 1977). However, the bias may not be affected if assumptions on the distribution of the outcome are not met (Lessler and Kalsbeek 1992). Bayesian estimation is incorporated in multiple imputation approaches to nonignorable nonresponse (Rubin 1987) and hierarchical models (Stasny 1991). Because nonignorable nonresponse models are so sensitive to model assumptions, a sensitivity analysis is recommended to explore the impacts of model assumptions (Little 1982).

14.6 Trend Estimation

Trend analysis will be conducted when three or more years of monitoring data are available. Several methods of estimating trend are available for estimating annual and net trend over time. Parametric approaches (Van Leeuwen et al. 1996; Piepho and Ogutu 2002) allow greater flexibility to simultaneously estimate trend, variance components, and the effects of covariates, but require more rigorous assumptions. Nonparametric approaches such as the seasonal Kendall test (Hirsch and Slack 1984) might produce only a test statistic and p-value for trend, but the robustness of nonparametric tests provides a useful check for parametric test results. We proceed with descriptions of parametric analysis with linear mixed models but suggest that a variety of trend tools be used before using the test results as an argument for management action.

Linear mixed model

A linear mixed model is used to test for trend at randomly-selected sites (Van Leeuwen et al. 1996; Piepho and Ogutu 2002). A mixed model allows some effects to be considered fixed and some to be considered random. Fixed effects contribute to the mean of the outcome and random effects contribute to the variance. Random effects are used to estimate variation of linear trends among subjects (sites) and over time (years). Restricted maximum likelihood (REML) is used to obtain the estimates for the variances of the random effects. The linear mixed model is a parametric model, requiring the assumptions of independent and normally distributed errors with equal variance. We will assume that those conducting data analyses are familiar with the assumptions and methods for checking that they are met.

Piepho and Ogutu (2002) improve the estimator proposed by Van Leeuwen et al. (1996) by modeling the random site effect as correlated with the random site-level slope effect. In general, the random

intercept for sites is modeled as random if the sample has been chosen using a probability sample and modeled as a fixed effect otherwise. However, modeling the site intercept as fixed may be needed to avoid convergence problems and to optimize test power when residual variance is large (Piepho and Ogutu 2002). For this example, we will assume that the sites were selected randomly and model the intercept as fixed.

The proposed mixed model for trend is:

$$y_{ij} = \mu + w_j\beta + b_j + a_i + w_j t_i + e_{ij},$$

where i=1,..,m_a; j=1,..,m_b; and

m_a = the number of sites in the sample;

m_b = the number of consective years in the sample;

y_{ij} = outcome of interest for the i^{th} site in the j^{th} year;

w_j = constant representing the j^{th} year (covariate);

μ and β = fixed intercept and slope of the linear time trend;

b_j = random effect of the j^{th} year;

a_i = random intercept of i^{th} site, independent and identically distributed as $N\left(0,\sigma_a^2\right)$;

t_i = random slope of i^{th} site, independent and identically distributed as $N\left(0,\sigma_t^2\right)$; and

e_{ij} = unexplained error, independent and identically distributed as $N\left(0,\sigma_e^2\right)$.

For measuring net trend over time as a percent change, the response must be logged so that exponential change may be estimated. In this case, the response y_{ij} is actually the natural log of the response being modeled, i.e., $\log\left(y_{ij}\right)$. Therefore, inference on the original scale is actually made on median trend rather than mean trend.

The null and alternative hypotheses under consideration are that of no trend ($\beta = 0$) versus a non-zero trend ($\beta \neq 0$):

$$H_o : \beta = 0 \text{ vs } H_A : \beta \neq 0$$

As defined above, β is the coefficient of the w_j covariate and represents annual trend of the outcome on the log scale. This test is analogous to the test of:

$$H_o : \delta = 0 \text{ vs } H_A : \delta \neq 0$$

where δ is the net change as a proportion. For example, a net change of δ =1.4 implies a 40% increase of the population parameter over the specified period of time, whereas δ = 0.6 implies a

40% decrease. The test statistic is derived for the two-sided hypothesis and the rejection region is based on a *t*-distribution Type I error level of $\alpha = 0.10$. Satterthwaite degrees of freedom are recommended (Van Leeuwen et al. 1996; Spilke et al. 2005).

14.7 Zero-inflated Models

Zero-inflation occurs when the proportion of zeros in a dataset exceeds that of a standard distribution (Ridout et al. 1998). Excess zeros may be observed when a resource is in decline, when detection of the resource is imperfect, or when observed effects are insufficient to explain species distributions. When an outcome is zero-inflated, assumptions of underlying distributions required by the linear modeling approaches may not be met. Zero-inflated models combine a standard probability distribution with a Bernoulli distribution exhibiting non-zero probability for the occurrence of zeros. The basic form of a zero-inflated distribution for a discrete random variable, *Y*, is:

$$f_Y(y) = \begin{cases} q + (1-q) f(0), & \text{y = 0} \\ (1-q) f(y), & \text{otherwise} \end{cases}$$

where *q* is the probability of an excess zero and $f(y)$ is the probability mass of the random outcome, *Y*. Choice of the appropriate distribution, $f(y)$, depends on the type of outcome (discrete versus continuous) and the possible range of outcome values.

Zero-inflation models allow the estimation of trend in the mean over time as well as the trend in the proportion of zeros over time. Zero-inflation models have been applied to the log-normal (Calama et al. 2011), Poisson (Lambert 1992), binomial (Hall 2000), and beta (Opsina and Ferrari 2010) distributions. Warton (2005) cautions that abundance data with a high proportion of zeros may be adequately modeled with a negative binomial distribution without incorporating a mixture distribution for the zero inflation. Note that zero-inflated distributions are nonlinear, and estimation of random effects is problematic.

14.8 Data Analysis for Status and Trend Estimation

General data analysis approaches are outlined in this section, and issues such as nonresponse and zero inflation are discussed. Simulated data are used to demonstrate analysis approaches. The data were simulated from variance components obtained from SAMO and CHIS datasets. The simulated population spans a 10-year monitoring period and exhibits a 4% annual increase. The sample consists of 360 unique sites visited in a [2-4] revisit design for an annual sample of 120 sites. Three types of response disposition are simulated to use as examples for estimation under different missingness mechanisms. A separate outcome is simulated to use as an example of zero inflation. See Table 14.1 for response rate and the proportion of zeros simulated for outcomes in the dataset. The UTM coordinates were simulated from observed ranges of transects in the pilot data. These data were simulated as test data only and no inference should be made from results.

Table 14.1. Response rates and zero-inflation rates for simulated outcomes.

Year	Response rate			Prop. Zero inflation
	MCAR	MAR	NMAR	
2012	0.87	0.92	1.00	0.21
2013	0.86	0.90	1.00	0.19
2014	0.88	0.88	0.99	0.14
2015	0.90	0.87	0.97	0.18
2016	0.90	0.86	0.98	0.14
2017	0.91	0.87	0.96	0.10
2018	0.87	0.88	0.96	0.07
2019	0.90	0.87	0.90	0.03
2020	0.89	0.86	0.89	0.09
2021	0.91	0.87	0.85	0.05

Status estimation in R

A simulated data file called “ShrubPctData" can be requested from the MEDN Database Manager. The formatting necessary for data analysis can be obtained from examining this dataset. To import this data into R, go to *File/Change dir…* in the R menu and select the directory where the dataset is located. Then, use the following command:

```
ShrubPctData <-read.table("ShrubPctData.txt", header=T, sep="\t")
```

If the data are comma-delimited, use *sep=","*. To review the dataset, type “ShrubPctData” at the prompt in R after the workspace has been loaded.

Next, go to *File/Save* and save the workspace. Load libraries for R:

```
library(lme4)

library(spsurvey)
```

NOTE: These libraries must be loaded at the beginning of every R session for these analyses. Libraries are not saved within R workspaces. Packages may be downloaded from within R by choosing *Packages > Install Package(s)…* in the menu, selecting a local CRAN mirror site, and the choosing the package. These steps must be repeated for each package.

Examine the variable names of the dataset. The definitions of the variables are provided in Table 14.2.

```
names(ShrubPctData)
```

```
"Site"   "Year"   "WYear"   "Y"
"wgt"    "ZI"     "Z"      "UTM.X"   "UTM.Y"
"Slope"   "Resp.MCAR" "Resp.MAR" "Resp.NMAR"
```

Table 14.2. Definitions of variables in the simulated dataset.

Variable	Definition
Site	Unique identifier for the site/transect
Year	Survey year
WYear	Adjusted year such that the first survey year corresponds to 0
Y	The outcome of interest obtained from ground surveys, absolute percent shrub cover in this example
wgt	The design weight from the GRTS sample draw
ZI	Indicator of zero-inflation for the trend example
Z	Zero-inflated percent shrub cover outcome for the trend example
UTM.X	UTM easting
UTM.Y	UTM northing
Slope	Slope (in degrees) of the site
Resp.MCAR	Response disposition for an example of MCAR missingness: 1 if successfully surveyed and 0 if unable to survey
Resp.MAR	Response disposition for an example of MAR missingness: 1 if successfully surveyed and 0 if unable to survey
Resp.MCAR	Response disposition for an example of NMAR missingness: 1 if successfully surveyed and 0 if unable to survey

For this example, the 2021 status of percent shrub cover will be examined. Obtain a histogram of 2021 percent shrub cover, controlling the range and bin size of the histogram with the "breaks" option (Figure 14.1).

```
ShrubPctData.2021<-ShrubPctData[ShrubPctData$Year==2021,]
hist(ShrubPctData.2021$Y, xlab="Shrub cover (%)", main="",
breaks=seq(0,140,10), ylim=c(0,80))
```

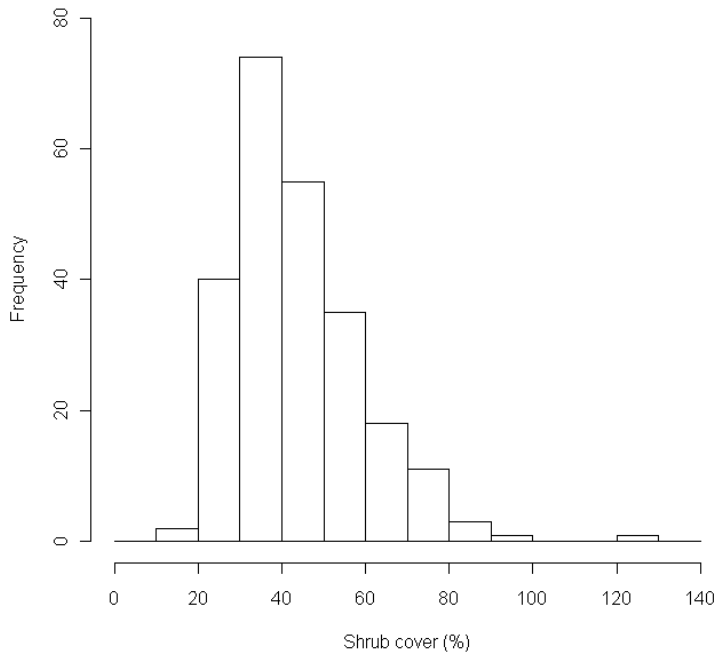


Figure 14.1. Percent cover in 2021.

Assuming no nonresponse, the *total.est* function is used to obtain the following estimates of the population mean:

```
StatusEst.Shrub.2021<- total.est(ShrubPctData.2021$Y,
ShrubPctData.2021$wgt,x= ShrubPctData.2021$UTM.X, y=
ShrubPctData.2021$UTM.Y, conf=90)
cbind(StatusEst.Shrub.2021[,1:2],
round(StatusEst.Shrub.2021[,3:6],2))
```

Output:

Statistic	NResp	Estimate	StdError	LCB90Pct	UCB90Pct
Total	240	466950.40	11932.48	447323.21	486577.59
Mean	240	48.64	1.24	46.60	50.69
Variance	240	510.74	66.20	401.85	619.63
Std. Deviation	240	22.60	1.46	20.19	25.01

The output is given for the mean, the SE of the mean, and the 90%-confidence interval endpoints for the mean. The 2021 estimate of the mean percent shrub cover is 48.64% (90%-confidence interval of 46.60% to 50.69%). The true mean from the simulated population is 48.79%. The true mean is covered by the 90%-confidence interval based on the neighborhood variance estimator for GRTS samples.

Status estimation with nonresponse

When nonresponse occurs, the nature of the missingness will determine the appropriate analysis approach. Classifying the nonresponse requires some knowledge of the issues contributing to the nonresponse and information on characteristics of the accessible and inaccessible sites.

Missing Completely At Random

If data are MCAR, then missingness does not depend on the outcome of interest, any covariates, or the sampling design (Little and Rubin 2002). In this case, the data are considered a random subsample of the original sample. Standard analysis approaches may be used with the subsample of accessible sites.

For the 2021 test data, 9% of the sites were not visited (Table 14.1). If the nonresponse is related to any covariates, then the MCAR assumption cannot be justified (Lohr 1999). In the test dataset (see appendix at end of this SOP), one covariate, the slope of the site, is provided for testing. Histograms of the distribution of the site slope for accessible and inaccessible sites are obtained as follows (Figure 14.2):

```
par(mfrow=c(2,1))
hist(ShrubPctData.2021$Slope[ShrubPctData.2021$Resp.MCAR==1],
breaks=seq(0,40,5) , main="Accessible sites", xlab="Slope")
hist(ShrubPctData.2021$Slope[ShrubPctData.2021$Resp.MCAR==0],
breaks=seq(0,40,5), main="Inaccessible sites", xlab="Slope")
```

Figure 14.2 shows that the site slopes span the same range for respondents and nonrespondents and do not indicate an effect of slope on the response mechanism. The slope covariate is a continuous measurement which will need to be broken into categories for examination. Breaking the slope into bins of 10% each, the chi-square test of association may be conducted as follows:

```
ShrubPctData.2021$SlopeClass<-
ifelse(ShrubPctData.2021$Slope<10, 1,
ifelse(ShrubPctData.2021$Slope<20, 2,
ifelse(ShrubPctData.2021$Slope<30, 3, 4)))
chisq.test(ShrubPctData.2021$Resp.MCAR,
ShrubPctData.2021$SlopeClass)
```

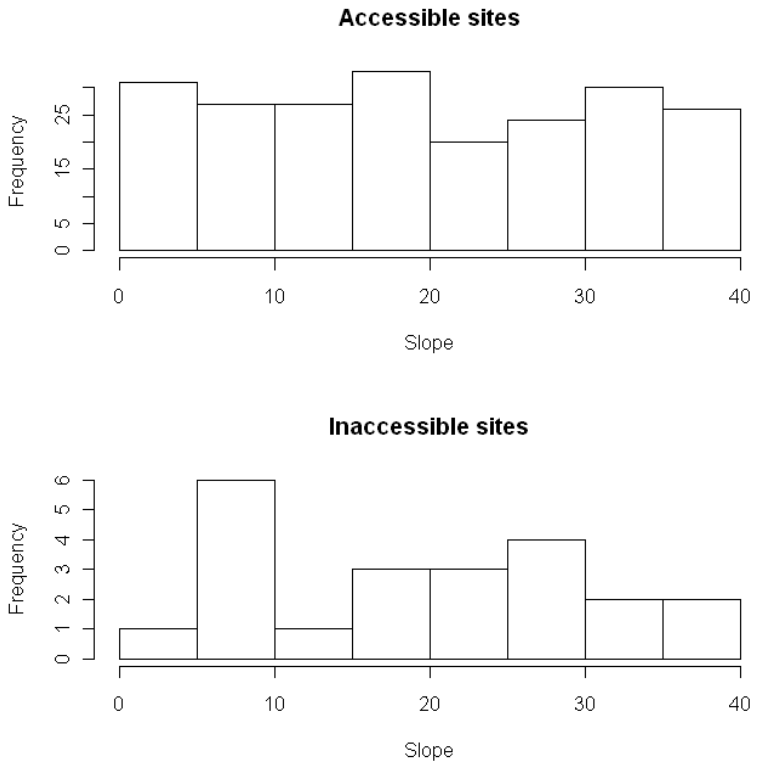


Figure 14.2. Histogram of slopes for accessible and inaccessible sites (MCAR).

No significant association is found among slope categories between the respondents and nonrespondents (χ^2 = 2.5777, df = 3, p-value = 0.4614).

Assuming that the missingness is MCAR, the estimate of the mean is obtained by using the information from the accessible sites as follows:

```
StatusEst.Y.Resp.MCAR <-
total.est(ShrubPctData.2021$Y[ShrubPctData.2021$Resp.MCAR==1],
ShrubPctData.2021$wgt[ShrubPctData.2021$Resp.MCAR==1],
x= ShrubPctData.2021$UTM.X[ShrubPctData.2021$Resp.MCAR==1],
y= ShrubPctData.2021$UTM.Y[ShrubPctData.2021$Resp.MCAR==1], conf=90)
StatusEst.Y.Resp.MCAR[2, 3:6]
```

The mean is estimated as 48.52% (90%-confidence interval of 46.39% to 50.65%), which is very close to the complete-case estimate assuming complete response and the true parameter value of 48.79%.

Missing At Random

In this section, the missingness is simulated as MAR and the estimate of status is obtained using the response disposition for MAR nonresponse (Resp.MAR). MAR nonresponse adjustments may be used when a variable related to the missingness may be obtained for both observed and missing sites. In this example, assume that a GIS shapefile of slope information is available. If the slope of a site is related to site accessibility, then sites with higher slopes may be subject to nonresponse. Given slope

information for the entire sample, histograms of the site slopes for accessible and inaccessible sites are obtained with the MAR response indicator for this example (Figure 14.3):

```
par(mfrow=c(2,1))
hist(ShrubPctData.2021$Slope[ShrubPctData.2021$Resp.MAR==1],
breaks=seq(0,40,5) , main="Accessible sites", xlab="Slope")
hist(ShrubPctData.2021$Slope[ShrubPctData.2021$Resp.MAR==0],
breaks=seq(0,40,5), main="Inaccessible sites", xlab="Slope")
```

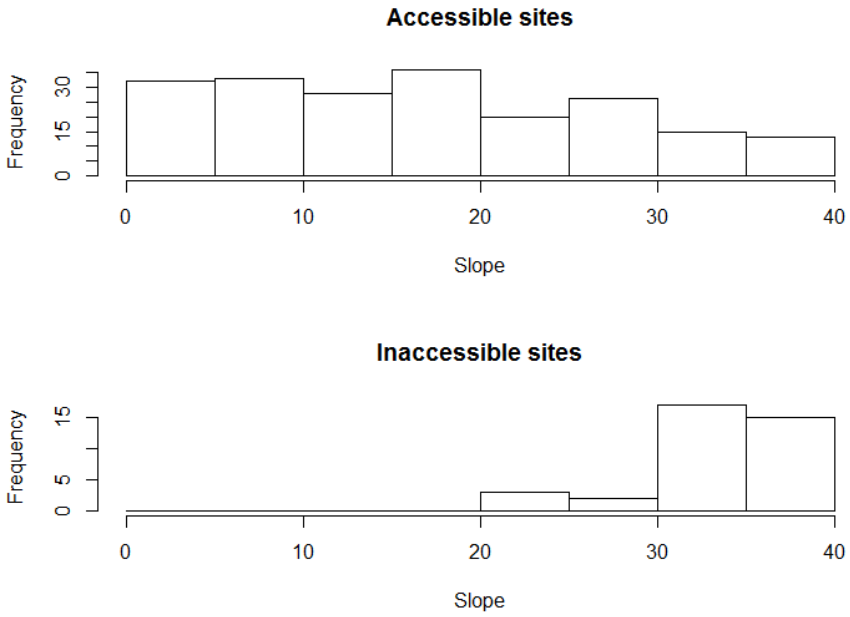


Figure 14.3. Histogram of slopes for accessible and inaccessible sites (MAR).

The histograms indicate that the missingness is restricted to the set of sites with slopes between 20˚ and 40˚ slope, with the highest proportion of missingness in the set of sites falling above 30˚ slope. Creating a two-level classification variable for sites with slopes above and below 30˚, the results of the Pearson's chi-squared test of association code in R indicates a significant difference between the proportion of sites within each slope class between accessible and inaccessible sites (χ^2 =84.3669, df = 1, p-value < 0.0001):

```
ShrubPctData.2021$SlopeClass2<-as.numeric(ShrubPctData.2021$Slope > 30)
chisq.test(ShrubPctData.2021$Resp.MAR,ShrubPctData.2021$SlopeClass2)
```

Because the nonresponse is associated with the slope of the site, nonresponse adjustment can be conducted within classes based on a categorical variable defined by slope. Assuming missing-at-random data, the weighting class adjustment estimator (Oh and Scheuren 1983; Lohr 1999) may be used to estimate the population mean while accounting for differences in the mean within different weighting classes based on the auxiliary variable indicating slope of 30˚ or more. At least five sampling units within each weighting class are needed for reliable variance estimation. R code for these calculations is provided below (Table 14.3) and in the appendix to this SOP. The data needed

for the weighting-class adjustment calculation includes the outcome of interest, the response disposition for each site (1 if accessible and 0 if not), and the weighting class variable that is correlated with missingness. For the simulated dataset, the confidence interval covers the true mean (48.79% cover).

```
ShrubPctData.2021$SlopeClass2<-as.numeric(ShrubPctData.2021$Slope>30)

est.total<-
WCAdjSRS.fcn(ShrubPctData.2021[,c("Y","wgt","Sampled","Resp.MAR","Slope
Class")])[c(1,3:5)]
Nhat<-sum(ShrubPctData.2021$wgt)   # 9600
est.mean<-est.total/Nhat
```

Table 14.3. Estimates of the mean for three adjustment classifications.

Est. Mean	SE	90%-CI lower bound	90%-CI upper bound
49.24	1.67	45.97	52.51

NMAR

Status estimation under nonignorable nonresponse is demonstrated using the response disposition for NMAR nonresponse (Resp.NMAR). When missingness is dependent on the outcome of interest, even a small proportion of nonresponse can greatly impact the bias of an estimate (Lohr 1999). In this example, the NMAR missingness is generated independently of the site slope, which is indicated by the chi-squared test of association (χ^2 =4.9333, df = 3, p-value = 0.1767) obtained with the following code:

```
ShrubPctData.2021$SlopeClass<-
ifelse(ShrubPctData.2021$Slope<10, 1,
ifelse(ShrubPctData.2021$Slope<20, 2,
ifelse(ShrubPctData.2021$Slope<30, 3, 4)))
chisq.test(ShrubPctData.2021$Resp.NMAR,
ShrubPctData.2021$SlopeClass)
```

When data are NMAR, some information about the nonrespondents must be obtained. This information may be obtained from other sources of information about the nonrespondents, such as from model assumptions in a model-based inference setting. Multiple imputation (Rubin 1987) and hierarchical models (Stasny 1991) incorporate distributional assumptions about the missing data in a Bayesian setting. A sensitivity analysis (Little 1982) provides a basis for understanding the impact of the assumptions on inference.

Trend Analysis in R

The linear mixed model is applied in R using the *lme4* package. Residual diagnostics indicate that a logarithmic transformation of the percent shrub cover outcome better meets the assumptions of linear modeling.

A plot of shrub percent cover by site over time may be obtained as follows:

```
Sites<-sort(unique(ShrubPctData$Site))
nSites<-length(Sites)

par(mfrow=c(2,1))
plot(ShrubPctData$Year, ShrubPctData$Y)
plot(as.numeric(as.character(ShrubPctData$Year)),
ShrubPctData$Y, pch="")

for (i in 1:nSites) {
lines(as.numeric(as.character(ShrubPctData$Year))
[ShrubPctData$Site==Sites[i]],
ShrubPctData$Y[ShrubPctData$Site==Sites[i]], lty=i)
}
```

The WYear (w_j) covariate is a scale year variable used in the trend analysis. Shifting the year variable to intersect zero allows more stable estimation of regression parameters. This variable has already been calculated for the test dataset.

```
# ShrubPctData$WYear<- ShrubPctData$Year - 2012
```

Obtain the mixed model fit for percent shrub cover with fixed effects for the slope and intercept of the regression line and random effects for site, year, and site-level slopes with the following code:

```
library(lme4)
fit <-lmer(log(Y) ~ WYear + (1+WYear|Site) + (1|Year),
data= ShrubPctData)
summary(fit)
```

The following output is obtained:

```
Linear mixed model fit by REML
Formula: log(Y) ~ WYear + (1 + WYear | Site) + (1 | Year)
 Data: ShrubPctData
 AIC   BIC   logLik    deviance  REMLdev
 -1665 -1627 839.5     -1694         -1679
Random effects:
 Groups  Name        Variance   Std.Dev.      Corr
 Site    (Intercept)  0.0831613 0.288377
         WYear        0.0012422 0.035245   0.009
 Year    (Intercept) 0.0011978  0.034609
 Residual             0.0052815 0.072674
Number of obs: 1680, groups: Site, 360; Year, 10
Fixed effects:
Estimate    Std.         Error         t value
(Intercept) 3.519682     0.025859   136.11
WYear       0.033494     0.004318      7.76
Correlation of Fixed Effects:
```

```
   (Intr)
WYear -0.616
```

Therefore, the annual trend for the outcome of interest is estimated as exp(0.033494) or 1.0341, indicating an annual increase of 3.4% over the 10-year monitoring period for the percent shrub cover metric. The residuals may be examined with the following code:

```
ResidDiagnostic<-function(fit) {
 par(mfrow=c(2,2))
 plot(fitted(fit), resid(fit),
 main="Residuals vs. Fitted Values")
 qqnorm(resid(fit))
 hist(resid(fit))
}
ResidDiagnostic(fit)
```

The residual plots indicate approximately normal errors with equal spread (Figure 14.4).

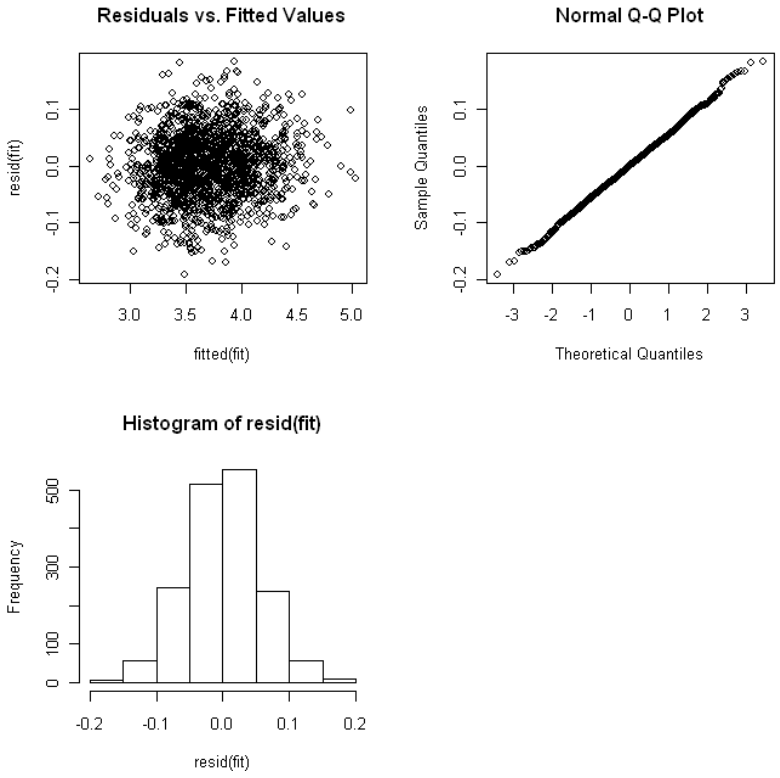


Figure 14.4: Residual diagnostic plots for the linear mixed model fit.

Approximate Satterthwaite degrees of freedom are obtained for confidence interval calculation and for the trend test (Sims et al. 2006, supplement):

```
Beta<-fixef(fit)[2]
VarBeta<- vcov(fit)[2,2]    # Est. variance of fixed trend est.
sig2a.hat <-VarCorr(fit)$Site[1,1]    # var(ai)
```

```
sig2t.hat <-VarCorr(fit)$Site[2,2]    # var(ti)
sigat.hat <- VarCorr(fit)$Site[1,2]      # cov(ai,ti)
sig2e.hat <-attr(VarCorr(fit),"sc")^2
sig2b.hat <- VarCorr(fit)$Year[1]
ma<- length(unique(ShrubPctData$Site))# number of sites
mb<-length(unique(ShrubPctData$Year)) # number of years
n<-dim(ShrubPctData)[1]        # total number of observations
Z1<- (sig2b.hat + (sig2e.hat/n))/sum(((1:mb)-(mb+1)/2)^2)
Z2<- sig2t.hat/ma
eta<- VarBeta^2/(((Z1^2)/(mb-2))+ ((Z2^2)/(ma-1)))
eta
```

Conduct the two-sided trend test:

```
t.stat<-fixef(fit)[2]/sqrt(VarBeta)
p.value<-2*(1-pt(t.stat, eta))
c(t.stat=t.stat, p.value =p.value)
```

The two-sided trend test indicates a significant trend at the 0.10 level (t = 7.7563, df = 13.1119, p < 0.0001). The Satterthwaite degrees of freedom may also be used to obtain the appropriate critical t-value for the confidence interval on the mean as follows:

```
c(exp(Beta-qt(1-alpha, eta)*sqrt(VarBeta)), exp(Beta+qt(1-alpha,
eta)*sqrt(VarBeta)))
```

The 90%-confidence interval on the mean is (1.0281, 1.0401).

Trend estimation with nonresponse

Nonresponse may also impact the accuracy of trend estimates, particularly if the nonresponse is nonignorable. For NMAR missingness, the inclusion of a site in the sample is dependent on the outcome of interest, which violates a primary assumption of model-based inference (Schreuder et al. 2001). Trends were estimated with the linear mixed model for the responding portion of the sample for the four possible response dispositions: no nonresponse, MCAR missingness, MAR missingness, and NMAR missingness (Table 14.4). All of the trend estimates slightly underestimate the true trend of 0.04 (corresponding to an annual increase of 4%). The confidence intervals for all response dispositions except NMAR cover the true trend parameter.

Table 14.4. Trend estimates for four response dispositions.

			90%-confidence interval	
Missingness	**Est. Trend**	**SE**	**Lower bound**	**Upper bound**
None	0.0335	0.0043	1.0281	1.0401
MCAR	0.0334	0.0043	1.0280	1.0400
MAR	0.0353	0.0043	1.0299	1.0419
NMAR	0.0310	0.0046	1.0251	1.0379

When nonresponse occurs, trend may be estimated from the nonresponse-adjusted status estimates. Random effects cannot be estimated since the park-level estimates will not reflect replication at the site level. However, more accurate trend estimation may be possible. The following code is used to obtain estimates of annual status using double sampling for stratification and the neighborhood variance estimator:

```
StatusByYear<-function(dat) {

yrs<-sort(unique(dat$WYear))
mb<-length(yrs)
StatusEstsByYear<-cbind(yrs, 0)

for (i in 1:mb)  {

dat.i<-dat[dat$WYear==yrs[i],]

StatusEst.Y <- total.est(dat.i$Y[dat.i$Resp.NMAR==1],
dat.i$wgt[dat.i$Resp.NMAR==1],
x= dat.i$UTM.X[dat.i$Resp.NMAR==1], y= dat.i$UTM.Y[dat.i$Resp.NMAR==1],
conf=90)

if(sum(dat.i$Resp.NMAR==0)<2) est<- StatusEst.Y[2,3]
if(sum(dat.i$Resp.NMAR==0)>=2) {
StatusEst.X <- total.est(dat.i$X[dat.i$Resp.NMAR==0],
dat.i$wgt[dat.i$Resp.NMAR==0],
x= dat.i$UTM.X[dat.i$Resp.NMAR==0], y= dat.i$UTM.Y[dat.i$Resp.NMAR==0],
conf=90)

Ybar.1<- StatusEst.Y[2,3]
Ybar.0<- StatusEst.X[2,3]
SE.1<- StatusEst.Y[2,4]
SE.0<- StatusEst.X[2,4]

n<-dim(dat.i)[1]
m<-sum(dat.i$Resp.NMAR)
est<-(m*Ybar.1/n)+((n-m)* Ybar.0/n)
}

StatusEstsByYear[i,] <-c(yrs[i], est)
}

StatusEstsByYear <-data.frame(StatusEstsByYear)
names(StatusEstsByYear)<-c("WYear", "mu.hat")
return(StatusEstsByYear)
}

AnnualStatus<-StatusByYear(ShrubPctData)
```

The trend estimates are provided in Table 14.4. The logarithmically-transformed estimates adjusted for NMAR missingness are used in a simple linear regression model over time to estimate the multiplicative annual increase.

```
fit.status.ests<-lm(log(mu.hat)~ WYear, data=AnnualStatus)
summary(fit.status.ests)
```

The following output is obtained:

```
Call:
lm(formula = log(mu.hat) ~ WYear, data = AnnualStatus)


Residuals:
     Min       1Q   Median       3Q      Max
-0.043507 -0.024313 0.003464 0.024844 0.030732

Coefficients:
             Estimate   Std. Error  t value    Pr(>|t|)
(Intercept) 3.553651   0.016891      210.39     2.92e-16 ***
WYear       0.039916   0.003164      12.62      1.46e-06 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02874 on 8 degrees of freedom
Multiple R-squared: 0.9521,   Adjusted R-squared: 0.9462
F-statistic: 159.2 on 1 and 8 DF, p-value: 1.463e-06
```

The estimate of annual trend in the nonresponse-adjusted status estimates is 0.0399 (90%-confidence interval of 1.0346, 1.0469), which is essentially unbiased for the true trend (0.04).

14.9 Zero Inflation

When an outcome exhibits zero-inflation due to absence of vegetative cover, two potential trend tests may be tested for these outcomes: trend in the mean of the outcome and trend in the probability of a zero (i.e., trends in the proportion of the population with no cover/no species). Nonlinear maximization of the likelihood function of the zero-inflated lognormal distribution is used to obtain maximum likelihood estimates of regression parameters. The likelihood of a reduced model that omits the trend effect is compared to the likelihood of the full model in a likelihood ratio test to test the significance of the trend effect. The likelihood ratio test may be used to test both the trend in the lognormal mean and the trend in the proportion of zeros in the outcome of interest. Estimation may be improved by obtaining naïve starting values for the regression parameters in both the model of the mean and the zero-inflation portion of the model.

A zero-inflated lognormal variable, Z, is included in the dataset. Fit the linear mixed model to the zero-inflated data as follows:

```
fit.z <-lmer(log(Z+.01) ~ WYear + (1+WYear|Site) + (1|Year), data=
ShrubPctData)
summary(fit.z)

 ResidDiagnostic(fit.z)
```

The residual diagnostic plots (Figure 14.5) indicate substantial zero-inflation that may violate model assumptions of residual error normality and equal variance.

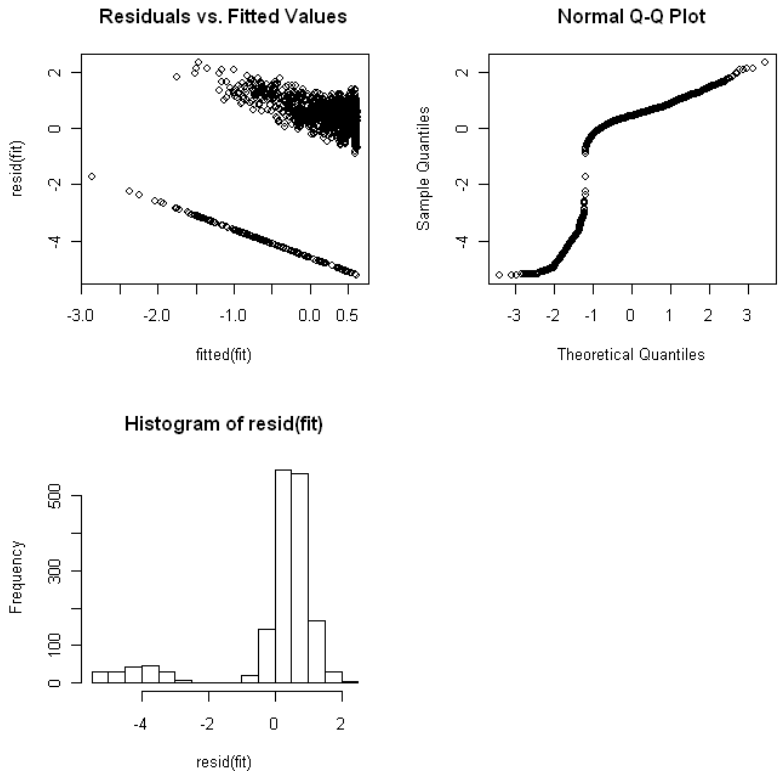


Figure 14.5. Residual diagnostic plots for the linear mixed model fit of the zero-inflated outcome.

The following function and commands provide the information necessary to test the zero-inflated lognormal random variable, *Z*, for trend. Note that adding or removing coefficients to the models of trend or the proportion of zeros will require additional changes to this function.

```
ZILN_MLE<- function(parms,vars, data){

tmp<-rep(0,5)
names(tmp)<-c("const.Mean","const.ZI", "Year.Mean", "Year.ZI",
"sigma2")
tmp[vars]<-parms

yr<-sort(unique(data$WYear))
names(yr)<- "WYear"
M<- length(yr)
```

```
Rows<- dim(data)[1]
LogLik<-ones<-rep(1,M)

# Model detection probs:
p<-expit(tmp[2]*ones+tmp[4]* yr)
# Model occupancy rates
mu<- tmp[1]*ones + tmp[3]*yr
ymat<-data$Z            # Outcome of interest

for(i in 1:M){
index<-(1:Rows)*as.numeric(data$WYear== yr[i])
index<-index[index!=0]
m<-length(index)
if(m>0) {
yvec<-ymat[index]
# Calc Likelihood
Lik.i<- (p[i]*(yvec==0))+ ((1-p[i])* dlnorm(yvec, meanlog = mu[i],
sdlog = sqrt(tmp[5])))
 }             # end if
# Calc log likelihood
LogLik[i]<- log(prod(Lik.i))
}                 # end i loop
sum(-1*LogLik)
}


# Full model – trend for the lognormal mean and trend for prop of zeros
# Get initial values
fit.full.logreg.all<-lm(log(Z + .01) ~ WYear,
data=ShrubPctData[ShrubPctData$Z>0,])
summary(fit.full.logreg.all)
# Obtain starting values for the ZI model with pilot data – prob of a 0
is modeled
fit.full.ZI<-glm(((Z ==0)) ~ WYear, family=binomial(logit),
data= ShrubPctData)
summary(fit.full.ZI)

v.all.full= c("const.Mean","const.ZI", "Year.Mean", "Year.ZI",
"sigma2")
mle.all.full<-nlm(ZILN_MLE, p= c(fit.full.logreg.all$coef[1],
fit.full.ZI$coef[1], fit.full.logreg.all$coef[2],
fit.full.ZI$coef[2],
summary(fit.full.logreg.all)$sigma^2),vars= v.all.full, data=
ShrubPctData, hessian=TRUE, iterlim=100000, steptol=0.000000000000001)
mle.all.full

# reduced model – no mean trend
fit.full.logreg.red<- lm(log(Z +.01) ~ 1,
```

```
data=ShrubPctData[ShrubPctData$Z>0,])
summary(fit.full.logreg.red)

v.all.red= c("const.Mean","const.ZI", "Year.ZI", "sigma2")
mle.all.red<-nlm(ZILN_MLE, p= c(fit.full.logreg.red$coef[1],
fit.full.ZI$coef[1], fit.full.ZI$coef[2],
summary(fit.full.logreg.red)$sigma^2), vars= v.all.red, data=
ShrubPctData, hessian=TRUE, iterlim=100000,
steptol=0.000000000001)
mle.all.red

# Likelihood ratio test for trend in the mean
chisq.all<- 2*(mle.all.red$minimum - mle.all.full$minimum)
p.value.all<-pchisq(chisq.all, 1, lower.tail=FALSE)
round(c(chisq.all, p.value.all), 4)
85.0432 0.0000

# reduced model – no trend in prop of zeros
fit.red.ZI<-glm(((Z ==0)) ~ 1, family=binomial, data=
ShrubPctData)
summary(fit.red.ZI)

v.all.red2= c("const.Mean","const.ZI", "Year.Mean", "sigma2")
mle.all.red2<-nlm(ZILN_MLE, p= c(fit.full.logreg.all$coef[1],
fit.full.ZI$coef[1], fit.full.logreg.all$coef[2],
summary(fit.full.logreg.all)$sigma^2),vars= v.all.red2, data=
ShrubPctData, hessian=TRUE, iterlim=100000, steptol=0.000000000001)
mle.all.red2

# Likelihood ratio test for trend in the prop with no cover
chisq.all<- 2*(mle.all.red2$minimum - mle.all.full$minimum)
p.value.all<-pchisq(chisq.all, 1, lower.tail=FALSE)
round(c(chisq.all, p.value.all), 4)
38.8627 0.0000
```

The results of the two-sided trend tests indicate significant trends in both the mean of the percent shrub cover outcome (likelihood ratio test statistic = 85.0432, $p < 0.0001$) and in the proportion of zeros observed in the outcome (likelihood ratio test statistic = 38.8627, $p < 0.0001$).

14.10 Other Issues

Inference may be desired for subpopulations not accounted for in the sampling design (e.g., vegetation types). Post-stratification is used to obtain unbiased inference for these subpopulations (Holt and Smith 1979). Because sample sizes are not predetermined in unplanned post-strata, the unconditional variance of post-strata estimators is increased by a variance component that accounts for random sample sizes. The benefits of post-stratification include conditional unbiasedness and gains in efficiency

14.11 Conclusions

The unbiased estimation of status and trend parameters is obtained with a variety of design-based, model-assisted, and model-based approaches. Design-based estimation will be based on GRTS sampling theory, and analysis will employ tools available in the *spsurvey* R package. Nonresponse should be addressed by examining the underlying missingness mechanism and choosing the appropriate analysis approach. Trend analysis will incorporate the linear mixed model, but nonparametric approaches may also be applied to provide corroborating evidence of significant trend. When outcomes are zero-inflated, non-linear maximization approaches can be used with zero-inflated models to obtain estimates of trend for both the mean and the proportion of zeros observed. The methods outlined in this SOP represent a few possible approaches for status estimation and trend testing, but other approaches may be appropriate for the monitoring data and should be considered and applied by qualified personnel so that appropriate inference is made.

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Appendix: Simulated Dataset and R Code for Analysis

Simulated dataset for analysis examples

```
ShrubPctData <-
structure(list(Site = c(1, 1, 1, 1, 2, 2, 2, 2, 3, 3, 3, 3, 4,
4, 4, 4, 5, 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 8,
8, 8, 8, 9, 9, 9, 9, 9, 10, 10, 10, 10, 11, 11, 11, 11, 12, 12,
12, 12, 13, 13, 13, 13, 14, 14, 14, 14, 15, 15, 15, 15, 15, 16,
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130, 131, 131, 131, 131, 132, 132, 132, 132, 133, 133, 133, 133,
134, 134, 134, 134, 134, 135, 135, 135, 135, 135, 136, 136, 136,
136, 136, 136, 137, 137, 137, 137, 137, 137, 138, 138, 138, 138,
138, 139, 139, 139, 139, 140, 140, 140, 140, 141, 141, 141, 141,
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142, 142, 142, 142, 142, 142, 143, 143, 143, 143, 144, 144, 144,
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147, 147, 148, 148, 148, 148, 149, 149, 149, 149, 150, 150, 150,
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183, 183, 184, 184, 184, 184, 184, 185, 185, 185, 185, 186, 186,
186, 186, 186, 187, 187, 187, 187, 187, 187, 188, 188, 188, 188,
189, 189, 189, 189, 189, 190, 190, 190, 190, 191, 191, 191, 191,
191, 192, 192, 192, 192, 193, 193, 193, 193, 193, 194, 194, 194,
194, 194, 195, 195, 195, 195, 195, 196, 196, 196, 196, 197, 197,
```

Data omitted for brevity. Full file can be provided by MEDN Database Manager.

R code for MAR weighting class adjustment estimation

```
# Program: WCAdjSRS.fcn

# Input columns: variable of interest, weight, sample indicator (0 or
1),
# survey indicator (0 or 1), class variables


WCAdjSRS.fcn <- function(mat,alpha=0.05) {

mat<-data.frame(mat)
N <- sum(mat[,2])    # N = sum of all weights
n <- dim(mat)[1]     # n = sample size
col <- dim(mat)[2]       # Number of columns (variables of interest)
classes <- ClassesPS.fcn(mat,col) # Obtain matrix of unique classes

colclass <- dim(classes)[2] # Number of class variables
H <- dim(classes)[1]     # Number of distinct classes

# Combine classes with no responses
flag<-FALSE          # Have not yet obtained an adj class with mh>=5
for (i in 1:H) {

   classesi<- unlist(classes[i,])
   matH <- data.frame(GetMatHPS.fcn(classesi, mat))
   mh<-sum(matH[,4])
   nh<-dim(matH)[1]

if(!is.na(mh))   {
if(mh>=5) {last.large.group<- i; flag<-TRUE}
if(mh<5) {
matches<-as.numeric(rowSums(t(matrix(rep(classesi, n),colclass,n))==
mat[,5:(5+colclass-1)])==colclass)
matchnum<-sum(matches)
if(i==H) {if(flag==FALSE) last.large.group<-H
# Get classes for previous group – this may be from an even more
# previous group if the H-1 class has mh<5
newclass<- classes[last.large.group,]
matH<- (cbind(matH[,1:4], t(matrix(rep(unlist(newclass),
matchnum),colclass,matchnum))))
}

if(i<H) {
matH<- (cbind(matH[,1:4], t(matrix(rep(unlist(classes[i+1,]),
matchnum),colclass,matchnum))))}
names(matH)<-names(mat)
```

```
mat<- rbind(mat[!matches,], matH)
if(i==H) {
 if(flag==FALSE) last.large.group<-H
# Get classes for previous group – this may be from an even more
# previous group if the H-1 class has mh<5
newclass<- classes[last.large.group,]
matH<- (cbind(matH[,1:4], t(matrix(rep(unlist(newclass),
matchnum),colclass,matchnum))))}

if(i<H) {
matH<- (cbind(matH[,1:4], t(matrix(rep(unlist(classes[i+1,]),
matchnum),colclass,matchnum))))}
}
}
}
classes <- ClassesPS.fcn(mat,col)  # Obtain matrix of unique classes
colclass <- dim(classes)[2]    # Number of class variables
H <- dim(classes)[1]    # Number of distinct classes
#Initialize
phi <- Vh <- nh <-   Nhath <- mh <- nbarh <- mbarh <-  YbarH <- Yh <-
deltah <- rep(0,H)

# Mean response for surveyed units
Ybar <- sum(mat[mat[,4]==1,1])/sum(mat[,4])
 for (i in 1:H) {
    matH <- GetMatHPS.fcn(unlist(classes[i,]), mat)
    nh[i] <- sum(matH[,3])  # nh = all rows in class h
    mh[i] <- sum(matH[,4])  # mh = surveyed rows in class h
    phi[i] <- mh[i]/nh[i]   # Observed sampling rate of class h
    Nhath[i] <- N*nh[i]/n
    nbarh[i] <- n*Nhath[i]/N   # exp value of n in class h
    mbarh[i] <- nbarh[i]*phi[i]# exp value of m in class h
Vh[i] <- ifelse(mh[i]<2,0,var(matH[matH[,4]==1,1]))
deltah[i]<-(n-nh[i])/(mh[i]*(n-1))
# sample var
YbarH[i] <- ifelse(mh[i]==0,0,sum(matH[matH[,4]==1,1])/mh[i])
# mean of responses
Yh[i] <- sum(matH[matH[,4]==1,1])         # sum of responses
if(i==1) NewMat<-cbind(matH, mh[i]/ nh[i])
if(i>1) NewMat<-rbind(NewMat,cbind(matH, mh[i]/nh[i]))
 }
# print(cbind(Nhath, mh, Yh, Vh))
# Estimate of total
Y <- sum(N*nh*Yh/(n*mh))
# Var est: Sarndal, Swensson, Wretman p.582 eq 15.6.13-15
VarComp1<-N*(N-n)*(sum(nh*(1-deltah)*Vh)+((n/(n-1))*sum((YbarH-
(Y/N))^2)))/(n^2)
```

```
VarComp2<-((N/n)^2)*sum((nh^2)*(1-(mh/nh))*Vh/mh)


VarY <- VarComp1 + VarComp2
 answer <- c(Y, VarY, sqrt(VarY), Y-(qnorm(1-alpha/2)* sqrt(VarY)),
Y+(qnorm(1-alpha/2)* sqrt(VarY)))
names(answer) <- c("EstTotal", "Var", "SE", "CI Low", "CI High")
   return(round(answer,0))
}

ClassesPS.fcn <- function(mat,col)
{
# Data frame of poststratification adj variables
 classmat<-data.frame(mat[,seq(5,col)])
classes<-unique.data.frame(classmat)  # Table of unique levels of the
PS vars
 colclass<-dim(classes)[2]
 rowclass<-dim(classes)[1]
 if(colclass==1) classes<-matrix(sort(unlist(classes)),
length(unlist(classes)),1)
 if(colclass==2) classes<-classes[order(classes[,1],classes[,2]),]
 if(colclass==3) classes<-
classes[order(classes[,1],classes[,2],classes[,3]),]
 if(colclass==4) classes<-
classes[order(classes[,1],classes[,2],classes[,3], classes[,4]),]
 if(colclass==5) classes<-
classes[order(classes[,1],classes[,2],classes[,3],
classes[,4],classes[,5]),]
 if(colclass==6) classes<-
classes[order(classes[,1],classes[,2],classes[,3], classes[,4],
classes[,5], classes[,6]),]
return(classes)
}

GetMatHPS.fcn <- function(classi, mat)
{
classno<-length(classi)

if (classno==1) matH<-mat[mat[,5]==classi[1],]
if (classno==2) matH<-mat[(mat[,5]==classi[1])&(mat[,6]==classi[2]),]

if (classno==3) matH<-
mat[(mat[,5]==classi[1])&(mat[,6]==classi[2])&(mat[,7]==classi[3]),]
if (classno==4) matH<-
mat[(mat[,5]==classi[1])&(mat[,6]==classi[2])&(mat[,7]==classi[3])&(mat
[,8]==classi[4]),]
```

```
if (classno==5) matH<-
mat[(mat[,5]==classi[1])&(mat[,6]==classi[2])&(mat[,7]==classi[3])&(mat
[,8]==classi[4])&(mat[,9]==classi[5]),]
if (classno==6) matH<-
mat[(mat[,5]==classi[1])&(mat[,6]==classi[2])&(mat[,7]==classi[3])&(mat
[,8]==classi[4])&(mat[,9]==classi[5])&(mat[,10]==classi[6]),]

return(matH)
}
```

SOP 15: Obtaining Permits (SAMO)

Version 1.0 (September 2016)

15.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 15 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

15.2 Overview

This SOP will describe the steps in acquiring permits, including the location of pertinent documents, outlining of the content of the application/renewal, and annual report organization. It also provides a list of the current permittees' and their contact information, and an example of an indemnification letter and insurance coverage statement letter.

15.3 Permit Procedures

Where permit related documents and permit information can be found

Permit information can be found in

> H:\Division\psrm\Plant_Ecology\Inventory and Monitoring_Terrestrial Veg & Weed Monitoring\Permits

Within this folder are separate folders for each organization that issued a permit or granted permission for the long-term vegetation monitoring project. Within each organization folder, there are MS Word documents of submitted permit requests (as well as annual reports and renewal requests if required), PDFs of issued permits, information about submitting annual reports and renewal requests, such as contact information and when reports are due and other permit related documents.

Application/Renewal of permits

Permit application

Applications can be found in that organization's folder and/or on that organization's website. Unless changes have been made in what is to be done, the permit application should be the same from year to year and need only minor revisions.

Explanation of the project

The application form only allows a brief explanation of what the permit is being requested for. Therefore, it is important to include a lengthier, more detailed explanation with the permit application.

Indemnification letter

Many landowners require a hold harmless agreement, waiver or release, or statement of insurance to protect them in the event of accidents. However, the federal government cannot by law indemnify an individual, organization, or agency. Instead, NPS will offer, as a substitute, a letter (Figures 15.1, 15.2) stating that all NPS employees and officially recognized volunteers of the NPS are covered by the Federal Tort Claims Act (PL 89-506; 80 Stat. 306). This act provides for property losses, property damage, personal injuries, and deaths claimed to have resulted from the negligent or wrongful acts or omissions of employees and volunteers in the course of their duties. In addition, claims for compensation for injury or death sustained by employees or volunteers of the government are covered under the Federal Employees' Compensation Act. Finally, all employees and volunteers are covered under the Office of Workers Compensation Program, to cover potential liabilities for personal injury or death.

The NPS shall cooperate in the submission of claims pursuant to the Federal Tort Claims Act against the United States for losses, damages, injuries and deaths arising out of the project. The NPS will require adequate liability insurance and workers compensation coverage to be obtained, carried, and maintained by its agents, contractors, and subcontractors who perform work or conduct activities on the property. The NPS will require any of its volunteers doing any tasks on the property to sign a volunteer form that makes the volunteer a federal employee for the purpose of being covered by the Federal Tort Claims Act (PL 89-506; 80 Stat 306) and Federal Workers Compensation Act (16 U.S.C.; 742 (c) (3)).

The indemnification letter must be printed on agency letterhead and signed by the park superintendent or deputy superintendent.

Permit renewal

Some permits will need to be renewed annually while others will not need to be renewed for several years. Those that need to be renewed annually will need to have an annual (progress) report included with the permit renewal. Those that are renewed after several years will need to have the latest report included. If the permit is not renewed, a final report will need to be submitted.

The renewal permit has several parts—the permit application, explanation of the project, annual/progress report, and necessary attachments. Look in the particular organization's folder to see what renewals have included in the past and include those parts, updated as necessary.

Annual/progress report (or final report)

This is a report summarizing the activities done and data collected for the year(s) the permit was granted (see annual report section below).

Annual report organization

Annual reports are organized like scientific articles, separated into sections such as the purpose/objectives of the study, methodology, results, etc. Look at the previously submitted annual reports and use these as a guideline. Some sections will need little or no revision, while others will need extensive revision. Also, read the original permit request to be sure all activities listed in the request are discussed in the annual report.

Note that you are writing the report for the year that just passed. If the report is due 12/31/2012 or 1/31/13, write only about activities done in 2011. If nothing was done that year you will need to say so and why.

Purpose/objectives of the study

This is a summary statement of what is hoped will be accomplished if the permit is granted. This section should not need to be changed unless the objectives or purpose of the study changes.

Methodology

This section explains what methods will be used to conduct the study and is separated into two subsections: data collection and data analysis. If new locations were added, you will need to revise the data collection and/or the results/conclusions section to include the information for the new locations. For the data analysis section, if data have been collected for two or more years and no analysis has been done, you will need to explain why.

Changes in methodology from the permit request and why changes were made

Discuss any changes in methodology that were made from what was proposed in the original permit request and the reason why those changes were made. Also, any requested activities included in the permit that were not done in the year the report covers and the reasons why they were not done will need to be stated. Information on the methodology and purpose for monitoring can be found in

H:\Division\psrm\Plant_Ecology\Inventory and Monitoring_Terrestrial Veg & Weed Monitoring\Protocol

Preliminary results or conclusions

Summarize the data collected that year and state any conclusion that can be made. Consult park database manager for the current location of the data.

Attachments

Attachments may include a map of the area where monitoring is to occur, proof of insurance, etc.

List of permittees and their contact information

California Department of Fish and Game

Submit annual reports to CDFG by October 1. See report or copies of reports for what to include. Reports or other correspondence can be mailed or e-mailed as listed below.

Send Original to:
Branch Chief
Department of Fish and Game
Habitat Conservation Planning Branch
1416 8th Street, 12th Floor
Sacramento, CA 95814
Attn: Mary Ann Showers
mshowers@dfg.ca.gov
(916) 651-6594

Send copy to:
Ed Pert
Regional Manager
South Coast Region
4949 Viewridge Avenue
San Diego, CA 92123
Attn: Mary Meyer
mmeyer@dfg.ca.gov

California State Parks

Annually (permit expires the end of December each year) renew permit from California State Parks. Include annual report of work from the year prior with the renewal.

Send to:
California State Parks
1925 Las Virgenes Road
Calabasas, CA 91302

Attn: Suzanne Goode (sgood@parks.ca.gov)
(818) 880-0364

Ventura County Watershed Protection District

Annually (permit expires at the end of July each year) renew permit from Ventura County Watershed Protection District and include copies of any reports and/or studies. Visit their website for blank permit requests:

(http://portal.countyofventura.org/portal/page/portal/PUBLIC_WORKS/Watershed_Protection_District/About_Us/VCWPD_Divisions/Planning_and_Regulatory/Permits).

Send to:

Ventura County Watershed Protection District
800 South Victoria Avenue
Ventura, CA 93009
(805) 654-2001

Mountains Recreation and Conservation Authority

Submit to MRCA an update memorandum by 12/31 each year and 3 copies of any final publication or report no later than 3 months after completion/publication. (At minimum, send all reports relating to their property. They would appreciate receiving complete report.)

Note: Fernando Gomez should be contacted at least 48 hours before work is started each season: fernando.gomez@mrca.ca.gov (310) 858-7272 ex. 141

Send report to:

MRCA
Attn: Judi Tamasi
judi.tamasi@mrca.ca.gov
(310) 589-3230 ex. 1221
Or call: Paul Edelman (310) 589-3230 ex. 128

Conejo Open Space Conservation Agency

Submit a copy of the report annually.

Send to:

COSCA
2100 East Thousand Oaks Blvd.
Thousand Oaks, CA 91320
Attn: Shelly Austin
SAustin@toaks.org
(805) 449-2339

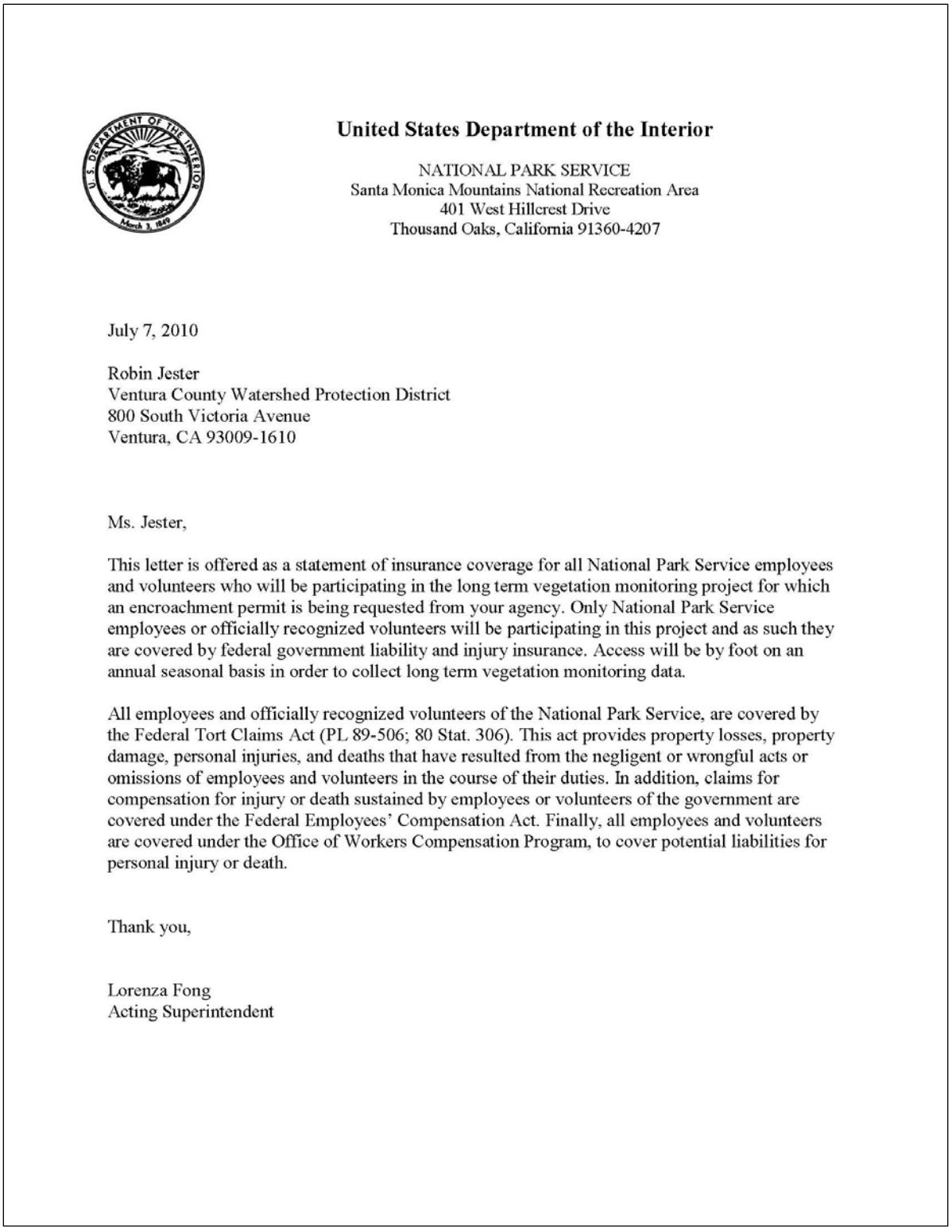
Mountains Restoration Trust

Submit a copy of the report annually.

Send to:

Mountains Restoration Trust

3815 Old Topanga Canyon Road
Calabasas, CA 91302
Attn: Debbie Bruschaber
dbruschaber@mountainstrust.org
98189 591-1701 ex. 203



United States Department of the Interior

NATIONAL PARK SERVICE
Santa Monica Mountains National Recreation Area
401 West Hillcrest Drive
Thousand Oaks, California 91360-4207

July 7, 2010

Robin Jester
Ventura County Watershed Protection District
800 South Victoria Avenue
Ventura, CA 93009-1610

Ms. Jester,

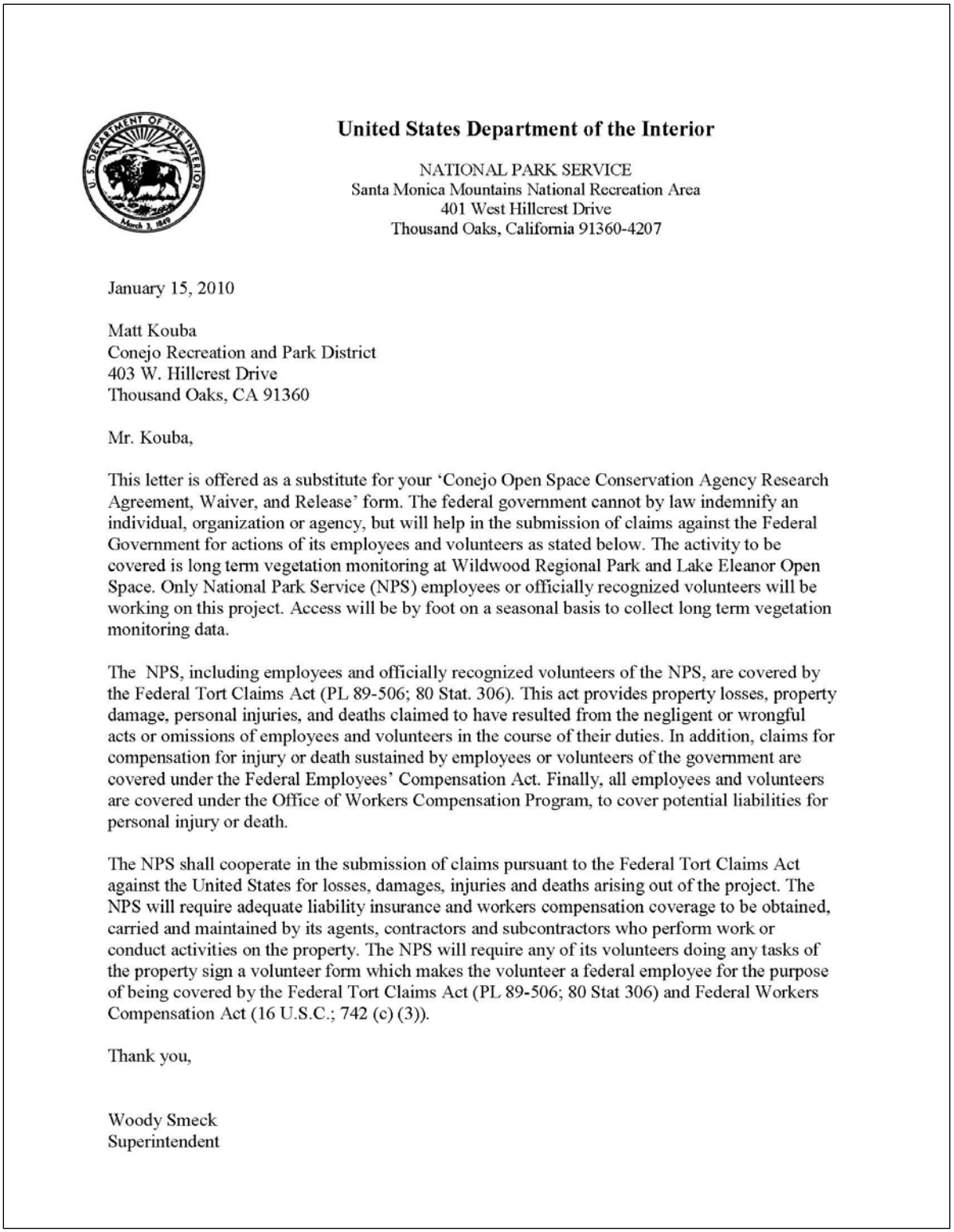
This letter is offered as a statement of insurance coverage for all National Park Service employees and volunteers who will be participating in the long term vegetation monitoring project for which an encroachment permit is being requested from your agency. Only National Park Service employees or officially recognized volunteers will be participating in this project and as such they are covered by federal government liability and injury insurance. Access will be by foot on an annual seasonal basis in order to collect long term vegetation monitoring data.

All employees and officially recognized volunteers of the National Park Service, are covered by the Federal Tort Claims Act (PL 89-506; 80 Stat. 306). This act provides property losses, property damage, personal injuries, and deaths that have resulted from the negligent or wrongful acts or omissions of employees and volunteers in the course of their duties. In addition, claims for compensation for injury or death sustained by employees or volunteers of the government are covered under the Federal Employees' Compensation Act. Finally, all employees and volunteers are covered under the Office of Workers Compensation Program, to cover potential liabilities for personal injury or death.

Thank you,

Lorenza Fong
Acting Superintendent

Figure 15.1. Example of an indemnification and insurance coverage statement letter.



United States Department of the Interior

NATIONAL PARK SERVICE
Santa Monica Mountains National Recreation Area
401 West Hillcrest Drive
Thousand Oaks, California 91360-4207

January 15, 2010

Matt Kouba
Conejo Recreation and Park District
403 W. Hillcrest Drive
Thousand Oaks, CA 91360

Mr. Kouba,

This letter is offered as a substitute for your 'Conejo Open Space Conservation Agency Research Agreement, Waiver, and Release' form. The federal government cannot by law indemnify an individual, organization or agency, but will help in the submission of claims against the Federal Government for actions of its employees and volunteers as stated below. The activity to be covered is long term vegetation monitoring at Wildwood Regional Park and Lake Eleanor Open Space. Only National Park Service (NPS) employees or officially recognized volunteers will be working on this project. Access will be by foot on a seasonal basis to collect long term vegetation monitoring data.

The NPS, including employees and officially recognized volunteers of the NPS, are covered by the Federal Tort Claims Act (PL 89-506; 80 Stat. 306). This act provides property losses, property damage, personal injuries, and deaths claimed to have resulted from the negligent or wrongful acts or omissions of employees and volunteers in the course of their duties. In addition, claims for compensation for injury or death sustained by employees or volunteers of the government are covered under the Federal Employees' Compensation Act. Finally, all employees and volunteers are covered under the Office of Workers Compensation Program, to cover potential liabilities for personal injury or death.

The NPS shall cooperate in the submission of claims pursuant to the Federal Tort Claims Act against the United States for losses, damages, injuries and deaths arising out of the project. The NPS will require adequate liability insurance and workers compensation coverage to be obtained, carried and maintained by its agents, contractors and subcontractors who perform work or conduct activities on the property. The NPS will require any of its volunteers doing any tasks of the property sign a volunteer form which makes the volunteer a federal employee for the purpose of being covered by the Federal Tort Claims Act (PL 89-506; 80 Stat 306) and Federal Workers Compensation Act (16 U.S.C.; 742 (c) (3)).

Thank you,

Woody Smeck
Superintendent

Figure 15.2. An example of a longer version of an indemnification and insurance coverage statement letter required by some agencies.

SOP 16: Revising the Protocol

Version 1.0 (September 2016)

16.1 Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to SOP 16 only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to this SOP since September 2016:

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedures may undergo modifications after monitoring is implemented. For the most current version, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

16.2 Overview

This SOP explains how to make and track changes to the protocol narrative and related SOPs.

Following these guidelines ensures that previous data collection and processing procedures are documented and retained for use and interpretation of historical datasets. Similarly, clear articulation of new methods is crucial to credible interpretation of data acquired since the implementation of changes.

Project staff should refer to this SOP when any changes to an approved protocol document are necessary. They must ensure that the proper level of review is conducted and that documentation standards are followed. They should also understand protocol versioning methods to ensure that the active version of a protocol document is revised and make the revisions in a timely manner in order to minimize disruptions to project operations.

16.3 Protocol Review

This protocol attempts to incorporate the soundest methodologies for collecting, managing, analyzing, and reporting terrestrial vegetation and soils data. However, the protocol will be updated as necessary when new technologies, methods, or equipment are adopted. Changes should first be evaluated in terms of cost and benefit, then subjected to appropriate review, and if approved, implemented in a timely manner.

All modifications should be reviewed for clarity and technical soundness. Small changes to existing documents, such as formatting, simple clarification of existing content, minor changes to the monitoring schedule or budget, or general updates to data management SOPs, are reviewed in-house by each park's staff and cooperators in consultation with the Program Manager. More substantial changes that are significant in scope and impact, such as those made to the sampling design, data collection methods, or analysis techniques, generally require an outside review coordinated by the MEDN Program Manager or NPS Pacific West Regional Office, using reviewers familiar with terrestrial vegetation monitoring and data analysis.

16.4 Document Life Cycle

Protocol documents are maintained as separate MS Word files for each component (e.g., narrative, SOP). During its life cycle, each document can be classified into one of six life cycle stages:

1. **Draft documents:** Documents that have been drafted or revised but have not yet been reviewed and approved.
2. **Review documents:** Draft documents distributed for peer or administrative review.
3. **Active documents:** Documents that have been reviewed and approved and are currently implemented for active monitoring projects.
4. **Inactive documents:** Older versions of approved protocol components that are no longer in active implementation.
5. **Archived documents:** Comprehensive set of active protocol documents, published NPS Natural Resource Report (NRR) series versions of the complete protocol, and inactive documents (see

above). These are stored on the Z:\ drive as read-only and provide the history of protocol components through time.

6. **Distribution copies:** .pdf versions of approved protocol components for posting to web sites or otherwise sharing outside the NPS.

16.5 Revision Procedures

The Program Leads, working with the Network Program Manager, are primarily responsible for protocol revisions, including making the actual edits and ensuring document review at the appropriate level.

Be aware that a change in one document may trigger changes in other documents. For example, a change in the protocol narrative may require edits in several SOPs, or renumbering an SOP may require changing references to that SOP in other protocol documents. Remember that appendices may also require updating.

1. **Discuss changes.** The Program Lead(s), Program Manager, and Data Manager should evaluate proposed modifications prior to revising any documents. Consulting with the data management staff is particularly important prior to making changes to ensure that dataset integrity and continuity will be maintained. To avoid interference with project operations, advance notice of changes is also important, because they may lead to revisions to the database structure or functions that require a significant amount of time to complete. Staff should agree on who will make the changes and establish a timeline for completion.
2. **Revise document.**
    a. Create the draft of the appropriate protocol document in MS Word. Add "_Draft" to the base file name of the protocol document.
    b. Turn on the Track Changes feature in MS Word prior to making any edits.
    c. Add " – Draft" to the document header and "(Draft)" after the version number in the title section.
    d. If desired, you may also add "DRAFT" to display as a diagonally printed watermark on each page.
    e. Make the agreed-upon revisions.
3. **Track revision history.** Use the Change History Log to document edits in only the document that is modified. Record the previous version number, date of revision, author of revision, a brief description of the changes, paragraphs and pages where changes were made, the reason(s) for the changes, and the new version number.
4. **Circulate for review.**
    a. For minor changes, circulate the revised draft among network staff and cooperators.
    b. If changes are substantial enough to merit formal peer review, create the review copy of the document by replacing "_Draft" with "_Review" in the file name**.**
    c. Submit the document for peer review through the Network Program Manager or Regional I&M Program Manager. The level of review required and the decision as to whether to

republish the documents should be decided in consultation with the Regional I&M Program Manager.

5. **Finalize document.** After approval and final changes:
   a. Ensure that version numbers, file names, etc., are updated appropriately throughout the protocol documents.
   b. Remove "_Draft" or "_Review" from the file name to designate it as the active document. Remove the "DRAFT" watermark, if one was used.
   c. Remove all editing markup and comments for the final (Active) version.
   d. Update the protocol version to the new version number in the project database.
   e. Inform the Data Manager of which protocol documents have been updated.
6. **Create distribution copies.** Data management staff are responsible for document distribution and archiving (Step 7).
   a. Create a pdf version of the revised MS Word document for posting to the internet and sharing with others. This pdf should have the same name as the MS Word file.
   b. Replace the previous distribution copy on the park monitoring web page with the revised pdf.
   c. Notify known users of the former version of the revised document that a new version is now available.
7. **Archive document.**
   a. Place a copy of each revised MS Word document (the new Active document) in

      H:\DIVISION\psrm\!Inventory_and_Monitoring\Vital_Signs\Terrestrial_Vegetation\Protocol.
   b. Place all pdf versions of documents in the Distribution_Copies subfolder of

      H:\DIVISION\psrm\!Inventory_and_Monitoring\Vital_Signs\Terrestrial_Vegetation\Protocol
   c. If the protocol has been republished, catalog the NRR number in the online IRMA (Integrated Resource Management Applications) portal and upload the new pdf.
   d. Send a copy of published and republished protocols to the Regional I&M Program Manager, and place a printed copy of the NRR in each park's reference library.

Appendix A: Terrestrial Vegetation Monitoring Forms and Datasheets

Version 1.0 (September 2016)

Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to Appendix A only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to these monitoring forms and datasheets since September 2016:

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedure data forms and sheets may undergo modifications after monitoring is implemented. For the most current versions, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

Vegetation Monitoring Location & Contact Information

PROVIDE COPIES TO MONITORS AND TAKE ONE WITH YOU INTO THE FIELD

DATE:	
Team 1 **Personnel (include cell phone numbers):** **HQ monitor 1* (Name & Phone number):** **HQ monitor 2* (Name & Phone number):** **Vehicle:** **InReach ID:** **Departure time:** **Estimated time back at HQ:**	**Team 2**
***Monitor will not leave for day without determining field crew has returned & will provide assistance if requested**	
Site 1 ID: **UTM:** **Park or Location Name:** **Proposed Access Route (include parking location):** **Estimated completion time Site 1:**	
Site 2 ID: **UTM:** **Park or Location Name:** **Proposed Access Route (include parking location):** **Estimated completion time Site 2:**	

https://explore.delorme.com/ User: **jtiszler@nps.gov** PW: **I&Mvegmonitor** **InReachGE.kml PW:SAMO** (UN:blank)	Cell Phones: **Veg iPhone:** 805-338-6297, **Veg flip phone:** 805-338-6276 Spare Vehicle Key Locker Combo: 854

To watch a VegMon team's (user's) position on the Delorme Map:

- Click the "Map" tab; click "User List" in upper left to turn on the user sidebar.
- Click on your user to highlight them (make sure the ID checkbox it ticked.)
- Click the "Center" bulls-eye in the user sidebar to move the map to their current location (Note: if this seems to have stopped working make sure your user is still highlighted in the sidebar.)
- Click the "Track" bulls-eye in the user sidebar to enable tracking. Probably set to "10 minutes"
- It seems the auto-refresh is not very reliable. Try clicking the browser refresh in the address bar if it seems not to be working. After doing this you will probably have to re-select your user in the sidebar.
- Click "Map Filters" in upper left to turn on the filter toolbar
- Set the "Date & Time Range:" filter dropdown to "Last 24 Hours"
- If desired, select the desired map type: Topo / Aerial / Road
- The "+" sign next to the current location can be clicked to expand the track.

August 22, 2016

Emergency and Supervisory/Assistance Contacts **Last updated August 2016**

Emergency Contacts: **Contact in the event of serious injury, incapacitation, or imminent threat**			
Name	**Phone**	**Radio Call**	**Instructions**
NPS (Angeles) Dispatch	661.723.3620	"Angeles Dispatch"	"Angeles dispatch, this is Resource/VIP7..."
Police Rescue	911		
SAMO Rangers		"Any LE"	"Any available LE near (*your location*), this is Resource/VIP7..."
State Parks Dispatch	951.443.2964		Secondary Contact: use when on State Parks land
MRCA Dispatch	310.456.7049		Secondary Contact: use when on MRCA/SMMC land
Other Emergency Contacts			
inReach GPS	USE ONLY IF OTHER EMRERGENCY CONTACTS UNAVAILABLE OR IF INSTRUCTED TO DO SO BY EMERGENCY PERSONNEL -Slide button to the left of "SOS" button to the left (unlocks "SOS"); press "SOS" button		

Stay calm, try to speak clearly. Be prepared to give precise information on both nature of the problem and your location.

Supervisory / Assistance Contacts: **Contact for non-emergency instructions / assistance***						
Name	**Office Phone**	**Cell Phone**	**Home Phone**	**Radio Call**	**Work Hours**	**Available?**
John Tiszler	805.370.2340			Resource 73	M-Th: 6am-4:30pm	
Marti Witter	805.370.2333			Resource 72	M-Th: 6am-4:30pm	
Irina Irvine	805.370.2370			Resource 71	T-Fr: 6am-4:30pm	
Tarja Sagar	805.370.2334			Resource 726	M-Th: 6am-4:30pm	
Mark Mendelsohn	805.370.2360			Resource 720	M-Fr: 7:30am-4 pm	
Other Supervisory Contacts						
Gillette Ranch Visitor Ctr	805.370.2301	805.370.2301		"Visitor Center"	M-Su: 9am-5pm	
NPS (Angeles) Dispatch	661.723.3620	--	--	"Angeles"	7 days; 24 hrs /dy	
SAMO Rangers	--	--	--	"Any LE"	Variable	

*Monitors can also provide assistance

Medical Assistance	**Location**	**Phone**	Address
URGENT CARE			
Thousand Oaks Urgent Care	CONEJO VALLEY - WEST	805.495.6866	620 E. Janss Rd, Thousand Oaks
Westlake Village Urgent Care	CONEJO VALLEY - EAST	805.379.9125	1220 La Venta Dr. #101
Woodland Hills Urgent Care	SAN FERNANDO VAL - WEST	818.888.7167	5995 Topanga Canyon Blvd, Woodland Hills
Family Urgent Care, Encino	SAN FERNANDO VAL - EAST	818.996.6319	16661 Ventura Blvd, Encino
Studio City Urgent Care	S.F. VALLEY EAST of 405	818.761.1800	12660 Riverside Dr., Ste 110,Valley Village
Channel Islands Urgent Care	COAST - WEST	805.484.7448	2103 Pickwick Dr., Camarillo
Malibu Urgent Care	COAST –MALIBU /CENTRAL	310.456.7551	23656 Pacific Coast Highway, Malibu
UCLA Brentwood Urgent Care	PACIFIC PALISADES to 405	310.208.7777	11980 San Vicente Blvd., Suite 102, L.A.
HOSPITAL			
Columbia Los Robles Hospital	CONEJO VALLEY	805.370.4521	215 W Janss Rd, Thousand Oaks
Kaiser Permanente de Soto Ave	WEST SAN FERNANDO VAL	818.719.2000	5601 de Soto Ave, Woodland Hills
Encino Hospital Medical Ctr.	EAST SAN FERNANDO VAL	818.995.5000	16237 Ventura Blvd, Los Angeles
UCLA Med. Ctr. Santa Monica	CENTRAL – EAST COAST	424.259.8400	1250 16th Street, Santa Monica
Saint John's Pleasant Valley Hos.	WEST COAST / INLAND	805.389.5800	2309 Antonio Ave, Camarillo

If possible, check with supervisor and/or return to HQ before going to Urgent Care *Try to avoid paying provider or giving your insurance card.*
When at Urgent Care or Hospital, tell them that this is a **Federal (or State) Workers Compensation** case, give contact info below.
National Park Service, 401 W. Hillcrest Dr, Thousand Oaks 91360 or **Mountains Restoration Trust**, 3815 Old Topanga Canyon Rd, Calabasas 91302
Workers Comp/Injury contacts: **NPS** -Felicia Nickelberry 805.370.2320 or Angelina Long 702.293.8851 or **MRT**- Debbie Sharpton 818.591.1701x205

*Database Code (office use only)*_____

TRANSECT ESTABLISHMENT/REVISIT

Revised 8/18/2016

DIRECTIONS TO TRANSECT

Transect Number_____ Date_____Surveyors_____

General Location_____ Park Unit_____

Trail/Road Name_____

Parking spot:
UTME_____ m UTMN_____ m UTM Zone 11 GPS datum: NAD83 or _____
Directions along trail (include notes on prominent landmarks):

Point of leaving trail:
UTME_____ m UTMN_____ m UTM Zone 11 GPS datum: NAD83 or _____
Directions in the backcountry (include notes on prominent landmarks/UTMs):

TRANSECT LOCATION

GPS Point name_____ GPS Unit_____ GPS datum: NAD83 or _____ UTM Zone 11

Coordinates for Transect beginning (A): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

Coordinates for Transect end (B): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

GPS Accuracy_____cm/m/in/ft Bearing of Transect from A → B _____°

Fire Plots Only
Coordinates for "upper left" corner (C): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

Coordinates for "upper right" corner (D): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

ENVIRONMENTAL DESCRIPTION

Elevation _____m/ft Slope steepness: 0°___ 1-5° ____ 5-25°_____ > 25°____
Slope exposure: N___ NE___ E___ SE___ S___ SW___ W___ NW___ Flat___ Variable___

Topography: flat____ concave_____ convex_____ undulating_____
bottom_____ lower_____ mid_____ upper_____ top_____

Physiognomy: woodland___ shrubland___ dwarf shrubland___ herbaceous ___ nonvascular___ sparse veg___
General Stand Height: waist___ chest___ head___ overhead___ General Veg Density: open___ closed___
Potential Hazards: high poison-oak cover___ loose soil/rock___ other_____

Data entered by_____ **Date**_____

Check 1 by_____ **Check 2 by**_____

*Database Code (office use only)*_____ **Page 2 of 2**

SAMPLING EVENT METADATA
v4 Aug 2016

Fire Event:___ Year:___ Name:_____

Plot/Transect:_____ Date:_____ Crew:_____

1. Overall state of vegetation (check up to two dominant phenophases)

HERBACEOUS: sprouting__ bolting__ flowering__ seeding__ senescing__ dead__

WOODY: basal sprouting__new leaves___stem growth___flowering__ seeding__ senescing__ dead__

2. Effect of sampling on site (disturbance level: **L**ow, **M**edium, **H**igh)

VEGETATION: inside 1m belt____ inside 10m belt____ 5m below transect____ 5m outside elsewhere____

SOIL: inside 1m belt____ inside 10m belt____ 5m below transect____ 5m outside elsewhere____

3. Plants of note in immediate vicinity (list). Photograph with GPS camera if possible:

4. Plants of note potentially resulting from previous sampling disturbance (list):

FOR YEAR 02 AND AFTER, ATTACH SCANNED DATA SHEETS FROM ORIGINAL TRANSECT ESTABLISHMENT

NOTES_____

Data entered by_____ **Date**_____

Check 1 by_____ **Check 2 by**_____

MEDN Terrestrial Vegetation Monitoring Program

Page 1

30-m LINE-POINT TRANSECT

(August 2016)

For Fire Plots Only:

Event _____ Year _____

Park/Island _____ **Transect #** _____ **Date** ____/____/_____

Species ID by _____ **Photos taken** _____

Data Recorder _____

PNT	L (cm)	HT (cm)	SUBSTR	lowest SP 1	SP 2	SP 3	SP 4	SP 5	highest SP 6
1	30								
2	60								
3	90								
4	120								
5	150								
6	180								
7	210								
8	240								
9	270								
10	300								
11	330								
12	360								
13	390								
14	420								
15	450								
16	480								
17	510								
18	540								
19	570								
20	600								
21	630								
22	660								
23	690								
24	720								
25	750								
26	780								
27	810								
28	840								
29	870								
30	900								
31	930								
32	960								
33	990								
34	1020								
35	1050								
36	1080								
37	1110								
38	1140								
39	1170								
40	1200								
41	1230								
42	1260								
43	1290								
44	1320								
45	1350								
46	1380								
47	1410								
48	1440								
49	1470								
50	1500								

Dieback codes: DP (spec code) = dead plant; DB (spec code) = dead branch on live plant

Record highest height of live and dead hits: 50(20) = live and dead; 50 = live only; (20) = dead only

PNT	L (cm)	HT (cm)	SUBSTR	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6
51	1530								
52	1560								
53	1590								
54	1620								
55	1650								
56	1680								
57	1710								
58	1740								
59	1770								
60	1800								
61	1830								
62	1860								
63	1890								
64	1920								
65	1950								
66	1980								
67	2010								
68	2040								
69	2070								
70	2100								
71	2130								
72	2160								
73	2190								
74	2220								
75	2250								
76	2280								
77	2310								
78	2340								
79	2370								
80	2400								
81	2430								
82	2460								
83	2490								
84	2520								
85	2550								
86	2580								
87	2610								
88	2640								
89	2670								
90	2700								
91	2730								
92	2760								
93	2790								
94	2820								
95	2850								
96	2880								
97	2910								
98	2940								
99	2970								
100	3000								

Comments _____

Dieback codes: DP (spec code) = dead plant; DB (spec code) = dead branch on live plant

Record highest height of live and dead hits: 50(20) = live and dead; 50 = live only; (20) = dead only

Entered by: _____ Entered date: _____ Validation by: _____ Validation date: _____

Shrub Density 30m belt transect in 1m x 5m subplots (Aug 2016) **PRINT ONE SIDED Page ___ of ___**

Transect:_____ Date:_____ Recorders:_____ Fire Only: Event___ Year___

Species Code: _____

Class	0-5	5-10	10-15	15-20	20-25	25-30
Seedling (new this year)						
Juvenile						
Adult						
Dead Adult						
Resprout						
Fire Only Classes						
Seedling (older than current year)						
Dead Seedling						
Dead Resprout						

Species Code: _____

Class	0-5	5-10	10-15	15-20	20-25	25-30
Seedling (new this year)						
Juvenile						
Adult						
Dead Adult						
Resprout						
Fire Only Classes						
Seedling (older than current year)						
Dead Seedling						
Dead Resprout						

Species Code: _____

Class	0-5	5-10	10-15	15-20	20-25	25-30
Seedling (new this year)						
Juvenile						
Adult						
Dead Adult						
Resprout						
Fire Only Classes						
Seedling (older than current year)						
Dead Seedling						
Dead Resprout						

Terrestrial Vegetation Species Richness (1m x 30m belt)

(August 2016)

Transect #_____________

Fire Only: Event _____ Year _____

Date _____/_____/_________

Crew ____________________

Outside category = ***5m*** *on either side of tape*

Species	0-1	1-5	5-6	6-10	10-11	11-15	15-16	16-20	20-21	21-25	25-26	26-30	Outside

For measurement of richness, a species is counted if any part of the plant overhangs the belt plot. The plant does not have to be rooted in the plot (unlike the shrub density protocol which counts only plants rooted within the plot). Counting the overhanging plants into the plot will assure that vines, such as wild cucumber and morning glory, are included in the richness measure. Species are recorded in 1x1 m^2 subplots nested in 1x5 m^2 segments along the 30m belt transect; i.e., record a species only once within a given 1 x 5m belt segment. For example, if a species occurs in the 5-6 m subplot, it is counted in that subplot, but not within the 6-10m subplot.

Terrestrial Vegetation Species Richness (1m x 30m belt)

Transect #______________ Date _____/______/__________

Species	0-1	1-5	5-6	6-10	10-11	11-15	15-16	16-20	20-21	21-25	25-26	26-30	Outside

Notes: ____

____

____

MEDN Terrestrial Vegetation Monitoring Program

Page _____ of _____

TREE MONITORING – 10x30m Belt Transect

(August 2016)

Date _____ **Park/Island** _____ **Transect #** _____ **Recorders** _____

Notes _____ _____

_____ _____

SPECIES CODE: _____

	# of Individuals		
Seedling			
Sapling/Juvenile			
Resprouts			
Dead Plants (s / j / a)		**Basal area (BA) / trunk**	**Relative dominance**
Live Tree[1] (dbh) 0 = dead trunk			

SPECIES CODE: _____

	# of Individuals		
Seedling			
Sapling/Juvenile			
Resprouts			
Dead Plants (s / j / a)		**Basal area (BA) / trunk**	**Relative dominance**
Live Tree[1] (dbh) 0 = dead trunk			

SPECIES CODE: _____

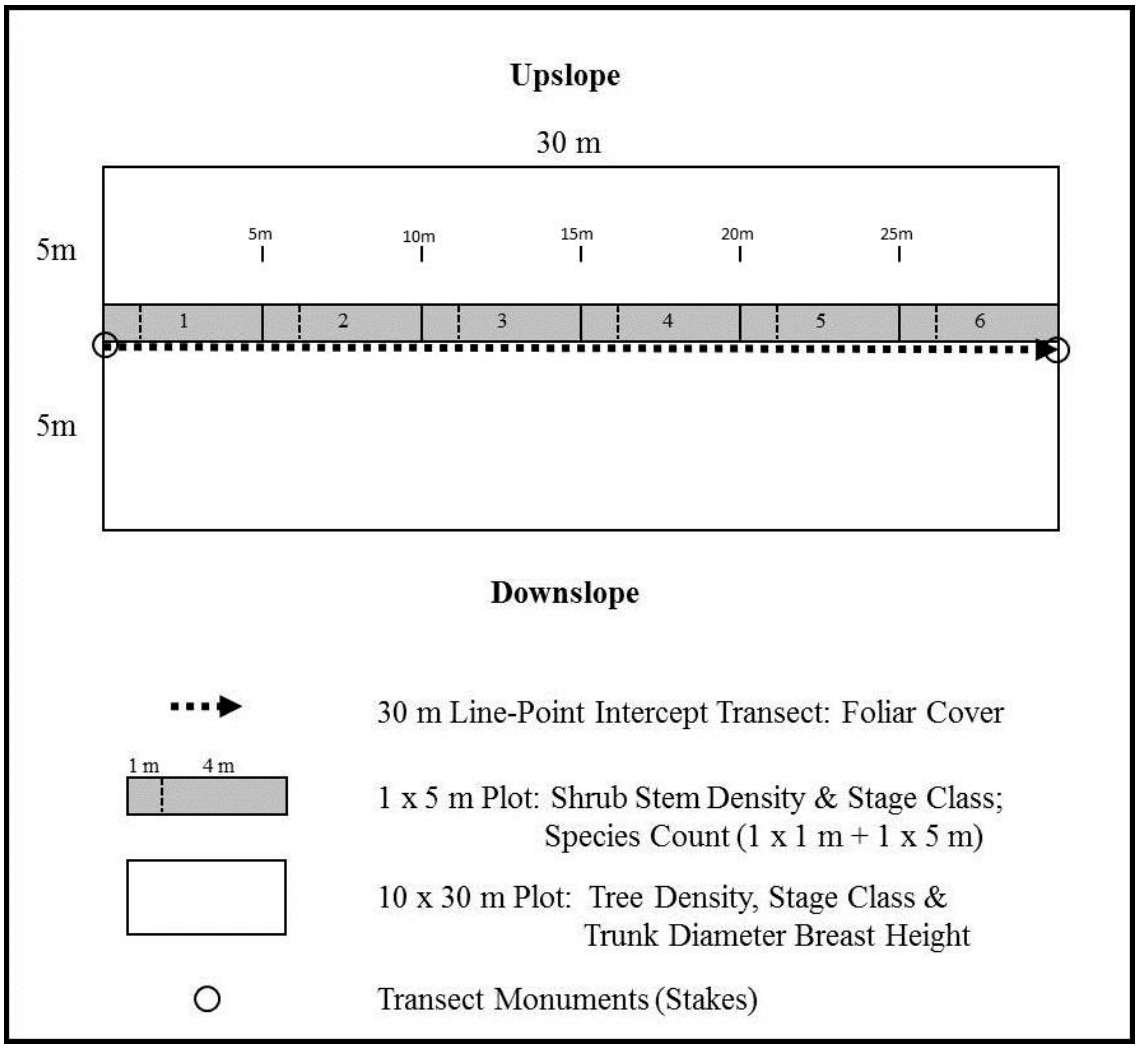
	# of Individuals		
Seedling			
Sapling/Juvenile			
Resprouts			
Dead Plants (s / j / a)		**Basal area (BA) / trunk**	**Relative dominance**
Live Tree[1] (dbh) 0 = dead trunk			

[1]A tree with any living tissue.

Entered by: _____ Entered date: _____ Validation by: _____ Validation date: _____

DIAGRAM OF VEGETATION MONITORING PLOT

June 2015



Voucher Specimen Field Documentation Form

Complete this form for each voucher specimen or photograph acquired during field work. Fill in as much of the information as you can; the information will be entered into the NPSpecies online database to create a voucher record documenting the presence of this species in the park.

Scientific Name: _____

Sensitivity Level: Federal ___ State ___ NPS Only ___

SAMO Collection ID: _____

Date Voucher Collected (mm/dd/yyyy): _____

Time Voucher Collected (24-hour clock, hh:mm): _____

Voucher Type: Complete ___ Specimen ___ Photograph ___

Part of specimen (explain below) ____ Other (explain below) ___

Voucher Type Details: _____

_____

_____

Collector (full name): _____

Habitat Description: _____

_____

_____

_____

Estimated Elevation: _____ feet _____ meters

Repository Specimen ID: _____

Specimen Steward/Repository: _____

_____

Location Description (concise description of collection site within the park from specimen label):

_____

_____

UTM X (northing): _____ UTM Y (easting): _____

UTM Zone: _____ Datum: _____ Coordinate Error (meters): _____

Collected in Park? Yes _____ No _____ Unknown _____

Comments: _____

_____

_____

_____

_____

_____

_____

_____

G:\Plant Ecology\Vegetation Monitoring\ _SOP\Voucher Specimen and Photo Field Documentation Form

Appendix B: Post-Fire Vegetation Monitoring Forms and Datasheets

Version 1.0 (September 2016)

Change History

Version numbers will be incremented by a whole number (e.g., Version 1.3 to Version 2.0) when a change is made that significantly affects requirements or procedures. Version numbers will be incremented by decimals (e.g., Version 1.6 to Version 1.7) when there are minor modifications that do not affect requirements or procedures for publication in the series.

This applies to Appendix B only. Other SOP changes are found under individual SOPs. Changes to the narrative are found at the beginning of the narrative document.

The following revisions have occurred to these monitoring forms and datasheets since September 2016.

Previous Version #	Date	Revised by	Changes	Justification	New Version #
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Note: These standard operating procedure forms and datasheets may undergo modifications after monitoring is implemented. For the most current versions, see the following website:

http://science.nature.nps.gov/im/units/medn/monitor/nativeplantcommunities.cfm

*Database Code (office use only)*_____

TRANSECT ESTABLISHMENT/REVISIT

Revised 8/18/2016

DIRECTIONS TO TRANSECT

Transect Number_____ Date_____Surveyors_____

General Location_____ Park Unit_____

Trail/Road Name_____

Parking spot:
UTME_____ m UTMN_____ m UTM Zone 11 GPS datum: NAD83 or _____
Directions along trail (include notes on prominent landmarks):

Point of leaving trail:
UTME_____ m UTMN_____ m UTM Zone 11 GPS datum: NAD83 or _____
Directions in the backcountry (include notes on prominent landmarks/UTMs):

TRANSECT LOCATION

GPS Point name_____ GPS Unit_____ GPS datum: NAD83 or _____ UTM Zone 11

Coordinates for Transect beginning (A): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

Coordinates for Transect end (B): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

GPS Accuracy_____cm/m/in/ft Bearing of Transect from A → B _____°

Fire Plots Only
Coordinates for "upper left" corner (C): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

Coordinates for "upper right" corner (D): UTME_ _ _ _ _ _ _ m UTMN_ _ _ _ _ _ _ _ m

ENVIRONMENTAL DESCRIPTION

Elevation _____m/ft Slope steepness: 0°___ 1-5° ____ 5-25°_____ > 25°____
Slope exposure: N___ NE___ E___ SE___ S___ SW___ W___ NW___ Flat___ Variable___

Topography: flat____ concave_____ convex_____ undulating_____
bottom_____ lower_____ mid_____ upper_____ top_____

Physiognomy: woodland___ shrubland___ dwarf shrubland___ herbaceous ___ nonvascular___ sparse veg___
General Stand Height: waist___ chest___ head___ overhead___ General Veg Density: open___ closed___
Potential Hazards: high poison-oak cover___ loose soil/rock___ other_____

Data entered by_____ **Date**_____

Check 1 by_____ **Check 2 by**_____

*Database Code (office use only)*_____ **Page 2 of 2**

FIRE SAMPLING EVENT METADATA
v4 Aug 2016

Fire Event:___ Year:___ Name:_____

Plot/Transect:_____ Date:_____ Crew:_____

1. Overall state of vegetation (check up to two dominant phenophases)

HERBACEOUS: sprouting__ bolting__ flowering__ seeding__ senescing__ dead__

WOODY: basal sprouting__new leaves___stem growth___flowering__ seeding__ senescing__ dead__

2. Effect of sampling on site (disturbance level: **L**ow, **M**edium, **H**igh)

VEGETATION: inside 1m belt____ inside 10m belt____ 5m below transect____ 5m outside elsewhere____

SOIL: inside 1m belt____ inside 10m belt____ 5m below transect____ 5m outside elsewhere____

3. Plants of note in immediate vicinity (list). Photograph with GPS camera if possible:

4. Plants of note potentially resulting from previous sampling disturbance (list):

FOR YEAR 02 AND AFTER, ATTACH SCANNED DATA SHEETS FROM ORIGINAL TRANSECT ESTABLISHMENT

NOTES_____

Data entered by_____ **Date**_____

Check 1 by_____ **Check 2 by**_____

MEDN Terrestrial Vegetation Monitoring Program

30-m LINE-POINT TRANSECT

(August 2016)

For Fire Plots Only:

Event _____ Year _____

Park/Island _____ **Transect #** _____ **Date** ____/____/_____

Species ID by _____ **Photos taken** _____

Data Recorder _____

PNT	L (cm)	HT (cm)	SUBSTR	lowest SP 1	SP 2	SP 3	SP 4	SP 5	highest SP 6
1	30								
2	60								
3	90								
4	120								
5	150								
6	180								
7	210								
8	240								
9	270								
10	300								
11	330								
12	360								
13	390								
14	420								
15	450								
16	480								
17	510								
18	540								
19	570								
20	600								
21	630								
22	660								
23	690								
24	720								
25	750								
26	780								
27	810								
28	840								
29	870								
30	900								
31	930								
32	960								
33	990								
34	1020								
35	1050								
36	1080								
37	1110								
38	1140								
39	1170								
40	1200								
41	1230								
42	1260								
43	1290								
44	1320								
45	1350								
46	1380								
47	1410								
48	1440								
49	1470								
50	1500								

Dieback codes: DP (spec code) = dead plant; DB (spec code) = dead branch on live plant

Record highest height of live and dead hits: 50(20) = live and dead; 50 = live only; (20) = dead only

PNT	L (cm)	HT (cm)	SUBSTR	SP 1	SP 2	SP 3	SP 4	SP 5	SP 6
51	1530								
52	1560								
53	1590								
54	1620								
55	1650								
56	1680								
57	1710								
58	1740								
59	1770								
60	1800								
61	1830								
62	1860								
63	1890								
64	1920								
65	1950								
66	1980								
67	2010								
68	2040								
69	2070								
70	2100								
71	2130								
72	2160								
73	2190								
74	2220								
75	2250								
76	2280								
77	2310								
78	2340								
79	2370								
80	2400								
81	2430								
82	2460								
83	2490								
84	2520								
85	2550								
86	2580								
87	2610								
88	2640								
89	2670								
90	2700								
91	2730								
92	2760								
93	2790								
94	2820								
95	2850								
96	2880								
97	2910								
98	2940								
99	2970								
100	3000								

Comments _____

Dieback codes: DP (spec code) = dead plant; DB (spec code) = dead branch on live plant

Record highest height of live and dead hits: 50(20) = live and dead; 50 = live only; (20) = dead only

Entered by: _____ Entered date: _____ Validation by: _____ Validation date: _____

Shrub Density 30m belt transect in 1m x 5m subplots (Aug 2016) **PRINT ONE SIDED Page ___ of ___**

Transect:_____ Date:_____ Recorders:_____ Fire Only: Event___ Year___

Species Code: _____

Class	0-5	5-10	10-15	15-20	20-25	25-30
Seedling (new this year)						
Juvenile						
Adult						
Dead Adult						
Resprout						
Fire Only Classes						
Seedling (older than current year)						
Dead Seedling						
Dead Resprout						

Species Code: _____

Class	0-5	5-10	10-15	15-20	20-25	25-30
Seedling (new this year)						
Juvenile						
Adult						
Dead Adult						
Resprout						
Fire Only Classes						
Seedling (older than current year)						
Dead Seedling						
Dead Resprout						

Species Code: _____

Class	0-5	5-10	10-15	15-20	20-25	25-30
Seedling (new this year)						
Juvenile						
Adult						
Dead Adult						
Resprout						
Fire Only Classes						
Seedling (older than current year)						
Dead Seedling						
Dead Resprout						

Terrestrial Vegetation Species Richness (1m x 30m belt)

(August 2016)

Transect #____________ Fire Only: Event _____ Year _____

Date _____/_____/_________

Crew ____________________ *Outside category =* ***5m*** *on either side of tape*

Species	0-1	1-5	5-6	6-10	10-11	11-15	15-16	16-20	20-21	21-25	25-26	26-30	Outside

For measurement of richness, a species is counted if any part of the plant overhangs the belt plot. The plant does not have to be rooted in the plot (unlike the shrub density protocol which counts only plants rooted within the plot). Counting the overhanging plants into the plot will assure that vines, such as wild cucumber and morning glory, are included in the richness measure. Species are recorded in 1x1 m^2 subplots nested in 1x5 m^2 segments along the 30m belt transect; i.e., record a species only once within a given 1 x 5m belt segment. For example, if a species occurs in the 5-6 m subplot, it is counted in that subplot, but not within the 6-10m subplot.

Terrestrial Vegetation Species Richness (1m x 30m belt)

Transect #______________ Date _____/_____/__________

Species	0-1	1-5	5-6	6-10	10-11	11-15	15-16	16-20	20-21	21-25	25-26	26-30	Outside

Notes:

FIRE MONITORING 10 X 10 DENSITY AND MORTALITY (Year 1 only)

(August 2016)

Page ___ of ___

Park Code _____ Plot _____ Date _____ Recorders _____

Subplot D1 D2 D3 Circle one

SPECIES	Skeleton	Resprout	Rsprt w/ Dieback	Live	Total all	Severity	
Subtotal						Low	% plot
Subtotal						0	
Subtotal						1	
Subtotal						2	
Subtotal						3	
Subtotal						4	
Subtotal						High	
Subtotal							
Subtotal							
Subtotal							

REVISED SCALE FOR FMH BURN SEVERITY

110

Table 28. Burn severity coding matrix.

		Forests		Shrublands		Grasslands	
		Substrate (S)	Vegetation (V)	Substrate (S)	Vegetation (V)	Substrate (S)	Vegetation (V)
0	Unburned (5)	not burned	not burned	not burned	not burned	not burned	not burned
1	Scorched (4)	litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	foliage scorched and attached to supporting twigs	litter partially blackened; duff nearly unchanged; wood/ leaf structures unchanged	foliage scorched and attached to supporting twigs	litter partially blackened; duff nearly unchanged; leaf structures unchanged	foliage scorched
2	Lightly Burned (3)	litter charred to partially consumed; upper duff layer may be charred but the duff layer is not altered over the entire depth; surface appears black; woody debris is partially burned; logs are scorched or blackened but not charred; rotten wood is scorched to partially burned	foliage and smaller twigs partially to completely consumed; branches mostly intact	litter charred to partially consumed, some leaf structure undamaged; surface is predominately black; some gray ash may be present immediately postburn; charring may extend slightly into soil surface where litter is sparse, otherwise soil is not altered	foliage and smaller twigs partially to completely consumed; branches mostly intact; less than 60% of the shrub canopy is commonly consumed	litter charred to partially consumed, but some plant parts are still discernible; charring may extend slightly into soil surface, but soil is not visibly altered; surface appears black (this soon becomes inconspicuous); burns may be spotty to uniform depending on the grass continuity	grasses with approximately two inches of stubble; foliage and smaller twigs of associated species partially to completely consumed; some plant parts may still be standing; bases of plants are not deeply burned and are still recognizable
3	Moderately Burned (2)	litter mostly to entirely consumed, leaving coarse, light colored ash; duff deeply charred, but underlying mineral soil is not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned-out stump holes are common	foliage, twigs, and small stems consumed; some branches still present	leaf litter consumed, leaving coarse, light colored ash; duff deeply charred, but underlying mineral soil is not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned-out stump holes are common	foliage, twigs, and small stems consumed; some branches (> 6–1 cm in diameter) (0.25–0.50 in) still present; 40–80% of the shrub canopy is commonly consumed.	leaf litter consumed, leaving coarse, light gray or white colored ash immediately after the burn; ash soon disappears leaving bare mineral soil; charring may extend slightly into soil surface	unburned grass stubble usually less than two inches tall, and mostly confined to an outer ring; for other species, foliage completely consumed, plant bases are burned to ground level and obscured in ash immediately after burning; burns tend to be uniform
4	Heavily Burned (1)	litter and duff completely consumed, leaving fine white ash; mineral soil visibly altered, often reddish; sound logs are deeply charred, and rotten logs are completely consumed. This code generally applies to less than 10% of natural or slash burned areas	all plant parts consumed, leaving some or no major stems or trunks; any left are deeply charred	leaf litter completely consumed, leaving a fluffy fine white ash; all organic material is consumed in mineral soil to a depth of 1–2.5 cm (0.5–1 in), this is underlain by a zone of black organic material; colloidal structure of the surface mineral soil may be altered	all plant parts consumed leaving only stubs greater than 1 cm (0.5 in) in diameter	leaf litter completely consumed, leaving a fluffy fine white ash, this soon disappears leaving bare mineral soil; charring extends to a depth of 1 cm (0.5 in) into the soil; this severity class is usually limited to situations where heavy fuel load on mesic sites has burned under dry conditions and low wind	no unburned grasses above the root crown; for other species, all plant parts consumed leaving some or no major stems or trunks, any left are deeply charred; this severity class is uncommon due to the short burnout time of grasses
0	Not Applicable (0)	inorganic preburn	none present preburn	inorganic preburn	none present preburn	inorganic preburn	none present preburn

Fire Monitoring Handbook

Fire Species Richness (three 100m^2 subplots)
(August 2016)

Transcect:_______________ Date:_______________ Page 1 of 2

Event:_____ Year:_____ Crew:____

Species	D1	% cover		D2	% cover		D3	% cover

Fire Species Richness (three 100m^2 subplots) **Transect:______________ Date:______________**

Species	D1	% cover		D2	% cover		D3	% cover

NOTES____

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 963/134108, September 2016

National Park Service
U.S. Department of the Interior

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