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Thousand Oaks, Ventura, & San Diego, California

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network:

Santa Monica Mountains National Recreation Area & Cabrillo National Monument

Version 1.0, September, 2006

Natural Resources Technical Report NPS/MEDN/NRTR—2006/005



ON THE COVER
Californinia horned lizard, *Phrynosoma coronatum*,
NPS photo by Scott Storey.

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Natural Resources Technical Report NPS/MEDN/NRTR—2007/005

Gary Busteed
National Park Service, Santa Monica Mountains NRA, 401 W. Hillcrest Dr., Thousand Oaks, CA 91360

J. Lane Cameron
National Park Service, Mediterranean Coast Network, 401 W. Hillcrest Dr., Thousand Oaks, CA 91360

Seth Riley
National Park Service, Santa Monica Mountains NRA, 401 W. Hillcrest Dr., Thousand Oaks, CA 91360

Lena Lee
National Park Service, Santa Monica Mountains NRA, 401 W. Hillcrest Dr., Thousand Oaks, CA 91360

Andrea Compton
National Park Service, Cabrillo National Monument, 1800 Cabrillo Memorial Dr., San Diego, CA 92106

Eileen Berbeo
National Park Service, Santa Monica Mountains NRA, 401 W. Hillcrest Dr., Thousand Oaks, CA 91360

Tiffany Duffield
National Park Service, Cabrillo National Monument, 1800 Cabrillo Memorial Dr., San Diego, CA 92106

U.S. Department of the Interior
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Mediterranean Cast Network
Thousand Oaks, California

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*Southern or San Diego alligator lizard (*Elgaria multicarinata*) in a pitfall trap. Note PVC hide tubes.*

Protocol Narrative

Background

Reptiles and amphibians in the parks of the Mediterranean Coast Network (MEDN) are affected by numerous stressors and impacts to their environment and habitat. Global fluctuations in temperature, increased exposure to ultraviolet radiation, interaction with exotic species, and changes in air and water quality have all been linked to declines in amphibian populations (c.f. Blaustein & Wake 1990). In addition, urban development has significantly altered or destroyed critical habitat for many reptile and amphibian species. This is especially so in the Santa Monica Mountains National Recreation Area (SAMO) and Cabrillo National Monument (CABR, located on Point Loma peninsula and included in the Point Loma Ecological Conservation Area, PLECA, formerly known as the Point Loma Ecological Reserve). Thirteen of the 34 species of herpetofauna found in the Santa Monica Mountains are listed as rare, threatened or endangered by the California Department of Fish and Game and/or the U.S. Fish and Wildlife Service. Seven of the nineteen species of herpetofauna historically known to occur on Point Loma are now thought to have been extirpated (Atkinson et al. 2003, attached).

Evaluation of historic data and some recent studies suggest that a number of reptile species in the mountains are in decline (NPS unpublished data; De Lisle et al. 1986; Gamradt & Kats 1996, 1997). Much of this information, however, is insufficient to determine the actual and/or potential impacts that have or might be occurring from expanding urbanization in southern California. Recent data suggests that certain reptile and amphibian species are sensitive to fragmentation of natural habitats by development and land use changes in the region of the Santa Monica Mountains (Busteed 2003). Additionally, studies from other areas of southern California have noted declines in reptile and amphibian species as a result of urban associated impacts (Robert Fisher, USGS, personal communication). These declines will likely continue as the human population of southern California continues to grow and urban development expands.

Because of the broad diversity of reptiles, their habitat requirements, and diet specificity, species richness has been suggested as a good indicator of ecosystem quality and integrity for these animals. Additionally, information on the distribution and abundance of reptiles and amphibians supports efforts to design restoration strategies and land management programs to aid in their protection and/or recovery from decline. Repeated quantitative assessments of the distribution and abundance of reptiles in the Santa Monica Mountains and the PLECA will provide information on the status and trends in status of these animals, providing information critical to NPS resource managers in evaluating the ecological health of these important indicator species and the broader ecosystems of which they are a part.

Monitoring of terrestrial reptile and amphibian species distribution and abundance has been ongoing in the PLECA since 1995 (Brown & Fisher 2002). This monitoring was initiated and conducted by staff from the United States Geological Survey (USGS), Western Ecological Research Center (WERC) following a generic protocol for monitoring herpetofauna using pitfall traps (Stokes et al. 2001). Because of the regional significance of reptiles and amphibians as indicators of ecosystem health similar monitoring was initiated in the broader Santa Monica Mountains ecosystem early in the monitoring planning process. This protocol captures the monitoring processes employed by Cabrillo NM in the PLECA and the Santa Monica Mountains as implemented by the MEDN, establishes a uniform process for administering these monitoring efforts within the network, and incorporates the sampling design optimization analysis completed for data collected in the PLECA (Atkinson et al. 2003).

Objectives

Long-term objectives for reptile monitoring include detecting population declines, identifying species that may be indicative of both short-term and long-term ecological change, and determining which species may be in immediate danger of extirpation. This monitoring protocol covers in-depth the methodology used for sampling terrestrial reptile and amphibian populations in southern California. To better understand stresses to native herpetofauna from invasive non-native Formicidae (ants), ant

trapping is included in this protocol and is addressed specifically in Standard Operating Procedure (SOP) No. 11. Vegetation habitat associations are important factors that greatly influence the distribution and abundance of reptiles and amphibians (Block & Morrison 1998, Davis & Verbeek 1972). To ensure data collected may be compared to regional herpetofauna monitoring conducted by other agencies or groups, vegetation habitat identifications follow the California Native Plant Society "A Manual of California Vegetation" (http://davisherb.ucdavis.edu/cnpsActiveServer/index.html & CNPS, 2001). See SOP No. 7 for guidance on completing vegetation surveys at pitfall arrays.

Questions & Objectives to be Addressed by the Protocol:

- Are population characteristics of terrestrial herpetiles in the Santa Monica Mountains & PLECA increasing or decreasing?
- Is the range of herpetile species diversity in the Santa Monica Mountains & PLECA increasing or decreasing?
- Is landscape fragmentation and loss of connectivity of natural open space in the Santa Monica Mountains impacting herpetile populations?
- Are any species of terrestrial herpetiles on Point Loma showing population declines at present?
- Maintain sufficient pitfall trap arrays, sampling periods (months), and sampling days (length of time pitfall traps open) per sampling period in the PLECA to detect a 30% drop in species richness of herpetiles, a 30% drop in the relative abundance of the orange-throated whiptail (*Cnemidophorus hyperythrus*) and striped racer (*Masticophis lateralis*), and some measure of drop in abundance or occupancy of western ring-necked snake (*Diadophis punctatus*) and southern Pacific rattlesnake (*Crotalus viridis*) as recommended in the sampling design optimization analysis performed for the PLECA (Stokes et al. 2001).
- Determine long-term trends in terrestrial herpetofauna distribution, abundance, and morphometrics from pitfall trap arrays nested in five habitat regions of the Santa Monica Mountains.

Sampling Design

Rationale for Sampling Design

Because of their small size, cryptic coloration, and nocturnal or fossorial behavior, effective sampling of reptile and amphibian populations can be difficult, and many techniques have been developed to assess the diversity and abundance of these species. Of the various methods tested, pitfall trapping with supplemental funnel snake-traps has been found to be an effective sampling methodology (Fisher & Case 2000a, 2000b, Case & Fisher 2001). Pitfall trapping has been used in southern California for monitoring distribution and abundance of terrestrial reptiles and amphibians since 1995 and is consistent with other long-term monitoring programs occurring in central California (Stokes et al. 2001).

Pitfall trapping consists of the deployment of a series of sampling arrays that are based upon the premise that ambulatory reptiles and amphibians can be directed by "drift" fences into bucket traps (pits) embedded in the ground. In this design each pitfall array consists of seven 5-gallon buckets buried so that the lip of the bucket is flush with the surface of the ground to serve as a "pitfall" (Campbell & Christman 1982, Corn 1994, Fisher & Case 2000a, Fisher et al. 2002). Buried buckets are situated approximately 7.5 meters apart along a "Y" configured drift fence. There are two buckets along each arm and one at the vertex of the three arms. Snake traps are placed along each arm of the drift fence. Drift fences intercept reptiles and amphibians directing them into either pitfall buckets or snake traps (Fitch 1992, Corn 1994, Greenberg et al. 1994, Fisher & Case 2000a, 2000b, Enge 2001). Ground cover boards are placed near one arm of each array in the PLECA to specifically sample California legless lizards (*Anniella pulchra*) and smaller snakes such as the ring-necked snake (*Diadophis punctatus*) and the night snake (*Hypsiglena torquata*).

Site Selection

Several factors govern the location of trap arrays: vegetation, terrain, proximity to

public trails, proximity to archaeological sites, and ease of accessibility. Specific vegetation habitats and fairly level terrain are required for locating trap arrays. Installing arrays on steep slopes was avoided because capture success is generally lower, trap maintenance more laborious, and erosion can fill buckets with debris or wash out drift fences (Fisher & Case 2000b). To minimize disturbance by the public, all trap arrays were installed several meters from and out of sight of trails. To ensure accessibility during inclement weather (when mud and rain make vehicular travel difficult on unimproved roads) all array sites were located within reasonable walking distance of improved roads or trails. Final locations of pitfall arrays were recorded using global positioning system (GPS) equipment. Array location data were entered into the SAMO and CABR GIS databases.

Santa Monica Mountains NRA
Five sampling regions were identified across the greater Santa Monica Mountains ecosystem for stratifying pitfall-trapping sites across various habitat types with varying degrees of urban impact within the functional ecosystem of which the Santa Monica Mountains are a part (see SOP No. 3). Within these five regions specific habitat types where pitfall traps were installed included: chamise, chaparral, chaparral/grass, grass, grass/rock, oak woodland, riparian/grass, sage, sage/grass, and sage/rock. Division of the mountains functional ecosystem into five sampling regions was also based upon logistical constraints in accessing sites, installation processes, and management of sampling personnel, and to allow for procedural refinement of the sampling protocol and analytical process though a phased approach to program implementation.

Sampling regions generally followed the drainage (watershed) characteristics of the mountain area and are identified as follows:

1. **Simi Hills** (20,987 ha) – Generally North of the US 101 Freeway with ~50% urbanized and highly fragmented habitat. In the west 20% of this region lies to the south of the US 101 Freeway.
2. **Western** (13,442 ha) – Point Mugu State Park, with the majority of pitfall arrays on state park lands.
3. **Central Coast** (11,423 ha) – Coastal habitats and hillsides with generally south facing slopes and steep canyons that are more mesic than other portions of the Santa Monica Mountains.
4. **Malibu Creek** (19,714 ha) – Malibu Creek State Park, south of the US 101 Freeway. This region has protected parkland and is adjacent to recently urbanized areas.
5. **Eastern** (15,239 ha) – Highly urbanized chaparral habitat.

Suitable trap array sites were selected after examination of topographic map layers from the SAMO Geographic Information System followed by on-site surveys. Cultural resource site maps and park cultural resource staff were consulted prior to array installation to limit disturbance to cultural resources.

Written approval for the placement of long-term sampling sites on lands that are not owned or managed by the National Park Service within the Santa Monica Mountains was obtained from California State Parks, City of Thousand Oaks, Conejo Open Space Conservation Authority, Mountains Restoration Trust, and Rancho Simi Parklands. Collection of wildlife specimens for research is managed by the California Department of Fish and Game. Scientific collecting permits are required for toe and scale clipping of reptiles and amphibians, collecting tissues for genetic research, or the taking of specimens for species identification. Approvals for access to non-NPS lands and collection permits are on file at the SAMO headquarters building in Thousand Oaks, California.

Point Loma Ecological Conservation Area
The PLECA is a cooperative land management partnership for the native undisturbed habitat remaining on Point Loma peninsula. Lands within the PLECA are owned primarily by the US Navy and the National Park Service. Other stakeholders who are signatories to the PLECA cooperative management memorandum of understanding include the US Coast Guard, the City of San Diego (Point Loma Wastewater Treatment Plant), the US Fish and Wildlife Service, and the Department of Veterans Affairs.

Pitfall trap array sites were chosen to represent the range of habitats found in

the PLECA in order to better understand the status and distribution of reptiles and amphibians throughout the peninsula. Point Loma was stratified by vegetation and the numbers of arrays placed in each habitat type are in approximate proportion to the proportion of that habitat type in the PLECA. Unique landscape features such as open sand washes were also included. The primary vegetation habitat types found on Point Loma include coastal sage scrub, maritime succulent scrub, and southern maritime chaparral. The distribution of these habitat types varies with aspect, exposure, slope, substrate, and disturbance history. Location access, visibility to visitors, vegetation type, and habitat sensitivity also affected array site selection.

Number & Location of Sampling Sites

Santa Monica Mountains
Pitfall trap sampling occurs on a by region basis. Twenty-two arrays are installed within 12 habitat patches within the Simi Hills region (see SOP No. 12). Habitat patches were selected based upon size of the patch, vegetation type of patch, and patch fragmentation characteristics. Arrays were installed in seven small patches (8 to 45 ha), three medium patches (328 to 445 ha), and two large patches (1909 to 2655 ha). A single array was placed in each of the small patches, and three arrays were placed in each of the medium and large patches. Arrays in the Simi Hills were intended to capture baseline data on reptile and amphibian abundance and distribution based upon the criteria listed above (patch size, vegetation, and fragmentation) and to enhance the interpretative power (in a non-statistical sense) of future monitoring results and to direct management actions intended to preserve and protect the terrestrial reptile and amphibian fauna of the Santa Monica Mountains. Nineteen pitfall trap arrays are installed within the western region. Pitfall arrays will be installed (twenty arrays are presently being installed in the Malibu Region) in the remaining three regions every other year until arrays have been installed in all regions.

Point Loma Ecological Conservation Area
Pitfall trap arrays are scattered throughout the PLECA to capture information about species present within a variety of habitats (e.g., coastal as compared to east-facing bay-side habitats, sandy washes, exposed south-facing slopes, drainages, and disturbed areas). Sixteen of the seventeen pitfall arrays originally installed are currently maintained and sampled within the PLECA (see SOP No. 12). Twelve of the arrays are installed in Maritime Succulent Scrub. three in Southern Maritime Chaparral, and one in an area of highly disturbed native vegetation. Array No. 6 (Southern Maritime Chaparral) was closed in 2005 following a statistical review of the data collected in the previous five years which showed that there was no difference in data collected between arrays No. 5 and 6 (Atkinson et al. 2003). See table 12-2 in SOP 12.

Frequency and Timing of Sampling

In the Santa Monica Mountains ecosystem, arrays are visited monthly by region, for five consecutive days (60 times a year), typically Monday through Friday. Each sampling event includes visiting twenty pitfall trap arrays. Twenty arrays can be visited by two teams in approximately five hours. Examination of pitfall traps is labor intensive and it is important that all sites be visited in a relatively short period of time in order to reduce the mortality from overheating of incidentally captured small mammals. Arrays are organized into sets of two. Each set is sampled by one of the two teams working parallel to each other. Concurrent sampling minimizes the length of time specimens are left in traps and minimizes the variability in capture success as a result of micro-climate variability.

Each pitfall array in the PLECA is sampled for four consecutive days typically Monday (when the traps are opened) through Friday (when the traps are closed) once a month from January through October. Pitfalls are sampled one additional week during November or December for a total of eleven sampling periods for each array in a twelve month period. Sixteen of the seventeen arrays installed in the PLECA are presently sampled during each sampling cycle (see SOP No. 2). Arrays are organized into two sites, nine arrays are located on NPS property and seven arrays are located on US Navy property within the PLECA. Arrays are typically sampled in the morning. All active arrays can be sampled in six hours by a single two person team.

Field Methods

Field Season Preparations and Equipment Setup

Field season preparation and equipment setup procedures are identical to those outlined in the attached USGS protocol and described in SOPs Nos. 1, 2, & 4.

Sequence of Events during Field Sampling

All procedures outlined for establishing and maintaining trap arrays are to be followed precisely. This includes preparation and placement of buckets, wire mesh snake traps, and drift fences. It is imperative that traps and arrays are always in the best possible condition when sampling begins. Cleanliness of bucket traps and consistency in maintenance ensures trapping success, benefits captured animals, facilitates data collection, and promotes a positive image of the project to all concerned. Array sites are subject to inspection by National Park staff and various state and federal agencies for compliance with the following requirements:

1. Trap arrays are to be checked and captures processed during early morning hours before the day becomes hot.
2. All bucket traps are thoroughly cleaned inside. A clean wet sponge is also laid flat in the bottom. Soil, debris, and potentially hazardous arthropods such as scorpions, centipedes, and large spiders should be removed each day during sampling. Each trap is provided with PVC tubing "hide tubes" as refuge shelter for captured animals.
3. The soil surrounding the bucket rim must be kept graded smooth to ensure that it is nearly flush with the bucket rim. Bucket traps and both sides of the drift fence should be inspected for disturbance caused by erosion or burrowing by small mammals or other wildlife. Deterioration of, or damage to array components must be repaired as soon as possible.
4. Snake traps are to be placed between the outer and middle buckets on the right side (looking outward from the center) of each of the three arms of the array (see SOP No. 2). Each trap is provided with a PVC hide tube for captured snakes, placed as close as possible to the drift fence, and covered with plywood.
5. Cover boards are placed near the end of one arm on each array within the PLECA.

Note: throughout this document and the accompanying SOPs metric and English measurements are intermixed. Building materials in the US are manufactured and marketed based on English standard units (inches, feet, yards, etc.). On the other hand scientific instrumentation and apparatus are manufactured and marketed based upon the metric standard (millimeters, centimeters, meters, milliliters, liters etc.). While metric units are the accepted standard for all aspects of scientific reporting, where the conversion to metric units provides no advantage and could create confusion in acquiring or producing pitfall trap components English units are reported.

Bio-technicians assigned to field sampling are to take a sampling kit with them each time they are in the field checking traps. This kit contains:

1. 30 g, 60 g, 100 g, and 1 kg Pesola® spring scales.
2. Several weighing bags (typically 1 quart or 1 gallon zip-lock bags).
3. A cloth weighing bag for large snakes.
4. A clear plastic metric ruler for measuring lizards and small mammals.
5. A 2 m measuring tape for snakes.
6. Large forceps for handling captured small mammals and large invertebrates.
7. Small cuticle scissors for toe and scale clipping.
8. Fifty 1.5 ml centrifuge tubes filled with at least 70% ethanol (ETOH) for preserving toe and scale clips.
9. Four 50 ml centrifuge tubes filled with at least 70% ETOH for dead specimens.
10. Five one gallon sized plastic bags for storing larger dead specimens that are to be preserved later in ETOH or by freezing.
11. Reptile and Amphibian Field Guide.
12. Small Mammal Field Guide.
13. Permanent (water and alcohol resis-

tant) pens to mark centrifuge tubes.

14. Colored marker for temporarily marking animals.
15. Data book or Personal Digital Assistant (PDA) for collecting monitoring data.
16. Blood-clotting powder (for use after toe or tail clipping).
17. Zip-ties or hog rings for repairing snake traps.
18. Rubber gloves for handling captured small mammals.
19. Leather gloves for handling snake traps.
20. First aid kit for treating minor cuts, scrapes, or insect bites.
21. Snake hook for removing venomous snakes from traps.
22. Packaged wet wipes or antibacterial hand gel for cleaning hands in the field.
23. A hammer for opening and closing pitfall buckets
24. Leatherman-type pocket tool.

Collecting and Recording Data

Date, site location, array number, and bucket, snake trap, or cover board number for each captured individual, including incidental small mammal captures, are recorded in the field notebook or on a PDA (see SOP Nos. 5 & 6). Species name is recorded using a four-character code consisting of the first two letters of the genus and species names (see Attachment 1). Reptile or amphibian species observed at the sampling sites and while traveling to and from array locations are noted on the species list in the field notebook or PDA. Array location, species identification, weight, age, sex, disposition, and tissue sampling information are recorded for all captures.

Captured specimens are placed in a tared plastic bag and weighed to the nearest ¼ gram with a Pesola® spring scale (weighing bags are tared with each scale at the beginning of each sampling day). Small amphibians, lizards, and mammals can be weighed with the 30 g or 60 g scale, larger lizards, mammals, and snakes with the 100 g scale, and large snakes with the 1 kg scale.

Measure the length of captured specimens using a metric ruler or tape measure. Measurements are taken from the tip of the snout to the posterior edge of the anal scale on reptiles, to the cloacal opening on amphibians, or to the base of the tail on mammals. Measurements are best accomplished by inverting the animal and gently pressing the ruler against its underside. Align the snout with the "0" increment on the ruler or tape measure and read the length while holding the animal straight. Larger snakes can be measured by pulling the tape measure along the snake's body. While lengths are determined with a cm rule, record all length measurements in millimeters.

Most species are marked for recapture identification by toe clipping (see toe clipping sequence guide in field kit notebook). Snakes are marked by clipping the subcaudal scales (those on the ventral surface of the tail) in left and right number combinations, with the numbering of the scales beginning at the anterior of the tail and immediately past the anal scale. Detailed clipping procedures and guidelines are found in SOP No. 6 and in the USGS herpetological sampling protocol that is attached (Stokes et al. 2001). Toe clips and distal tail segments (tail tips) removed from salamanders, lizards, and snakes are preserved in tissue vials provided in the field kit.

Mark lizards and snakes for recapture identification with a permanent marker. Recaptured individuals can be re-marked as necessary to restore marks if they appear faded or worn or have been lost due to shedding of the skin. Do not apply a pen mark on the dorsum or head as this may compromise the natural markings of the animal rendering it more susceptible to predation. Sex and age determination are made using the species guide provided with each field kit.

Temperature and weather data are collected daily at each pitfall array location during a trapping cycle. In the Santa Monica Mountains HOBO® data loggers are placed at the first and last trap arrays sampled in a day. In the PLECA a single data logger is placed in coastal, bay-side, and southerly facing habitats.

Processing of Incidental Mortality Among Captured Animals

While every precaution is taken to ensure the survival and safety of animals captured

in the traps, occasionally trapped animals succumb to predation or exposure. These animals can be saved as voucher specimens and stored for future genetic or morphometric analysis by preserving them in containers filled with 70% or 95% ETOH. Record the species name, collection date, site name, and array number on sample containers. Dead animals, not collected as vouchers, are discarded away from the trap array to limit impacts on trap efficiency (increase or decrease in capture rate) that might occur from the presence of dead animals.

Closing Arrays at End of Trapping Cycle
When closing trapping arrays on the last day of the trapping cycle remove all trap inclusions, foreign debris, and thoroughly clean the buckets. Secure a lid on each bucket. It is especially important that the bucket lids seal tightly to prevent small animals from becoming accidentally trapped. Placing rocks and/or dirt on top of the lids can be helpful in keeping them closed until the next trapping cycle. Remove at least one funnel from the ends of the snake traps (see SOP No. 5). Return the field kit, data book, and trap materials to the storage room at park headquarters after each sampling cycle.

Data Handling, Analysis and Reporting

Data & Metadata Procedures

Metadata captured during a trapping cycle are those designated by the USGS (Stokes et al. 2001) Temperature and weather data are collected daily at each pitfall array location during the trapping session or collected with digital HOBO® data loggers (Onset Computer Corporation). For each animal caught at each pitfall or snake trap, information such as species identification, length, weight, sex, age, condition of the animal (i.e. released, escaped, or dead), tissue sample, recapture and general comments, are also recorded. All data storage and preliminary analysis will be facilitated by the MEDN pitfall trap database. Information about each pitfall trap location, including daily temperature readings, weather, and animal capture data, as well as trap site habitat characteristics are stored in this database.

To ensure accuracy of the data as it is entered into the database, the MEDN data manager and the herpetofauna monitoring project managers conduct periodic training with the biological technicians performing data entry and perform quality control checks on entered data. Training is intended to ensure that specified data entry procedures are being followed.

Overview of Database Design

The MEDN pitfall trap database was developed in Microsoft Access® and is maintained by the MEDN data manager. Interactive computer screen data-entry forms are designed to meet the requirements of the project managers and are based on the existing field forms used to record data (SOP No. 5). The database is organized in a format that is consistent with the inventory and monitoring program guidance for the management of NPS natural resource data.

The database is structured to minimize data entry errors by guiding the data entry technician through a simple array of three interactive digital forms. In the first form, the user enters the field date and selects a pitfall trap section. In the second form, the array section is shown with temperature and weather fields. If data already exists, it will be displayed; otherwise the fields are blank and require the user to enter the appropriate field values. In the third form, the user navigates to each array to review or enter capture data. Entry of repeating values in data fields is streamlined by limiting choices to values from static look-up tables and drop-down value lists. Database structure and relational links among data tables are presented in SOP No. 10.

Data Entry, Verification, and Editing

Upon returning to the office technicians from SAMO enter all data from the field notebook into the MEDN pitfall trap database. This includes weather information from each array and all capture related information and data. All entered data is re-checked to ensure that it has been entered exactly as it appears on field forms. Difficulties with/or questions on data entry procedures are resolved by the project manager or the MEDN data manager. Once the data have been entered and saved, the

data manager checks the data for apparent outliers, inconsistencies in entry, null values, or any other obvious anomaly. Anomalies are reported to the project managers for resolution.

Field data are collected in the PLECA on Personal Digital Assistants (PDA) via a Pendragon™ software data form interface. This interface allows PDAs using the Palm Operating System (OS) to store and download data to any MS Access database. Data collected are downloaded into a mirror of the Access database currently in use at SAMO. Specifics of the digital data-entry form construction and PDA use are presented in the attached USGS Draft Administrative Protocol, "Protocol for Pitfall, PDA: New Pitfall Survey Form Use". As an additional quality assurance and quality control precaution, PDA data are downloaded within two hours of collection. Data are checked and verified from the database. After this verification process the data are available for analysis and reporting.

Data Summarization and Statistical Analysis

Within the Santa Monica Mountains reptile and amphibian monitoring under this protocol is in the development stages and specific guidelines for determining baseline conditions and trend analysis will be evaluated following four years of data gathering within each region. The specific process will mirror that used for the Point Loma herpetofauna sampling optimization analysis, which determined baseline conditions and initial trends from the first five years of sampling in the PLECA.

The primary variables to be analyzed based upon the Point Loma model include:

- Number of species detected per array (used as surrogate for species richness)
- Simpson's measure of species evenness[1]
- Herpetofauna captures (lizards, snakes, and salamanders)
- Lizard captures
- Snake captures or sightings
- Number of arrays with 1 or more snake captures
- Rare species captures

Based on the experience from pitfall trapping in the PLECA data for analysis will be grouped into three categories:

Group 1 – Variables in this group are those with large amounts of data at all or nearly all arrays. Average number per array per year can be calculated and these data can be used to conduct sample size analysis. Analyses for this group include:

- Regression analysis in which arrays are treated as class variables and years are treated as the regression variable
- Sample size calculations
- Calculation of control limits

Group 2 – This group includes species which have much smaller number of captures even when summed across all arrays (15 or less captures per year). This group of variables consists of either a) total number of captures summed across all arrays or b) the number of arrays at which an organism was present. Analyses for this group include: regression analysis and the calculation of control limits.

Group 3 – This group involves species with very low capture rates summed across all arrays per year (i.e. 3 or fewer captures per year). Analysis includes calculation of the control limits (95% or 99% confidence interval) for the expected number of years with zero captures.

Reporting Schedule

A formal data and analysis report is to be completed at the end each field season to correspond with the fiscal funding year for the National Park Service. This report is to be delivered to the MEDN network coordinator by December 30th of each year following the fiscal year it covers. The annual report includes all data gathered (as an appendix) in the current reporting year as well as all previous years data. An updated analysis and evaluation of the data are also included. Noteworthy observations or species occurrences or other results observed during the course of sampling are noted. Changes in sampling and or analysis procedures are also noted.

Quality control and quality assurance procedures are included and a summary of metadata handling and organization are included as well. The report also includes

an accounting of all funds expended in the fiscal year and an estimated budget for the next year's monitoring effort. The report also includes any recommended changes in the monitoring program for the next year that have come about because of experience with procedures, field observations, or data collection during the previous year.

Summary Tables

Examples of possible tables for summarizing data for herpetofauna captures to be included in annual reports are provided in Tables 1 & 2.

Methods for Long-term Trend Analysis

After gathering at least four years of baseline data from each sampling region in the Santa Monica Mountains, trends in the data for Group 1 variables will be evaluated by an analysis of variance and/or regression analysis. Ninety-five and ninety-nine percent control limits (confidence intervals) for capture rate data over the baseline period will be calculated to evaluate mean capture rate data in future years. If no trends in the data are observed from the regression analyses then those data may be used to develop control limits for comparison of subsequent years data. Use of control limits for data comparisons is a technique used in industrial quality control to monitor whether a process is within statistical control (variation present is attributable to inherent sources only) and is remaining within acceptable limits without having to continually re-run complex statistical analyses. Processes that are out of statistical control include variation from an outside stressor or influence. Adapting this method to herpetofauna capture rate data allows easier analysis of Group 2 and 3 variables.

Annual analysis of Group 1 variables will include an analysis of variance coupled with a contrast analysis among past years data. If capture rate data for the new year falls outside the control limits for Group 1 variables it will be found to be significantly different from the baseline data from the analysis of variance. Control limits can also be used as a coarse guide for assessing trends in Group 2 and Group 3 variables.

Table 1. Total number of herpetofauna captures per year by species.

	Species	Year 1	Year 2	Year 3	Year 4
Amphibians	Species No. 1				
	Species No. 2				
Lizards	Species No. 1				
	Species No. 2				
	Species No. 3				
Snakes	Species No. 1				
	Species No. 2				
	Species No. 3				
Summary Statistics	Total Captures/yr				
	Total Lizard Captures/yr				
	Total Snake Captures/yr				
	No. of species detected across all arrays				
Diversity Indices	Average No. species detected/array				
	Simpson's species evenness				
	Shannon-Weiner diversity index				

Table 2. Number of herpetofauna captures per month by species.

	Species	J	F	M	A	M	J	J	A	S	O	N	D	Total
Amphibians	Species No. 1													
	Species No. 2													
Lizards	Species No. 1													
	Species No. 2													
	Species No. 3													
Snakes	Species No. 1													
	Species No. 2													
	Species No. 3													
Grand Total of Captures														

Point Loma Ecological Conservation Area

The USGS WERC recently conducted a statistical review of the herpetofauna monitoring program in the PLECA. The results of this review are summarized in "Sampling Design Optimization and Establishment of Baselines for Herpetofauna Arrays at the Point Loma Ecological Conservation Area" (Atkinson et al. 2003, see attached). This report addresses the number of arrays being sampled, the number of sampling days per array per year, and the ability of the survey to address the following questions:

1. What species are currently found in the PLECA versus species that were historically reported from this area?
2. Are any of the targeted species listed showing declines at present?
3. How many arrays, sampling periods, and sampling days per sampling period would be needed to detect a:

- 30% drop in species richness,
- 30% drop in the relative abundance of orange-throated whiptail (*Cnemidophorus hyperythrus*) and striped races (*Masticophis lateralis*),
- Some measure of drop in abundance or occupancy of western ring-necked snake (*Diadophis punctatus*) and southern Pacific rattlesnake (*Crotalus viridis*)?

Confidence limit calculations for normally distributed data (Eq. 1, after Montgomery 2001) and data exhibiting a Poisson distribution (Eqs. 2a &2b, Zar 1999).

Equation 1.

$$ConfidenceLimits = \bar{x} \pm Z_{\alpha/2} S$$

Equations 2a & 2b.

$$UpperLimit = \chi^2\left(\alpha/2, v\right) / 2$$

$$LowerLimit = \chi^2\left(1-\alpha/2, v\right) / 2$$

To answer these questions a four step analysis process was instituted:

Step 1) Derive variables, including:

- Number of species detected per array (used as surrogate for species richness)
- Simpson's measure of species evenness[1]
- Herpetofauna captures (lizards, snakes, and salamanders)
- Lizard captures
- Snake captures or sightings
- Number of arrays with 1 or more snake captures

Step 2) Separate variables into the three analysis groups based on capture rates as described above.

Step 3) Conduct regression analyses to test for existing trends.

Regression analyses are to be performed on variables in Groups 1 and 2 to test for trends occurring in the existing data sets.

Step 4) Develop preliminary 95% and 99% control limits where possible to determine when the capture rate during a new year is outside the range of variation experienced in the baseline years.

Control limits are calculated from 95% and 99% confidence limits. Calculation of these confidence limits varies depending on whether the data are normally distributed or display a Poisson distribution.

Normal distribution: Equation 1, after Montgomery 2001

Poisson distribution: Equation 2a & 2b , Zar 1999

It's important to note that the calculation of control limits is dependent upon the assumption that there is no trend during the baseline sampling years. If a trend was occurring during this time period, then calculating control limits is not a valid procedure. Note that any data transformations that were performed prior to calculation of these limits must also be performed on data collected in the future before comparing with these limits.

Change Detection

Currently, SAMO is in a baseline phase of data collection to establish limits to variation in distribution, abundance, and diversity of reptiles and amphibians within

the Santa Monica Mountains and adjacent undeveloped open space. Although apparent differences in the distribution and abundance for certain herpetofauna have been noted that are apparently correlated with habitat patch size, additional data are needed before the level of change detected per sampling effort can be evaluated. This baseline data gathering and protocol implementation phase is expected to take several years following the complete installation of pitfall trapping arrays in all sampling regions. Installation of arrays within sampling regions follows a four-year cycle where new regions are opened and sampled annually over each of four years. After the completion of four years of sampling in each region the data will be reviewed and evaluated to determine if the level of effort being expended and the number of sampling arrays deployed are sufficient to detect a reasonable amount of change in population characteristics should it occur.

Similar sampling at CABR (in the PLECA) has been evaluated for its ability to detect a specific change in species abundance. Sampling design optimization analysis from five years of baseline data at Point Loma suggests that the number of sampling arrays and sampling days could be reduced by eliminating two of the seventeen arrays and by reducing sampling from 50 to 40 days per year. This streamlined monitoring effort would still be able to detect a 30% change in species numbers with a power of 80% (except for orange-throated whiptails). However decreases in the number of sampling days per year may increase the length of time required to detect rare species. Within the PLECA detecting declines in rare species is one of the primary objectives of the monitoring program. No arrays should be eliminated which capture large numbers of striped racers (*Masticophis lateralis*), ring-necked snakes (*Diadophis punctatus*), or southern Pacific rattlesnakes (*Crotalus viridis*). Results of this analysis are provided in "Sampling Design Optimization and Establishments of Baselines for Herpetological Arrays at the Point Loma Ecological Conservation Area (Atkinson et al. 2003, see attached).

Data Archival Procedures
Data entered into the MEDN pitfall trapping database at SAMO are backed up nightly and saved on a tape drive. All hard copies of the original field data sheets are stored in project files maintained by the project manager. Data entered in the MEDN pitfall trapping database at CABR are backed up weekly and saved on a tape drive. Hard copies of the data are stored in project files maintained by the project manager.

To facilitate a broader regional perspective and a more comprehensive evaluation of amphibian and reptile species richness, distribution and abundance data collected in the Santa Monica Mountains ecosystem and the PLECA are incorporated into a regional database maintained by the USGS WERC.

Personnel & Training

Roles and Responsibilities

Santa Monica Mountains
One full-time manager (Wildlife Biologist or Natural Resource Specialist 0486/0411 - GS 9-11) is responsible for installation, implementation and maintenance of pitfall trap arrays, supervision of field crews and data collection, data entry and data analysis.

At full implementation this protocol will require six wildlife technicians (0404 – GS 5/6/7). These technicians assist the project manager and are responsible for array installation, array set-up prior to each sampling period, sampling of pitfall arrays, capture data entry, and maintenance of pitfall trap arrays.

Wildlife interns or volunteers conscripted through the NPS Volunteers In Parks (VIP) program have been of great value in this program by accompanying wildlife technicians, and helping with all aspects of sampling, trap maintenance, and data entry.

Point Loma Ecological Conservation Area
One full-time manager (Biological Sciences Technician, GS-0404-07) is responsible for installation, implementation, and maintenance of pitfall trap arrays, supervision of field crews, data collection, entry, and analysis. Monitoring field crews are comprised of wildlife interns or NPS VIPs who provide critical support in completing all aspects of monitoring sampling and trap array maintenance in the PLECA.

Qualifications

Qualifications for the program manager and technicians are those applicable to the grade and series at which they are hired; Wildlife Biologist (Series 0486 – GS 11) or Natural Resource Specialist (Series 0411 – GS 11), and Wildlife technician (0404 – GS 5/6/7). Experience and familiarity with the herpetofauna of southern California is desirable.

Training Procedures

New technicians, volunteers, or interns are paired with more experienced personnel to learn procedures and familiarize themselves with sampling each site. To ensure adequacy of training and expertise in data collection, the project manager may occasionally accompany the field crews to observe adherence to SOPs.

Operational Requirements

Annual Workload and Field Schedule
At full implementation approximately 100 pitfall trap arrays will be deployed across the functional ecosystem that includes SAMO. Of these 100 arrays only 40 will be open for sampling in any given year. Each of the 40 open arrays are visited for five consecutive days in each month of the year. Pitfall arrays are sampled on the first and third weeks of the month. A two person field crew can sample as many as 20 arrays (one person for 10 arrays) on a single day. Pitfall arrays are installed in groups of 10 that are relatively close together and are sampled in the same week of each month each year. Arrays are opened and prepared for sampling on day one of the five day sampling cycle, captured animals are processed on each of the four succeeding days of the cycle, and arrays are closed on the fifth day of the cycle following processing of captured animals.

Sixteen functioning arrays in the PLECA are sampled on a schedule similar to that at SAMO. Pitfall arrays are opened on the first day of a five day sampling cycle and closed after four days of capture sampling. Arrays are sampled one sampling cycle each month January though October and once in November or December.

Facility and Equipment Needs
Specifics of facilities requirements and sampling equipment needs are given in SOPs Nos. 5 & 6. The sampling crew when in the field must also carry an NPS two-way radio for both routine and emergency communications. The crew must have continuous access to a field vehicle preferably one with four wheel drive. There should also be a personal computer available for data entry and data quality control for each day of sampling.

Equipment, specimen processing, and specimen storage space is also required and must meet all safety requirements for storing of the chemicals (ETOH) used for preserving tissue samples and voucher specimens.

Startup Costs and Budget Considerations
The greatest long-term expense is to cover salaries for field personnel. Once installed pitfall traps require only occasional maintenance and repair. Table 3 presents startup costs for constructing 20 pitfall trap arrays and providing the necessary sampling supplies for approximately 24 months of operation.

Footnotes

[1]Simpson's evenness is a measure that evaluates the degree to which all species present are equally common i.e. is the community dominated by a few species and all other species put in rare occurrences or are all species present equally common. Simpson's evenness is calculated as $E = (1 / \Sigma p_i^2) \times (1 / s)$, where s = # species in the sample and p_i = proportion of total sample belonging to the *i*th species (Krebs, 1999).

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Table 3. Representative start-up costs for monitoring terrestrial reptiles and amphibians.

	Quantity	Unit Price	Total
Funnel Trap			
1 box medium binder clips (5/8 inch)	20	$1.25	$25
1/4 inch hardware cloth (100 ft roll)	10	$153.00	$1,530
zip ties (100 pk)	20	$4.00	$80
plywood (4' X 8' X 1/2")	60	$20.75	$1,245
tin snips	2	$14.98	$30
Drift Fence			
shade cloth (yards)	45	$39.00	$1,755
wooden stakes (1x2x24) (400 pieces)	4	$656.20	$2,625
staple gun (T-50 M)	4	$17.98	$72
staples (5000 pk)	3	$3.95	$12
Buckets and Lids			
2X4 lumber for legs	40	$4.27	$171
5 gallon buckets	560	$2.65	$1,484
bucket lids	1120	$1.05	$1,176
1-1/4 drywall screws (lb)	40	$3.69	$148
SAE washers #8	40	$0.79	$32
Tools			
gloves	3	$4.98	$15
shovel	5	$7.97	$40
pick axe	5	$17.98	$90
sledge hammer	4	$19.95	$80
rock bar	5	$20.91	$105
electric drill	1	$49.95	$50
fiber glass tape measure (100 m)	1	$78.95	$79
Site Operation			
cellulose sponges (1 box of 36)	12	$49.32	$592
max-min thermometers	80	$34.34	$2,747
1.5 inch pvc pipe (8' length)	55	$2.98	$164
1 inch pvc pipe (8' length)	40	$1.98	$79
cotton batting (package)	10	$4.49	$45
meal worms (dz)	20	$7.00	$140
Field Kit Supplies			
carrying case	2	$19.99	$40
notebook	8	$3.99	$32
data forms	2		$-
small mammal field guide	2	$15.95	$32
reptile and amphibian field guide	12	$15.95	$191

50ml centrifuge tubes (case of 500)	2	$137.13	$274
1.5ml centrifuge tubes (1 case)	2	$13.40	$27
fiber board storage box (12 pk)	2	$22.36	$45
fiber board divider grid (12 pk)	4	$17.85	$71
straight micro-scissors	10	$3.95	$40
lab marker	10	$2.50	$25
metric spring scales (30 g)	2	$31.95	$64
metric spring scales (100 g)	2	$31.95	$64
metric spring scales (1000 g)	2	$31.95	$64
clear plastic ruler	2	$0.99	$2
fade resistant waterproof pens (10 pk)	4	$15.85	$63
small ziplock bags (24 box)	10	$2.39	$24
gallon sized ziplock bags (12 box)	10	$2.39	$24
small tweezers	2	$2.40	$5
large tweezers	2	$9.35	$19
snake hook	2	$30.00	$60
snake bag	4	$4.99	$20
Ethyl Alcohol (liter)	16	$17.65	$282
antifreeze (gallon)	16	$6.99	$112
blood coagulant (blood stop)	2	$7.49	$15
Total			**$16,203**

Attachment 1. Reptile, amphibian & small mammals species checklist.

Species Code	Scientific Name	Common Name
ANLU	*Aneides lugubris*	arboreal salamander
ANPU	*Anniella pulchra*	silvery legless lizard
BAMA	*Batrachoseps major*	garden slender salamander
BANI	*Batrachoseps nigriventris*	California slender salamander
BAPA	*Batrachoseps pacificus*	garden slender salamander
BUBO	*Bufo boreas*	California toad
CNHY	*Cnemidophorus hyperythrus*	orange-throated whiptail
CNTI	*Cnemidophorus tigris*	coastal whiptail
COCO	*Coluber constrictor*	western yellowbelly racer
CORU	*Crotalus ruber*	red diamond rattlesnake
CRVI	*Crotalus viridis*	southern pacific rattlesnake
DIAG	*Dipodomys agilis*	pacific kangaroo rat
DIPU	*Diadophis punctatus*	San Bernardino ringneck snake
ELMU	*Elgaria multicarinata*	San Diego alligator lizard
ENES	*Ensatina eschscholtzii*	Monterey ensatina
EUSK	*Eumeces skiltonianus*	western skink
HYCA	*Hyla cadaverina*	California tree frog
HYRE	*Hyla regilla*	Pacific tree frog
HYTO	*Hypsiglena torquata*	San Diego night snake
LAGE	*Lampropeltis getula*	California kingsnake
LAZO	*Lampropeltis zonata*	San Diego kingsnake
LECA	*Lepus californicus*	black-tailed jack rabbit
LEHU	*Leptotyphlops humilis*	southwestern blind snake
MAFL	*Masticophis flagellum*	red coachwhip
MALA	*Masticophis lateralis*	California striped racer
MICA	*Microtus californicus*	California vole
MUMU	*Mus musculus*	house mouse
NEFU	*Neotoma fuscipes*	dusky-footed woodrat
NELE	*Neotoma lepida*	desert woodrat
NOCR	*Notiosorex crawfordi*	desert shrew
PEBO	*Peromyscus boylii*	brush mouse
PECA	*Peromyscus californicus*	California mouse
PEER	*Peromyscus eremicus*	cactus mouse
PEMA	*Peromyscus maniculatus*	deer mouse
PETR	*Peromyscus truei*	piñon mouse
PGCA	*Perognathus californicus*	California pocket mouse
PHCO	*Phrynosoma coronatum*	California horned lizard
PICA	*Pituophis catenifer*	San Diego gopher snake
RAAU	*Rana aurora*	California red-legged frog
RACA	*Rana catesbeiana*	bullfrog
RANO	*Rattus norvegicus*	Norway rat
RARA	*Rattus rattus*	black rat
REME	*Reithrodontomys megalotis*	western harvest mouse
RHLE	*Rhinocheilus lecontei*	long-nosed snake

SAHE	*Salvadora hexalepis*	coast patchnose snake
SCGR	*Sciurus griseus*	western gray squirrel
SCHA	*Scaphiopus hammondii*	western spadefoot
SCLA	*Scapanus latimanus*	broad-footed mole
SCNI	*Sciurus niger*	fox squirrel
SCOC	*Sceloporus occidentalis*	Great Basin fence lizard
SOOR	*Sorex ornatus*	ornate shrew
SYAU	*Sylvilagus audubonii*	desert cottontail
SYBA	*Sylvilagus bachmani*	brush rabbit
TAPL	*Tantilla planiceps*	western blackhead snake
TATO	*Taricha torosa*	California newt
THBO	*Thomomys bottae*	Botta's pocket gopher
THHA	*Thamnophis hammondii*	two-striped garter snake
THIS	*Thamnophis sirtalis*	California red-sided garter
TRBI	*Trimorphodon biscutatus*	California lyre snake
UTST	*Uta stansburiana*	California side-blotched lizard

Alligator Lizard (Gerrbonotus multicarinatus multicarinatus).



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 1 - Pitfall Trap Array Design and Component Construction

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Monitoring Methods

Rationale

Many techniques for reptile and amphibian sampling have been used to assess species diversity and abundance. However, because of their small size, cryptic coloration, and nocturnal or fossorial behavior effective sampling can be difficult. Of the various methods tested, pitfall trapping in conjunction with drift fences and funnel traps is an effective sampling method for analyzing the diversity and abundance of reptiles, amphibians, and invertebrates (Fisher & Case 2000a, 2000b, Case & Fisher 2001). Pitfall trapping methodology has been used in southern California for monitoring population and community characteristics and trends of reptiles and amphibians since 1995, and is consistent with other long-term sampling efforts in central California (Stokes *et al*. 2001).

Array Design

Pitfall trapping consists of the deployment of a series of trapping arrays that are based upon the premise that ambulatory reptiles and amphibians can be directed by "drift" fences into bucket (pitfall) traps embedded in the ground. Pitfall trap arrays can vary in size and shape. Examples of array designs can be found in Heyer *et al.* 1994. For consistency the Santa Monica Mountains National Recreation Area and Cabrillo National Monument are using an array design tested and described in Stokes *et al*. 2001.

Each pitfall trap array consists of 7 pitfall traps and 3 funnel snake traps (Figure 1-1). Pitfall traps are buried 7.5 meters apart arranged in a "Y" configuration, each arm separated by approximately 120°. Drift fences connect each pitfall to intercept reptiles and amphibians directing them to either pitfalls or snake traps. Snake traps are placed along each arm between the middle and last bucket; always on the right side when looking away from the center bucket (Campbell & Christman 1982, Corn 1994, Fisher & Case 2000, Stokes *et al*. 2001).

Array & Trap Numbering

At every array each arm is assigned a number. Each bucket is assigned a letter. The outer buckets along the arm are "A" buckets followed by the middle "B" buckets, and the center "C" bucket". Cover boards are also designated by the letter "C". Snake Traps are assigned the letter "S". Snake and bucket traps are also labeled with the array arm number they

are associated with. For example "1A" is the outer-most bucket trap along arm 1. The center bucket trap is always given the number "0". A single snake trap is placed along each arm of the arrays.

In the Santa Monica Mountains pitfall arrays are assigned a unique number and name reflecting the sampling region in which they are located. In the PLECA arrays are numbered in the order they were installed and are grouped by habitat type (*See rationale for sampling by region in Protocol Narrative, Sampling Design-Site Selection*).

Array Components & Construction

Pitfall Traps

In SAMO and the PLECA 5-gallon white plastic buckets are used for each of the pitfalls (Campbell and Christman 1982, Corn 1994, Fisher *et al*. 2002). White plastic buckets dampen heating in the buckets that can contribute to mortality of trapped animals. Each bucket is buried so that the lip of the bucket is flush with the ground surface (Figures 1-1 & 1-2). Five small drainage holes are drilled in the bottom of each bucket to prevent flooding during rain events. Holes also prevent buckets from floating out of the ground when winter rains saturate the soil.

Pitfall Trap Lids

When sampling is not occurring all pitfall trap buckets are sealed (closed) using standard white plastic bucket lids. Closing of pitfalls keeps unwanted debris and/or rainwater from accumulating in the buckets and eliminates incidental trapping of animals. To facilitate closure of traps and subsequent removal of bucket lids make vertical cuts in the outer lip of each lid every 15 cm around the margin of the lid. Removing the rubber seal in the lid also facilitates lid placement and removal. Scrape away 4-5 cm of soil from around the bucket lip before closing traps to allow for complete and secure closure of the bucket. If necessary large rocks may be placed on the lids of closed traps for added security.

By attaching legs to the top of bucket lids and inverting the lids during sampling, lids double as trap covers to shade the traps and prevents most debris, litter, and/or precipitation from entering open buckets, while allowing sufficient space for small animals to enter the trap (Figure 1-2).

Lid legs are constructed from pieces of 2" × 3" boards 2.75" long and cut at a 35° angle. Three legs are attached with the cut sides parallel to the lid surface and extending outward from the lid using 1.25" drywall screws and SAE #10 washers. When the traps are open, the lid is turned over with the legs facing downward (Figure 1-2).

Drift Fencing

Drift fences are constructed from 6 strips of nylon shade cloth 30 cm tall and 7.5 m long. Forty-five meters of shade cloth is needed for each array. Wooden stakes (1" × 2" × 24") are used to secure drift fences upright. The shade cloth is secured to the stakes by using heavy-duty staples and a heavy-duty staple gun. Ten to 15 stakes are used per 15 m arm of fencing; however the number of stakes varies for each array depending on the ground type. Steel survey stakes with pre-drilled holes (for securing drift fence to the stake) are used in rocky terrain. Drift fencing is also installed to accommodate the landscape, and as necessary is bent around shrubs, trees and other obstacles. Care should be taken to select array sites with the fewest obstacles to accommodate.

Shelter within Pitfall Traps

Shelter should be provided within the pitfall traps for captured animals. Two "hide tubes" of 6" to 8" PVC pipe 1" and 1.5" diameter may be used for this purpose. Cotton or polyester batting insulation is placed in the PVC pipes to provide shelter from cold for incidentally captured small mammals.

A moistened 6" × 4" × 2" sponge is placed in pitfall traps to provide moisture for trapped amphibians. Most sponges come pretreated with a fungicide which can cause harm to amphibian species and must be thoroughly washed prior to initial use. Washing sponges by running them through a complete cycle in a home washing machine without using detergent is effective. Sponges are wetted on a daily basis when traps are in operation. It is important to moisten sponges outside of

the buckets. Damp sponges are placed in the bottom of the bucket so that the largest surface area is in contact with the bottom of the bucket. During the winter months it is imperative that sponges are more dry than wet. Excessive moisture in the traps can result in thermal stress and possible death in captured animals. Sponges are removed if ants are attracted to the trap. At the end of a trapping cycle, all sponges are collected, cleaned and dried for storage.

Snake Traps

Snake traps are constructed from ¼" hardware cloth (Heyer *et al.* 1994, Stokes *et al*. 2001) by forming cylinders approximately 6" in diameter from sections of hardware cloth 36" long and 18" wide. The overlapping edges (1") of the hardware cloth are fastened with hog-rings or UV-resistant cable ties (Figure 1-3). Cable ties are easier to work with in the field but are not as reliable as hog rings. Trap ends are made from the same hardware cloth by cutting a 24" diameter circle of hardware cloth into 4 equal pie-slice sections (Figure 1-4). These are rolled into cone shapes and secured by hog-rings or cable ties. Trim hardware cloth from the small end of the cone to form an opening approximately 2" in diameter. This allows animals including large snakes to enter into the cylinder. Fit two funnels cones into each end of the cylinder with the small ends pointing inwards. Evenly cut the overhanging material in five to seven places to the edge of the cylinder body to form flaps (Figure 1-5). Fold the overhanging flaps over the edge of the cylinder so that the funnels fit snugly onto the cylinder. It is important that these flaps overlap the cylinder sufficiently enough to not leave any gaps or holes which can allow trapped snakes to escape. Finally, fasten the funnels to the cylinder with medium-sized binder clips, two per funnel end (Figure 1-6).

Over time cones on snake traps must be replaced as the flaps used to hold cones in place can break during use. Spare cones are made in advance to use as replacements for each new trap cycle.

Trim off all sharp points and edges created during the cutting and construction process. This can prevent injury to captured animals and field personnel. Gaps and holes in snake traps can cause serious injury and death to captured vertebrates as they try to escape from the trap. In the field, position the funnel traps with the seams of both the tube and end cones facing upwards to prevent injury to trapped animals on any rough edges of the hardware cloth.

To mitigate exposure to sunlight and precipitation snake traps are covered at all times with a 18" × 36" piece of 1/8" plywood or 5" × 8.25" wooden shingles (Figure 1-7). A 6" to 8" long piece of 1.5" PVC pipe (hide tube) with cotton or polyester batting or some other suitable material is placed inside the trap for additional shelter and insulation.

Ground Cover Boards

Ground cover boards of 24" × 48" × 1" plywood are placed near one are at each array in the PLECA to monitor for California legless lizards (*Anniella pulchra*), smaller snakes, and the night snake (*Hypsiglena torquata*). This size board is necessary in order to create the microhabitat required for these snakes and lizard. Ground cover boards are not presently installed at pitfall arrays in the Santa Monica Mountains.

Air Temperature

Air temperature is recorded at each trap array with a Fisher Scientific maximum and minimum mercury thermometer or an Onset Computer Corporation HOBO® data logger.

Thermometers or data loggers are deployed at the center of each array facing in a northerly direction. Maximum and minimum temperature is recorded during daily inspection of traps and then the thermometer is reset. HOBO data loggers are deployed throughout a trapping cycle and returned to the office for downloading recorded data. See SOP 13 for complete instructions on the use of HOBO temperature data loggers.

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Fisher R.N. and T.J. Case. 1997. A field guide to the reptiles and amphibians of coastal southern California. Biological Resources Division of the United States Geological Service. Lazer Touch, San Mateo, California.

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Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster. 1994. Measuring and monitoring biological diversity: Standard methods for amphibians. Smithsonian Institution Press, Washington, D. C.

Stokes, D.C., C.J. Rochester, R.N. Fisher, and T.J. Case. 2001. DRAFT Herpetological monitoring using a pitfall trapping design in southern California. U.S. Geological Survey Open File Report , Sacramento, California.

Figure 1-1. Schematic of general layout of pitfall trap array. Note "Y" shaped drift fencing, locations of pits and snake traps.

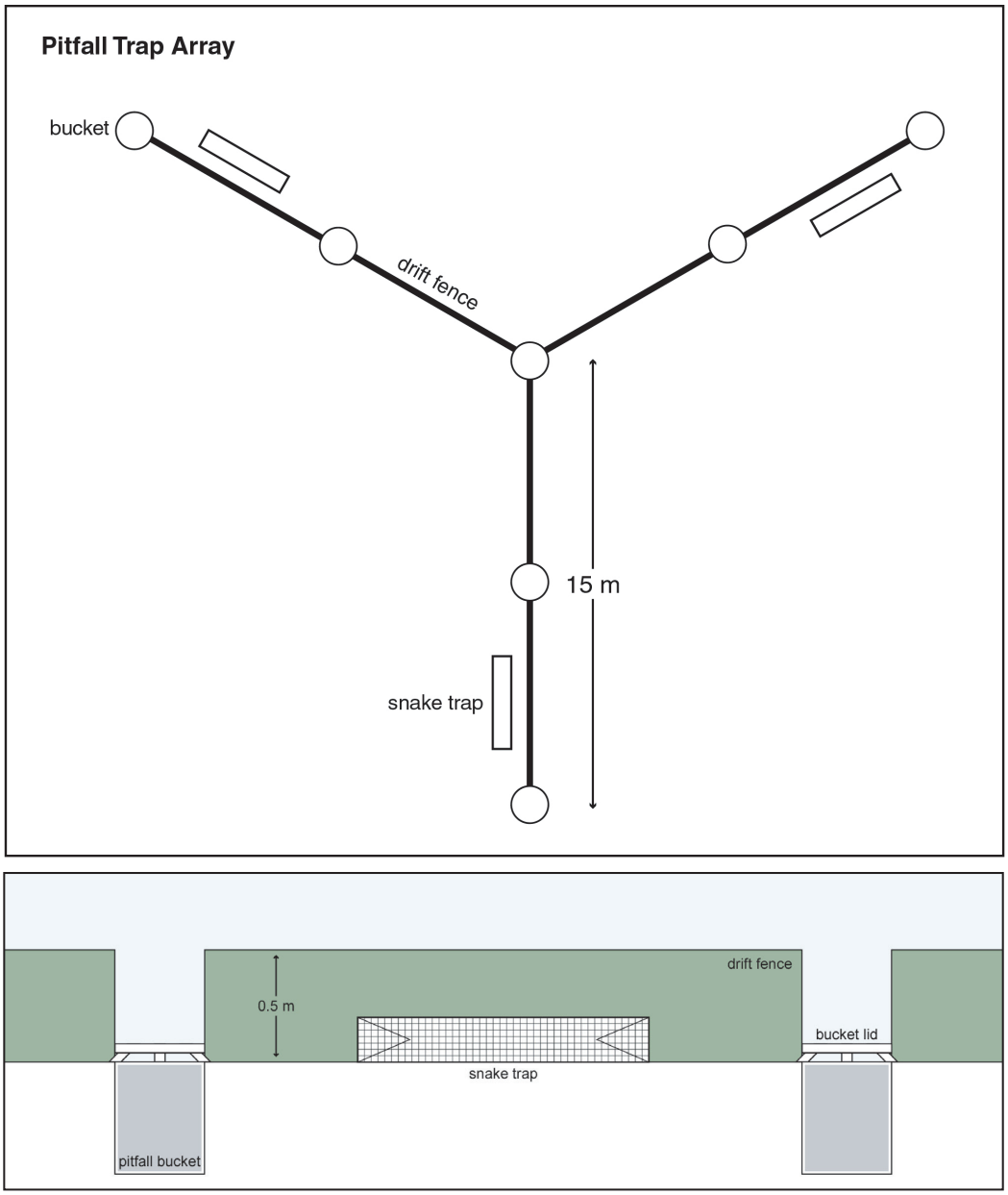


Figure 1-2. Schematic presentation of embedded pits and associated drift fencing.

Note the lid resting on wooden legs as deployed during sampling.

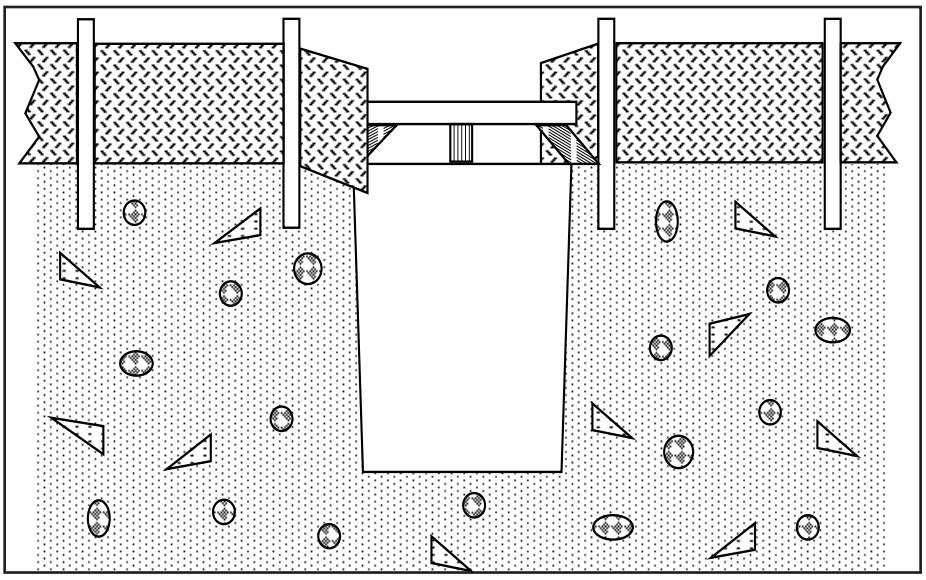


Figure 1-3. Snake trap assembly diagram.

A. Basic size and cut of hardware cloth for body of the trap. B. Roll hardware cloth along the long axis forming a tube. Overlap the cloth by 1" to form a seam secured by hog rings or plastic cable zip ties. C. Recommended placement of hog rings or cable ties to form body of trap.

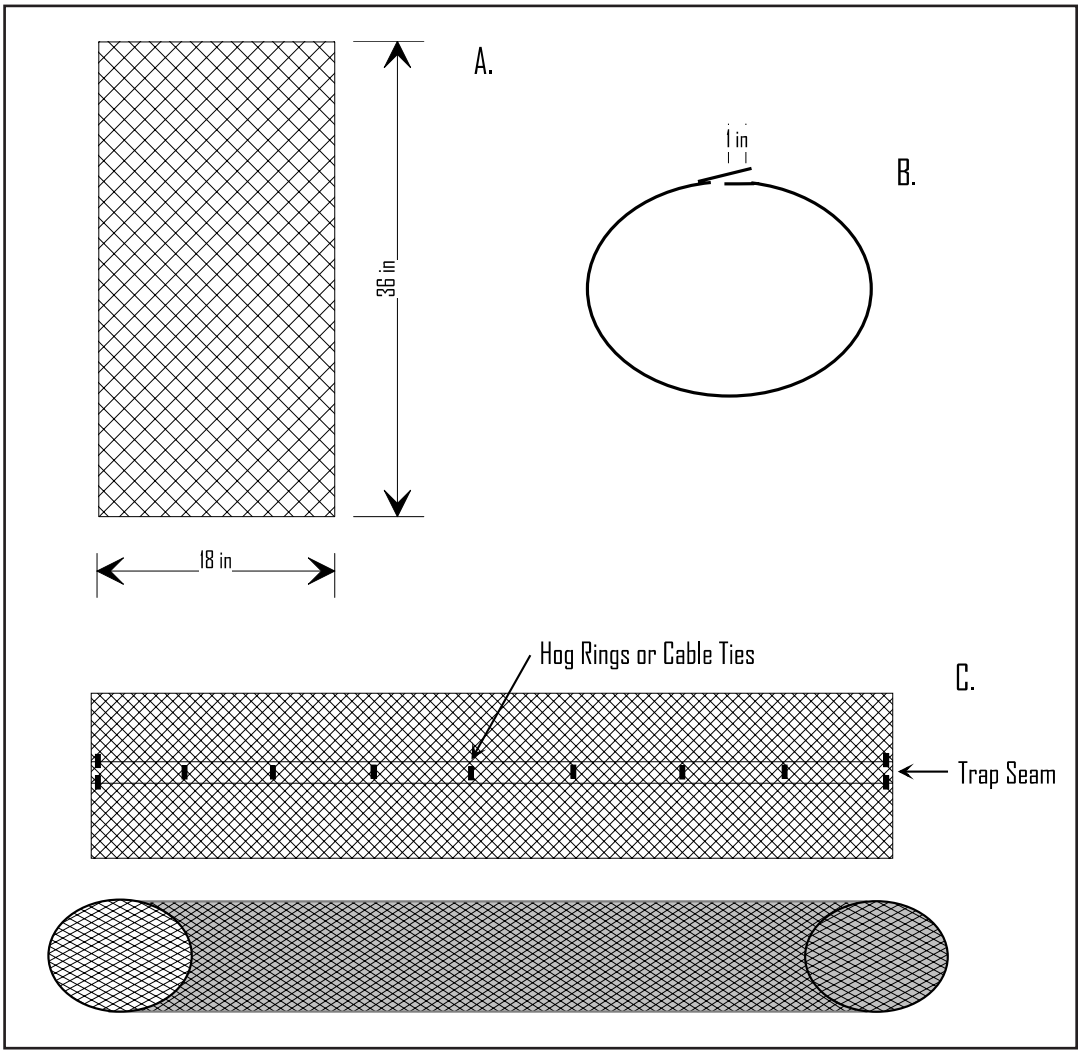


Figure 1-4. To make cone end enclosures for traps cut and quarter a 24 inch diameter circle from quarter-inch hardware cloth.

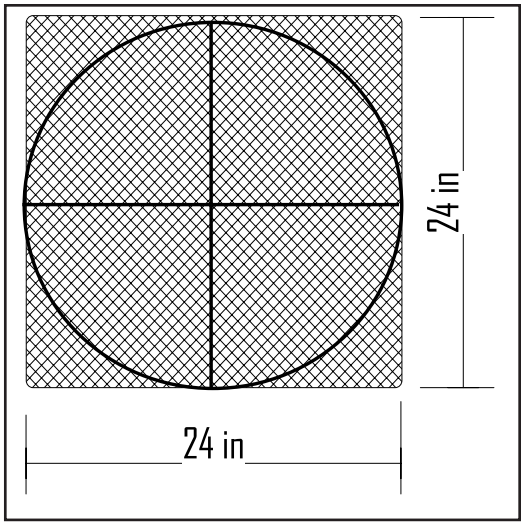


Figure 1-5. Construction of snake trap end-cones.

A. Roll the quarter circle sections of hardware cloth into cones and overlay edged to form a seam secured by hog clips or cable ties. B. Trim approximately 2 inches off the tip of the cone to form the entrance funnel for the trap. C. Insert a funnel into each end of the previously prepared trap body. D. Cut rim of the funnel in five to seven places to fold over the edge of the trap body.

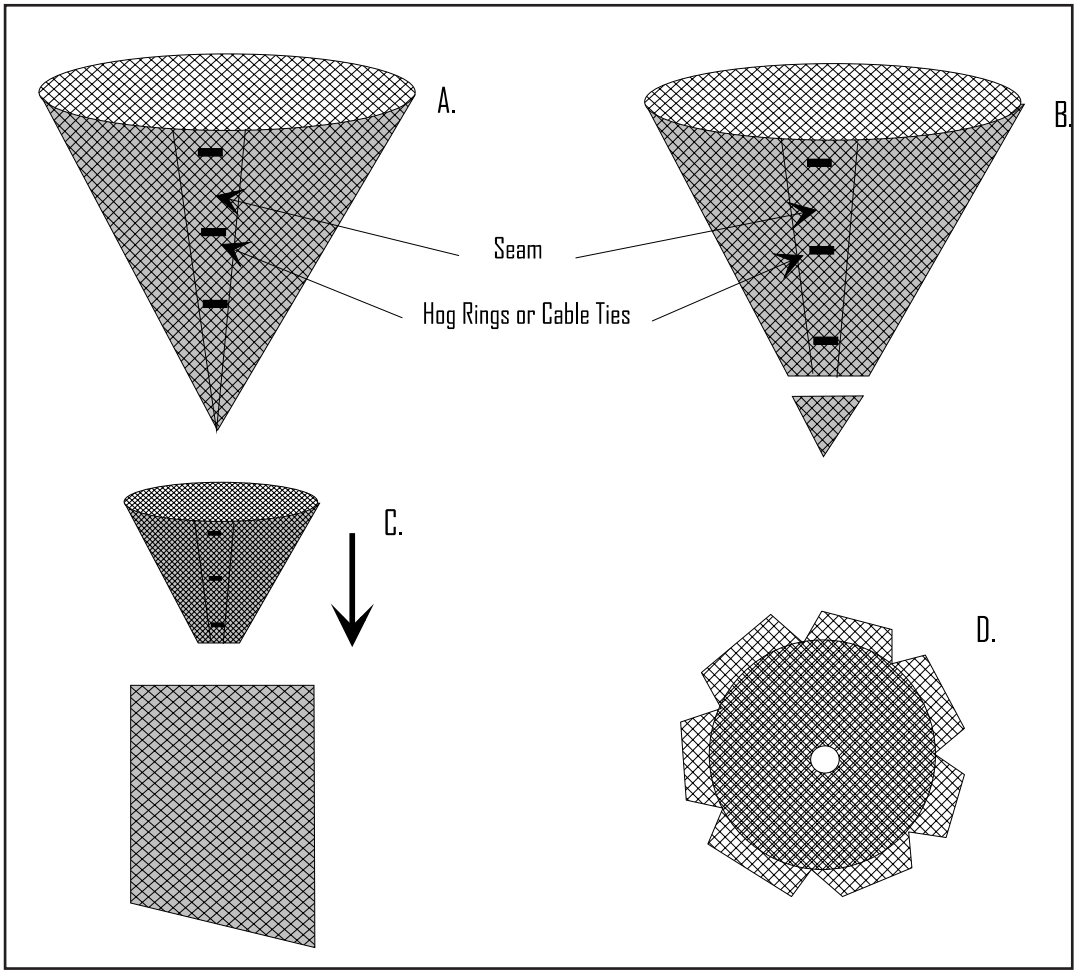


Figure 1-6. A completed funnel trap with entrance funnels held in place with binder clips.

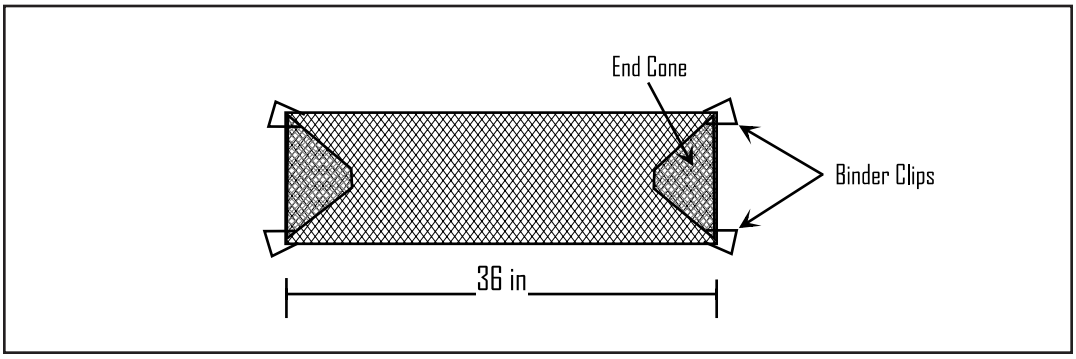
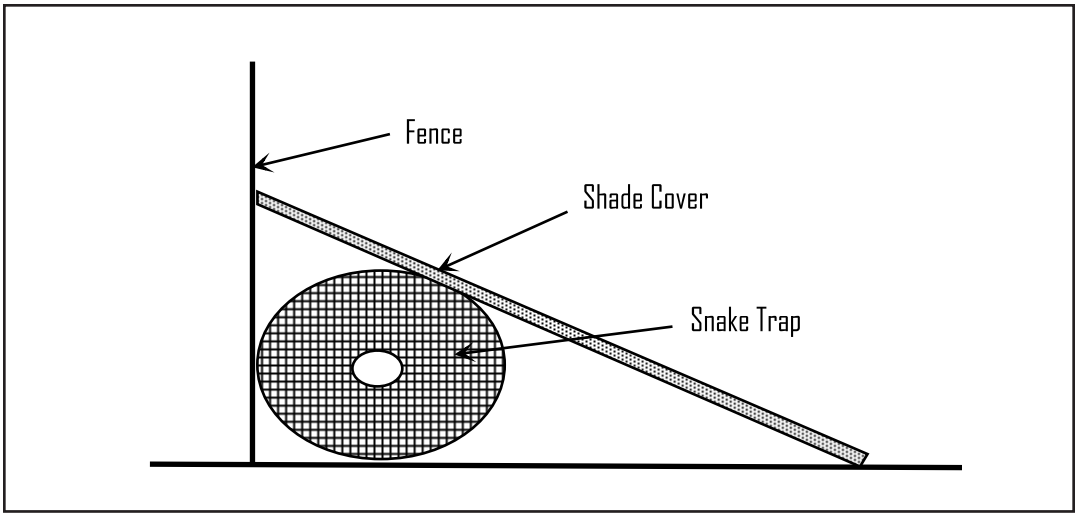


Figure 1-7. Snake trap in place adjacent to drift fence with plywood shade board in place.





Pitfall Trapping of Reptiles & Amphibians in the MEDN

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 2 - Pitfall Trap Installation

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Installation of Pitfall Trap Arrays

Personnel Requirements

Installation of pitfall-trap arrays requires 4-6 laborers. On average two or three arrays can be installed in a typical work day; the actual number of pitfall arrays that can be installed depends on the skill of the laborers, terrain, substrate, and weather conditions. It is important to allow enough time for installation of pitfall trap arrays before sampling is to begin.

Equipment

The following equipment is needed for installing pitfall arrays:

1. 50 m measuring tape. To be used for measuring array arm lengths and trap placement
2. Surveyors flags (at least 7 per array)
3. Shovels for each person
4. Rock bars or pry bars
5. (Optional) Auger for drilling pitfall trap holes.
6. Pickaxes – helpful for trenching for drift fencing
7. Sledge hammer (3-5 pounds) for hammering stakes
8. Heavy duty staple gun and staples
9. Tin snips for bucket lids
10. Scissors for cutting drift fencing
11. Wooden stakes for securing drift fence
12. White plastic 5-gallon buckets, 7 per array
13. Pre-assembled bucket lids (see SOP No. 1)
14. Shade cloth to be used as fencing material
15. Pre-assembled snake traps and covers (see SOP No. 1)
16. “Hide Tube” shelter pieces for bucket traps
17. Ground Cover Boards (PLECA only) (see SOP No. 1).

Installation

Each pitfall array location should be laid out and bucket locations flagged prior to installation. To lay out the array arms start from the location of the center bucket and measure 15 m in a northerly direction. Place a bucket lid or surveyor’s flag at 7.5 m and 15 m from the location of the center bucket. The lids (flags) mark the locations for digging the pitfall traps. Lay out the other two arms at approximately 120º east or west from this first arm. If viewed from above the array should resemble “Y” with equal angles for the arms. Lay out the three fence arms as straight as possible, but as necessary the drift fence can make bends around rocks and/or vegetation.

Holes for each of the pitfall traps should be dug just large enough to accommodate the bucket and deep enough that the lip of the bucket is at or slightly lower than ground level. If the bucket holes are too large, buck-

ets may easily shift or pull out of the ground.

Remember that to facilitate removal of the lids when opening and closing the traps, the rim of the lid should be cut using tin snips in several places and the rubber gasket on the lid should be removed (see SOP No. 1). Fill in all empty spaces of the hole around the bucket with excavated dirt and using a shovel, pack dirt between the bucket and the wall of the hole.

Install drift fencing by digging a trench approximately 15 cm deep along the route of each arm of the array using a pick-axe. Pound stakes into the ground approximately one meter apart along the trenches and securely attach the fencing material (shade cloth) to the stakes with staples. Staples should be concentrated at the top and bottom of the fencing material. Bend fencing around obstructions by installing a sufficient number stakes to eliminate sharp angles in the fence that might stop or redirect movement of animals moving along the fence towards a pitfall trap.

Fencing material should extend 15 cm beyond the terminal stakes in each arm segment (near the bucket traps). Where fencing material extends beyond the stakes make a cut horizontal to the ground approximately 15 cm up from the bottom and extending back to the terminal stake. Fold the bottom portion of cut material around the stake and staple it so that it faces back along the drift fence. The extra fencing material should extend past the terminal stake and over the lip of the pitfall traps. See Figure 2-1. Once the drift fence is in place and securely stapled to the stakes backfill the trench to cover the bottom 15 cm of shade cloth material.

Snake traps are placed on the right side (looking along the fence away from the center bucket) as close as possible to the drift fence (Figure 2-2) between the distal and middle buckets of each arm of the fence. Be sure to place the plywood shade cover over the trap.

Position a ground cover board near the end of one arm of each array (PLECA only). Cover boards must be placed flat on the ground To create the desired micro-habitat.

Pitfall Arrays in the Santa Monica Mountains

Because of environmental differences in climate, aspect, and vegetation and considering the area to be sampled in the Santa Monica Mountains (> 75,000 ha) pitfall trap arrays are installed in five specified sampling regions on a two-year cycle. Twenty arrays are installed in each region (see SOP No. 12). Except for the first year of sampling two regions are sampled every year, with a complete rotation of sampling through the five sampling regions in twelve years.

Pitfall Arrays in the PLECA

In the PLECA sixteen of the seventeen pitfall arrays originally installed are currently maintained and sampled (see SOP No. 12). Array No. 6 was closed in 2005 following a statistical review of five years of data which showed that there was no difference in data collected between arrays No. 5 and 6 (Atkinson et al. 2003).

Literature Cited

Atkinson, A.J., R.N. Fisher. C.J. Rochester, & C.W. Brown. 2003. Sampling design optimization and establishment of baselines for herpetofauna arrays at the Point Loma Ecological Reserve. USGS, Western Ecological Research Center.

Figure 2-1. Schematic presentation of embedded pits and associated drift fencing (occurs as Figure 1-2 in SOP 1).

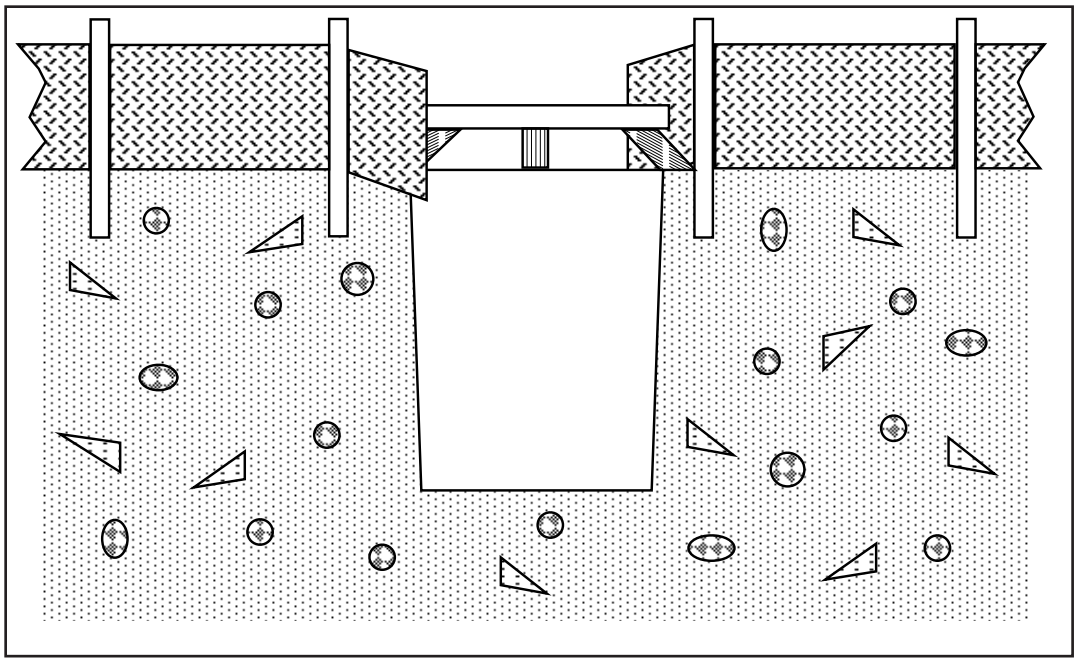
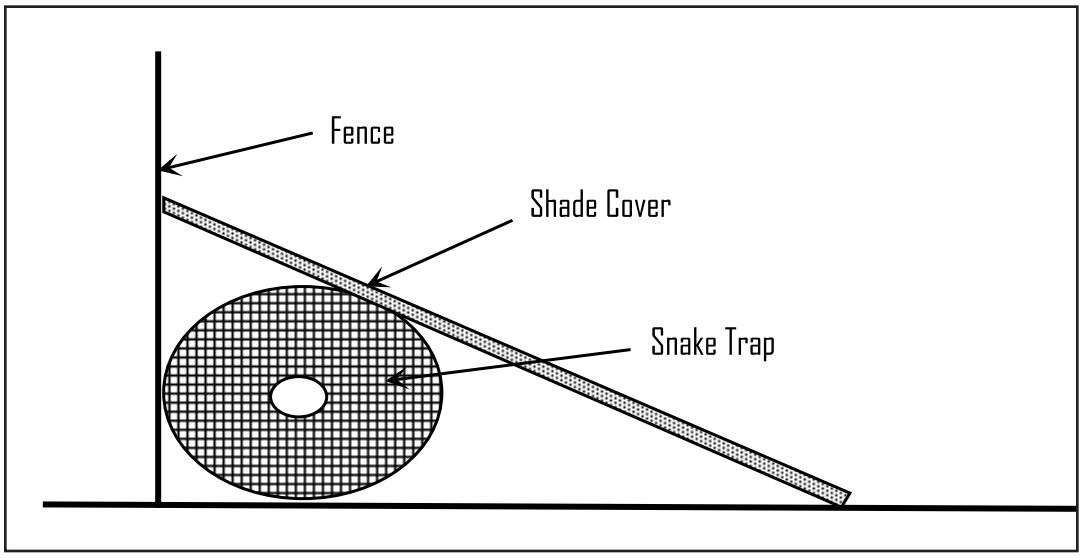


Figure 2-2. Snake trap in place adjacent to drift fence with plywood shade board in place (occurs as Figure 1-7 in SOP 1).



Pitfall Trap Array in Coastal Sage Scrub (SAMO).



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 3 - Site Selection

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Site Selection

Identifying Pitfall Array Locations

Suitable trap sites are identified by site visits following examination of topography, vegetation, cultural resources, road, and trail map layers in the SAMO and PLECA GIS databases. These five map layers coupled with site visits (to determine accessibility and proximity to trails) govern site selection for trap arrays. A representative sample of several vegetation types on fairly level terrain is identified for trap arrays. Installation on steep slopes is avoided because capture success is lower, trap maintenance is more laborious, and erosion often fills buckets with debris and disturbs drift fences (Fisher & Case 2000). To minimize disturbance by the public all trap arrays are installed several meters from trails and hidden from view. To avoid harm to potential and known archaeological sites, maps showing the locations of known cultural resources and cultural resource specialists (archaeologists) are consulted prior to array installation. To permit sampling of all arrays in an eight-hour period and to ensure accessibility during inclement weather (when mud and rain make vehicular travel difficult on dirt roads) all sites are located within reasonable walking distance of improved and maintained roads. Final locations of pitfall arrays are recorded using a global positioning system (GPS) and mapped in the SAMO and PLECA GIS databases.

Site organization

To manage the sampling effort across the Santa Monica Mountains ecosystem the mountains and surrounding area was divided into regions based on distinguishing habitat characteristics (such as watershed boundaries or vegetation) and degree of urban development. This allows for work to be organized by region and for sites to be expanded into other regions as time, funding, and personnel permit.

Five sampling regions were identified for the purpose of stratifying pitfall-trapping sites across varying habitats, and across varying degrees of urban impact (Figure 3-1). Within these five regions specific habitat types where pitfall traps are to be installed include: chamise, chaparral, chaparral/grass, grass, grass/rock, oak woodland, riparian/grass, sage, sage/grass, and sage/rock. Not all habitat types are found in each region, and it will not be until all regions have been sampled that data from each of these habitat types will be available. Dividing the mountains functional ecosystem into five sampling regions was necessitated by logistical constraints on accessing sites, installing trap arrays, the management of sampling personnel, and to allow for procedural refinement of the sampling protocol and analytical process though a phased approach to program implementation. Sampling regions generally followed the drainage (watershed) characteristics of the mountain area and are identified as follows:

1. **Simi Hills** (20,987 ha) – Generally North of the 101 Freeway with ~50% urbanized and highly fragmented habitat. In the west approximately 20% of this region lies to the south of the 101 Freeway.
2. **Western** (13,442 ha) – Point Mugu State Park with the majority of pitfall arrays on state park lands. Majority of this habitat is protected and non-urbanized.
3. **Central Coast** (11,423 ha) – Coastal habitats and hillsides with generally south-facing slopes and steep canyons that are more mesic than other portions of the Santa Monica Mountains.
4. **Malibu** (19,714 ha) – Including Malibu Creek State Park and watershed south of the 101 Freeway. This region has protected parkland and is adjacent to recently urbanized areas.
5. **Eastern** (15,239 ha) – This region is similar to the Central Coast Region with mesic south-facing slopes, but with highly urbanized areas surrounded by protected park land.

Pitfall trap sampling occurs on a by region basis. Twenty-two arrays are installed within 12 habitat patches within the Simi Hills region (see SOP No. 12). Habitat patches were selected based upon size of the patch, vegetation type within the patch, and patch fragmentation characteristics. Arrays were installed in seven small patches (8 to 45 ha), three medium patches (328 to 445 ha), and two large patches (1909 to 2655 ha). A single array was placed in each of the small patches, and three arrays were placed in each of the medium and large patches. Arrays in the Simi Hills were intended to capture baseline data on reptile and amphibian abundance and distribution based upon the criteria listed above (patch size, vegetation, and fragmentation) to enhance the interpretative power (in a non-statistical sense) of future monitoring results and management actions based upon the results of monitoring activities. Additionally, nineteen pitfall trap arrays are installed within the western region and twenty arrays will soon be installed in the Malibu region. Pitfall arrays will be installed in the remaining two regions in succeeding years on a two year interval until pitfall arrays have been installed all regions. Sampling pitfall traps can be very labor intensive. It is important that all sites are visited in a relatively short amount of time in order to reduce mortality from hypothermia (especially in the cooler winter months) of small mammals incidentally captured in traps. Each region to be sampled has approximately twenty pitfall trap arrays. Because of the size of the area being sampled twenty pitfall-trap arrays can be visited by two teams in approximately five hours.

Pitfall trap array sites in the PLECA (~271 ha) were chosen to represent the range of habitats found in the PLECA in order to better understand the status and distribution of reptiles and amphibians throughout the peninsula. The PLECA was stratified by vegetation and arrays were placed in each habitat type in approximate proportion to the proportion of that habitat type present. Unique landscape features such as open sand washes were also included.

The primary habitat types of native vegetation on Point Loma include coastal sage scrub, maritime succulent scrub, and southern maritime chaparral. The distribution of these habitat types varies with aspect, exposure, slope, substrate, and disturbance history. Location access, visibility to visitors, vegetation type, and habitat sensitivity also affected array site selection.

Regional Installation and Sampling Schedule.

Pitfall arrays at the remaining two regions in the Santa Monica Mountains, Central Coast and Eastern, are scheduled for installation over the next five years. Sampling in a given region continues for four years and is then discontinued for six years. Sampling occurs in two regions only at any given time. There is a complete rotation of sampling through the five sampling regions in twelve years (Figure 3-2).

Once the baseline characteristics of reptile distribution and abundance are established sampling regions will be intermittently sampled on a long-term basis. Specifics of the temporal scale for sampling are to be determined based upon the analysis of results of four years of sampling and data from each sampling region.

In the PLECA the 16 active arrays can be visited in a single day.

Agency Approvals

SAMO and the PLECA present a mosaic of land ownerships. Once sites have been selected, land management agencies are consulted and where necessary written approval is obtained for long-term sampling on lands outside the ownership and jurisdiction of the National Park Service. Other land management agencies in the Santa Monica Mountains National Recreation Area include—California State Parks, City of Thousand Oaks, Conejo Open Space Conservation Authority, Mountains Restoration Trust and Rancho Simi Parklands. Lands in the PLECA are co-managed by the US Navy, US Coast Guard, the City of San Diego, and the Department of Veterans Affairs. Management of the PLECA is a combined activity supported by the various land owners and formalized by a memorandum of understanding among all the relevant parties. Other relevant scientific collecting permits are obtained from California Fish and Game. Written agreements and permits are on file at the SAMO headquarters in Thousand Oaks, California and the headquarters of CABR on Point Loma.

Cultural Resources Sensitivity

It is possible that an ideal pitfall trap site is also the site of unknown significant archaeological or cultural resources. Prior to site selection it is important to consult existing archaeological site maps to avoid sensitive areas. Additionally, prior to digging pitfall traps an archaeologist should be consulted to approve array locations. In the event archaeological resources are discovered during trap array installation, digging should be immediately stopped and the appropriate cultural resource specialist or archaeologist consulted.

Literature Cited

Fisher, R.N. and T.J. Case, 2000. Southern California herpetofauna research and monitoring: 1995-1999 data summation report. California Fish and Game, Sacramento, and U.S. Fish and Wildlife Service, Carlsbad, California.

Figure 3-1. Herpetological monitoring regions for the Santa Monica Mountains National Recreation Area. Pitfall array locations are as of FY 2004.

Sites for installing pitfall arrays are limited to protected park lands with a slope of less than or equal to fifteen degrees. High priority areas (those less than 250 meters from a road or trails) meeting all siting requirements are highlighted in bright pink. Low priority sites (those greater that 250 meters from a road or tail) are highlighted in subdued pink.

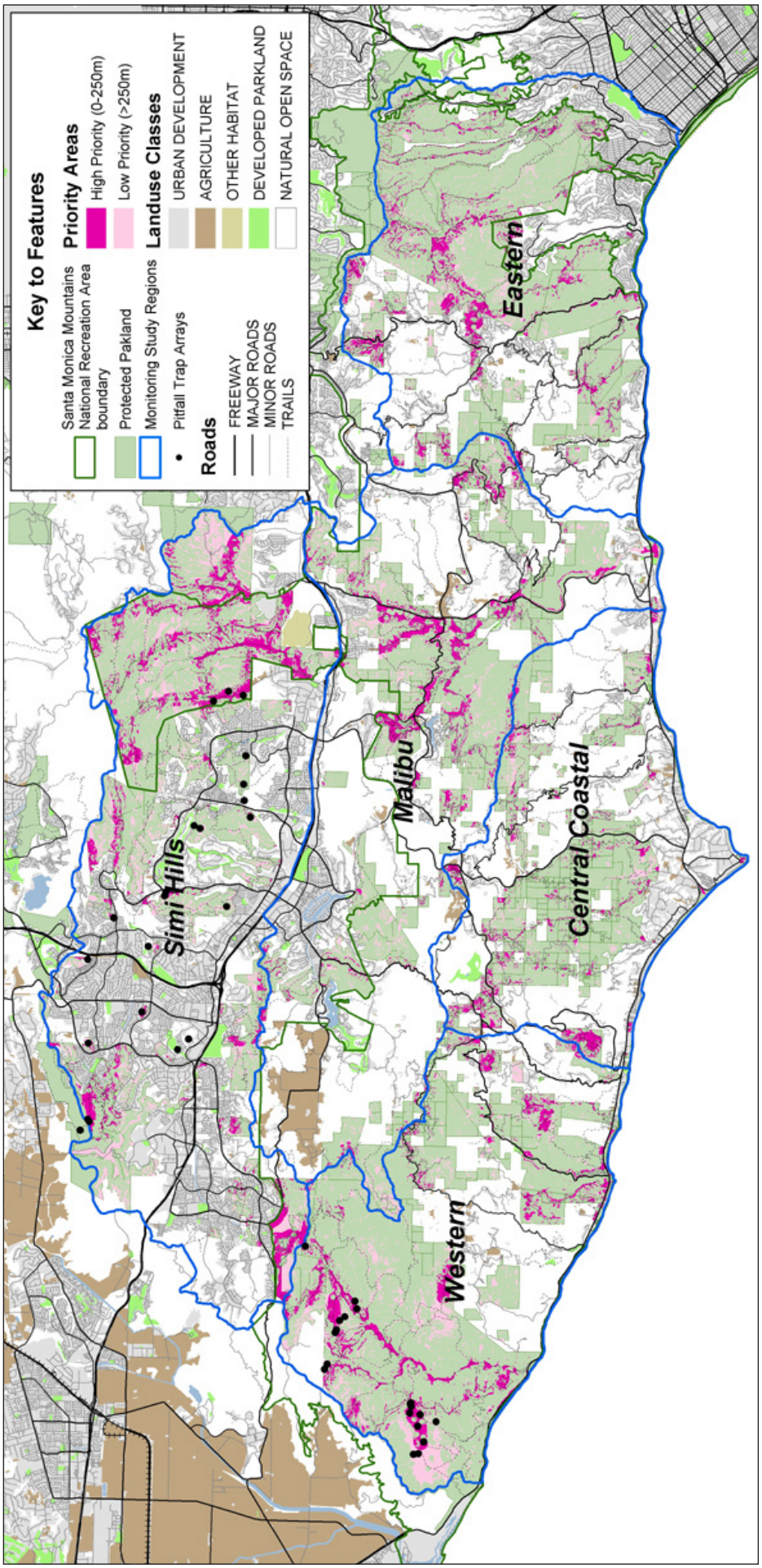


Figure 3-2. Pitfall sampling frames for the Santa Monica Mountains and the Point Loma Ecological Conservation Area. Generally in the Santa Monica

Mountains 20 pitfall trap arrays from each of five sampling regions will be monitored once each month a year on a 4 (year) - 6 (year) rotation. Practically 22 arrays have been installed in Region 1 (Simi Hills) and 19 in Region 2 (Western). Sampling within regions is staggered on a two year cycle. Monitoring occurs in only two regions in any one year.

In the Point Loma Ecological Conservation Area 16 pitfall arrays are monitored eleven times a year as indicated. Note that pitfall arrays are opened for one week only in either November or December of each year. See narrative text for a discussion on the closure of Array 6 in 2005.

Santa Monica Mountains

	Year											
Panel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Region 1	20	20	20	20								
Region 2			20	20	20	20						
Region 3					20	20	20	20				
Region 4							20	20	20	20		
Region 5									20	20	20	20
Total	20	20	40	40	40	40	40	40	40	40	20	20

Point Loma Ecological Conservation Area

	Month										
Panel	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov-Dec**
Array 1	×	×	×	×	×	×	×	×	×	×	×
Array 2	×	×	×	×	×	×	×	×	×	×	×
Array 3	×	×	×	×	×	×	×	×	×	×	×
Array 4	×	×	×	×	×	×	×	×	×	×	×
Array 5	×	×	×	×	×	×	×	×	×	×	×
Array 6	**Closed in 2005**										
Array 7	×	×	×	×	×	×	×	×	×	×	×
Array 8	×	×	×	×	×	×	×	×	×	×	×
Array 9	×	×	×	×	×	×	×	×	×	×	×
Array 10	×	×	×	×	×	×	×	×	×	×	×
Array 11	×	×	×	×	×	×	×	×	×	×	×
Array 12	×	×	×	×	×	×	×	×	×	×	×
Array 13	×	×	×	×	×	×	×	×	×	×	×
Array 14	×	×	×	×	×	×	×	×	×	×	×
Array 15	×	×	×	×	×	×	×	×	×	×	×
Array 16	×	×	×	×	×	×	×	×	×	×	×
Array 17	×	×	×	×	×	×	×	×	×	×	×

Boney Ridge from La Jolla Valley (Point Mugu State Park) in SAMO



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 4 - Field Preparations

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Preparing for Field Monitoring

Field Notebooks

Prior to going into the field for sampling in the Santa Monica Mountains, all previous field notes should be removed from the notebook and cataloged or entered into the appropriate database. If needed, additional data sheets should be added to the notebook. Ensure that sufficient data sheets including species entry forms (Figure 4-1), weather (Figure 4-2), and toe clipping or scale clipping data sheets (Figures 4-3 & 4-4) are available. These forms can be downloaded from the network server at SAMO headquarters at: G:\Animal_Ecology\Reptiles and Amphibians\Pitfalls\documents\Field\

Personal Digital Assistants

Data collected in the field by monitoring staff at CABR are recorded in Personal Digital Assistants (PDAs). Procedures for using PDAs are detailed in the attached USGS WERC administrative protocol "Protocol for Pitfall, PDA New Pitfall Survey Form Use."

Field Kits

Field kits should be cleaned prior to use and new trapping materials added as needed. The trapping kit contains:

1. 30 g, 60 g, 100 g, and 1 kg Pesola® spring scales.
2. Several weighing bags (typically 1 quart or 1 gallon zip-lock bags).
3. A cloth weighing bag for large snakes.
4. A clear plastic metric ruler for measuring lizards and small mammals.
5. A 2 m measuring tape for snakes.
6. Large forceps for handling captured small mammals and large invertebrates.
7. Small cuticle scissors for toe and scale clipping.
8. Fifty 1.5 ml centrifuge tubes filled with at least 70% ethanol (ETOH) for preserving toe and scale clips.
9. Four 50 ml centrifuge tubes filled with at least 70% ETOH for dead specimens.
10. Five one gallon sized plastic bags for storing larger dead specimens that are to be preserved later in ETOH or by freezing.
11. Reptile and Amphibian Field Guide.
12. Small Mammal Field Guide.
13. Permanent (water and alcohol resistant) pens to mark centrifuge tubes.
14. Colored marker for temporarily marking animals.
15. Data book or Personal Digital Assistant (PDA) for collecting survey data.
16. Blood-clotting powder (for use after toe or tail clipping).
17. Zip-ties or hog rings for repairing snake traps.
18. Rubber gloves for handling captured small mammals.

19. Leather gloves for handling snake trap.
20. First aid kit for treating minor cuts, scrapes, or insect bites in the field.
21. Snake hook for removing venomous snakes from traps.
22. Packaged wet wipes or antibacterial hand gel for cleaning hands in the field.
23. A hammer for opening and closing pitfall buckets.
24. Leatherman-type pocket tool.

Pitfall arrays may require general maintenance during sampling visits. SOP No. 8 lists other supplies and equipment that should be available during sampling to perform repairs as needed.

Personnel Training

Using field guides, web sites (*www.werc.usgs.gov/fieldguide*), and through discussions with experienced field personnel, new personnel are trained to recognize all the primary species likely to be found in the sampling area. New personnel are also taught to recognize sex, age, and reproductive condition (if possible) of species likely to be trapped. Reptiles and amphibians that are not easily identifiable in the field may be photographed or placed in a cloth bag and brought back to the office for identification.

California king snake (*Lampropeltis getula*).



Figure 4-1. Data entry sheet for recording captured specimens while in the field.

Region is area being sampled. Array = pitfall array number. Site = general description of vegetation. Bucket = the bucket number (e.g. 1A, 1B, 2A, 2B, or OC). Snake trap = either 1, 2, or 3. Species = four letter code. Weight = grams. Length (from snout to vent) = millimeters. Sex = male, female or unknown. Age = juvenile, adult, or unknown. Disp = disposition (escaped, released or dead). Recap = whether or not the animal has been captured previously. Tissue = whether or not a tissue specimen was collected on that day. Clip # = the toe or scale clip number that was used. Coll. = collector's initials. Notes = any other relevant data such as coloration of the throat or tail, tail loss and regeneration, or scars. Check-mark column is only to be filled in upon return from the field after data has been entered into the database.

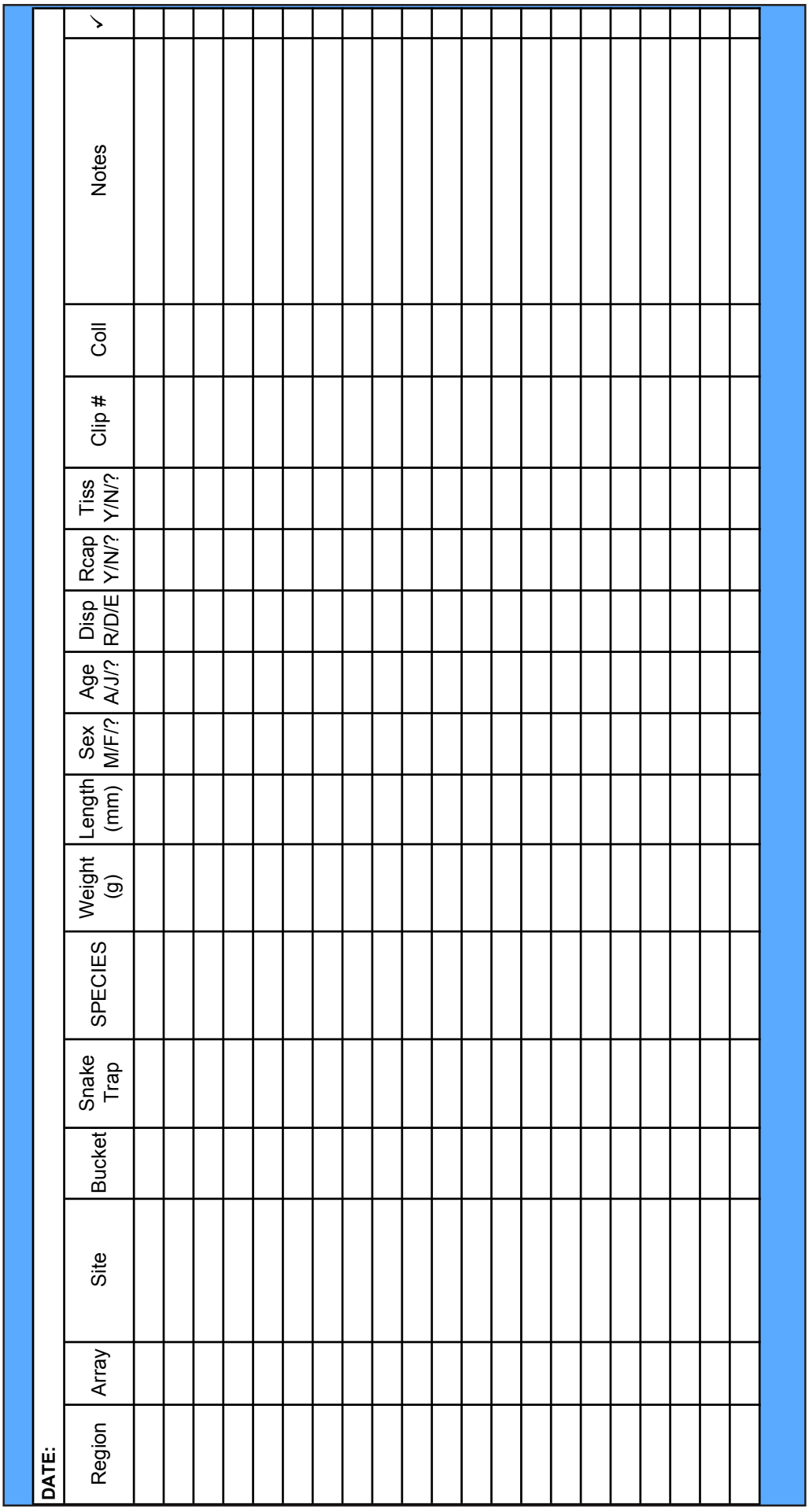


Figure 4-2. Weather data entry sheet.

Date is to be entered for each day of pitfall sampling. Array number is to be filled in for each array that is visited. For each array record the maximum and minimum temperatures along with a general weather description (1 = sunny, 2 = foggy, 3 = overcast, 4 = precipitation). Temperatures need not be recorded from the field if HOBO temperature data loggers are used in place of maximum and minimum thermometers.

			Array Number											
Day	Date	Climate												
1		Temp Max												
		Temp Min												
		Weather												
2		Temp Max												
		Temp Min												
		Weather												
3		Temp Max												
		Temp Min												
		Weather												
4		Temp Max												
		Temp Min												
		Weather												
5		Temp Max												
		Temp Min												
		Weather												

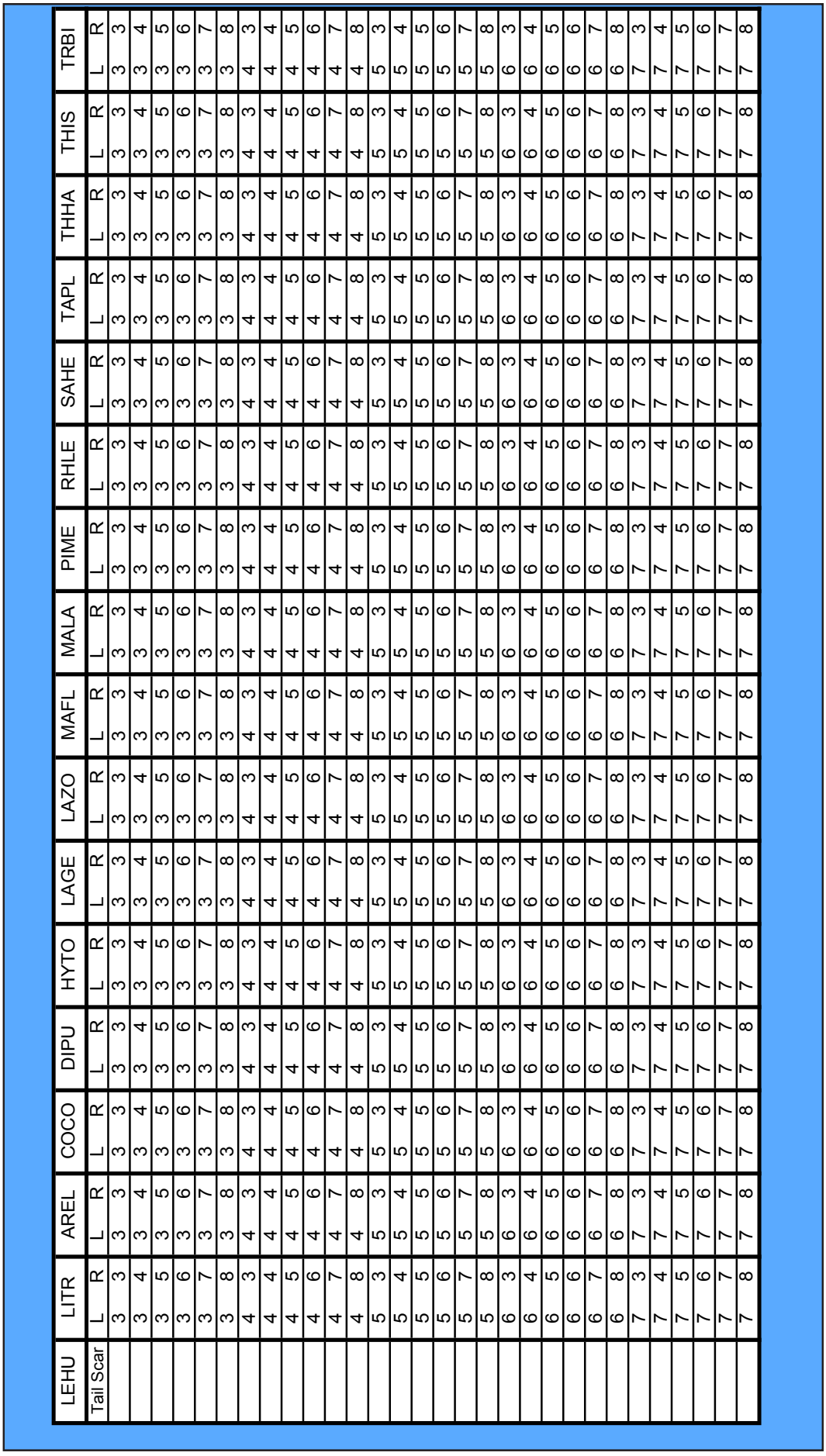
Figure 4-3. Example of a toe clip number assignment sheet for lizards and amphibians.

As a toe clip number is used it is marked off the above sheet so that it will not be used on another specimen from a given trap array.

ANLU	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
ENES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
TAT0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
HYCA	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
HYRE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
BUBO	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
BUMI	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
BUPU	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
RAAU	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
RACA	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
SCHA	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
COVA	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
XAHE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
XAVI	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
ANPU	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
ELMU	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
EUGI	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
EUSK	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
CNHY	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
CNTI	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
SCOC	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
SCOR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
UTST	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
PHCO	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000
GAWI	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	…	1000

Figure 4-4. Example of snake scale-clip sheet included in field notebook for recording clip numbers used from pitfall arrays.

As a scale clip number is used it is marked off the above sheet so that it will not be used on another specimen from a given trap line. LEHU are not individually clipped but scales along the side of the tail are removed for scaring. For all other species record the scale clip number in the data book with the left side as the 100's digit and the right side as the 10's digit (i.e. 3L4R would be recorded as 340 for the scale clip number).



LEHU	LITR		AREL		COCO		DIPU		HYTO		LAGE		LAZO		MAFL		MALA		PIME		RHLE		SAHE		TAPL		THHA		THIS		TRBI	
Tail Scar	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4
	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5
	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6
	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7
	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8	3	8
	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3
	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5
	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6
	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7
	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8	4	8
	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3	5	3
	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4	5	4
	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6
	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7
	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8	5	8
	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3
	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4	6	4
	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5	6	5
	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7
	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8
	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3	7	3
	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4	7	4
	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5	7	5
	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6	7	6
	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8	7	8

Central bucket from pitfall array installed in La Jolla Valley of the Santa Monica Mountains.



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 5 - Field Methods

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Field Methods

Sampling Frequency

In the Santa Monica Mountains pitfall arrays are sampled monthly by region for four consecutive days (48 time a year). Sampling begins on Monday when the traps are opened and concludes on Friday when they closed until the next trapping cycle. Regions are sampled as described in SOP No. 2. Each sampling day includes visiting all arrays (~20) in a given region. Arrays are organized into sets of two and sampled by one of two teams working concurrently. All arrays within one region in the Santa Monica Mountains can be visited by two teams in approximately five hours. Concurrent sampling minimizes the length of time specimens are left in traps and minimizes the variability of capture success as a result of daily changes in temperature and weather.

Pitfall arrays in the PLECA are sampled once a month for four consecutive days (44 times a year). Monthly sampling begins in January and ends in October. One additional sampling sequence is completed during November and December. Ground cover boards are checked periodically throughout the year. All pitfall arrays in the PLECA can be sampled by one two-person team in approximately 6 hours

Array Operation

1. To ensure the welfare of trapped animals, arrays are checked and captures processed during the early morning hours before the day becomes hot. During the late spring and summer months all sampling is completed no later than 1 PM each sampling day.

2. A standard carpenter's hammer may be useful in opening and closing buckets. Each sampling day all buckets are thoroughly cleaned of debris and feces and provided with a clean piece of cotton or polyester batting and one "hide tube" with insulation laid flat in the bucket bottom. A clean wet sponge is also laid flat in the bottom of each bucket. Sponges should be wetted outside the buckets (e.g. on the trap lid). Water in the traps can cause mud to build-up in the buckets, making cleaning difficult and endangering trapped animals impacting survivability in some cases. Sponges should be well moistened but not dripping when placed in buckets. Soil, debris, and potentially hazardous arthropods such as scorpions, centipedes, and large spiders should be removed each day during sampling (see SOP No. 1).

3. The soil surrounding the bucket rim must be kept graded smooth to ensure that it is nearly flush with the bucket rim. Pitfall traps with rims above ground level may be ineffective. On occasion, animals such as squirrels, skunks, raccoons, and coyotes may dig around the buckets or drift fences. Disturbance of this type must be repaired immediately. Both sides of the drift fence should be inspected for disturbance caused

by erosion or wildlife impacts (such as burrowing or digging) and repaired as soon as possible (see SOP No. 8).

4. Snake traps are placed between the outer and middle buckets on the right side of each of the three arms of the array. Each trap is provided with 1 piece of 1.5" PVC piping 8" long. Snake traps are sheltered from excessive sun and heating by covering the traps with plywood boards or roofing shingles. Before leaving an array ensure that each snake trap is placed as close as possible to the drift fence and covered end-to-end by plywood or shingles (See SOPs No. 1 & 2).

5. In the PLECA ground cover boards are checked periodically throughout the year by carefully lifting a board and recording species observed. Extreme caution should be used when lifting a cover board in case a venomous snake is resting underneath. If possible collect animals found under the board and gather morphometic data taken from pitfall trapped specimens (see below and SOP No. 6).

6. When closing the arrays on the last day of the trapping cycle collect the sponges and remove the cotton from the buckets. Remove all foreign debris and thoroughly clean the buckets. The PVC hide tube and insulation may be left in the bucket. Once buckets are cleaned clear the dirt from around the bucket lip and firmly secure a lid on each bucket. It is especially important that the bucket lids are well sealed to prevent small animals from being accidentally trapped. Placing rocks and/or dirt on top of the lids can be helpful in keeping them closed until the next trapping cycle. Both funnels must be removed from the ends of the snake traps.

7. In the Santa Monica Mountains the field kit, data book, and trap materials are returned to the storage room at SAMO headquarters after each sampling period. Once sampling in finished in the PLECA all sampling equipment is returned to the project manager.

Collecting and Recording Data

1. Date, region, array number, and bucket/ snake trap/cover board number for each captured individual, including incidental small mammal captures, are recorded on data sheets in the field notebook (Figure 5-1) or on a PDA. Species name is also recorded using a four-character code consisting of the first two letters of the genus and species (Table 5-1). Weight, morphometrics, recapture, age, sex, and disposition (i.e. alive and released, dead and preserved, or escaped) and tissue sample (sample collected in a vial) data are also recorded for all captures. Infrequently captured reptile or amphibian species observed at the sampling sites and while traveling to and from array locations are recorded.

2. Captured specimens are placed in a plastic bag and weighed to the nearest ¼ gram with a Pesola® spring scale (tare the weighing bag with each scale at the beginning of each sampling day). Small amphibians, lizards, and mammals can be weighed with the 30 g or 60 g scales; larger lizards, mammals and small snakes with the 100 g and the largest snakes with the 1 kg scale provided in each kit. Experience with these procedures is the best guide for choosing the appropriate scale to use.

3. Depending on the length of the specimen, measure captured specimens using a metric ruler or tape measure. Measurements are taken from the tip of the snout to the posterior edge of the anal scale on reptiles, to the cloacal opening on amphibians, or to the base of the tail on small mammals. Measuring is easiest by inverting the animal and pressing its underside gently against the ruler. Align the snout with the 0 increment on the ruler (or tape) and read the ruler while holding the animal in a straight position. Larger snakes can be measured by pulling the tape straight along with the snake's body. Record all length measurements in millimeters.

4. Most species are marked for recapture identification by clipping a portion of their toes (see SOP No. 6 and the toe clipping sequence guide in the field notebook). To permanently mark a specimen, clip ½ of each selected toe. Snakes are marked by clipping the subcaudal scales (those on the ventral surface of the tail) in left and right number combinations. Scale numbering begins at the anterior of the tail, immediately after the anal scale. Detailed clipping procedures and guidelines are found in the USGS herpetological sampling protocol that is attached. Toe clips and distal tail segments (tail tips) removed from salamanders, lizards, and snakes are placed in the tissue vials filled with at least 70% ETOH provided

in the field kit. Using a waterproof and alcohol-proof fine-point marker record the sample date, region, array number, bucket or snake trap number, and toe/scale clip number on the top or the roughened portion of the vial. Tissue samples collected should be recorded on the data sheet or in the PDA.

5. For identification of captured specimens use permanent markers to place one or more dots on the ventral surface of the body or base of the tail. This marks lizards and snakes temporarily for recapture identification, but will not last and is not a reliable method of marking individual specimens for between sampling cycle identification. If marks wear away or have been lost due to shedding of the skin individuals recaptured within a sampling cycle may be repainted as necessary. Do not apply a pen mark anywhere on the dorsal surface or head as this may compromise the natural cryptic markings of the animal.

6. Sex and age determination are best made by use of the species guide provided with each field kit (see attached). If in doubt as to gender and/or age of a specimen, do not guess. Bag (see SOP No. 6) the animal in question. Label the bag with the site number, array, and bucket or trap number and bring to headquarters for further examination. All specimens brought in for evaluation are to be returned to the site where collected before the end of the working day.

7. Upon returning to the office enter in all information from the field notebook or download data from the PDAs into the "MEDN Pitfall Trap Database" (Microsoft Access). This includes weather information from each array and all capture related information and data. Re-check your work to ensure that information and data are entered exactly as entered on the field form. Resolve questions on data entry with your supervisor or the program manager.

Post-collection Processing of Samples

While precautions are taken to ensure the survival and safety of specimens captured in pitfall traps, occasionally captured animals succumb to starvation, predation and/or exposure. Dead specimens are to be placed in a 50 ml centrifuge tube or vial filled with 70% to 95% ETOH or stored on ice for later freezing. Record species name, collection date, site name, and array number on the sample container. The animal will be saved as a voucher specimen and stored for future genetic or morphometric evaluation.

Mortalities occur most commonly with smaller mammals. Shrews in particular are very vulnerable. Survivability can be increased by placing meal worms and PVC pipe (with insulation) for shelter in the pitfall traps during the trapping cycle. Other mammals, particularly dispersing juveniles or smaller rodents may also expire in traps if they are recaptured multiple times in the same array or captured early in the evening and spend all night in a trap. As trapping activity occurs in cooler months or following rains, mortality of mammals is likely to increase. To reduce capture induced mortality during the wet season it may be necessary to close specific buckets that are prone to flooding. Ants can stress rodents and kill juvenile lizards and snakes if they invade the buckets. If ants invade pitfall buckets thoroughly clean the affected bucket to eliminate anything that may have attracted the ants. If cleaning does not solve the problem then the bucket should be closed for the remainder of that sampling cycle.

Training

Proper training of field technicians, interns, and volunteers is important to assure the accuracy and quality of the data collected. After familiarizing themselves with the written protocols and instructions, new personnel are accompanied in the field by experienced field biologists or technicians for at least two full trapping cycles (two weeks). Mentoring and hands-on experience ensures that new personnel are familiar with trap locations, animal handling, mark/recapture procedures, and species identification.

Table 5-1. Reptile, Amphibian & Small Mammal Species Checklist

Species Code	Scientific Name	Common Name
ANLU	*Aneides lugubris*	arboreal salamander
ANPU	*Anniella pulchra*	silvery legless lizard
BAMA	*Batrachoseps major*	garden slender salamander
BANI	*Batrachoseps nigriventris*	California slender salamander
BAPA	*Batrachoseps pacificus*	garden slender salamander
BUBO	*Bufo boreas*	California toad
CNHY	*Cnemidophorus hyperythrus*	orange-throated whiptail
CNTI	*Cnemidophorus tigris*	coastal whiptail
COCO	*Coluber constrictor*	western yellowbelly racer
CORU	*Crotalus ruber*	red diamond rattlesnake
CRVI	*Crotalus viridis*	southern pacific rattlesnake
DIAG	*Dipodomys agilis*	pacific kangaroo rat
DIPU	*Diadophis punctatus*	San Bernardino ringneck snake
ELMU	*Elgaria multicarinata*	San Diego alligator lizard
ENES	*Ensatina eschscholtzii*	Monterey ensatina
EUSK	*Eumeces skiltonianus*	western skink
HYCA	*Hyla cadaverina*	California tree frog
HYRE	*Hyla regilla*	Pacific tree frog
HYTO	*Hypsiglena torquata*	San Diego night snake
LAGE	*Lampropeltis getula*	California kingsnake
LAZO	*Lampropeltis zonata*	San Diego kingsnake
LECA	*Lepus californicus*	black-tailed jack rabbit
LEHU	*Leptotyphlops humilis*	southwestern blind snake
MAFL	*Masticophis flagellum*	red coachwhip
MALA	*Masticophis lateralis*	California striped racer
MICA	*Microtus californicus*	California vole
MUMU	*Mus musculus*	house mouse
NEFU	*Neotoma fuscipes*	dusky-footed woodrat
NELE	*Neotoma lepida*	desert woodrat
NOCR	*Notiosorex crawfordi*	desert shrew
PEBO	*Peromyscus boylii*	brush mouse
PECA	*Peromyscus californicus*	California mouse
PEER	*Peromyscus eremicus*	cactus mouse
PEMA	*Peromyscus maniculatus*	deer mouse
PETR	*Peromyscus truei*	piñon mouse
PGCA	*Perognathus californicus*	California pocket mouse
PHCO	*Phrynosoma coronatum*	California horned lizard
PICA	*Pituophis catenifer*	San Diego gopher snake
RAAU	*Rana aurora*	California red-legged frog
RACA	*Rana catesbeiana*	bullfrog
RANO	*Rattus norvegicus*	Norway rat
RARA	*Rattus rattus*	black rat
REME	*Reithrodontomys megalotis*	western harvest mouse
RHLE	*Rhinocheilus lecontei*	long-nosed snake
SAHE	*Salvadora hexalepis*	coast patchnose snake

SCGR	*Sciurus griseus*	western gray squirrel
SCHA	*Scaphiopus hammondii*	western spadefoot
SCLA	*Scapanus latimanus*	broad-footed mole
SCNI	*Sciurus niger*	fox squirrel
SCOC	*Sceloporus occidentalis*	Great Basin fence lizard
SOOR	*Sorex ornatus*	ornate shrew
SYAU	*Sylvilagus audubonii*	desert cottontail
SYBA	*Sylvilagus bachmani*	brush rabbit
TAPL	*Tantilla planiceps*	western blackhead snake
TATO	*Taricha torosa*	California newt
THBO	*Thomomys bottae*	Botta's pocket gopher
THHA	*Thamnophis hammondii*	two-striped garter snake
THIS	*Thamnophis sirtalis*	California red-sided garter
TRBI	*Trimorphodon biscutatus*	California lyre snake
UTST	*Uta stansburiana*	California side-blotched lizard

Field crew collecting data and tissues samples from snake caught in pitfall trap in La Jolla valley (SAMO).



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 6 - Processing of Captured Herpetofauna & Small Mammals

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Processing Animals

Processing of animals includes handling, identification, measuring, recording of data, and marking (also see SOP No. 5). After processing, all captured animals are immediately released. Dead animals are preserved as voucher specimens and for genetic investigations. Voucher specimens (regardless of condition) are placed in 50 ml centrifuge tubes in 70% to 95% ETOH or put on ice for transportation back to the office. Later these specimens can be stored permanently in 70% to 95% ETOH or frozen. Photographs can be taken of captured animals to supplement the data record and to serve as voucher metadata for later analysis and publication. Any reptile specimen that is not easily identifiable is placed in a cloth bag and brought back to the office for identification and photographing. Bagged specimens must be held in a cool shady area to avoid overheating.

Processing of captured specimens is done in the following order:

1. Identify the species before handling.
2. Record the array and trap number (i.e. Array 25 bucket 1B or Array 23 snake trap 2).
3. Determine age (juvenile or adult) using the field guide as reference – this depends on size.
4. Measure length (snout to vent length or cloacal opening) to nearest millimeter (Figure 6-1).
5. Determine weight (to the nearest ¼ gram).
6. Determine sex and reproductive status (i.e. Female – Gravid) using the field guide as reference.
7. Record any unusual or identifying marks.
8. Mark reptiles and amphibians by toe- or scale-clipping as described below.

Lizards, Newts, Salamanders, Frogs & Toads

Marking – Toe Clipping

Nearly all of the reptiles and amphibians with the exception of snakes are toe clipped upon capture. However, some species are difficult to handle and are not toe-clipped (see Table 6-1).

Numbering of toe clips for lizards, newts and salamanders is described in figure 6-2. Toe clipping provides each individual a unique number for recapture identification. No two individuals of the same species are clipped in the exact same sequence. Individual specimen numbers are read by looking at the feet from the dorsal side. The left hand (appendage nearest the head) records the numbers one to five. The right hand records the numbers 10 to 50. The right foot records the numbers 100 to

Figure 6-1. Snout-to-vent length. The snout-to-vent length of each animal is measured and recorded in millimeters.

A ruler is pressed against the underside of the animal, aligned with the animal's snout and the length to the vent is measured. In the diagram, this lizard is 75 millimeters.



Table 6-1. Toe and scale clipping guide for reptiles, amphibians & snakes.

1 = toe clip, 2 = collect tail clip, no toe clipping, 3 = Clip scales and remove ½ inch of tail tip & 4 = Do not handle, record occurrence, estimate size & release

Lizards & Amphibians		Code
Anedies lugubris	ANLU	2
Anniella pulchra	ANPU	2
Batrachoseps nigriventris	BANI	2
Batrachoseps pacificus	BAPA	2
Bufo boreas	BUBO	1
Cnemidophorus tigris	CNTI	1
Elgaria multicarinata	ELMU	1
Ensatina eschscholtzi	ENSC	1
Eumeces skiltonianus	EUSK	1
Hyla cadaverina	HYCA	1
Hyla regilla	HYRE	1
Phrynosoma cornatum	PHCO	1
Sceloporus occidentalis	SCOC	1
Taricha torosa	TATO	1
Uta stansburiana	UTST	1
Snakes		
Arizona elegans	AREL	3
Coluber constrictor	COCO	3
Crotalus viridis	CRVI	4
Diadophis punctatus	DIPU	3
Hypsiglena torquata	HYTO	3
Lampropeltis getula	LAGE	3
Lampropeltis zonata	LAZO	3
Leptotyphlops humilis	LEHU	3
Masticophis flagellum	MAFL	3
Masticophis lateralis	MALA	3
Pituophis catenifer	PICA	3
Rhinocheilus lecontei	RHLE	3
Salvadora hexalepis	SAHE	3
Tantilla planiceps	TAPL	3
Thamnophis hammondii	THHA	3
Thamnophis sirtalis	THSI	3
Trimorphodon biscutatus	TRBI	3

500, and the left foot records the numbers from 1000 to 5000. All toes are assigned a numerical value counting left to right (Figure 6-2).

Because frogs and toads have only four toes on their from limbs toe-clip numbers 5 and 50 are never used when toe clipping frogs and toads. Each newly captured specimen is toe clipped. Consult the notebook toe clipping chart or the PDA for the next available toe clipping number. Cross out numbers from the notebook as they are used.

It is important to clip toes with a sharp pair of scissors. If scissors are dull or damaged see project manager for replacement. When clipping toes, clip enough of the toe so that it is easily recognizable that the toe has been clipped; usually clipping at the first knuckle will suffice. If there is insufficient tissue for a genetics analysis, ¼ inch of the tail may also be clipped.

If after toe or tail clipping bleeding does not stop, apply pressure to the wound by pinching the clipped area. Blood clotting powder is provided in each field kit and may help stop bleeding if used in combination with pressure. All toe and tail tips are to be stored in 1.5 ml centrifuge tubes in 70% to 95% ETOH. On each tube record the following:

- Species four letter code (e.g. *Sceloporous occidentalis* is SCOC)
- Toe clip number
- Collection date (e.g. 19 March 2004)
- Array and trap number (e.g. 24.3.A meaning Array 24, bucket 3A)
- Note sampling region

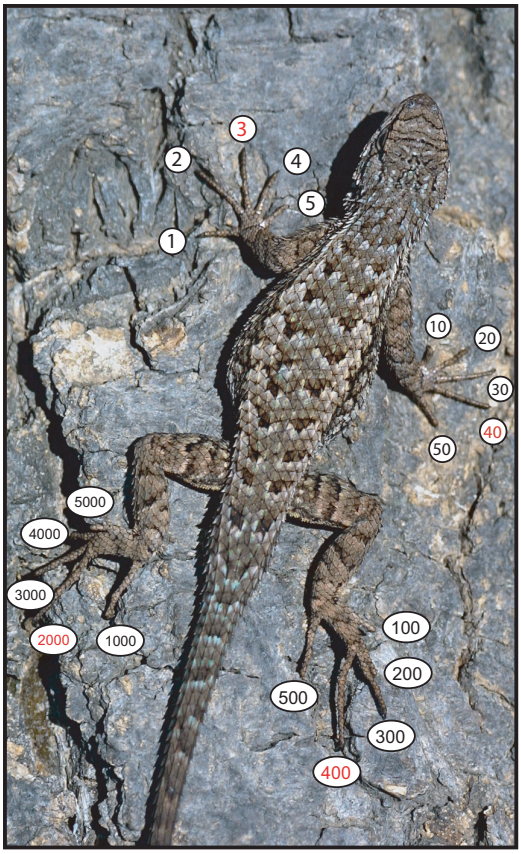
Missing Toes

In some cases an individual may already be missing toes from natural causes. In these instances check the log in the notebooks to see if that missing toe corresponds to a previously clipped individual. If specimen is a new capture, assign the next available toe-clip number that incorporates the missing toe. For example, if the middle toe is missing on the front left foot, then the next available number with "3" should be used.

In some cases multiple toes may be missing from an individual. In these circumstances the toe numbers are added together and a new number is created. For example if the fourth and fifth toes are missing on the front

Figure 6-2. Toe Clip Diagram.

Most reptiles and amphibians can be marked by toe-clipping. Each toe is assigned a value, from 1 to 5000 starting with the outer toe of the front left limb, and proceeding in a clockwise pattern. For a lizard with the toe clip number of 0043, the 40 toe on the front right limb and the 3 toe on the front left limb are clipped. The 400 and 2000 toes on the hind limbs should never be clipped. These have been identified as important in the locomotion. Similarly, the 4 and 10 toes (thumbs) of frogs and toads are not clipped because they are important in amplexus.



right foot, then the toe clip number is "90".

Exceptions to Toe Clipping
Certain species such as slender salamanders are too small for toe clipping, and in some rare instances a juvenile animal may be too small to toe clip. Limbless lizards cannot be toe- or scale-clipped. In these situations collect a small sample of the tail for genetic analysis and place in a 1.5 ml centrifuge tube in 70% to 95% ETOH .

Snakes
Record the same information as for limbed species, except for reading and/or assigning toe clip numbers. Snakes are identified by scale clips on the tail (Figure 6-3).

1. Identify the species before handling.
2. Record the array and trap number (i.e. Array 25 bucket 1B or Array 23 snake trap 2).
3. Determine age (juvenile or adult) using the fiedl guide as reference– depends on size.
4. Measure length (snout to vent length) – to nearest millimeter.
5. Measure weight (grams).
6. Note sex and reproductive status (Female – Gravid) using the field guide as reference.
7. Note unusual and identifiable marks.
8. Mark by scale clipping.

Scales are read from the ventral or bottom of the snake with the tail pointing away from you. Scales are typically divided immediately after the vent. The left scales are 100's digits and the right scales are 10s digits. So, for example "460" would clip the fourth left scale after the vent and the sixth scale on the right after the vent (Figure 6-3).
To clip scales use sharp cuticle scissors and gently lift the scale from the body so that the blade of the scissors is under the scale. The goal is to clip the scale's growth plate. This will scar the scale and allow for future identification. When possible try to clip a small sample of the tail for genetics analysis. Place all scale and tail tissue in a 1.5 ml centrifuge vials filled with 70% to 95% ETOH.

Venomous Snakes
No measurements are taken on venomous snakes.

The southern Pacific rattlesnake is the only venomous snake that is present in the Santa Monica Mountains and on Point Loma. It is one of the more common snake species likely to be encountered in pitfalls, snake traps and along trails. Field personnel must dress appropriately (long pants and hiking boots) to protect against snake bite and must avoid direct contact at all costs.

If a large rattlesnake is found in a pitfall trap, remove the lid and let it leave on its own. If a small rattlesnake is found in a trap use a long stick or snake tongs to remove it from the pitfall trap. If a rattlesnake is captured in a snake trap, gently and carefully remove the cone of the snake trap that is the farthest from the snake (i.e. the head), and allow the snake to leave on its own.

If bitten in the field, immediately report to the hospital for treatment. Draw a circle around the swollen portion of the bite wound and record the time. This information will be useful to the hospital when administering antivenin, and may reduce the recovery time.

Bottom-line
Avoid rattlesnakes at all costs!

Small Mammals
Rodents and rabbits are also occasionally caught in pitfall traps. Handle these species with care. Larger rodents can bite and all

species may carry diseases. If bitten it is important to clean the wound thoroughly and apply an antibacterial ointment or compound.

The following data are to be recorded on trapped rodents: Species Code, Array and Trap Number, Age, Sex, and Weight

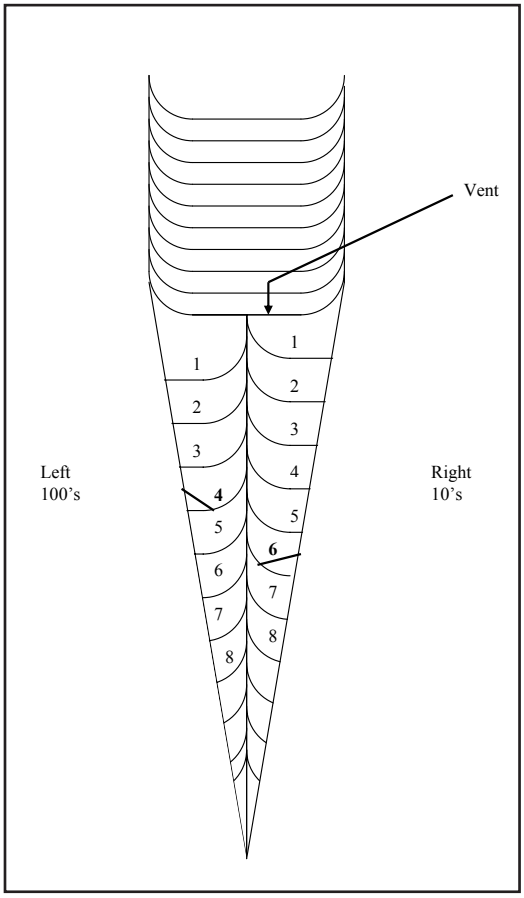


Figure 6-3. Scale-clip diagram.

Snakes are marked by clipping the post-anal scales following the above diagram. The first and second scales typically are not clipped. To clip a snake as number 460, the fourth scale on the left is clipped, and the sixth scale on the right is clipped. Figure redrawn from Stokes et al. 2001.

Using the gloves or tongs provided place captured rodents or rabbits in a bag to be weighed. If species confirmation is needed, record ear length, hind foot length, head-body length , and tail length. After measuring release animals into nearby vegetation. If an animal is dead, place the specimen in a container filled with 70% to 95% ETOH or put it on ice until it can be frozen.

Invertebrates

Currently, invertebrates captured in pitfall traps are not collected nor any data recorded about them. However, poisonous invertebrates such as centipedes, scorpions, and large spiders such as trapdoor spiders should be removed from the traps with tongs. The remaining invertebrates can be left in the buckets as food for shrews that may be captured in pitfalls. All invertebrates remaining in traps at the end of a trapping cycle are removed and released on the last day of sampling. Within the Santa Monica Mountains pitfall arrays may incorporate separate ant traps (see SOP no. 11).

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 7 - Describing the Habitat

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Habitat Measurements

Six habitat parameters are measured at each pitfall trap aray at the time of installation: vegetation composition, maximum canopy height, ground cover, slope, aspect, and soil composition. In addition, daily weather (cloudy, foggy, sunny, or rain) and maximum/minimum temperature (Celsius) are recorded at each array during sampling as outlined in SOP No. 1.

Vegetation Surveys

In the Santa Monica Mountains vegetation composition, maximum canopy height, and ground cover are determined using the point-intercept method (Sawyer & Keeler-Wolf 1995). Data are collected along four 25-meter transects that extend in each of the cardinal compass directions from near the center bucket of each array (Figure 7-1). To avoid vegetation that may have been trampled during bucket installation and subsequent sampling, each transect begins 1.5 meters out from the center bucket; from this point a stadia rod is dropped vertically at half meter intervals for 25 meters. At each of the 50 points along the transect, plant species touching the rod and the height of the tallest species are recorded.

Vegetation is analyzed by layer: herb, shrub, and tree. Plants shorter than 40 cm are considered herbs, those from 40.5 cm to 249.5 cm are shrubs, and those taller than 250 cm are trees (Sawyer & Keeler-Wolf 1995). Height alone determines how a plant is classified and to which vegetation layer it belongs; i.e. small members of tree species, such as *Quercus agrifolia*, are counted as part of the herb or shrub layer if their height is less than 40 cm or 250 cm, respectively. Ground cover is also recorded at each half-meter interval as leaf litter (loose dead leaves, usually under shrubs and trees), thatch (dead grass and herbs, often flattened but still rooted) or bare ground.

Variables collected to define habitat types in the PLECA include primary plant species, vegetation canopy and sub-canopy heights, substrate, leaf litter height, incidental plant species, slope and aspect. Sampling takes place along a 50 meter north-south transect centered over the center bucket of each array. Vegetation data is recorded at points every 0.5 m along the transect. The resulting data describes the habitat in a circular plot with a 25 meter radius around the array (2,000 m^2). Species composition (or percent cover by species) may be calculated with these data, based on the number of times a species is encountered ("hits"). Point data are collected by placing a pole down perpendicular to the ground every 0.5 m along the entire transect on either the east or west side of the transect. Height and identification of the vegetation is recorded in centimeters (cm). Record all plant species that touch the pole within one of three height classifications tree, shrub, or herb. Trees include any plant taller then 3 m (300.0 cm). Shrubs included all

plants between 50.0 cm and 299.9 cm in height. Plants less than 50.0 cm in height are classified as herbs. A total of 100 points of data are recorded. At each point where the pole touches the ground record the substrate type from one of the following categories: bare rock, cobble stone, cryptogamic crust, leaf litter, moss/lichen, organic dirt, or sandy soil, also record leaf litter height (or depth in cm) where the pole touches the ground. Record zero leaf litter height and a substrate type other than leaf litter if there is no leaf litter where the pole meets the ground. Leaf litter includes dead organic material such as leaves, grasses, branches, seeds, roots, fruits, and any other loose substances. If vegetation is still alive, but trampled down to the ground to form a mat it should be included as leaf litter. Cryptogamic crusts refer to soil that is covered by a thin layer of cryptogams – lichens, mosses, liverworts, and hornworts (c.f. Hutten & Woodward, 2002).

Physical Habitat Surveys

Slope and aspect are measured at the center bucket of each array. Slope is estimated as percent using a hand-held clinometer. Aspect is estimated in degrees (azimuth) by determining the compass bearing of the direction the hillside faces. Slope and aspect are thought to have a cumulative influence on the vegetation through increasing insolation. Borchert (1989) suggests an index of northness can be compared among sites. This index ranges from one to minus one and is calculated as the cosine of the azimuth times the sine of the slope. A south facing vertical cliff would have a northness index of minus one and presumably receive a greater amount of solar radiation than that of surrounding areas with northness values greater than minus one.

Soil Surveys

Soil is classified by the three major categories: sand, silt or clay (Figure 7-2). Subcategories such as sand/clay, loam, etc. can also be used to classify soil type. Soil is collected near the center bucket of each array and soil type is classified by soil texture using the texture by feel method (Figure 7-3).

Literature Cited

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Sawyer, J.O. and Keeler-Wolf. 1995. A Manual of California Vegetation. California Native Plant Society, Sacramento, California.

Borchert, M.I., F.W. Davis, J. Michaelsen and L.D. Oyler. 1989. Interactions of factors affecting seedling recruitment of blue oak (*Quercus douglasii*) in California. Ecology **70**:389-404.

Figure 7-1. Arrangement of vegetation transects as applied at each pitfall trap array in the Santa Monica Mountains.

Twenty-five meter transects, one in each of the cardinal compass directions, begin 1.5 m from the central pitfall trap.

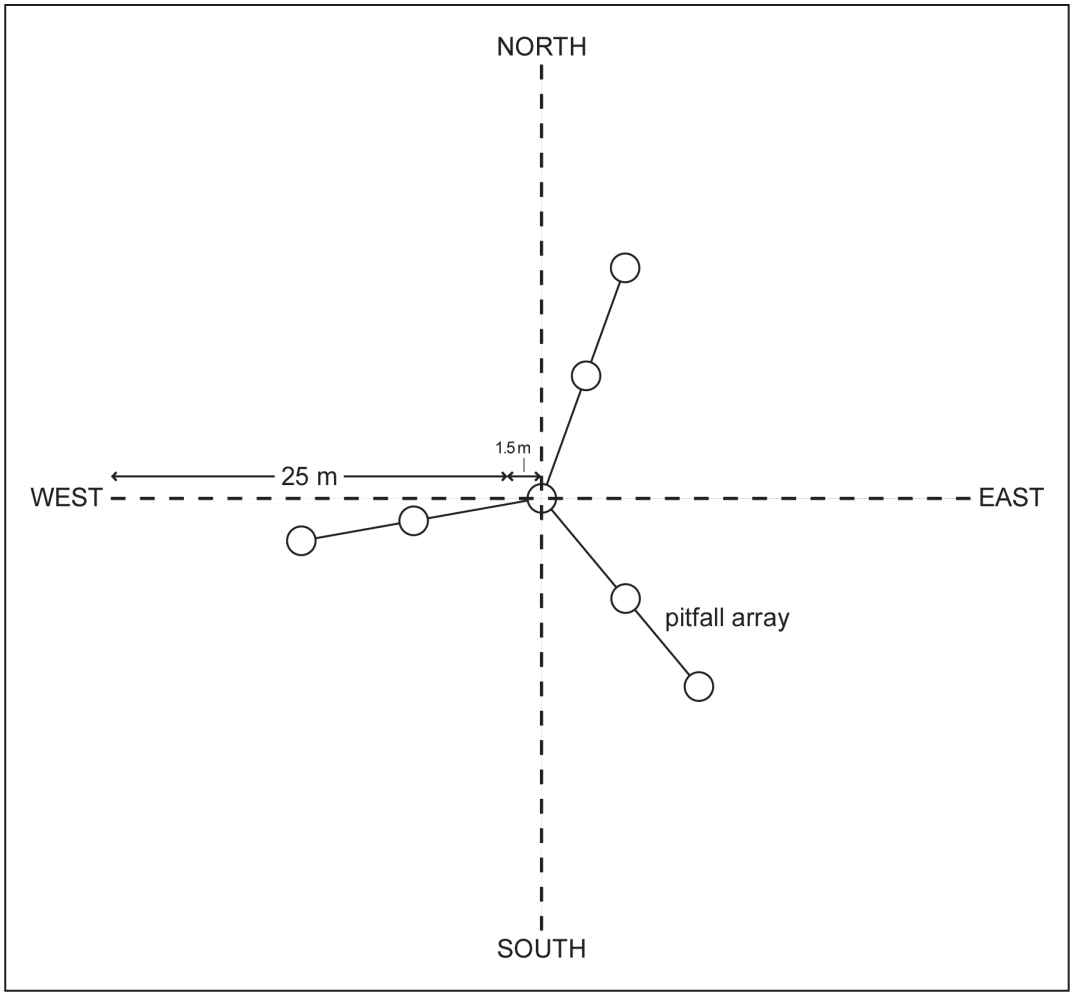


Figure 7-2. The twelve soil texture classifications of the Bienz Soil Chart (U.S. Department of Agriculture). Percentage of soil textures are based on soil size.

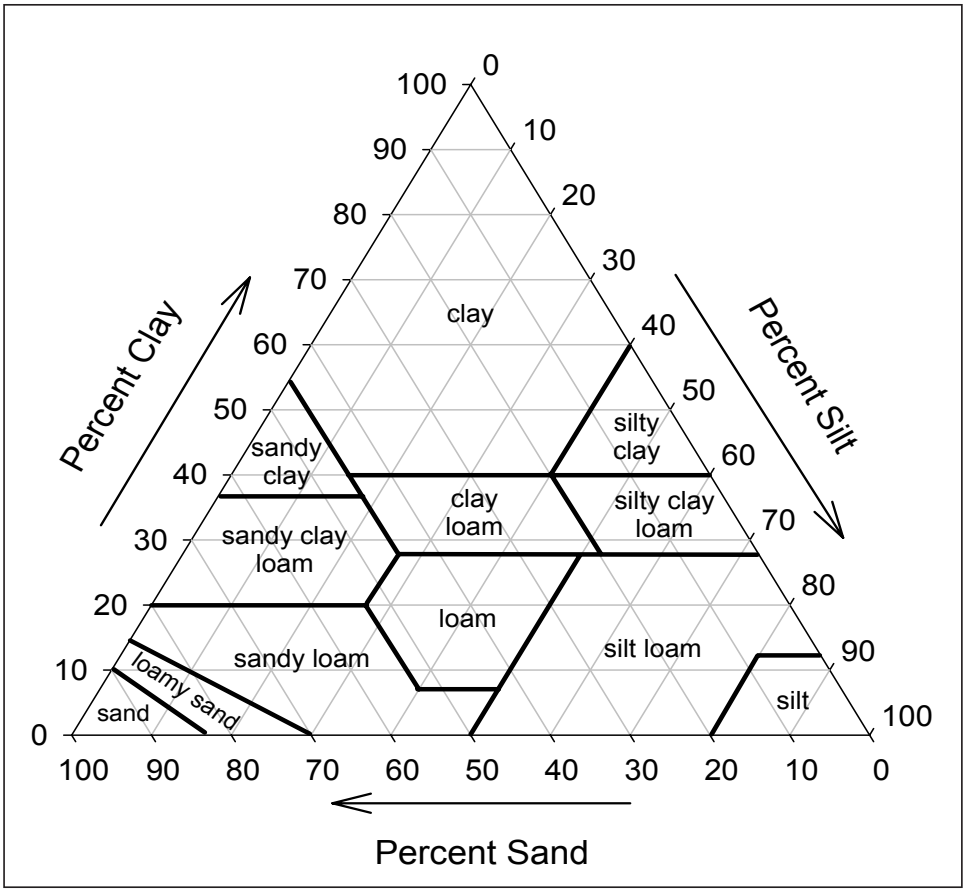
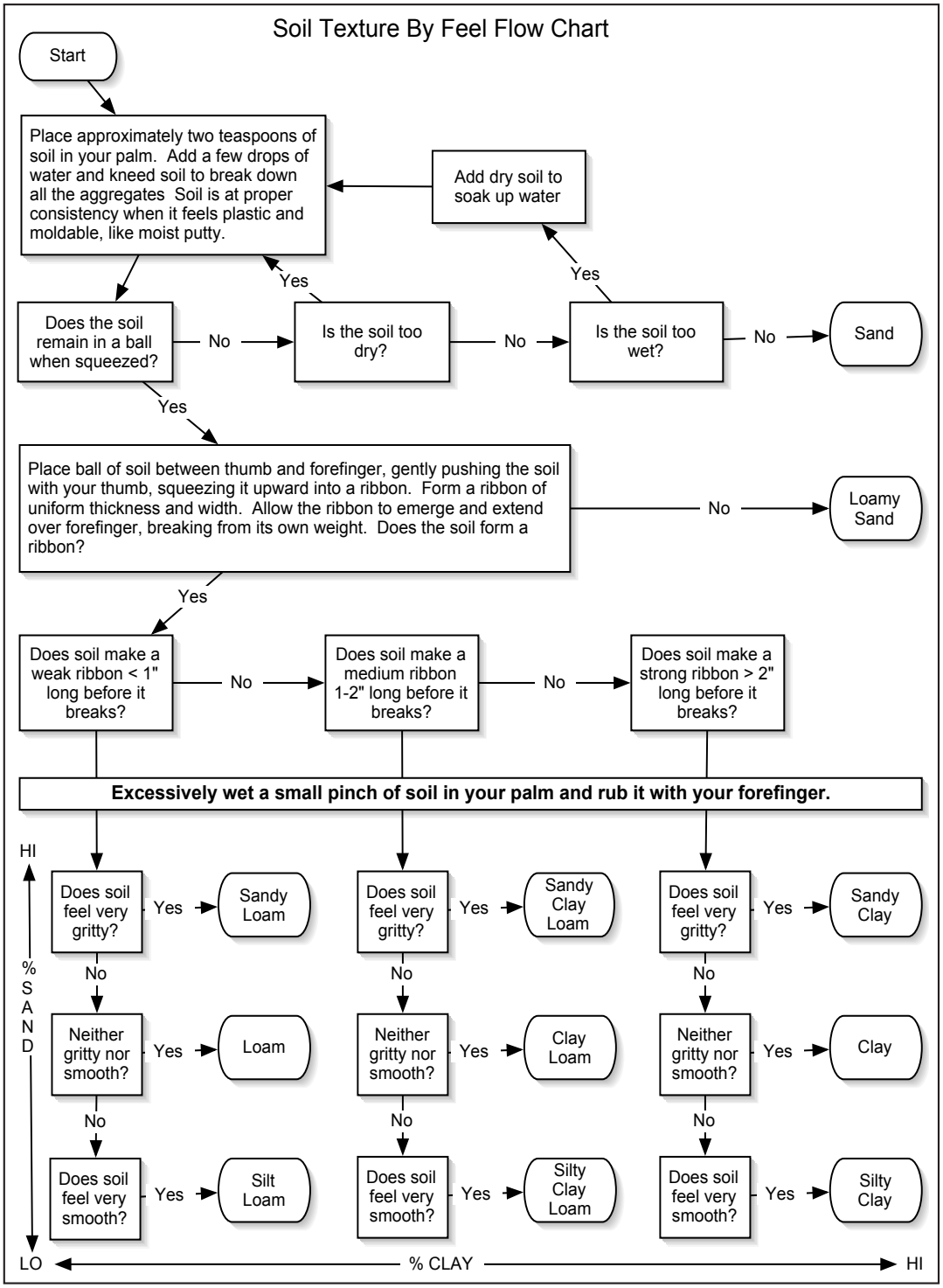


Figure 7-3. A guide to estimating soil texture and soil type for each pitfall array, http://www.bigsiouxwaterfestival.org/teachers/28/soil.pdf



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 8 - Periodic Maintenance of Trap Arrays

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Periodic Array Maintenance

Periodic maintenance is essential for trapping success and to ensure the well being of captured animals. Poorly maintained pitfalls and snake traps can result in animal injury or death. The opening of traps prior to sampling is the best opportunity to conduct necessary repairs.

Maintenance & Equipment

All procedures outlined for establishing and maintaining trap arrays are to be followed precisely. Careful attention to detail ensures that traps and arrays are always in the best possible condition during sampling. Cleanliness and consistency in maintenance benefits captured animals, facilitates data collection, and promotes a positive image of the project.

Pitfall trap arrays are examined and repaired (if necessary) on the day of opening for sampling or a few days prior to opening. Possible repairs that might be needed include replacing wooden stakes, drift fencing, and broken lids; re-burying and re-stapling drift fences, or repairing snake traps. Cotton batting is to be replaced and clean sponges are to be ready for deploying in the traps.

The following tools and supplies are to be taken to the field when opening traps for sampling:

1. Zip ties or hog rings for snake trap repair.
2. Hardware cloth end-cones for funnel trap repair.
3. Staple gun and staples for drift fence repair.
4. Extra fence stakes & spare bucket lids.
5. Leatherman-type pocket tool.
6. Small sledge hammer.
7. Carpenter's hammer to pry open lids of closed buckets.
8. Wire cutters for fitting funnel ends to snake traps and for trimming fencing.

Snake Traps

Cone Replacement
Occasionally the tabs on the snake trap cones become brittle and break. These tabs allow the cones to fit securely and prevent injury to - or escape of trapped animals. Prior to opening pitfall arrays, the cones should be inspected and damaged cones replaced. Spare cones made up in advance are taken to the field to use as replacements as needed.

Zip Tie or Hog Ring Replacement
Zip ties or hog rings hold the cones and the snake tube together. Extra zip ties or hog rings should be placed in trapping kits and replaced as required.

Pitfall Traps

Fencing
Occasionally wildlife will chew a hole in the fencing or pull fencing away from the stakes.

Fencing may also wear out with age and weathering. It is important that fencing be re-stapled prior to opening arrays.

Wooden Stakes
Replace stakes that are rotten or damaged by termites. These stakes typically do not sit firmly in the ground. Fencing along rotten stakes typically has fallen or is loose. Replacing stakes or adding additional stakes usually resolves these problems. Stakes should be brought to arrays on opening day and replaced as needed.

Bucket Lids
Bucket lids will occasionally warp or crack. Lids should be replaced when they are broken along the edges and no longer seal with the bucket traps. Lids that are no longer in good condition do not secure adequately to buckets when closed and may come off during storms or when jostled by wildlife.

Array or trap numbers written on lids must be periodically refreshed. Care should be taken to ensure that the correct number is marked on each lid. Periodic checking of trap numbering against the GIS maps and original GPS coordinates is recommended.

Replacement of Lid Legs
Functionality of the wooden legs on bucket lids will decrease with continued use. Occasionally they will split and fall off of bucket lids. Repeated handling can strip the screw-thread holes causing legs to wobble or lean. Loose or split legs create an unstable foundation for lids which can tip or lean over partially closing an open pitfall trap. This reduces the capture reliability and efficiency of the trap potentially biasing capture data. Legs should be replaced as needed.

Buckets
Buckets with chipped or cracked lips that no longer seal tightly with a lid should be replaced prior to closing the arrays following a sampling cycle. If the ground is too dry and hard to allow bucket replacement duct tape may be used to temporarily attach lids to buckets and seal any holes or gaps between the bucket and the lid. In this case buckets should be replaced as soon as soil conditions allow.

Thermometers
Maximum/minimum mercury thermometers used at arrays in the Santa Monica Mountains should be replaced and disposed of according to established procedures when cracked or unusable. They should also be replaced if, when tared, the minimum and maximum temperatures are not the same, or when bubbles develop in the glass which can result in erroneous temperature readings.

Hobo Data Loggers
Check batteries before each sampling cycle and replace as needed.

Ground Cover Boards
Ground cover boards should be replaced when they become warped or weathered to the point that they no longer create the desired microhabitat.
Shelter Within Pitfall Traps
Each pitfall trap should be equipped with two insulated PVC hide tubes at all times. Snake traps should have one insulated hide tube (see SOP No. 1). Cotton or polyester batting should be included in the traps during the cooler winter months and should be replaced when dirty or wet. Replace sponges as they deteriorate.

Maintenance Documentation in Database

Record trap and array repairs made in the MEDN Pitfall Trapping Database. Recording maintenance events can provide data on equipment longevity and allow estimation of maintenance costs over time.

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 9 - Safety Procedures

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Safety Precautions

Weather and Field Attire

Summer conditions are often hot and dusty (between 80 - 110° F) and winter conditions can be cold, wet and muddy (between 4 – 70° F). It is important to dress appropriately for weather conditions. Because of the possibility of encountering rattlesnakes all field personnel should wear long pants and high topped hiking boots. To reduce the risk of tick bites during sampling, leg "Gaiters" are also recommended. Field personnel should take snack food and drinking water into the field. It is also recommended the personnel bring a first aid kit and CPR microshield into the field with them.

Animal Handling

Handling of reptiles, amphibians and small mammals can expose personnel to a number of diseases. However, trap cleanliness and prudent use of personnel protection equipment such as heavy leather or rubber gloves can protect field personnel from most incidents.

Rodents caught in pitfall traps may carry Hantavirus. Therefore, it is important to thoroughly clean pitfall traps when opening and prior to closing trap arrays. A mild bleach solution should be used to occasionally clean buckets. Ensure that the buckets are rinsed thoroughly after use. Leave buckets unused several days after cleaning to ensure that chlorine from the bleach evaporates completely. This is especially important when amphibians may become trapped. Sponges placed in the buckets to provide moisture for trapped animals are to be removed and thoroughly washed between sampling events to prevent fungus growth and disease hazard.

Reptiles and amphibians can also carry salmonella; therefore field personnel must wash their hands thoroughly after each trapping day, or prior to eating and drinking. Waterless hand cleansers provided in each field kit can be used for this purpose.

Extreme caution should be used while handling rodents to minimize bites. All field personnel must have current tetanus shots (boosters) prior to any fieldwork.

Other Field Hazards

Rattlesnakes are present in the study areas (both SAMO & CABR) and caution should be used when walking to pitfall arrays and while sampling pitfalls and snake traps.

Rattlesnakes are not to be handled at any time. It is important to use great care in checking pitfall traps and snake traps in the event a rattlesnake is present. A snake trap can be tilted to allow the snake to rest on one side or end of the trap, while the other end is opened. The trap can then be placed back along the drift fence and the snake allowed to leave on its own.

Small rattlesnakes captured in pitfall traps can be lifted out with snake tongs or a large stick. If field personnel are uncomfortable

with removing a snake from a trap, leave the trap open with the lid removed. Alert the program manager or other senior park staff to remove the snake using appropriate snake capture tools.
In the event of snakebite seek immediate medical attention. Use a Sharpie™ marker to draw a circle around the bite wound and take note of the time at which the incident occurred. This information is important in determining the progression of swelling to prescribe how much antivenin to use.

Biting or stinging invertebrates (centipedes, wasps, scorpions and spiders) may also be trapped in open pitfalls. The bites or stings from these animals can be painful but not fatal. Use caution when checking pitfall traps. If bitten or stung and painful swelling occurs seek medical attention.

Poison Oak is found in more mesic habitats of southern California. Before doing any fieldwork personnel must become familiar with the dangers associated with exposure to this native plant. If exposure occurs, wash the affected area thoroughly with soap and rinse with plenty of water as soon as possible then apply Technu™ ointment (provided at headquarters). If a reaction occurs, seek medical attention.

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 10 - Data Management

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Background

This Standard Operating Procedure documents the database MEDNPitfall.mdb and provides instructions for the development, maintenance and distribution of monitoring data associated with the Reptile and Amphibian Monitoring Protocol for the Mediterranean Coast Network. Procedures for data handling and quality assurance/quality control for all monitoring protocols implemented by the Mediterranean Coast Network monitoring program are detailed in the program's Data Management Plan. Microsoft Access XP is the primary software environment for managing capture data. ESRI ArcGIS 8 serves as a tool for validation and analysis of spatial data residing in Access.

MEDN Pitfall Database – Data Model

The database consists of two linked files, a front-end user interface (MEDNPitfall.mdb) and a back-end data BLANK (MEDNPitfallData.mdb). The user interface contains forms, queries and VBA code for the application itself, whereas the data BLANK 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.

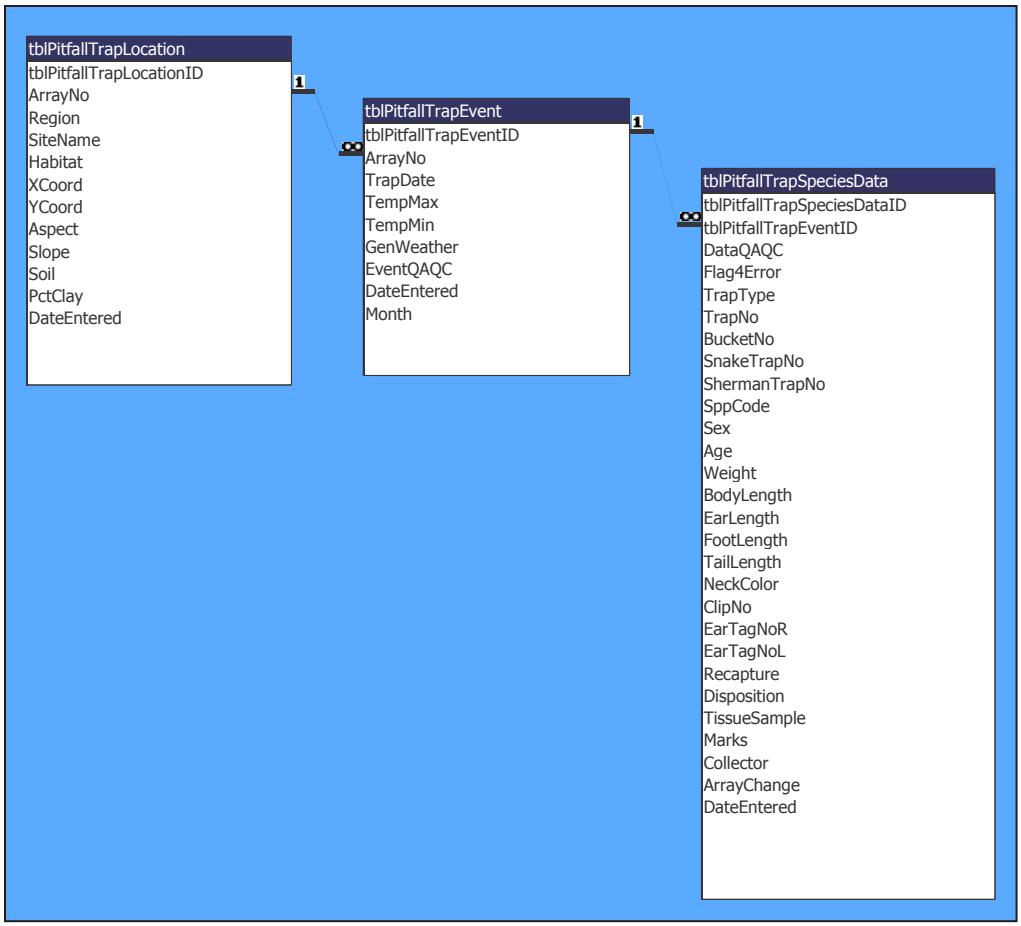
The primary table for storing array site information is tblPitfallLocation. The table contains one record for each pitfall trap array and includes data on the site such as site name, x- and y-coordinates, general habitat class, soil makeup, slope and aspect.

The primary table for storing trapping event data is tblPitfallTrapEvent. The table contains one record for each pitfall trap array per trapping date and includes data on the actual trapping session such as maximum and minimum temperature and weather.

The primary table for storing pitfall capture data is tblPitfallTrapData. The table contains one record for each individual caught during a pitfall trapping event and includes data such as species, age, sex, weight, body length.
Regardless of whether or not animals were caught during a trapping session, data in the tblPitfallTrapEvent table is always collected.

Supporting tables include tluPitfallSpecies and tluWildlifeCrew. tluPitfallSpecies contains a list of species (reptiles, amphibians and small mammals) that are likely to be captured during a trapping session. The table also includes ITIS TSN numbers. tluWildlifeCrew contains a list of wildlife technicians and interns that have been or are currently involved with data collection.

Figure 10-1 Relationships among the primary data tables in the MEDN pitfall trap database.



Database Administration

Data management procedures that are common to all monitoring protocols implemented by the Mediterranean Coast Network monitoring program, are contained in the network Data Management Plan.

Data Maintenance

Any editing of the archived data is accomplished jointly by the Project Manager and Data Manager. Changes to any record in the database are documented in the record itself and must include a description of pre- and post-edit changes.

Data Organization

Version Control

Prior to any major changes of a data set, a copy is stored with the appropriate version number to allow for tracking of changes over time. Versioning of archived data sets is handled by adding a three digit number to the file name. Each additional version is assigned a sequentially higher number. Frequent users of the data will be notified of the updates.

Data Logs and Backups

CD backups of all project databases are made once weekly. Maintaining a current backup of the data is essential for protecting data files from corruption or accidental deletion. Once a data set has passed QA/QC procedures specified in the protocol, a formal entry will be made in the Inventory and Monitoring Dataset Catalog.

Database Table Construction

tblPitfallTrapLocation
Description:

Primary table storing array site information including site name, x- and y-coordinates, general habitat class, soil makeup, slope and aspect. There is one record for each pitfall trap array.

Field Name	Field Type	Size	Field Description
tblPitfallTrapLocationID	Long Integer	4	Unique identifier (autonumber) for tblPitfallTrapLocation
ArrayNo	Long Integer	4	Pitfall trap array number
Region	Text	10	Sampling region
SiteName	Text	25	Site name
Habitat	Text	15	General habitat category
XCoord	Long Integer	6	UTM X-coordinate (Zone 11, NAD27)
YCoord	Long Integer	7	UTM Y-coordinate (Zone 11, NAD27)
Aspect	Integer	2	Aspect
Slope	Integer	2	Slope
Soil	Text	15	General soil category
PctClay	Integer	2	Percent clay

tblPitfallTrapEvent
Description:

Primary table storing trapping event data including maximum and minimum temperature and weather. The table contains one record for each pitfall trap array per trapping date.

Field Name	Field Type	Size	Field Description
tblPitfallTrapEventID	Long Integer	4	Unique identifier (autonumber) for tblPitfallTrapEvent
tblPitfallTrapLocationID	Long Integer	4	tblPitfallTrapLocation ID code
TrapDate	Date/Time	8	Trap date
TempMax	Long Integer	4	Maximum temperature recorded
TempMin	Long Integer	4	Minimum temperature recorded
GenWeather	Text	15	General weather description (sunny, foggy, overcast, precipitation)
EventQAQC	Yes/No	1	Has the data been QA/QC-ed?
DateEntered	Date/Time	8	Data entry date

tluPitfallSpecies
Description:

Supporting table listing species (reptiles, amphibians and small mammals) that are likely to be captured during a trapping session. The table contains one record for each possible species.

Field Name	Field Type	Size	Field Description
tluPitfallSpeciesID	Long Integer	4	Unique identifier (autonumber) for tluPitfallSpecies
TSN	Long Integer	4	ITIS TSN
SppCode	Text	4	4-letter species code
SciName	Text	50	Scientific name
ComName	Text	50	Local common Name
Class	Text	15	Herpetofuana or Mammal
Type	Text	15	Lizard, Snake, Amphibian, Rodent, Insectivore, or Rabbit

tblPitfallTrapData Description:

Primary table storing pitfall capture data including species, age, sex, weight, body length, etc. The table contains one record for each individual caught during a pitfall trapping event.

Field Name	Field Type	Size	Field Description
tblPitfallTrapDataID	Long Integer	4	Unique identifier (autonumber) for tblPitfallTrapData
tblPitfallTrapEventID	Long Integer	4	tblPitfallTrapEvent ID code
Flag4Error	Yes/No	1	Does the data contain an error?
DataQAQC	Yes/No	1	Has the data been QA/QC-ed?
BucketNo	Text	5	Bucket number
SnakeTrapNo	Text	5	Snake trap number
tluPitfallSpeciesID	Long Integer	4	Species code (tluSpeciesInfo)
Sex	Text	5	Sex (**M**ale, **F**emale, **?**Unknown)
Age	Text	5	Age (**A**dult, **J**uvenile, **?**Unknown)
Weight	Single	4	Weight in grams
BodyLength	Integer	2	Length in millimeters
NeckColor	Text	10	Neck color of
TailRegen	Text	5	Tail regeneration
TailLost	Text	5	Tail lost/missing
ClipNo	Integer	2	Toe/scale clip number
Recapture	Text	5	Has this individual been recaptured before? (**Y**es, **N**o, **?**Unknown)
Disposition	Text	5	(**R**eleased, **E**scaped, **D**ead)
TissueSample	Text	5	Was a tissue sample taken? (**Y**es, **N**o, **?**Unknown)
DataComments	Text	100	Additional comments
Collector	Text	50	Field collector (tluWildlifeCrew ID)
ArrayChange	Text	5	Was the individual caught at a different pitfall array?
DateEntered	Date/Time	8	Data entry date

Local MEDN Fields:

Small mammal data collected during pitfall trapping events.

Field Name	Field Type	Size	Field Description
ShermanTrapNo	Text	5	Sherman trap number
EarLength	Integer	2	Ear length in millimeters
FootLength	Integer	2	Foot length in millimeters
TailLength	Integer	2	Tail length (base to tip)in millimeters
EarTagR	Integer	2	Right ear tag number
EarTagL	Integer	2	Left ear tag number

tluWildlifeCrew
Description:

Supporting table listing wildlife technicians and interns that have been or are currently involved with data collection.

Field Name	Field Type	Size	Field Description
tluWildlifeCrewID	Long Integer	4	Unique identifier (autonumber) for tluWildlifeCrew
NameCode	Text	5	3-letter name code
FullName	Text	100	Full name
AbbrName	Text	50	Abbreviated name (first initial, full last name)
Status	Long Integer	4	Employment status (1 = current, 2 = inactive)
Rank	Text	25	SAMO position title (e.g. biologist, biotech, intern)

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 11 - Ant Trapping

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Background

As part of the sampling effort for reptiles and amphibians, ant traps can be placed at pitfall trap arrays to sample ant and invertebrate diversity. Certain ant species, such as carpenter and harvester ants are impacted by the spread of Argentine ants (Suarez 1998). The placement of ant traps is fairly simple and does not require much staff time nor effort.

This pitfall method "is relatively unbiased for comparison among areas within species" (Suarez et al. 1998). However, it may be biased in some aspects, such as foraging patterns (Suarez et al. 1998). Consequently, the abundance and diversity of arboreal species are not represented by these methods.

Methods

Five pitfall ant traps are incorporated into an existing reptile and amphibian array. Plastic centrifuge tubes (50 ml), filled with 25-30 ml of anti-freeze[1], are used as traps. These tubes are placed adjacent to the outer buckets of the amphibian and reptile array. The vials are positioned so that the lip of the vial is flush with the ground surface, specifically allowing ground foraging ants to fall in.

Initial installation is accomplished by driving a PVC pipe (2.5 cm in diameter and 20 cm long) into the ground where the trap is going to be positioned. The pipe makes for easy removal and placement of the centrifuge vials, which fit inside the pipe. The vials are placed into the PVC pipe for the duration of the sample period, which is for five consecutive days (four nights). After the sample period, each vial is capped and brought back to SAMO headquarters. An empty closed vial should be placed into each PVC pipe to prevent debris or invertebrates from falling into the trap and clogging it.

One vial is placed at the end of each of the 15-meter arms of the pitfall array and one at the junction of the three arms. A fifth vial is independent of the pitfall array and is placed 15 meters away from the center bucket so that an aerial view of the array resembles the number five side of a die.

Vials are brought back to the lab and the contents are sifted from the anti-freeze. Anti-freeze can than be stored in labeled containers and re-used (consult MSDS on the back of manufacturer label for storage information). Once invertebrates are removed they should be rinsed with ethyl alcohol (ETOH) and stored in 80% ethyl alcohol. The mixture allows for adequate preservation of genetic material, without rendering the specimen too brittle for positioning as museum collections or for display purposes.

[1] To preserve and attract ants non-toxic Sierra™ anti-freeze (Polypropylene glycol) was placed in centrifuge tube traps (Suraez et al. 1998). Because of its high viscosity, non-evaporative and tissue preservation properties anti-freeze works

well to preserve captured specimens during trapping cycles.

Literature Cited

Bolger, D.T., A.V. Suarez, K.R. Crooks, S.A. Morrison and T.J. Case. 2000. Arthropods in urban habitat fragments in southern California: area, age and edge effects. Ecological Applications **10**: 1230-1248.

Suarez, A.V., D.T. Bolger and T.J. Case. 1998. Effects of fragmentation and invasion on native ant communities in coastal southern California. Ecology **79**:2041-2056.

Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 12 - Driving Directions to Pitfall Trap Locations

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Simi Hills Pitfall Trap Line Arrays

Arrays 1—10

Array 1

1. Leave the office at the bottom of the hill turn right onto McCloud.
2. On your right you will see a dirt road climbing Fireworks Hill. Drive up the hill and park near a large boulder. The trail leads you to array 1.

Array 2:

1. From Array 1, travel back down McCloud to Toulumne Ave.
2. Park by retaining wall and cross the creek to Array 2 on the top of the hill.

Array 3

1. Take Toulumne Ave to Gainesborough Road and turn right.
2. Turn left on Dover. Take this road till it dead ends in cul-de-sac.
3. Climb hill to Array 3.

Arrays 4, 5, and 6

1. Turn right (west) on Janss Road.
2. Turn right on Lynn Road.
3. Turn left on Avenida de Los Arboles.
4. Take to end of Avenida de Los Arboles, u-turn into Wildwood Trailhead Parking Lot.
5. Take Dirt Road to a gate. Combo 3343 on lock with yellow reflective sticker.
6. Array 4 is on right side of road. For a landmark look for a lone sugarbush in a field to your left. Array 5 is behind that bush.
7. From arrays 4 and 5, continue on dirt road.
8. Take first right fork in the trail and then turn right on second fork, which will descend into Box Canyon.
9. Look for flagging about 100 meters down the road below gas pipeline.

Array 7

1. From array 6 make your way back to the Wildwood Parking lot and Avenida de Los Arboles. Turn right onto Avenida de Los Arboles.
2. At the stop light turn left onto Lynn Road. Be aware that Lynn Road eventually turns into Olsen Road.
3. Turn left into the California Lutheran University campus.
4. Follow road and take the right fork on campus. That will lead you into the dormitory parking lots. Drive toward the baseball diamond to your right.
5. Park in the parking lot, Array 7 is on hill above parking lot.

Array 8

1. From California Lutheran University get back onto Olsen/Lynn Road. Turn Right.
2. Turn Right onto Pedersen Road which is the first road on your right after second stop light on Olsen.

3. Turn left onto Northwood. And park near the tennis courts and pool.

Array 9

1. From Northwood turn around and turn left back onto Pedersen Road.
2. Turn Right on Erbes Road.
3. Turn Left onto Avenida de Los Arboles.
4. At stop sign turn left onto Parkview drive.
5. Park at speed limit sign and walk up hill.

Array 10

1. Turn Right onto Avenida de Los Arboles.
2. Turn left onto Erbes.
3. Turn Right onto Marview. On Erbes look for a sign on left hand side of the road that directs you to Old Meadows Park.
4. Park at fallen oak tree on left hand side of road. Walk up the hill to array 10.

Once sampling is completed retrace your route back to Satwiwa and return to park headquarters to process data collected.

Arrays 11—22

Array 11 – Westlake

1. Take 101 freeway east to Los Angeles.
   - Left onto McCloud
   - Right onto Hillcrest
   - Left on Lynn.
   - Cross the 101 freeway. Freeway entrance on right hand side of the road.
2. Exit Westlake
3. Turn left on Westlake.
4. Left on Hillcrest. (This should be the second traffic light).
5. Gate on right hand side of road. Combo 3313.

Array 12 and 13 – Peacock

1. Get back onto Hillcrest Drive. Turn left.
2. Left on Westlake Blvd.
3. Turn left onto Peacock. This is a cul-de-sac at a four way stop sign intersection.
4. Array 12 is at the top of the hill.
5. Array 13 is the first one you come to at the bottom of the hill.
6. Do the top one first.

Array 14 and 15 – Bowfield

1. From Peacock go straight onto Kanan.
2. Right onto Falling Star Ave.
3. Right onto Lakeview Canyon.
4. Climb hill to arrays 14 and 15.
5. Array 14 is at the top of the hill.
6. Walk past array 15, and the trail takes you on up to Array 14.
7. Do Array 14 first.

Array 16 – Hedgewall

1. Turn right onto Lakeview Canyon.
2. Turn right onto Lindero.
3. Turn right on Hedgewall.
4. Park at the park and walk up the hill to Array 16.

Arrays 17, 18 and 19 – Rancho Simi

1. Turn left on Lindero (north)
2. Right onto Rockfield Street.
3. Right on Bayport Way.
4. Go through gate adjacent to Lindero Creek.
5. Array 17 is in the grove of oaks on right hand side of the road.
6. Drive up steep hill
7. Array 18 is at the fork at the top of hill.
8. Take left fork.
9. At next fork turn right. (Fork is on the top of the hill.
10. Follow spine of the hill.
11. Make tight left turn toward large water tank.
12. Park under oak tree for Array 19.

Array 20, 21 and 22 – Palo Camado

1. Go through gate. Turn right on Conifer.
2. Left on Kanan
3. Right on Sunnycrest
4. Go through gate on “Possum Road”.
5. Cross creek and turn right.
6. Stay on Palo Camado. Park under Oaks. Walk to Array 20.
7. In Palo Camado Canyon Array 21 is on left side of road.
8. Look for flagging.
9. Look for widening in road. Trail is on right hand side.
10. Look for flagging.

Once sampling is completed retrace your route back to Satwiwa and return to park headquarters to process data collected.

Western Region Pitfall Trap Arrays

Pitfall trap arrays in the western sampling region are all accessed from the Big Sycamore Canyon Trail head at Rancho Sierra Vista

and connecting trails in Malibu State Park. The nineteen arrays are sampled in two groups. Arrays 23 – 32 are sampled together and arrays 33 – 41 are sampled together. Entry to the trail with a vehicle requires a BC-1 key at the gate in front of the Satwiwa Culture Center. Orange surveyors tape is used to mark the locations of all trails that lead to pitfall arrays, turnouts for parking, forks in trails and, marker vegetation along trails leading to pitfall trap arrays. Directions to sampling points reference the Tom Harrison Trail Map for the western portion of the Santa Monica Mountains, and GIS maps provided in this SOP. Roads within the park are a mix of paved and dirt single lane roads. Junction points and mileage distances are marked by numbered red dots on the Harrison maps. Road or trail names are on sign posts at junctions along the trails.

Arrays 23 – 32

1. Take the Big Sycamore Canyon Trail to the fork with Ranch Center Fire Road (trail point 375, 1.9 miles from the entrance gate).
2. Stay to the right on Big Sycamore Canyon Trail to the junction with the Overlook Fire Road (trail point 209, 2.5 miles from the entrance gate).
3. Turn right on Overlook Fire Road towards Deer Camp Junction (trail point 265, 3.2 miles from entrance gate).
4. Continue on Overlook Fire Road to the trail head for the La Jolla Loop Trail and the Guadalasca Trail (trail point 908, 3.6 miles from entrance gate).

Arrays 23 and 24

1. To locate pitfall arrays 23 & 24 continue along the Overlook Fire Road (a left hand turn at this junction) for about 10 yards and park along the side of the road.
2. Array 23 is on the east side of the road just into the Chaparral. Look for surveyors tape marking the location of trail to array.
3. Array 24 is on the west side of the road again in the chaparral. Look for surveyors tape marking trail to array.

Array 25

1. Back vehicle down Overlook Fire Road to continue along the La Jolla Loop trail.
2. Once on the La Jolla Loop Trail continue west approximately 0.1 mile and stop where the ridge line of the small hill on your left merges with the road.
3. Look for surveyors tape on the left (south) side of the road marking a trail through the Coastal Sage Scrub to array 25.

Array 26

1. Continue west on La Jolla Loop Trail another 0.4 mile to the start of a grassy area on the right (north) side of the trail forming a break in the chaparral.
2. Again look for surveyors tape marking a trail at the boundary of the grass and chaparral to the array located in the chaparral just north of the trail.

Arrays 27 and 28

1. Continue in the vehicle another 0.1 mile along the La Jolla Loop Trail and park on the south side of the road.
2. Look for surveyors tape marking the beginning of a social trail across a grassy area to the south.
3. Follow this trail across grassy area across the southern arm of La Jolla Loop Trail into the Chaparral.
4. Array 27 will be on the east side of this trail approximately 0.1 mile from where you parked. Look for surveyors tape marking the location of the pitfall array.
5. Array 28 is another 0.3 of a mile along the trail in the Chaparral on the east side of the trail. There is a small pond just off the west side of the trail approximately half way between arrays 27 and 28.
6. Again look for surveyors tape marking the location of the point to leave the trail and locate the pitfall array.

Array 29

1. Return to the vehicle and proceed west along La Jolla Loop Trail another 0.2 mile.
2. Look for a water hydrant stand pipe painted yellow 4L on the left side of the road, park in the small pullout on the north side of the road just past the hydrant.
3. Follow the marked trail along the western edge of the chaparral to the array.

Arrays 30, 31, and 32

1. Proceeding west along the La Jolla Loop Trail another 0.3 mile to a well used pullout on the north side of the road. This is as far as you can go in the

vehicle as there is a stream channel just ahead in the chaparral that can only be crossed on foot.
2. Continue along the La Jolla Loop trail out into a large grassy flat and locate the pitfall arrays using the GIS maps provided and looking for surveyors tape marking the locations of the trails leading to the arrays.

Once sampling is completed retrace your route back to Satwiwa and return to park headquarters to process data collected.

Arrays 33—41

Array 33

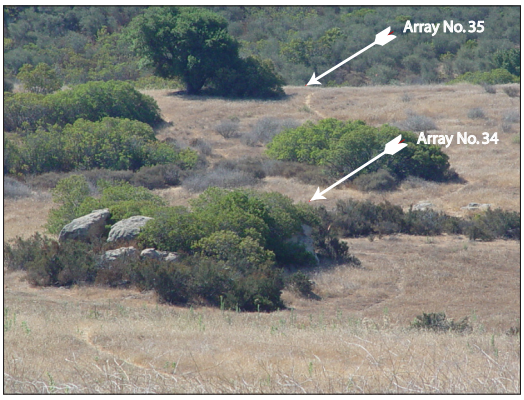
1. From the gate on the Big Sycamore Canyon Trail in front of the Satwiwa Culture Center follow the trail 0.3 mile to trail point 872 at the crest of the hill where there is a water tank on the north side of the road.
2. Park at the water tank and follow the trail along the east side of the tank along the chaparral to the second fork in the trail.
3. Take the second fork into the chaparral where array 33 is located.

Arrays 34 and 35

1. Continue west on Big Sycamore Canyon Trail to the junction with Ranch Center Road (trail point 375, 1.9 miles from the entrance gate).
2. Take the right fork onto Ranch Center Road and continue for approximately 0.9 mile to a large Coast Live Oak on the south side of the road.
3. Orange surveyors tape is tied to one of the branches of this tree.
4. There is trail on the east side of this tree that leads to the south across a grassy area to arrays 34 and 35.
5. The figure below is a telephoto shot taken across the grassy flat showing the trail wandering back towards the chaparral in the distance. Array 34 is located in the foreground of the figure behind the clump of rocks and shrubs while array 35 is in the background at the margin of the chaparral seen in the distance.

Arrays 36 and 37

1. Continue west approximately 0.2 miles further west on the south and north sides of Ranch Center Road.
2. The locations of these two arrays are indicted by surveyors tape tied to the vegetation on both sides of the road.



Arrays 38 and 39

1. Proceed west along Ranch Center Road past the junction with Ranch Center Fire Road at trail point 670.
2. Continue on Ranch Center Road another 0.4 miles to Ranch Center (trail point 475) and park on the right side of the road before making the loop south on to Wood Canyon Trail.
3. The figure below shows the best place to park for accessing arrays 38 and 39.
4. From the vehicle follow a trail to the east through the grass to array 38.
5. Array 39 is further along the trail across a dry stream bed and at the back of a small grove of eucalyptus trees to the north of Ranch Center.



Arrays 40 and 41

1. These arrays are located along Big Sycamore Canyon Trail and are accessed by retracing your route along Ranch Center Road to Ranch Center Fire Road (trail point 670).
2. Continuing south along Ranch Center Fire Road 1.0 miles to trail point 280 at the junction with Big Sycamore Canyon Trail.
3. Turn east on Big Sycamore Canyon Trail and travel 0.5 miles.
4. Array 41 is located on the north side of the road under a large sycamore tree.
5. Array 40 is 0.2 miles further east on

the south side of the road as is visible from the road. The locations of both of these arrays are marked with surveyors tape.

Once sampling is completed retrace your route back to Satwiwa and return to park headquarters to process data collected.

Point Loma Ecological Conservation Area Pitfall Arrays

The Point Loma Ecological Conservation Area Reserve (PLECA) herpetofauna pitfall trap arrays span the peninsula. Nine arrays are located on Cabrillo NM property, with the remaining eight located on navy land. Navy badges are needed for access to all arrays on Navy property. All communication with the Navy for these badges is coordinated by the Cabrillo NM Natural Resource Science Bio-technician. Persons requesting a badge must be US citizens and furnish the following information: name as it appears on official identification card (driver's license, passport, etc.), social security number, date of birth, and place of birth. Badge requests are made in a formal letter to appropriate naval personnel. The letter can also include vehicle information if needed. When the access is granted the NPS Bio-technician is notified and the individual requesting a badge is instructed how and where to pick up it up. Processing time usually takes no more than two or three days.

The following directions guide personnel to the existing arrays on the PLECA. Starting from the Cabrillo NM visitors center follow the start to finish order for checking the herpetofauna pitfall trap arrays. All trails are relatively narrow, and care should be taken to use only these paths rather than impacting the habitat by creating numerous trails to and from each array.

Arrays are listed in the order they are sampled.

Arrays 13—17

Arrays 13 – 17 are located along or near the Bayside Trail Drive through the north bay parking lot as if exiting the park. Rather than turning right on Cabrillo Memorial Dr., turn left and follow the road towards the lighthouse. Turn right onto the road towards the Old Pt. Loma lighthouse. When approaching the lighthouse, veer left onto the service road until reaching the head of the Bayside Trail. This total distance is less than 1 mile. If traveling in a Think Electric Vehicle (Think EV), drive down the Bayside Trail; if traveling in a regular sized vehicle, park on the right hand (northwest) side of the service road across from the head of the trail and walk the remainder of the trail.

Array 17
Travel along the bayside trail, north, to the end, ¾ mile (there is a sign that reads "end of trail, return same route"). Along the left side of the trail across from this sign and slightly south is an area to park the Think EV. Directly west of the sign, is a narrow path with steps worn into the dirt leading up a small sandstone cliff. Follow this narrow trail up through the brush for approximately 85 feet to the northern arm of Array 17.

Arrays 16 and 15
From Array 17, travel along the bayside trail south approximately ¾ of the way up, approximately 375 feet beyond the sharp bend at the historic searchlight and just prior to the bend in the trail with the erosion control blocks. Park along the right side of the trail. From the trail, climb under or over the northern most section of post and rope (between the 6th and 7th posts from the north) for this part of the trail. Travel east 40 feet to a well defined trail heading both south and further east. The trail heading east is rather steep and leads 75 feet to the western most arm of Array 16. The trail heading south travels 185 feet to the north western arm of Array 15. This trail will veer east before the Yucca and will then lead to Array 15.

Array 14
Travel south west to the top of the Bayside Trail, cross the service road, and park the Think EV on the right hand side of the service road. Walk on the trail towards the ridge line to the water pipe and turn right at the pipe, continue walking North, veering west as the sandstone cliff inclines. Follow this narrow trail north 300 feet (towards the whale watch overlook) and you will come to the southeastern arm of Array 14.

Array 13
From Array 14, travel out on the same trail you traveled in, 140 feet down. There will be a fork in the trail where another narrow trail veers northeast (to your left). Follow

this trail 100 feet to the center bucket of Array 13.

Arrays 1—4

Arrays 1 – 4 are located along Cabrillo Rd. and Gatchell Rd. on the western side of the monument From the service road near the bayside trail, drive back out from the lighthouse to the visitor center parking lot. Travel towards the exit and turn right on Cabrillo Memorial Dr. Turn left on Cabrillo Rd. and travel southwest, beyond the hairpin turn where the road changes to Gatchell Rd., towards the tidepool area approximately ¾ mile to the Coast View parking lot on the west side of the road. Park in the Coast View parking lot.

Array 1
Looking east from the parking lot, Array 1 is on the west facing slope below a medium sized boulder. From the parking lot travel directly across the street and find the narrow trail in the brush which leads 235 feet to the western most arm of Array 1.

Array 2
From the southern most edge of Coast View parking lot, travel south on the west side of Gatchell Rd. for 630 feet and turn right onto a path in the brush. Follow this path 50 feet to the eastern most arm of Array 2.

Arrays 3 and 4 are located just north of the hairpin turn on Cabrillo Rd. which is the road that travels down to the tidepools. From Coast View parking lot, travel approximately ½ mile south on Gatchell/ Cabrillo Rd. and turn right into the navy parking lot just north of the US Coast Guard Lighthouse. Park in one of the first 5 parking spots on the left side of the parking lot.

Array 3
There are a few large clusters of cholla growing along the northern curb of the parking lot; to the right of this cholla is a narrow trail. Follow this trail 125 feet through the brush to the southwestern arm of Array 3.

Array 4
From this Navy parking lot, travel north along the right side of Cabrillo Rd. for 350 feet. Just before arriving at the water pipe, and meter 15-6, turn right and follow the path in the brush up the hill 190 feet to the western arm of Array 4.

Arrays 8—12

Arrays 8-12 are located on the North West side of the peninsula From Cabrillo Rd., turn left onto Cabrillo Memorial Dr./ Catalina Blvd. Travel just over 2 miles to Woodward Rd., turn left on Woodward Rd. where there is a navy security gate (guard post 5). At this gate, show proper badge to enter the navy property on the western side of the peninsula.

Travel west along Woodward Rd. and turn left on Gatchell Rd. Travel along Gatchell Rd. less than 1 mile until the waste water treatment plant is in sight. Just north of the waste water treatment plant there will be an area to the east of the road available for parking. Park here, near the telephone pole.

Array 10
Walk up the asphalt paved ditch heading east up the small hill. When reaching a dirt (partially used) road travel south 366 feet until reaching the northwestern arm of Array 10.

Array 11
From the northwestern arm of Array 10, travel north on the dirt road 250 feet to the 6 ft. pole that reads “CP STA 1000”. This pole is 20 feet west of the northwestern arm of Array 11.

Array 12
Starting from bucket 11-3B, travel east along the open dirt path that narrows between two large bushes of lemonade berry. This path will lead 130 feet to the western arm of Array 12.

Array 9
From Arrays 10-12, drive on Gatchell Rd. to Woodward Rd. Turn left onto Woodward Rd. and travel approximately ¾ mile. Park on the right side of this road near the “unmanned robotic vehicle testing” sign. Travel east, across the road, to the path in the brush 158 feet to the western arm of Array 9.

Array 8
From Array 9, travel south on Woodward Rd. 1/8 mile to Susan Hower Dr. When reaching Susan Hower Dr., park on the right side of the road, just south of the intersection. Cross the street to the east side of the road between Robart Rd. and Susan Hower Dr. and follow the path on the south side of the green box labeled N16. The path leads into the brush towards the hill 150 feet to

the southwestern arm of Array 8.

Arrays 5—7

Arrays 5 - 7 are located on the Navy sub base on the eastern side of the peninsula. From the Woodward Rd. Navy gate, travel North on Catalina Blvd 1/8 mile and turn right onto McClelland Rd. This will lead to the submarine base guard gate. Show proper badge to enter the base. Travel southeast on McClelland Rd. approximately 1/8 mile, and turn right in the gravel paved dirt road across from the Child Development Center and just before reaching the hazardous waste area. Park along the right side of this dirt and gravel road just prior to reaching the steep hill that leads up to building 380.

Array 5
Walk up the steep hill toward building 380, then veer left and continue up the steep dirt road. Once reaching the sign "Archaeological site" 496 feet from the vehicle, turn right and walk 80 feet to the center bucket of Array 5.

Array 6
From bucket 5-1A travel south west along the sandy path 75 feet and turn right for 30 feet to the northeastern arm of Array 6.

Array 7
From bucket 6-1A, travel west up the small sandstone cliff for 50 feet. When reaching the top of the sandstone ridge, follow the path south along the low ridge continuing through the Chamise and *Ceanothus* brush 475 feet to an open and patchy area near the cemetery fence. At this clearing, veer left and follow the path 110 feet along the brush, down a sandstone ridge, and towards a telephone pole. West of this pole is the southern arm of Array 7.

Table 12-1. Pitfall trap locations in the Santa Monica Mountains (NAD27).

Array	Habitat	Latitude	Longitude	UTM 11	
				Easting	Northing
1	Sage/Grass	34.187	118.882	326558	3784275
2	Sage/Grass	34.191	118.886	326166	3784693
3	Sage/Grass	34.203	118.871	327569	3786025
4	Sage	34.220	118.915	323577	3788033
5	Grass	34.220	118.916	323492	3787974
6	Sage/Grass	34.223	118.920	323170	3788325
7	Sage/Grass	34.220	118.884	326406	3788010
8	Sage	34.221	118.851	329527	3788032
9	Sage/Grass	34.213	118.834	331072	3787060
10	Sage/Grass	34.201	118.845	330009	3785781
11	Sage	34.175	118.828	331498	3782866
12	Grass	34.196	118.824	332029	3785129
13	Sage/Grass	34.195	118.823	332907	3785165
14	Sage	34.168	118.792	334819	3781995
15	Grass	34.186	118.796	334506	3784081
16	Sage/Grass	34.184	118.797	334401	3783853
17	Grass	34.170	118.785	335437	3782212
18	Sage	34.170	118.779	336051	3782239
19	Sage/Grass	34.169	118.767	337098	3782156
20	Sage	34.171	118.743	339353	3782252
21	Grass	34.176	118.741	339505	3782797
22	Sage/Grass	34.181	118.745	339144	3783357
23	Chamise	34.110	119.027	313028	3776021
24	Chaparral	34.110	119.028	312976	3776040
25	Chaparral	34.110	119.029	312885	3776002
26	Chaparral	34.110	119.031	312641	3776060
27	Coastal Sage Scrub	34.107	119.032	312574	3775675
27	Coastal Sage Scrub	34.102	119.035	312319	3775084
29	Coastal Sage Scrub	34.108	119.037	312151	3775765
30	Coastal Sage Scrub	34.106	119.043	311565	3775547
31	Grass	34.107	119.048	311128	3775743
32	Chamise	34.109	119.048	311111	3775925
33	Chaparral	34.146	118.965	318845	3779939
34	Chaparral	34.133	118.993	316080	3778673
35	Grassland	34.135	118.995	316232	3778486
36	Chamise	34.136	118.998	315734	3778794
37	Chamise	34.136	118.999	315633	3778834
38	Grassland	34.138	119.012	314457	3779131
39	Coastal Sage Scrub	34.139	119.014	314270	3779234
40	Oak Woodland	34.129	118.987	316809	3778086
41	Grassland	34.129	118.990	316522	3778020

Table 12-2. Pitfall trap locations on the Point Loma peninsula (NAD27).

Array	Habitat	Latitude	Longitude	CA State Plane Zone 0406	
				Easting	Northing
1	Maritime Succulent Scrub	32.673	117.243	1694369.355	186020.358
2		32.671	117.243	1694243.942	185280.750
3		32.666	117.241	1694934.578	183477.661
4		32.668	117.241	1694885.954	183884.420
5	Southern Maritime Chaparral	32.695	117.242	1694775.036	193982.997
6		32.695	117.242	1694630.115	193870.483
7		32.694	117.242	1694606.171	193574.533
8	Maritime Succulent Scrub	32.703	117.252	1691597.153	196756.997
9		32.705	117.252	1691510.976	197584.448
10	Disturbed Habitat	32.682	117.246	1693297.679	189306.193
11	Maritime Succulent Scrub	32.683	117.246	1693252.479	189583.475
12		32.683	117.246	1693386.821	189692.266
13		32.669	117.240	1695245.871	184504.375
14		32.670	117.240	1695194.232	184618.835
15		32.668	117.237	1696175.005	184154.310
16		32.669	117.237	1696192.818	184345.865
17	Southern Maritime Chaparral	32.675	117.236	1696389.187	186402.233

Figure 12-1. Pitfall trap array sites within the western sampling region of the Santa Monica Mountains.

Red line indicates boundary for SAMO. Colored shading represents different vegetation types.

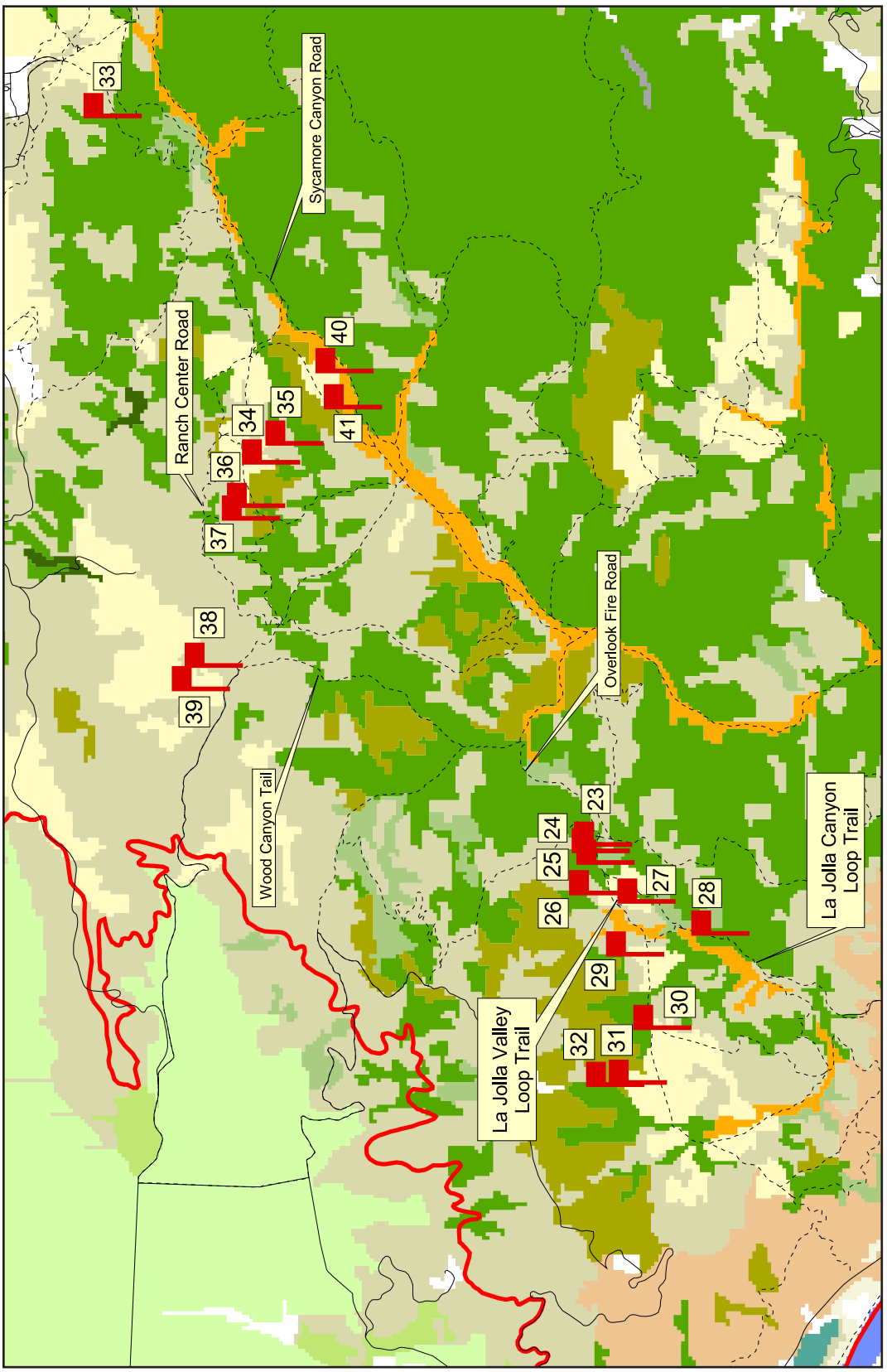


Figure 12-2. Locations of pitfall trap arrays in the Simi Hills sampling region which is located to the north of SAMO.

Red line represents the boundary of SAMO. Nearly all pitfall arrays in this region are located outside of SAMO

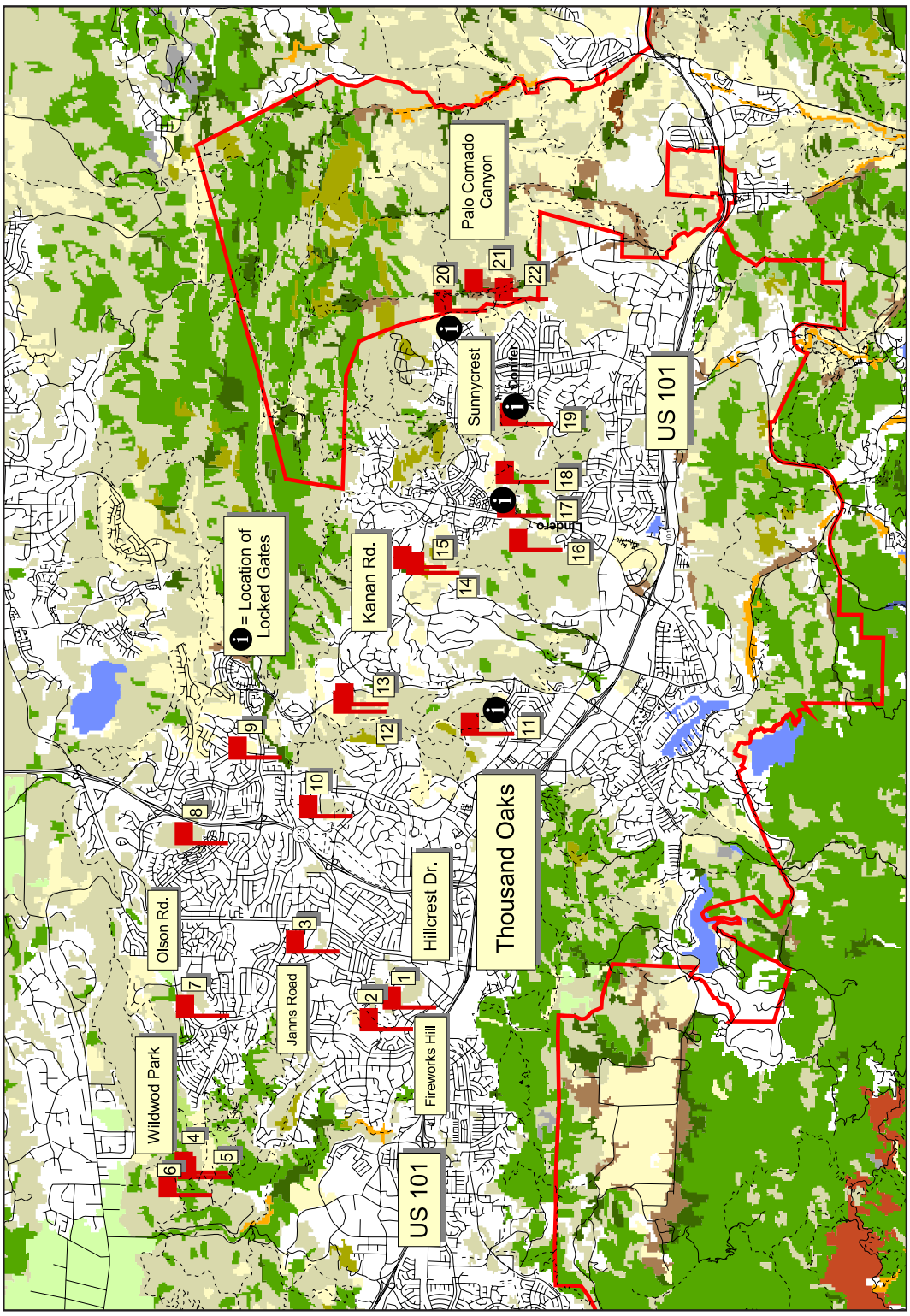
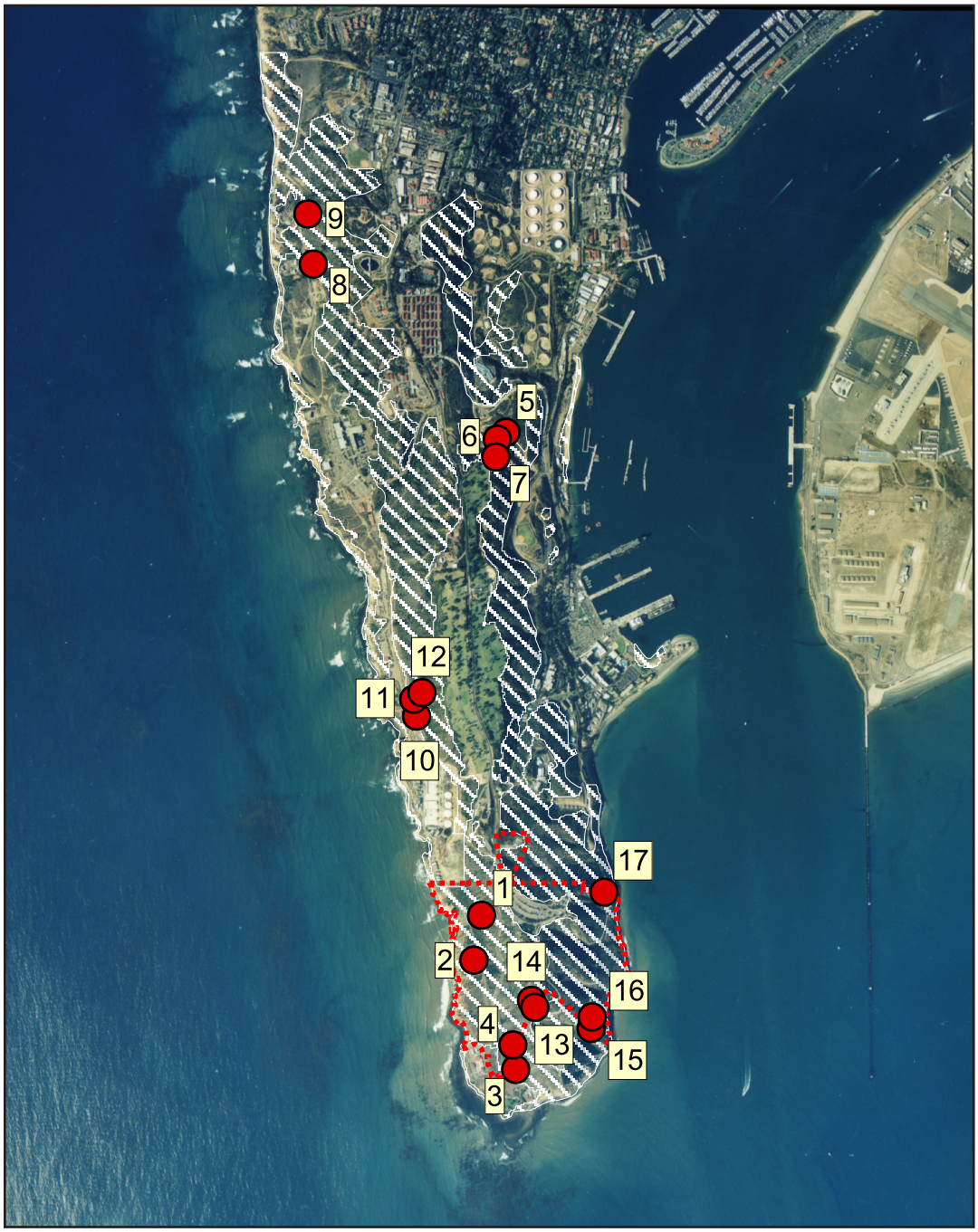


Figure 12-3. Pitfall trap locations on Point Loma peninsula.

White hash marks delineate the Point Loma Ecological Reserve. Cabrillo National Monument is outlined in red.



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 13 - Downloading Data from HOBO® Data Loggers

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Background

HOBO H08-001-02 (temperature only) data loggers (Figure 13-1) are deployed at select pitfall trap arrays to record ambient air temperature continuously over the length of a trapping cycle (5 days). The number of data points that the HOBO is able to store is limited by the data acquisition frequency, the memory capacity of the logger, and the length of time the logger is deployed.

Programming the HOBO Data Logger

To manage the HOBO data logger, install a current version of BoxCar or BoxCar Pro™ software from Onset Computer on a personal computer that is readilly accessible to the field crews. A com port adapter is required to allow the computer to communicate with the HOBO data logger. When a data logger is connected to the personal computer, loggers are programmed by opening BoxCar (see Figure 13-2) and inputting the pitfall trap array number and date of launch for the site at which the HOBO will be deployed. Select frequency of data collection (i.e. 3 minutes for 5 days). Select both Fahrenheit and Celsius temperature formats. Check delayed start, selecting the day and time you would like the HOBO to start collecting data. WARNING, you may want to select a time when you are confident the data loggers will be deployed. Otherwise, the logger may begin to collect temperature data before deployment. See figure 13-3 for an example of launching a HOBO data logger.



Figure 13-1. Onset Computer Corporation HOBO data logger. Unit is show nearly actual size.

Deploying HOBO Data Loggers

HOBO data loggers are deployed on the opening day and retrieved on the closing day of each sampling cycle. The HOBO data loggers are placed at representative sites (pitfall arrays) within each region. In the PLECA data loggers are deployed at the southeast (array No. 15), northeast (array No. 5), and northwest (array No. 8) sites on Point Loma. In the Santa Monica Mountains data loggers are placed at the first and last arrays visited within a given region during a sampling cycle. HOBOs are hung on an upright post two feet above ground level. The post is a 2" X 2" X 4' piece of lumber

buried two feet in the in the ground. The HOBO data logger is hung from a screw near the top on the north facing side of the post. An inverted white five gallon plastic bucket, with ¼ of the side cut out for breathing, is attached to the post to provide shade for the data logger (Figure 13-4).

Downloading Temperature Data

At the end of the trapping cycle HOBO data loggers are collected and brought back to the office (lab) to download temperature data. To download data connect the HOBO to the computer using the com port link. Open BoxCar, select the readout logger icon (Figure 13-5) and follow the instructions in BoxCar (see Figure 13-6).

All temperature data from the Santa Monica Mountains are stored on the SAMO network G drive at *G:\Animal_Ecology\Reptiles and Amphibians\Pitfalls\Pitfall temp data* (see Figure 13-6).

Select the folder for the region where data were gathered (Malibu, Western , Coastal, Simi Hills) and select the folder with the corresponding month and year to your sampling period. If the month and year are not available for your particular sampling period you can create a new folder in this folder. Save the data file and disconnect data logger. Repeat this process until all data has been downloaded from data loggers.

All temparature data from the PLECA are stored at CABR in the network J drive at: *J:\Data\physical\climate\HOBO-herpTemps*.

Select the folder for the corrsponding year and then the month in wihch the data were collected. If necessary create the appropriate folders for the data to be downloaded.

Figure 13-2. Download HOBO data step 1.

Find the launch icon and click to program a HOBO data logger. The next screen will ask you what day, time, and temperature (Celsius or Fahrenheit).

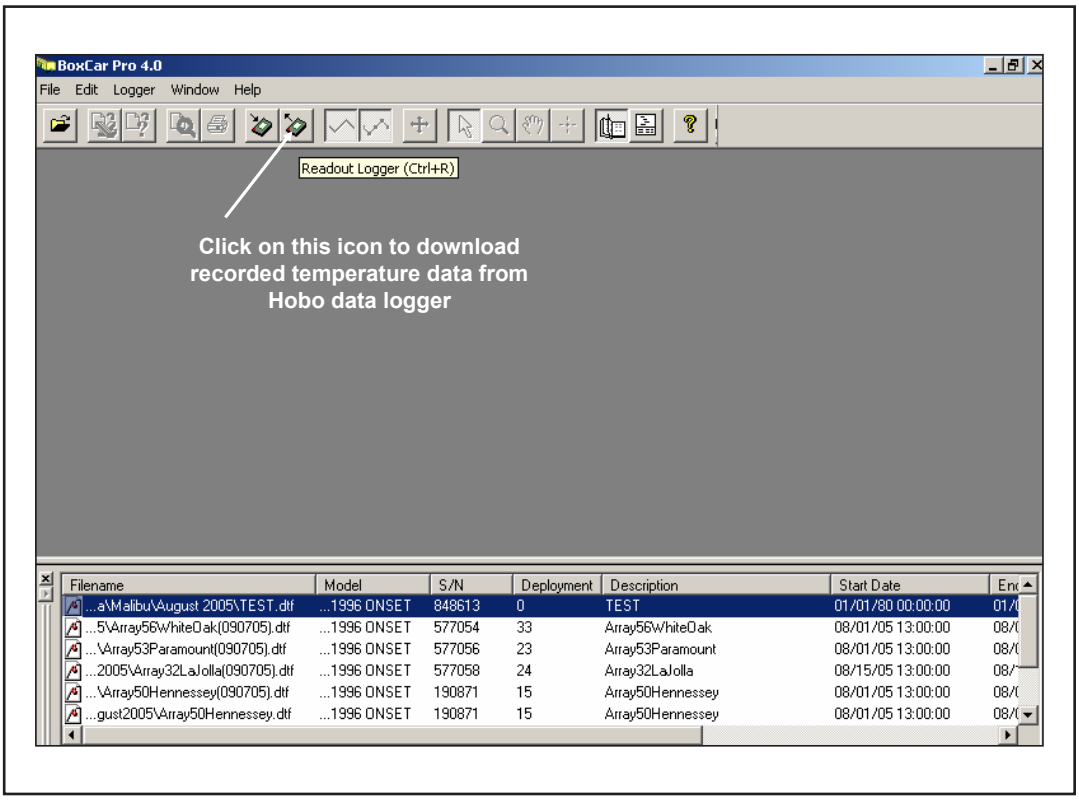


Figure 13-3. Download HOBO data step 2.

Make sure the description field has the name of the array, array number and date. (e.g**. Array 43Carlisle(091205)). Duration should reflect the entire duration of the sampling period. Check to see there is enough battery life. Check box—delayed start and select the day**

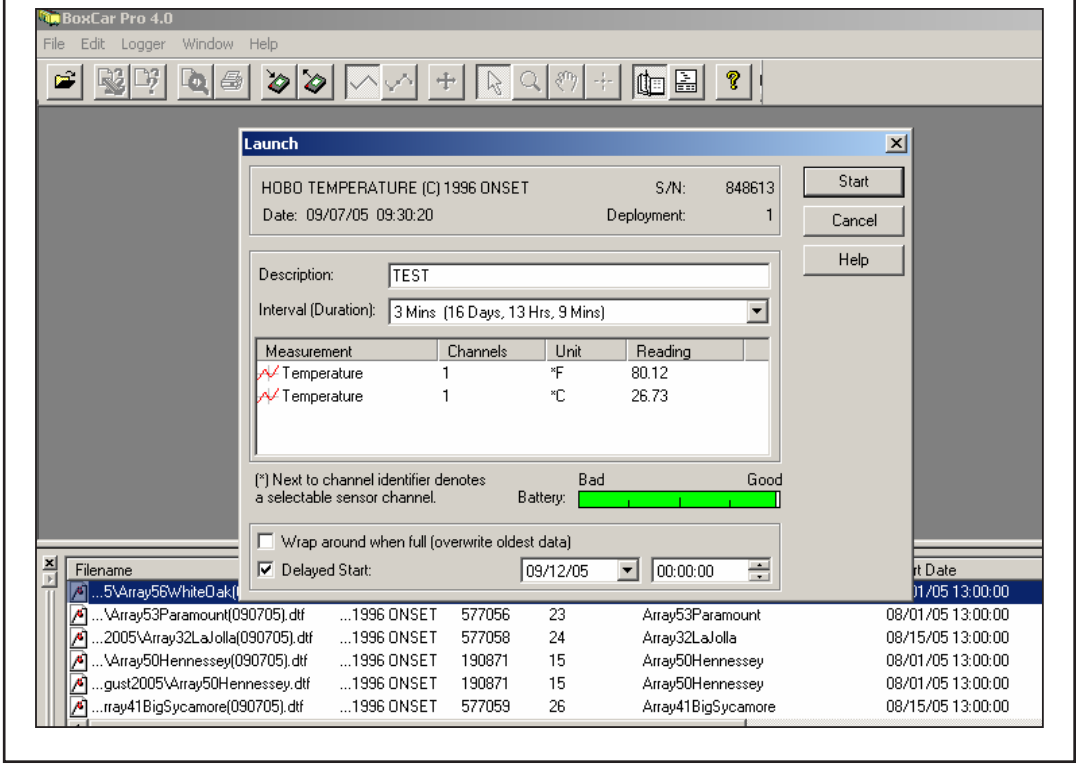


Figure 13-4. Diagram of HOBO temperature data logger deployment.

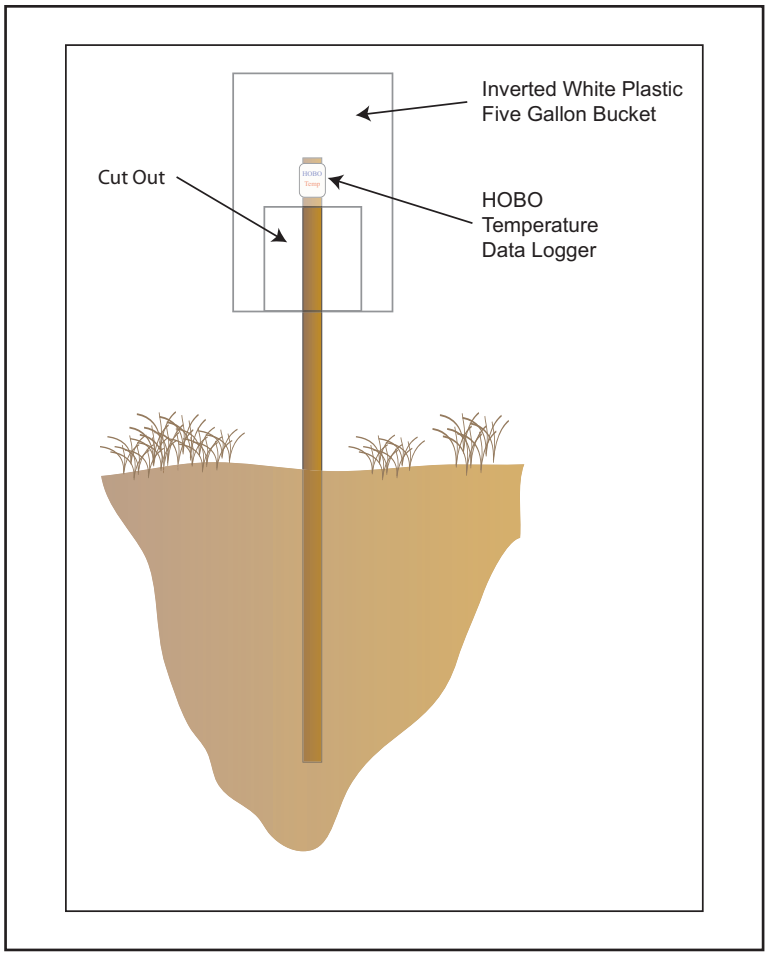


Figure 13-5. Download HOBO data step 3.

Select the "readout logger" icon shown above to download recorded temperature data from the HOBO data logger into the

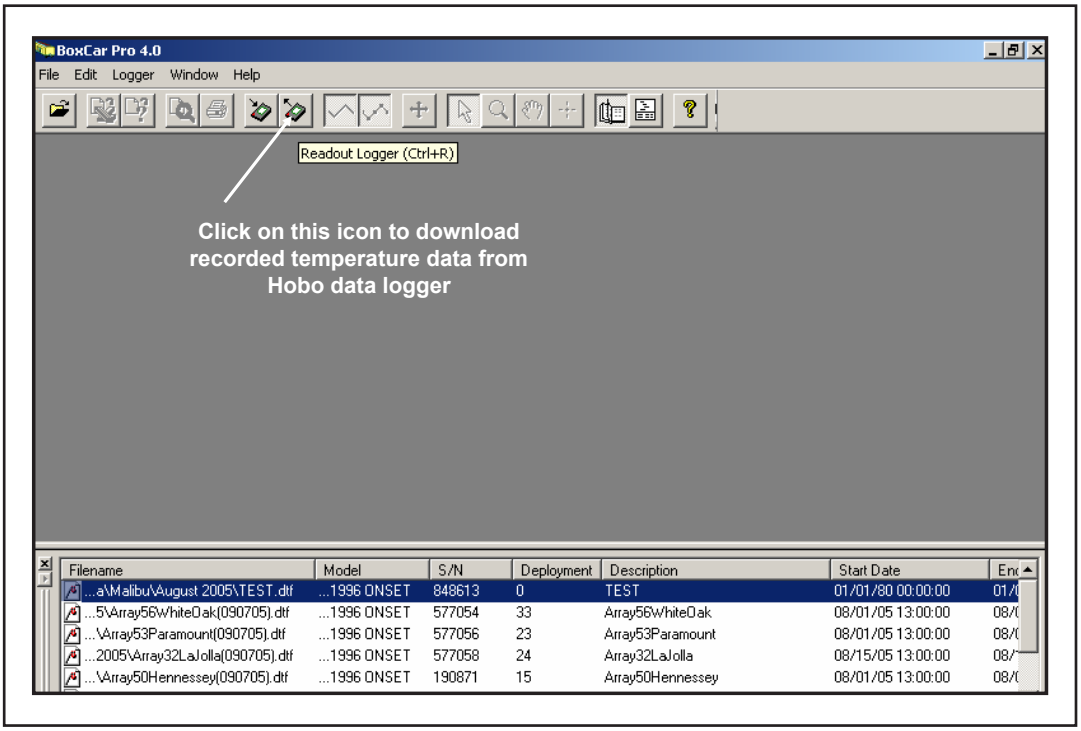


Figure 13-6. Download HOBO data step 4.

In the SAMO G drive: G:\Animal_Ecology\Reptiles and Amphibians\Pitfalls\Pitfall temp data. Select the region and month and year that is appropriate for saving temperature data. And select save. Then select all for both Fahrenheit and Celsius, and save. You can then disconnect the data logger and download data from other loggers.

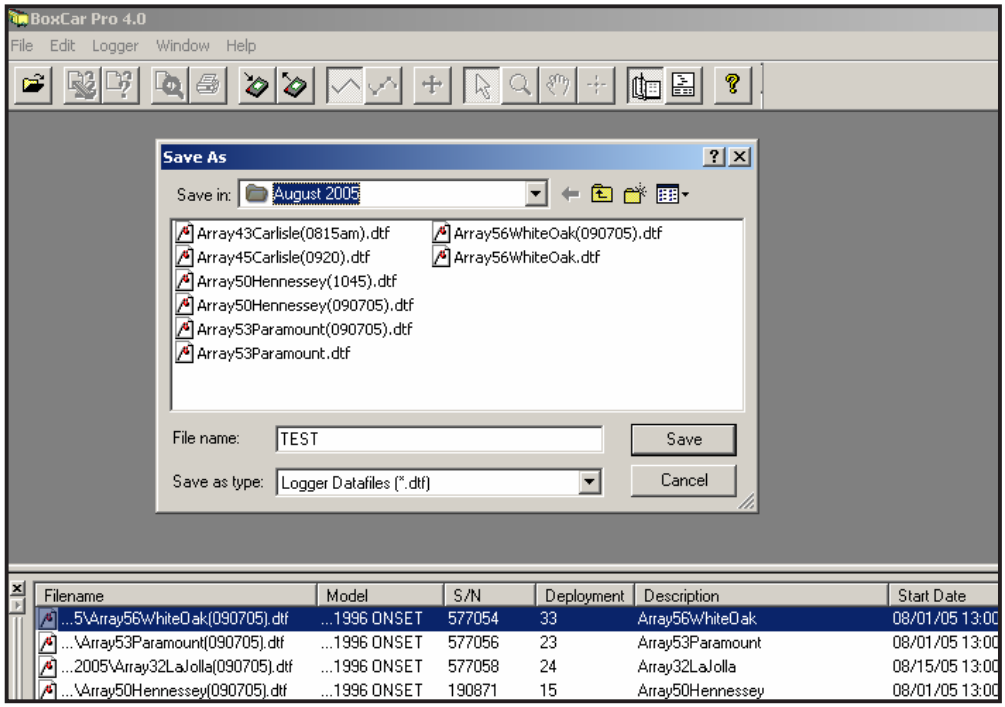
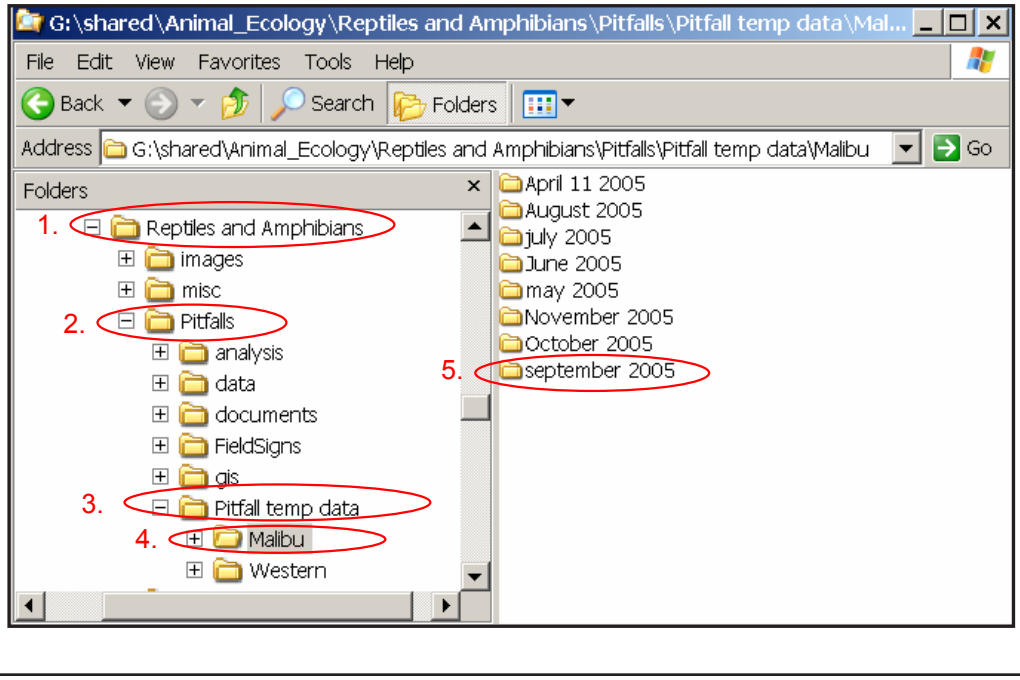


Figure 13-7. Download HOBO data step 5.

G: drive path at SAMO for locating folders for placing temperature data downloaded form the HOBO data loggers.



Funnel trap with captured snake.



Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network

SOP No. 14 - Procedures for Revising SOPs

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Background

Periodic review of procedures included in this monitoring protocol may reveal changes that should be made to refine sampling processes, adapt to changing technologies, respond to analytical deficiencies, etc. It is therefore important to establish a process by which changes or revisions can be implemented and documented.

Revision Procedures

The revision process may take several pathways, may be relatively minor with little overall impact on the focus of the existing protocol, or they may be significant requiring changes in key components or process of monitoring activities. Revision of existing approved SOPs will be administered by the network monitoring coordinator working in consultation with the technical committee and individual subject matter experts as may be required on an ad hoc basis. Revisions should not impact the opportunity for data sharing and agency partnerships in monitoring efforts unless those revisions are necessary to eliminate deficiencies in data integrity, sampling procedures, or trends analysis necessary to meet stated monitoring objectives.

Within each SOP there is a revision history log in which revisions to protocols are recorded. Older versions of SOP's should be archived or kept as an appendix to this document.

Naming Convention

All initial SOPs are given a 1.0 version number. Each change to an SOP will require a new version number. Minor changes are recorded as decimal numbers (e.g. 1.0, 1.1, 1.2, etc.). A major modification of the protocols such as changes from a pitfall trapping methodology to a visual transect survey or a significant change in data handling and analysis would be a change in the primary SOP number (e.g. 1.0, 2.0, and 3.0).

Review

Some changes in SOPs may necessitate a peer review of the proposed change. All revised SOPs will be submitted to the regional inventory and monitoring coordinator for determination if peer review is required before the revised SOP is implemented.

Volunteers recording data from pitfall array in Chaparral (SAMO).



Monitoring of Terrestrial Reptiles & Amphibians y Pitfall Trapping in the Mediterranean Coast Network

SOP No. 15 - Protocol Development Summary

Revision History Log:

Previous Version No.	Revision Date	Author	Changes Made	Reasons for Change	New Version No.
1.0	4/06	JLC - GTB	Format & Content	Response to internal & peer review	1.1

Development Summary

Parks Where Protocol Will be Implemented

Cabrillo National Monument (CABR) and Santa Monica Mountains NRA (SAMO).

Justification or Issues Being Addressed

Reptiles (and amphibians) in the Santa Monica Mountains are potentially affected by numerous environmental changes and impacts to their habitat. In addition, urban development and its associated impacts have drastically altered or destroyed crucial habitats for many herpetile species in the Santa Monica Mountains and significantly reduced habitat area on Point Loma. In the Santa Monica Mountains of the 34 species of reptiles and amphibians resident there 13 are listed as rare, threatened or endangered. Cabrillo National Monument which is located on the Point Loma Peninsula is part of and co-manages the Point Loma Ecological Conservation Area (PLECA). The PLECA protects all remaining undisturbed natural lands on the peninsula under federal ownership. This reserve is isolated from other natural lands by the ocean and urbanization that effectively creates an island of rare natural habitats. These habitats include maritime succulent scrub, coastal sage scrub, and chaparral which are home to many sensitive species of plants and animals. Historically (through the 1930s) 19 species of reptiles and amphibians occurred on the peninsula. Six of these species are now considered sensitive at the state or federal level.

Specific Monitoring Questions & Objectives to be Addressed by the Protocol

- Are population characteristics of terrestrial herpetiles in SAMO & CABR increasing or decreasing?
- Is the range of herpetile species diversity in SAMO & CABR increasing or decreasing?
- Is landscape fragmentation and loss of connectivity of natural open space in SAMO impacting herpetile populations?
- Are any species of terrestrial herpetiles on Point Loma showing population declines at present?
- Maintain sufficient pitfall trap arrays, sampling periods (months), and sampling days (length of time pitfall traps open) per sampling period in the PLECA to detect a 30% drop in species richness of herpetiles, a 30% drop in the relative abundance of the orange-throated whiptail (*Cnemidophorus hyperythrus*) and striped racer (*Masticophis lateralis*), and some measure of drop in abundance or occupancy of western ring-necked snake (*Diadophis punctatus*) and southern Pacific rattlesnake (*Crotalus viridis*).
- Determine long-term trends in

terrestrial herpetofauna distribution, abundance, & morphometrics from 20 pitfall trap arrays nested in five habitat regions of the Santa Monica Mountains.

Basic Approach

Because of the diversity of terrestrial herpetofauna and their specificity of habitat and diet in the Santa Monica Mountains and on Point Loma, herpetile species richness is a good indicator of ecosystem health, quality and integrity. This information may also support efforts to design restoration and land management strategies that can support the preservation of these species and improve the overall health of their habitat. In addition, data collected in the Santa Monica Mountains and on Point Loma will add to regionally collected data on herpetofauna distribution, abundance and status.

Sampling Strategies

Monitoring of terrestrial herpetofauna species diversity and abundance has been ongoing at CABR and the Point Loma Ecological Conservation Area for more than ten years. Monitoring began in 1995 under the direction of the USGS Western Ecological Research Center, but has been under NPS direction since 2000. Pitfall trap arrays were originally installed at seventeen locations representative of the suite of vegetation habitat types across the PLECA. Each of these arrays is sampled once a month for eleven months out of every Year (Figure 15-1).

Five sampling regions in SAMO characterized by their vegetation habitat types and level of urbanization will each host 20 pitfall trap arrays that will be visited once each month for four consecutive years (Figures 15-2 & 15-3). After four years of monthly sampling trap arrays in each region will be closed for six years. Initiation of sampling within regions will be staggered every two years so that after the first two years sampling will be ongoing in two regions simultaneously. This strategy represents a fully connected design with sampling array membership (location) in a given panel determined by selecting representative locations constrained by slope and access.

In the PLECA sixteen of the seventeen pitfall arrays originally installed are currently maintained and sampled (see SOP No. 12). Array No. 6 was closed in 2005 following a statistical review of five years of data which showed that there was no difference in data collected between arrays No. 5 and 6 (Atkinson et al. 2003).

Figure 15-1. Pitfall trap sampling frame for the seventeen arrays that have been installed in representative vegetation habitat stands throughout the Point Loma Ecological Conservation Area.

	Month										
Panel	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov-Dec**
Array 1	×	×	×	×	×	×	×	×	×	×	×
Array 2	×	×	×	×	×	×	×	×	×	×	×
Array 3	×	×	×	×	×	×	×	×	×	×	×
Array 4	×	×	×	×	×	×	×	×	×	×	×
Array 5	×	×	×	×	×	×	×	×	×	×	×
Array 6	**Closed in 2005**										
Array 7	×	×	×	×	×	×	×	×	×	×	×
Array 8	×	×	×	×	×	×	×	×	×	×	×
Array 9	×	×	×	×	×	×	×	×	×	×	×
Array 10	×	×	×	×	×	×	×	×	×	×	×
Array 11	×	×	×	×	×	×	×	×	×	×	×
Array 12	×	×	×	×	×	×	×	×	×	×	×
Array 13	×	×	×	×	×	×	×	×	×	×	×
Array 14	×	×	×	×	×	×	×	×	×	×	×
Array 15	×	×	×	×	×	×	×	×	×	×	×
Array 16	×	×	×	×	×	×	×	×	×	×	×
Array 17	×	×	×	×	×	×	×	×	×	×	×

Principal Investigators and NPS Lead

Gary Busteed and Seth Riley are the principal investigators at SAMO, with Gary Busteed being the NPS lead for protocol development and implementation. Andrea Compton and Stephanie Glenn are the

principal investigators at CABR, with Ms. Compton being the NPS program lead for terrestrial herpetofauna monitoring at CABR. Principal investigators will regularly compare methodology and results to ensure the most appropriate methods are employed network-wide.

Figure 15-2. Sampling frame for pitfall trap arrays in the Santa Monica Mountains. Five sampling panels (regions) will be sampled on a (4-6) rotation with 20 separate pitfall traps installed in each region.

	Year											
Panel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Region 1	20	20	20	20							20	20
Region 2			20	20	20	20						
Region 3					20	20	20	20				
Region 4							20	20	20	20		
Region 5									20	20	20	20
Total	20	20	40	40	40	40	40	40	40	40	40	40

Development Schedule

FY06

1. Final approved of peer reviewed protocol will initiate protocol implementation early in FY 2006.

Budget

1. Equipment & Supplies: $18,000. Includes all materials for construction of pitfall trap arrays, repeated sampling, and handling incidental mortality of trapped animals.
2. Vehicle: $14,000. Use of two GSA vehicles for one year.
3. Personnel: $125,000 to $150,000 per year depending upon the number of trap arrays deployed.

Expected Products

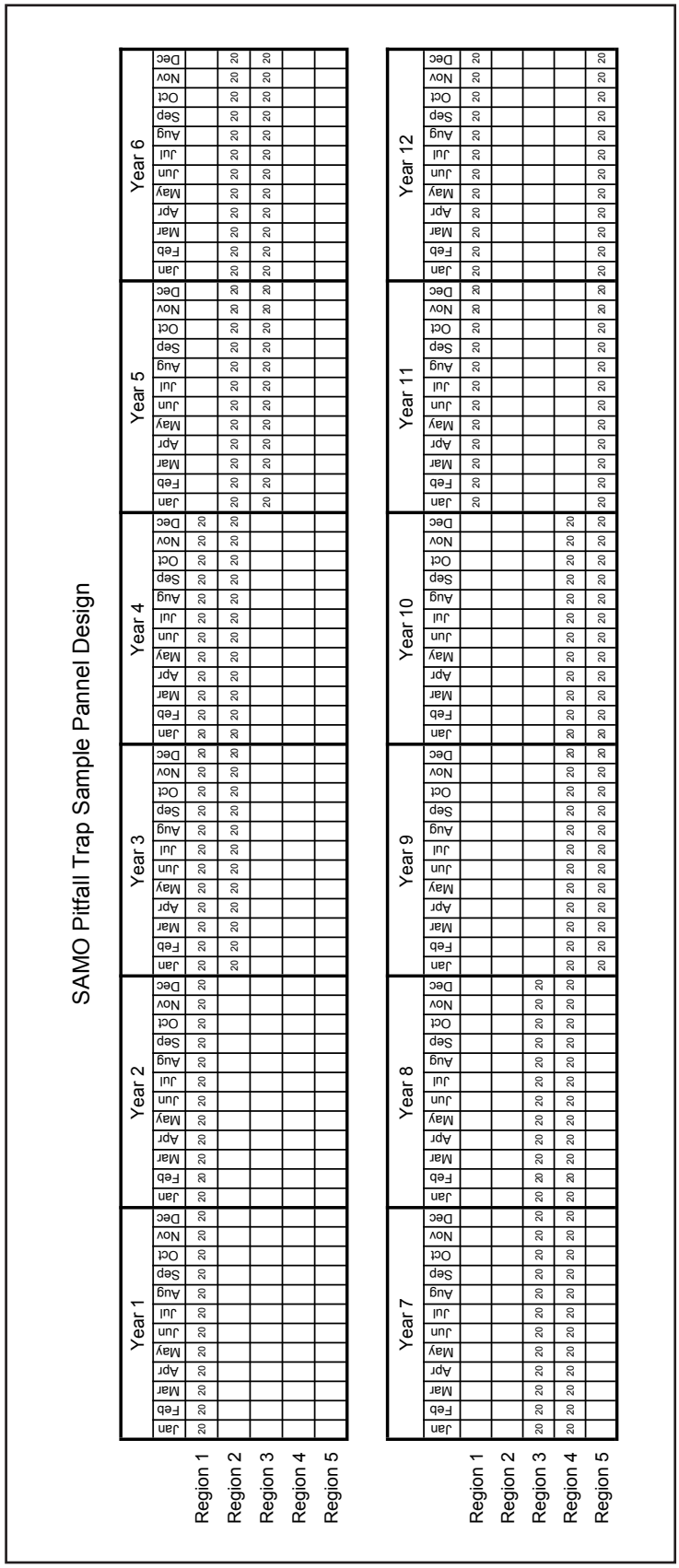
1. Protocol for peer review.
2. SOPs to accompany protocol.
3. Database and field forms.
4. Analytical plan.

Literature Cited

Atkinson, A.J., R.N. Fisher, C.J. Rochester, and C.W. Brown. 2003. Sampling design optimization and establishment of baselines for herpetofauna arrays at the Point Loma Ecological Reserve. USGS, Western Ecological Research Center.

Figure 15-3. Finer grained view of pitfall trap sampling frame as proposed for SAMO.

Twenty pitfall trap arrays will be sampled once a month for four consecutive years in each of five sampling regions on a rotating (4-6) schedule.





Monitoring of Terrestrial Reptiles & Amphibians by Pitfall Trapping in the Mediterranean Coast Network:

Santa Monica Mountains National Recreation Area &
Cabrillo National Monument

ABOVE
The western rattlesnake, ***Crotalus viridis,*** in the Santa Monica Mountains, Photograph by Scott Story, National Park Service