



Invasive Plant Monitoring Protocol for the Mediterranean Coast Network—Santa Monica Mountains National Recreation Area and Channel Islands National Park

Standard Operating Procedures, Version 1.0

Natural Resource Report NPS/MEDN/NRR—2016/1171.1



ON THE COVER

Tumbleweed (*Salsola australis*) infestation along an equestrian trail at Cheeseboro Canyon.
Photograph courtesy of Santa Monica Mountains National Recreation Area.

*And since, methinks I would not grow so fast
Because sweet flowers are slow and weeds make haste.*

-William Shakespeare

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**Invasive Plant Monitoring Protocol for the Mediterranean Coast Network
Standard Operating Procedures**

Version 1.0 (March 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.

The following revisions have occurred to this protocol since March 2016:

Previous Version #	Date	Revised by	Changes	Justification	New Version #

Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes, along with the new version number.

Notify the MEDN Data Manager of any changes to the protocol narrative or SOPs so that the new version number can be incorporated in the metadata of the project database.

Post new versions on the internet and forward copies to all individuals with a previous version of the protocol narrative or SOPs.

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

Irvine, I. C., T. Sagar, L. Lee, C. A. Brigham, J. Tiszler, L. A. Starcevich, D. Rodriguez, T. Handley, and S. Ostermann-Kelm. 2016. Invasive plant monitoring protocol for the Mediterranean Coast Network—Santa Monica Mountains National Recreation Area and Channel Islands National Park: narrative, version 1.0. Natural Resource Report NPS/MEDN/NRR—2016/1171. National Park Service, Fort Collins, Colorado.

SOP 1: Field Preparation, Permits and Equipment

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 2016)

1.1 Change History

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This applies to SOP 1 only. Other SOP changes are found under individual SOPs. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

SOP 1

1.2 Overview

This Standard Operating Procedure (SOP) reviews the steps to prepare for the field season and training of interns.

1.3 Recruiting Field Technicians

Each park will have one permanent Ecologist (GS-11 or higher) to serve as the Program Lead to oversee implementation of this protocol. In addition, at SAMO at least two but preferably three or four botany interns will be recruited annually through the park volunteer or internship programs. Ideally, at least one intern will be available to assist with monitoring at CHIS.

Recruitment of interns to serve as field technicians will begin in January of the monitoring year. The Program Lead sends 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 should be made to generate interest in MEDN field internships among advanced undergraduate or post-baccalaureate students with training in botany.

In addition to having botanical skills and field experience, interns must be in excellent physical condition and able to thrive in difficult field conditions. The physical and mental demands of monitoring in high temperatures while negotiating ticks, poison oak, and rattlesnakes should not be underestimated. Certification as a First Responder (or Wilderness First Aid) and CPR is an asset.

Hiring personnel should interview all well-qualified candidates at least once and call three references. Emphasis will be given to candidates who have field experience, background to easily learn new plants, and the physical ability to withstand difficult field conditions and hike up to six miles in a day.

1.4 Preparing for the Field Monitoring Effort

Obtain Collection Permits from Non-NPS Landholders (SAMO)

Unknown plants should be collected and taken back to the office for identification. To account for collections from non-NPS lands, we must obtain permits from non-NPS landholders for this activity prior to the field season. See Appendix D in the protocol narrative (Irvine et al. 2016) for information on obtaining and renewing permits. Be sure to coordinate with the MEDN terrestrial vegetation monitoring lead regarding permits to avoid duplication of effort.

Prepare Data Files

Acquire the list of locations/points to be monitored for each park from the Program Lead.

Work with MEDN Data Manager and Park GIS staff to prepare appropriate data files for uploading into GPS units.

Prepare General Reference Packets

Prepare the General Reference Packet to be carried by the field crew while conducting monitoring, which contains the following:

SOP 1

Pertinent SOPs. The field packets will include SOPs 4-7. These SOPs describe GPS use, site establishment, transect add/drop procedures, field data collection, data sheets, and methods to be used when collecting and documenting unknown plant species.

Landscape-scale map(s) designed to help with navigation to and from monitoring sites. These maps should show the monitoring sites, important topographic features, and any roads and trails helpful in travelling either to or from monitoring sites.

Permits for access and collection on non-NPS lands.

Field forms and documents:

- Data collection forms
- Forms for documentation of voucher specimens
- Safety information (hospitals and phone numbers) and emergency contact information for each field crew member
- NPSpecies Invasive Species lists and “watch” lists for species known in the region but not yet in the park

Prepare Site Information Packets

For each site that will be monitored during the current work tour, include:

Directions to the site

Local-scale map showing the location of the site in the context of nearby roads, trails, and landscape features, and note any known hazards. A scale of 1:1000 is generally useful for this work.

If the site is a POE, a set of maps for manual recording of infestations in the event of GPS failure. If the site is a DRT point and the GPS fails, you will not be able to accurately determine the GRTS point – do not proceed, return with working equipment. If the site is in an area where a satellite signal cannot be obtained because of terrain or vegetation, follow the procedures for dropping a point.

If the site has been visited in the past, a copy of the datasheet from the most recent visit.

Prepare the Plant Species Lists

Generate a species list for the field from the certified NPSpecies Invasive Species List “watch” lists for species known in the region but not yet in the park, available from the MEDN Data Manager and/or Program Lead. Review the invasive species list and previously unidentified plant species from former monitoring efforts to identify any unique plants that may be encountered.

Prepare Field Schedules and Notify Park Staff and Supervisors

In addition to submitting the preliminary field schedule, the program lead must also submit requests for park housing, camping permits (if necessary), and any other special requests (e.g., boat transportation).

Verify that collection permits have been established with the individual parks being monitored. See Appendix D in the protocol narrative (Irvine et al. 2016) for information on permits.

SOP 1

Just prior to the field season provide the MEDN I&M Program Manager, Law Enforcement staff, and other appropriate park staff the actual dates field-crew members will be working in the park and approximate locations of monitoring activity.

Prepare Equipment

All equipment (see list below) should be organized and prepared for the field season at least one month in advance of the field season. This allows time to make needed repairs and to order/replenish equipment.

Essential Safety Equipment

inReach (or similar) satellite communication device for emergency use

2-way handheld radio

First aid kits

Insect repellent and tweezers for tick removal

Measuring Equipment

Camera

50 m measuring tape

6" ruler

Plant ID references (species check list, and at SAMO, iPad with SAMO flower website application)

Hand lens (10x or larger)

Pin flags

Flagging tape

2m long folding avalanche pole (to rapidly identify the belt transects along DRT)

Navigation and Recording

GPS, preloaded with monitoring location waypoints and shapefiles

Clipboard and pencils with erasers

Miscellaneous Field Equipment

Plastic file box for storage of datasheets, extra forms (including checklists of species that were encountered in previous seasons' monitoring plots) and pencils.

Trowel (for collecting unknown plant species)

Plastic ziploc bags (for collecting unknown plant species)

Wire brush for cleaning tires, boots, and trousers of weed seeds

Spare batteries for electronics

Coin for coin toss, in the event a DRT point needs to be adjusted

1.5 Literature Cited

Irvine, I. C., T. Sagar, L. Lee, C. A. Brigham, J. Tiszler, L. A. Starcevich, D. Rodriguez, T. Handley, and S. Ostermann-Kelm. 2016. Invasive plant monitoring protocol for the Mediterranean Coast Network—Santa Monica Mountains National Recreation Area and Channel Islands National Park: Narrative, version 1.0. Natural Resource Report NPS/MEDN/NRR—2016/1171. National Park Service, Fort Collins, Colorado.

SOP 2: Field Data Collection Training

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 2016)

2.1 Change History

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This applies to SOP 2 only. Other SOP changes are found under individual SOPs. The following revisions have occurred to this SOP since March 2016.

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<http://science.nature.nps.gov/im/units/medn/monitor/invasiveplants.cfm>

2.2 Overview

This SOP explains the procedures for hiring and training invasive species monitoring personnel. Training should ensure that all crew leaders are able to identify, by sight and through the use of technical floras and keys, all target species known to occur in the park(s) where they are working. It is essential that field technicians are able to accurately and consistently follow standard operating procedures to assure data quality over time. Technicians must also be prepared mentally and physically for considerable heat and difficult terrain encountered at SAMO and CHIS.

2.3 Training and Testing of Interns

To determine whether interns are sufficiently trained and calibrated to allow accurate data collection independent of permanent NPS staff, a plant identification and cover/density estimation test will be required. Interns will be tested after being trained and accompanying the Field Crew Lead or Program Lead for at least one week. Interns will not collect data without NPS staff until they have easily passed the ID (25-30 species), distribution pattern, and density and cover class test (10 plots within +/- 10%) with >90% correct answers.

2.4 Training of Observers

The Program Lead for each park, assisted by staff that are well versed in the protocol and SOPs, will conduct the training. Interns will be trained for this protocol as well as the MEDN Terrestrial Vegetation Monitoring Program, as they will implement both protocols. The interns will be provided a copy of the narrative and SOPs prior to arriving on site for training so that they will be familiar with the program objectives, ecological context, and field methods.

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

Goals for Technicians or Interns:

Appreciation of the overall program monitoring goals and competence in all field skills, including meticulous data entry and attention to detail in the field environment.

Proficiency in the use of GPS equipment and navigation to sampling points.

Proficiency in the use of Pathfinder software, including troubleshooting.

Understand procedures for boundary decisions, defining patches, sampling frame errors, and dropping and adding sites.

Competence and consistency in visually estimating plant canopy cover (for the general plant community only as intact, intermediate, and disturbed), the distribution pattern, and density.

Proficiency in identification of principal native and non-native plant genera and species targeted in this protocol.

Review plant identification manuals, keys, and photos.

Proficiency with plant identification terminology.

SOP 2

Commitment to follow safety procedures, including regular communication with park points of contact.

Appreciation for, and commitment to follow, weed spread prevention procedures during field work.

Materials:

Protocol narrative and SOPs for each participant

Field Reference Manuals for each crewmember

GPS units

Digital cameras

Measuring equipment (tape, pin flags, flagging)

Data sheets

Park plant list, watch list, and key

2.5 Orientation Week Agenda

Day 1

Morning

Arrival and orientation, get acquainted, team building exercises

Individual protocol study, online GPS tutorial (http://www.trimble.com/gps_tutorial)

Afternoon

Group program orientation and protocol discussion, including data management

Review of safety procedures and contact information; sign safety docs

Review of invasive plant spread prevention procedures

Day 2

Morning

Field demonstration of all field methods, including use of Pathfinder

GPS practice

Review of drop site criteria and documentation

Afternoon

Plant identification in lab setting

Distribution pattern, density, and canopy cover class estimation and defining patches – practice and calibration

Day 3

Morning

Practice use of Field Reference Manual materials

Field walk identifying plants

SOP 2

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 DRT/points of entry

Afternoon

Group practice – completion of 1-2 real DRT/points of entry

Day 5

Morning

Group practice, troubleshooting, GRTS and field decisions

Afternoon

Monitoring certification test

2.6 Training Procedures

- 1) Field measurement techniques are best taught outside, at the park site or another analogous location. Do not conduct training in or near sampling locations in order to avoid trampling vegetation. Personnel should already have basic GPS navigation and data entry skills, but additional training on those topics 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.
- 2) Adequate time must be given to properly set up DRT monitoring transects, and for patch definition (POE monitoring), and sampling frame errors encountered in the field. While efforts have been made to minimize these, 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.
- 3) 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 5 m either up or down the trail (determined by a coin toss). If offsetting does not resolve the problem, the transect location should be dropped from the sample. Dropped locations and the associated transect number must be entered in the Microsoft Access (MS Access, Access) database with a note describing the met criteria. The criteria and procedures for dropping and adding GRTS points are located in SOP 6. Added sites must come from the oversample list, which are included in the GPS and maps for each sampling frame. Oversample sites are numbered in sequential order, starting with the next

SOP 2

transect after the sample size (transect $n + 1$). For example, if a sample size for a given frame is $n = 60$, the first replacement site should be transect #61.

- 4) Objective positioning of the strip 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. Trail edges can be difficult to define at times. Look for an elevated area of the trail, a depression, or clear change from no vegetation (on trail) to vegetation occurring on the sides of the trail.
- 5) Visual density estimation, and defining distribution patterns and patches should be practiced repeatedly as a group and as individuals who then compare results among group members. As part of the training and calibration of the plant community described above, evaluation of repeatability should also be conducted. Repeatability is an important issue and needs to be assessed throughout the field season.
- 6) 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. The target species list in the protocol narrative (and as revised over time according to SOP 11) represents the principal species of current emphasis for this program, and should be the priority during training. In some cases, species will not be encountered at a training site and the field leader must provide additional training at the start of sampling at each park. Typically this will occur during the first morning of field work at each park, and will provide an opportunity for the team to re-calibrate to the new surroundings and vegetation. Hand lens use should be practiced in the lab and field setting to assist in plant identification. 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 anatomical and technical key characteristics that differentiate a principal plant species from similar species that may cause confusion.
- 7) The interns will assist in collecting plant specimens to complete the park's voucher collection. Proper collection and documentation of the vouchers will be reviewed in the lab following instructions in SOP 7.
- 8) Use of the Pathfinder software for uploading GPS data must be practiced and thoroughly understood by all field personnel. Use the Pathfinder quick reference guide located at the GIS work station and additional instructions in SOP 4 on backing up data and for updating species picklists. Allow time for field practice as a group in data entry and in post-field backup procedures. Troubleshooting tips will be reviewed.
- 9) Safety procedures are outlined in SOP 3. This must be reviewed individually and as a group in a focused session.
- 10) **Invasive plant 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

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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

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 2016)

3.1 Change History

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<http://science.nature.nps.gov/im/units/medn/monitor/invasiveplants.cfm>

3.2 Overview

This SOP explains steps to take to ensure the safety of all crew members. Regardless of the relative nearness of urban areas, the backcountry conditions 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 Safety Overview

All people (permanent, seasonal, interns) involved in any fieldwork must receive a detailed safety orientation. To help ensure this occurs, each year the following Protocol Readiness Review Pre-Certification, Hazard Abatement Actions, and Protocol Readiness Review Certification must be completed by the Program Lead at each park before commencing fieldwork (documents are below).

**Mediterranean Coast Network Inventory & Monitoring Program
Protocol Readiness Pre-Certification (PRPC) 2013**

The purpose of this document and process is to ensure that safety is a prominent and routine component of the Inventory and Monitoring (I&M) Program. Although MEDN I&M programs are implemented using park staff in most cases, there is a clear need to improve the safety culture and practices of NPS staff.

Beginning in 2012, the Pacific West Regional Office required the completion of Protocol Readiness Reviews to encourage communication between park staff and I&M staff before and during field work. This document, the Protocol Readiness Pre-Certification, defines the steps necessary to prepare for signing a Protocol Readiness Review.

The Program Lead will ensure that all steps below have been completed and then will obtain approval signatures from the Chief of Resources and the I&M Program Manager to complete the Protocol Readiness Pre-Certification process. Program Leads will then sign the PWR Protocol Readiness Review Certification and submit it for signature by the I&M Program Manager and SAMO Superintendent. All documents will be updated on an annual basis, distributed to the MEDN Board of Directors Chair, the Pacific West Region I&M Program Manager, and stored on the PWR I&M sharepoint site.

Actions to be taken:

- 1) Each field crew member will review the following documents and sign a Protocol Readiness Documents Form:
 - a) Protocol and associated safety SOP(s)
 - b) Pertinent job hazard analysis: ticks, poison oak, slips and falls, driving, marijuana gardens, heat exhaustion and stroke, etc.
 - c) Park specific safety directives/safety plans
 - d) Annual Operational Risk Management Analysis (a.k.a. GAR –green, amber, red analysis) is completed by the Program Lead in collaboration with the Chief of Resources and I&M Program Manager at a minimum
 - e) Operations plan for various scenarios (falls, snakebites, etc.) that lists emergency numbers, which hospital(s) to use, how to call for a helicopter, etc.
 - f) Radio operations guide
- 2) There will always be a designated Crew Leader in the field who is responsible for the actions of the crew. The Program Lead will assign the Crew Leader and/or a system for designating the Crew Leader on a daily or rotating basis.
- 3) Each field crew member must demonstrate proficiency using park radios and other communication devices, and understand when to use each type of radio or phone. They will also receive a handout on radio operations to be kept with them while in the field.

SOP 3

- 4) Each field crew will sign in and out on radios when entering and leaving the field. When signing in, they will report the general areas where they will be working and will provide the name of trails and roads when appropriate.
- 5) Each crew will carry a satellite communication device (e.g., inReach) with the tracking feature activated for emergency communication and location.
- 6) Each crew member will carry a whistle at all times for emergency communication.
- 7) The Program Lead and/or Crew Leader will discuss risk management and conduct tailgate safety meetings with all field crew members at the beginning of each week, when staff change, or when field conditions change significantly.
- 8) All crew members will wear protective gear as required by the Program Lead (e.g., long pants and boots). The Program Lead will make protective equipment available, including but not limited to snake gaiters, tick kits, hats, Ivy Block, and Tecnu.

We agree the above procedures have been completed or implemented, or will be by (date).

Monitoring Program _____

Program Lead

Printed Name	Signature	Date
--------------	-----------	------

Chief of Resources

Printed Name	Signature	Date
--------------	-----------	------

I&M Program Manager

Printed Name	Signature	Date
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Mediterranean Coast Network I&M Program

Invasive Plant Monitoring

Emergency Contact Information

(Date here)

Park	Name	Cell phone	Home phone	Alternate contact person and phone	Signature verifying safety documents were reviewed

Invasive Plant Monitoring Hazard Abatement Actions

Driving to and from Remote Field Sites

Seatbelts. WEAR SEATBELTS AT ALL TIMES WHEN VEHICLE IS MOVING.

Safe speed. Maintain a safe speed for the road conditions (this is often below the legal speed limit); 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.

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.

Wildfire. Wildfire can ignite from vehicle undercarriage/catalytic converter. Track fire hazard warnings from the park and other agencies. Obey road closures, such as 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. Park on bare earth if possible or in areas with low, sparse vegetation.

Communication—Loss of Contact with Field Partner(s)/Team Member(s)

Make sure radios are charged and on the correct channel. Use cell phone (if available and have coverage), as this may be more reliable for communication in remote locations. Establish regular contact/meeting times where failure to contact triggers emergency procedures. Establish clear triggers for emergency procedures and avoid false alarms.

Make sure each crew has a satellite communication device (SCD) for emergency use and that the batteries are charged. All crew members should be trained in how to use the SCD.

Unable to reach a radio repeater in a remote location. Make sure radio is charged. 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 SCD or cell phone in vehicle (if available) for communication in remote locations.

Tracking location and safe return of crews. CHIS and SAMO dispatch will be notified when and where field staff plan to go and their expected time of return. Staff at SAMO headquarters tracks its monitors in the field with an SCD through an online tracking program. In addition it has a whiteboard for recording the time of departure, the expected time of return, and the field locations you expect to visit. You will be working in a minimum 2-person team for safety and efficiency reasons. Bring a radio with you and carry a mobile phone if you have one (also provide the phone number on the whiteboard). Upon your return erase your daily information. NOTE: at both CHIS and SAMO, if you forget to erase your info from the whiteboard or notify your supervisor/dispatch of your safe return, the supervisor/dispatch must launch a search for you.

Hiking

Steep, rugged, and slippery terrain. Assess terrain conditions to find a safe route and modify monitoring 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. Avoid walking below another person due to the potential for rocks to dislodge from above.

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

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

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. If no gate is available, cross under or over with caution.

Encountering Noxious Plants, Animals, Disease, People, and Marijuana Cultivation Sites

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 the individual with allergy carries prescribed medication to prevent anaphylactic shock. Crew First Aid kit should include a bee sting kit, Benadryl or other antihistamine. Be aware of the ground where you step—some hornets build nests in the ground at the base of trees or shrubs, or in rotten logs. Watch for bees buzzing in and out of holes or around ground level. If possible, flag a nest so future surveyors won't run into it.

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 (Program Lead will handle this). Fill out an accident report in the event that symptoms of Lyme disease appear (red bull's eye rash).

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

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

Rattlesnakes (SAMO). 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 ball point pen or marker and write down the time it occurred, sit still, call and wait for help.

Mountain lions (SAMO). Avoid mountain lions. If you encounter a lion that doesn't run from you, yell at the lion, look big by raising your arms and/or jacket, and slowly leave the area. If attacked, fight back!

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

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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.

Encounters with marijuana cultivation sites (SAMO). 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.

Exposure to Environmental Dangers

Treatment of general injuries. All NPS field staff should have current first aid and CPR certification. Training interns in CPR and first aid is encouraged; certification is optional, depending upon class availability.

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.

Hyperthermia. Hyperthermia may occur during high temperatures. Monitor for dehydration, heat exhaustion, heat cramps, and heat stroke. Symptoms include nausea, headache, and flushed, red skin. Drink plenty of water even when you are not thirsty. As heat increases, take frequent breaks in cool locations. Wear a light shirt.

Giardia. Giardia is caused by drinking contaminated water. Carry plenty of water on outings—consider all streams contaminated.

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.

Required* and Recommended Personal Protective Equipment

Back pack	Personal water bottles*
Sturdy hiking boots*	Food*
Long pants*	First Aid Kit*
Long sleeved shirt (ticks)	Park radio*
Tall socks (ticks)	Satellite communication device*
Insect repellent (ticks)	GPS Unit*
Warm clothing / hat	Compass
Rain gear	Maps
Sun hat*	Emergency contact information/Field Reference
Sunscreen	Manual*
Sunglasses	

**Pacific West Region Inventory and Monitoring
Protocol Readiness Review Certification
Monitoring Protocol: MEDN Invasive Plant Monitoring**

Park and Network: _____ - MEDN

Year: _____

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; and 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).

By 'Electronically Signing' below, we are confirming our identification as indicated, and that we understand that an electronic signature is taking place, and we intend to be bound by and authenticate this electronic record, and attest to the statements contained within, and that we understand that submitting another individual's electronic signature or attesting to false statements in an electronic record is a false statement and is punishable. By typing our names in the indicated fields, we hereby certify that all of the information submitted is true, accurate and complete. We agree that conducting business electronically is in accordance with the Government Paperwork Elimination Act (GPEA) (P.L. 105-277, 44 U.S.C. 3504 note).

NPS Official	Electronic Signatures	Park or Network	Date (m-d-y)
Park Superintendent	/s/		
I&M Program Manager	/s/	MEDN	
Protocol Field Supervisor	/s/		

SOP 4: Using a GPS - Field Data Collection and Processing

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

4.2 Overview

This SOP explains basic GPS standards, use of a GPS, and navigational techniques necessary for invasive plant monitoring. Specific information on geodatabase structure and instructions regarding the use of NISIMS may be found in the user's guide

(<https://irma.nps.gov/App/Reference/Profile/2216091>).

4.3 A General Note about Using a GPS Unit

- 1) All GPS measurements should be set to:
 - a) UTM coordinates
 - b) NAD83 datum
 - c) Meters

Park	UTM Zone
SAMO	11
CHIS Santa Barbara Island Anacapa Island Santa Cruz Island	11
CHIS Santa Rosa Island San Miguel Island	10

- 2) All crew members should be familiar with the operation of their GPS unit. The appropriate user's guide for the specific equipment at each park should be reviewed by all crew members and carried while in the field. Prior to the beginning of field season, all crew members will complete training in the use of their respective GPS unit.
- 3) Field personnel must be able to use a GPS to map target invasive species at the Points of Entry (POE), and to navigate to GRTS points along dirt roads and trails (DRT). This is achieved by marking waypoints.
- 4) In general, crew members will be using a Trimble GPS unit. A data dictionary will be provided and includes all relevant fields for attributing point locations, such as plot number, survey date, species name, etc., for upload into the park and national NISIMS geodatabase.
- 5) All data collected should be checked for completeness and edited if needed in ArcMap upon return from the field. For detailed instructions on data collection, see instructions below as well as in the NISIMS user's guide.

4.4 Pre-Data Collection: The Data Dictionary

The use of a Data Dictionary promotes consistency and efficiency in the data collecting process. It allows the user to collect data in a systematic manner by specifying the necessary predefined attributes. MEDN will be adopting the NISIMS data dictionary for this protocol. Management of the Invasive Plants data dictionary will be through Pathfinder Office. Specific instructions on uploading

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the data dictionary to the Trimble GPS unit are found in the NISIMS user's guide (Section 3.2). In brief, the steps are as follows:

- 1) Open Pathfinder Office.
- 2) Create a project folder that will be locally stored at C:\Pfddata\ on the GIS lab GPS computer. Your project folder should also be copied to wherever you are storing the project data on the park's Invasive Plant Monitoring Program directory, e.g.,
H:\DIVISION\psrm!\Inventory_and_Monitoring\Vital_Signs\Invasive_plants\Database\NISIMS
- 3) Use the Data Dictionary Editor to inspect the existing data dictionary and check for any updates that may be needed at the beginning of the field season. These include adding or updating crew names and any new target invasive species to the attribute lists.
- 4) Save your data dictionary in your project folder on the GIS lab computer's C drive and the network project directory.
- 5) Transfer the data dictionary to the GPS unit using the Data Transfer tool in Pathfinder Office.

Create Waypoints to Navigate to Monitoring Sites

Waypoints can assist field crews in navigating to monitoring sites. When waypoints are added to the Trimble device, the user can use the "Navigate" tool to navigate to those predefined waypoints (i.e., the POE or GRTS point). In addition to directions, useful information, like distance to those points, may also be obtained. Waypoints should be used if there is a need to find and revisit an unfamiliar site or one that is difficult to relocate.

Creating a Waypoint File

- 1) Open PATHFINDER OFFICE.
- 2) Click FILE> WAYPOINTS > NEW.
- 3) Navigate to the desired location and give your file a name.
- 4) Click NEW.
- 5) The WAYPOINT PROPERTIES tab should open.
- 6) Click CREATE.
- 7) This should open the CREATE WAYPOINT window. This window will allow you to create each point you would like to add to your file.
- 8) Give your waypoint a name by entering it in the NAME Textbox.
- 9) Create the waypoint.

Setting the General Coordinate System

If the coordinate system is not in the correct format, change the general coordinate system in Pathfinder Office. If the coordinates are correct, skip the bullet points and move to step 1.

Click on OPTIONS> COORDINATE SYSTEM....

Under SELECT BY select the COORDINATE SYSTEM AND ZONE radio button

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Under SYSTEM: select UTM

Under ZONE: Select 11NORTH

Under DATUM: Select NAD 1983 (CONUS)

- 1) Enter the coordinates under the NORTH and EAST textboxes.
- 2) Enter the estimated elevation under ALTITUDE (MSL) in meters if you are using UTM coordinates.
- 3) Click SAVE.
- 4) Once you save your point, the textboxes will clear so that you may enter your second point, and then your third, and so on.
- 5) Click CLOSE when you have entered all of your points.
- 6) After adding all of your points and closing the CREATE WAYPOINT window, you will be able to edit points you have added, create more points, and delete points.
- 7) Click CLOSE in the WAYPOINT PROPERTIES window when you are satisfied with the points in your list.

Transferring Your Waypoint File to Your Trimble GPS Unit

- 1) Make sure that your Trimble GPS unit is connected to your computer.
- 2) Open PATHFINDER OFFICE.
- 3) Select UTILITIES > DATA TRANSFER...
- 4) **Note** If you are prompted to save the waypoint file you created, select YES.
- 5) In the DATA TRANSFER window select the SEND tab.
- 6) Click ADD > WAYPOINT.
- 7) Navigate to your Waypoint file.
- 8) Click OPEN.
- 9) Once you add all of the waypoint files you wish to transfer, click on TRANSFER ALL in the DATA TRANSFER window.

If the file did not load properly, and the reason for the failure is not clearly apparent, go back to step 1 and repeat all of the steps. If the issues persist, contact the MEDN Data Manager or any available park GIS Tech for support.

4.5 Field Data Collection (for field crew members)

TerraSync software loaded on Trimble GPS units will be used to collect field data using the NISIMS data dictionary ("NISIMSField.ddf"). In order to adequately collect field data, a series of settings must be addressed. Using and not correcting inaccurate settings may result in distortion of data. To assign the appropriate settings, and to understand how to properly use your Trimble unit in the field, follow the steps outlined below.

Check Data Configuration on Trimble GPS Unit

- 1) Check the Trimble GPS unit configuration settings (see GPS to GIS Pathfinder Systems 2007 training manual).
- 2) Use planning software to check for satellite geometry if desired (see GPS to GIS Pathfinder Systems 2007 training manual).

Set Up Trimble GPS Unit Configuration

- 1) Power on by tapping the power button quickly.
- 2) Go to START: TERRASYNC

Note: At times the START button may not work. If this occurs, select GPS from the bottom right hand corner of the screen and it will activate the default program, Terrasync.

- 1) Select SETUP from the pull-down menu.
- 2) Select COORDINATE SYSTEM icon
- 3) In the COORDINATE SYSTEM window select the following:
 - a) SYSTEM: UTM
 - b) ZONE: 11 North
 - c) DATUM: NAD 1983 (Conus)
 - d) ALTITUDE REFERENCE: HAE
 - e) ALTITUDE UNITS: Meters
 - f) COORDINATE UNITS: Meters
 - g) COORDINATE ORDER: North/East

Note: If this step is skipped, the Datum can be converted during export. If the Datum cannot be converted, the user will need to recreate the point using the proper coordinate system and datum.

- 4) Press OK.
- 5) Select SETUP: GPS SETTINGS: COM3.
- 6) Get a clear view of the sky. GPS positions may not always be available, particularly in or near buildings, in vehicles, or under tree canopy.
- 7) Check the GPS status. When the TerraSync software starts, it automatically connects to the GPS receiver and then begins to track visible satellites and to calculate its current satellite position. Use the satellite icon on the status bar to check whether the receiver is computing GPS positions.

Note: If you are in clear view of the sky and the receiver fails to track satellites, return to the SETUP menu and press the GPS icon and you will be automatically connected to the satellites.

Creating Point and Line Features with Your Trimble GPS Unit

Note: Additional information on collecting point and line features may be found in the NISIMS user guide (Section 3.3).

- 1) Select STATUS from the pull-down menu.
- 2) Confirm that the line on the right hand side of the screen surpasses the notch. This is a visual of your satellite strength. If the shaded line does not surpass the notch, adjust the productivity

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versus precision toolbar at the bottom of the screen. Try to keep the productivity vs. precision measurement relatively near the center or higher (more to the right side) to ensure adequate accuracy. Decreasing this strength will only decrease the placement accuracy when projected, it will not impede the ability to create and collect the feature.

Note: This is a measure of the satellite strength. The window view is a skyplot showing the number of satellites the device may access. Tree cover or canyon walls may impede satellite strength. If there are too few satellites, data cannot be collected.

- 3) Select DATA from the pull-down menu.
 - a) FILE TYPE: Rover
 - b) LOCATION: Select location where the data is to be saved, Default (on machine) or SD card.
 - c) FILE NAME: Name the file.
 - d) DICTIONARY NAME: Select a Data Dictionary if necessary (e.g., NISIMSField).

Note: This is a good time to fill out the 'GPS File ID' field on the datasheet with the FILE NAME. Additionally, in the notes section, add the following information: "Trimble ID – Site Number" and date file was created in the notes section (e.g.: Trimble A – POE 65 05/16/11)
- 4) Press CREATE.
- 5) The CONFIRM ANTENNA HEIGHT form appears, press OK.
- 6) The COLLECT FEATURES screen appears. This screen shows a list of all the features offered in the NISIMS data dictionary.

To create a point select 'NISIMS Point Data'

To create a buffered line select 'NISIMS Line Data'

A new data file is now created. Fill out the attribute fields of the data dictionary. All underlined fields are required.

- 1) Next to OPTIONS in the upper right-hand corner of the screen, select LOG. This will begin plotting of the point or line.
 - a) *Note: Before you select LOG, the plotting function may be paused or is already logging. The PENCIL symbol means that TerraSync is logging information. If the symbol is FLASHING, it is either paused or there is not enough satellite strength to continue logging.*
 - b) *Note: If satellite strength is low, move around or wait 2-3 minutes to see if signal strength increases. If it does not increase, adjust the productivity/precision toolbar in the STATUS window. Moving the bar to the left will decrease accuracy but will allow capture of satellites. Once the pencil begins to move again you are collecting data. If there are too few satellites, data cannot be collected.*
 - c) *More canopy and cloud cover means less satellite strength, if any. Very cloudy days will not be a good time to use the Trimble. Users should try again on a different day if signal is still not strong enough after decreasing productivity/precision.*

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- 2) Mark the point or walk the line making sure that satellite strength is uninterrupted.
- 3) When finished, select PAUSE.

Note: You can pause and resume the logging at any time.

- 4) Select the red square OK. You will be asked to confirm - close feature: x, press OK.
- 5) If you do not want to add any more features to the existing file, select CLOSE: OK. Select CLOSE: YES to completely exit the file.

Note: Not selecting close will result in multiple shape files that cannot be projected independently.

Viewing Your Results in the Field

- 1) Select DATA. Underneath DATA, select EXISTING FILE, highlight file, select OPEN: OK.
- 2) Select MAP from the pull-down menu. This will draw a picture of the map that was logged.

4.6 Post-Processing of Field Data

Post-processing of field data should occur soon after the field data have been collected. The differential correction requires the use of base files, which are provided by numerous base stations. Some stations update their base files at the top of each hour, while some take up to 24 hours to update their base file, but no more. It is possible to go online and determine when the base file was last updated for any given base station, but leaving a 24 hour gap ensures that the file has been updated without having to do a search for the station. Data should be processed ASAP after the corrected base files become available and while the field sites are still familiar to the field crew.

Differential Correction and Exporting Data to NISIMS Geodatabase

Note: Additional information on exporting point and line features may be found in the NISIMS user guide (Section 3.4 and 3.5).

- 1) Make sure that your Trimble GPS unit is connected to your computer.
- 2) Open PATHFINDER OFFICE.
- 3) Select UTILITIES/DATA TRANSFER. Transfer current rover files and almanac to PC project folder.
- 4) For the following step you should allow at least 24 hours before continuing. While some base station update their data every hour, some base stations go up to 24 hours between updates.
- 5) Select UTILITIES\ DIFFERENTIAL CORRECTION, use the closest CORS base data (can check correction settings and base station, but probably ok).
- 6) Open corrected files for editing in map view. You can view multiple files, but can only edit one at a time. Immediately SAVE AS “Roverfile #_Edited”.
- 7) Clean up/edit point and line features as necessary.
- 8) Export the corrected, edited rover file to the NISIMS file geodatabase. In the EXPORT window, choose ‘NISIMS DD File Geodatabase’ for the Export Setup from the drop-down menu. Make sure the GIS Coordinate System is correct: for SAMO and CHIS (Santa Barbara, Anacapa, and

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Santa Cruz Islands), the coordinate system is NAD 83 UTM 11N. For CHIS on Santa Rosa or San Miguel Islands, change the coordinate system to NAD 83 UTM 10N.

- 9) Once Export is completed, check to make sure all data have been converted correctly and make changes as necessary.

Viewing Spatial Data

Newly transferred features should be viewed in ArcCatalog or ArcMap to ensure invasive species locations were correctly mapped. Feature classes may be added to any ArcMap project in the same manner as shapefiles. To quickly view the features in the master geodatabase in ArcCatalog:

- 1) Open 'ArcCatalog' and navigate to the specified directory where the park's master NISIMS geodatabase is stored.
- 2) Select the point or line feature class of interest.
- 3) Choose 'Preview' tab in large right window of ArcCatalog interface.
- 4) Within lower drop-down box, choose either 'Geography' or 'Table' to view those portions of the shapefile.
- 5) Use the 'Geography' tab to check that the points and lines are in the correct location, that there are the appropriate number of points, and that there are no 'wayward' points far from other points due to loss of good reception, etc.
- 6) Use the 'Table' preview to check that the file has been correctly and fully attributed. If necessary utilize the editor toolbar to make any changes.
- 7) If all are correct, proceed to the next step to view or edit features.

Editing Spatial Data (to be accomplished with a GIS specialist)

Features may also need to be edited in ArcMap after GPS data transfer to correct any errors in mapping. To edit mapped features in ArcMap:

- 1) Open 'ArcMap'. Use the 'Add Data' tool to open the files to edit. Click through the error on projection messages (if necessary).
- 2) Click "Start editing" on the Editing toolbar.
- 3) Choose the proper feature class in the file geodatabase to edit; check the editing target on the toolbar if you have multiple field data files loaded into your project for editing.
- 4) Make changes to attributes or delete extra points, lines, etc., and then choose 'Save edits' using the editor drop-down menu on the editor tool bar.
- 5) When all edits are complete, choose 'Stop editing' on the same drop-down menu of the editor tool bar.

SOP 5: Data Sheets

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

MEDN I&M Invasive Plant Monitoring Team Calibration Datasheet

Date: ____ / ____ / ____ Name: _____
 day month year

For the TRANSECT SURVEY, use the following codes for each recorded species:

Density Classes: 1 = <10 2 = 10-100 3 = >100

Distribution Pattern:

N = none | I = isolated | L = linear | SC = scattered | P = patchy | C = continuous | M = monoculture

Dominant Vegetation Type:

R = riparian | C = chaparral | CSC = coastal sage scrub | G = grassland | OW = oak woodland |
 O = other

Surrounding Vegetation Percentage:

Intact = ≥ 90% native | Intermediate = 51-89% native | Disturbed ≤ 50% native

Percent Correct: #correct/total # of trials (out of 10 max) × 10 = percent

NOTES:

TARGET INVASIVE SPECIES LOCATED INSIDE THE DRT TRANSECT OR POE INFESTATION

Trial #	Species Name	Density Class (circle one)	Dist. Pattern	Dominant Veg Type	Surrounding Veg %
1.		1 2 3			
2.		1 2 3			
3.		1 2 3			
4.		1 2 3			
5.		1 2 3			
6.		1 2 3			
7.		1 2 3			
8.		1 2 3			
9.		1 2 3			
10.		1 2 3			
% correct					

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**MEDN I&M Invasive Plant Monitoring
Dirt Roads & Trails Data Collection Form**

Site ID: _____ GRTS Point _____

UTM: N _____ E _____ 11NORTH NAD83

Date: ____ / ____ / ____ Time: start ____ : ____ end ____ : ____
day month year hour min hour min

Crew _____

Crew Leader _____ Data Recorder _____

Survey Area Characteristics (circle one):

Most abundant vegetation community type:

Chaparral Coastal Sage Scrub Grassland Oak Woodland Riparian Other: _____

Vegetation Status:

Intact (>90% native cover) Intermediate (51-89% native cover) Disturbed (<50% native cover)

TARGET INVASIVE SPECIES LOCATED OUTSIDE THE DRT TRANSECT

Species Name	GPS X Coordinate	GPS Y Coordinate	Bearing or Direction of Infestation	Notes
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

For the TRANSECT SURVEY, use the following codes for each recorded species:

Distribution:

N = none | I = isolated | L = linear | SC = scattered | P = patchy | C = continuous | M = monoculture

Density Classes: <10 10-100 >100

NOTES/Treatment:

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	NNIS Species Code	Left Strip Transect		Trail bed		Right Strip Transect	
		Dist	Dens	Dist	Dens	Dist	Dens
Sub-transect 1 0-50m							
Trail Width @ 0m: _____m							
Sub-transect 2 50-100m							
Sub-transect 3 100-150m							
Sub-transect 4 150-200m							
Sub-transect 5 200-250m							
Sub-transect 6 250-300m							
Sub-transect 7 300-350m							
Sub-transect 8 350-400m							
Sub-transect 9 400-450m							
Sub-transect 10 450-500m							
Trail Width @ 500m: _____m							

SOP 5

MEDN I&M Invasive Plant Monitoring Points of Entry Data Collection Form

Site ID: _____ POE Name _____

UTM: N _____ E _____ 11N NAD83 POE Type: _____

Date: ____ / ____ / ____ Time: start ____ : ____ end ____ : ____
day month year hour min hour min

Crew _____

Crew Leader _____ Data Recorder _____

Survey Area Characteristics (hardscape + 50 m along connected trail + 20 m buffer)

Most abundant vegetation community type:

Chaparral Coastal Sage Scrub Grassland Oak Woodland Riparian Other: _____

Vegetation Status:

Intact (>90% native cover) Intermediate (51-89% native cover) Disturbed (<50% native cover)

TARGET INVASIVE SPECIES LOCATED OUTSIDE THE POE SURVEY AREA

Species Name	GPS X Coordinate	GPS Y Coordinate	Bearing or Direction of Infestation	Notes
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				

NOTES/Treatment: _____

SOP 5

For the POE SURVEY, use the following codes for each recorded infestation:

Distribution:

N = none | I = isolated | L = linear | SC = scattered | P = patchy | C = continuous | M = monoculture

Density Classes: <10 | 10-100 | >100

TARGET INVASIVE SPECIES LOCATED WITHIN THE POE SURVEY AREA

[illegible]

SOP 6: Field Data Collection

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

6.2 Overview

This SOP describes the methods used to collect data for points of entry (POE) and dirt roads and trails (DRT). Spatial data will be collected on Trimble GPS units, while other data will be recorded on paper datasheets.

Methods for collecting data with Trimble GPS units, including the loading and use of appropriate data dictionaries, are detailed in SOP 4: Using a GPS - Field Data Collection and Processing.

6.3 Preventing Spread of Non-Native Species While Surveying

Many plants have seeds that are specially adapted to maximize seed dispersal, and many of these adaptations are designed to help seeds stick to animal fur or clothing. Field crew should take action to reduce the likelihood of spreading non-native seeds, especially target invasive plant species, while monitoring. After each survey is completed, and before leaving the survey area, field crews should use a stiff brush to remove seeds and other debris from boots (especially soles and laces), pants, shirt sleeves, backpacks, and any other items that seeds might get caught in or stuck on. This procedure may also be used at other times, as frequently as necessary to prevent the spread of non-native seeds.

6.4 Establishing New Monitoring Sites

Points of Entry (POE) Monitoring

Load POE locations as waypoints onto the GPS unit. Refer to SOP 4.

Navigate to the site. Use road maps to find an efficient route to travel from park headquarters to the POE.

Dirt Roads and Trails (DRT) Monitoring

Load GRTS locations as waypoints onto the GPS unit. Refer to SOP 4.

Plan your route. Before leaving for the field, review the project map. Locate the set of sites to be visited during the current day/tour. Find the roads and trails that will be helpful in travelling to and from these sites. Decide on a route that will allow you to safely and efficiently visit all of these sites.

Navigate to the site. Following your travel plan, use road maps and topographic maps to navigate to the general area of each site. Use the GPS to assist in fine-scale navigation. Note that while GRTS points are intended to be exactly on the centerline of a road or trail, due to inaccuracies in both GPS and GIS, the actual location of these points will likely be a small distance (<3 m) away from the centerline. When this happens, use the GPS to travel to the point on the centerline of the road/trail that is as close as possible (within 25 m) to the GRTS point (parameters set per GRTS protocols). This centerline-point will be the center of the road/trail monitoring site, unless the GPS point is farther than 25 m from the nearest road or trail, in which case the site must be rejected.

Accept or reject the point. The first time that a DRT GRTS site is visited, the Crew Leader will need to make a decision about the safety of accessing and monitoring the site. If the site is on a slope that is >40 degrees, or if more than 10% of the site is not safely observable, then the site should be rejected. When this happens, carefully record the reason for rejecting the site on the datasheet and be

sure this information is transferred to the appropriate table in the database. It is essential that the justification for dropping points is recorded so that the data analysis and interpretation can be adjusted accordingly.

6.5 Monitoring Points of Entry

The POE consists of the area that is hardscaped (e.g., compacted earth, gravel, pavement, fencing) or developed, the first 50 m along any dirt road or trail connected to the POE, and a 20 m zone surrounding these areas (Figure 6.1). All spatial data collected for POE will be recorded on Trimble GPS units using the NISIMS TerraSync data dictionary file (“NISIMSFld.ddf”). Additional information on how to collect spatial data can be found in SOP 4 and the NISIMS user’s guide. Paper datasheets for recording all other POE data can be found in SOP 5.

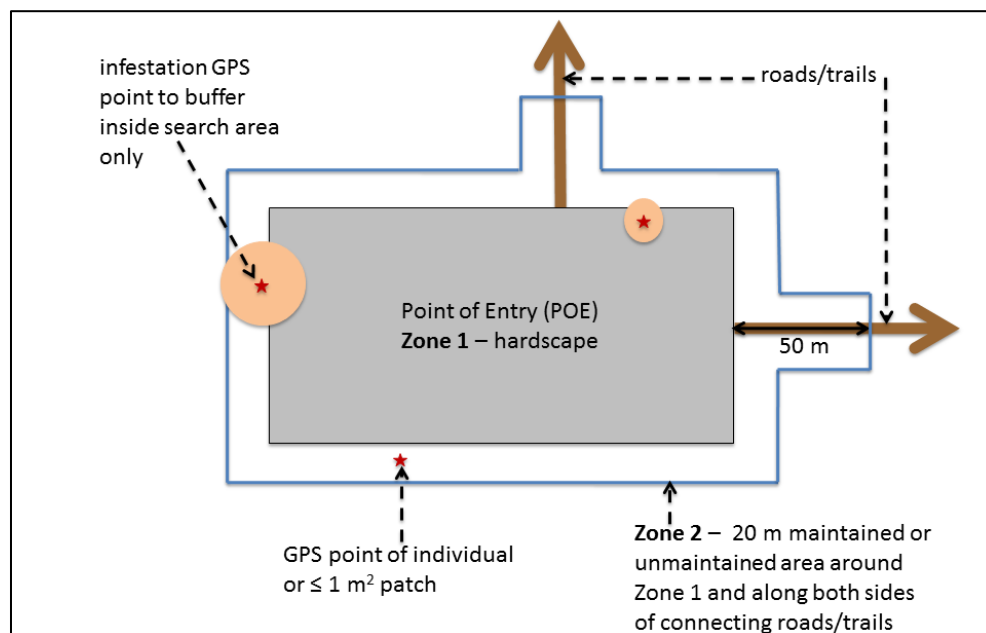


Figure 6.1. Diagram of an example point of entry. The POE survey area includes the hardscaped area and the first 50 m of any connected dirt roads or trails (Zone 1), plus a 20 m area (Zone 2) surrounding Zone 1.

If Necessary, Record the Perimeter (or “polygon”) of the POE Hardscape

To create a polygon for the POE (if the POE has changed or is new and no recent satellite image is available to delineate the polygon in the office), set the GPS to record a polygon, and then walk the outer edge of the POE. When you come to a road or trail, walk 50 m out along the road/trail, walk back along the trail to the edge of the POE, and then continue walking along the edge of the POE. It is important to record the boundaries of the POE (i.e., to “polygon the POE”), since the edges of the POE may change over time (e.g., maintenance, improvements, or acts of nature). The 20 m zone (i.e., a 20 m buffer) will be added to the file in the office. The 20 m buffer begins at the outer edge of the graded or compacted area where the vegetation begins, or, if vegetation is not present, where the soil is level with the surrounding ungraded area.

Identify the Survey Area

The search area for a given POE is divided into two zones. Zone 1 includes the hardscape or developed area of the POE and the first 50 m along any connected dirt road or trail. Zone 2 is a 20 m area (either maintained or unmaintained) surrounding Zone 1.

Before beginning the search, use measuring tapes, flagging, and the GPS as needed to measure distances from the POE and the roads and trails that connect to the POE, to denote the survey area. Make sure that you have an accurate sense of the extent of the survey area before beginning data collection.

Record Survey Event Information

Record on the datasheet each of the following:

POE site number, name, and type (trailhead/campground/airstrip etc.)

UTM coordinates

Survey date and time

Field crew including crew leader and data recorder

Characterize the Survey Area (Zone 1 and 2)

Record on the datasheet each of the following:

Dominant vegetation community type (chaparral, coastal sage scrub, grassland, oak woodland, riparian, or other).

General state of the vegetation community (intact: canopy cover of natives $\geq 90\%$; intermediate: canopy cover of natives 51-89%; disturbed: canopy cover of natives $\leq 50\%$).

Target Non-native Invasive Species outside the POE Survey Area

Record on the datasheet any target non-native invasive species found outside the survey area and include a GPS point and direction (bearing) for the location.

Map Populations within the Survey Area

Refer to SOP 4. Load the NISIMS data dictionary ("NISIMSField.ddf") onto the Trimble GPS unit. Use the GPS to record a point or line around every patch of target non-native invasive species within the survey area. If a patch extends outside the search area, only map and assess the portion of the patch that is within the survey area. Clusters of target non-native invasive species that are separated by a gap of less than 2 m should be recorded as one patch, whereas clusters that are separated by more than 2 m should be recorded as different patches.

For each point or line, record data for fields that are underlined in the NISIMS data dictionary, including: survey date, monitoring team, park unit, species name and buffer distance.

If the species is present throughout the 20 m area (Zone 2) that surrounds the POE, then the entire 20 m area is the polygon. If the species is present in $\leq 50\%$ of Zone 2, map each occurrence as a separate point or line.

Collect Information on NNIS Populations

On the datasheet, for each patch that is mapped, record the species name, the associated GPS file, whether the species is in Zone 1 or 2, the distribution pattern (Figure 6.2), and density of the patch.

Do not leave blank fields in the data dictionary or paper datasheet.

Unknown species should be collected and identified according to SOP 7.

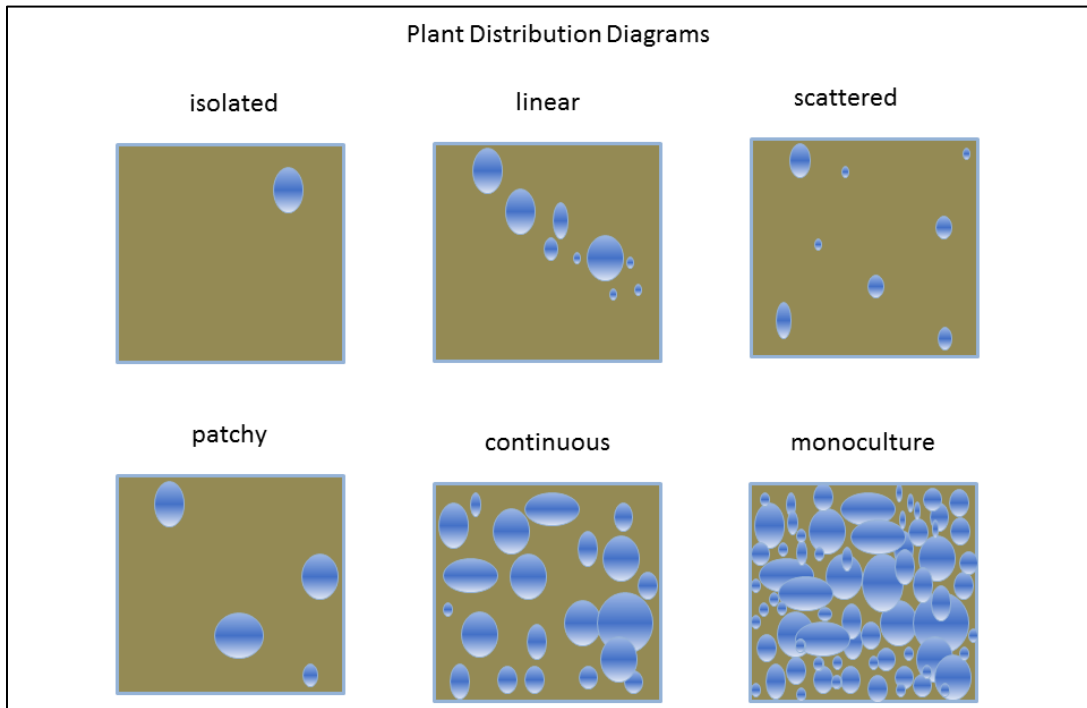


Figure 6.2. Plant distribution diagram used to describe target non-native invasive species patch patterns.

6.6 Monitoring of Dirt Roads and Trails

Road and trail monitoring of target non-native invasive species involves surveying a 500 m transect of the trail and noting the presence/absence of target NNIS in the road/trail bed and in a 2-m-wide strip adjacent to the road/trail (Figure 6.3). Transects will be sub-divided into ten 50 m segments. Distribution and density of each target NNIS found will be recorded at the sub-transect level. All data collected for dirt roads and trails (DRT) will be recorded on paper datasheets (SOP 5).

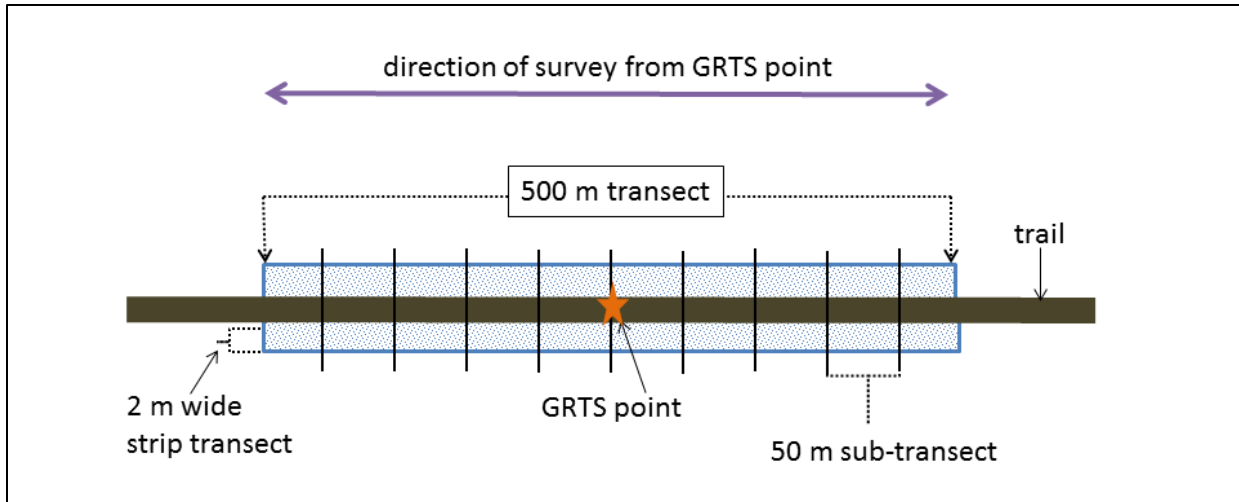


Figure 6.3. Diagram showing transects at a GRTS point along a dirt road or trail (DRT).

Record Survey Event Information

Record on the datasheet each of the following:

GRTS point number and name

UTM coordinates

Survey date and time

Field crew including crew leader and data recorder

Characterize the Survey Area

Record on the datasheet each of the following:

Dominant vegetation community type (chaparral, coastal sage scrub, grassland, oak woodland, riparian, or other).

General state of the vegetation community (intact: canopy cover of natives $\geq 90\%$; intermediate: canopy cover of natives 51-89%; disturbed: canopy cover of natives $\leq 50\%$).

Trail or road width at the start and end of the transect (0 m and 500 m mark). The trail or road is defined as the graded or compacted, level bed of the trail/road and the cut slope adjacent to it. Trail crews clean the trail edges every 3-4 years so that trail edges are relatively stable and generally easy to delineate.

Identify the Sub-transect Survey Area

GRTS points should be on the centerline of a trail, however there can be some inaccuracy in mapping and navigation. If the GRTS point is not on the centerline, move as close as possible to the GRTS point, while remaining on the centerline of the road/trail. Mark that point with a flag. Using a measuring tape, walk 50 m on the road/trail and place a flag on the centerline. Where the trail is very curved and/or you cannot see 50 m ahead, split the 50 m sub-transect into two 25 m sections. Be sure to measure these distances along the length of the road/trail, tracing any curves in the road/trail. Next, using a measuring tape or avalanche pole, delineate the boundaries of the 2 m strip that parallels the

SOP 6

road/trail. The 2-m-wide strip adjacent to the road/trail is measured from the outer edge of the graded area where the natural vegetation begins (or, if vegetation is not present, where the soil is level with the surrounding ungraded area).

Target Non-native Invasive Species outside the DRT Sub-transect Survey Area

Record on the datasheet any target non-native invasive species found outside the sub-transect survey area and include a direction (bearing) to its location.

Observe and Record

Observations may be made from the trail using the naked eye or from within strips, if strips may be entered safely and without excessive disturbance to the vegetation or landscape. For the trail bed and each 2 m strip, record on the datasheet any target non-native invasive species, its spatial distribution (Figure 6.2), and its density within the sub-transect.

Once the sub-transect has been surveyed, move up or down the trail towards to the next 50 m segment. Identify the sub-transect survey area and observe/record any target NNIS found. Continue surveying the transect until 10 sub-transects have been surveyed, for a total of 500 m.

Do not leave blank fields on the paper datasheet.

Unknown species should be collected and identified according to SOP 7: Collecting and Identifying Unknown Plants.

SOP 7: Collecting and Identifying Unknown Plants

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

7.2 Overview

This SOP explains the standards for collecting and identifying unknown plant species, including collection, documentation, and curation of vouchers.

7.3 Collecting Vouchers

When an unknown species is encountered, we will make every effort to identify it the same day of collection using the following technique; however, if same day identification is not possible, the sample should be pressed in a plant press kept in the vehicle:

- 1) Assign a name to the species. Names should consist of the word 'Unknown', followed by a number and observer's initials. Unknowns should be numbered in the order in which they were observed.
- 2) Search the area for several more individuals before collecting one sample, using a general rule that a whole individual should be collected only when there are at least 20 other individuals in the general area (Simpson 2006). If individuals are relatively small (e.g., would comfortably fit in a gallon-sized Ziploc bag), and there are at least 20 other individuals in the area, then collect the most identifiable individual.
- 3) If it is determined critical to make a collection regardless of having less than 20 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.
- 4) 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 on the field form as 'Unknown', with consecutive number attached to it (e.g., Unknown1).
- 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) Carefully place the specimen inside a resealable plastic bag labeled with the site name, transect number, unknown species code, date, and collector written in permanent ink or pencil. Blow a little air into the bag so that the sample can retain its natural form as best as possible under the field conditions.
- 8) Keep the sample in your bag and in shade until you can get it to the cooler.
- 9) Attempt to identify the plant the same day once back in the office.
- 10) 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 respective park's expert botanists (CHIS = Santa Barbara Botanic Garden; SAMO = UCLA Herbarium) to get help in resolving difficult identities.

- 11) Press and label (Date, Site, Transect#, Unknown code, Collector) unidentified specimen to be retained as a voucher for possible future identification.
- 12) Press and label specimen (what is left of it) that is identified successfully to be included in the park's herbarium collection.

7.4 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 respective herbarium collection to be housed together with other park vouchers.

Label information must include both field site data and plant data. Field site data includes at minimum:

- 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-minute 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 data to include at minimum:

- 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 (herb, 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 exposed, 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 / 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).

7.5 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 Data Manager.

7.6 Aids to Terminology and Structures Important in Plant Identification

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

Hickman, J. C., Ed. 1996. The Jepson Manual: higher plants of California. University of California Press, Berkeley.

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

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

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

Wildflowers of the Santa Monica Mountains National Recreation Area website:
<http://www.researchlearningcenter.com/bloom/bloom.htm>

SOP 8: Data Entry and Data Management

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

8.2 Overview

This SOP details the data management steps once data collection (Data Acquisition on the Data Management Life Cycle) has been completed at the end of each day (SAMO) or tour (CHIS). The following directions apply to all field data collected for Points of Entry and Dirt Roads and Trails in this protocol, including tabular data and spatial data. File-naming conventions and storage locations will be similar for both SAMO and CHIS.

8.3 Field Form Review and Data Entry

Following data collection, data entry and processing of spatial and non-spatial data will occur in the following steps:

- 1) **Data completeness.** The field crew members confirm that all data sheets are complete and attempt to verify the identity of any unknown plants. Data sheets are amended as needed by making corrections in red ink to distinguish them from field collected data.
- 2) **Review at the end of field day.** Data forms are reviewed at the end of each field day for legibility and correct spelling of species codes and are corrected in red ink as needed. Note: The person reviewing the data form should be someone other than the person who collected the data.
- 3) **Print out electronic data.** If data were collected electronically, download the data and generate paper copies for those data.
- 4) **Copy and scan data sheets.** Store copies separately from originals and place scanned copies in the appropriate project folder on the network.
- 5) **Data entry by two people.** Data will be entered daily. When possible, data are entered as partners, with one person reading the data out loud as another enters it into the database.
- 6) **Process spatial data from Trimble GPS units.** Follow the procedures outlined in SOP 4 for transferring Trimble GPS data to the park's master NISIMS file geodatabase. Files should be transferred at end of each survey day or tour and filed into the appropriate folders on the network server as described in SOP 4.
- 7) **Opening the database and entering data.** Non-spatial data for the invasive plant monitoring protocol are entered and stored in a 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 park's Program Lead.

The user interfaces with the database through a series of custom-built forms. Each form has been designed in a way 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 that are unfamiliar with MS Access to query the database and export datasets for analysis.

Instructions are provided on each form, where applicable, to help guide the user in making the correct selection. When the database is first opened, the Main Menu window appears. Currently, five options are available: Data Entry for Road and Trails, Data Entry for Point of Entry, Data Validation Queries, Data Analysis, and Reports (Figure 8.1).

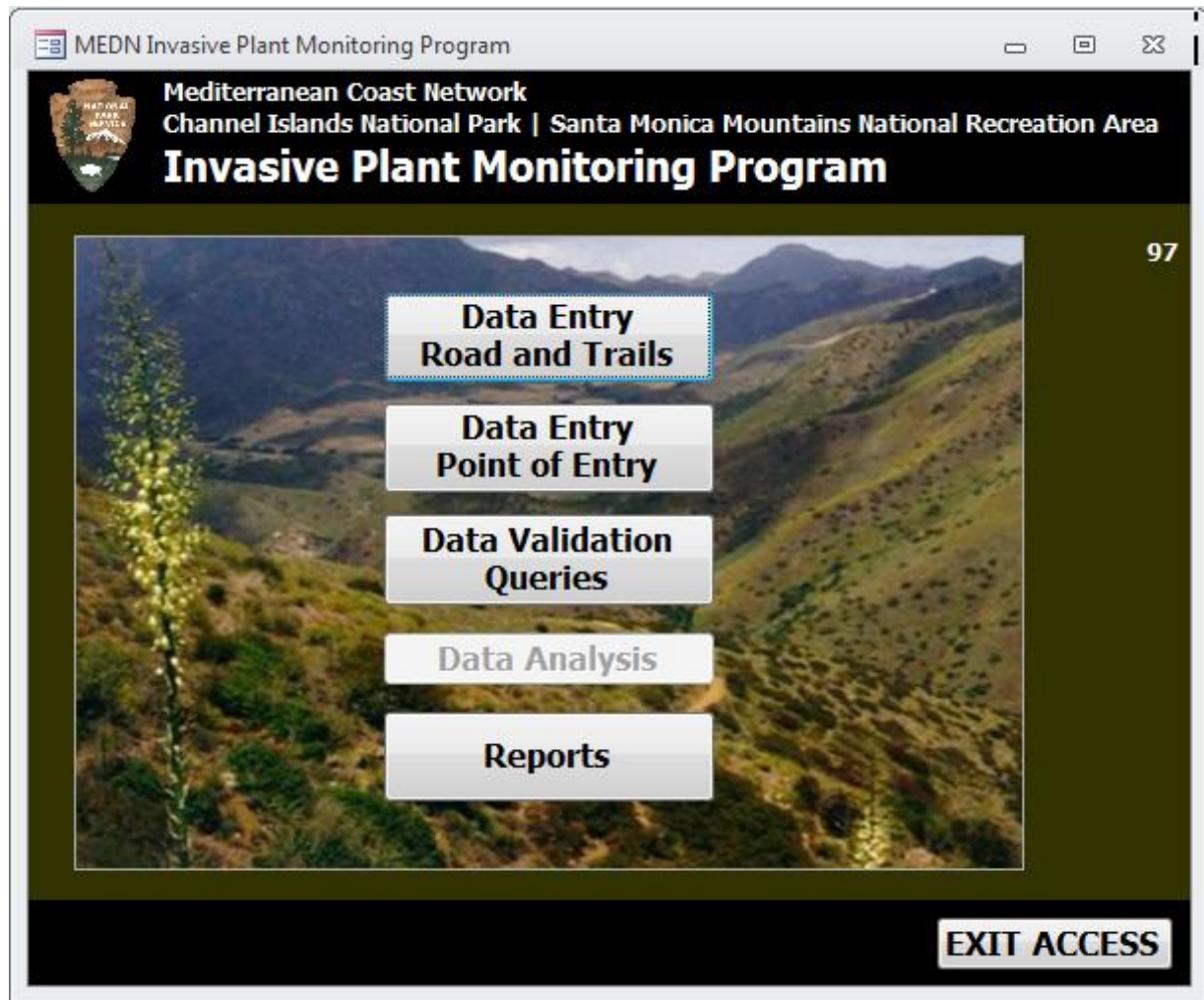


Figure 8.1. Screen shot of the “Main Menu” form window in the MEDN Invasive Plant Database.

- 1) **Data Entry.** The Data Entry Menu allows users to enter field collected data into the database. When Data Entry is selected from the Main Menu, the data entry form for the appropriate method (i.e., road and trail or point of entry) will open to a new record (Figures 8.2 for DRT and 8.3 for POE). Plans to include various navigation and record searching functions are in progress and are expected to be completed by the end of fiscal year 2016.

SOP 8

MEDN Invasive Plant Monitoring Program

**Mediterranean Coast Network
Invasive Plant Monitoring Program**

Road and Trail Data Entry Form

FILTER: Site: GRTS-001 Year: Show All Close Form

GRTS Point: GRTS-001 Add New Location Edit Record Save Record 2

Site ID: Serrano Cyn Rd, W end
UTM: East 317866 North 3774478 Edit Site Info

Date: 6/30/2014 Time (24-hour) Start: 14:15 End: 15:30
Crew: T. Valois, A. Huffman
Crew Leader: Data Recorder: A. Huffman

Notes: Burned in Springs Fire, May 2013

Page 1 - General Page 2 - Invasive Plants

Vegetation Status: intact
Surrounding Vegetation: chaparral coastal sage grassland oak woodland riparian other

Trail width at 0 m: meters
Trail width at 500 m: meters

Species Name	Bearing/ Direction	Notes
▶ FOE_VUL		Small individual plants along road
*		

Verified_By Verified_Date VERIFY
Validated_By Validation_Date VALIDATE
Certified_By Certified_Date CERTIFY

Record: 14 1 of 2 Filtered Search

Figure 8.2. Screen shot of the “Road and Trail Data Entry” form window in the MEDN Invasive Plant Database. Note verification, validation, and certification options at the bottom of the screen.

MEDN Invasive Plant Monitoring Program

Mediterranean Coast Network
Invasive Plant Monitoring Program

Filter: POE-01 Year: Show All

Close Form

POE ID #: POE-01 Add New Location Edit Record Save Record

POE Name: POE Site ID: 17; Franklin Canyon Park -- Ranch (Franklin Canyon Park) POE type:

Date: 5/30/2013 Time (24-hour) Start: 12:45 End: 14:25

Crew: V. Ryden and S. Del Rio

Crew Leader: Data Recorder: SDR

Page 1 - General Page 2 - Invasive Plants Notes

Vegetation Status: intermediate

Surrounding Vegetation: chaparral coastal sage grassland oak woodland riparian other

Species Name	Bearing/Direction	Notes
CAR_PYC		W of trail
CON_MAC		W of trail
*		

Verified_By tsagar Verified_Date 9/19/2013 8:53:13 AM VERIFY

Validated_By Validation_Date VALIDATE

Certified_By Certified_Date CERTIFY

Record: 1 of 1 Filtered Search

Figure 8.3. Screen shot of the “Point of Entry Data Entry” form window in the MEDN Invasive Plant Database. Note verification, validation, and certification options at the bottom of the screen.

8.4 Data QA/QC: Verification and Validation

The Program Lead for each park oversees the verification and validation process. These two levels of QA/QC are undertaken before data can be distributed. 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. Additionally, even if entered 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 can be used to verify entered data with the actual data (field form) and represent a

physical hard copy of the entered data. If printed, data verification reports are filed behind the original field form.

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 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 form, 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 be remained 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.

8.5 Data Certification

Once data have been checked, verified, and validated, 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 and validated by the Program Lead(s) and MEDN 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 associated with data certification. Certified data will be posted annually to the NPS IRMA (Integrated Resource Management Applications) data system by the Data Manager.

8.6 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, JMP, etc., for analysis. It should be noted that queries and query parameters are not saved to the database. Data analysis queries and reports are currently being developed and refined; these products are expected to be completed by the end of fiscal year 2016.

8.7 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 Invasive Plant 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., Terrestrial Vegetation Monitoring Program dataset, Water Quality and Riverine Integrity Monitoring Program dataset)

8.8 Physical File Organization

Field Forms

Field forms are stored in file cabinets at each park's respective resource division. Files should be properly labeled.

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 form). Final data verification reports represent a physical hard copy of the entered data and are filed behind the original field form.

Archives

Once data have been certified, the original paper field forms and final data verification reports for the year are archived with the respective park's curator. A copy of the field form and data verification report should be made and kept in their respective site folders.

8.9 Digital File Organization

Documents and Non-GIS Files

All digital documents and non-GIS files associated with the invasive plant monitoring protocol for SAMO and CHIS are located on each park's network server. At SAMO, the data will be located on the H drive, a mapped directory (\DIVISION\psrm) on the park's server (\inpsamo-hq1\). There are several directories within the H drive where files can be located:

Protocol and annual report documents and data summaries are located in

\\Inventory_and_Monitoring\Vital_Signs\Invasive_Plants

The Invasive Plant Database is located in

\\Inventory_and_Monitoring\Vital_Signs\Invasive_Plants\Database

The latest front-end user interface (MEDN_InvasivePlants_Database_v1.0.accdb) is located in this directory. The directory has four subdirectories:

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Archive, Data, Manuals, and Working. Previous versions of the front-end databases are located in the 'Archive' subdirectory. Back-end data tables (MEDN_InvasivePlantsDATA_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

\Plant_Ecology\Inventory and Monitoring\Invasive_Plants

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\Invasive_Plants

The Invasive Plant Database is located in

\Im\Invasive_Plants_Monitoring\Database

The latest front-end user interface (MEDN_InvasivePlants_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_InvasivePlantsDATA_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 the following folder, as well as in other subdirectories:

\Im\Invasive_Plants_Monitoring\documents

GIS Data

All GIS data associated with the invasive plant I&M 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\)) 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\invasive

All GIS data associated with the invasive plant I&M 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\Invasive_Plants_Monitoring

8.10 File Maintenance

All files on each park's server are backed up nightly. The server is maintained by the each park's Information Technology Specialist.

SOP 9: Database Structure

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

9.2 Overview

This SOP details the database structure for the Invasive Plant Database and briefly touches on the NISIMS geodatabase structure.

9.3 Invasive Plant Database

The MEDN Invasive Plant Database is a customized relational database developed in MS Access 2007 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 <http://science.nature.nps.gov/im/datamgmt/applications/template/>. 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_InvasivePlant_Database_v1.0.accdb) and a “back-end” database (MEDN_InvasivePlantDATA_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 8.

9.4 Tables

The data tables for this project are located in a back-end database (MEDN_InvasivePlantDATA_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.

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The database includes the following standard tables:

tbl_Sites	List of park-specific geographic areas
tbl_Locations	Sampling unit locations
tbl_Events	Description of the sampling event

The following are project-specific data tables:

tbl_Site_Info	Site specific information collected at each monitoring location
tbl_RoadTrail_Info	Site specific information collected along each DRT location
tbl_Target_Outside	Target species information outside the POE
tbl_POE_Species	Species specific information collected at point of entry
tbl_RoadTrail_TransectSpecies	Species specific information collected along road or trail

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

tlu_Contacts	Contact data for project-related personnel
tlu_Enumerations	Enumerated lookup table
tlu_Protocols	List of protocols
tlu_Species_List	List of invasive species

Values and domain ranges for each table field can be found in the database and will not be listed in this SOP.

The primary table for storing site information (i.e., island, park site) is tbl_Sites (Table 9.1). 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. Figure 9.1 below shows the relationships among the primary tables.

Table 9.1. tbl_Sites is the primary table for storing information on park-specific geographic information such as island or park site name.

Name	Type	Size	Description
Site_ID	Long Integer	4	Unique identifier
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

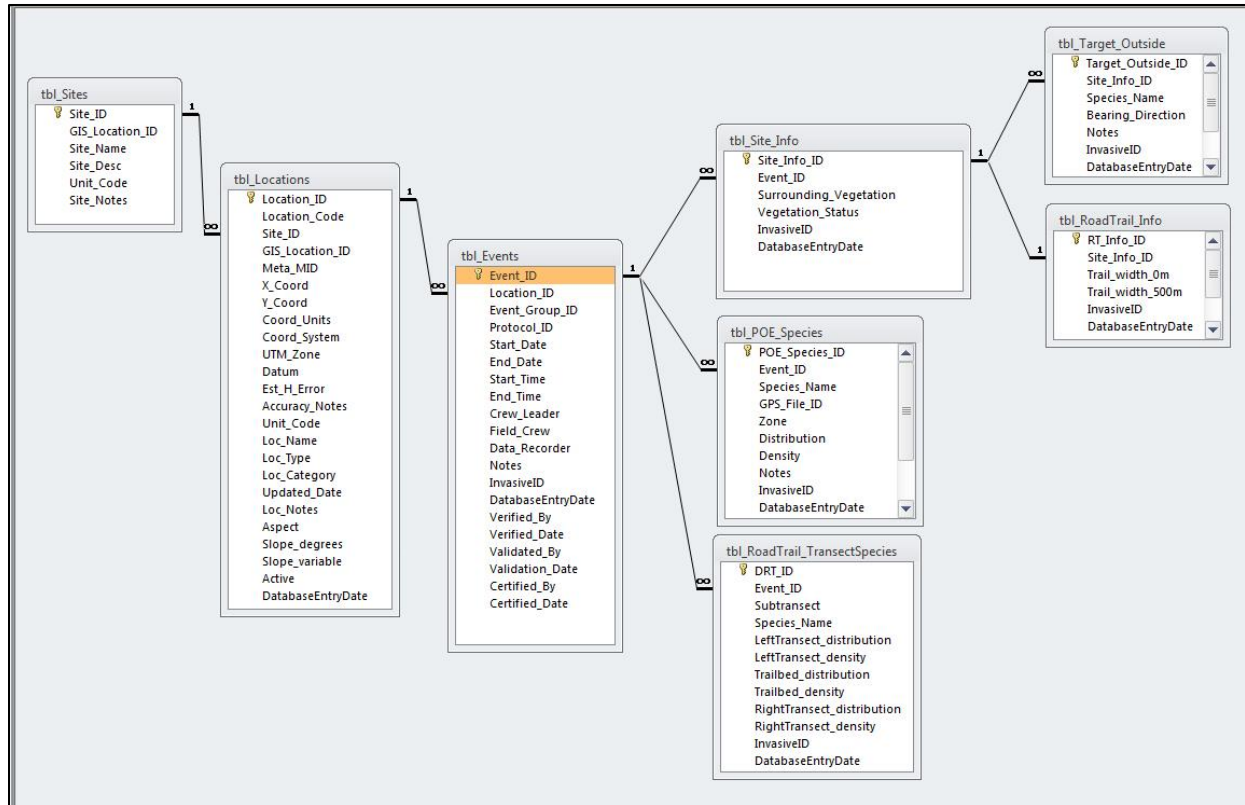


Figure 9.1. Relationship diagram for the primary tables in the MEDN Invasive Plant Database. Relationships between tables are represented by lines.

The primary table for storing sampling unit location information is `tbl_Locations` (Table 9.2). This is a core mandatory table under the NRD 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.

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Table 9.2. 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.

Name	Type	Size	Description
Location_ID	Long Integer	4	Unique identifier
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
Coord_Units	Text	50	Coordinate distance units
Coord_System	Text	50	Coordinate system
UTM_Zone	Text	50	UTM Zone
Datum	Text	50	Datum of mapping ellipsoid
Est_H_Error	Single	4	Estimated horizontal accuracy
Accuracy_Notes	Text	255	Positional accuracy notes
Unit_Code	Text	12	Park, Monument or Network code
Loc_Name	Text	100	Name of the location
Loc_Type	Text	25	Location type category
Loc_Category	Text	25	Type of location. For POE: campground, parking lot, trailhead, etc. For DRT: trail.
Updated_Date	Text	50	Date of entry or last change
Loc_Notes	Memo	-	General notes on the location
Aspect	Text	2	Aspect
Slope_degrees	Long Integer	4	Slope in degrees
Slope_variable	Text	6	Slope range (variable)
Active	Text	5	Is this an active monitoring location?
DatabaseEntryDate	Date/Time	8	Date of data entry

The primary table for storing information on survey event is tbl_Events (Table 9.3). 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.

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Table 9.3. 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.

Name	Type	Size	Description
Event_ID	Long Integer	4	Unique identifier
Location_ID	Long Integer	4	Link to tbl_Locations
Event_Group_ID	Long Integer	4	Link to tbl_Event_Group
Protocol_ID	Long Integer	4	The ID of the protocol governing the event
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
Crew_Leader	Text	50	Full last name and first initial of crew leader
Field_Crew	Text	255	Full last name and first initial of all people in the crew; separate names by a comma
Data_Recorder	Text	50	Full last name and first initial of the person recording data
Notes	Memo	-	Notes for the event
DatabaseEntryDate	Date/Time	8	Date of data entry
Verified_By	Text		Name of person verifying the data
Verified_Date	Date/Time		Date of verification
Validated_By	Text		Name of person validating the data
Validation_Date	Date/Time		Date of validation
Certified_By	Text		Name of person certifying the data
Certified_Date	Date/Time		Date of certification

Site Information

The primary table for storing site specific information for both DRT and POE surveys is tbl_Site_Info (Table 9.4). The table is linked to tbl_Events by the Event_ID field. The table contains one record for each location and survey visit and includes data on the vegetation status of the site and surrounding vegetation.

Table 9.4. tbl_Site_Info is the primary table for site specific information, including general state of the site and surrounding vegetation. The table contains one record for each location and survey visit.

Name	Type	Size	Description
Site_Info_ID	Long Integer	4	Unique identifier
Event_ID	Long Integer	4	Link to tbl_Events
Surrounding_Vegetation	Text	20	Most abundant vegetation community type at site: <i>chaparral, coastal sage, grassland, oak woodland, other, riparian</i>
Vegetation_Status	Text	20	Status of vegetation: <i>intact, intermediate, disturbed, unknown</i>
DatabaseEntryDate	Date/Time	8	Date of data entry

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Additional site information for road and trail surveys can be found in tbl_RoadTrail_Info (Table 9.5). The table is linked to tbl_Site_Info by the Site_Info_ID field. The table contains one record for each site information record and includes data on the trail width at 0 and 500 m.

Table 9.5. tbl_RoadTrail_Info is the primary table for site specific information at a road and trail survey site, including trail width at 0 and 500 m. The table contains one record for each site for a given survey.

Name	Type	Size	Description
RT_Info_ID	Long Integer	4	Link to tbl_Events
Site_Info_ID	Long Integer	4	Unique identifier
Trail_width_0m	Long Integer	4	Trail width taken at 0 m
Trail_width_500m	Long Integer	4	Trail width taken at 500m
DatabaseEntryDate	Date/Time	8	Date of data entry

The primary table for storing information on target non-native invasive species located outside the point of entry survey site is tbl_Target_Outside (Table 9.6). The table is linked to tbl_Site_Info by the Site_Info_ID field. The table contains one record for each species observed at the location and includes data on the species and bearing direction of infestation.

Table 9.6. tbl_Target_Outside is the primary table for target invasive species located outside of the site and includes information on the species and bearing direction of infestation. The table contains one record for each species at a given location.

Name	Type	Size	Description
Target_Outside_ID	Long Integer	4	Unique identifier
Site_Info_ID	Long Integer	4	Link to tbl_Site_Info
Species_Name	Text	10	Invasive plant species name
GPS_X_Coordinate	Long Integer	4	GPS X Coordinate
GPS_Y_Coordinate	Long Integer	4	GPS Y Coordinate
Bearing_Direction	Long Integer	4	Bearing or direction of infestation
Notes	Memo	-	Additional notes
DatabaseEntryDate	Date/Time	8	Date of data entry

Dirt Roads and Trails

The primary table for storing information on species for DRT surveys is tbl_RoadTrail_TransectSpecies (Table 9.7). The table is linked to tbl_Events by the Event_ID field. The table contains one record for each species observed at each sub-transect and includes data on species presence, distribution, and density.

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Table 9.7. tbl_RoadTrail_TransectSpecies is the primary table for species information for road and trail surveys including species presence, distribution, and density. The table contains one record for each species at a given sub-transect.

Name	Type	Size	Description
DRT_ID	Long Integer	4	Unique identifier
Event_ID	Long Integer	4	Link to tbl_Events
Subtransect	Long Integer	4	Subtransect number
Species_Name	Text	10	Invasive plant species name
LeftTransect_distribution	Text	3	Distribution pattern in left transect: <i>isolated, linear, scattered, patchy, continuous, monoculture, no data, not applicable</i>
LeftTransect_density	Text	6	Density category in left transect: <10, 10-100, >100
Trail bed_distribution	Text	3	Distribution pattern in trail bed: <i>isolated, linear, scattered, patchy, continuous, monoculture, no data, not applicable</i>
Trail bed_density	Text	6	Density category in trail bed: <10, 10-100, >100
RightTransect_distribution	Text	3	Distribution pattern in right transect: <i>isolated, linear, scattered, patchy, continuous, monoculture, no data, not applicable</i>
RightTransect_density	Text	6	Density category in right transect: <10, 10-100, >100
DatabaseEntryDate	Date/Time	8	Date of data entry

Points of Entry

The primary table for storing species observed for Points of Entry surveys is tbl_POE_Species (Table 9.8). The table is linked to tbl_Events by the Event_ID field. The table contains one record for each mapped infestation observed and includes information on the species' identification, distribution and density.

Table 9.8. tbl_POE_Species is the primary table for storing species information observed at the point of entry. The table contains one record for each mapped infestation observed.

Name	Type	Size	Description
POE_Species_ID	Long Integer	4	Unique identifier
Event_ID	Long Integer	4	Link to tbl_Events
Species_Name	Text	10	Invasive plant species name
GPS_File_ID	Text	25	Name of GPS rover file
Zone	Long Integer	4	Infestation found in Zone 1, 2 or Both
Distribution	Text	3	Distribution pattern: <i>isolated, linear, scattered, patchy, continuous, monoculture, no data, not applicable</i>
Density	Text	6	Density class: <10, 10-100, >100
Notes	Memo	-	Additional notes
DatabaseEntryDate	Date/Time	8	Date of data entry

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Other tables in the MEDN Invasive Plant Database include:

tlu_Contacts – Contact data for project-related personnel

Field name	Field type and Size	Description
Contact_ID	Long Integer (4)	Contact identifier
Last_Name	Text (50)	Last name
First_Name	Text (50)	First name
Middle_Init	Text (4)	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
PersonnelTypeCode	Text (1)	Code describing the role of the contact
DatabaseEntryDate	Date/Time (8)	Data entry date

tlu_Enumerations – Enumerated lookup table

Field name	Field type and 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 and Size	Description
Protocol_ID	Long Integer (4)	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

tlu_Species_List – List of invasive species

Field name	Field type and Size	Description
Species_ID	Long Integer (4)	Unique identifier for the table
Species_code	Text (10)	Unique species code
Species_name	Text (100)	Scientific name
Species_type	Text (20)	Species type (native, non-native, invasive)

9.5 Invasive Plant Geodatabase

The MEDN Invasive Plant Monitoring Program will adopt the National Invasive Species Information Management System (NISIMS) geodatabase to store spatial data on invasive infestations at POEs. NISIMS will also be used by SAMO and CHIS as part of their Invasive Plant Management Plan. Using the same data collection methodologies for early detection of invasive plants will help park managers track, assess and treat infestations in one comprehensive system. Detailed information on NISIMS data structure and organization can be found in Section 5 of the user's guide (<https://irma.nps.gov/App/Reference/Profile/2216091>).

SOP 10: Data Analysis and Reporting

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

10.2 Overview

Data analysis will be conducted annually for status reports and every four years for trend reports after site replication is available. Annual reports will include single-year estimates of status obtained with methods that reflect the sampling design (i.e., design-based methods of estimation). Periodic trend reports will employ model-based analysis approaches to determine how outcomes of interest are changing over time.

10.3 Annual Reporting of Status

Annual reports will include descriptive statistics such as the mean, median, standard error, minimum, maximum, percentiles, and range. The reported statistics will reflect measures of the outcomes of interest that best describe the condition of the resource in each park. Status estimates will be calculated annually with methods that reflect the Generalized Random Tessellation Stratified (GRTS) sampling design. The following status estimates will be reported annually:

Points of Entry (POE):

Estimates of total gross infested area of each target NNIS

Estimates of total net infested area of each target NNIS

Estimate of the mean number per unit area of target NNIS at each site

Dirt Roads and Trails (DRT):

Estimates of overall frequency of each target NNIS

Estimates of proportions of sites within each distribution class

Interior Parklands:

Estimates of mean percent and foliar NNIS cover by target NNIS

Estimate of mean number of target NNIS per site

When computing the mean and variance, the GRTS sampling design will be incorporated. Design-based estimates computed from data collected in a single year are obtained with the Horvitz-Thompson estimator (Horvitz and Thompson 1952). The neighborhood variance estimator (Stevens and Olsen 2003, 2004) is used to account for the spatial balance of the sample and is calculated as:

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

where:

$\hat{\mu}$ is the estimator of the population mean, μ ,

$s_{i,j}$, or k are sample points,

R is the domain of the sampled population defined as a set of points occupied by the population elements,

$D(s_i)$ is the local neighborhood for site i ,

w_{ij} are weights chosen to reflect the behavior of the pairwise inclusion function for GRTS, and are constrained so that $\sum_i w_{ij} = \sum_j w_{ij} = 1$,

$z(s_i)$ is the real-valued outcome measured at the i th point, and

$\pi(s_i)$ is the inclusion density for site i .

The R statistical software (2014) package *spsurvey* (Kincaid and Olsen 2013) will be used to obtain design-based estimates with standard errors and confidence intervals derived from the neighborhood variance estimator. The *spsurvey* package contains functions for computing design-based estimates of means, totals, variances, percentiles, proportions, and cumulative distribution functions. Unbiased design-based analysis relies on using the appropriate design weight, so design weights for initial samples reduced in annual surveys by factors such as panel designs, insufficient sampling windows, inaccessible sites, and inclusion of sites that are not in the target population must be adjusted appropriately for unbiased inference.

One concern is that, because the width of the road is variable throughout the sampling frame, the area of the strip transects also varies by sampling unit. Frequency is a scale-dependent measure (Elzinga et al. 2001), and the probability that a site contains a NNIS increases as the DRT transect/POE area increases. Also, the number of species at a site tends to increase nonlinearly with the size of the site (Rosenzweig 1995). Accounting for the area of the sampling units in the design-based analysis may be conducted by post-stratifying by an area classification and only making inference to similarly-sized sampling units.

10.4 Trend Reporting

The primary analytical goal of the synthesis and trend reports is to detect and quantify trends in the distribution and abundance of target non-native invasive species. Trend is estimated with model-based approaches that can account for changes over time as well as partition sources of variability. Linear models will be used to describe the changes in the outcomes of interest over time, and the type of linear model used will depend on the qualities and behavior of each outcome of interest. Models such as simple linear regression (SLR), generalized linear models (GLM), linear mixed models (LMM), and generalized linear mixed-effects models (GLMM) (e.g., Zuur et al. 2009) may be used to assess trends in invasive plant outcomes. When the assumptions of parametric tests are not met, then nonparametric tests of trend such as the Kendall Regional tau trend test (Helsel and Franz 2006) will be applied when appropriate.

Model Considerations

Regression Models

The simple linear regression model describes the mean of an outcome of interest as a linear combination of unknown fixed effects (McCullagh et al. 2008). Fixed effects are unknown constants that account for the influence on the outcome of interest from measured covariates such as rainfall, temperature, or elevation. Model validation requires an examination of residuals to be sure that assumptions of normality, homoscedasticity, and independence of the residuals are met.

When the features of the outcome of interest do not meet the assumptions of the residuals, a GLM may be used for certain distributions. A GLM consists of three parts: a linear model containing fixed effects, a distribution family, and a transformation (McCullagh et al. 2008). Error structures reflecting a particular distribution, such as binomial or Poisson, may be assumed when assumptions of normality are not met. A transformation that matches the chosen distribution, called a link function, is applied to the outcome of interest to meet assumptions of the linear model. For example, the frequency of a species within subplots at a site may be measured as the proportion of sub-transects containing NNIS. A binomial GLM may be used to model the true site frequency as measured by the number of “hits” among the 10 sub-transects within each transect. The logistic link function is then used to describe the mean frequency as a linear function of predictors (such as the year to estimate trend) and the error is assumed to reflect that of a binomial random variable. Overdispersion may also be addressed with a GLM. Residual diagnostics for model evaluation are conducted with Pearson or deviance residuals depending on the distributional assumptions (Zuur et al. 2009).

A linear mixed model describes the mean structure with fixed effects and the variance structure with random effects (McCullagh et al. 2008). Random effects are not constants but assumed to be random variables from a larger population of effects. For example, ecological outcomes at a given site are influenced by an almost uncountable number of environmental effects. Rather than trying to explicitly model the many factors influencing site-to-site variation, a random effect of site would be included to partition out the variation contributed by the sample of sites and reduce the amount of unexplained variation in the model. In addition to standard residual diagnostics for the linear model, assumptions of the random effects must be examined as well (see Pinheiro and Bates 2000, section 4.3). A generalized linear mixed-effects model (GLMM) combines a GLM with a random effects model, and assumptions for each part of the model must be examined as described above.

Parametric model parameters may be estimated with one of several methods. In the method of maximum likelihood (ML), the parameter values that maximize the likelihood of the data are used as the estimates. Alternatively, the likelihoods may be used in a Bayesian context to estimate posterior probabilities for model parameters. The Bayesian approach is generally more flexible, allowing for more complex models, but requiring significantly more computation time.

Nonparametric tests of trend are useful when distributional assumptions of parametric tests are not met. However, nonparametric trend tests are not completely distribution-free. For example, the Kendall Regional Tau trend test (Helsel and Franz 2006) does not require assumptions of normality, is robust to outliers, and is invariant to power transformations (i.e., logarithmically-transformed data will yield the same trend test results as untransformed data), but the p-values for the test are not interpretable when data are serially correlated (Helsel and Frans 2006). The trend-free pre-whitening approach (Yue et al. 2002) removes effects of serial correlation without diminishing trend or the power to detect trend.

Other Considerations for Trend Analysis

Ecological datasets often share a number of features of statistical importance. To obtain accurate and precise results from a model, each of these features must be considered, and then accounted for

within the model. Common features of ecological datasets include variable sampling unit area, zero inflation, and correlation. In the following sections, we briefly discuss each of these issues, and offer some possible methods for handling them.

Variable Sampling Unit Area

To account for differences in sampling unit area in the trend analysis, measurements of the area of each POE and for the area of each strip on each DRT site will be collected during the survey. The GPS data collected in the field should provide adequate information to calculate the areas. Once these numbers are in hand, functions of area (e.g., area, area²), may be used to standardize outcomes of interest as measured per unit area, as covariates in the models, or to weight the regression analysis.

Zero Inflation

Ecological data commonly have more zero values than can be explained by a standard parametric model. Such data are said to be ‘zero-rich’ or ‘zero-inflated’. Zero richness causes violation of model assumptions and may provide misleading results, such as inaccurate p-values or fixed-effect coefficients. Several types of zero-inflated models are available (Zuur et al. 2009). The simplest of these models is the hurdle model. A hurdle model combines a Bernoulli random variable that models the probability of a zero with a parametric for the non-zero measurements. No distinction is made among the zero observations of the source of the zeros. In a zero-altered model, both distributions may take values of zero, so the zeros are partitioned into different sources. For example, a survey to measure the mean number of northern spotted owl fledglings might employ several visits to a site within a year. This replication is used to model both the probability that owls are detected at a site and the number of fledglings in occupied sites.

Correlation

Most statistical models, and most standard hypothesis tests, assume that the results of observations are independent and identically distributed (IID). In ecological systems and in ecological datasets, the assumption of independence is generally untrue. Observations that are close together in either time or space are generally more similar than observations that are far apart in time or space. In other words, observations are correlated, and are thus not completely independent. To the extent that observations are not independent, models that assume independence will produce liberal results that underestimate both confidence interval widths and p-values.

When successive observations at the same site are collected, outcomes are often not mutually independent and exhibit temporal autocorrelation (TAC). Temporal autocorrelation may be assessed with tools such as the partial autocorrelation plot to assess the temporal distance at which observations are independent. One of the most common methods is to add an autoregressive component to the error portion of a model, in the style of a Markov process. For example, Saveliev et al. (2009) describe a first-order autoregressive model (AR1) which may be used to fit abundance data. Unfortunately, first-order models are often unrealistically simple, and more complex models require many years of data. Biological experience suggests that acute events often have effects for many years into the future, and that some events may have delayed effects that are not apparent until many years after the original event has concluded (personal communication, T. Philippi, Quantitative Ecologist, NPS). In both cases, an accurate model of temporal autocorrelation requires multiple

parameters to describe the complex way in which the size of an effect varies with the amount of time since the event occurred. Such models can be both interesting and useful, but generally require decades of monitoring data in order to fit. Additionally, multicollinearity can be a significant problem. Since inter-site variation is equivalent to temporal autocorrelation, there may be unwanted multicollinearity between a model of TAC and a random effect of site.

This protocol proposes to monitor a number of sites within the same ecoregion. Groups of sites that are geographically close will often be influenced by the same set of environmental factors, and thus have a correlated, non-independent response referred to as spatial autocorrelation (SAC). However, GRTS sampling, which spatially distributes sampling units so that they are not spatially clustered, does not provide the basis for modeling spatial autocorrelation. Most SAC models assume that correlation is a function of distance. For the ecosystems and spatial scales at which we are working, this assumption is usually false (personal communication from Tom Philippi, Quantitative Ecologist, NPS). Instead, plant species and communities tend to be distributed across the landscape in a patchwork pattern, and the obvious spatial covariates (e.g., slope, aspect, elevation) only explain a small portion of the patchiness. Thus, even when the effects of known covariates are accounted for, the residual variation is spatially patchy. When distributions are patchy, correlation is not a simple function of distance. Sites that are within the same vegetation type will tend to be more similar than sites that are within different vegetation types regardless of spatial proximity. We anticipate modeling SAC as a random effect of community type.

Outcomes of Interest for Trend Analysis

The following metrics will provide useful information for answering management and scientific questions:

Points of Entry:

Trend in total gross infested area (sum over all POEs) of each target NNIS

Trend in total net infested area (sum over all POEs) of each NNIS

Trend in number of target NNIS

Dirt Roads and Trails:

Trend in overall frequency of each target NNIS at the park level

Size and direction of the effect of various park-level environmental factors (precipitation, temperature, etc.) on frequency for each target NNIS

Trend in proportion of sites in each distribution class

Interior Parklands:

Trend in cover (% foliar) of each target NNIS

Size and direction of the effect of various environmental factors (e.g., precipitation, temperature, aspect, and slope) on NNIS cover for each target NNIS

Trend in number of target NNIS per site

Proposed Trend Approaches

The model-based methods used for each trend analysis will reflect the qualities of the data, such as the type of outcome of interest (e.g., real-valued, integer, categorical, zero-inflated), the sources of correlation (spatial and/or temporal), potential related covariates, and sources of variation. While all of these factors cannot be completely anticipated prior to data collection and analysis, the following discussion outlines the types of analyses that will be considered.

Points of Entry

Note that POE are censused and treated for NNIS, so trends estimated for these outcomes are interpreted relative to the NNIS removal treatment. Total gross area infested and net area infested will be calculated at the site level. These two area outcomes will be initially modeled with a linear mixed model, but we anticipate that the areas of infestation will be skewed to the right and require a logarithmic transformation to meet parametric model assumptions. If the data contain more zeros than can be modeled with a standard parametric model, then models that can accommodate zero richness (e.g., a zero-inflated log-normal model) will be examined.

The number of target NNIS, a count variable, will be modeled with a Poisson GLMM. Model fit will be assessed with Pearson residuals and overdispersion will be examined. The list of target NNIS may expand over time but species may not be removed from the list to ensure that the trend results are interpretable. (Note: The parks may decide to remove a species from the list that they will continue to target for control for various reasons, see SOP 11). Deviance residual diagnostics will be used to validate model assumptions for the GLM (McCullagh and Nelder 1989), and residual diagnostics for the random effects will be examined as recommended by (Pinheiro and Bates 2000, section 4.3).

Dirt Roads and Trails

Analysis of pilot data indicated that the area of infestation outcome was zero for a large proportion of sites (68% of sites in 2013 and 73% of sites in 2014). In the NNIS-infested sites, the areas of infestation were highly skewed to the right and parametric models demonstrated poor fits. The large proportion of zeros precluded the use of nonparametric trend tests as evidenced by a power analysis.

The sampling design was changed to use larger transects (from 30 m to 500 m) so that each site had a higher probability of NNIS occupancy. The new response design will incorporate 10 sub-transects within each transect where NNIS occupancy will be evaluated. The sub-transect-level measure of occupancy is a binary response (1 if NNIS is found and 0 otherwise) that will be modeled with a binomial GLMM. Extra-binomial variation will be examined. If these models fit poorly to the data, then the trend in design-based park-level estimates of annual frequency may be estimated with a simple linear regression approach. The annual park-level frequency estimates may exhibit temporal autocorrelation and require additional diagnostics and modeling for appropriate analysis and trend testing.

Interior Parklands

Trend analysis of cover data may be modeled with a LMM of the transformed continuous cover proportion. If the cover proportion is constrained in the interval [0,1], then a slight location shift and logistic transformation, a probit transformation, or an arc-sine square-root transformation may be

used. If these transformations are insufficient to meet LMM assumptions, then beta regression (Ferrari and Cribari-Neto 2004) may be applied with the *betareg* package in R. The chosen regression model can then incorporate various environmental factors (precipitation, temperature, aspect, and slope) to assess their effect size and direction relative to NNIS cover for each target NNIS. Trend in the number of target NNIS per site will be estimated with a Poisson GLMM as for POE.

10.5 Literature Cited

- Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 2001. Measuring and Monitoring Plant Populations. Blackwell Science, Inc., Malden, Massachusetts.
- Ferrari, S. L. P., and F. Cribari-Neto. 2004. Beta regression for modelling rates and proportions. *Journal of Applied Statistics* 31:799-815.
- Helsel, D. R., and L. M. Frans. 2006. Regional Kendall test for trend. *Environmental Science and Technology* 40:4066-4073.
- Horvitz, D. G., and D. T. Thompson. 1952. A generalization of sampling without replacement from a finite universe. *Journal of the American Statistical Association* 47:663-685.
- Kincaid, T. M., and A. R. Olsen. 2013. *spsurvey*: Spatial Survey Design and Analysis. R package version 2.6.
- McCullagh, P., and J. A. Nelder. 1989. Generalized linear models. Vol. 37. CRC press.
- McCullagh, C. E., S. R. Searle, and J. M. Neuhaus. 2008. Generalized, Linear, and Mixed Models, 2nd edition. Wiley, Hoboken, New Jersey.
- Pinheiro, J. C., and D. M. Bates. 2000. Mixed-Effects Models in S and S-Plus. Springer, New York.
- R Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at <http://www.R-project.org/>.
- Rosenzweig, M. L. 1995. Species Diversity in Space and Time. Cambridge University Press.
- Saveliev, A. A., M. Cronin, M., Zuur, A. F., Ieno, E. N., N. J. Walker, and G. M. Smith. 2009. Incorporating temporal correlation in seal abundance data with MCMC. Pages 503-529 in A. F. Zuur, E. N. Ieno, N. J. Walker, A. A. Saveliev, and G. M. Smith (eds.). *Mixed Effects Models and Extensions in Ecology with R*. Springer, New York.
- Stevens Jr., D. L., and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. *Environmetrics* 14:593-610.
- Stevens Jr., D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal of American Statistical Association* 99:262-278.

- Yue, S., P. Pilon, B. Phinney, and G. Cavadias. 2002. The influence of autocorrelation on the ability to detect trend in hydrological series. *Hydrological Processes* 16:1807-182.
- Zuur, A. F., E. N. Leno, N. J. Walker, A. A. Saveliev, and G. M. Smith. 2009. *Mixed Effects Models and Extensions in Ecology with R*. Springer, New York.

SOP 11: Reviewing and Revising the Target Invasive Species List

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

11.2 Overview

This SOP explains how and when to review and revise the list of target non-native invasive plant species that is used in this monitoring. The methods for selecting the original 19 target species list were developed in 2007 (Althoen et al. 2007). The review is a yearly event that should take place as a component of pre-field season preparations, and be carried out by the Program Lead (or designee) for each park. The review should include consultation with park staff, land managers, and subject matter experts, as well as a review of federal, state, and regional invasive plant information resources.

The target species list should be reviewed every year, during the pre-field season preparation, though the list may not require revision every year. Keep in mind that the list should be realistic, and include only as many species as may reasonably be monitored with the available resources. Species should be prioritized based on their potential for ecological damage and the potential for effective control. Only high-priority species should be placed on the list. For example, non-native annual grasses and mustards can have serious ecological impacts. However, both groups are so widespread that they will likely never be effectively controlled. It is more important to focus on those species where control or containment is attainable.

11.3 Considerations for the Annual Species List Review

Species should not be removed once placed on the target list for monitoring because it would interfere with long-term trend analyses (see SOP 10). Species should be considered for addition to the list, if any of the following are true:

The species is invasive elsewhere, and is present in the park at low abundance or with limited distribution.

The species is known to be particularly harmful, and known to be moving into the region, but has not yet been detected in the park.

The state or region has issued an alert on the species, and it is known that there is habitat within the park which is potentially suitable for the species.

NOTE: The parks may consider species for removal from their list of species *that will continue to be controlled* if any of the following are true, however they will continue to be monitored through the invasive plant I&M program:

The species has been locally eradicated for long enough that seed banks are likely to be depleted. Note that the time required for depletion of seed banks is different for each species.

The species has expanded to the point where there is no longer a reasonable possibility of control, and there has been a park management decision to remove it from the list

The species has been reclassified by state or regional authorities, and is no longer believed to be of concern. (e.g., removed from the noxious species list)

11.4 Consultations Needed during the Review/Revision Process

Consult with park staff and managers for on the ground observations and management concerns.

Consult with regional, state, and national invasive plant databases and watch lists such as: California Department of Food and Agriculture, local Agriculture Commissioners, USDA CalFlora database,

California Invasive Plant Council (Cal-IPC), University of California Cooperative Extension, and local Weed Management Areas.

Consult with subject matter experts (e.g., academics, practitioners, land managers, conferences/symposia, etc.).

11.5 What to Include in Documentation and Reporting of the Review and Revision Process of the List

A. For reviews that **Do Not** result in revising the list:

- Date of review
- Name and title of person(s) conducting the review
- Names of all entities/resources consulted
- A short narrative describing the process, findings, and conclusions

B. For reviews that **Do** result in revising the list:

- Date of review
- Effective date for the revised list
- The new target species list for inclusion in the protocol
- Name and title of person(s) conducting the review
- Names of all entities/resources consulted
- Name(s) of all species that are added to or removed from the list
- A narrative describing the process, findings and conclusions. This narrative must include a justification for each addition and/or removal.

If reviews result in revisions to the list, the documentation must be submitted to the MEDN Data Manager before the field season to allow for database updates. Distribute the new list and species identification information to the team members at the beginning of the field season. Retain the review/revision documentation in electronic form and in hardcopy form. Store the hardcopies in a fire-safe cabinet, alongside other files for the invasive plant I&M program.

11.6 Literature Cited

Althoen, Emily J., Elliot Chasin, Saklani Kent, Emmeline Kiyan, and Sarah Schliemann. 2007.

Biology and management of non-native plant species in the Santa Monica Mountains National Recreation Area. Master's thesis. University of California Santa Barbara, Donald Bren School of Environmental Science and Management.

SOP 12: Obtaining Data from Interior Parkland Monitoring Programs

MEDN I&M Terrestrial Vegetation Monitoring Program and the Water Quality and Riverine Integrity I&M Program MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

12.2 Overview

This SOP explains how to obtain the quality-assured invasive plant data collected via the MEDN Terrestrial Vegetation Monitoring Program and the Water Quality and Riverine Integrity Monitoring Program. These data will be entered and quality-checked and assured by those programs.

12.3 Obtaining Invasive Plant Data from the MEDN Terrestrial Vegetation Monitoring Program and File Storage

Program Lead opens the MEDN Terrestrial Vegetation Database (Microsoft Access).

Under the 'Export Menu', select 'Query for Invasives Protocol' under the drop-down menu for 'Type of Query to Export'.

Click the 'Export' button. Name the file with the following convention:

[park]_terrestrialvegetation_invasives_date

where the date consists of the 4-number year, 2-digit month number and 2-digit day number (e.g., SAMO_terrestrialvegetation_invasives_20120627).

Data will be exported as a CSV-formatted file.

No further data quality checking or assurance is necessary, as the Terrestrial Vegetation Monitoring Program and the MEDN Data Manager have already certified the data.

Store the data in electronic form in a folder named 'terrestrial vegetation invasives data':

H:\DIVISION\psrm\Inventory_and_Monitoring\Vital_Signs\Invasive_plants\Data\terrestrial_veg_invasives_data.

12.4 Obtaining Invasive Plant Data from the Water Quality and Riverine Integrity Monitoring Program

The protocol for this monitoring program is still in development. The procedure for obtaining invasive plant data from this program will be similar to that of the Terrestrial Vegetation Monitoring Program. This SOP will be revised when the procedures are finalized.

SOP 13: Annual Report Template

MEDN Invasive Plant Monitoring Protocol

Version 1.0 (March 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.

This applies to SOP 13 only. Other SOP changes are found under individual SOPs. The following revisions have occurred to this SOP since March 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/invasiveplants.cfm>

13.2 Overview

The annual report will be prepared as a Natural Resource Data Series report. Guidance on the content, format and style, along with a manuscript submittal checklist can be found at the Natural Resources Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

The annual report will be organized into four main sections: Introduction, Methods, Results, and Discussion. The body of the report will be followed by two appendices containing separate tabular and graphical data summaries for CHIS and SAMO.

13.3 Suggested Figures and Tables

Figures

Figure 1. Map showing locations of sites monitored at each park (POE and DRT only).

Figure 2. Histogram of total number of target NNIS (number of different species) found per strip transect along dirt roads and trails.

Figure 3. Roads/trails sites showing average density class of target NNIS species by strip transect.

Figure 4. Number of NNIS per site (Y axis = # of weeds, X axis = site number)

Figure 5. Map of location of new NNIS species detected during the year, coded by species per park.

Tables

Table 1. The number of sites monitored, planned but not monitored, and GRTS points rejected. (Described in text, but may need table with coordinates.)

Table 2. The number of target NNIS and new species found in 20XX.

Table 3. Summarize the percent of area (m²) infested for POE by each zone (the hardscape and the 20 m area surrounding it), and the number and species identity of detections outside the survey area.

Table 4. [PARK] Summary of observed abundance by each component of monitoring (by various metrics).

Figures in Appendices

Figure A1. Roads/trails sites showing distribution of target NNIS species and their average distribution pattern and density class by strip transect (histogram).

Tables in Appendices

Table A1. Average NNIS distribution pattern by transect along dirt roads and trails at SAMO.

Distribution	Trail bed	Strip A	Strip B
% absent			
% isolated			
% linear			
% scattered			
% patchy			
% continuous			
% monoculture			

13.4 Introduction (Background and Objectives)

This section provides the background and objectives of the MEDN Invasive Plant Monitoring Program. It is essentially an abbreviated version of the Background and Objectives section of the protocol narrative. It should include a regional map showing the location of the parks, brief summaries of the importance of MEDN vegetation, and the monitoring need, followed by the monitoring objectives.

13.5 Methods Section

This section is divided in two.

Section 1 - provides *brief* descriptions of the following:

- Sampling procedure
- Response design (with plot schematic, e.g., Figures 4 and 6 of the narrative)
- Response measures (distribution, density, etc.)
- Measurement techniques
- Response metrics (individual species, area covered, distribution)
- Data QA/QC procedures

Section 2 - provides information on the plot installation and data collection at each park. It includes the following, described separately for each park:

- Site assessment and new transect establishment
 - Number of sites visited, new transects established and transects rejected
 - Name and position of individuals who performed the work
 - Dates that the work was performed and person-hours required to perform the work
 - Brief discussion of reasons plots were rejected and any other difficulties encountered
 - In the appendix for each park, be sure to provide specific information on each potential transect location rejected and each new transect established

- Monitoring activities
 - Number of sites monitored, and number of sites scheduled for monitoring but not monitored
 - Name and position of individuals who performed the work
 - Dates that the work was performed and person-hours required to perform the work
 - A brief discussion of noteworthy happenings during the monitoring: practical difficulties, alterations to the protocol, unusual events (e.g., fires, landslides), injuries, etc.
 - In the appendix for each park, be sure to provide specific information on each POE and DRT monitored and those that were scheduled for monitoring, but not monitored
- Data Management
 - *Use this sample text as a guide:* “At the end of each field day, the spatial data and tabular data collected by the GPS units (and hardcopy datasheets) from that day were entered into their respective customized databases and checked to ensure legibility, completeness, and correct use of species codes. Secondary checking and assurance was conducted after the end of the 20XX invasive plant monitoring field season by {name(s)} between {date} and {date}.”

13.6 Results Section

Findings for each park will be described separately.

- Provide a brief summary of the following attributes broken out by component of the monitoring, as applicable for each park.
 - Number of transects established and rejected (with reasons for rejection)
 - Number of species detected overall at POEs and DRT
 - Area covered, percent cover by species or growth form (if of interest)
 - For each target species, provide a brief summary of the average density category, distribution pattern, and parkwide distribution for each park. Reference Table X in appendix.
 - Provide a brief summary of changes in distribution and cover by site type (POE, DRT, interior) observed over the most recent six years of monitoring. The purpose of this section is *not* to provide a trend analysis with statistical tests for change. Rather, it is to provide the reader with a sense of how summary data (mean and standard deviation) have changed over the five years preceding the reading. Reference Figure 5.
 - Highlight any interesting or unusual findings, such as an unexpected or dramatic change in an individual species or a growth/life form, notable phenologic events, or detection of new species.

13.7 Appendices A and B

Create a separate appendix for each park showing summary graphs and tables.

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 159/132106, 638/132106, March 2016

National Park Service
U.S. Department of the Interior



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