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. 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.

DESERT TORTOISE MONITORING HANDBOOK

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INTRODUCTION

The overall goal of the U.S. Fish and Wildlife Service (USFWS) recovery plan for the desert tortoise is the recovery and delisting of the tortoise. This monitoring project contributes annual population density estimates of the Mojave desert tortoise - information that the USFWS will use to assess the status of the tortoise 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 (λ) for desert tortoises are increasing (i.e., $\lambda > 1$) over at least 25 years (a single tortoise generation), as measured…by extensive, range-wide monitoring across tortoise conservation 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 to annually estimate the number of tortoises in managed areas of the Mojave Desert. Distance sampling has been implemented in a variety of settings; this project trains crews in the general approach to distance sampling as well as the specifics of how this is 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

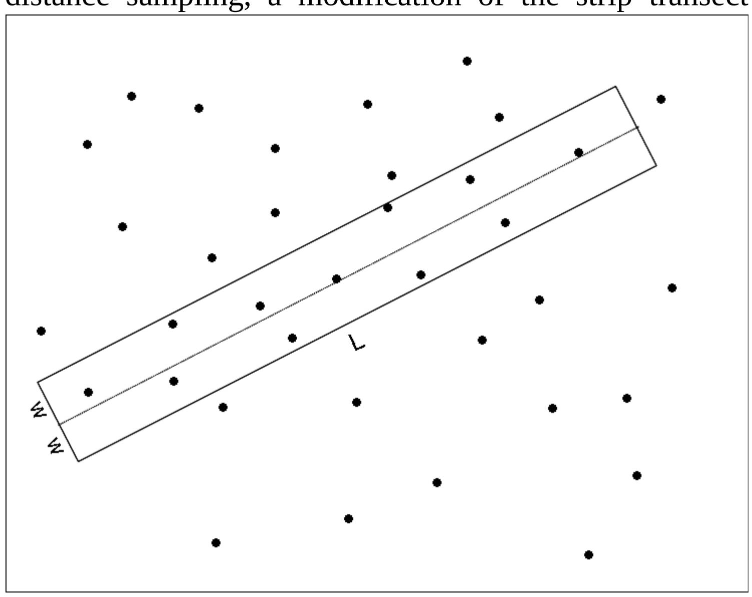


Figure 1. Hypothetical strip transect of length L and width 2w. Eleven objects are counted in the transect, giving density $D = 11/2wL$.

logistical problems, such as 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

<u>Correcting Population Estimates to Reflect Imperfect Detection</u>

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

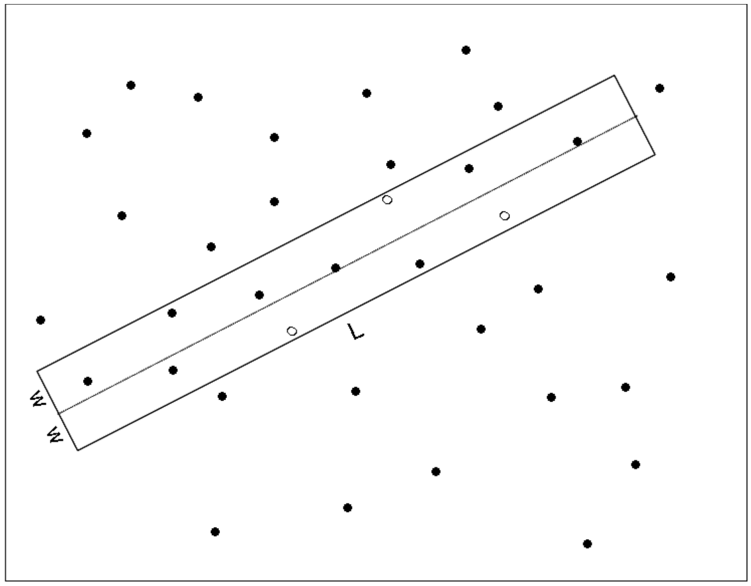


Figure 2. Same example as in Fig. 1, except that 3 objects have been missed (unfilled circles). The density estimate is now $D = 8/2wL$ and has 27% negative bias. Note that objects farther from the centerline have a greater chance of being missed.

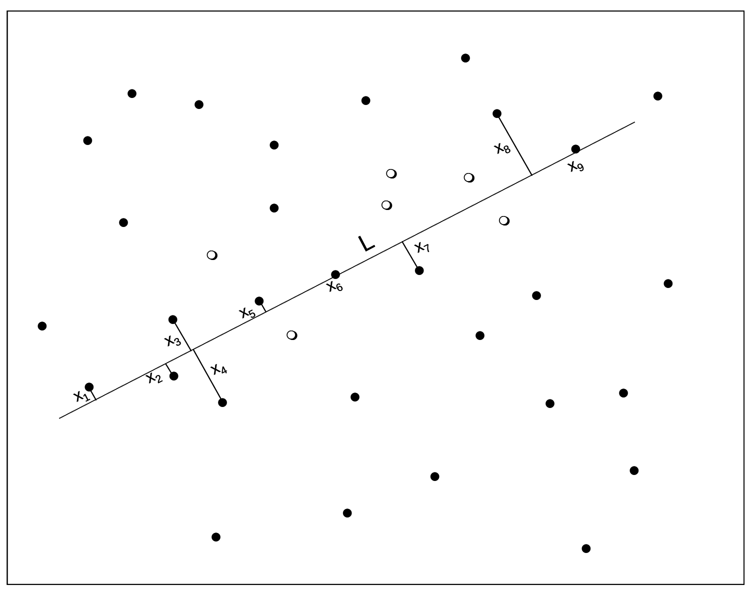


Figure 3. Line transect of length L. Nine objects at distances x_1, x_2, … x_9 from the line were detected. Six objects (unfilled circles) within the farthest observed distance (x_8) were missed. After Buckland et al. (2001), Fig. 1.2.

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.

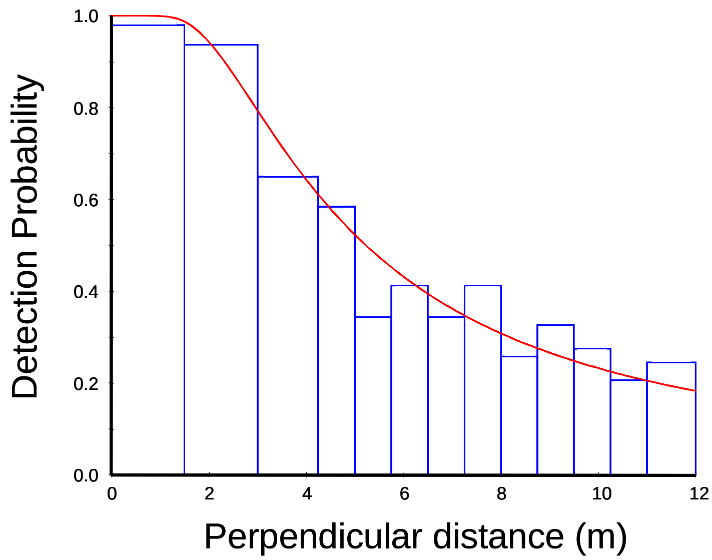


Figure 4. Histogram of observations and detection function to 12m for adult tortoises in the Mojave Desert in 2005.

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*0.02*8000) = 0.312 tortoises per km^2. However, adjusting for detection in the equation above, we refine our estimate to 0.625 tortoises per km^2.

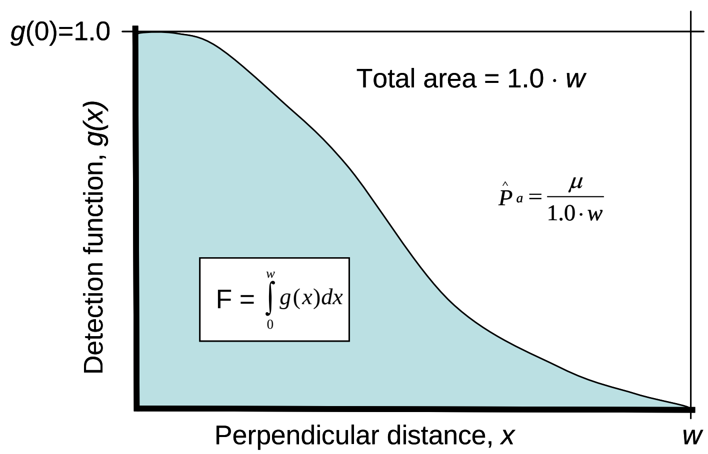


Figure 5. Probability of detecting an animal within distance *w* of the transect centerline is the area under the curve (modeled from the distribution of observed perpendicular distances) divided by the total area of the rectangle 1.0·*w*. After Buckland et al. (2001), Fig. 3.1.

<u>Assumptions of Distance Sampling</u>

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.

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.

<u>Proportion of Tortoises That Are Not Available for Sampling</u>

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). This parameter, G_0 (pronounced “Gee sub-zero”), should not be confused with $g(0)$ (“*g* at zero”) the probability of detection at distance = 0. Estimation of G_0 consists of the observation of a cohort of focal tortoises in 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^2, 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^2.

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.

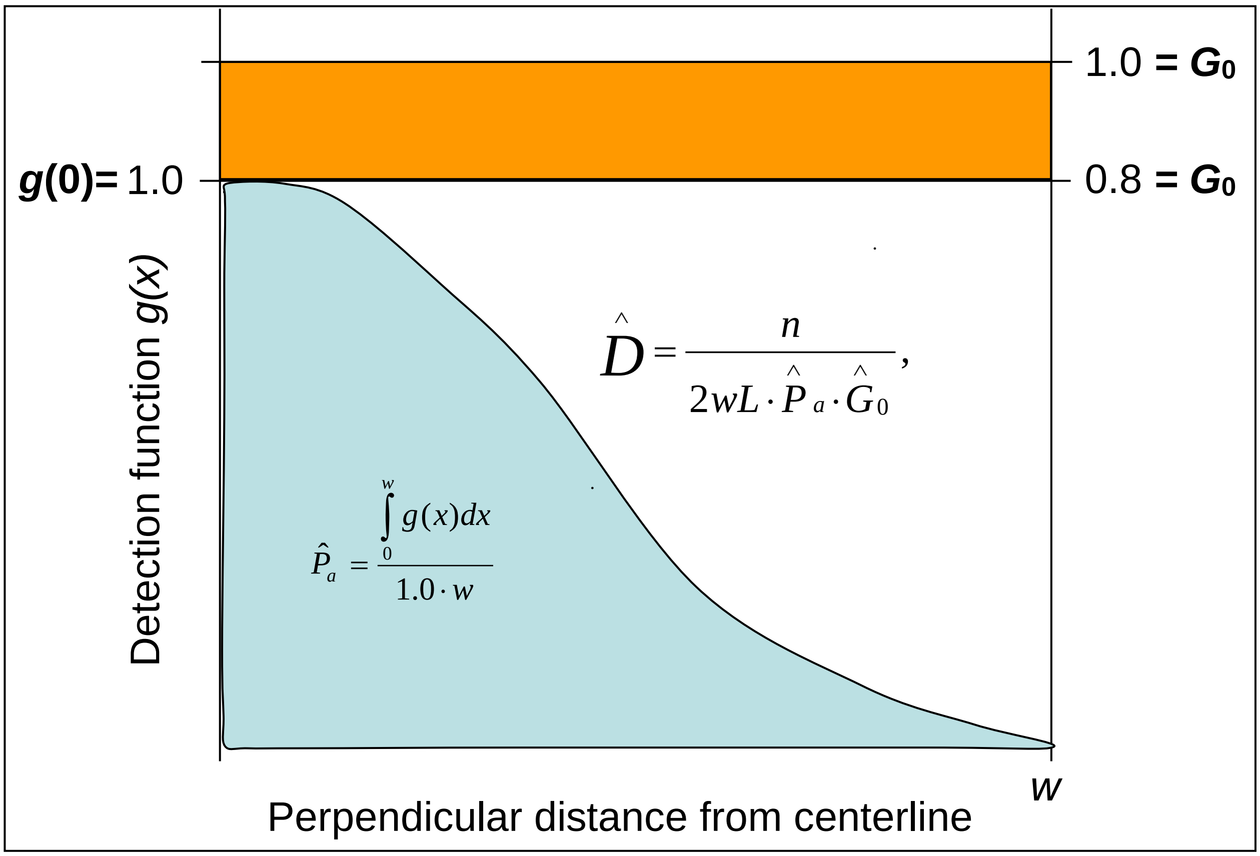


Figure 6. Probability of detecting a visible animal within distance *w* of the transect centerline is the green area under the curve divided by the total area of the rectangle 1.0·*w*. The rest of that rectangle (in white) is visible but undetected because as cryptic animals like tortoises are farther 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 have been federally designated a threatened species and are protected by state and federal laws. Proper handling is required to comply with these laws and to insure safe and humane treatment of the tortoises. Proper handling includes 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. This 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 stipulate permit “Terms and conditions” that are the basis for the desert tortoise handling protocols for this project.

Objective 1: Compliance with state and federal 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.

<u>Key Facts</u>
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 excessive predation of hatchlings and juveniles 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 toe nails. 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 state and federal 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 once or twice 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 State and Federal 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. 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 103^0 F and 112^0 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, trifectant or chlorhexidine diacetate are approved for use, prepared according to manufacturers' instructions. Like 30% 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. Once mixed, solutions may be used for up to one week.

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 using an oral syringe, remember to avoid touching the syringe to the tortoise. Instead, create a slow, steady flow that moves over the tortoise's nares and mouth. Offer fluids while positioning yourself away from the tortoise's line of sight; standing behind the tortoise and holding the syringe 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 at least a full [50 ml] syringe of fluids and as many as 2 more as long as the tortoise appears to be accepting fluids. Water offered to the tortoise should be kept separate from human drinking water. Discard the syringe if it touches the tortoise; do not disinfect.

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

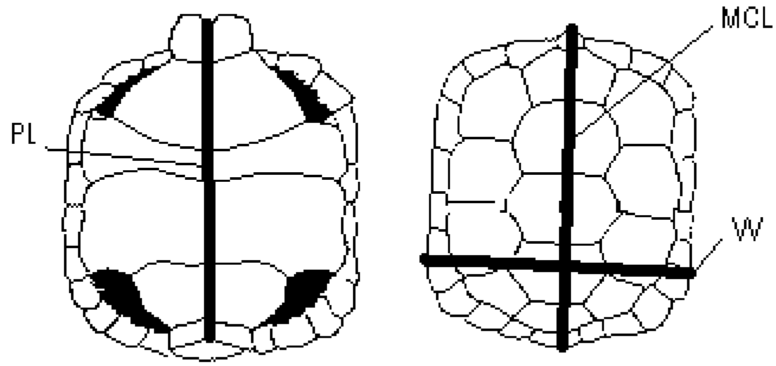
During this project you will collect information about tortoises detected on transects and encountered while on the way to and from transects. Related data will be collected for carcasses. See data sheets in Appendix I.

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 calipers, MCL is measured in millimeters from the

most anterior scute (i.e. the nuchal; where the head emerges) in a straight line along the carapace to the most posterior scute (i.e. the supracaudal or pygal scute; where the tail emerges).

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.

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



Plastron **Carapace**

Plastron Length (PL): Length of the plastron (bottom shell) from gular notch to anal notch.

Midline Carapace Length (MCL): Length of carapace (top shell) along vertebral scutes from the nuchal to the rear marginal (supracaudal) scute.

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 have large well-developed chin glands that sometimes leak fluid at this time of year. When in doubt, record sex as "unknown."

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 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. 2011. 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: http://www.fws.gov/nevada/desert_tortoise/dt_assessments.html.

<u>Body condition scoring</u>
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

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.

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.

Asymmetrical - One naris is larger and/or wider than the other.

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

Occluded – Plugged or reduced size of either naris opening.

Ticks

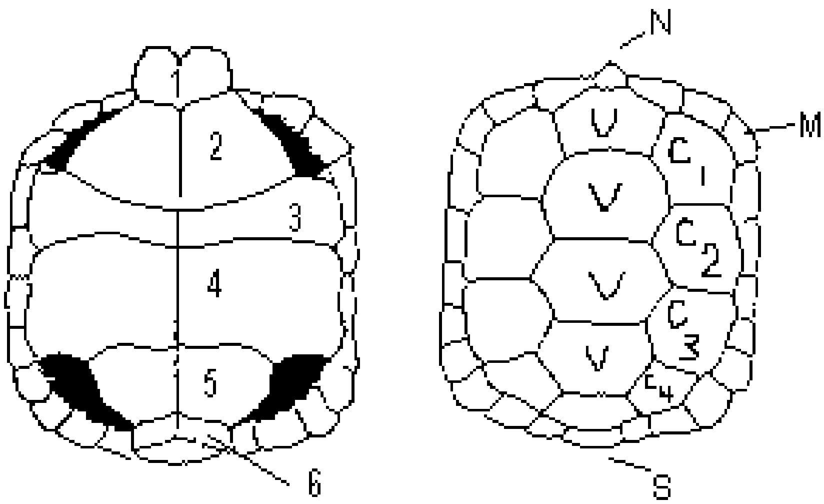
Ticks will attach themselves on soft tissue, including skin of the limbs, vent, and tail. They are often associated with soft tissues associated with the beak, eyes, and nares. Also examine the shell for possible attachment in the seams between scutes of the carapace and plastron, or on the scutes themselves.

Marking a tortoise

Paper tags will be affixed to a scute of each unmarked tortoise. Minimize the abrasion the tag will be subjected to; select a scute with a natural depression, considering first any of the costals, then the vertebrals (if the depression is quite deep- vertebrals endure a lot of scraping). Because tortoises are often relocated head-down in burrows, using the 4^{th} right or left costal scute will increase the likelihood the tag will be read. When affixing the tag, under no circumstances should epoxy touch the margins of the scutes, where growth must occur. Subadult 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 were used since 2008. Besides the use of tags, many researchers mark tortoises by notching the marginal scutes (Figs. 2-2 and 2-3).

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**

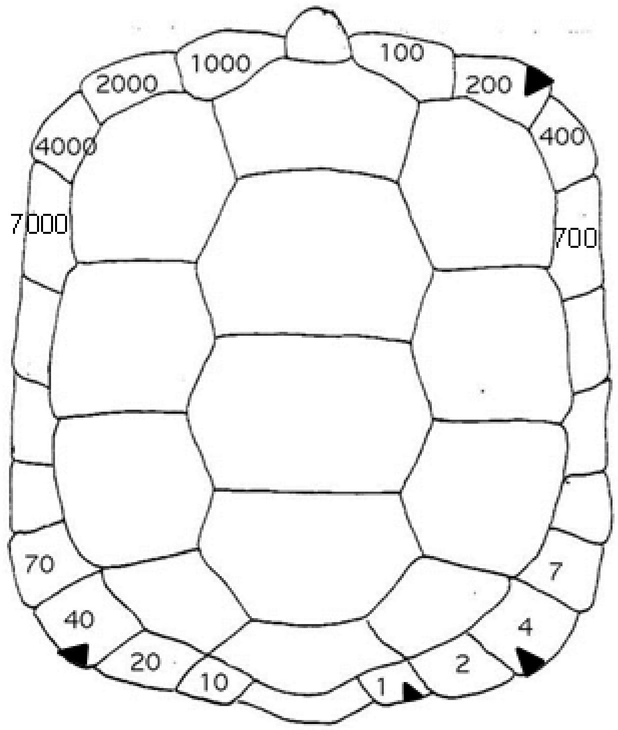
1 – gular horn
2 – humeral
3 – pectoral
4 – abdominal
5 – femoral
6 – anal

C – Costal scute
V – Vertebral scute
M – Marginal scute
N – Nuchal 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.

When notching, remember that bone seams are generally offset from scute seams, so avoid notching directly in the middle of the scute. Also avoid creating fragile, narrow, breakable scute fragments by notching close to the scute seam. Notches should be as large and defined as possible without marking the underlying bone. Once you have finished all notches, it is good practice to revisit each one with an eye on optimizing the size of the notch.

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.” 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 of 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
    - 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
        - Several meters away from burrow entrance if nearby
        - Place thermometer in the shade approximately 10 cm above where the tortoise will be handled to ensure suitable temperatures
    - Observe whether the tortoise has an existing tag and/or has been notched
    - Make basic observations of body condition score
    - Finish recording any distance data prior to handling tortoise
    - Remove needed handling gear from the pack; place in the processing area
        - Place tape and calipers on the ground at the processing area
    - If an existing tag is present, use a small amount of non-drinking water to clear dust and read the tag number.
    - At the backpack, cut out the paper tag and mix the epoxy on cardstock.
    - Record all relevant fields, such as transmitter 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
        - Place the measuring tape on the ground to the left of the tortoise
        - Do not place equipment under the tortoise
        - Do not place gear where the tortoise might step on it.
- Apply ID tag if necessary
- Hold calipers near the tips to move them to the correct measuring position.
- Read MCL by placing calipers on the ground next to but not touching the tape.
- 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)
    - 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.
- Do not return tortoise to its 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 if working alone.
- 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 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. Use a **navigational GPS** to locate transect start points, keep track of meters walked, check the Nexus phone 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 Nexus phone GPS is not for navigation; it is used solely to transfer location data to the collection system.

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

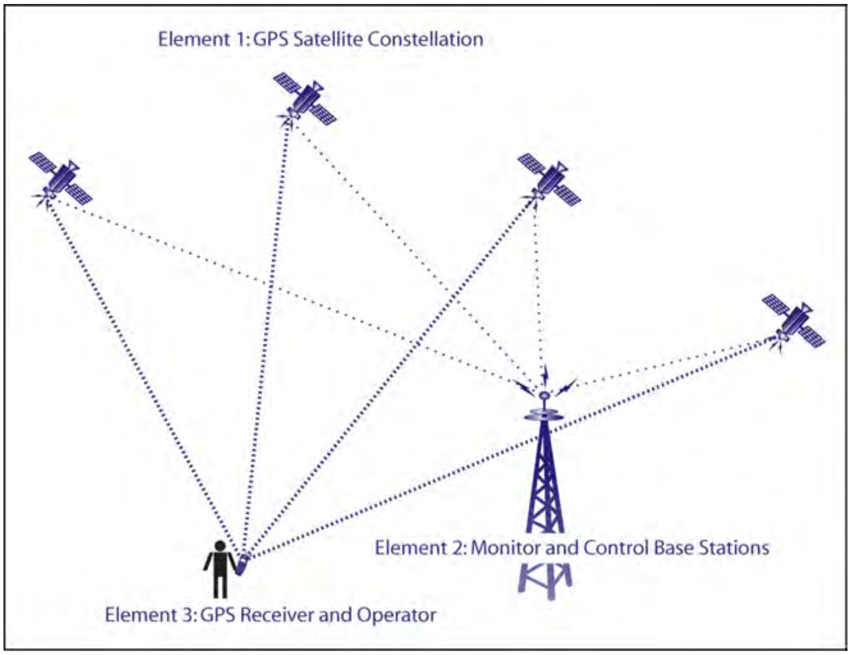
Objective 2: Basic understanding of compass use.
Compasses are provided by each monitoring team, so compass set up, operation, and maintenance are the responsibility of each team. Emphasis in USFWS training is on application to line distance sampling for desert tortoises.

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[1] was turned off. There are three basic elements to the system (www.gps.gov):



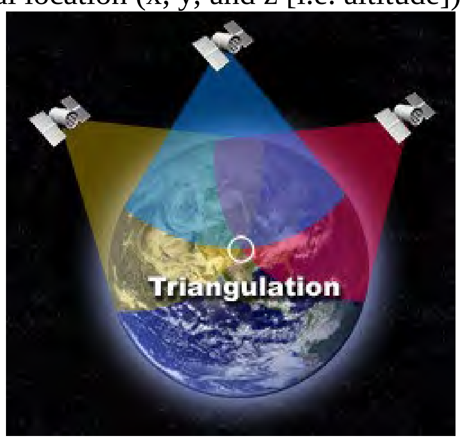
i. The space element is made up of a constellation of 24 operating satellites that transmit one-way signals of the GPS satellite's current position and time.
ii. The control element consists of monitor and control base stations around the world that ensure the satellites stay in their proper orbits and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

[1] 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.

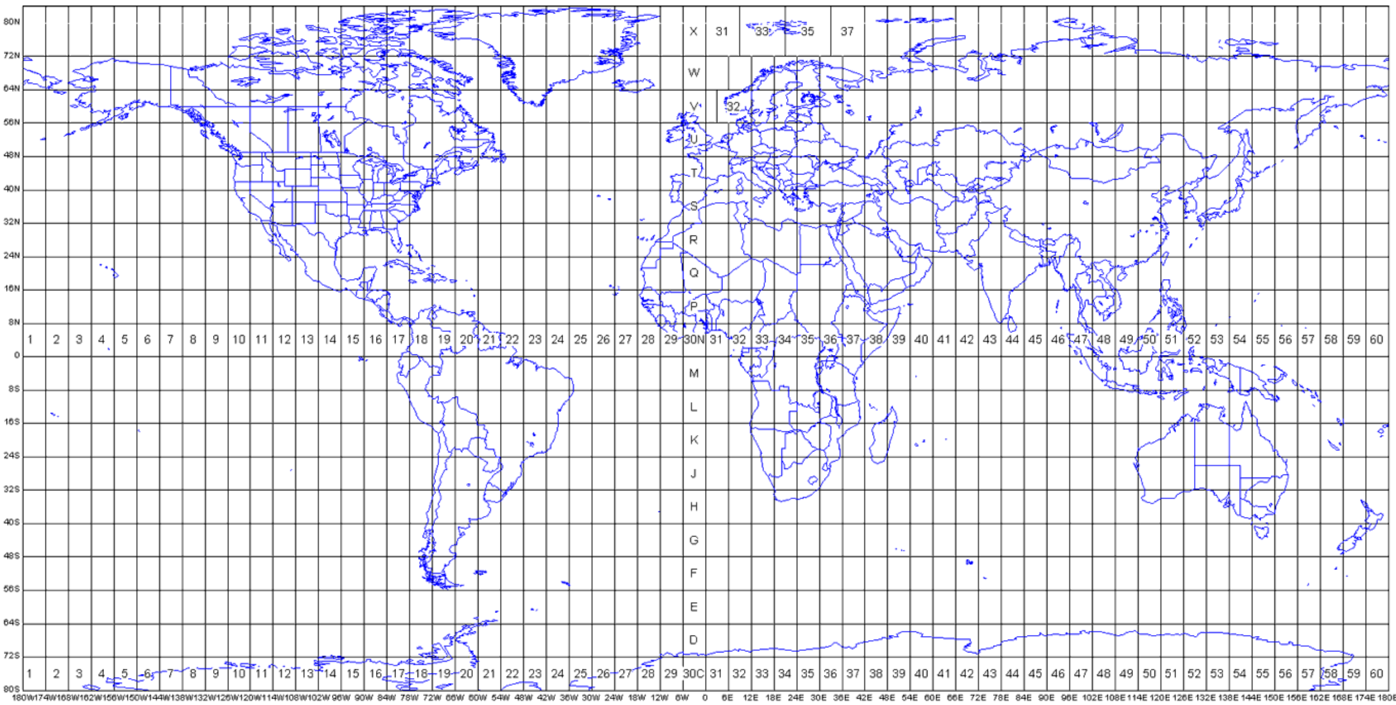
- How GPS works –
  i. Each operational GPS satellite circles the earth in a very precise asynchronous orbit twice a day, transmitting signal data to active, within-view GPS receivers.
  ii. The receiver uses the signal data to calculate the user's location through triangulation.
    - Triangulation 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.

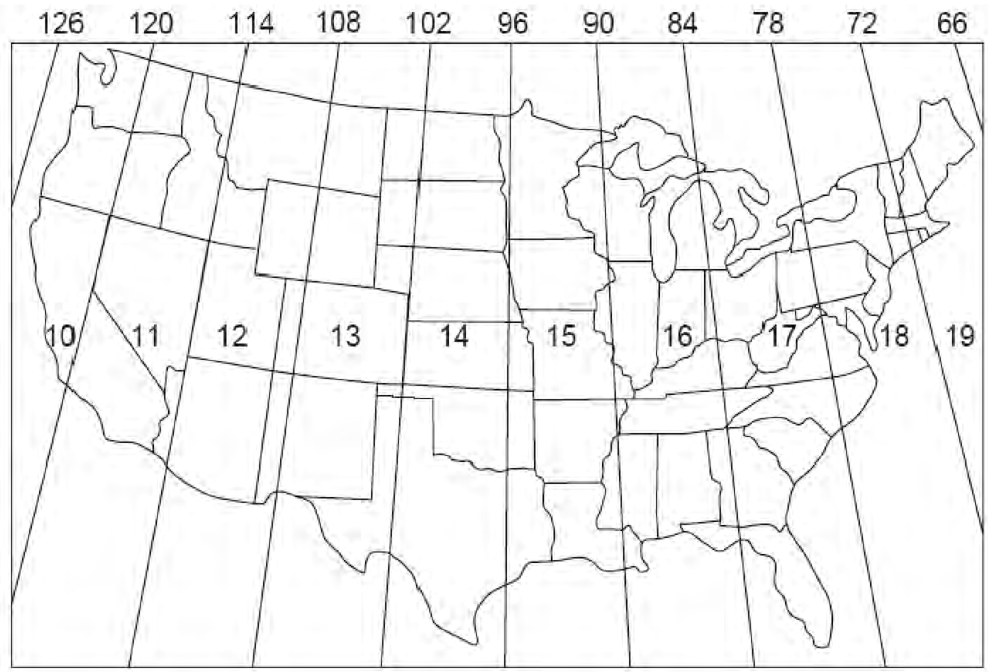
- With the UTM system, the earth is divided into 60 zones, numbered 1 (at the International Date Line) and proceeding east to 60. Each zone is 6 degrees of longitude wide.
- Each numbered zone is then divided into horizontal lettered bands that span 8 degrees of latitude, starting with C in the south 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 the Nexus phone. 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 five 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 Nexus phone grab – Compare electronic and navigational GPS coordinates to confirm validity of the electronic version. This comparison is important when

- Your Nexus phone has been off for more than an hour
- Your HDOP is six or more
- There are fewer than five available satellites
- The grab took an unusually long amount of time

v. Recording coordinate data if the integrated Nexus phone GPS grab does not work – At some point during your monitoring duties, your Nexus phone 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. 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 Nexus phone is used for one purpose only – to capture coordinate data in the electronic database.

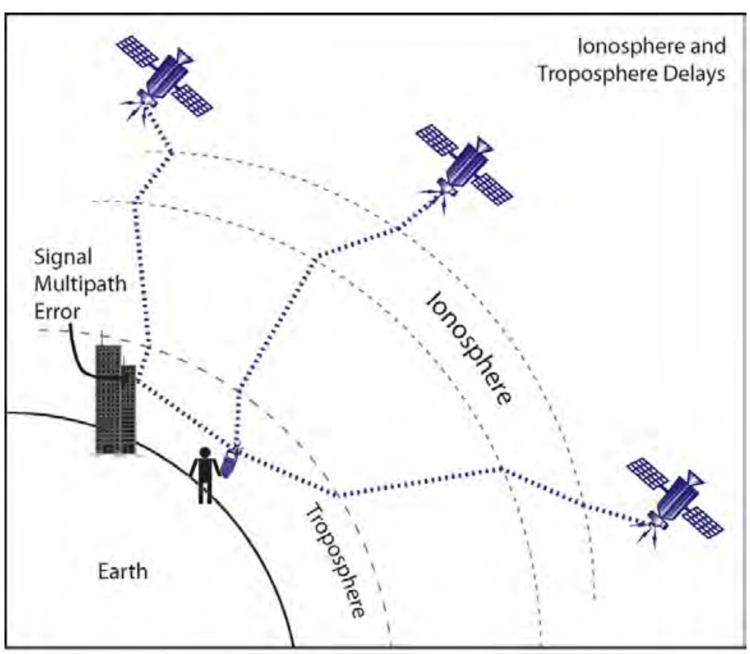
  i. You will use the Nexus phone unit whenever you record a waypoint, tortoise, or carcass.

  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).

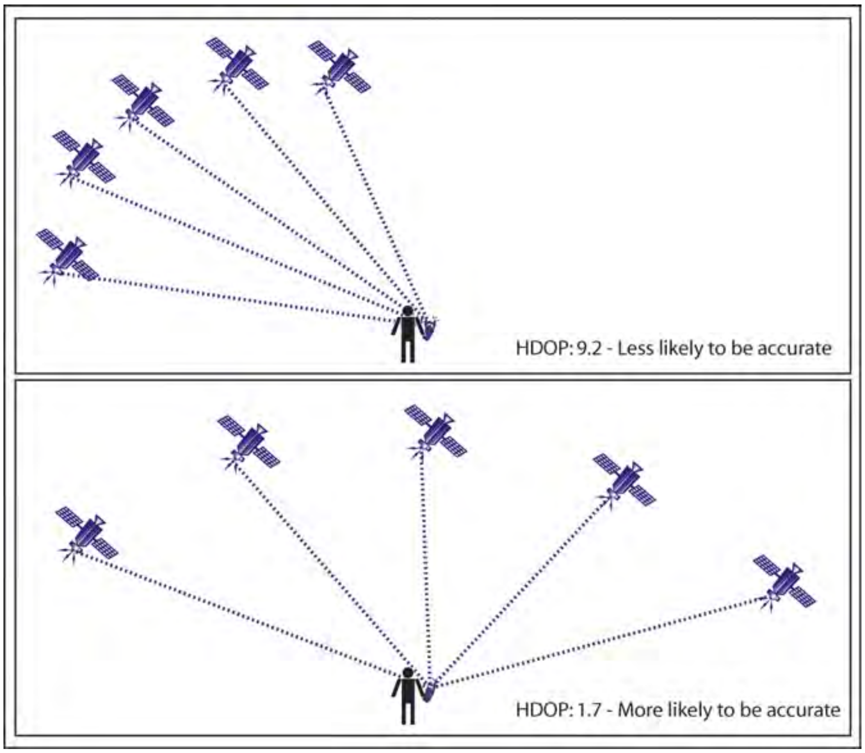


iii. Receiver clock errors occur when the built-in clock is not as accurate as the atomic clock on a GPS satellite, causing slight timing errors.

iv. Orbital errors occur when the reported location of a satellite is inaccurate.

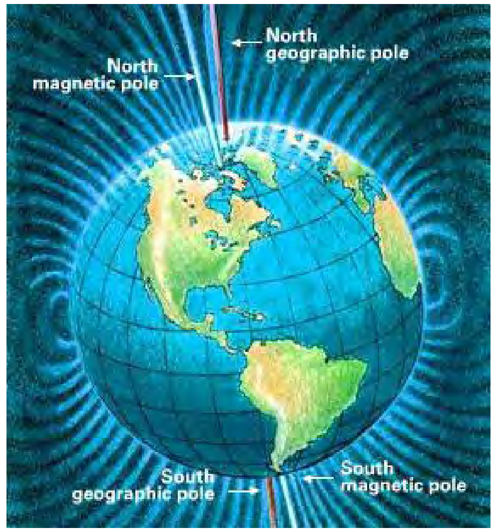
v. Number of satellites visible – The more satellites a GPS receiver has clear access to, the better its positional accuracy will be. Satellite signals are blocked or degraded by buildings, mountains, dense foliage, and other electronic signals, and typically do not work indoors, underground, or underwater.

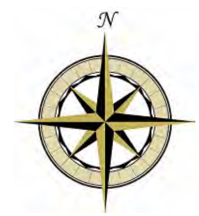
vi. Satellite geometry – The spread, or geometry, of satellites available to a receiver can affect the accuracy of a reading. When satellites are closer together in the sky, the reading is likely to be less accurate than one from satellites that are spread out. The goodness of satellite geometry is expressed most commonly as HDOP or PDOP (Horizontal or Positional Dilution of Precision):



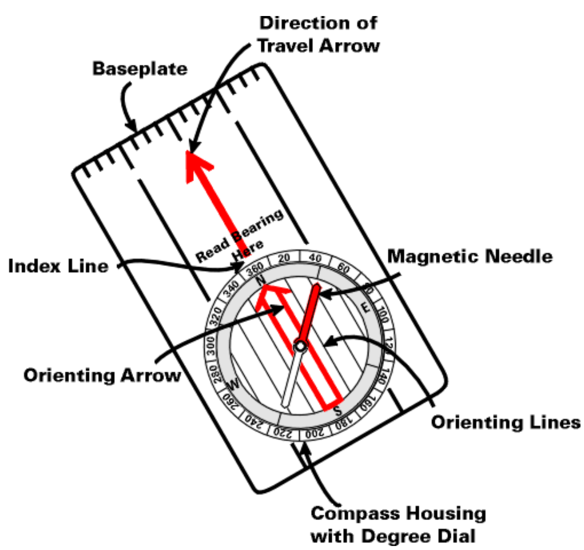
- Knowing what makes a signal go bad or get interrupted can help you get the best signal possible. Here are some other tips:
  - i. The receiver needs as clear a view of the sky as possible – since your body can block a signal, hold it out in front of you with your arm extended.
  - ii. Many navigational 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 Nexus phone 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.

Objective 2: Understanding Compass Basics



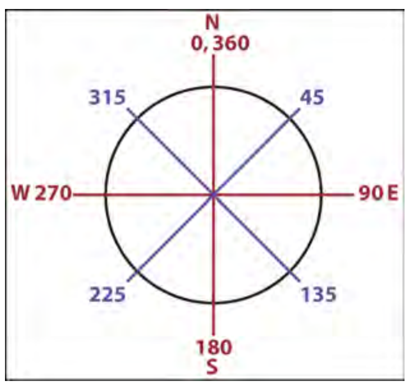


1. **Basic Compass Terminology and Anatomy**
   - **Bearing and Azimuth:** Bearing and azimuth refer to direction in degrees and are determined using your compass. For our purposes, bearing is the direction in degrees you walk along a transect, whereas azimuth is the angle from the line you are walking 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.

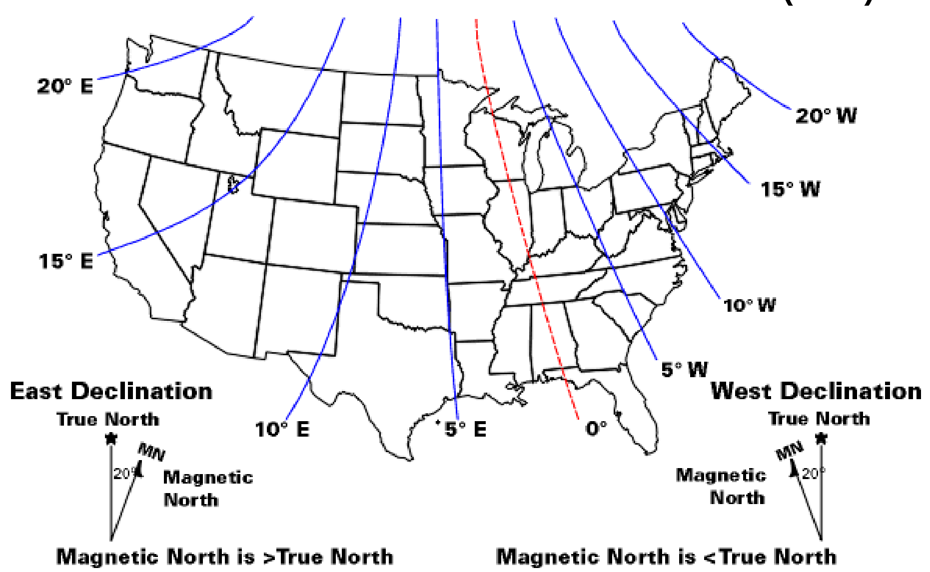
- **Read a Bearing from a Map:** Occasionally you may reflect a transect and travel in a non-cardinal direction. To read the correct bearing from the map, you will orient using the north arrow and base lines on the map.
  - **i.** Settle the baseplate of the compass on the map so that the compass housing 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:

General lines of declination in the United States (1998)



   - **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 US), 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. 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˚). Because the area around Las Vegas currently has a declination value of about 12 degrees east (+12), when your compass indicates 0° from magnetic north, you are actually traveling a bearing of 12° from true north (0 + (+12) = 12°)). To travel a true 0° path, subtract 12° from your planned bearing. Following a bearing of (360-12)=348° will compensate for declination and result in a true 0° 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:
    - **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

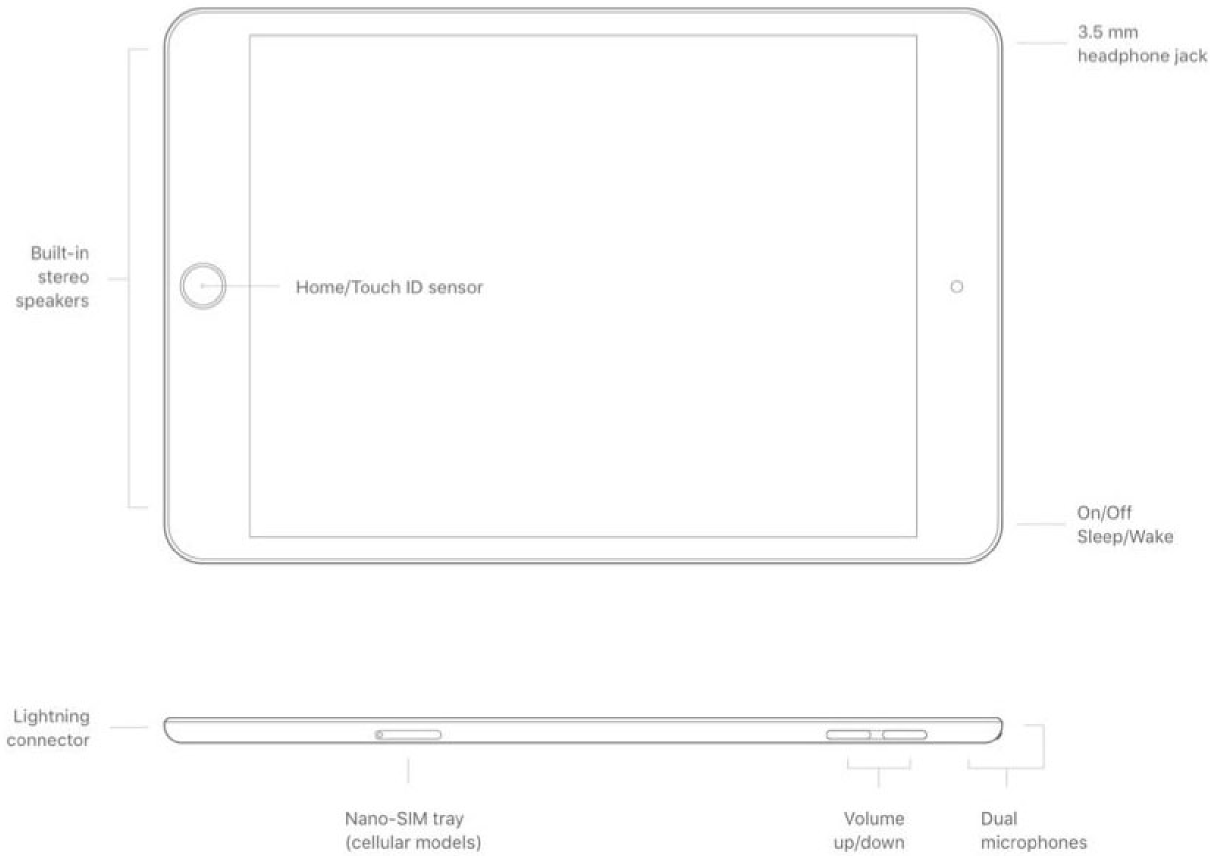
1. set up the iPad mini (e.g. charge, use battery saving settings, turn on/off, set date/time, and identify components of iPad mini)
2. navigate menus
3. maintain the iPad
4. troubleshoot common iPad mini problems through a restart.

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



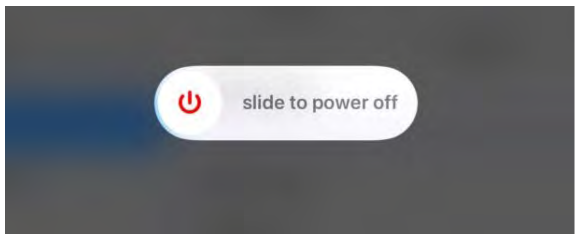
1. **Setting up the iPad mini**
    - **Components**
        i. the iPad mini itself,
        ii. AC adaptor cable used for charging,
        iii. Vehicle power adapter for charging

    - **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.

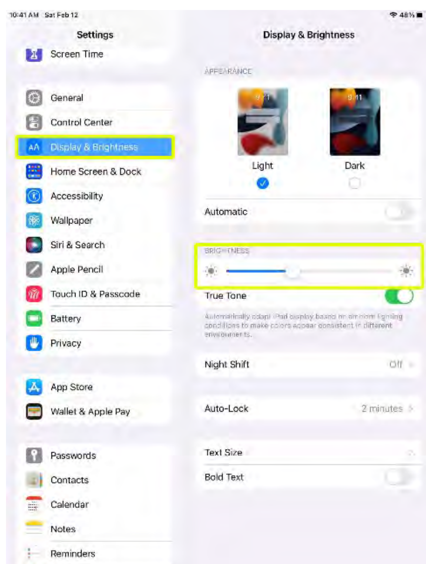
      To determine how full the battery is:
        i. Press the power button on the iPad mini

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 more. 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 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!

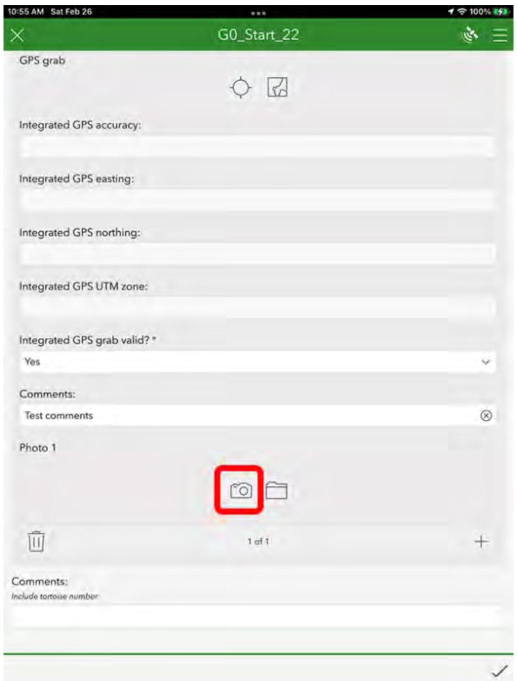
3. **Troubleshoot Common iPad mini Problems:** The typical way to troubleshoot a non-responsive iPad mini is rebooting it. If the problem persists, speak with your data specialist about possible solutions.

    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 2022” 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_2022.jpg
Waypoints	photo_to_wp_xplus1	Tranxxx.x_st_wpww_to_plus1_yyyy	Tran234.1_BW_wp21_to_plus1_2022.jpg
TranLiveObs	photo_tort1	Tranxxx.x_st_TLzz_1_yyyy	Tran012.0_BW_TL02_1_2022.jpg
TranLiveObs	photo_tort2	Tranxxx.x_st_TLzz_2_yyyy	Tran012.0_BW_TL02_2_2022.jpg
TranCarcObs	photo_carc	Tranxxx.x_st_TCzz_yyyy	Tran245.0_BW_TC12_2022.jpg
OppLiveObs	photo_tort	Tranxxx.x_st_OLzz_yyyy	Tran967.0_BW_OL05_2022.jpg
OppCarcObs	photo_carc	Tranxxx.x_st_OCzz_yyyy	Tran009.0_OC01_2022.jpg
G0_Obs	photo1	G0_site_tttt_yyyymmdd_FL_photo1	G0_OR_621_20220310_PF_photo1.jpg
G0_Obs	photo2	G0_site_tttt_yyyymmdd _FL_photo2	G0_GB_GBP-0051_20220421_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. 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.

METHODS

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 (in spring) and with annual mating cycles (in fall). 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 is most consistent and highest in the second week of the field season at this site (Fig. 5-4). 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, tortoise 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 transmittered 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.

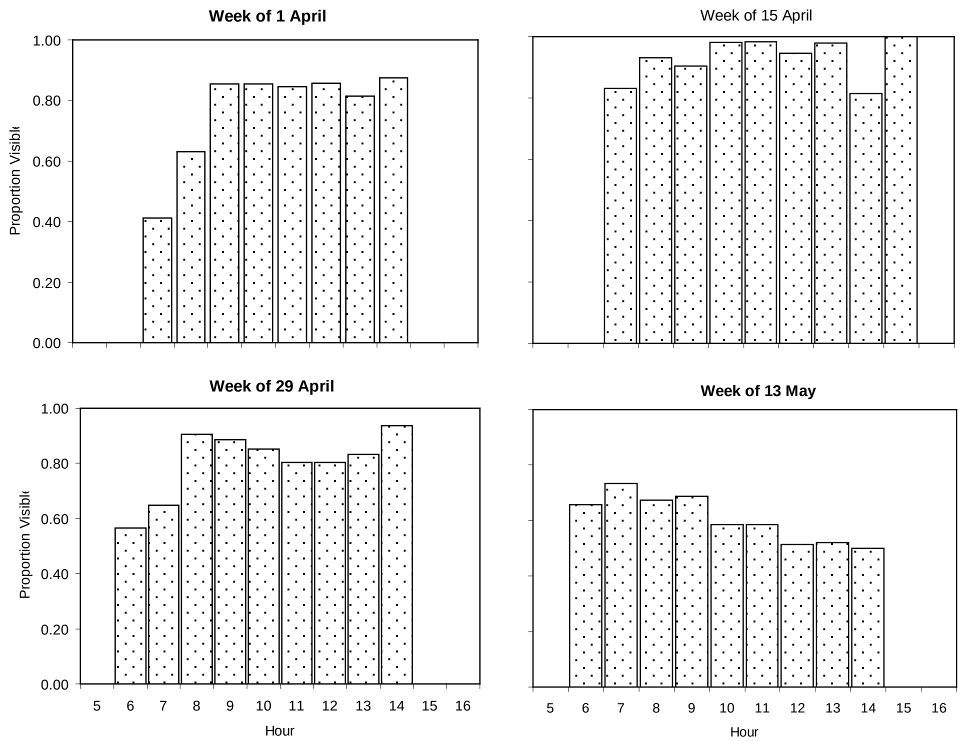


Figure 5-1. Proportion of tortoises at the Coyote Springs G_0 site that were scored "visible" after detection by radio receiver. Observations are graphed separately for each week and plotted for every other week of the monitoring season.

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.

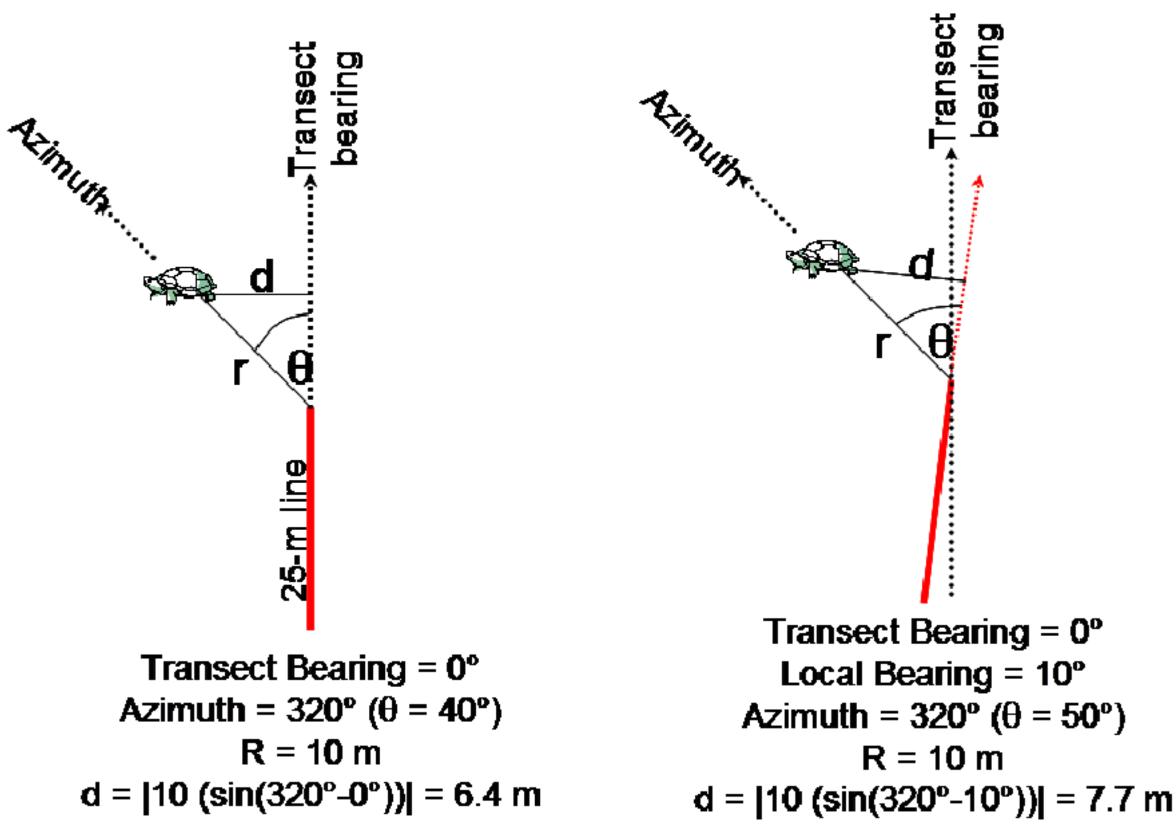


Figure 5-2. Schematic of position data collected to determine the perpendicular distance from a tortoise to the transect. The perpendicular distance, *d*, will be calculated automatically by the forms program in the Nexus phone.

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.

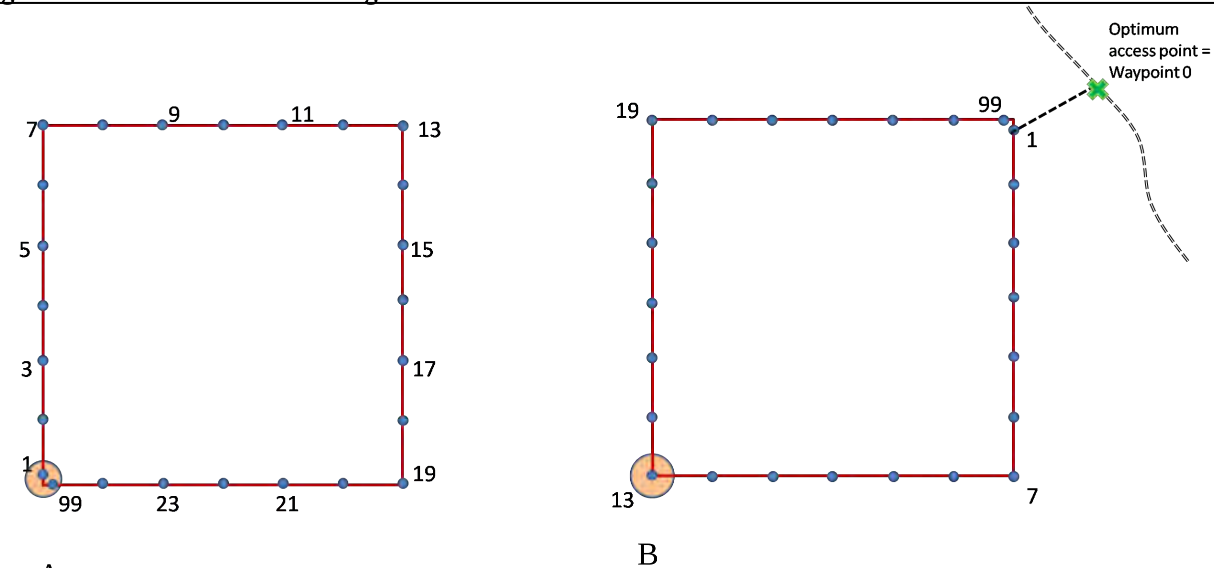
If a tortoise or carcass is detected between the ends of the 25-m line, perpendicular distance can be measured directly to the transect line on the ground. It is important to confirm that you are measuring the path at 90 from the line, but taking both the local bearing and azimuth would potentially add more measurement error. Instead, enter the [intended] transect bearing as the local bearing, enter a 90˚ azimuth to the transect bearing while also confirming this path to the line, and enter the perpendicular distance to the line as the radial distance. Check that the calculated perpendicular distance given by the Nexus phone is the same value as the radial distance you measured. Inaccuracies can also arise if the tortoise is detected only a couple meters in front of the 25-m line. In this case, continue walking the current bearing until the perpendicular distance can be measured to the tortoise using the simpler and less error-prone method above. In all other circumstances, use the 3-measurement method to estimate the perpendicular distance because movement by observers after an object (tortoise) is detected has been shown for other projects to add bias to density estimates.

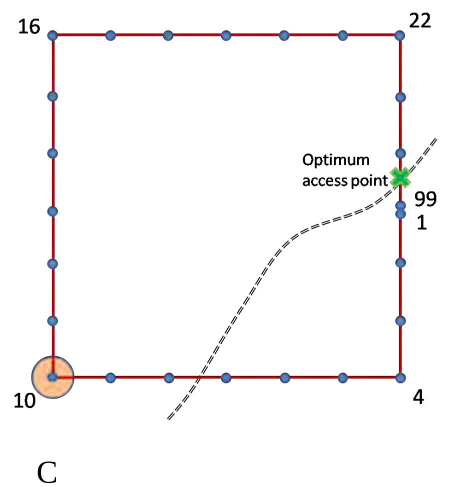
Objective 4: Implement Appropriate Techniques for Standard Transects

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

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.

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 a staff 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.

- 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 *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, the 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 (*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 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.
- When at least half of a tortoise carapace is located, or if any carapace 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, tortoises or carcasses 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.

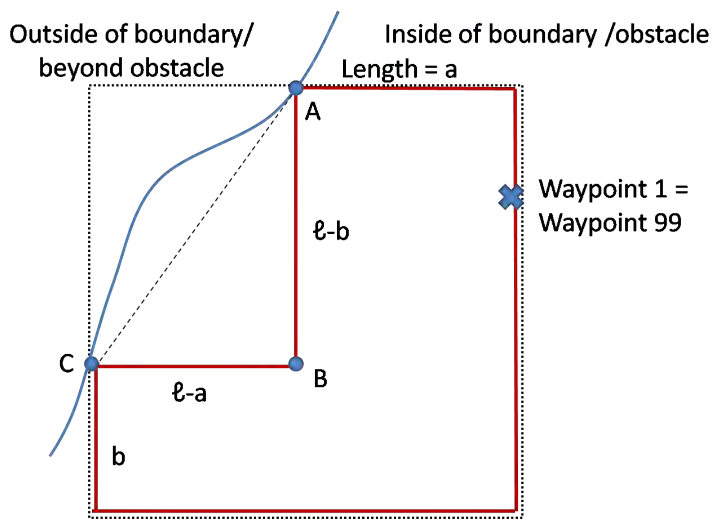
Objective 5: Implementing Protocols for Non-Standard Transects

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.

<u>Avoiding human infrastructure and administrative boundaries (12-km transects)</u>
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.)

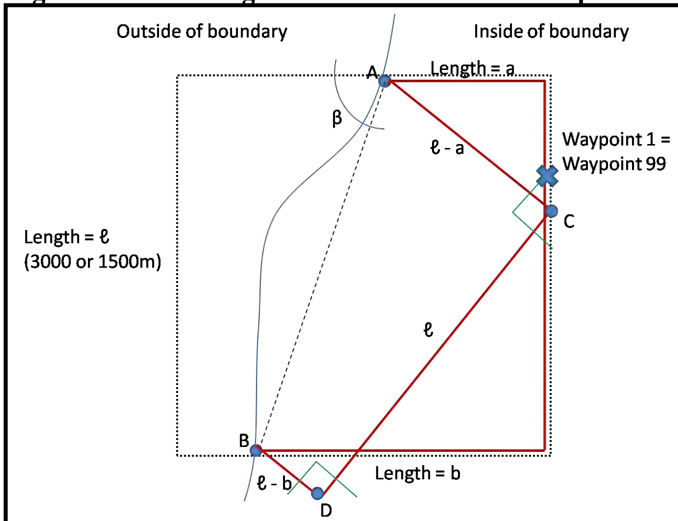
Transects should be rebuilt appropriately before the field season to move inside stratum boundaries and to one side of other identified obstacles listed above. Some structures are not indicated on our planning maps, so crews should understand the rules below and how to apply them when these situations 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.



The planned transect (dotted square) is reflected inside the boundary (blue line) to create a new transect (red line). Crews must be given distances “a” and “b” before starting, or must measure these themselves based on the easting and northing at Point A and at the corner before it (here, the northeast corner). The length of a side, ℓ, is usually 3000 m. Crews reorient at A, B, and C.

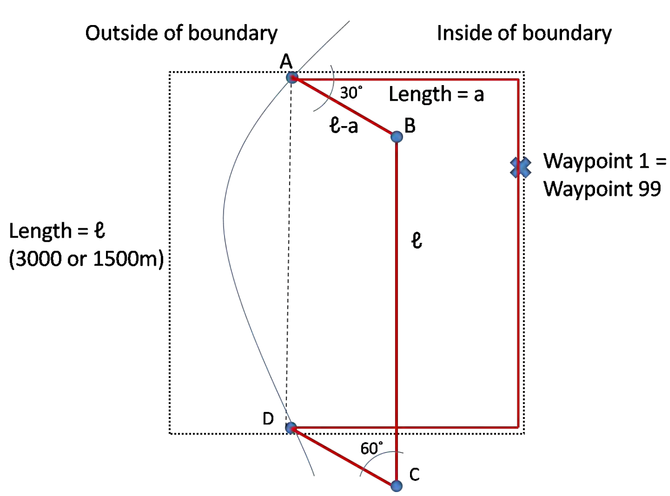
Figure 5-5. Reflecting two corners around an oblique boundary



The planned transect (dotted square) is reflected inside the boundary (blue line) to create a new transect (red line).

Crews must be given maps or planning materials with distances “a” and “b” before starting, as well as their new bearing at Point A. Crews reorient at A, B, C, and D.

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



The planned transect (dotted square) is reflected inside the boundary (blue line) to create a new transect (red line). Crews must be given distance “a” before starting. At Point A, they will reorient 30° south or west if the transect is odd-numbered. For the obstacle crossing from north to south in this example, the crew would walk south. They would reorient west for a boundary crossing east-to-west. (Crews reorient north or east if the transect is even-numbered.) Corresponding shifts must be implemented at Points B, C, and D.

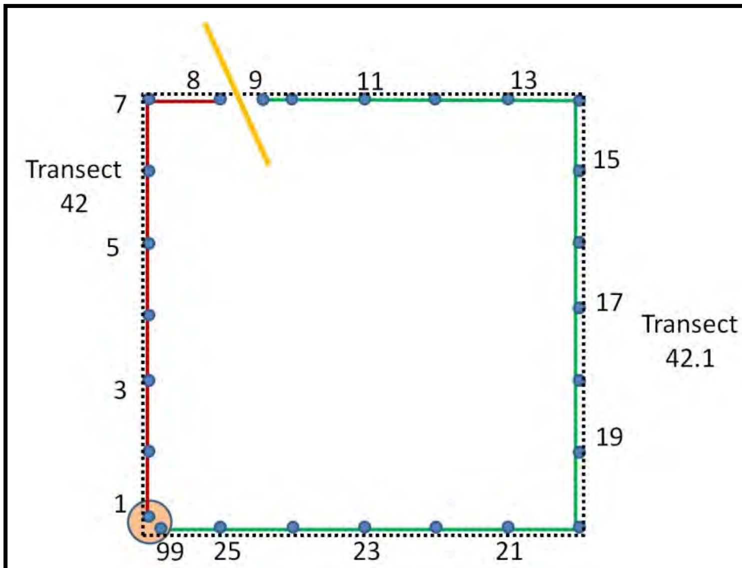
Sampling through rugged terrain

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 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.

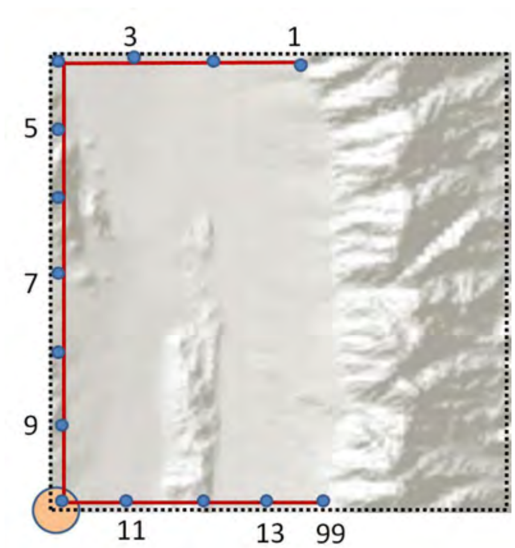
Figure 5-7. Interrupting a transect to move around a barrier. This diagram uses transect and waypoint numbers to match the example that follows.



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. Waypoint 99 is only used in the last segment (in this case, the end of Transect 42.1).

- 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 planned transect (dotted square) traverses impassable terrain or is through passable terrain but at such a slow pace that it cannot be completed before 4 pm. Consider a shortened version of the transect instead, following the original path and using interruptions to avoid impassable terrain (red line).

This approach should be used when it is anticipated that at least 6 km of the original 12-km path will be sampled. Crews may also need to further shorten the transect in order to return to their vehicles by 4 pm.

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, the Nexus phone will return you to the transect description section of the transect form. 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.

- For non-standard transects, you will identify the types of obstacles (terrain, substrate, other) that led you to modify the transect. Use the "other" field when a transect was modified to avoid an administrative boundary (e.g. stratum edge) or an uncrossable highway. 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. 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, tortoises or carcasses 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 "end_part" 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 "tran_standard=N", and will describe obstacles that shortened that segment. The final segment may indicate "trans_standard=Y" or "tran_standard=N," depending on whether it ends as planned, or at an obstacle. As with waypoints, 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 Nexus phone. 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

Transect 42

Waypoints 0, 1, 2, 3, 4, 5, 6, 7, and 8
At waypoint 8, end_part = Yes
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 tran_standard=No and provide the list of obstacles.

Transect 42.1

Waypoints 9, 10, 11, 12, and 13.
At waypoint 13, end_part = Yes
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 tran_standard=No and provide the list of obstacles.

Transect 42.2

Waypoints 14, 15, 99, and 100.
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
Waypoint 99 time 3:22 pm, end_part = No
End the transect record, enter tran_standard=Yes
All other regularly recorded transect information.

EXAMPLE – paper form

Transect 42

Waypoints 0 to 15, 99, and 100.
In the comment for Waypoints 8 and 13, indicate an interruption initiated.
In the comment for Waypoints 9 and 14, indicate Tran_num 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
A single transect sketch indicating all waypoints and observations, plus "42.1" and "42.2" written next to the waypoints where each new electronic form was started

6. Radio Telemetry and G_0 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 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_0 tortoises ("gee-sub-zero") for the mathematical term in the density equation that represents tortoise availability.

The primary goal of G_0 training is successful implementation of the G_0 protocol by telemetry crews. This includes correct use of telemetry equipment, understanding G_0 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_0 monitors will be proficient in using telemetry equipment to locate tortoises.
Standard: G_0 monitors will be proficient at collecting appropriate data.

Metric: G_0 monitors will use telemetry equipment to locate radio-equipped tortoises and will complete site-day 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.

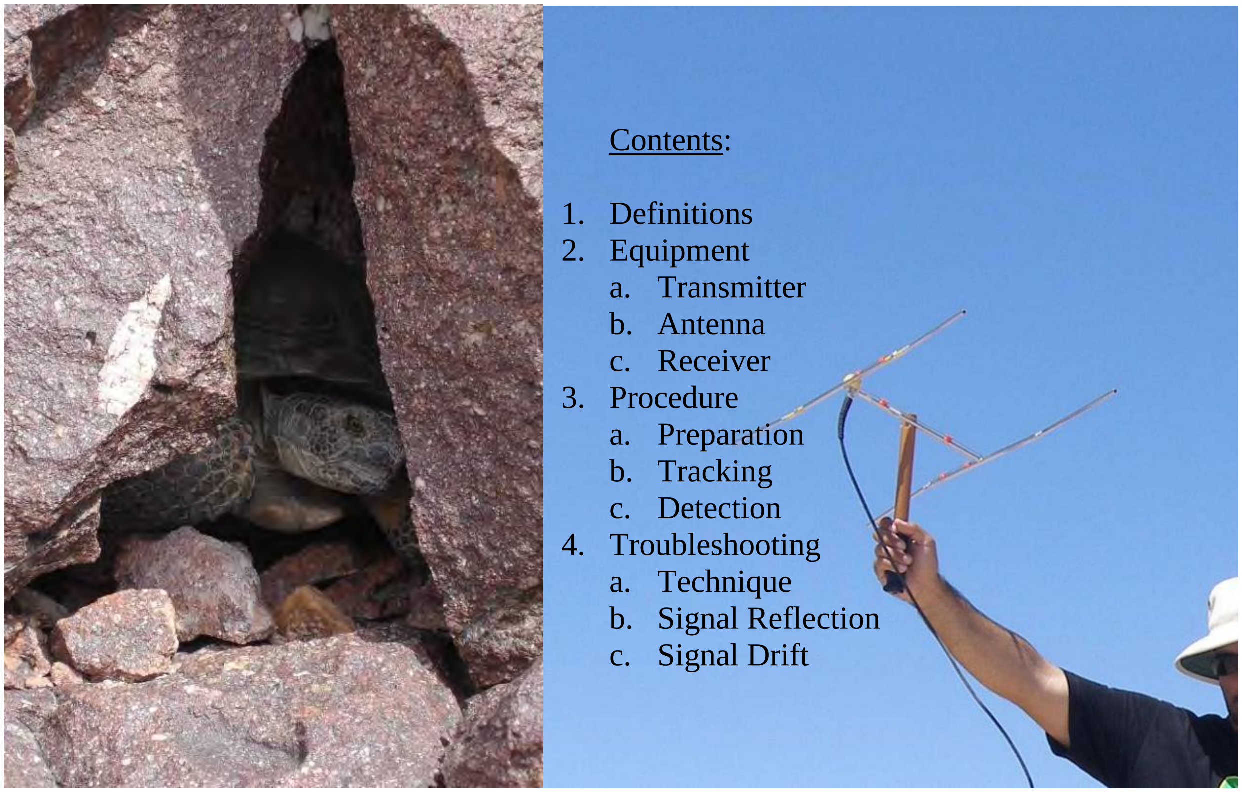
Refer to **Appendix I** for paper data sheets.

Objective 2: Implement the daily G_0 protocol.

Standard: G_0 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_0 site, 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 (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_0 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



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 164-168 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 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. While this antenna may be completely attached, more commonly it extends loosely behind the tortoise, reducing the epoxy mass and making the unit less cumbersome (see Figure 1).

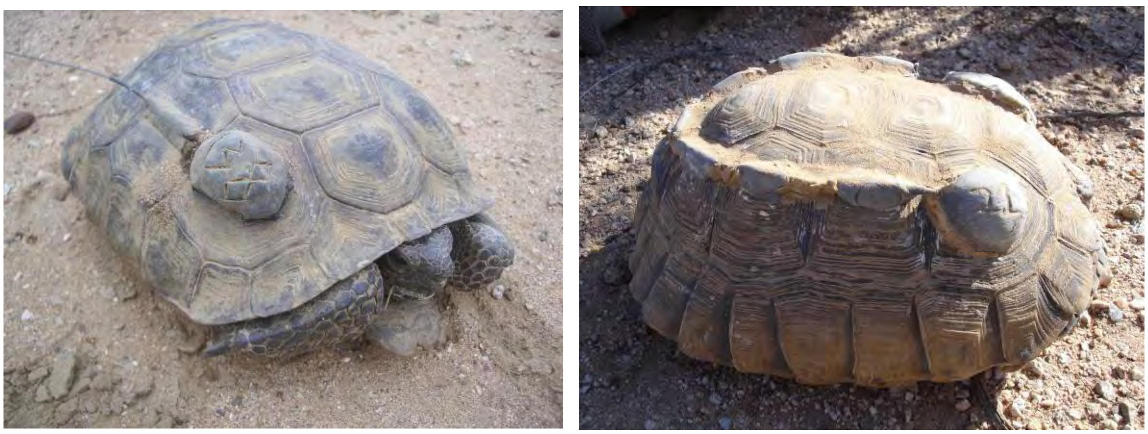


Figure 1. Examples of typical VHF transmitter attachment to desert tortoises.

Transmitters currently in use for LDS broadcast in the VHF frequency range, between 164-168 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 antenna (Telonics RA-2AK) is used, but other multi-element Yagi antennas exist. Each antenna is specifically tuned to a 2K 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.

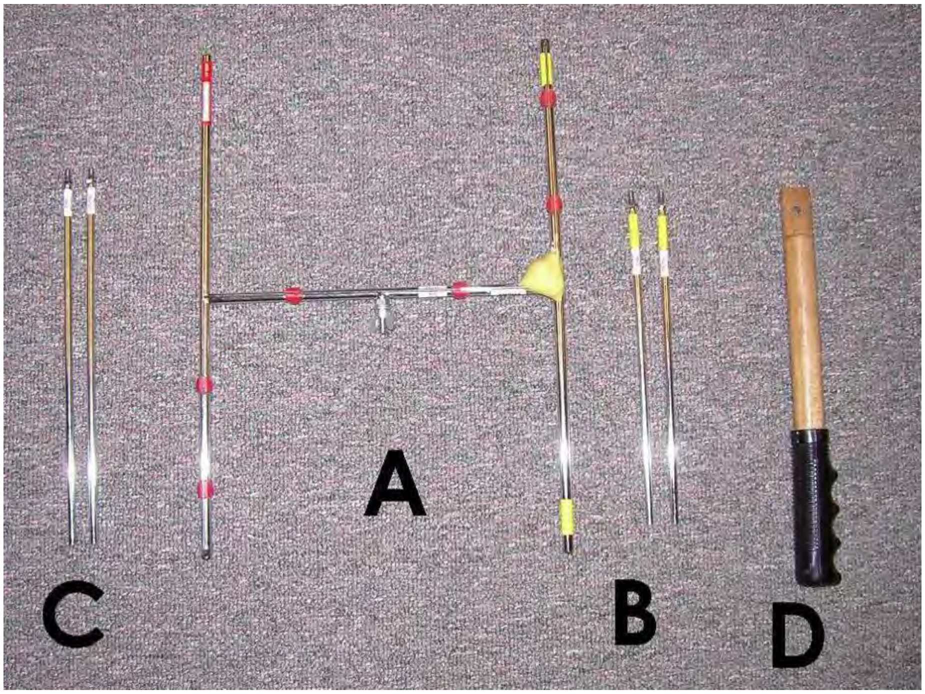


Figure 2. Telonics RA-2AK VHF 2 element Yagi antenna.

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, www.telonics.com.

Comparison	Icom IC-R10/R20	Telonics TR-2	Telonics TR-5
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
- PDA
- 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 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 Nexus phone 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.

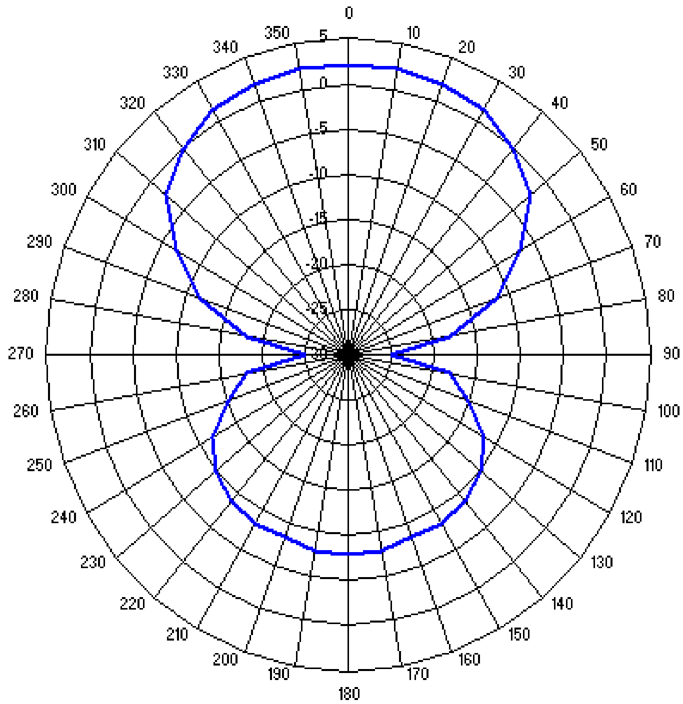


Figure 5. The listening footprint for an antenna held horizontally; northward (0°) sets the signal's source.

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, s/he 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 G_0 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 (in spring) and with annual mating cycles (in fall). 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 7am 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 “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 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

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 **Appendices I and II** for collection database dictionaries and 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

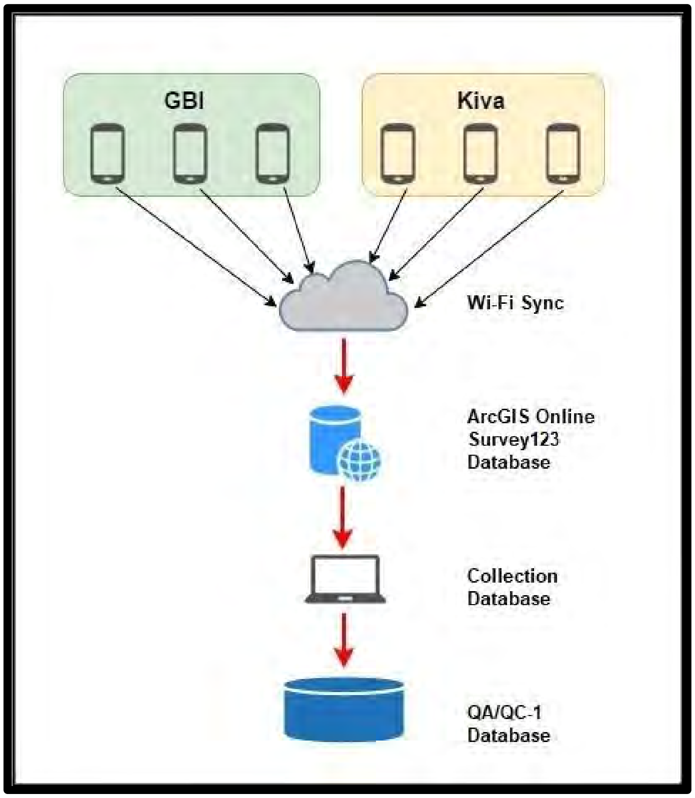


Figure 7-1

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 is checked to make sure it is the same on paper and iPad while it is 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.

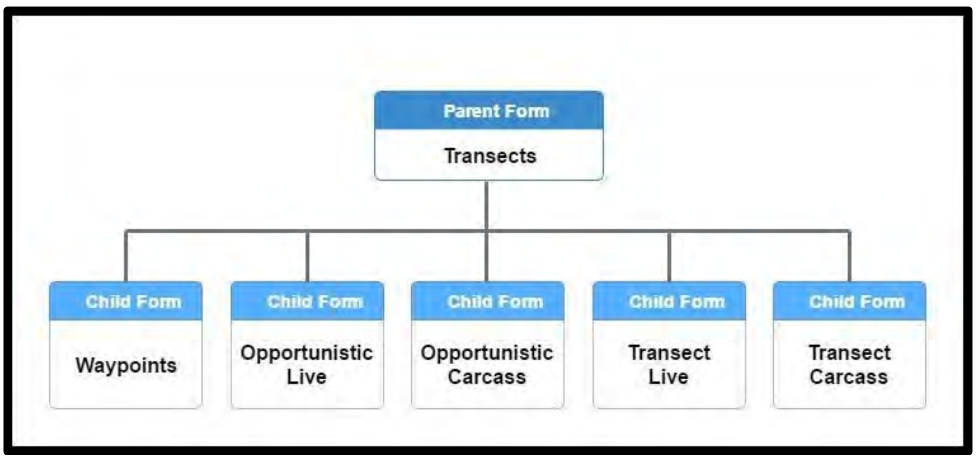


Figure 7-2

- 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.
    a. 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 ArcGIS username and password provided by your supervisor
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."

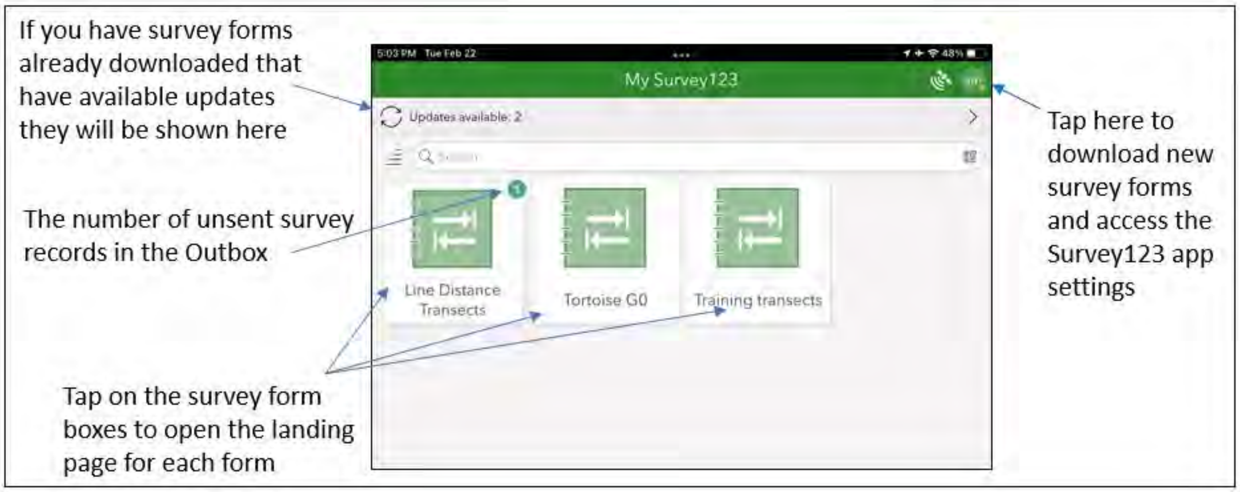


Figure 7-3

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 G0
  - 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 the Appendix for a detailed explanation of the purpose of each field in a form.

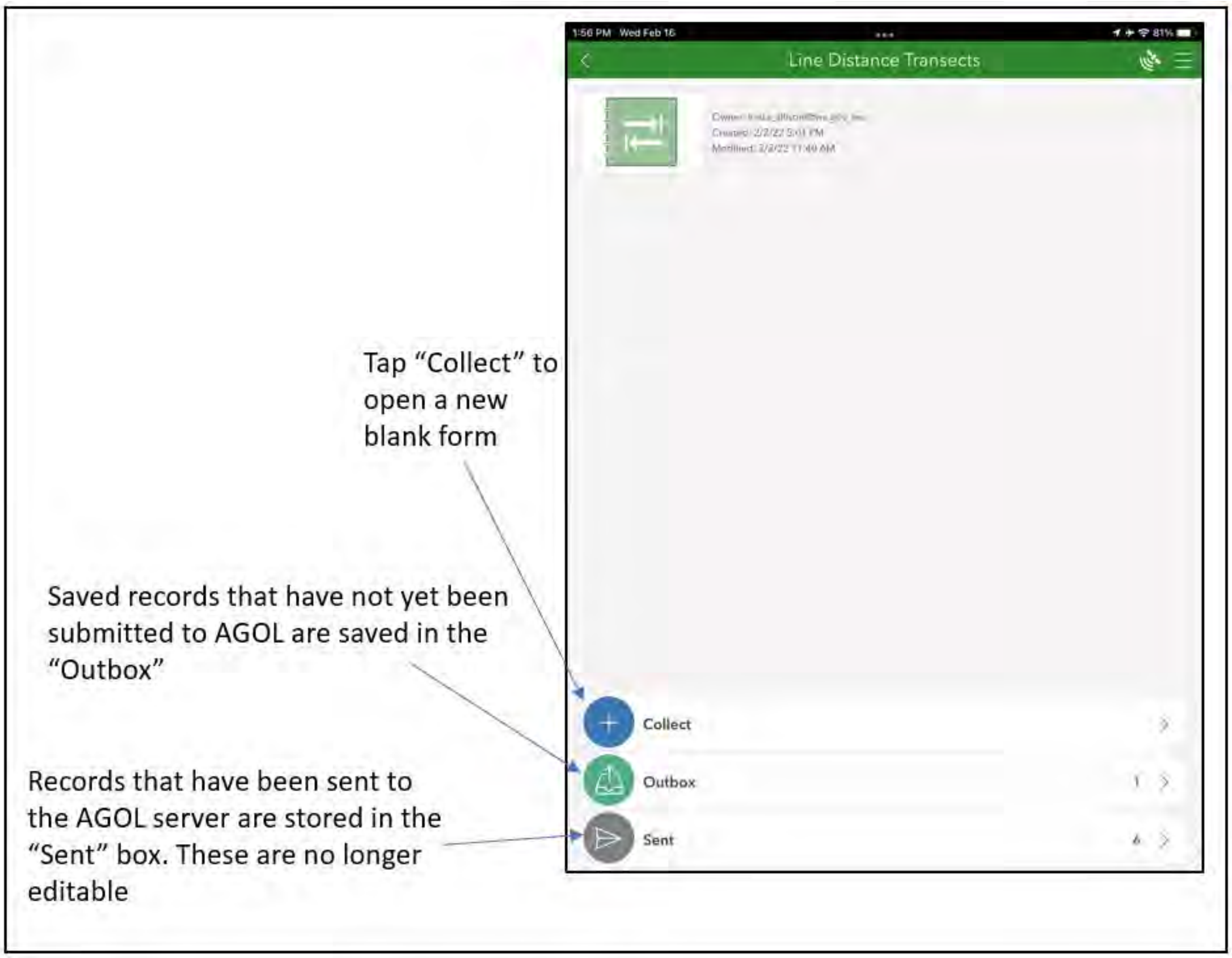


Figure 7-4

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).

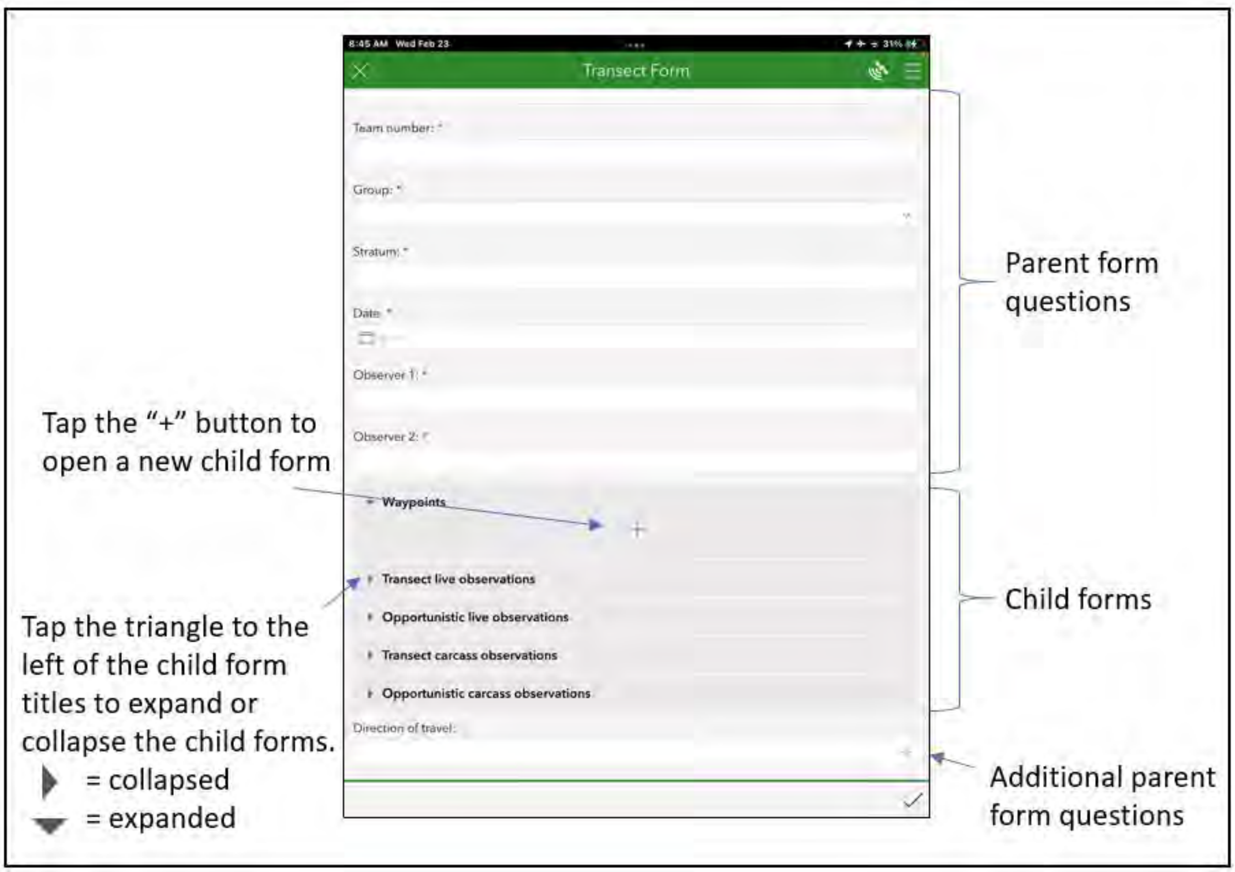


Figure 7-5

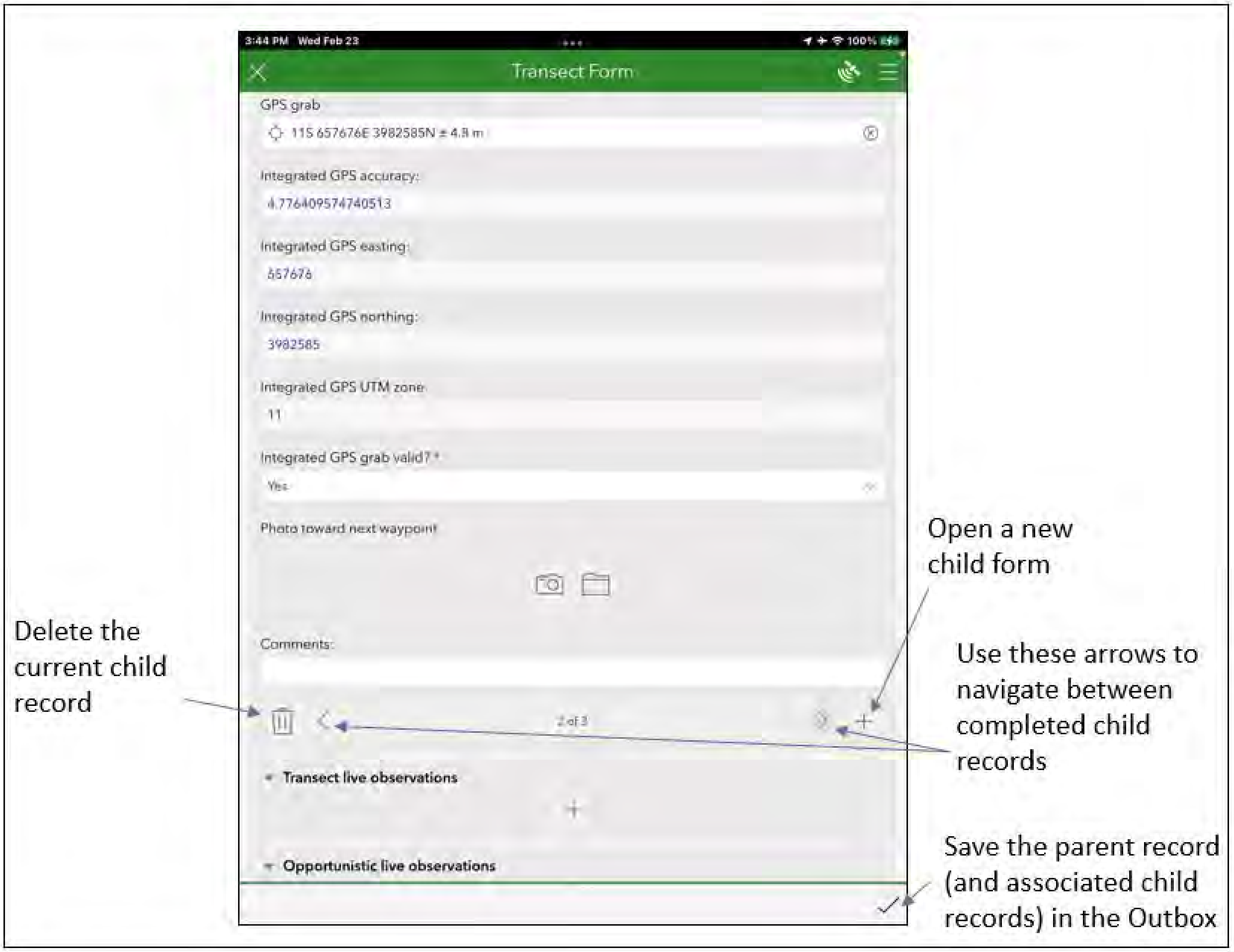


Figure 7-6

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 carcass you find 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.

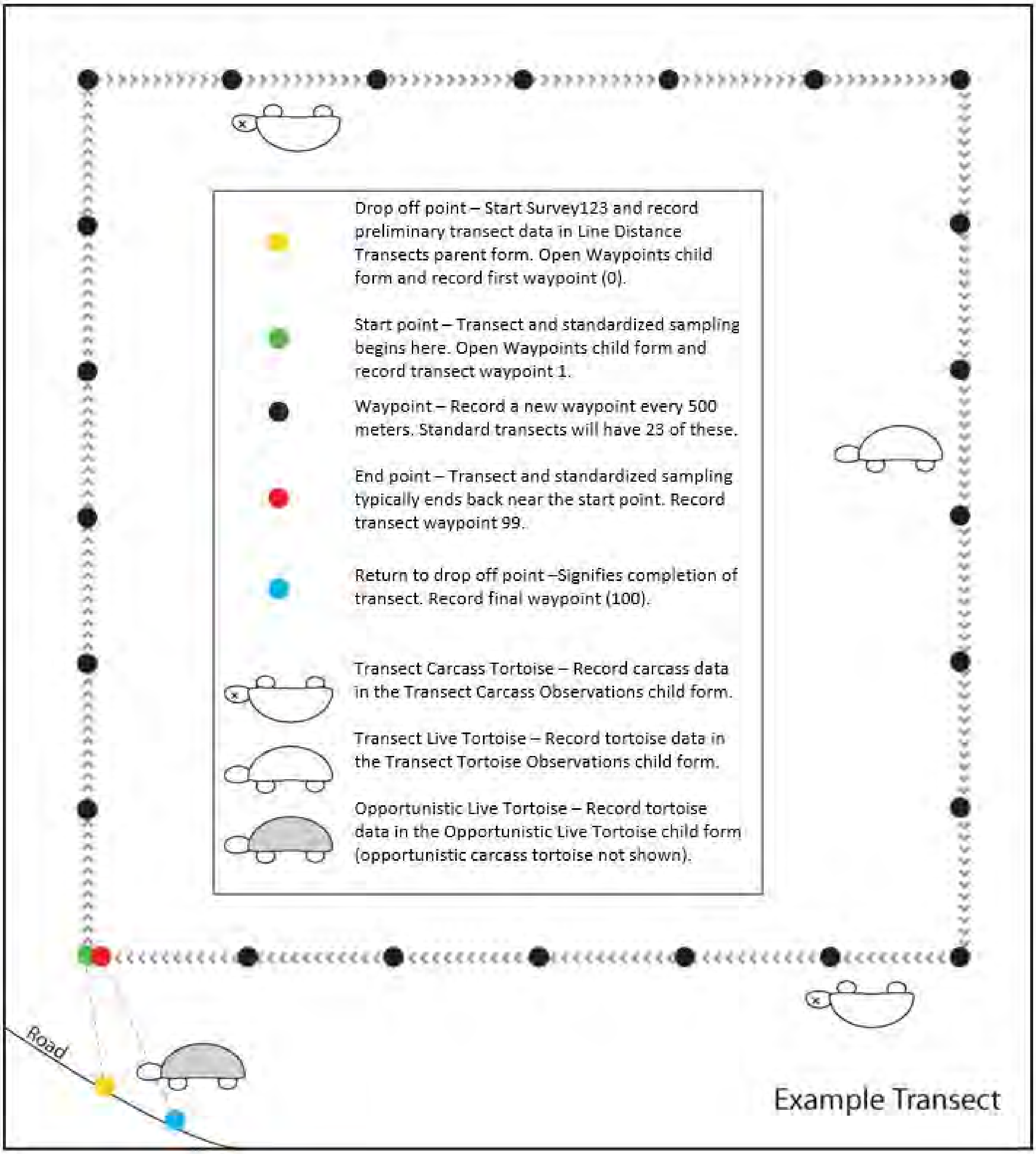


Figure 7-7

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 accidently 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.

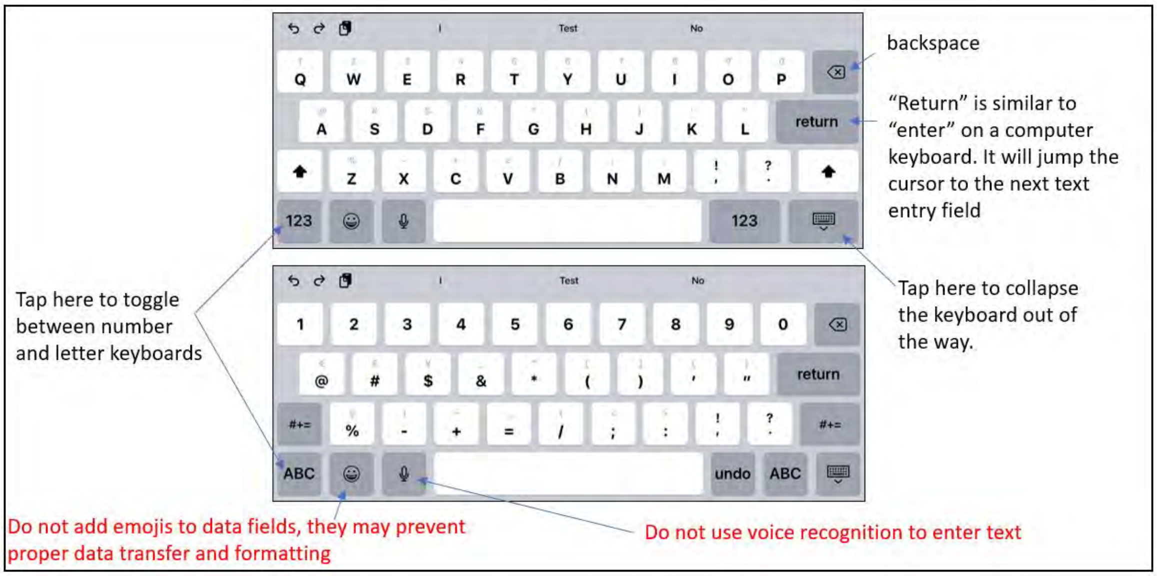


Figure 7-8

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 accidently 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.

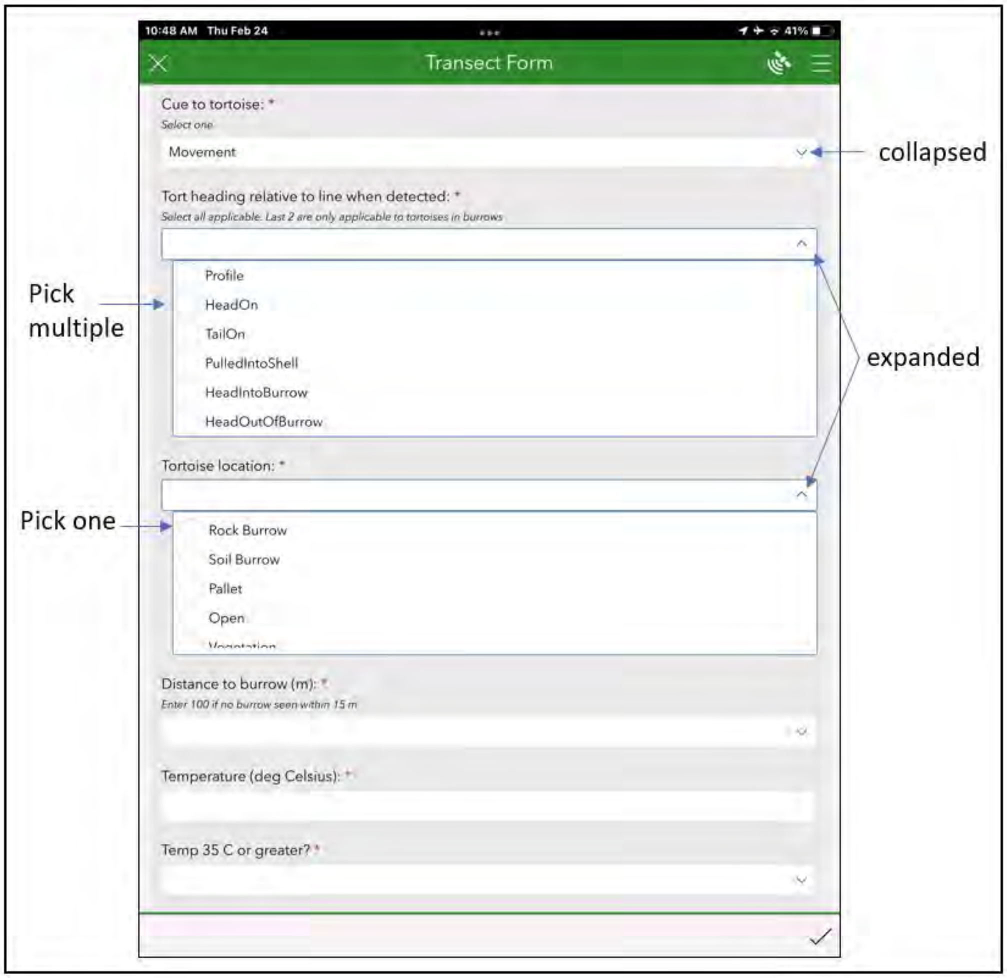


Figure 7-9

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).

Add a photo comment to describe all photos (these can be short). 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).

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.

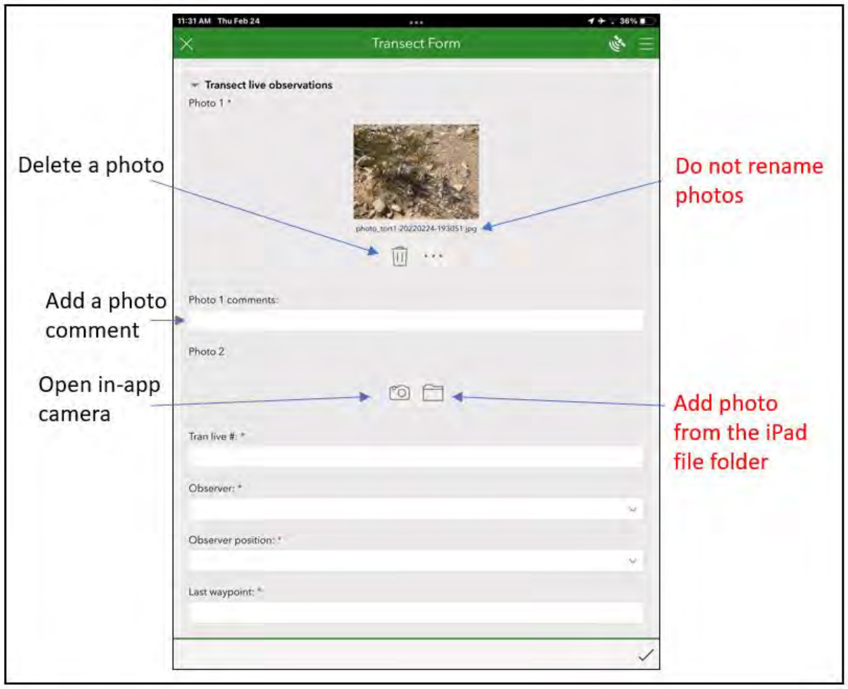


Figure 7-10

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 7-11). 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.

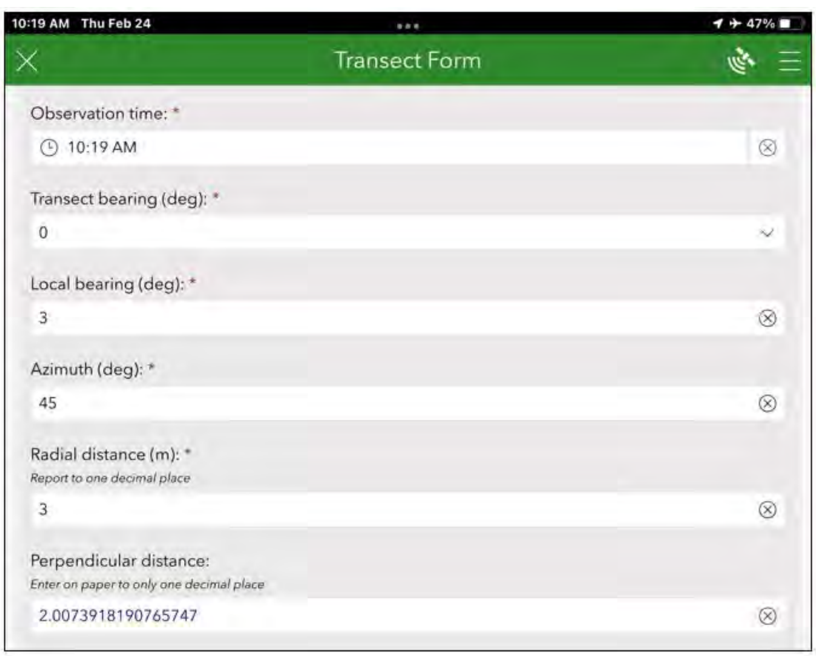


Figure 7-11

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.

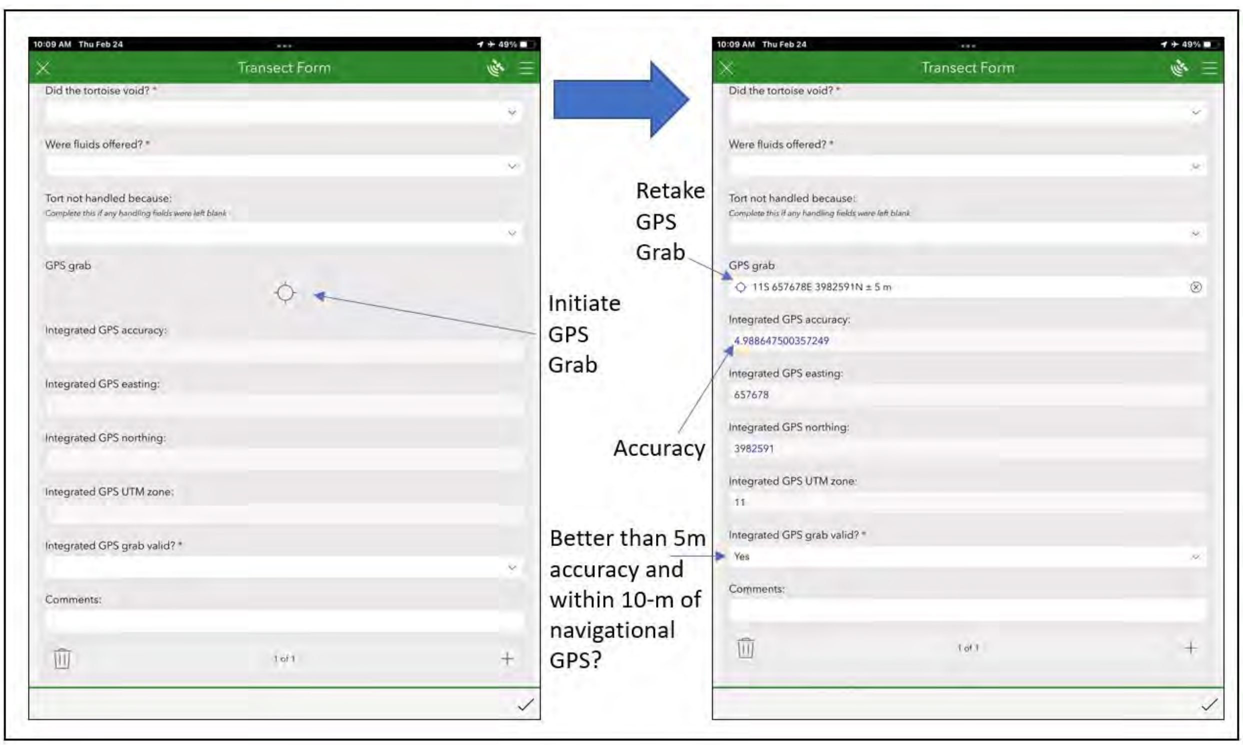


Figure 7-12

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 easting 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 the coordinates are within 20 meters of each other along both axes, you can mark the Integrated GPS grab valid field as "Yes." If the 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 purpose 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 accidently 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 accidently 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 insuring 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 GBI 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 last year's datasheet, but the comments and clarifications about legible and complete forms still apply.

Desert Tortoise Distance Sampling Transect Form (Waypoints 1)

Be sure to write stratum names in full on first page

Transect Num:	908	Team Num:	25
Stratum:	PV		Kiva (GBI)
			Matt Rothrock
Date:	13 April 2021	Observer 2:	Rachel Russell

Use letters for month! Can be abbreviated

Time:	37 (am) / pm	Easting:	0702445	UTM Zone:	(11) 12
		Northing:	3898462	GPS grab valid?	(Y) N

Waypoint 1 Time: 6:55 (am) / pm. Easting: 0702378. Northing: 3898640. UTM Zone: (11) 12. GPS grab valid? (Y) N. Photo to next waypt? (Yes) No. Photo comment:
Lead (to next): (Observer 1) / Observer 2
Comments:

Waypoint 2 Time: 7:07 (am) pm. Easting: 0701872. Northing: 3898643. UTM Zone: (11) 12. GPS grab valid? (Y) N. Photo to previous waypt? (Yes) No. Photo comment: Photo to next waypt? (Yes) No. Photo comment:
Burrow ct (from previous): 0
Transect interrupted? Y (N)
Lead (to next): Observer 1 / (Observer 2)
Comments: corner

Waypoint 3 Time: 7:28 (am) / pm. Easting: 0701895. Northing: 3899147. Photo to previous waypt? Yes (No). Photo comment: Photo to next waypt? Yes (No). Photo comment:
Burrow ct (from previous): 1
Transect interrupted? Y (N)
Lead (to next): Observer 1 / (Observer 2)
Comments:

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

Waypoint 4 Time: 7:42 (am) pm. Easting: 0701883. Northing: 3899657. UTM Zone: (11) 12. GPS grab valid? (Y) N. Photo to previous waypt? Yes (No). Photo comment: Photo to next waypt? Yes (No). Photo comment:
Burrow ct (from previous): 1
Transect interrupted? Y (N)
Lead (to next): Observer 1 / (Observer 2)
Comments:

Waypoint 5 Time: 7:54 (am) pm. Easting: 0701884. Northing: ~~3900148~~ 3900149. UTM Zone: (11) 12. GPS grab valid? (Y) N. Photo to previous waypt? Yes (No). Photo comment: Photo to next waypt? Yes (No). Photo comment:
Burrow ct (from previous): 0
Transect interrupted? Y (N)
Lead (to next): Observer 1 / (Observer 2)
Comments:

Waypoint 6 Time: 8:10 (am) pm. Easting: 0701874. Northing: 3900674. UTM Zone: (11) 12. GPS grab valid? (Y) N. Photo to previous waypt? Yes (No). Photo comment: Photo to next waypt? Yes (No). Photo comment:
Burrow ct (from previous): 0
Transect interrupted? Y (N)
Lead (to next): Observer 1 / (Observer 2)
Comments:

Waypoint 7 Time: 8:23 (am) / pm. Easting: 0701883. Northing: 3901141. UTM Zone: (11) 12. GPS grab valid? (Y) N. Photo to previous waypt? Yes (No). Photo comment: Photo to next waypt? Yes (No). Photo comment:
Burrow ct (from previous): 0
Transect interrupted? Y (N)
Lead (to next): Observer 1 / (Observer 2)
Comments:

Waypoint 8 Time: 8:34 (am) / pm. Easting: ~~0701817~~ 0701879. Northing: 3901631. UTM Zone: (11) 12. GPS grab valid? (Y) N. No. No.
Burrow ct (from previous): 0
Transect interrupted? Y (N)
Lead (to next): (Observer 1) / Observer 2
Comments: corner

Use a simple strike through for edits

Comments (include waypoint number):

Data recorded by: Matt Rothrock

Data proofed by:

Page 1 of 4

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.

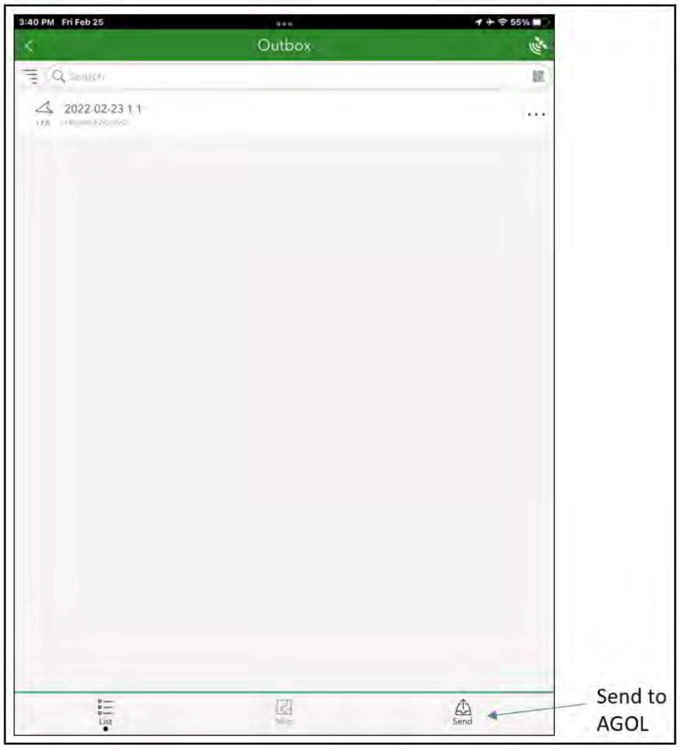


Figure 7-13

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 7-14). 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.

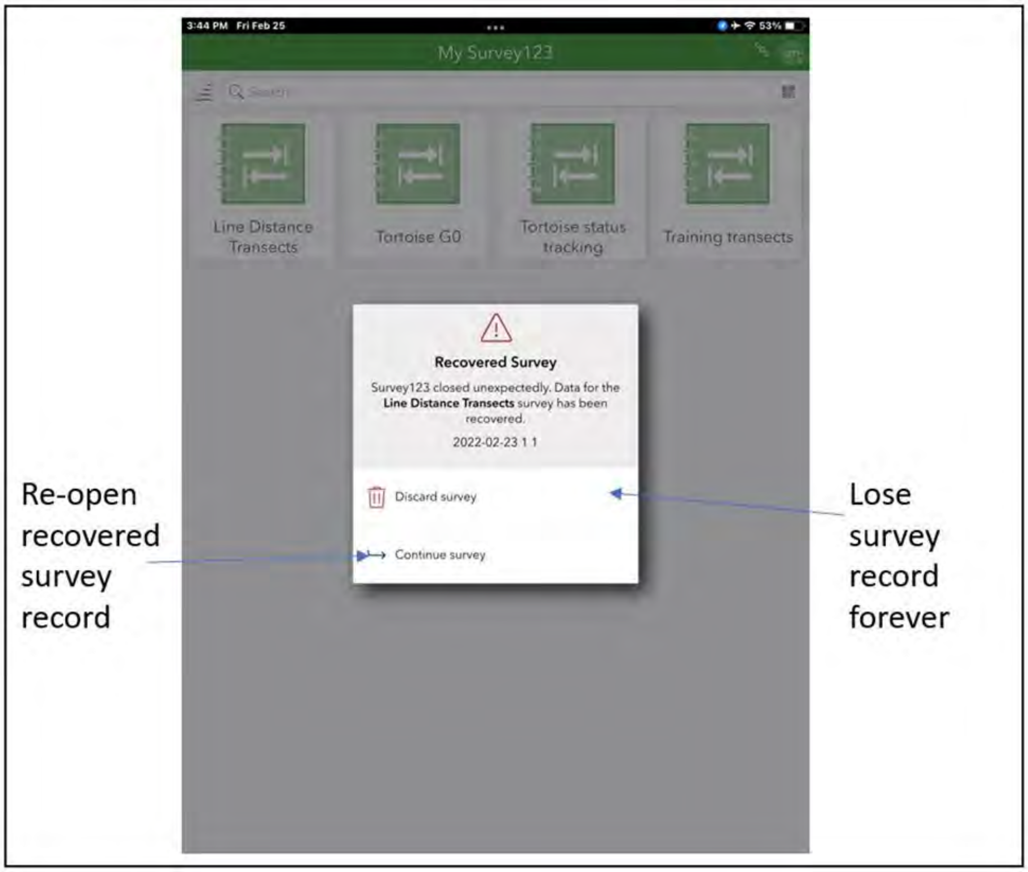


Figure 7-14

2. **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 7-15).

   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.

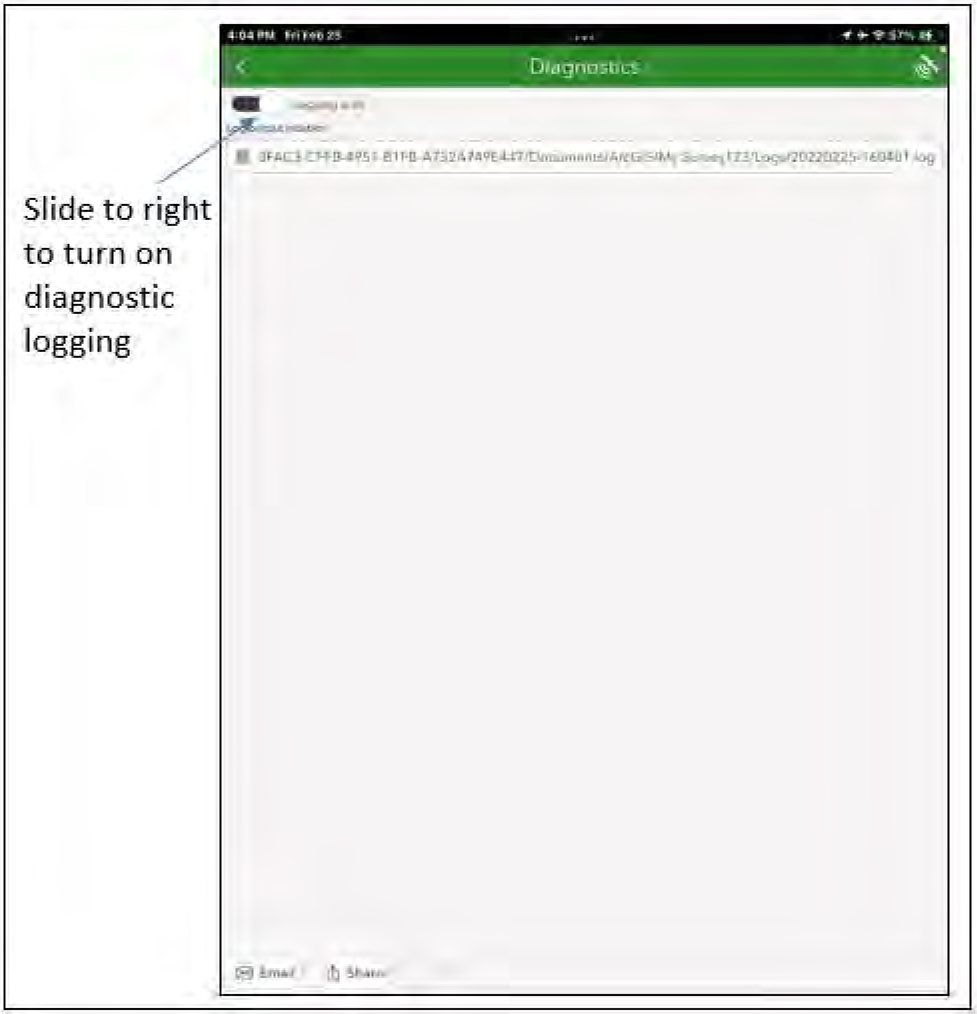


Figure 7-15

APPENDIX I: ANNOTATED PAPER DATA SHEETS

Desert Tortoise Distance Sampling **Training Transect Form**

Trial Number		Transect Bearing	35 °	215 °	Group:	Kiva GBI
Team Number		Transect Segment Num:				
Training line color	Red Yellow Magenta	Training Date:			Lead:	
	White Orange Green	Train Start Time:			Follow:	
Starting Post	A B C D E F	Training End Time:				
	G H I J K L	Comments:				
Observation Time:		Original observation	from line	Azimuth: °	Tortoise Size:	Adult
Observer Name:			while at another model	Radial Dist: m		Immature
Observer Position:	Lead Follow	Local Bearing:	°	Perpendicular Dist: m	Tortoise ID:	
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 Juno. If the number is incorrect or does not display, recheck your LineColor, StartingPost, and TransectBearing

Observation time

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

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".

Radial Distance

Enter only to one decimal place (tenths of a meter).

Perpendicular Distance

The former is entered; the latter 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 RDA 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_0 Start and Obs Form

Date:		Site:	
Group:	GBI Kiva	Observer:	
Comments:			

Transmitter freq:		Tortoise location:		Behavior:		GPS grab valid?	
Tortoise Num:		RockBurrow SoilBurrow		Agonistic AtRestActive			Yes No
Time:		Pallet Open Vegetation Rock		Basking Digging			
Tort Visible?:	Yes No	Burrow Visibility:	High Med Low Not	Eating RestingEyesClosed		Easting:	
Dist to burrow:	m	Tort in Burrow Visibility:	High Med Low Not	Mating Moving		Northing:	
		Tortoise visibility	High Med Low Not	Unknown		UTM zone:	

Photo 1:	Yes No	Photo 1 comments:	
Photo 2:	Yes No	Photo 2 comments:	
Comments:			

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, the distance is "0". Use "100" if you do not see a burrow within 15m of the tortoise.

Tortoise location:

SoilBurrow - Dirt constructed hole. A tortoise in a burrow is at the mouth of the burrow, deep inside, or anywhere in between.
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.

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. 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.

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 in soil or rock burrows).

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.

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.

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. 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.

Photo 1

Photo 1 comments

The Yes/No field is to indicate whether each of the 4 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 provide helpful information to interpret the photo.

Desert Tortoise Distance Sampling **Transect Form (Waypoints 1)**

Transect Num: ______ Team Num: ______ Group: Kiva GBI

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: ______
Transect interrupted? Y N UTM Zone: 11 12
GPS grab valid? Y N

Comments: ______

Waypoint 100 Easting: ______ UTM Zone: 11 12
Time: am / pm 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)**

Team: ______ Date: ______ Stratum: ______ Transect Num: ______

Transect Summary

Direction of Travel: Clockwise / Counterclockwise

Transect Standard? Y N

Unplanned modification? Y N

Terrain Obstacles: Mountainous Cliff Deep Washes Prohibited Access Major Road Boundary Time

Substrate Obstacles: Rock Gravel Tallus Sand

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):

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 "Waypoint 99" - 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 Waypoints1 transect form. On the continuation pages, the appropriate abbreviation can be used.

Date

Whatever the iPad reads, the paper entry should be written 31 Apr 2022. Use an abbreviation instead of numbers for the month.

Waypoint 0

The location where the crew left their vehicle. 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. If you arrive at this point early, time should not be recorded until you are about to leave for Waypoint 2.

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. 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. 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

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.

Easting
Northing

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

In the iPad, start with a GPS grab. If that fails or is more than 20 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.

GPS grab valid?

If the integrated GPS differs from the navigational GPS by more than 20m, try regrabbing; otherwise, indicate the grab was invalid and enter the navigational (manual) GPS coordinates. Compare the integrated and navigational GPS units if…

The iPad has been off for more than an hour

the location accuracy is greater than 5.0

There was anything unusual, such as an unusually long grab

UTM Zone

Only entered by hand in the iPad if a manual GPS grab was required

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.

Transect standard?

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

Interrupted tran?

Record whether you have interrupted the transect so that you used more than one electronic transect record to collect the data for this transect.

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

Substrate obstacles

Only complete this field if you identified a non-standard transect. Only substrates that affected 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 human-built obstacles. "Prohibited access" is a

Directions to transect

This information is only on the paper sheet, not on the iPad, so it very important.

Drawing of transect

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

Desert Tortoise Distance Sampling Transect Form (TranCarcObs)

Tran Num:		Stratum:		Team Num:		Date:	
Tran Carc #:		Transect Bearing:	0º 90º 180º 270º	Carcass Condition:	Intact D/A	**GPS location**	
Observer:	1 2	Other Tran Bearing:	º	MCL ≥ 180?	Yes No Unk	Easting:	
Obs Position:	Lead Follow	Local Bearing:	º	MCL (mm):		Northing:	
		Azimuth:	º	Sex:	M F Unk	UTM Zone:	11 12
Last Waypoint:		Radial Distance:	m	Existing Tag:	Yes No U/R	GPS grab valid?	Yes No
Observation Time:		Perpendicular Dist:	m	ET Number:			
				ET Color:	B W G	Photo taken?	Yes No
				Other Tag Color:		Comments:	
Azimuth:	º	ET Color:	B W G	Comments:			
Comments:							

Opp Carc #

Remains of a tortoise are recorded as a carcass only if at least half of the shell (plastron and carapace) are present.

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 was intact - this field should not be estimated. If you estimate an MCL, enter it in the Comments

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). 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!

Photo taken

Photo file name

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

Use the photo to capture pictures if you think the carcass is informative, for instance if you think it indicates a particular cause of death. In this case, use the comment field to communicate your intent to the viewer. If the photo was not taken as part of this subform, provide the label assigned by the camera in the comment. Alternatively, if the photo was integrated in the subform, you will not be provided with a photo name and should not fill in the latter field.

Desert Tortoise Distance Sampling Transect Form (TranLiveObs)

Tran Num:		Stratum:		Team Num:		Date:	

Tran Live #:		Burrow Visibility:	High Med Low	Existing Tag:	Yes No U/R Unk
Observer:	1 2	Tort in Burrow Visibility:	High Med Low	Existing Tag Number:	
Observer Position:	Lead Follow	Tortoise visibility:	High Med Low	Existing Tag Color:	Blue White Green
Last Waypoint:		Distance to burrow:	m	Other Tag Color:	
Observation Time:	am / pm	Temperature:	ºC	New Tag Attached?	Yes No
Transect Bearing:	º	Temp > 35?:	Yes No	New Tag Number:	FW
Local Bearing:	º	MCL ≥ 180:	Yes No Unk	Tortoise Void	None Urine Feces Both
Azimuth:	º	MCL:	mm	Fluids offered	Yes No
Radial Distance:	m	Sex:	M F Unk	Fluids accepted	Yes No Unk
Perpendicular Dist:	m	Ticks:	0 1-10 >10 Unk	Tort not handled b/c:	

GPS Location

Easting:	
Northing:	
UTM Zone:	11 12
GPS grab valid?:	Yes No

Cue to tortoise: SearchedVeg BodyPart Movement Burrow BurrowApron Audible

Tort heading relative to line when detected: Profile HeadOn TailOn PulledIntoShell HeadIntoBurrow HeadOutOfBurrow

Tortoise location: RockBurrow SoilBurrow Pallet Open Vegetation Rock

Body condition score: Under Acceptable Over
1 2 3 4 5 6 7 8 9 Unk

Nares appearance: Normal Asymmetrical Eroded Occluded Unk

Nares discharge: None Serous 1 2 3 Mucous 1 2 3 Unk

Photo_tort1: Yes No
Comment:

Photo_tort2: Yes No
Comment:

Comments:

Observer Position

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

Radial Distance

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 iPad 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 seen the mouth of the burrow initially, but went to investigate what you thought was 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), although when you directed your attention there, the tortoise might also be visible

Tortoise location:

SoilBurrow - 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 - 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.

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.

Profile - The tortoise was in a burrow and neither head-in or head-out, or was out of a burrow and approximately perpendicular to the transect

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

FacingIntoBurrow - at least part of the tortoise is **inside the mouth of a burrow**, and the animal is facing into the burrow

FacingOutOfBurrow - At least part of the tortoise is **inside the opening of the burrow**, and the tortoise Is facing out from the burrow.

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.

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 not visible 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 or apron.

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.

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 vegetation.

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 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.

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.

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

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.

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, the distance is "0". Use "100" if you do not see a burrow within 15m of the tortoise.

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 of tort

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.

Body condition score

Please reference the handbook for pictures to illustrate muscle development and fat deposition evidence to match each score

Nares appearance

If any fields are left blank, even if you are able to conclude the transect form, your QAQC specialist will have to interview you to attempt to fill in information. If you can instead use one 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.

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

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 not handled b/c

If any fields are left blank, your QAQC specialist will interview you to attempt to fill in information. If you can instead use one 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
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

Photo_tort1

Photo comment

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

Use the photo to capture pictures of cooperative tortoises if desired, 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. If the photo was not taken as part of this subform, provide the label assigned by the iPad in the comment. If the photo instead was integrated in the subform, you will not be provided with a photo name and should not fill in the latter field.

Desert Tortoise Distance Sampling Transect Form (OppCarcObs)

Tran Num:		Stratum:		Team Num:		Date:	
Opp Carc #		Sex:	M F Unk	Easting:		Photo_Carc: Yes No	
		Existing Tag:	Yes No U/R	Northing:		*Comments* :	
Carc Condition:	Intact D/A	ET Number:		UTM Zone:	11 12		
MCL>180?	Yes No Unk	Existing Tag Color:	Blue White Green				
MCL (mm):		Other Tag Color:		GPS grab valid?	Yes No		
Comments:							

Tran Num

you may process the tortoise, but 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. For each transect, not for each segment of an interrupted transect, restart numbering sequentially from 1. For interrupted transects, continue numbering sequentially

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."

Desert Tortoise Distance Sampling Transect Form (OppLiveObs)

Team Num: ____ Date: ____ Stratum: ____ Trans Num: ____

Opp Live #		MCL≥180?	Yes No Unk	Ticks:	0 1-10 >10 Unk	Tort not handled b/c:	
Time:	am / pm	MCL (mm):		Existing Tag:	Y N U/R Unk		
Tortoise location:	RockBurrow SoilBurrow	Sex:	M F Unk	ET Number:		GPS grab valid?:	Yes No
Pallet Open	Vegetation Rock	**Body condition score:**	Under / Acceptable / Over	Existing Tag Color:	Blue White Green	Easting:	
Burrow Visibility:	H M L			Other Tag Color:		Northing:	
Tort in Burrow Visibility:	H M L		1 2 3 4 5 6 7 8 9 Unk	New Tag Attached?	Yes No	UTM Zone:	11 12
Tortoise visibility	H M L	**Nares appearance:**		New Tag Number:	FW		
Distance to burrow (m):			Eroded Occluded NoneOfAbove Unk	Tortoise Void	None Urine Feces Both	**Photo taken:**	Yes No
Temperature:	ºC	**Nares discharge:**		Fluids Offered	Yes No	*Comment:*	
Temp > 35?:	Yes No		None Serous 1 2 3 Mucous 1 2 3 Unk	Fluids Accepted	Yes No Unk		

Comments:

Trans Num

Opportunistic tortoises must be associated with a transect. Once you have closed out your transects (for instance when camping later that day), you may process the tortoise, but 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