FINAL REPORT

Validation and Development of a Certification Program for Using K9s to Survey Desert Tortoises

ESTCP Project RC-200609

AUGUST 2011

Mary Cablk, Ph.D.
Desert Research Institute

Russell Harmon, Ph.D.
US Army Research Laboratory

This document has been cleared for public release

TABLE OF CONTENTS

LIST OF FIGURES iii

LIST OF TABLES v

ACRONYMS vii

ACKNOWLEDGMENTS viii

1.0 INTRODUCTION 1
- 1.1 BACKGROUND 1
- 1.2 OBJECTIVES OF THE DEMONSTRATION 5
- 1.3 REGULATORY DRIVERS 6

2.0 TECHNOLOGY/METHODOLOGY DESCRIPTION 8
- 2.1 OVERVIEW OF DTK9 TEAMS 8
- 2.2 DTK9 DEVELOPMENT 18
- 2.3 ADVANTAGES AND LIMITATIONS OF DTK9 TEAMS 39

3.0 PERFORMANCE OBJECTIVES 42
- 3.1 CERTIFICATION TESTS YIELD TEAMS THAT PERFORM TO STANDARD 44
- 3.2 DOG TEAMS FIND TORTOISES OF ALL SIZE CLASSES 44
- 3.3 DTK9S CAN OPERATE IN “READ AND GO” REWARD STRATEGY 45
- 3.4 SAFETY 45
- 3.5 DTK9 TEAMS FIELDED UNDER NATURAL ENVIRONMENTAL CONDITIONS AND EMPLOY SEARCH STRATEGY 45

4.0 SITE DESCRIPTION 47
- 4.1 SITE LOCATION AND HISTORY 47
- 4.2 SITE CHARACTERISTICS 48

5.0 TEST DESIGN 50
- 5.1 CONCEPTUAL TEST DESIGN 50
- 5.2 BASELINE CHARACTERIZATION AND PREPARATION 52
- 5.3 DESIGN AND LAYOUT OF TECHNOLOGY AND METHODOLOGY COMPONENTS 61
- 5.4 FIELD TESTING 65
- 5.5 SAMPLING PROTOCOL 68
- 5.6 SAMPLING RESULTS 70

6.0 PERFORMANCE ASSESSMENT 76
- 6.1 CERTIFICATION TEST YIELDS TEAMS THAT PERFORM TO STANDARD 76
- 6.2 CAPABILITY - FINDING TORTOISES OF ALL SIZE CLASSES 77
- 6.3 MAINTAIN IN-FIELD CALIBRATION – ‘READ AND GO’ 78
- 6.4 SAFETY 79

6.5 OPERATE EFFECTIVELY UNDER EXPECTED FIELD CONDITIONS 79

7.0 COST ASSESSMENT 81
7.1 COST MODEL 81
7.2 COST DRIVERS 83
7.3 COST ANALYSIS AND COMPARISON 83
7.4 COST INTERPRETATION AND SCALING 85

8.0 IMPLEMENTATION ISSUES 88
8.1 REGULATIONS AND PERMITTING 88
8.2 DECISION-MAKING FACTORS FOR END USERS 90
8.3 PROCUREMENT AND RELATED ISSUES 91

9.0 REFERENCES 93

APPENDICES 96
APPENDIX A. POINTS OF CONTACT 97
APPENDIX B. SPATIAL DATA RESULTS FROM PIUTE VALLEY 98
APPENDIX C. INITIAL ODOR RECOGNITION AND SEARCH TRAINING PROTOCOLS 104
APPENDIX D. DTK9 STANDARD OF PRACTICE (DRAFT) 137

LIST OF FIGURES

Figure 1. Mojave desert tortoise (*Gopherus agassizii*). 1
Figure 2. Locating tortoises in burrows or shrubs is challenging using visual methods. 2
Figure 3. Small tortoises are able to exploit mammalian burrows such as the one shown. 2
Figure 4. A tortoise biologist uses an 8-foot scope in an attempt to determine if there is a tortoise in a burrow (left). A tortoise is marked with each successive capture for mark-recapture studies (right). 3
Figure 5. A hatchling desert tortoise rests at the mouth of a very small burrow. 4
Figure 6. The DOD restricts activities in desert tortoise critical habitat. 6
Figure 7. A DTK9 team is one dog and one handler. 8
Figure 8. Additional field personnel may be assigned to or accompany a DTK9 team as needed by the survey type and conditions. 9
Figure 9. A DTK9 performing its trained alert (sit) focuses on the handler reaching for the toy reward. 11
Figure 10. Flow chart depicting the approach employed in the final demonstration conducted in spring 2008. The demonstration occurred at handlers' home locations, at the DTCC and Piute Valley, NV. 12
Figure 11. This flow chart shows the process for achieving status as a permitted DTK9 team, certified for consideration to be permitted, and thus deployed for work, by the permitting agencies. 13
Figure 12. Chronological sequence of DTK9 development from 2004 to present. The sponsor for each progression is shown by color. Most of the research and development was sponsored by DOD. 14
Figure 13. A handler rewards her dog for finding a tortoise while field technicians collect data during the 2004 pilot study. 15
Figure 14. The 2006 human-dog comparison team consisted of six DTK9 teams and 8-10 human surveyors in addition to the scientific research team. Photo credit: Todd Esque 16
Figure 15. A handler prepares her dog for surveys in 2006. 17
Figure 16. Cages designed for training odor recognition of small tortoises were held in place by rocks and always attended by at least one tortoise biologist. 19
Figure 17. A DTK9 sniffs the cage with small tortoises (upper image) and then performs its trained alert (lower image). 20
Figure 18. Totes placed in a line-up contained a tortoise or did not contain a tortoise. Different color tape indicated to the handler whether or not a tortoise was present. 21
Figure 19. Totes were also placed in a circular arrangement so that there was no defined start and stop point to the dog. 22
Figure 20. Introduction of the dogs to small tortoises is done with complete knowledge of the location of the tortoise by all people involved in the training activity. A small tortoise is identified in the white outline. 23
Figure 21. Field technicians collect data on a tortoise found by a DTK9 during the trials. 24
Figure 22. Example GPS track from one of the dogs during trial number 20. 26
Figure 23. Survey areas at the FISS overlaid on Digital Ortho Quads. 28
Figure 24. Data from FISS trials. 'Found' is the number of tortoises located by DTK9s and 'known' is the number of tortoises available to be found in the survey area. 29

Figure 25. Process step flow chart that defines an operational DTK9 team operating with a neutral mindset in Read and Go. 31
Figure 26. The partial reward of Read and Go demonstrated. Dog identifies tortoise is present (left) and prepares to sit. Dog stares at the small burrow while being given a partial reward (right) because there is a tortoise present. 33
Figure 27. Working dogs on-leash was established as the rule during the 2007 field season to heighten safety to small tortoises and for more thorough search area coverage. 35
Figure 28. Transmitters were attached to small tortoises in accordance with USFWS permit regulations (top images) and released into disease-free pens at the mouths of burrows (bottom image). 36
Figure 29. Small tortoise locations were verified via telemetry after DTK9 teams completed their search of the area. 37
Figure 30. Results from trials testing Read and Go. 38
Figure 31. Demonstration sites in southern Nevada are shown with green dots. 48
Figure 32. The landscape at Piute Valley, NV where the field testing (Phase II) was conducted. 49
Figure 33. The field crew for the 2008 DTK9 demonstration at Piute Valley included seven DTK9 teams, three PIs, ARO Program Manager, DTK9 Master Trainer and eight tortoise biologists/field technicians. 51
Figure 34. The conceptual test design. 52
Figure 35. Aerial image of the southern end of the DTCC where safety and high density assessments were conducted. 53
Figure 36. The low density assessment area was located in Henderson, NV in an area recently cleared of tortoises. 54
Figure 37. Before the team enters the pen for a safety assessment the evaluator conducts a check to ensure that the dog is wearing its equipment (booties and collars), that they are properly seated on the dog, and functional. 57
Figure 38. Example set up for the safety assessment. The dog is relaxed and not fixated on moving tortoises. 58
Figure 39. An example of very relaxed behavior during a safety assessment. 59
Figure 40. The three-pass search strategy deployed for tortoise searching optimizes searching for moving targets. 60
Figure 41. A tortoise 110mm MCL with transmitter released during Phase II trials. The transmitter is attached to the posterior of the carapace. 62
Figure 42. Required equipment deployed to cool the dog. 63
Figure 43. The dogs wore an i-Blue 4" GPS data logger attached to their harness to record dog tracks. 64
Figure 44. The Piute Valley demonstration area and the location of survey plots by date. 66
Figure 45. Verification of a transmittered tortoise was conducted using telemetry equipment. .. 68
Figure 46. Example of track data downloaded from a dog GPS data logger. 72
Figure 47. Ground surface temperature data during the time periods DTK9 teams were conducting surveys at Piute Valley. The time period begins with the first team starting their search and ending at the time that the last team completed their search effort. 73
Figure 48. Air surface temperature data during the time periods DTK9 teams were conducting surveys at Piute Valley. The time period begins with the first team starting their search and ending at the time that the last team completed their search effort. 74

LIST OF TABLES

Table 1. Summary of results for 2006 DTCC trials for DTK9 teams on small tortoises. CF = 'confirmed finds'. Efficacy = finds and misses; Reliability = trained alerts for CF; overall = CF, misses, and NPA of total available to be found. 25
Table 2. Summary of within dog variability in reliability for each of the trial sizes. 25
Table 3. Number of tortoises placed and found over the course of 20 trials at the DTCC by configuration. 25
Table 4. Tortoise find results by search pass. Perimeter search was not executed on the 0.25 ha plots. 26
Table 5. Mean time for DTK9 teams to complete surveys by pass. Perimeter search was not conducted for the 0.25 ha trials. 27
Table 6. Distance covered and time summaries. 27
Table 7. Terminology definitions for an Operational Team. 32
Table 8. Data pertaining to transmittered tortoises released at the DTCC in April 2007. 35
Table 9. Meteorological station data recorded for the time period when the DTK9 teams were participating in the trials on the first two dates. Rabbits ate the wiring of the data logging device on the evening of April 27 and no data were recorded after this date. 39
Table 10. Performance objectives established to validate DTK9 teams. 43
Table 11. DTK9 team data. Team is unique identifier. M' = male and 'F' = female. DTK9 veteran indicates the dog had prior deployment as DTK9. Origin is the handler's home state where initial scent training was conducted. 50
Table 12. Results from the baseline assessments. 55
Table 13. Results of the safety assessment for each DTK9 team. The range of passing scores is 9-15. 56
Table 14. DTK9 team data with pass/fail designation. Team is unique identifier. 'M' = male and 'F' = female. DTK9 veteran indicates the dog had prior deployment as DTK9. Group identifies pass (P) or fail (F) of Phase I baseline characterization (certification). 62
Table 15. Sampling dates at Piute Valley. 68
Table 16. Data collected when a handler determined the dog alerted. 69
Table 17. Expected and actual count distribution of tortoises available to be found by each team over the course of the field trials. 71
Table 18. Number of tortoises in each of the three size classes that were located by DTK9 teams, grouped by either having passed or failed the baseline assessment. 71
Table 19. Time data recorded per plot(s) per day. No data = no data available. N/A = team did not work that date. 71
Table 20. Meteorological data collected at 15 minute increments (average) for the time period the DTK9 teams were actively surveying assigned plots in plots in Piute Valley. . 75
Table 21. Results of certification test utility to produce capable teams. 77
Table 22. Efficacy results summarized by tortoise size and by 'pass' or 'fail' group. 78
Table 22. Cost model for DTK9 teams based on expenditures from 2008 demonstration. 82
Table 23. Cost model for DTK9 teams based on expected costs provided by consultants and revised DTCC facility fee schedule. 84

Table 24. Cost comparison of human survey teams and DTK9 teams. Estimates presented represent the number of teams to cover the specified area in a given day. M = million. 87
Table 25. Required permits for the implementation of DTK9 teams. This list incorporates all of the potential permit sources that were encountered during this project and lists others that may exist or be originated subsequent to this report. 89

ACRONYMS

ACUC	Animal Care and Use Committee
ANOVA	Analysis of Variance
ARL	Army Research Laboratory
ARO	Army Research Office
BLM	Bureau of Land Management
CESA	California Endangered Species Act
CF	Confirmed Find
DOD	Department of Defense
DRI	Desert Research Institute
DTCC	Desert Tortoise Conservation Center
DTK9	Desert Tortoise Canine
DTRO	Desert Tortoise Recovery Office
DWMA	Desert Wildlife Management Area
EAFB	Edwards Air Force Base
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute, Inc.
ESTCP	Environmental Security Technology Certification Program
FISS	Ft. Irwin Study Site
GPS	Global Positioning System
GSD	German Shepherd Dog
K9	Canine
LDS	Line Distance Sampling
MCL	Median Carapace Length
NAC	Nevada Administrative Code
NPA	Non-productive Alert
NTC	National Training Center
NV	Nevada
OTS	Off The Shelf
PDF	Portable Document Format
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
UTM	Universal Transverse Mercator

ACKNOWLEDGMENTS

Funding for this demonstration was provided by the DOD Environmental Security Technology Certification Program (ESTCP). We acknowledge Dr. Jeffrey Marqusee, ESTCP Director and Dr. Robert Holst and Dr. John Hall, ESTCP Sustainable Infrastructure Program Managers, former and present, for financial and technical support. The authors thank HydroGeoLogic, Inc., contractor for the ESTCP program, for technical and administrative support, including John Thigpen, Carrie Wood, Kristen Lau, Lucia Valentino, Sheri Washington, Jennifer Rusk, Susan Walsh, Pedro Morales, and Badrieh Sheibeh.

This demonstration was a collaborative effort among the scientific investigators, the master trainer, the dog handlers, and field technicians. The unique contributions made by each and all of the demonstration team members enabled this work to continue through to its final success. The diversity of each individual's professional backgrounds enriched the demonstration in countless measures over the course of successive field seasons.

Dr. Russell S. Harmon (ARO) provided the mechanism for funding this work, technical guidance, and program support. Without his efforts and interest in the promise of DTK9 teams to meet the needs of the military and partnering agencies, this demonstration would not have been possible.

Co-performers (USGS) on this demonstration were Dr. Kenneth Nussear and Dr. Todd Esque. Their willingness to participate in seeking part of a solution for current conservation issues for the Mojave Desert tortoise was significant. Their role in managing the field technicians supporting the DTK9 teams is also acknowledged. Master Trainer Cindee Valentin integrated the language of 'dogs and handlers' into the scientific process. She ensured tortoise safety every time dogs and tortoises interfaced. Her expertise, guidance, and professionalism resulted in significant contributions to our understanding of detection and specifically wildlife detection. Although not a scientist, her role on the scientific team was critical towards accomplishing the demonstration objectives.

We would like to acknowledge the following dog handlers who participated in one or more of the demonstrations with their dogs: Aimee Hurt with 'Finney' and 'Wicket', Margaret "Tudy" Morris and 'Storm', John Rarity and 'Kai', Chris Salisbury and 'Denali', Meaghan Thacker and 'Nandi', Laura Totis and 'Sammy', Alice Whitelaw and 'Camas', and Kristin Winford and 'Tango'. Many field technicians worked alongside handlers and PIs alike and we acknowledge their efforts: Aaron Bevill, Phillip Chalker, Hannah Converse, Paul Cossman, Kristina Drake, Peter Graham, Jordan Harrison, Allison Hawkins, Brian Jacobs, Jennifer Oliphant, Claire Phillips, Melissa Rosenberg, Emily Roskam, Michelle Sargent, Peter Van Linn, and Carrie Walters.

This project would not have been possible without the assistance and support of the US Fish and Wildlife Service's Desert Tortoise Recovery Office, directed by Roy Averill-Murray and his staff. We also thank Polly Conrad (Nevada Department of Wildlife) and Rebecca Jones (California Department of Fish and Game) for their support and permit assistance.

The demonstration was conducted at multiple sites and we would like to thank Mr. Mickey Quillman for his support at the National Training Center (NTC) Ft. Irwin and the Ft. Irwin Study Site (FISS). Dr. Kenneth Nagy and Scott Hillard, both from UC Los Angeles, provided our research team access to their research tortoises at the FISS. Scott also provided valuable field assistance and technical guidance on small tortoise transmittering. Michelle McDermott managed the Desert Tortoise Conservation Center (DTCC) for much of the time we conducted training and testing activities with the dog teams at the DTCC and her efforts to provide us with the resources necessary to conduct the work were invaluable. Gerald Hickman allowed us to use Bureau of Reclamation lands for the low density portion of our evaluation procedures.

Dr. Jill S. Heaton of the University of Nevada Reno contributed technical assistance and personnel early in the demonstration. Dr. Susan Clark played a critical role in integrating the team members who came together from different disciplinary backgrounds. She worked to ensure the training protocols ran at maximum efficiency and was able to help translate Cindee Valentin's process in a meaningful way to both handlers and scientists. Lisa Wable (DRI) provided technical assistance, particularly with graphics, in this report.

EXECUTIVE SUMMARY

This project demonstrated the ability of Desert Tortoise Canine (DTK9) teams to locate Mojave Desert Tortoises in the field at natural population densities, with an emphasis on finding small size classes. DTK9s were shown to be successful at this task. Performance objectives were evaluated in each of two phases conducted in southern Nevada: Phase I was the training and testing phase at the Desert Tortoise Conservation Center (DTCC) and Phase II was the field demonstration at Piute Valley. The objective of Phase I was to demonstrate that DTK9 teams can pass a testing regime that assesses their capability at finding tortoises under both high and low tortoise density scenarios with tortoise safety maintained throughout. Phase II demonstrated that teams deemed qualified to conduct field searches for tortoises based on meeting Phase I testing criteria performed similarly in the field, while those teams that failed to meet the testing criteria did not perform to standard in the field. Performance objectives were met and in some cases performance exceeded the criteria.

Phase I included three different tests, (i) safety, (ii) high density tortoise scenario, and (iii) low density tortoise scenario. Quantitative metrics included threshold scores for safety, based on nine different behaviors, and for efficacy and reliability. Behavioral measures of safety included aggression (defensive and overt), excessive flight, play interaction, growling, barking, stalking, excessive focus and inability to relax in the presence of or aimed directly at tortoises. Efficacy is the number of targets (e.g., tortoises) found of the total available to be found. Reliability is the number of trained alerts performed by the dog divided by the total number of targets found. Both efficacy and reliability are calculated based on the first encounter with a particular tortoise. Together, efficacy and reliability are a capability metric of a team. For the high density scenario a minimum efficacy of 70% and minimum reliability of 75% were required. For the low density scenario the teams were scored as pass/fail. Handlers were required to maintain safety at all times and were required to use the in-field calibration method we termed ‘Read and Go’. All teams passed the safety test. Six of the seven teams passed the high density scenario and six passed the low density scenario. In total, five teams passed all three assessments and two teams failed the testing criteria.

All teams were fielded for the Phase II demonstration that was conducted on a population of wild, transmittered desert tortoises supplemented with transmittered small tortoises in Piute Valley, Nevada, in desert tortoise critical habitat. Performance assessment was based on finding three size classes of tortoises: small (< 110 mm median carapace length (MCL)), medium (110 – 180 mm MCL) and large (> 180 mm MCL). The required efficacies to pass the assessment for these classes were 50%, 60%, and 70%, respectively with reliability of 75% for all size classes. The five teams that passed Phase I tests yielded 78% (small), 96% (medium), and 100% (large) efficacy and 90% reliability. The two teams that failed Phase I yielded 14% (small), 50% (medium), and 75% (large) efficacy and 55% reliability.

The testing procedures implemented in Phase I resulted in producing teams that were both safe and capable of surveying for desert tortoises in natural field conditions, across all size classes at expected natural densities. It was also demonstrated that the testing procedures in Phase I would have eliminated teams that did not perform to required standards in the field environment. Thus the testing procedures were valid and relevant in relation to the program goals.

1.0 INTRODUCTION

1.1 BACKGROUND

Department of Defense (DOD) installations in the Mojave Desert face conflict between installation mission (e.g., training and testing) and environmental compliance with regard to the federally- (US Fish and Wildlife Service 1990) and state-listed (NAC 503.080, CESA Fish and Game Code §§2050, *et seq.*) Mojave desert tortoise, *Gopherus agassizii* (Figure 1). Military operations are identified as one of the threats impacting tortoise populations in the 1994 Recovery Plan (US Fish and Wildlife Service 1994 p. D14; Boarman 2002). The desert tortoise has low annual fecundity over a long lifespan with low and variable egg and hatchling survival (Wilbur and Morin 1988; Congdon and Gibbons 1990, US Fish and Wildlife Service 2008). There exists a gap in the knowledge base about desert tortoises because the smaller size/age cohorts are relatively unstudied and are difficult to locate during typical survey efforts. As long as desert tortoises are afforded legal protection, the DOD will be required to comply with requirements set forth by the USFWS Biological Opinions for individual installations. This compliance comes at significant monetary cost and can alter military training and testing to avoid physical contact with tortoises and habitat destruction.

Figure 1. Mojave desert tortoise (*Gopherus agassizii*).

To support meeting mission goals in compliance with environmental law, DOD participates in desert tortoise density surveys as well as clearance surveys as part of translocations of tortoises from military lands to other public lands. Desert tortoise habitat is currently surveyed using a number of different methods involving humans using visual detection methods to find tortoises

(Figure 2). Smaller size classes of tortoises are so infrequently encountered by these surveys that they are omitted from analysis under current range-wide monitoring efforts (US Fish and

Figure 2. Locating tortoises in burrows or shrubs is challenging using visual methods.

Wildlife Service, 2010a). Figure 3 depicts one reason that the smallest tortoises can be difficult to locate. Small tortoises are able to exploit mammalian burrow complexes such as the one shown. Observing a tortoise in such burrow complexes is difficult with visual methods. The line distance sampling (LDS) method currently used for range wide surveys of desert tortoises does not require that surveyors find all tortoises, only that they find all tortoises on a defined survey line (US Fish and Wildlife Service, 2011). Based upon analysis of past years range wide survey data it has been shown that training improves a person's ability to see tortoises and with training, humans can find a high percentages of both adult (290 mm MCL) and sub-adult (180 mm MCL) sized models (US Fish and Wildlife Service, 2006; US Fish and Wildlife Service, 2010a), yet numbers from the field yield few observations of smaller animals.

Figure 3. Small tortoises are able to exploit mammalian burrows such as the one shown.

Detection of a stable or upward population trend is the first criteria required for delisting of this species and the projected rates of recovery under ideal conditions may be as slow as 1% per year (US Fish and Wildlife Service, 1994; US Fish and Wildlife Service, 2008). Detection of trends of this magnitude requires precise methods of density estimation (Nussear and Tracy, 2007) and the new recovery plan calls for demographic study plots to be monitored for trends in population demographics (US Fish and Wildlife Service, 2008). At present, the causes of desert tortoise population declines are linked to threats primarily associated with human land uses, however little data are available to support the affects of specific stressors (Tracy et al., 2004) or quantify the effects of threats on populations. It is widely recognized that a deficit exists for data on smaller size classes of tortoises and, as a consequence, also on demographic processes (US Fish and Wildlife Service, 1994; Doak et al., 1994, Tracy et al., 2004, US Fish and Wildlife Service, 2008). This is largely due to the difficulty in detecting these individuals in the field. Additional demographic data would be useful in determining which of several possible threats may be impacting specific life stages of desert tortoise populations in a given area, and therefore guide management on where to focus conservation efforts in support of strategic recovery elements. It is unlikely that the desert tortoise will be de-listed without a better understanding of its population demographics, and how population distributions change over time, determined through monitoring. A sound demographic analysis of desert tortoise populations must include data on small desert tortoises, including recaptures of marked individuals over time (Figure 4).

Figure 4. A tortoise biologist uses an 8-foot scope in an attempt to determine if there is a tortoise in a burrow (left). A tortoise is marked with each successive capture for mark-recapture studies (right).

The technical barrier the DOD faces in maintaining compliance with federal laws regarding desert tortoise population monitoring is rooted in the same challenges. For the DOD having an accurate means of finding small tortoises (Figure 5) not only offers a means of improving the efficacy of clearance work, but also offers the potential for an improved means for government land managers to conduct long-term monitoring of desert tortoise populations in discrete locations with specific emphasis on smaller size classes of tortoises. This type of data collection would also support strategic elements identified in the revised Recovery Plan (US Fish and Wildlife Service, 2008) designed to improve the 1994 Recovery Plan.

Figure 5. A hatchling desert tortoise rests at the mouth of a very small burrow.

De-listing the tortoise is an important issue for DOD installations that have desert tortoises and their habitat due to the expense in funds, time, resources, and interruptions to training or testing that result when a tortoise is encountered during military activities. Recent analysis of range-wide monitoring data shows that the highest densities of Mojave Desert tortoises were reported on DOD land, in the Eastern Colorado recovery unit on the Chocolate Mountain Air Gunnery Range; sampling data are reported separately for DOD land in this recovery unit (US Fish and Wildlife Service, 2010a). The cost of recovery is substantial. The US Fish and Wildlife Service estimated the cost of recovery for Mojave Desert tortoise to be a minimum of $159,000,000 (US Fish and Wildlife Service, 2008).

RC-200609 was undertaken to meet the needs of the military through improved data collection that support environmental regulatory compliance directly, via improved survey methods, and indirectly in efforts to support de-listing the Mojave desert tortoise. This was accomplished using dog teams trained to find live desert tortoises, termed 'DTK9s'. A DTK9 team is defined as one dog with one handler. DTK9s are trained to find live desert tortoises. The use of DTK9 teams was developed as a proof-of-concept for the U.S. Army in 2004 - 2005. Results of that work yielded estimates of the capability of dog teams to locate adult desert tortoises and compared detection rates for adult tortoises by DTK9s to human search teams. RC-200609 completed the development of testing to qualify DTK9 teams and validated their capability to locate desert tortoises of all size classes in the field at natural population densities, in three microhabitat

configurations (underground, on the surface in vegetation, and on the surface in the open), with an emphasis on finding small desert tortoises. DTK9s were successful at this task.

The increased detectability achieved by using DTK9s to locate small desert tortoises could enhance the current capability to quantify population parameters and, could improve the ability to detect and model future population trends. This more complete information of desert tortoise populations would be a major step forward for land managers who are responsible for directing and focusing conservation efforts. The first two Recovery Objectives of the revised Recovery Plan are demography and distribution (US Fish and Wildlife Service 2008). Based on the success of this demonstration it is anticipated that DTK9s may provide a means of gathering currently unavailable data. These data could greatly expand the knowledge base of desert tortoise demography and also could offer a way of detecting subtle population trends for a broader range of size classes of animals than presently possible. These studies are recommended in the original Recovery Plan (US Fish and Wildlife Service 1994), the Recovery Plan Assessment (Tracy et al. 2004) and are a major focus in the revised Recovery Plan (US Fish and Wildlife Service 2008).

1.2 OBJECTIVES OF THE DEMONSTRATION

The overarching objective of RC-200609 was to demonstrate the utility of a new technology useful to survey for Mojave Desert tortoises that enables detection of the smallest size classes. In support of this, RC-200609 demonstrated that DTK9 teams can effectively find a complete demographic of desert tortoises at natural population densities in desert tortoise habitat, under realistic survey conditions. In addition the demonstration established deployment parameters including a test to certify safe, effective teams. This new approach to surveying desert tortoises using DTK9 teams has the potential to address the critical deficiency of the current survey method and would support management objectives on military installations that harbor desert tortoises, focused on environmental regulatory compliance.

The performance objectives were established to demonstrate (i) that DTK9 teams could pass a three stage testing regime designed to simulate actual field conditions while maintaining safety to tortoises at all times (Phase I), and (ii) that the testing regime was adequate in that those teams that passed these tests proved capable under natural survey conditions while those teams that did not pass the tests did not prove capable under natural survey conditions (Phase II). Both phases were conducted in southern Nevada. Phase I, baseline characterization, was conducted at the DTCC and Phase II, the field demonstration, was conducted in Piute Valley. The results of the demonstration validated that those teams which passed the three stage testing regime in Phase I went on to perform equally or better under actual survey conditions and that teams failing Phase I tests were found to be ineffective at surveying. The certification test developed as a prerequisite qualification for federal and state agency permitting was thus validated to identify capable and safe DTK9 teams, while excluding those teams that would not be capable of producing accurate survey results. Under natural working conditions in desert tortoise habitat, certified DTK9 teams were also validated to be able to locate a full range of size classes of desert tortoises including hatchlings and juveniles in all configurations (surface, subsurface, shrub). Deployment parameters were established.

1.3 REGULATORY DRIVERS

The regulations governing desert tortoise protection apply at multiple spatial scales including range-wide (i.e. throughout the entire range of the Mojave Desert tortoise population which includes portions of four States), regional, and local. At a range-wide level, military installations are governed by the Endangered Species Act and recovery actions are recommended in the USFWS Desert Tortoise Recovery Plan (US Fish and Wildlife Service, 2008). Regionally, the National Training Center (NTC) Ft. Irwin, Edwards Air Force Base, the Naval Air Warfare Center Weapons Division at China Lake, and the Marine Corps Air Ground Combat Center fall under the California Endangered Species Act. Locally there are two USFWS Biological Opinions related to the desert tortoise that apply to the NTC Ft. Irwin, one that governs its daily operations in the cantonment and training areas and a second governing actions related to the new expansion areas. In addition to the federal Endangered Species Act, which protects Mojave desert tortoises range-wide, they are also protected by the California Endangered Species Act, the State of Nevada Department of Conservation and Natural Resources, the Arizona Department of Game and Fish, and the Utah Division of Wildlife Resources. Local administrative units of the US Bureau of Land Management (BLM), US National Park Service, US Department of Energy, and US DOD all regulate activities to provide protection of the desert tortoise and its critical habitat (Figure 6).

Figure 6. The DOD restricts activities in desert tortoise critical habitat.

Responsibility for implementing recovery actions is shared among the land managers in the Mojave Desert, and DOD plays an active role in stewardship. Officials from each branch of the US Armed Forces with installations containing desert tortoises participate in the Desert Tortoise Management Oversight Group (MOG), established in 1988, along with other federal, state,

county, and tribal agencies. The MOG plays a leadership role in coordinating activities of management agencies in support of implementing the recovery plan (US Fish and Wildlife Service, 2008). The ultimate de-listing of the desert tortoise from the Endangered Species Act is a responsibility shared among federal land managers. Under current policy, the de-listing of the desert tortoise can only occur at a range-wide scale, not for individual populations or for selected areas. While it is important to comply with regional and local regulatory restrictions, delisting of the desert tortoise is unlikely if all affected parties limited their efforts solely to these activities. The DTK9 technology presented here potentially supports the call for improvements on how desert tortoises are surveyed, demographic modeling (US Fish and Wildlife Service, 1994; Tracy et al., 2004, US Fish and Wildlife Service, 2008), population distribution and monitoring, and may provide an ability to better detect population demographic trends.

2.0 TECHNOLOGY/METHODOLOGY DESCRIPTION

2.1 OVERVIEW OF DTK9 TEAMS

The technology is a highly sophisticated biosensor that has a history of use for other target applications modified and reworked to meet a strict set of requirements to comply with federal and state regulations – working dogs trained to locate desert tortoises. A DTK9 team is one dog and one handler (Figure 7). Because handlers are not expected to be in direct contact with tortoises, an authorized tortoise biologist will likely accompany a DTK9 team (Figure 8).

Figure 7. A DTK9 team is one dog and one handler.

Figure 8. Additional field personnel may be assigned to or accompany a DTK9 team as needed by the survey type and conditions.

Properly trained and certified DTK9s are able to find tortoises that occupy a variety of different and sometimes complex microhabitats (e.g. on the surface, under shrubs, and in burrows) even when they are effectively invisible to human observers. This level of detection is possible because dogs largely depend on olfaction to guide them to the tortoise. Olfaction is the sensory perception that is least understood scientifically. Putative olfactory receptors have been identified (Buck and Axel, 1991; Buck, 1993; Ngai et al., 1993; Raming et al., 1993). The process by which scent is transferred to the brain is somewhat understood (Shepherd, 1994), however, the mechanisms by which receptors detect odorants, and thus the molecular basis of odor, remain unclear. As has been noted by Turin (1996), structure-odor relations provide conflicting evidence. It is known, however, that animals have the ability to differentiate targets based on scent and recent scientific advancements have shown that odor recognition is a function of quantum mechanics and not molecular shape (Franco et al., 2011). Dogs can be trained to find specific classes of targets, and can even discriminate one person's scent from all other human and non-human scent (Schoon, 1998), yet how they do this remains unexplained. Recent research by Franco et al. (2011) has shed some insight using fruit flies however this work has yet to be validated in mammals. Therefore, it is not possible to explain precisely *how* dogs use scent to find desert tortoises, other reptiles (Schwartz et al., 1984; Engeman et al., 1998), or even to

distinguish cancer in human subjects (McCulloch et al., 2006) However the results of past studies conducted to assess dog capabilities at finding desert tortoises document this capability (Cablk and Heaton, 2006; Cablk et al., 2008; Nussear et al., 2008).

The use of odor recognition, rather than visual, provides an orthogonal detection tool. During the course of this project and others conducted previously, dogs were observed to initially investigate targets that possessed tortoise-like characteristics (i.e., similar shape, size and color) which included rocks along with actual tortoises, using visual recognition. These instances were observed when the dog was typically upwind of the object. However when visual recognition was used to make a choice to investigate further, the dog's determination of whether or not the target was 'tortoise' appeared to be confirmed using olfaction. Dogs would move into a position downwind of the object or sniff the object, at times coming into direct physical contact. Based on these observations, it appeared that the dogs did not identify objects as being a tortoise without confirming via odor recognition. This demonstrates the dog's recognition of the specific scent for which it was trained. In some instances dogs had difficulty differentiating when tortoises were recently present at a location but had moved on to another location, from actual presence (e.g., a tortoise was in a burrow overnight but had moved out of the burrow and was active nearby).

DTK9s are trained to locate live tortoises and not deceased animals, tortoise remains, scat, urine, or residual tortoise odor persisting in the absence of a live tortoise. This is because the typical management need is to locate live animals and not sign. Scat, urine, residual tortoise odor, and tortoise remains can be fairly ubiquitous and long lasting in the desert environment and may persist long after a tortoise has moved location. Focusing effort to clear a burrow which contains scat and not a live tortoise can be environmentally destructive and counterproductive for the survey goals. Dogs could be trained to locate a broader target class to include scat and deceased animals, however these teams would not necessarily be appropriate for all types of survey deployments, such as those where only live tortoises were the target.

The dogs in this program were initially trained as described in Cablk and Heaton (2006). For a dog to be able to locate a desert tortoise it must first learn to recognize desert tortoise odor, which is a chemically un-described odor signature. This is referred to as the dog's target odor. Teaching the dog target odor recognition is accomplished through behavioral patterning using reinforcement by presenting reward in association with desert tortoise odor. Typically dogs are rewarded with handler-focused play, such as tugging or very short distance retrieve of a toy, or with food. Once the dog has established its target odor it must learn to be able to communicate to its handler when it detects the presence of target odor. To accomplish this, the dogs are taught that to elicit their desired reward they must perform the trained behavior 'sit' next to the tortoise or next to the burrow or shrub where a tortoise is located (Figure 9). This is quickly accomplished when the dog has high motivation for its reward and the trainer is skilled at the timing of reward delivery. Dogs are taught to not interact with tortoises using a variety of methods depending on the dog's response to the tortoise. They are trained not to alert (sit) at non-target odors primarily through reinforcing just the live tortoise odor. However this may also be accomplished through either non-reinforcement or negative reinforcement of non-tortoise odor responses as appropriate or necessary.

Figure 9. A DTK9 performing its trained alert (sit) focuses on the handler reaching for the toy reward.

Field operation of a dog trained to locate a live animal of a federally and state protected species of any kind requires a skilled handler. The handler is responsible for optimizing the dog's nose such that the dog has every opportunity possible to cross its minimum detection threshold of tortoise odor. This is accomplished by implementing a grid search strategy which requires the handler be capable of multi-tasking, e.g., handling of the dog and leash, working a Global Positioning System (GPS) unit, maintaining straight grid lines of travel, reading the dog's behavior as it searches, and ensuring safety at all times. There are two instances when a properly trained dog may not perform its trained alert although a tortoise may be present: (i) the location of the tortoise presents an odor picture with concentrations lower than or at the threshold that the dog has been trained to; and (ii) the particular tortoise odor is at the edge of the dog's generalized 'tortoise' signature. In either instance the dog approaches the threshold of what triggers it to identify the presence of a live tortoise and perform its trained alert. It is the responsibility of the handler to recognize the behavior of the dog signaling a tortoise may be present in the absence of the trained alert. The handler is also responsible for maintaining the health and welfare of the dog, recognizing when environmental conditions are outside the acceptable range for DTK9 deployment, and ensuring that the dog is calibrated and motivated as it works. Because of the cryptic nature of desert tortoises in combination with being particularly vulnerable to being

crushed when small, the handler must be highly aware of where he or she steps just as would any human surveyor. The challenge for the dog handler is the need to maintain situational awareness for both the human and dog components of the team during all active survey times.

The overall methodology for the final demonstration conducted in spring 2008 is shown in Figure 10. Initial scent training was conducted individually by each handler at their home location using a defined protocol (Appendix C) with provided training aids. Upon completing this preliminary training the teams traveled to Las Vegas for participation in the demonstration. This preparation included all final training components for dog and handler. Upon arrival at the DTCC, each team was evaluated on training aids to determine whether or not the dog had been properly trained to recognize tortoise odor. The dogs were then desensitized to tortoises. Desensitization was done so the dogs would be accustomed to the sounds and movements of live tortoises, which were not associated with their target odor as trained at home. The dogs were

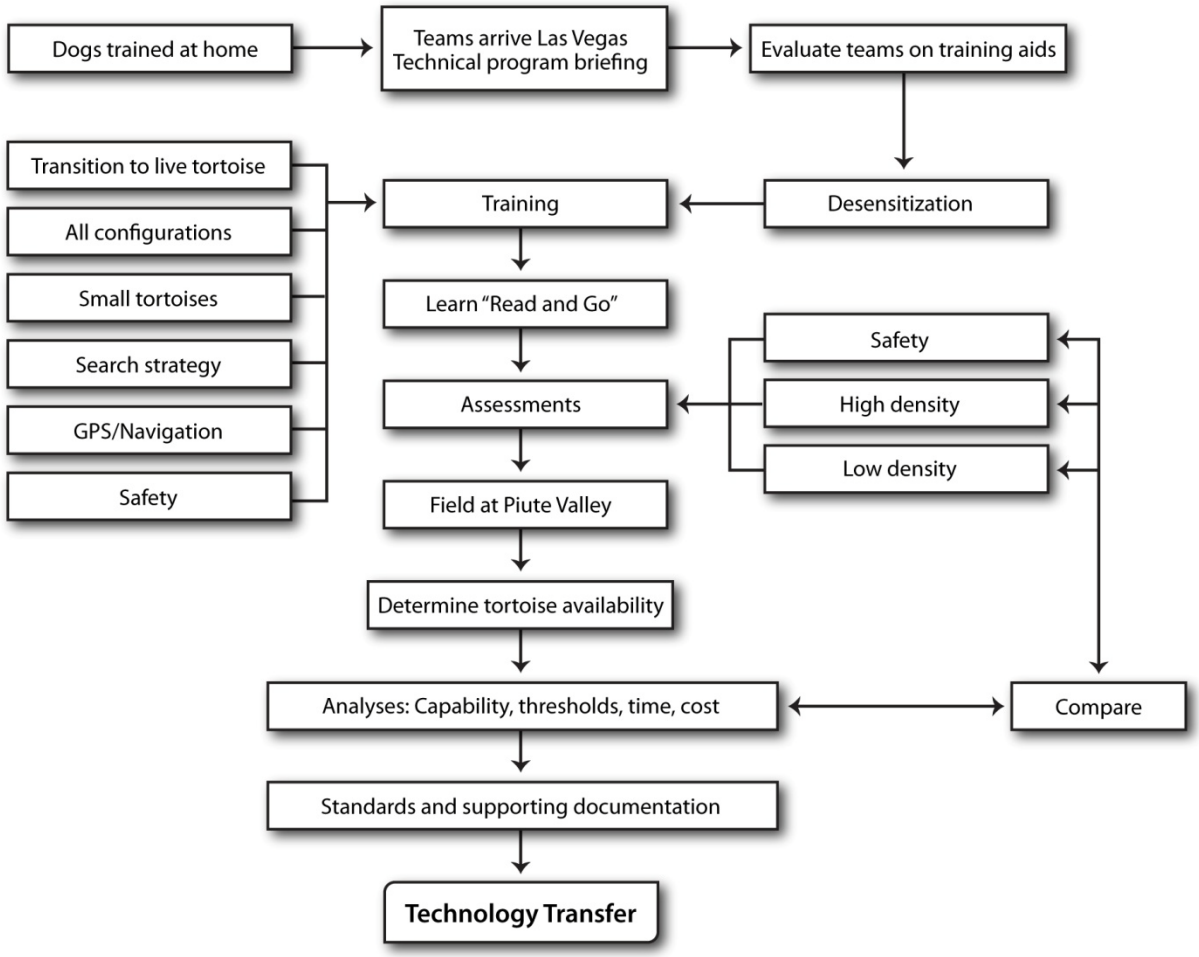

Figure 10. Flow chart depicting the approach employed in the final demonstration conducted in spring 2008. The demonstration occurred at handlers' home locations, at the DTCC and Piute Valley, NV.

then transitioned to live tortoises as described in Section 2.2. Handlers were also trained to execute a prescribed search strategy, use a GPS, and were trained on safety measures. The DTK9 teams were then taught Read and Go as described in Section 2.2. Three assessments that together comprised the 'certification' were then conducted. The three assessments included safety, a high density scenario and a low density scenario. All of this work was accomplished at the DTCC from 1 – 22 April 2008. Dog teams were then fielded in Piute Valley 23-29 April 2008. Each day of the field trials tortoise availability was determined, which was necessary to conduct the calculation of metrics in support of performance objectives. Following the field testing at Piute Valley, data were complied and analyzed. Results from the DTCC and Piute Valley were compared. Based on the results, standards and supporting documentation were written.

Figure 11 diagrams the process for how the technology can be implemented. This approach has been developed with and continues to be under discussion with USFWS as the agency responsible for federal permitting and oversight of the DTCC. Dog teams may or may not be trained by professional trainers using the DTCC facility during initial training stages before undergoing the testing process (developed and assessed from Phase I). Elective final preparation at the DTCC prior to taking the certification test would be recommended but not required. The certification testing would be conducted using the DTCC facilities. Those teams that pass the

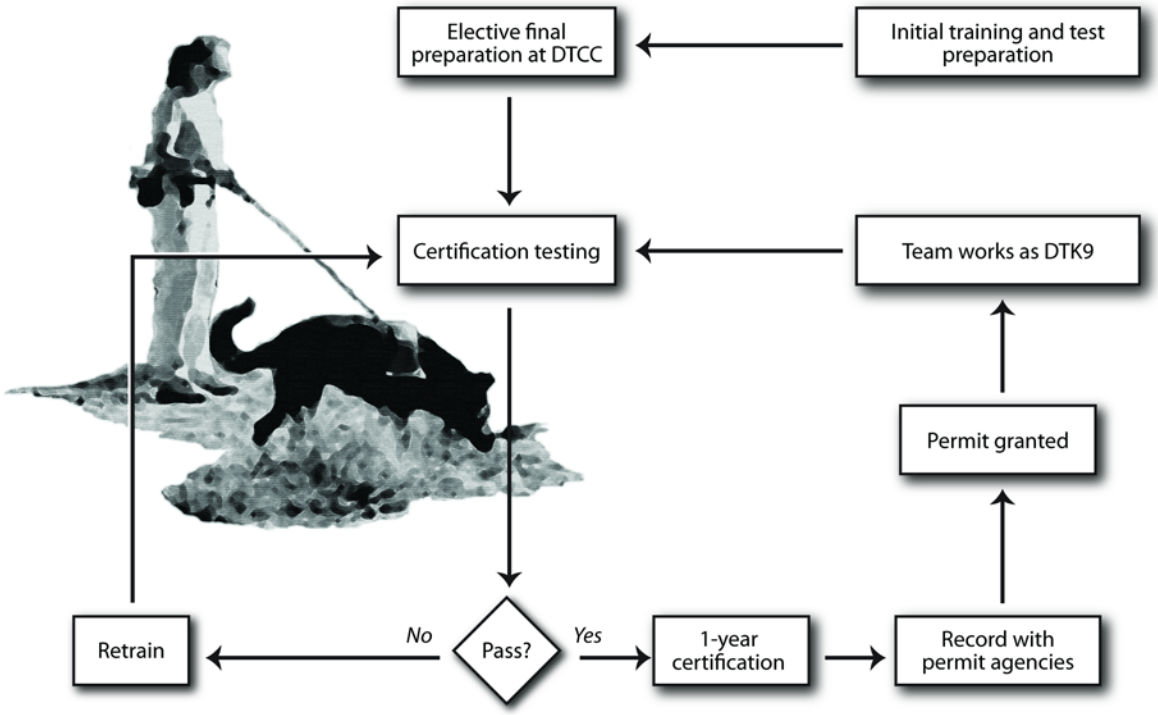

Figure 11. This flow chart shows the process for achieving status as a permitted DTK9 team, certified for consideration to be permitted, and thus deployed for work, by the permitting agencies.

tests would receive documentation to submit to the permitting agencies (e.g., USFWS and appropriate state agency) with permit applications to conduct work involving desert tortoises using dogs. This is complementary to the process for permitting human surveyors as an individual's *curriculum vitae* (CV) is required documenting specific desert tortoise handling and related experience. Documentation of passing the certification test for desert tortoise is the equivalent to a dog's CV in that it shows that the team was able to meet a minimum level of proficiency and maintain safety while surveying. Teams that did not pass would be unable to provide documentation to permitting agencies and would require retraining before attempting the certification test again. We recommend that dog teams that are granted permits to work with desert tortoises be considered 'certified' for one year and should pass the testing regime annually to maintain current status for permitting purposes.

The chronological development of the DTK9 technology began in 2002 with the initial idea of using dogs to find desert tortoises arising out of the need for an additional survey tool and is diagrammed in Figure 12. The first two years involved non-field efforts putting together a qualified team to conduct the initial pilot study and securing permits for the research. The first pilot study pairing dogs and tortoises was conducted in April 2004 and the chronological sequence of research and development is detailed as follows.

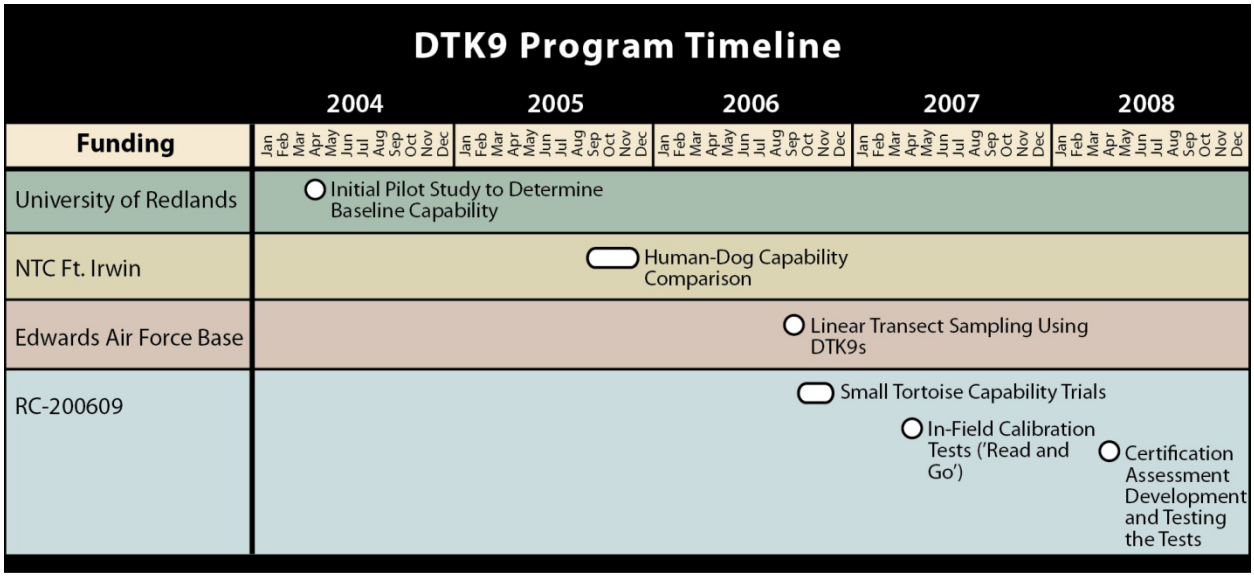

Figure 12. Chronological sequence of DTK9 development from 2004 to present. The sponsor for each progression is shown by color. Most of the research and development was sponsored by DOD.

April 2004: Initial Pilot Study to Determine Baseline Capability

The pilot studies were conducted at the DTCC to provide a proof-of-concept verification that dogs could be trained to find desert tortoises (Figure 13). The pilot study focused on safety and used quantitative metrics of efficacy and reliability to determine success. Professional wildlife-scat detection dogs were evaluated for participation in the project. Initially five dogs were evaluated, two of which were subsequently selected for participation in the research. Safety

Figure 13. A handler rewards her dog for finding a tortoise while field technicians collect data during the 2004 pilot study.

concerns with three of the five dogs resulted in their being excused from the program. Of interest was that the dogs rejected for safety reasons were deemed 'certified desert tortoise dogs' by the trainer/owner. The two dog teams that participated in the trials returned greater than 90% find rates of adult tortoises and could do so safely under the semi-natural conditions at the DTCC. The dogs found five very small tortoises less than 60mm MCL, although these finds were not part of the designed research trials. Nonetheless the finds provided the first evidence suggesting dogs might be capable of locating small desert tortoises. The results of this pilot research, published in Cablk and Heaton (2006), were positive and the next phase of development, a human-dog capability comparison, was funded by the NTC Ft. Irwin through the US Army Research Office.

September – November 2005: Human-Dog Capability Comparison

Having completed the proof-of-concept the next step in the DTK9 development was to compare the effectiveness of dog teams with that of human teams surveying for desert tortoises in the natural field setting. DTK9 training was conducted at the DTCC and the field comparison was conducted at the NTC Ft. Irwin Southern Expansion Area. A call for handlers was released that

targeted dog handlers with a background conducive for the work. Primarily, dogs trained in search and rescue applied. DTK9 teams were trained at home using methods described in Cablk and Heaton (2005) and then brought to the DTCC, where they transitioned to live tortoises and subsequently completed a twelve-day training and testing program. The training focused on adult and sub-adult tortoises. Limited training was provided on tortoises smaller than 110 mm MCL. Of the ten DTK9s evaluated at the DTCC six were selected based on capability and safety. These six DTK9s were fielded at the NTC Ft. Irwin as the 'dog' team against which they competed with the 'human' team. The comparison used six dog teams versus 10 humans (Figure 14). Each team surveyed a total of 10 km^2 (the same geographical area) over five weeks, making two complete passes of the area. The data from 'dog' and 'human' surveys were compared. Dogs and humans performed equally well at finding desert tortoises under the ambient conditions present at the NTC Ft. Irwin during that time period, with a probability of detection for either humans or dogs approximately 0.70. Dogs were found to have higher find rates for tortoises in shrubs. They were also able to complete the equivalently-sized search areas to humans' significantly faster, although this was not shown to be a true advantage over humans since the dogs could not work additional areas in a day. The results of this work are published in Nussear et al. (2008).

Figure 14. The 2006 human-dog comparison team consisted of six DTK9 teams and 8-10 human surveyors in addition to the scientific research team. Photo credit: Todd Esque

September 2006: Linear Transect Sampling Using DTK9s

In 2006 DTK9 teams were used to collect data for a comparison with results from standard line-distance sampling efforts conducted by USFWS on Edwards Air Force Base, CA. Four DTK9 teams surveyed the same linear transects previously surveyed by line-distance sampling teams

(humans). Figure 15 shows one of the DTK9 teams preparing for a survey. The implementation of the activity in the field seemed to work well with the exception of individual navigation problems involving long distances over linear transects. However the results were ambiguous and few tortoises were found (Cablk et al., 2007).

Figure 15. A handler prepares her dog for surveys in 2006.

Expected applications of DTK9 teams are limited to Mojave Desert tortoise, although it is possible that with some adjustment in training and in search strategy they could be deployed to search for Sonoran desert tortoises as well. Under the current training and testing regime DTK9 teams would be appropriate for surveys where the objective is to locate live Mojave Desert tortoises. This might include clearance surveys, assistance with mark-recapture and telemetry studies, demographic surveys, and also to assist in locating hatchling and juvenile tortoises where nests recently hatched or in the vicinity of numerous females of reproductive age. DTK9 teams would be useful to locate tortoises for studies involving health assessments, genetic surveys, and identifying gravid females, among others. They may be fielded in conjunction with human survey teams or as a stand-alone approach although handling of desert tortoises is expected to be outside of the responsibility of the handler. The degree to which DTK9s can readily transfer to other tortoise or turtle species is unstudied however it has been shown in other detection dog disciplines that once a dog learns one target odor, learning additional target odors

is accelerated. It should not be assumed, however, that because a dog has certified to tortoise odor that it would be successful at locating other tortoise or turtle species without additional training.

2.2 DTK9 DEVELOPMENT

Section 2.1 presents a chronological summary of the development of DTK9 teams to the beginning of RC-200609. The work conducted under RC-200609 encompasses three years of additional development and the final demonstration of the technology. The funded work included focus specifically on dog teams finding small tortoises using rigorous experimental approaches, field experiments with small tortoises *in situ*, advancements in training protocols and deployment, development of a certification test, administering and validating that test, and final demonstration of DTK9 capabilities to locate all size classes of tortoises in the natural environment and expected densities using quantitative and qualitative performance metrics. Significant changes in the deployment of dog teams were made during the course of RC-200609 based on advancements in understanding of search strategy optimization for small target odor coupled with safety aspects, which in turn expanded the range of conditions under which dogs can be fielded.

<u>October – November 2006: Small Tortoise Capability Trials</u>

All development of DTK9 teams up until 2006 had been primarily on adult or sub-adult desert tortoises. DTK9s had not been shown to be able to locate the smaller size classes of tortoises with any certainty. Training specifically on small tortoises had not been integral to the training program for a number of reasons including availability of small tortoises for use in training at the DTCC, safety concerns, and time and cost constraints. Because the previous studies had provided mixed results on small tortoises, the first step was to undertake a rigorous approach to test DTK9 team capability for the smallest size classes. Several possibilities existed to explain why the DTK9 teams were unsuccessful at locating small tortoises during the 2005 human-dog comparison. These included:

- Small tortoises were not present in the study area;
- The dogs had not generalized ‘tortoise’ odor across all size classes;
- The dogs had not been taught a complete odor signature that included the smallest tortoises;
- Search strategy was a limiting factor for detection;
- Other unknown factors.

It was known that one hatchling tortoise was present during the time a DTK9 team was searching during the 2005 NTC Ft. Irwin effort, as it was located by an observer not involved with the study. Although it was anticipated that the DTK9 teams would find small tortoises the DTK9 team searching in the vicinity where this small tortoise was observed did not find it. Humans did not find small tortoises either. Ultimately the number of small tortoises present during the surveys and how many were missed by either team was unknown. There was no remedial action that could be taken to address a lack of tortoises being present in future efforts. Similarly, the last possibility of ‘other unknown factors’ was irresolvable.

The remaining three possibilities were factors that could be addressed through additional research and development, specifically in terms of training. This is where RC-200609 focused efforts to complete the development and demonstration of DTK9 capability.

To begin to address the remaining possible influential factors, a training program was designed specifically for small desert tortoises. Because the odor signature that dogs recognize as 'tortoise' is unknown, the overlap between adult and juvenile and hatchling tortoise odor was and still is, unknown. However it is not necessary to know the volatile organic compound signature of a dog's target odor to train the dog for that target odor. The training program drew four of the six DTK9 teams from the previous field season at the NTC Ft. Irwin. These teams were already trained and accomplished at conducting field surveys for desert tortoises and presented a low safety risk. Dog breeds used included one Labrador retriever-mix, two German Shepherd Dogs (GSDs), and one Australian kelpie.

The training program focused entirely on the smallest size classes of tortoises. A total of 21 different tortoises between 52-84 mm MCL were used over the course of the training. Training began with basic odor recognition exercises with dogs worked on leash and tortoises placed in small protective cages approved for use by the USFWS (Figure 16). These small protective cages allowed for air flow while providing partial shade so that the tortoise could thermoregulate. The dogs were able to smell the small tortoises without coming into direct contact with them reducing risk. Initially the alert was cued by the handler (Figure 17).

Figure 16. Cages designed for training odor recognition of small tortoises were held in place by rocks and always attended by at least one tortoise biologist.

Figure 17. A DTK9 sniffs the cage with small tortoises (upper image) and then performs its trained alert (lower image).

The next progression followed standard detection dog training methods involving scent box line ups (e.g., Mistafa 1998; Appendix C). The scent boxes were plastic totes with a hole cut into the lids to allow a dog to sniff inside the tote while maintaining a physical barrier to the tortoise for safety. Only a proportion of totes contained a tortoise. Totes that contained tortoises were stored

separately from those that did not contain tortoises to prevent contamination of non-tortoise totes. Non-tortoise totes were stored off-site of the DTCC to prevent cross contamination. Totes were placed either in a linear display (Figure 18) or in a circular arrangement (Figure 19). With the circular arrangement the dog could continue to sniff totes without interruption or learning which position held the positive (tortoise) tote. Dogs were worked on leash and the handler presented the hole in the tote for the dog to sniff. This was conducted until the dogs were able to correctly and independently alert ('sit').

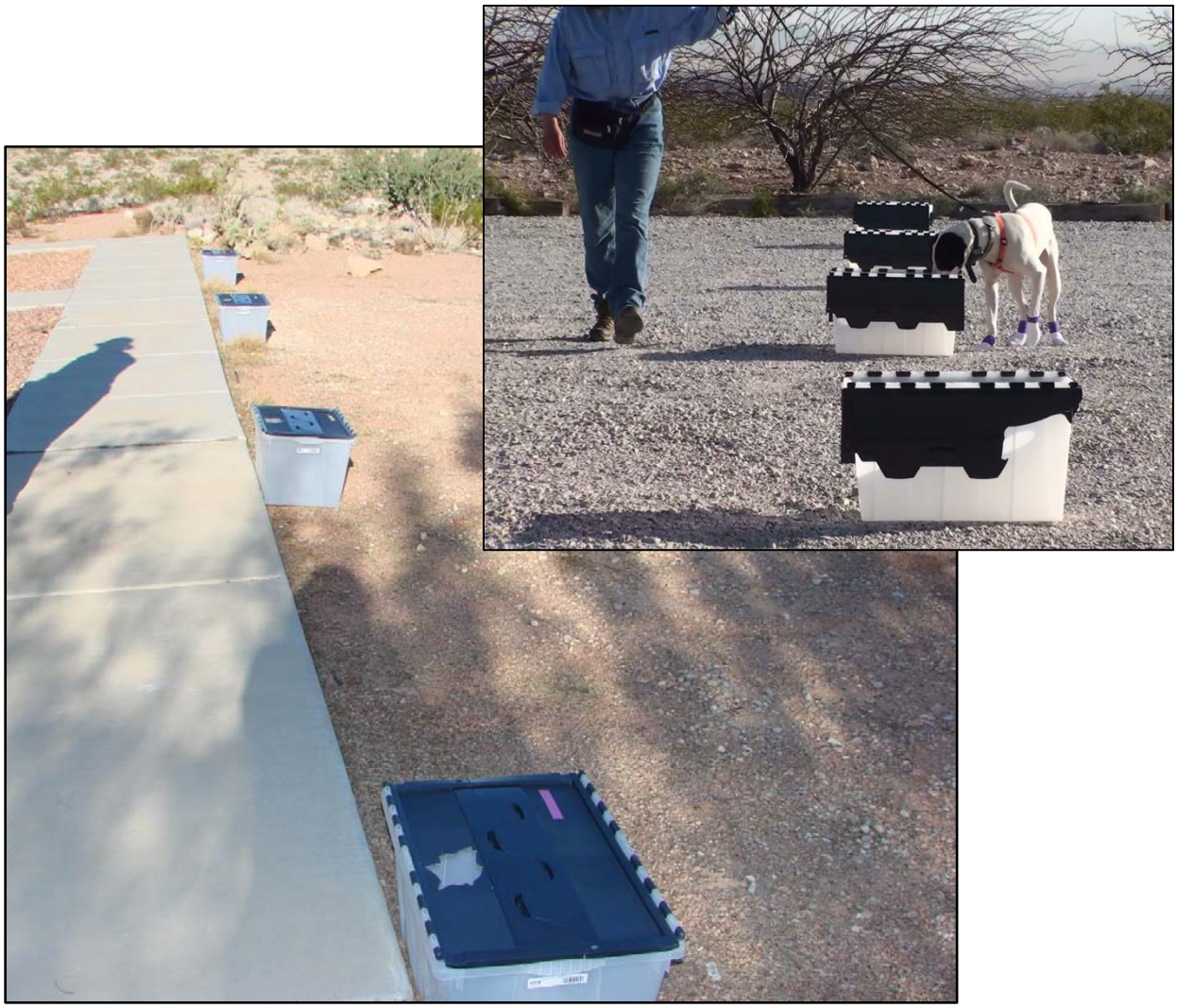

Figure 18. Totes placed in a line-up contained a tortoise or did not contain a tortoise. Different color tape indicated to the handler whether or not a tortoise was present.

Figure 19. Totes were also placed in a circular arrangement so that there was no defined start and stop point to the dog.

Other methods designed to simulate small tortoises in burrows were evaluated and discarded. These included use of polyvinyl chloride pipe to create a burrow matrix. The training next progressed to presenting tortoises to the dogs directly, without barriers. This was accomplished with strict control over the location of the small tortoises, which involved assigning one tortoise biologist to each small tortoise, who tracked its location at all times. The dog worked on leash and the handler knew the location of the tortoise (Figure 20). These exercises facilitated setting an alert distance for the dog so that the dog was taught to sit one to two feet from the small tortoise.

Once the dogs were actively searching for, safely locating, and performing independent alerts on small tortoises the experimental trials began. The four objectives for these experimental trials were to quantify: (i) efficacy, (ii) reliability, (iii) within-dog variability, and (iv) among-dog variability of DTK9 teams at finding small desert tortoises under semi-natural conditions in a controlled environment. Efficacy and reliability are not necessarily related, but together show the capability of a DTK9 team. Variability within and among DTK9 teams distinguishes the performance levels of individual dogs, and quantifies the consistency of dogs as a survey resource. At the DTCC, two 100 x 100 m pens were identified for testing and then cleared of tortoises for use in the trials and divided into four 50m x 50m quarters. Two different size search areas were used, 50 x 50 m (0.25 ha) and 100 x 100 m (0.5 ha).

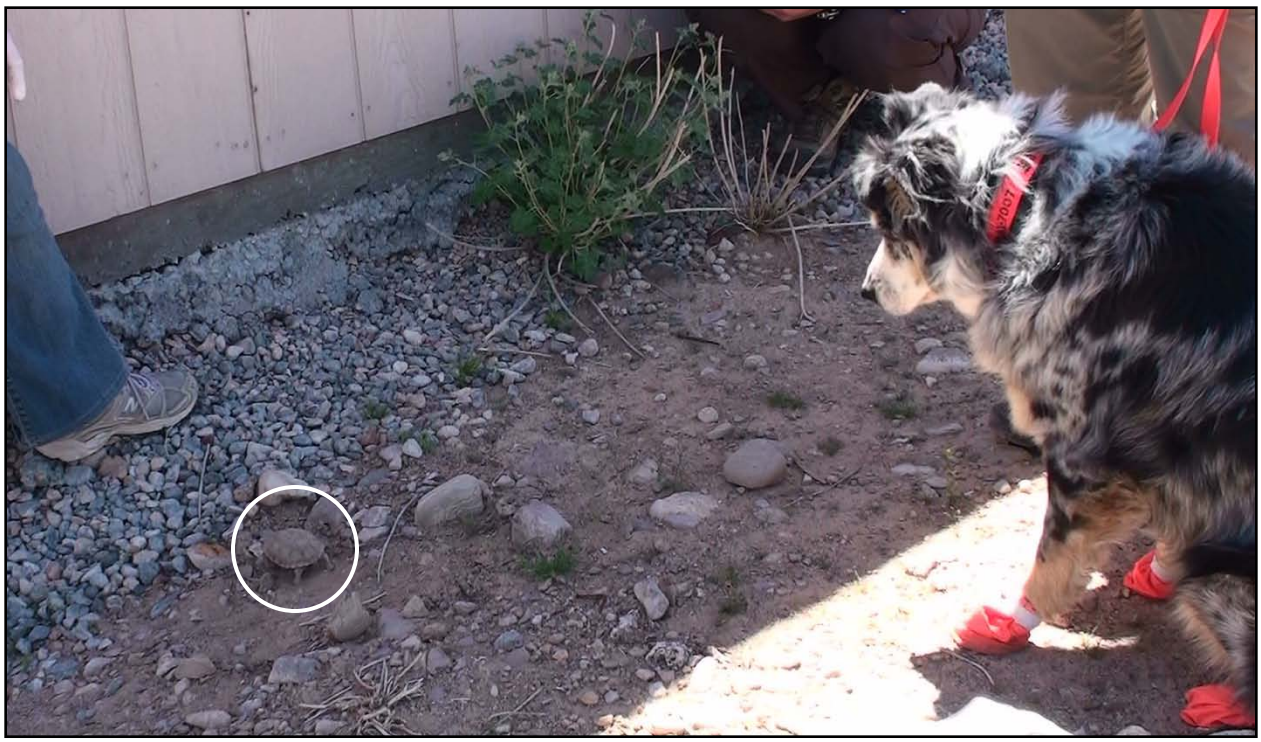

Figure 20. Introduction of the dogs to small tortoises is done with complete knowledge of the location of the tortoise by all people involved in the training activity. A small tortoise is identified in the white outline.

Using estimates of variance from the 2004 study, it was determined that the effect size at the 80% power level was a sample size of 56 and then determined the effect size that could be detected, which would correspond to a 10% difference in between-dog variability. A minimum of 10 tortoises were used per trial, so that the increments of efficacy were 10% or smaller. Because the standard deviation of efficacy calculated on actual trial data after 14 trials was less than 5%, the search area was expanded from 50 x 50 m plots to 100 x 100 m plots, holding the number of tortoises placed in a plot constant. At a standard deviation of <1%, $\alpha = 0.05$, and $\beta = 0.74$, it was possible to detect a 3% difference between dogs. Increasing the search area size to 100 x 100 m allowed us to quantify efficacy, reliability, and within-dog and among-dog variability under controlled experimental conditions with a lower tortoise density. Decreasing the tortoise density also began the process of moving the DTK9 teams towards survey efforts on the desert tortoise population densities expected under natural environmental conditions.

A total of 20 trials were conducted between 29 October and 12 November 2006. Forty-three tortoises were placed in two configurations on the landscape, either in a burrow or under a shrub. The tortoises used in the trials ranged in size from 54 - 81 mm MCL and had been withheld from training exercises thus were not previously encountered by the dogs. Placement of tortoises on the surface posed significant risk to safety both from a direct impact from feet or paws and from potential temperature limitations, and was thus not an included configuration. To ensure that tortoises remained where they were placed, each tortoise was packaged in a fine wire mesh screen. The screen cage allowed for minimal movement. Placements were sited at spatially random points in the DTCC test plots.

Data were recorded using Trimble GPS data loggers (Figure 21). Start and stop times were recorded at the handler's notification that they were either beginning or had completed each of three different search passes: perimeter, detail, hasty. Pen identification number, phase number, trial number, team, dog name, search pass, and whether or not the dog was on lead or off-lead were recorded. When a handler determined her dog had located a tortoise, the data recorder recorded the time, the configuration, whether the dog performed its trained alert or if the handler made the call based on change of behavior, and whether it was a confirmed find (CF) and a tortoise was present or a non-productive alert (NPA) where no tortoise had been placed that day. Once the handler had completed the trial all tortoises that were missed and their location was recorded.

Figure 21. Field technicians collect data on a tortoise found by a DTK9 during the trials.

Results are presented in Table 1. Overall the DTK9s were 98% accurate for finds and misses. They were 94% accurate on the basis of finds, misses, and non-productive alerts. Overall, the DTK9 teams were 85% reliable. They located 98% of the small desert tortoises placed at the base of shrubs and 97% of the desert tortoises placed in burrows. There was no significant difference in efficacy across the DTK9s for the 0.25 ha trials, (X^2 = 2.68, n = 56, p = 0.44), but a significant difference in efficacy was observed for the 0.5 ha trials (X^2 = 9.35, n = 24, p = 0.03). It should be noted that the mean range of efficacy for 0.5 ha trials for the four dogs was 93% to 99%. Although the test had sufficient power to determine a statistically significant difference in performance between a 93% dog and a 99% one, all dogs performed exceptionally well from a practical perspective and would not be considered unsuitable for fielding as a result of being 'only' 93% accurate.

Table 1. Summary of results for 2006 DTCC trials for DTK9 teams on small tortoises. CF = 'confirmed finds'. Efficacy = finds and misses; Reliability = trained alerts for CF; overall = CF, misses, and NPA of total available to be found.

Team	CF	Misses	Efficacy	Reliability	Overall
1	209	5	.9766	.9569	.9045
2	202	8	.9619	.7624	.9484
3	215	1	.9954	.9116	.9598
4	201	7	.9633	.7662	.9526
Combined			.9752	.8513	.9414

Results for within dog reliability are presented in Table 2 where dogs were found to be variable in their consistency in performing trained alerts. There was no relationship between encounter number and trained alert nor was there a relationship between the location of a particular tortoise and whether or not the dog alerted.

Table 2. Summary of within dog variability in reliability for each of the trial sizes.

	0.25 ha (df = 13)			0.50 ha (df = 5)		
Dog	reliability	X^2	p	reliability	X^2	p
1	92.11	11.29	0.59	97.93	19.27	0.002
2	93.22	41.84	<0.001	66.43	2.13	0.83
3	95.59	26.69	0.014	89.19	14.65	0.012
4	91.67	32.34	0.002	70.21	7.87	0.16

The dog teams found more than 98% of the tortoises placed in shrubs and almost 97% of those placed in natural burrows. Neither of the two tortoises in artificial burrows was missed. Table 3 presents these data. In the 0.25 ha plot trials dog teams found almost all of the tortoises during their detailed search pass. In the larger 0.5 ha plots just over 40% of the tortoises were located during the perimeter pass and more than half were found during the detailed search pass. These results are presented in Table 4. Figure 22 shows an example of the GPS track data and tortoise location data collected during these trials. In this figure the blue dots are the GPS location of tortoises. It is possible to identify the location where the dog was rewarded as indicated by a highly dense track near to the location of a tortoise.

Table 3. Number of tortoises placed and found over the course of 20 trials at the DTCC by configuration.

Location	Number found	Percent found	Total placed
Shrub	419	98.36	426
Natural burrow	406	96.97	420
Artificial burrow	2	100	2
Total	827		848

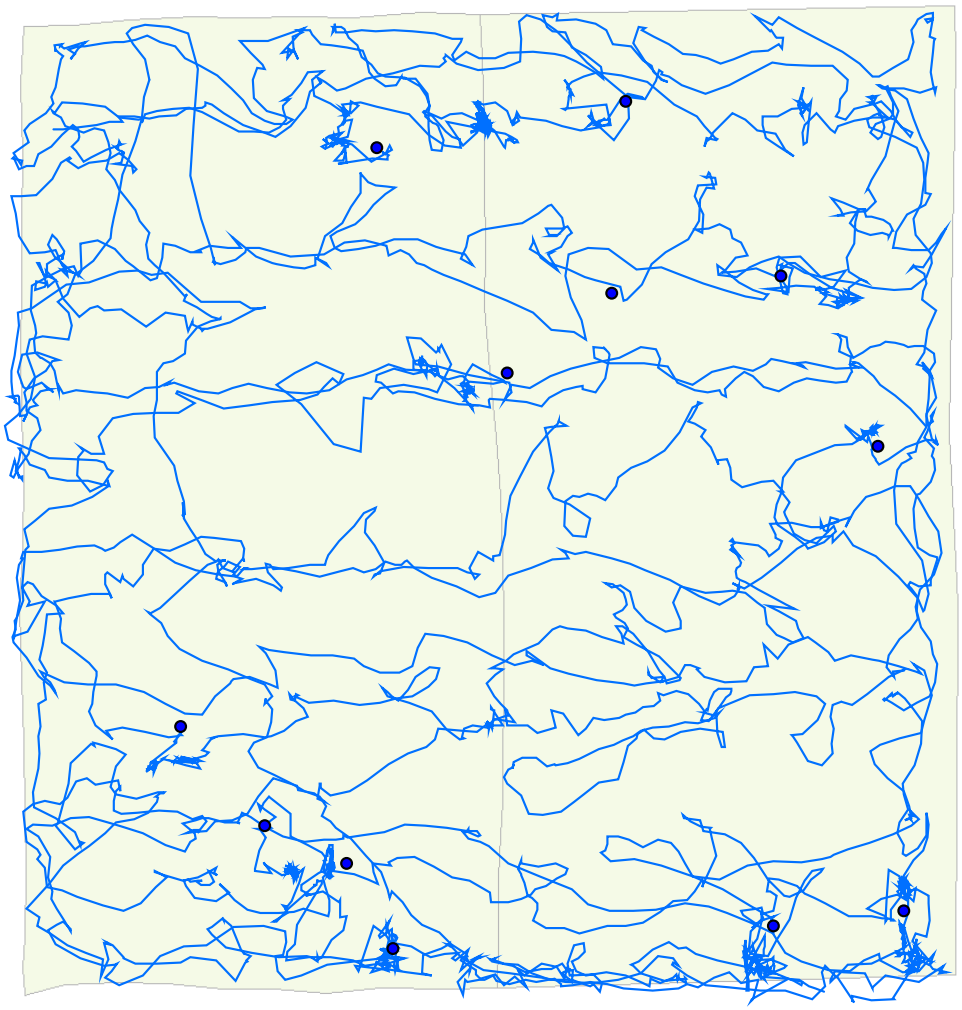

Figure 22. Example GPS track from one of the dogs during trial number 20.

Table 4. Tortoise find results by search pass. Perimeter search was not executed on the 0.25 ha plots.

	0.5 ha		0.25 ha		all	
	Count	Percent	Count	Percent	Count	Percent
Perimeter	109	43.43	-	-	109	13.18
Detail	136	54.18	554	96.18	690	83.43
Hasty	6	2.39	22	3.82	28	3.39

Table 5 presents the time data for all teams to complete each of the three passes to cover their search area in the trials. Table 6 presents the results of distance traveled and time worked as recorded during the trials. DTK9 teams were able to cover 0.25 ha in approximately 30 minutes and as would be expected, covered 0.5 ha in just over an hour on average. One way ANOVA was used to test for differences in total time worked by trial and total time worked by DTK9

team. Total working time did not differ across trials (0.25 ha: $F(13,42) = 1.31$, $p = 0.243$; 0.5 ha: $F(1,6) = 0.07$, $p = 0.802$). For 0.5 ha plots there was no difference in time to complete surveys between DTK9 teams ($F(3,4) = 0.91$, $p = 0.513$) however for the 0.25 ha plots one DTK9 team differed significantly from each of two other teams ($F(3, 52) = 6.96$, $p < 0.001$).

Table 5. Mean time for DTK9 teams to complete surveys by pass. Perimeter search was not conducted for the 0.25 ha trials.

	Time (min)	
Search Pass	0.25 ha	0.50 ha
Perimeter	-	0:30:34
Detail	0:37:37	1:15:38
Hasty	0:09:19	0:21:30

Table 6. Distance covered and time summaries.

	0.25 ha		0.50 ha	
Dog team	Mean distance (km)	Mean time	Mean distance (km)	Mean time
1	2.1 ± 0.3	0:31:34	5.0 ± 0.9	1:26:10
2	2.4 ± 0.4	0:24:56	5.1 ± 0.9	0:57:30
3	2.5 ± 0.3	0:34:13	5.4 ± 0.9	1:11:40
4	1.7 ± 0.3	0:28:34	5.1 ± 0.9	1:06:50
All	2.2 ± 0.4	0:29:49	5.2 ± 0.8	1:10:33

The four DTK9 teams were then fielded at the NTC Ft. Irwin Study Site (FISS) from 15 to 19 November 2006 to determine their capability in locating small radio frequency transmitter-bearing desert tortoises under natural field conditions and tortoise densities (Figure 23). As part of an ongoing study by Dr. Ken Nagy of the University of California Los Angeles, a small population of juvenile desert tortoises had been transmittered, released and allowed to disperse freely for up to 3 years prior to our test. These tortoises were part of an ongoing 'Head Start' research project and had been living in the natural environment with transmitters for most of their lives. The FISS is the only location on military land in the Mojave where small tortoises with transmitters and known locations were available for use. Because these small tortoises were part of other research projects they could not be disturbed for the purposes of this study and for this reason repeated surveys over the areas were not possible. However, a preliminary snapshot about whether or not the DTK9 teams could find small tortoises under natural environmental conditions was gained. Dr. Nagy provided information on transmitter radio-frequencies, last known locations, and biological information (i.e. size and sex, if known, etc.) for these tortoises. The small population size of small desert tortoises at the FISS permitted only the acquisition of descriptive performance statistics. DTK9s were assigned to ~1 ha areas of various side dimensions in which 1 to 4 tortoises were known to be present.

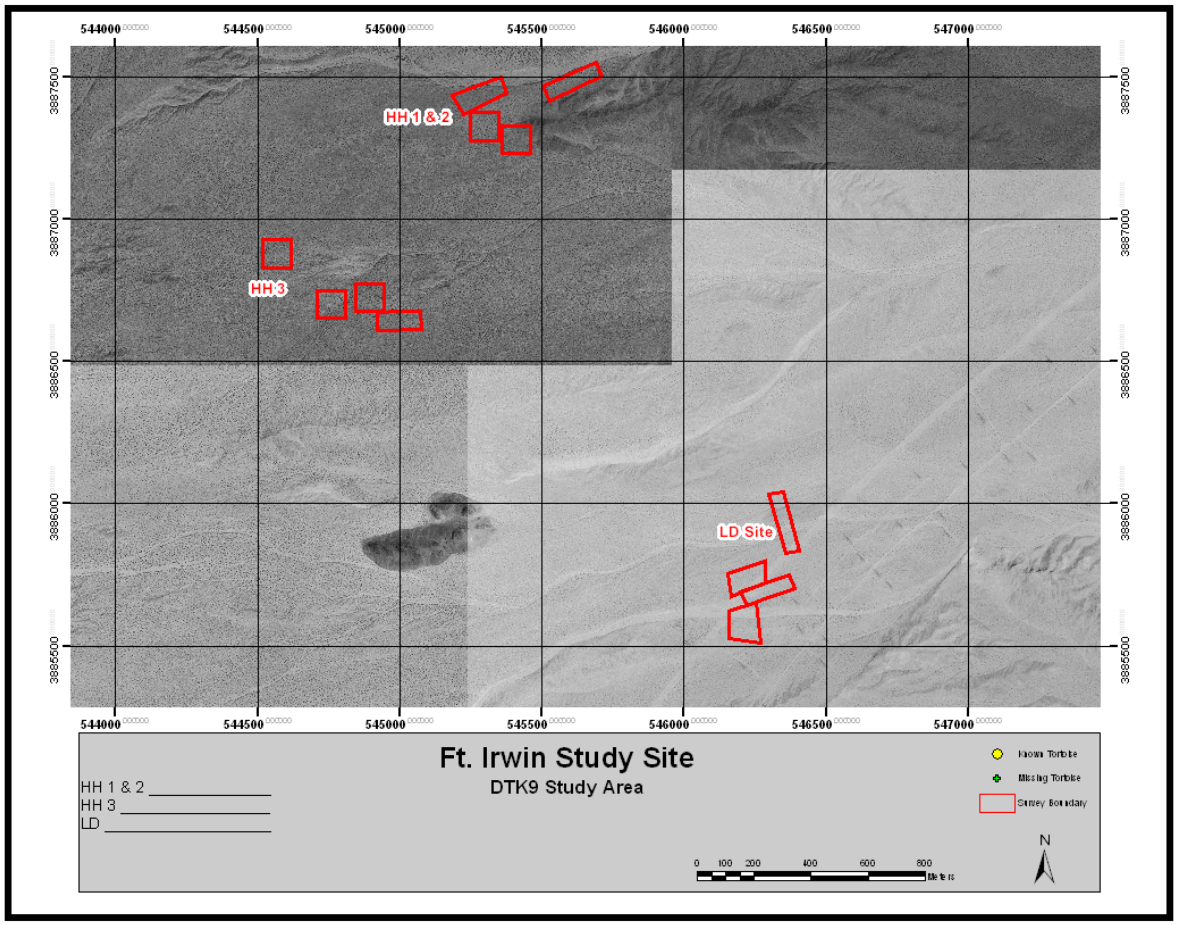

Figure 23. Survey areas at the FISS overlaid on Digital Ortho Quads.

The dogs performed collectively at a maximum of 50% effectiveness, which was much lower than the results from the DTCC trials recorded immediately prior to fielding at the FISS. On the first day at the FISS the DTK9 teams found no tortoises. Additional training was conducted on day 2 and resulted in an improvement of performance on day 3. Without training between day 3 and day 4, performance decreased. These results are presented in Figure 24.

Given the success demonstrated at the DTCC these results were unexpected. A number of possibilities were identified as potential confounding factors that might have affected the teams' performance. These related to environmental conditions, time of year, and physiology of the tortoises, among others. Two factors were identified as having a high degree of impact on the FISS field trial results that could also be mitigated through a different preparation schedule prior to fielding: (i) minimize extraneous odors in the dog's recognition of the odor signature 'tortoise'; and (ii) maintain team calibration in a search environment where targets are unverifiable and occur in very low densities. Other possible factors such as weather, tortoise physiology, or airflow dynamics of burrows were deemed uncontrollable from training and testing perspectives. A follow-on study was designed and an additional field season, focused on DTK9 training (including minimization of tortoise handling) was scheduled at the DTCC for April 2007 to address the issues raised by the FISS test.

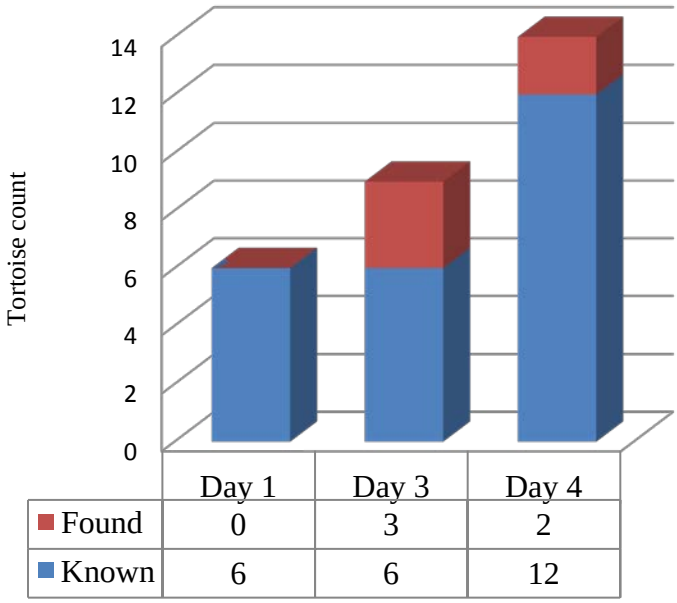

Figure 24. Data from FISS trials. 'Found' is the number of tortoises located by DTK9s and 'known' is the number of tortoises available to be found in the survey area.

April 2007: In-Field Calibration Tests ('Read and Go')

Two of the four teams from the fall 2006 FISS study returned to the DTCC in April 2007 and participated in a modified training protocol. This new training protocol was developed to address the potential issues that were identified in the previous field season at the FISS in November 2006. In the 2006 experiments at the DTCC the tortoises were handled heavily and maintained in small cages to enable a rigorous experimental design with repeated measures while simultaneously protecting the tortoises. While this provided for good statistical power it undercut the research because it resulted in the dogs being tested on an expanded odor signature rather than solely on small desert tortoise target odor. There is a simple and logical explanation for what occurred. At the DTCC during the experimental trials each of the dogs was reinforced more than 200 times in 15 days on an expanded target odor signature that included: live human odor, latex glove, mesh screening, staples and safety pins, alfalfa, plastic tote, and live tortoise. These were all of the constituents associated with the care, protection, and necessary handling of the tortoises to enable execution of the sound research design. The lesson learned was significant.

Another factor that affected the results from fall 2006 was that transitional training was not conducted for the dogs or their handlers between the DTCC and FISS deployments. For the dogs the transitional training would have been to minimize if not eliminate the background non-tortoise odors, and to reinforce live tortoise odor. For handlers the transitional training would have included preparation for a drop in find rate, which had already been documented in previous work. The impact of all of these factors was not understood during implementation by the investigators but in hindsight, and with a better understanding of odor detection and reinforcement in dogs, it now seems obvious. The impact of dramatic shift in team performance on handler was completely unexpected. Having been so heavily reinforced to identify an

expanded target odor signature it is not unexpected that the dogs were unable to correctly identify small, unhandled tortoises in the natural setting. This was not their target odor signature. Seeing the drop in their dogs' detection rate without understanding why was devastating to the handlers, which in turn affected the dogs.

Under natural conditions DTK9 teams can work for days without finding any tortoises. When the dog performs its trained alert at a burrow the handler does not have an opportunity to investigate the burrow and therefore the dog will not be given its reward. Correct behavior by the dog extinguishes in the absence of reinforcement. Reinforcement can only be given when the answer is both known and the dog is correct. The handler risks reinforcing non-target odor and false alerts when rewarding the dog in the absence of certainty that a target is present. This is particularly problematic when the dog's target is usually subsurface, and as such its presence cannot be confirmed in an appropriate frame to reinforce the correct behavior of the dog. These problems were resolved with the development of an in-field calibration process using a variable-intensity reward system designed for low target density with unconfirmed alerts. This process was termed 'Read and Go' because the overarching objective as explained to handlers was that they read their dog's behavior, make their determination of target or no target, and continue on with their search strategy. Read and Go is the foundation of an operational DTK9 team (Figure 25).

In addition to the practical aspects of operant conditioning on the dog, there is a human element that plays a significant role in the dog's performance. This was learned over the course of RC-200609 and scientifically validated later by Lit et al. (2011). Handlers have the ability to bias their dog's performance simply by having a belief about targets in their search area. In the case of tortoise surveys what was particularly difficult for the handler was not being able to reward his or her dog when the dog had performed correctly (because they understood the importance of only rewarding the dog when target presence was confirmed); and secondly they succumbed to doubtful or negative thought patterns about their dog's abilities as time passed and their dog made no finds or performed its trained alert. This occurred without the handler having knowledge of presence or absence of tortoises. Their belief was irrelevant to the fact that tortoises may not have been present in their search area. When the handler had doubts about the dog, came to judgment about the dog's performance, or struggled with not being able to reward the dog, the dog was affected. The team became un-calibrated. Managing the handler mindset became a requirement for maintaining an operational team.

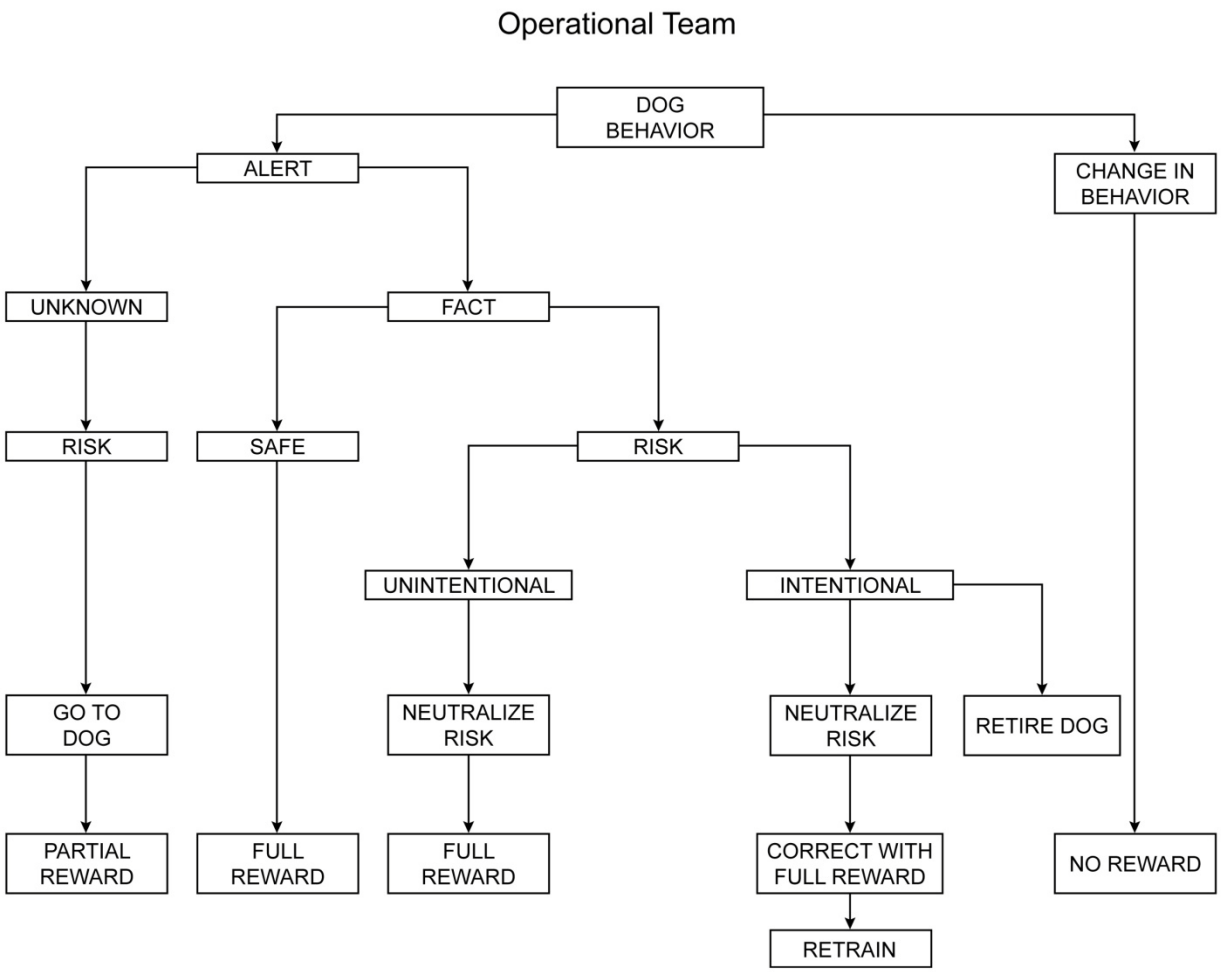

Figure 25. Process step flow chart that defines an operational DTK9 team operating with a neutral mindset in Read and Go.

An operational team functions using a rule-base decision tree termed 'Read and Go', as shown in Figure 25. Definitions of terminology are presented in Table 7. The handler implements this process based on the dog's behavior. Thus the process begins with the handler determining that the dog has exhibited a behavior, which will be one of two options – change of behavior or an alert (sit). If the dog exhibits a 'change in behavior' which is a revised term for what has been previously defined in Cablk and Heaton (2006) as 'body language' the handler continues the search pattern and the dog receives no reward. Change in behavior can occur for many reasons and may or may not be related to tortoise odor. The dog may exhibit a change of behavior because residual tortoise odor is present but the tortoise has moved on for example, or because the dog is simply interested in a novel odor that is unrelated to target odor. Rewarding change of behavior degrades the dog's training. A dog may exhibit a change of behavior in the presence of a tortoise as well, such as when the conditions present an odor signature at or near the dog's threshold, or an odor signature outside of the dog's generalized 'tortoise odor'. In these instances the dog may not perform its alert and the handler may request additional search efforts in the area. Examples when this might occur are in areas with small mammal burrow complexes where a small tortoise is deep underground.

Table 7. Terminology definitions for an Operational Team.

Term	Definition
Alert	The 'trained sit' that the dog performs at target odor.
Change in behavior	Dog behavior which causes handler to decide that an area needs to be re-searched for a tortoise
Unknown	Handler cannot confirm tortoise presence or specific location
Fact	Handler visually confirms tortoise presence and specific location
Risk	Tortoise faces potential harm from dog or handler
Safe	Tortoise does not face immediate potential danger and has been visually confirmed by the handler
Unintentional (Risk)	No motivation to cause harm by handler or dog
Intentional (Risk)	Inappropriate dog or handler interaction with a tortoise or burrow
Go To Dog	Dog holds the sit in place while handler moves to dog
Neutralize Risk	Verbal and/or physical process of minimizing harm to tortoise
Retire Dog	Permanent removal of dog from all tortoise detection w/consideration for other high-risk animate programs
Partial Reward	Dog receives validation from the handler that is neither food nor toy, for an indication where the target is not visually confirmed
Full Reward	Pre-determined food or play interaction between dog and handler
Correct with Full Reward	Neutralize risk with an action that causes dog to consider not repeating that behavior, such as physical collar correction and/or verbal
No Reward	When dog no longer exhibits change of behavior and leaves area, handler follows dog neutrally away
Retrain	Dog is removed from operation. Process for decreasing animation and negative behavior in the dog with the intention of becoming operational again

The other dog behavior option that a handler will recognize is the trained alert, a sit. When the dog performs the sit the handler determines immediately whether or not he or she can see a tortoise. If the handler cannot verify presence of a tortoise immediately they operate under the condition of 'unknown', regardless of whether or not a tortoise is present. A tortoise can be present and not visible for many reasons, including because it is behind the dog and blocked from view, it is in a shrub or in a burrow, and it is a very small tortoise and is moving, among others. When a handler cannot determine where the tortoise is located, the situation must be considered to have 'risk' because the possibility exists for the tortoise to be stepped on. It is also possible that the dog is alerting and no tortoise can be verified. In either situation the handler sees the dog's alert, cannot see a tortoise, operates under criteria for 'risk', and goes to the dog while the dog holds the alert in place. The reason the handler moves is because people are able to be cognizant of risk to a tortoise and can move cautiously. Once the handler reaches the dog, he or she delivers a partial reward, which is a prescribed petting regime (Figure 26). The handler stands next to the dog facing the same direction and delivers 30 seconds of long, slow, full body strokes. This partial reward is very important for maintaining the handler mindset. It allows the handler to interact with the dog in a positive manner. If the dog is correct and the tortoise is not visible (i.e. in a burrow) the dog still receives reinforcement for correctly performing the sit at target. If the dog is not correct it does not receive its full reward. In both instances, tortoise present or absent, the pet acts to shift the dog's behavior accordingly; either to try harder to sit

Figure 26. The partial reward of Read and Go demonstrated. Dog identifies tortoise is present (left) and prepares to sit. Dog stares at the small burrow while being given a partial reward (right) because there is a tortoise present.

and communicate the find to its handler when a tortoise is present, or extinguishes the behavior when a tortoise is not present.

When the dog performs its alert and the handler can see the tortoise the handler deems the situation to be 'fact'. A tortoise is present. In that moment the handler must determine if the situation is 'safe' or if there is 'risk'. A 'safe' determination is made when the reward process can occur without physical disturbance to the tortoise. When the handler sees the dog alert, sees the tortoise and recognizes that the dog can be rewarded away from the tortoise or its burrow, the dog is given its full reward. This reinforces the dog performing its trained behavior upon locating its target and maintains calibration of the team. The handler benefits from being able to engage in positive interaction and sees the dog working.

In some instances the handler may determine a tortoise is present but also recognizes potential 'risk'. Risk is then determined to be either 'unintentional' or 'intentional'. Unintentional risk is when the possibility exists for a tortoise to be stepped on, flipped, etc. simply by its proximity to either the handler or the dog. An example would be a tortoise that is very close to the dog, between the dog's front legs, or a dog sitting on top of a burrow with a tortoise in it. In the unintentional risk situation the handler will 'neutralize the risk' so that he or she can give the dog its full reward. Neutralizing the risk may involve physically moving the dog away from the

proximity to the tortoise or commanding the dog to hold its position until the tortoise moves itself out of the way. When the risk to the tortoise is thus neutralized the dog is rewarded and thus both handler and dog are able to maintain calibration.

It is also possible for intentional risk to occur, although this is expected to be a rare instance due to the heavy screening process for dogs. Nonetheless there must be a complete process step to handle potential risk situations stemming from a dog. Intentional risk is when the dog interacts with a tortoise. It may stem from a desire to elicit a response from the tortoise to engage in play, a desire to provide a physical indication of the target location to the handler or it may stem from a desire to harm. If the dog's response is to harm the tortoise such as with the intent to kill, the dog is retired immediately. If the handler observes intentional risk such as desire to play with, they immediately take steps to neutralize the risk. This might involve a verbal correction (i.e., loud, stern "no!") and/or a physical correction in the moment of interaction. When the dog is in the sit position looking at its handler it is immediately given its full reward, to reinforce the correct and desired behavior, removed from the field and retrained. Retraining involves extinguishing the improper behavior at tortoises while reinforcing the correct behavior. It may be determined over the course of retraining that the dog should be retired.

At any time the decision branch may shift from unknown to fact, for example, or from risk to safe and vice versa. The handler continually operates under this simple, clear rule base to maximize safety to tortoises and maintain calibration of the team.

The development and testing of 'Read and Go' was conducted from April 18 - May 3, 2007. The overall objective of this field season was to assess and refine training protocols developed for small desert tortoises. The specific objective was to evaluate degradation in alert behavior in the dogs over time when given varying levels of reward for finding tortoises. The initial training included a systematic progression of assessing the dog alert process and safety around tortoises to fielding of dog teams at the DTCC with primary emphasis on small tortoises < 100 mm MCL. The dog teams were continuously evaluated over the course of the training period for safety and performance. Dogs were allowed to interact with tortoises at the DTCC under controlled conditions that progressed from dogs sitting next to caged tortoises to dogs searching for and then sitting next to free ranging tortoises on the surface, under shrubs, and in burrows. All dog activities were performed on-leash (Figure 27). This was the origin point for all DTK9 teams work on-leash and was established for safety and search strategy reasons.

Eighteen small tortoises were transmittered (Figure 28) and released into outdoor pens at the DTCC on April 12, 2007, prior to the dog teams' arrival (Table 8). This enabled human odor associated with the transmittering and handling of the tortoises to dissipate and allowed the tortoises to locate within pens naturally. The odor of the transmitters will be part of the reinforced signature but previous work had showed that dogs were not using transmitter odors as their primary target (Nussear et al., 2008). The dogs were trained on small to large tortoises with minimal handling. An additional 18 hatchling/juvenile tortoises without transmitters were used in the training assessment activities. These were captive tortoises that were over-wintered in the DTCC facility.

Figure 27. Working dogs on-leash was established as the rule during the 2007 field season to heighten safety to small tortoises and for more thorough search area coverage.

Table 8. Data pertaining to transmittered tortoises released at the DTCC in April 2007.

Transmitter	Tortoise size		Transmitter	Tortoise size	
Weight (g)	MCL (mm)	Weight (g)	Weight (g)	MCL (mm)	Weight (g)
1.2	57.4	40.9	1.4	69.5	62.6
1.2	54.9	33.3	1.4	73.3	72.3
1.2	60.1	43.9	1.4	70.0	67.1
1.2	53.1	32.3	1.6	86.1	110.9
1.2	66.6	44.0	1.6	77.2	64.7
1.2	59.1	40.0	1.6	79.3	88.5
1.2	55.2	36.2	1.6	70.1	67.1
1.2	65.3	49.7	1.6	79.2	80.3
1.4	71.7	73.8	1.6	82.3	97.6

Figure 28. Transmitters were attached to small tortoises in accordance with USFWS permit regulations (top images) and released into disease-free pens at the mouths of burrows (bottom image).

Handlers were taught the rule-base underlying 'Read and Go'. Upon completing this training, the teams participated in experimental trials that mimicked the conditions at the FISS site (except

that the population density of small desert tortoises was greater) to determine if their efficacy and reliability diminished over time with implementation of 'Read and Go'. Handlers worked two different search areas each day as an Operational Team using Read and Go. In the first area the number and size classes of tortoises was unknown. The second area contained transmittered small tortoises that were verified after the handlers completed their search and left the area. Tortoises were verified using telemetry which enabled them to remain unhandled and established in their self-selected location (Figure 29). Handlers were never provided with their response rates. The first areas were selected for having very low densities of tortoises. The second areas had only small tortoises and were used to assess the dog response in terms of alert behavior.

Figure 29. Small tortoise locations were verified via telemetry after DTK9 teams completed their search of the area.

The results showed that the dogs' alert behaviors did not diminish over time with the variable intensity reward system Read and Go (Figure 30). Neither dog had a significant change in proportion of independent alerts to non-alerts at tortoises over the course of the five days of testing (Dog 1 $X^2(3, n = 5) = 5.0$, $p = 0.172$; Dog 2 $X^2(9, n = 5) = 11.25$, $p = 0.26$). The dogs continued to present independent alerts and receive partial rewards over time without a significant increase in non-alerts. The implementation of Read and Go was consistent between the two handlers who were not significantly different in providing partial reward ($F(4,4) = 1.91$, $p = 0.547$) or full reward ($F(4,4) = 1.06$, $p = 0.957$) over the course of the trials. These results suggested that the use of Read and Go maintained the dogs' alerts and is a means to maintain team calibration in-field. Over the five days of trials the dogs readily located small desert tortoises in relatively uncomplicated presentations under bushes and in burrow entrances, but more importantly they also found the small tortoises deep in diminutive mammal burrow complexes, not readily visible and where digging was required to extract the tortoise. The dogs continued to present their trained alert over time with the variability in reward.

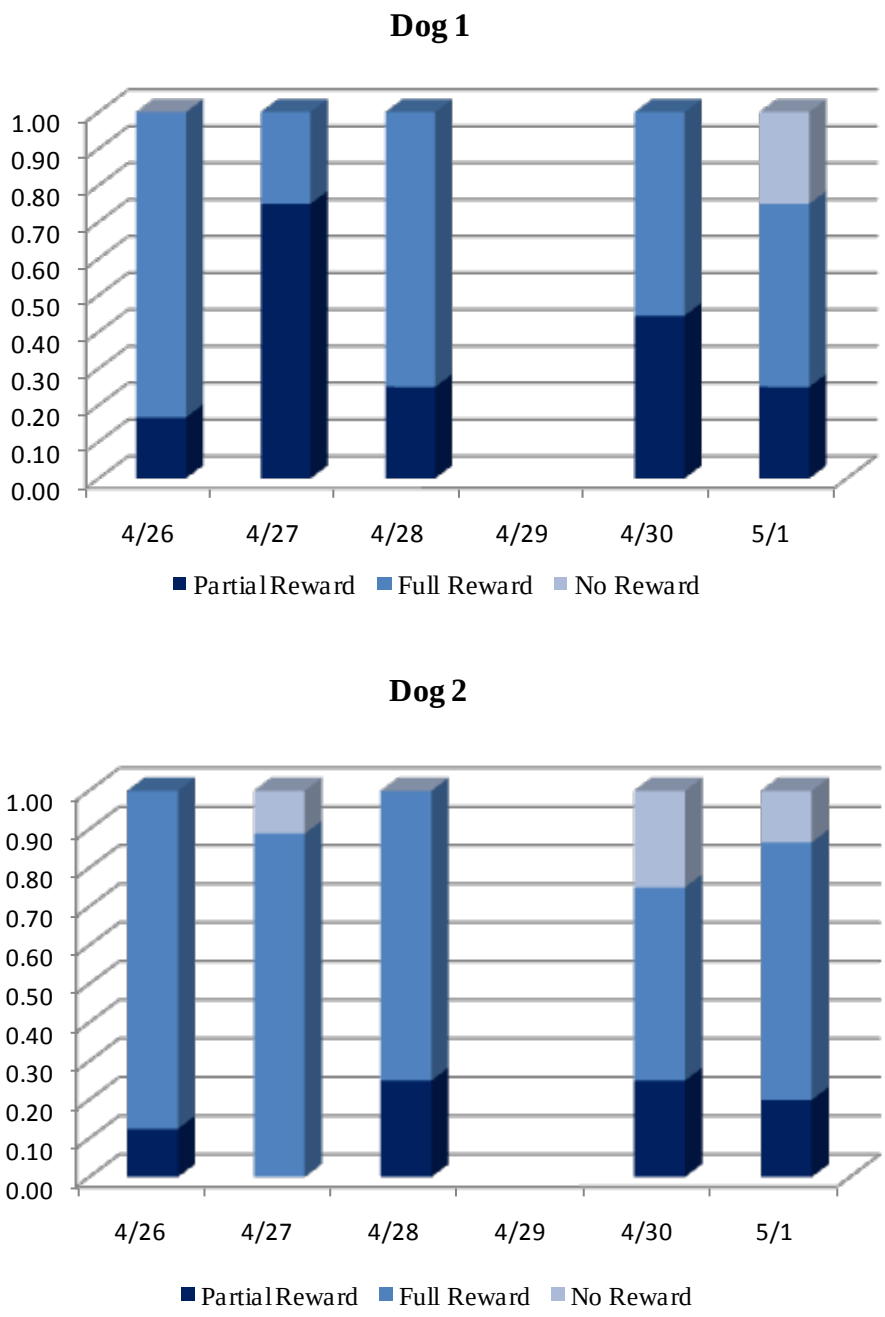

Figure 30. Results from trials testing Read and Go.

Meteorological data were recorded in one minute intervals using an Onset Hobo station during the time the DTK9 teams were training and testing. Due to unexpected circumstances the devices failed to record data after the evening of 27 April. The environmental conditions during the first two days of testing are presented in Table 9.

Table 9. Meteorological station data recorded for the time period when the DTK9 teams were participating in the trials on the first two dates. Rabbits ate the wiring of the data logging device on the evening of April 27 and no data were recorded after this date.

26-April 2007	**Dog = 1**				
Deployment time	**Metric**	**Min**	**Max**	**Mean**	**St. Dev**
0603 to 0827	Temperature C	15.65	22.63	19.21	2.57
	RH %	16.3	25.2	21.086	3.191
	Solar Radiation W/m^2	10.6	413.1	214	131.5
0852 to 1004	Temperature C	22.32	25.68	24.37	0.89
	RH %	14.5	17.4	15.582	0.736
	Solar Radiation W/m^2	333.1	739.4	637.0	88.4
	Dog = 2				
Deployment time	**Metric**	**Min**	**Max**	**Mean**	**St. Dev**
0605 to 0815	Temperature C	14.41	24.10	19.80	3.41
	RH %	16.8	25.2	21.435	3.014
	Solar Radiation W/m^2	11.9	413.1	210	124.4
0815 to 0937	Temperature C	20.39	22.11	21.29	0.44
	RH %	14.5	17.4	16.179	0.932
	Solar Radiation W/m^2	221.9	679.4	480.0	147.3
27-April 2007	**Dog = 1**				
Deployment	**Metric**	**Min**	**Max**	**Mean**	**St. Dev**
0605 to 0825	Temperature C	14.41	24.22	20.10	3.46
	RH %	20.2	32.4	25.532	4.313
	Solar Radiation W/m^2	16.9	453.1	223.8	131.2
0919 to 1041	Temperature C	25.45	28.02	26.55	0.70
	RH %	16.8	18.8	18.048	1.484
	Solar Radiation W/m^2	628.1	823.1	726	55.9
	Dog = 2				
Deployment	**Metric**	**Min**	**Max**	**Mean**	**St. Dev**
0610 to 0841	Temperature C	14.53	24.8	20.75	3.41
	RH %	19.9	32.2	24.732	4.265
	Solar Radiation W/m^2	25.6	506.9	257.8	143.2
0927 to 1110	Temperature C	25.45	31.20	28.54	1.56
	RH %	15.6	18.7	17.548	0.854
	Solar Radiation W/m^2	649.4	885.6	769	69

2.3 ADVANTAGES AND LIMITATIONS OF DTK9 TEAMS

As with any tool or method, there are advantages and limitations to using dog teams to find desert tortoises, particularly in the harsh desert environment. Based on the results from RC-200609, DTK9 teams could provide means to gather demographic data to meet regulatory and stewardship needs when trained and deployed properly. A cost-effective and efficient means of documenting the full desert tortoise population, and not just the adult segment, offers the

possibility of better understanding the reasons for the declining numbers of desert tortoise across the Mojave Desert. This is a specific technical advantage of DTK9s.

DTK9s have been shown to be better at finding tortoises in shrubs than do humans (Nussear et al. 2008) which has particular relevance since tortoises spend up to 20% of their time in shrub cover (second only to time spent subsurface). An assessment of human capability comparable to RC-200609 remains outstanding, making it difficult to directly compare DTK9 teams versus humans over the full range of desert tortoise size classes. Statistics on human find rates for tortoises ≥ 180 mm MCL are reported in US Fish and Wildlife Service range-wide monitoring reports. Humans have variable find rates for desert tortoises ≥ 180 mm MCL depending on level of training (U.S. Fish and Wildlife Service, 2010a). DTK9 team find rates also exhibit variability however the measurement range is over an expanded range of size classes.

While the use of DTK9 teams presents an opportunity to gather data on the missing desert tortoise demographic there are limitations to be considered. Along with demonstrating that the DTK9 teams can find small tortoises, results from RC-200609 have also determined deployment parameters, including realistic area coverage estimates to detect the smallest size classes of tortoises. Conducting surveys for small size classes of tortoises over expansive areas would require tens or hundreds of DTK9 teams due to the necessary methodical search strategy required to conduct searches at that level of effort. The cost of conducting such detailed survey efforts at a broad scale would be considerable. Finding the smallest tortoises requires more detailed searching, which means that less area can be covered in a given day. Larger areas will thus require either more time to be covered thoroughly, and/or additional DTK9 teams. Both of these options will increase costs. Surveying for the larger size classes of tortoises with DTK9 teams is expedient. Dogs can cover the same geographic area as humans in less time when searching for larger size classes of tortoises however they have not been shown to be able to cover more area per day than humans. Dogs can work into higher air temperatures when on leash than off leash, because their speed and subsequent energy expenditure can be controlled. However it is unknown if working on leash to survey for larger tortoises would expand or reduce the area that could be covered or the length of time worked because this was not specifically tested after 2005. Surface temperatures can be a limiting factor for a dog even with foot protection.

Although detection rates of adult tortoises by either dogs or humans have not been found to differ with environmental conditions (Nussear et al. 2008), the permitted cutoff temperature for handling tortoises as set by USFWS is 30º C (95º F). Humans work within this temperature by USFWS regulation regardless of cloud cover. By contrast, because of their limited cooling capabilities, dogs can work effectively only into the mid ~27º C (80º F) range in full sunlight. While dogs may work at higher temperatures in the absence of direct solar radiation (i.e. cloudy days), such conditions are not common in the typical Mojave Desert climate. For these reasons the length of survey season during warm months is more limited for DTK9 teams than for humans. Humans wear foot protection which significantly buffers their feet from surface temperatures that can be up to 30º F hotter than air temperatures. While booties protect a dog's foot from sharp vegetation a dog's foot is one of two places where active heat dissipation occurs through sweating. Wearing footwear limits the dog's ability to dissipate body heat and dramatically increases the dog's temperature, which limits the ability to effectively work.

Because dogs are physically closer to the ground, which tends to be hotter, they tend to experience warmer air temperatures than humans do.

At the other temperature extreme, the possibility exists for conducting winter surveys of burrows, although this was not tested as part of RC-200609, and also to survey for small tortoises that may surface on anomalous and occasional 'warm' winter days. It should be noted that extracting or disturbing tortoises in burrows in winter would not be permissible so surveying with DTK9 teams during cold months would have limited scope and application. This brings to light another challenge for which no resolution has yet been decided. That challenge is validating dog alerts for un-transmittered and small tortoises which cannot be verified using visual means.

No tool is perfect and for this reason not all dog alerts will necessarily be correct or precise. The only means at present to validate a dog's alert on a burrow is either visual confirmation by a human or to excavate. The latter is problematic because excavating a burrow is destructive. In the case of small mammal burrow complexes it is destructive not only to the tortoise and a tortoise burrow, but also destructive for a greater complement of biota including the shrub itself. The challenge with using a human, whether or not proficient with tools (i.e., scope, probe, etc.) to validate a dog alert, is that the return rate for humans on small tortoises has not been determined. Because the efficacy rate has been calculated for certified DTK9 teams it may be possible to employ statistical correction to data when validation cannot be determined through excavation. It may be desirable to use another DTK9 team to validate alerts, where X of Y alerts from N different teams is required to deem a tortoise present. How unconfirmed alerts are to be handled in data collection should be determined prior to fielding teams.

Maintaining calibration of teams requires the handler to ensure both him/herself and dog function as an Operational Team (Figure 25). In the absence of any surface or known tortoises over the course of an extended survey period the dogs will require calibration on live tortoises that can be transported to the teams in their survey areas. It is not expected that Read and Go can maintain a team's calibration for five or more days of surveying with no reward for the dog. Building in the possibility to have calibration tortoises available and a means to deploy them effectively during surveys is a permitting consideration.

A natural extension of dogs to locate Mojave Desert tortoise is the potential to use dogs to find tortoises in other habitats. The Sonoran population of desert tortoise is protected at the state level in Arizona but is not federally protected south and east of the Colorado River. While its habitat is described to have very different characteristics than the Mojave populations, it may be possible with adjustment of training, testing, and deployment guidance to use dogs for tortoises outside of the Mojave Desert.

3.0 PERFORMANCE OBJECTIVES

Performance objectives are the primary criteria established to evaluate the utility of DTK9s and provide the basis for evaluating performance and cost. Meeting these performance objectives was essential for successful demonstration and validation of DTK9 utility. In this section we describe the performance objectives (Table 10). All of the objectives were met and are discussed in full in Section 6.0.

Both quantitative and qualitative performance objectives were established that related directly to safety and capability. A dog team, either dog or handler or both, that poses a safety threat does not meet the criteria to be a DTK9 team. Capability is the combination of efficacy and reliability where *efficacy* is the number of tortoises found of the number available to be found and *reliability* is the number of times a dog performs its trained alert, the 'sit', upon first encounter with a tortoise. The DTK9 team should have high efficacy and high reliability. A team with high efficacy and low reliability needs retraining to meet the qualifications. A team with low efficacy and high reliability may need retraining or may not meet the criteria for a DTK9 team. A team with low efficacy and low reliability does not meet the criteria for a DTK9 team.

Table 10. Performance objectives established to validate DTK9 teams.

Performance Objective	Metric	Data Requirements	Success Criteria	Results
Quantitative Performance Objectives				
Certification tests yield teams that perform to standard	• Team capability in the field reflects performance on assessment tests	• Assessment data • Field data for efficacy and reliability	• Efficacy for tortoises ≥ 70% • Reliability ≥ 75%	• 'Passed' teams met success criteria (Efficacy and reliability both = 90%) • 'Failed' teams did not meet success criteria (Efficacy = 50%; Reliability = 44%)
Dog teams find tortoises of all size classes	• Efficacy • Reliability	• Test plots with transmittered tortoises of all size classes • Tortoise locations verified to validate alerts • Data recorded on dog alert behavior	• Efficacy for small tortoises ≥ 50% • Efficacy for medium tortoises ≥ 60% • Efficacy for large tortoises ≥ 70% • Reliability ≥ 75%	• Efficacy for small tortoises = 0.78 • Efficacy for medium tortoises = 0.96 • Efficacy for large tortoises = 100% • Reliability across all size classes = 90%
DTK9s can operate in "Read and Go" reward strategy	• Reliability • Handlers administer variable reward as defined by "Read and Go".	• Reliability calculations • Three levels of reward recorded in the field	• Dog team maintains ≥ 75% reliability throughout the survey • Dog team is effective • Handler administers three levels of reward in the field	• 'Passed' teams: Reliability across all size classes = 90% • 'Failed' teams: Reliability across all size classes = 55% • Efficacy reported as above • Read and Go administered
Qualitative Performance Objectives				
Safety	• No permit violations that cannot be mitigated	• Tortoises of all size classes • Dogs have full access to tortoises without physical protection	• Project continues to completion	No permit violations that could not be mitigated
DTK9 teams fielded under natural environmental conditions and employ search strategy	• DTK9 teams complete surveys of their assigned areas in one day	• Completed data sheets • GPS track data	• GPS track shows at least one complete pass through the search area • Field survey is completed with a database to analyze project data	• GPS tracks indicated at least one pass was completed for each surveyed area • A final database was complete and used to analyze project data

3.1 CERTIFICATION TESTS YIELD TEAMS THAT PERFORM TO STANDARD

This performance objective was designed to determine the suitability of the certification test that included three phases of assessment, described in detail in Section 5.2, to produce DTK9 teams that could conduct field surveys to a known detection rate. The purpose of this objective was to validate the design of the certification testing recommended for permitting DTK9 teams in the future. Furthermore this objective demonstrated that DTK9 teams could perform to a known standard.

The performance metric was that the teams performed at least as well in the Piute Valley field surveys as they did during the certification. This was evaluated by direct comparison of efficacy and reliability results from the DTCC to those from Piute Valley.

Data required to measure capability included certification assessment data at the DTCC and field data from Piute Valley. The data required to calculate efficacy included the number of tortoises available to be found, their identifying number, the number of tortoises found and each found tortoise's identifying number. This enabled filtering out of repeat finds of the same tortoise. Reliability is calculated only on the subset of tortoises that the dog finds. Visual finds by the handler or where the dog does not perform an independent alert are not included in the reliability calculation. The data required to calculate reliability included the number of tortoises found by the dog and for each recorded 'find' by the dog whether or not it was the first encounter and whether or not the dog performed an independent alert.

The success criterion for this objective was a threshold value for each of efficacy and reliability. Success was indicated when a team (i) met the success criteria for both the certification AND the demonstration or when a team (ii) failed the success criteria for both the certification AND the demonstration. If a team was able to meet the certification criteria but not meet the criteria during the demonstration, the result of the objective was considered 'not met'. Likewise, if a team that did not meet the certification criteria went on to meet the demonstration criteria in the field at Piute Valley, then that too would have been an unsuccessful result. The latter two results did not occur. Teams both met the criteria during certification assessment AND went on to meet them during the field demonstration, or they did not meet the certification criteria AND also failed to meet them during the field deployment.

3.2 DOG TEAMS FIND TORTOISES OF ALL SIZE CLASSES

The purpose of this performance objective was to demonstrate that the DTK9 teams that passed the certification criteria would detect the full complement of size classes that occur in nature. This was assessed using efficacy and reliability calculated by size class for each phase and directly compared. Data requirements included test plots that contained a population of tortoises with known size and known location, determined each day. The data required to calculate efficacy and reliability are as described above in Section 3.1. Data on individual tortoises were also recorded so that efficacy and reliability could be calculated by size class.

Success criteria for efficacy were threshold values by size class. Reliability threshold was constant across size classes. The threshold criteria are provided in Table 10. The success criteria were exceeded for all size classes and are also presented in Table 10.

3.3 DTK9S CAN OPERATE IN "READ AND GO" REWARD STRATEGY

The ability to remain an operational team with the dog remaining calibrated over potentially long time periods without finds and/or reward for finding tortoises, underlies the usefulness of a DTK9 team. The dog must continue to find and alert on live tortoises in the absence of reward. The handler must continue to maintain a positive mindset without imparting bias to the dog (Lit et al., 2011). This objective was assessed during the field demonstration at Piute Valley.

Two metrics were established to assess this performance objective, (i) reliability and (ii) the handler administered Read and Go. The data requirements for reliability are the same as described in above sections. Data required for documenting Read and Go included recording one of the three levels of reward (full reward, the pet, or none) delivered by the handler when his or her dog alerted.

Success criteria included the same reliability threshold as for the other two quantitative performance objectives, the dog being effective as established in Section 3.2, and whether or not the handlers administered Read and Go. Each of the success criteria were met as shown in Table 10.

3.4 SAFETY

Safety is a paramount requirement for a listed species and was continually assessed throughout the course of this demonstration. The permitting agencies establish the types and number of 'take' incidents allowed during the course of work conducted under a specific permit. Because take has a fairly broad definition, permit violations may sometimes be mitigated. An example might be take from a vehicle, with mitigation action being reduced speed limit and people walking ahead of vehicles to sweep for tortoises.

The metric to assess safety to tortoises was that there were no permit violations that could not be mitigated. The data requirements for this metric included use of tortoises of all size classes and dogs having access to tortoises without physical protection (e.g., cage or tote). Success was determined by the project continuing to completion. There were no permit violations that could not be mitigated over the entire course of this demonstration. This success criterion was met.

3.5 DTK9 TEAMS FIELDED UNDER NATURAL ENVIRONMENTAL CONDITIONS AND EMPLOY SEARCH STRATEGY

To document DTK9 utility as a standalone technology it was necessary to conduct the final demonstration under the expected deployment conditions. A DTK9 team should be able to complete his/her survey area each day while meeting the other performance metrics. A number of factors may affect a DTK9 team's ability to complete their survey area including but not limited to surface and air temperature, fitness of the handler and dog, physical health of the dog (or handler), and accumulated fatigue over time. To be effective at detecting tortoises within an area the team must at least survey within that area. The results of the survey in the form of data are also important.

The metric evaluated was whether or not teams completed their assigned survey areas each day. Data required included the data sheets for each DTK9 team, recorded and collected each day, and GPS track data. The success criterion was a GPS track that showed at least one complete pass through the search area and the data recorded for each team over the surveys resulted in a database. These success criteria were met (Table 10).

4.0 SITE DESCRIPTION

4.1 SITE LOCATION AND HISTORY

Two sites were selected for the demonstration conducted in southern Nevada and are shown in Figure 31. The DTCC is located southwest of Las Vegas on BLM land in Clark County, Nevada, and managed by Clark County, BLM, and USFWS. It has a mandate to support desert tortoise research and was created as a mitigation action for development in the Las Vegas valley after the desert tortoise (Mojave population) was federally listed as a threatened species. The DTCC contains desert tortoises considered to have been 'taken' and are therefore eligible for research designed to promote the conservation of wild populations. All training and testing involving the interface of tortoises and dogs prior to fielding teams in Piute Valley occurred at the DTCC. This site was selected because it is unique in being the only facility where a full demographic profile, from hatchling tortoises to adults, is maintained and readily accessible.

The landholding dedicated to the facility is large, consisting of approximately 4,452 ha in total and of which 89 ha are completely fenced areas where tortoises are maintained for research purposes. The tortoises are housed in pens of various sizes from a few meters on a side to nine hectares in area. There are multiple replicates of pen configurations with different sizes, which facilitate sample sizes sufficient for robust experimental design and analysis. The facility is open to the environment; thus the animals are exposed to ambient conditions and their behavior can generally be assumed to be similar to that of tortoises in wild populations living nearby, although some of the DTCC tortoises are subsidized with food or water when not used for research. The adult tortoises that were used in training and testing DTK9 teams that live outdoors in the research pens were not subsidized. Laboratory facilities and physical infrastructure on site includes running water, a cool room, refrigerator, electricity, and meeting rooms. The DTCC provides shade and potable water for maintaining compliance with the Animal Care and Use Protocols for the dogs. A particular benefit of the DTCC is the ability to have complete control over the numbers and sizes of tortoises employed in each experiment and, because it is a secure facility, conducting the training and experimental trials at the DTCC ensured maximum likelihood of success.

An interior perimeter road provides access throughout the site. During the course of this demonstration the facility was maintained by a contractor to Clark County. The facility is now managed with a Memorandum of Understanding between the USFWS and the San Diego Zoo and has a full-time site manager and staff.

The Piute Valley field demonstration site is in the Nevada Mojave Desert in desert tortoise critical habitat and managed by the USGS. There are no facilities at this site and it is an unfenced open landscape. The Piute Valley study site is home to a population of animals at the Piute-Eldorado Desert Wildlife Management Area (DWMA), sixty miles south of Las Vegas, Nevada, near the town of Searchlight. This population consists of 20 desert tortoises, a subset of which were used in this demonstration, that have been monitored as a part of the US Fish and Wildlife Service line distance sampling program since the year 2000 when research and monitoring of this population was established by the University of Nevada, Reno. Beginning in 2004 this population began to be used for more detailed behavioral studies by USGS and continues to be used for monitoring and research functions.

Figure 31. Demonstration sites in southern Nevada are shown with green dots.

4.2 SITE CHARACTERISTICS

Piute Valley is an area of desert tortoise critical habitat largely composed of Mojave Desert scrub, with areas of mixed Mojave Desert scrub typical of mid elevation sites in the Mojave (Figure 32). The area was suitable for the final demonstration because a situation was required where we had access to transmittered desert tortoises so that finds could be confirmed when a DTK9 alert occurred. This site had the known population of transmittered adults and we were able to augment the area with small transmittered tortoises to create a known population to

reflect the expected demographic distribution of a natural tortoise population. Access to transmittered small tortoises and transmittered adult tortoises is not available elsewhere across the species' distribution. In addition the Piute Valley site is desert tortoise critical habitat.

Figure 32. The landscape at Piute Valley, NV where the field testing (Phase II) was conducted.

5.0 TEST DESIGN

5.1 CONCEPTUAL TEST DESIGN

The test design was conceptually straightforward: train DTK9 teams, evaluate the teams based on quantitative and qualitative performance metrics (a certification standard), and compare the capability of teams in the natural deployment environment to determine (i) the robustness of the certification test and (ii) the actual field performance of qualified DTK9 teams. The certification standard was developed based on field results from prior years of DTK9 testing but was unique in the validation approach to determine whether or not the certification standard would in fact yield qualified, capable teams; neither holding back qualified teams that should have been fielded nor allowing unqualified teams to be certified and fielded when they should not be. DTK9 team descriptive data are presented in Table 11. Each DTK9 team was assigned one tortoise biologist. Additional field technicians participated in the daily activities involving calibration and telemetry to locate tortoises daily. The field crew is shown in Figure 33.

Table 11. DTK9 team data. Team is unique identifier. M' = male and 'F' = female. DTK9 veteran indicates the dog had prior deployment as DTK9. Origin is the handler's home state where initial scent training was conducted.

Team	Dog Breed	Handler	Dog	DTK9 veteran	Dog age (yrs)	Origin
7	GSD	F	F	Y	7	NV
11	GSD	F	F	Y	10	MT
12	Labrador mix	F	F	Y	4	MT
13	Australian Shepherd	F	M	N	5	OH
14	GSD	M	M	N	2	TX
15	Hound mix	F	M	N	1	MD
16	Labrador	F	M	N	2	WI

There were several operational training periods that supported the performance objective evaluations. Not all of these operational periods resulted in tangible results however the entire progression was critical to support evaluation of the performance objectives. The performance objectives were specifically focused on assessing DTK9 capability and the appropriateness of the assessment tests used to make capability determinations. The conceptual test design is shown in Figure 34, which is based on the demonstration design flow chart shown in Figure 10. The different operational training periods are color-coded to represent the different phases used to evaluate the technology.

Figure 33. The field crew for the 2008 DTK9 demonstration at Piute Valley included seven DTK9 teams, three PIs, ARO Program Manager, DTK9 Master Trainer and eight tortoise biologists/field technicians.

The green box in Figure 34 represents the four-week training period prior to participation on site at the DTCC where handlers trained the dogs on residual odor and accustomed the dogs to working on a leash. The protocol for this training is provided in Appendix C. When this initial training period was complete the teams traveled to the DTCC in Las Vegas where they were evaluated for odor recognition and alert process.

Phase I is shown in both dark and light blue colored boxes. This phase was considered 'baseline characterization and preparation' and is fully described in Section 5.2, below. Phase I began when teams arrived at the DTCC and the dogs were de-sensitized to live tortoises as part of the transition from residual tortoise scent to live tortoises, shown in box labeled 'desensitization'. The 'training' box includes all aspects of dog and handler skills as indicated in the left boxes which point to 'training'. When dog and handler were skilled at searching for and indicating live tortoises on the surface, in shrubs and in burrows, teams were taught the in-field calibration technique 'Read and Go' (Cablk et al., 2007). Teams were tested using the three assessments which collectively comprised the certification standard. Performance objective metric data were collected and analyzed to determine which teams scored sufficiently to 'pass' and which teams 'failed'. Once the assessments were complete the demonstration moved to Phase II, evaluating the test and demonstrating full field capability of DTK9 teams. The DTK9 handlers were not informed about whether or not they received a 'pass' or 'fail' of the certification test in Phase I so as to reduce human bias in performance during Phase II.

During Phase II (tan boxes) data on each individual team's performance at Piute Valley were collected, analyzed and compared with their performance during the assessments in Phase I at the DTCC. This approach then enabled quantitative and qualitative assessment of the teams using performance criteria presented in Section 3.0.

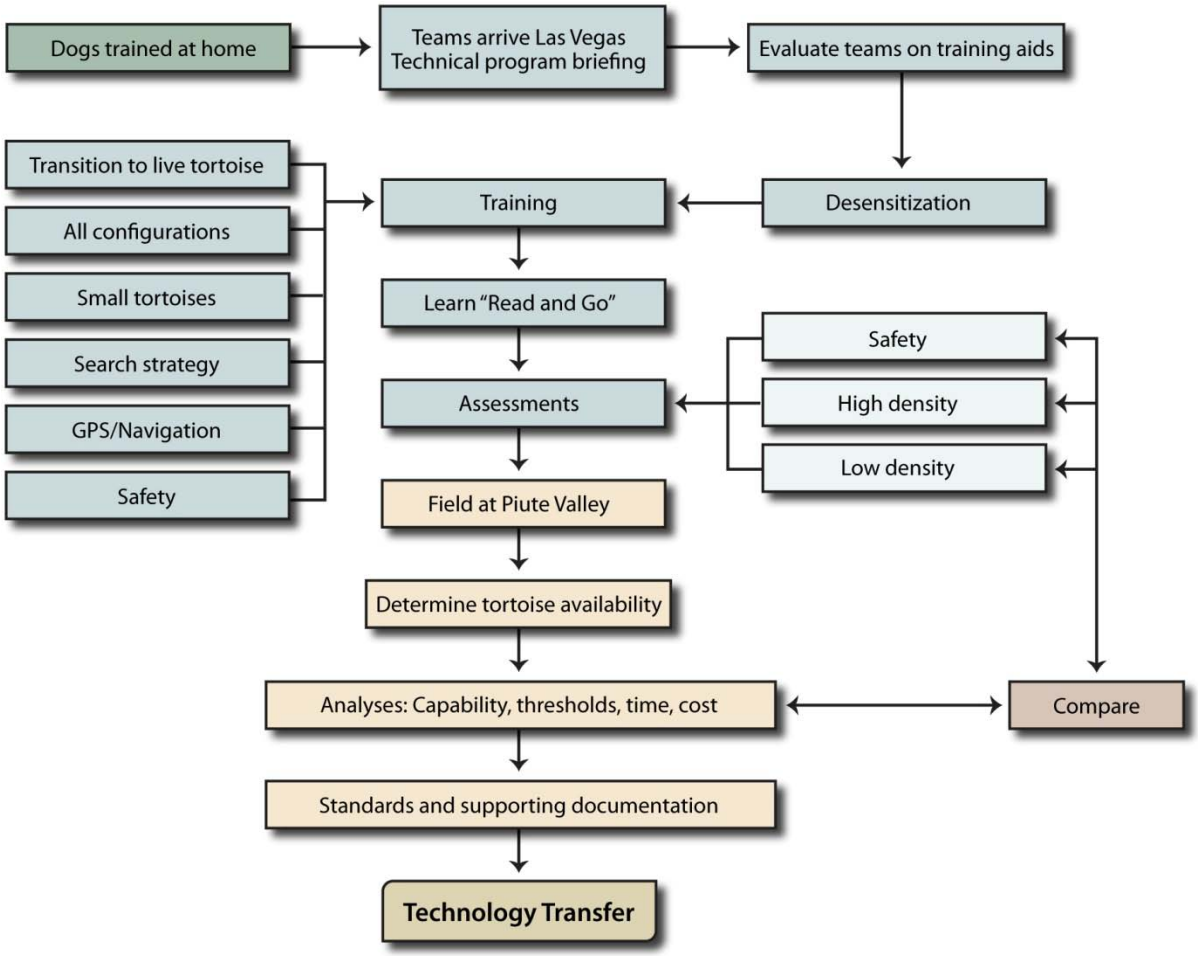

Figure 34. The conceptual test design.

For all aspects of the demonstration, safety was the highest priority used to evaluate the DTK9 teams. Any team that caused a permit violation that could not be mitigated at any time during the demonstration would have been deemed 'failed' but also would have been removed from the program. This situation did not occur during the demonstration but was a critical evaluation component.

5.2 BASELINE CHARACTERIZATION AND PREPARATION

Baseline characterization was constructed from the point at which teams were evaluated for having accomplished basic scent recognition training through the final certification testing. The baseline was established for each of three different criteria: (i) safety; (ii) capability under high tortoise density conditions; and (iii) capability under low tortoise density conditions. The results of the baseline characterizations aggregated teams into one of two groups, those that 'passed' all

assessments and those that 'failed'. A team had to pass all three assessments to be considered part of the 'passed' group. Comparing the results from Piute Valley to this baseline was the means to evaluate whether or not the certification tests as designed yielded teams that performed similarly under realistic field survey deployments.

The safety and high density assessments were conducted at the DTCC in locations indicated in Figure 35. The low density assessment was conducted in an area of BLM property adjacent to the Southern Nevada Water Treatment Facility in Henderson, NV (Figure 36). This area had been recently cleared of tortoises as they were frequently killed on nearby roads.

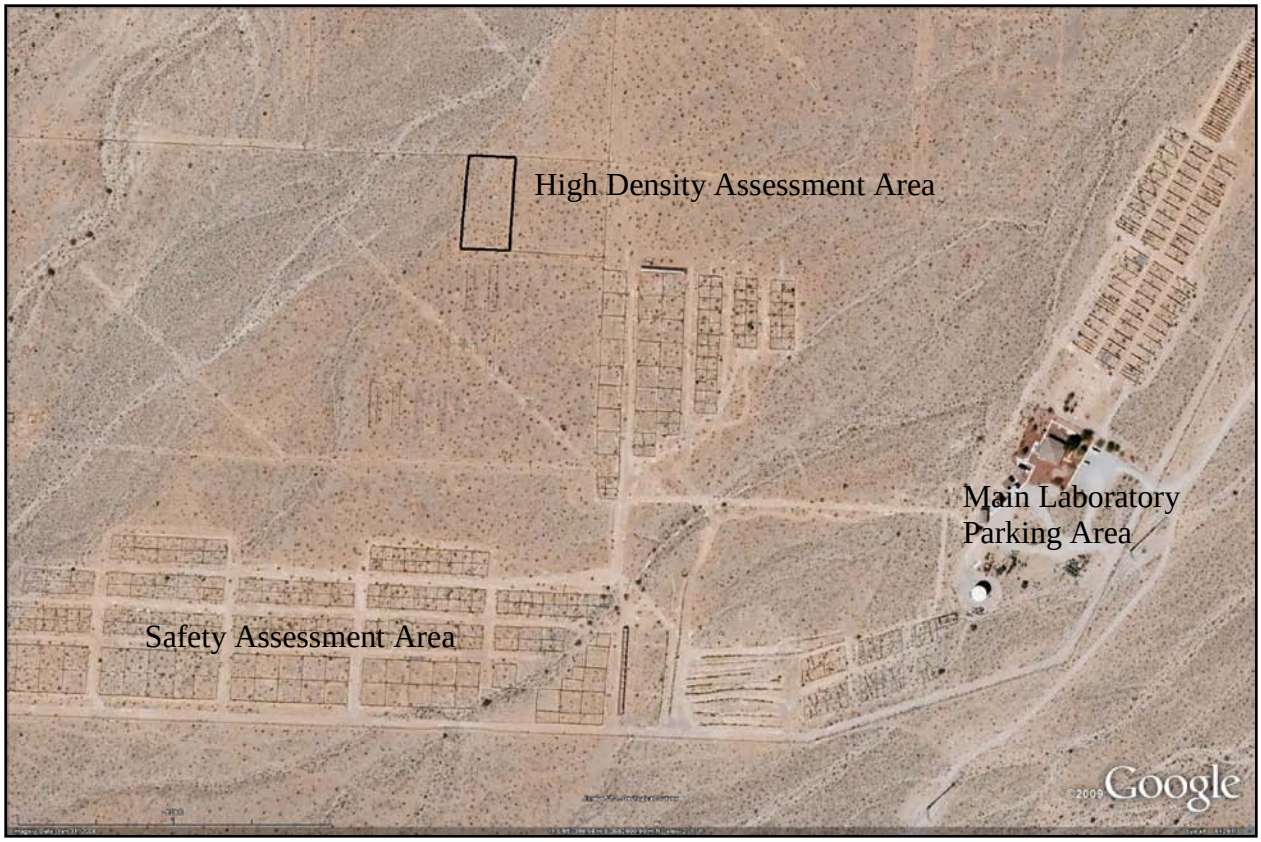

Figure 35. Aerial image of the southern end of the DTCC where safety and high density assessments were conducted.

Figure 36. The low density assessment area was located in Henderson, NV in an area recently cleared of tortoises.

Results from the baseline characterization are provided in Table 12. All teams received a 'pass' on the safety evaluation, six teams met or exceeded the reliability threshold and six teams received a 'pass' for the low density assessment. Overall the results of the baseline characterization yielded five teams considered 'pass' and two considered 'fail'. Team 13 was not functional in Read and Go. This team did not locate the tortoise after searching for a long time period without a find, and team 14 was not reliable. Each of the assessments is described in detail below.

Table 12. Results from the baseline assessments.

	Safety	High Density		Low Density	Overall
Dog Team	*Score*	*Reliability*	*Efficacy*	*Functional?*	*Pass/Fail*
7	9	1.00	0.82	Y	P
11	9	0.89	0.75	Y	P
12	-	0.70	0.83	Y	P
13	10	0.82	0.92	N	F
14	9	0.33	0.75	Y	F
15	11	0.78	0.82	Y	P
16	12	0.82	0.92	Y	P

Baseline 1 - Safety Assessment

Although safety was evaluated throughout the entire demonstration, an initial safety assessment of dogs in the presence of live tortoises was needed to mimic implementation of future test conditions. Small pens approximately 15m x 15m and housing 2-3 adult tortoises were used for the safety assessment. Locations of the tortoises were verified by field personnel prior to a team entering the pen. The handler was made aware of all tortoise locations as well. The dog wore its working equipment which included a flat collar, booties, 6 foot leash and a remote training collar. The evaluator verified that the equipment was properly seated on the dog and working prior to the handler stepping into the pen. The dog's equipment was designed to provide safety assurances. The assessment began when the handler and dog were inside the pen. The dog was not given any commands nor allowed to move beyond the extent of the leash. The dog was observed for a total of 10 minutes while the tortoises free-roamed within the constraints of the exercise. The tortoises in the pen were unrestrained and field personnel were responsible for ensuring that the tortoises did not approach within 10 feet of the dog. After 10 minutes at the evaluator's direction the dog team exited the pen and the exercise was scored. Safety was evaluated using the following nine distinct behaviors. Aggression is defined as an attempt to cause intentional harm to a tortoise.

i. Defensive aggression – Dog shows reduced body posture
ii. Overt aggression – Dog shows confident body posture
iii. Excessive Flight - Dog shows reduced body posture and repeatedly attempts to move away from the target
iv. Play interaction – Dog attempts to engage the target in play activity
v. Growling – Dog vocalizes with a low rumbling sound at any time for any purpose or target during the test time period.
vi. Barking – Dog vocalizes with a range of sounds including whining at any time for any purpose or target during the test time period.
vii. Stalking – Dog shows low confident body posture while attempting to hunt or herd the target

viii. Excessive Focus – Dog does not easily look away from the target

ix. Inability to Relax – Dog cannot assume relaxed body posture

Each of these behaviors were scored from 1-5 so that a minimum (optimal) score is 9. A score of greater than 15 is considered a 'fail' and if any single behavior is scored 5 the team automatically fails. The following would result in a score of '5' and automatic failure: rushing a tortoise; attempting excessive flight greater than 15 seconds; play interaction attempted more than once; excessive focus more than 2 minutes; and inability to relax for more than 9 of the 10 allotted minutes. In addition if the dog showed or did any of the following behaviors towards a tortoise at any time during any of the assessments the team would automatically 'fail': growl, bark, or stalk.

Results for each of the teams are shown in Table 13. DTK9 team 12 was not evaluated using this formal test because the team was not able to participate on the dates this test was administered. This team continued participation because handler and dog had worked in this program successfully for several years prior. Any team that did not pass this first assessment would have been excluded from further participation in the demonstration for safety concerns. Safety threat was the No-Go criterion for any team. No team tested failed this element.

Table 13. Results of the safety assessment for each DTK9 team. The range of passing scores is 9-15.

Dog	Score
7	9
11	9
12	-
13	10
14	9
15	11
16	12

Figure 37 depicts the gear check prior to participating in the safety assessment. Figure 38 shows a dog during the safety assessment with two adult tortoises active on the surface. The dog shows relaxed behavior. Figure 39 shows another example of relaxed behavior during a safety assessment.

Figure 37. Before the team enters the pen for a safety assessment the evaluator conducts a check to ensure that the dog is wearing its equipment (booties and collars), that they are properly seated on the dog, and functional.

Figure 38. Example set up for the safety assessment. The dog is relaxed and not fixated on moving tortoises.

Figure 39. An example of very relaxed behavior during a safety assessment.

Baseline 2 – High Density Search Environment

Baseline characterizations conducted also included the high and low density assessments, which tested the teams in the two extreme densities possible during desert tortoise surveys. The high density assessment was designed to assess the team's ability to work in a situation where many tortoises would be present in a relatively small area, such as a recently hatched nest. In the high density assessment 13 transmittered tortoises were released in a pen approximately 0.25 ha in size that contained natural burrows and shrub cover typical of desert tortoise habitat. The pen was not used for training activities prior to the assessment and was novel to the dogs. The counts of tortoises per size class released and available to be found were as follows: Small (≤ 110 mm MCL) – 5; Medium (110 - 180 mm MCL) – 6; Large (> 180 mm MCL) – 2.

Dog teams were required to search the pen employing the standard three-pass search strategy involving a perimeter search followed by two cross-grid passes which were termed the detail and hasty, respectively (Figure 40). The handler determined the entry point into the pen and verified visually that no tortoise was present at the point of entry. There was a 60 minute time limit to

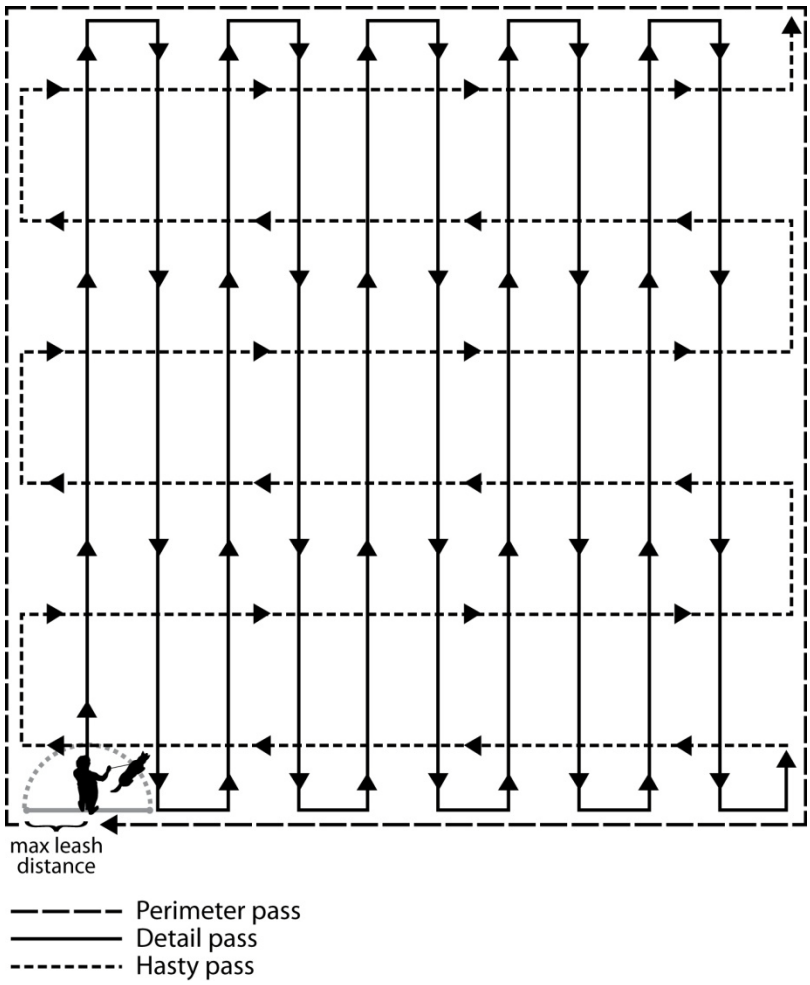

Figure 40. The three-pass search strategy deployed for tortoise searching optimizes searching for moving targets.

complete the three passes and the assessment began when the team entered the pen. The dogs worked on a 10' long line. Teams were scored with either a 'pass' or a 'fail' based on two quantitative criteria both which had to be met for a 'pass': efficacy ≥ 70% and reliability ≥ 75%. Safety to tortoises remained a qualitative criterion. To establish whether or not a team met the quantitative criteria field technicians used telemetry equipment and wore headphones to verify a tortoise was present when a handler stated they had located a tortoise. The following data were collected each time a handler stated "tortoise", indicating a find: (i) dog or handler find; (ii) if 'dog' find whether or not the dog performed the 'sit'; (iii) whether or not a tortoise was present; if so, (iv) transmitter frequency and (v) time. When the handler completed the search and exited the pen, the clock was stopped or the exercise was stopped at 60 minutes. Efficacy and reliability were then calculated. For the qualitative safety metric the following criteria were used: (i) no permit violation (harm to a tortoise); (ii) leash not dragging on the ground; (iii) handler maintains contact with leash at all times; (iii) dog does not dig; and (iv) team operates as an Operational Team (Figure 25).

All but one team received a 'pass' in this assessment; the team that did not 'pass' did not meet the reliability threshold criterion. All teams maintained safety.

Baseline 3 – Low Density Search Environment

The other extreme condition that occurs with desert tortoise surveys is very low densities or areas devoid of tortoises. These are difficult conditions to work in and the low density assessment was designed to demonstrate that DTK9 teams could remain effective under such circumstances. In the low density assessment each team searched a 2 ha area of desert tortoise habitat that was cleared of all tortoises. The handlers were not aware that the areas were not expected to contain tortoises. Upon completing the 2 ha search area each team was moved to a second area that contained one adult tortoise, unbeknownst to them. The criterion for receiving a 'pass' was the handler correctly determining the location of the tortoise. A 'fail' was given when the team did not locate the tortoise.

Each handler was provided a 2 ha area with the plot boundaries uploaded to their GPS as waypoints. The handlers wore the GPS with the track log set to 'on' and carried with them the following equipment:

- Sufficient potable water for the dog and handler during the survey;
- Portable shade for the dog (i.e., umbrella);
- Rectal thermometer in working condition for the dog;
- Reward (toy or food);
- Active and passive cooling equipment to include at least: 50% alcohol-water mix in spray bottle, ice packs, shade;
- Medical/veterinary care items to include at a minimum: forceps, band-aids, gauze, self-adhering bandage;
- Footwear for the dog.

There was a four hour time limit to complete the search of the 2 ha area. Each handler was assigned a tortoise biologist who walked along with the team. The time began when the evaluator started the exercise. All teams worked simultaneously in adjacent search areas and executed the three-pass search strategy (Figure 40). The dogs worked on the same leash as in the high-density assessment. Handlers were called from their search area as they approached completion of their area, to search a second area. The team had to identify the presence of the tortoise in the second area, but unknown to them, either via a trained alert articulated by the handler or by the handler recognizing and articulating a change of behavior in the dog that indicated the presence of a tortoise. All but one team received a 'pass' from this assessment. The 'fail' was due to the dog neither alerting on the tortoise nor the handler recognizing the dog's change of behavior. This was not an Operational Team in a low-density environment.

5.3 DESIGN AND LAYOUT OF TECHNOLOGY AND METHODOLOGY COMPONENTS

The monitored adult tortoises currently residing at the Piute Valley site are wild, free-ranging desert tortoises and their locations and home ranges are well known. They are a research population used for behavioral calibration for monitoring surveys. Fourteen transmittered adult tortoises were monitored at the site (5 Females, and 9 Males) and were tracked daily during the

demonstration. Seventeen tortoises in hatchling and juvenile size classes were transmittered and released among these adults following permit requirements. A total of 7 tortoises less than 110 mm MCL and 10 tortoises between 110 mm and 167 mm MCL were released on 22 April 2008. Figure 41 shows a tortoise in the small size class at 110 mm MCL with a transmitter. The number of tortoises of each size released was determined based upon their availability at the DTCC and the number of transmittered adult tortoises at the site, where the number of small and medium size class tortoises released was a proportionate number to match a known wild population (Esque and Duncan, 1985).

Figure 41. A tortoise 110mm MCL with transmitter released during Phase II trials. The transmitter is attached to the posterior of the carapace.

DTK9 team descriptive data and group (P/F) are presented in Table 14. Each DTK9 team was assigned one tortoise biologist. Additional field technicians participated in the daily activities involving calibration and telemetry to locate tortoises daily.

Table 14. DTK9 team data with pass/fail designation. Team is unique identifier. 'M' = male and 'F' = female. DTK9 veteran indicates the dog had prior deployment as DTK9. Group identifies pass (P) or fail (F) of Phase I baseline characterization (certification).

Team	Dog Breed	Handler	Dog	DTK9 veteran	Group	Dog age (yrs)
7	GSD	F	F	Y	P	7
11	GSD	F	F	Y	P	10
12	Labrador mix	F	F	Y	P	4
13	Australian Shepherd	F	M	N	F	5
14	GSD	M	M	N	F	2
15	Hound mix	F	M	N	P	1
16	Labrador	F	M	N	P	2

Handlers carried the required gear as described in Section 5.2 *Baseline 3 – Low Density Search Environment*. Figure 42 shows some of the required equipment deployed during a rest while searching at Piute Valley. The umbrella increases shade, the dog's ears are turned inside out and sprayed with a mist of 50/50 water/alcohol mix and the handler has ice water for herself and the dog to drink. The dog is wearing protective foot covering (300 denier Cordura attached with Velcro) and both a flat and training collar. The handler's GPS is attached to her backpack and the dog's toy (ball on a rope) is visible below. Although not visible in Figure 42, the dog is wearing a black harness with GPS attached.

Figure 42. Required equipment deployed to cool the dog.

The dogs wore foot covering to protect against the rough, and in places sharp, desert surface. Typically the dogs wore cotton baby socks which were held in place with self-adhering bandages (Vetrap) as shown in Figure 43. Dogs do not sweat through their skin, only through their pads. For this reason cotton baby socks are preferred in the Mojave Desert environment because they

allow the dog to dissipate heat through sweating while providing physical protection. Cotton baby socks, replaced each day with a new pair, also allow the dog's feet to spread, enable the dog to grip, and permit some feeling of the surface which minimizes disruption to the dog's natural movements. An alternative foot protection worn by some dogs were booties made from lightweight 300 denier Cordura fabric attached with Velcro above the dog's wrist. The dogs also wore a remote training collar, a flat collar, and a nylon harness to which the GPS was attached.

Handlers carried Garmin eTrex Vista GPS units attached to their backpack. Dogs wore 4" i-Blue 747 Bluetooth data logger GPS receivers attached to their harness (Figure 43). The unit was encased in a Ziploc bag and the bag was duct taped to the harness. In this manner the GPS antenna was both secured in place and provided with maximum sky view with minimum disruption to the dog. These devices have no screen or utility functions like a hand held GPS unit rather they are solely position logging devices. These units offered advantages for recording dog tracks in their small size and shape, light weight, and the ability to be duct taped repeatedly to a dog harness.

Figure 43. The dogs wore an i-Blue 4" GPS data logger attached to their harness to record dog tracks.

5.4 FIELD TESTING

Once the baseline assessments were completed as described in Section 5.2, field testing commenced. All seven dog teams participated in field testing. Because teams were not informed of the results of the baseline assessments the handler's belief about their capability was expected to have minimal effect on their performance at Piute Valley. This was critical as dog team performance is directly affected by handler mindset (Lit et al., 2011). Field testing during Phase II began on 24 April 2008 and ended 29 April 2008. One rest day was taken on 27 April 2008. On this date no trials were run however tortoises were tracked.

Data collection to calculate efficacy and reliability was conducted within search area boundaries which were delineated based on last known locations of transmittered tortoises in Piute Valley. Upon completion of all search areas each day, all tortoises were re-located using telemetry and these data were used to set the next day's search area boundaries. Search area boundaries were delineated to provide comparable distributions of tortoises for each of the three size classes for each of the dog teams. Because the search areas changed daily to encompass the known population of tortoises, the areas used for the demonstration were not permanently marked, but instead virtually maintained in a GIS. Survey plot corner points were uploaded into the handler's GPS prior to beginning their survey and handlers were responsible for navigating to those locations. The track log was set to 'on' to record the handler's tracks. GPS track data were downloaded each night and all data removed from units prior to uploading the next day's plot boundaries. The data used to delineate search areas to sample the tortoises based on their location recorded the previous day are provided in Appendix B. The study area and survey plots are shown in Figure 44.

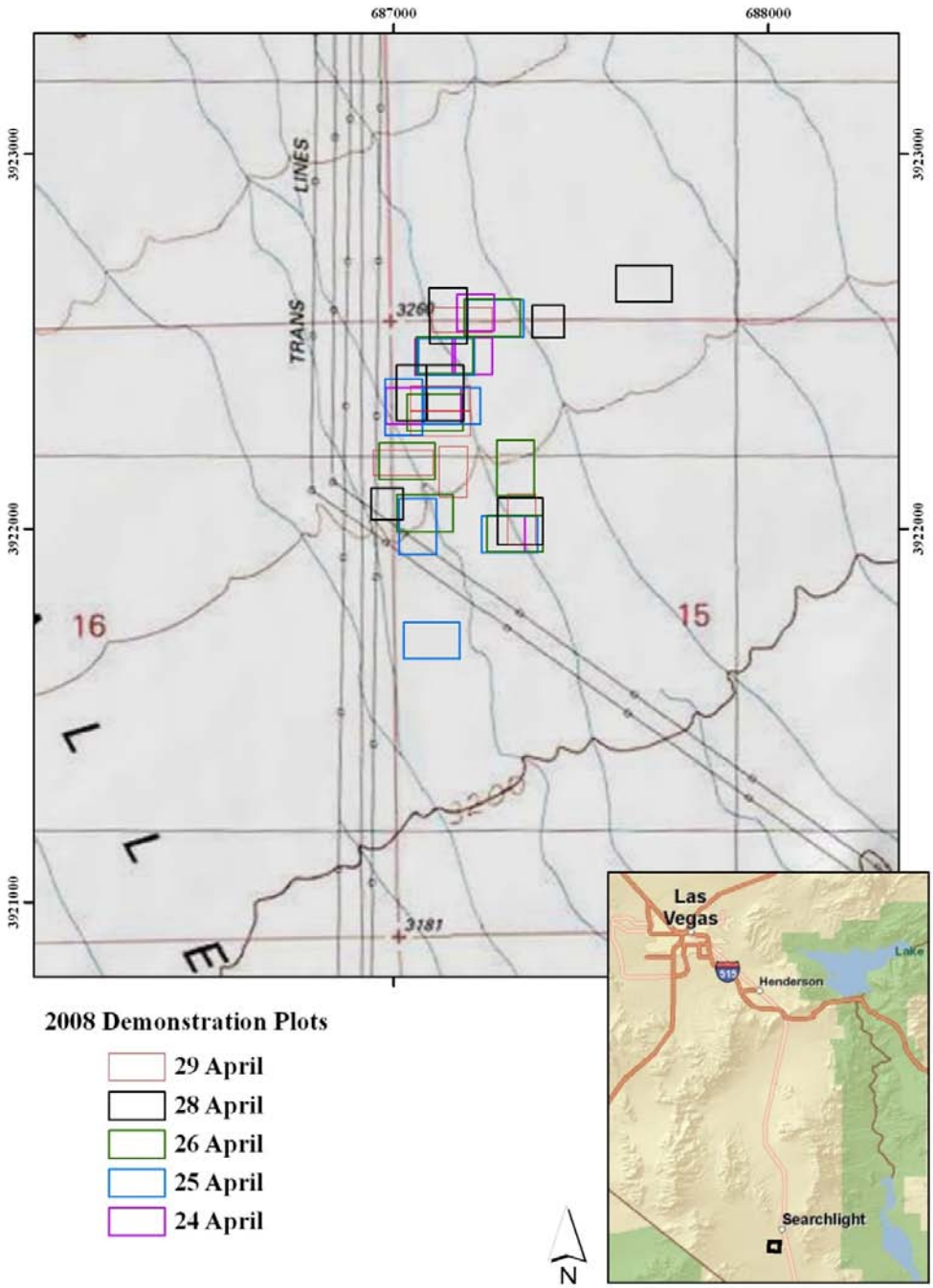

Figure 44. The Piute Valley demonstration area and the location of survey plots by date.

Each morning the research team and DTK9 teams received their assigned area to survey as indicated by the waypoints in their GPS. Immediately prior to beginning the survey the dogs were calibrated using tortoises withheld from release and retained specifically for the purpose of calibration. The objective of calibration was twofold: (i) to ensure that the dog was ready to survey as indicated by it performing the 'sit' upon locating a tortoise and (ii) to ensure the team

was operating safely in the presence of tortoises. Calibration involved working a dog a short distance into position where it could encounter tortoise odor, find the tortoise, and be rewarded. Handlers did not know the location of the tortoise but did know a tortoise was present. If a dog did not immediately perform the 'sit' upon finding the tortoise it was cued by its handler to do so and the exercise was repeated until the dog performed the trained alert independently. Because calibration was conducted in the presence of field personnel, specifically the master trainer, safety issues could be observed and addressed at that time. Calibration was conducted serially, one team at a time. Teams went directly from calibration to their survey areas and began their surveys.

Teams worked simultaneously and there was no time limit to complete the assigned survey plot. Handlers searched the assigned plots using the three pass grid strategy. GPS tracks were recorded for both dogs and handlers. Each handler determined when to break the dog and how long the breaks lasted. Handlers were responsible for monitoring the dog for signs of overheating including taking rectal temperatures. Dogs with temperatures greater than 104 °F were put on break and cooled with both active and passive means as described in Section 5.3.

Each DTK9 team was assigned a tortoise biologist who wore headphones with the telemetry equipment to immediately validate finds in the field. Handlers did not know how many or where tortoises were located within their assigned survey plots. Tortoises that were found en route to or from the survey plots were recorded but did not count towards demonstration criteria. During surveys handlers stated out loud to their tortoise biologist when they believed a tortoise was present, whether the clue was the dog performing the 'sit' or based on the dog's change of behavior. The handler implemented Read and Go and continued with his or her search while the tortoise biologist established whether or not a tortoise was present. Using telemetry equipment, the tortoise biologist could establish quickly and non-invasively the presence of a known tortoise based on frequency (Figure 45). If the telemetry equipment returned no signal from the known tortoise frequencies the tortoise biologist conducted a physical search as would be conducted by a human in a tortoise survey without the use of dogs. In this manner any 'wild' tortoises that were not telemetered could be identified and counted. Handlers were not provided with results from their search efforts. All data were recorded on paper data sheets, digitized and entered into multiple databases each evening after returning from the study site.

After the day's surveys were completed the handlers returned to Las Vegas, NV. Field personnel then tracked and located each transmittered tortoise. When all tortoises had been located field personnel left the study site. The tortoise location data were entered into the GIS and used in part to guide delineations of the next day's survey plot boundaries. At the office each evening, the GPS unit data were downloaded, the data from daily data sheets entered and tortoise locations from that day's final tracking effort were uploaded into the GIS; DTK9 team assignments were made to the survey plots based on the size class of tortoises teams had or had not yet encountered, and corner points uploaded into the GPS units. On the last day of Phase II (29 April2008) when telemetry tracking was conducted the tortoises that were released for this study were collected from the field and returned to the DTCC.

Figure 45. Verification of a transmittered tortoise was conducted using telemetry equipment.

5.5 SAMPLING PROTOCOL

Sampling at Piute Valley was conducted to establish efficacy and reliability under field conditions for expected wild population demography. The sampling was conducted to determine whether or not the Performance Objectives identified in Table 10 were met, as shown in Table 15. Other data were also collected which included meteorological conditions during the time teams surveyed assigned areas and time to complete surveys. The amount of time required to complete the survey coverage of the assigned area(s) were recorded with breakdown of time into the time spent on break (i.e., rest, water, gear adjustment, etc.), the total time worked minus breaks, and total time in the field.

Table 15. Sampling dates at Piute Valley.

Start Date	End Date	Location	Event
24-Apr-08	26-Apr-08	Piute Valley	Field Trials
27-Apr-08	27-Apr-08	N/A	Rest Day
28-Apr-08	29-Apr-08	Piute Valley	Field Trials

Data were collected when a handler determined that a dog alerted (Table 16). General data included information about the date and time of the alert and identified who the data recorder was by initial. The tortoise information included the transmitter frequency of the tortoise and the unique identification number for that tortoise. Team information was the unique identification

number for the team that made the find, the handler's last name and the dog's name. Redundancy in the collected data was for quality assurance and control, described below. Behavioral information about the find itself was also collected and included whether or not the dog indicated ('alert'), the type of reward to the dog ('full', 'pet', or 'none'), whether or not the dog performed an independent or a dependent alert, whether or not there was physical contact between the dog and tortoise and if so what type, whether the find was by the dog or the handler, and whether or not the handler knew the tortoise was present at the time of the find. Sometimes the dog's behavior draws the handler's attention to the tortoise and the handler is able to see the tortoise immediately prior to the dog alerting. Location data were collected where the tortoise was located as UTM coordinates. The configuration of the tortoise (surface, shrub, or burrow) was recorded. Data recorders also recorded the degree to which a shrub or burrow was able to be completely searched by a human based on the dog's alert. Confirmation data included whether or not the alert was confirmed to indicate a tortoise ('verified'), the method of confirmation ('visual' or 'frequency'), and if the tortoise was 'known' or 'unknown' based on it being one of the released tortoises or a wild tortoise.

A nearby meteorological station that was used for other tortoise monitoring in Piute Valley was used to collect data on relative humidity, temperature and wind speed. The UTM location of this station was 11S 686588E, 3920006N. Data were collected and averaged at 15 minute increments.

Table 16. Data collected when a handler determined the dog alerted.

General	Tortoise	Team	Behavior	Location	Confirmation
Date	Frequency	Unique ID	Alert	Configuration	Verified
Time	Unique ID	Name	Reward	Search-ability	Method
Recorder		Dog Name	Cue	UTM X	Type
			Touch	UTM Y	
			Interaction		
			Found by		
			Disposition		

Quality assurance sampling

Redundancy was built into the data collection forms. Examples include tortoise frequency and unique ID; Team unique ID, handler name and dog name. Other quality assurance methods were conducted each evening based on database queries for nonsensical record entries. For example, a tortoise cannot be un-verified and have a recorded frequency. Time stamps for finds had to have occurred within the time stamps recorded for the survey. These queries were run within 24 hours of the data being collected such that error source could be identified. In that manner field recording errors could be corrected because each encounter was still easily recalled by the field assistant. There were few enough tortoise encounters each day that it was relatively easy to recall details about each encounter and associated data parameters. Blank fields were immediately corrected by the field technician and/or the handler in certain instances, such as data related to dog behavior.

The plot boundaries and team assignments were created the evening prior to surveys. Each day's field data were imported into the GIS and overlaid on the plot boundaries. Queries were executed in the GIS to verify correct data entry of team variables and general variables. When field biologists conducted their tracking after all surveys were complete they cross-referenced the frequency of the tortoise with its identification number in the field at the tortoise location. Each tortoise had its unique ID on its carapace for cross-reference.

Sample documentation

Field data were collected on paper forms which were handed to the PI by each field technician who collected the data upon return to the field base location. The paper data sheets were scanned using a ScanSnap S510 into PDF format. Each file was saved in a file labeled by the date it was collected. All field data sheets were stored in the PDF for that date. The PDF was emailed to an off-site data entry assistant who manually entered the data into an excel spreadsheet. The spreadsheet was emailed back to the PI who imported the file into the GIS (ArcGIS) where files were maintained in ESRI geodatabase and shape file formats. The original paper data sheets and digital files are maintained at Desert Research Institute.

At the office each evening post-survey, the GPS unit data were downloaded using the program DNR (Department of Natural Resources) Garmin version 5.3.2 and converted to ESRI shape files. These shape files were then imported into the same GIS and stored accordingly. The results of the day's tortoise track efforts to locate each of the transmittered tortoises post-survey were collected on paper and then entered into an excel spreadsheet each evening as well. These files were emailed to the PI who imported the locations into the GIS using ArcGIS. The paper data sheets are stored by the USGS co-performers. The digital data are maintained at DRI.

The GPS unit data were deleted from each unit after it was downloaded and imported into the GIS and subsequently verified for completeness. At that time all data were deleted from the GPS units. In the GIS, the next day's survey plot corners were drawn and DTK9 team assignments were made to those survey plots. The corner points were exported from the GIS and then uploaded into the GPS units.

5.6 SAMPLING RESULTS

During the five days of field trials in Piute Valley a total of 75 tortoise finds were possible. All tortoise location and find data are presented graphically in Appendix B. Tortoises move and thus the actual distribution of tortoises often changed before the dog teams began their search effort. Using a combination of the location where tortoises were recorded the day prior to searching, tortoise locations during finds, and tortoise locations during the final telemetry at the end of each day, the number of tortoises per size class available for each dog to find was calculated. The rule base to establish whether or not a tortoise was missed by a DTK9 team was that the tortoise had to be present in the search area the day prior and the day of the survey as established by telemetry. Only tortoises located within the search areas counted as a find. These data are presented in Table 17. Expected and actual distributions differed because tortoises move. Table 18 shows the results of the numbers of tortoises located grouped by 'pass' dogs and 'fail' dogs.

Table 17. Expected and actual count distribution of tortoises available to be found by each team over the course of the field trials.

	Tortoise Size Class – Designed			Tortoise Size Class - Actual		
Dog team	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*
7	3	5	2	6	10	2
11	6	9	5	1	6	1
12	3	6	1	4	5	2
13	4	9	2	4	8	3
14	4	4	5	3	6	1
15	6	6	1	4	3	1
16	5	4	1	3	1	1

Table 18. Number of tortoises in each of the three size classes that were located by DTK9 teams, grouped by either having passed or failed the baseline assessment.

	S	**M**	**L**	**Total**
(5) passed dogs	18	25	7	50
(2) failed dogs	7	14	4	25
total	25	39	11	

Table 19 shows the time to complete the search of the assigned survey area by team for each date of surveying, and includes the time spent working (total time – break time) and the total time in the field. Teams searched ~1.5 ha per day. The DTK9 teams completed this size area between three and five hours including breaks. The actual time spent searching, less break time, was approximately three hours. The variability in total work was team dependent and is a function of the dog and handler need for breaks. Track data from a dog GPS is illustrated in Figure 46.

Table 19. Time data recorded per plot(s) per day. No data = no data available. N/A = team did not work that date.

	Work time minus break time (hh:mm)/Total time worked by team (hh:mm)							
	7	**11**	**12**	**13**	**14**	**15**	**16**	**Mean**
23 April[1]	4:38/5:34	No data	N/A	5:06/6:07	4:22/5:45	6:21/7:09	5:56/7:20	5:17/6:23
24 April	3:24/4:05	2:06/3:09	N/A	2:36/2:58	3:39/2:45	3:32/3:54	4:14/6:13	3:15/3:50
25 April	3:39/4:43	2:20/3:12	3:43/5:04	4:36/7:03	3:03/4:59	4:00/5:03	2:40/4:10	3:25/4:53
26 April	4:12/4:55	2:16/2:34	2:55/3:46	2:43/3:03	3:25/4:16	4:50/5:15	3:14/5:23	3:22/4:10
28 April	N/A	2:41/3:23	3:54/5:15	3:03/4:00	2:24/3:03	2:24/4:48	2:51/6:04	2:52/4:25
29 April	N/A	2:13/3:47	No data	3:26/3:35	2:41/4:16	4:51/5:14	2:59/5:00	3:14/4:22
Mean[2]	3:20/4:34	2:24/3:13	3:31/4:41	3:17/4:02	3:02/3:52	3:55/4:57	3:12/5:22	

[1]On this date the teams search 2ha plots. Subsequent plots were 1.5 ha.
[2]Calculated for 24-29 April with comparable search area sizes.

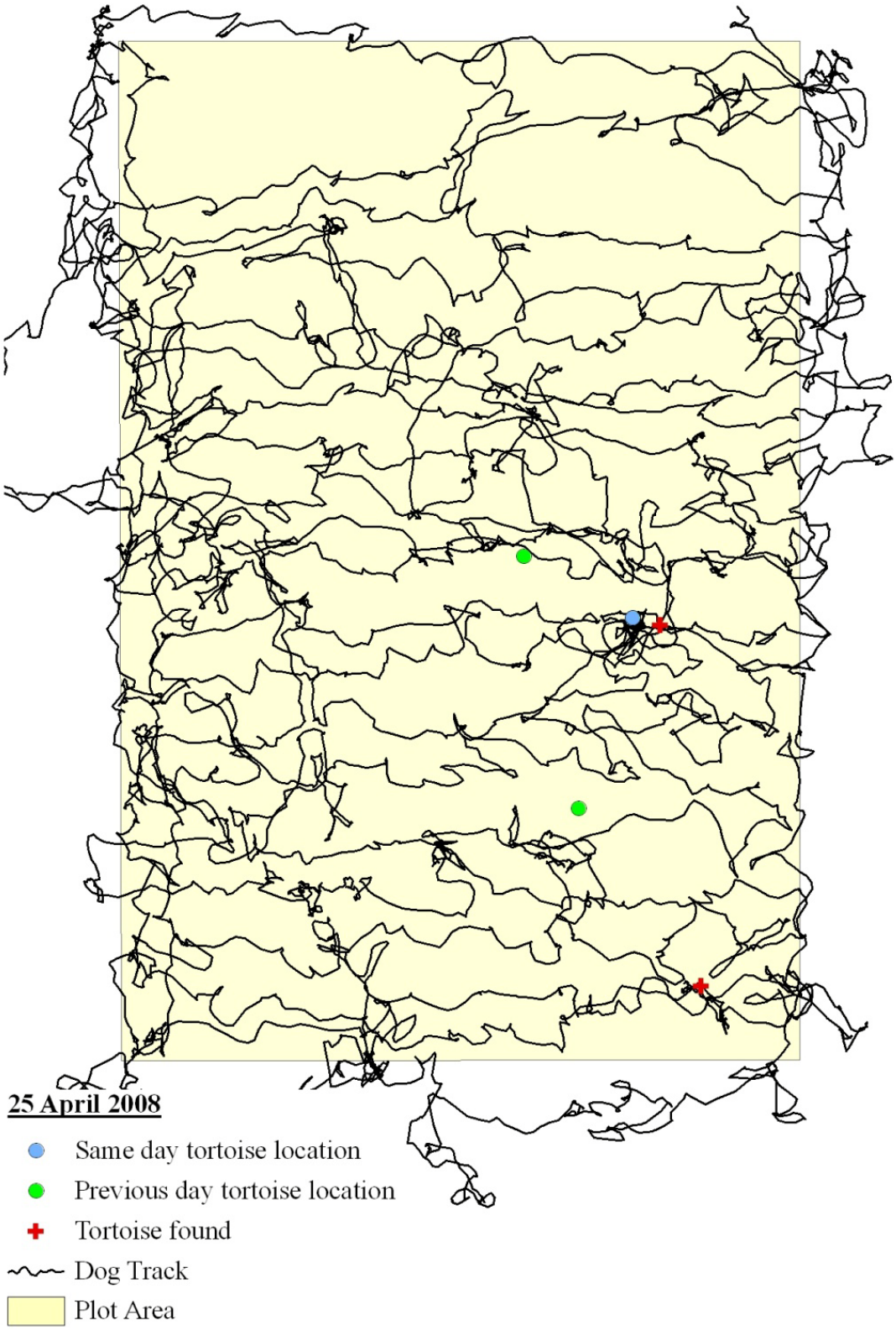

Figure 46. Example of track data downloaded from a dog GPS data logger.

Meteorological data collected during the time period that the DTK9 teams were actively surveying in assigned areas in Piute Valley are presented in Table 20. Ground and surface temperature are presented in graphical format to show daily trends in Figure 47 and Figure 48, respectively. Ground temperatures increased over the working time period at similar rates however temperatures increased earlier in the day as time progressed from the 23rd of April to the 29th of April. Air temperatures exhibited a similar trend with the exception of a large rise in temperature between the 26th of April and the survey dates 28-29 April.

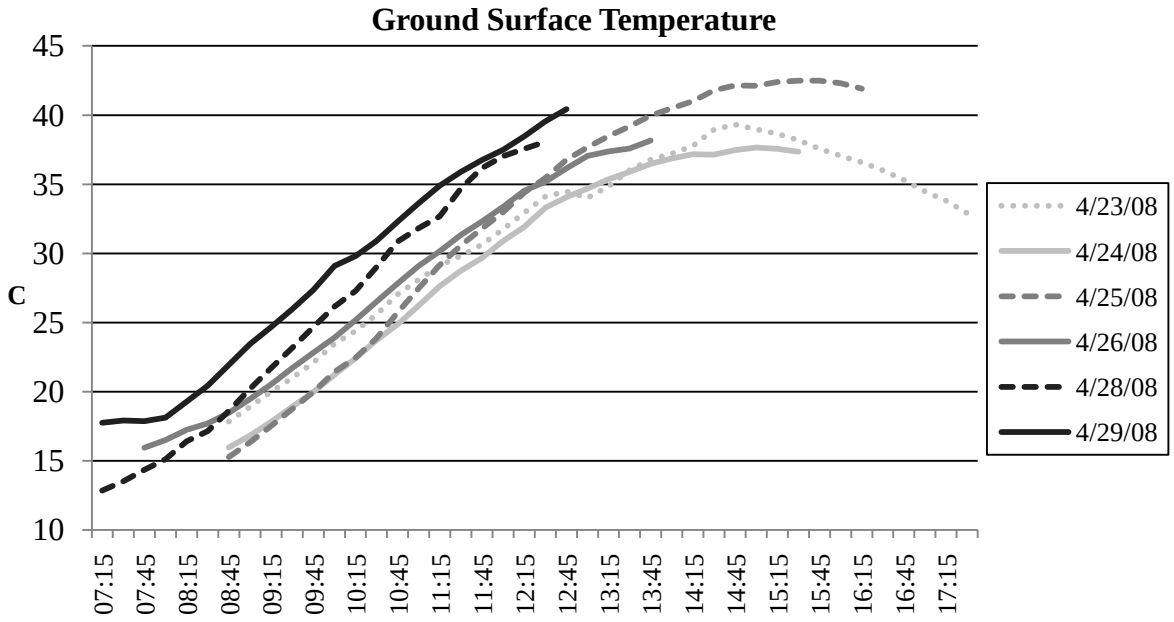

Figure 47. Ground surface temperature data during the time periods DTK9 teams were conducting surveys at Piute Valley. The time period begins with the first team starting their search and ending at the time that the last team completed their search effort.

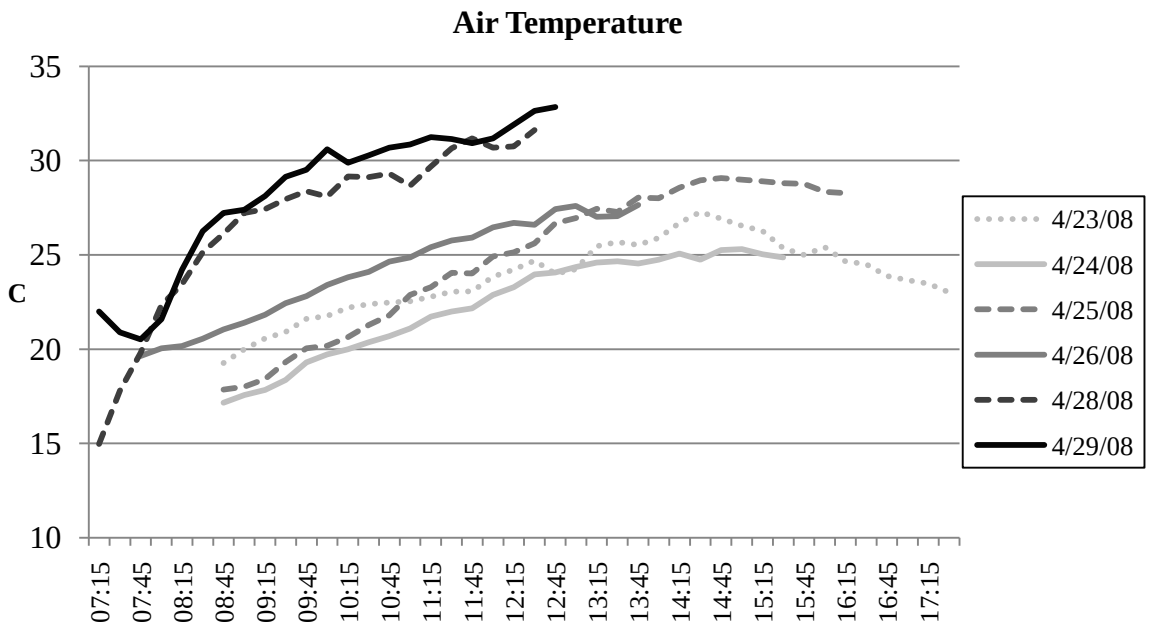

Figure 48. Air temperature data during the time periods DTK9 teams were conducting surveys at Piute Valley. The time period begins with the first team starting their search and ending at the time that the last team completed their search effort.

Table 20. Meteorological data collected at 15 minute increments (average) for the time period the DTK9 teams were actively surveying assigned plots in plots in Piute Valley.

	Ground Temp		Air Temp		Wind Speed	
23-April-08	°C	°F	°C	°F	m/s	mph
min	17.84	64.11	19.27	66.69		
max	39.31	102.76	27.27	81.09		
mean	31.82	89.28	23.86	74.94	5.15	11.52
std dev	6.39	43.51	2.00	35.60	0.92	2.07
24-April-08	°C	°F	°C	°F		
min	15.98	60.76	17.16	62.89		
max	37.66	99.79	25.30	77.54		
mean	29.57	85.22	22.33	72.20	4.66	10.42
std dev	7.43	45.38	2.67	36.80	0.59	1.33
25-April-08	°C	°F	°C	°F		
min	15.27	59.49	17.86	64.15		
max	42.50	108.50	29.07	84.33		
mean	32.72	90.90	24.86	76.74	2.57	5.74
std dev	9.30	48.75	3.82	38.88	0.57	1.26
26-April-08	°C	°F	°C	°F		
min	15.95	60.71	19.64	67.35		
max	38.16	100.69	27.64	81.75		
mean	27.44	81.40	24.17	75.51	4.92	11.00
std dev	7.62	45.72	2.67	36.81	0.45	1.00
28-April-08	°C	°F	°C	°F		
min	12.85	55.13	14.97	58.95		
max	38.08	100.54	31.62	88.92		
mean	25.41	77.74	26.79	80.23	2.16	4.83
std dev	8.60	47.49	4.51	40.12	0.95	2.13
29-April-08	°C	°F	°C	°F		
min	17.76	63.97	20.52	68.94		
max	40.43	104.77	32.84	91.11		
mean	28.43	83.18	28.31	82.95	2.89	6.47
std dev	7.82	46.08	3.89	39.01	1.40	3.14

6.0 PERFORMANCE ASSESSMENT

A total of five performance objectives were set, both quantitative and qualitative. All were met or exceeded. Results showed the certified DTK9 teams were able to exceed the set performance metrics, which would be useful for setting expectations in future applications of the technology. Improvement in DTK9 team performance was shown from previous work conducted in 2006 at military installations in the Mojave Desert of California (Cablk et al. 2007; Nussear et al. 2008).

6.1 CERTIFICATION TEST YIELDS TEAMS THAT PERFORM TO STANDARD

The first quantitative performance objective established that the certification test, which was comprised of three separate assessments fully described in Section 5.2, yielded teams that performed comparably under natural field conditions. This metric, established to determine whether or not the certification tests were effective, was evaluated by direct comparison of capability results during the Phase I assessments to Phase II performance in the field at Piute Valley.

To establish whether or not the efficacy and reliability success criteria were met, data were collected and analyzed on all tortoise finds during the certification tests as described in Section 5. Regardless of whether or not the team was considered 'passed' or 'failed', they fielded during the field trials in Piute Valley. Teams were never told whether they had 'passed' or 'failed' to prevent bias in the resulting data. Table 21 shows the data results from the DTCC certification assessment for high and low density tests and the resulting capability for each team's performance at Piute Valley. Threshold criteria in certification tests were 70% efficacy and 75% reliability. Overall the teams that passed the certification test had an average of 90% for both efficacy and reliability whereas the teams that did not pass the certification test collectively returned only 50% efficacy and 44% reliability during the field tests at Piute Valley.

The results also show an increase in performance for those teams that 'passed' between the DTCC and Piute Valley. Efficacy scores increased for each team. Reliability remained comparable for two teams, increased for two teams, and dropped by 1% for one team. All of the 'passed' teams represent high efficacy/high reliability cases.

The DTK9 teams 13 and 14 were deemed 'failed' for different reasons. Team 14 met the efficacy threshold under the high density assessment but did not meet the reliability criterion. The results at the DTCC corroborated performance under the stress of working in the natural environment. The dog in team 14 went on to have a 0% reliability score at Piute Valley. The dog never performed its trained alert at Piute Valley without cue from the handler. Although team 14 did meet the efficacy score under the high density scenario they only found 40% of the tortoises during the Piute Valley demonstration. It is possible that the dog did find more than 40% of the tortoises but because it was not reliable at communicating finds to its handler, those tortoises not visible were missed. This team represented a low efficacy/low reliability case. For team 13 the reason for certification 'fail' was that this team did not pass the low density assessment despite passing the high density assessment. This team went on to have a low efficacy score in Piute Valley, and when the dog did find a tortoise it alerted with 86% reliability. This team represented a low efficacy/high reliability case.

The results of this performance objective showed that the combination of assessments (safety, high density, low density) which formed the certification test yielded teams that performed comparably under actual working conditions. Teams that 'passed' the assessment criteria went on to perform successfully in the field while teams that 'failed' the assessment criteria did not perform successfully in the field. This was an important metric to demonstrate that the test is effective. It essentially weeds out teams that do not find tortoises under the stress of the real working environment and does not exclude teams that would actually be capable in the field setting.

This criterion was met.

Table 21. Results of certification test utility to produce capable teams.

	Reliability	*Efficacy*		*Reliability*	*Efficacy*
Criteria	0.75	0.70	Functional?	0.75	0.70
	High Density Assessment		**Low Density Assessment**	**Piute Valley Field Trials**	
Dog Team	*Reliability*	*Efficacy*	*Y/N*	*Reliability*	*Efficacy*
7	1.00	0.82	Y	1.00	0.88
11	0.89	0.75	Y	0.88	0.84
12	0.70	0.83	Y	1.00	0.88
13	0.82	0.92	N	0.86	0.47
14	0.33	0.75	Y	0.00	0.40
15	0.78	0.82	Y	0.78	0.91
16	0.82	0.92	Y	1.00	1.00

6.2 CAPABILITY - FINDING TORTOISES OF ALL SIZE CLASSES

This performance objective was designed to establish the capability of DTK9 teams to find tortoises of all size classes and was also used to support the analysis of the certification performance objective (Section 6.1). The metrics used to establish capability are efficacy and reliability. The success criteria were established based on past field experience of the research team in quantifying capability for individual size classes over prior years. Degree of difficulty to locate tortoises of different size classes is reflected in the minimum efficacy thresholds, which were established at 50% for small, 60% for medium, and 70% for large tortoises, respectively. Efficacy results from Piute Valley are presented in Table 22**.** Reliability is independent of efficacy and is expected to be maintained at a minimum level of proficiency regardless of the tortoise size or location. Reliability was also determined based on past years of experience and was set to 75%. Reliability by team is presented in Table 21.

The DTK9 teams that passed the certification test exceeded minimum criteria for each of the size classes. They were 28% more effective at finding small tortoises, 36% more effective at finding medium tortoises, and performed 30% better for adult tortoises than previously shown under natural field conditions (Nussear et al., 2008). Although the 'passed' dog teams scored a 100%

find rate for adult tortoises it is not expected that a perfect find rate might become a revised standard. In addition to exceeding the efficacy criteria, these dogs also communicated finds reliably to their handler, exceeding the reliability criteria. Both veteran and first season DTK9 teams were successful at finding all size classes of tortoise and performing reliably.

Table 22. Efficacy results summarized by tortoise size and by 'pass' or 'fail' group.

Tortoise size	**Small**	**Medium**	**Large**
Criteria	0.50	0.60	0.70
Dog Teams	**Small**	**Medium**	**Large**
Passed	0.78	0.96	1.00
Failed	0.14	0.50	0.75

In contrast the two DTK9 teams that 'failed' the certification test met only the large tortoise criterion. These DTK9 teams each found less than half of all tortoises available to be found. Neither would be considered successful under the established performance objective. However teams deemed certified via the certification assessment were successful, and exceeded, the performance objectives.

This criterion was met.

6.3 MAINTAIN IN-FIELD CALIBRATION – 'READ AND GO'

This performance objective is foundational to capability (efficacy and reliability) under natural working conditions. Capability is in laymen's terms how good a dog team is at finding tortoises and the likelihood of the dog to tell the handler when it has found a tortoise. As with any measuring instrument, calibration is required and with use the tool drifts from its established baseline. This concept applies both to the dog and to the handler. To be able to maintain the dog's alert and to maintain the team's interest and enthusiasm in searching for tortoises over long time periods when it may be days in between finds, in-field calibration is necessary. Although calibration of humans surveying for tortoises is similarly expected, it has not been studied.

As described in Section 2.2 we developed what is considered behaviorally as an intermittent reward system, modified by establishing a rule-base to deliver a variable intensity reward to the dog rather than varying a constant level of reward at random intervals. This method is termed 'Read and Go' and was demonstrated effective in earlier project work. Maintaining the calibration of the team in-field is measured quantitatively using the reliability metric, set to 75% and through efficacy, which shows that the team continues to be effective finding tortoises. The other piece for establishing whether or not the handler is properly executing 'Read and Go' is through demonstrating execution of the three levels of reward (full, pet, none).

As described above, data were collected to calculate reliability and efficacy. Those results are presented in Table 21. During the Piute Valley field surveys, data were recorded regarding the level of reward that handlers administered. These data reflected the handler's ability to operate in 'Read and Go', demonstrated by correct execution of the different reward levels. All handlers administered the variable level reward system in the field however not all teams performed at the

minimum 75% reliability level or met the efficacy criteria. The five teams that 'passed' the certification tests performed above the 75% reliability criteria and also met the efficacy criteria. One of the 'failed' teams also met the reliability criteria but did not meet the efficacy criteria. Based on the results of this analysis 'Read and Go' was successful in maintaining the dog's alert in the field setting in six of seven teams. However we report that only those teams that were deemed 'certified' and thus considered a DTK9 team were able to meet the 'Read and Go' performance objective. This further supports the validity of the certification tests to produce DTK9 teams.

This criterion was met.

6.4 SAFETY

Arguably the most important of the performance objectives, and certainly from a permitting perspective, is safety. While one cannot guarantee that no harm will come to a tortoise, in the context of developing a means to survey a protected species the likelihood that harm will be incurred from the survey tool is expected to be minimized. For this reason safety was established as one of if not the primary metric and was measured based on permit violations. The established metric was that no permit violation could occur that could not be mitigated. The data requirements included tortoises and dogs with access to tortoises. Success was determined by the project continuing through to completion without being shut down due to permitting issues.

During the course of this demonstration we did have a permit violation that was the result of a vehicle running over two wild hatchling tortoises at the DTCC. Fencing at the DTCC has been inadequate to constrain tortoises. Tortoises in the outdoor pens also reproduce freely and without knowledge of DTCC staff as to where nests are located and when they hatch. Although at the time of writing this report the DTCC has changed management and husbandry issues are among the many aspects being revised, during the time period when RC-200609 was at the DTCC tortoises of all sizes regularly escaped outdoor pens. The permit violation during this demonstration was mitigated by capturing and moving the remaining hatchlings that could be found in the area and a minimization of vehicular traffic. Further safety precautions were also added to daily routines while at the DTCC. It should be noted that no violation was reported due to a dog-tortoise encounter.

This criterion was met.

6.5 OPERATE EFFECTIVELY UNDER EXPECTED FIELD CONDITIONS

The single qualitative performance objective was to demonstrate that the DTK9 teams were able to field and search under actual deployment conditions. This criterion was established based on prior expertise fielding DTK9 teams at the NTC Ft. Irwin and Edwards Air Force Base. The criteria for success were twofold: (i) the teams were able to complete their search areas in one day and (ii) data were collected from the surveys to create a database for analysis. Table 19 above, shows the amount of time to complete the search of the assigned survey area by team for each date of surveying, and includes the time spent working (total time – break time) and the total time in the field. The search strategy employed was the three-pass grid strategy involving a search first of the perimeter of the area followed by a detailed search in the area directing the dog

to sniff all shrubs and possible burrows, and finished with a last hasty orthogonal grid search over the area. This strategy was shown above in Figure 39. However the metric for this objective was demonstration of at least one pass through the search area. As described above both the dogs and handlers wore GPS units during the demonstration at Piute Valley. Tracks were evaluated each day to determine if the handler had covered their search area with at least one pass. All teams were able to accomplish this.

The second metric was the completed data sheets for each team at the end of each survey day. A complete database was built based on the Piute Valley field data collected (Table 16). This database supported all other quantitative metric evaluation. Handlers completed at least one pass through their search areas each day and most of the time they were able to complete all three passes, the standard search strategy for tortoises.

This criterion was met.

7.0 COST ASSESSMENT

7.1 COST MODEL

The cost of a DTK9 team is dynamic and subject to market forces. At present there has yet to be an assessment of other survey technologies to the level conducted under RC-200609 demonstrating comparable ability to locate all size classes of desert tortoises. As such the benefit of this technology to its demonstrated level is unique and it is difficult to place relative value estimates on DTK9 teams. Without an equivalently rigorous study for human performance there is no means to conduct a direct cost comparison for the same capability. In RC-200609 we relied upon the use of transmitters and telemetry to validate dog finds to be able to conduct capability assessments. There were instances when the dogs alerted and small non-transmittered tortoises were validated by the tortoise biologists as well as instances where alerts could not be validated. Without having transmittered the population for this demonstration, the use of humans alone to validate dog finds would have required extensive time and personnel resources without a guaranteed return.

The cost to field a DTK9 team follows a pricing structure that models the costs to field human survey teams. To date dog handlers have not been permitted to handle tortoises so permitted tortoise field technicians would be necessary for data collection. Dog handlers who are also permitted to handle tortoises would potentially not require an additional technician to be part of their team and would thus reduce costs. Costs estimates for the elements associated with DTK9 teams during the demonstration are provided in Table 22. These estimates were based on the most current information available and actual costs during the demonstration, whichever were more current. This is due to changes that occurred after the demonstration was completed.

The expected overall implementation costs will be less than those tracked during the ESTCP demonstration because the research and development aspects would no longer apply. The principal investigators, data technicians, and master trainer, for example, are not required elements of DTK9 teams as a standalone technology. Critical elements of implementation were specifically tracked for use in providing realistic estimates to technology end users. The degree to which costs beyond the direct cost of a DTK9 team and field technician applies will vary with the scope of the project. For example, the cost of permitting may not apply solely to the DTK9 portion of a project as the use of DTK9s as a survey tool may be one of many permitted aspects. The costs listed in Table 22 are detailed as follows.

The DTK9 team is the technology and is the most costly element. This cost included all dog and handler expenditures such as food and veterinary care as well as personal dog gear not specifically provided for the demonstration (i.e., GPS, data loggers). Travel costs for handler to participate in training and testing activities were reimbursed at allowable federal per diem rates. Reimbursement to handlers was conducted on a task-specific scale. There was an opportunity cost to handlers participating in this demonstration and that is reflected in the reimbursement rate for training at the DTCC and for non-working days during the field demonstration at Piute Valley.

Table 23. Cost model for DTK9 teams based on expenditures from 2008 demonstration.

Cost Element	Data Tracked During the Demonstration	Actual Costs
DTK9 team (each) without permitted biologist	Daily cost per type of task.	• 0$ scent recognition training off-site • $200/day training at DTCC • $400/day working • $200/down day
Permitted biologist for DTK9 team	From Nussear et al. (2008)	$176/day
Facility Fee (DTCC)	N/A	N/A
Training/Testing by Master Trainer	Cost to conduct individual team training, maintain training schedule, and oversee safety for dog-tortoise encounters at the DTCC.	• $450-$600/day during training for ≤ 8 teams • DTCC personnel costs unknown
Travel, Lodging, and per diem	Federal per diem rate for Las Vegas, NV	• $183/day (average) • 0.55/mi federal rate
Permitting fees	Fees paid for state (1) and federal (1) permits	$200

Initial scent recognition training was done without compensation to the potential handler, however initial scent recognition training is expected to be a recovered cost once implemented. The initial cost to train a dog for tortoise detection is a one-time expenditure as it is a one-time event. Maintenance training must be absorbed by the handler unless working on a multi-year project where training can be shown to directly benefit the specific project. It would be expected that a returning DTK9 team would be effective and reliable at the start of the survey season, whether maintenance training were conducted over the course of a few months, or done intensively immediately preceding fielding (or recertification). Using locally available DTK9 teams will reduce travel and per diem expense associated with any personnel, handler or otherwise. It should also be noted that handlers received a different rate for days when they were fielding as a DTK9 team versus rest days. It would seem appropriate to negotiate on this rate, or to have handlers contribute to the project in ways that do not involve dog-handling for compensation. Dogs do not work on rest days for any purpose.

Typically the handler is not expected to be permitted to handle tortoises and during the demonstration this was the case. For the demonstration purposes the tortoise biologists had multiple duties including data collection and safety responsibilities. During actual surveys by certified DTK9 teams it is more efficient to have separate roles for the handler and the tortoise biologist. The tortoise biologist processes tortoises while the handler continues to cover the search area. The cost estimate provided is based on published costs in Nussear et al. (2008). The cost for a permitted biologist will vary depending on a number of factors including the individual's experience, the employing organization or company, and the number of surveys or projects occurring at a given time (supply and demand). Market forces apply to qualified, permitted biologists which may significantly affect this cost element.

At the time of the demonstration and for all years preceding the demonstration, there was no fee to use the DTCC or to receive personnel support. This changed immediately after the demonstration was complete and new policies and procedures are being implemented. These changes include the potential for a facility-use fee to be implemented. Included in the fee might also be an expense for DTCC personnel support. At this time the fee schedule is not in place. Future facility use fees associated with the DTCC in the future should be included for a realistic cost estimate.

Two permit fees were also necessary to conduct the demonstration. These were for Nevada Department of Wildlife and for the USFWS.

7.2 COST DRIVERS

The main cost driver will be the level of detail that is required of the survey, where surveys that require detailed searches to locate all size classes of tortoises or in particular the smallest tortoises will require approximately 1 dog team per 2 ha per day. Thus a detailed search of a parcel 1 km^2 in area would require 50 dog-team days whereas searching for larger tortoises would require six to ten dog-team days.

The two components of the technology that are likely to incur the most cost are the rates charged by the handler/dog teams, and the staffing for the training and evaluation sessions that are to occur on an annual basis, which will be absorbed into the cost estimate for working DTK9 teams. In addition the cost of human surveyors will affect project costs as authorized tortoise biologists will be necessary personnel to process (e.g., handle, draw blood, attach transmitters, etc.) tortoises. These costs are market driven. As most users of this technology are expected to be Federal Agencies, subcontractors thereof, or consultants to developers conducting surveys, contracts of this type would be expected to be of a cost that must be put out for bid. As such the rates charged by handlers may be driven by this process through market competition.

Staffing required to train and evaluate dog teams on an annual basis will likely require flexible staffing numbers, as the numbers of DTK9 teams that will need to be processed will vary based on the anticipated number of surveys to occur in the following year.

7.3 COST ANALYSIS AND COMPARISON

Operational implementation of DTK9 teams will involve certification, permitting, and field costs including travel. These costs are provided in Table 23. The cost estimate for certifying DTK9 teams is based on the only facility currently available to provide the full complement of size classes of tortoises, the DTCC. Initial training on adult tortoises might be possible using captive pet tortoises however this would not represent a complete odor signature for the dog, as demonstrated through RC-200609. For these reasons at this time all testing would be conducted at the DTCC in Las Vegas, NV and the cost estimate reflects this.

The cost estimate assumes teams will field for surveying for the Mojave Desert tortoise and as such costs are not expected to vary with site throughout the range of the Mojave Desert tortoise. Coverage by DTK9 teams would decrease with increasing landscape complexity, just as it does for human-based surveys. The more complex terrain the more locations needed to be closely

inspected and thus the longer search time and effort required. This would vary more when searching for small tortoises than for larger tortoises. Fielding teams to locate Sonoran populations of desert tortoises may require additional training and testing as suitable habitat tends to be of a different character than in the Mojave.

The cost analysis assumes similar costs elements and extent of survey area coverage as that documented during RC-200609. It also assumes that variable rates such as per diem, travel, organization overhead, other internal operating costs, fixed costs, etc. will vary with location of project, project extent, project scope, and the particular organization or company doing the work, among other factors and will be incurred regardless of whether the survey resource is human or DTK9.

Table 24. Cost model for DTK9 teams based on expected costs provided by consultants and revised DTCC facility fee schedule.

Cost Element	Estimation Basis	Estimated Cost
Dog/handler team (each)	Estimates made based on 2010 cost estimates from consultants[1]	• $1725 basic training off-site[2] • $242/day training at DTCC[3] • $483/day working[4] • $230/non-working day
Facility fee (DTCC)[5]	USFWS-provided estimate.	• undetermined yet
Training and testing to the DTK9 Standard	Cost to certify teams for permitting[6].	• $600/day during training for ≤ 8 teams (Master trainer) • $176/day field assistants[7]
Travel, lodging, and per diem costs	Federal per diem rate[8]	• $183/day (average) per diem for Las Vegas • 0.25/mi to 0.50/mi federal mileage reimbursement
Permitting fees	Fees paid for state and federal permits	• $200 (Federal and one state)

[1] Cost estimates provided by PackLeader Dog Training and by Working Dogs for Conservation. Both organizations are businesses that provide wildlife detection dog teams.
[2] For first-time dog needing scent recognition training for tortoise.
[3] Tortoise training for transitioning to live animals and/or refresher training for veteran team on live animals.
[4] For a certified team working in the field surveying for tortoises.
[5] This is a new fee since conducting the demonstration.
[6] Research & Development cost, expected to be less upon implementation because the program and its material have been developed.
[7] Based on estimates from Nussear et al. (2008). Consultant cost could be 2-4 times higher with market forces.
[8] This rate will vary with location and time of year. Use of local teams will minimize per diem costs.

Human surveyors permitted to conduct desert tortoise surveys must be trained as well. A cost accounting of training and testing of humans is unavailable. To conduct surveys as a desert tortoise authorized biologist requires extensive experience handling and receipt of training under authorized tortoise biologists. Application requirements include certification of total time spent conducting authorized and supervised tortoise activities, miles/kilometers walked, handling of wild tortoise by size, coursework, field training, and translocation activities, among others (http://www.fws.gov/ventura/speciesinfo/protocols_guidelines/). In addition the US Fish and Wildlife Service (2010a) reports human surveyors undergo 5 weeks of training prior to

conducting LDS surveys. Human surveyors conducting surveys that involve health assessments, such as translocation projects, must undergo additional training. This includes health assessment training ($1500 for a 5-day rotation) and drawing blood ($1800 and an additional 5-day rotation) (US Fish and Wildlife Service, 2010b). Attaching transmitters to tortoises or conducting other procedures requires additional training and associated cost. The USFWS reports survey costs to conduct LDS for fiscal year 2011 at $1,074,300 of which DOD is expected to contribute $300k (http://www.fws.gov/nevada/desert_tortoise/documents/recovery_plan/20110310.Desert.tortoise.monitoring.coop.venture.pdf).

Life cycle costs for DTK9 teams directly relate to the age at which the dog starts training for desert tortoises, becomes certified, and the age at which the dog retires. Other factors for life-cycle cost include the number of other target odors the dog is trained to and actively works, and how much of the non-tortoise survey season the dog works for detection. Working dogs typically begin training when acquired which can be as early at 8 weeks old. The amount of time before a dog is considered field ready and certified, where standards exist, varies with the skill level of the trainer/handler and the ability to conduct necessary training. A dog can begin working as part of a certified team by the time it is a year old assuming professional training began early in the dog's life. The length of time a dog works over its lifespan varies tremendously. Injuries can end a dog's career at a relatively young age and at the same time one of the DTK9 dogs continued to work at age 13, although this would not be considered typical. In terms of estimated life-cycle cost of the technology our research has shown that once the dog learns tortoise as its target, minimal re-training is necessary prior to beginning a new field season. Furthermore when a dog continues to work locating other non-tortoise targets in off seasons the detection and alert behavior is reinforced which translates across its recognized target odors. Searching and training for other targets helps maintain the dog in working condition. Therefore the estimated cost to maintain the dog as a tortoise detector over the course of its life, even while not searching for tortoises, can be minimal. There is no associated cost for a DTK9 team to survey for targets other than tortoises. The annual cost to maintain the DTK9 varies with demand in any particular year. As training and evaluation requirements are likely to persist from year to year, the costs per DTK9 team that passes the certification are not expected to change markedly throughout the lifetime of the team.

Unlike a mechanical device, a trained detection dog does not depreciate with time. Rather it may actually appreciate in value because the dog learns and learning translates directly into the dog's capability with each field deployment. The more repetitions in reinforcement with reward, which would be expected to occur during field surveys, the 'better' the dog becomes. An experienced dog actually increases in value and requires less maintenance over time, which results in lowered annual costs.

7.4 COST INTERPRETATION AND SCALING

The use of DTK9 teams is not intended to replace existing survey means, particularly since the search strategy for an olfaction-based detection tool differs from a visual tool. The DTK9 development was conducted to provide an additional survey tool and specifically to add utility by focusing on small tortoises. For example, DTK9 teams may serve to enhance existing human-based surveys in instances where human survey data indicates the presence of smaller tortoises might be expected. The 2005 'human-DTK9 comparison' was designed to be a direct

comparison of the effectiveness and cost of human survey teams compared with dog survey teams and it was anticipated that small tortoises would be found by both teams. When results did not yield small tortoises, additional effort was conducted to further investigate dog capability specifically for small tortoises, which ultimately resulted in the advancements and technology development outlined here. However no additional efforts were conducted for further training or assessment of human survey teams. To this end there exists a void in baseline capability against which to compare existing visual (human) survey methods with the DTK9s. It is possible that a combined effort of human and DTK9 search teams could be deployed but it is unknown whether doing so would result in significant cost savings.

Interpretation of the cost to obtain and deploy a DTK9 team as well as how to scale the costs would be done with respect to the physical size of the area to be surveyed for desert tortoises and the level of detail desired. Results from RC-200609 and previous studies have shown the expediency of DTK9 teams to cover an area. There is a direct relationship between the speed of the team and the size classes they can effectively detect. Therefore to conduct more thorough surveys requires additional time as the size of the search area increases. Contracting more teams enables larger areas to be surveyed with sufficient detail. As would occur with any tool, costs will increase with the number of teams and with the amount of time teams spend working. The objectives of the survey would dictate whether to (i) field fewer teams over more days; (ii) field more teams over fewer days; (iii) relax the size constraint of the tortoises to be detected; (iv) employ stratified sampling to focus more intensive effort.

Previous cost estimates for human teams in Nussear et al. (2008) were based on limited student and government labor rather than contractor costs. Contractor based costs could be up to four times or more depending on market forces. Table 24 presents a revised cost comparison for human only teams and DTK9 teams for two levels of survey effort based on tortoise size class and based on area to be covered. These estimates are based on survey team sizes from the 2005 human-DTK9 team comparison with revised cost estimates for both human contractors and current DTK9 rates. The costs assume preparatory training and permitting are in place and are thus not included. Support and logistic personnel would be expected to be similar as the scope of the project increased for either type of team. In 2005 six DTK9 teams were deployed to cover 1km^2 per day with one authorized tortoise biologist accompanying each team. Based on improvements in training and deployment parameters it would be feasible to have fewer tortoise biologists on call (roving or strategically located) to respond to a dog alert within a 1km^2 area when searching for tortoises≥ 180 mm MCL. Completing a survey of 50 km^2 per day would be an ambitious undertaking for either survey method.

Because previous work has shown that a team of 11 humans without scopes, but with mirrors and probe poles, were unsuccessful at locating small tortoises, assumptions must be made to conduct a direct cost-comparison for the full desert tortoise demographic (Nussear et al., 2008). In this same study DTK9 teams were equally deficient however results from RC-200609 resolved this problem and resulted in area-effectiveness rates for DTK9 teams. The 11:6 ratio for human to DTK9 teams therefore requires modification for a cost comparison. When conducting surveys to include smaller desert tortoises, one DTK9 team can effectively cover 0.015 km^2 per day. Using straight scaling based on the area-effectiveness of DTK9 teams, 122 humans would be needed to cover 1 km^2 for all size classes assuming more people result in improved detection.

For this type of survey each DTK9 team should have an authorized tortoise biologist accompany them. For humans adding the use of scopes, and assuming the surveyors are trained and proficient with this tool, might serve to increase find rates. Using scopes increases the amount of time required to cover an area, which would dictate increasing the team size to complete an area within one day. In the 2005 study the humans searched an average of 8.52 hours per day. The same number of humans could be tasked to survey 12 or more hours a day, or more people could be added to the survey team; both options will reflect cost increases and requiring such concentrated effort for increased hours may be ultimately counterproductive to the task at hand. For simplification, Table 24 uses a multiplier of 1.5 to accommodate the level of effort to effectively use burrow scopes and to conduct a thorough search for small desert tortoises, without increasing the number of hours each person would spend surveying.

Table 25. Cost comparison of human survey teams and DTK9 teams. Estimates presented represent the number of teams to cover the specified area in a given day. M = million.

	Tortoises ≥ 180 mm MCL			Tortoises < 180 mm MCL		
Team	Area (km^2)	Count[1]	Total cost/day	Area (km^2)	Count	Total cost/day
Human	1	11	$4,840-7,744	1	183	$80,520-128,832
DTK9	1	10[2]	$4,658-5,714	1	67	$61,841-79,529[3]
Human	50	55	$24,200-38,720	50	9,150	$4.026m-6.442m
DTK9	50	50	$23,290-28,570	50	3,350	$3.093m-3.977m[3]

[1] Number of humans or DTK9 teams + tortoise biologists.
[2] Six dog teams would rely on four authorized tortoise biologists to process tortoises found.
[3] Calculated for one authorized tortoise biologist accompanying each DTK9 team.

Surveying 50 km^2 in one day for all size classes of desert tortoise is unlikely given the resources required. There might also be concern for environmental consequences of fielding such a large number of people in a given area as the desert can be susceptible to foot traffic. This cost comparison shows that DTK9 teams are not necessarily cost-prohibitive or more costly than human survey teams alone. Market cost for authorized tortoise biologists drive the cost estimate.

8.0 IMPLEMENTATION ISSUES

8.1 REGULATIONS AND PERMITTING

Regulations and permits related to the implementation and deployment of DTK9 teams are primarily related to the protection of desert tortoises and their habitats and the specific concerns for lands set aside for particular management prescriptions for tortoises and their habitats or otherwise. As with any survey conducted for federal and/or state listed species, permits to interface both humans and dogs will be required. The permit process for the human side of deploying DTK9 teams is the same as for any other permit involving human-based surveys. For interfacing the dog side of the DTK9 team, we recommend permitting agencies look to the certification standard developed as part of this demonstration (Appendix D). Surveys have been conducted in the Mojave using dogs without acquiring permits prior to RC-200609. Based on the results presented here we do not advocate continuing this procedure.

Table 25 presents the permits, agency, and pertinent regulations that would be anticipated for fielding DTK9 teams. Several of these permits may be required simultaneously for the legal use of DTK9s to search for desert tortoises. Any possibility of "take" of an endangered species or their habitats requires the issuance of an endangered species permit under the Endangered Species Act (1973). State wildlife permits and coordination will be necessary for the states where the projects will occur. Each state where the tortoise is protected by Federal law also has its own regulations to protect listed species, and the regulations require the acquisition of a scientific collection permit for work with desert tortoises. Sufficient lead time is required by these agencies comparable to that required for the Federal permit.

Other Federal, State, County, Municipal or Private entities may legally require permits to enter their jurisdictions and these may be based on regulations requiring scientific collection permits, cooperative agreements, or letters of permission. Suffice it to say that land ownership should be considered for all DTK9 activities and owners should be contacted to ensure that regulations are being adhered to. Finally, in addition to responding to land-based regulations, research projects in cooperation with state universities often require Animal Care and Use Committee (ACUC) coordination for the use of dogs in research projects for the protection of wildlife and the dogs.

The following guidance is provided to illustrate examples of why the regulations are necessary and provide the opportunity to explore potential situations that require consideration in advance of DTK9 implementation. DTK9 implementation requires coordination with a variety of regulatory agencies primarily because of the potential for "take" of the Threatened Desert Tortoise as defined in the Endangered Species Act (ESA - 1974). "Take" has a legal definition in the ESA and can be summarized as any human activity that causes harm to desert tortoises or their habitats in a very broad sense. DTK9 work may be allowed to occur with appropriate adherence to regulations and acquisition of appropriate permits from regulatory agencies in the Federal, State and Local governments. Regulations and permitting described herein are focused not only on human and dog activities that potentially result in the illegal "take" of the desert tortoise but also entering lands that have additional regulations associated with the administrative agencies with jurisdiction over particular land parcels where DTK9 activities are planned to occur. Permit applications for any purpose can take as long as one year to acquire and insufficient lead-time to complete the permitting process could result in the delay or

postponement of planned activities involving DTK9 teams. Because this is a relatively new process it should be expected that the permitting process might be especially arduous and the maximum time available should be invested by parties planning to engage in permitting for DTK9 activities.

Table 26. Required permits for the implementation of DTK9 teams. This list incorporates all of the potential permit sources that were encountered during this project and lists others that may exist or be originated subsequent to this report.

Agency	Required Permit	Law / Regulation
Federal Agency		
United States Fish and Wildlife Service	Threatened Species Permit	Endangered Species Act (ESA) of 1973
State Wildlife Agencies		
California Department of Fish and Game	Scientific Collecting Permit	California Endangered Species Act
Nevada Department of Wildlife	Scientific Collection Permit	Sect. 503.080.2 Nevada Administrative Code
Utah Division of Wildlife	Endangered Species Recovery Permit	Utah Administrative Code Title 23: Rule 657-3-25
Arizona Game and Fish Department	Scientific Collecting Permit	Arizona Revised Statutes. Title 17, Game and Fish
U.S. Department of Interior Agencies		
Bureau of Land Management	Cooperative Agreement	Code of Federal Regulations, Title 43 (Public Lands: Interior)
National Park Service	Scientific Research and Collecting Permit	Title 36 of U.S. Code of Federal Regulations
National Wildlife Refuge	Research Permit	Code of Federal Regulations, Title 50 (Wildlife and Fisheries)

The potential for take is always present when working with live desert tortoises and their habitats with or without the use of dogs. Take could occur at any time when human personnel are working in an official capacity as a DTK9 team during training, or the implementation of a DTK9 program, even in the absence of dogs. Vehicular accidents are a primary concern when personnel are traveling in occupied desert tortoise habitat. Training activities also increase the probability for humans to “take” desert tortoises by stepping on small unseen individuals. Just as people are taught not to directly or inadvertently harm tortoises, dogs are taught not to touch tortoises, and just as people make mistakes so are dogs imperfect. People may inherently show restraint towards handling tortoises in the absence of such education, but dogs will not. For these reasons there exists an additional level of risk when interfacing un-tested (i.e., untrained or insufficiently trained) dogs with tortoises. Although we found that our testing process yielded teams that could operate in proximity with tortoises safely, the addition of dogs to surveys inherently adds a level of risk of harming tortoises. The risks stem from the presence of dogs, albeit relatively small based on our demonstration results, and due to the necessity of the handler to share focus on multiple tasks simultaneously – watching their own foot placements, watching the dog’s feet placements, watching dog’s general body movements, and maintaining search

lines. These are all elements that are required to maintain permit compliance and minimize if not avoid unnecessary take.

Any activity that could purposefully or inadvertently result in habitat destruction would also be considered “take” and be restricted by permits acquired through agencies. Purposeful habitat destruction would include activities such as driving or parking on previously untrammeled habitat in areas where such activities are restricted. These few examples are by no means comprehensive and for this reason all personnel directly involved with hands-on activities with desert tortoises must be listed by name on Federal and State Endangered Species permits.

The DTK9 Demonstration RC-200609 has provided a benefit to the establishment of a more widespread program involving DTK9s for tortoise searches because the permits that were required for all phases of the Demonstration plan provide a template for considerations involved in issuing such a permit. Furthermore, during the course of this multi-year development of the demonstration, the permit was revised to account for aspects of the permitting that resulted in irresolvable management issues, were irrelevant to the implementation activities, or were simply logistically unfeasible. Therefore, future permitting applications will benefit from previous permits by using those templates.

8.2 DECISION-MAKING FACTORS FOR END USERS

In a large part, this program was designed to consider and remedy potential end-user concerns and to address decision-making considerations. Acceptance of the certification standard (Appendix D) developed as part of this report must be complete prior to the implementation of the program. In spite of the intensive planning involved in writing the certification standard as a standalone document, which remain in discussion with the permitting agencies, several factors are not under the control of any entity (e.g. environmental conditions) and thus a discussion of these factors can assist potential DTK9 users in making well-informed decisions in planning activities.

It is important to recognize that placing dogs in desert tortoise habitats automatically sends up red flags for the constituents (e.g. the public and agency personnel) of regulatory agencies due to the potential for the dogs to interact with tortoises and their habitats in negative ways. Dogs are innately driven to explore the possibility of many wild animals as prey species and predatory behaviors may be expressed in their presence such as lunging at, digging around, chasing and/or biting potential prey items. The DTK9 program was developed with a keen awareness of this sensitivity and its developers have gone to great lengths to alleviate the concerns of regulatory agencies. For example, a research project was specifically designed and implemented during the early development of the DTK9 program to address many of these concerns (Heaton et al., 2008). Specifically, Heaton et al. demonstrated that (i) wild canines (e.g. coyote and fox) were not attracted to sites where DTK9 teams recently worked, and (ii) there was no detectable harm to tortoises above background levels for at least two years after an intensive DTK9 survey was implemented. Although it is unlikely that all such fears will be alleviated to the satisfaction of all involved individuals, scientific literature developed as a result of RC-200609 provides an avenue to facilitate permitting DTK9 implementation.

Regardless of preparation, when DTK9 teams work in desert tortoise habitat there is potential for unintentional harm by dogs, humans, and vehicles by merely trampling small tortoises (e.g. < 100 mm carapace length). The other primary concern for tortoises and their habitats during implementation includes the potential of aggressive behaviors toward tortoises which could result in burrow destruction, trampling of tortoises or actually having a tortoise injured by overly enthusiastic finds or actually being bitten. The DTK9 training program included extensive instruction designed to avoid such encounters, but the fact is that dogs in association with tortoises provide opportunity for the unexpected and thus permits are required according to appropriate regulations. All phases of the DTK9 program development focused on safety for the tortoises and their habitats as a priority as a means to reduce the probability of harm. The emphasis of safety is documented throughout all documents related to RC-200609.

The end-users are in partnership with a group of agencies because any entity that decides to implement a DTK9 program will minimally be required to coordinate these activities with the USFWS and appropriate State wildlife agency. The primary concern of the regulatory wildlife management agencies will be the health and safety of desert tortoises that are involved in DTK9 surveys and to minimize stress and injury to those animals. Therefore, the primary concern of the end-user will be to work with well-trained and preferably highly experienced DTK9 teams. Several scenarios are provided for consideration by potential end-users. These scenarios hold true for both use of DTK9 teams and human survey teams.

Scenario 1 - Permits must be applied for up to 1 year prior to activities. However, the availability of trained and previously permitted DTK9 teams may be limited due to the initial costs of investing in the training. Therefore, permit applications may be applied for without naming individuals and their credentials for inclusion in field activities. These details must be considered and worked through with permitting agencies during preliminary contacts.

Scenario 2 - Should field work not be implemented due to project failure, permit complications, or biological factors such as large-scale tortoise inactivity, it will affect the contractor and project initiators. Tortoise activity is dependent on environmental variables (Zimmerman et al. 1994, Nussear and Tracy 2007, Inman et al. 2009) such that some spring seasons are unlikely to be conducive to finding tortoises adequately. In these cases, fieldwork may be cancelled thus creating contracting conflicts, which should be accounted for in advance of issuing a contract for work.

Scenario 3 - Training should probably be conducted in the active season prior to project implementation for new DTK9 teams. This is because the window of time when DTK9 work can be conducted is limited to the spring and fall due to temperature restrictions. DTK9 teams should plan for a brief but intensive refresher just prior to actual DTK9 implementation and this must be accounted for in permitting and contracting.

8.3 PROCUREMENT AND RELATED ISSUES

Equipment such as technological hardware is a relatively minimal investment for those wishing to procure DTK9 teams to search for desert tortoises. Those interested in fielding DTK9 teams will need to make a choice between contracting professional DTK9 teams (i.e., off-the-shelf ‘OTS’) and developing teams in-house.

The DTK9 program developed under RC-200609 has functioned as a program using contractors and thus most similar to an OTS type of project. In this way several of the important considerations regarding the development of the DTK9 program were basically designed for the off-the-shelf type of program. The primary consideration for development of an In-house program is the amount of time during which it is impractical to field the K9s. This down-time would likely reduce the cost-effectiveness of such a program unless the DTK9s were trained for other activities that could be conducted during non-tortoise surveying time periods. Training the teams to search for other sensitive plants and/or potentially animals during the parts of the year when they are not needed to search for tortoises is one way to increase the cost-effectiveness of such a program. Certainly there must be several species that require similar types of data to that used for desert tortoise surveys among the U.S. military installations.

Thoughtful consideration and a full understanding of detection dog training and deployment is necessary before committing to train a dog for multiple target odors to ensure optimal performance is maintained for each target species. A multi-species approach is beyond the scope of this program at this time and was not evaluated as part of this project. However, several of the DTK9 teams that fielded as part of this program work throughout the entire calendar year on multiple wildlife scat targets or for law enforcement search and rescue activities.

9.0 REFERENCES

Boarman, W.I. 2001. *Threats to Desert Tortoise populations: A critical review of the literature*. Unpubl. Report, prepared for the West Mojave Planning Team and the Bureau of Land Management. 86 pp.

Buck, L. 1993. *Identification and analysis of a multigene family encoding odorant receptors: implications for mechanisms underlying olfactory information processing.* Chemical Senses. 18:203-208.

Buck, L. and R. Axel. 1991. *A novel multigene family may encode odorant receptors- a molecular basis for odour recognition.* Cell. 65:175-187.

Cablk, M.E., R.S. Harmon and C. Valentin. 2007. *Maintaining real-time calibration of detection dog teams during field deployment given uncertainty in target location.* The Partners in Environmental Technology Technical Symposium and Workshop: Meeting DOD's Environmental Challenges. December 4-6, 2007. Washington, D.C.

Cablk, M.E. and J.S. Heaton. 2005. *Efficacy and reliability of dogs for surveying desert tortoises: Results from the DT-K9 trials*. March 28-April 15, 2004 Desert Tortoise Conservation Center – Las Vegas, NV. *Prepared for:* University of Redlands. Task order# 121220-02-02A. 57p.

Cablk, M.E. and J.S. Heaton. 2006. *Accuracy and reliability of dogs in surveying for Desert Tortoise (Gopherus agassizii).* Ecological Applications. 16(5):1926-1935.

Cablk, M.E., K.N. Nussear, and T.C. Esque. 2007. *Desert tortoise surveys on the Precision Impact Range Area October 2006, Edwards Air Force Base, California*. Final report to Edwards AFB. 22 pp.

Cablk, M.E., J.C. Sagebiel, J.S. Heaton and C. Valentin. 2008. *Detection distance: A quantitative analysis of how far away dogs detect tortoise scent and follow it to source.* Sensors. 8(4):2208-2222.

Congdon, J. D. and J. W. Gibbons. 1990. *Turtle eggs: their ecology and evolution.* In J. W. Gibbons (ed.). Life History and Ecology of the Slider Turtle. Smithsonian Press, Washington, D.C.

Doak, D., P. Kareiva, and B. Kleptetka. 1994. *Modeling population viability for the Desert Tortoise in the Western Mojave Desert.* Ecological Applications. 4(3):446-460.

Engeman, R.M., D.S. Vice, D.V. Rodriquez, K.S. Gruver, W.S. Santos and M.E. Pitzler. 1998. *Effectiveness of the detector dogs used for deterring the dispersal of Brown Tree Snakes*. Pacific Conservation Biology. 4:256-260.

Esque, T.C. and R.B. Duncan. 1985. *A population study of the desert tortoise (Gopherus agassizii) at the Sheep Mountain Study Plot of Nevada*. Final report to Nevada Department of Wildlife. 84 pp.

Franco, M.I., L. Turin, A. Mershin, and E.M.C. Skoulakis. 2011. *Molecular vibration-sensing component in Drosophila melanogaster olfaction*. Proceedings of the National Academy of Sciences. 108(9):3797-3802.

Heaton J.S., M.E. Cablk, K.E. Nussear, T.C. Esque, P.A. Medica, J.C. Sagebiel, and S. Francis. 2008. *Comparison of effects of humans versus wildlife-detector dogs*. Southwestern Naturalist. 53(4):472-479.

Inman, R. D., K. E. Nussear, and C. R. Tracy. 2009. *Detecting trends in population growth: elusive behavior inflates variance in estimates of population density.* Endangered Species Research. doi: 10.3354/esr00214.

Lit, L., J. Schweizer, and A.M. Oberbaruer. 2011. *Handler beliefs affect scent detection dog outcomes.* Animal Cognition. 14(3):387-394.

Mistafa, R. 1998. *K9 Explosive Detection.* Detselig Enterprises. Calgary, Alberta, Canada. 189 p.

McCulloch, M. 2006. *Diagnostic accuracy of canine scent detection in early- and late-stage lung and breast cancers.* Integrative Cancer Therapies. 5(1):30-39.

Ngai, J., M.M. Dowling, L. Buck, R. Axel, and A. Chess. 1993. *The family of genes encoding odorant receptors in the channel catfish.* Cell. 72:657-666.

Nussear, K.E. and C.R. Tracy. 2007. *Can modeling improve estimation of desert tortoise population densities?* Ecological Applications 17:579–586.

Nussear, K.E., T.C. Esque, J.S. Heaton, M.E. Cablk, K.K. Drake, C. Valentin, J.L. Yee, and P.A. Medica. 2008. *Are wildlife detector dogs or people better at finding tortoises (Gopherus agassizii)?* Herpetological Conservation and Biology. 3(1):103-115.

Raming, K., J. Krieger, J. Strotmann, I. Boekhoff, S. Kubick, C. Baumstark, and H. Breer. 1993. *Cloning and expression of odorant receptors.* Nature. 361:353-356.

Schoon, G.A.A. 1998. *A first assessment of the reliability of an improved scent identification lineup.* Journal of Forensic Sciences. 43(1): 70-75.

Schwartz, E.R., C.R. Schwartz, and A.R. Kiester. 1984. *The three-toed box turtle in central Missouri, Part II: a nineteen year study of home range, movements and population.* Missouri Department of Conservation Publication. Terrestrial Series 12, Jefferson City, Missouri, USA.

Shepherd, G.M. 1994. *Discrimination of molecular signals by the olfactory receptor neuron.* Neuron. 13:771-790.

Tracy, C.R., R. Averill-Murray, W.I. Boarman, D. Delehanty, J. S. Heaton, E. McCoy, D. Morafka, K. Nussear, B. Hagerty and P. Medica. 2004. *Desert tortoise recovery plan assessment*. Report submitted to the U.S. Fish and Wildlife Service.

Turin, L. 1996. *A spectroscopic mechanism for primary olfactory reception*. Chemical Senses. 21(6):773-791.

U.S. Fish and Wildlife Service. 1990. *Endangered and threatened wildlife and plants; determination of threatened status for the Mojave population of the desert tortoise.* Federal Register 55:12178-12191.

U.S. Fish and Wildlife Service. 1994. *The desert tortoise (Mojave population) Recovery Plan.* U.S. Fish and Wildlife Service, Portland, Oregon, USA.

U.S. Fish and Wildlife Service. 2004. *Biological Opinion for the proposed addition of maneuver training lands at Fort Irwin, California (1-8-03-F-48).* U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. 2006. *Range-wide Monitoring of the Mojave Population of the Desert Tortoise: 2001-2005 Summary Report*. Report by the Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada.

U.S. Fish and Wildlife Service. 2008. *Draft revised recovery plan for the Mojave population of the desert tortoise (Gopherus agassizii).* U.S. Fish and Wildlife Service, California and Nevada Region, Sacramento, California. 209 pp.

U.S. Fish and Wildlife Service. 2010a. *DRAFT Range-wide Monitoring of the Mojave Population of the Desert Tortoise: 2010 Annual Report.* Report by the Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada.

U.S. Fish and Wildlife Service. 2010b. *Translocation of Desert Tortoises (Mojave Population) from project sites: Plan Development Guidance*. August 2010.

U.S. Fish and Wildlife Service. 2011. *2011 Desert Tortoise Monitoring Handbook.* Desert Tortoise Recovery Office, U.S. Fish and Wildlife Service, Reno, Nevada. Version: 7 March 2011.

Wilbur, H. M. and P. J. Morin. 1988. *Life history evolution in turtles*. Pp. 387-439. In C. Gans and R. B. Huey (eds). Biology of the Reptilia. Vol. 16. Ecology B. Defence and Life History. Alan R. Liss, New York.

Zimmerman, L.C., O'Connor, M.P., Bulova, S.J., Spotila, J.R., Kemp, S.J., and Salice, C.J. (1994). *Thermal ecology of desert tortoises in the eastern Mojave desert: Seasonal patterns of operative and body temperatures, and microhabitat utilization.* Herpetological Monographs. 8:45-59.

APPENDICES

APPENDIX A. POINTS OF CONTACT

POINT OF CONTACT	ORGANIZATION	Phone Fax E-mail	Role in Project
Mary Cablk, Ph.D.	DRI 2215 Raggio Parkway Reno, NV 89512	775-673-7371 775-673-7459 Mary.cablk@dri.edu	Co-PI
Russell S. Harmon, Ph.D.	Environmental Sciences Division (RDRL-ROE-V) ARL Army Research Office PO Box 12211 Research Triangle Park, NC 27709-2211	919-549-4326 919-549-4310 Russell.harmon@us.army.mil	Co-PI
Ken Nussear, Ph.D.	US Geological Survey 160 N. Stephanie St. Henderson, NV 89704	702-564-4515 702-564-4600 knussear@usgs.gov	Co-performer
Todd Esque, Ph.D.	US Geological Survey 160 N. Stephanie St. Henderson, NV 89704	702-564-4506 702-564-4600 tesque@usgs.gov	Co-performer
Cindee Valentin	Applegate School for Dogs 1910 Florence Lane Concord, CA 94520	(925) 699-1480 cindeeval@aol.com	Industry Partner
Susan Clark, Ph.D.	Education Design Group 250 Bell St. Reno, NV 89509	775-329-3224 775-329-3882 susan@250bell.com	Industry Partner
Roy Averill-Murray	Desert Tortoise Recovery Coordinator U.S. Fish and Wildlife Service 1340 Financial Blvd, #234 Reno, NV 89502	775-861-6362 Roy_Averill-Murray@fws.gov	Regulator

APPENDIX B. SPATIAL DATA RESULTS FROM PIUTE VALLEY

The following figures show data of the locations of the transmittered tortoises from the day prior to surveying used to delineate search areas, the locations of the tortoises found by DTK9 teams during surveys of those search areas, and the locations of the tortoises located by telemetry after the day's surveys were complete. Because tortoises move the same animal may be located in one, two or three different locations over the course of 24 hours.

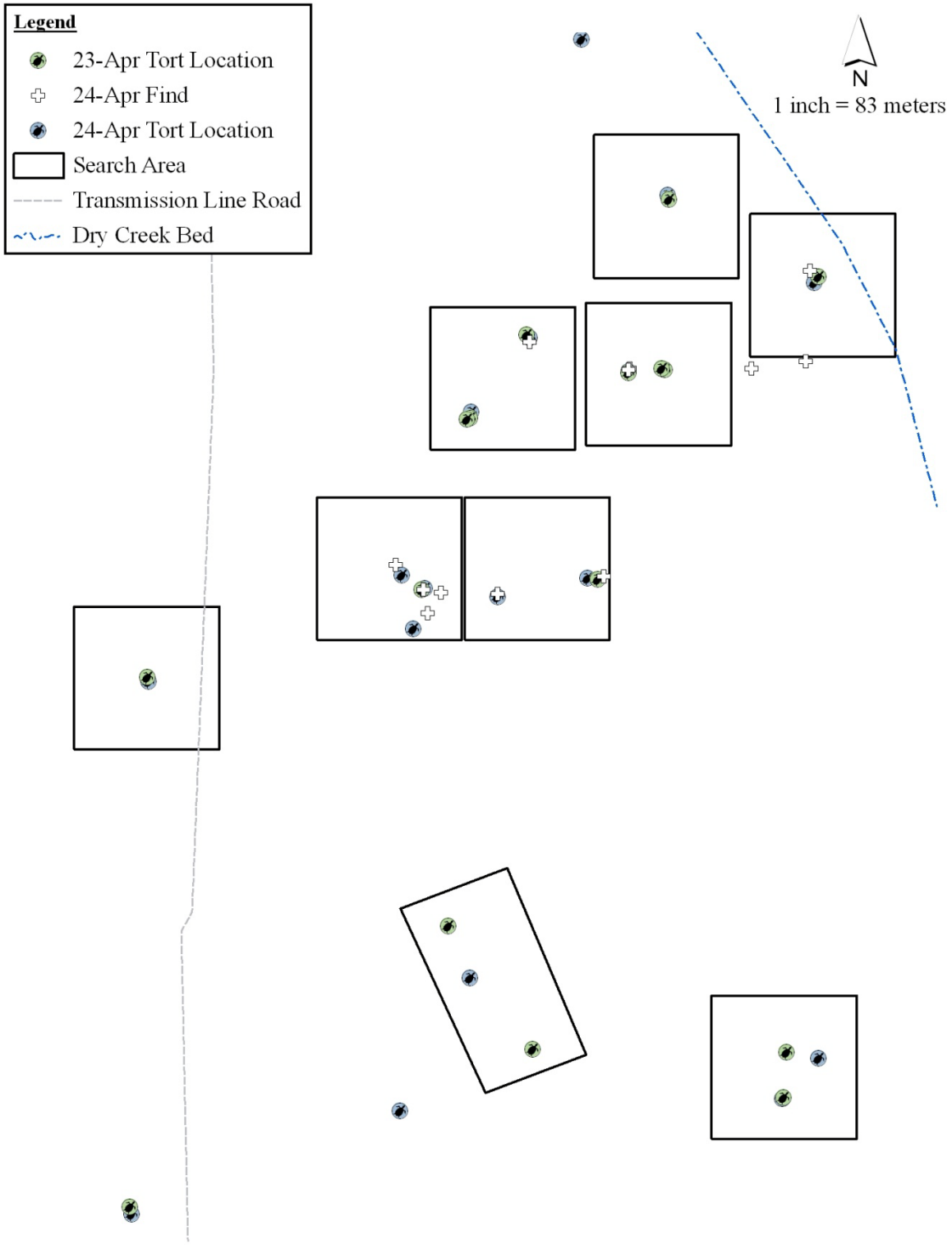

Figure B- 1. Tortoise location data for 23-24 April 2008 and search area delineation for 24 April 2008.

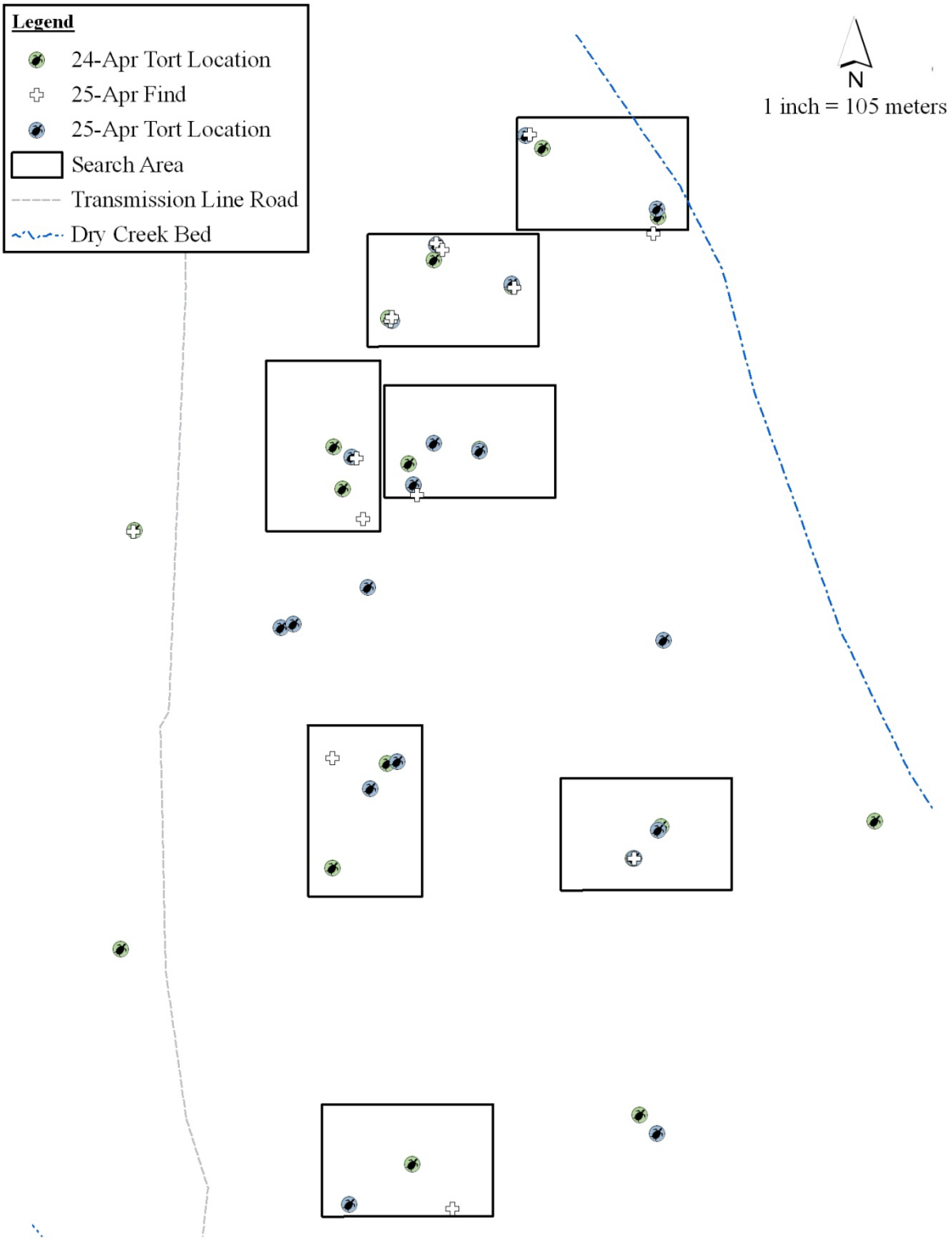

Figure B- 2. Tortoise location data for 24-25 April 2008 and search area delineation for 25 April 2008.

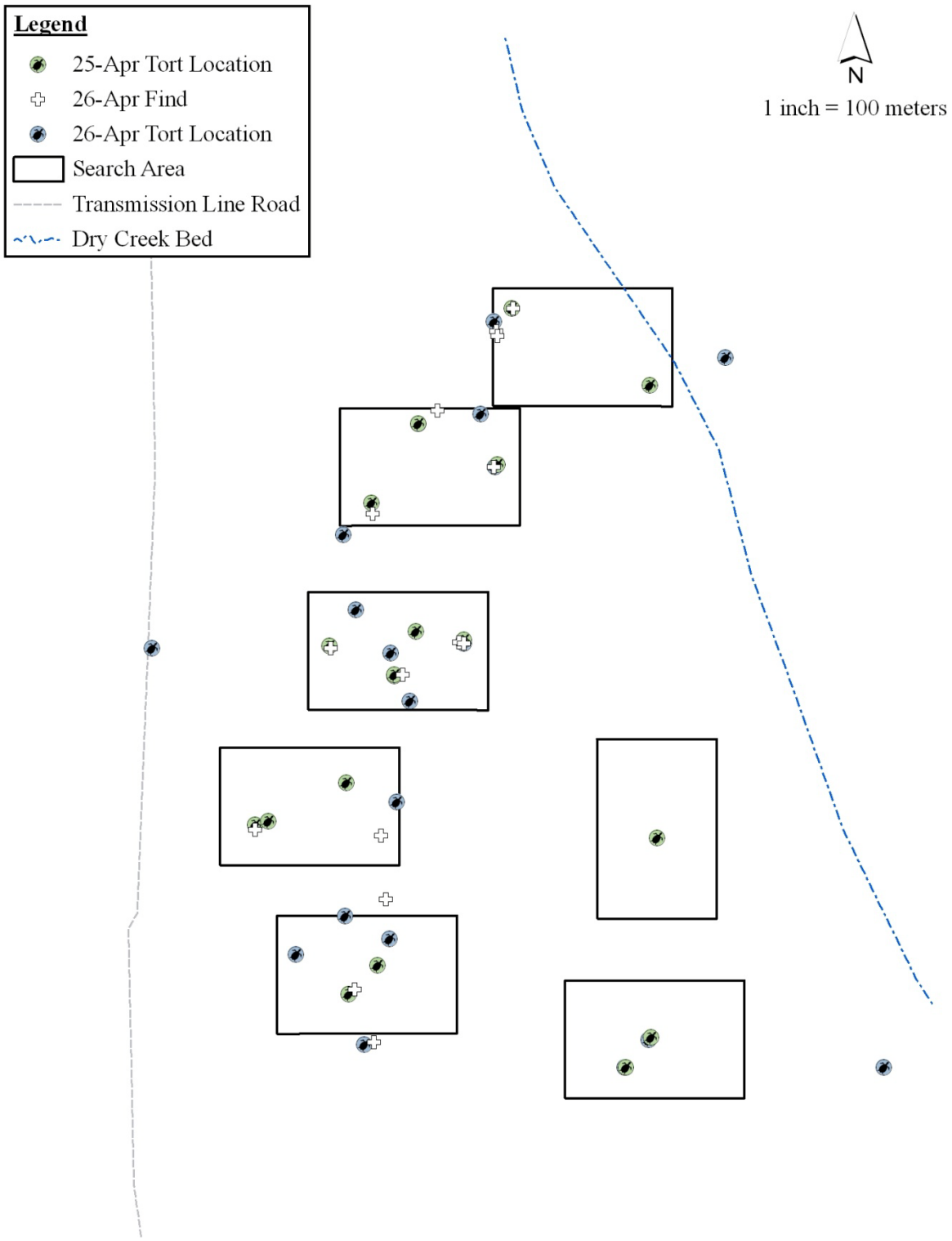

Figure B- 3. Tortoise location data for 25-26 April 2008 and search area delineation for 26 April 2008.

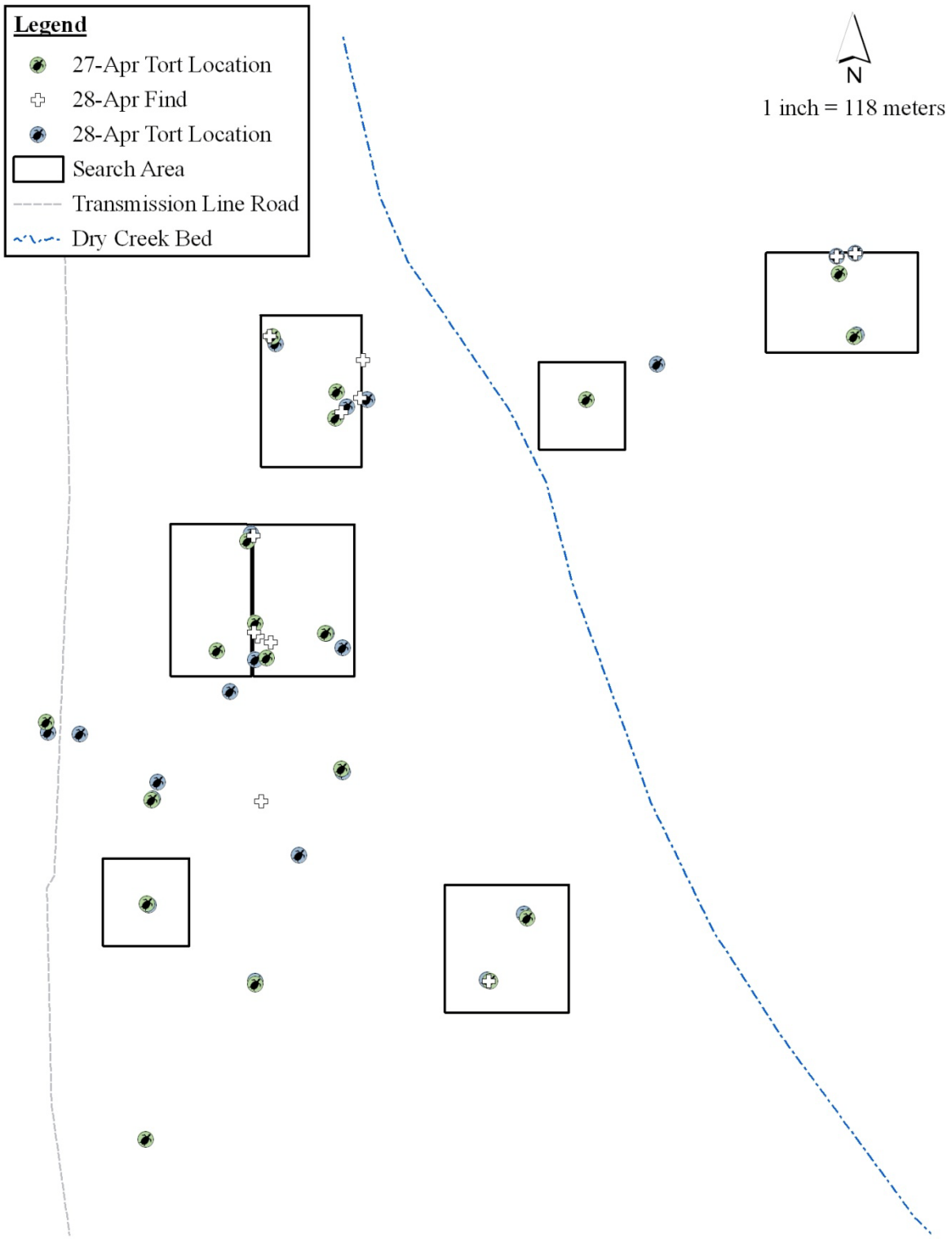

Figure B- 4. Tortoise location data for 27-28 April 2008 and search area delineation for 28 April 2008.

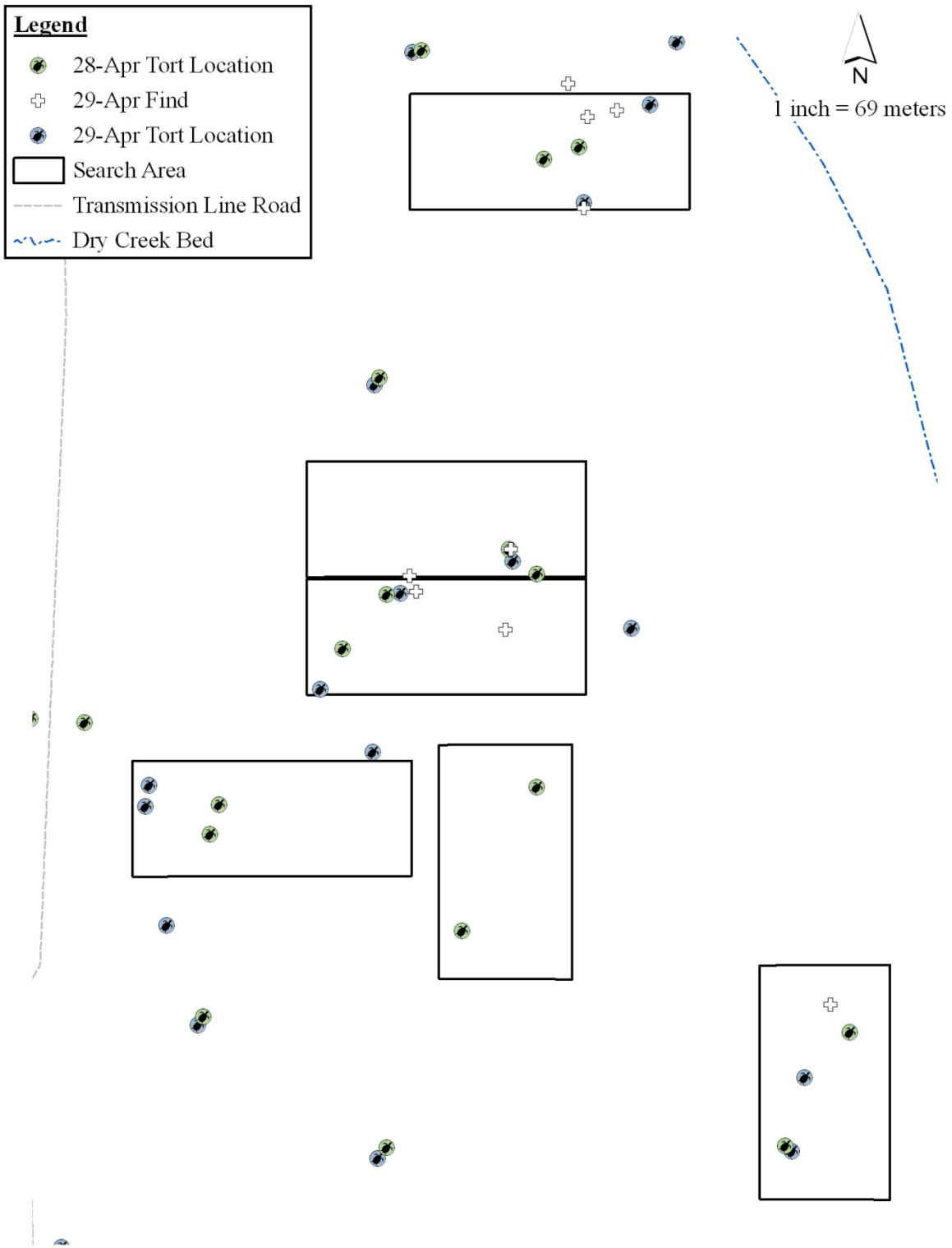

Figure B- 5. Tortoise location data for 28-29 April 2008 and search area delineation for 28 April 2008.

APPENDIX C. INITIAL ODOR RECOGNITION AND SEARCH TRAINING PROTOCOLS

The following are the training protocols that were developed and implemented to train potential DTK9 dogs and handlers on residual desert tortoise odor. All candidate teams completed the protocols presented here, including the purchase and use of required equipment. The training protocols were designed to establish the baseline training on the dog for searching on leash and using required equipment. The handler learned to implement a grid search strategy and manage the dog on leash as well as perform odor recognition and reinforcement training tasks. This training was completed prior to arriving at the DTCC.

APPENDIX C: TABLE OF CONTENTS

Required Equipment List 105
General Training Protocols 106
Prerequisites to starting Day 1 of the Training Program 106
General Guidelines 106
Scent Source Protocols 107
Training Protocols Week One – *Lineups* 108
Training Objectives 108
Training Log Information Week One - *Lineups* 110
Training Protocols Week Two – *Field Search* 116
Training Objectives 116
Training Log Information Week Two – *Field Search* 118
Training Protocols Week Week Three- *Field Search* 123
Training Objectives 123
Training Log Information Week Three- *Field Search* 125
Training Protocols Week Four – *Field Search* 131
Training Objectives 131
Training Log Information Week Four – *Field Search* 133

REQUIRED EQUIPMENT LIST:

- **Muzzle**: Enameled Wire Muzzle from www.dog.com item #320702
- **Gentle Leader**: Available at pet stores
- **Remote training collar:** Dogtra 200 NCP Gold.
- **Booties:** Any bootie is fine for training. In the desert, consider a lightweight bootie or baby socks with duct tape. Available online at www.dogbooties.com
- **Flat Buckle Collar**: Leather or nylon. Must be tight enough so that the dog cannot back out of it
- **Fur Saver Collar:** Optional
- **Leash:** Six foot RAMTech www.RayAllen.com, leather or nylon
- **Long Line:** #RA130 33' RAMTech leather alternative www.RayAllen.com or www.signaturek9.com (biothane line)
- **Clicker**
- **Treats:** Need to be soft, small, and not produce crumbs. Recommend Natural Balance 4# food rolls cut up into ½" size squares and frozen. Available at pet stores work well.
- **Treat Pouch:** Needs to be open and deep. Chalk bags from REI www.REI.com
- **Toy:** Retrieve or tug toy. Bite Stick or ball is acceptable. No Kongs or Frisbees for the safety of the tortoises. Bite Sticks are available at www.RayAllen.com under Primary Training Aids
- **Portable Crate:** Light weight wire or plastic. Soft sided canvas crate should not be used for the safety of the tortoises.
- **Water Bucket:** stainless steel. Flat sided buckets available at www.signaturek9.com
- **Back Up Water Container** (3-5 gallons)
- **Dog First Aid Equipment:** 2 Instant cold packs, digital rectal thermometer, vet wrap, extra booties, duct tape, plastic spray bottle with 50% alcohol/water mix, shade (umbrella or similar) for in the field, gauze, portable water bowl.
- **Scent boxes:** Scent boxes are opaque plastic tubs with closeable lids. You will need 4 of them. Drill one hole 1" diameter on each of the short ends and two holes 1" diameter along the long edges. Holes should be approximately 2-3" from the ground. The boxes are at least approximately 24" long by 12" wide by 14" tall. They can be found at Home Depot, Bed Bath and Beyond and similar stores. Three will house blanks and one will house training aids. You will label them as described below.

GENERAL TRAINING PROTOCOLS

Prerequisites to starting Day 1 of the Training Program:

- Dogs will have a solid, consistent, immediate sit (at a distance of 30' from the handler) on command before beginning the process of training the alert to odor.
- Dogs will have a clear understanding that hearing a click means that either food or a toy is on its way. Pair Click with food or toy before day 1 of the training program
- Dogs should be obsessive compulsive in play drive (retrieve or tug) and/or voracious eaters who do not pass up food for any reason or both. Prey drive will be low to moderate. Dog should not have the tendency to become bored over multiple repetitions. Dog should have a high degree of forgiveness. Low drive dogs are unsuitable for this program.

General Guidelines:

- Hides and blanks will be on the surface, out in the open, and in brush or cover for all field search training. Do not hide odor in holes, under dirt or leaves, below surface or up high during any part of the odor recognition and alert training.
- Do not allow your dog to interact with a live turtle or tortoise of any species outside of your direct active supervision. All interaction should be under direct training protocols.
- Dogs will work in a fur saver collar or a flat collar during on leash training. No pinches, nylon slip, or choke collars. Once you choose the dollar do not change it around.
- All dogs will work in an e-collar for all phases of this training program.
- Food or Toy Reward: Use the reward that is most appealing from the dog's perspective. Use **either food or toy – not both.** Once you choose it, you need to stick with it and not change things around. If you use food, do not have a play session as a reward for the last find.
- Do not reward pawing or mouthing at the source. Only reward for the mouth being purposefully near the source.
- Never ask for a "show me" or "touch it" throughout the training as this increases desire to paw or mouth the odor source. **Think of all sources as bombs that, if touched by a dog, will explode.**
- If at any time the dog approaches a container that has an animal (turtle or tortoise) in it or tortoise scent pads reward them. Do not pull the dog off of the scent even if the exercise has been completed. Feed or play the dog off of the source.
- Play (or feed slowly) for at least 30 seconds after a find. This is what the dog works for. Stay focused on the reward and the dog instead of chatting with the humans about performance. Human discussions can take place after the dog is satisfied for a job well done.
- Always run the dog back to the vehicle with the toy in the mouth after a line up or short problem to keep drive and attitude up beat.
- Dogs will be crated with the door closed immediately after each full training session (16 hides) for at least 30 minutes.

SCENT SOURCE PROTOCOLS

Training aids and blanks will be sent via FedEx for the duration of the initial scent training period. Training aids will be sent in a separate package from blanks to eliminate cross contamination. Training aids should be stored in their original mailed containers in which they arrive when not in use and should be kept frozen in a freezer that does not contain other training aids of any kind (live human, cadaver, etc.). Training aids should be stored separately from blanks. While transporting aids in a vehicle the tortoise aids should be kept in the cab of the truck with you and blanks should always be transported in the back or trunk. In storing the aids at home the tortoise aids should be kept in a different room from the blanks, be consistent and maintain location of aids. Do not switch aid versus blank room storage to avoid cross contamination.

When new training aids arrive (either on Friday or Saturday), old training aids should be discarded. Do not reuse old training aids once new ones arrive.

The training method is to use cotton pads that contain desert tortoise scent. The dog is trained to find the odor of desert tortoise over four weeks of training and then transferred to live tortoises over a shorter training period. The dog is then never allowed to find scent pads again.

Scent sources are tortoise scent on cotton pads. The scent is called a HIDE. A BLANK is a gauze pad that does not contain tortoise scent. To ensure clarity to your dog, do not handle a blank with the same gloves used to handle a hide or a hide box. Do not handle any aids, either blank or source, with your bare hands. If you handle blanks or hides with your hands you reinforce live human odor, which is not desirable for this effort.

Each scent box and its lid are labeled either “H” for tortoise hide or “B” for blank. Only tortoise wipes will be placed in an “H” container. Only blanks will be placed in a “B” container. Ensure that “H” containers have “H” lids and “B” containers have “B” lids.

Blanks: Put on a fresh pair of gloves. Assemble boxes that will contain blanks. Open the Ziploc with blanks. Insert one blank gauze pad into each “B” blank container and set them in the appropriate line-up order. Reseal the blank Ziploc and put it back, preferably in the back or trunk of your car.

Hides: Assemble boxes that will contain the tortoise wipe or animal. Open the Ziploc that contains the tortoise aids. Insert one gauze pad with tortoise scent into the corresponding tortoise box and insert tortoise scent box in the lineup. Reseal Ziploc. Remove gloves and throw them away. Put away Ziploc with aids, preferably in front of your car. For live tortoises/turtles, keep them in an appropriate temperature environment separate from the blank boxes. Keep blank boxes in the trunk or back of pickup truck.

Cross Contamination: If you accidentally cross-contaminate a box by putting an H aid in a B container or handling a B container after handling an H wipe, all materials will be disposed of. <u>Running a container through the dishwasher or other decontamination method is not OK.</u> Throw all materials away. If a B gauze is put into an H container, throw the gauze away. It cannot be used as a tortoise or blank training aid.

Treat the blank gauze as if it was biohazard and you do not want cross-contamination with tortoise scent.

Moving Lineups: Put on a new pair of gloves before moving the order of the boxes. Move blank boxes first. Remove gloves and throw them away after you have moved the order of the lineup and before you work your dog. Handle blank boxes first with gloves and then hide boxes.

TRAINING PROTOCOLS
WEEK ONE – LINEUPS

Training Objectives:

- Odor recognition on leash
- Search command is paired with the odor
- Reward is established - food or bite stick
- Dog begins to hear "Tort" in command form
- Begin sit alert behavior

The Lineup: Hide boxes are set in a row spaced evenly 15 feet apart with the wind moving perpendicular to the lineup. After each lineup the boxes will be moved to a new location to minimize residual scent. The HIDE box will be put in a different order each time so the dog learns odor recognition and not box counting or place behaviors. Dogs will work 16 lineups per day (each day Sunday thru Thursday).

Each lineup will consist of 3 BLANKS (boxes containing a clean odor free gauze pad) and 1 HIDE (box containing a gauze pad with tortoise odor).

E-collars: Every morning from now through the last day of the Basic Training Program (including days off) put the e-collar on the dog in the morning and remove it at night (approximately 8 hours). This is to desensitize the dog **and** handler to the collar. Be sure to fit the collar snuggly around the neck per manufacturer's instructions. Be upbeat and happy when putting it on (play or treat for no reason) and be quiet when taking it off. Leave the transmitter at home. You won't be using it for day to day training unless you have animal chasing challenges.

Blanks: If the dog hesitates, the handler needs to simply move the dog forward immediately. Do not give the dog time to investigate and alert on blanks. Do not correct the dog for showing interest in or alerting on blanks. The dog should never be given an opportunity to alert on a blank.

Day 1 – 3 (Sunday, Monday, Tuesday)

With the dog on a 6' leash and in front of the handler, the handler will move backwards through the lineup targeting each box. Pointing with hand or finger is an acceptable targeting method. Encourage the dog to sniff each box and move on. When the dog's mouth reaches the box with tortoise odor (hide box) and the dog is in full odor, **mark it (with the clicker), say "Tort" and deliver the reward (food or toy) to the dog.** If using toy reward encourage tug over retrieving the toy away from source. Run the dog back to the vehicle and into the crate. Give the dog a 5-minute break and some water and move on to the next line up. Optimally by the end of day three, the dog is actively working to get to the odor to get the reward.

Day 4 – 5 (Wednesday, Thursday)

With the dog on a 6' leash and in front of the handler, the handler will give the search **command, "Tort"** and move backwards through the lineup targeting each box. Encourage the dog to sniff each and move on. When the dog's mouth reaches the box with tortoise odor (hide box) and the dog is in full odor, **mark it (with the clicker), and say "Sit".** As soon as the dog's rear end is on the ground, deliver the reward (food or toy) to the dog and give release command (free / recess / okay). Do not use the dog's collar to get him or her into sit position. Drive the sit action with the food or toy. After the end of day 5 the dog will no longer have boxes in the search area.

Friday and Saturday are days off to play, swim, hike and relax.

Training logs are due Thursday by 5:00 pm (Pacific Standard Time).

TRAINING LOG INFORMATION
WEEK ONE - LINEUPS

<u>Days 1-3 Sunday, Monday, Tuesday</u>

Training Objectives:

- Odor recognition on leash
- Search command is paired with the odor
- Reward is established - food or bite stick
- Dog begins to hear "tort" in command form
- Begin sit alert behavior

DAY 1 (February 24th)

Location:	AM NOON PM	Temperature:
Hide Number	**Position in Lineup**	**Comments**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

DAY 2 (February 25th)

Location:	AM NOON PM	Temperature:
Hide Number	**Position in Lineup**	**Comments**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

DAY 3 (February 26th)

Location:	AM NOON PM	Temperature:
Hide Number	**Position in Lineup**	**Comments**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

REPORT THE FOLLOWING IN TRAINING LOGS:

What are you using for your training aids?

How many total aids do you have access to?

Did the dog complete 48 repetitions in the first three days of training to associate the command “Tort” with the odor of a turtle or tortoise?
Comments:

Does the dog associate the click sound with food/toy?
Comments:

Does the dog associate the command "Tort" with the odor of the hide box (H)?
Comments:

Does the dog associate the command "Tort" with the odor of the blank box (B)?
Comments:

Is the dog eagerly working to get to the hide box (H) to get the reward?
Comments:

Is the dog focused or distracted by the environment?
Comments:

Is the dog attempting to get the reward on any or all of the boxes, hides or blanks?
Comments:

Has there been interest in any of the hides by insect or animal life (including ants)?
Comments:

Days 4-5 Wednesday, Thursday

Training Objectives:

- Dog begins to hear "Tort" in command form.
- Begin sit alert behavior

DAY 4 (February 27th)

Location:	AM NOON PM	Temperature:
Hide Number	**Position in Lineup**	**Comments**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

DAY 5 (February 28th)

Location:	AM NOON PM	Temperature:
Hide Number	**Position in Lineup**	**Comments**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

Did the dog complete 32 repetitions of hearing the command "tort", finding the hide (T), getting the click, hearing and completing the sit, and receiving the reward?
Comments:

Is your **timing** of commands, associative words, clicks, and food/toy delivery perfect?
Comments:

Is the dog sitting immediately upon hearing the command "sit"?
Comments:

Is the dog eagerly working to get to the hide box (H) to get the reward?
Comments:

Are you waiting until the dog is in full odor to click and say "Sit"?

Are you waiting to see if the dog sits on its own?

Are you delivering the reward to the dog's mouth?

Has the dog ever been allowed this week to sniff a source and not get rewarded?

Has the dog this week ever been pulled off of a source?

Has your dog at any time in training line ups this week felt correction-- whether you meant it to be a correction or not?

Are you delivering the reward to the source?
Have you made any changes to the type of training aids you are using?

How many times did the dog physically touch an animal this week?

How many times did the dog push, lick, or put an animal in its mouth this week?

How many times did an animal urinate or defecate or hiss after being found by the dog?

Has your dog worn the E-collar every day from morning to evening?
Comments:

Has your dog ever been worked in an e-collar before the start of this program?
Explain how the training was done, what commands the dog has been trained to on the collar and the dog's responses:

Do you have the following equipment?

Item	**Yes**	**No**
Crate		
Water Bucket		
Clicker		
Treats		
Treat Pouch		
Bite Stick or Ball		
Flat Collar		
Fur Saver Collar		
6' Leash		
30' Long line		
Light Weight Booties		
Medical Tape / Duct Tape		
Dogtra 200NCP Electronic Collar – functioning and reliable		
Basket Muzzle - with a center strap that fits your dog		
Gentle Leader		

Outline all of the changes made to your program this week with the trainer using **IF/THEN** statements (ex: **IF** the dog doesn't sit, **THEN** I say sit). This format will be helpful in future training with you and your dog as a team.

TRAINING PROTOCOLS
WEEK TWO - FIELD SEARCH

Training Objectives:

- Acclimate the dog to e-collar, gentle leader, and booties
- Active searching for odor in a field setting on a 6' leash.
- Immediate response to "sit" command in odor.
- Dog sitting in odor up to 6' away from handler

Days 1-5 (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday)

E-collars will be placed on the dog every morning and removed only at night before bed. The collar will be charged each night and placed on the dog each morning. This is critical to optimize training and avoid animal fatalities in the field.

Put the Gentle Leader and booties on for short periods of time each day and go for a walk to get the dog used to them. Distract the dog with food or toys to help keep him from taking everything off. Do not use them while searching this week.

Dogs will work a total of 16 hides per day for 5 days (Sunday – Thursday). They will then have 2 days to relax, play or swim and just be a dog. We recommend no training on days off if at all possible. Physical exercise is encouraged.

The setup is provided on the next page.

The set up: Hides will be placed in 4 different small search areas (50'x50') with 4 hides in each area. The dog will have small breaks (with water in a crate in the vehicle) between each area. Dogs will be crated immediately after the training session for at least 30 minutes

With the dog on a 6' leash and in front of the handler, the handler will give the search command, "Tort" and move through the search area targeting the areas where the dog should search. Encourage the dog to sniff around brush, rocks, and cover as you move along at a consistent pace. When the dog's nose reaches the hide and the dog is in full odor, **say "Sit":**

If the dog sits within 2 seconds	**Then Click.** Give the release command as you deliver the toy **or** after you have treated for 30 seconds.	This is the goal for each and every alert this week
If the dog does not sit within 2 seconds	**Then** drive the sit with the reward	Praise with great enthusiasm.
If the dog sits within 6 feet of the source	**Then** coax him to source by showing it to him	Say sit. praise happily and deliver the reward
If the dog **picks it up**	**Then** correct until it is out of his mouth. Do not show emotion!	With neutral body language, put him in his crate to soak for 10 minutes – no reward
If the dog **physically pushes it** with nose	**Then** correct him into the sit	Praise – no toy or food. With neutral body language, put him in his crate to soak for 10 minutes
If the dog is continuously distracted with non-tortoise odor	**Then** put him in his crate for awhile. Try again in a less distractive environment	Practice 'Leave-it' command while hiking - daily

Training logs are due Thursday by 5:00 pm (Pacific Standard Time).

TRAINING LOG INFORMATION
WEEK TWO – FIELD SEARCH

<u>Days 1-5 Sunday, Monday, Tuesday, Wednesday, Thursday</u>

Training Objectives:

- Active searching for odor in a field setting on a 6' leash.
- Immediate response to "sit" command in odor.
- Dog sitting in odor up to 6 feet away.

DAY 1 WEEK 2

Location:	AM NOON PM	Temperature:
Hide Number	**Area 1**	**Verbally Cued "Sit"**
1	Surface Cover	Yes No
2	Surface Cover	Yes No
3	Surface Cover	Yes No
4	Surface Cover	Yes No
	Area 2	
5	Surface Cover	Yes No
6	Surface Cover	Yes No
7	Surface Cover	Yes No
8	Surface Cover	Yes No
	Area 3	
9	Surface Cover	Yes No
10	Surface Cover	Yes No
11	Surface Cover	Yes No
12	Surface Cover	Yes No
	Area 4	
13	Surface Cover	Yes No
14	Surface Cover	Yes No
15	Surface Cover	Yes No
16	Surface Cover	Yes No

DAY 2 WEEK 2

Location:	AM NOON PM	Temperature:
Hide Number	**Area 1**	**Verbally Cued "Sit"**
1	Surface Cover	Yes No
2	Surface Cover	Yes No
3	Surface Cover	Yes No
4	Surface Cover	Yes No
	Area 2	
5	Surface Cover	Yes No
6	Surface Cover	Yes No
7	Surface Cover	Yes No
8	Surface Cover	Yes No
	Area 3	
9	Surface Cover	Yes No
10	Surface Cover	Yes No
11	Surface Cover	Yes No
12	Surface Cover	Yes No
	Area 4	
13	Surface Cover	Yes No
14	Surface Cover	Yes No
15	Surface Cover	Yes No
16	Surface Cover	Yes No

DAY 3 WEEK 2

Location:	AM NOON PM	Temperature:
Hide Number	**Area 1**	**Verbally Cued "Sit"**
1	Surface Cover	Yes No
2	Surface Cover	Yes No
3	Surface Cover	Yes No
4	Surface Cover	Yes No
	Area 2	
5	Surface Cover	Yes No
6	Surface Cover	Yes No
7	Surface Cover	Yes No
8	Surface Cover	Yes No
	Area 3	
9	Surface Cover	Yes No
10	Surface Cover	Yes No
11	Surface Cover	Yes No
12	Surface Cover	Yes No
	Area 4	
13	Surface Cover	Yes No
14	Surface Cover	Yes No
15	Surface Cover	Yes No
16	Surface Cover	Yes No

DAY 4 WEEK 2

Location:	AM NOON PM	Temperature:
Hide Number	**Area 1**	**Verbally Cued "Sit"**
1	Surface Cover	Yes No
2	Surface Cover	Yes No
3	Surface Cover	Yes No
4	Surface Cover	Yes No
	Area 2	
5	Surface Cover	Yes No
6	Surface Cover	Yes No
7	Surface Cover	Yes No
8	Surface Cover	Yes No
	Area 3	
9	Surface Cover	Yes No
10	Surface Cover	Yes No
11	Surface Cover	Yes No
12	Surface Cover	Yes No
	Area 4	
13	Surface Cover	Yes No
14	Surface Cover	Yes No
15	Surface Cover	Yes No
16	Surface Cover	Yes No

DAY 5 WEEK 2

Location:	AM NOON PM	Temperature:
Hide Number	**Area 1**	**Verbally Cued "Sit"**
1	Surface Cover	Yes No
2	Surface Cover	Yes No
3	Surface Cover	Yes No
4	Surface Cover	Yes No
	Area 2	
5	Surface Cover	Yes No
6	Surface Cover	Yes No
7	Surface Cover	Yes No
8	Surface Cover	Yes No
	Area 3	
9	Surface Cover	Yes No
10	Surface Cover	Yes No
11	Surface Cover	Yes No
12	Surface Cover	Yes No
	Area 4	
13	Surface Cover	Yes No
14	Surface Cover	Yes No
15	Surface Cover	Yes No
16	Surface Cover	Yes No

Questions:

Does the dog seem to understand that odor + sit = food/toy?
Comments:

Does the dog associate a mark word with odor + sit = food/toy?
What is the mark word?
Comments:

Does the dog associate the command "Tort" with the idea of searching to find odor?
Comments:

Is the dog eagerly working to get to the odor?
Comments:

Is the dog focused or distracted by the environment?
Comments:

Did the dog complete 80 repetitions of hearing the command "tort", finding the hide, hearing and completing the sit, getting the click and receiving the reward for 30 seconds?
Comments:

Is your **timing** of sit command, click, and food/toy delivery to the dog's mouth perfect?
Comments:

Is the dog sitting immediately upon hearing the command "Sit"?
Comments:

Are you waiting until the dog is in full odor to say "Sit"?

Has the dog ever been allowed this week to sniff a source and not get rewarded?

Has the dog this week ever been pulled off of a source?

Has your dog at any time in training line ups this week felt correction -- whether you meant it to be a correction or not?

Are you and your dog enjoying the training game?

Did the dog wear the E-collar for at least eight hours per day for seven days this week?

Do you have the following equipment?

Item	**Yes**	**No**
Crate		
Water Bucket		
Clicker		
Treats		
Treat Pouch		
Bite Stick or Ball		
Flat Collar		
Fur Saver Collar		
6' Leash		
30' Long line		
Light Weight Booties		
Medical Tape / Duct Tape		
Dogtra 200NCP Electronic Collar – functioning and reliable		
Basket Muzzle - with a center strap that fits your dog		
Gentle Leader		

Outline all of the changes made to your program this week with the trainer using **IF/THEN** statements (ex: **IF** the dog doesn't sit, **THEN** I say sit). This format will be helpful in future training with you and your dog as a team.

TRAINING PROTOCOLS
WEEK THREE- FIELD SEARCH

Training Objectives:

- Dog is actively searching for and sitting in odor in a field setting at a distance of up to 30'.
- Begin automatic sit response in odor without command from handler

Dogs will work in booties for all search work this week. E-collars will be worn as previously instructed. Dogs will continue to be desensitized to the Gentle Leader this week, though not while training on hides.

Start desensitization on the muzzle this week. Put the muzzle on your dog before going for a short on leash walk. Keep the dog moving at a fast pace. This will keep the front feet busy walking and not pulling the muzzle off. Keep it positive. Be upbeat and happy and moving forward. Remove the muzzle when the dog has not tried to get it off for at least 15 minutes. Tip: Always approach the mouth with the muzzle from below the chin so the dog does not see it coming. Wrap the strap of the muzzle around the flat collar once to help prevent the dog from removing it himself.

Dogs will work 16 hides per day for 5 days (Sunday - Thursday). They will then have 2 days to relax, play or swim and just be a dog.

Hides will be placed in 4 larger areas (50 yards x 50 yards) with 4 hides in each area. Hides will be on the surface out in the open and hidden in brush or cover.

Day 1-2 (Sunday, Monday)

With the dog on a 30' leash and in front of the handler, the handler will give the search command, "Tort" and move through the search area targeting the areas where the dog should search. Handler will section and grid the entire area with 25 yard spacing, keeping the dog in sight working as a team at all times.

Encourage the dog to sniff around brush, rocks, and cover as you move along at a consistent pace. When the dog's nose reaches the hide and the dog is in full odor give the dog 2 seconds to sit in his own. If he sits deliver the reward to the dog's mouth. If he does not sit, use slight upward pop on the collar as you say sit (not strong or emotional). Say sit in a normal tone of voice. Do not use your voice as a correction. Do not say sit more than once! As soon as the dog's rear end is on the ground deliver the reward (food or toy) to the dog's mouth. Give the release command as you deliver the toy or after you have given the treat for 30 seconds.

Days 3-5 - Automatic sit at the source (Tuesday, Wednesday, Thursday)

Use the same techniques as days 1 & 2 of this week however, **do not say "sit". If the dog sits:** As soon as the dog's rear end is on the ground deliver the reward (food or toy) to the dog's mouth. Give the release command as you deliver the toy or after you have given the treat. Play or feed slowly for at least 30 seconds.

If the dog does not sit: Give a light collar correction. Again – a very light correction is not strong or emotional. It is showing the dog what you want with no expectation that the dog knows to sit automatically each and every time. **As soon as the dog's rear end is on the ground**

deliver the reward (food or toy) to the dog's mouth. Give the release command as you deliver the toy or after you have given the treat for 30 seconds.

If you get frustrated, sweetly put the dog in his crate for his thirty minute soak and get some stress relief for yourself. To help repair the dog/human working relationship and develop confidence and trust, do a couple of fun play sessions with the dog to keep him upbeat and happy.

Go into each training session with your training plan memorized, no big expectations, a happy upbeat attitude, patience and an understanding that dogs need multiple repetitions in supportive environment to learn.

Never let the dog leave the source without sitting and getting rewarded. This assumes that the dog is in odor.

Friday and Saturday are days off to play, swim, hike and relax.

Training logs are due Thursday by 5:00 pm (Pacific Standard Time).

TRAINING LOG INFORMATION
WEEK THREE – FIELD SEARCH

<u>Days 1-5 Sunday, Monday, Tuesday, Wednesday, Thursday</u>
Training Objectives:

- Dog is actively searching for and sitting in odor in a field setting at a distance of up to 30'.
- Begin automatic sit response in odor without command from handler

DAY 1 WEEK3

Location:	AM PM	Temp:			
Hide	**Area 1**	**Verbal "Sit"**	**Correction**	**Touch**	**Intent**
1	Surface Cover	Yes No	Yes No	Yes No	
2	Surface Cover	Yes No	Yes No	Yes No	
3	Surface Cover	Yes No	Yes No	Yes No	
4	Surface Cover	Yes No	Yes No	Yes No	
	Area 2				
5	Surface Cover	Yes No	Yes No	Yes No	
6	Surface Cover	Yes No	Yes No	Yes No	
7	Surface Cover	Yes No	Yes No	Yes No	
8	Surface Cover	Yes No	Yes No	Yes No	
	Area 3				
9	Surface Cover	Yes No	Yes No	Yes No	
10	Surface Cover	Yes No	Yes No	Yes No	
11	Surface Cover	Yes No	Yes No	Yes No	
12	Surface Cover	Yes No	Yes No	Yes No	
	Area 4				
13	Surface Cover	Yes No	Yes No	Yes No	
14	Surface Cover	Yes No	Yes No	Yes No	
15	Surface Cover	Yes No	Yes No	Yes No	
16	Surface Cover	Yes No	Yes No	Yes No	

DAY 2 WEEK3

Location:	AM PM	Temp:			
Hide	**Area 1**	**Verbal "Sit"**	**Correction**	**Touch**	**Intent**
1	Surface Cover	Yes No	Yes No	Yes No	
2	Surface Cover	Yes No	Yes No	Yes No	
3	Surface Cover	Yes No	Yes No	Yes No	
4	Surface Cover	Yes No	Yes No	Yes No	
	Area 2				
5	Surface Cover	Yes No	Yes No	Yes No	
6	Surface Cover	Yes No	Yes No	Yes No	
7	Surface Cover	Yes No	Yes No	Yes No	
8	Surface Cover	Yes No	Yes No	Yes No	
	Area 3				
9	Surface Cover	Yes No	Yes No	Yes No	
10	Surface Cover	Yes No	Yes No	Yes No	
11	Surface Cover	Yes No	Yes No	Yes No	
12	Surface Cover	Yes No	Yes No	Yes No	
	Area 4				
13	Surface Cover	Yes No	Yes No	Yes No	
14	Surface Cover	Yes No	Yes No	Yes No	
15	Surface Cover	Yes No	Yes No	Yes No	
16	Surface Cover	Yes No	Yes No	Yes No	

DAY 3 WEEK3

Location:	AM PM	Temp:			
Hide	**Area 1**	**Verbal "Sit"**	**Correction**	**Touch**	**Intent**
1	Surface Cover	Yes No	Yes No	Yes No	
2	Surface Cover	Yes No	Yes No	Yes No	
3	Surface Cover	Yes No	Yes No	Yes No	
4	Surface Cover	Yes No	Yes No	Yes No	
	Area 2				
5	Surface Cover	Yes No	Yes No	Yes No	
6	Surface Cover	Yes No	Yes No	Yes No	
7	Surface Cover	Yes No	Yes No	Yes No	
8	Surface Cover	Yes No	Yes No	Yes No	
	Area 3				
9	Surface Cover	Yes No	Yes No	Yes No	
10	Surface Cover	Yes No	Yes No	Yes No	
11	Surface Cover	Yes No	Yes No	Yes No	
12	Surface Cover	Yes No	Yes No	Yes No	
	Area 4				
13	Surface Cover	Yes No	Yes No	Yes No	
14	Surface Cover	Yes No	Yes No	Yes No	
15	Surface Cover	Yes No	Yes No	Yes No	
16	Surface Cover	Yes No	Yes No	Yes No	

DAY 4 WEEK3

Location:	AM PM	Temp:			
Hide	**Area 1**	**Verbal "Sit"**	**Correction**	**Touch**	**Intent**
1	Surface Cover	Yes No	Yes No	Yes No	
2	Surface Cover	Yes No	Yes No	Yes No	
3	Surface Cover	Yes No	Yes No	Yes No	
4	Surface Cover	Yes No	Yes No	Yes No	
	Area 2				
5	Surface Cover	Yes No	Yes No	Yes No	
6	Surface Cover	Yes No	Yes No	Yes No	
7	Surface Cover	Yes No	Yes No	Yes No	
8	Surface Cover	Yes No	Yes No	Yes No	
	Area 3				
9	Surface Cover	Yes No	Yes No	Yes No	
10	Surface Cover	Yes No	Yes No	Yes No	
11	Surface Cover	Yes No	Yes No	Yes No	
12	Surface Cover	Yes No	Yes No	Yes No	
	Area 4				
13	Surface Cover	Yes No	Yes No	Yes No	
14	Surface Cover	Yes No	Yes No	Yes No	
15	Surface Cover	Yes No	Yes No	Yes No	
16	Surface Cover	Yes No	Yes No	Yes No	

DAY 5 WEEK3

Location:	AM PM	Temp:			
Hide	**Area 1**	**Verbal "Sit"**	**Correction**	**Touch**	**Intent**
1	Surface Cover	Yes No	Yes No	Yes No	
2	Surface Cover	Yes No	Yes No	Yes No	
3	Surface Cover	Yes No	Yes No	Yes No	
4	Surface Cover	Yes No	Yes No	Yes No	
	Area 2				
5	Surface Cover	Yes No	Yes No	Yes No	
6	Surface Cover	Yes No	Yes No	Yes No	
7	Surface Cover	Yes No	Yes No	Yes No	
8	Surface Cover	Yes No	Yes No	Yes No	
	Area 3				
9	Surface Cover	Yes No	Yes No	Yes No	
10	Surface Cover	Yes No	Yes No	Yes No	
11	Surface Cover	Yes No	Yes No	Yes No	
12	Surface Cover	Yes No	Yes No	Yes No	
	Area 4				
13	Surface Cover	Yes No	Yes No	Yes No	
14	Surface Cover	Yes No	Yes No	Yes No	
15	Surface Cover	Yes No	Yes No	Yes No	
16	Surface Cover	Yes No	Yes No	Yes No	

Questions:

Does the dog associate the command "Tort" with the idea of searching to find odor?

Comments:

Is the dog eagerly working to get to the odor?

Comments:

Does the dog seem to understand that odor + the decision to sit automatically = food/toy?

Comments:

Does the dog actively trying to sit upon recognizing the odor at 6'?

Comments:

How many seconds does it take for the dog to start to sit?

Comments:

Is the dog focused or distracted by the environment?

Comments:

Did the dog complete 80 repetitions of hearing the command "tort", finding the hide, completing the sit, getting the click and receiving the reward?

Comments:

Has the dog offered to leave the odor this week without sitting?

Comments:

In the last 16 repetitions (day 5) what percentage of the time did you have to say "sit" and correct?

Comments:

Is your **timing** of the click and food/toy delivery to the dog's mouth perfect?

Comments:

Has the dog ever been allowed this week to sniff a source and not get rewarded?

Has the dog this week ever been pulled off of a source?

Has your dog at any time in training this week felt moderate to hard correction?

Explain:

Was the correction emotional on your part?

Explain:

What are you thinking about when your dog is working?

Is there any required equipment that you do not have?

Please list:

Outline all of the changes made to your program this week with the trainer using **IF/THEN** statements (ex: **IF** the dog doesn't sit, **THEN** I say sit). This format will be helpful in future training with you and your dog as a team.

TRAINING PROTOCOLS
WEEK FOUR – FIELD SEARCH

Objectives for the week:

- Dog is actively searching for tortoise odor in a field setting.
- Dog does immediate (within 2 seconds) "sit" automatically at the source (no verbal/physical cue from handler).
- Dog is working and immediately responsive to handler's commands for recall and checking targeted areas.
- Dog is able to work for five consecutive days doing two hour problems each day (with breaks) finding 16 hides per day.

Sit Stay practice at the source – allow the dog to find a source and "sit" automatically. Verbally praise the sit and get the dog to stay for up to 30 seconds with you at a distance of 30'. Slowly move up to the dog, release and reward food/toy. Play extra long for all of that hard work staying. Practice this 1-2 times per day. It is important that the dog eagerly anticipates the release/reward and does not think he made a mistake in finding the source!

Dogs will work 16 hides per day for 5 days (Sunday – Thursday). Hides will be placed in 2 areas (100 yards x 100 yards) with 8 hides in each area.

Handler will section and grid the entire area with 25 yard spacing, keeping the dog in sight working on leash as a team at all times.

Dogs will search in booties all week.

Working on a 30’ leash, encourage the dog to sniff around brush, rocks, and cover as you move along at a consistent pace. When the dog's mouth reaches the hide and the dog is in full odor, wait 2 seconds for the automatic sit. As soon as the dog's rear end is on the ground deliver the reward (food or toy) to the dog's mouth. Give the release command as you deliver the toy or after you have treated for 30 seconds.

If the dog sits automatically within 2 seconds at source	**Then** Give the release command as you deliver the toy or after you have treated for 30 seconds.	This is the goal for each and every alert
If the dog does not sit within 2 seconds	**Then** immediately correct for sit (without emotion)	Praise happily and deliver the reward
If the dog is continuously distracted with non tortoise odor	**Then** put him in his crate for awhile.	Practice Leave-it command while hiking - daily
If the dog leaves the source (walks it)	**Then** correct for sit within 2 steps of leaving the source	Praise happily and deliver the reward
If the dog shows aversion behavior	**Then** drive the sit with the reward and continue to do so for the next 32 repetitions.	Causes: tough and/or emotional correction before the dog ready
If the dog sits within 6 feet of the source	**Then** coax him to source by showing it to him	Say sit. praise happily and deliver the reward
If the dog picks it up	**Then** correct until it is out of his mouth	With neutral body language, put him in his crate to soak for 10 minutes – no reward

At the end of the 4 weeks, the dogs will not work again until they come to the project. Give the dog lots of relaxation time, plus swimming and hiking for conditioning.

Training logs are due Thursday by 5:00 pm (Pacific Standard Time).

TRAINING LOG INFORMATION
WEEK FOUR – FIELD SEARCH

<u>Days 1-5 Sunday, Monday, Tuesday, Wednesday, Thursday</u>

Training Objectives:

- Dog is actively searching for tortoise odor in a field setting.
- Dog does immediate (within 2 seconds) "sit" automatically at the source (no verbal/physical cue from handler).
- Dog is working and immediately responsive to handler's commands for recall and checking targeted areas.
- Dog is able to work for five consecutive days doing four hour problems each day (with breaks) finding 16 hides per day.

DAY 1 WEEK 4

Location:	AM NOON PM	Temperature:		
Hide	**Area 1**	**Automatic Sit**	**> 2 seconds**	**Correction**
1	Surf Cover	Yes No	Yes No	Yes No
2	Surf Cover	Yes No	Yes No	Yes No
3	Surf Cover	Yes No	Yes No	Yes No
4	Surf Cover	Yes No	Yes No	Yes No
5	Surf Cover	Yes No	Yes No	Yes No
6	Surf Cover	Yes No	Yes No	Yes No
7	Surf Cover	Yes No	Yes No	Yes No
8	Surf Cover	Yes No	Yes No	Yes No
9	Surf Cover	Yes No	Yes No	Yes No
10	Surf Cover	Yes No	Yes No	Yes No
11	Surf Cover	Yes No	Yes No	Yes No
12	Surf Cover	Yes No	Yes No	Yes No
13	Surf Cover	Yes No	Yes No	Yes No
14	Surf Cover	Yes No	Yes No	Yes No
15	Surf Cover	Yes No	Yes No	Yes No
16	Surf Cover	Yes No	Yes No	Yes No

DAY 2 WEEK 4

Location:	AM NOON PM	Temperature:		
Hide	**Area 1**	**Automatic Sit**	**> 2 seconds**	**Correction**
1	Surf Cover	Yes No	Yes No	Yes No
2	Surf Cover	Yes No	Yes No	Yes No
3	Surf Cover	Yes No	Yes No	Yes No
4	Surf Cover	Yes No	Yes No	Yes No
5	Surf Cover	Yes No	Yes No	Yes No
6	Surf Cover	Yes No	Yes No	Yes No
7	Surf Cover	Yes No	Yes No	Yes No
8	Surf Cover	Yes No	Yes No	Yes No
9	Surf Cover	Yes No	Yes No	Yes No
10	Surf Cover	Yes No	Yes No	Yes No
11	Surf Cover	Yes No	Yes No	Yes No
12	Surf Cover	Yes No	Yes No	Yes No
13	Surf Cover	Yes No	Yes No	Yes No
14	Surf Cover	Yes No	Yes No	Yes No
15	Surf Cover	Yes No	Yes No	Yes No
16	Surf Cover	Yes No	Yes No	Yes No

DAY 3 WEEK4

Location:	AM NOON PM	Temperature:		
Hide	**Area 1**	**Automatic Sit**	**> 2 seconds**	**Correction**
1	Surf Cover	Yes No	Yes No	Yes No
2	Surf Cover	Yes No	Yes No	Yes No
3	Surf Cover	Yes No	Yes No	Yes No
4	Surf Cover	Yes No	Yes No	Yes No
5	Surf Cover	Yes No	Yes No	Yes No
6	Surf Cover	Yes No	Yes No	Yes No
7	Surf Cover	Yes No	Yes No	Yes No
8	Surf Cover	Yes No	Yes No	Yes No
9	Surf Cover	Yes No	Yes No	Yes No
10	Surf Cover	Yes No	Yes No	Yes No
11	Surf Cover	Yes No	Yes No	Yes No
12	Surf Cover	Yes No	Yes No	Yes No
13	Surf Cover	Yes No	Yes No	Yes No
14	Surf Cover	Yes No	Yes No	Yes No
15	Surf Cover	Yes No	Yes No	Yes No
16	Surf Cover	Yes No	Yes No	Yes No

DAY 4 WEEK 4

Location:	AM NOON PM	Temperature:		
Hide	**Area 1**	**Automatic Sit**	**> 2 seconds**	**Correction**
1	Surf Cover	Yes No	Yes No	Yes No
2	Surf Cover	Yes No	Yes No	Yes No
3	Surf Cover	Yes No	Yes No	Yes No
4	Surf Cover	Yes No	Yes No	Yes No
5	Surf Cover	Yes No	Yes No	Yes No
6	Surf Cover	Yes No	Yes No	Yes No
7	Surf Cover	Yes No	Yes No	Yes No
8	Surf Cover	Yes No	Yes No	Yes No
9	Surf Cover	Yes No	Yes No	Yes No
10	Surf Cover	Yes No	Yes No	Yes No
11	Surf Cover	Yes No	Yes No	Yes No
12	Surf Cover	Yes No	Yes No	Yes No
13	Surf Cover	Yes No	Yes No	Yes No
14	Surf Cover	Yes No	Yes No	Yes No
15	Surf Cover	Yes No	Yes No	Yes No
16	Surf Cover	Yes No	Yes No	Yes No

DAY 5 WEEK 4

Location:	AM NOON PM	Temperature:		
Hide	**Area 1**	**Automatic Sit**	**> 2 seconds**	**Correction**
1	Surf Cover	Yes No	Yes No	Yes No
2	Surf Cover	Yes No	Yes No	Yes No
3	Surf Cover	Yes No	Yes No	Yes No
4	Surf Cover	Yes No	Yes No	Yes No
5	Surf Cover	Yes No	Yes No	Yes No
6	Surf Cover	Yes No	Yes No	Yes No
7	Surf Cover	Yes No	Yes No	Yes No
8	Surf Cover	Yes No	Yes No	Yes No
9	Surf Cover	Yes No	Yes No	Yes No
10	Surf Cover	Yes No	Yes No	Yes No
11	Surf Cover	Yes No	Yes No	Yes No
12	Surf Cover	Yes No	Yes No	Yes No
13	Surf Cover	Yes No	Yes No	Yes No
14	Surf Cover	Yes No	Yes No	Yes No
15	Surf Cover	Yes No	Yes No	Yes No
16	Surf Cover	Yes No	Yes No	Yes No

Questions:
Does the dog actively trying to sit upon recognizing the odor at 30'?
Comments:

Did the dog complete 64 repetitions of hearing the command "tort", finding the hide, completing the sit, and receiving the reward?
Comments:

Has the dog offered to leave the odor this week without sitting?

In the last 16 repetitions (day 5) what percentage of the time did you have to say "sit" and correct?
Comments:

Has the dog ever been allowed this week to sniff a source and not get rewarded?

Has the dog this week ever been pulled off of a source?

Has your dog at any time in training this week felt hard correction?
Explain:

Is your dog enjoying the game?

Did the dog wear the e-collar every day this week?
Comments:

How much of the time did the dog wear booties?

How many times did you have to replace booties?

How many times did your dog watch your body language and alert as a result?

Will the dog alert reliably on a source that is 20-30 yards away from your position?

Is the dog responsive to recall command 95% of the time while searching?

Is the dog responsive to checking areas that you send him/her into?

Are you working together as a team?

Outline all of the changes made to your program this week with the trainer using **IF/THEN** statements (ex: **IF** the dog doesn't sit, **THEN** I say sit). This format will be helpful in future training with you and your dog as a team.

APPENDIX D. DTK9 STANDARD OF PRACTICE (DRAFT)

The following scope was developed as the certification standard based on the results of RC-200609. This certification standard is in discussion with permitting agencies that have provided an initial review. The final DTK9 Standard of Practice will be completed in coordination with permitting agencies.

DTK9 Standard of Practice (DRAFT)

Certification standards and test procedures for desert tortoise detection dog teams (DTK9).

1. Scope
    a. The purpose of this standard is to identify dog-handler teams that can search for and locate Mojave Desert tortoises (*Gopherus agassizii*) under field conditions in a safe manner. These teams are deployable within the geographic range of the species and are expected to encounter and locate tortoises of any size and in any of three configurations (surface, shrub, or burrow). Certified DTK9 teams do not present an intentional harm to a desert tortoise(s) and the probability of harm is small. As with all activities with protected species, appropriate considerations for safety are required.
    b. A team that demonstrates the ability to maintain safety while exhibiting a minimum capability at finding desert tortoises will be certified to practice as a DTK9 team for the term of the certification and within the limitations of the permit under which they deploy. Certified DTK9 teams are limited to search for desert tortoises. The certification does not qualify a team to search for other species.
    c. Certification criteria are measured quantitatively using a scale of 1-5 for safety metrics, a minimum threshold for efficacy and reliability calculated on a scale of 0.00 to 1.00, a qualitative rating of 'pass' or 'fail' for safety throughout all assessment tests, GPS recorded track, and an overall rating of either 'pass' or 'fail' based on results of the entire assessment.
    d. Harm to a tortoise at any time from a dog or handler results in an immediate 'fail' regardless of performance in the other assessments.
2. Relevant Documents
    a. Cablk, M.E., J.C. Sagebiel, J.S. Heaton and C. Valentin. 2008. Detection distance: A quantitative analysis of how far away dogs detect tortoise scent and follow it to source. Sensors. 8(4):2208-2222.
    b. Cablk, M.E., K. Nussear, T. Esque, C. Valentin, R.S. Harmon, and S. Clark. 2008. Final Assessment of DTK9 Teams – Results from the 2008 Field Tests. The Partners in Environmental Technology Technical Symposium and Workshop: Meeting DOD's Environmental Challenges. December 2-4, 2008. Washington, D.C. http://www.serdp-estcp.org/Symposium2008/Posters/upload/W99Cablk.pdf
    c. Cablk, M.E., R.S. Harmon and C. Valentin. 2007. Maintaining real-time calibration of detection dog teams during field deployment given uncertainty in target location. The Partners in Environmental Technology Technical Symposium and Workshop: Meeting DOD's Environmental Challenges. December 4-6, 2007. Washington, D.C.
    d. Cablk, M.E., and J.S. Heaton. 2006. Accuracy and reliability of dogs in surveying for Desert Tortoise (*Gopherus agassizii*). Ecological Applications. 16(5):1926-1935.
    e. Cablk, M.E., J.S. Heaton, K. Nussear, T. Esque, S. Clark, K. Nagy, and C. Valentin. The Desert Tortoise K9 (DTK9) Program – Validation and demonstration. The Partners in Technology Environmental Technology Technical Symposium and

Workshop. November 28-30, 2006. Washington, DC. http://www.serdp-estcp.org/Symposium/posters/upload/30-W_Cablk-2.pdf

f. Heaton J.S., M.E. Cablk, K.E. Nussear, T.C. Esque, P.A. Medica, J.C. Sagebiel, and S. Francis. 2008. Comparison of effects of humans versus wildlife-detector dogs. Southwestern Naturalist 53(4):472-479.

g. Nussear, K.E., T.C. Esque, J.S. Heaton, M.E. Cablk, K.K. Drake, C. Valentin, J.L. Yee, and P.A. Medica. 2008. Are wildlife detector dogs or people better at finding tortoises (*Gopherus agassizii*)? Herpetological Conservation and Biology. 3(1):103-115.

h. U.S. Fish and Wildlife Service. 2008. Draft revised recovery plan for the Mojave population of the desert tortoise (*Gopherus agassizii*). U.S. Fish and Wildlife Service, California and Nevada Region, Sacramento, California. 209 pp.

3. Terminology

a. Alert: Dog sits at target odor

b. Change of behavior: Dog behavior which causes handler to decide that an area needs to be re-searched for a tortoise

c. Close on odor: Dog passes through target odor, recognizes the presence of that odor, moves itself through the odor and ultimately locates the target

d. Correction: An action taken by a handler towards a dog using negative reinforcement

e. Detail Search: The team conducts a search that allows the dog to sniff every potential burrow and every shrub and the dog is specifically targeted to do so

f. DTK9: Desert tortoise detection dog

g. Efficacy: the number of targets (e.g., tortoises) found of the total available to be found

h. Fact: Handler visually confirms tortoise presence and specific location

i. Full Reward: Pre-determined food or play interaction between dog and handler

j. GPS: Handheld global positioning system

k. Go to Dog: Dog holds the sit in place while handler moves to dog

l. Hasty Search: The team searches the area without targeting the dog to sniff every potential burrow or every shrub

m. Intentional Risk: Inappropriate dog or handler interaction with a tortoise or burrow

n. MCL: Midline carapace length

o. Neutralize Risk: Verbal and/or physical process of minimizing harm to tortoise

p. No Reward: When dog no longer exhibits change of behavior and leaves area, handler follows dog neutrally away

q. Operational Team: Handler manages dog following a set of contingencies designed maintain the alert process in the dog while minimizing risk (Figure D-1)

r. Partial Reward: Dog receives validation from the handler that is neither food nor toy, for an indication where the target is not visually confirmed

s. Perimeter Search: The team searches along the search area boundary

t. Reliability: number of indications (e.g., sit) performed by the dog divided by the total number of targets found calculated for first encounters only

u. Retire Dog: Permanent removal of dog from all tortoise detection w/consideration for other high-risk animate programs

v. Retrain: Dog is removed from operation. Process for decreasing animation and negative behavior in the dog with the intention of becoming operational again

w. Risk: Target is in immediate danger of intentional or unintentional manipulation by a dog or handler

x. Safe: Tortoise does not face immediate potential danger and has been visually confirmed by the handler

y. Target: The object the dog is trained to find and alert on (i.e., Mojave desert tortoise)

z. Unintentional Risk: No motivation to cause harm by handler or dog

4. Summary of Practice

   a. A certified DTK9 team operates under the following practice:

      i. A certified DTK9 team is one dog and one handler that together have passed the certification assessments identified here;

      ii. The handler manages the dog to optimize the finding of live desert tortoises using an appropriate search strategy;

      iii. The dog relies primarily on olfaction to locate live desert tortoises;

      iv. A permitted tortoise biologist may accompany the DTK9 team;

      v. DTK9 handlers are responsible for providing and utilizing gear required for field deployment;

   b. The principal of the practice of using DTK9 teams is to deploy a dog trained to recognize live tortoise odor to locate live tortoises. The handler uses a search strategy to optimize the opportunity for the dog to encounter live tortoise odor, such that the dog is able to follow the tortoise odor to the live tortoise, at which point the dog will alert. The handler may or may not be able to visually verify the presence of a live tortoise, depending on the configuration (i.e., burrow, shrub). The dog's alert is maintained for the duration of the deployment(s) whether or not tortoises are verified and the dog receives its reward.

5. Significance and Use

   a. Certified DTK9 teams are fielded to locate Mojave Desert tortoises. Demonstrated to be successful at this task through the certification process, one of the advantages of using certified DTK9s for locating desert tortoises includes contributing to improved population demographic information and maximizing safety of the target species. This is accomplished through the ability to collect the data necessary to complete life-

tables, detect population trends, and improve demographic knowledge. Certified DTK9s provide an alternative cost-effective solution for conducting desert tortoise surveys including the full range of desert tortoise size classes.

b. The objective of the certification assessment process is to demonstrate a DTK9 team's capability to find desert tortoises of all size classes on the surface, in shrubs and in burrows while maintaining safety at all times. Teams that receive a 'pass' and achieve certification demonstrate a minimum level of proficiency and are expected to perform similarly if not exceed capability demonstrated during the assessments during actual field surveys.

c. Certified DTK9 teams are used for purposes related to the need to provide exact locations of live desert tortoises. Teams do not alert on residual odor, feces, urine, deceased animals or animal remains. They may be fielded in conjunction with human survey teams or as a standalone survey tool. They are particularly useful where a small tortoise(s) has been found, such as recent hatchlings, to search for additional small tortoises in the immediate vicinity. Certified teams are listed (both handler and dog) on the permits authorizing the surveys. Dogs are fielded on leash, 10-20' in length, always held by the handler and not dragged, for safety and to reduce impact. Search strategy is devised and implemented based on the following:

    i. Size of the tortoises sought;

    ii. Size of the area to be covered;

    iii. Amount of time available to cover the search areas;

    iv. Ability of the handler to maintain safety during searching.

d. As with any tool there are limitations to using dog teams to find desert tortoises, particularly in the harsh desert environment.

    i. Regardless of whether surveys are conducted by humans or DTK9s, a qualified tortoise biologist must be present to handle desert tortoises, if the survey requires it.

    ii. In general, dogs are most effective when air temperatures are less than or equal to the mid-80 ºF range, although the permitted cutoff temperature for handling tortoises as set by USFWS is 95 ºF. Dogs may be able to work at higher temperatures in the absence of direct solar radiation (i.e. cloudy days).

    iii. Surface temperatures may limit the ability of the dog to continue searching effectively and reliably.

    iv. The temperature condition of the dog involved in these activities is paramount to acquisition of reliable tortoise encounter data as well as the general welfare of the dogs. Internal body temperature of the dog, measured rectally, that is greater than 104 ºF is generally considered the point at which work ceases and the dog is cooled. Work may continue so long as the dog's body temperature measured rectally remains less than 104 ºF.

    v. Capability of DTK9 teams at locating desert tortoise nests has not been studied and thus they are not fielded to search for nests.

vi. DTK9 teams have not been tested for capability at scent discriminating individual tortoises. They are not fielded to identify specific individual animal(s) using a scent article.

vii. DTK9 teams fielded for live tortoises are trained specifically not to indicate on tortoise scat. While there may be utility for such a purpose, it is outside the scope of this practice.

e. There are situations or conditions in which fielding certified DTK9 teams may not be applicable. These include:

i. When working outside the scope of practice;

ii. When prohibited by temperature constraints;

iii. When hazards or hazardous conditions prevent safe entry of the handler into an area;

iv. When external or additional validation of tortoise presence/absence is required (such as via scope or other means) but the necessary tools/personnel are not available;

v. When handling of tortoises is required, but the necessary personnel are not available;

vi. When the handler does not have sufficient resources to maintain the well-being of the team, such as lack of water or portable shade.

f. DTK9 teams can be compared with other practices surveying for desert tortoise and surveying for wildlife scat, but the practice of using DTK9 teams is unique in its scope and in certain applications.

i. The use of dog teams to conduct desert tortoise surveys complements existing methods involving human teams through the use of a different sensory mechanism, olfaction.

ii. Desert tortoise habitat can be surveyed using a number of different methods involving humans using visual detection methods to find tortoises, which tend to be biased toward the adult members of the population. Difficulty exists in detecting smaller size classes of tortoises, which are so infrequently encountered in human surveys that they are omitted from analysis under current range-wide monitoring efforts (US Fish and Wildlife Service, 2008). Thus a more robust means of undertaking this census is a critical current need. Deployment of certified DTK9 teams directly addresses this critical need as a tool viable to collect data not only for compliance but also in support of assessing the tortoise against its de-listing criteria.

iii. Surveying for live animals presents additional challenges over other detection disciplines. Dogs are used in other wildlife species applications to locate scat, although there does not exist a standard scope of practice for doing so, either generally or for particular species. Interfacing dogs with wildlife, particularly a listed species, generates a risk to the target that does not factor in to surveying for inanimate objects. Because desert tortoises tend to make a vocal

(hissing) and physical response (retraction) when approached, they may elicit behavior from the dog, which can increase risk. In contrast, should a dog ingest or otherwise destroy scat, only data are lost. In such an instance with a live animal not only are data lost, harm may occur, and a permit violation may ensue.

6. Procedure
    a. Instructions for the practice are as follows:
        i. The dog is the sensory tool used to actively seek out live desert tortoise odor, follow it to source to the extent possible, and upon olfactory based validation of target performs the alert.
        ii. The handler manages the dog and maintains all safety aspects related to the team with respect to tortoises, dog and handler. The primary role of the handler is to optimize deployment of the dog with the purpose of locating live desert tortoises. This includes devising and implementing the search strategy to cover the entire search area within time constraints while ensuring the dog has opportunity to encounter and close on desert tortoise odor of the size class(es) sought. The search strategy involves a perimeter, detail and hasty searches. The handler also looks for tortoises during surveys using visual clues. The handler maintains the health and well-being of the dog and of him/herself for the purposes of accomplishing the survey objectives and permits requirements, and maintains the capability of the team. The handler may or may not be permitted to handle desert tortoises. The handler identifies in a GPS and with other permitted means (i.e., flagging, pin flags, etc.) locations where the dog alerts. The handler may or may not validate the presence of a tortoise during surveys.
    b. The minimum requirements for DTK9 teams to participate in field surveys include:
        i. Current certification;
        ii. Permitted by applicable regulatory agencies to conduct the work, which may be by site or project basis;
        iii. Proof of state-required veterinary vaccinations.
    c. In addition to 7(b) DTK9 handlers shall consider the following as part of standard practice.
        i. Maintain needed equipment and infrastructure including:
            1. Sufficient potable water for the dog and handler during the survey;
            2. Portable shade for the dog;
            3. Rectal thermometer in working condition for the dog;
            4. Reward (toy or food);
            5. Active and passive cooling equipment to include at least: 50% alcohol-water mix in spray bottle, ice packs, shade;

6. Medical/veterinary care items to include at a minimum: forceps, band-aids, gauze, self-adhering bandage (e.g., Vetrap);
7. GPS;
8. Footwear for the dog;
9. Ability to transport the team to emergency medical and/or veterinary care.

ii. Optimize deployment which includes consideration of, but is not limited to

1. Season
2. Time of day
3. Survey objective
4. Environmental conditions

iii. Dog maintenance

1. Physical well-being
2. Maintain the alert

iv. Manage other humans accompanying the team during surveys

7. Test Methods

a. There are three assessments: (i) safety, (ii) practice demonstrated in high density tortoise environment, (iii) practice demonstrated in low density tortoise environment. Each team must receive a 'pass' for each of the three assessments to receive certification. A 'fail' in any of the three assessments negates qualification as a certified DTK9 team. Safety to desert tortoises is the primary criteria throughout the entire testing phase. Harm to a tortoise during assessment from a dog or handler results in an immediate 'fail' regardless of performance in the other assessments. The safety assessment is the first assessment conducted. The safety assessment and high density assessment may be conducted in the same day. The low density assessment will be conducted on a separate day when that is the only assessment conducted.

b. <u>Safety Assessment</u>: Test methods for the safety assessment involve a rank of 1 (none exhibited) to 5 (highest level exhibited) for each of the following behaviors in the dog:

i. Aggression: attempt to cause intentional harm to the tortoise

1. Defensive – Dog shows reduced body posture
2. Overt: – Dog shows confident body posture

ii. Excessive Flight - Dog shows reduced body posture and repeatedly attempts to move away from the target

iii. Play interaction – Dog attempts to engage the target in play activity

iv. Growling – Dog vocalizes with a low rumbling sound at any time for any purpose or target during the test time period.

v. Barking – Dog vocalizes with a range of sounds including whining at any time for any purpose or target during the test time period.

vi. Stalking – Dog shows low confident body posture while attempting to hunt or herd the target

vii. Excessive Focus – Dog does not easily look away from the target

viii. Inability to Relax – Dog cannot assume relaxed body posture

The minimum (optimal) score obtainable is 9. A score of less than or equal to 15 is a 'pass' score for the safety test provided no score of 5 or higher is received on any individual behavior. A score in excess of 15 is a fail. The following table also defines what will automatically result in a score of '5' for each of the behaviors:

Behavior	*Automatic score of '5', and fail*
Defensive aggression	Rushing a tortoise
Overt aggression	Rushing a tortoise
Excessive flight	> 15 seconds
Play interaction	Occurs more than once
Excessive focus	For more than 2 minutes
Inability to relax	For more than 9 of the 10 minutes

The following behaviors are pass/fail. If the dog shows or does any of the following behaviors at any time the test results in an immediate 'fail':

ix. Growling

x. Barking

xi. Stalking

c. <u>High density tortoise environment:</u> This assessment demonstrates the team's capability at locating and reporting desert tortoises while maintaining safety under a high tortoise density scenario based on the following measures:

i. Tortoise safety

1. No tortoises harmed while team is conducting survey;
2. Leash is not dragging on the ground;
3. Handler maintains contact with leash at all times while moving;
4. Dog does not dig;
5. Team operates as an Operational Team;

ii. Efficacy (≥ 0.70)

iii. Reliability (≥ 0.75)

iv. False indications equal no more than 25% of the total 'tortoise' calls, either by handler or by dog indication.

d. Low density tortoise environment: This assessment demonstrates the team's ability to maintain capability under a low density tortoise environment based on the following measures:

   i. Safety

      1. No tortoises harmed while team is conducting survey;
      2. Leash is not dragging on the ground;
      3. Dog does not dig;
      4. Team operates as an Operational Team;
      5. Pack check;

   ii. Search area coverage;

   iii. Efficacy (1.00)

e. Test procedures are conducted as follows. One evaluator proctors a team's assessments and an evaluator proctors multiple assessments. This provides continuity in assessing team safety throughout the assessments. Helpers provide assistance in administering the tests including set-up, data collection, and take-down. Helpers are permitted for the activities, operate within permitted activities, and must be briefed and agree to adhere to testing criteria that are essential to the success of the project (e.g., not divulging testing procedures or test-critical information to handlers, being aware of how to minimize non-verbal indications of test-critical information).

f. Safety Assessment:

   i. The assessment is conducted in a 15m x 15m pen with 2 or 3 adult, unrestrained tortoises. At least one tortoise is on the surface and visible when the assessment begins.

   ii. The handler's primary objective is safety to tortoises.

   iii. The dog is on a flat collar and 6' leash which the handler holds loosely at all times. The dog must wear an electronic collar, turned to the 'on' position with the transmitter held by the evaluator. The transmitter is verified 'on' by the evaluator prior to the team entering the pen. The collar is verified to be 'on' by turning the stimulus level to 0, pressing the stimulate button, and verifying the light on the collar registers the signal. The dog may not wear a bark collar.

   iv. The handler is aware of the location of the tortoises immediately prior to entering the pen with the dog. The handler enters the pen with the dog from a location that is opposite from where the tortoises are located only at the evaluator's request.

   v. The assessment begins when the handler and dog are in the pen.

   vi. The dog may not be rewarded in the pen. There is no dog-tortoise interaction, no search command, and no food allowed in the pen. The handler gives no

commands or corrections during the test, excluding any action to prevent harm to a desert tortoise.

vii. The dog is allowed to move without command no farther than the end of the leash.

viii. The dog may not drag the handler from their location in the pen.

ix. Helpers will ensure the tortoises never approach the dogs to a point where they are less than 10' from the dog in any direction.

x. Tortoise will not be visible to the dog when moved by helpers.

xi. The evaluator will observe the dog for a total of 10 minutes. The evaluator may make notes to assist in the final score for each of the nine behaviors.

xii. At the end of the 10 minutes, at the evaluator's direction, the handler will exit the pen at the same location of entry. Helpers will move tortoises back from that point of exit beforehand.

g. <u>High Density Tortoise Environment</u>

i. The assessment is conducted in a pen between 0.20 and 0.25 ha in area, either a square or rectangle, with any side being no less than 30 m in length.

ii. The assessment pen will have natural burrows and shrub cover that mimics typical desert tortoise habitat. Artificial burrows will be blocked to prevent habitation by desert tortoises. Ideally, there are no artificial burrows in the assessment pen.

iii. A minimum of 12 to a maximum of 15 transmittered tortoises will have been released into the assessment pen no less than 2 weeks prior to being used.

iv. The desert tortoise size distribution will be as follows:

1. 3 or 4 less than or equal to 110 mm MCL
2. 6 to 8 between 110 and 180 mm MCL
3. 2 or 3 between 180 and 200 mm MCL
4. 1 or 2 larger than 200 mm MCL

v. All transmitters will be verified to be 'on' and tortoises will be verified to be 'alive' no more than one day prior to the assessment.

vi. The handler determines where they will enter the pen and looks over the pen fence to verify no tortoise is present prior to entering the pen. The handler verifies that the evaluator is prepared before entering the pen.

vii. The team has 60 minutes to complete their search, including breaks.

viii. The assessment begins when the handler and dog step into the pen.

ix. The team searches their assigned area using the three-pass strategy of perimeter, detail and hasty. The dog is worked on a 10-20' line.

x. Helpers are present with telemetry equipment, including headphones, with the receiver programmed with the tortoise frequencies. A helper verifies tortoise presence/absence using the telemetry equipment and records data.

xi. The handler states out loud 'Tortoise' when they believe a tortoise is present. The dog may indicate or the handler may make the statement based on the dog's alert.

xii. The handler may state 'I see a tortoise' and point to where they see a tortoise, which is a valid find.

xiii. When the handler states 'tortoise' the helper records the following:

1. Dog or handler find;
2. If 'dog', indication yes/no;
3. Tortoise present yes/no;
4. Tortoise frequency ##;
5. Time stamp;

xiv. The handler does not mark the location of finds.

xv. The handler will exit the pen when the time is over. Once the evaluator states the time is up no additional finds are recorded.

h. <u>Low Density Tortoise Environment</u>

i. This evaluation is conducted in an area that is 2-ha in size, either square or rectangular.

ii. The test area is desert tortoise habitat known to have few or no tortoises present.

iii. One tortoise with a transmitter is known to occur in the assessment area and will be verified one day prior to the assessment. The tortoise may not be visible to the handler or dog.

iv. Evaluator will observe the handler has a backpack containing at a minimum the items listed in 7(c)(i). Each handler must provide his/her own equipment to demonstrate a complete pack. Sharing equipment is not permitted.

v. The handler wears a GPS with the track log recording set to 'on'. The handler is responsible for ensuring the GPS is functioning properly and records the track for the extent of the survey.

vi. There is a four-hour time limit. The time begins when the evaluator indicates the search is started.

vii. The team searches their assigned area using the three-pass strategy of perimeter, detail and hasty. The dog is worked on a 10-20' line.

viii. A helper simulating a tortoise biologist accompanies each team.

ix. The helper marks indications using flagging and records data using the Low Density environment assessment sheet (Figure D-2).

x. When the handler has completed his/her search s/he will stop the GPS, save the track and turn the track log to 'off', and verify that the track was recorded. The handler will present their GPS with the download cable to the evaluator. A helper may do the actual downloading or the handler may do the download with evaluator oversight. The GPS and cable are returned to the handler upon successful downloading.

xi. All teams will immediately return to the evaluator when the evaluator indicates the time is 'up'. The assessment stops when the evaluator calls for handlers to stop searching.

xii. Failure to produce a track log from the GPS will result in an automatic 'fail'.

8. Report

a. Safety Assessment: The evaluator scores each of nine behavior categories based on the 10 minutes of observation of the team. The evaluator scores the team immediately after the team leaves the test pen using Safety Assessment score sheets (Figure D-3 and Figure D-4). Teams are notified of a 'pass' or 'fail' when the Safety Assessment is completed for all teams. A copy of the score sheet will be provided to the team. A copy of the score sheet will remain with the official record.

b. High Density Tortoise Environment: Upon completion of the time or when the handler exits the pen stating they have completed their search, data sheets are combined in order of time stamp from start time to stop time. First finds are the only data used to determine efficacy and reliability. First finds are determined by time-stamp where the earliest time a tortoise is recorded to have been found is deemed the first find. The number of tortoises found during the search time period, determined by counting the number of different tortoises recorded to have been found on the data sheets, divided by the total available to be found in the pen determines the team's efficacy score. The number of indications the dog was reported to perform upon first encounter with each tortoise found determines the team's reliability score. The team must locate 0.70 of the tortoises in the pen and the dog must indicate on 0.75 of those that were found. Finds will be immediately verified using telemetry. All of these criteria must be met to receive a 'pass' on this assessment. Harm to a desert tortoise will result in a 'fail'. Observation by the evaluator of a handler allowing a dog to drag its leash or work off-leash will result in a 'fail'. Two or more indications on desert tortoise scat will result in a 'fail'.

c. Low Density Tortoise Environment: The evaluator checks-off each of the listed equipment items. The GPS track must record the handler's entire 3-pass search strategy including perimeter, detail and hasty passes and demonstrate complete coverage of the search area. The team must correctly flag the location of the desert tortoise which will be immediately verified using telemetry. Both the search area coverage and correct location of the desert tortoise must be completed within the allotted 4 hour time. All of these criteria must be met to receive a 'pass' on this assessment. Harm to a desert tortoise will result in a 'fail'. Observation by the evaluator of a handler allowing a dog to drag its leash or work off-leash will result in a 'fail'.

9. Figures

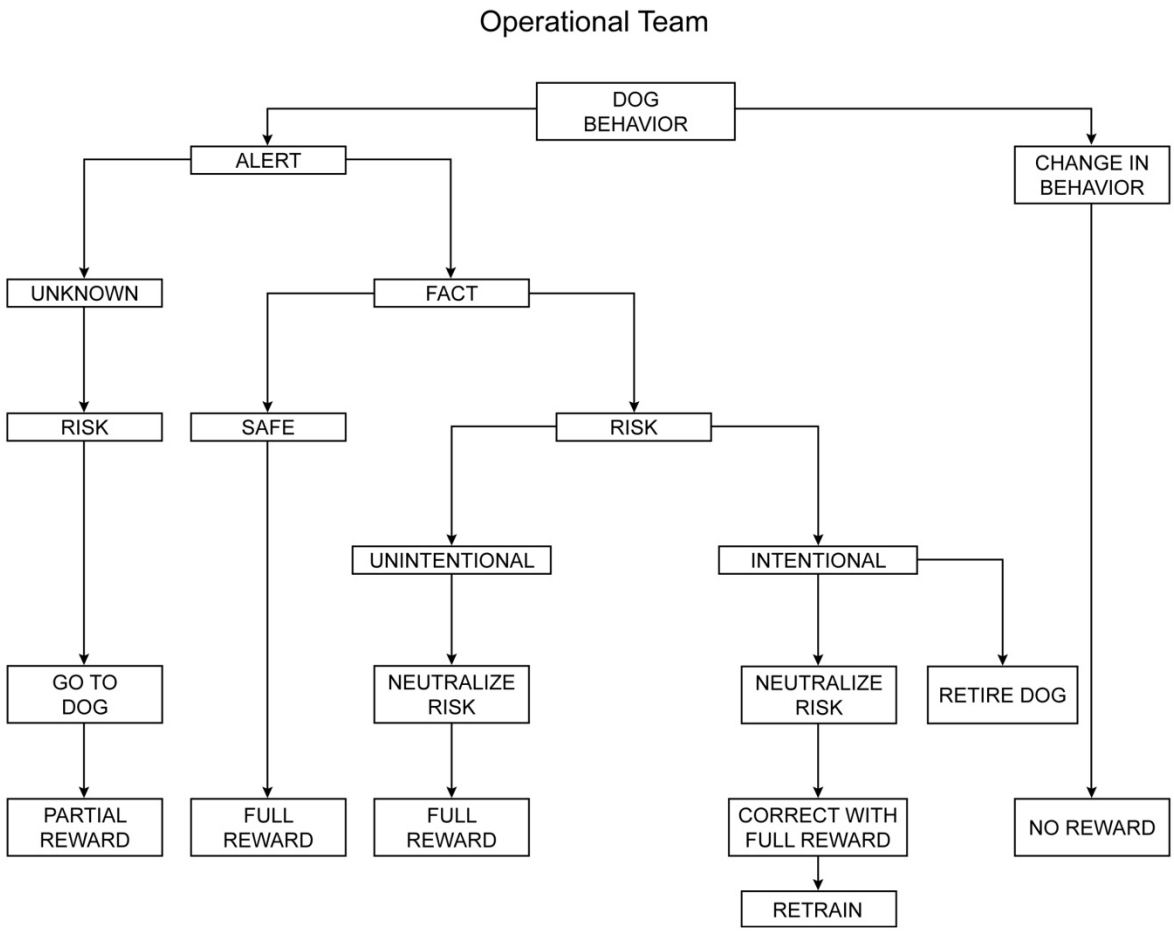

Figure D-1. This figure is the contingency diagram used by the handler to work as an Operational Team.

Safety Assessment

Date	Time	No. Tortoises

Evaluator: _____

Pen ID: _____

Handler Name	Dog Name

Behavior	1 to 5
defensive aggression	
overt aggression	
excessive flight	
predatory behavior	
play interaction	
growling	
barking	
stalking	
excessive focus	
inability to relax	

1 = none exhibited

5 = highest level exhibited

Sum total = [ ]

Comments:

Figure D-2. Safety Assessment Score sheets – Use one page for each team.

Date	Time	Event	Recorder:		Tort ID
			Tort Freq:		

Team	Dog Name	Alert	Cue	Touch	Interaction
		Yes	Dependent	Yes	Nose
		No	Independent	No	Paw
				Unknown	Lick
					Other
					None
					Unknown

Call	Disposition	Location	Searchability
Dog	Known	Shrub	straight burrow
Handler	Unknown	Surface	curved burrow
		Burrow	burrow in shrub
		Artificial Burrow	burrow complex
		Rock	

Verified Tort	Verification	Tortoise	X Coord:	
Yes	Frequency	Known	Y Coord:	
No	Visual	Wild		

Tortoise size: _____ mm

Sex: M F U

Comments:

Figure D-3. High Density Tortoise Assessment Score sheets – Use one page for each time a handler calls an alert.

Date	Time	Event	Recorder:	Tort ID
			Tort Freq:	

Handler Name	Dog Name	Alert	Cue	Touch	Interaction
		Yes	Dependent	Yes	Nose
		No	Independent	No	Paw
				Unknown	Lick
					Other
					None
					Unknown

GPS Track	Pack Complete	Reward
Yes	Yes	Full
No	No	Pet
		None

Found By	Disposition	Location	Searchability
Dog	Known	Shrub	straight burrow
Handler	Unknown	Surface	curved burrow
		Burrow	burrow in shrub
		Rock	burrow complex
			dense shrub

Verified Tort	Verification	Tortoise
Yes	Frequency	Known
No	Visual	Wild

X Coord: _____

Y Coord: _____

Tortoise size: _____ mm

Sex: M F U

Comments:

Figure D-4. Low Density Tortoise Assessment Score sheets – Use one sheet per tortoise encounter.