MONITORING PROTOCOL

TESTING THE USE OF OCCUPANCY SAMPLING TO DETECT STATUS AND TRENDS OF MOJAVE DESERT TORTOISE (*GOPHERUS AGASSIZII*) IN THE BOULDER CITY CONSERVATION EASEMENT

CLARK COUNTY

MULTIPLE SPECIES HABITAT CONSERVATION PLAN

October, 2011

Revised 2/7/13

desert conservation PROGRAM

MONITORING PROTOCOL

TESTING THE USE OF OCCUPANCY SAMPLING TO DETECT STATUS AND TRENDS OF MOJAVE DESERT TORTOISE (*GOPHERUS AGASSIZII*) IN THE BOULDER CITY CONSERVATION EASEMENT

CLARK COUNTY MULTIPLE SPECIES HABITAT CONSERVATION PLAN

October, 2011
Revised February 2013

Prepared for:

desert conservation PROGRAM

Prepared by:

Enduring Conservation Outcomes

SCIENCE ADVISOR
2009-ECO-801A

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

ACRONYMS AND ABBREVIATIONS

BCCE	Boulder City Conservation Easement
BLM	Bureau of Land Management
DCP	Desert Conservation Program
DWMA	Desert Wildlife Management Area
GIS	geographic information system
GPS	global positioning system
GRTS	Generalized Random Tessellation Stratified
ha	hectares
m	meters
MCL	midline carapace length
mm	millimeters
MSHCP	Multiple Species Habitat Conservation Plan
NDOW	Nevada Division of Wildlife
NPS	National Park Service
OHV	off-highway vehicle
%	percent
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

ABSTRACT

Mojave Desert tortoise (*Gopherus agassizii*) is a priority species for conservation in Clark County, Nevada (U.S.) and is listed as threatened under the Federal Endangered Species Act. Studies have shown that the species has declined and continues to decline throughout its range in the Mojave Desert. Assessing the population status and trends of the species is essential to determine if the species is continuing to decline or beginning to recover in response to protection and management actions. This monitoring protocol outlines the use of occupancy sampling for monitoring tortoise habitat use in smaller desert conservation areas (less than 100,000 to 250,000 acres; 40, 469 to 101,171 hectares). Occupancy sampling assesses the proportion of habitat occupied by a species and does not estimate abundance or density. The potential values of using occupancy sampling are: (1) the greater precision in the detection of change in spatial extent of tortoise populations versus changes in density; (2) the ability to accurately assess ecological and management covariates within the plot design; and (3) reduced resource costs of monitoring over both annual and multi-year time frames. The protocol provides details on objectives and assumptions, indicators, sampling design, sampling method, data analysis, and management response to changes in occupancy. It has two appendices, one on data management and the other on a tortoise burrow classification. The intent is for the Clark County Desert Conservation Program to implement this protocol in the 86,423-acre (34,974 hectare) Boulder City Conservation Easement. While being designed for a specific site, the overarching goal is to provide a protocol that could be used by land managers who need to make restoration and conservation decisions at smaller spatial and temporal scales; areas smaller than the size of a desert tortoise recovery unit and the detection of change over timeframes of five to ten years. This protocol will be tested during a pilot phase, and decisions about the value of this sampling design and method to other areas and applications should only be made once the pilot phase is complete and in conjunction with the U.S. Fish and Wildlife Services' Desert Tortoise Recovery Office.

1.0 INTRODUCTION

Mojave Desert tortoise (*Gopherus agassizii*) is a priority species for conservation in Clark County and throughout its range in the southwestern United States (U.S.). Studies have shown that the species has declined and continues to decline throughout its range in the Mojave Desert (USFWS, 2011; 2009b; 1994). Until recently the species was thought to range from the Mojave Desert in the north, through the Sonoran Desert south to southern Sonoran and northern Sinaloa, Mexico (Murphy et al., 2011), with the Mojave Desert population listed as threatened under the Endangered Species Act in 1990 (USFWS, 1990). It is now recognized that the tortoise populations west of the Colorado River in Utah, Nevada, and California are a species distinct from the remainder of the taxon (Murphy et al., 2011).

Assessing the population status and trends of the species is essential to determine if the species is continuing to decline or beginning to recover. The Desert Tortoise Management Oversight Group endorsed the use of line distance sampling as the method for estimating range-wide tortoise density (USFWS, 2011; 2009b). The low density of tortoises and their slow rate of increase contribute to low precision in density estimates and low power to detect positive population trends (Anderson & Burnham, 1996; USFWS, 2009b). Additionally, the species is difficult to detect because only part of the population is outside of burrows at any given time and individuals of the species are difficult to see among rocks and vegetation. Although line distance sampling methodology has been extensively tested and refined to improve its precision and the detectability of tortoises, the precision of density estimates are low over short periods of time (Nussear & Tracy, 2007).

The focus of the current line distance sampling design on assessing status and trend at the landscape scale and the time needed to obtain precise estimates of abundance and density limit the usefulness of the line distance sampling method for most land managers. Land managers need to make restoration and conservation decisions at smaller spatial and temporal scales; areas smaller than the size of recovery units and the detection of change over shorter timeframes of generally five to ten years. Additionally, information on tortoises and the appropriate ecological and management covariates (e.g., vegetation, invasive species control) are better assessed in sample units of a shape and size that contain less variability than the transects used in line distance sampling. Lastly, land managers need to be concerned about the resource costs of monitoring over both annual and multi-year time frames.

This monitoring protocol explores the use of occupancy sampling for monitoring Mojave Desert tortoise to meet the needs of land managers for smaller conservation areas. Occupancy sampling assesses the proportion of habitat occupied by a species and does not estimate abundance or density. Zylstra et al. (2010) assessed the efficiency and statistical power of occupancy sampling for the Sonoran Desert tortoise in the Sonoran Desert. Their work suggests that occupancy sampling may be more efficient and have greater statistical power to detect annual declines in the proportion of area occupied as compared with annual declines in density detected by line distance sampling. Occupancy sampling has also been suggested as a monitoring approach in the Revised Recovery Plan (USFWS, 2011).

The Clark County Desert Conservation Program (DCP) intends to initiate a multi-year pilot study to test this protocol in the Boulder City Conservation Easement (BCCE) in eastern Clark County. The BCCE covers 86,423 acres (39,974 hectares (ha)) of land owned by the City of Boulder City. The easement is held by Clark County and is managed by the DCP.

1.1 Species Information

Mojave Desert tortoises are found in southern Nevada, southeastern California, western and southern Arizona, southwestern Utah, and portions of Sonora and Sinaloa, Mexico (Murphy et al., 2011). Until recently only one species was thought to occur in this range. It is now recognized that the tortoise populations west of the Colorado River in Utah, Nevada, and California are a species distinct from the remainder of the taxon (Murphy et al., 2011).

Desert tortoises are herbivorous terrestrial reptiles that may occur at elevations between sea level and 7,300 feet (Luckenbach, 1982). Suitable habitat for tortoises includes areas with sufficient available forage consisting of annual and perennial vegetation, and soils suitable for construction of subterranean burrows for nesting, resting, escaping the heat, and for longer periods of brumation. Tortoises are most active above ground within southern Nevada between March 15 and October 15. Tortoise monitoring generally takes place during the most active portion of the above ground period, in spring and early summer when preferred annual forage species are most available. During years with low annual plant productivity, tortoises may spend considerably more time below ground.

Tortoise home ranges can be between 25 to 200 acres (10 to 81 ha), with individuals able to range up to seven miles on a single foray (Berry & Turner, 1986). Males typically have home ranges twice as large as females (Berry & Turner, 1986). Tortoises reach sexual maturity at 15 to 20 years of age and reproductive rates have been shown to be low (Tracy et al., 2004). Key threats to tortoise survival and recovery include, but are not limited to, mortality by vehicles, disease (specifically upper respiratory tract disease), and habitat loss and habitat degradation due to invasive species, fire, and other habitat disturbances (Tracy et al., 2004; USFWS, 2011).

Additional information about tortoise biology and habitat requirements may be found in the revised recovery plan for the Mojave Desert tortoise (USFWS, 2011).

1.2 Study Area

The protocol will be tested separately in two sections of the BCCE. The BCCE is located at the upper reaches of the Eldorado Valley and southwest of the populated area of Boulder City. Shown on Figure 1, the easement is split by U.S. Highway 95 into an east section (39,048 acres or 15,802 ha) and a west section (47,375 acres or 19,172 ha). There are 3,064 acres designated by Boulder City for energy development (Energy Zone) that are excluded from the west section of the easement. Small acreages to the east of U.S. Highway 95 and south of State Route 165 will not be included in the study areas to be surveyed.

The area was previously managed by the Bureau of Land Management (BLM). In July 1995 the land was transferred to Boulder City and Clark County purchased the conservation easement from the City. Prior to establishment of the easement, the land was managed for multiple uses including mining, energy transmission, telecommunications, off-highway vehicle (OHV) racing, hunting, grazing, and open recreation. The conservation easement specifies that of these historic uses, only limited transmission of energy and telecommunications, hunting, non-speed vehicular events, and non-ground disturbing recreation may occur on the property. Research, non-speed vehicular events, and ground disturbing activities may occur with written permission from Boulder City and the County. The County is required by the easement agreement to provide law enforcement on the BCCE area, which is currently provided through an interlocal agreement with Boulder City for the equivalent of one full-time officer from the Boulder City Police Department.

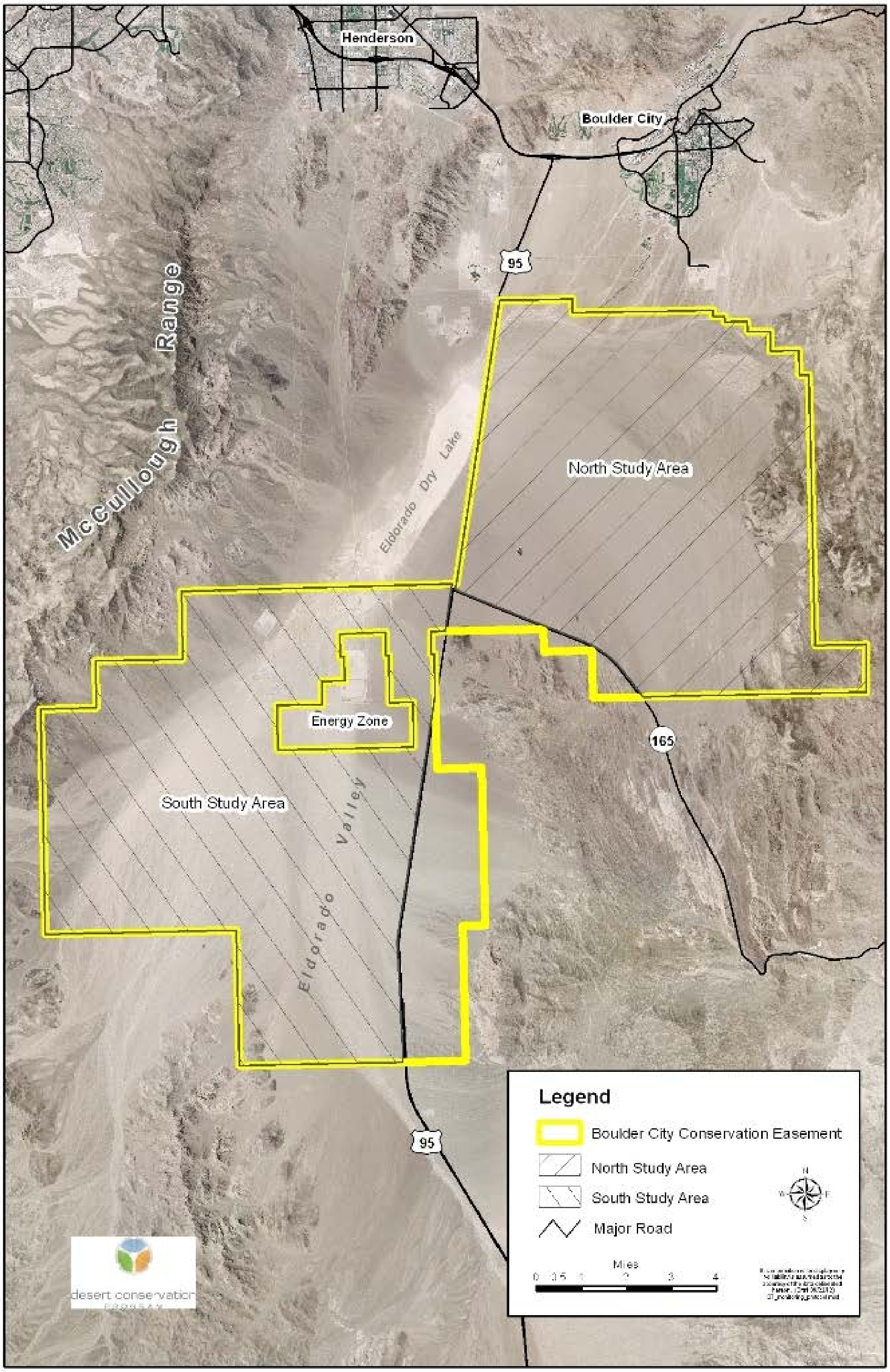


Figure 1. Location of Study Areas within Boulder City Conservation Easement

Land to the east, west, and south is primarily under federal ownership and land to the north is in Boulder City jurisdiction. The northern boundary is approximately two miles south of residential developments of Boulder City. The Energy Zone and three electrical substations are located in the west section. The eastern edge of the east section is adjacent to the National Park Service (NPS) Lake Mead National Recreation Area. The Sloan Canyon National Conservation Area is to the west of the easement and the Piute-Eldorado Area of Critical Environmental Concern managed by the BLM is to the south. Paved roads and desert tortoise exclusion fencing divide the two sections of the BCCE and also separate the southern border of the east section of the BCCE from BLM lands. The Eldorado and McCullough mountains surround the BCCE to the east and west, respectively.

The BCCE is within a closed drainage basin at an elevation between 1,800 and 3,000 feet (549 and 914 meters (m): O'Farrell, 2009). There is no permanent surface water within the BCCE. Runoff following large precipitation events drains onto a playa known as Eldorado Dry Lake, located at the lowest elevation just north of the southwest section (O'Farrell, 2009). The soils within the BCCE are primarily young alluvial deposits derived from sedimentary and igneous sources (Heaton et al., 2011). These soils are characterized as gravelly and sandy with coarse texture; low organic matter content; and low carbon/nitrogen ratios (O'Farrell, 2009). Rock outcrops occur within the BCCE at the foothills of the McCullough Range and Eldorado Mountains.

The BCCE is mostly Mojave Desert scrub ecosystem with approximately two percent (%) covered by salt desert scrub (Heaton et al, 2011). Approximately 80% of the BCCE is in the valley bottom with deep sands and a near surface hardpan, dominated by vegetation of creosote bush (*Larrea tridentata*) and bursage (*Ambrosia dumosa*) (O'Farrell, 2009). Areas with rocky soils (approximately 15%) are dominated by creosote bush, desert thorn (*Lycium andersonii*), and spiney hop-sage (*Grayia spinosa*) (O'Farrell, 2009).

2.0 OCCUPANCY SAMPLING

The past decade has seen extensive assessment of a sampling methodology, line distance sampling, to estimate the abundance and density of Mojave Desert tortoise in Desert Wildlife Management Areas (DWMAs) (USFWS, 2011; 1994; Nussear & Tracy, 2007; Clark County, 2009). These efforts have identified issues with tortoise detectability that have limited the precision of abundance and density estimates, issues that will also impact the precision of occupancy estimates. There are two sources of detectability issues for tortoises. The first is the number of tortoises present above ground that can be counted. Tortoises spend much of the year in burrows even during the active season so that during a sampling period, only a proportion of the population is above ground. The second source that limits detectability is the ability of the observer to detect tortoises while surveying.

The lack of precision in estimating abundance and density and the inability to use this data to make conservation decisions within short timeframes has led to suggestions of other monitoring approaches (Zylstra et al., 2010; Nussear & Tracy, 2007; Tracy et al., 2004). One suggested method is occupancy sampling (USFWS, 2011; Zylstra et al., 2010). Occupancy sampling is defined as determining the proportion of habitat within an area that contains evidence of a targeted species. This approach uses a probabilistic sampling design to select sample units, with each sample unit visited two or more times per sample period to incorporate a measure of detectability (MacKenzie et al., 2004; 2005). Occupancy can be determined by the presence of the targeted species and/or signs of the species' presence (e.g., burrows, nests, scat, tracks, etc.).

The use of occupancy sampling is based on the assumption that the status and change over time of a population can be assessed by changes in the proportion of the sample units that are occupied or used by the species. This is a different question than sampling for abundance or density and as such is insensitive to changes in density except at low density levels. Thus, the approach assumes that the species will respond to changes in habitat, habitat alteration, or management practices by their occupancy or use of an area. For increases in the population or management success to be detected, tortoises would have to increase in their occupancy of the sample units, and alternatively, a decrease would only be measured by a reduction of sample units occupied by the species.

The strength of occupancy sampling is the potential of greater efficiency and statistical power to detect annual declines in the proportion of area occupied or used compared with detection of annual declines in density by line distance sampling (Zylstra et al., 2010). While population abundance or density trends cannot be reported by occupancy sampling, temporal changes in presence/absence of tortoises or their sign in each sampling unit and changes in the proportion of area occupied or used within a sampling stratum can be detected. In addition, patterns of occurrence and use across multiple sample units can be assessed related to particular areas or habitat covariates. This information can provide valuable information to land managers to assess the species responses to habitat quality, threats, and management activities. The assessment of covariates will strengthen with multiple years of data from each sample unit.

The components of this protocol that should increase the reliability of occupancy sampling include:

- Increasing detectability by a structured search protocol within each sample unit to insure a thorough 100% survey, with surveyors expected to deviate from a straight line to more effectively inspect all bushes, shrubs, and suspected burrows.
- Using active burrows as an additional indicator of occupancy.
- Tagging tortoises. Zylstra et al. (2010) note that as long as one tortoise is present in a sampling area, occupancy may not change if the same individual is being detected over and over. The method proposed here includes uniquely tagging individual tortoises so that such a pattern could be detected over time.

For tortoises, occupancy sampling will provide spatial distribution of tortoise occupancy in sampling units as assessed by two indicators, presence of live tortoises and presence of active burrows. These indicators can be visually presented in geographic information systems (GIS), individually and combined, showing the distribution of these indicators within the BCCE and their change over time.

3.0 MONITORING OBJECTIVES AND ASSUMPTIONS

The Clark County Multiple Species Habitat Conservation Plan (MSHCP) requires tracking the status and trends of covered species (Clark County, 2000). Mojave Desert tortoise, a federally listed threatened species, is a covered species under the MSHCP. The Mojave Desert tortoise is also a protected species in the State of Nevada. The line distance sampling method has been used to estimate tortoise density in the Mojave Desert since 2001. This method has been extensively developed and tested, especially to address detectability issues associated with this species. Additionally, the USFWS 5-point policy recommends that habitat conservation plans also monitor the effectiveness of uncertain mitigation practices (Federal Register, 2000). Habitat conservation plans have flexibility in design and selection of monitoring programs, and measures of habitat use are acceptable (Jeri Krueger, USFWS, personal communication October 13, 2011).

The monitoring objectives for this protocol are to:

1. Analyze the status and change over time in occupancy/use of tortoise habitat within the BCCE using the indicators of live tortoises and active burrows. The goals of this project are to detect a 20% change in occupancy over a 5- to 10-year time period, with a statistical power of 0.8 and an alpha of 0.1. The power of 0.8 accepts the probability of saying a change has taken place when it has 8 out of 10 times. The alpha of 0.1 accepts the probability of 1 of every 10 times of saying a change has taken place (perhaps resulting in some management action) when it has not. The initial sample size is 40 plots per strata. The variance of the indicator will be provided by two or more years of data, allowing the assessment of variability over a single sampling season and over multiple years.
2. Correlate the pattern and change in occupancy/use with habitat (e.g., cover of vegetation, herbaceous vegetation), habitat alteration (e.g., roads, off-road vehicle disturbance), and management practices (e.g., closing roads, vegetation restoration).
3. Anecdotally assess the demographic condition of the population from tortoise size classes and gender.

These objectives are based on the following assumptions:

1. Tortoises will respond to changes in habitat, habitat alteration, or management practices by altering their occupancy or use of an area. For increases in the population or management success to be detected, tortoises will have to increase in their occupancy of the sample units, and alternatively, a decrease will only be measured by a reduction of sample units occupied by the species.
2. Tortoises will not occupy unsuitable habitat unless all suitable habitat is beyond capacity to support additional tortoises. Thus, a land management unit that is at or below tortoise carrying capacity will have areas that are not occupied by tortoises, and 100% occupancy is not an appropriate goal for many land management units. Tortoises will not consistently attempt to occupy unsuitable habitat unless tortoise carrying capacity has been reached or exceeded. Thus, some areas may periodically include tortoise presence but will not consistently appear to be occupied. This natural variance in occupancy rates should be accounted for in the design's sample unit size and management response thresholds.
3. When an area experiences a decline in tortoise populations due to emigration and/or mortality, tortoises will vacate non-preferred suitable habitat areas before vacating preferred suitable habitat areas.
4. No translocation of tortoises will take place during the pilot study, although wild tortoises picked up by the Wild Tortoise Assistance Hotline from within the BCCE will be returned to the same portion of the BCCE.
5. Management actions can make improvements to non-preferred or non-suitable habitat to increase their suitability and value to tortoises. Management actions can also prevent declines in suitability or preference value of habitat areas.
6. The Desert Tortoise Recovery Office's range-wide monitoring efforts within the Piute-Eldorado DWMA will continue to include the BCCE within their sample design, and the current levels of connectivity of the BCCE with the rest of the Piute-Eldorado DWMA will be maintained. Understanding long-term population abun-

dance trends within the larger landscape will assist managers in interpreting localized monitoring results and field observations.

4.0 INDICATORS FOR ASSESSING MONITORING OBJECTIVES

The indicators that will be used to assess the monitoring objectives include the presence of live tortoises and active tortoise burrows. Data on tortoise carcasses will also be collected. Vegetation and habitat indicators, including habitat alterations and management practices will be developed in another protocol and are only briefly described below.

4.1 Tortoise Indicators

Indicators that will be used for tortoises include observations of live tortoises and active tortoise burrows.

Live Tortoises

All live adult tortoises (carapace length greater than or equal to 180 millimeters (mm)) will be recorded when observed in each sample unit. Each observed tortoise will be measured, sexed, and tagged. A general health assessment will be conducted. Surveyors will also record data on live adult tortoises encountered while traveling between sample units as incidental observations.

1. Important Comments on Handling and Maintaining Sterile Conditions

   Tortoises shall be treated in a manner to ensure they do not overheat or exhibit signs of overheating, which include aggressive struggling by the tortoise, hot to the touch, frothing at the mouth, excessive salivation, or voiding its bladder. Tortoises shall not be placed in a situation where they cannot maintain surface and core temperatures necessary to their well-being. Should a tortoise begin to void, the surveyor must discontinue any assessment, move away from the tortoise, and note in the data dictionary and paper data sheets that the assessment was not completed due to tortoise voiding.

   Non-porous disposable gloves must be worn when touching a tortoise. This type of glove must be kept on during the entire time a single tortoise is handled. Even if the tortoise is not processed and only moved, gloves should be worn. Replace the glove if it is torn while handling the tortoise, which is likely when its toenails scrape the glove. Once used, disposable materials must be disposed of promptly in a manner so as not to come into contact with sterilized materials, fresh gloves, equipment, or any other item that might come into contact with a tortoise. All equipment that comes into contact with any part of a tortoise or any instrument or item that has been in contact with a tortoise must be sterilized with a 30% bleach solution.

2. Measuring and Sexing

   Measure the tortoise using the midline carapace length (MCL) from the nuchal to pygal scutes using calipers, which provide the most accurate measurement. Measurements will be taken to the nearest mm. The sex of tortoises less than 180 mm MCL cannot be accurately determined based on external characteristics. For larger tortoises, generally the following male characteristics differentiate them from females: (a) concave plastron; (b) longer, more curved gulars; (c) larger, well-developed chin glands; (d) longer, broader, more conical tail; and (e) shorter, thicker toenails. Pay particular attention to the gular projection and the shape of the plastron which are the two best features for differentiating the sexes. For very large tortoises, feel the concave (male) or flattened (female) plastron or see it by holding the tortoise at eye level without turning the tortoise on its back. When in doubt, record all other information and mark "sex unknown" on the data sheet (USFWS, 2009a).

3. Tagging

Identification tags unique to the DCP will be affixed to a scute of each unmarked tortoise. Tag number will be recorded. Select the 4th right or left costal scute to increase the likelihood of reading the tag when tortoises are in a burrow (USFWS, 2009a). Quick drying epoxy will be used to affix tags to tortoises. Epoxy will be mixed on a file card or piece of paper, then transferred to the tag on the shell with something such as a toothpick, wooden coffee stirrer, or tongue depressor (USFWS, 2009c). Under no circumstances should epoxy touch the margins of the scutes where growth must occur.

Tortoise Burrows

Active tortoise burrows within the sample unit will be mapped and surveyors will record data on active tortoise burrows encountered while traveling between sample units as incidental observations.

Appendix B – Burrow Classification Description includes a decision process to follow in first identifying burrows and dens as tortoise burrows, and second, classifying tortoise burrows as active or non-active. At best, burrows match the half-circle or half moon-profile of the tortoise shell but tortoises also use canid or mustelid excavations and may be found in burrows of other animals, particularly kit foxes (USFWS, 2009a). For purposes of the pilot study, active tortoise burrows are defined as burrows occupied by a tortoise or with recent tortoise activity (e.g., scat, tracks). Potential burrows and caliche dens will be inspected using a hand mirror to assess presence of tortoises. Presence of a tortoise in a burrow will be considered as occupancy by a live tortoise and an active tortoise burrow.

A tortoise burrow will be defined as inactive if it cannot be classified as active following the decision tree in Appendix B. Signs that may individually or collectively with others render a tortoise burrow inactive include collapse, deterioration, erosion, siltation, and accumulation of litter, organic debris, or vegetation growth in and around the burrow opening. During brumation, tortoises may backfill the burrow giving the appearance of the terminus. Spider webs, litter, and other debris may accumulate in burrow openings overnight, and openings may collapse during winter rains. Only the presence of fresh, dark brown scat that is readily visible at the burrow opening will be considered one sign of recent tortoise activity that classifies the burrow as active.

Removal of tortoises from burrows will not be attempted.

Tortoise Carcasses

Although a tortoise carcass will not count towards occupancy, carcasses will be recorded when observed by surveyors in sample units or when encountered while traveling between sample units. The data taken on carcasses includes carcass condition, midline carapace length, and sex. Tag number will be recorded if present on the carcass.

4.2 Habitat Indicators

Another protocol is currently being developed to measure habitat, habitat alteration and management actions in the plots established for occupancy sampling. These indicators will be measured for possible correlation with tortoise occupancy. The potential indicators that may be measured are listed below.

Vegetation and Habitat Indicators

Habitat quality indicators include:

1. Site topography and geomorphic features, including washes, slope, and presence of rocks.
2. Vegetation species cover and richness, including both vegetative and basal cover of shrubs and cover of native herbaceous species and winter annuals.
3. Distribution of invasive plant species, especially non-native grasses and mustards.
4. Distance to springs, washes, or outfall areas with higher moisture availability.

Habitat Alteration Indicators

Habitat alteration (threat) indicators include:

1. Number and density of open or closed roads.
2. Vehicular activity above the speed limit or off designated roads.
3. Density of above ground utility lines, which have in general been associated with increases in opportunistic predator (e.g., ravens, other birds of prey) activity.
4. Distance from tortoise exclusion fencing along State Route 165 or U.S. Highway 95.
5. Distance from construction, maintenance, or other activities associated with utility rights-of-way (including substations).

Distance from construction, maintenance, or other activities associated with the Energy Zone or other adjacent land uses and existing data for open and closed roads, tortoise exclusion fencing, and existing rights-of-way structures and facilities will be updated periodically from observations and/or aerial photography. Data on vehicular activity and construction, maintenance, or other activities associated with rights-of-way or the Energy Zone will be provided by law enforcement reports, DCP staff site visits, and other observations. The locations, length of activities, and descriptions of permitted activities will be available from permit copies.

Management Practices

Management practice indicators include:

1. Frequency, time, and locations of law enforcement patrols.
2. New barriers to vehicular traffic.
3. New closures of roads, tracks, and trails.
4. Rehabilitation or restoration of damaged sites.
5. Fire suppression or fuel reduction activities.
6. Enhancement (through increased food plants or burrow sites) of non-preferred or non-suitable habitat areas.
7. Increased avoidance, minimization, and restoration activities for authorized ground disturbing activities.
8. Distance to documented breaches in tortoise exclusion fencing along State Route 165 or U.S. Highway 95.

Law enforcement GPS data and reports will be used to track frequency and location of law enforcement patrols. Project data and reports will be used to document installation of barriers, closures of roads, and implementation of rehabilitation, restoration, and enhancement projects. Rights-of-way permits, DCP staff site visits, and project reports will be used to document any changes in avoidance, minimization, and restoration activities for authorized ground disturbing activities. Law enforcement, DCP staff and other observations will be used to document the time between detection and repair of breaches in tortoise exclusion fencing, which is managed by the Nevada Department of Transportation within their rights-of-way.

For the above indicators, correlations between tortoise occupancy in spatial or temporal overlap, or with distance to threats or management practices, will be assessed using GIS and other techniques.

5.0 SAMPLING DESIGN

A good sampling design minimizes data variability and maximizes the detection of status and change over time. There are six major sampling design decisions that need to be made:

1. What "population" is inferred?

The protocol will be tested in the BCCE (see Figure 1) that is physically stratified into two sections that have different human impacts and adjacent land designations:

- The east stratum nearest the populated area of Boulder City and east of U.S. Highway 95 has an extensive road network, several above and below ground utility line rights-of-way, adjacent solar and natural gas power facilities and electrical substations, and significant recreational uses, such as historical OHV race courses, past and current hunting, and current casual motorized and other uses. This study portion of this section (see Figure 1) is 37,593 acres (15, 213 ha) and is bordered by public lands to the east (NPS), north and west (Boulder City), and southeast (BLM). State Route 165 and tortoise exclusion fencing crosses parts of the section on the south, cutting off 1,455 acres (589 ha) from the core area of the easement that will be excluded from the study area.
- The study portion of the west stratum (see Figure 1) is 40,937 acres (16,567 ha) and includes the area west of U.S. Highway 95 but excludes the Energy Zone. Although this section experiences less human impact, it does have the Energy Zone and an extensive network of above ground utility line rights-of-way and electrical substations in the northern part of the section. This section is bordered by the Sloan Canyon National Conservation Area and multiple use public lands to the northwest, and public lands to the west and south, all of which are managed by BLM. U.S. Highway 95 and tortoise exclusion fencing cuts off 6,438 acres (2,605 ha) of the BCCE that will be excluded from the study area.

2. What sample unit size and shape best obtains data on tortoises?

The sample unit size and shape are designed to balance several conflicting criteria. The units need to be small enough to sample a sufficient number over the time frame of sampling (i.e., March 15 to May 15) to obtain an appropriate level of precision, but large enough to cover sufficient area to increase the evidence of tortoises. The sample unit size also needs to be efficient to establish and sample by the number of observers in each team. Because the survey crews will be uniquely tagging individual tortoises and recording the tag numbers of each tortoise encountered, we will be able to address concerns regarding sample unit size relative to potential home range or territory sizes of tortoises. Balancing these criteria, the sample units are four square hectares, or approximately 10 acres in size.

3. Are the sample units permanent or temporary?

The sample units are permanent across years to maximize the ability to relate changes in habitat indicators to the occupancy of tortoises.

4. How will the sample units be spatially allocated?

The sample units are randomly placed within the strata. Random placement was done by using the Generalized Random Tessellation Stratified (GRTS) sampling approach (Figure 2). GRTS is a form of probability sampling that results in greater spatial balance (i.e., less clumping) in the sample draw, while decreasing the variance about sample estimators and thus increasing statistical power (Stevens & Olsen, 2003). As with a simple random sample, a GRTS draw results in independent, random site selection. However, the resulting draw is more evenly spread across the study area with fewer pairs of very close points. The full range of environmental variability can thus often be better captured with a GRTS design.

GRTS selects a set number of primary sample locations and secondary sample locations selected for each stratum. The primary sample locations are sampled in their order of selection (numeric order). If any of the primary sample locations are eliminated due to the criteria listed below, then the first of the secondary sample locations can be added. GRTS is designed to allow the elimination of some sample locations and the replacement of these sample units while maintaining a random and interspersed draw.

The criteria for the rejection of a sample location are:

- Overlap with external or internal boundaries of the easement.
- Overlap the footprint of facilities and substations where fences prevent sampling within the footprint.
- Locations are inaccessible due to terrain or distance from access roads (e.g., taking longer than two hours to hike to the sampling location).

5. How often will the sample units be sampled (What is the frequency of sampling)?

To choose the number of sample units and how often each would be sampled, it is necessary to seek existing tortoise detectability estimates and make several assumptions. We assumed that the detection probability of tortoises in the sample units was greater than 0.8. This number, in part, comes from the detection probabilities for tortoises in the Piute / Eldorado Valley reported by USFWS (Linda Allison, personal communication October 13, 2011) but we also assume it would be higher for the occupancy monitoring protocol that line distance sampling because of the methods that will be used to survey each sample unit (100% coverage survey techniques). Thus, we assume that nearly all tortoises above ground within sample units during surveys will be detected by the surveyors.

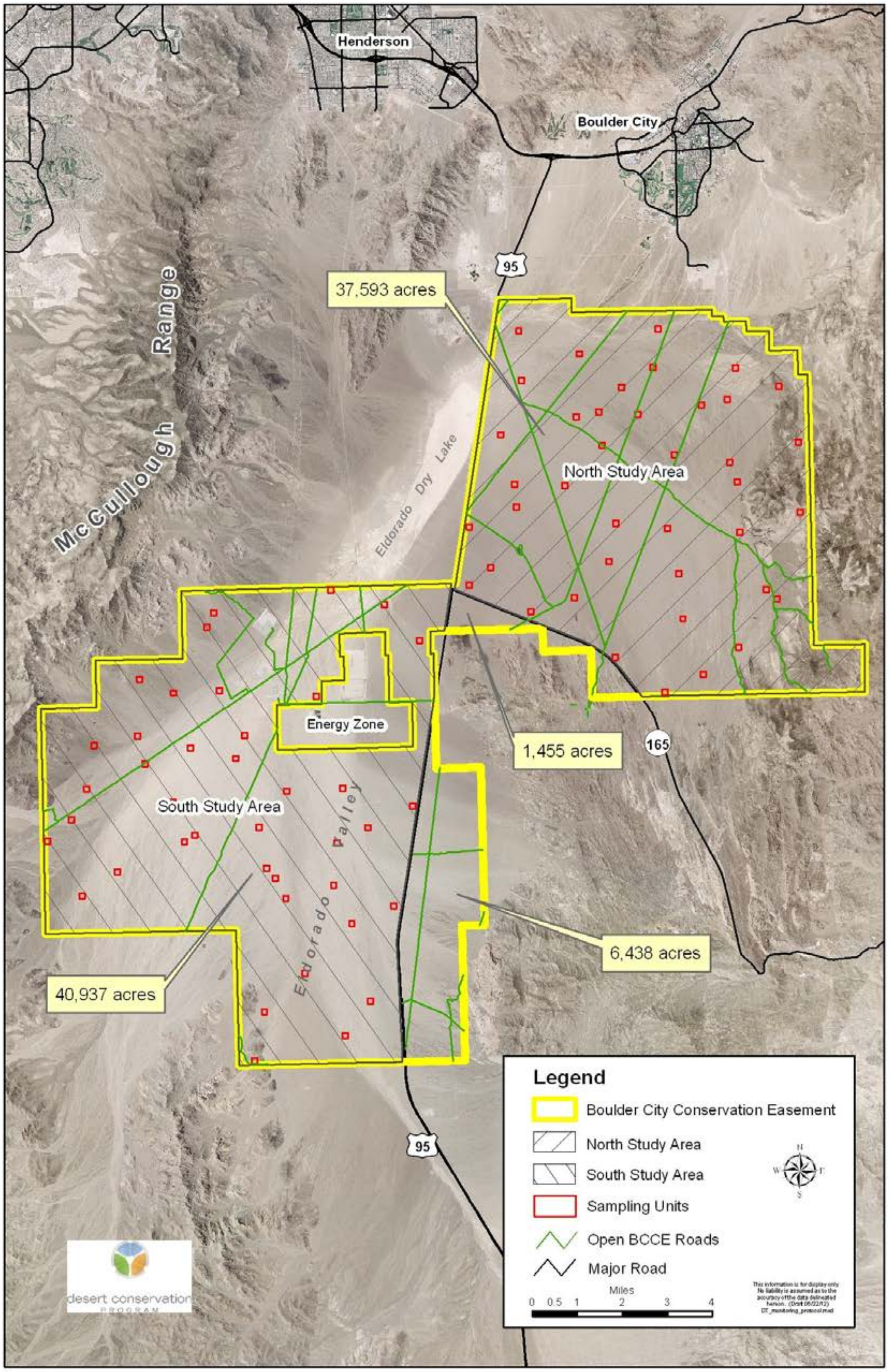


Figure 2. GRTS Placement of Sample Units in the Study Areas

In addition, the presence of active tortoise burrows will be used to increase detectability of tortoises that may be present yet below ground during a survey. To further increase the probability that tortoises present in a sample unit will be detected, sample units will be sampled multiple times annually during a two-month sampling season (MacKenzie personal communication 2011, Zylstra et al., 2010; MacKenzie & Royle, 2005). Similarly, covariate indicators for tortoises will be sampled annually. Using Table 3 in MacKenzie & Royle (2005), to determine the maximum number of tortoise surveys to conduct each year for each sample unit with a detection probability of approximately 0.8, three surveys were selected. After each year of the pilot test, the sample design will be evaluated and refinements to the number of sample units or number of surveys per year will be recommended. The project will be continued for at least two or three years to assess the ability of the data to detect change of spatial extent over time (statistical power).

6. How many sample units will be sampled?

While greater numbers of sampling units provide more statistical insight into tortoise occupancy/use rate, based upon the above information and assumptions, the following sample size per stratum is proposed as an efficient starting point for the first year of the pilot test of this monitoring protocol:

- 40 sample units in the northeast section with 20 secondary locations identified.
- 40 sample units in the southwest section with 20 secondary locations identified.

The number of sample units surveyed in each section may increase or decrease based upon pilot test results.

6.0 SAMPLING METHOD

The sampling method will be implemented with the guidelines described below.

Prior to the start of the field season, the sampling unit corners will be marked for easy identification during the field season. Each survey crew will use a GPS unit with accuracy of one meter or less which will enable easy location of the sampling unit. Each sampling unit will be four hectares (approximately 10 acres) and is estimated to take between two to three hours to survey. Temperature, wind speed and cloud cover measurements will be taken at the beginning and end of sampling each unit. The sampling procedures include:

- Surveyors shall be at the corner of their first sample unit ready to start by approximately one half hour after sunrise. Either two or three plots will be sampled each day, dependent on the time it takes to sample the plots and move between plots. The starting time for each plot will be recorded. All surveys must be completed by approximately 1400.
- Two surveyors will walk 10-meter belt transects, back and forth across the unit, beginning at the nearest corner of the sample unit. While walking transects, the first surveyor is responsible for tracking their movements within the unit to ensure they remain within the boundaries of the given transect. During the survey, surveyors are expected to deviate from the belt transect to more effectively inspect all bushes, shrubs, suspected burrow, etc., to achieve 100% coverage of the sample unit. Surveyors can confer to determine occupancy and record data as appropriate, then surveyors should resume the belt transect.

- Surveyors will travel between sampling units (spread 10 meters apart) on the most direct route possible. All adult tortoises, active burrows and carcasses located while moving between sampling units will be assessed and spatially located.
- Sample units will be surveyed three times during the season (as specified from March 1 to May 31). Each sample unit will be sampled in a different daily order over the course of the field season as directed by the DCP. Two or three sample units will be assigned to each team so that approximately six sample units are completed daily. Additional plots may be completed within a day if time and environmental conditions allow. It is estimated that the field season will be approximately 40 days.

As mentioned earlier, detectability issues for tortoises are as significant for occupancy sampling as for methods that estimate density and total abundance. Several details of the occupancy sampling design will increase the detectability of tortoises above ground. These include:

- Multiple visits to each sample unit during the annual sampling period, estimated to be between March 15 and May 15, including distributing the multiple visits at different times between 30 minutes after sunrise (estimated approximately 0600) and 1400.
- Using two surveyors to walk 10-meter wide transects within the sample unit and having them search thoroughly under shrubs and among rocks for tortoises and burrows. Each unit will be sampled with a 100% search. Since this design is not using a line distance sampling approach, surveyors do not have to walk a center line within the transect.

7.0 DATA MANAGEMENT

Guidelines for data management are provided in Appendix A – Data Management Plan. These guidelines address the following topics:

- Roles and responsibilities of the individuals involved in data collection and management.
- Guidelines for efficient and accurate data collection, including the design of the data dictionary and data sheets, standard procedures for the collection of data and the use of instrumentation, and training to insure accurate data collection and processing.
- Procedures for data verification (verifying that all the data was collected) and validation (assessing that the quality of the data entered meets minimum standards).
- Guidelines for data management, including entering and downloading data from the field, updating files, version control, and data storage and archiving.
- Approaches to data review and adaptive data collection and management.

8.0 DATA ANALYSIS

The outcome of the annual occupancy surveys will be recorded as a sequence of 1's and 0's to indicate whether evidence of tortoise presence was detected during each survey of a sample unit. For example, if tortoises were detected in the first and third surveys of a sample unit that was surveyed three times in a year it would be recorded as 101, and a sample unit that was surveyed three times with no detection of tortoises would be recorded as 000. Occupancy data resulting from surveys of adult tortoises and active burrows will be analyzed using methods detailed in Mac-

Kenzie et al. (2006). A single-season occupancy model will be used to analyze the data from the first year, while a multiple-season model will be used once surveying has been completed for multiple years.

The single-season model (MacKenzie et al., 2002; 2006) enables the presence or absence of tortoises at each sample unit to be related to characteristics of that sample unit (e.g., habitat type, management actions), while accounting for potential false absences by explicitly incorporating detection probability. This is accomplished by acknowledging that when tortoises are not detected in a sample unit it may be the result of either tortoises being present but never observed at the sample unit, or tortoises were really absent from the sample unit. While it is not possible to definitively determine whether tortoises are truly present or absent from a sample unit when they are not detected there, it is possible to probabilistically account for both options (MacKenzie et al., 2002). For example, if ψ_i is the probability sample unit *i* is occupied by tortoise and p_{ij} is the probability of detection in the *j*th survey of sample unit *i*, given the unit is occupied, the probability of tortoises being present but undetected in *k* surveys of sample unit *i* is,

$$\psi_i \prod_{j=1}^{k} \left(1 - p_{ij}\right),$$

and the probability of tortoises being absent is,

$$1 - \psi_i .$$

As it is not possible to differentiate between these two options based solely upon the occupancy data, the overall probability of not detecting tortoises at a sample unit is a combination of these two options (presuming three surveys are conducted):

$$\Pr\left(h_i = 000\right) = \psi_i \prod_{j=1}^{3} \left(1 - p_{ij}\right) + \left(1 - \psi_i\right),$$

with the '$+$' indicating that either option is possible. At sample units where tortoises are detected at least once, that is considered definitive of confirming tortoise presence therefore there is only one option for any sequence of 1's and 0's (with at least one 1). For example, the overall probability of observing the sequence 101 could be expressed as:

$$\Pr\left(h_i = 101\right) = \psi_i p_{i1} \left(1 - p_{i2}\right) p_{i3} .$$

The resulting set of expressions, or probability statements for all surveyed sample units could be used to estimate occupancy and detection probabilities (or the effect of associated covariates) using either maximum likelihood or Bayesian methods of inference. Maximum likelihood-based approaches have been implemented in Program PRESENCE 3.1 (Hines, 2006) while Bayesian approaches can be implemented in software such as OpenBUGS. Currently it is planned that data will be analyzed using Program PRESENCE 3.1.

Relationships between occupancy and/or detection with potential habitat covariates will be explored by utilizing the logit-link function which transforms covariates that may be on the plus or minus infinity scale on to the 0-1 scale required for probabilities. This amounts to performing simultaneous logistic regression analyses on both occupancy and detection and as a result the estimated regression coefficients are corrected for the effects of imperfect detection, unlike if the raw data was analyzed using simple logistic regression. Note that site-specific estimates of occupancy and detection are only possible if covariates are included in the analysis.

The multiple season model (MacKenzie et al., 2003; 2006) will be used to analyze the tortoise occupancy data once two or more years of data has been collected. Essentially, the single season model is applied to the first year's data to determine initial occupancy, and subsequently, changes in occupancy at each sample unit is modeled in terms of local colonization (unoccupied sample unit becomes occupied by tortoises) and 'extinction' (occupied sample unit becomes unoccupied). As above, the effect of covariates on colonization and extinction probabilities can be incorporated into the analysis to investigate what factors (e.g., management practices, habitat alteration, or other sample unit characteristics) may be impacting the population. The level of occupancy in each year can also be determined from first year occupancy (ψ_1) and colonization (γ_t) and extinction (ε_t) probabilities using the following recursive equation:

$$\psi_{t+1} = \psi_t \times (1 - \varepsilon_t) + (1 - \psi_t) \times \gamma_t$$

All occupancy assessment and correlation analyses will be performed by an experienced statistician. An anecdotal assessment of the demographics of each sample stratum (study area) will be performed by DCP staff by looking at the categories of tortoise size and gender detected each year and at the numbers and identities of tagged versus previously untagged tortoises.

To assess the efficiency and statistical power of occupancy sampling, both will be assessed on an annual basis after year 2. Efficiency will be assessed by maintaining records on all costs associated with the project, including data collection, processing and analysis, and oversight of the project.

Statistical power will be assessed using an appropriate equation for testing proportions selected by an experienced statistician. Statistical power is the probability of detecting a change given that a change has truly occurred. Its value is dependent on the amount of change one is attempting to detect, the false-change error rate (alpha, or Type 1 error), the sample size, and the variance of the indicator. The goals of this project are to detect a 20% change in occurrence over a 5- to 10-year time period with a statistical power of 0.8 and an alpha of 0.1. The power of 0.8 accepts the probability of saying a change has taken place when it has 8 out of 10 times. The alpha of 0.1 accepts the probability of saying a change has taken place (perhaps resulting in some management action) when it has not. The initial sample size is 40 plots per strata but sample size increases with multiple years of sampling. The variance of the indicator will be provided by two or more years of data, allowing the assessment of variability over a single sampling season as well as over multiple years.

9.0 MANAGEMENT RESPONSE

Data from the monitoring program will be used by the DCP to assess the effectiveness of the monitoring to achieve the monitoring objectives and to evaluate and recommend potential management responses. Management responses include adjustments to current management practices within the BCCE and recommendations for new management actions and/or more focused assessment of detected patterns. New management responses are also categorized into two groups – those that can be implemented immediately with existing budgets and those that would require additional budget approvals by the Permittees and USFWS.

9.1 Objectives

The three monitoring objectives will be addressed in the following manner by the DCP functional roles described below:

- Assess the status and change over time in occupancy/use of tortoises within the BCCE. The indicators of tortoise occupancy include the presence of live tortoises (with information on size and identity of unique tortoises) and presence of active burrows. The goals of this project are to detect a 20% change in occurrence over a 5 to 10 year time period, with a statistical power of .8 and an alpha of .1. The power of .8 accepts the probability of saying a change has taken place when it has 8 out of 10 times. The alpha of .1 accepts the probability of saying a change has taken place (perhaps resulting in some management action) when it has not. The initial sample size is 40 plots per strata. The variance of the indicator will be provided by two or more years of data, allowing the assessment of variability over a single sampling season as well as over multiple years.
  - Upon analysis of data each year, results of occupancy monitoring and covariates will be compiled in a written monitoring report by the DCP Adaptive Management Program and provided to BCCE management staff. If a decline of 20% or greater is detected between any two sampling years for any monitoring stratum within the BCCE, the Plan Administrator will be notified and potential immediate management responses will be evaluated by the Plan Administrator and BCCE management staff.
  - The Adaptive Management Report will include a summary of the monitoring results and trends or patterns in the data. This report will be produced by the Adaptive Management Program and shared with Permittees, USFWS, and other stakeholders.
- Correlate changes in and patterns of tortoise occupancy with habitat (cover of vegetation, herbaceous vegetation), habitat alteration (roads, off-road vehicle disturbance), and management practices (closing roads, vegetation restoration)
  - The BCCE management staff and the Adaptive Management Coordinator will receive reports from the DCP Project Manager of any unusual encounters or threats detected by field teams within 48 hours of the detection. The BCCE management staff and Adaptive Management Program staff will recommend a course of action to the Plan Administrator within one week of detection.
  - Adaptive Management Program staff and BCCE management staff will meet and review the analyses of occupancy and habitat indicators on an annual basis. This meeting will include recommendations for long-term adjustments to management for each BCCE monitoring stratum.
- Assess the demographic condition of the population from tortoise size classes.
  - The annual written monitoring report will include a summary of any evidence for recruitment within each section of the BCCE.
  - A compilation of the above information will also be included in each Adaptive Management Report.

In addition, the following responses will be considered if the frequency of occupancy decreased by 25% or greater across a monitoring stratum:

- If one or more of the habitat or habitat alteration indicators were correlated with the change in tortoise occupancy, management actions to either decrease a habitat threat or increase habitat value will be strongly considered for implementation.
- If the decrease was only correlated with the presence of a habitat management practice, immediate investigation of implementation practices and potential negative impacts of the management practice will begin, and ceasing the management practice will be strongly considered.
- If no habitat or habitat alteration indicators were correlated with the decrease in tortoise occupancy, available regional data on tortoise density or other habitat indicators will be reviewed and discussions with the USFWS will be initiated to understand whether larger-scale DWMA trends may be affecting localized management and to determine an appropriate course of study and/or action within that section of the BCCE.

9.2 Types and Examples of Potential DCP Management Responses

Types of responses that could be taken by DCP management include:

- Immediate responses – those that can likely be accomplished within existing budgets and authorities:
  - Increase law enforcement patrols within a local area by decreasing patrols in some other area(s).
  - Increase frequency of signage inspections and repair within a local area.
  - Post new or additional signs within a local area.
  - Remove trash/debris in a local area.
  - Conduct localized weed treatments.
  - Increase priority of maintenance and inspection of human exclusion barriers or tortoise exclusion fencing in a localized area.
  - Assign a volunteer monitor to a local area or request current volunteer monitor conduct additional visits.
  - Increase outreach for a particular reserve unit to better educate users/neighbors.
- Long-term Responses – those that require approval of Plan Administrator, Permittees, landowner, and/or USFWS or may require additional budget approvals:
  - Close, relocate, or open a road.
  - Remove an allowable use from a local area, avoid issuing use permits within a local area, allow a new use or increase concentration of an existing use.
  - Conduct a restoration/rehabilitation project.
  - Increase overall law enforcement within the easement.
  - Install, upgrade, or replace barriers or tortoise exclusion fencing.
  - Conduct outreach to key neighbors or user groups to request voluntary actions (or avoidances) on their part to benefit the easement.
  - Develop new outreach to achieve focused goal.

- Update easement management documents or legal agreements.

9.3 Data Communication

The communication of monitoring data is the essential link to improving decision making and conservation. This section summarizes the answers to these questions:

- Who are the appropriate decision makers that need to know the results of monitoring? How will the data be presented to them?
- How and to whom will the monitoring results be communicated to improve the work of others?
- How and to whom will the monitoring results be communicated to facilitate peer review and the improvement of the work?

Decision makers impacted by the results of this pilot study include, but are not limited to, the DCP, MSHCP Permittees, USFWS, and Nevada Division of Wildlife (NDOW). The results of the pilot study will be presented in a written final technical report that will receive peer review as described below. Once the outcomes of the peer review are addressed in the final report, it will be shared with the above key decision makers. Other local land managers may also benefit from the outcomes of this pilot study and the technical report will be shared with them. This pilot study report may also be formatted for submittal to a peer reviewed journal for publication. Both the technical report and publication will be part of the public records of the DCP and would be available for inspection by anyone who requests them. In addition, the report will be posted on the DCP public website and the DCP may seek opportunities to deposit the technical report and publication in open access repositories such as the Nevada State Library and local university repositories.

After a maximum of three seasons of the pilot test of the protocol and data analysis, a report on the results of the pilot study will be prepared and the report will receive peer review. Decisions about the value of this sampling design and applicability of this sampling method to other areas and applications should only be made once the pilot phase is complete and in conjunction with the U.S. Fish and Wildlife Services' Desert Tortoise Recovery Office.

9.4 Data Archiving

Data collected by the pilot study and digital copies of all field sheets will be stored as records of the DCP within standard County record management systems. Academic archives, such as University of Nevada, Las Vegas, will also be assessed to permanently house copies of the data.

10.0 PROTOCOL LOGISTICS

This section summarizes the logistical issues related to implementing the Mojave Desert tortoise monitoring protocol.

10.1 Staffing

One authorized biologist is required to be on site during all monitoring activities. All field survey crew members will be permitted to handle tortoises. The consultant project manager will report to the DCP project manager or other staff as assigned.

10.2 Equipment

Each field survey team will have a GPS (Trimble XT) receiver with a data dictionary, paper data sheets, and a field kit containing identification (ID) tags, calipers, mirrors, handheld radios (has to be compatible so that all teams are able to communicate with each other and so that DCP staff can also communicate out in the field), thermometers (with 2% or ± 4°F/2°C), kestrels, clipboards, pens, flagging, epoxy, gloves, disinfectant, Q-tips, batteries, camera, and tooth-picks.

The data sheets and data dictionary will be created by the DCP staff and provided consultant for field survey crews. Data dictionary files will be provided and the contractor must upload the data dictionary to each GPS Trimble XT receiver.

10.3 Training

A training program will be developed by DCP staff to include:

- Background on occupancy sampling.
- Outline the monitoring objectives.
- Describe roles and responsibilities of the field survey crew members.
- Introduce the participants to the study area.
- Describe safety and access issues for the study area.
- Describe the sampling design.
- Describe and demonstrate the standardized procedures and instrumentation that will be used to collect the data.
- Describe data verification and validation and the field survey crew roles in each.
- Provide a field test of the survey crew members completing a survey plot, data verification, and data upload steps.
- Provide feedback and suggestions to the field collection and data verification or upload protocols.

Training will be done up to the week before the initiation of data collection and be of an appropriate length to adequately cover the material. It is anticipated that training will take two-three days to complete. Field data collection crews will receive a training manual and a copy of the protocol. Prior to release to conduct the monitoring, all field crews must successfully complete a test sample plot while adhering to the protocol and this data management guide, including successful download, verification, and delivery of the plot data. The DCP project management team members will also complete the data validation methods described in this document.

10.4 Necessary Permits and Authorizations

All necessary permits and authorizations will be obtained prior to the start of the pilot study and monitoring program. Permits are required from the USFWS and NDOW. Authorization will be required from the parties to the BCCE agreement (Clark County, Boulder City and USFWS). Sample units that overlap with any federal inholdings within the BCCE area may require permissions from those landowners.

10.4.1 USFWS Permits and Authorization

As administrator for the MSHCP, Clark County currently holds an incidental take permit (ITP) pursuant to section 10(a)(1)(B) of the Endangered Species Act (USFWS, 2000). Per Section 10 of the Act, Clark County is also required to obtain a letter from the USFWS authorizing any handling of Mojave Desert tortoises to implement the protective measures stated in the MSHCP. The USFWS has provided authorization to Clark County to oversee the monitoring project. The field work must be conducted under the direction of an authorized biologist approved by the USFWS. Submission of the General Desert Tortoise Qualifications Statement form requires a minimum of 30 days for review and approval by the USFWS. If the current DCP staff does not qualify as an authorized biologist, an authorized biologist will be contracted for the project by the DCP and be responsible for all tortoise related field activities.

At least one authorized biologist and three desert tortoise occupancy assistants will be required to implement the monitoring protocol.

10.4.2 NDOW Permits

The NDOW requires a scientific collection permit for handling tortoises. Approval letters from the USFWS for each individual handler must be submitted along with the permit application to NDOW. Once the completed permit application has been received, NDOW requires four to six weeks for the permit to be reviewed and issued. The permit may be amended to add authorized staff during the life of the permit. The permit can be obtained for either a one year ($50) or two-year duration ($100).

10.4.3 Landowner Authorizations

The DCP staff will make a formal request for permission to conduct the study from the County as the holder of the conservation easement, the City of Boulder City as the landowner of the BCCE area and from the USFWS. Written approval must be received from the County, City and USFWS. Additionally, field monitoring activities will be coordinated with the entity that provides law enforcement for the BCCE.

If any sample units are on lands that were reserved to the U.S. during the 1995 transfer of land to the City of Boulder City, permission must also be sought from the appropriate federal agency. The DCP staff will review sample unit locations and initiate any request(s) for permission from the federal agency(ies).

11.0 ASSESSING THE VALUE OF OCCUPANCY SAMPLING AND NEXT STEPS

Clark County is exploring the use of occupancy sampling to detect the status and change over time of the Mojave Desert tortoise in the BCCE, with the focus on obtaining data for land managers at small spatial and short temporal scales. Occupancy sampling is a statistical analysis of changes in the proportion of habitat occupied or used by the target species. It assumes that the status and trends in a population can be assessed by changes in the proportion of the sample units in which the target species has been observed. Occupancy sampling does not provide data on density or abundance.

Three objectives were outlined for the pilot test of the monitoring protocol described in this document. Each objective is repeated below with a brief discussion of how each will be assessed.

- *Analyze the status and trend (change) in occupancy/use of Mojave Desert tortoise within the BCCE using the indicators of live tortoises and active burrows.*

The peer review of this protocol will pay particular attention to the approach and sampling design outlined in this document, assessing whether the protocol will provide the guidance needed to collect good occupancy data. If this project is tested on the ground over a two-year period, the design and the statistical analysis will also be peer reviewed to assess whether the occupancy sampling provides the information needed for managers at the scale of the BCCE.

- *Correlate the pattern and changes of tortoise occupancy/use with habitat (e.g., cover of vegetation, herbaceous vegetation), habitat alteration (e.g., roads, off-road vehicle disturbance), and management practices (e.g., closing roads, vegetation restoration).*

The ability to test for potential covariates will be assessed after one or two seasons of monitoring. The vegetation monitoring, to be described in another protocol, will be designed, reviewed, implemented, and assessed as a separate but related project.

- *Assess the demographic condition of the population from measured tortoise size classes.*

The demographic condition of the population will be summarized and compared to the local USFWS data.

After each year of the pilot test and at the conclusion of the pilot test, a draft report with recommendation(s) to reject, refine, or adopt the monitoring protocol will be sent for peer review. The pilot test final report and potential recommendations within the report will be revised to address concerns raised during peer review and a final report will be provided to the MSHCP Plan Administrator for consideration in future budgets.

12.0 ACKNOWLEDGEMENTS

This monitoring protocol was prepared for the Clark County Desert Conservation Program with contractual assistance from Enduring Conservation Outcomes, LLC as the Science Advisor to the program. Robert Sutter, Mary B. Peters, and Darryl I. MacKenzie served as Science Advisor in this capacity. The DCP staff instrumental in preparing the protocol includes Elizabeth Bickmore, Sara VanLinn, Sue Wainscott, and Lee Bice. This protocol benefited from discussions with Erin Zylstra, Robert Steidl, Roy Averill-Murray, and Linda Allison, peer review by Robert Unnasch and two anonymous reviewers coordinated by the U.S. Geological Survey. Their input greatly improved this protocol. Carolyn Ronning, Polly Conrad and Cris Tomlinson are thanked for their comments on an early draft of the protocol. Any errors and omissions are the responsibility of the Science Advisor.

13.0 REFERENCES

Anderson, D.R. & Burnham, K.P. 1996. A Monitoring Program for the Desert Tortoise. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, CO. 15pp.

Berry, K.H. & Turner, F.B. 1986. Spring Activities and Habits of Juvenile Desert Tortoises, *Gopherus agassizii*, in California. Copeia 1986:1010–1012.

Clark County. 2000. Final Clark County Multiple Species Habitat Conservation Plan and Environmental Impact Statement for Issuance of a Permit to Allow Incidental Take of 79 Species in Clark County, Nevada. September 2000.

Clark County. 2009. Desert Tortoise (*Gopherus agassizii*) Monitoring 2009 Final Project Report. Project #2007-USFWS-785.

Desert Tortoise Council. 1999. Guidelines for Handling Desert Tortoises during Construction Projects. Edward L. LaRue, Jr., editor. Wrightwood, California.

Federal Register. 2000. Final Addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process. U.S Fish and Wildlife and National Oceanic and Atmospheric Administration. June 1, 2000. Pages 35242-35257.

Hines, J.E. 2006. PRESENCE2—Software to Estimate Patch Occupancy and Related Parameters. U.S. Geological Survey, Patuxent Wildlife Research Center. http://www.mbr-pwrc.usgs.gov/software/presence.html.

Luckenbach R.A. 1982. Ecology and Management of the Desert Tortoise (*Gopherus agassizii*) in California. pp. 1-37. In: R. B. Bury (ed.). North American Tortoises: Conservation and Ecology. USDI, Fish and Wildlife Service. Wildlife Resource Department. 12.

MacKenzie, D.I., Nichols, J.D., Lachman, G.B., Droege, S., Royle, J.A., & Langtimm, C.A. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83: 2248-2255.

MacKenzie, D.I., Nichols, J.D., Hines, J.E., Knutson, M.G., & Franklin, A.D. 2003. Estimating site occupancy, colonization and local extinction when detection probabilities are less than one. Ecology 84: 2200-2207.

MacKenzie, D.I., Royle, J.A., Brown, J.A., & Nichols, J.D. 2004. Occupancy Estimation and Modeling for Rare and Elusive Populations. Pages 149-172 *in* Sampling Rare or Elusive Species, edited by W.L. Thompson.

MacKenzie, D.I. & Royle, J.A. 2005. Designing Occupancy Studies: General Advice and Allocating Survey Effort. Journal of Applied Ecology 42:1105–1114.

MacKenzie, D.I., Nichols, J.D., Sutton, N., Kawanishi, K., & Bailey, L.L. 2005. Improving Inferences in Population Studies of Rare Species that are Detected Imperfectly. Ecology 86:1101–1113.

MacKenzie, D.I., Nichols, J.D., Royle, J.A., Pollock, K.H., Bailey, L.L., & Hines, J.E. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Academic Press, San Diego, California, USA.

Murphy, R.W., Berry, K.H., Edwards, T., Leviton, A.E., Lathrop, A., & Riedle, J.D. 2011. The Dazed and Confused Identity of Agassiz's Land Tortoise, *Gopherus agassizii* (Testudines, Testudinidae) with the Description of a New Species, and its Consequences for Conservation. ZooKeys 113:39-71.

Nussear, K.E. & Tracy, C.R. 2007. Can Modeling Improve Estimation of Desert Tortoise Population Densities? Ecological Applications 17:579–586.

O'Farrell, T.P. 2009. Management Action Plan for the Boulder City Conservation Easement. Report to the Clark County, Nevada, Desert Conservation Program, Department of Air Quality and Environmental Management.

Stevens, D.L., Jr., & Olsen, A.R. 2004. Spatially-balanced Sampling of Natural Resources. Journal of the American Statistical Association, 99, 262-278.

Tracy, C.R., Averill-Murray, R., Boarman, W., Delehanty, D., Heaton, J., McCoy, E., Morafka, D., Nussear, K., Hagerty, B., & Medica, P. 2004. Desert Tortoise Recovery Plan Assessment. U. S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 1990. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Mojave Population of the Desert Tortoise. Federal Register 55:12178–12191.

__________. 1994. Desert Tortoise (Mojave Population) Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 73 pages plus appendices.

__________. 2000. Intra-Service Biological Opinion and Conference Opinion on Issuance of an Incidental Take Permit to Clark County, Nevada for a Multiple Species Habitat Conservation Plan. File No. 1-5-00-FW-575. November 19, 2000.

__________. 2006. Biological Opinion for the Proposed South Kyle Canyon Master Plan Project in Clark County, Nevada. File No. 1-5-06-F-465. March 8, 2006

__________. 2009a. Desert Tortoise Population Monitoring Handbook. Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. Online at: http://www.fws.gov/nevada/desert_tortoise/dt_reports.html .

__________. 2009b. Range-wide Monitoring of the Mojave Population of the Desert Tortoise: 2007 Annual Report. Report by the Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. Online at: www.fws.gov/nevada/desert_tortoise/reports.

__________. 2009c. Desert Tortoise (Mojave Population) Field Manual: (*Gopherus agassizii*). U.S. Fish and Wildlife Service, Region 8, Sacramento, California. Online at: http://www.fws.gov/ventura/species_information/protocols_guidelines/.

__________. 2011. Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*). Pacific Southwest Region, Sacramento, California. 222 pp.

Zlystra, E.R., Steidl, R.J., & Swann, D.E. 2010. Evaluating Survey Methods for Monitoring a Rare Vertebrate, the Sonoran Desert Tortoise. Journal of Wildlife Management 74(6):1311–1318.

APPENDIX A

Data Management Plan

MONITORING PROTOCOL

TESTING THE USE OF OCCUPANCY SAMPLING TO DETECT STATUS AND TRENDS OF MOJAVE DESERT TORTOISE (*GOPHERUS AGASSIZII*) IN THE BOULDER CITY CONSERVATION EASEMENT

APPENDIX A
DATA MANAGEMENT PLAN

October, 2011

Revised 11/30/12

Revised 3/7/13

Prepared for:

desert conservation PROGRAM

Prepared by:

Enduring Conservation Outcomes

SCIENCE ADVISOR
2009-ECO-801A

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

BCCE	Boulder City Conservation Easement
C	Celsius
DCP	Desert Conservation Program
dpi	dots per inch
F	Fahrenheit
ftp	file transfer protocol
GPS	global positioning system
ISO	International Standards Organization
MSHCP	Multiple Species Habitat Conservation Plan
NAD	North American Datum
NAP	North American Protocol

ON	observation number
PN	plot number
QA/QC	quality assurance / quality control
UTM	Universal Transverse Mercator

1.0 INTRODUCTION

The Mojave Desert tortoise (*Gopherus agassizii*) is a priority species for conservation in Clark County as set forth in the Multiple Species Habitat Conservation Plan (MSHCP: Clark County, 2000). The Desert Conservation Program (DCP) plans to conduct a pilot study to test occupancy of the Boulder City Conservation Easement (BCCE) by the Mojave Desert tortoise. The results of the study will guide restoration and conservation decisions in managing the BCCE.

With the assistance of the Science Advisor, the DCP prepared a monitoring protocol for the pilot study. The monitoring protocol details how the pilot study will test the use of occupancy sampling to detect tortoise habitat use status and changes over time (trend) in the BCCE. Occupancy sampling is defined as determining the proportion of habitat within an area that contains indicators of a targeted species. For the pilot study, tortoise indicators (i.e., occupancy) will be determined by observation of live tortoises and active tortoise burrows.

An essential component of a successful monitoring project is the quality of the data. Quality data is required for results that meet the objectives of the project. Errors, however, are common in data collection and many projects are compromised by incomplete, poor, or missing data. The information presented herein supplements the monitoring protocol by further describing the data collection process and management of that data. To ensure the highest quality data for the pilot study, this appendix provides guidelines on the following topics:

- Roles and responsibilities of the individuals involved in data collection and management.
- Guidelines for efficient and accurate data collection, including the design of the data dictionary and data sheets, standard procedures for the collection of data and the use of instrumentation, and training to ensure accurate data collection and processing.
- Procedures for data verification (i.e., verifying that all data was collected) and validation (i.e., assessing the quality of the data entered meets minimum standards).
- Guidelines for data management, including entering and downloading data from the field, updating files, version control, and data storage and archiving.
- Approaches to data review and adaptive data collection and management.

The guidelines presented in this document are supplemented by specific metrics established for the data collection. The metrics/measurements include descriptors and definitions, standard operating procedures, and how each metric will be verified and validated. The metrics are presented by the separate field data sheets in the tables in Attachment 1.

This data management plan will be reviewed and followed by all project staff involved in data collection or management for the pilot study.

2.0 ROLES AND RESPONSIBILITIES

There will be two distinct groups of individuals involved in data collection and data management for the pilot study – the Project Management Team and the Field Data Collection Team. It will be important that each member of both teams understand their role and specific responsibilities in ensuring data quality.

2.1 Project Management Team

The Project Management Team is within the DCP and includes those individuals involved in designing, directing, and reporting on the pilot study. This team will:

- Communicate the importance of quality data to the field survey/data collection crews.
- Work with Science Advisor to refine the monitoring protocol.
- Ensure compliance of field survey crews with monitoring protocols and data verification.
- Perform data validation.
- Work with field survey crews to identify sources of errors.
- Lead efforts to reduce sources of errors.
- Provide quality data for analysis.
- Ensure proper transfer of interim data and archival of final data.

2.2 Field Data Collection Team

The Field Data Collection Team includes the contracted individuals (Authorized Biologists and Occupancy Assistants) who will be collecting the data and providing it to the Project Management Team. This team will:

- Participate in the initial and ongoing training for the project.
- Follow the established protocols for data collection, entry and verification.
- Download and verify the data collected each day.
- Provide each day's data to the Project Management Team.
- Work with the Project Management Team members to identify sources of errors and assist in developing solutions to reduce sources of error.

3.0 DATA COLLECTION

The section explains the different parts of the data collection process.

3.1 Data Dictionary and Field Data Sheets

Data templates for electronic data collection and field data sheets have been developed to record information on the survey plots, live tortoises, tortoise carcasses, and active burrows. The observation and location information on each data sheet is presented in the same format. The order of data entry parallels the logical approach to collecting data in the field, from observation at a distance to data collected up close for a tortoise or a burrow. Definitions of all terms are provided in a metrics table for each data sheet. This information will be provided in the field survey crew training materials. A data dictionary that defines the database fields and domains used for field data collection and storage has been developed. The data dictionary will be loaded onto the global positioning system (GPS) units and used for data collection.

The field data sheets that will be used for the pilot study include:

- Start of Plot Description Data Sheet
- End of Plot Description Data Sheet
- Live Tortoise Data Sheet
- Burrow Observation Data Sheet
- Carcass Data Sheet
- End of Day Data Sheet

3.2 Spatial Data

Spatial data and attribute data will be recorded both on paper field data sheets and on a Trimble XT model GPS receiver with data logging capabilities. This GPS receiver has an accuracy of plus or minus 1 meter in the field and plus or minus 50 centimeters post processing (differential correction in the lab). Data will be recorded in UTM 11 NAD83 projection and datum. The spatial coordinates recorded in the field will be entered on each paper field data sheet at the time of data collection. Digitally stored spatial coordinates will be differentially corrected by field survey crews at the end of each field day.

3.3 Photographic Data

Photographs will be taken of each active burrow encountered within plots or as incidental data while moving between plots. The purpose of the photographs is to provide documentation of the characteristics used to classify a burrow as active.

Photographs will be taken using a digital camera that has a minimum of five megapixel capacity. Each field survey crew's camera clock will be synchronized each morning with the date and time of the crew's GPS receiver.

Photographs of each burrow will be taken to (1) maximize the assessment of burrow characteristics (width and height of burrow and burrow opening and apron), and (2) assess the location of the burrow in relationship with soils, topography, and vegetation.

Optional photographs may be taken of tortoises, carcasses or plots.

3.4 Training on Data Collection and Data Quality

Training individuals involved in data collection and data assessment is also essential for data quality. The training will provide:

- Background on occupancy sampling.
- Outline the monitoring objectives.
- Describe roles and responsibilities of the field survey crew members.
- Introduce the survey crews to the study areas.
- Describe safety and access issues for the study areas.
- Describe the sampling design.
- Describe and demonstrate the standardized procedures and instrumentation that will be used to collect the data.
- Describe data verification and validation and the field survey crew roles in each.
- Provide a field test of the survey crew members completing a survey plot, data verification, and data upload steps.
- Provide feedback and suggestions for the field collection and data verification or upload protocols.

Training will be completed up to the week before the initiation of data collection and be of an appropriate length to adequately cover the material. It is anticipated that training will take two- three days to complete. Field data collection crews will receive a training manual and a copy of the monitoring protocol and appendices. Prior to releasing the field data collection crew to conduct the monitoring, all field crews must successfully complete a test sample plot while adhering to the monitoring protocol and this data management guide, including successful download, verification, and delivery of the plot data. The DCP Project Management Team members will also complete the data validation methods described in this document.

4.0 DATA COMPLETENESS AND QUALITY

The overall system of management activities designed to assure the quality of the data generated by a project or program is commonly known as QA/QC, or Quality Assessment and Quality Control. For the purpose of this data management plan, QA/QC is being described by its two major components, data verification and data validation.

4.1 Data Verification

Data verification assesses the entry of data into each field in the database, making sure that all required data have been collected and recorded. This will be accomplished by reviewing a spreadsheet of the data looking for blank fields. This verification process will occur within a time frame after data collection that allows for accessing the recollection of the data collectors (i.e., Field Data Collection Team) and, if needed, the potential recollection of data.

The data dictionary and GPS receivers will automate some data verification steps by forcing users to complete an entry in certain fields before allowing the user to enter other information. In addition, certain fields in the data dictionary will have maximum or minimum values to limit data entry errors.

The Field Data Collection Team will review the data to insure that all data has been collected. This will occur at the completion of each survey plot, after collection of all incidental observations walking among the plots, and at the end of each field day. At the end of each field day the team will compare paper field data sheets with the data on the GPS receiver, checking plot numbers, observation numbers, and other data while field collection team memories are fresh. This includes making notations on paper field data sheets of any corrections made. Any error corrections will be noted on the applicable paper field data sheet.

The Project Management Team will conduct separate data verification after receipt of each day's data from the Field Data Collection Team.

4.2 Data Validation

Data validation assesses the quality of each data entry, checking its numeric range and the logic of the entry. For the pilot study, this includes the range of reasonable values for air temperature, presence of consecutive tag numbers, or comparison between the expected and entered GPS coordinates. Data validation requires a reviewer that understands each of the metrics and their range of values. The validation method to be used for each data field is listed in the table of metrics for each field data sheet. The Project Management Team will complete the data validation process.

The data dictionary and GPS receivers will automate some data validation steps. Three automated processes will be used to check data on spreadsheets.

- Range checking highlights values that are outside of the expected range of the value. Examples include air temperatures too low (less than 60 degrees F (15.6 degrees C)) or too high (over 120 degrees F (48.9 degrees C). The use of this validation method requires that the appropriate ranges are known in advance. The range for any value is iterative as data is reviewed and can be adjusted by the Project Management Team.
- Sorting entries by date or observation and checking for the logic of the entries.
- Comparing new data with already validated data to identify values that are new or beyond the current range of the data.

Aspatial data will also be graphed and assessed for patterns and outliers. Data will be compared across multiple entries by graphing plot or observation number against the measurement value.

Spatial data will also be validated. The Project Management Team will review all spatial data on the base map of the study areas and survey plots and all data points will be matched with plots and areas surveyed.

Data will be validated by Project Management Team members daily for the first four days and then weekly for the rest of the sampling period. Errors in more than two percent of the entries in any data field will trigger a review of the data collection and verification protocols and may require additional field survey crew training.

5.0 DATA MANAGEMENT

Data management covers the topics of logistics of entering and/or downloading the data, developing and maintaining data files, and archiving data.

5.1 Entering and Downloading Data

Field survey crew members will enter data on paper field data sheets and in the GPS receiver data loggers simultaneously. One member will be assigned as the GPS Data Recorder and the other will be the Data Sheet Recorder and they will maintain those responsibilities for a complete plot.

After each field survey day, the GPS receiver data sets and digital images will be downloaded to a local computer by the Field Data Collection Team. All images will be downloaded for that day's data collection and stored in .tif or an equivalent lossless image file format with file names updated as described in the file naming convention below. All paper field data sheets will be scanned at 300 dpi (dots per inch) resolution and saved in Adobe Acrobat (.pdf) format according to the file naming convention below.

5.2 Preparing Data for Upload

Data for each plot or incidental observation will include GPS data and paper data sheets. If a burrow is present, digital images will be provided. Each is discussed below.

GPS data will be differentially corrected using Trimble Pathfinder Office by the consultant on each day for all the field data collection teams. Data from each GPS receiver will be downloaded first into a temporary Microsoft Excel spreadsheet file for differential correction. After this step is completed for each GPS receiver data set, the day's datasets will be merged into one verified file, in ESRI compatible format such as Microsoft Excel (.xls). All differentially corrected files will then be converted to .shp or geodatabase files and uploaded to a contractor-provided ftp (file transfer protocol) website.

The day's GPS data set will be named according to the following naming convention, where "verified" represents the version control level described in the section below and the sample day is April 17, 2012:

BCCE Desert Tortoise_verified_20120417.xls , and

BCCE Desert Tortoise_verified_20120417 ESRI file extensions

The scanned field data sheets will be compiled into one file and will be named as follows, where "PN" is the plot number, "ON" is the observation number and the sample day is April 17, 2012:

BCCE Desert Tortoise_sheets_PN-ON-20120417.pdf

All digital images taken during a sample day will be named as follows, where "#" is a sequential number for each image, "PN" is the plot number, "ON" is the observation number and the sample day is April 17, 2012:

BCCE Desert Tortoise_image_#_PN-ON_20120417.tif

5.3 Uploading Data

The digital data files for a complete field day from all Field Data Collection Teams will be compressed into a single compressed (.zip) file and uploaded to an ftp site maintained by the Field Data Collection Team. Alternately, the zip file may be generated and stored to a network drive in the DCP offices if all post field processing takes place in the DCP offices.

Paper field data sheets will be delivered to the DCP Project Management Team on a weekly basis or as agreed upon in the contract.

5.4 Version Control

Version control is the process of managing copies of changing files over the course of a project. Any alteration or update to a file is considered a change and is reflected in the complete file name. Version control includes developing file-naming guidelines that include the file name, the QA/QC status, and the date of the file. For example:

BCCE Desert Tortoise_verified_20120417.zip

is the file of the spatial and aspatial data table for the sample day of April 4, 2012 and the data have been through the data verification process. The categories of QA/QC versions are *_verified_* for data that have been verified, *_valid_* for data that have been validated, and *_master_* for the master compilation of data that have completed all the QA/QC steps.

5.5 Data Storage

Data will be retrieved from the ftp site each workday morning and stored by the DCP on network servers that are backed up nightly with a series of backup tapes stored in a secure off-site location. Paper field data sheets will be stored by any contracted field survey crews for up to one week prior to delivery to the Project Management Team. The Field Data Collection Team will also maintain a complete copy of data, scanned data sheet files, and image files for the term of each annual sampling period.

5.6 Data Compilation

The DCP Project Management Team will compile all data from a field season for the analyses. This compilation will be a new file or set of files and no prior files will be overwritten. The Project Management Team will also complete metadata records for the spatial data and attributes tables following ISO 19115, NAP or another appropriate standard.

5.7 Data Archiving

Data archiving is the long-term (multi-year/multi-decade) management of the data once it is received by the DCP. It acts as a backup to the active datasets managed by the project team during the life of the project, as well as the location of the datasets after the project is complete. The pilot study will adhere to Clark County records management policy and record retention schedule for archiving data. Academic archives, such as University of Nevada, Las Vegas, will also be assessed to permanently house copies of the data, protocol, and training materials.

6.0 DATA QUALITY REVIEW

The process of data verification and validation often highlights ways to improve the data collection through changes in the data sheets, types of menus used, or by providing additional training. The Project Management Team will meet periodically and as needed to review the outcomes of the data verification and validation process and review all aspects of data collection for the pilot study.

7.0 REFERENCES

Clark County. 2009. MSHCP Data Management Plan Development Guidelines. Version 2009.002. April 13, 2009.

Grainger W. 2007. Data management plan for the Gulf Coast Network. Version 1.1. USDI National Park Service. Washington DC. 141pp. http://science.nature.nps.gov/im/datamgmt/docs/DMPlans/GULN_DMPlan_07.pdf

Palmer, C and M Sappington. Unknown date. Information management and quality assurance for resource management data collection efforts. http://www.georgewright.org/0394palmer.pdf

Press, D.T. 2005. Data management plan for the San Francisco Area Network Inventory and Monitoring Program. USDI National Park Service. San Francisco, CA. 113 pp.

ATTACHMENT 1

Field Data Sheets and Metrics

Start of Plot Description Data Sheet

Unique No ID: __________ PDOP Set High (circle one): yes/no

GPS Unit #: __________ Date: __________________ (YYYY/MM/DD) Time: _____________ (0000-2400) Plot #: _______________

GPS Data Recorder: ________________________ Data Sheet Recorder: ________________________

UTM: N________________________ E________________________

Air Temperature: _______________ °C Wind Speed: _______________ kph

Cloud Cover (circle one): Cloudy Overcast Sunny Raining Other: ______________________

Comments: ____

____

____

____

____

____

____

____

____

____

Start Plot Data Metrics

Measurements	Descriptors	Measurement Objective / Descriptor Definitions	Collection Standard Operating Procedure	Data Verification / Validation
GPS Unit #		Unique number assigned to each GPS unit	Hand key or enter onto datasheets	Compare to units known to be used by a crew on that date and in each plot or incidental observation location.
Date		No error expected	Automatically generated when data sheet is activated, or hand entered in format YYYY/MM/DD	Dates within range of possible dates, check consecutive nature of dates
Time		No error expected	Automatically generated when data sheet is activated, or hand entered in 24-hour time format (0000-2400)	Times within range of possible times (0500 to 1500), graph date and times
Plot #		Unique number assigned to each plot	Hand key or enter onto datasheets	Graph plot number and opportunistic data by date and time entries to ensure plot number is correctly entered.
GPS Data Recorder		Name of GPS operator	Select from drop down list of crew members	May not equal entry in Data Sheet Recorder field
Data Sheet Recorder		Name of data sheet recorder	Select from drop down list of crew members	May not equal entry in GPS Data Recorder field
GPS Coordinates (UTMs: N and E)		Automatically generated with use of GPS	Automatically generated with use of GPS function	Spatial data mapped and visually inspected to make sure within boundaries, correlated with correct plot and the daily survey route. Post processing will be within 50 cm of recorded location.
Air Temperature		Kestrel 2000 Wind Meter - +/- 1 °C	Kestrel unit follow instructions and display is digital. Record displayed reading in °C in data collection devices.	Check with range of possible values
Wind Speed		Kestrel 2000 Wind Meter - +/- larger of 3% of reading or least significant digit. Meter display resolution of 0.1.	Kestrel unit follow instructions and display is digital. Record displayed reading in km/hr units in data collection devices.	Check with range of possible values
Cloud Cover	Cloudy	Between 25% and 90% cloud cover	Visual assessment	One entry must be selected, assume selection is accurate
	Overcast	Complete cloud cover, less than 10% blue sky visible		
	Sunny	Mostly blue sky; <25% cloud cover		
	Raining	Precipation falling and wetting the soil		
	Other	None of the above	Enter description in comments field	Assume selection is accurate
Comments		Notes about plot not captured elsewhere	Hand key or enter onto datasheets	

Page 1 of 1

Live Tortoise Data Sheet

Unique No ID: __________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: _________________ Time: ________________
(YYYY/MM/DD) (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ____________________________

UTMs: N______________________ E________________________

Location of Tortoise (circle one): Burrow Open Rock Vegetation Pallet Other: _______________

Behavior when found (circle one): Walking Basking Eating Digging
Fighting Resting Mating Other: __________________

Cloud Cover (circle one): Cloudy Overcast Sunny Raining Other: _____________

Tortoise found in wash (circle one): Yes No Ground Temperature: __________ °C

Sex (circle one): Male Female Unknown MCL: ______________mm

MCL Recorded (circle one): Yes Juvenile Stress Burrow Other

Tag # (if present): ________________________ Tag color (if present): ________________
New Tag # (if applied): ____________________ Photograph Taken (circle one): Yes No

Comments____

Unique No ID: __________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: _________________ Time: ________________
(YYYY/MM/DD) (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ____________________________

UTMs: N______________________ E________________________

Location of Tortoise (circle one): Burrow Open Rock Vegetation Pallet Other: _______________

Behavior when found (circle one): Walking Basking Eating Digging
Fighting Resting Mating Other: __________________

Cloud Cover (circle one): Cloudy Overcast Sunny Raining Other: _____________

Tortoise found in wash (circle one): Yes No Ground Temperature: __________ °C

Sex (circle one): Male Female Unknown MCL: ______________mm

MCL Recorded (circle one): Yes Juvenile Stress Burrow Other
Tag # (if present): ________________________ Tag color (if present): ________________

New Tag # (if applied): ____________________ Photograph Taken (circle one): Yes No

Comments____

Live Desert Tortoise Metrics

Measurements	Descriptors	Measurement Objective/Descriptor Definitions	Collection Standard Operating Procedure	Data Verification / Validation
Observation #		Unique number assigned to each observation	Entered manually; consecutively by day	Observation number checked to ensure no duplicates or out of sequence
GPS Unit #		Unique number assigned to each GPS unit	Hand key or enter onto datasheets	Compare to units known to be used by a crew on that date and in each plot or incidental observation location.
Date		No error expected	Automatically generated when data sheet is activated, or hand entered in format YYYY/MM/DD	Dates within the range of possible dates, check consecutive nature of dates
Time		No error expected	Automatically generated when data sheet is activated, or hand entered in 24-hour time format (0000-2400)	Times within range of possible times (0500 to 1500), graph date and times
Plot # / Incidental #		Unique number assigned to each plot	Hand key or enter onto datasheets	Graph plot number and opportunistic data by date and time entries to ensure plot number is correctly entered.
Observer Name		Name of crew member making observations	Hand key or enter onto datasheets	Compare to crew members present for that plot or incidental observation location and date stamp
GPS Coordinates (UTMs: N and E)		Automatically generated with use of GPS	Automatically generated with use of GPS function	Spatial data mapped and visually inspected to make sure within boundaries, correlated with correct plot and the daily survey route. Post processing will be within 50 cm of recorded location.
Location of Tortoise	Burrow	Burrows include both dirt constructed holes and caliche dens. A tortoise in a burrow is at the mouth of the burrow, deep inside, or anywhere in between.	Record location of tortoise where first observed	One entry must be selected
	Open	Tortoise is in the open and not under vegetation or rock.		
	Rock	Tortoise is under or in the shade of a rock.		
	Vegetation	Tortoise is under the drip line or in the shade of vegetation.		
	Pallet	Tortoise is in unconstructed shelter less than 2 tortoise body lengths.		
	Other	None of the above	Enter description in comments field	
Behavior	Walking	Tortoise is moving.	Record behavior of tortoise when first observed	One entry must be selected, assume selection is accurate
	Basking	Tortoise is lying exposed to sun and warmth.		
	Eating	Tortoise is chewing, vegetation visible from mouth and/or vegetation stain around mouth is visible.		
	Digging	Tortoise is moving soil materials with feet.		
	Fighting	Two tortoises are moving agressively towards or at each other; generally facing each other.		One entry must be selected; assume selection is accurate; data recorded for two tortoises
	Mating	Male mounted on female		
	Resting	Tortoise is not moving or has stopped moving		One entry must be selected, assume selection is accurate
	Other	None of the above	Enter description in comments field	Assume selection is accurate

Page 1 of 2

Cloud Cover	Cloudy	Between 25% and 90% cloud cover	Visual assessment	One entry must be selected, assume selection is accurate
	Overcast	Complete cloud cover, less than 10% blue sky visible		
	Sunny	Mostly blue sky; <25% cloud cover		
	Raining	Precipation falling and wetting the soil		
	Other	None of the above	Enter description in comments field	Assume selection is accurate
Tortoise in Wash	Y / N	Ephemeral drainage; discernible channel bed and banks	Record when tortoise first observed	One entry must be selected
Ground Temperature		Recorded temperature will be +/- 2% of the reading, or +/- 2 °C	Instrument (Wide Range Mini IR Thermometer) is pointed to the side of the tortoise within 10 cm of the tortoise and temperature reading is displayed digitally in °C. This number is entered into data collection devices.	Temperatures within a range of possible values (TBD)
Sex	Male	Concave plastron; longer, more curved gulars; larger, well-developed chin glands; longer, broader, more conical tail; shorter, thicker toenails.	Are all external characteristics that can be seen in visual inspection or while handing tortoises for tagging.	One entry must be selected
	Female	Flat plastron; shorter, less curved gulars; smaller, less-developed chin glands; shorter, narrower, less conical tail.		
	Unknown	Sex characteristics are uncertain or not visible.		
Midline Carapace Length (MCL)		Accuracy within 1 mm	Use calipers with 1mm accuracy, measure distance along vertebral column to outer edge of scutes.	Allowable range of entries between 180 mm - 50 cm
Tag #		No error expected		Tag number within range of possible numbers
Tag Color		No error expected		Tag color within range of possible colors
New Tag #		No error expected	Tags will be provided with pre-printed numbers	Tag number within range of possible numbers and in consecutive order with date and time
Photograph Taken	Y / N	Indicate if any photos are taken at this observation point	Hand key or enter onto datasheets	Verify against digital photo files with that date and timestamp in each plot or incidental observation location.
Health		Intact carapace and skutes without obvious damage; fluid draining from nostrils or eyes.	Document in the comments any obvious signs trauma to the carapace; or other obvious health conditions.	

Burrow Observation Data Sheet

Unique No ID: __________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: _________________ (YYYY/MM/DD) Time: ________________ (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ____________________________
UTMs: N______________________ E________________________ Is it (circle one): Burrow Den

Occupied by live tortoise: Yes / No / Unknown Tortoise Data Sheet completed: Yes / No

Photograph Taken: Yes / No Camera # (circle one): 1 / 2

Camera Photo Label: ____

Burrow width: _________ cm Burrow height: __________ cm

Burrow collapsed or silted in: Yes / No Scat or tracks visible at burrow opening: Yes / No

Apron - Is apron absent, compacted or eroded from exposure?: Yes / No

Litter or debris accumulated at opening: Yes / No

Cobwebs present and trapped with debris or litter: Yes / No Burrow/Den Active: Yes / No / Unknown

Burrow in wash? Yes / No

Location of Burrow (circle one): Vegetation Open Rock Other: _________________________

Substrate Type (circle one): Sand Gravel Rocky Caliche Other: _________________________

Comments ____

Unique No ID: __________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: _________________ (YYYY/MM/DD) Time: ________________ (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ____________________________
UTMs: N______________________ E________________________ Is it (circle one): Burrow Den
Occupied by live tortoise: Yes / No / Unknown Tortoise Data Sheet completed: Yes / No

Photograph Taken (circle one): Yes / No Camera # (circle one): 1 / 2

Camera Photo Label: ____

Burrow width: _________ cm Burrow height: __________ cm

Burrow collapsed or silted in: Yes / No Scat or tracks visible at burrow opening: Yes / No

Apron – Is apron absent, compacted or eroded from exposure?: Yes / No

Litter or debris accumulated at opening: Yes / No

Cobwebs present and trapped with debris or litter: Yes / No Burrow/Den Active: Yes / No / Unknown

Burrow in wash? Yes / No

Location of Burrow (circle one): Vegetation Open Rock Other: _________________________

Substrate Type (circle one): Sand Gravel Rocky Caliche Other: _________________________

Comments ____

Desert Tortoise Burrow Metrics				
Measurements	**Descriptors**	**Measurement Objective / Descriptor Definitions**	**Collection Standard Operating Procedure**	**Data Verification / Validation**
Observation #		No error expected	Entered manually; consecutively by day	Observation number checked to ensure no duplicates or out of sequence
GPS Unit #		Unique number assigned to each GPS unit	Hand key or enter onto datasheets	Compare to units known to be used by a crew on that date and in each plot or incidental observation location.
Date		No error expected	Automatically generated when data sheet is activated, or hand entered in format YYYY/MM/DD	Dates within the range of possible dates, check consecutive nature of dates
Time		No error expected	Automatically generated when data sheet is activated, or hand entered in 24-hour time format (0000-2400)	Times within range of possible times (0500 to 1500), graph date and times
Plot #/ Incidental		Unique number assigned to each plot	Hand key or enter onto datasheets	Graph plot number and opportunistic data by date and time entries to ensure plot number is correctly entered.
Observer Name		Name of crew member making observations	Hand key or enter onto datasheets	Compare to crew members present for that plot or incidental observation location and date stamp
GPS Coordinates (UTMs: N and E)		Automatically generated with use of GPS	Automatically generated with use of GPS function	Spatial data mapped and visually inspected to make sure within boundaries, correlated with correct plot and the daily survey route. Post processing will be within 50 cm of recorded location.
Burrow or Den	Burrow	Subsurface cavity formed by erosion and/or excavation by tortoise; characteristic half circle shape and flat floor	Follow tortoise burrow decision tree	One entry must be selected
	Den	Karstic cavity in wash channel and banks; weaker cementing layers removed by erosion, tortoise, other animals; caliche den		
Burrow Occupied by Live Tortoise	Y / N	No error expected	Use handheld mirror to direct sunlight into burrow opening; kneel or lay on ground for better visual angles.	All "Y" observations should match in location to a live tortoise observation.
Tortoise Data Sheet Filled Out	Y / N	No error expected	Prompts survey crew to fill out a live tortoise observation data sheet if a live tortoise is in burrow/den	
Photograph Taken	Y / N	Indicate if any photos are taken at this observation point	Hand key or enter onto datasheets	Verify against digital photo files with that date and timestamp in each plot or incidental observation location.
Burrow Height		Accuracy within 2 cm	Use rigid tape measure or ruler placed in front of burrow opening	Height that correlates to sub-adult/adult tortoise with >180 mm MCL and maintains characteristic half circle shape
Burrow Width		Accuracy within 2 cm	Use rigid tape measure or ruler placed in front of burrow opening	Width that correlates to sub-adult/adult tortoise with >180 mm MCL; width ≥ 13 cm
Burrow in Wash	Y / N	Ephemeral drainage; discernible channel bed and banks; burrow/den located in channel bed, along toe of bank, up the side of bank	Select either yes or no	One entry must be selected
Collapsed or Silted In	Y / N	Burrow no longer has characteristic shape; destroyed by erosion, physical disturbance	Select either yes or no	One entry must be selected

Page 1 of 2

Scat or Tracks at Opening	Y / N	Fresh, dark brown scat readily visible at burrow opening; tracks that are clearly distinguishable as tortoise.	Select either yes or no	One entry must be selected
Apron Compacted or Eroded from Exposure	Y / N	Pile of excavated soil materials formed in front of burrow opening, compacted, faded from exposure	Select either yes or no	One entry must be selected
Litter or Debris at Opening	Y / N	Organic debris, trash, garbage, and/or litter accumulated at or plugging burrow opening such that ingress/egress is blocked.	Select either yes or no	One entry must be selected
Cobwebs with Debris or Litter	Y / N	Intact or remnant webs covered with accumulated dirt, debris, or litter that hinders ingress/egress.	Select either yes or no	One entry must be selected
Burrow Active	Y / N	Occupied by a live tortoise or exhibits signs of recent tortoise activity.	Select either yes or no	One entry must be selected
Location of Burrow	Vegetation	Burrow is under vegetation	Record location where burrow observed	One entry must be selected
	Open	Burrow is in the open and not under vegetation or rock.		
	Rock	Burrow is under or adjacent to a rock.		
	Other	None of the above	Enter description in comments field	
Substrate type	Sand	Fine, medium, or coarse granular rock and mineral particles with diameters up to 2 mm	Select one entry	One entry must be selected
	Gravel	Coarse rock or mineral particles and pebbles >2 mm and <64 mm in diameter		
	Rocky	Very coarse rock or pebbles >64 mm and <256 mm in diameter		
	Caliche	Sedimentary rock, hardened deposits of calicum carbonate that forms hardpan, imprevious surfaces		
	Other	None of the above	Enter description in comments field	One entry must be selected

Page 2 of 2

Carcass Data Sheet

Unique No ID: ___________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: __________________ Time: _________________
(YYYY/MM/DD) (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ______________________________

UTMs: N________________________ E_________________________

Tag # (if present): ______________________ Tag color (if present): _______________________

Carcass Condition (circle one): Intact Disarticulated Sex (circle one): Male Female Unknown

MCL (if applicable): __________________mm Photograph Taken (circle one): Yes No

Comments____

Unique No ID: ___________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: __________________ Time: _________________
(YYYY/MM/DD) (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ______________________________

UTMs: N________________________ E_________________________

Tag # (if present): ______________________ Tag color (if present): _______________________

Carcass Condition (circle one): Intact Disarticulated Sex (circle one): Male Female Unknown

MCL (if applicable): __________________mm Photograph Taken (circle one): Yes No

Comments____

Unique No ID: ___________ PDOP Set High (circle one): yes/no
Observation #: _______ GPS Unit #: __________ Date: __________________ Time: _________________
(YYYY/MM/DD) (0000-2400)
Plot #/INCIDENTAL (circle one): ________________ Observer Name: ______________________________

UTMs: N________________________ E_________________________

Tag # (if present): ______________________ Tag color (if present): _______________________

Carcass Condition (circle one): Intact Disarticulated Sex (circle one): Male Female Unknown

MCL (if applicable): __________________mm Photograph Taken (circle one): Yes No

Comments____

Desert Tortoise Carcass Metrics

Measurements	Descriptors	Measurement Objective / Descriptor Definitions	Collection Standard Operating Procedure	Data Verification / Validation
Observation #		No error expected	Entered manually; consecutively by day	Observation number checked to ensure no duplicates or out of sequence
GPS Unit #		Unique number assigned to each GPS unit	Hand key or enter onto datasheets	Compare to units known to be used by a crew on that date and in each plot or incidental observation location.
Date		No error expected	Automatically generated when data sheet is activated, or hand entered in format YYYY/MM/DD	Dates within the range of possible dates, check consecutive nature of dates
Time		No error expected	Automatically generated when data sheet is activated, or hand entered in 24-hour time format (0000-2400)	Time within range of possible times (0500 to 1500), graph date and times
Plot #/ Incidental		Unique number assigned to each plot	Hand key or enter onto datasheets	Graph plot number and opportunistic data by date and time entries to ensure plot number is correctly entered.
Observer Name		Name of crew member making observations	Hand key or enter onto datasheets	Compare to crew members present for that plot or incidental observation location and date stamp
GPS Coordinates (UTMs: N and E)		Automatically generated with use of GPS	Automatically generated with use of GPS function	Spatial data mapped and visually inspected to make sure within boundaries, correlated with correct plot and the daily survey route. Post processing will be within 50 cm of recorded location.
Tag #		No error expected		Tag number within range of possible numbers
Tag Color		No error expected		Tag color within range of possible colors
Carcass Condition	Intact	Plastron and carapace remain connected.	Enough plastron and carapace to measure MCL and sex tortoise	One entry must be selected
	Disarticulated	Plastron and carapace are separated.	Does not meet definition of Intact	
Sex	Male	Concave plastron; longer, more curved gulars; larger, well-developed chin glands; longer, broader, more conical tail; shorter, thicker toenails.	Enough external characteristics defining sex remain and are visible upon inspection.	One entry must be selected
	Female	Flat plastron; shorter, less curved gulars; smaller, less-developed chin glands; shorter, narrower, less conical tail.		
	Unknown	Sex characteristics are uncertain or not visible.		
Midline Carapace Length (MCL)		Accuracy within 1 mm	Use calipers with 1mm accuracy, measure distance along vertebral column to outer edge of scutes.	Allowable range of entries between 180 mm - 50 cm
Photograph Taken	Y / N	Indicate if any photos are taken at this observation point	Hand key or enter onto datasheets	Verify against digital photo files with that date and time stamp in each plot or incidental observation location.

Page 1 of 1

End Plot Description Data Sheet

Unique No ID: __________ PDOP Set High (circle one): yes/no

GPS Unit #: __________ Date: ___________________ Time: _____________ Plot #: ______________
(YYYY/MM/DD) (0000-2400)

UTM: N_________________________ E__________________________

Air Temperature: ______________ °C Wind Speed: ______________ kph

Cloud Cover (circle one): Cloudy Overcast Sunny Raining Other: _______________________

Plot Totals: # Live Tortoise: _____________ # Carcasses: _____________ # Burrows: ________________

Brief Summary Description of Plot (substrate, habitat, slope, threats etc.) _____________________________

____

____

____

____

____

____

Comments: ____

____

____

____

End Plot Data Metrics

Measurements	Descriptors	Measurement Objective / Descriptor Definitions	Collection Standard Operating Procedure	Data Verification / Validation
GPS Unit #		Unique number assigned to each GPS unit	Hand key or enter onto datasheets	Compare to units known to be used by a crew on that date and in each plot or incidental observation location.
Date		No error expected	Automatically generated when data sheet is activated, or hand entered in format YYYY/MM/DD	Dates within the range of possible dates, check consecutive nature of dates
Time		No error expected	Automatically generated when data sheet is activated, or hand entered in 24-hour time format (0000-2400)	Times within range of possible times (0500 to 1500), graph date and times
Plot #		Unique number assigned to each plot	Hand key or enter onto datasheets	Graph plot number and opportunistic data by date and time entries to ensure plot number is correctly entered.
GPS Coordinates (UTMs: N and E)		Automatically generated with use of GPS	Automatically generated with use of GPS function	Spatial data mapped and visually inspected to make sure within boundaries, correlated with correct plot and the daily survey route. Post processing will be within 50 cm of recorded location.
Air Temperature		Kestrel 2000 Wind Meter - +/- 1 °C	Kestrel unit follow instructions and display is digital. Record displayed reading in °C in data collection devices.	Check with range of possible values
Wind Speed		Kestrel 2000 Wind Meter - +/- larger of 3% of reading or least significant digit. Meter display resolution of 0.1.	Kestrel unit follow instructions and display is digital. Record displayed reading in km/hr units in data collection devices.	Check with range of possible values
Cloud Cover	Cloudy	Between 25% and 90% cloud cover	Visual assessment	One entry must be selected, assume selection is accurate
	Overcast	Complete cloud cover, less than 10% blue sky visible		
	Sunny	Mostly blue sky; <25% cloud cover		
	Raining	Precipation falling and wetting the soil		
	Other	None of the above	Enter description in comments field	Assume selection is accurate
Totals	# Live Tortoise	Enter total number of live tortoise observations within the plot	Prompts survey crew to complete field verification of data sheets and data entry forms	Compare total entries from data sheets to total observations recorded by GPS receiver
	# Carcasses	Enter total number of tortoise carcass observations within the plot		
	# Burrows	Enter total number of active burrow observations within the plot		
Brief Summary of Plot		Notes about substrate, habitat, slope, threats observed within the plot not captured in other data forms	Hand key or enter onto datasheets	
Comments		Notes about plot not captured elsewhere	Hand key or enter onto datasheets	

Page 1 of 1

End of Day Data Sheet

Unique No ID: __________

GPS Unit #:____________ Date: ____________________ Time: _____________________

(YYYY/MM/DD) (0000-2400)

UTM: N_________________________ E__________________________

Plot # Completed: Total Observations by plot:

____________________________ # Tortoise: _________ # Carcasses: __________ # Burrows: _________

____________________________ # Tortoise: _________ # Carcasses: __________ # Burrows: _________

____________________________ # Tortoise: _________ # Carcasses: __________ # Burrows: _________

____________________________ # Tortoise: _________ # Carcasses: __________ # Burrows: _________

____________________________ # Tortoise: _________ # Carcasses: __________ # Burrows: _________

Total Plot Observations: # Tortoise: _________ # Carcasses: __________ # Burrows: _________

Total Incidental Observations: # Tortoise: _________ # Carcasses: __________ # Burrows: _________

GRAND TOTAL OBSERVATIONS: # Tortoise: _________ # Carcasses: __________ # Burrows: _________

Comments: ____

____

____

____

____

____

____

End of Day Metrics				
Measurements	**Descriptors**	**Measurement Objective / Descriptor Definitions**	**Collection Standard Operating Procedure**	**Data Verification / Validation**
GPS Unit #		Unique number assigned to each GPS unit	Hand key or enter onto datasheets	Compare to units known to be used by a crew on that date and in each plot or incidental observation location.
Date		No error expected	Automatically generated when data sheet is activated, or hand entered in format YYYY/MM/DD	Dates within the range of possible dates, check consecutive nature of dates
Time		No error expected	Automatically generated when data sheet is activated, or hand entered in 24-hour time format (0000-2400)	Times within range of possible times (0500 to 1500), graph date and times
Plot Numbers Completed		Numbers of each plot completed that day	Hand key or enter onto datasheets	
Total Incidental Observations	# Live Tortoise	Enter total number of live tortoise observations outside of plots	Prompts survey crew to complete field verification of data sheets and data entry forms	Compare total entries from data sheets to total observations recorded by GPS receiver
	# Carcasses	Enter total number of tortoise carcass observations outside of plots		
	# Burrows	Enter total number of active burrow observations outside of plots		
Comments		Notes about the field day not captured elsewhere	Hand key or enter onto datasheets	

Page 1 of 1

APPENDIX B

Burrow Classification Description

MONITORING PROTOCOL

TESTING THE USE OF OCCUPANCY SAMPLING TO DETECT STATUS AND TRENDS OF MOJAVE DESERT TORTOISE (*GOPHERUS AGASSIZII*) IN THE BOULDER CITY CONSERVATION EASEMENT

APPENDIX B
BURROW CLASSIFICATION DESCRIPTION

October 2011

Prepared for:

desert conservation PROGRAM

Prepared by:

Enduring Conservation Outcomes

SCIENCE ADVISOR
2009-ECO-801A

TABLE OF CONTENTS

Page

ACRONYMS AND ABBREVIATIONS

BCCE	Boulder City Conservation Easement
cm	centimeters
DCP	Desert Conservation Program
GPS	global positioning system
MCL	midline carapace length
mm	millimeters
MSHCP	Multiple Species Habitat Conservation Plan
USFWS	U.S. Fish and Wildlife Service

1.0 INTRODUCTION

The Mojave Desert tortoise (*Gopherus agassizii*) is a priority species for conservation in Clark County as set forth in the Multiple Species Habitat Conservation Plan (MSHCP) (Clark County, 2000). The Desert Conservation Program (DCP) plans to conduct a pilot study to test occupancy of the Boulder City Conservation Easement (BCCE) by the Mojave Desert tortoise. The results of the study will guide restoration and conservation decisions in managing the BCCE.

With the assistance of the Science Advisor, the DCP prepared a monitoring protocol for the pilot study. The monitoring protocol details how the pilot study will test the use of occupancy sampling to detect tortoise habitat use status and changes over time (trend) in the BCCE. Occupancy sampling is defined as determining the proportion of habitat within an area that contains indicators of a targeted species. For the pilot study, tortoise indicators (i.e., occupancy) will be determined by observation of live tortoises and active tortoise burrows.

The information presented herein supplements the monitoring protocol by further describing the occupancy indicator of active tortoise burrows. The physical features that will be classified as a tortoise burrow are described first, followed by the characteristics that will guide the determination of tortoise use (active or inactive) associated with a burrow. The purpose for describing the classification process for active tortoise burrows is to minimize the uncertainty for surveyors in the field and to maximize their survey time.

2.0 TORTOISE BURROW DESCRIPTION

Much literature discusses the importance of shelter or cover to desert tortoise survival (USFWS, 1994, 2008; Riedle et al., 2008; Inman et al., 2009; Lukenbach, 1982). Two common terms used to describe different cover types are "burrow" and "den". These two cover types will be one focus in describing a tortoise indicator for occupancy sampling. Although these cover types have different physical characteristics, they will collectively be referred to as "burrows" in the data collection and analysis of occupancy indicators.

2.1 Burrow

Burge (1978) defined "burrow" as a subsurface cavity formed by erosion, excavated by a tortoise or other animal, or any combination of these. The opening of a burrow dug in the soil by a tortoise is characteristic in shape, being a relatively well-defined half circle or half moon with a flat bottom. This characteristic shape is consistent in all age groups. The size and shape of the opening and most of the interior conform to that of the tortoise (i.e., tortoise carapace profile). This characteristic shape is depicted in photos 1 through 4.

The slope or inclination of a tortoise burrow floor is typically without major undulation. The slope usually continues at the same degree of inclination in burrows used by adult tortoises[1]; however, burrows used by smaller tortoises generally show no change in slope (Burge, 1978). A burrow floor that was not flat or insufficiently compacted probably indicates the burrow was dug and/or was being used by another animal (Burge, 1978). The degree of slope of a

[1] Adult and sub-adult tortoises are defined as having a midline carapace length (MCL) greater than 180 millimeters (mm) (USFWS, 2008).

Photo 1: Characteristic half circle shape and flat bottom of tortoise burrow in sandy silty soils.

Photo 2: Characteristic half circle shape and flat bottom of tortoise burrow in gravely, sandy soils.

Photo 3: Characteristic half circle shape and flat bottom of tortoise burrow in gravely silty soils.

Photo 4: Characteristic half circle shape and flat bottom of tortoise burrow in consolidated gravel wash channel.

Photo 5: Loose soils (versus compacted) and rounded (versus flat) bottom floor; not a tortoise burrow.

burrow floor is also dependent on the location of the burrow on the terrain and soil materials and substrate. Photo 5 shows an example of a burrow that does not have a flat or compacted floor and would not likely be a tortoise burrow. The minimum burrow length would be relative to the size of the tortoise – about 30 centimeters (cm) (300 mm or approximately 12 inches (")) for an adult tortoise (Burge, 1978). Smaller burrows are more difficult to see and more difficult to identify as tortoise burrows because other animals (e.g., rodents, lizards) use them and tend to alter the characteristic half circle shape of the opening (Burge, 1978). These animals can also obscure other tortoise sign such as tracks or scat.

For purpose of the pilot study for occupancy sampling at the BCCE, a minimum width in conjunction with the characteristic shape will be used to classify a burrow as a tortoise burrow. This purpose is twofold – minimize uncertainty and maximize survey time. At the minimum length of 180 mm MCL (18 cm or approximately 7"), an approximate width of an adult or sub-adult would be 130 mm (13 cm or approximately 5"). Therefore, minimum width needed for a burrow that exhibits the characteristic shape (or nearly so) to be classified as a tortoise burrow is 13 cm (approximately 5") wide across the base. Photo 6 shows a burrow that is less than the minimum base width of 13 cm and thus would not be classified as a tortoise burrow for the pilot study. Photo 7 shows a burrow with a bottom width of greater than the minimum 13 cm (approximately 5") and a prominent characteristic half circle shape.

Photo 6: Base of burrow is less than minimum width – not a tortoise burrow.

Photo 7: Base of burrow is greater than minimum width with prominent half circle shape – a tortoise burrow.

2.2 Den

Burge (1978) defined "den" as a type of burrow, possibly originally a karstic cavity or one excavated in part by tortoises by removal of weaker cementing layers of the consolidated gravels that form portions of the banks of stream channels or washes. These dens are also referred to as caliche dens or caves. A den can be located along the toe of the bank and up the side of the bank depending on the substrate and soil materials. There is no characteristic shape for a den but the shape and dimensions would have to accommodate a tortoise. It is common for different animals to share use of these dens. Photo 8 is an example of a den at the toe of a wash channel bank.

For purpose of the pilot study for occupancy sampling at the BCCE, minimum dimensions will be used to classify a den as a tortoise burrow. As described above, the minimum width to accommodate an adult or sub-adult tortoise would be approximately 5". Lovich and Daniels (2000) only used burrows that were approximately shell-deep or more in their statistical analyses in determining habitat use, and those burrows were typical of the size used by adult tortoises (>180 mm MCL). Together with the findings of Burge (1978), the length of the den should be 18-30 cm (approximately 7-12") to be classified as a tortoise burrow.

3.0 TORTOISE BURROW ACTIVITY

The most recent tortoise field manual (USFWS, 2009a) provides five categories to classify tortoise burrows based on condition and activity; however, for this protocol only certain signs of live desert tortoise activity will be used to classify a tortoise burrow as active.

3.1 Active

For purpose of the pilot study for occupancy sampling at the BCCE, an active tortoise burrow is defined as a burrow with a live tortoise occupying it or with recent signs of tortoise activity. All burrows and dens that are classified as a tortoise burrow according to Section 2.0 will be inspected using a hand mirror to assess presence of any live tortoises. A burrow occupied by a live tortoise will be noted as both occupancy indicators (live tortoise and active tortoise burrow) at the same location and one GPS point will be recorded.

Presence of tortoise scat is a common indicator of tortoise presence. Positive identification of tortoise scat varies greatly based on interpretation of the descriptive categories and surveyors' skill and experience. Because of this, only the presence of fresh, dark brown scat that is readily visible at the burrow opening will be considered one sign of recent tortoise activity that classifies a burrow as active. The surveyor should not look for scat more than one foot beyond the burrow opening based on the substrate, nor attempt to identify scat inside the burrow. Photo 9 shows an example of fresh, dark brown scat.

Tortoise tracks at the burrow opening will be considered one sign of recent tortoise activity that classifies the burrow as active. However, the tracks must be clearly distinguishable as made by a tortoise and not be marred by other activity such as a lizard.

Certain animals that share use of dens with tortoises create middens inside and outside the dens, particularly wood rats (*Neotoma lepida*). These middens vary in size and can block access or obscure signs of tortoises (e.g., scat, tracks). To eliminate uncertainty regarding burrow activity, occupation of the den by a live tortoise must be observed

Photo 8: Typical den in desert wash channel.

Photo 9: Example of fresh scat; typically dark brown in color.

to classify the den as an active tortoise burrow. Photo 10 shows an example of a den occupied by a live tortoise and thus this would be classified as an active burrow.

Wherever a live tortoise is observed on the surface, the surveyor should search for nearby burrows.

Photo 10: Live tortoise occupying den at toe of wash channel bank – active tortoise burrow.

3.2 Inactive

A tortoise burrow will be defined as inactive if it cannot be classified as active according to Section 3.1. Signs that may individually or collectively with others render a tortoise burrow inactive include collapse, deterioration, erosion, siltation, and accumulation of litter, organic debris, or vegetation growth in and around the burrow opening. The condition of the burrow apron (i.e., pile of excavated soil materials formed in front of the opening) may indicate the state of activity. An apron that is compacted, eroded, or discolored or faded from exposure may indicate age of a burrow and not necessarily inactivity without consideration of other signs. Cobwebs that have trapped organic debris or litter are signs of inactivity, whereas intact spider webs could have been spun recently. Photos 11 and 12 compare an active and inactive burrow located in a similar substrate.

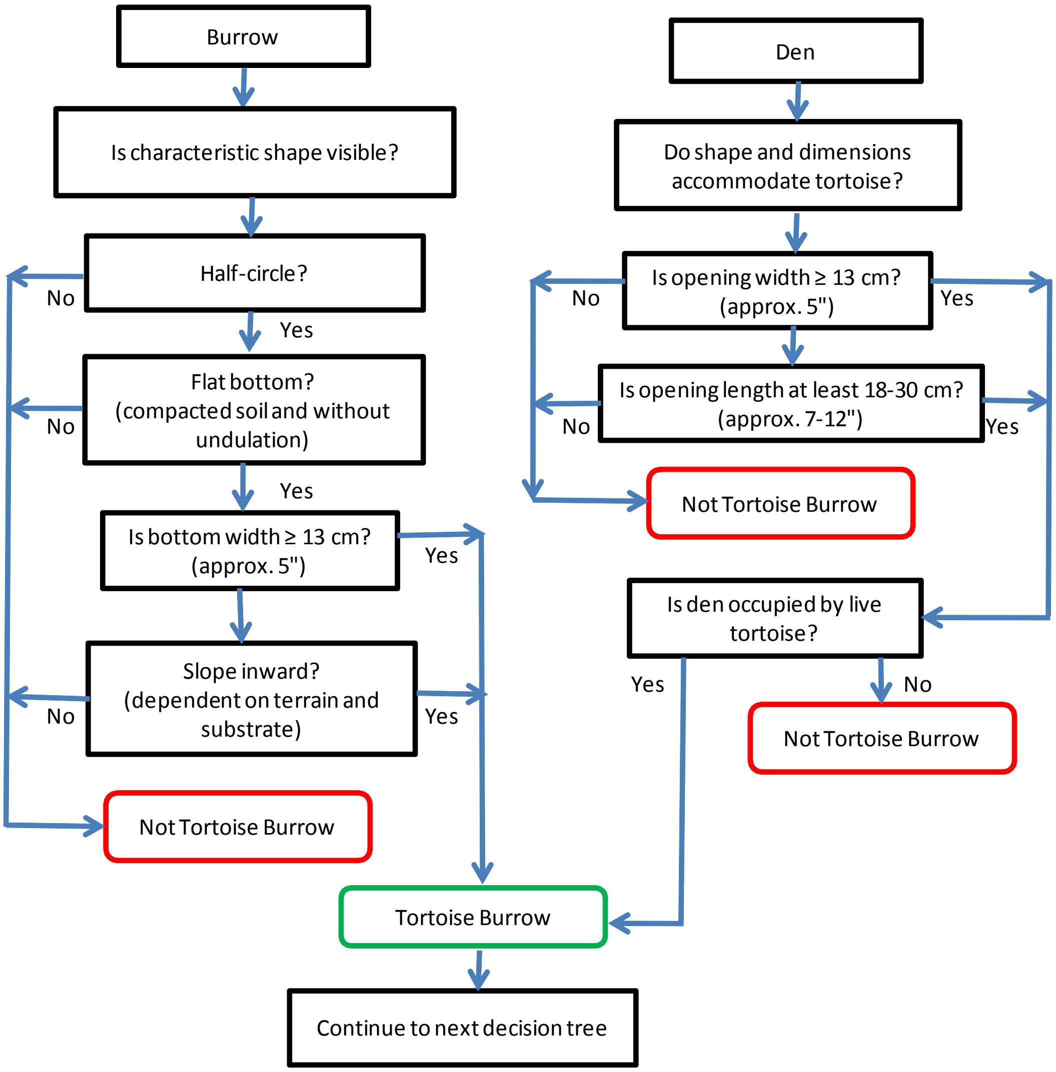
Photo 11: Active tortoise burrow.

Photo 12: Inactive tortoise burrow.

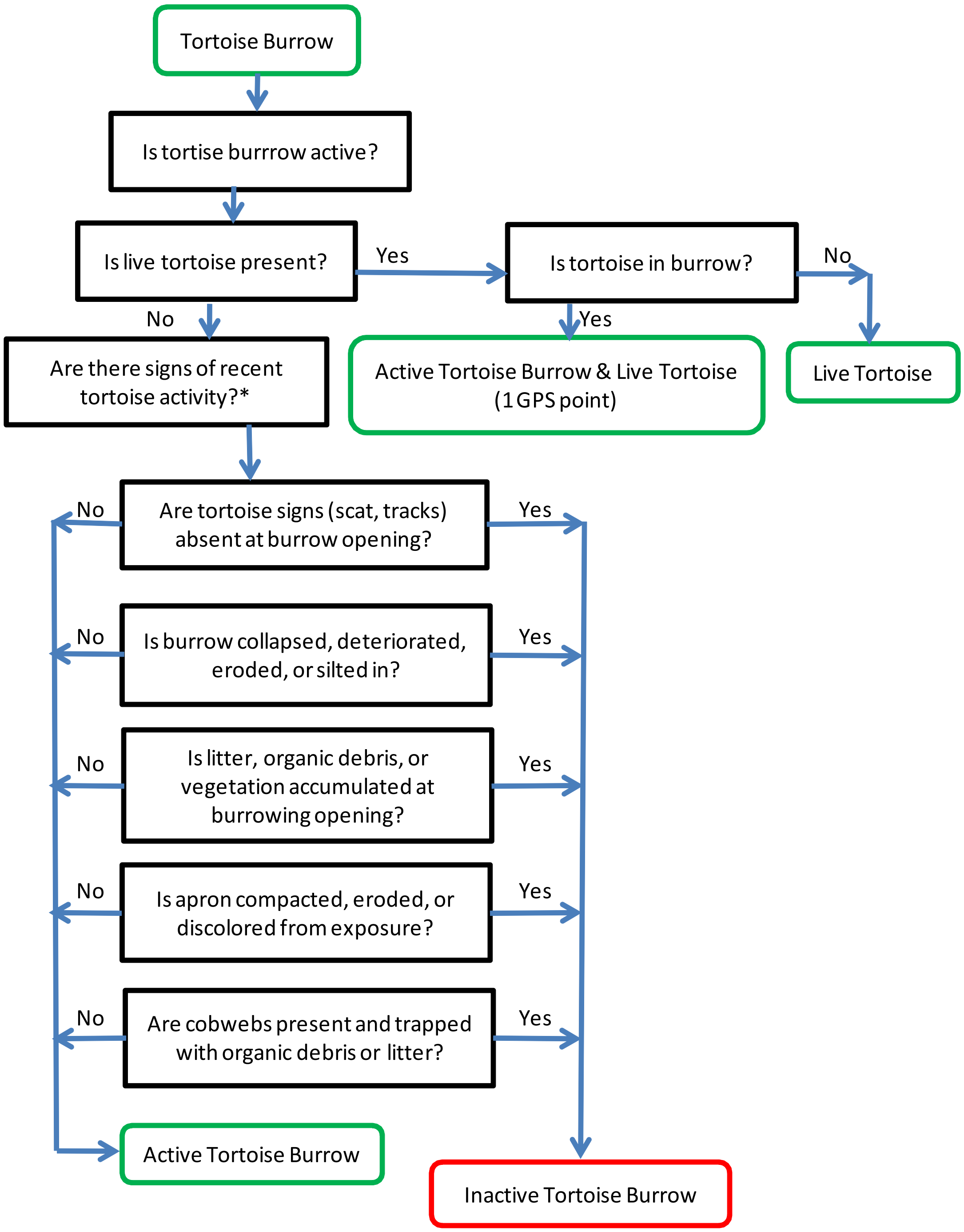
4.0 SUMMARY – DECISION TREE

The information described in the previous sections for classifying active tortoise burrows is summarized in the following decision trees for ease of use by the field surveyors. The first decision tree classifies burrows and dens as tortoise burrows and the second classifies the tortoise burrow as active or inactive.

DECISION TREE FOR CLASSIFYING BURROWS AND DENS AS TORTOISE BURROWS



DECISION TREE FOR CLASSIFYING TORTOISE BURROWS AS ACTIVE OR INACTIVE



* Not all signs need be to be present to classify a burrow as active. The dominant signs (i.e., more "no" than "yes" in the decision tree) will influence the classification.

5.0 REFERENCES

Berry, K.H. & F.B. Turner. 1986. Spring Activities and Habits of Juvenile Desert Tortoises, *Gopherus agassizii*, in California. Copeia 1986:1010–1012.

Burge, B.L. 1978. Physical Characteristics and Patterns of Utilization by the Desert Tortoise (*Gopherus agassizii*) in Southern Nevada. Proceedings of the Desert Tortoise Council Symposium 1978:80-111.

Burge, B.L. 1996. The Desert Tortoise (*Gopherus agassizii*). Online at: http://www.desertusa.com/june96/du_tort.html Accessed June 10, 2011.

Clark County. 2000. Final Clark County Multiple Species Habitat Conservation Plan and Environmental Impact Statement for Issuance of a Permit to Allow Incidental Take of 79 Species in Clark County, Nevada. September 2000.

__________. 2009. Desert Tortoise (*Gopherus agassizii*) Monitoring 2009 Final Project Report. Project #2007-USFWS-785.

Desert Tortoise Council. 1999. Guidelines for Handling Desert Tortoises during Construction Projects. Edward L. LaRue, Jr., editor. Wrightwood, California.

Inman, R., K. Nussear, & C.R. Tracy. 2009. Detecting Trends in Desert Tortoise Population Growth: Elusive Behavior Inflates Variance in Estimates of Population Density. Endangered Species Research Vol. 10:295-304.

Lovich, J. & R. Daniels. 2000. Environmental Characteristics of Desert Tortoise (*Gopherus agassizii*) Burrow Locations in an Altered Industrial Landscape. Chelonian Conservation and Biology, Volume 3, Number 4.

Luckenbach R.A. 1982. Ecology and Management of the Desert Tortoise (*Gopherus agassizii*) in California. pp. 1-37. In: R. B. Bury (ed.). North American Tortoises: Conservation and Ecology. USDI, Fish and Wildlife Service. Wildlife Resource Department. 12.

Nussear, K.E. & C.R. Tracy. 2007. Can Modeling Improve Estimation of Desert Tortoise Population Densities? Ecological Applications 17:579–586.

Riedle, J.D., R. Averill-Murray, C. Lutz, & D. Bolen. 2008. Habitat Use by Desert Tortoise (*Gopherus agassizii*) on Alluvial Fans in the Sonoran Desert, South-Central Arizona. Copeia 2008, No. 2, p. 414-420.

Tracy, C.R., R. Averill-Murray, W. Boarman, D. Delehanty, J. Heaton, E. McCoy, D. Morafka, K. Nussear, B. Hagerty, & P. Medica. 2004. Desert Tortoise Recovery Plan Assessment. U. S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 1994. Desert Tortoise (Mojave Population) Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 73 pages plus appendices.

__________. 2008. Draft Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*). U.S. Fish and Wildlife Service, California and Nevada Region, Sacramento, California. 209 pp.

__________. 2009a. Desert Tortoise (Mojave Population) Field Manual: (*Gopherus agassizii*). U.S. Fish and Wildlife Service, Region 8, Sacramento, California. Online at: http://www.fws.gov/ventura/species_information/protocols_guidelines/.

__________. 2009b. Desert Tortoise Population Monitoring Handbook. Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. Online at: http://www.fws.gov/nevada/desert_tortoise/dt_reports.html.

__________. 2009c. Range-wide Monitoring of the Mojave Population of the Desert Tortoise: 2007 Annual Report. Report by the Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. Online at: http://www.fws.gov/nevada/desert_tortoise/dt_reports.html.

__________. 2010. Preparing for Any Action that May Occur Within the Range of the Mojave Desert Tortoise (*Gopherus agassizii*). Desert Tortoise Recovery Office. 2010 Field Season.