



# DESERT TORTOISE MONITORING HANDBOOK

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This is the most recent incarnation of handbooks that have been used each year of the range-wide monitoring program. The University of Nevada, Reno and their collaborators at the U.S. Geological Survey were involved in earlier versions of the handbook. Linda Allison continued to develop and refine project design, data collection protocols, and the handbook in her role as the Desert Tortoise Monitoring Coordinator with U.S. Fish and Wildlife Service from 2006-2022. Dr. Jay Johnson has worked in recent years to update the training program for handling tortoises and has made extensive contributions to the associated chapter in this handbook. Rohit Patil and James Cash (GBI) updated the material on data collection hardware and software for this handbook, with help from Joey Danielson.

## Handbook Change Record

Handbook Version	Date	Description of Change
2022	1 March 2022	<b>Chapter 3. Compass and Navigational GPS:</b> added section 4. Care of the Compass. <b>Chapter 4. Electronic Equipment Care and Maintenance:</b> removed instructions for Nexus phones and replaced with instructions for setting up and using iPad mini devices. <b>Chapter 7. Data Collection and Verification:</b> removed Pendragon instructions and replaced with updated data collection protocol using ArcGIS Survey123.
2024	5 March 2024	Baseline edits throughout, replaced “Nexus phone” with “data collection device” throughout. <b>Chapter 2. Desert Tortoise Handling, Objective 1:</b> disinfectant and rehydration sections updated; <b>Objective 2:</b> handling and marking sections updated, Health Assessment Procedures Handbook reference updated to 2019; <b>Approaching and collecting data on desert tortoises:</b> section updated. <b>Chapter 3. Compass and Navigational GPS, Objective 1:</b> GPS track collection protocol added. <b>Chapter 5. Line Distance Protocols, Objective 3:</b> outdated distance protocols removed; <b>Objective 5:</b> added additional information regarding non-standard transects & example forms. <b>Chapter 6. Radio Telemetry and G0 Protocols, Objective 1:</b> transmitter attachment and photos updated. <b>Chapter 7. Data Collection and Verification, Objective 3:</b> photo collection protocol added; <b>Objective 4:</b> GPS grab valid protocol updated.
2024	11 March 2024	<b>Appendix I: Annotated Paper Data Sheets:</b> data collection forms and annotations updated.
2024	5 June 2024	<b>Chapter 5. Line Distance Protocols, Objective 5:</b> updated figure 5-7 to follow example. <b>Chapter 8. Demographic Plot Surveys</b> added; <b>Appendix I: Annotated Paper Data Sheets:</b> data collection forms added, annotations updated.

# DESERT TORTOISE MONITORING HANDBOOK

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## INTRODUCTION

On April 2, 1990, the U.S. Fish and Wildlife Service (USFWS) listed the Mojave population of the desert tortoise north and west of the Colorado River as Threatened under the Endangered Species Act of 1973 (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). The overall goal of the USFWS recovery plan for the Mojave desert tortoise (*Gopherus agassizii*) is the recovery and delisting of the tortoise. The Desert Tortoise Monitoring Project contributes annual population density estimates of the desert tortoise - information that the USFWS will use to assess the status of the species at various stages during recovery.

The revised recovery plan (USFWS. 2011. Revised recovery plan for the Mojave population of the desert tortoise (*Gopherus agassizii*). USFWS, Pacific Southwest Region, Sacramento, California. 222 pp.) requires for delisting that “Rates of population change ( $\lambda$ ) for desert tortoises are increasing (i.e.,  $\lambda > 1$ ) over at least 25 years (a single tortoise generation), as measured a) by extensive, range-wide monitoring across tortoise conservation areas within each recovery unit, and b) by direct monitoring and estimation of vital rates (recruitment, survival) from demographic study areas within each recovery unit.”

The USFWS coordinates this monitoring program to

- 1) Collect data range-wide that are scientifically credible,
- 2) Use these data to develop accurate and precise estimates of population densities in each recovery unit, and then
- 3) Update the design and annual implementation of this project to allow detection of meaningful population recovery after 25 years.

Training outlined in this manual addresses the specialized skills required to collect these data. Desert tortoise population monitoring relies on distance sampling and demographic surveys to annually estimate the number of tortoises and tortoise vital rates in managed areas of the Mojave Desert. These surveys are implemented separately, during different time periods, and this project trains crews in the general approach to distance sampling or demographic surveys as well as the specifics of how these methods are implemented for desert tortoises. Each chapter in this Handbook addresses a focal issue, stating the training objectives and standards, and providing written reference material. The following definitions apply:

**Objective:** Statement of aim or purpose to be pursued; a priority, or an end, towards which significant effort is directed.

**Standard:** Statement of the necessary activities required to meet specific training objectives. By the end of training, each crew member should feel confident in their performance of these standards.

**Metric:** Quantitative or qualitative means used to gauge success or failure in performance. By the end of training, instructors will have evaluated all trainees using these metrics.

# **DESERT TORTOISE MONITORING HANDBOOK**



# 1. DISTANCE SAMPLING AND DESERT TORTOISES

Although it is easy to assume that enumerating a sedentary animal (desert tortoises) in the relatively open habitat of the Mojave Desert would present few problems, this assumption is not supported by experience. A certain number of desert tortoises are underground and not visible at any given time. When they are out of their shelters, they are cryptically colored and shaped. Their behavior also does not draw attention to them. Distance sampling methods are therefore employed to correct our population estimates for the proportion that were hidden and not visible, and for the proportion that were not detected although they were on the surface.

Logistic considerations also affect our ability to estimate population size in desert tortoises. Desert tortoises are sparsely distributed and the area to be sampled is vast, resulting in the need for a large number of transects to provide an adequate sample size. The optimum period for sampling is brief (about 8 weeks in the spring), so this project is a large scale effort that must be mobilized and completed in a very short time frame. Many transects will be in terrain that is physically demanding, and tortoises are not found on all transects. This challenges observers to remain alert and attentive to the details of the methods. Departures from the methods can result in poor-quality data that lead to biased estimates. The ability to conclude anything about the status of the desert tortoise with any confidence depends on trainees performing to the best of their abilities in both the training and data collection phases.

**Objective 1:** Understanding how data collection affects precision and bias of the density estimate.

**Objective 2:** Understanding how different types of field data contribute to calculation of the density estimate.

This section includes a rudimentary introduction to distance sampling theory and a more detailed discussion of some of the specific issues involved in using distance sampling to estimate abundance of desert tortoises. For more information on the theory and general use of distance sampling, consult: *Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford Univ. Press, Oxford. 432 pp.*

## Objective 1: Understanding How Data Collection Affects Precision and Bias of the Density Estimate

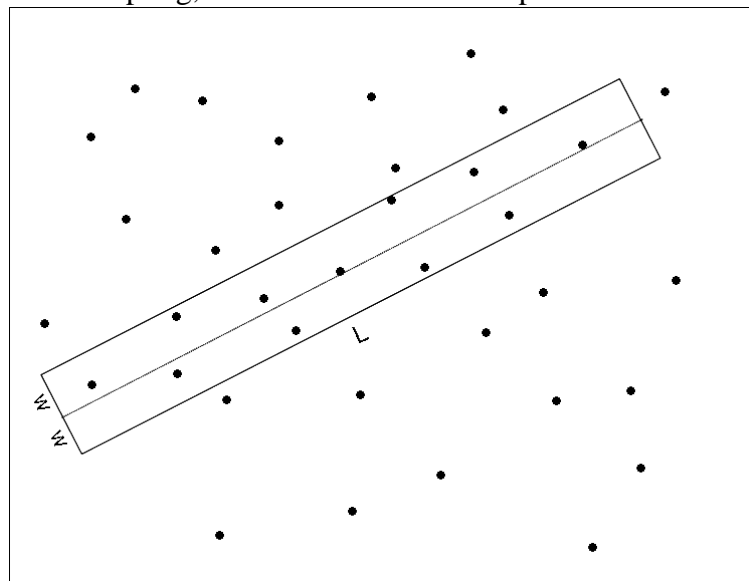
### Precision and Bias

The methods involved in monitoring desert tortoise populations have two immediate objectives: to maximize precision and to minimize bias. Precision represents the amount of uncertainty (variance) in the estimate of abundance. If there is too much variance in annual estimates, the ability to draw conclusions about the magnitude or direction of change from year to year is diminished. Adequate precision in studies of wildlife abundance usually cannot be achieved with small samples. Therefore, a large number of biologists walk thousands of kilometers in the Mojave Desert each year to sample tortoise populations. Because precision is largely a function of effort, it is relatively immune to the influence of training. Training is more important for minimizing the bias in the estimates of tortoise abundance.

Bias is the discrepancy between the estimated abundance and the true abundance and can be either negative (the estimate is lower than the true abundance) or positive (the estimate is too high). It can result from both the methods employed and the set of samples used to collect the data. The first step in combating bias is a good study design. All unbiased monitoring of animal populations requires some form of randomization so that the samples are independent of the distribution of the animals. For example, the estimates of tortoise abundance would have positive bias if transects were conducted only in areas known to have large populations of tortoises. The locations selected each year for transects are designed to be as free as possible from sampling bias, so every effort should be made to conduct each transect at the selected location, and any rejected locations must be well justified. Bias can also result from improper methods or correct methods improperly applied. Training teaches the methods used to sample desert tortoises, but it should also make crews aware of the importance of following correct procedures and the larger consequences of poor quality data collection.

Desert tortoise monitoring uses line distance sampling, a modification of the strip transect method.

In strip transect surveys, an observer travels down the centerline of a strip of defined length ( $L$ ) and width ( $2w$ , where  $w$  equals the distance from the center to the edge of the strip) and records every object observed ( $n$ ). Density ( $D$ ) is then simply  $n$  divided by the area searched ( $2wL$ ) (Fig. 1). This method assumes that all objects within the strip are located. If objects within the strip are not counted (Fig. 2), the density estimate will be too low (negative bias). In practice, some objects will be missed, and with a simple one-time count of the strip, there is no way to estimate the magnitude of the bias. Additional logistical problems, such as



**Figure 1.** Hypothetical strip transect of length  $L$  and width  $2w$ . Eleven objects are counted in the transect, giving density  $D = 11/2wL$ .

accurately defining the width of the strip, make this method impractical in most cases, especially for animals like desert tortoises that are sparsely distributed in large landscapes.

## Objective 2: Understanding How Different Types of Field Data Contribute to Calculation of the Density Estimate

### Correcting Population Estimates to Reflect Imperfect Detection

The line distance sampling method essentially adds one piece of data to the observations in a strip transect, the perpendicular distance ( $d$ ) from the center of the transect to the object detected (Fig. 3). **Because objects close to the line are more likely to be detected than are objects farther from the line**, the distribution of detection distances can be used to estimate a probability of detection ( $\hat{P}_a$ ) within a given distance  $x$  from the transect centerline. One critical assumption in this method is that all objects on the transect centerline are detected, or the probability of detecting an object at distance 0,  $g(0) = 1$ . If this assumption is met, then density can be estimated using the general formula:

$$\hat{D} = \frac{n}{2wL \cdot \hat{P}_a},$$

where  $\hat{P}_a$  is the probability of detecting a tortoise within  $w$  meters of the transect line. To estimate  $\hat{P}_a$ , a curve is built describing the function  $g(x)$ , the probability of detection at distance  $x$  (Fig. 4). This curve is derived from the distribution of observed perpendicular distances out to a maximum distance  $w$ , which defines the strip width of interest. Figure 5 illustrates our expectation

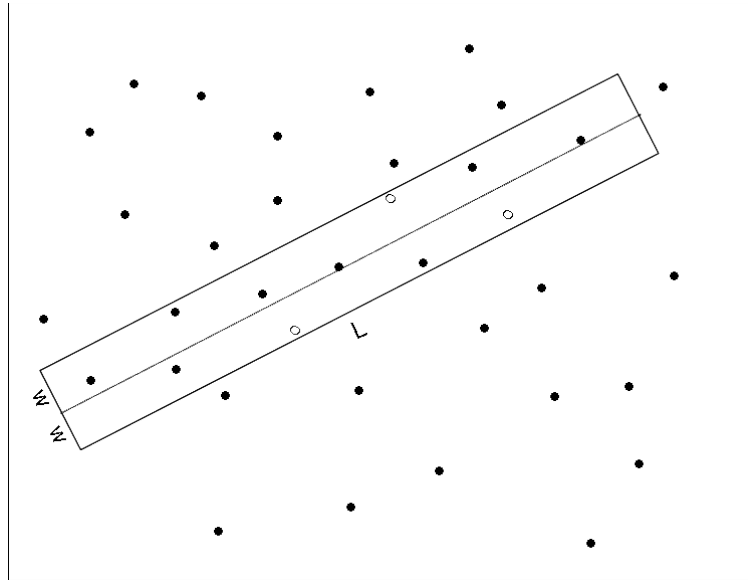


Figure 2. Same example as in Fig. 1, except that 3 objects have been missed (unfilled circles). The density estimate is now  $D = 8/2wL$  and has 27% negative bias. Note that objects farther from the centerline have a greater chance of being missed.

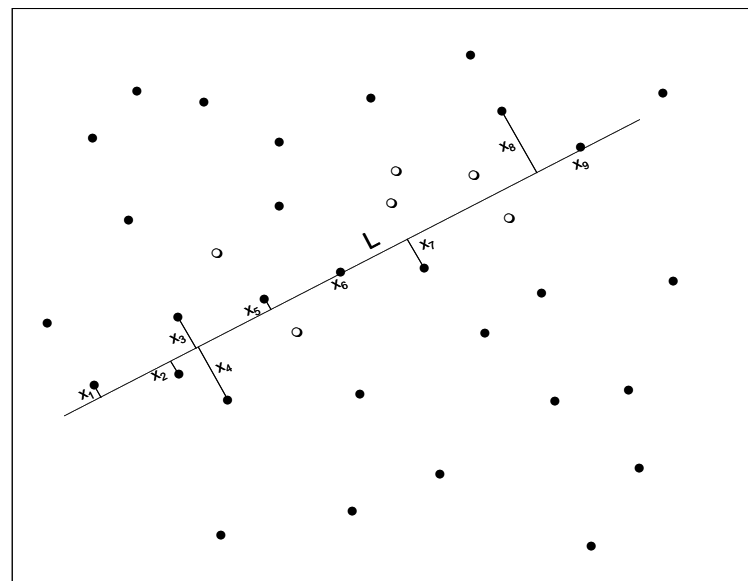


Figure 3. Line transect of length  $L$ . Nine objects at distances  $x_1, x_2, \dots, x_9$  from the line were detected. Six objects (unfilled circles) within the farthest observed distance ( $x_8$ ) were missed. After Buckland et al. (2001), Fig. 1.2.

that all tortoises on the transect line ( $g(0)$ ) are detected, but tortoises farther from the line are less visible. There is no reason to expect fewer tortoises to occur farther from the line, so we interpret the graph to mean that if we had perfect vision, we could see all the tortoises represented by the rectangle ( $1.0 \cdot w$ ) in Figure 5. Instead, we only see a certain proportion,  $\hat{P}_a$ , which is the proportion of that rectangle that is represented by the shaded area under the curve. In essence, the density of the detected objects is used to estimate the density of the undetected (missed) objects, and these two quantities together estimate the true density.

As an example, in a given year, we might walk 8000 km ( $L$  in the density equation above) and report seeing 100 tortoises ( $n$ ) within 20 m of the transect line ( $w$ ), but estimate that we only detected 50% of the tortoises that were present ( $\hat{P}_a$ ). Without correcting for detection, we would estimate there are  $100/(2 \cdot 0.02 \cdot 8000) = 0.312$  tortoises per  $\text{km}^2$ . However, adjusting for detection in the equation above, we refine our estimate to 0.625 tortoises per  $\text{km}^2$ .

#### Assumptions of Distance Sampling

In addition to the assumption that all objects on the line are detected, two additional conditions need to be met for unbiased density estimation using distance sampling: objects are detected at their initial location, prior to movement in response to the observer, and perpendicular distances are measured accurately. Fortunately, in using line transect methods for desert tortoises, these conditions are relatively easy to meet. Desert tortoises generally do not move rapidly in response to approaching observers, except sometimes when retreating into a burrow. In this case, the distance should be measured to the point where the tortoise was first seen. Perpendicular distances can be accurately measured, particularly if the transect centerline is clearly marked (Anderson et al. 2001), but the method used for desert tortoises does not use a marked centerline and satisfying the second condition requires careful application of the field protocol.

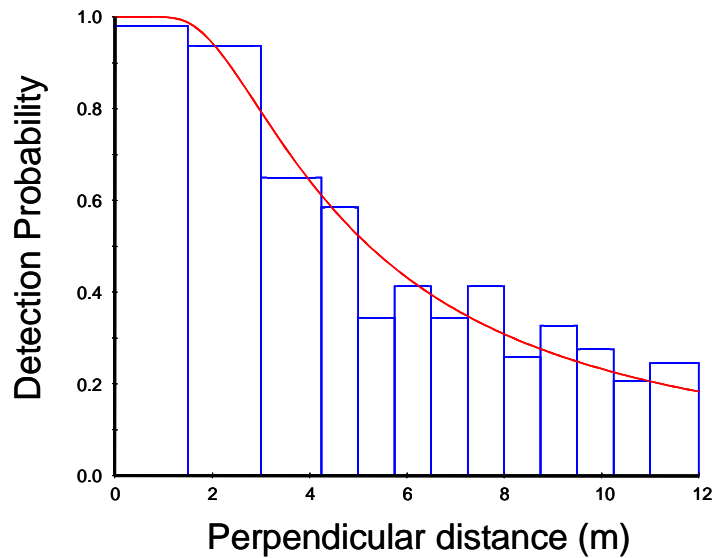


Figure 4. Histogram of observations and detection function to 12m for adult tortoises in the Mojave Desert in 2005.

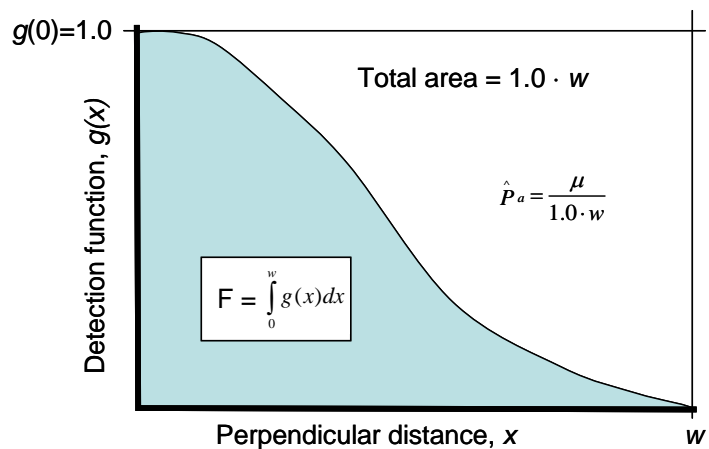


Figure 5. Probability of detecting an animal within distance  $w$  of the transect centerline is the area under the curve (modeled from the distribution of observed perpendicular distances) divided by the total area of the rectangle  $1.0 \cdot w$ . After Buckland et al. (2001), Fig. 3.1.

Line transects for desert tortoises typically produce data suitable for generating detection functions (Fig. 5). However, these data alone do not result in unbiased estimates of abundance. Both training and field data show regular violation of the assumption that  $g(0) = 1.0$ , that all tortoises on the transect centerline are detected. Some tortoises on or very near the line will be missed, despite being available for sampling (see below). This can happen for a number of reasons, perhaps because a tortoise was hidden from view on the far side of a shrub or because the observer was momentarily inattentive. If the number of tortoises missed cannot be estimated, then the estimate of abundance will underestimate true abundance and the magnitude of this negative bias will be unknown and unknowable. To address this problem, a dual-observer technique can be used. Transects are conducted by two observers who search for tortoises independently, which allows a detection probability to be computed for tortoises on (or very near) the transect centerline. If needed, a correction factor can be applied to the estimates of abundance.

#### Proportion of Tortoises That Are Not Available for Sampling

Thus far, we have discussed the role *distance* plays in accounting for cryptic tortoises. A larger source of negative bias results from the basic *natural history* of desert tortoises. Tortoises spend a considerable proportion of time underground in burrows or in vegetation, sometimes deep enough that they are not visible to personnel conducting transects. This proportion of the population not available for sampling varies from year to year. If this proportion is not accounted for, then estimates of abundance will underestimate true abundance. Worse, estimated abundance will vary among years, probably in ways that bear no relationship to variation in true abundance, and there would be no ability to know the magnitude of the negative bias. Fortunately, if the proportion of the population available for sampling can be known or estimated, the estimate of abundance can be adjusted.

Focal tortoises equipped with radio transmitters are used to estimate the proportion of tortoises visible to sampling each year (see **Chapter 6. Radio Telemetry and G<sub>0</sub> Protocols**). This parameter, G<sub>0</sub> (pronounced “Gee sub-zero”), should not be confused with  $g(0)$  (“g at zero”) the probability of detection at distance = 0. Estimation of G<sub>0</sub> consists of the observation of a cohort of focal tortoises associated with each monitoring stratum. The focal animals are equipped with radio transmitters and observed daily while transects are being sampled in that area. Information is recorded on tortoise location and visibility. Typically, at any time during the optimal time of day, 80% of tortoises are above-ground or visible in burrows. This means that even if we adjust our density estimate to correct for lower probability of detection farther from the transect centerline, we are still underestimating the density of tortoises by 20%. To account for this “invisible” portion of the population, we use the following equation:

$$\hat{D} = \frac{n}{2wL \cdot \hat{P}_a \cdot \hat{G}_0}$$

Starting from our example above, with 0.625 tortoises/ km<sup>2</sup>, we can now consider the significance if only 80% of the tortoises were available to count. Using the equation above, we estimate there were 0.625/0.80 = 0.781 tortoises/km<sup>2</sup>.

Figure 6 depicts this new information. The larger square of the graph represents the actual size of the population. The proportion described in Fig. 5 and encompassing the rectangle with an area of  $1.0 \cdot w$  is only the visible portion of the total population. This visible portion comprises two parts: The proportion we see is the area under the curve in blue. The proportion that is visible but undetected (due to distance from the transect line) is in white. Finally, the portion of the total population that we discuss in this section and that is invisible in burrows is the additional area in orange.

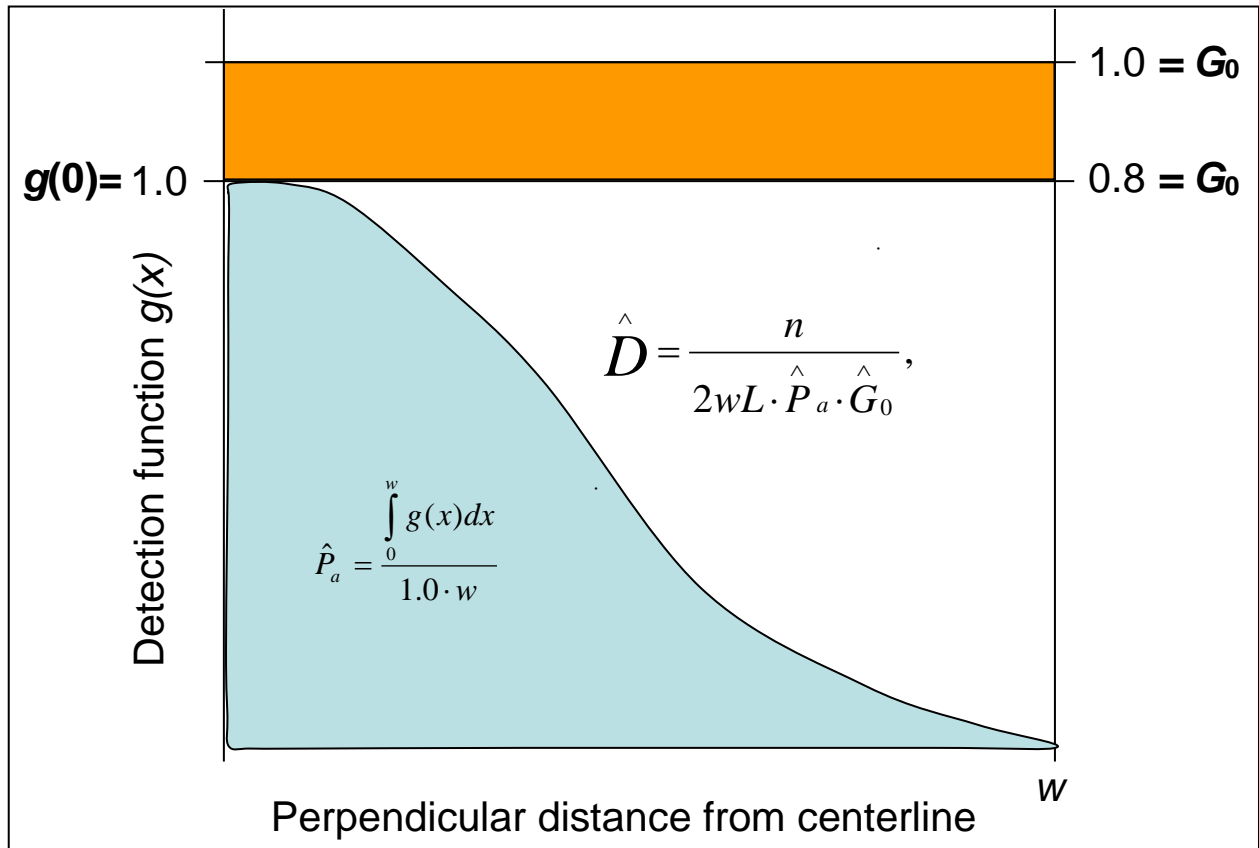


Figure 6. Probability of detecting a visible animal within distance  $w$  of the transect centerline is the green area under the curve divided by the total area of the rectangle  $1.0 \cdot w$ . The rest of that rectangle (in white) is visible but undetected because as cryptic animals like tortoises are farther from the observer, they are harder to detect. This rectangle is the visible portion of the total population (the larger rectangle), which includes tortoises invisible in burrows (the orange rectangle).

## 2. DESERT TORTOISE HANDLING

Mojave desert tortoises are designated as a federally threatened species under the Endangered Species Act, and are also protected by state laws. Proper handling is required to comply with these laws and to ensure safe and humane treatment of the tortoises. Proper handling requires attention to protocols to reduce the likelihood of infection or disease transmission. Tortoises are also vulnerable to overheating and death if improperly exposed to direct sunlight and high ambient temperatures. Desert tortoise surveys include collection of data on size, sex, and health status of encountered tortoises. Handling can cause fluid loss if tortoises void their bladders. To minimize impacts to tortoise health, the U.S. Fish and Wildlife Service (USFWS) as well as state wildlife agencies develop conservation measures and stipulate permit “Terms and Conditions” that provide a basis for desert tortoise handling protocols for this project.

**Objective 1:** Compliance with federal and state desert tortoise handling protocols.

1. Each trainee will have a thorough understanding of the important elements of the USFWS desert tortoise recovery permit terms and conditions.
2. Each trainee will have a thorough understanding of the important elements of relevant state wildlife agency desert tortoise permit terms and conditions.
3. Each trainee will fully comply in letter and spirit with every element of the USFWS and the relevant state wildlife agency desert tortoise handling protocols (or permit terms and conditions). For example, strict adherence to temperature limitations is not enough; quick, efficient, shaded, 2-handed processing of desert tortoises during handling and data collection is imperative.

**Objective 2:** Accurately measure, mark, examine for general health, and identify the sex of tortoises

**Metrics:** Trainees will demonstrate understanding of USFWS and relevant state wildlife agency desert tortoise handling protocols (or permit terms and conditions), and will demonstrate ability to handle a tortoise without violating any of these protocols. Each trainee must implement correct approaches to avoid tortoise hyperthermia, avoid loss of fluids by the tortoise, and to avoid human transmission of disease or parasites between tortoises. Each trainee must properly handle, accurately measure length, accurately determine sex of live tortoises, and accurately report body condition score plus nasal appearance and discharge.

### Key Facts

The Mojave population of the desert tortoise was listed as threatened under the Endangered Species Act in 1990; recent genetic work has resulted in this “population” being designated as a full species. Potential threats to the desert tortoise include habitat loss, degradation, and fragmentation, illegal collecting, vehicle impacts, and predation of all size classes by ravens and other species. Mycoplasmosis and other identified and unidentified infections may play a role in population declines. Non-native annual plants and their effects on fire regimes have also been implicated.

The desert tortoise is found only in the deserts of Arizona, California, Nevada, and Utah. It is the largest reptile in the Mojave Desert and is the state reptile for both California and Nevada. The desert tortoise is without question a flagship species, and possibly a keystone and indicator species, so its persistence and recovery is culturally and ecologically important.

Desert tortoises have a lifespan of 50 to 100 years. Adults can be as large as 380 mm long, and male tortoises tend to be larger than females. Males typically have a longer tail and longer upward curving gular horns than females, as well as larger chin glands and a concave plastron; females tend to have longer rear toenails. Despite their long-life spans and hardened exteriors, tortoises can be injured or die from improper handling. Anyone handling Mojave desert tortoises or conducting scientific research on them or their habitat must have appropriate federal and state permits.

Desert tortoises are herbivores that primarily feed upon annual grasses and flowering plants. They start to reproduce at 15 to 20 years of age, and females lay 1 to 6 eggs one to as many as three times a year. Desert tortoises spend much of their time in underground burrows, buffered from extremes of the desert climate. They are found in habitats characterized by creosote bush, salt bush, cactus scrub, shadscale scrub, and Joshua tree woodlands, usually below 1280 m (4200 ft) elevation. Historically, reported local densities exceeded dozens of tortoises per square kilometer; however no known areas support this many tortoises today. Tortoises display seasonal activity patterns with most above-ground activity between March and May and then again in September and October; they are usually underground and inactive during the rest of the year, with occasional above-ground activity probably driven by temperature and precipitation.

A distinctive feature of tortoises is their shell. The dorsal (top) shell is the carapace and the ventral (bottom) shell is the plastron. Each section of the shell is called a scute (pronounced *scoot*). Individual scutes, or scute series, are identified by position and/or name. Notching is used on some projects to mark tortoises, so it is one form of marking you may use or encounter.

### **Objective 1: Compliance with Federal and State Desert Tortoise Handling Protocols**

Desert tortoise handling training is provided to ensure the safety and well-being of desert tortoises encountered during monitoring activities. Safe practices include basic techniques that reduce stress and likelihood of disease transmission to tortoises. These techniques also reflect terms and conditions of USFWS and state wildlife agency tortoise permits.

Once trained and approved in tortoise handling, you will be covered under a USFWS permit, and other required permits, to handle tortoises during this project. Beyond following the specific terms of these permits, you are responsible for following the guidance we provide to interact with tortoises without harming them. The brief description of proper tortoise handling procedures given here is only an overview.

#### *Avoiding desert tortoise hyperthermia.*

Tortoises have little effective physiological capacity to dissipate heat, so it is the handler's responsibility to guard against over-heating. Desert tortoises should not be exposed to direct sunlight. Keep them in the shade of a shrub or of your body or shade you create with an object (e.g. shade cloth or sun umbrella). Remember that ground temperatures are much hotter than air temperatures, so minimize tortoise/ground contact when temperatures are hot. The critical maximum body temperature of desert tortoises is between 103<sup>o</sup> F and 112<sup>o</sup> F.



*Avoiding transmission of diseases between tortoises.*

You should handle a tortoise at all times as if it has a communicable disease. Do not allow tortoises to come into contact with your clothing or skin. Before touching a tortoise, put on a clean pair of non-porous disposable gloves (e.g. latex, vinyl, or similar material), and keep them on during the entire time you handle a tortoise. If your glove is torn during handling of a tortoise, replace it. Once used, gloves and any other disposable materials must be contained so as not to come into contact with disinfected materials, fresh gloves, equipment, or any other item that might come into contact with a tortoise. A fresh pair of gloves must be used for each tortoise. All non-disposable 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 treated with an approved disinfectant. Currently, Rescue®, Trifectant®, or chlorhexidine diacetate are approved for use when prepared according to manufacturers' instructions. Like 5% bleach, these are broad-spectrum disinfectants, but compared to bleach they are less corrosive and their disinfecting strength is somewhat less compromised by exposure to organic material.

- Rescue® is sold as ready to use liquid disinfectant and is effective against viruses, bacteria, fungi, and tuberculoids. Contact time for disinfection is 1 minute. This solution uses powerful surfactants (detergents) that are compatible with a wide range of materials including metal. It uses hydrogen peroxide as the active ingredient, breaking down into water and oxygen and reducing environmental impact. Note: The wipes and concentrated solution are not recommended for our purposes.
- Trifectant® is sold as a powder or tablet and is effective against viruses, bacteria, and fungi. It is also fairly resistant to inactivation by hard water and organic matter. Once mixed, the solution is stable for seven days. Contact time for disinfection is 5-10 minutes and metal instruments should not be soaked for more than ten minutes. A 1-2% solution should be mixed according to instructions on the packaging.
- Chlorhexidine diacetate is sold as a liquid and is effective against viruses, bacteria, and fungi. It should be prepared according to the instructions on the packaging.

Note: Do not leave disinfectant solutions (e.g. Rescue®, Trifectant®) in direct warm sunlight or in hot vehicles.

*Avoiding loss of fluids by tortoises.*

Special precautions should be taken to prevent or minimize the fluid loss that occurs if tortoises void their bladder during handling. Do not handle the tortoise more than necessary. For the basic distance sampling project, the most important information (distance from the transect centerline) does not require handling of tortoises. It is important to minimize risk to tortoises when they are handled in the course of data collection. Always use two hands when picking up a tortoise, and do not turn it on its back or move it rapidly. Sudden movements can cause the tortoise to void (urinate), which can result in dehydration and increases risk of death. Tortoises found in burrows should only be extracted if they are accessible without reaching more than a foot into the burrow (for instance, if they are basking near the mouth), and if they can be extracted without use of force. Refer to your permits for what to do should a tortoise void its bladder. When offering fluids via nasal-oral water administration with the use of a sterile syringe, remember to avoid touching the syringe to the tortoise. Instead, create a slow, steady flow that moves over the tortoise's nares

(nostrils) and mouth. Offer fluids while positioning yourself away from the tortoise's line of sight; standing behind the tortoise and holding the syringe above and behind the tortoise's face is best. This may minimize the stress response from the tortoise and should avoid pushing material back into the nares. Offer a minimum of 15 ml regardless of weight and as much as 40 ml/kg as long as the tortoise appears to be accepting fluids. Water offered to the tortoise should be kept separate from human drinking water. Syringes used for rehydration are single use only; discard the syringe once it has been used, do not disinfect.

## **Objective 2: Accurately Measure, Mark, Identify the Sex of Tortoises, and Report their Health Status**

During this project you will collect information about tortoises detected on transects and encountered while on the way to and from transects. Related data will be collected for carcasses. See annotated data sheets in **Appendix I**.

### *Measuring tortoise length*

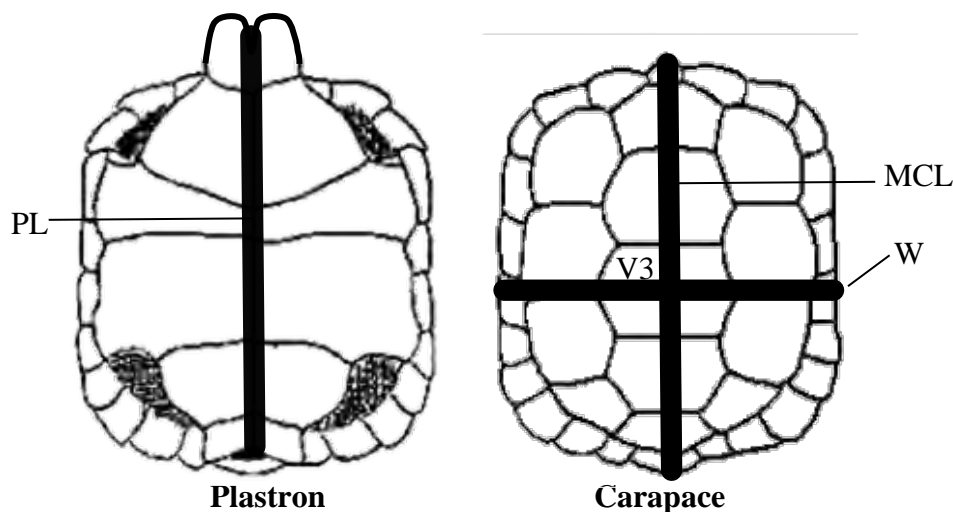
Of the measurements illustrated in Figure 2-1, you will measure only midline carapace length (MCL) on all accessible live tortoises. Using tree calipers, MCL is measured in millimeters from the center of the most anterior scute (i.e. the nuchal; where the head emerges) in a straight line directly over the center line of the tortoise to the most caudal aspect of the carapace (i.e. often the supracaudal or pygal scute; where the tail emerges). Note that the most caudal end of the carapace may not be the edge of the supracaudal scute.

If a tortoise cannot be removed from a burrow, it is nonetheless important to record whether unhandled tortoises are at least 180 mm MCL ("adult") or are sub-adults. These size categories are used for density analysis, so every effort should be made to determine whether the tortoise is larger than 180 mm.

### *Determining sex of a tortoise*

Determining the sex of a tortoise smaller than 180 mm MCL is generally difficult. Tortoises larger than this can usually be sexed using the following guidelines, with the most reliable characteristics listed first. The easiest way to identify males is to look for a concave plastron (females have minimal or no plastron concavity). Remember, never turn a tortoise onto its back. The second most obvious characteristic is that males have longer, more curved gulars than females. A third telling characteristic is their tail. Males have long, broad, conical shaped tails, while the female tail may be just a nub at the end of the cloaca. If you are still not sure of the sex, look for chin glands – males often have large well-developed chin glands that sometimes leak fluid at this time of year. When in doubt, record sex as "unknown."

**Figure 2-1. Typical measures of the dimensions of desert tortoises.**



**Plastron Length (PL):** Length of the plastron (bottom shell) from gular notch to anal notch. *Note this measure was discontinued in 2015, see the Health Assessment Procedures for the Desert Tortoise (Gopherus agassizii): A Handbook Pertinent to Translocation referenced below for more information.*

**Midline Carapace Length (MCL):** Length of carapace (top shell) along the vertebral scutes from the center of the nuchal to the most caudal end of the carapace, often the rear marginal (supracaudal or pygal) scute.

**Width (W):** Width of the carapace measured by holding calipers directly over the center line of the tortoise crosswise in the middle of the 3<sup>rd</sup> vertebral scute. Keep the calipers level with the ground.

**Height (not illustrated):** Height of the carapace measured by placing one arm of the calipers across the center of the 3<sup>rd</sup> vertebral scute on the carapace and the other arm across the plastron. The arms of the calipers should extend all the way from one side of the tortoise to the other while being held level against the carapace and plastron.

#### *Reporting information about tortoise health*

Although there are various metrics to describe tortoise health, many of these require blood sampling or other procedures that may cause a stress response in the tortoise. Because our project does not otherwise require such procedures, we are only collecting visual information to describe general health condition.

Specifically, you will examine the tortoise (soft tissue as well as the shell) and report whether they have no ticks, 1-10 ticks, or more than this. You will also examine the condition and discharge from their nares, which provides insight into current and chronic respiratory condition. Finally, you will examine muscle development and fat storage on the head and forelimbs to

describe the overall health of the tortoise. *Remember that even if an individual tortoise does not exhibit signs of illness, many diseases develop over time such that clinical signs will not be apparent. Other diseases express themselves periodically, or will not be apparent based on the characteristics you are reporting. Do not at any time assume that you can relax any protocols for avoiding disease and parasite transmission.*

The material described in this section is from: USFWS. 2019. Health Assessment Procedures for the Desert Tortoise (*Gopherus agassizii*): A Handbook Pertinent to Translocation. Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. This report can be found at: <https://www.fws.gov/media/2019-desert-tortoise-health-assessment-procedures-handbook>.

### Body condition scoring

Body condition scoring (BCS) was developed for domestic animals to estimate the average body condition of animals in a herd of livestock. This system results in a relative score based on an evaluation of muscle mass and fat deposits in relation to skeletal features. The San Diego Zoo has adapted this concept to the desert tortoise. Because tortoises can vary considerably in hydration state, length-corrected weight alone is not a good indicator of body condition. The BCS evaluates characteristics that reflect the way a tortoise's body condition will change with life stage, season of the year, drought, food availability, and disease.

BCS is a score that ranges from one to nine. Assigning a BCS is a two-step process. The numbers are divided into 3 groups (during training, a veterinarian will use pictures to illustrate the specific scores):

- Under condition (scores 1-3): Because the digestive tract is relatively empty, the tortoise feels light for its size. Muscle mass on the arms is not convex (may be concave), and the muscle mass on top of the head slight enough that it is flush with the skull or concave; the sagittal crest may be visible.
- Good condition (scores 4-6): The tortoise has been eating, although it may be slightly lighter or heavier than expected. Muscle mass on top of the head is convex to prominent. Muscle mass along the front of the forelimb is flat or convex.
- Over-condition (scores 7-9): The tortoise feels much heavier than expected. Muscle mass on top of head and front of forelimbs is prominent. Subcutaneous fat deposition is apparent.

### Nares condition and discharge

With chronic illness, the form of the nares themselves will be affected. Considering both nares together, you will determine whether their appearance is:

Normal – Usual shape and/or size.

Eroded - Loss of scales and skin around either naris opening.

Occluded – Plugged or reduced size of either naris opening.

Discharge from nares may provide evidence of disease to the respiratory system. You will consider discharge from both nares and report the most severe version that is expressed.

None – No discharge present.

Serous - Clear, watery discharge present. Also report the amount:

1. Mild - Moisture present around nares.

2. Moderate - Discharge coming out of the nares, but not running far from the nares themselves.

3. Severe - Discharge coming from nares that is running down the beak.

Mucous – Cloudy, thick discharge present. Also report the amount:

1. Mild - Moisture present around nares.

2. Moderate - Discharge coming out of the nares, but not running far from the nares themselves.

3. Severe - Discharge coming from nares that is running down the beak.

### Ticks

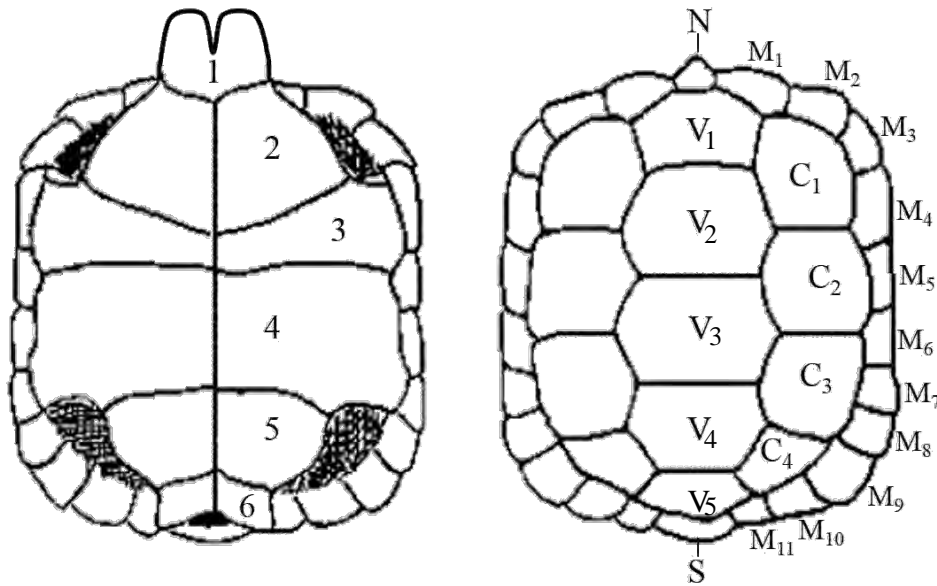
Ticks will attach themselves on soft tissue, including skin of the limbs, vent, and tail. They are often associated with soft tissues associated with the beak, eyes, and nares. Also examine the shell for possible attachment in the seams between scutes of the carapace and plastron, or on the scutes themselves.

### *Marking a tortoise*

Paper tags will be affixed to a scute of each unmarked tortoise. Because tortoises are often relocated head-down in burrows, using the 4<sup>th</sup> right or left costal scute will increase the likelihood the tag will be read and tags should be placed in this location. Minimize the abrasion the tag will be subjected to; select a scute with a natural depression. When affixing the tag, under no circumstances should epoxy touch the margins of the scutes, where growth must occur. Small tortoises with scutes that are too small to safely affix tags should not be marked.

In addition to recording information for the new tag you attach, you will be asked about markings or tags that are already present on each tortoise. Floy© tags were used by range-wide monitoring crews in 2005 and 2007, and paper tags have been used since 2008. Besides the use of tags, many researchers mark tortoises by notching the marginal scutes (Figs. 2-2 and 2-3). Any existing tags should be recorded in the corresponding data field and any existing notches should be noted in the comments, include both notch location (see below for more details) and type (file, epoxy, etc.).

**Figure 2-2. Tortoise Scute Identification.** Individual scutes, or scute series, of the plastron (lower shell) and carapace (upper shell) of desert tortoises. As illustrated for costals, individual scutes are identified by counting from anterior to posterior; marginals are also identified as left (L) or right (R) from the tortoise’s perspective.



**Plastron**

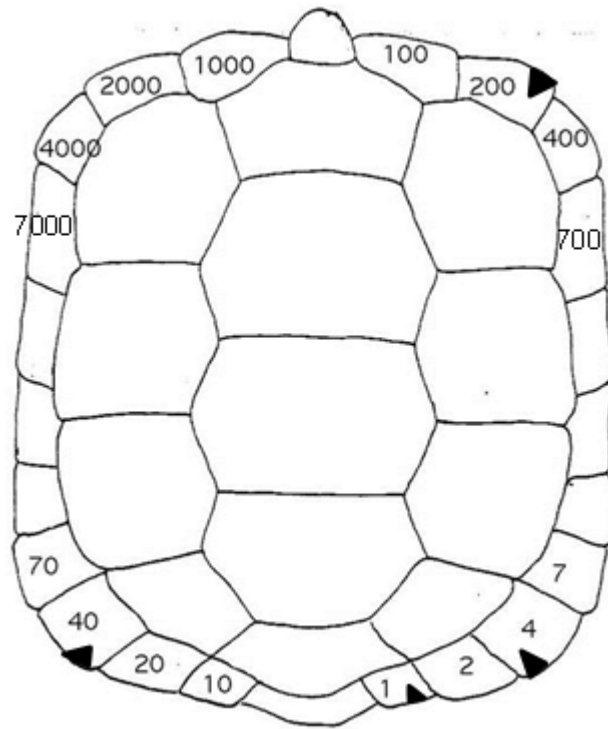
**Carapace**

- 1 – Gular Horn
- 2 – Humeral Scute
- 3 – Pectoral Scute
- 4 – Abdominal Scute
- 5 – Femoral Scute
- 6 – Anal Scute

- N – Nuchal Scute
- V – Vertebral Scute
- C – Costal Scute
- M – Marginal Scute
- S – Supracaudal Scute

The notching system used for most current translocation projects is the “highly modified Honegger system,” illustrated below. When you are not notching, do not assume you know the system used on a particular project – there are many of these systems! Simply report the side and marginal number(s) with notching: e.g., L9 / R2,9,11 is the accurate report of notches in Fig. 2-3.

**Figure 2-3.** The Highly Modified Honegger notching system. The illustrated notching pattern corresponds to the number “245,” and when encountered would be reported as “L9 / R2,9,11”



### *Carcasses*

Only report carcasses if at least half of the shell is present, or if a smaller part of the carcass is available but identifying marks are present. Record MCL and sex of carcasses only if you are able to determine these measures accurately. If the carcass/carapace is not sufficiently intact to measure MCL, it is “disarticulated”, if the MCL can be measured it is “intact.” Other projects may have a different operational definition for this term. Some projects also request information on “Carcass class”:

#### Carcass Classes

1. fresh or putrid
2. normal color, scutes attached
3. scutes peeling off bone
4. shell bone falling apart and scute rings peeling
5. disarticulated, scattered

## Approaching and collecting data on desert tortoises

The order of the following steps is meaningful and is designed to 1) start at a distance and move closer, 2) move from least to most disruptive to the tortoise, and 3) minimize actual handling time. If you are working in a two-person team, establish which person will handle the tortoise and contaminated materials and which will handle uncontaminated materials and record data.

- Always use your “field voice” when out in the field
- When a tortoise is located
  - Observe the tortoise and its surroundings
  - Record or make a note of the time of observation
  - Put away non-handling equipment
    - Place pack several meters away from tortoise (out of tortoise sight)
  - Identify an area for processing the tortoise
    - Shade of vegetation preferable or use your own body or shade cloth/umbrella
    - Several meters away from burrow entrance if nearby
    - Place thermometer in new shade approximately 5 cm above where the tortoise will be handled to ensure suitable temperatures based on permit terms and conditions (if there is old shade available this is where the tortoise should be processed, however the temperature should always be recorded in new shade)
  - Observe whether the tortoise has an existing tag and/or has been notched
  - Make basic observations of body condition score (if indicated)
  - Take pictures of the tortoise, at least one photo should be taken looking down on the tortoise's head and carapace, capturing the head and possibly upper half of the forelimbs (see **Chapter 7. Objective 3: Understanding How to Enter Data on the iPad mini** for more details about photos)
  - Finish recording any distance data prior to handling tortoise
  - Remove needed handling gear from the pack; place in the processing area
    - Place calipers on the ground at the processing area
  - If no existing tag is present, back at the pack, cut out the paper ID tag
  - Record all relevant fields, such as transmitter (if applicable and permitted) or ID tag number, prior to attaching it to the tortoise and handling
- If temperatures are suitable for handling, move the tortoise to the processing area
  - Put on latex gloves
  - Approach and pick up the tortoise from behind using 2 hands, one on either side of the shell.
  - Keep the tortoise close to the ground and in correct orientation.
  - Keep all clean equipment on the left side of the tortoise
    - Do not place equipment under the tortoise
    - Do not place gear where the tortoise might step on it
- If an existing tag is present, if needed, use a small amount of clean water or an alcohol swab to clear dust and read the tag number
- If no existing tag is present, mix the epoxy on cardstock and apply ID tag
- Hold calipers near the tips to move them to the correct measuring position
- Read MCL while holding calipers parallel to the carapace with caliper tips in place.



- If needed and with the tortoise close to the ground, lift and tilt the tortoise slightly to view plastron and tail for sex determination
- Observe tortoise for any health abnormalities (if indicated) and to better assess body condition score. Count ticks (if indicated)
- Notch and apply transmitters to shells (if indicated and permitted)
- Handle only parts of non-disposable gear that can be disinfected
- Continue to place all contaminated items to the right of the tortoise while working.
- If tortoise voids during handling, offer fresh water via nasal-oral fluid administration
- Return tortoise to its original location if shaded, otherwise, if in sun, place tortoise in the shade near the original location
- Pick up cardstock, Q-tips, and other contaminated disposable items in one hand.
  - Turn this glove inside out as it is removed in order to contain the trash
- Remove other glove, taking care to not contaminate skin, then place both gloves in the disposal bag taking care to not contaminate the outside of the bag
- Finish recording all data gathered
- Open disinfecting solution and apply liberally to equipment or to the cloth/toothbrush used for cleaning
- Apply a new pair of gloves and use the cloth or toothbrush to remove any dirt and debris from contaminated items
  - Completely cover all contaminated areas with liberal amounts of disinfectant solution and allow to air dry.
  - Place items in the sun away from processing area to allow for further UV disinfection
- Survey area for any trash or equipment left on the ground prior to leaving
- Remove gloves and place them in the trash bag.
- Place the cleaned equipment and trash bag back in the pack
  - Use standard separate locations in pack

### 3. COMPASS AND NAVIGATIONAL GPS



Two methods of navigation will be used while you conduct monitoring with distance sampling. Use a **navigational GPS** to locate transect start points, keep track of meters walked, check the data collection device grab for validity, and return to your vehicle from the transect. A **compass** will be used to set and hold the correct bearing as you walk, and to report azimuth and bearing. The integrated data collection device GPS is not for navigation; it is used solely to transfer location data to the collection system. For demographic plot surveys a **navigational GPS** will be used to locate transect start/end points, report locations, and navigate along a specified easting or northing.

The **goal** of Compass and Navigational GPS training is to enable you to confidently and correctly apply your existing knowledge of GPS and compass navigation to distance sampling. It is expected that you already have a basic understanding of how to navigate with a compass and a standard recreational grade GPS unit. These skills are crucial to collecting data, as well as to your personal safety and the safety of those around you.

**Objective 1:** Basic understanding of GPS.

Navigational GPSs are provided by each monitoring team, so unit set up, operation, and maintenance are the responsibility of each team. Emphasis in USFWS training is on application to distance sampling for desert tortoises.

**Standard:** Understand GPS basics, including what GPS is and how it works

**Standard:** Understand coordinate systems and how they are applied to GPS

**Standard:** Understand the importance of GPS signal strength

**Standard:** Correctly utilize GPS in the context of distance sampling surveys

**Objective 2:** Basic understanding of compass use.

Compasses are provided by each monitoring team, so compass set up, operation, and maintenance are the responsibility of each team. Emphasis in USFWS training is on application to line distance sampling for desert tortoises.

**Standard:** Know basic compass terminology and anatomy

**Standard:** Understand the difference between true and magnetic north.

**Standard:** Correctly utilize compasses in the context of distance sampling surveys

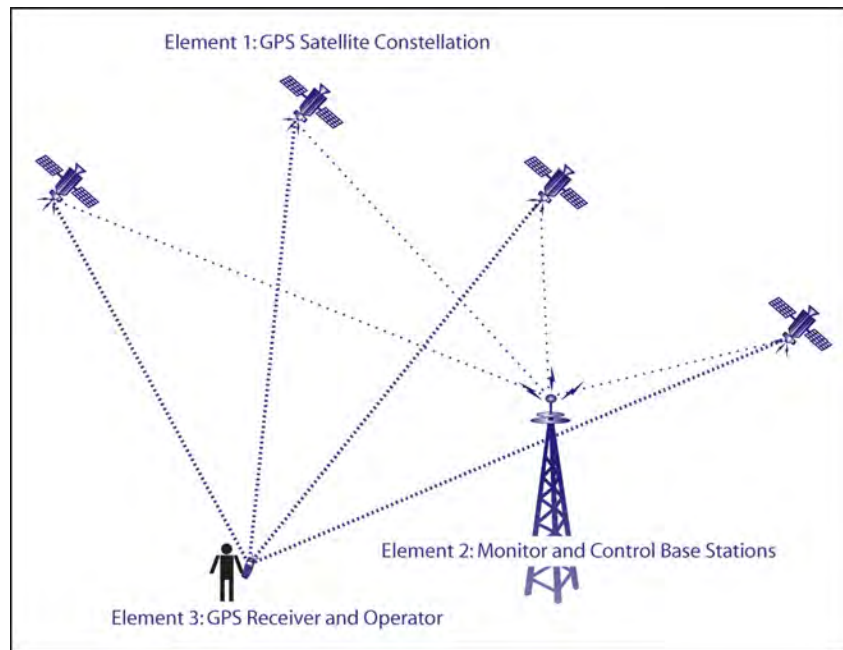
**Metrics:** Trainees will be evaluated on use of compass and navigational GPS through practical exercises, including performance on training lines and navigation on practice transects. Proficiency must be demonstrated by everyone conducting distance sampling.

## Objective 1: Basic Understanding of GPS



- **GPS Basics**

- What is GPS - The Global Position System (GPS) was originally developed for military purposes by the U.S. Department of Defense. In the 1980s, the system, which provides positioning, navigation, and timing (PNT) services, became available for civilian use. In addition, in 2000 selective availability<sup>1</sup> was turned off. There are three basic elements to the system ([www.gps.gov](http://www.gps.gov)):



- i. The space element is made up of a constellation of 24 operating satellites that transmit one-way signals of the GPS satellite's current position and time.
- ii. The control element consists of monitor and control base stations around the world that ensure the satellites stay in their proper orbits and stay accurately

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<sup>1</sup> Selective Availability (SA) is the intentional degradation of GPS signals that was put in place by the U.S. Department of Defense as an attempt to prevent military adversaries from acquiring highly accurate GPS data. SA was turned off in May of 2000, vastly improving the accuracy of civilian GPS receivers.

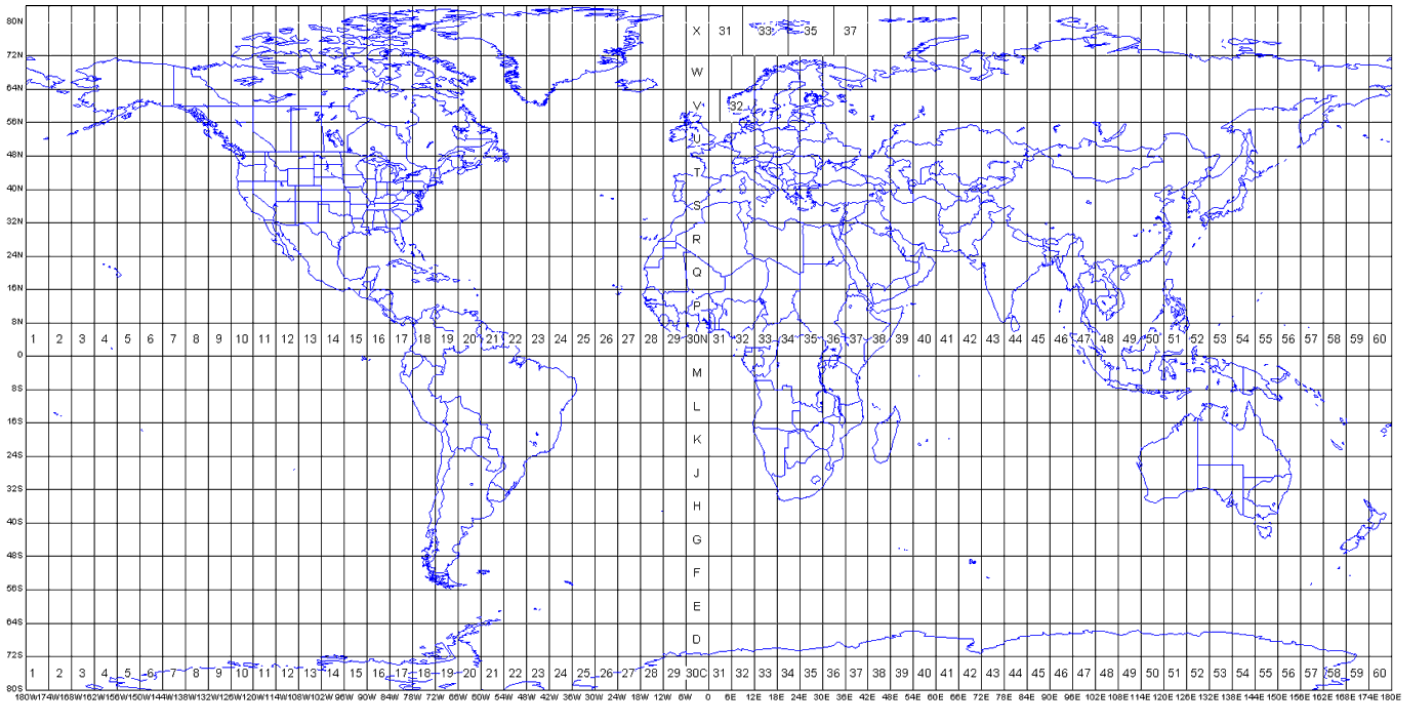
timed. These stations also track the GPS satellites, update them with navigational data as it becomes available, and collectively maintain the health and status of the GPS constellation.

- iii. The final element is the end user, consisting of the GPS receiver equipment and you, the equipment operator. The equipment uses GPS satellite signals to calculate the user's three dimensional position and time. If applicable, it displays this information to the user in an understandable way.
- How GPS works –
    - i. Each operational GPS satellite circles the earth in a very precise asynchronous orbit twice a day, transmitting signal data to active, within-view GPS receivers.
    - ii. The receiver uses the signal data to calculate the user's location through triangulation.
      - Triangulation compares the time a signal is sent by a satellite with the time it was received to determine how far away the satellite is.
      - Triangulation requires at least three satellite signals to determine a 2 dimensional location (x and y).
      - With four or more satellite signals, a receiver can calculate its 3 dimensional location (x, y, and z [i.e. altitude]).



- iii. Once the location is determined, the receiver can track speed, distance, elevation gain, and other information.
- **Coordinate Systems and GPS** – Geographic coordinate systems allow any point on Earth to be defined and represented by a numbering scheme, the most common of which is latitude and longitude, but monitoring data will be collected in the Universal Transverse Mercator (UTM) coordinate system.
    - Most GPS receivers come out of the box set to latitude and longitude, so you may need to refer to the user manual to change the settings. **Your display units must be in UTM.**
    - UTM is typically a better coordinate system for navigating across and collecting data on smaller areas, like transects and monitoring strata. When navigating larger distances, the latitude longitude system is easier for pilots and sailors to use.
    - The UTM grid system originated in 1947 out of the U.S. Army's need for a way to designate rectangular coordinates on large scale (i.e. small area) military maps but is becoming more prevalent because the coordinates are easier for the typical civilian navigator to use than latitude and longitude.

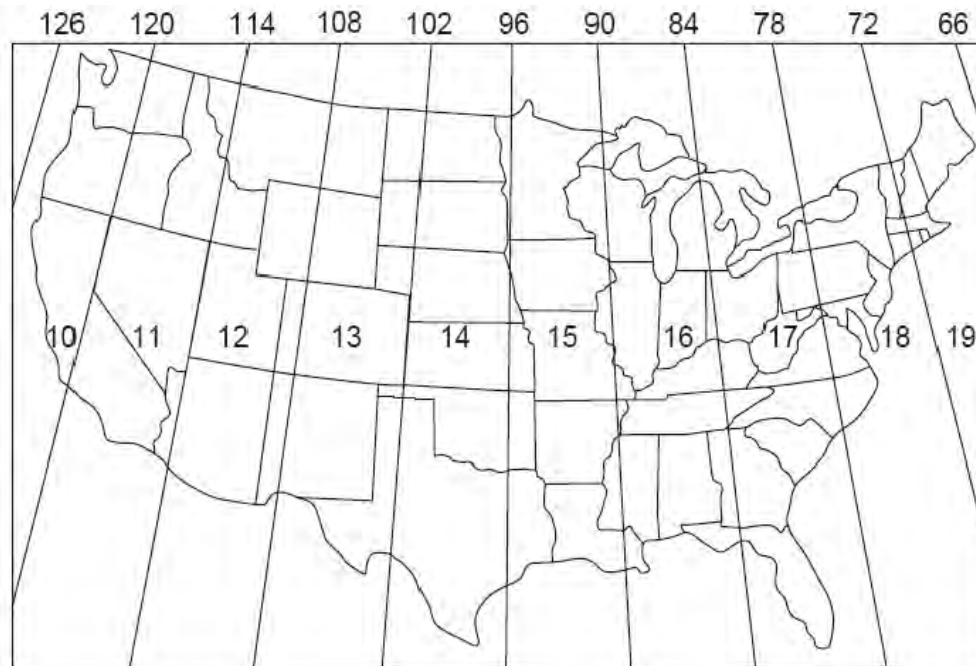
- With the UTM system, the earth is divided into 60 zones, numbered 1 (at the International Date Line) and proceeding east to 60. Each zone is 6 degrees of longitude wide.
- Each numbered zone is then divided into horizontal lettered bands that span 8 degrees of latitude, starting with C in the south and proceeding to X in the north. I and O are skipped due to their similarity to 1 and 0. The map below shows the entire UTM grid system.



- UTM coordinates are expressed in Easting and Northing
  - i. Easting** – easting is measured from the vertical center line, or central meridian, of the zone. The center line is given an arbitrary value of 500,000 meters, so anything to the west of the central meridian is less than 500,000, and anything to the east is greater. Because the zones are 6 degrees wide and never more than 674,000 meters wide, an easting of zero is not possible.
  - ii. Northing** – northing is measured relative to the equator.
    - In the northern hemisphere, the equator is assigned a value of 0 meters north and increases as you travel north.
    - In the southern hemisphere, the equator is assigned a value of 10,000,000 meters north and decreases as you travel south, which avoids the possibility for negative numbers.
    - It is possible to have the same Northing value in the north and in the south, but confusion is avoided by including the letter of the latitude band or by including North or South.
    - Because Northing is determined based on the equator instead of the latitude bands, the bands become unnecessary and are often not used.
    - Many GPS receivers denote whether the northing is north or south of the equator by simply adding N or S to the number. This can create confusion

because southern Nevada and California are in UTM Zone 11 latitude band S, but on your navigational GPS, it will likely show up as UTM Zone 11N because it is north of the equator).

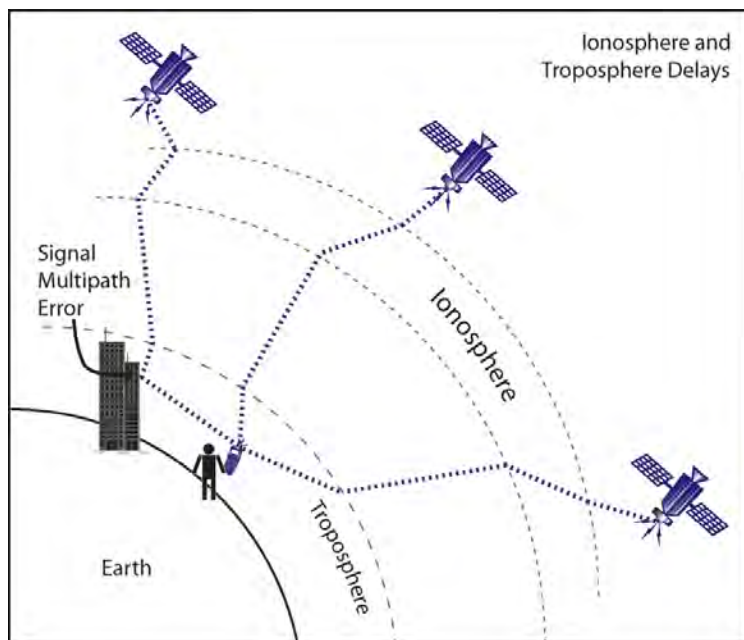
- Arizona and Utah transects are in UTM Zone 12 and your navigational GPS unit should automatically switch to the new zone as appropriate. The map below shows the UTM zones of the U.S. with Longitude along the top.



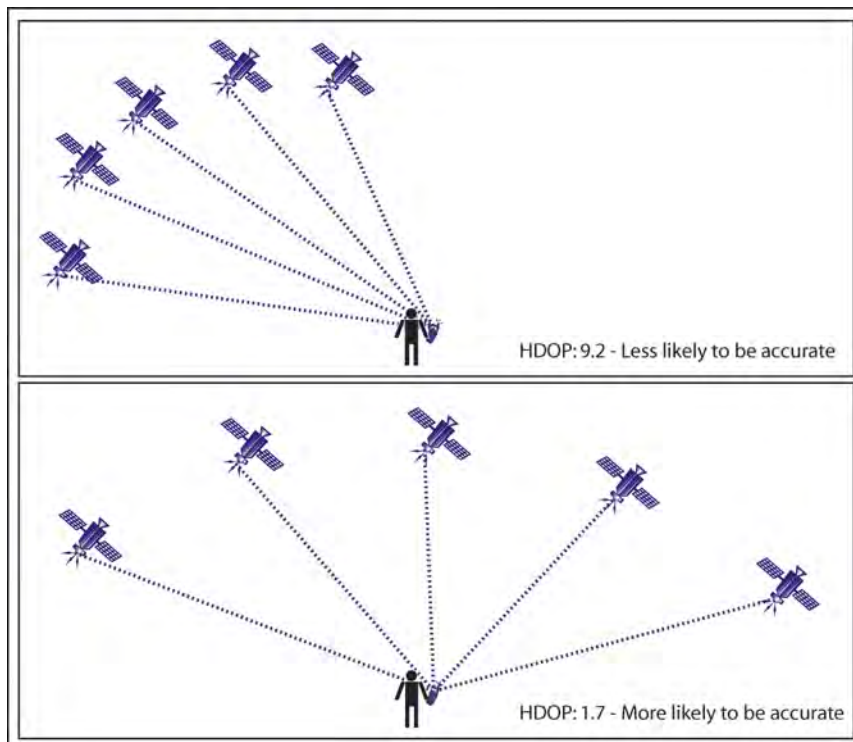
- Datum – A datum is the model used to match the location of a feature on the ground to the coordinates of the feature on a map. GPS uses the World Geodetic System (WGS) 1984, an Earth-centered datum that was adopted from the North American Datum of 1983. **Make sure your navigational GPS is set to UTM, WGS 1984.**
- **How GPS is Applied to Monitoring** - While completing a transect, you will use both a navigational, interactive GPS unit and the non-interactive GPS that is integrated into a data collection device (e.g. an iPad mini). The navigational GPS unit is not provided by the USFWS, so training on menu navigation and GPS care is up to you and your team leaders.
- The navigational GPS unit will be used in six different ways:
  - i. Navigating to a transect start point – for each transect assigned to you, it is up to you, and your group to determine how you will get to the [closest] access point on the transect.
  - ii. Keeping track of meters walked – most navigational GPS units display distance traveled. Instead of pacing 500 meters in your head as you walk, use the GPS interface to track distance traveled since previous waypoint.
  - iii. Recording GPS coordinates on paper – At each waypoint, record navigational GPS coordinates on the paper sheets. These coordinates may not match those grabbed into the electronic form, so they provide important information.
  - iv. Checking the validity of the integrated data collection device GPS grab – Compare electronic and navigational GPS coordinates to confirm validity of the

electronic version (see **Chapter 7. Objective 4: Using the Integrated iPad GPS from within Survey123** for more details). This comparison is important when

- Your data collection device has been off for more than an hour
  - Your HDOP is six or more (see GPS signal strength below)
  - There are fewer than five available satellites
  - The grab took an unusually long amount of time
- v. Recording coordinate data if the integrated data collection device GPS grab does not work – At some point during your monitoring duties, your data collection device GPS unit may not take a grab for one reason or another. In this case, manually enter the easting, northing, and zone from your navigational GPS into the electronic database.
- vi. Recording a GPS track of the surveyed transect each day – At the beginning of the day (waypoint 0) you will clear the current GPS track (after confirming that the previous day’s tracks were saved, if applicable), for a Garmin GPSmap unit this is done by navigating to the GPS menu, selecting “Track Manger”, “Current Track”, and scrolling down to “Clear Current Track.” To save the track at the end of the day (waypoint 100), navigate to the GPS menu then select “Track Manager”, Current Track”, and “Save Track.” Rename the track using the following naming convention: CS#####XXXYY. Where CS represents the stratum (in this case Coyote Springs), ##### represents the 4-digit transect number, XXX represents your three letter initials, and YY are the last two digits of the current year. For example, transect 19 walked by ABC in 2024, the track would be named: CS0019ABC24.
- vii. Finding your way back to your vehicle – If necessary, use the navigational GPS unit for its most traditional purpose – finding your way from point A (transect end point) to point B (pick up location).
- The GPS unit integrated into the data collection device is used for one purpose only – to capture coordinate data in the electronic database.
    - i. You will use the data collection device unit whenever you record a waypoint, tortoise, or carcass.
    - ii. Automatically transferring coordinate data eliminates the opportunity for human-caused error.
  - **GPS Signal Strength** – Reliability of a GPS satellite reading or grab is almost entirely dependent on the strength and geometry of the signals coming from the satellites.
  - There are occasions when a GPS signal weakens, becomes undetectable, or degrades before it reaches a GPS receiver. When and why this degradation occurs:
    - i. Ionosphere and troposphere delays – As the satellite’s signal passes through the atmosphere, it slows down, disrupting the receiver’s triangulation calculation (see graphic below). This is partially compensated for through a built-in calculation based on the average delay time.
    - ii. Signal multipath happens when the GPS signal bounces off of a surface, like a tall building or a large rock formation, before reaching the receiver. This increases the travel time and causes a calculation error (see graphic below).



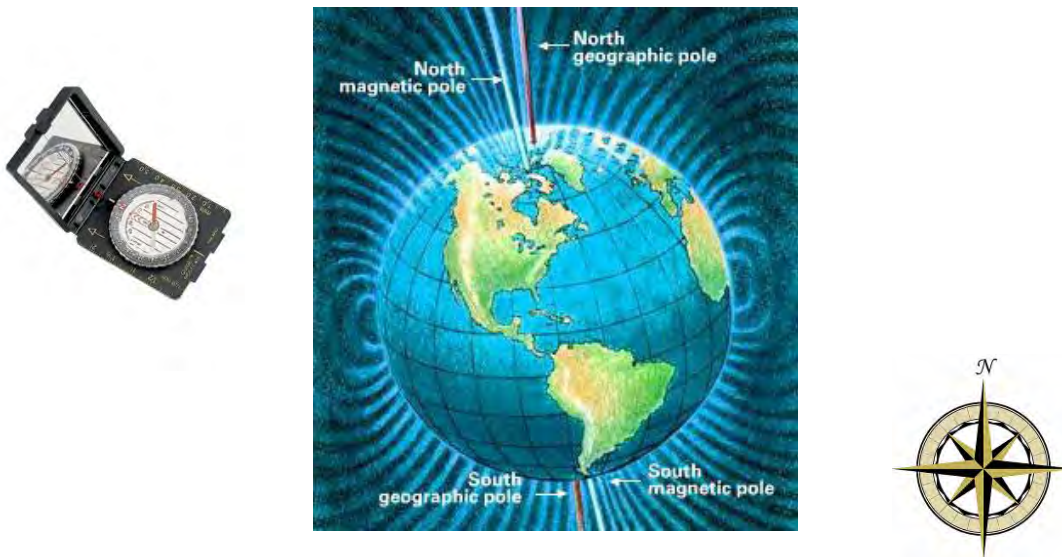
- iii. Receiver clock errors occur when the built-in clock is not as accurate as the atomic clock on a GPS satellite, causing slight timing errors.
- iv. Orbital errors occur when the reported location of a satellite is inaccurate.
- v. Number of satellites visible – The more satellites a GPS receiver has clear access to, the better its positional accuracy will be. Satellite signals are blocked or degraded by buildings, mountains, dense foliage, and other electronic signals, and typically do not work indoors, underground, or underwater.
- vi. Satellite geometry – The spread, or geometry, of satellites available to a receiver can affect the accuracy of a reading. When satellites are closer together in the sky, the reading is likely to be less accurate than one from satellites that are spread out. The effect of satellite geometry is expressed most commonly as HDOP or PDOP (Horizontal or Positional Dilution of Precision):





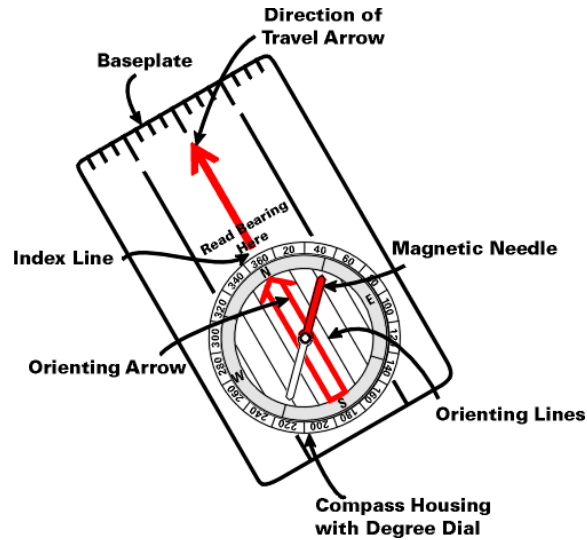
- Knowing what makes a signal go bad or get interrupted can help you get the best signal possible. Here are some other tips:
  - i. The receiver needs as clear a view of the sky as possible – since your body can block a signal, hold it out in front of you with your arm extended.
  - ii. Many navigational GPS units have a Skyplot option, which shows the position and the strength of available satellites. This can help determine if you need to compare the data collection device grab coordinates to the navigational GPS coordinates.
  - iii. The signal is more likely to introduce error to the grab when you are in an area with large rock formations or rocky substrate. In situations like this, the GPS reading is likely to bounce around as it refreshes. If readings vary more than 20m, the grab is more likely to be poor. Compare the grab to the most consistent navigational GPS reading.
- For more detailed information on GPS, visit [www.gps.gov](http://www.gps.gov).

## Objective 2: Understanding Compass Basics



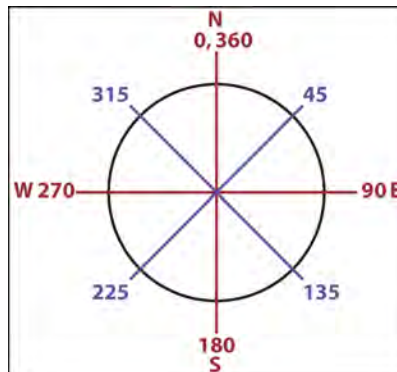
### 1. Basic Compass Terminology and Anatomy

- **Bearing and Azimuth:** Bearing and azimuth refer to direction in degrees and are determined using your compass. For our purposes, bearing is the direction in degrees you walk along a transect, whereas azimuth is the angle from the line you are walking to a tortoise or carcass. Both range from 0 to 360 degrees.
- **Compass Anatomy:** The four most important pieces of your compass, and the ones that you will use every day are the direction of travel arrow, orienting arrow, magnetic needle and compass housing. Compasses are provided by each monitoring team, not by the USFWS. Therefore, our description of compass anatomy may vary from what your actual compass looks like or comes with.



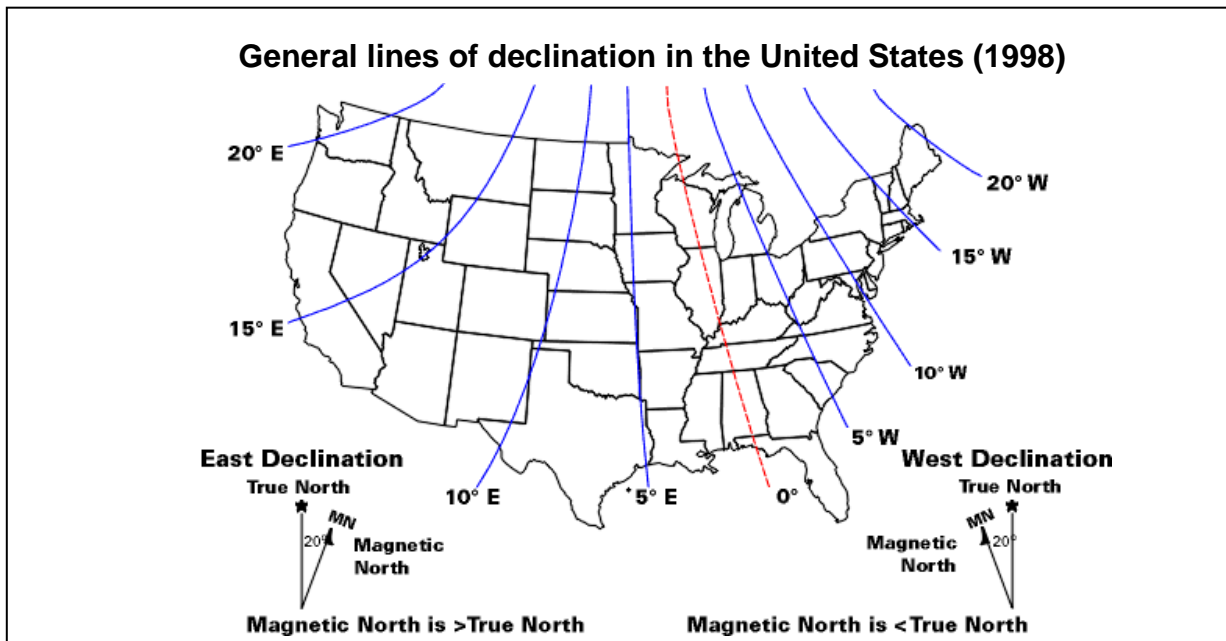
- i. **Compass Housing:** the sealed center compartment of the compass that contains the magnetic needle and a liquid that allows the needle to move freely, but not rapidly or shakily
- ii. **Baseplate:** the bottom part of the compass that you hold flat in your hand; includes the direction of travel arrow and any millimeter and inch scales
- iii. **Direction of Travel Arrow:** points in the direction you should travel after setting your bearing
- iv. **Magnetic Needle:** located within the compass housing and is typically a red and white needle; the red end is magnetized and points to magnetic north when the compass is held steady and flat
- v. **Degree (Bearing) Dial:** the numbers located along the compass housing that indicate the angular difference in degrees between any point and magnetic north (can be adjusted for declination); bearings range from 0 to 360 degrees
- vi. **Orienting Lines:** parallel lines in or on the compass housing and base
- vii. **Orienting Arrow:** stationary arrow within the compass housing
- viii. **Declination Adjuster:** typically a small notch on the back of the compass that requires a key to turn; allows you to adjust for declination (not shown on figure). You must have a compass with an adjustable declination.

2. **Basic Compass Navigation:** Correctly navigating with and reading a compass is an essential part of monitoring. The steps below explain what you need to know, and should be a review.



- **Follow a Bearing (i.e. use a compass to walk in a certain direction):** On transects you need to follow a bearing; a compass will help you keep on that bearing. You will mainly be heading north (0), east (90), south (180), and west (270), focusing the majority of your attention on finding tortoises, and only occasionally checking that you are following the correct bearing. Here's how:
  - i. With the compass open, the bottom held as flat and steady as possible, and the direction of travel arrow pointing away from you, rotate the compass housing until the desired degree lines up with your direction of travel arrow (i.e. 0, 90, 180, 270).
  - ii. With the compass held directly in front of you at chest level, turn your body until the magnetic needle lines up with the orienting arrow. In nearly every compass Red in the Shed is the rule.
  - iii. Now lift the compass to eye level and fold the mirror until you can see the arrow's reflection. Make sure they stay aligned during the next step.
  - iv. Look down the direction of travel arrow, beyond the compass, and find an object that stands out (i.e. a Joshua tree off in the distance, prominent mountain features) and lines up with the direction of travel arrow.
  - v. Walk towards the chosen object, glancing up occasionally to ensure you are still on the right path.
  - vi. If a distant navigational target is not available, pause every hundred meters or so to check your bearing and identify new, closer targets as necessary.
- **Read a Bearing from a Map:** Occasionally you may reflect a transect and travel in a non-cardinal direction. To read the correct bearing from the map, you will orient using the north arrow and base lines on the map.
  - i. Settle the baseplate of the compass on the map so that the compass housing straddles the path for which you will determine a bearing.
  - ii. Rotate the compass housing so that the compass orienting lines are parallel to north-south base lines on the map; the 360 position on the degree dial now indicates north as depicted by the map.
  - iii. Read the bearing of interest where the mapped path crosses the degree dial.
- **Take a Bearing (i.e. use a compass to find your direction of travel):** You will record a local bearing and a transect bearing each time you find a tortoise or carcass. The transect bearing is the bearing that you planned to walk (i.e. 0 for North, 90 for East, etc.); this is a planned, not a measured quantity. You will use your compass to take the local bearing, which is the bearing you are actually walking. *We want you to focus on looking for tortoises rather than looking at instruments to stay on an exact bearing the whole time, so we also expect that your actual bearing will vary from the transect bearing, but hopefully not too much.* The directions below assume you have a compass with a folding mirror.
  - i. With the compass open, the bottom held as flat and steady as possible, and the direction of travel arrow pointing away from you, hold the compass up to your sighting eye.
  - ii. Standing at your position (leader or follower), line up the direction of travel arrow with the 25m tape. **NOTE:** The bearing measured back from the leader position ("back-bearing") will be 180° different from the bearing from the follower position. Either bearing will give the correct calculation.

- iii. Fold the mirror portion so you can see the magnetic needle and orienting arrow in its reflection. Keeping the compass steady, rotate the compass housing with the bearing degrees until the orienting arrow (hollow and within housing) lines up with the north end of the magnetic compass needle, so the red end of the magnetic needle fits nicely within the hollow of the orienting arrow. Red in the Shed!
  - iv. By using the mirror, you avoid lowering the compass and shifting its orientation as you line up the orienting arrow with the magnetic needle. Look in the reflection to align the two, then lower the compass and record the bearing at the index line. That is the local bearing.
  - **Take an Azimuth (i.e. use a compass to find the direction of an object):** Accurately recording the distance a carcass or live tortoise is from the transect line you are walking is an essential part of monitoring. The calculation of this distance requires the exact azimuth and distance of the tortoise from where you spotted it on the transect line. To take an azimuth:
    - i. Immediately stop walking when you spot a live tortoise or carcass. It is important to record the azimuth from where you first spotted it, not two steps down the line.
    - ii. With the compass open, the bottom held as flat and steady as possible, and the direction of travel arrow pointing away from you, hold the compass up to your sighting eye.
    - iii. Without stepping from your spot, rotate your body until you can point the direction of travel arrow directly at the tortoise or carcass
    - iv. Fold the mirror down until you can see the magnetic needle and orienting arrow reflecting in the mirror.
    - v. Rotate the bearing dial until the magnetic needle and orienting arrow align in the mirror. Meantime, keep the direction of travel arrow pointed directly at your find.
    - vi. Once the arrows are aligned, lower your compass and record the bearing number that aligns with the direction of travel arrow. That is the azimuth of the tortoise.
3. **True and Magnetic North:** When navigating by compass, there are two different Norths to consider: the north that can be found on a map (true), and the north that a compass points to (magnetic).
- **Magnetic North:** The earth is a giant magnet with a magnetic field that is inclined at about 11 degrees from the planet's axis, so magnetic north and true north do not usually line up. Because Earth's core is molten, the magnetic field is shifts gradually. This magnetic field pulls the magnetic arrow within a compass away from true north and towards magnetic north.
  - **Declination:** Declination is the angular difference between true north and magnetic north. Declination depends on where you are:



- **Declination for Tortoise Monitoring:** In Mississippi, we wouldn't have to worry about declination; true north and magnetic north would more or less line up. Declination values are expressed as Easterly (positive) or as Westerly (negative) values. When magnetic north is east of true north (as in the southwestern U.S.), the declination is positive. In an added twist, the lines of declination shift westward about 0.5 to 1 degrees every year. So although declination is indicated at the bottom of many local maps including all USGS topographic maps, older maps will not reflect current conditions. A declination calculator for a particular area on a particular day can be found at <http://www.ngdc.noaa.gov/geomag-web/>. For instance, the declination in Barstow, CA on 1 April 2017 will be 11 degrees and 58 minutes east and in Las Vegas, NV it will be 11 degrees and 45 minutes east. At the beginning of the season, data specialists will inform you of the current declination for your region. After you adjust your compass to compensate for declination, recheck the setting at least once a week.
- **Example to further clarify declination:** You are starting a transect near Las Vegas and want to travel along a true north bearing ( $0^\circ$ ). Because you were informed by the data specialists that the area around Las Vegas has a declination value of about 12 degrees east (+12), when your compass indicates  $0^\circ$  from magnetic north, you are actually traveling a bearing of  $12^\circ$  from true north ( $0 + (+12) = 12^\circ$ ). To travel a true  $0^\circ$  path, subtract  $12^\circ$  from your planned bearing. Following a bearing of  $(360-12)=348^\circ$  will compensate for declination and result in a true  $0^\circ$  path. Instead of doing this on the fly you should adjust your compass for declination. When the declined compass indicates a bearing of 0 degrees, you are following true north.
- **Adjusting for Declination:** The compass you use on transects must adjust for declination. Here's how to adjust for declination in the Las Vegas area based on the example above:

  - i. As you will be walking transects that have easterly declinations, you will need to follow a bearing of twelve degrees less than magnetic north.
  - ii. On the back of your compass, there should be a small screw that you can turn with the key provided on the lanyard. Turn the screw until the magnetic north

arrow points at 12. After adjustment, your bearings and azimuths will report true bearings and collect true azimuths.

**iii. If you fail to adjust for declination, your first 3km segment will be ~750m off (~250m/km), with the error compounding as the transect gets longer.**

- **True North** (also geographic north or map north): True north is the geographic North Pole where all longitude lines on a map meet. Nearly all maps have a north arrow indicating true north, but a compass's arrow points towards magnetic north.

#### 4. Care of the Compass

- Remember, compass readings can be affected by metal or magnetic objects held in close proximity: jewelry, magnets on hydration bags, pen clips, etc. If the needle moves when the compass is approached by an object, that is the sign they need to be kept apart for accurate readings.
- Compass polarity can be permanently reversed or partially affected if compasses are stored with metallic or magnetic objects in bins, backpacks, or pockets.

## 4. ELECTRONIC EQUIPMENT CARE AND MAINTENANCE



We use an electronic data collection system for tortoise monitoring to enhance the accuracy, validity and integrity of the data you collect. Effective use of an electronic data collection system, compared to a solely paper based system, allows us to:

- 1) reduce data entry errors such as misspelled words (carcass and carcas are not the same), by providing such tools as look up lists and drop down menus,
- 2) eliminate the problems associated with hand-entered data (e.g., data entry errors due to repetitive tasks, undecipherable hand writing, lost data sheets),
- 3) reduce the time from field data collection to data assessment, final QA/QC, and analysis,
- 4) enhance QA/QC by automating certain operations in the field and providing in-office QA/QC tools, both of which assist the field teams to deliver the best data possible, and
- 5) automate and consequently reduce errors in spatial data collection (GPS grabs).

The goal of Electronic Equipment Care and Maintenance training is to enable you to confidently and correctly care for and operate the data collection equipment in your duties as a tortoise monitor. This portion of the training does not deal with what data to collect (e.g. MCL) or how to collect it (tape measure, calipers, etc.). The outline below details the individual objectives and standards, as well as the final metric for which you will be held accountable after completing this training.

**Objective 1:** Proficiency with basic iPad mini operations.

You are responsible for ensuring that the iPad mini is operational and correctly set up each day. Each crew member will know how to

1. set up the iPad mini (e.g. charge, use battery saving settings, turn on/off, set date/time, and identify components of iPad mini)
2. navigate menus
3. maintain the iPad
4. troubleshoot common iPad mini problems through a restart.

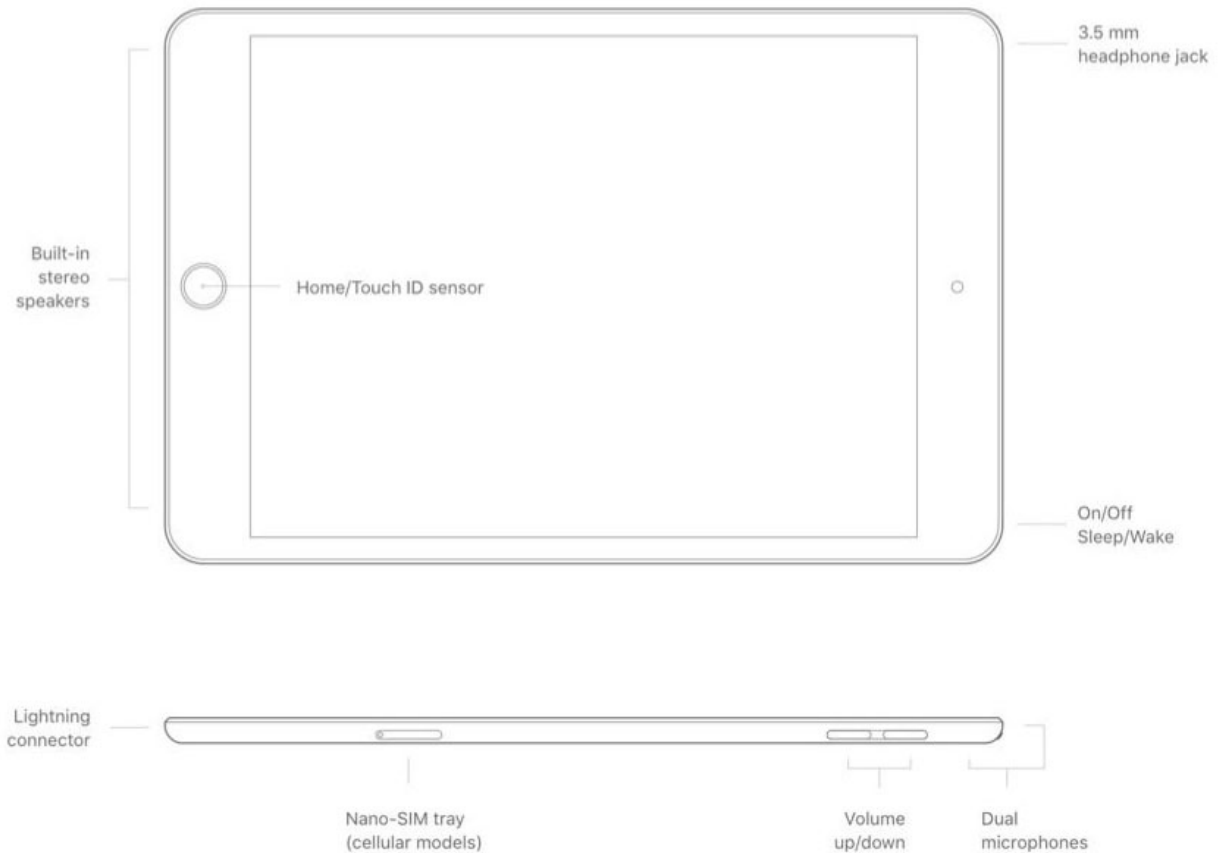
**Objective 2:** Proficiency with the built-in camera

1. Parts of the camera and taking a picture
2. Adjusting camera settings

**Metrics:** During training you will be asked to demonstrate for an instructor how perform a reboot and must successfully perform all tasks before you can participate in sampling.



## Objective 1: Understanding Basic iPad mini operations



### 1. Setting up the iPad mini

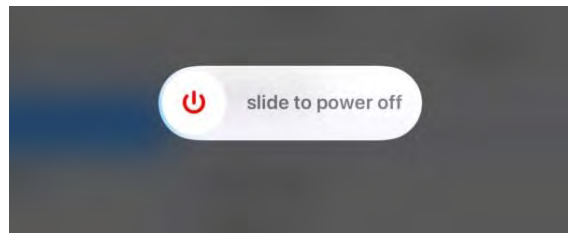
- **Components**
  - i. the iPad mini itself,
  - ii. AC adaptor cable used for charging,
  - iii. Vehicle power adapter for charging
- **Charging the unit:** Connect the AC adaptor to the bottom of the iPad mini at the power connector port. Plug the AC adaptor into a wall outlet. For safety reasons, make sure the iPad mini is **completely dry** before plugging it in. On a completely drained battery, charging time takes about 4 hours. Unplug the safety adapter when not in use. Charge the battery at the end of every field day.

To determine how full the battery is:

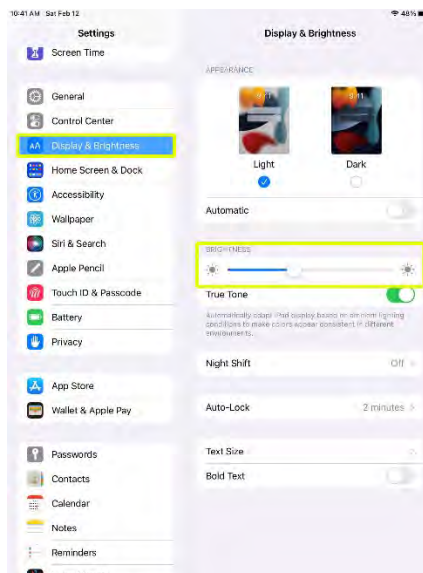
- i. Press the power button on the iPad mini

- ii. Enter your passcode to unlock the iPad.  
The current battery percentage is visible at the top right of the screen.

- **Turn the unit on or off:** Briefly press and release the Power button to turn the unit on from standby mode. When on, type in your passcode. To conserve battery power put the unit in suspend mode by briefly pressing the power button (i.e. between waypoints); the unit does this automatically when not in use for 30 seconds. Briefly press the power button to return from suspend mode. To turn the unit off, press and hold the power button for 2 seconds, until the “slide to power off” option becomes visible. Swipe right to turn off the iPad. You can also summon the “slide to power off” option from Settings, under the General settings, select “Shut Down” at the bottom of the list on the right side of the screen. It is recommended that the device is only turned off if it will not be used for three months or more.



- **Screen brightness:** The iPads are set to automatically adjust brightness depending on the light conditions. If the current brightness is not enough it can be adjusted in Settings. Press the Home button, then tap on Settings. On the left side of the screen, find and select “Display and Brightness.” In the middle of the screen there is a brightness slider to adjust brightness. Adjust the brightness to your liking in the field, remembering that battery power is conserved when the screen is darker.



- **Setting up Touch ID:** From the Home screen select Settings. From here, you may need to scroll down to see and select the option for Touch ID and Passcode on the left side of the screen. On the right side of the screen, select “Add a Fingerprint.” This will prompt you for the passcode, after which, you follow instructions to add your fingerprint. Once it is set, you can use the Touch ID to unlock the iPad mini. Occasionally, you will have to enter the passcode, but then can go back to using Touch ID.

**2. Maintaining the iPad mini:** The iPad mini is basically a field computer running the iOS operating system. It has an integrated high sensitivity GPS receiver with 5m accuracy. They are durable devices but are not fully rugged. We have added a case onto it but that does not make them rugged, waterproof, or immune to dirt. Do not remove the iPad mini from its case under any circumstances. If there are technical issues, return the unit to the data specialist for your team.

- **Keep the screen clean.** Touch-screens are great, but they present a host of problems when used in the field. The iPad minis are enclosed in protective cases but their screens are only covered with a thin plastic cover. If care is not taken the screen can easily be scratched or damaged. Here are some tips for screen care:
  - i. Do not use your fingernail, a pen cap, a twig, a pencil, or any other object you might think is suitable.
  - ii. If the case or protective plastic screen cover is dusty or dirty, gently wipe them down with a clean cloth, damp if possible.
  - iii. When stowing the iPad mini in your backpack, be aware of its placement. In the past, many screens have been ruined simply by the way they’re carried around or stored. Do not store the iPad mini in your backpack and then use your backpack as a chair.
- **Cleaning and storing the iPad mini:** You and your iPad mini are likely to encounter dirt and mud, if you are lucky enough to experience rain or snow while walking transects. To clean the iPad mini, use a clean, damp cloth or, if really dirty, a soft bristle brush (do not use on the screen). Make sure the iPad mini and all its protective covers are clean and completely dry before charging or operating. Store in a cool, dry place.
- **Battery Care:**
  - i. The iPad mini comes with a custom rechargeable lithium polymer battery pack. You should never remove or handle the iPad mini’s battery pack. For that matter, you should never attempt to remove the protective case from the iPad.
  - ii. Typically, you will use the vehicle power adaptor or AC adaptor to charge the unit. The included USB data cable may also be used for recharging the iPad mini.

- iii. If possible, charge every night and avoid fully discharging the battery. Unlike most rechargeable batteries, lithium polymer batteries will have a longer life span when consistently only partially drained.
- iv. Again, make sure the unit and cables are **completely dry** before plugging into an electrical source. Clean connections with a clean, dry cloth or compressed air, taking care not to freeze anything.
- v. Do not immerse the battery in water, store in a hot vehicle, drop or puncture it, and do not open it.
- vi. To save battery, under Settings, go to Battery, then turn on “Low Power Mode” (the battery indicator in status bar will turn yellow). You can also turn off unused apps in the background by double tapping the home button then swiping up on all apps that are shown. Do not do this to Survey 123 while recording data!

- 3. Troubleshoot Common iPad mini Problems:** The typical way to troubleshoot a non-responsive iPad mini is rebooting it. If the problem persists, speak with your data specialist about possible solutions.

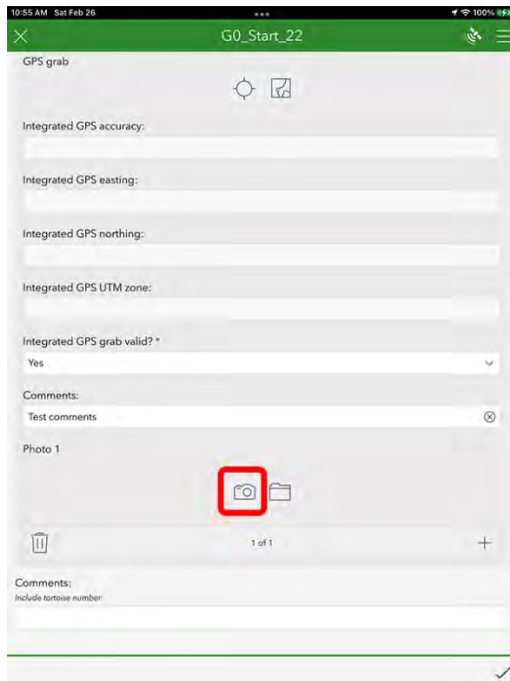
**Reboot:** A reboot gives the iPad mini a fresh start, similar to rebooting a computer. A reboot saves data, closes all open applications, and then restarts the iPad. To reboot the unit, press and hold the power key button for 2 seconds, until the “slide to power off” option becomes visible. Swipe right to turn off the iPad. You can also summon the “slide to power off” option from Settings, under the General settings, select “Shut Down” at the bottom of the list on the right side of the screen. To turn the iPad back on, press and hold the power key button for 2 seconds until you see the Apple logo. The device should now restart in few seconds.

- 4. Time zone:** We collect all data in Pacific Time. So you need to force the iPad to stay in the Pacific time zone when crossing into Utah. Go to Settings > General > Date & Time. Make sure Time Zone = Cupertino and turn off “Set Automatically” (slider to the left).

## Objective 2: Built-In Camera settings

### 1. Taking a Picture

- a. To take a picture for any photo field in Survey123, tap the Take Picture button to start the camera application (left image below). Since the camera has autofocus it will automatically focus on the center part of the screen. For subjects that are off-center, tap on the subject on the screen. This will redirect where the camera attempts to focus. To capture an image, press on the white button.



### 2. Adjusting Camera Settings


While in the camera application, you can access Camera settings to digitally zoom into the target before taking the picture. This can be done by using the zoom slider control as seen in image below. Use the zoom feature only if the iPad cannot be moved closer to the target.

To set the required camera image format, go to Settings > Camera > Formats, then choose “Most compatible.”



### 3. Manual photos

You may *very occasionally* want to take more than the allowed number in a given form. In these cases, use the standard iPad camera app. Turn off the “live” and “HDR” photo functions.

After taking the photo, open the Photo or Camera app, click the share icon  at the top, scroll down and choose “Save to files.” Save the photo under a “DT 2024” folder (create this folder if need be). Add the correct photo file name (see below). Add a comment to the record indicating there is a manual photo and provide the photo name.

Use the Safari app to email the photo to the QA/QC specialist on the same day you sync your data.

Table Name	Field name	Naming convention	Example
Waypoints	photo_to_wp_xminus1	Tranxxx.x_st_wpww_to_minus1_yyyy	Tran234.0_BW_wp03_to_minus1_2024.jpg
Waypoints	photo_to_wp_xplus1	Tranxxx.x_st_wpww_to_plus1_yyyy	Tran234.1_BW_wp21_to_plus1_2024.jpg
TranLiveObs	photo_tort1	Tranxxx.x_st_TLzz_1_yyyy	Tran012.0_BW_TL02_1_2024.jpg
TranLiveObs	photo_tort2	Tranxxx.x_st_TLzz_2_yyyy	Tran012.0_BW_TL02_2_2024.jpg
TranCarcObs	photo_carc	Tranxxx.x_st_TCzz_yyyy	Tran245.0_BW_TC12_2024.jpg
OppLiveObs	photo_tort	Tranxxx.x_st_OLzz_yyyy	Tran967.0_BW_OL05_2024.jpg
OppCarcObs	photo_carc	Tranxxx.x_st_OCzz_yyyy	Tran009.0_OC01_2024.jpg
G0_Obs	photo1	G0_site_tttt_yyyymmdd_FL_photo1	G0_OR_621_20240310_PF_photo1.jpg
G0_Obs	photo2	G0_site_tttt_yyyymmdd_FL_photo2	G0_GB_GBP-0051_20240421_ZS_photo2.jpg

xxx.x: transect number

st: stratum abbreviation

ww: waypoint number for current photo

zz: observation number

FL: first and last initials for the observer (as named in the database drop-down lists)

yyyy: 4-digit year; mm: 2-digit month; dd: 2-digit day

tttt: tort\_num (alphanumeric)

## 5. LINE DISTANCE PROTOCOLS

The goal of conducting line-distance surveys is to acquire an unbiased estimate of the density and abundance of desert tortoises. Achieving this requires integration of various field activities, but most directly it requires the ability to define the transect, locate tortoises, and accurately measure the distance from the transect to the tortoise. Two types of practice arenas are used to assess your ability to successfully achieve these goals: 1) a model population of desert tortoises (“styrotorts”) is utilized for training and testing on detection and measurement, and 2) practice transects are walked in the Large-Scale Translocation Site (LSTS) near Jean, Nevada.

Desert tortoise monitoring using distance sampling requires that distance from the transect line to live tortoises and carcasses be accurately measured. Surveyors walk transects at specified locations on predetermined bearings. When a tortoise or carcass is observed you must 1) use a compass to determine the local transect bearing (this may be different from the predetermined bearing), 2) use a compass to determine the bearing (azimuth) from the point of observation to the tortoise or carcass, and 3) measure the distance to the tortoise or carcass using a measuring tape. These data are used to calculate the distance from the observed tortoise or carcass to the local transect line. Accuracy and precision in these measurements are critical for adequate estimates of tortoise density.

Tortoises are not active and visible consistently throughout the day. For this reason, the timing of transect completion must be coordinated with optimum tortoise activity periods. These periods will change over the course of the many weeks of monitoring, and teams are responsible for matching their transect start times to these shifting windows in coordination with USFWS. Each day of the field season, all transect teams are maintaining start times and distance sampling protocols that must be consistent with all other transect teams. They must also coordinate their activity with telemetry crews who collect information on the proportion of tortoises that might not have been visible even during the optimum time of day.

Refer to **Appendix I** for paper data sheets and description of fields.

**Objective 1:** Crews will apply the search technique as trained so that tortoise detection probabilities and densities are accurately estimated.

**Metrics:** Data collected by each team on tortoise models will be used to evaluate

- 1) Detection functions. These must reflect proper search technique by demonstrating consistent, high detection rates on the transect line out to about 2 m, with declining detection rates beyond this.
- 2) Accurate tortoise abundance estimates. Each team’s estimates of abundance must include the true value within the 95% confidence interval.
- 3) Detection on the line. Dual-observer teams will detect close to 100% of all models within 2 m of the transect center line. Leader-only detections will be over 80%.

Detection curves for teams of crews will also be reviewed and assessed on a weekly basis during the field season.

**Objective 2:** Each team will complete transects in the prescribed fashion within specified time limits, including start time and minimum total time.

**Metrics:** On practice transects, crews will demonstrate ability to navigate to start points by the preplanned time, and will complete full transects each day, moving at a sufficiently slow pace so that tortoise detection is not compromised. These metrics will also be assessed for each team on a weekly basis during the field season. On a daily basis, transect crews will communicate their transect completion times to telemetry crews so that scheduling of transects and radio-tracking can be coordinated.

**Objective 3:** Each crew member will accurately and precisely measure the local bearing of a transect, and the azimuth and distance from the point of initial observation to a tortoise/carcass.

**Metric:** Perpendicular distances of tortoise models to the transect center line should be estimated to within 10% of the known value and without significant bias.

**Objective 4:** Crews will correctly implement distance sampling protocols for desert tortoises on standard transects.

**Metric:** On practice transects, crews will demonstrate ability to implement the set of guidelines for standard transects, appropriately collecting and entering data on paper and electronic forms. These metrics will also be assessed for each team on a weekly basis during the field season.

**Objective 5:** Crews will appropriately implement techniques to walk non-standard transects when obstacles prevent completion of planned standard paths.

**Metric:** On practice transects, crews will demonstrate ability to implement the set of guidelines for non-standard transects, appropriately modifying the transect and documenting changes on paper and electronic forms. These metrics will also be assessed for each team on a weekly basis during the field season.



## **Objective 1: Apply the Search and Detection Technique**

This objective will be the emphasis of training in the arenas with tortoise models. See **Chapter 1. Distance Sampling and Desert Tortoises** for description of detection functions that result from correct implementation of search techniques. See Objective 4 (below) for description of the protocol applied to standard transects.

## **Objective 2: Start and Complete Transects to Optimize Tortoise Detections**

### Optimizing monitoring to coincide with tortoise activity

One adaptation that tortoises have for living in the desert is to restrict surface activity to fairly narrow windows of time during the year. In general, tortoises predictably emerge from deep within shelters (burrows) from mid-March through mid-May and then again (less predictably) in the fall. These periods coincide with flowering of their preferred food plants and with annual mating cycles. The range-wide monitoring effort is scheduled to match the spring activity period for tortoises.

During this season, not all tortoises are above ground or visible in burrows. To encounter as many tortoises as possible, monitoring is scheduled to be completed before the hottest time of day. Because we are finding tortoises by sight, monitoring is restricted to daylight hours. Based on past experience, we expect tortoises to become most active after 8 am at the beginning of April, but to emerge earlier and earlier until their daylight optimal activity period is closer to sunrise by mid-May. In May, we also expect daytime temperatures to limit tortoise above-ground activity as the morning progresses to afternoon.

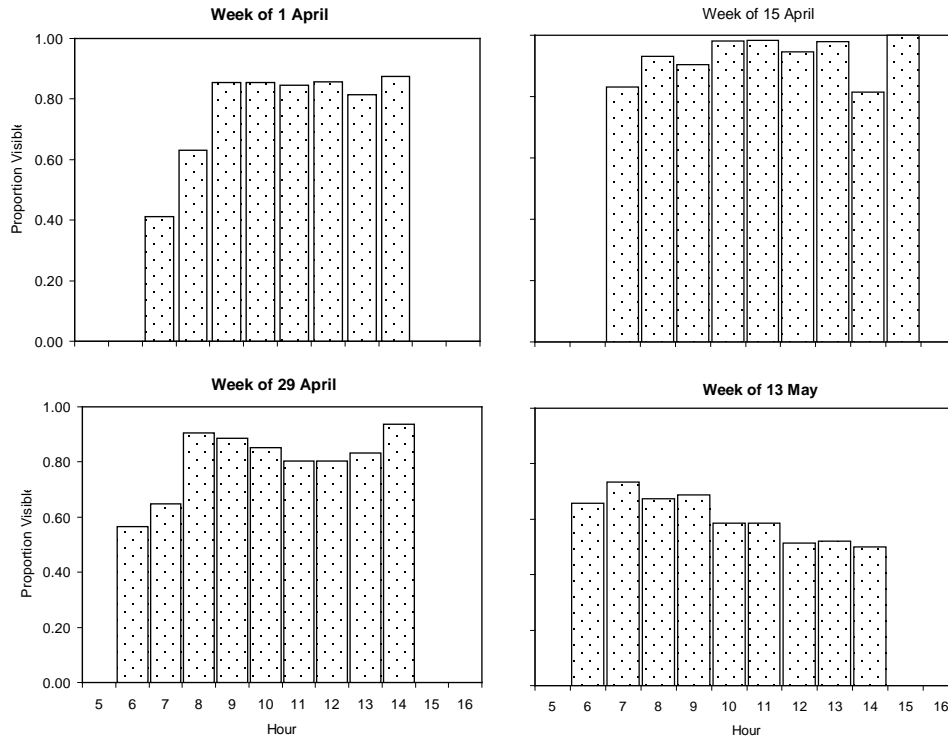
Field crews should complete transects during this optimal period each day. Start times are decided in advance, and crews should arrive at their starting waypoints at similar times on a given morning. Start times are arranged each week between the field crew leaders and USFWS. However, completion times will be more variable, and will be affected by terrain, air temperature, number of tortoises encountered, etc.

Although we have general expectations about when tortoises are most active each day, and indeed have expectations of the proportion that will be active, density estimates are corrected using real-time information about of tortoise visibility during the actual periods tortoises are counted. The role of telemetry crews is to provide these activity descriptions (=estimates of  $G_0$ ).

$G_0$  graphics are presented in Fig. 5-1. Note that the proportion of radio-tracked tortoises was most consistent and highest in the second week of the field season at this site (Fig. 5-1). Activity was depressed early in the morning earlier in the field season and there is overall lower activity by the end of the field season, especially in the afternoon. Note that even though they may be “visible,” you may be cautioned that tortoises are harder to find (visible but more concealed in burrows or vegetation) earlier in the day in April or later in the day in May. Crews should remember that after emerging for daily activity, tortoises may withdraw to less visible above-ground locations.

Telemetry and transect crews are responsible for beginning the field day at the scheduled time. For transect crews, the field day begins at Waypoint 1. For telemetry crews it starts with the first behavior observation of a transmitted tortoise. Each field group will use their own method to

communicate between transect and telemetry crews so that telemetry crews monitor until all transects have been completed for the day.



**Figure 5-1. Proportion of tortoises at the Coyote Springs G<sub>0</sub> site that were scored “visible” after detection by radio receiver. Observations are graphed separately for each week and plotted for every other week of the monitoring season.**

### **Objective 3: Measure the Local Bearing of a Transect and the Azimuth and Radial Distance to each Tortoise**

When a tortoise or carcass is found, after taking the local bearing (from the observer back to the other end of the 25-m cord), record the azimuth (bearing from observer to tortoise) and finally the distance from the observer to the tortoise (the radial distance,  $r$ ). Radial distances are recorded to the nearest 0.1 m. The database will calculate the perpendicular distance automatically (Fig. 5-2). Ideally, the bearing of the 25-m line should be close to the transect bearing, but the detection function must be developed using distance from the traversed line, not from the ideal line. In the example illustrated in Fig. 5-2, the intended transect path would have passed 6.4 m from the tortoise, whereas the local bearing determined from the 25-m line resulted in an actual perpendicular distance of 7.7 m.

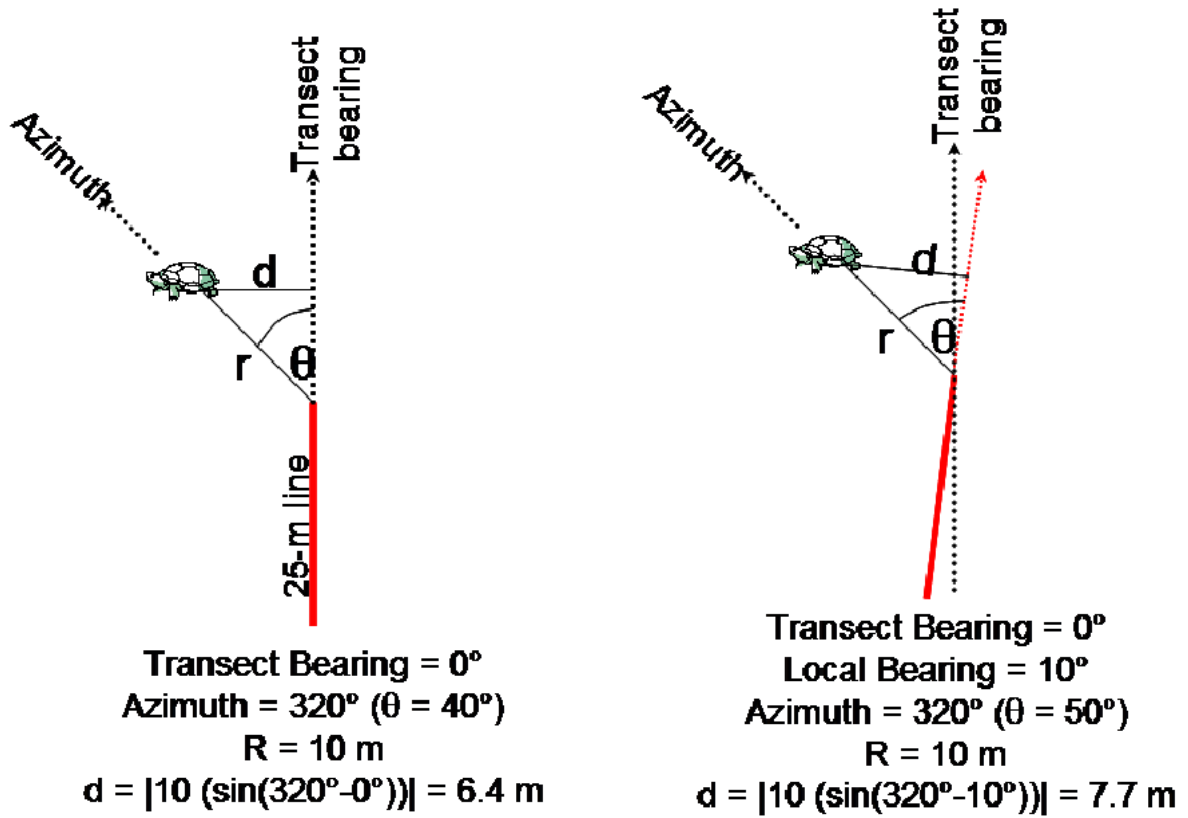


Figure 5-2. Schematic of position data collected to determine the perpendicular distance from a tortoise to the transect. The perpendicular distance,  $d$ , will be calculated automatically by the forms program in the data collection device.

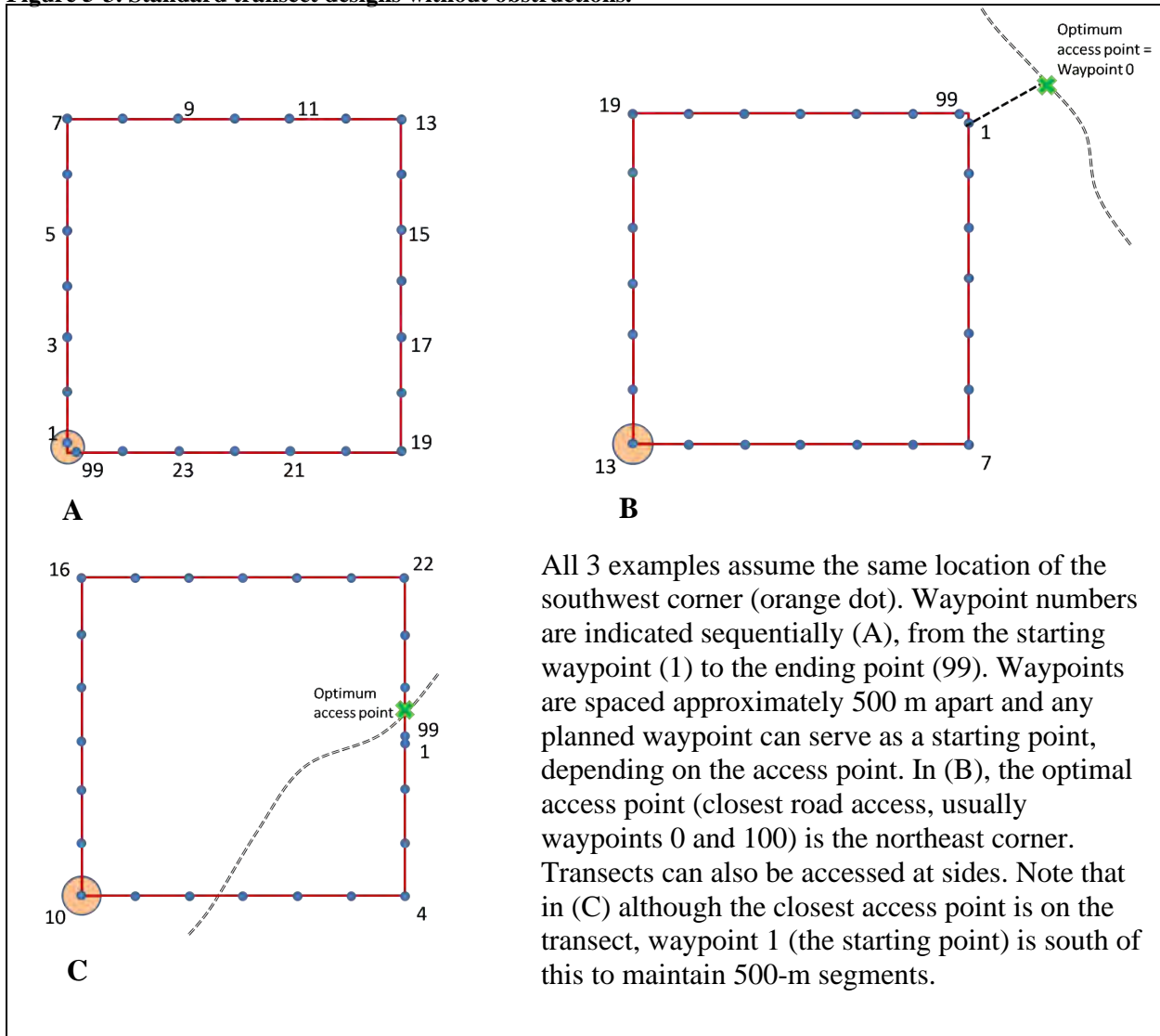
Occasionally, a tortoise or carcass will be located behind the end of the 25-m line. In general, measure the azimuth and distance from the end of the line that is closest.

#### **Objective 4: Implement Appropriate Techniques for Standard Transects**

Monitoring strata are typically a combination of Desert Wildlife Management Areas and USFWS Critical Habitat. A systematic design is used to place transects within strata. Standard transects for range-wide monitoring are 12 km long, comprising 24 500-m segments. The standard transect forms a square with 3-km sides (Fig 5-3A). If there are sufficient square transects in a stratum, they will occasionally intersect. A transect's starting point should be based on the location that is most efficient to access by vehicle (Fig. 5-3B). However, it is desirable to maintain segment lengths (the distance between waypoints) at 500 m, so the start point should be a multiple of 500 m from the first corner that will be encountered (Fig. 5-3C). Determining the best car-entry point for each transect requires planning and map work before the transect is walked. Spatial files of the planned transects have been provided to GIS specialists for each field team and have been used to plan access to transects and whether the transect is expected to be completed as a standard 12-km square. Once the starting point is located and initial data (transect number, crew information, etc.) are collected, the transect is walked according to the following procedure. Note that all bearings are with reference to true north, so all **compasses must be adjusted for appropriate declination**.

- Under normal conditions, you and a partner will walk one 12km square transect each day. You will be paired before training begins and should remain partners throughout the field season. Partners alternate lead and follow positions at each corner of each transect, each person spending an equal amount of time in the leader and follower positions. The first leader each day should be the person who finished the previous day (transect) as follower.
- Using a compass adjusted for declination, you will start walking on the designated bearing, pulling a 25-m length of durable line. The walked path becomes the centerline of the transect. While it is pulled, the line helps the follower report to the leader on whether the transect is on course; when the line is placed on the ground after a tortoise or carcass is detected, the line facilitates measurement of the local transect bearing. The walked length of each transect is calculated as the straight-line distance between GPS point coordinates that are recorded along the transect (waypoints). Therefore, it is important to walk a straight line between waypoints, using reference to the compass, a sighted point on the horizon, and the trailing line. The line should be passed over the top or directly through shrubs or trees that lie in the transect path, attaching the line to the leader if necessary. Waypoints are recorded at 500-m intervals and at corners where the transect turns. The leader maintains the correct bearing and is responsible for determining the correct length of each leg of the transect.

**Figure 5-3. Standard transect designs without obstructions.**



All 3 examples assume the same location of the southwest corner (orange dot). Waypoint numbers are indicated sequentially (A), from the starting waypoint (1) to the ending point (99). Waypoints are spaced approximately 500 m apart and any planned waypoint can serve as a starting point, depending on the access point. In (B), the optimal access point (closest road access, usually waypoints 0 and 100) is the northeast corner. Transects can also be accessed at sides. Note that in (C) although the closest access point is on the transect, waypoint 1 (the starting point) is south of this to maintain 500-m segments.

- The follower will trail the leader at the end of the 25-m line. Both leader and follower scan for tortoises independently, and the role of the crew member finding each tortoise is recorded in the data. Although the leader will see most of the tortoises, it is intended that the follower will see all the remaining tortoises near the centerline, so this role is crucial to unbiased estimation of tortoise densities. The follower will also notify the leader if the transect is deviating from the designated bearing.
- The leader progresses along the transect, scanning the ground for tortoises or carcasses.
  - Concentrate on scanning the ground in a radius of about 5 m and as far out as 10 m. Little time should be spent scanning the horizon (except as necessary to maintain a consistent bearing) or scanning right around one's feet.
  - Special attention should be paid to searching vegetation intersected by the transect.
  - If it is necessary to leave the transect path to investigate a burrow or suspected tortoise or carcass more closely, the leader should drop the end of the line in place, so that the transect path remains unambiguous.

- Attention should be given to ensuring the transect line does not “drift” toward a tortoise when one is observed. Tortoise density estimates would be biased if the transect consistently bends toward tortoises.
- The follower uses the same search technique as the leader. It is important that both crew members are searching for tortoises in the same manner.
  - If the leader stops to investigate a burrow, the follower should also stop to maintain position at the end of the 25-m line.
  - Likewise, if the follower needs to investigate a burrow or suspected tortoise, the leader should stop while this is taking place.
- When a tortoise or carcass is located, the leader drops the line, and the necessary data fields on both the electronic and paper data forms are completed. Electronic data collection reduces data entry and transcription errors but is not foolproof. Paper sheets are independent versions of data on the electronic data forms, *not* backup data. It is essential to take accurate data, and to complete each section of the data sheet in both paper and electronic forms before moving ahead. Refer to **Chapter 2. Desert Tortoise Handling** for details on proper handling and measurement techniques.
- Ideally, when a tortoise or carcass is found the bearing of the 25-m line should be close to the transect bearing, but the detection function must be developed using distance from the traversed line, not from the intended line. In all cases when the transect has been paused, recheck the bearing of the transect. Resume walking on the measured local bearing (after recording a tortoise) or on the original planned transect bearing (from a waypoint).
- In addition to tortoise data, crew members will collect waypoints at regular 500-m intervals, or more frequently if a corner or interruption is needed (see *Implementing Protocols for Non-Standard Transects*, below).
- If an existing tag or marks are present, they should be recorded. Various identifying techniques have been used on tortoises for other projects, and the database is equipped to record identifying information from these marks. Crews may need to clean the tags to make them legible and should have any necessary reading gear with them; the numbers are small and will otherwise be difficult to read. If no tag is present, a provided tag should be applied.
- If a tortoise is in a burrow and cannot be removed, it is nonetheless important to record whether unhandled tortoises are adults at least 180 mm MCL or subadults/juveniles.
- When at least half of a tortoise carcass is located, or if any carcass with identifying marks is located, the necessary data fields will be completed. Shell remains persist for a number of years in the Mojave Desert.
- Tortoises or carcasses located anywhere in the course of a transect day (between the vehicle (waypoint 0) and return-to-vehicle point (waypoint 100) but without using the distance searching protocol should be recorded using the “opportunistic” tortoise and carcass forms.
- GPS coordinates must be collected at all waypoints, tortoise, and carcass locations. If an automated GPS grab is not possible, UTM coordinates will be entered manually.
- Occasionally, transects will encounter obstacles that make it impossible to complete a standard transect. Paved roads with light traffic and rail lines should be crossed safely without interrupting the transect. Obstacles that should lead to changes in the transect path include major highways (e.g., all Interstate highways, US Highway 95 and 395, and California Highway 58), hazardous rock formations, or hills or washes too steep for safe navigation. When such obstacles are encountered, the transect path should be adjusted according to *Implementing Protocols for Non-Standard Transects*, below.

### *Additional documentation for range-wide monitoring on paper data forms*

The electronic and paper data forms are carefully matched to have the same fields and collect the same information. The exception is that paper data forms are also designed to collect information about how each transect was completed. Information on access routes, including GPS locations for important intersections, can be written long-hand on the paper data forms. These forms also have an area to sketch the transect as you completed it. Please indicate all waypoints, numbering 0, 1, 99, and 100. Also indicate roughly where any obstacles were encountered along the transect. These sketches can be used in the future to indicate access points, and in this season to clarify potentially misleading information such as inaccurate GPS grabs.

### **Objective 5: Implementing Protocols for Non-Standard Transects**

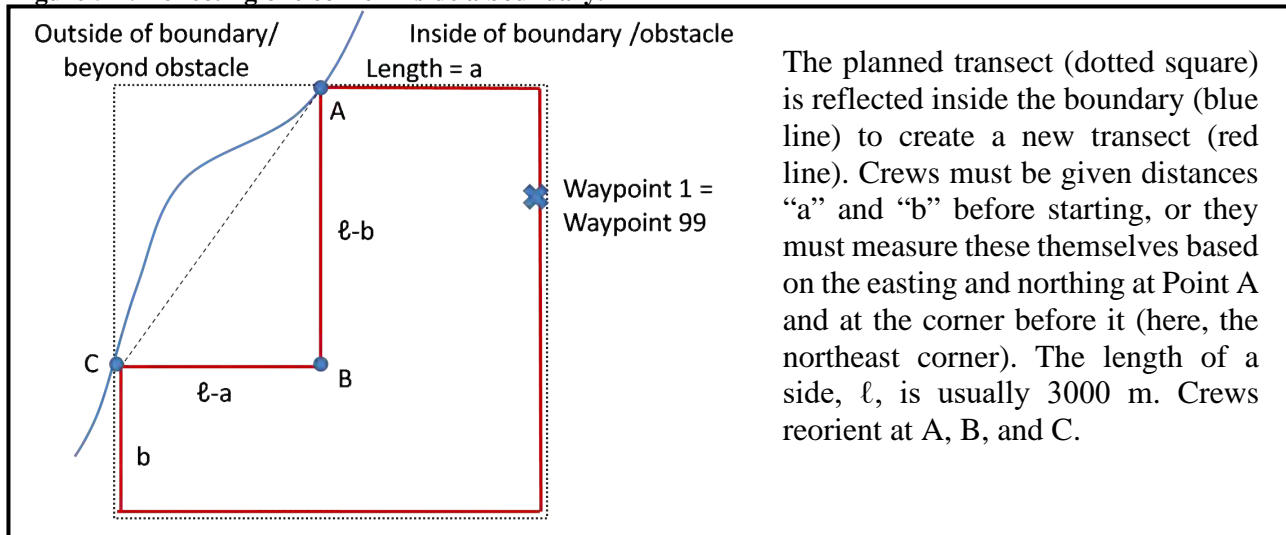
Each monitoring transect is associated with a “sampling stratum.” For analysis, all data from all kilometers walked in a stratum are combined, and the analysis proceeds from there. If we only walked transects in mountains, we should only relate our analysis to mountainous areas of the stratum; if we only walked transects in flat areas, our estimates of tortoise density only apply to flat areas. Instead, each stratum has different terrains, topographies, vegetation types, and substrates. We are pretty sure that each of these attributes affects the density of tortoises, so to apply our tortoise density estimates to the entire stratum, we need proportional, representative sampling across the varieties of habitats that are available.

#### Avoiding human infrastructure and administrative boundaries (12-km transects)

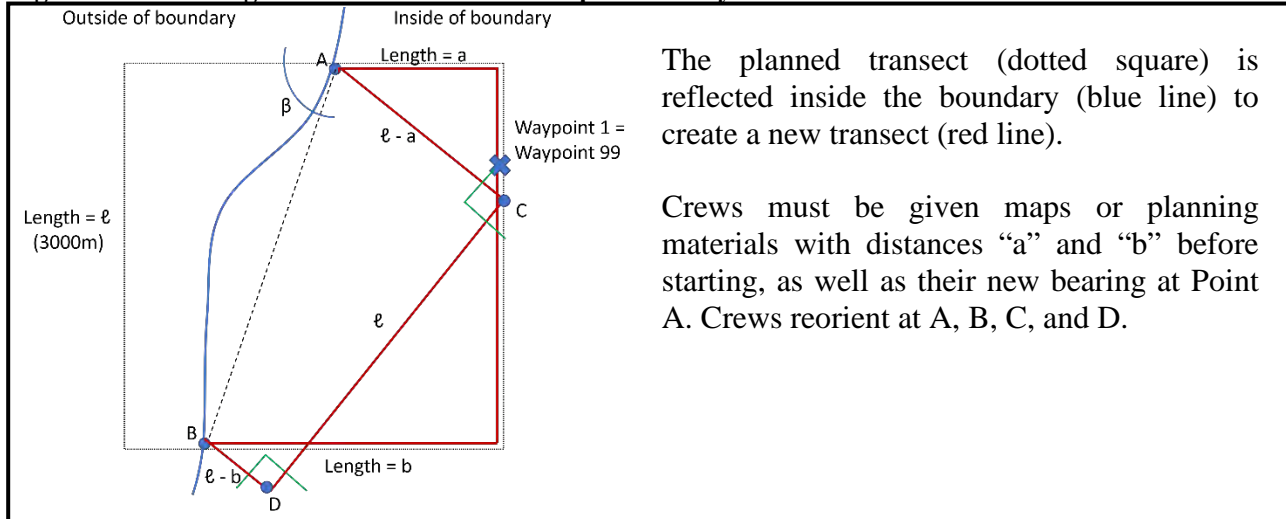
To sample stratum edges, we include some transects that would also cross out of strata and into adjacent lands. Before walking these transects, the “outside” portion is pulled into the stratum so that the path walked is the same distance from the stratum boundary but is now inside. There are other cases in which the landscape and the transect are intersected by human structures such as signed properties that prohibit access, or by major highways. (Roads with light traffic and railroads can be safely crossed as part of a standard transect.)

Transects should be rebuilt appropriately before the field season to move inside stratum boundaries and to one side of other identified obstacles listed above. Some structures are not indicated on our planning maps, so crews should understand the rules below and how to apply them when these situations arise unexpectedly. The figures below illustrate how to reflect a planned transect based on where a boundary (or fence that prohibits access, or interstate highway) intersects the transect. There are different approaches depending on whether a single corner is outside the boundary (Fig. 5-4), the boundary crosses at an oblique angle and excludes 2 corners (Fig. 5-5), or it crosses parallel to one of the sides, excluding 2 corners (Fig. 5-6). Applying 5-6 is also a simpler option for the unplanned situation in 5-5 when it is encountered.

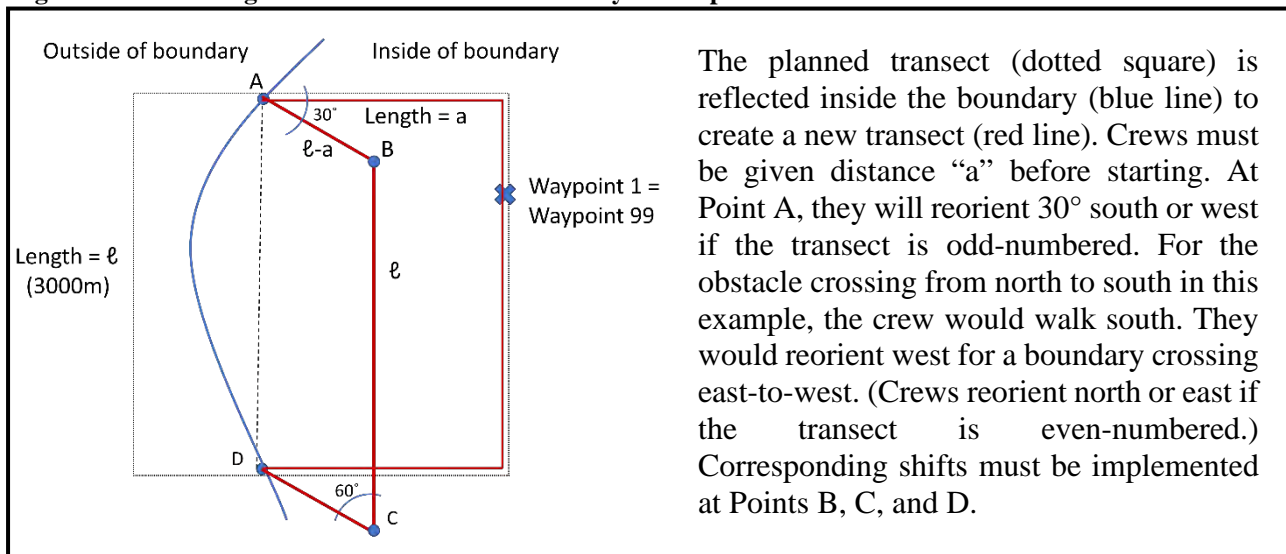
**Figure 5-4. Reflecting one corner inside a boundary.**



**Figure 5-5. Reflecting two corners around an oblique boundary**



**Figure 5-6. Reflecting two corners around a boundary that is parallel to a transect side.**





### Sampling through rugged terrain

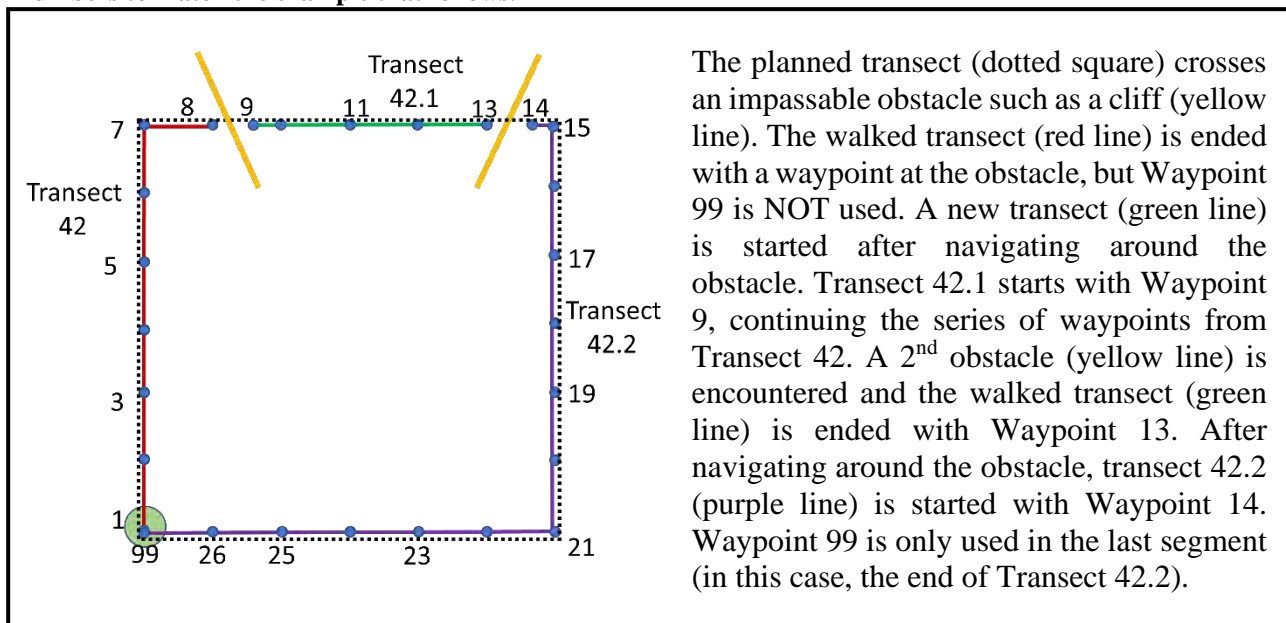
We would prefer for all transects to be walked exactly as they are selected so that we are confident of the applicability of our tortoise density estimates to the entire stratum. However, there are limits to what can reasonably be sampled. In particular, crews must return safely and be able to rest sufficiently to work safely the next day as well. As a rough guide, crews should evaluate their ability to return to their vehicles by 4 pm each day. The following material describes the types of changes that will be implemented in rugged terrain to modify standard transects (Figs. 5-7 to 5-8) or those already restructured to avoid human-built boundaries (Figs. 5-4 to 5-6).

#### *The transect is partially or entirely intersected by rugged terrain or unstable substrate*

This can usually be determined before attempting the transect, although deeply incised washes or large stretches of instable substrate may not be obvious until the crew has started the transect.

- Is it interrupted by a very short but severe obstacle? Some transects cross a ravine or other relatively short, steep area. When small obstacles occur on a transect, crews can use a short scramble (~20-30m) to get up or over something, look really hard before scrambling, turn around and look really hard again. The lead scrambles up with the line, the follow stays at the bottom. After the line has been examined by both the lead and the follow, the follow scrambles up to meet the lead and the line is resumed as normal. The transect follows the regular assigned path. It is not a standard transect, but it is also not a “shortened” transect.
- Is it interrupted by severe obstacle like a cliff? When more than 500 m of the planned route is not traversable, you should shorten the transect.
  - Internal interruptions – If you have completed some of the transect and a continuation of the transect is possible after you navigate the obstacle, enter a waypoint to interrupt the transect, find a safe route around the obstacle, and resume the transect at the point where it can once again be navigated (Fig. 5-7). The same path is sampled as for the standard transect, interrupting as needed to avoid areas of non-traversable terrain. This is also a non-standard transect, and it has been shortened.

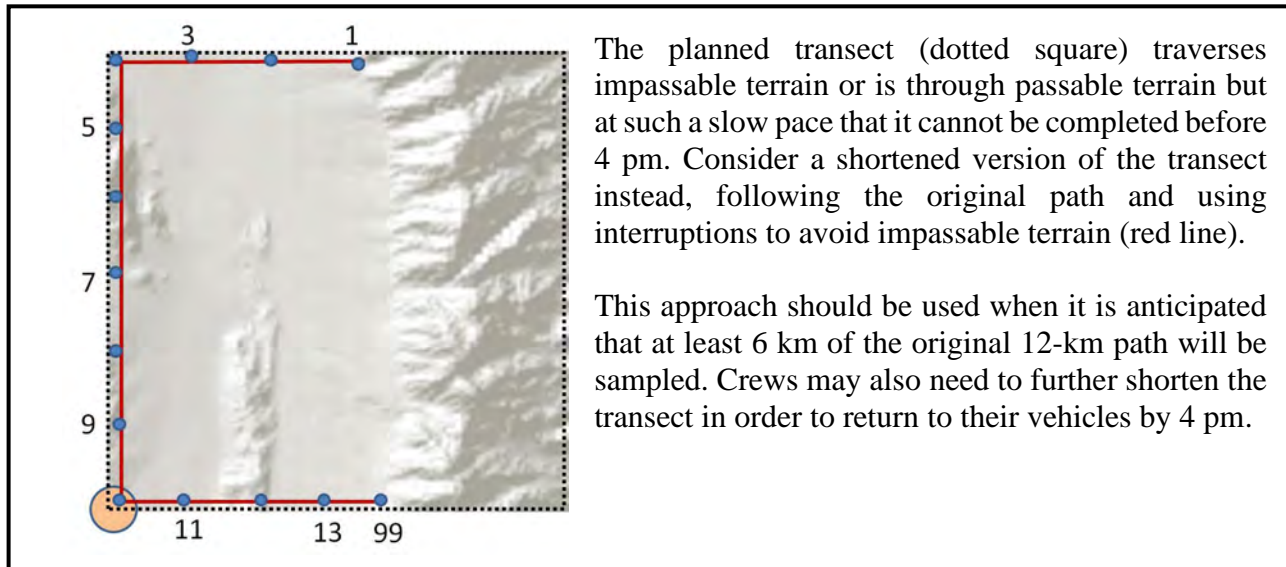
**Figure 5-7. Interrupting a transect to move around a barrier. This diagram uses transect and waypoint numbers to match the example that follows.**



The planned transect (dotted square) crosses an impassable obstacle such as a cliff (yellow line). The walked transect (red line) is ended with a waypoint at the obstacle, but Waypoint 99 is NOT used. A new transect (green line) is started after navigating around the obstacle. Transect 42.1 starts with Waypoint 9, continuing the series of waypoints from Transect 42. A 2<sup>nd</sup> obstacle (yellow line) is encountered and the walked transect (green line) is ended with Waypoint 13. After navigating around the obstacle, transect 42.2 (purple line) is started with Waypoint 14. Waypoint 99 is only used in the last segment (in this case, the end of Transect 42.2).

- Is it covered by more than a few hundred meters of un-navigable terrain? Shorten the transect along the original path, (Fig. 5-8). In this case, there are no internal interruptions, just one continuous but shortened transect. The transect is not standard, and it has been shortened.
- If even a shortened transect is not possible, do not attempt the transect.

Figure 5-8. Shortening a transect when the planned 12-km version is too rugged.



*The transect must be accessed by hiking in for several kilometers*

On-foot access increases either the time-to-transect in the morning, or the time-to-vehicle in the afternoon. Consider whether the transect can be completed as planned or shortened as appropriate. If a crew cannot access and complete the transect, then return to the vehicle by 4 pm, do not attempt the transect. One exception to this is if the field team uses base-camping to provision remote access of one or more transects. There is no “penalty” for returning to the vehicle after 4 pm; this is simply a guideline for handling inaccessible and/or rugged terrain.

#### Use appropriate documentation for non-standard transects.

- At each point where a turn is made for a reflection, a waypoint should be recorded. At the points where a transect is interrupted and then restarted, waypoints should be recorded. Waypoints should be no more than 500 m apart and can be much closer together as needed on non-standard transects. Each waypoint subform includes a field to communicate whether the transect is interrupted at this waypoint, as well as a field for comments, and it is appropriate to note the start of a reflection or transect shape change in this field. The numbers of waypoints are tracked on your sketch of each transect; the sketch and associated waypoint numbering for non-standard transects is particularly important.
- When all waypoints on a transect are completed, scroll to the bottom of the transect form on the data collection device to the transect description section. You will be asked whether the transect was walked as a standard transect, 12 km long with 3-km sides. All other shapes and lengths are not standard. Interrupted transects are not standard. **Any modification to a 12 km square transect, even if the distance is not shortened, is considered a non-standard transect.**

- For non-standard transects, you will identify the types of obstacles (terrain, substrate, other) that led you to modify the transect. Terrain obstacles cover multiple categories including terrain, private property, administrative boundaries (e.g. stratum edge), uncrossable highways, time, and tortoise fences. Use the “other” field when a transect was modified to avoid an obstacle that isn’t listed as an option under terrain obstacles. If a transect has been pre-reflected, crews should know why before going into the field. If the transect was not pre-reflected, use the “unplanned modification?” field to indicate this. If you are alerted before beginning a transect that you will need to make a reflection but the transect map is not pre-reflected this is still considered an unplanned modification and should be recorded as such. Unplanned modifications might occur due to new private fencing, construction, or mining activity.

#### *Additional documentation on paper data forms*

The electronic and paper data forms are carefully matched to have the same fields, although paper data forms are also used to collect information about how each transect was completed. Information on access routes, including GPS locations for important intersections, can be written on the paper data forms and there is an area to sketch the transect as you completed it. Indicate all waypoints, numbering 0, 1, 99, and 100. Also indicate roughly where any obstacles were encountered along the transect. These sketches provide information for future access and clarify potentially misleading information such as inaccurate GPS grabs.

#### *Using two or more transect forms to collect data on one interrupted transect*

Normally, we assume that waypoints plot the continuous path walked on a transect, so if a transect is interrupted internally (Fig. 5-7), use the “comment” and “transect interrupted?” fields to indicate that you are interrupting the search at this waypoint. You must also end the electronic transect form at this waypoint. Once the obstacle is navigated, begin a new transect form, with the new transect number equal to the original number plus “0.1”. If the original transect was 42, for instance, the transect number for the section after the obstacle would be 42.1. If a subsequent interruption is required, a new transect would be created and designated as 42.2.

Treating the walkable parts as separate transects is an important bookkeeping device for data processing. A few things will be different from a standard transect though. Instead of beginning with Waypoint 1, waypoint numbers will continue in sequence through all transect segments. For example, if the last waypoint recorded on transect 42 was 8, the start waypoint for transect 42.1 will be 9. In the case of using multiple transect forms to document a single interrupted transect, only the final transect form will end with Waypoints 99 and 100. In this example, if you have transects 42, 42.1, and 42.2, only the completed transect 42.2 will have a Waypoint 99 or 100. Waypoint 0 (drop off) will only be recorded for transect 42.

Record all transect or opportunistic observations of tortoises or carcasses under the transect part where they were found. The first transect records will indicate “standard transect?=N” and will describe obstacles that shortened that segment. The final segment may indicate “standard transect=Y” or “standard transect=N,” depending on whether it ends as planned, or at an obstacle. If the transect returns to and ends at waypoint 1 as planned without a reflection, even if it was interrupted earlier, the final segment should be recorded as “standard transect=Y” in the electronic form. As with waypoints, tortoise and carcass observations are numbered continuously through all parts of the transect; do not start counting again from “1” when you start a new transect part.

In summary, although the waypoint and observation numbers continue in sequence through all parts of the interrupted transect, all transect parts will have their own transect number, will hold their own observations, will describe obstacles unique to that segment, and will have their own transect form on the data collection device. However, a single set of paper data sheets is used to document all parts of the transect. At the appropriate waypoints, write in the new transect number used in the electronic form, and on the transect drawing, indicate where the interruptions occurred and new transect numbers were instituted.

EXAMPLE – electronic form for figure 5-7 transect diagram

Transect 42

Waypoints 0, 1, 2, 3, 4, 5, 6, 7, and 8

Waypoint 8, indicate Transect interrupted = Yes, leave Lead to next waypoint blank,  
Comments = Transect interrupted for XX, end transect 42. Additionally, take 1 photo  
back toward the walked transect and 1 toward the interruption (include notes).

0 transect live observations

2 transect carcass observations, numbered 1 and 2

1 opportunistic live observation, numbered 1

1 opportunistic carcass observation, numbered 1

Waypoint 1 time 7:00am

End the transect record using Standard transect=No, Unplanned modification=Yes, and  
provide the list of obstacles for this segment.

Transect 42.1

Waypoints 9, 10, 11, 12, and 13

Waypoint 9, Comments = Begin transect 42.1

Waypoint 13, indicate Transect interrupted = Yes, leave Lead to next waypoint blank,  
Comments = Transect interrupted for XX, end transect 42.1. Additionally, take 1 photo  
back toward the walked transect and 1 toward the interruption (include notes).

1 transect live observation, numbered 1

1 transect carcass observation, numbered 3 to follow those in transect 42

0 opportunistic live observations

0 opportunistic carcass observations

End the transect record using Standard transect=No, Unplanned modification=Yes, and  
provide the list of obstacles for this segment.

Transect 42.2

Waypoints 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 99, and 100

Waypoint 14, Comments = Begin transect 42.2

0 transect live observations

1 transect carcass observation, numbered 4 to follow the one in transect 42.1

0 opportunistic live observations

1 opportunistic carcass observation, numbered 2 to follow the one in transect 42

Waypoint 99 time 3:22 pm

End the transect record, enter Standard transect=Yes

All other regularly recorded transect information.

EXAMPLE – paper form for figure 5-7 transect diagram

Transect 42

Waypoints 0 to 26, 99, and 100.

In the comment for Waypoints 8 and 13, indicate an interruption initiated.

In the comment for Waypoints 9 and 14, indicate Begin transect 42.1 or 42.2, respectively.

1 transect live observation

4 transect carcass observations, numbered consecutively.

1 opportunistic live observation

2 opportunistic carcass observations, numbered consecutively.

Transect Start time 7:00 am

Transect End Time 3:22 pm

Indicate Transect standard = No, Unplanned modification = Yes, and provide the cumulative list of obstacles.

A single transect sketch indicating all waypoints and obstacles, plus “42.1” and “42.2” written next to the waypoints where each new electronic form was started.

## 6. RADIO TELEMETRY AND G<sub>0</sub> PROTOCOLS

Across the Mojave Desert, several small groups of 8-12 tortoises each have been equipped with radio transmitters and are used to estimate the proportion of tortoises in the local area that are active/visible. Individuals are observed repeatedly throughout the day using a VHF (very high frequency) radio receiver and a directional antenna. Each time a tortoise is located, data are recorded indicating its visibility on the surface, in a burrow, or in vegetation. These data allow us to calibrate distance sampling results to account for the proportion of the population that eludes sampling due to fossorial or cryptic behavior. The radio-equipped tortoises are called G<sub>0</sub> tortoises (“gee-sub-zero”) for the mathematical term in the density equation that represents tortoise availability.

The primary goal of G<sub>0</sub> training is successful implementation of the G<sub>0</sub> protocol by telemetry crews. This includes correct use of telemetry equipment, understanding G<sub>0</sub> data collection fields, observation of as many radio-equipped tortoises as possible during the day, observing the appropriate focal population for the transects being sampled, and a window of observation that overlaps the day’s transect time window for each sampling area. An additional goal is to make related work on transects more understandable to line distance crews.

**Objective 1:** Locate tortoises and collect activity data.

Standard: G<sub>0</sub> monitors will be proficient in using telemetry equipment to locate tortoises.

Standard: G<sub>0</sub> monitors will be proficient at collecting appropriate data.

**Metric:** G<sub>0</sub> monitors will use telemetry equipment to locate radio-equipped tortoises and will complete G<sub>0</sub> start and observation forms correctly. They will demonstrate correct operation of VHF radio receivers. When a tortoise is not immediately detected with a receiver, they will apply appropriate troubleshooting procedures to locate the tortoise.

Refer to **Appendix I** for paper G<sub>0</sub> and monthly focal tracking annotated data sheets.

**Objective 2:** Implement the daily G<sub>0</sub> protocol.

Standard: G<sub>0</sub> monitors will successfully complete daily monitoring activities related to schedule coordination with line distance crews and with one another to collect sufficient daily observations on each tortoise.

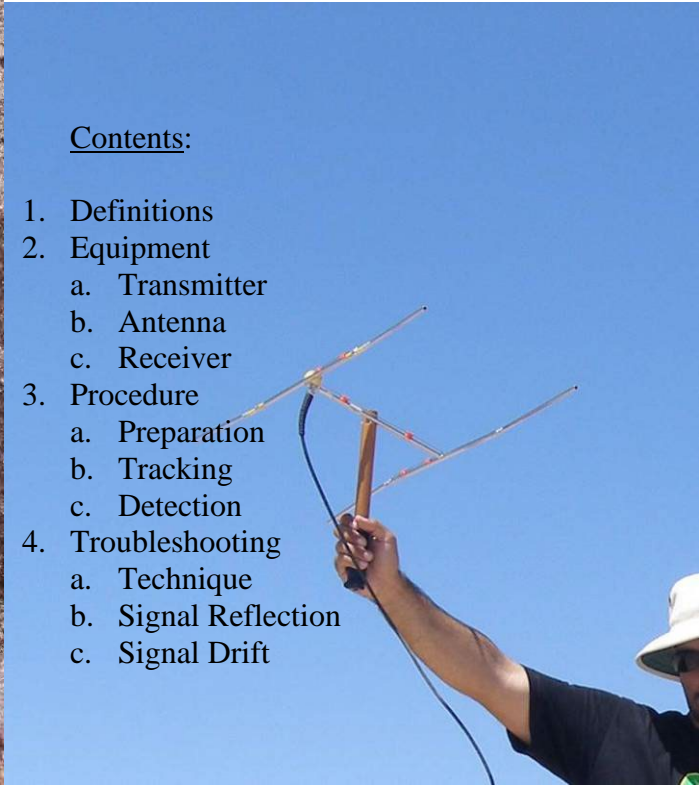
**Metrics:** At an actual G<sub>0</sub> site, monitors will locate and record G<sub>0</sub> data at a rate equivalent to that required to sample 10 tortoises at least 3 times a day (the length of which is defined by the time between typical start and end times for transect monitoring) and bounding the transect sample period as assigned by trainers. G<sub>0</sub> monitors will coordinate with their team leaders to schedule their activities while data are collected on transects.

## Objective 1: Locate Tortoises and Collect Activity Data



### Contents:

1. Definitions
2. Equipment
  - a. Transmitter
  - b. Antenna
  - c. Receiver
3. Procedure
  - a. Preparation
  - b. Tracking
  - c. Detection
4. Troubleshooting
  - a. Technique
  - b. Signal Reflection
  - c. Signal Drift



## 1. Definitions

- **Radio Telemetry** involves data transmission over a distance. In this case, the observer uses a receiver to detect a signal emitted from a transmitter attached to a desert tortoise.
- A **Radio Transmitter** radiates a regularly timed signal at a very specific frequency.
- The **Frequency** is built into the battery-powered transmitter and is a specific band within the electro-magnetic spectrum (in this situation 160-168 MHz).
- Approximately once per second, the transmitter emits a “beep” at one precise frequency; this **Signal** travels in a wave over a specific distance (its **Range**). To detect this signal, the observer needs to be within this range (generally 500 - 900 meters).
- The transmitter signal’s frequency is not auditory to humans. Thus a radio **Receiver** is used, allowing the observer to hear the signal when s/he sets the correct frequency into the receiving unit.
- The **Directional Antenna** boosts the receiving power and, because it is tuned to be loudest in only one direction, allows the observer to follow the sound to the signal’s source.
- Increasing **Gain** increases the receiving unit’s amplification of the signal, but sometimes also increases noise. The gain differs from **Volume**, which only changes the noise intensity coming from the receiver's speaker.

## 2. Equipment

The equipment used to conduct radio telemetry on desert tortoises is typical of that used on many types of animals. The distance from which a signal can be detected is a result of many interacting factors involving the power of the transmitter, the quality of the receiver, and the specificity and gain of the receiving antenna. In addition, your ability to track will be influenced by outside factors such as climate, terrain, and obstructions or interfering structures (e.g. power lines).

### **Transmitter:**

Many tortoises in the Mojave Desert are subjects of research or monitoring programs and carry a radio transmitter. Comprising the transmitter are a battery, a frequency emitter, and a



whip antenna. While size, design and location on the tortoise may vary, the transmitter's basic operation remains the same.

Epoxy binds the transmitter to a scute (segment) on the tortoise's carapace (shell). The transmitter should be attached as low as possible on the shell while avoiding the scute seams so it doesn't affect the tortoise's profile. The whip antenna is affixed to one or more scutes as an additional measure to prevent the transmitter's accidental removal. In the event that this antenna is damaged or severed, the tracking range becomes severely limited, typically less than 50 meters. The antenna should not be completely attached and wrapped around the tortoise, but should be left extending loosely behind the tortoise, reducing the epoxy mass and making the unit less cumbersome (see Figure 1).



Figure 1. Examples of typical VHF transmitter attachment to desert tortoises.

Transmitters currently in use for desert tortoise monitoring broadcast in the VHF frequency range, between 160-168 megahertz (MHz). Each tortoise has a unique frequency, for example, one tortoise may have the frequency 164.236. Yet the signal will “bleed” into neighboring frequencies, so this tortoise may be heard at 164.234 or even 164.238 depending on the transmitter's accuracy and the receiver type. Nearby tortoises must possess sufficiently dispersed frequencies (i.e. 20 or more Hz) to ensure the ability to track the correct tortoise.

### **Antenna:**

A directional antenna amplifies the signal from a transmitter and allows the observer to aim toward the source. Commonly, the “H” shaped 2- element Yagi (Telonics RA-2AK) or 3- element Yagi antennas are used, but other multi-element Yagi antennas exist. Each antenna is specifically tuned to a 2K or 3K MHz range of frequencies (e.g. 164-166 for the antenna in Figure 2), but may also receive frequencies outside of this range, albeit with lower efficiency.

*These fragile antennas are costly and should be treated with care.*

The two-element Yagi depicted in Figure 2 requires assembly, while other models may unfold into the correct operating configuration. For the H-style Yagi, each “kit” should include the main body (A), the arms (B and C) and the handle (D). The arms vary in length and must connect into the correct port on the antenna body. The yellow colored tape on the arms matches that on the body. When assembled, the shorter arms screw into the antenna's forward portion.

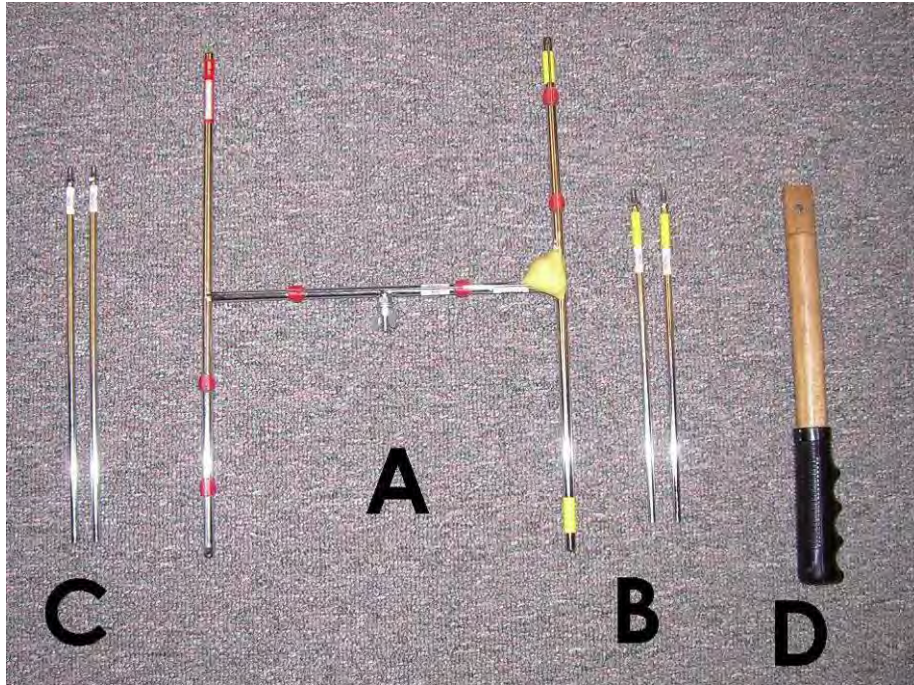


Figure 2. Telonics RA-2AK VHF 2 element Yagi antenna.

A small sticker on the antenna body indicates the “front” (the part to point toward the transmitter) and generally is where the antenna cable attaches. A coaxial cable with BNC connectors on both ends connects the telemetry receiver to the antenna.

*Each crew should carry an operational spare cable in the event that the first fails.*

**Receiver:**

Telemetry receivers are radios capable of receiving in the VHF bandwidth. Several companies manufacture receivers specifically used for telemetry (e.g. Telonics, ATS, Lotek, etc.), but other multi-band receivers can be used as well (e.g. Icom). Technical specifications and control layout differ among various receivers, but similar concepts govern their operation.

The tracker enters the tortoise's individual frequency into either a number pad or a series of dials. Some models require entry of all six digits (XXX.XXX) to enter the frequency, while others require the entry of only a portion of the whole frequency (e.g. X.XX) where another knob or button adjusts the frequency by small increments (usually 0.001 MHz, or 1 KHz).

In multi-band receivers, the "Band" or "Mode" button alternates the various modes to AM, FM, WFM, LSB, USB and CW. For tracking, CW mode is often used, but you should track using the band that allows for the best auditory clarity of the signal. The "best" mode for use may change while tracking a tortoise as the distance to the source decreases.

All receivers allow manipulation of both "Volume" and/or "Gain" to tune the directionality and auditory expression of the transmitter signal during tracking. As the tracker approaches the animal or requires additional directionality, reduction in the Gain (and/or the combined Gain and Volume control) aids in the signal's attenuation.

**Volume** on a receiver matches that on any radio; it simply adjusts the signal's amplification to the speaker. The tracker need only set the Volume at a comfortable level.

**Gain** refers to the receiver's amplification of the signal. Increasing Gain increases the distance from which the observer can detect the signal, but it also increases background noise and reduces directionality. Lowering the Gain reduces noise and increases directionality, but also diminishes the signal's detection range.



Figure 3. Examples of three typical VHF receivers used in radio telemetry. The Icom IC-R10 (top left) is a multi-band VHF receiver, while the Telonics TR-5 (top right) and Telonics TR-2 (bottom) operate in more limited frequency ranges.

Table 1. Comparison of three typical VHF receivers used in radio telemetry: the Icom IC-R10/R20, the Telonics TR-2, and the Telonics TR-5. Information collected from: [www.icomamerica.com](http://www.icomamerica.com), [www.telonics.com](http://www.telonics.com).

<b>Comparison</b>	<b>Icom IC-R10/R20</b>	<b>Telonics TR-2</b>	<b>Telonics TR-5</b>
Control Panel	Digital, clear	Dials, intuitive	LCD, Digital, often difficult to read
Frequency entry	Enter every digit, including the decimal	The 16 is assumed, the four other numbers are then entered in sequence. For the frequency 164.236, you would see 423 on the dials, and the frequency knob would be turned to 6.	Enter every digit including the decimal, and then press enter.
Knobs / Controls	R-10: The Volume and Gain knob are the same: R-20: The Volume and frequency knob are the same. For both, hold down the button labeled "RF GAIN" until the screen reads "Set RF Gain," use the knob to adjust Gain. When it says "max" or "10", press the "RF GAIN" button a second time to return it to Volume or frequency control.	A single knob combines both Gain and Volume, and they cannot be changed separately.	Up/Down arrows allow Gain and frequency changes with a separate knob for Volume.
Receiving Power	Low (Often need to be within 300-500 meters)	Medium- High (Often need to be within 500-900 meters)	High (Often need to be within 700-900 meters)
Charge	11 hours	10 hours	>16 hours
Size	Small 0.32 kg 6 x 14.2 x 3.48 cm	Medium 0.86 kg 11.7 x 5.1 x 18.0 cm	Large 1.2 kg 17.8 x 11.1 x 6.2 cm
Portability	Handheld or shirt clip	Leather case with shoulder strap	Blue cloth case with shoulder strap
Recharge	Wall charger	Wall charger	8 AA batteries
Frequency Band	Extensive, multi-band VHF receiver: SSB, CW, AM, FM, and WFM. 0.150-3304.999 MHz CW: 118.000-146.999 MHz	Limited: SSB and CW 2K or 4K MHz range: set at factory e.g. 164.000-166.999	Limited 4K MHz range: set at factory 163.000-167.999
Pros	Light, easy to use, relatively inexpensive changeable or rechargeable batteries	Intuitive to use, lightweight, manual frequency scanning accomplished easily	Powerful, water resistant, changeable batteries Freqs can be programmed
Cons	Limited range, less effective under powerlines, wrong buttons easily pressed, modes confusing	Batteries cannot be changed, recharge only, non-programmable. Gain and volume coupled.	Heavy, difficult to use, display difficult to read, Gain change takes time, frequency adjustment awkward.

### 3. Procedure

#### Preparation:

Assemble the necessary equipment:

- GPS
- Data collection device (e.g. iPad mini)
- Two-way radio
- Charged receiver
- Yagi antenna
- 2 Coaxial cables
- Sufficient replacement batteries
- A list of past known locations and frequencies for each tortoise
- Mirror
- Compass
- Paper datasheets
- Writing implements
- Safety equipment
- Water

Check the tortoise frequencies and bring the appropriate receiver and antenna prior to heading into the field.

*Never track when lightning may strike.*

#### Tracking:

1. Follow the provided GPS coordinates to the tortoise's last known location; start as close as possible to that site.  
(Note: Listening to the tortoise's frequency while traveling to its last location, and even scanning for other nearby tortoises as well, is recommended. Tortoises move frequently during the activity season, increasing the likelihood that the tortoise you seek will be found in a different location than the last. You will save time if you listen for each animal while traveling between locations.)
2. Assemble the antenna and connect it to the receiver using the coaxial cable.
3. Turn on the receiver and enter the correct frequency.
4. Set Gain to maximum.
5. Listen for the signal:
  - a. Stand a few meters away from vehicles or structures.
  - b. Hold the antenna high at arm's length.
  - c. Orient the antenna in a Vertical position (see Figure 4). The Vertical orientation provides more range but less directionality.
  - d. Listening for the transmitter beep, rotate your body in a slow, *complete* circle.
  - e. Determine the direction from which the signal sounds strongest.



Figure 4. The Vertical antenna position on the left (handle parallel to the ground) provides more range but less directionality in detecting the signal, while the Horizontal antenna position on the right (handle perpendicular to the ground) allows better directionality while lessening range.

6. Follow the signal and adjust:
  - a. Walk toward the loudest sound.
  - b. Continue listening while walking, sweeping the antenna from side to side to confirm a strong signal directly forward.
  - c. If the signal weakens, repeat Step 5 and continue in the new direction.
  - d. Reducing Gain while approaching the source also aids in narrowing the loudest signals direction.
7. Improving Directionality:
  - a. When you hear the signal clearly (about 300 meters or so), orient the antenna in a Horizontal position (see Figure 4). This provides less range, but better directional certainty. Once you hear the signal using this orientation, the Vertical position becomes unnecessary.
  - b. Repeat Step 5 using the Horizontal orientation.
  - c. Continue lowering the Gain as you approach the tortoise until the signal sounds loud at minimum Gain.

### **Detection:**

#### 1. Final Location:

- a. When very close, the beeping becomes loud enough to sound distorted and omnidirectional. Continue walking and sweeping until the signal weakens or sounds louder behind you to triangulate to the correct location.
- b. Upon determining a small area with the strongest signal, point the antenna perpendicular to that area and walk in a circle around it to confirm the correct location; this may take time. At close range the signal may sound equally strong directly behind as well as in front of you.
- c. At this point, begin scanning visually for the tortoise or burrows.

#### 2. Burrow:

- a. If the signal seems to emanate from a burrow, make a visual inspection to locate the tortoise. The tortoise may be deep inside; you should use a mirror to reflect sunlight into the burrow.
- b. If the tortoise cannot be seen, two things can be done to detect its exact location:

*Be careful: do not step on or collapse the burrow while performing these.*

- 1) Remove the cable and antenna from the receiver. If beeps can still be heard, the tortoise is very close.
- 2) You may “fish” for the tortoise. Remove the cable from the antenna, but leave it connected to the receiver. Dangle the antenna over the burrow and move it around to the loudest point – the tortoise’s most likely location. To avoid getting dirt in the BNC connector, do not let the cable bottom touch the ground.

*To avoid stepping on the antenna, place it up high or in a creosote bush.*

- c. If you see a tortoise, make sure it is the one you seek by checking for a transmitter and even a tortoise number on a floy or paper ID tag glued to the shell.

#### 3. Record Location:

- a. Record the Tortoise Number, Frequency, Northing, Easting, Date, Time, Observer, and any other necessary information.
- b. Use your data collection device to record required information as well.

## **4. Troubleshooting**

### **Technique:**

**Antenna.** Understanding the antenna’s performance may assist in tracking the signal. In figure 5, the antenna’s listening pattern, the sound intensity appears loudest when the antenna points directly at the signal’s origination (0 degrees). **Backfeed** may be heard when the antenna receives a signal from the opposite direction as well. An alternative exists to determine the correct direction when following the loudest signal is not possible. Holding the antenna horizontally, identify the “signal nulls,” or the sections in which the beeping disappears completely, as opposed to the “signal peaks,” while turning in a complete circle. Walking in the direction exactly opposite to the middle of the null areas forms a viable option.



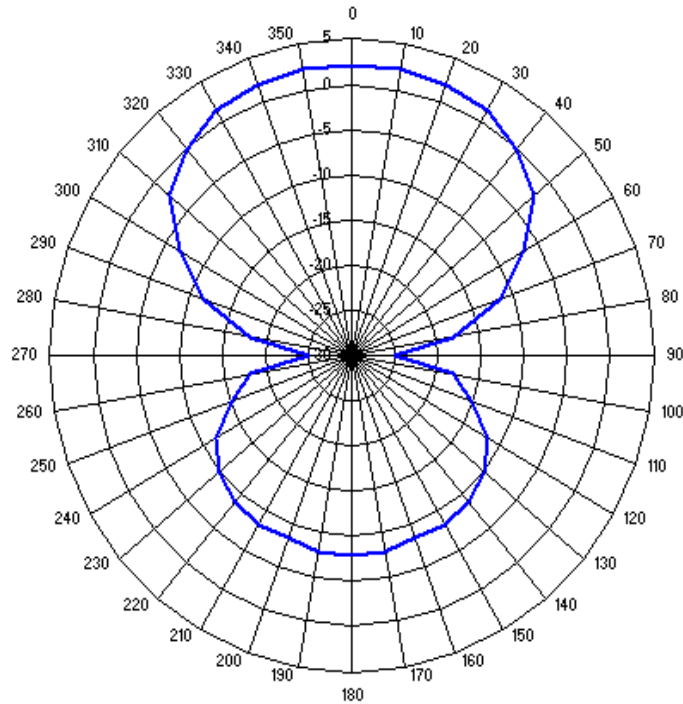


Figure 5. The listening footprint for an antenna held horizontally; northward ( $0^\circ$ ) sets the signal's source.

**Receiver.** At minimum **Gain**, the sound may occur at the same intensity from all sides. This phenomenon makes locating the tortoise at close range particularly difficult. Shifting the frequency slightly up or down may provide a difference in beep intensity. Lowering the frequency until a “thump” sounds or raising it until a very high-pitched beep occurs may provide some direction.

**Signal Reflection.** Many factors may distort the signal's direction including frequencies from other transmitters, complex terrain, powerlines, and even nearby fences or vehicles. In all cases, the tracker should move away from obstructions to allow for open space through which the signal may travel.

**Terrain.** Rocky terrain, hills, washes, cliffs, and even mountains may obscure or redirect signals. Height above the ground, obtained by climbing hills or up to ridge-tops, increases a signal's range. The signal may be lost when dropping into a canyon or wash. If a signal does become lost, a tracker should climb to a high place near the tortoise's last known location to listen for the signal or walk the ridge above a canyon while following the sound.

**Echoes.** As some tortoises do tend to live in washes and cliffside caliche caves, echoes may sound louder than the true direction. For example, a tortoise may be on a mountaintop while the tracker walks below, between mountains; rocks may obscure the signal's source, but the echo resonates clearly bouncing off the opposite mountain. In this case, it is best to climb to a higher point and listen.

**Powerlines.** Powerlines distort or mask signals, making them difficult to acquire or follow. The tracker should walk at least 100 m away from the lines to listen. As an aside, some people have received mild electrical shocks while tracking under the lines.

**Burrow Substrate.** The signal may become dampened or distorted if the tortoise rests deep within its burrow. Caliche seems to mask the signal the most, requiring that the tracker be very near to detect the signal or in a direction corresponding with the orientation of the burrow opening. Other substrates may impede the sound as well.

**Signal Drift:**

A transmitter's frequency may "drift" up or down with changes in climate and over time. Other factors affecting the emitted frequency and transmitted signal include terrain, temperature, humidity, wind speed, the receiver, and the antenna.

If, while in the field, a tracker cannot detect the provided frequency, they should first check that the inputted frequency matches that of the desired focal tortoise. When the correct frequency does not yield a signal, the tracker should listen in a complete circle while adjusting the frequency up and down at least 6 KHz away from the original incrementally in both directions. If this does not yield results near the last known location, the tracker may choose to listen from an elevated location, such as a mountain or hilltop. While this may seem like extraneous effort, finding the tortoise immediately represents the best option as it may move even further away if already distant.

Finally, if searching for at least 30 minutes yields no signal, the tracker should proceed to the next tortoise and continue searching for the missing animal while moving among the other animals in the observer's tracking schedule. This animal may be encountered associated with another as tortoises seem to aggregate at times.

## **Objective 2: Implement the Daily Go Protocol**

### **Optimizing monitoring to coincide with tortoise activity**

One of the adaptations tortoises have for living in the desert is to restrict surface activity to fairly narrow windows of time during the year. In general, tortoises predictably emerge from deep within shelters (burrows) from mid-March through mid-May and then again (less predictably) in the fall. These periods coincide with flowering of their preferred food plants and with annual mating cycles. Both periods also represent the most likely times to find water in plants or on the surface. The annual range-wide monitoring effort is scheduled to match the spring activity period for tortoises.

During this season, all tortoises are not above ground or visible in burrows. In order to encounter as many tortoises as possible, monitoring is scheduled for early in the day and to be completed before the hottest time of day. Because we are using vision to find tortoises, monitoring is restricted to daylight hours. Based on past experience, we expect tortoises to become most active after 8 am at the beginning of April (it is usually too cool before this time), but to emerge earlier and earlier until their optimal activity period is around sunrise by the beginning of May. In May, we also expect daytime temperatures to limit tortoise above-ground activity as the morning

progresses to afternoon (see **Chapter 5: Line Distance Protocols, Objective 2: Start and Complete Transects to Optimize Tortoise Detections**).

### **Coordinating start and end times with transect crews**

Field crews on transects are working to complete transects during this optimal period each day, so crews are likely to arrive at transects at similar times on a given morning. The role of telemetry crews is to provide data to estimate daily tortoise activity during the period when transects are walked. Telemetry monitors will locate and record  $G_0$  data at a rate equivalent to that required to sample 10 tortoises at least 3 times a day between the start and end times for transect monitoring. Each day telemetry monitors should choose a tortoise from the population to start with at random and change the direction in which they track individuals daily. Telemetry and transect crews are responsible for beginning the field day at the scheduled time. However, completion times will be more variable, and will be affected by terrain, air temperature, number of tortoises encountered, etc. Each field group will use their own method to communicate between transect and telemetry crews so that telemetry crews monitor until all transects have been completed for the day. In general, at the end of the day, when each crew has finished their transect and is back at the truck, they make contact with the logistics coordinator for the group. After this coordinator has heard from everyone that day, the telemetry crew is notified. Telemetry crews cease monitoring once they hear from the logistics coordinator or it is 4pm, whichever comes first.

## 7. DATA COLLECTION AND VERIFICATION



# ArcGIS Survey123

You will use ESRI's Survey123 app for data collection, which has been installed on every iPad mini. The survey forms on Survey123 allow real-time electronic data collection in the field, preventing the need for substantial post-season data entry. These forms also allow for an initial level of data quality control to be implemented, because the values that are allowed in each field can be constrained. A great deal of effort goes into creating a survey form that is a balance between user friendliness and functionality. While some fields do have validity checks, we cannot anticipate all potential data collection scenarios and so have not added strict validity checks on every field. Our less constrained approach means it is possible to enter non-valid data, so extra care and precision are required on your part to ensure the highest quality data comes in from the field.

The goals of Survey123 and Database training are to provide you with the necessary knowledge and practice so that you accurately enter data and correct mistakes if necessary. The outline below details the individual objectives and standards, as well as the final metric for which you will be held accountable after completing this training. **Note that this chapter primarily references the Transects database and forms as examples but the same principles apply to the G0 and Training Transects databases and forms.**

Refer to **Appendix I** for collection field explanations.

**Objective 1:** Proficient understanding of Survey form and Database structure.

Each crew member will know 1) the basic terminology (form, sub-form, parent, child, record) and design of the survey form/database, and how forms are related as parent and child; 2) how to download and update forms in Survey123; and 3) the purpose and initiation of each form and child form in the Transects database.

**Objective 2:** Proficiency working with Survey forms.

Each crew member will know how to 1) understand data entry restrictions and validity checks; 2) navigate among existing child records; 3) save a record; and 4) delete a record.

**Objective 3:** Proficient data entry and understanding of Survey form fields.

Each crew member will know 1) how to use the on-screen keyboards to enter data; 2) how to use pick-list fields; 3) how to use time and date fields; 4) how to use photo fields; and 5) how to use auto-calculated fields.

**Objective 4:** Proficient understanding of how to use the Integrated iPad GPS.

Each crew member will know how to 1) take a GPS grab; and 2) check the GPS grab for validity.

**Objective 5:** Limiting mistakes, data quality control, and correcting data entry errors on electronic and paper forms.

Each field technician will 1) understand best practices to limit data entry mistakes; 2) understand how to review data during and after data collection; and 3) know how to correct mistakes.

**Objective 6:** Upload the data collected to the AGOL online server

Each field technician will know how to 1) sync and upload the collected data to the online AGOL server; and 2) troubleshoot data transfer issues.

**Objective 7:** Survey123 diagnostics and data recovery

Each field technician will know how to 1) recover Survey123 data in the event of an app or iPad malfunction, and 2) enable diagnostic logging to help with troubleshooting persistent issues.

**Metrics:** Trainees will be expected to maintain their equipment, successfully perform GPS grabs, and accurately record data on their iPad mini. This will be evaluated based upon successful delivery of complete and valid training line and pre-season LSTS transect data. These demonstrated skills are required by the USFWS in order to participate in monitoring.

**Metrics:** Trainees will submit data in clean, correct, complete, and legible paper format, matching the associated electronic data which should also be error-free. There will be opportunities on training lines, practice transects, and during telemetry practice to demonstrate proficiency.

## Objective 1: Understanding Survey Form and Database Structure

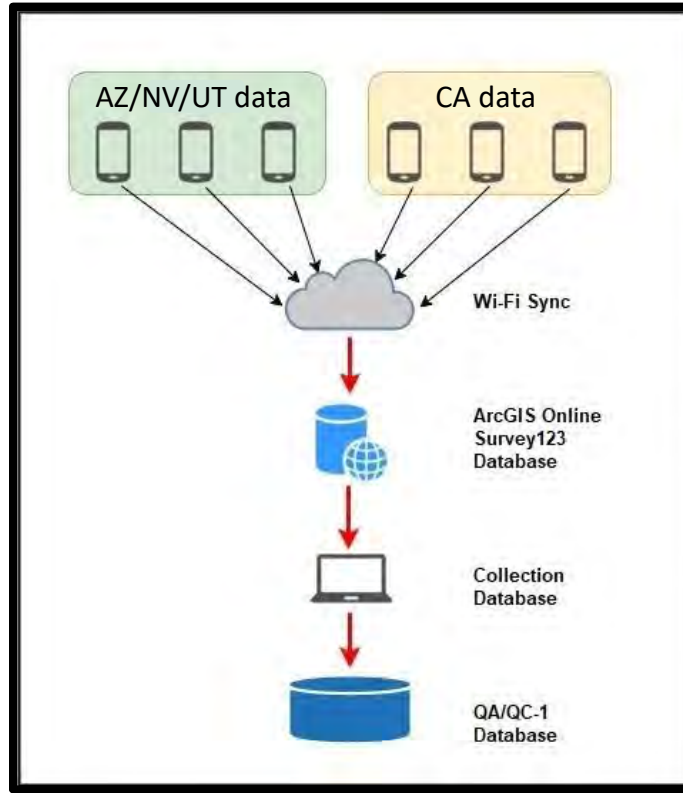


Figure 7-1

- 1. Basic Terminology and Design of the Survey123 Database** – Databases are complex electronic entities that have whole fields of study devoted to them. Below is a very brief and general review of database information and terminology relevant to your monitoring duties.
  - Database – The Survey123 database you will be adding to while monitoring is comprised of related electronic data that will be organized to allow easy access and querying once finalized. The final database is created in four stages, described in Figure 7-1 and the steps below. Each stage passes through several iterations of Quality Assurance/Quality Control (QA/QC) to create an accurate database.
    1. Data are collected in the field using Survey123 Forms on iPads and paper datasheets. The data are checked to make sure they are the same on paper and iPad while being collected and at the end of the day.
    2. Data is uploaded to ArcGIS Online (AGOL) along with data from other crews during weekly Wi-Fi syncs at the office.
    3. The compiled AGOL database is downloaded into a Collection database in Microsoft Access
    4. The data in the Collection database is imported into a QA/QC database in Access, where the data are reviewed using scripted and manual processes to identify missing or inconsistent data records.
  - Form – Within the Survey123 app on the iPad mini, a form is an electronic sheet of monitoring questions to be answered by you. Questions (a.k.a. fields) within each

form relate to one subject and each form related to line distance sampling transects is detailed in Standard 3 of this objective. Forms are the building blocks for the database – each time you complete a form, it will become a record in a table within the final database.

- **Sub-form (Parent and Child)** – A sub-form is a form that can only be accessed through and is dependent on another form. This dependency is also referred to as a parent and child relationship. For example, the parent form, Line Distance Transects, is the access point for several child forms. The child forms are Waypoints, Transect Live Observations, Opportunistic Live Observations, Transect Carcass Observations, and Opportunistic Carcass Observations. A child form cannot exist until a parent form is created. This is called a one-to-many relationship; a single transect can have many observations or waypoints, but an individual waypoint or observation can belong to only one transect. Figure 7-2 diagrams the Parent and Child structure of our transect database.

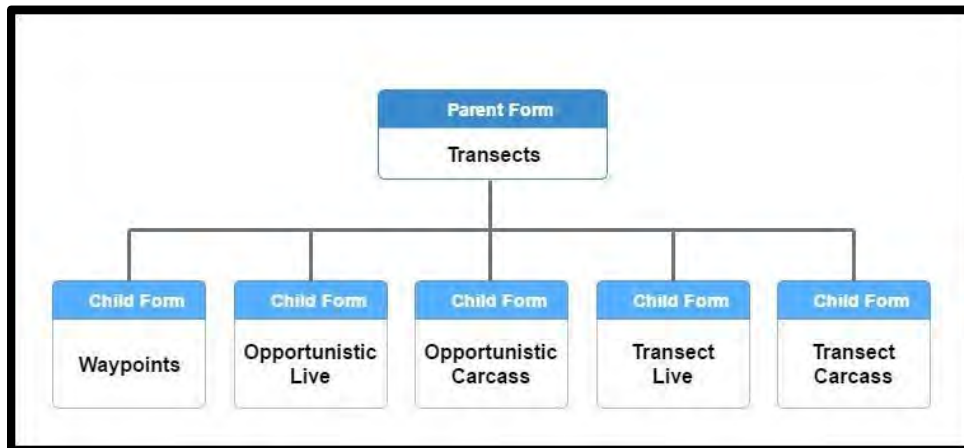


Figure 7-2

- **Record** – A record is a single event within a database table. Each individual transect, waypoint, or tortoise observation is a record. When you fill out a parent or child form, you create a new record. In this chapter when we discuss reviewing or editing records, we are referring to parent and child forms that have been filled out with data. If you have multiple child forms of the same type filled out (e.g., waypoints 1 and 2) each of those is a separate child record. Records are related to records in other tables via a primary key, also known as a unique identifier. A transect’s primary key is carried over and recorded in each child form as a means to identify which transect a waypoint or observation belongs to.

**2. Downloading and Updating Forms in Survey123** – When you first use your iPad it may already be logged into Survey123 and have all relevant forms downloaded and up-to-date. Or your iPad may be partially but not fully set up with the necessary Survey123 forms. This section assumes you are starting from the beginning of the process.

- Open the Survey123 App by tapping on the app icon from the iPad Home Screen:



- b. You will be presented with 3 options on the landing page. Choose “Sign in with ArcGIS Online.”
- c. Enter the FWS ArcGIS collaborator username and password that was setup ahead of time.
- d. After signing in you will be directed to the “My Survey123” homepage (note that if you are already signed in to ArcGIS Online the app will open to this page when you first launch the app- steps b and c are only necessary when you are logged out of ArcGIS Online). If you have survey parent forms already downloaded they will be listed on this page. If you don’t have any forms the page will say “You don’t have any surveys on your device.”

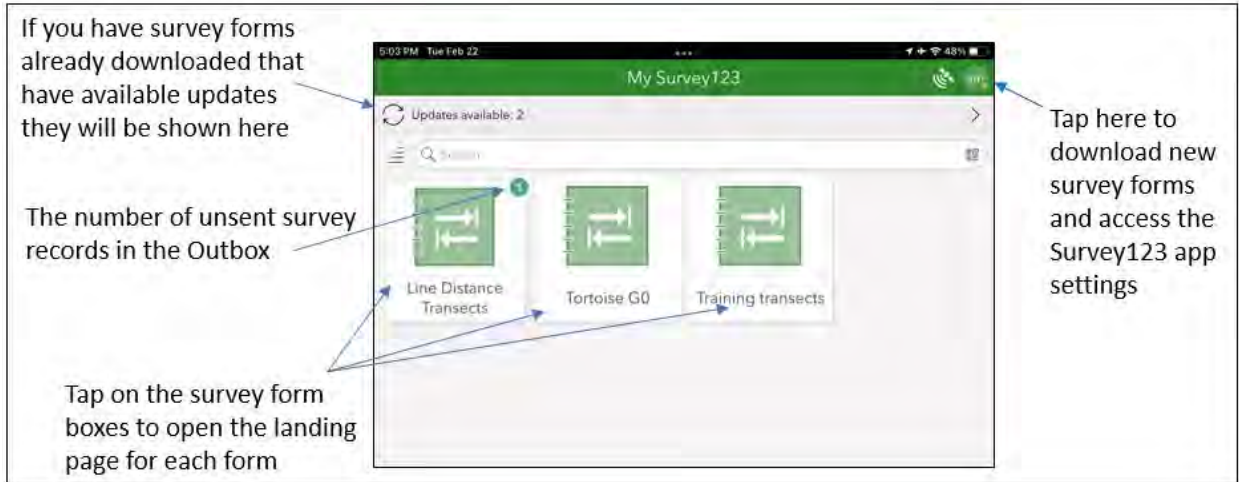





Figure 7-3

- e. If you need to download new survey parent forms you can click on the circular icon in the top right corner, which will have the initials of your ArcGIS username (Figure 7-3). This will open a side bar, from which you can choose  **Download Surveys** . This will open the “Download Surveys” page, which will have all available USFWS survey forms. Scroll until you see the form you need. Tap the  icon to the right of the form you need to download it.
- f. If you already have survey parent forms downloaded but they are out of date (i.e., they have been revised by project management) you will be alerted with a message on the My Survey123 homepage that you have updates available (Figure 7-3). Tap on that message, then tap on the  symbol to the right of each of the listed surveys to update them. Crews should be informed directly by project management whenever survey forms are updated, but it is still a good idea to keep an eye out for these alert messages in the My Survey123 page.

Note: You will only be able to download or update surveys if you are connected to Wi-Fi and logged into ArcGIS Online. You will not receive “Update available” alerts if you are not connected to Wi-Fi and signed into ArcGIS Online.

3. **Initiation and Purpose of Survey123 Forms**– There are three Parent forms, each with one or more child forms that you will use while monitoring (depending on your position as a telemetry or transect technician):



- Line Distance Transects
  - Waypoints
  - Transect Live Observations
  - Opportunistic Live Observations
  - Transect Carcass Observations
  - Opportunistic Carcass Observations
- Tortoise GO
  - Tracking Observations
- Training Transects
  - Training Observations

Each parent form will automatically contain all associated child forms, you do not need to download the child forms separately.

The following outlines some basic information on each form in the transects database and provides a practical guide on how and when to access them on your iPad mini. Refer to the annotated datasheets in **Appendix I** for a detailed explanation of the purpose of each field in a form.

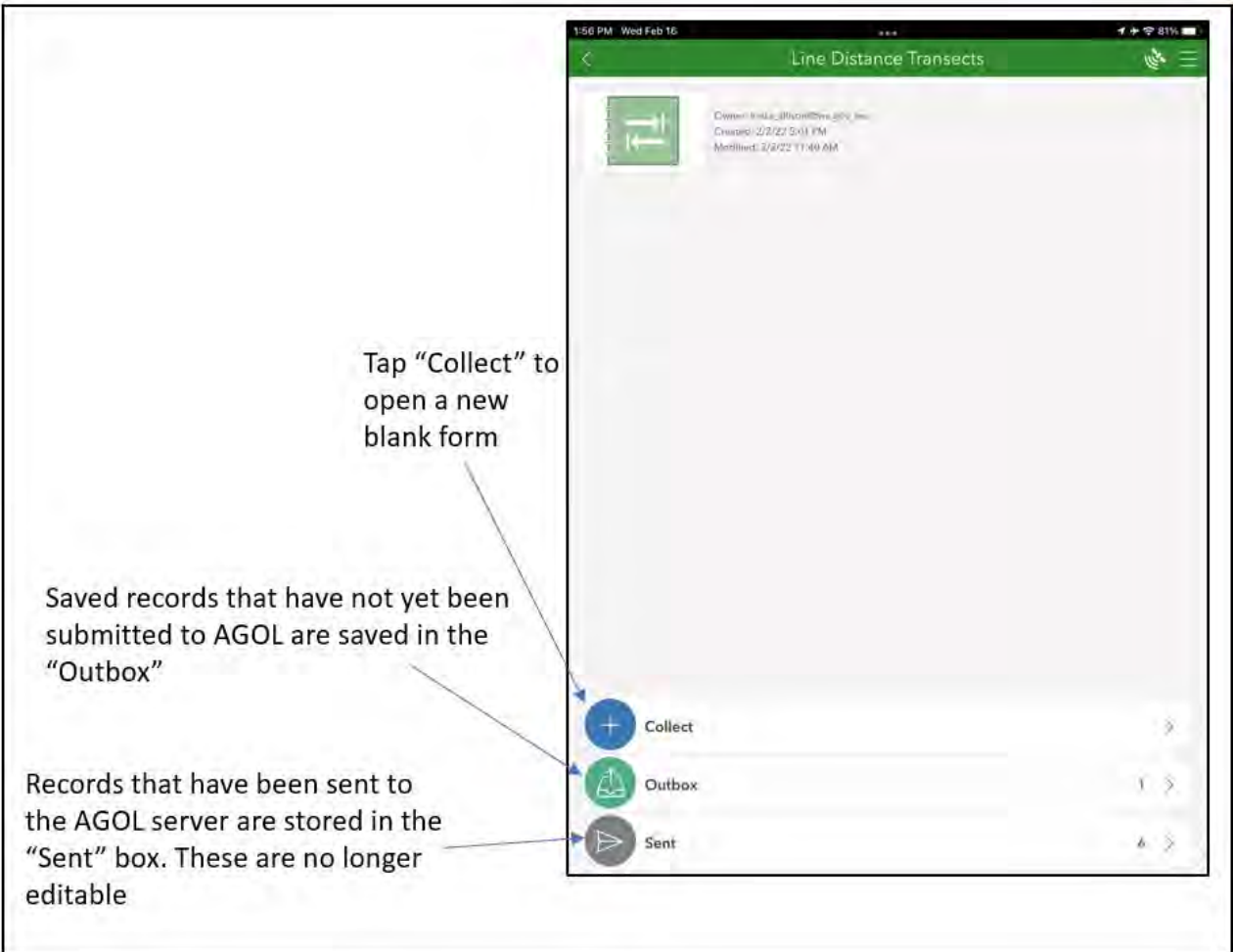


Figure 7-4

To initiate a parent form, choose it from your My Survey 123 homepage. Once you have the form's landing page tap "Collect" (Figure 7-4). The form is now open and ready for data collection.

**Line Distance Transects Parent Form -**

**Purpose -** This is the parent form for the transect database (Figure 7-5). The child forms cannot be accessed until this form is opened. Its purpose is to record general information about transects, including names of the observers and condition of the transect (i.e. mountainous, encountering prohibited access, etc.). The transect record is created when team members start hiking to a transect from their "drop off" (or parking) point each morning, and is closed when team members return to the drop off point. In the case of non-standard transects, a new parent form is used for every transect segment following interruptions.

To initiate a child form for the first time, tap on the ⊕ button below the child form title in the parent form (Figure 7-5). If this icon is not visible you may need to expand the child form using the ▸ button to the left of the child form title. To create subsequent records of the same child form (e.g., the next waypoint), you will need to tap the + button at the bottom right of the previously completed child record (Figure 7-6).

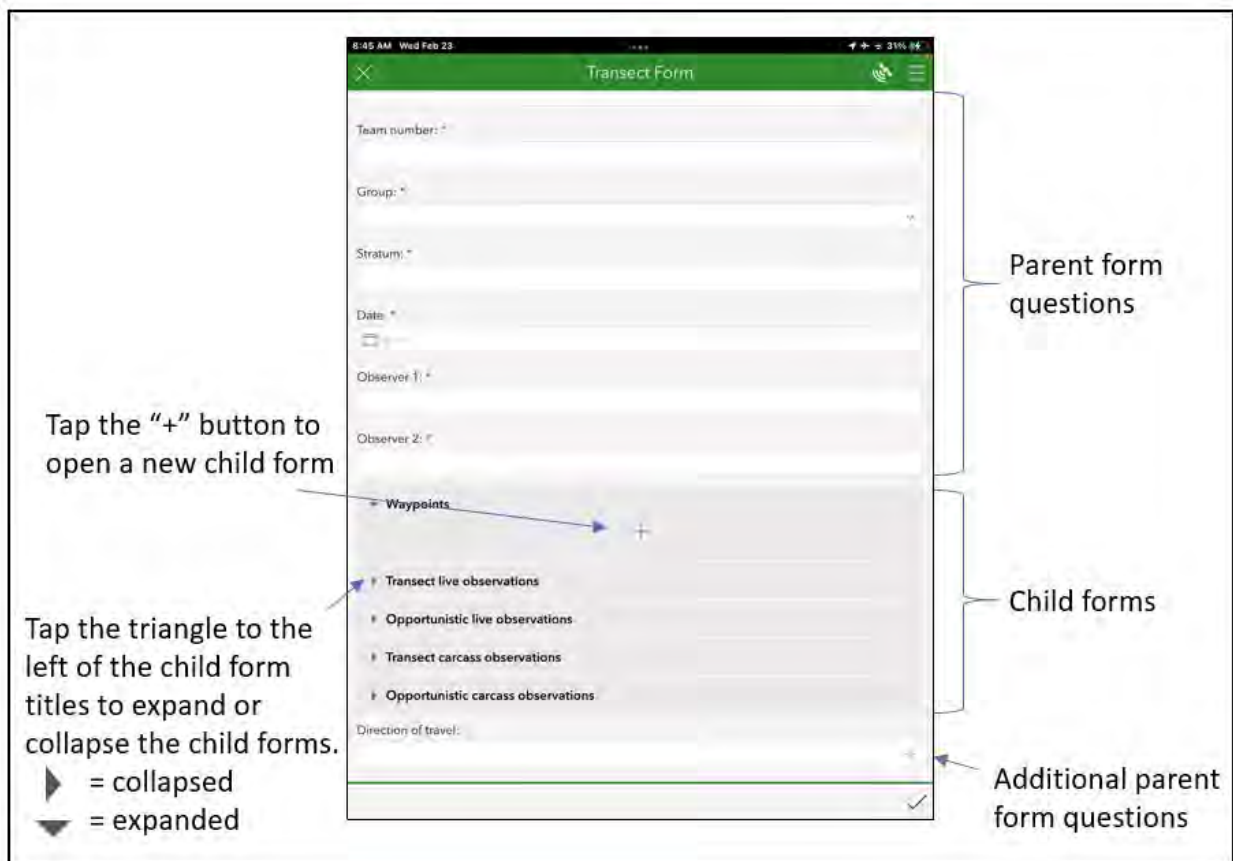


Figure 7-5

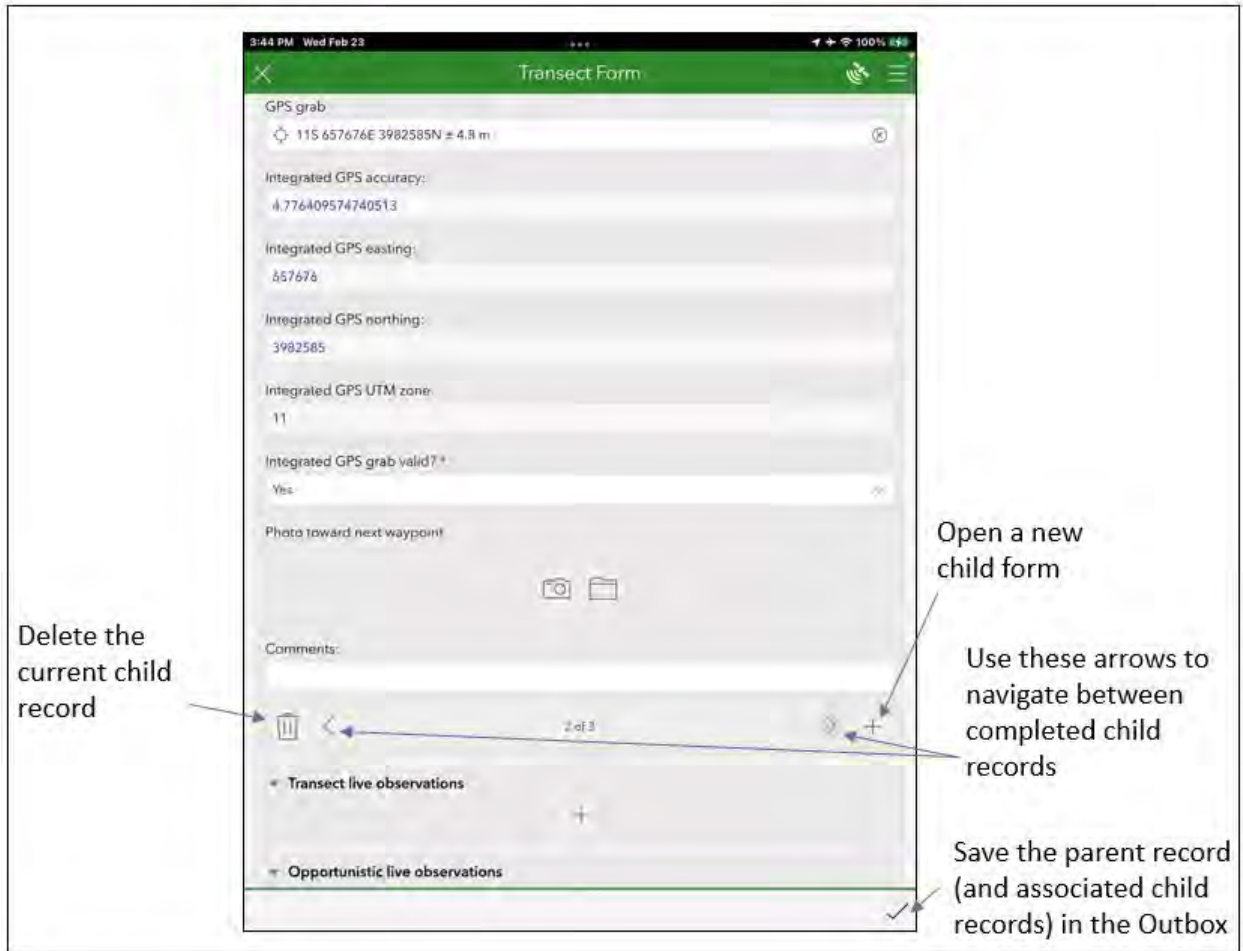


Figure 7-6

#### Waypoints Child Form -

While walking a transect, you will create a new waypoint record and take a GPS grab approximately every 500 meters, making this your most frequently completed child form. Waypoints show where you actually walked, so we do not rely on the idealized transect outline or on your descriptions. Every transect that is attempted must have at the very least 4 waypoints – waypoint 0 for the drop off location, 1 for the start point, 99 for the end point, and 100 for the return to drop off point. The recorded time for waypoint 0 is the time that you started walking towards your transect and waypoint 100 is the time you return to the drop off point, NOT the time that you are picked up. These times are used for estimating travel time to and from transect start points.

#### Transect Live Observations Child Form –

On those happy occasions when you find a live tortoise while walking a transect, this is the form you will complete. You will complete information on the individual tortoise's size, sex, location, azimuth, and distance along with a GPS grab and additional tortoise-related data.

#### Opportunistic Live Observations Child Form -

This is the least frequently needed Child form. Opportunistic tortoises are those found while walking between the drop off point and the transect start or end points, or any other time a live tortoise is found while not actively following line distance sampling protocol. Information similar to the transect live child form is requested, with the exception of azimuth, bearing, and radial distance, because these observations are not made using the distance search method.

#### Transect Carcass Observations Child Form –

You must fill out a new carcass observation form for every reportable carcass you find (at least half of the shell present or a smaller part of the carcass available but identifying marks are present) while completing a transect. General information about the carcass, such as size, sex, and condition, is reported, along with a GPS grab and basic line distance sampling information fields.

#### Opportunistic Carcass Observation Child Form –

Opportunistic carcasses are tortoise carcasses that are found while not walking the actual transect or found while not actively following line distance sampling protocol. Information similar to the transect live child form is requested, with the exception of azimuth, bearing, and radial distance, because these observations are not made using the distance search method.

The picture below shows a sample transect and when to complete each form.

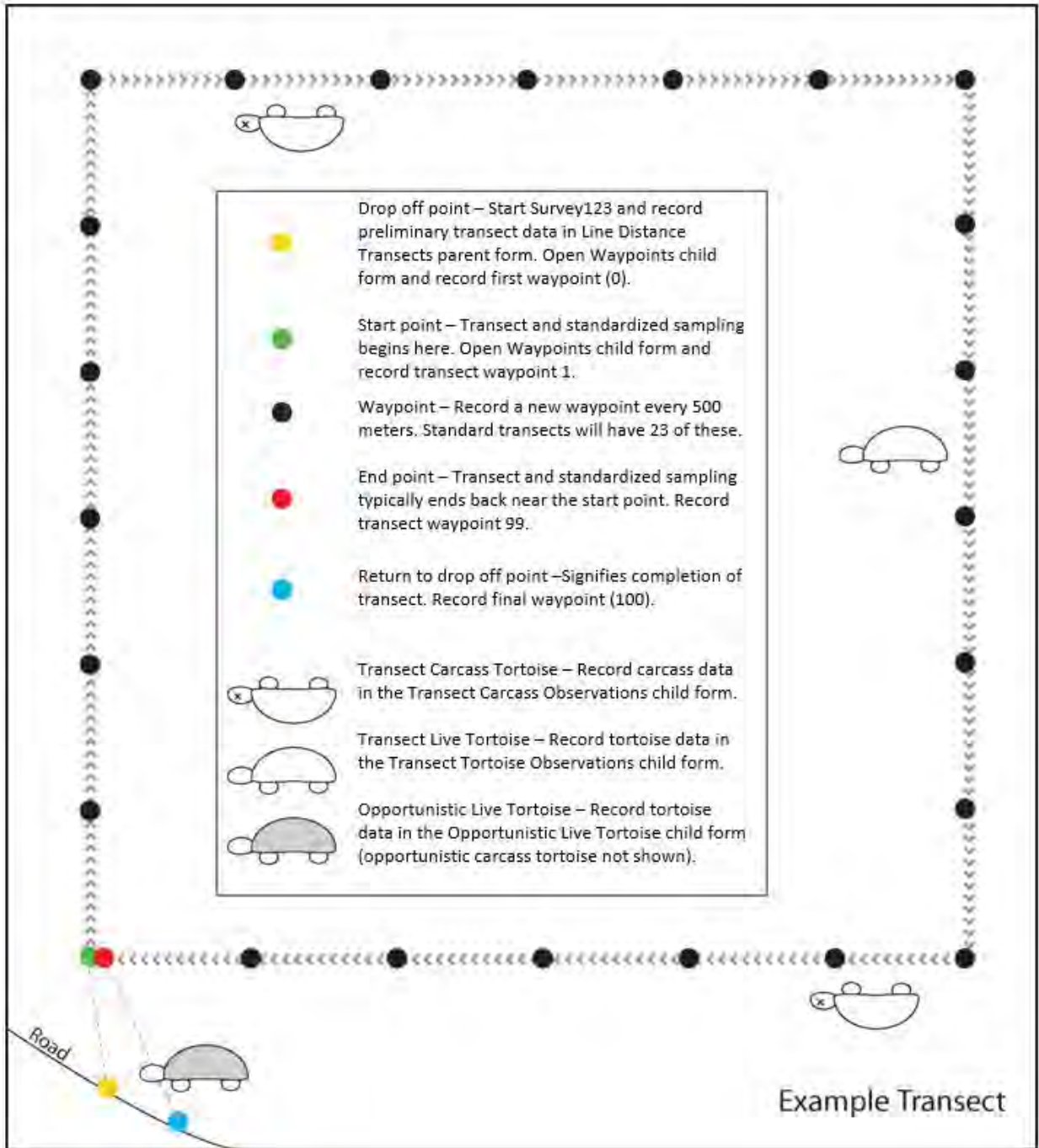


Figure 7-7

## Objective 2: Working with Survey Forms

1. **Understand Data Entry Restrictions and Validity Checks** – As discussed in the introduction, the Survey123 form has built-in features to help insure valid and complete data are entered.
  - a. The first line of defense to ensure valid data entry are field type restrictions. This prevents the wrong type of data from being recorded in certain fields (e.g., some fields only accept numbers, others are pick-lists of pre-defined options).
  - b. Additionally, some fields (known as conditionally visible fields) are only visible if the entry in a previous field indicates that the conditionally visible field is relevant. For example, “burrow visibility” is only shown in the live observation child forms if soil burrow or rock burrow is given as the tortoise location in the previous field.  
*Note that if you enter data (or take a photo) in a conditionally visible field, and then you change the value of the field that determines the relevance of the conditional field, you will lose the data in the conditionally visible field. If you change the other field again and the conditionally visible field reappears, it will be blank.*
  - c. Certain fields are marked with an asterisk (\*) to indicate that they are required. The app will not let you open or review a different child record of the same type or submit the parent form to the Outbox unless these required fields are filled in. Some fields that are not marked “required” in the forms are still required in some (or most) scenarios based on our protocol, so do not assume you can skip a field just because it is not marked required.
  - d. Finally, the forms include built-in QA/QC validity checks. These include single-field checks for things like unreasonably high or low numbers as well as multi-field checks for data entries that are inconsistent among fields. It is important to keep in mind that these checks are not exhaustive and that it is possible to enter non-valid data. A data entry can also easily be valid but still be incorrect. For instance, if a tortoise was incorrectly measured as 120 mm when it was really 130 mm, the 120 mm entry would be accepted as a valid entry by the form even though it is the wrong measurement.



The validity checks are triggered when 1) a new child form of the same type is opened, and 2) the parent record is marked as ready to be sent to the Outbox. It is best to force a validity check as soon as you complete a child record so that if there is something wrong with the entry you can quickly address it. Opening a new child form to force a validity check on the previous record is **not** a good method. We check discrepancies between user-entered times and time stamps that are saved when new records are generated, so pre-opening new child forms will raise red flags. That method would also result in extra unused child form records needing to be deleted at the end of the transect.

Instead, tap the checkmark ✓ on the bottom right of the form to indicate that you are (at least temporarily) done with the survey (Figure 7-6). If there are invalid entries the app will circle them with a red box and text saying “Invalid” (if you missed a required


field it will be boxed in red and read “Required”). If all the entries are valid and no required fields are missing, a menu will open to “Continue this Survey” or “Save in Outbox.” If you need to enter more data immediately, choose “Continue this Survey.” If you are done entering data for now you should “Save in Outbox,” which will save the parent record and all associated child records.

2. **Navigate among existing child records** – You can view subsequent and previous child records of the same type by tapping on the > and < symbol at the bottom of a completed child record (Figure 7-6). Objective 5 covers data review protocol in more detail.
3. **Save a transect record** – When you complete a child record and prepare to continue walking the transect it is a good idea to save the parent record in the “Outbox” (which will also save all associated child records). This forces a validity check on the data you just entered and guards against data loss in the event of an app or iPad malfunction. To save the parent record in the Outbox (including all associated child records), tap the checkmark ✓ on the bottom right of the form and choose “Save in Outbox” (Figure 7-6). A couple things to avoid:
  - a. Tapping the “X” in the top left corner of the form opens a menu that includes options to “Close and lose changes” as well as “Save in drafts.” While it may seem intuitive to save your incomplete record as a draft, do not do so for 2 reasons. One, it is too easy to accidentally tap “close and lose changes” in this menu, which would result in data loss with no option to recover. Two, saving as a draft does not force validity checks.
  - b. If you are connected to a Wi-Fi hotspot when you tap the checkmark ✓ on the bottom right, an additional option to “Send Now” will also be visible. Do not choose that option, because once you send a record to the AGOL server you can no longer edit it on the iPad and re-send it. To avoid this issue, you should not be connected to Wi-Fi while collecting or reviewing data.

To re-open a parent record saved in the Outbox, first open the Outbox for the parent form landing page of interest (Figure 7-4), then find the record you want to review. Tap on the record name and choose “yes” to the “Do you want to edit this survey?” question. Be sure you opened the correct transect record! Double check the date and transect number of the record you just opened to confirm it is the one you need to edit.

4. **Delete a child or parent record** – If you need to delete a child record you can do so using the trash can symbol  on the bottom left of the child form (Figure 7-6). If you need to delete an entire parent record (and all its associated child records) you can do so from the Outbox. Open the Outbox from the parent form landing page (Figure 7-4), tap on the three dots to the right of the parent record you want to delete, and then tap on the trash can symbol .

### Objective 3: Understanding How to Enter Data on the iPad mini

- 1. On Screen Keyboard** – Text and number entry fields will open a keyboard when you tap on them. You can toggle between number and letter keys (Figure 7-8). Do not use speech or photo recognition options to enter text, they are too error prone. Also, do not add emojis or other cartoon symbols, they may negatively impact the data import process and data formatting. When you are done entering text you can tap the  symbol in the bottom right corner to collapse the keyboard so it is out of the way.

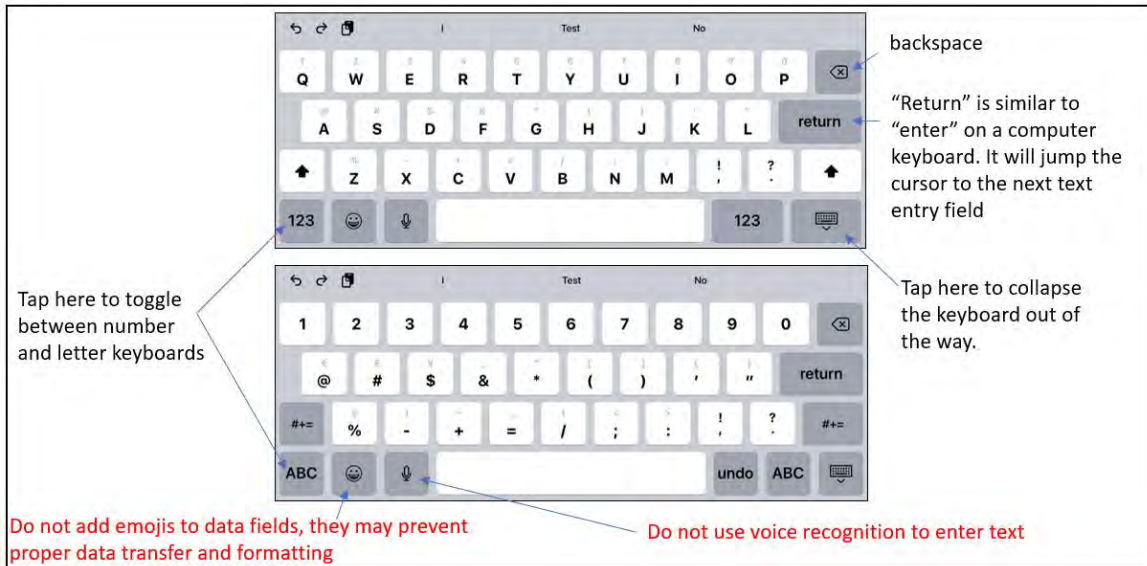




Figure 7-8

- 2. Pick-list Fields** – Pick list fields allow entry of pre-defined options, which prevents spelling errors. Pick-one fields have circles next to each option, pick-multiple fields have squares (Figure 7-9). Pick-multiple fields allow but do not require multiple options to be chosen. Pick lists are collapsed by default, tap on the  symbol to the right of the field to expand the option list. An entry can be chosen by tapping anywhere on its row (not just in the circle or square on the left) so be careful when scrolling through lists to not accidentally choose an incorrect option.

After choosing your option(s), collapse the pick list by tapping the  symbol. This will clean up your view of the form and prevent accidental data entry changes.



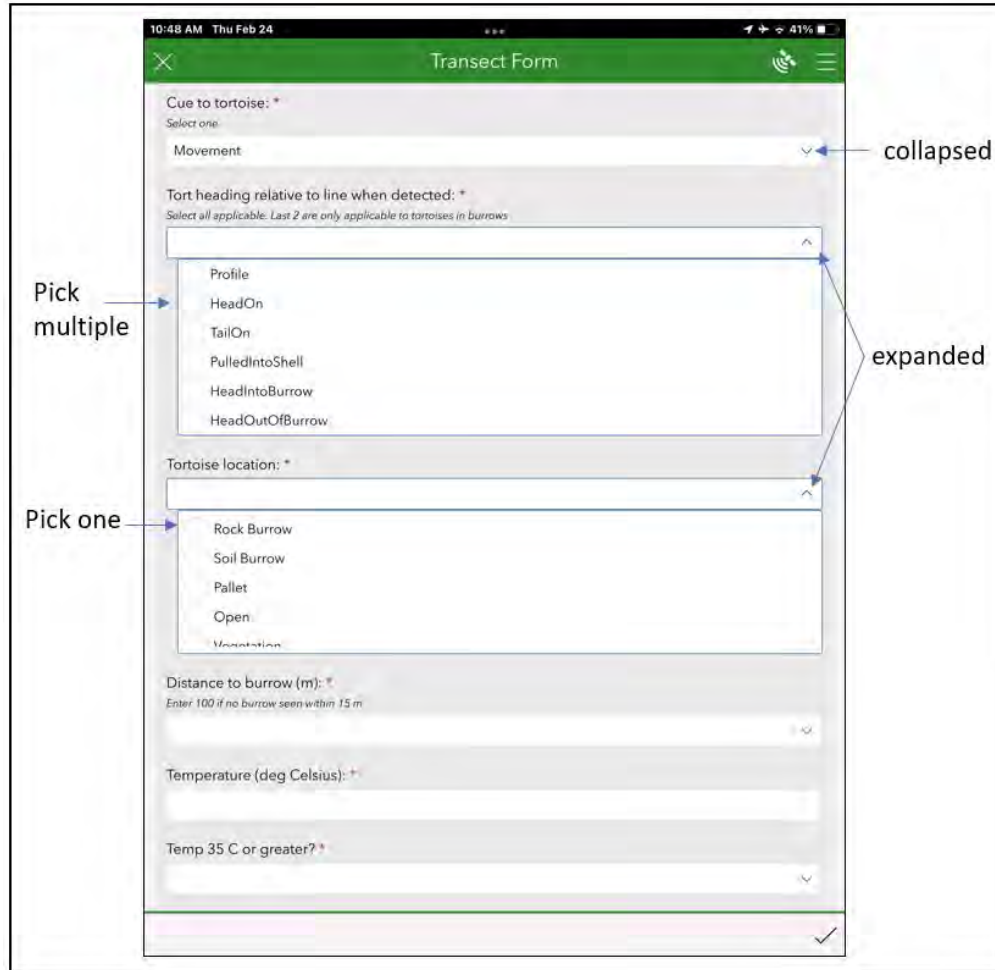


Figure 7-9

- 3. Time and Date Fields** – These allow for automated entry and manual corrections. For both fields, tapping on the empty field will auto-fill the field with the current time or date. At the same time, a manual correction tool opens so that you can change the time or date as needed (for instance if you are entering data off a paper datasheet at the end of the day due to the iPad running out of batteries). You can tap the next field on the form to collapse the manual entry tool on the time or date field.

*NOTE: We compare the user-entered times and dates from these fields to automated time and date stamps that are collected behind the scenes for each record (and are not visible or editable by the field user). If there is a discrepancy between these times (or the dates don't match), we will need an explanation. To avoid time spent tracking you down for an explanation, please put one in the comments when you know there will be a discrepancy (e.g., "iPad died in field, data entered at camp in evening").*

- 4. Photo Fields** – Photo fields are used to document the transect at waypoints as well as document live and carcass observations. Please take all photos in "landscape" orientation (iPad held horizontal) unless a particular situation requires vertical orientation. For waypoint

photos, try to include as much land and as little sky as possible. Use 1X zoom level, zooming in degrades the photo quality (the iPads do not have telephoto lenses).

When to use photo fields:

Waypoints Child Form –

Take photos at each corner, reflection, and interruption. One photo should be taken facing back toward the previous waypoint (not applicable for waypoint 1) and one taken facing toward the next waypoint (not applicable for waypoint 99 unless transect is shortened and ended) or interruption. Make sure to capture waypoint photos in the correct field (photo field 1: *Photo toward previous waypoint* or photo field 2: *Photo toward next waypoint*). Note that photos aren't needed for waypoints 0 and 100.

Transect Live Observations Child Form –

Take at least one photo of every tortoise. Ideally one photo should be taken looking down on the tortoise's head and carapace, capturing the head and possibly upper half of the forelimbs (Figure 7-10). If a photo from above isn't possible, take a headshot from the front or side to show BCS. If the tortoise is tucked in or in a burrow and a headshot photo isn't possible, take a tortoise in habitat shot.

Additionally, take photos of any existing tags or notches or of nares or body condition features to clarify scoring. In the latter cases, use the comment field to communicate your intent to the viewer.



Figure 7-10

Opportunistic Live Observations Child Form –

See Transect Live Observations Child Form above.

Transect Carcass Observations Child Form –


At least one photo should be taken of each recorded carcass, showing any existing tags or notches if present.

Opportunistic Carcass Observations Child Form –

See Transect Carcass Observations Child Form above.

Add a photo comment to describe all photos taken (these can be short but should be a full word, e.g. “Waypoint 1”, “tortoise”, or “carc with tag”). Do not rename photo file names in Survey123. If you need to take more photos than the form allows you will need to do so using the iPad camera app and manual file names (see **Chapter 4. Electronic Equipment Care and Maintenance**).

If a photo field is conditionally visible based on the entry in another field and you take a photo, then change the value in that other field you will lose the photo you took when the photo field disappears. However, there is a way to recover the photo. This process also applies if you need to delete a record and add the photos from that record to a new record:

- a) In the photo field that you need to add the photo to, tap on the file folder icon 
- b) Choose “Files,” then the Survey123 folder, then “ArcGIS”, and finally “My Survey123 Attachments.”
- c) Tap on the photo you want to add. Make sure you choose the correct one! You can sort by date and time to make it easier to find the most recent photo. It is a good idea to write down (on a notepad) the file name of the photo from the original photo field it was recorded in before attempting to move it to another field so that you are sure you added the correct photo to the new field. Adding the photo to the new field before deleting the old child form is a good idea as well, so you can verify the photos match. Once a photo is uploaded to a new field, a new copy of that photo - with an updated file name - will be added to the My Survey123 Attachments folder on the iPad.

This method can be used to access photos that disappeared from conditionally visible fields or that were in deleted child records, but not photos that were directly deleted from the form using the trash can symbol.

Note that photos over 10MB cannot be synced to the AGOL database. The only time we’ve run into this issue is when technicians have tried transferring photos between records by taking screenshots of photos and then adding them to the new record using the file folder browser. Screenshots are stored in .png format which has minimal compression and thus results in large file sizes. If you transfer photos between records using the method outlined above (through the Survey123 file folder) you will not have an issue.

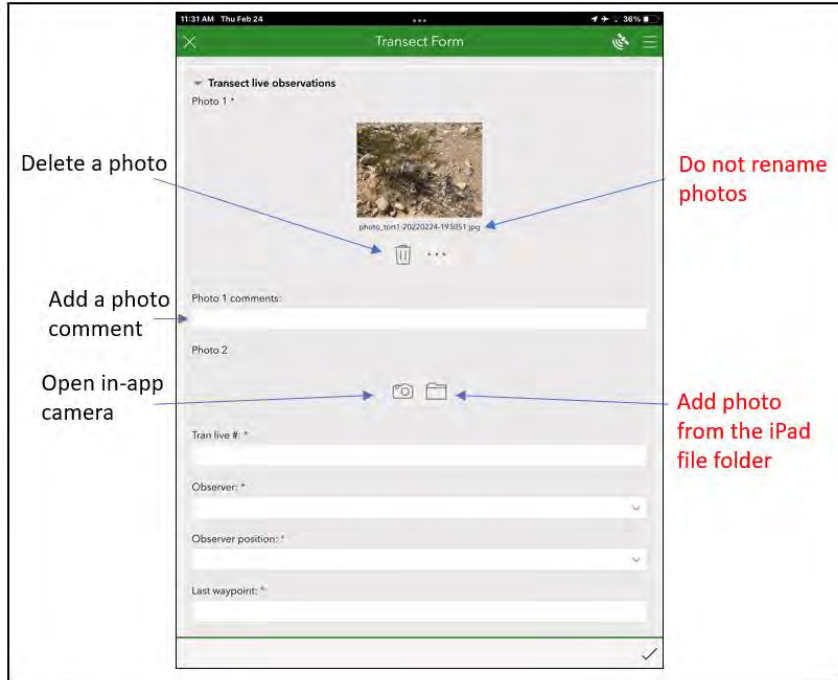


Figure 7-11

- 5. Auto-calculated Fields** – Several fields are auto calculated based on the input in previous fields, for example Perpendicular distance is calculated based on the Local bearing, Azimuth, and Radial distance fields (Figure 7-12). Once the required input fields are filled in, tap on the calculated field to trigger the calculation. The text in these fields is blue and cannot be manually edited.

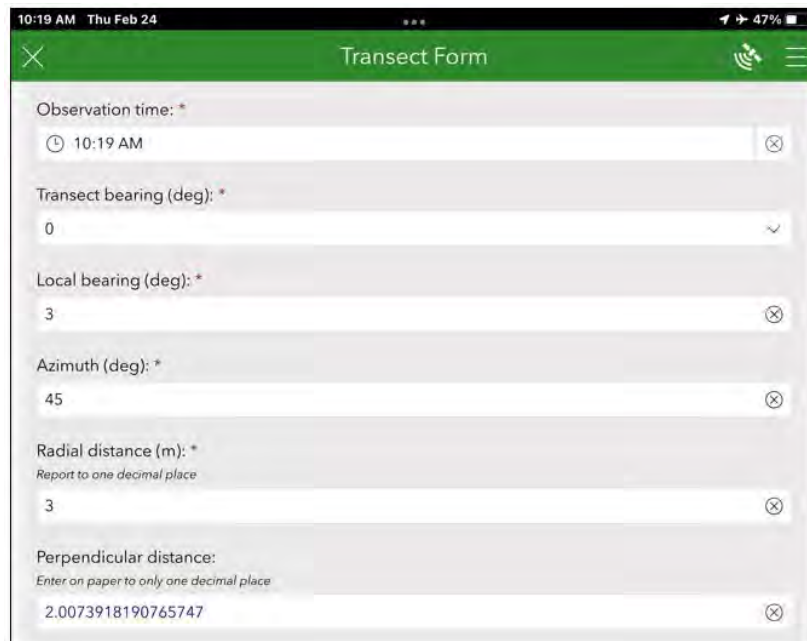




Figure 7-12

## Objective 4: Using the Integrated iPad GPS from within Survey123

1. **Take a GPS Grab** - Every child form (except for training transects) requires that you collect spatial coordinates (i.e., an easting and a northing) which are transferred from the Integrated GPS in your iPad mini to Survey123. This is often referred to as “taking a GPS grab.”

To collect data in the “GPS grab” field, hold the iPad mini so it is directly over the point you want to record (tortoise, carcass, or waypoint) and has as clear a view of the sky as possible.

Tap the crosshairs  symbol to initiate the GPS Grab. The grab is complete when the Integrated GPS accuracy, easting, northing, and UTM zone fields auto-populate. The GPS location recorded in your iPad mini will be the location of the integrated GPS, **NOT** the location of the navigational GPS the other observer is using. In other words, if your teammate has a navigational GPS and is 20 ft ahead of you and you are attempting to record the location of a tortoise at your feet, the eastings and northings recorded will be different, one where your crew member is and one where you are. Be mindful of this when acquiring data.

*Note: if your iPad is connected to Wi-Fi there will also be a map  symbol that if chosen will allow you to choose your location on a map, DO NOT USE THE MAP TO SET A LOCATION. Also, if you review a record while connected to Wi-Fi there will be a visible satellite map in this field, do not open that map because you risk moving the location grab. It is better to collect and review data when not connected to Wi-Fi to avoid this risk.*

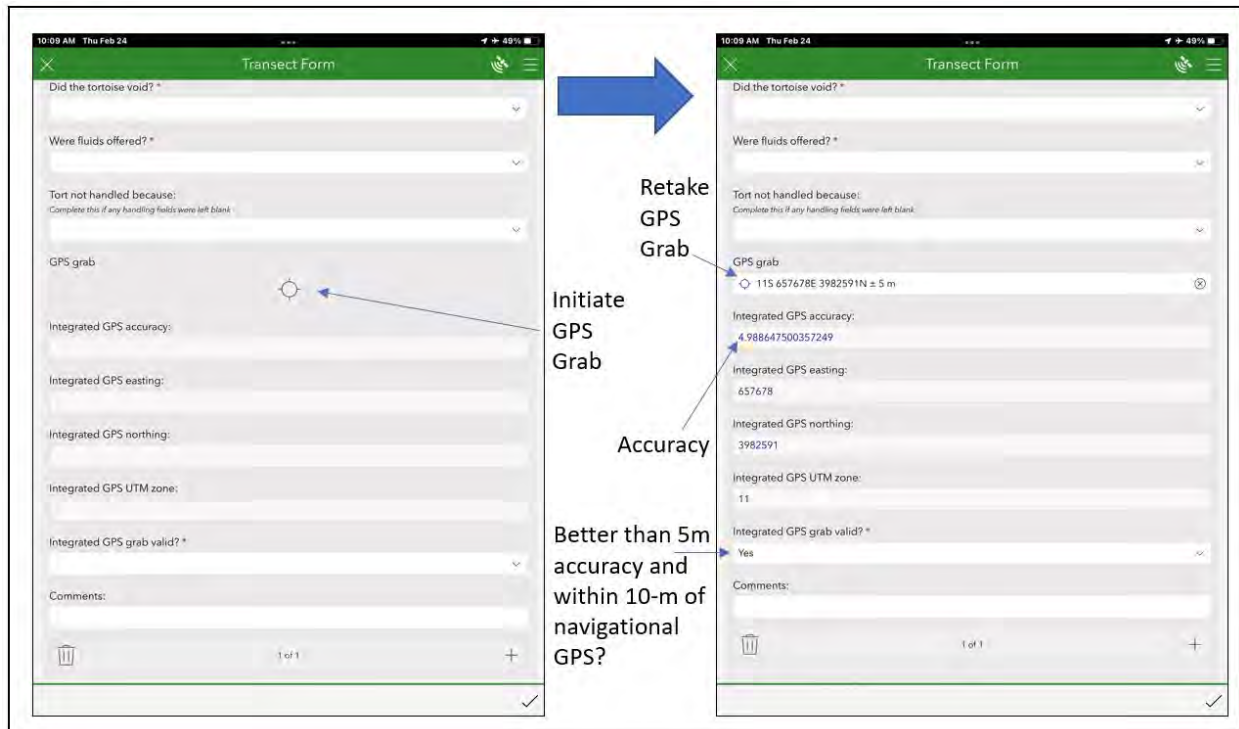



Figure 7-13

2. **Check the GPS grab** – GPS systems are fallible and can give false readings. For that reason we verify the accuracy of our GPS grabs using 2 methods.
- a. Review the reported accuracy of the integrated GPS grab. This number represents the estimated margin of error of the given coordinates. We want to see accuracy measurements of 5 meters or better (smaller number = better), meaning that the true coordinates are estimated to be within 5 meters of the reported coordinates. If the accuracy is worse than 5 meters (i.e., margin of error is higher than 5.0 meters), try retaking the GPS grab by tapping the  symbol. You can try this a few times, waiting a minute or so between attempts. If you cannot get accuracy better than 5 meters, or if the device cannot get any GPS signal, mark Integrated GPS Grab Valid = “No” and proceed to step (c). If the device reports 5 meter or better accuracy, proceed to (b).
  - b. Even if the integrated GPS reports 5 meter or better accuracy we still verify the coordinates with the separate handheld navigational GPS (often a Garmin GPSMap unit). First, verify that the navigational GPS itself is reporting 5 meter or better accuracy. If the accuracy is over 5 meters, wait for a better fix. Once you’ve confirmed 5 meter accuracy, compare the eastings and northings of the integrated GPS grab and navigational GPS (with them held in the same location- but not touching as they may impact each other’s reading). If each of the coordinates are within 10 meters of each other (both eastings within 10 meters and both northings within 10 meters), you can mark the Integrated GPS grab valid field as “Yes.” If the individual coordinates are more than 10 meters apart or if the Integrated GPS Accuracy is worse than 5 meters, Integrated GPS Grab Valid must be “No.”
  - c. When Integrated GPS Grab Valid = “No” is entered, new fields will appear to enter the manual (i.e., from the navigational GPS) easting, northing, and UTM zone. **The manual coordinates are also always entered on the paper datasheet**, regardless of the validity of the integrated GPS grab.

A few things to keep in mind:

- Integrated GPS grab valid = “no” if the integrated accuracy is worse than 5.0 meters (e.g., 5.1 meters) even if the integrated GPS coordinates match the manual coordinates. We check the database to make sure manual coordinates are entered every time accuracy is worse than 5.0 meters.
- We do not ask for you to record the accuracy reported by the navigational GPS unit, but you must remember to check this every time you take a GPS grab! If the navigational GPS has accuracy worse than 5 meters and it does not improve, note this in the comments.
- GPS units can have poor accuracy for several reasons, including low number of satellite connections, poor satellite geometry, and signal barriers such as heavy cloud cover, steep terrain, or heavy vegetation. There’s not much you can do about satellite geometry (it varies by time and location), but you can try to give the unit as clear a view of the sky as possible (don’t lean over it) and give it time to connect to as many satellite signals as possible (may take several minutes if the unit was just turned on).
- We make the assumption that when there is a conflict between the navigational GPS and the iPad GPS that the navigational GPS is more likely to be correct because those units are purposely built for receiving GPS signals and thus are likely to be more reliable/accurate. We are also making the assumption that you

are carrying (e.g. maintaining good sky visibility) and caring for your navigational GPS correctly.

- Do not use satellite communicators (e.g., Garmin inReach units) in place of dedicated navigational units such as the Garmin GPSMap series because the satellite communicators cannot connect to as many GNSS satellites as the navigational GPS units and thus may be less accurate. Only use the inReach device in place of a navigational GPS if your navigational GPS malfunctions. Every observation you make in which you use an inReach in place of a navigational GPS needs to have a comment indicating such. Inform your QA/QC specialist of any GPS malfunctions as soon as possible.
- Add comments to record any reason you may have to doubt the validity of the integrated or navigational GPS accuracy.

### **Objective 5: Limiting Mistakes, Reviewing Data, and Correcting Data Entry Errors**

**1. Limiting mistakes** – The best way to address data errors is to avoid them in the first place. The most important thing you can do to avoid mistakes is to make sure you fully understand the data collection protocol and how to use your measurement equipment! However, even if you follow the protocol exactly, errors can and will make their way into your data entry. On this project we collect all data in tandem on paper datasheets and electronic survey forms, so that we always have a second record of everything that is collected. These two data copies should always be collected simultaneously unless there are extenuating circumstances such as a drained iPad battery.

Data errors can make their way into the electronic data easier than they can into the paper data. To minimize electronic errors please follow these rules:

- Always collapse pick-lists and date/time entry fields. These can be accidentally modified while scrolling through the form if they are not collapsed (see Objective 3). Pick lists in particular should be treated with caution because the selected choice can be changed by tapping in the blank space next to an option, not just in the square or circle on the left side.
- Always collapse the keyboard when you are done entering a text field.
- Do not collect or review data while connected to Wi-Fi so that there is no risk of changing the GPS location in the Wi-Fi enabled location map (see Objective 4) or of sending the data to the server before it has gone through final field review (see Objective 2).
- Collapse child forms that are not in use so that they are not accidentally edited (Figure 7-5 in Objective 1). This also makes it easier to navigate the parent form.

**2. Reviewing data** – Each monitoring crew is responsible for delivering accurate data, a goal best achieved by reviewing records multiple times, including during data collection and after data collection by both the collecting team and an independent team.

a. Reviewing records while collecting data

While completing a record, you should always review what you have already collected and make changes as necessary. As you collect data, you and your teammate repeat aloud the information as one writes it down and the other records it in the iPad mini. Consider a situation in which your teammate

measures a tortoise and deems it to be 200 millimeters, but you hear 300 and record that in the iPad mini while they record 200 on the paper. At the end of the transect, after 5 hours of walking, neither of you can recall which is correct and are forced to leave the records mismatched with a comment about measurement uncertainty. The problem could probably have been avoided by verbally repeating the entries. Running through the complete record immediately after the observation is also a good way to identify errors.

If you make a mistake on the paper datasheet and catch it in real-time, draw a single line through the entry and write the correct entry next to it.

b. Reviewing records at the end of the day

At the end of each day you will review your full transect record **and** the full transect record of the other team on your crew (including all associated child records). This double-review system allows for your team to identify and correct any errors in your own data while also ensuring independent review of each record by a different team (its sometimes easy to miss errors in your own work- similar to proofreading an essay!).

Open a parent record from the Outbox to review it (see Objective 2 for information on opening parent records from the Outbox as well as navigating among completed child records).

When doing nightly review, one person will have the iPad and the other will have the paper datasheets. Both people must read each field entry out loud to confirm that they match. Do not have one person read and the other listen, too many mistakes slip past this way, both reviewers must say each field entry out loud.

After you complete your independent review of the other team's data you will **print** your name on the bottom of their datasheet in the "Data Proofed by" field. Every page must be proofed and signed by someone other than the data collection team.

Things to look for when reviewing data (at observations and after transect completion):

- Are all required fields filled out? Remember that a field may not be marked as required in the Survey123 form but it may be required based on our survey protocol, so think critically about what should be recorded!
- Does the paper datasheet and the electronic Survey123 form have matching entries? This includes comment fields! We do not systematically review paper datasheets so if you comment on anything it needs to be on both paper and Survey123.



- Do the entries make sense? Again, this one requires some critical thinking. Do any of the fields contradict each other? Are there unusual number entries? If there are any unusual entries but they are confirmed to be real, make sure to include a note in the comments to confirm and explain the unusual entry, otherwise the QA/QC specialist will have to contact you for an explanation.

**3. Correcting Data Entry Errors** – When a discrepancy arises between the paper datasheet and Survey123, you should attempt to resolve the issue by either correcting the data in Survey123 or correcting the paper datasheet. Typically the paper datasheet is less likely to have entry errors, but if you cannot confidently recall which is correct, do not guess and randomly change one answer to match the other. Instead, let the discrepancy remain and add an electronic and paper datasheet comment for your QA/QC specialist so they are aware of the issue. This is why double-checking entries while in the field is crucial. In addition to adding comments for data discrepancies or uncertainties, please alert the QA/QC specialist during the weekly crew debrief of the issue.

If a paper datasheet entry is discovered to be incorrect during nightly review, cross it out with a single line and write the correct entry next to it (or circle the correct entry for multiple choice fields). You must also initial the correction (this is different than real-time corrections during initial data entry, which do not require initials). Do not scribble out incorrect entries, we need to be able to see what the original entry was, so just use a single line to cross it out. *If a paper datasheet entry is discovered to be incorrect after the date it was collected, in addition to making the correction, you must initial and date the correction.*

All resolvable, correctable, or fixable (synonyms used for emphasis!) data entry issues should be resolved before submitting the data. With each passing day, issues become more and more difficult and time-consuming to fix.

Note that following proofing by individual crews, the combined records from all crews are scrutinized carefully each week by QA/QC performed by data specialists and the U.S. Fish and Wildlife Service. Any issue uncovered in this process will be clarified by the QA/QC specialist, so crews should preemptively explain unusual situations using comment fields to avoid delayed and time-consuming resolution by the specialist.

The QA/QC specialist will follow up with specific crews when weekly checks identify a recurring issue with their team's data. In addition, crews are responsible for ensuring they have discussed each weekly assessment provided by the U.S. Fish and Wildlife Service to the crew leaders. These assessments report on issues that are priorities for all field crews.

The following graphic is based on a datasheet from a transect walked in 2021, but the comments and clarifications about legible and complete forms still apply.

Desert Tortoise Distance Sampling <del>Transect Form</del> (Waypoints 1)			
Transect Num:	908	Team Num:	25
Stratum:	PV	Observer 1:	Matt Rothrock
Date:	13 April 2021	Observer 2:	Rachel Russell
Time:	37 am / pm	Easting:	0702445
		Northing:	3898462
		UTM Zone:	11 12
		GPS grab valid?	<input checked="" type="radio"/> Y <input type="radio"/> N
Waypoint 1	Time: 6:55 am / pm	Easting: 0702378	Photo to next waypt? <input checked="" type="radio"/> Yes <input type="radio"/> No
		Northing: 3898640	Photo comment:
	Lead (to next): <input checked="" type="radio"/> Observer 1 / <input type="radio"/> Observer 2	UTM Zone: 11 12	
		GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	
Comments:			
Waypoint 2	Time: 7:07 am / pm	Easting: 0701872	Photo to previous waypt? <input checked="" type="radio"/> Yes <input type="radio"/> No
	Burrow ct (from previous): 0	Northing: 3898643	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N	UTM Zone: 11 12	Photo to next waypt? <input checked="" type="radio"/> Yes <input type="radio"/> No
	Lead (to next): <input type="radio"/> Observer 1 / <input checked="" type="radio"/> Observer 2	GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	Photo comment:
Comments: corner			
Waypoint 3	Time: 7:28 am / pm	Easting: 0701895	Photo to previous waypt? Yes <input checked="" type="radio"/> No
	Burrow ct (from previous): 1	Northing: 3899147	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N		Photo to next waypt? Yes <input checked="" type="radio"/> No
	Lead (to next): <input type="radio"/> Observer 1 / <input checked="" type="radio"/> Observer 2		Photo comment:
Comments:			
Waypoint 4	Time: 7:42 am / pm	Easting: 0701883	Photo to previous waypt? Yes <input checked="" type="radio"/> No
	Burrow ct (from previous): 1	Northing: 3899657	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N	UTM Zone: 11 12	Photo to next waypt? Yes <input checked="" type="radio"/> No
	Lead (to next): <input type="radio"/> Observer 1 / <input checked="" type="radio"/> Observer 2	GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	Photo comment:
Comments:			
Waypoint 5	Time: 7:54 am / pm	Easting: 0701884	Photo to previous waypt? Yes <input checked="" type="radio"/> No
	Burrow ct (from previous): 0	Northing: <del>3900148</del> 3900149	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N	UTM Zone: 11 12	Photo to next waypt? Yes <input checked="" type="radio"/> No
	Lead (to next): <input type="radio"/> Observer 1 / <input checked="" type="radio"/> Observer 2	GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	Photo comment:
Comments:			
Waypoint 6	Time: 8:10 am / pm	Easting: 0701874	Photo to previous waypt? Yes <input checked="" type="radio"/> No
	Burrow ct (from previous): 0	Northing: 3900674	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N	UTM Zone: 11 12	Photo to next waypt? Yes <input checked="" type="radio"/> No
	Lead (to next): <input type="radio"/> Observer 1 / <input checked="" type="radio"/> Observer 2	GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	Photo comment:
Comments:			
Waypoint 7	Time: 8:23 am / pm	Easting: 0701883	Photo to previous waypt? Yes <input checked="" type="radio"/> No
	Burrow ct (from previous): 0	Northing: 3901141	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N	UTM Zone: 11 12	Photo to next waypt? Yes <input checked="" type="radio"/> No
	Lead (to next): <input type="radio"/> Observer 1 / <input checked="" type="radio"/> Observer 2	GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	Photo comment:
Comments:			
Waypoint 8	Time: 8:34 am / pm	Easting: <del>0701817</del> 0701879	Photo to previous waypt? <input type="radio"/> Yes <input checked="" type="radio"/> No
	Burrow ct (from previous): 0	Northing: 3901631	Photo comment:
	Transect interrupted? <input type="radio"/> Y <input checked="" type="radio"/> N	UTM Zone: 11 12	Photo to next waypt? <input type="radio"/> Yes <input checked="" type="radio"/> No
	Lead (to next): <input checked="" type="radio"/> Observer 1 / <input type="radio"/> Observer 2	GPS grab valid? <input checked="" type="radio"/> Y <input type="radio"/> N	Photo comment:
Comments: corner			
Comments (include waypoint number):			
Data recorded by:	Matt Rothrock		
Data proofed by:			


Use letters for month!  
Can be abbreviated

Be sure to write  
stratum names in  
full on first page

Circle am or pm. Do  
not use 24-hour clock.

Use a simple strike  
through for edits

## Objective 6: Upload Collected Data to the AGOL Online Server

1. **Sync and upload data to the online AGOL server:** Collected data should be transferred to the online AGOL database server on a weekly basis (called a data sync). For this operation, the iPad mini needs to be connected through a Wi-Fi connection to the internet.
  - a. Open the My Survey123 homepage and select Parent forms with unsent records stored in the Outbox (indicated by a green circle with a number inside in the top right corner of the Parent form box on the My Survey123 homepage: Figure 7-3).
  - b. Tap the Send button  to begin uploading records from the Outbox.
  - c. Once complete, the records will be moved to the Sent folder. Note that when a parent record is sent, all associated child records are sent as well.
  - d. If you successfully sent all data for the week your Outbox will be completely empty.

Do not attempt to edit or resend records from the Sent folder! Once they have been sent to the AGOL server all subsequent edits must be done in the Access QA/QC database by the QA/QC specialist. If you become aware of an issue after the data has been sent, please notify your QA/QC specialist.

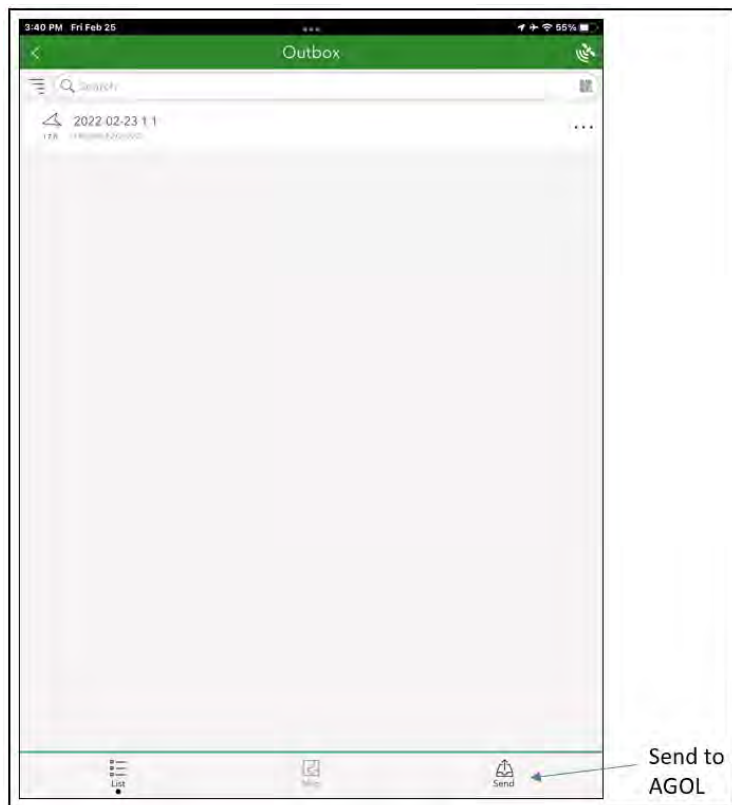


Figure 7-14

## 2. Troubleshooting Sync issues

- If you are connected to a limited bandwidth Wi-Fi connection do not try to sync multiple devices at once. Doing so will slow the connection speed for all devices and may result in a server timeout error from AGOL. When this happens, or if the sync process fails for any other reason, ESRI (the company that developed Survey123) has assured us that there is no risk of data loss. However, there can be duplicate records in the AGOL database if a Survey123 record fails to sync properly and has to be resent.
- If the sync process appears to get stuck and will not complete the data transfer there are a couple possible reasons that we've seen before:
  - If there are photos in the record that exceed 10MB the record will not sync to AGOL. The in-app camera will not produce images this large, but if you take a screenshot of a photo to try to move it between records you may encounter this issue. See Objective 3 for more information on photo fields.
  - If the AGOL database structure has been updated by project management but your forms were not updated to match the new format, the sync process will get stuck on "Getting Service Information." If this happens please contact your QA/QC specialist.
- If you are having trouble syncing your data but are confident that the cause is not one of the above options (slow Wi-Fi, > 10MB photo, or AGOL database update) please enable diagnostic logging (see Objective 7) and try again, then contact your QA/QC specialist. There is a way to extract the data manually if need be, which the QA/QC specialist will need to complete.
- If there are records in the Outbox that attempted to Sync to AGOL but failed, there will a red circle with an exclamation mark next to the record in the Outbox and the parent form box on your "My Survey123" homepage will have a red circle in the top right hand corner with the number of failed sync records written inside the circle. This number reflects the number of failed parent records regardless of how many associated child records each one has.

### Objective 7: Survey123 Database Recovery and Error Log Diagnostics

1. **Recover Survey123 forms:** The equipment you will be using is good, but not perfect; and at some point during your surveys, chances are that the batteries will run out or the iPad will crash. Survey123 auto-saves in-progress forms as fields are completed. But it is important to understand how to properly restore data after an unexpected malfunction so that data is not lost completely. If the app crashes or the iPad mini shuts down while a survey is in progress the app will automatically recover the in-progress survey once the app is reopened. When prompted with the "Survey Recovered" window tap "Continue

Survey” (Figure 7-15). Do not tap “Discard Survey,” the data will be deleted and can no longer be recovered.

According to ESRI documentation, recovered data should include everything up to the last field that you entered because automatic data backup occurs after every field entry. In our experience this is not always the case and you may lose several fields worth of data. On at least a couple occasions we’ve also experienced the auto recovery feature not work at all, which is why A) we always use paper backups, and B) we save incomplete forms in the Outbox between observations.

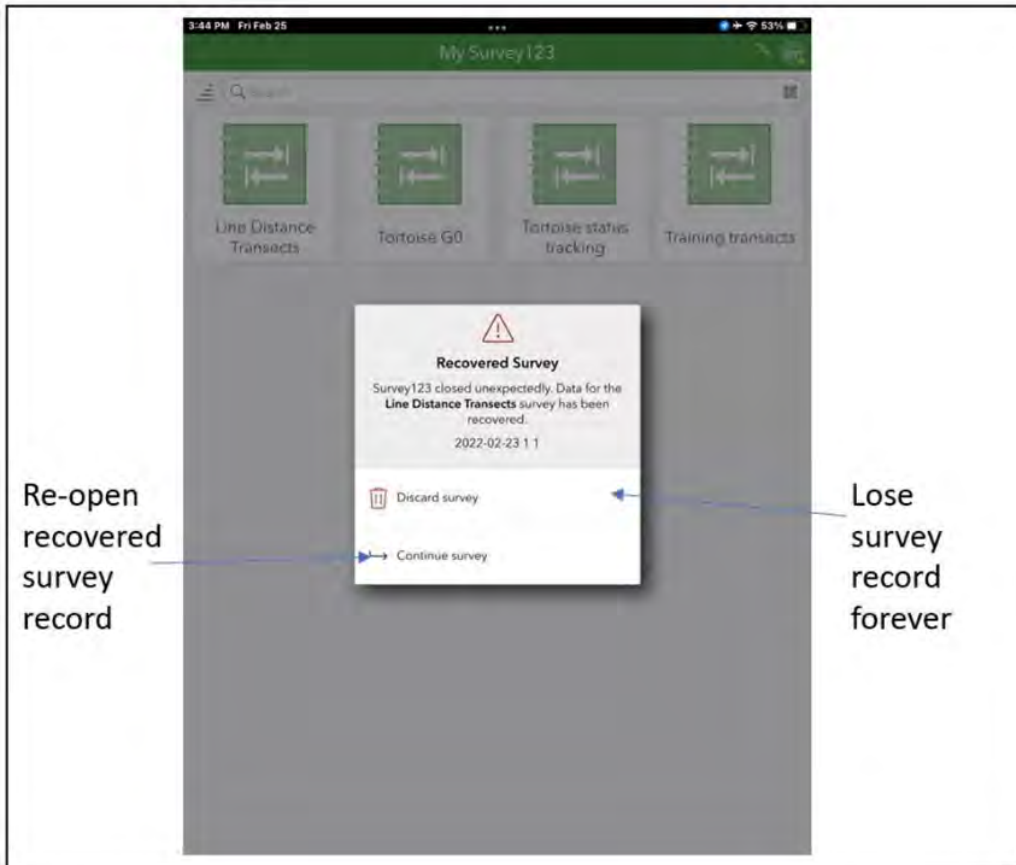


Figure 7-15

- Record Diagnostic Logging:** If you experience a recurring issue with the app crashing or failing to sync data, it is helpful to enable diagnostic error logging so that ESRI technical support specialists can help identify and correct the issue. To do this, start on the “My Survey123” homepage and tap in the upper right corner of the page like you would if you were going to download new surveys (Figure 7-3). Tap “Settings” in the side bar that opens up, then tap “Diagnostics.” Tap the slider at the top so that it moves to the right and indicates “Logging is on” (Figure 7-16).

Note that this process has to be repeated each time the app is shutdown and restarted (the default setting is for logging to be turned off).

If you continue to have issues with the app after turning on diagnostic logging please contact your QA/QC specialist so that they provide guidance on extracting the error log for review by ESRI.



Figure 7-16

## 8. DEMOGRAPHIC PLOT SURVEYS

The goal of conducting demographic plot surveys is to evaluate desert tortoise demography (animal sex, age structure, and condition). Achieving this requires integration of various field activities, but most directly it requires the ability to define and walk transects, locate tortoises, and correctly identify any individuals that are relocated.

The longevity of tortoises and their ability to persist in harsh environments and suboptimal habitats can mask demographic changes that can precipitate population declines, such as persistent lack of recruitment, skewed sex ratios, or low reproductive output. Capture-recapture surveys will be conducted to locate tortoises over a three-day period at demographic plots across the range of the desert tortoise to quantify juvenile and adult tortoise population status as well as observed tortoise carcasses present at these locations.

Refer to **Appendix I** for paper data sheets and description of fields.

**Objective 1:** Crews will correctly implement survey protocols for desert tortoises on demographic plots.

**Metric:** After reviewing protocols in the field, crews will demonstrate the ability to implement the set of guidelines for demographic plot surveys, appropriately collecting and entering data on paper and electronic forms.

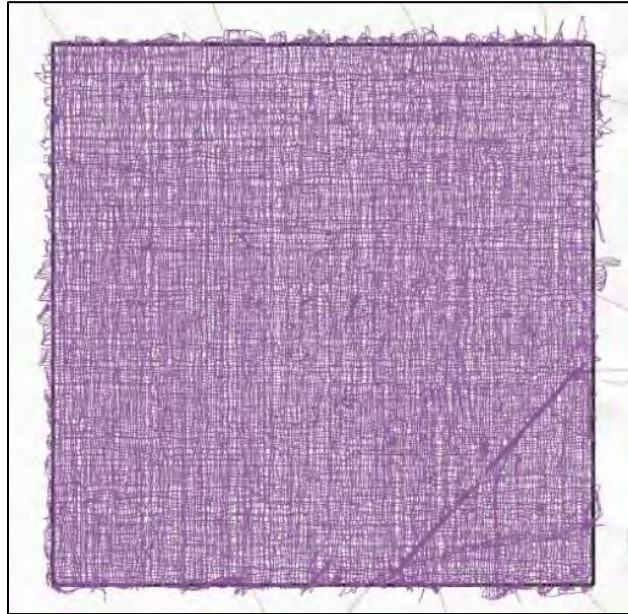
## Objective 1: Implement Demographic Plot Survey Protocols

Several permanent desert tortoise study plots have been established across the range and this project may rely on a combination of historic and contemporary plots. For this project, contemporary 1 km<sup>2</sup> demographic plots are generally selected at random from a subset of suitable areas based on habitat suitability, tortoise density, tortoise occupancy, and other relevant factors depending on the focus of the plot. Survey efforts will use a modification of Pollock's robust design (i.e., using 3 or more passes within sampling periods separated by a year or more among periods) and each plot survey will occur over a three-day period.

- Survey teams will complete a full coverage pass of the 1 km<sup>2</sup> plot at 5 m interval spacing each day over three days, resulting in 1 mark/capture period and 2 recapture periods. On day two crews will switch transect orientation and on day three crews will survey the same orientation as day one (for example, starting on day one with N-S transects, on day two teams switch to E-W, and on day three teams switch back to N-S). It doesn't matter which direction is surveyed on day one, but it's suggested to start with the direction that will provide the best access.
- Surveyors will be divided into 5 groups of 4 and each team will be responsible for covering a 200 m strip each day with each surveyor walking 10 km of transects. The teams will remain the same for each plot. On subsequent days the orientation of teams in respect to other teams will change to minimize teams re-walking the same area and reduce surveyor bias. Teams can switch up their internal walking order on subsequent days.
- Teams should rely on one or two individuals to navigate. The other surveyors should space themselves 5 m off the navigator(s) and maintain the same survey pace. All team members scan for tortoises independently and are responsible for surveying their 5 m transect swath.
  - Concentrate on scanning the ground in a radius of 5 m. Little time should be spent scanning the horizon or looking at the GPS unit (except as necessary to stay on transect) or scanning right around one's feet.
  - Special attention should be paid to searching vegetation intersected by the transect.
  - If a team member stops to investigate a burrow, the rest of the team should also stop to maintain the same pace and stay in line.
- The goal is to find as many tortoises of all sizes as possible! Take your time and be thorough while keeping a pace that will allow you to complete all assigned transects by the end of the day. When a tortoise is located it will be called in to the processing team who will process it and collect the required data. If you can audibly detect a tortoise in a burrow but cannot see it, it counts as a detection and should be called in.
- All tortoises encountered during surveys will be tagged with a unique identifier glued to the carapace and given an inconspicuous temporary color mark to differentiate capture during the three sampling occasions so that within-survey captures could be scored with minimal handling. Data collected for each capture will include at a minimum tortoise identification number, date and time of capture, spatial capture location (easting and northing), and demographic information including size in midline carapace length (MCL) and sex (male, female, or unknown). Refer to **Chapter 2. Desert Tortoise Handling** for details on proper handling and measurement techniques.



- When at least half of a tortoise carcass is located, or if any carcass with identifying marks is located, it should be called in as well. The location should be marked in a way to distinguish those that have been called in as they should only need to be processed once.
- Global positioning system (GPS) tracks for all field biologists will be continuously recorded to document search effort and habitat coverage throughout the survey. **Make sure your navigational GPS is set to UTM, WGS 1984.**



**Figure 8-1. GPS track coverage of a plot after a 3-day survey.**

## **APPENDIX I: ANNOTATED PAPER DATA SHEETS**

Desert Tortoise Distance Sampling **Training Transect Form**

Trial Number	Transect Bearing	35 °      215 °	Group:	
Team Number	Transect Segment Num:			
Training line color	Training Date:		Lead:	
Red Yellow Magenta	Train Start Time:		Follow:	
White Orange Green	Training End Time:			
Starting Post	Comments:			
	A B C D E F			
	G H I J K L			

---

Observation Time:	Original observation	from line	Azimuth:	°	Tortoise Size:	Adult
Observer Name:		while at another model	Radial Dist:	m		Immature
Observer Position:	Local Bearing:	°	Perpendicular Dist:	m	Tortoise ID:	
	Lead      Follow					

Comments:

---

Comments (include Tort ID):

If more than 10 detections occur on a segment, use a new data sheet.

Copy header information and record stop time on all sheets. Total page count each *day*.

	Page      of
--	--------------

Data Recorded By:       Data Proofed By:

**Trial number**

It usually takes 2 days to complete a trial (walk 16 transects).  
The first 2 days walked on training lines is "Trial 1". Likewise, the second pair of days is "Trial 2".

**Date**

To avoid data entry errors, dates are reported as DD MMM YYYY, with months indicated by 3-letter abbreviations.  
For instance, "20 Mar 2022"

**Start Post**

Each starting post identifies a new "transect" and a new form must be started on paper and in the Juno

**Transect Segment Num**

This is calculated in the data collection device. If the number is incorrect or does not display, recheck your LineColor, StartingPost, and TransectBearing

**Transect Bearing**

Predetermined transect bearing

**Observation time**

Write the time in the same format (12-hour) that it appears on the data collection device.

**Original observation**

If this particular model was first seen using the distance search technique from the centerline, circle "from line".  
If the model was seen while working at the previous model, circle "while at another model".

**Local Bearing**

Bearing from the observer back to the other end of the 25-m cord. This may be different than the transect bearing, but if the local bearing is >30 degrees off from the transect bearing include a comment.

**Azimuth**

Bearing from the point of observation to the tortoise

**Radial Distance**

Distance from observer to the tortoise, enter only to one decimal place (tenths of a meter).

**Perpendicular Distance**

Radial distance is entered; Perpendicular distance is calculated automatically. Consider the resulting "perpendicular distance from the line". Does it match your eyeball estimate? If not, recheck your bearing, azimuth, and radial distance entries.  
Partial calculations may appear in the box when only a portion of the necessary data has been entered.  
Touch the box for Perpendicular Distance to recalculate before writing the value on your paper sheet.  
The data collection device will not round the Perpendicular distance calculation at all. On the paper sheet you must enter only to one decimal place.  
*Rules for rounding to one decimal place: if there is a 0, 1, 2, 3, or 4 in the second decimal place, do not change the first decimal place. If there is a 5, 6, 7, 8, or 9 in the second decimal place, round the first decimal place up.*

**Data proofed by**

This field should record the name of the first reviewer who was not involved in collecting the data.  
On monitoring transects, data are proofed by the member of a different team, the crew leader, or QAQC specialist.

## Desert Tortoise Distance Sampling **G<sub>0</sub> Start and Obs Form** (version 02-12-2024)

Date:

Site:

Group:

Observer:

Comments:

Transmitter freq:	<input style="width: 100%; height: 20px;" type="text"/>	Tortoise location:				Behavior:		GPS grab valid?	
Tortoise Num:	<input style="width: 100%; height: 20px;" type="text"/>	RockBurrow	SoilBurrow			Agonistic	AtRestActive	Yes	No
Time:	<input style="width: 100%; height: 20px;" type="text"/> am / pm	Pallet	Open	Vegetation	Rock	Basking	Digging		
Tort Visible?:	<input style="width: 50%; height: 20px;" type="text"/> Yes <input style="width: 50%; height: 20px;" type="text"/> No	Burrow Visibility:		High	Med	Low	Not	Easting:	<input style="width: 100%; height: 20px;" type="text"/>
Dist to burrow:	<input style="width: 100%; height: 20px;" type="text"/> m	Tort in Burrow Visibility:		High	Med	Low	Not	Northing:	<input style="width: 100%; height: 20px;" type="text"/>
		Tortoise visibility:		High	Med	Low	Not	UTM zone:	<input style="width: 100%; height: 20px;" type="text"/>
Photo 1:	<input style="width: 50%; height: 20px;" type="text"/> Yes <input style="width: 50%; height: 20px;" type="text"/> No	Photo 1 comments: <input style="width: 800px; height: 20px;" type="text"/>							
Photo 2:	<input style="width: 50%; height: 20px;" type="text"/> Yes <input style="width: 50%; height: 20px;" type="text"/> No	Photo 2 comments: <input style="width: 800px; height: 20px;" type="text"/>							
Comments: <input style="width: 850px; height: 20px;" type="text"/>									

**Transmitter freq:**

Transmitter frequency for this tracked tortoise

**Tortoise Num:**

Number on the tracked tortoise. Include FW or other prefix

**Time**

The first observation of each day at a site determines the "start time" for telemetry observations that day. This time should not be later than the transect start time designated for that day, so telemetry observers must be careful to start early enough to locate their first tortoise by the designated start time.

**Tort visible?**

Is the tortoise visible at all? Other fields on the form are directed at describing how visible the tortoise is.

**Dist to burrow?**

Without using a tape measure, estimate the distance in meters from this tortoise to the nearest burrow. If in the burrow (>50% inside), the distance is "0". If not in burrow (<50% inside) but on burrow apron and within 1m, distance should be "1". Enter a comment for tortoises that are on the apron but not in burrow. Distance is only "0" if tortoise is in a burrow. Use "100" if you do not see a burrow within 15m of the tortoise.

**Tortoise location:**

- SoilBurrow - Dirt constructed hole, more than 1 tortoise length deep. A tortoise in a burrow has at least 50% of its body under the burrow lip or inside the mouth of the burrow, is deep inside, or anywhere in between. Tort on the apron is only in burrow if >50% its body is inside.
- RockBurrow - May be partially constructed. Rock is the substrate of the top of the burrow, maybe also the bottom
- Vegetation - Tortoise is under the drip line, or in the shade of vegetation.
- Rock - Tortoise is in the shade of a rock.
- Pallet - Tortoise is in a similar configuration to the mouth of a burrow, but the shelter is shorter than one tortoise length.
- Open - Tortoise is in the open and not under vegetation or rock.

**Burrow visibility:**

This field must be populated if "Tortoise location = burrow". Consider the burrow as the center of a circle. Visibility will be estimated by the degrees of approach through which the burrow would be openly visible from 5 m away.

**High**

Distinguishing characteristics of a burrow (opening, mound, or apron) would be visible from more than 75% of the angles of approach. High visibility includes a burrow out in the open and facing you, or very obvious under sparse vegetation.

**Medium**

The expectation is that most burrows detected on a transect will be "medium" visibility. The approach will be to expect "medium" and then for a given tortoise to decide if use of the other categories is warranted in case this is an unusual situation for a burrow. Medium-visibility burrows are blocked through more than 25% but less than 75% of the angles of approach. Medium visibility includes a burrow visible under vegetation, but where vegetation obscures tell-tale shapes of the mouth, mound, or apron.

**Low**

The burrow is blocked from view through more than 75% but less than 100% of the angles of approach. Low visibility does not include burrows obscured completely by vegetation.

**Not Visible**

The burrow is completely blocked from view. This will be the case if you plunge into vegetation (usually a shrub) to follow a signal, but nothing is visible from the outside, and the "not visible" tortoise is actually in a "not visible" burrow.

### **Tortoise-in-burrow-visibility**

This field must be populated if "Tortoise location = burrow". Consider the burrow as the center of a circle. Visibility will be estimated by how much of the tortoise can be seen and is related to how deep the tortoise is in the burrow.

#### High

High visibility tortoises include those at the mouth of the burrow, and easily seen without bending over and no need for use of a mirror or flashlight.

#### Medium

Medium visibility tortoises include those that require bending over or getting down on your knees and the use of a mirror or flashlight.

#### Low

Low visibility tortoises include those so deep within a burrow that you are required to lay flat on the ground, searching the depths of the burrow with a mirror or flashlight. Your confirmation of the tortoise may include only an arm or leg, or small portion of the shell.

#### Not Visible

No part of the tortoise is visible when you look inside with a mirror or flashlight. If the tortoise is in a burrow, and "tort visible? = No", then the burrow and/or the tortoise in the burrow are concealed. If you have indicated that "burrow\_visibility = not visible", then the tort\_in\_burrow\_visibility may be high, medium, low, or not visible. However, if the burrow\_visibility is "high", "medium", or "low", then "tort\_in\_burrow\_visibility = not visible".

### **Tortoise visibility**

This field is only used for tortoises not associated with a burrow or caliche cave. Consider the tortoise as the center of a circle. Visibility will be estimated by the degrees of approach through which the tortoise would be openly visible from 5 m away.

#### High

The tortoise would be visible from more than 75% of the angles of approach. Typically, high visibility includes tortoises out in the open, but they could be under vegetation or rocks but not obscured by them, or they could be in a pallet.

#### Medium

Medium-visibility tortoises are blocked through more than 25% but less than 75% of the angles of approach. Medium visibility includes tortoises slightly obscured by vegetation, including in the open but behind vegetation because of your angle of approach, in a pallet, or under rocks (not in soil or rock burrows).

#### Low

The tortoise is blocked from view through more than 75% of the angles of approach. This might be the case if you investigate because the signal is coming from and it looks like there should be a tortoise there, but it isn't immediately visible. Low visibility includes tortoises completely obscured by vegetation or rocks, including obscured in a pallet.

#### Not Visible

The tortoise is completely blocked from view, usually deep in a shrub or high forbs/grasses. Since you will have indicated "Tort visible? = No", this option is redundant, but we maintain it for consistency in the visibility fields.

### **Behavior**

#### Agonistic

The tortoise is an aggressive interaction with another tortoise.

#### AtRestActive

The tortoise is visible, appears to be awake, but does not appear to be doing anything. It may be facing away from you in or out of a burrow. Compare to "Basking"

#### Basking

Shell on ground, legs sprawled out to maximum skin exposure posterior or broadside to sun orientation. Compare to "AtRestActive"

#### Digging

The tortoise is modifying a burrow or pallet by digging, or possibly nesting. This can be with all four feet. Sometimes you can discern digging when the tortoise is not visible, (i.e. dirt flying out of the back of a burrow).

#### Eating

The tortoise appears to be biting vegetation or other possible food items.

#### RestingEyesClosed

The tortoise is visible and you can clearly see that its eyes are closed and it is not alert

#### Mating

The tortoise is engaged in mating activity with another tortoise (courtship behavior or copulation).

#### Moving

This typically involves the tortoise walking, with the plastron off the ground. However, if you hear what you believe to be the tortoise moving in the back of a burrow, record behavior as moving. Because observers frequently startle the animal, when possible observe behavior before approaching.

#### Unknown

The tortoise is not visible, and the behavior cannot be discerned.

If the tortoise is not visible behavior can only be unknown, digging, or moving. Probably 99% of the time it will be unknown.

**Easting****Northing**

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit.

In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational use the manual easting and northing fields to record the navigational coordinates.

In this case, always record both the easting, the northing, and the UTM zone.

**UTM Zone**

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

**GPS grab valid?**

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is  $> 5.0$  m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be  $\leq 5.0$  m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

**Photo 1/Photo 2****Photo 1 comments/Photo 2 comments**

The Yes/No field is to indicate whether each of up to 2 possible site photos were taken.

Use photos to illustrate the landscape of the site and/or to show burrows used by the tortoises here. Comments are required for each photo and provide helpful information to interpret the photo.

**Desert Tortoise Distance Sampling Transect Form (Waypoints 1)** (version 02-14-2024)

Transect Num:  Team Num:  Group:   
 Stratum:  Observer 1:   
 Date:  Observer 2:

**Waypoint 0** Time:  am / pm Easting:  UTM Zone:  11 12  
 Northing:  GPS grab valid?  Y N  
 Comments: \_\_\_\_\_

**Waypoint 1** Time:  am / pm Easting:   
 Northing:  UTM Zone:  11 12 Photo to next waypt?  Yes No  
 Lead (to next):  Observer 1 / Observer 2 GPS grab valid?  Y N Photo comment:   
 Comments: \_\_\_\_\_

**Waypoint 2** Time:  am / pm Easting:  Photo to previous waypt?  Yes No  
 Burrow ct (from previous):  Northing:  Photo comment:   
 Transect interrupted?  Y N UTM Zone:  11 12 Photo to next waypt?  Yes No  
 Lead (to next):  Observer 1 / Observer 2 GPS grab valid?  Y N Photo comment:   
 Comments: \_\_\_\_\_

(many other waypoints here...)

**Waypoint 24** Time:  am / pm Easting:  Photo to previous waypt?  Yes No  
 Burrow ct (from previous):  Northing:  Photo comment:   
 Transect interrupted?  Y N UTM Zone:  11 12 Photo to next waypt?  Yes No  
 Lead (to next):  Observer 1 / Observer 2 GPS grab valid?  Y N Photo comment:   
 Comments: \_\_\_\_\_

**Waypoint 99** Time:  am / pm Easting:  Photo to previous waypt?  Yes No  
 Burrow ct (from previous):  Northing:  Photo comment:   
 UTM Zone:  11 12 Photo to next waypt?  Yes No  
 GPS grab valid?  Y N Photo comment:   
 Comments: \_\_\_\_\_

**Waypoint 100** Time:  am / pm Easting:  UTM Zone:  11 12  
 Northing:  GPS grab valid?  Yes No  
 Comments: \_\_\_\_\_

Comments (include waypoint number): \_\_\_\_\_

Data recorded by:   
 Data proofed by:  Page 3 of

# Desert Tortoise Distance Sampling **Transect Form (Waypoints 4)** (version 02-27-2024)

Team:

Date:

Stratum:

Transect Num:

### Transect Summary

Direction of Travel:

Transect Standard?

Unplanned modification?

Terrain Obstacles:

Substrate Obstacles:

Other Obstacles?: \_\_\_\_\_

Other relevant information (military reservation, wilderness area, etc.): \_\_\_\_\_

Directions to transect (include UTM coordinates and/or names of nearest major roads, description of notable intersections, steep/challenging road conditions):

Comments:

#### Tran num

The transect number, a whole number assigned before arriving at the transect. There is one exception: if an obstacle must be navigated so that there is a break in the transect, each continuous segment must have a unique identifying number. After each segment is ended (with a "Transect interrupted?"= Y and a comment - see below), the next transect increments up by a tenth from the one before. If the original transect was "42" subsequent segments, in order, would be "42.1", "42.2", etc.

#### Stratum

This should be written long-hand on the Waypoints 1 transect form. On the continuation pages, the appropriate abbreviation can be used.

#### Date

Regardless what the data collection device reads, dates are reported as DD MMM YYYY. Use a 3-letter abbreviation instead of numbers for the month. For instance, 31 Apr 2024.

#### Waypoint 0

The location where the crew left their vehicle/were dropped off. These data are taken when leaving for Waypoint 1, not when you arrive at the site (not the night before...). For interrupted transects, Waypoint 0 is entered only on the base segment, not in the continuation records.

#### Waypoint 1

The start point on the transect. Transects should be started at the designated time. If you arrive at this point early, time should not be recorded until you are about to leave for Waypoint 2. If the start time is >15min past designated time, include a comment describing why there was a late start.

#### Waypoints 2 through 24

Subsequent waypoints on the transect.

#### Waypoints 25 through 40

These will only be used on non-standard transects, if additional turns or interruptions are made in the transect.

#### Waypoint 99

The final location on the transect. On a standard transect, this would correspond to the return to the original start point, and in sequence would have been "Waypoint 25." For transects that are interrupted and resumed after navigating an obstacle, new electronic records are started, but "99" is used only for the last waypoint on the last segment of the transect.

#### Waypoint 100

Where the crew returns to their vehicle/waits to be picked up. Record the time you arrive at the vehicle/pickup spot, not when you leave from there. May differ from Waypoint 0. For interrupted transects, after completing Waypoint 99 for the final segment of an interrupted transect, record Waypoint 100 with this electronic record, the last one for the transect.

#### Burrow ct

While walking from Waypoint 1 to Waypoint 2 (for example), use tick-marks to keep track of the number of burrows you examine for tortoises. Only record burrows that could have held tortoises greater than 180mm MCL, and only if they are not blocked or collapsed. This count should include caliche caves and non-tortoise burrows. When you arrive at Waypoint 2, while entering relevant data, also enter the count of these tick marks.

#### Transect interrupted?

Are you taking this waypoint as a prelude to navigating around an obstacle (without using the distance searching protocol)? If so, indicate "Y" here so it is understood that the path to the next waypoint was not searched. Once you interrupt a transect, you should continue collecting data on the same paper datasheet, but need to start a new electronic record, using decimal increments to link all parts of the same transect in the correct order.



**Lead (to next)**

Indicate the observer who will lead from this waypoint to the next one. You should switch leaders at each corner, so if you are taking the coordinates for waypoint 4 and are at a corner, record the new leader under waypoint 4, not waiting until waypoint 5.

You will retain the observer # position (observer 1 or observer 2) assigned to you for your team for the entirety of the season.

**Easting****Northing**

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit.

In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates.

In this case, always record both the easting, the northing, and the UTM zone.

**UTM Zone**

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

**GPS grab valid?**

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is  $> 5.0$  m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be  $\leq 5.0$  m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

**Data recorded by****Data proofed by**

The recorder participated in collecting the data. The proofer must be someone other than one of the data collectors. Candidates are other field personnel, crew leaders, or the QAQC specialist.

**Direction of Travel**

Indicate whether you walked the transect in a clockwise or counterclockwise direction

**Transect standard?**

A transect is only "standard" if it was a 12km long square transect, with 4-3km sides at right angles to one another. Any other shapes or lengths, or the use of interruptions or reflections is non-standard, whether planned or unplanned. If non-standard, the terrain, substrate, or other obstacles should be identified as a follow-up.

**Unplanned modification?**

Record whether you have interrupted the transect or reflected in a way that was not anticipated by the map you were provided. This is not about a reflection 100 m sooner or later, but about an obstacle the map maker was unaware of.

**Terrain obstacles**

Only complete this field if you identified a non-standard transect. What obstacles to forward progress caused you to shorten or otherwise alter your transect path? Please note obstacles that you had to accommodate, not hills and mountains that you were able to traverse, for instance.

**Substrate obstacles**

Only complete this field if you identified a non-standard transect. Only substrates that affected the ability to complete the transect should be noted here.

Loose or rough substrate, particularly combined with sloping terrain, can impede progress, and cannot be reliably identified using remote sensing technology; it is difficult to identify transects that will be impacted by difficult substrate.

**Other obstacles**

Only complete this field if you identified a non-standard transect. This field should be used to identify obstacles not already included under terrain

**Directions to transect**

This information is only on the paper sheet, not on the data collection device, so it very important.

**Drawing of transect**

Draw this free-hand. This is not on the data collection device, but provides information that is often referenced during data verification. Do not indicate live or dead tortoises on the drawing

**Comments (bottom of page 4)**

Use this comment field to provide additional information about how the transect was completed. This information does not need to match the data collection device.

# Desert Tortoise Distance Sampling Transect Form (TranLiveObs) (version 02-12-2024)

Team:  Date:  Stratum:  Transect Num:

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### Tran Live #

The count of live obs in sequence detected on this transect. For each transect, not for each segment of an interrupted transect, restart numbering sequentially from 1. For interrupted transects, continue numbering sequentially

### Observer

Who saw the tortoise? You will retain the observer # position (observer 1 or observer 2) assigned to you for your team for the entirety of the season.

### Observer Position

It is extremely important to record whether the tortoise was first seen by the person in the "lead" or "follow" position.

### Last Waypoint

Number of the last recorded waypoint before this observation

### Observation time

This should be the time you first observe the tortoise

### Transect Bearing/Other Tran Bearing

Predetermined transect bearing

### Local Bearing

Bearing from the observer back to the other end of the 25-m cord. This may be different than the transect bearing, but if the local bearing is >30 degrees off from the transect bearing include a comment.

### Azimuth

Bearing from the point of observation to the tortoise

### Radial Distance

Distance from observer to the tortoise, enter only to one decimal place (tenths of a meter).

### Perpendicular Distance

This field is calculated automatically after you enter the 3 input fields. Does the data collection device result match your eyeball estimate? If not, recheck your bearing, azimuth, and radial distance entries. Record result on paper datasheet to one decimal place.

Partial calculations may appear in the box when only a portion of the necessary data have been entered.

Touch the box for Perpendicular Distance to recalculate before writing the value on your paper sheet.

*Rules for rounding to one decimal place: if there is a 0, 1, 2, 3, or 4 in the second decimal place, do not change the first decimal place.*

*If there is a 5, 6, 7, 8, or 9 in the second decimal place, round the first decimal place up.*

### Cue to tortoise:

SearchedVeg - Your attention was captured by a promising shrub, but no part of the tortoise was immediately apparent

BodyPart - Although the tortoise may not have been completely visible, you identified all or part of the tortoise and went to investigate

Movement - Your attention was captured by motion [of the tortoise]

Burrow - You found the tortoise after going to investigate a burrow. The tortoise might have been in the burrow, or you noticed it in the open after going to investigate the burrow itself.

BurrowApron - You didn't see the mouth of the burrow initially, but went to investigate what you thought was an excavation from or path into a burrow. The tortoise might have been in the burrow or on the apron, or you noticed it in the open after going to investigate the excavation itself.

Audible - Your attention was captured by a noise (often air being expelled), when you directed your attention there, the tort might also be visible

### Tort heading relative to line when detected:

This question is about the orientation of the tortoise when you first saw it. Indicate all applicable descriptions.

The last three options only apply to tortoises in burrows (>50% of body under burrow lip or inside the mouth)

Profile - The tortoise **is not in a burrow** and approximately perpendicular to the transect line when detected

HeadOn - The tortoise **is not in a burrow** and was facing toward the transect

TailOn - The tortoise **is not in a burrow** and is facing away from the transect path

PulledIntoShell - The tortoise's legs and head were retracted

HeadIntoBurrow - The tortoise **is in a burrow** (at least 50% of the body is inside), and the animal is facing into the burrow

HeadOutOfBurrow - The tortoise **is in a burrow** (at least 50% of the body is inside), and the tortoise is facing out from the burrow.

SidewaysInBurrow - The tortoise **is in a burrow** (at least 50% of the body is inside), and the tortoise is neither head-in or head-out.

**Tortoise location:**

- SoilBurrow - A constructed hole in dirt, more than 1 tortoise length deep. A tortoise in a burrow has at least 50% of its body under the burrow lip or inside the mouth of the burrow, is deep inside, or anywhere in between. Tort on the apron is only in burrow if >50% its body is inside.
- RockBurrow - May be partially constructed. Rock is the substrate of the top of the burrow, maybe also the bottom
- Vegetation - Tortoise is under the drip line, or in the shade of vegetation.
- Rock - Tortoise is in the shade of a rock.
- Pallet - Tortoise is in a similar configuration to the mouth of a burrow, but the shelter is shorter than one tortoise length.
- Open - Tortoise is in the open and not under vegetation or rock.

**Burrow visibility:**

Consider the burrow as the center of a circle. Visibility will be estimated by the degrees of approach through which the burrow would be openly visible from 5 m away.

**High**

Distinguishing characteristics of a burrow would be visible from more than 75% of the angles of approach. High visibility includes a burrow out in the open and facing you, or very obvious under sparse vegetation.

**Medium**

The expectation is that most burrows detected on a transect will be "medium" visibility. The approach will be to expect "medium" and then for a given tortoise to decide if use of the other categories is warranted in case this is an unusual situation for a burrow. Medium-visibility burrows are blocked through more than 25% but less than 75% of the angles of approach. Medium visibility includes a burrow visible under vegetation, but where vegetation obscures tell-tale shapes of the mouth, mound, or apron.

**Low**

The burrow is blocked from view through more than 75% of the angles of approach. This might be the case if you investigate because it looks like there should be a burrow there, but it isn't immediately visible. Low visibility includes burrows obscured completely or nearly completely by

**Tortoise-in-burrow-visibility****High**

High visibility tortoises include those at the mouth of the burrow, and easily seen without bending over and no need for use of a mirror or

**Medium**

Medium visibility tortoises include those that require bending over or getting down on your knees and the use of a mirror or flashlight.

**Low**

Low visibility tortoises include those so deep within a burrow that you are required to lay flat on the ground, searching the depths of the burrow with a mirror or flashlight. Your confirmation of the tortoise may include only an arm or leg, or small portion of the shell.

**Tortoise visibility**

This field is only used for tortoises not associated with a burrow or caliche cave. Consider the tortoise as the center of a circle. Visibility will be estimated by the degrees of approach through which the tortoise would be openly visible from 5 m away.

**High**

The tortoise would be visible from more than 75% of the angles of approach. Typically, high visibility includes tortoises out in the open, but they could be under vegetation or rocks but not obscured by them, or they could be in a pallet.

**Medium**

The expectation is that most tortoises detected on a transect will be "medium" visibility. The approach will be to expect "medium" and then for a given tortoise to decide if use of the other categories is warranted. Is it an unusual situation for a transect tortoise? Medium-visibility tortoises are blocked through more than 25% but less than 75% of the angles of approach. Medium visibility includes tortoises slightly obscured by vegetation, including in the open but behind vegetation because of your angle of approach, in a pallet, or under rocks (not burrows or caves).

**Low**

The tortoise is blocked from view through more than 75% of the angles of approach. This might be the case if you investigate because it looks like there should be a tortoise there, but it isn't immediately visible. Low visibility includes tortoises completely obscured by vegetation or rocks, including obscured in a pallet.

**Distance to burrow**

Without using a tape measure, estimate the distance in meters from this tortoise to the nearest burrow. If in the burrow (>50% inside), the distance is "0". If not in burrow (<50% inside) but on burrow apron and within 1m, distance should be "1". Enter a comment for tortoises that are on the apron but not in burrow. Distance is only "0" if tortoise is in a burrow. Use "100" if you do not see a burrow within 15m of the tortoise.

**Temperature/Temp > 35?**

in degrees Celcius, measured 5 cm above the ground in new shade.

**MCL≥180?****MCL (mm)**

For all visible tortoises, the first field will have an entry. Although "Unknown" is an option, indicate "Yes" or "No" if at all possible. If the tortoise is the size of a measurable burrow opening, for instance, use this to evaluate whether it is larger than 180mm. The second field will only have an entry if the tortoise was handled - this field should not be estimated. However, you can record a guess as a Comment

**Sex**

If there is any uncertainty about the sex of the tortoise, record "unknown," although a guess can be provided in Comments  
It is more difficult to identify the sex of smaller tortoises. In particular, those under 180mm are often considered juveniles. A comment must be provided if sex is recorded under 180 mm

**Ticks**

Examine the shell, seams, and soft tissue and report the number of ticks observed

**Body condition score**

First select the BCS grouping category, then select the corresponding BCS score below. A score may be unknown even if a grouping is selected. Please reference the handbook for descriptions of each score.

### Nares appearance

- Eroded - Loss of scales and skin around naris opening.
- Occluded – Plugged or reduced size of naris opening.
- NoneOfAbove - Usual shape and/or size.
- Unk - You can't see the tortoise's nares

### Nares discharge

None - No discharge from either naris

Serous - Clear, watery discharge. Must simultaneously score the severity (1, 2, or 3) based on the naris with the most severe level of discharge.

Mucous - Thick discharge, usually cloudy. Must simultaneously score the amount (1, 2, or 3) based on the naris with the most severe level of discharge.

- 1 - Moisture present around one or both nares.
- 2 - Discharge coming out of at least one of the nares, but not running far from the nares themselves.
- 3 - Discharge coming from at least one naris that is running down the beak.

Unknown - If the tortoise's behavior prevents you from examining the nares, continue processing and collecting data. Attempt to score the nares one more time before leaving the location, but do not manipulate the tortoise to attempt the examination.

### Existing Tag

For live tortoises, the possibilities are that the tortoise definitely has an existing tag (you have been able to handle the tortoise, see it in the open, or have a clear view of the tag on the tortoise in a burrow), or that you know the tortoise definitely does not have an existing tag (you have been able to handle the tortoise or see it in the open), or the tag exists but is unreadable ("U/R"; ultraviolet can for instance darken tags), or you can't see the entire tortoise, cannot handle it, and you can't confirm that the invisible portions are tag-less.

*FW tag numbers are recorded without hyphens. All other tag numbers are recorded as they appear.*

### Existing Tag Color

#### Other Tag Color

If any tag is present, it is likely to be blue, white, or green. Otherwise, use "Other tag color" and spell it out!

### Tort data not collected b/c

If any handling fields are left blank including MCL, sex, ticks, BCS, nares, new tag attached, existing tag=unknown, your QAQC specialist will interview you to attempt to fill in information. If you can instead use one or more of the pick list provided here, or can clearly describe a different situation that prevented handling of the tortoise, then the extra follow-up work will be avoided.

Deep in burrow	Tortoises should only be extracted from burrows if the animal does not struggle or become agitated
Scutes too small	This situation would preclude affixing a tag
In social interaction	Tortoises that are courting, mating, in combat, or other social interactions should not be disturbed
Research project area	Transmittered animals or others under behavioral observation in designated areas should not be approached
Temperature	Greater than 35 degs C, so we can't handle the tortoise
Tucked in shell	Tortoise was tucked in and nares, head, etc not visible
Voided	Once the tortoise voids, further handling should be avoided
No permit	You will have all federal permits, but if you don't have a state permit, don't handle
Other	Use this option to describe another situation, or to retract an entry under this field

### Easting

#### Northing

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit.

In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates.

In this case, always record both the easting, the northing, and the UTM zone.

### UTM Zone

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

### GPS grab valid?

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is > 5.0 m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be ≤ 5.0 m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

### Photo\_tort1/Photo\_tort2

#### Photo comment

If you take a photo of the tortoise, whether taken as part of this subform or no, indicate "Yes."

Take at least one photo of every tortoise. Ideally one photo should be taken looking down on the tortoise's head and carapace, capturing the head and possibly upper half of the forelimbs. If a photo from above isn't possible, take a headshot from the front or side to show BCS. If the tortoise is tucked in or in a burrow and a headshot photo isn't possible, take a tortoise in habitat shot. Additionally, take photos of any existing tags or notches or of nares or body condition features to clarify scoring, use the comment field to communicate your intent to the viewer. Add a comment to describe all photos. If the photo was not taken as part of this subform, provide the label assigned by the data collection device in the comment.

### Was Tort Handled?

Did you physically handle the tortoise? Even if all handling data weren't collected, but tort was handled, select yes

## Desert Tortoise Distance Sampling Transect Form (OppLiveObs) (version 02-14-2024)

Team:  Date:  Stratum:  Transect Num:

Opp Live #	<input type="text"/>	MCL ≥ 180?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unk	Ticks:	<input type="checkbox"/> 0 <input type="checkbox"/> 1-10 <input type="checkbox"/> >10 <input type="checkbox"/> Unk	Tort data not collected b/c:	<input type="text"/>																			
Time:	<input type="text"/> am / <input type="text"/> pm	MCL (mm):	<input type="text"/>	Existing Tag:	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U/R <input type="checkbox"/> Unk	<b>GPS Location</b>																				
<b>Tortoise location:</b>	<input type="checkbox"/> RockBurrow <input type="checkbox"/> SoilBurrow <input type="checkbox"/> Pallet <input type="checkbox"/> Open <input type="checkbox"/> Vegetation <input type="checkbox"/> Rock	Sex:	<input type="checkbox"/> M <input type="checkbox"/> F <input type="checkbox"/> Unk	ET Number:	<input type="text"/>	Easting:	<input type="text"/>																			
Burrow Visibility:	<input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<b>Body condition score (select grouping &amp; score) :</b>		Existing Tag Color:	<input type="checkbox"/> Blue <input type="checkbox"/> White <input type="checkbox"/> Green	Northing:	<input type="text"/>																			
Tort in Burrow Visibility:	<input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<table border="1" style="font-size: small; width: 100%;"> <tr> <th colspan="3">Under</th> <th colspan="3">Good</th> <th colspan="3">Over</th> <th>Unk</th> </tr> <tr> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td>8</td><td>9</td> <td>Unk</td> </tr> </table>	Under			Good			Over			Unk	1	2	3	4	5	6	7	8	9	Unk	Other Tag Color:	<input type="text"/>	UTM Zone:	<input type="checkbox"/> 11 <input type="checkbox"/> 12
Under			Good			Over			Unk																	
1	2	3	4	5	6	7	8	9	Unk																	
Tortoise visibility:	<input type="checkbox"/> H <input type="checkbox"/> M <input type="checkbox"/> L	<b>Nares appearance (circle all that apply) :</b>		New Tag Attached?	<input type="checkbox"/> Yes <input type="checkbox"/> No	GPS grab valid?:	<input type="checkbox"/> Yes <input type="checkbox"/> No																			
Distance to burrow (m):	<input type="text"/>	Eroded <input type="checkbox"/> Occluded <input type="checkbox"/> NoneOfAbove <input type="checkbox"/> Unk		New Tag Number:	<input type="text"/> FW	Was tort handled?:	<input type="checkbox"/> Yes <input type="checkbox"/> No																			
Temperature:	<input type="text"/> °C	<b>Nares discharge:</b>		Tortoise Void:	<input type="checkbox"/> None <input type="checkbox"/> Urine <input type="checkbox"/> Feces <input type="checkbox"/> Both	<b>Photo taken:</b>	<input type="checkbox"/> Yes <input type="checkbox"/> No																			
Temp > 35?:	<input type="checkbox"/> Yes <input type="checkbox"/> No	None <input type="checkbox"/> Serous 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Mucous 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> Unk		Fluids Offered:	<input type="checkbox"/> Yes <input type="checkbox"/> No	<i>Comment:</i>	<input type="text"/>																			
				Fluids Accepted:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unk																					

Comments:

Record opportunistic live tortoises when walking to or from a transect, taking a break, or any other situation where the tortoise was encountered without using the distance searching protocol. Add a comment describing the situation for opportunistic tortoises recorded inside a transect.

**Transect Num**

Opportunistic tortoises must be associated with a transect. If you have closed out your transects you will have to reopen the corresponding transect record and add the data to the appropriate paper and electronic forms.

**Opp Live #**

For each transect, not for each segment of an interrupted transect, restart numbering sequentially from 1. For interrupted transects, continue numbering sequentially

**See TranLiveObs annotated datasheet for details on all other fields**

## Desert Tortoise Distance Sampling Transect Form (TranCarcObs) (version 02-12-2024)

Team: <input style="width: 100%;" type="text"/>	Date: <input style="width: 100%;" type="text"/>	Stratum: <input style="width: 100%;" type="text"/>	Transect Num: <input style="width: 100%;" type="text"/>
Tran Carc #: <input style="width: 100%;" type="text"/>	Transect Bearing: <input style="width: 100%;" type="text"/>	Carcass Condition: <input style="width: 100%;" type="text"/>	<b>GPS location</b>
Observer: <input style="width: 100%;" type="text"/>	Other Tran Bearing: <input style="width: 100%;" type="text"/>	MCL ≥ 180? <input style="width: 100%;" type="text"/>	
Obs Position: <input style="width: 100%;" type="text"/>	Local Bearing: <input style="width: 100%;" type="text"/>	MCL (mm): <input style="width: 100%;" type="text"/>	Northing: <input style="width: 100%;" type="text"/>
Last Waypoint: <input style="width: 100%;" type="text"/>	Azimuth: <input style="width: 100%;" type="text"/>	Sex: <input style="width: 100%;" type="text"/>	UTM Zone: <input style="width: 100%;" type="text"/>
Observation Time: <input style="width: 100%;" type="text"/>	Radial Distance: <input style="width: 100%;" type="text"/>	Existing Tag: <input style="width: 100%;" type="text"/>	GPS grab valid? <input style="width: 100%;" type="text"/>
Comments: <input style="width: 100%;" type="text"/>	Perpendicular Dist: <input style="width: 100%;" type="text"/>	ET Number: <input style="width: 100%;" type="text"/>	Photo taken? <input style="width: 100%;" type="text"/>
		ET Color: <input style="width: 100%;" type="text"/>	
		Other Tag Color: <input style="width: 100%;" type="text"/>	

Remains of a tortoise are recorded as a carcass only if at least half of the shell (plastron and carapace) are present or if a smaller part is available but identifying marks are present.

### Tran Carc #

The count of carc obs in sequence detected on this transect. For each transect, not for each segment of an interrupted transect, restart numbering sequentially from 1. For interrupted transects, continue numbering sequentially.

### Observer

Who saw the carcass? You will retain the observer # position (observer 1 or observer 2) assigned to you for your team for the entirety of the season.

### Observer Position

Record whether the carcass was first seen by the person in the "lead" or "follow" position.

### Last Waypoint

Number of the last recorded waypoint before this observation

### Observation time

This should be the time you first observe the tortoise

### See TranLiveObs annotated datasheet for details on Bearing, Azimuth, and Distance fields

### Carcass Condition

These definitions are project specific. You may have used other definitions, but for us, if the MCL can be measured, the tortoise is "intact," regardless of how much has fallen off or whether carapace and plastron are attached. Otherwise it is "disarticulated."

### MCL ≥ 180?

### MCL (mm)

For all carcasses, the first field will have an entry. The second field will only have an entry if the carcass condition is intact - this field should not be estimated. If you estimate an MCL, enter it in the Comments

### Sex

Record sex only if you are able to determine accurately. If there is any uncertainty about the sex of the tortoise, record "unknown." Tortoises smaller than 180 mm are generally "unknown." You can record best guesses in the Comments.

### Existing Tag

For carcasses, the possibilities are that it definitely has an existing tag ("Y"), or that you know it definitely does not have an existing tag ("N"), or the tag exists but is unreadable ("U/R"; ultraviolet can for instance darken tags). Because carcasses can always be removed and examined completely, it will never be appropriate to say it is "unknown" whether the carcass has an existing tag (live tortoises may be "Unk" to have a tag). If you can't find a tag with a carcass now, you won't find one at a later date.

### Existing Tag Color

### Other Tag Color

If any tag is present, it is likely to be blue, white, or green. Otherwise, use "Other tag color" and spell it out!

### Easting

### Northing

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit.

In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates.

In this case, always record both the easting, the northing, and the UTM zone.

### UTM Zone

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

### GPS grab valid?

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is > 5.0 m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be ≤ 5.0 m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

### Photo taken

### Photo comments

If you take a photo of the carcass, whether taken as part of this subform or no, indicate "Yes."

At least one photo should be taken of each recorded carcass, showing any existing tags or notches if present. Use the comment field to communicate your intent to the viewer. Add a comment to describe all photos. If the photo was not taken as part of this subform, provide the label assigned by the data collection device in the comment.

**Desert Tortoise Distance Sampling Transect Form (OppCarcObs)** (version 02-12-2024)

Team:  Date:  Stratum:  Transect Num:

Opp Carc #	<input type="text"/>	Sex:	<input type="text"/> M <input type="text"/> F <input type="text"/> Unk	Easting:	<input type="text"/>	Photo_Carc: <input type="text"/> Yes <input type="text"/> No Comments:
Carc Condition:	<input type="text"/> Intact <input type="text"/> D/A	Existing Tag:	<input type="text"/> Yes <input type="text"/> No <input type="text"/> U/R	Northing:	<input type="text"/>	
MCL <sub>≥</sub> 180?	<input type="text"/> Yes <input type="text"/> No <input type="text"/> Unk	ET Number:	<input type="text"/>	UTM Zone:	<input type="text"/> 11 <input type="text"/> 12	
MCL (mm):	<input type="text"/>	Existing Tag Color:	<input type="text"/> Blue <input type="text"/> White <input type="text"/> Green	GPS grab valid?	<input type="text"/> Yes <input type="text"/> No	
Other Tag Color:	<input type="text"/>					
Comments: <input style="width:90%;" type="text"/>						

**Transect Num**

Opportunistic carcasses must be associated with a transect. If you have closed out your transects you will have to reopen the corresponding transect record and add the data to the appropriate paper and electronic forms.

**Opp Carc #**

Remains of a tortoise are recorded as a carcass if at least half of the shell (plastron and carapace) are present or if a smaller part is available but identifying marks are present. For each transect, not for each segment of an interrupted transect, restart numbering sequentially from 1. For interrupted transects, continue numbering sequentially

**See TranCarcObs annotated datasheet for details on all other fields**

**Desert Tortoise Plot Survey – Live Tortoises Form** (version 06-04-2024)

Entered \_\_\_\_\_

Plot Name \_\_\_\_\_ Date \_\_\_\_\_ Day \_\_\_\_\_ of 3 Observer(s) \_\_\_\_\_

Proofed \_\_\_\_\_

Tort ID	Time	WGS84 UTM Zone 11S		On Plot?	<sup>1</sup> Spotter	<sup>2</sup> Location	<sup>3</sup> Behavior	New Cap	Color Mark	Yell Prev	Blue Prev	Sex	MCL (mm)	Mass (g)	<sup>4</sup> Ticks	<sup>5</sup> BCS Grouping & Score	<sup>6</sup> Nares Appearance	<sup>7</sup> Nares Discharge	<sup>8</sup> Existing tag?	Existing tag color	Existing tag number	<sup>9</sup> Existing notches?	Existing notch type & locations	Photos & #
		Easting	Northing																					

<sup>1</sup>Spotter = Searcher (S); Processor (P); <sup>2</sup>Location (choose one) = SoilBurrow (SB); RockBurrow (RB); Vegetation (Veg); Rock; Pallet; Open;

<sup>3</sup>Behavior (choose one) = Agonistic; AtRestActive (ARA); Basking (Bask); Digging; Eating; RestingEyesClosed (REC); Mating; Moving; Unk; <sup>4</sup>Ticks (choose one) = 0; 1-10; >10; Unk;

<sup>5</sup>BCS Grouping [Score] = Under [1-3]; Good [4-6]; Over [7-9]; Unk [Unk]; <sup>6</sup>Nares Appearance (all that apply) = Eroded, Occluded (Occ), NoneOfAbove (None), Unk; <sup>7</sup>Nares discharge (all that apply) = None; Serous 1, 2, 3 (S); Mucous 1, 2, 3 (M); Unk; <sup>8</sup>Existing tag? (choose one) = Yes; No; Unreadable (U/R); Unk; <sup>9</sup>Existing notches? (choose one) = Yes; No; Unk;

**Additional Notes** (include tort ID & time, note if voided, rehydrated, and/or fluids accepted): [e.g. FW14000, 0852am: voided urine & feces, rehydrated via nasal oral, accepted fluids]

**Tort ID:** Record new ID if tag attached or existing tag if present

**Time:** Use am/pm, do not use 24 hour clock

**Easting:** Easting coordinate of waypoint, recorded from Garmin GPS unit

**Northing:** Northing coordinate of waypoint, recorded from Garmin GPS unit

**On plot?:** Is the tortoise located within the plot boundaries on your GPS unit? Yes or no?

**Spotter:** Was the tortoise found by a searcher (S) during the survey or by a processor (P)?

**Location:**

SoilBurrow (SB)- A constructed hole in dirt, more than 1 tortoise length deep. A tortoise in a burrow is at least half inside the mouth of the burrow, deep inside, or anywhere in between

RockBurrow (RB)- May be partially constructed. Rock is the substrate of the top of the burrow, maybe also the bottom

Vegetation (Veg)- Tortoise is under the drip line, or in the shade of vegetation.

Rock - Tortoise is in the shade of a rock.

Pallet - Tortoise is in a similar configuration to the mouth of a burrow, but the shelter is shorter than one tortoise length.

Open - Tortoise is in the open and not under vegetation or rock.

**Behavior**

Agonistic - The tortoise is an aggressive interaction with another tortoise.

AtRestActive (ARA)- The tortoise is visible, appears to be awake, but does not appear to be doing anything. It may be facing away from you. Compare to "Basking"

Basking (Bask)- Shell on ground, legs sprawled out to maximum skin exposure posterior or broadside to sun orientation. Compare to "AtRestActive"

Digging - The tortoise is modifying a burrow/pallet by digging, or possibly nesting. Sometimes you can discern digging when the tortoise is not visible, (i.e. dirt flying out of the back of a burrow).

Eating - The tortoise appears to be biting vegetation or other possible food items.

RestingEyesClosed (REC)- The tortoise is visible and you can clearly see that its eyes are closed and it is not alert

Mating - The tortoise is engaged in mating activity with another tortoise (courtship behavior or copulation).

Moving - This typically involves the tortoise walking, with the plastron off the ground. However, if you hear what you believe to be the tortoise moving in the back of a burrow, record behavior as moving.

Unknown (Unk)- The tortoise is not visible, and the behavior cannot be discerned.

If the tortoise is not visible behavior can only be unknown, digging, or moving. Probably 99% of the time it will be unknown.



**New Cap:** First time this tortoise was captured during the 3 day survey? Yes or no?

**Color Mark:** Yellow (day 1), Blue (day 2), or Red (day 3)

**Yell Prev:** Used on day 2 or 3, does this tortoise have a yellow dot? Yes or no?

**Blue Prev:** Used on day 3, does this tortoise have a blue dot? Yes or no?

**\*\*The following data will only need to be recorded the first time a tortoise is captured during a survey, unless there was missing data from a previous capture**

**Sex:** If there is any uncertainty about the sex of the tortoise, record "unknown." Tortoises smaller than 180 mm are generally "unknown." You can record best guesses in the Comments

**MCL:** MCL in mm should be measured. Unless a tortoise cannot be extracted, then note that it's an estimate, at a minimum record whether it is greater or less than 180 mm

**Mass:** Recorded in grams

**Ticks:** Examine the shell, seams, and soft tissue and report the number of ticks observed. 0; 1-10; >10; Unknown (Unk)

**Body condition score:** First select the BCS grouping category, then select the corresponding BCS score. A score may be unknown even if a grouping is selected.

Please reference the handbook for descriptions of each score. A score of 1-3 is under condition, 4-6 is acceptable to good condition, and 7-9 is over condition.

#### **Nares appearance**

Eroded - Loss of scales and skin around naris opening.

Occluded (Occ)- Plugged or reduced size of naris opening.

NoneOfAbove (None)- Usual shape and/or size.

Unk - You can't see the tortoise's nares

#### **Nares discharge**

None - No discharge from either naris

Serous (S)- Clear, watery discharge. Must simultaneously score the severity (1, 2, or 3) based on the naris with the most severe level of discharge.

Mucous (M)- Thick discharge, usually cloudy. Must simultaneously score the amount (1, 2, or 3) based on the naris with the most severe level of discharge.

1 - Moisture present around one or both nares.

2 - Discharge coming out of at least one of the nares, but not running far from the nares themselves.

3 - Discharge coming from at least one naris that is running down the beak.

Unknown (Unk)- If the tortoise's behavior prevents you from examining the nares

**Existing tag:** For live tortoises, the possibilities are that the tortoise definitely has an existing tag and it's readable ("Y"), the tortoise definitely does not have an existing tag ("N"), the tag exists but is unreadable ("U/R"), or you can't see the entire tortoise, cannot handle it, and you can't confirm that the invisible portions are tag-less ("Unk").

*FW- tag numbers are recorded without hyphens. All other tag numbers are recorded as they appear.*

#### **Existing tag color**

#### **Existing tag number**

Record what you can read, use \* for unreadable digits. Please take a photo of existing tags.

**Existing notches?:** Yes, no, or unk

**Existing notch type and locations:** File, epoxy notches, or other. List the marginals with notches, e.g. RM1, RM11, LM2

#### **Photos & #**

Did you submit photos in the digital form? How many?

Please take a photo of any previous tags, notches, an overview photo of the tortoise, or of nares or body condition features to clarify scoring, and any other pictures you think are informative.

Use the comment field in the digital form to describe photos.

#### **Additional notes**

Note if voided, tortoise was rehydrated, and/or fluids accepted

**Desert Tortoise Plot Survey – Shell Remains Form** (version 06-04-2024)

Entered \_\_\_\_\_

Plot \_\_\_\_\_ Date \_\_\_\_\_ Day \_\_\_\_\_ of 3 Observer(s) \_\_\_\_\_

Proofed \_\_\_\_\_

Carcass # (numerical order for the day)	Time	WGS84 UTM Zone 11S		On Plot ?	<sup>1</sup> Spotter	<sup>2</sup> Condition	<sup>3</sup> Class	MCL ≥ 180?	MCL (mm)	Sex	<sup>4</sup> Existing tag?	Existing tag color	Existing tag number	<sup>5</sup> Existing notches?	Existing notch type & locations	Photos & #	Notes (Provide description of visible notches and tag if present, any other relevant information)
		Easting	Northing														
[e.g.] 1	0852 am	508250	3850500	Y	S	Intact	3	Y	241	Unk	U/R	white	FW2***	Y	File; RM1, RM11, LM2	Y, 3	Part of tag legible, last 3 digits unreadable

<sup>1</sup>Spotter = Searcher: S; Processor: P; <sup>2</sup>Condition (choose one) = Intact; Disarticulated;

<sup>3</sup>Class (choose one) = 1 (fresh or putrid); 2 (normal color, scutes attached); 3 (scutes peeling off bone); 4 (shell bone falling apart and scute rings peeling); 5 (disarticulated, scattered);

<sup>4</sup>Existing tag? (choose one) = Yes; No; Unreadable (U/R); Unk; <sup>5</sup>Existing notches? (choose one) = Yes; No; Unk;

**Additional Notes** (include tort ID & time): [e.g. 1, 0852: 3 file notches visible, missing rear L marginal scutes (LM9-LM12)]

**Carcass #:** Existing tag ID if present or numerical order for your team for the day. Remains of a tortoise are recorded as a carcass only if at least half of the shell (plastron and carapace) is present or there is an existing id or visible notches

**Time:** Use am/pm, do not use 24 hour clock

**Easting:** Easting coordinate of waypoint, recorded from Garmin GPS unit

**Northing:** Northing coordinate of waypoint, recorded from Garmin GPS unit

**On plot?:** Is the carcass located within the plot boundaries on your GPS unit? Yes or no?

**Spotter:** Was the tortoise found by a searcher (S) during the survey or by a processor (P)?

**Condition:** If the MCL can be measured, the tortoise is "intact," regardless of how much has fallen off or whether carapace and plastron are attached. Otherwise, it is "disarticulated."

**Class:**

1: "fresh or putrid" - May be cleaned out but some flesh present, indicating it is from this year;

2: "normal color, scutes attached" - No flesh is present but nothing falling off;

3: "scutes peeling off bone" - Loose and/or falling off;

4: "shell bone falling apart and scute rings peeling" - Scutes are peeling for 3 too, so the difference is the bone;

5: "disarticulated, scattered" - Probably not 50% present so this category should be rare

**MCL≥180? / MCL (mm)**

For all carcasses, the 1st field will have an entry. The 2nd field will only have an entry if the carcass was intact- this field should not be estimated. If you estimate an MCL, enter it the Notes

**Sex:** If there is any uncertainty about the sex of the tortoise, record "unknown." Tortoises smaller than 180 mm are generally "unknown." You can record best guesses in the Comments.

**Existing tag:** For carcasses, the possibilities are that it definitely has an existing tag ("Y"), or that you know it definitely does not have an existing tag ("N"), or the tag exists but is unreadable ("U/R"; ultraviolet can for instance darken tags).

**Existing tag color**

**Existing tag number:** Record what you can read, use \* for unreadable digits. Please take a photo of existing tags.

**Existing notches?:** Yes, no, or unk

**Existing notch type and locations:** File, epoxy notches, or other. List the marginals with notches, e.g. RM1, RM11, LM2.

**Photos & #**

Did you submit photos in the digital form? How many? Please take a photo of any previous tags, notches, an overview photo of the carcass, and any other pictures you think are informative. Use the comment field in the digital form to describe photos.

# Tortoise Status Tracking Form (version 3-7-2024)

Site name:

Date:

Observer:

Comments:

**Transmitter freq:**   
**Tortoise Number:**   
**Time:**  am / pm  
**Tort Visible?:** Yes  No   
**Dist to burrow:**  m

**Tortoise location**

RockBurrow	SoilBurrow	Pallet
Open	Vegetation	Rock

**Behavior:**

Agonistic	AtRestActive	Basking
Digging	Eating	Mating
RestingEyesClosed	Unk	Moving

**Is there a handling event associated with this observation?**  
*If so, did you complete both a tracking obs and a trans attach (handling) form?*

Yes	No
-----	----

**Burrow visibility:**

High	Med	Low	Not
------	-----	-----	-----

  
**Tort in burrow vis:**

High	Med	Low	Not
------	-----	-----	-----

  
**Tortoise visibility:**

High	Med	Low	Not
------	-----	-----	-----

**GPS grab valid?**

Yes	No
-----	----

  
**Easting:**   
**Northing:**   
**UTM Zone:**

11	12
----	----

**Tortoise environment**

OpenScrub	On/AboveGentleSlope
DirtRoad	On/AboveSteepSlope
WithinWashRim	DesertPavement

**Photo 1:**

Yes	No
-----	----

  
**Photo 2:**

Yes	No
-----	----

**Photo 1 comment:**   
**Photo 2 comment:**

Comments:

**Transmitter freq:**

Transmitter frequency for this tracked tortoise

**Tortoise Num:**

Number on the tracking tortoise. Include FW or other prefix

**Time:**

Time tracked, use am/pm, do not use 24 hour clock

**Tort visible?**

Is the tortoise visible at all? Other fields on the form are directed at describing how visible the tortoise is.

**Dist to burrow?**

Without using a tape measure, estimate the distance in meters from this tortoise to the nearest burrow. If in the burrow (>50% inside), the distance is "0". If not in burrow (<50% inside) but on burrow apron and within 1m, distance should be "1". Enter a comment for tortoises that are on the apron but not in burrow. Distance is only "0" if tortoise is in a burrow. Use "100" if you do not see a burrow within 15m of the tortoise.

**Tortoise environment**

Description of area within 20 m of the tortoise

**Tortoise location:**

- SoilBurrow - Dirt constructed hole, more than 1 tortoise length deep. A tortoise in a burrow has at least 50% of its body under the burrow lip or inside the mouth of the burrow, is deep inside, or anywhere in between. Tort on the apron is only in burrow if >50% its body is inside.
- RockBurrow - May be partially constructed. Rock is the substrate of the top of the burrow, maybe also the bottom
- Vegetation - Tortoise is under the drip line, or in the shade of vegetation.
- Rock - Tortoise is in the shade of a rock.
- Pallet - Tortoise is in a similar configuration to the mouth of a burrow, but the shelter is shorter than one tortoise length.
- Open - Tortoise is in the open and not under vegetation or rock.

**Burrow visibility:**

This field must be populated if "Tortoise location = burrow". Consider the burrow as the center of a circle. Visibility will be estimated by the degrees of approach through which the burrow would be openly visible from 5 m away.

- High**  
Distinguishing characteristics of a burrow (opening, mound, or apron) would be visible from more than 75% of the angles of approach. High visibility includes a burrow out in the open and facing you, or very obvious under sparse vegetation.
- Medium**  
The expectation is that most burrows detected on a transect will be "medium" visibility. The approach will be to expect "medium" and then for a given tortoise to decide if use of the other categories is warranted in case this is an unusual situation for a burrow. Medium-visibility burrows are blocked through more than
- Low**  
The burrow is blocked from view through more than 75% but less than 100% of the angles of approach. Low visibility does not include burrows obscured completely by vegetation.
- Not Visible**  
The burrow is completely blocked from view. This will be the case if you plunge into vegetation (usually a shrub) to follow a signal, but nothing is visible from the outside, and the "not visible" tortoise is actually in a "not visible" burrow.

**Tortoise-in-burrow-visibility**

This field must be populated if "Tortoise location = burrow". Consider the burrow as the center of a circle. Visibility will be estimated by how much of the tortoise can be seen and is related to how deep the tortoise is in the burrow.

- High**  
High visibility tortoises include those at the mouth of the burrow, and easily seen without bending over and no need for use of a mirror or flashlight.
- Medium**  
Medium visibility tortoises include those that require bending over or getting down on your knees and the use of a mirror or flashlight.
- Low**  
Low visibility tortoises include those so deep within a burrow that you are required to lay flat on the ground, searching the depths of the burrow with a mirror or flashlight. Your confirmation of the tortoise may include only an arm or leg, or small portion of the shell.
- Not Visible**  
No part of the tortoise is visible when you look inside with a mirror or flashlight. If the tortoise is in a burrow, and "tort visible? = No", then the burrow and/or the tortoise in the burrow are concealed. If you have indicated that "burrow\_visibility = not visible", then the tort\_in\_burrow\_visibility may be high, medium, low, or not visible. However, if the burrow\_visibility is "high", "medium", or "low", then "tort\_in\_burrow\_visibility = not visible".

### Tortoise visibility

This field is only used for tortoises not associated with a burrow or caliche cave. Consider the tortoise as the center of a circle. Visibility will be estimated by the degrees of approach through which the tortoise would be openly visible from 5 m away.

**High**  
The tortoise would be visible from more than 75% of the angles of approach. Typically, high visibility includes tortoises out in the open, but they could be under vegetation or rocks but not obscured by them, or they could be in a pallet.

**Medium**  
Medium-visibility tortoises are blocked through more than 25% but less than 75% of the angles of approach. Medium visibility includes tortoises slightly obscured by vegetation, including in the open but behind vegetation because of your angle of approach, in a pallet, or under rocks (not in soil or rock burrows).

**Low**  
The tortoise is blocked from view through more than 75% of the angles of approach. This might be the case if you investigate because the signal is coming from and it looks like there should be a tortoise there, but it isn't immediately visible. Low visibility includes tortoises completely obscured by vegetation or rocks, including obscured in a pallet.

**Not Visible**  
The tortoise is completely blocked from view, usually deep in a shrub or high forbs/grasses. Since you will have indicated "Tort visible? = No", this option is redundant, but we maintain it for consistency in the visibility fields.

### Behavior

**Agonistic**  
The tortoise is an aggressive interaction with another tortoise.

**AtRestActive**  
The tortoise is visible, appears to be awake, but does not appear to be doing anything. It may be facing away from you in or out of a burrow. Compare to

**Basking**  
Shell on ground, legs sprawled out to maximum skin exposure posterior or broadside to sun orientation. Compare to "AtRestActive"

**Digging**  
The tortoise is modifying a burrow or pallet by digging, or possibly nesting. This can be with all four feet. Sometimes you can discern digging when the tortoise is not visible, (i.e. dirt flying out of the back of a burrow).

**Eating**  
The tortoise appears to be biting vegetation or other possible food items.

**RestingEyesClosed**  
The tortoise is visible and you can clearly see that its eyes are closed and it is not alert

**Mating**  
The tortoise is engaged in mating activity with another tortoise (courtship behavior or copulation).

**Moving**  
This typically involves the tortoise walking, with the plastron off the ground. However, if you hear what you believe to be the tortoise moving in the back of a burrow, record behavior as moving. Because observers frequently startle the animal, when possible observe behavior before approaching.

**Unknown**  
The tortoise is not visible, and the behavior cannot be discerned.

If the tortoise is not visible behavior can only be unknown, digging, or moving. Probably 99% of the time it will be unknown.

### GPS grab valid?

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is  $> 5.0$  m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be  $\leq 5.0$  m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

### Easting

#### Northing

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit. In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates. In this case, always record both the easting, the northing, and the UTM zone.

### UTM Zone

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

### Is there a handling event associated with this observation?

Did you handle tortoise to attach transmitter, remove transmitter, tag, etc? Or is this a mortality event? If so you must also complete a transmitter attach (handling) or mortality form in addition to this form, depending on the event.

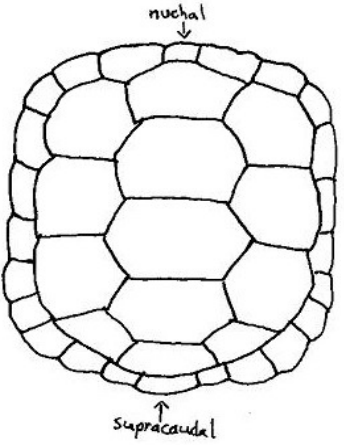
### Photo 1/Photo 2

#### Photo 1 comments/Photo 2 comments

Photos are not required for routine tracking, however, if there are unusual circumstances take photo. Add comments for all photos, comments provide helpful information to interpret the photo.

## Transmitter Attach (Handling) Form (version 03-07-2024)

Use this form to record handling events: initial transmitter, transmitter replacement, repair transmitter, tag tortoise, remove transmitter & release

<b>Site Name:</b>		<b>Observer:</b>				<b>Date:</b>									
<b>Existing Transmitter Freq:</b>		<b>Which handling activity? (circle all that apply)</b>		InitialTransmitter		TransmitterReplaced		RepairTransmitter		TagTortoise		Remove&Release			
<b>Existing Tag Present?:</b>		Yes No		<b>Perm trans attached?:</b>		Yes No		<b>Reason for removal and release:</b>							
<b>Existing Tag #:</b>				<b>Perm trans serial #:</b>											
<b>Encounter Time:</b>		am / pm		<b>Trans factory frequency:</b>											
<b>Temperature:</b>		°C		<b>Trans best frequency:</b>											
<b>Temp &gt; 35?:</b>		Yes No		<b>New tag attached:</b>		Yes No		<b>GPS grab valid?:</b>		Yes No					
<b>Sex:</b>		M F Unk		<b>New tag #:</b>				<b>Easting:</b>							
<b>MCL (mm):</b>				<b>Tortoise Void:</b>		None Urine/Urates		<b>Northing:</b>							
<b>Height at V3 (mm):</b>				<b>Fluids offered?:</b>		Yes No		<b>UTM Zone:</b>		11 12					
<b>Width at V3 (mm):</b>				<b>Fluids accepted?:</b>		Yes No		<b>Did you complete a tracking obs form for this handling record?</b>		Yes No					
<b>Initial weight (g):</b>				<b>Fluids accepted?:</b>		Unk		<b>Anytime this form is used, a tracking obs record is also needed</b>		Yes No					
<b>Ticks:</b>		0 1-10 >10 Unk		<b>Final weight (g):</b>				<b>Photo 1:</b>		Yes No		<b>Photo 3:</b>		Yes No	
<b>Body condition score (select a grouping and score):</b>		Under Good Over Unk		<b>Photo 1:</b>		Yes No		<b>Photo 3:</b>		Yes No		<b>Photo 5:</b>		Yes No	
1 2 3 4 5 6 7 8 9 Unk				<b>Photo comment:</b>				<b>Photo comment:</b>				<b>Photo comment:</b>			
<b>Nares appearance (circle all that apply):</b>		Eroded Occluded NoneOfAbove Unk		<b>Photo 2:</b>		Yes No		<b>Photo 4:</b>		Yes No		<b>Photo 5:</b>		Yes No	
<b>Nares discharge:</b>		None Serous 1 2 3 Mucous 1 2 3 Unk		<b>Comments:</b>				<b>Comments:</b>				<b>Comments:</b>			

**Existing transmitter freq:**

If currently transmitted, current transmitter frequency for this tracked tortoise

**Existing tag #:**

Tortoise ID/existing tag number. Include FW or other prefix

**Encounter time:**

Time tracked, use am/pm, do not use 24 hour clock

**Temperature:**

Air temperature at 5 cm from the ground in new shade in Celcius (no decimal)

**Temp > 35?**

Is this temperature below 35 C so that handling is permitted?

**Sex:**

If there is any uncertainty about the sex of the tortoise, record "unknown," although a guess can be provided in Comments

**MCL (mm):**

Measurement of carapace in mm

**Height at V3 (mm)**

Height measured at V3 in mm, see handbook for more info

**Width at V3 (mm):**

Width measured at V3, see handbook for more info

**Initial weight (g)**

Weight in grams before attaching/removing transmitter

**Ticks**

Examine the shell, seams, and soft tissue and report the number of ticks observed

**Body condition score**

First select the BCS grouping category, then select the corresponding BCS score below. A score may be unknown even if a grouping is selected. Please reference the handbook for descriptions of each score.

**Nares appearance**

Eroded - Loss of scales and skin around naris opening.  
 Occluded – Plugged or reduced size of naris opening.  
 NoneOfAbove - Usual shape and/or size.  
 Unk - You can't see the tortoise's nares

**Nares discharge**

None - No discharge from either naris  
 Serous - Clear, watery discharge. Must simultaneously score the severity (1, 2, or 3) based on the naris with the most severe level of discharge.  
 Mucous - Thick discharge, usually cloudy. Must simultaneously score the amount (1, 2, or 3) based on the naris with the most severe level of discharge.  
 1 - Moisture present around one or both nares.  
 2 - Discharge coming out of at least one of the nares, but not running far from the nares themselves.  
 3 - Discharge coming from at least one naris that is running down the beak.  
 Unknown - If the tortoise's behavior prevents you from examining the nares, continue processing and collecting data. Attempt to score the nares one more time before leaving the location, but do not manipulate the tortoise to attempt the examination.

**Which handling activity occurred?**

Circle all activities that occurred as part of this handling event

**Perm tran attached?**

Whether transmitter epoxied to tortoise

**Perm transmitter serial #**

This field must be populated if "Permanent transmitter attached"="Yes". ID number from permanent transmitter

**Perm transmitter factory freq:**

This field must be populated if "Permanent transmitter attached"="Yes". Factory frequency of permanent transmitter, 3 decimals required

**Perm transmitter best freq:**

This field must be populated if "Permanent transmitter attached"="Yes". Best frequency of permanent transmitter after attaching, 4 decimals required

**New tag attached:**

Did you apply a new tag? Yes or No

**New tag #:**

This field must be populated if "New tag attached"="Yes". New # attached to tortoise. Include FW or other prefix

**Did the tortoise void?:**

Choose one option

**Fluids offered?**

If the tortoise voided, were fluids offered? Yes or no

**Fluids accepted?**

Required if "Were fluids offered" = "Yes"

**Final weight (g):**

Weight in grams after attaching/removing transmitter

**GPS grab valid?**

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is > 5.0 m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be ≤ 5.0 m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

**Easting****Northing**

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit. In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates. In this case, always record both the easting, the northing, and the UTM zone.

**UTM Zone**

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

**Did you complete a tracking obs form for this handling record?**

This should always be yes; anytime this form is used a tracking obs record is also needed

**Photo 1 - 5****Photo 1 - 5 comments**

At a minimum take a before and after photo. Add additional photos of clinical signs, trauma, or abnormalities. Add comments for all photos, comments provide helpful information to interpret the photo.

**Tortoise diagram**

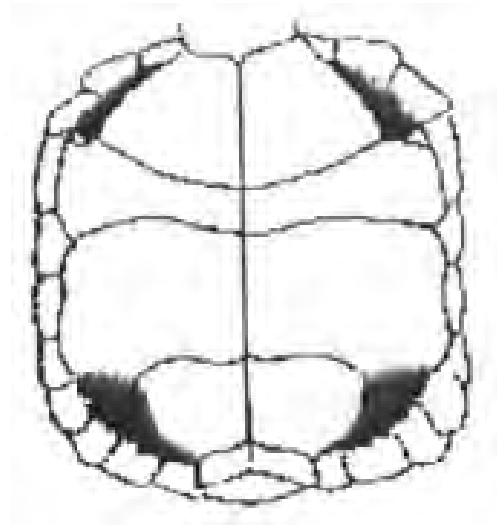
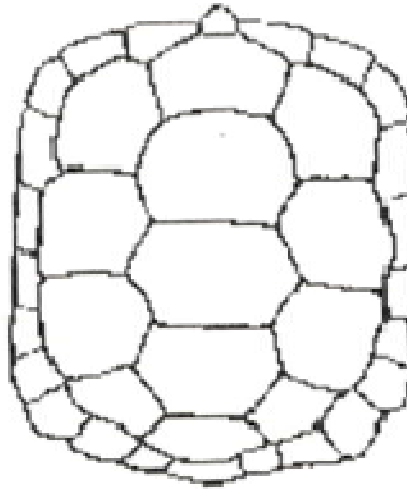
Draw transmitter and antenna location, notches, and location of new/existing tags

## Tortoise Mortality Form (version 03-07-2024)

<b>Site Name:</b>	<b>Observer:</b>	<b>Date:</b>
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<b>Existing Tag Present?:</b>	Yes	No	
<b>Existing Tag #:</b>			
<b>Encounter Time:</b>	am / pm		
<b>Sex:</b>	M	F	Unk
<b>MCL (mm):</b>			
<b>Carc condition:</b>	Intact	Disarticulated	
<b>Carc class:</b>	1. Fresh		
	2. Scutes Attached		
	3. Scutes Peeling		
	4. Bone Separating		
	5. Scattered		
<b>Head:</b>	Entire	Partial	None
<b>Left foreleg:</b>	Entire	Partial	None
<b>Right foreleg:</b>	Entire	Partial	None
<b>Left hindleg:</b>	Entire	Partial	None
<b>Right hindleg:</b>	Entire	Partial	None
<b>Scutes present (%):</b>			
<b>Shell bones present (%):</b>			

Draw evidence of trauma, disease, or other.  
Add "V" in location of notches and "W" in location of existing tag.



<b>Carc disposition:</b> <i>(select all that apply)</i>	Upright	Overturned			
	Tortoise Cover Site	Predator site	Fenceline		
	Open	Vegetation	Buried		
<b>Cause of death indicators:</b> <i>(select all that apply)</i>	Puncture wounds		Chew/gnaw marks		
	Predator tracks or sign		Livestock tracks or sign		
	Vehicle tracks or sign	Gunshot	Other		
<b>Cause of death inddicator other:</b>					
<b>Indicator description:</b>					
<b>Predator or other suspected based on indicators:</b>	On carapace	Canid	Raptor	Raven	Mountain Lion
	Crushed	Hyperthermia	Unknown	Other	
<b>Reasons/explanation for suspected:</b>					

<b>GPS grab valid?</b>	Yes	No
<b>Easting:</b>		
<b>Northing:</b>		
<b>UTM Zone:</b>	11	12

<b>Photo 1:</b>	Yes	No
<i>Photo comment:</i>		
<b>Photo 2:</b>	Yes	No
<i>Photo comment:</i>		
<b>Photo 3:</b>	Yes	No
<i>Photo comment:</i>		
<b>Photo 4:</b>	Yes	No
<i>Photo comment:</i>		
<b>Photo 5:</b>	Yes	No
<i>Photo comment:</i>		
<b>Did you complete a tracking obs form for this record?</b>		
<b><i>Anytime this form is used, a tracking obs record is also needed</i></b>		
Yes      No		

**Comments:**

**Existing tag present?**  
**Existing tag #:**  
 Required if "Existing tag present"="Yes". Tortoise ID/exisiting tag number. Include FW or other prefix

**Encounter time:**  
 Time tracked, use am/pm, do not use 24 hour clock

**Sex:**  
 If there is any uncertainty about the sex of the tortoise, record "unknown," although a guess can be provided in Comments

**MCL (mm):**  
 Measurement of carapace in mm if carcass condition is intact/measurable

**Carcass Condition:**  
 If the MCL can be measured, the tortoise is "intact," regardless of how much has fallen off or whether carapace and plastron are attached. Otherwise, it is "disarticulated."

**Carcass Class:**

- 1: "fresh or putrid" - May be cleaned out but some flesh present, indicating it is from this year;
- 2: "normal color, scutes attached" - No flesh is present but nothing falling off;
- 3: "scutes peeling off bone" - Loose and/or falling off;
- 4: "shell bone falling apart and scute rings peeling" - Scutes are peeling for 3 too, so the difference is the bone;
- 5: "disarticulated, scattered"

**Head / Left foreleg / Right foreleg / Left hindleg / Right hindleg**

For each category indicate what is present, whether entire, partial, or none

**Scutes present / Shell bones present**

For each category estimate the percentage present

**Carc disposition:**

Select all that apply to describe the carcass position and physical location

**Cause of death indicators:**

Select all that apply to describe what sign is present on or around the carcass that could indicate cause of death

**Indicator description:**

A brief text description of the cause of death indicators observed/selected

**Predator or other suspected based on indicators:**

Select a suspected predator or other cause based on the indicators observed/selected

**Reasons/explanation for suspected:**

Text description explaining your selection to the question above

**GPS grab valid?**

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is > 5.0 m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. **Both the integrated GPS accuracy must be ≤ 5.0 m and the integrated GPS and navigational GPS coordinates must be within 10 m of each other (both eastings within 10 m and both northings within 10 m) for "GPS grab valid?" = Yes.**

**Easting**

**Northing**

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit.

In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates.

In this case, always record both the easting, the northing, and the UTM zone.

**UTM Zone**

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.

**Did you complete a tracking obs form for this record?**

This should always be yes; anytime this form is used a tracking obs record is also needed

**Photo 1 - 5**

**Photo 1 - 5 comments**

At a minimum take a photo of the carcass in situ, a photo zoomed out to show surroundings, and any cause of death indicators observed. Add comments for all photos, comments provide helpful information to interpret the photo.

**Tortoise diagram**

Draw evidence of trauma, disease, or other, notches, and location of existing tags. Use crosshatches to indicate missing areas.



## Lost Tortoise Form (version 03-07-2024)

<b>Site Name:</b>	<b>Observer:</b>	<b>Date:</b>
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Transmitter Frequency	Tortoise Number	Observation Time	Minutes Searched	Signal Description <i>If signal is detected, note direction and strength</i>	GPS grab <i>If applicable</i>	Comments
					GPS grab valid?:  Easting:  Northing:  UTM Zone:	

Data proofed by:	Page      of
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Use this form to document anytime a tortoise cannot be located, including search time for missing tortoises, transmitters found unattached, instances where signals are detected but the tortoise isn't located, etc.

**Transmitter freq:**

Transmitter frequency for the tortoise being tracked

**Tortoise Number:**

Number of the tortoise being tracked. Include FW or other prefix

**Observation Time:**

Time of search, use am/pm, do not use 24 hour clock

**Minutes Searched:**

Total minutes spent searching for a missing tortoise

**Signal Description:**

If signal is detected but tortoise cannot be located note direction and strength, reason tortoise cannot be located, and any other relevant information

**GPS grab (not required)**

Take a GPS grab to represent the search area, where you detected a signal, etc. Include a comment describing what it represents

**GPS grab valid?**

If the integrated GPS differs from the navigational GPS by more than 10m for either coordinate or the integrated GPS accuracy is > 5.0 m,

**Easting**

**Northing**

On the paper sheet, these fields are recorded from the navigational (handheld) GPS unit.

In the data collection device, start with a GPS grab. If that fails or one of the coordinates is more than 10 meters from the navigational coordinates, use the manual easting and northing fields to record the navigational coordinates.

In this case, always record both the easting, the northing, and the UTM zone.

**UTM Zone**

Only entered by hand in the data collection device if a manual GPS grab was required. Zone 11 is CA and NV, Zone 12 is AZ and UT.