MOJAVE DESERT TORTOISE TRANSPORTATION ECOLOGY WORKSHOP REPORT

Credit: Elizabeth Fairbank

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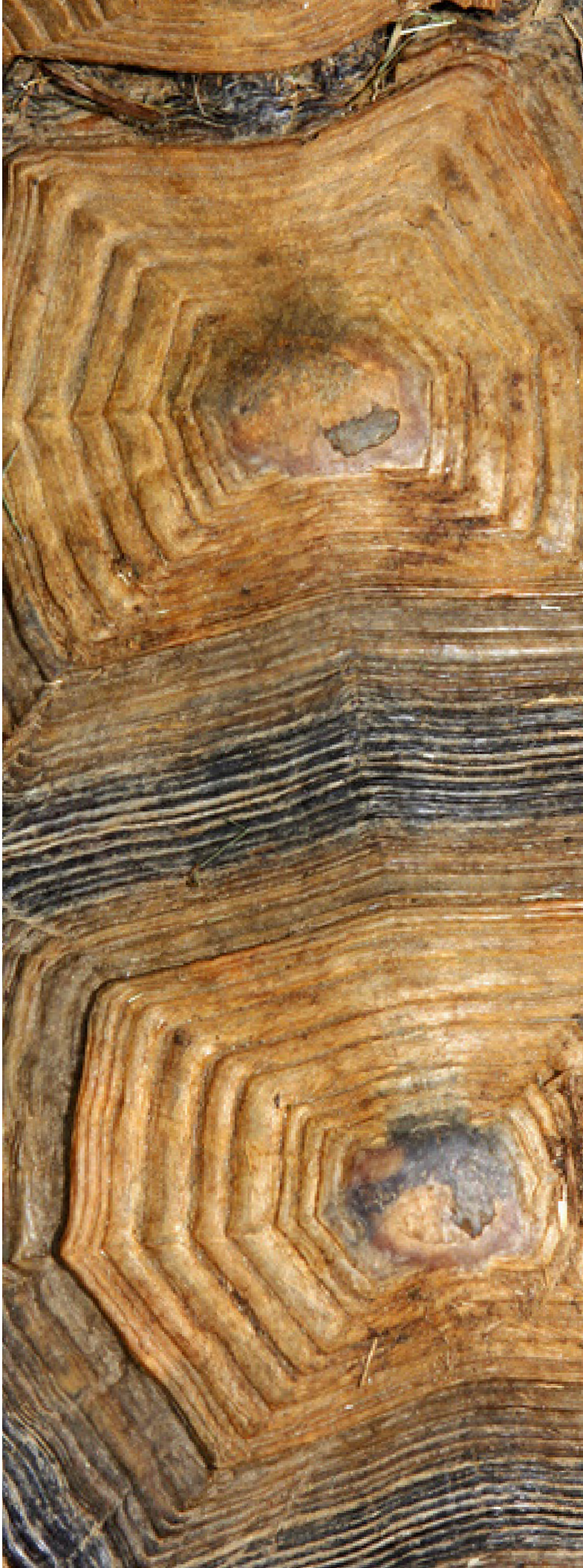


This event was the culmination of time and effort from many agencies, organizations, and individuals. It would not have been possible without the leadership of the U.S. Fish and Wildlife Service, the Center for Large Landscape Conservation, and the workshop planning team members who contributed their time and expertise to ensure that this event was a success and volunteered to help moderate sessions during the workshop. Many thanks go to Shawn Johnson from the University of Montana for facilitating the workshop, and to his student Nicholas Maya for assisting throughout the process. Thank you to all of our notetakers and moderators for the sessions, to the University of Nevada Las Vegas Film School and our student filmmakers Ahmad Abushamma and Isabelle Link, and to all of the practitioners who were willing to be interviewed for the film. Thank you to all of the workshop participants for taking the time to attend, engage, and provide your expertise and ideas to make this effort worthwhile. Finally, thank you to our funders, National Fish and Wildlife Foundation and the Clark County Desert Conservation Program, for their support and leadership, and to the numerous in-kind contributions of staff time by the agencies and organizations represented on the planning team.

Research cameras in a culvert for Mojave desert tortoise, US HWY 95 near Indian Springs, Nevada

EXECUTIVE SUMMARY

The intent of this report is to summarize and share the key activities, takeaways, and recommendations from the three-day Mojave Desert Tortoise (MDT) Transportation Ecology Workshop and the series of pre-workshop activities leading up to it. The workshop was held virtually March 22, 23, and 26, 2021, with more than 130 attendees representing a diverse, interdisciplinary audience of state and federal transportation, wildlife, natural resource, and land management agencies, counties, non-governmental organizations, and academic institutions.

The overarching goals of the workshop and preceding activities were to 1) build baseline knowledge around key wildlife and transportation issues, focused on Mojave Desert Tortoise habitat, 2) identify and prioritize challenges and opportunities as they relate to MDT recovery and transportation infrastructure, and 3) launch a Task Force and outline a set of related workshop products that will carry this conversation forward.

Day 1 focused on effects of transportation infrastructure on tortoise survival and recovery, and the roles and responsibilities of the various agencies and stakeholder groups in implementing recovery actions regarding transportation infrastructure. The day began with a Leadership Panel, where various state and federal leadership voices shared their perspectives on the need and opportunity this workshop presents and their goals for what they hope the workshop will achieve. The panel was followed with a series of presentations that provided baseline information to workshop participants on MDT status and issues specific to transportation infrastructure. The day ended with a breakout session, where practitioners were divided between transportation and natural resource sectors to identify the key challenges and opportunities they face when working on this issue.

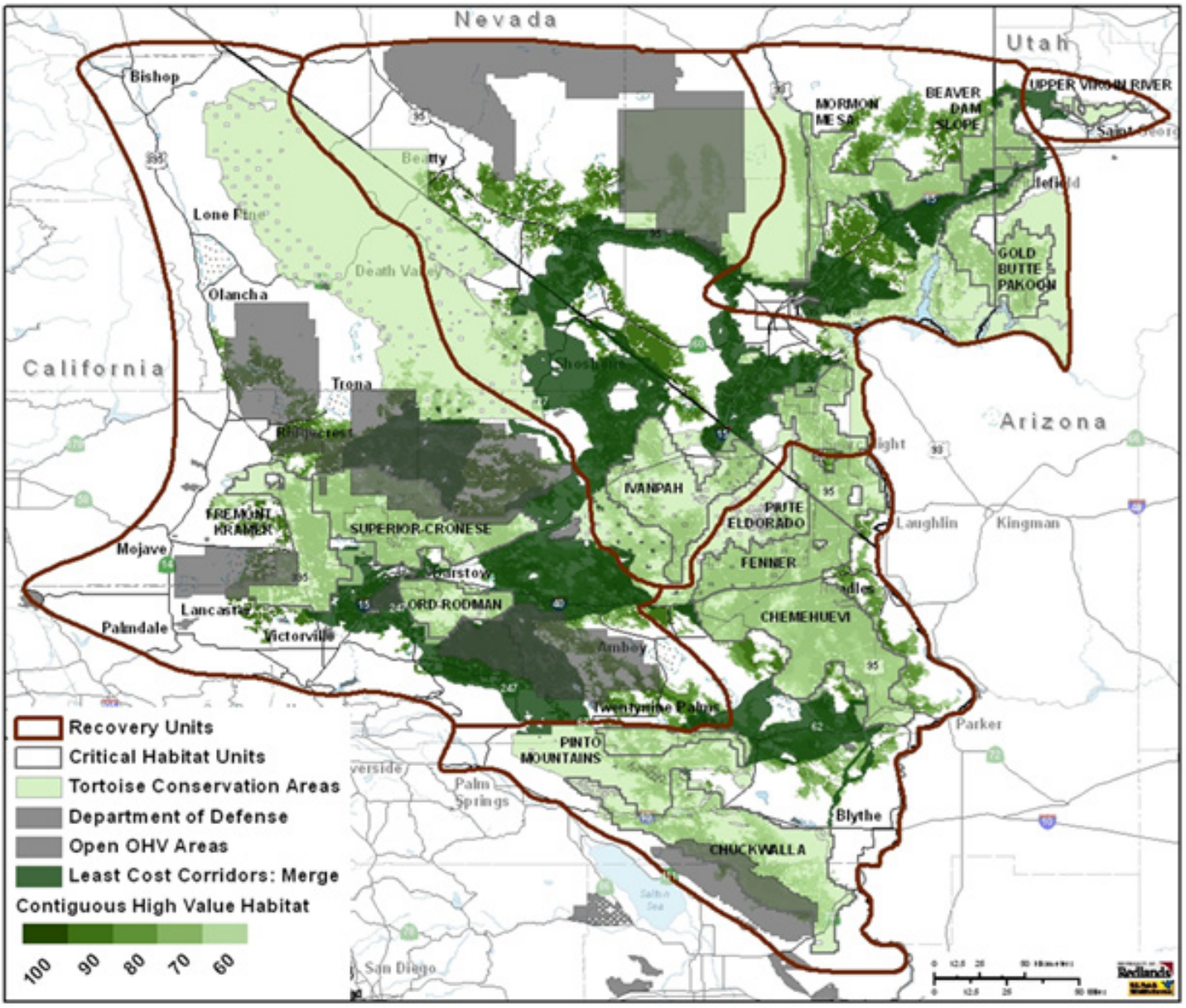
On Day 2 each sector provided a report out on the challenges and opportunities identified through the previous day's activities. From here, participants were split into interdisciplinary groups and moved through a series of five discussions based on the main themes that were identified the first day. By working in diverse teams on one priority issue at a time, small groups explored and documented their emerging ideas and solutions to the major challenges identified through the exercise from the previous day. Discussion topics included 1) interagency and transboundary communication and collaboration, 2) policy and regulatory compliance issues, 3) technical issues: fencing, culverts, maintenance, predator management, and invasive species, 4) funding for prioritization, implementation, maintenance, and monitoring, and 5) consistency of management across the range: best management practices for prioritization, implementation, maintenance, and monitoring/adaptive management.

The final day of the workshop was dedicated to discussing and launching an interdisciplinary Task Force to take all of the discussions from the workshop and carry them forward into actions to improve the implementation of measures to reduce MDT road mortality and improve habitat connectivity across transportation infrastructure. Participants developed an initial framework, discussed roles and responsibilities, and made commitments to participate in and provide support to the Task Force and resulting products and activities in the year(s) to come.

BACKGROUND: MOJAVE DESERT TORTOISE RECOVERY AND TRANSPORTATION IMPACTS

The range of the Mojave desert tortoise (*Gopherus agassizii*) occurs throughout the Mojave and Colorado Deserts in southern Nevada, southern California, the southwest corner of Utah, and a small strip of northern Arizona (Figure 1). The Mojave desert tortoise (MDT) is federally listed as a threatened species under the Endangered Species Act, and the United States Fish and Wildlife Service is tasked with overseeing the recovery the species (USWFS 2011).

Figure 1. Recovery units, critical habitat units, conservation areas, and contiguous high value habitat. Source: USFWS, 2011



A specialized wildlife crossing with underpass designed to allow threatened Mojave desert tortoise habitat access. Short fences keep them off the road. Clark County, Nevada

Desert tortoise mortality and illegal capture along roads and highways has been identified as a significant issue relative to recovery of the species (USFWS 2011). The construction of over 60,000 kilometers of roads and highways throughout the range of the desert tortoise has permanently fragmented previously contiguous habitat and reduced connectivity among populations (USFWS 2011). Restricted movement of tortoises may limit or entirely prohibit access to suitable habitat, resources, and mates on either side of existing roads and highways. The desert tortoise (and other chelonid species) has been identified as one of the highest risk species for road mortality, which can have significant cumulative effects on population viability (Brehme et al. 2018) and can result in “dead zones” in tortoise populations adjacent to highly trafficked roads (Nafus et al. 2013). The presence of roads may also result in significant habitat loss through degradation (e.g., altered hydrology, introduction and spread of non-native invasive plant species, and increased risk of fire) (USFWS 2011). Structures and artificial subsides, such as garbage, roadkill, and water resources, may attract and support populations of ravens, who prey on hatchling and juvenile tortoises.

The installation of tortoise fencing to limit mortality and encourage re-colonization of habitat adjacent to roads has been recommended (Boarman and Sazaki 2006, Boarman 2009, Nafus et al. 2013, and Peaden et al 2015). Therefore, USFWS has identified installation of tortoise fencing and wildlife crossings as one of the highest priority conservation actions for desert tortoise recovery (USFWS 2011 and 2015), yet many roads throughout desert tortoise habitat remain unfenced and lack suitable safe crossing opportunities.

Installation of permanent desert tortoise exclusion fencing is expensive, ranging from $15,000 to $25,000 per mile, depending on terrain and other factors, resulting in increased costs to state and federal transportation agencies for road repair and construction projects within areas of desert tortoise habitat. Technical and administrative obstacles to fencing installation are also common.

The following are typical examples of issues and challenges encountered when attempting to implement installation of fencing and culverts to reduce tortoise road mortality, ensure connectivity, and protect desert tortoise populations and habitat:

1. Federal and state transportation agencies are reluctant to foot the bill for costs of fencing and culvert installation.
2. Agencies disagree on who should be responsible for the workload and costs of installation and maintenance; workloads to conduct maintenance are burdensome and too costly for a single agency to realistically manage.
3. Service-recommended specifications for desert tortoise fencing installation and culvert construction may conflict with state and Federal Highway Administration (FHWA) and Federal Rail Administration (FRA) specifications for road/rail construction and public safety.
4. Fencing and culvert designs that work best for tortoises may conflict with designs needed to address hydrological issues.
5. Some state wildlife agencies have required transportation agencies to compensate for loss of habitat in the medians and ROWs after desert tortoise fencing installation, which significantly increases the cost of fencing installation to the point that it is no longer feasible.
6. Park and refuge leadership is sometimes reluctant to install fencing within park/refuge boundaries due to concerns regarding “view-scape,” visitor access, increased maintenance burden, and costs.
7. The threat of fire and habitat loss from presence of roads within desert tortoise conservation areas continues to increase due to the spread of non-native plant species. Maintenance and weed management plans may need to be developed or revised to more effectively address these issues.
8. Transportation agency engineers and management staff complain that conservation measures required to be implemented during road projects in desert tortoise habitat are burdensome, slow down work activities, and result in increased costs.
9. Ravens are attracted to subsidies provided by transportation infrastructure, such as roadkill, water resources, and trash. Other structures along roads may provide roosting or nesting sites for ravens, such as power transmission structures, fencing, road signs, and billboards.

In order to address these issues, USFWS has partnered with the Center for Large Landscape Conservation (CLLC) to develop and coordinate a suite of activities to bring together local, state, and federal agencies, practitioners, and other stakeholders to identify and develop ideas for technical solutions, best management practices, and other recommendations that could be consistently implemented across the range of the MDT. Originally, this was intended to be a multi-day workshop including fieldtrips and site visits, however due to the complications of meeting in person during the COVID-19 pandemic, we had to shift our approach to a series of activities that could be carried out virtually or while observing strict COVID-19 precautions. In order to effectively plan and implement these activities, an interdisciplinary Workshop Planning Team, led by USFWS and CLLC, was established to guide the workshop and other associated activities.

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PRE-WORKSHOP ACTIVITIES

Due to delays in planning and implementing the Workshop as a result of the COVID-19 pandemic and the urgency of addressing transportation-related impacts to MDT, the Workshop Planning Team decided to move forward with a series of educational opportunities. The purpose was to educate and engage local, state, and federal agency staff, practitioners, researchers, and other stakeholders about MDT transportation ecology issues and identify the greatest needs in terms of which issues should ultimately be addressed through the Capstone Workshop. Pre-workshop activities included a five-part webinar series, a pre-workshop practitioner survey, and a documentary film to serve as a "virtual fieldtrip" for workshop participants.

MOJAVE DESERT TORTOISE TRANSPORTATION ECOLOGY WEBINAR SERIES

From Fall 2020 through Spring 2021 the USFWS and CLLC hosted a five-part webinar series focused on presenting research and issues associated with MDT transportation ecology. The webinars featured speaker presentations followed by discussion and brainstorming sessions (Figure 2). Full summaries of these presentations are available as Appendix C of this document.

Figure 2. Schedule and Topics of Webinar Series.

Date	Topic	Speakers/Discussion Leads
10/15/20	Collection, analysis, and interpretation of road mortality data to inform and prioritize management and recovery actions	Speakers: **Fraser Shilling**, Professor, Co-Director, Road Ecology Center, UC Davis; **Kerry Holcomb**, Fish and Wildlife Biologist, PSFWO; **Jeanette Perry**, Ecological Environmental Monitoring, Mission Support and Test Services, LLC, NNSS, **Flo Deffner**, Desert Tortoise Recovery Biologist, SNFWO
11/05/20	Discussion & brainstorming sessions: desert tortoise fencing design & installation issues; alternative fencing designs to address topography, soil substrates	Discussion Leads: **Flo Deffner**, Desert Tortoise Recovery Biologist, SNFWO; **Kerry Holcomb**, Fish and Wildlife Biologist, PSFWO
12/03/20	Brainstorming session: road effects of desert tortoises and alternative approaches to reducing road mortality	Speakers: **Cheryl Brehme**, Western Ecological Research Center, USGS; **Mark Peaden**, PhD, Assistant Professor, Rogers State University; Discussion Lead: **Flo Deffner**
01/07/21	Inter-agency regulatory issues: Section 7, implementation of conservation measures, and mitigation; ideas for range-wide PBO for desert tortoise	Speakers: **Brian Croft**, PSFWO; **Glen Knowles**, SNFWO; **Dan Buford**, FHWA; **Catherine Liller**, USFWS HQ
02/04/21	Transportation infrastructure and connectivity	Speaker: **Ken Nussear**, Assistant Professor, University of Nevada-Reno

Federal Highway Administration (FHWA); Nevada National Security Site (NNSS); Palm Springs Fish and Wildlife Office (PSFWO); Southern Nevada Fish and Wildlife Office (SNFWO); U.S. Fish and Wildlife Service (USFWS); U.S. Geological Survey (USGS)

Desert tortoise habitat in Joshua Tree National Park, CA. Credit: Elizabeth Fairbank

PRACTITIONER SURVEY

In the fall of 2020, the Center for Large Landscape Conservation administered a survey on behalf of the Desert Tortoise Transportation Ecology Workshop Planning Team. The purpose of the survey was to collect information on attitudes and priorities related to desert tortoise conservation to inform the Desert Tortoise Capstone Workshop scheduled for the spring of 2021. The Desert Tortoise Survey (DTS) was administered using SurveyMonkey. Invitations to participate in the survey were distributed via email to prospective participants identified by a member of the working group. A total of 209 individuals were contacted to participate in the survey and referral recruiting (snowball sampling) was encouraged. The survey was open from November 16th to December 7th, 2020, and a total of 70 responses were collected of which 57 (81%) completed all questions of the survey and 13 were partially completed. The full survey report is available as Appendix B of this document.

DOCUMENTARY AND VIRTUAL FIELD TRIP

In order to provide workshop participants with a “virtual fieldtrip” the concept for a documentary film was developed. The Workshop Planning Team coordinated with students at The University of Nevada - Las Vegas (UNLV) film school to conduct site visits, collect footage, and interview land managers and researchers. The film was produced by USFWS biologist Flo Deffner, who supervised the students, as well as organizing and leading by the tour. Representatives from CLLC and the Western Transportation Institute – Montana State University participated in the documentary filming and collected relevant data from field sites visited during the tour. The 25-minute documentary titled “The Road to Recovery” presents a holistic overview of road effects on desert tortoises across the range of the species while highlighting specific examples of best practices and problematic implementation, interviews with agency representatives, and presentation of relevant issues. This film was funded by the Clark County Desert Conservation Program and can be viewed at: https://vimeo.com/526980854/9da53c724f

Mojave desert tortoise on road near Jean, Nevada. The tortoise is a dead, freeze dried individual supplied by USFWS for demonstration purposes. Credit: Marcel Huijser

CAPSTONE WORKSHOP

INTRODUCTION

Mojave desert tortoise (MDT), a federally listed threatened species, occurs across portions of Nevada, California, Utah, and Arizona. MDT populations continue to decline across their range, where over 60,000 kilometers of major roads have been constructed, permanently fragmenting their habitat. These roads are sources of direct and indirect impacts to MDT through road mortality, habitat loss, habitat degradation, and loss of connectivity across the landscape. Roads and associated infrastructure also provide roosting/nesting and other subsidies, such as trash and water resources, which attract ravens and other predators and serve as the introduction point for many invasive species, further reducing habitat quality and available nutrition and increasing fire risk.

While the United States Fish and Wildlife Service (USFWS) has identified reducing road impacts on MDT as a top priority recovery action across their range, there are many challenges that are currently standing in the way of implementing the recommended actions, such as installing tortoise fencing and providing safe crossing opportunities to reconnect fragmented populations. Management of MDT, especially when it comes to transportation infrastructure, consists of complex jurisdictional frameworks and requires coordination across multiple levels of state and federal transportation, wildlife, natural resource, and land management agencies. Lack of communication and coordination, conflicting agency missions and priorities, technical and administrative issues, and expense are often obstacles to implementing effective mitigation strategies for MDT.

To address these issues and develop ideas for technical solutions, best management practices, and other recommendations that could be consistently implemented across the range of MDT, the USFWS and the Center for Large Landscape Conservation (CLLC) partnered to develop and co-host the Mojave Desert Tortoise Transportation Ecology Workshop, held virtually March 22, 23, and 26, 2021. The following workshop summary provides an overview of the key elements of the workshop and identifies next steps for implementation of effective mitigation strategies across the MDT range.

WORKSHOP OBJECTIVES

- Build baseline knowledge around key wildlife and transportation issues, focused on issues and concerns in MDT habitat.
- Identify and prioritize challenges and opportunities as they relate to MDT recovery and transportation infrastructure.
- Launch a Task Force and outline a set of related workshop products that will carry this conversation forward.

A road lined with short fencing to prevent the threatened species Mojave desert tortoise from crossing.

Day 1: Monday, March 22, 2021

Day 1 focused on effects of transportation infrastructure on tortoise survival and recovery, and the roles and responsibilities of the various agencies and stakeholder groups in implementing recovery actions regarding transportation infrastructure. Overall, 128 participants joined the workshop on Monday representing a diverse interdisciplinary audience of state and federal transportation, wildlife, natural resource, and land management agencies, counties, non-governmental organizations, and academic institutions. The workshop was led and moderated by Shawn Johnson, Managing Director of the Center for Natural Resources & Environmental Policy at the University of Montana, and an expert in Natural Resource Conflict Resolution.

LEADERSHIP PERSPECTIVES

After the welcome, introduction, and brief overview of pre-workshop activities, the day began with a Leadership Perspectives Panel, where various state and federal leadership voices shared their perspectives on the need and opportunity this workshop presents and their goals for what they hope the workshop will achieve. The leadership panel consisted of:

- **Michael Senn**: Deputy Assistant Regional Director, Ecological Services Division, U.S. Fish & Wildlife Service California-Great Basin Region
- **Roy Averill-Murray**: Desert Tortoise Recovery Coordinator, U.S. Fish and Wildlife Service
- **Amy Fesnock Parker**: Wildlife Lead, CA Bureau of Land Management State Office, Sacramento
- **Dan Buford**: Ecologist, Federal Highway Administration Headquarters
- **Joshua Fife**: Biology Team Lead, Environmental Planning, Arizona Department of Transportation
- **Scott Quinnell**: Branch Chief, Environmental Stewardship & Monitoring, California Department of Transportation
- **My-Linh Nguyen**: Chief, Environmental Division, Nevada Department of Transportation
- **Matt Flores**: Habitat Biologist, Water Development Program, Nevada Department of Wildlife
- **Matt Howard**: Natural Resource Manager, Utah Department of Transportation

Michael Senn, Deputy Assistant Regional Director of the Ecological Services Division, U.S. Fish & Wildlife Service California-Great Basin Region, expressed enthusiasm regarding accomplishments for MDT recovery of the past five years, while acknowledging that challenges inherent with 60,000 km of roads still exist. He discussed how roads produce dead zones, loss of habitat, corridor for predators (ravens, etc.), and vectors of diseases, while decreased connectivity may lead to reproduction and genetic issues. Challenges also include the costs for constructing and maintaining fences and culverts, invasive species, climate change issues, etc. Moving forward will require collaboration and agency partnerships to develop new and innovative ways to come up with solutions. The call to action to improve MDT recovery is the need to work together!

Roy Averill-Murray, Desert Tortoise Recovery Coordinator, U.S. Fish and Wildlife Service, reviewed the objectives of Desert Tortoise Recovery Office:

1. Coordinate recovery, research, and monitoring activities
2. Provide a scientific basis for decision-making
3. Assess short- and long-term benefits of recovery actions
4. Provide information and synthesis in a timely manner and useful format
5. Facilitate communication of progress toward, and maintain an open dialogue regarding, desert tortoise recovery goals.

Even after 30 years of attention to improve MDT recovery, a negative population trend still exists and needs to be addressed if the MDT has a chance for survival and recovery. Road mortality is a major threat to recovery of this species and unfenced highways could lead to virtual extirpation of MDT populations. The installation of tortoise exclusion fencing is increasing but far from meeting the extent necessary for achieving recovery goals. Modeling has identified stretches of unfenced road where fencing would provide the best recovery for the money and found that fencing the top 16 priority areas would reclaim about 54,000 acres of tortoise habitat located in “dead zones” adjacent to major roads. As dead zones are addressed there is also the need to increase population connectivity to eliminate the isolation of the tortoise population. Roy hopes that this workshop will build baseline knowledge to identify challenges/opportunities for practical recommendation and that all agencies will work together to rebuild tortoise populations.

Warning sign for Mojave desert tortoise (*Gopherus agassizii*), Joshua Tree National Park, California. Credit: Marcel Huijser

Amy Fesnock Parker, Wildlife Lead, CA BLM State Office, Sacramento, discussed that BLM plays a key role to MDT recovery since about 70% of the habitat is public while the remaining land is either private or Department of Defense. This workshop should provide a solid foundation of issues relating to tortoise decline, effects of vehicle strikes, and how to create an effective path forward. Agencies must collaborate to develop and implement policies to find avenues to complete fencing across the landscape; one agency alone will not be effective.

Dan Buford, Ecologist with the Federal Highway Administration Headquarters, reviewed the role of the Federal Highway Administration in compliance with Congressional mandated Endangered Species Act for the recovery of the MDT. Dan stressed the need for ongoing mandates and for an interdisciplinary approach to overcome the challenges facing MDT recovery. Although every agency has a specific mission, collaboration among agencies is required to alleviate the challenges.

Joshua Fife, Biology Team Lead for Environmental Planning, Arizona Department of Transportation, reviewed several federal transportation projects and maintenance work on Arizona highways. The first project discussed was the work completed on Interstate 15 in the far northwest corner of Arizona that received fencing and a bridge reconstruction. While replacing the bridge, the agency worked with contractors to ensure that the protocols and guidelines were followed for handling MDTs, fencing installation, construction of bridge crossings, and providing awareness education/training to the contractors. A second project discussed included the South Mountain Freeway – 43,194 linear feet of fencing, three multiuse crossings, and two small animal crossings to help with connectivity. Joshua stressed the importance of education awareness for all contractors working in an area with MDT.

Scott Quinnell, Branch Chief for Environmental Stewardship & Monitoring, California Department of Transportation, presented an overview of this agency and their programmatic approaches to enhance MDT recovery when working with contractors and maintenance to ensure recovery of the species. The problems with rock slope design and connectivity, which is for essential for MDT survival, was addressed.

My-Linh Nguyen, Chief for the Environmental Division, Nevada Department of Transportation, discussed past projects of fencing and how they are working to evaluate the efficiency of programs including specific guidelines, protocol, and requirements to comply with the ESA and help with the MDT recovery. She is looking forward to sharing concerns, learning from others, and working with other agencies.

Matt Flores, Southern Region Supervising Wildlife Diversity Biologist, Water Development Program, stated that MDT is a state protected and priority species for Nevada and they are working with permitting procedures, small restoration projects, and technical review for projects.

Matt Howard, Natural Resource Manager for Utah Department of Transportation, stated that although Utah has a smaller range for MDT, their problems arise from the area's rapid development. The agency is working proactively to design projects that address flooding that washes out fences, tortoise handling when they come into construction sites, and other issues.

Culvert with tortoise fencing and open median on divided highway, US Hwy 95 near Indian Springs, Nevada.

UNDERSTANDING KEY ISSUES AND CHALLENGES

A series of presentations provided baseline information to workshop participants on MDT status and issues specific to transportation infrastructure. The first presentation was the documentary film "The Road to Recovery," created through a partnership between USFWS, CLLC, Clark County Desert Conservation Program, the Western Transportation Institute – Montana State University (WTI), and University of Nevada - Las Vegas (UNLV) film department. Two UNLV film students, Ahmad Abushamma and Isabelle Link, along with partners from USFWS, CLLC, and WTI, travelled across the MDT range and interviewed diverse stakeholders involved in MDT recovery. This documentary provided a high-level overview of MDT road issues and challenges for implementing mitigation.

The next presentation was by Nicholas Maya, a graduate student from the University of Montana's Natural Resource Conflict Resolution program. Prior to the Workshop, the planning team initiated a series of informational webinars covering MDT transportation ecology issues. Nicholas presented the key highlights from that webinar series and the topics covered included:

- Overview and importance of connectivity
- Collection, analysis, and interpretation of road mortality data to inform and prioritize management and recovery
- MDT fencing design, specifications, cost, and installation issues.
- Endangered Species Act
- Road effects on desert tortoise and alternative approaches to reducing desert tortoise mortality
- Inter-agency regulatory issues: Section 7, implementation of conservation measures, and mitigation
- Transportation infrastructure and habitat connectivity for MDT

Full summaries of the presentations can be found in Appendix C

To wrap up the Monday morning session Marcel Huijser, PhD, Senior Research Ecologist at the Western Transportation Institute's Road Ecology Program, provided a "virtual field trip" for participants based on the site visits conducted during the filming of "The Road to Recovery" documentary. His presentation covered the technical, ecological, design, implementation, and maintenance challenges encountered when mitigating roads for MDT, as well as policy and administrative challenges impeding implementation. Topics included MDT life history characteristics, fencing and culvert designs, hydrological issues, construction and maintenance challenges, research questions, interagency coordination, state and federal policy, and funding.

IDENTIFYING KEY CHALLENGES AND OPPORTUNITIES BY SECTOR

After lunch on Monday, the group engaged in a short question and answer session and discussed new projects, fencing issues, raven management, and collaboration efforts. Workshop participants were divided into two main cohorts based on their sector, categorized as either Natural Resource or Transportation focused. During the first session each sector was divided into four small breakout groups of 10 participants or fewer. Each small group was asked to discuss key challenges they face when implementing recovery actions for MDT, and to come up with a list of the top 3-5 challenges they face within their respective agencies. During the second session, participants were divided into two larger groups by sector and asked to report out on the smaller group discussions from the previous session. Then, each sector was asked to prioritize the top 3-5 challenges they face in implementing effective road mitigation strategies for MDT. The responses from each sector were recorded and used to inform the topics of discussion for the following day.

Culvert primarily for hydrology, but also for Mojave desert tortoise, blocked by tumbleweeds, I-15 near Barstow, California.

Day 2: Tuesday, March 23, 2021

The participants on Tuesday represented a diverse, interdisciplinary audience of state and federal transportation, wildlife, natural resource, and land management agencies, counties, non-governmental organizations, and academic institutions. They began the day as one large group reflecting on important takeaways from Day 1. Examples of topics raised included: necessity of interagency collaboration, design, urgency, limiting raven perching/nesting opportunities and subsidies, interagency teamwork, etc. Next, the sectors were asked to report out on the key challenges they identified during the breakout sessions.

Report Out: Priority List of Issues and Challenges By Sector

The morning session began with a report out on the top priority issues and challenges each sector identified through the breakout discussions on Monday afternoon. The report out from the two sectors is summarized below.

Wildlife Sector Priority Issues/Challenges:

1. Funding: Installation, maintenance, monitoring, potential need for an endowment fund for transportation mitigation projects.

2. Maintenance: Who pays for it? Who monitors and is responsible? Can other stakeholders outside of the States' transportation departments contribute?

3. Interagency coordination, collaboration, communication: Need for formal commitments/memorandums of understanding (MOUs)/agreements, as well as cooperative agreements.

4. Need for range-wide best management practices (BMPs) to cover prioritization, implementation, design, maintenance, and monitoring of transportation mitigation projects.

Transportation Sector Priority Issues/Challenges:

1. Interagency cooperation and communication: need for improvement both within and between agencies.

2. Regulatory compliance issues: lack of consistency between federal and state requirements; lack of consistent management techniques across the range (such as California Department of Fish and Wildlife (CDFW) land compensation issues).

3. Design/maintenance issues: challenges with hydrological considerations for both culverts and fencing, lack of flexibility in approved designs and materials, lack of capacity/resources to address maintenance issues in a timely manner.

4. Funding: construction, maintenance, land acquisition, etc.- discrepancy between available funding for upfront construction costs vs. long-term maintenance; balance between federal vs. state funding; high costs and ineffective management outcomes associated with CDFW compensation requirements.

After the report outs, the participants were split into small breakout groups, but this time the groups were interdisciplinary, with representatives from both the transportation and natural resource sectors in each group. Based on the main themes that emerged through the discussions on the first day, the groups moved through a series of five thematic discussions, each with a dedicated subject-matter expert acting as facilitator and dedicated notetakers. By working in diverse teams on one priority issue at a time, small groups explored and documented their emerging ideas and solutions to the major challenges identified through the exercise from Day 1.

Riprap in front of culverts to reduce erosion, but the boulders are a dangerous barrier to Mojave desert tortoise, I-11, near Boulder City, Nevada. Credit: Marcel Huijser

Fence for Mojave desert tortoise (*Gopherus agassizii*) but passable by bighorn sheep, US Hwy 93 near Overton, Nevada.

EMERGING IDEAS AND SOLUTIONS

Working in interdisciplinary teams, breakout groups rotated through each thematic discussion topic with facilitators and notetakers permanently assigned to a specific discussion topic. The goal was to have an additive conversation that really focused in on clarity, meaningful solutions, and implementation of the challenges identified by both sectors. The discussion topics included:

1. Interagency and Transboundary Communication and Collaboration
   Kerry Holcomb (facilitator) and Nicholas Maya (notetaker)

2. Policy and Regulatory Compliance Issues
   Rob Ament (facilitator) and Braden Hance (notetaker)

3. Technical Issues: Fencing, Culverts, Maintenance, Predator Management, Invasive Species
   Marcel Huijser (facilitator) and Marta Brocki (notetaker)

4. Funding for Prioritization, Implementation, Maintenance, and Monitoring
   Angela Volpe (facilitator) and Liz Fairbank (notetaker)

5. Consistency of Management Across the Range - BMPs for Prioritization, Implementation, Maintenance, and Monitoring/Adaptive Management
   Flo Deffner (facilitator) and Meg Desmond (notetaker)

Report Out: Emerging Ideas and Solutions

Each notetaker/facilitator team recorded and shared the key ideas and solutions that emerged around their issue. The key takeaways from the five areas are summarized below.

1. Interagency and Transboundary Communication and Collaboration

- Important to define role, responsibility, and commitment at the beginning of projects for everyone to understand their agency or organization's role, responsibility, and commitment over the life of the project. Need to set clear practical expectations for both short- and long-term maintenance and management of projects. Formal agreements and/or Memorandums of Understanding (MOUs) could be helpful.

- Funding was listed as a critical issue, primarily when funding originates for both construction and maintenance of fencing.

- Interagency communication is difficult. Need more frequent and transparent communication both within and between agencies and organizations.

- Need for agreement and consistent expectations from state and federal agencies. Specifically, need to get CDFW and USFWS on the same page about DT recovery actions such as land compensation. Also, need for clearer translocation guidance and less red tape.

- Need for a process to incorporate third parties into projects. They could serve as a fiduciary or take on some of the monitoring and maintenance activities associated with culverts and fencing that state DOTs may struggle to find capacity to complete in a timely manner.

Credit: Elizabeth Fairbank

Mojave desert tortoise.
Credit: Flo Deffner

2. Policy and Regulatory Compliance Issues

- Inconsistent regulations exist across the range for MDT transportation mitigation resulting in policy conflicts, which often preclude installation of fencing where it is most needed. In California, CDFW requires land acquisitions to compensate for habitat lost when fencing is installed, however the right-of-way area that is fenced out does not provide suitable habitat and purchasing and managing land to replace the “lost habitat” is extremely expensive, especially in addition to the cost of fencing. Current availability of high quality habitat parcels is scarce, and most parcels purchased are low quality habitat or not located within strategic conservation areas, generally providing little benefit to MDT recovery. This is a huge impediment to the implementation of roadside fencing and is not an effective or efficient use of limited resources when it comes to MDT recovery.

- Need for cooperative agreements and a more collaborative approach. Stakeholders need to come together to develop policies and processes for a shared stewardship framework so that the responsibilities of mitigating transportation infrastructure for MDT do not fall on any one agency.

- Need for more flexible and context-specific designs for MDT fencing. Currently the USFWS-approved design may not work in all areas due to hydrological issues or hard substrates that do not allow for a dig barrier (the part of the fencing that goes below the surface). More flexibility in approved fencing designs could greatly improve implementation in areas where it may currently be too difficult or expensive to install fencing given the current parameters.

- Currently, DOTs have a hard time being able to retrofit culverts to improve passage for MDT and reduce maintenance issues due to hydraulic issues and collection of debris within culverts. Retrofitting or constructing culverts as mitigation should be a net positive and DOTs should not be penalized for doing so.

Crushed Mojave desert tortoise on road.
Credit: Flo Deffner

3. Technical Issues: Fencing, Culverts, Maintenance, Predator Management, Invasive Species

- **Fencing —** Erosion, sedimentation, and blowouts during storm events are the primary threats to fencing integrity, and lack of monitoring and maintenance decreases the efficacy of the fencing in reducing MDT mortality. Problems with installation create gaps between fences and culverts and many may need to be retrofitted. DOT maintenance staff lack capacity to carry out monitoring and repairs, but there is currently no process in place for these activities to be carried out by other groups. This could be better managed as a separate activity leveraging capacity and resources from other agencies or organizations. Maintenance and monitoring activities need to be recognized and indicated as a priority during the permitting process. Issues with attaching tortoise fencing to existing right-of-way fencing need to be resolved.

- **Culverts —** Currently, most culverts are built to serve a dual purpose - providing a hydrological function as well as the connectivity function for movement of MDT. Features of culverts that enhance hydrological function can be an impediment to their use by tortoises, so there is tension between these functions. Upsizing culverts to disperse water can decrease erosion issues while also making them more passable by tortoise. Upsizing has potential to address resilience metrics and accommodate larger volumes of water. There is an opportunity to leverage the resilience issue to facilitate implementation.

- **Design —** Currently there is a lack of sufficient data to inform design solutions and encourage agencies to implement novel approaches to facilitate an iterative trial-and-error process learning from projects. Need for a mechanism to share information across the MDT range from maintenance staff, inspectors, researchers, and citizen scientists.

Billboards, transmission lines, and other structures near transportation infrastructure provide ravens and other avian predators with perching and nesting opportunities. Credit: Flo Deffner

- **Predation —** Raven presence along roads, especially due to human subsidies in terms of food (trash and roadkill) and nesting/perching subsidies associated with transportation infrastructure, is a huge threat to juvenile MDT. Need to develop measures to reduce subsidies and keep ravens from nesting along transportation corridors. May be a need to reduce raven populations in general, but this is also problematic from a management perspective.

- **Invasive Species —** Invasives affect forage quality and increase fire risk. Tumbleweeds clog culverts, making them impassable by MDT. Is there an opportunity for transportation authorities to issue contracts for habitat restoration activities, and management of invasive weeds? Again, maintenance and monitoring could be completed by third parties, but there is currently no framework for this type of shared stewardship approach.

4. Funding for Prioritization, Implementation, Maintenance, and Monitoring

- Need better interagency communication early on during project scoping. Often biological consultation and management actions are identified years after a project has been scoped/budgeted by the DOT and there isn't enough money earmarked for the recommended actions.

- Clear roles and responsibilities for who pays for installation and completes maintenance of fencing at the start of projects. Often up-front funding for construction is available through federal transportation programs, but funding for long-term maintenance falls solely on state DOT budgets. Need mechanism for third party contributions of both funding and capacity. Endowment fund for maintenance?

- Need upper-level management buy-in on MDT recovery actions and how funding will be allocated for projects in both the short and long term. Coordination among agencies must occur to be successful in MDT recovery.

- **Need a solid priority action list with buy-in across states and across agencies!** This priority list should include a range of actions including fencing installation, culvert construction or retrofitting, predator management, invasive species management, maintenance, and monitoring across the range or at least statewide. Population augmentation should be prioritized following fencing installation and restoration of connectivity.

- Need for policy change by CDFW to address land compensation issues. This money could instead be directed toward management actions (such as construction, maintenance, and monitoring of fencing and culverts) that could have a much bigger impact on MDT recovery.

- Translocation monitoring is cost-prohibitive. There needs to be more manageable policies to ensure successful translocations especially for small numbers of individuals.

5. Consistency of Management Across the Range - BMPs for Prioritization, Implementation, Maintenance, and Monitoring/Adaptive Management

   Currently a standardized approach to mitigating transportation infrastructure for MDT is lacking. Without a set of BMPs that are clear and consistent across the range, states will continue to take a fragmented approach.

- Habitat restoration may need more flexible time frames than currently given.

- Need to come up with priority areas and actions and provide guidance on BMPs for prioritization, design options, database, implementation, monitoring, and maintenance for MDT recovery actions related to transportation infrastructure.

- Need a platform to share BMPs and lessons learned so that adaptive management techniques can be developed and implemented consistently.

- Raven management must be addressed.

- A programmatic approach is needed to prioritize and implement the most effective and efficient mitigation measures in the most important areas for MDT.

After the report out, time was given to reflect on the day's activities and information. Examples of the reflections shared included the following topics:

- How do we take today's information and move forward?

- A platform for sharing information is extremely needed.

- What should the makeup of Task Force look like?

- What are the best outcome measures for reporting, especially when reporting to upper-level management?

- How do we creatively use advanced technology (cameras, drones) to increase capacity to monitor fencing and culverts, especially to identify maintenance needs in a timely manner?

Desert tortoise crossing a road in Death Valley National Park

Day 3: Friday, March 26, 2021

The final day of the workshop was dedicated to discussing and launching an interdisciplinary Task Force to take all of the discussions from the workshop and carry them forward into actions to improve the implementation of mitigation measures to reduce MDT road mortality and improve habitat connectivity across transportation infrastructure. Overall, 88 participants joined the workshop on Friday, representing a diverse interdisciplinary audience of state and federal transportation, wildlife, natural resource, and land management agencies, counties, non-governmental organizations, and academic institutions.

Day 3 started with the group reflecting on the question “What from the workshop is giving you hope about the road ahead?” Some examples of these topics included:

- New relationships and partnerships that are forming
- The willingness for collaboration that is becoming apparent
- The communication of new ideas to advance our goals
- The sense of urgency to move forward
- The voice of many is so much stronger than voice of one
- Finding mechanisms to ensure efficiency and consistency across the range of agencies and states; creating joint funding mechanisms for larger scale mitigation projects to improve outcome measures; inspection and maintenance will always be an issue and needs to be recognized; new approaches for sharing ideas and experiences and collect data regarding the problems; developing and facilitating a cooperative agreement and prioritizing road segments.

THE ROAD AHEAD: MOJAVE DESERT TORTOISE TRANSPORTATION ECOLOGY TASK FORCE

TASK FORCE FRAMEWORK, ROLES, AND RESPONSIBILITIES

Flo Deffner gave suggestions for a basic framework for a Desert Tortoise Transportation Ecology Task Force that included goals, three basic components that may be addressed, and what time commitment and technical guidance needed for the Task Force.

The goals of the Task Force should include:

- An interdisciplinary approach to problem solving
- A platform to share professional expertise
- Develop better working relationships and build trust between stakeholders
- Promote creativity and outside-of-the-box solutions
- Develop guidelines and technical solutions to be implemented range-wide
- Assist with resolution of policy issues and conflicts

Three tasks/components proposed for the Task Force development:

1. Technical solutions and design options may include: fencing, other exclusion barrier options, culverts, minimizing maintenance needs (durability, cost efficiency), and effective conservation measures. To be effective the Task Force needs to represent a diversity of jurisdictions, agencies, organizations, and disciplines. There will need to be representation from the following groups for all three components:

    - Federal Highway Administration
    - USFWS
    - State DOT representatives from NV, CA, UT, and AZ. There must be engineers, biologists, ecologists, hydrologists, and maintenance staff included
    - State wildlife/natural resource agency staff from NV, CA, UT, and AZ
    - State and federal land management agency staff
    - Policy experts
    - NGO representatives including academic researchers, policy experts, and MDT conservation specialists

2. Policy issues and conflicts: This area should help facilitation of effective communication among agencies, assist with development of interagency cooperative agreements and MOUs, develop approaches to ensure consistent rangewide implementation of BMP and monitoring and funding. Organize an agency leadership oversight to help with policy issue and conflicts

3. Monitoring programs: What should we be monitoring? (examples: baseline conditions, effectiveness, durability, maintenance and workload burden and research studies)

LAUNCH AND NEXT STEPS

After sharing several creative ideas and the framework for developing a Task Force, workshop participants were split into groups to discuss the development of the Task Force and who needs to be involved, priorities, tasks, etc. The underlying question for the breakout groups was “How do we help to ensure that this task force can be as successful as possible, particularly what can we hope to accomplish by this time next year and what will it take to reach that success?” Conversations resulting from the last breakout session include the following ideas/recommendations for the Task Force:

- Stakeholders need to come together and open lines of communication
- Taking a more programmatic, broad, range-wide approach and having consistent management of projects
- Making sure there is a diverse group of people on the Task Force
- What do we already know and how do we best use that to build shared understanding?
- What are other research and information needs?

After this discussion, Shawn asked the group what information and resources should be available to the group and the following requests were discussed:

- All recent BO, PBO, BA, PBA, for CA, AZ, UT, and NV for MDT
- Updated USFWS Field Manual for MDT that includes surveying, construction, and operation
- Agreed upon possible conservation measures to choose from
- Recovery status of the MDT
- List of all technical solutions for fences, culverts, and other wildlife fences, monitoring, etc
- State of effects of weather (storm, temperature, wind), pollutants (i.e., Natural Occurring Asbestos), genetic variabilities, natural mortality, and predation on MDT life stages and population dynamics
- Examples of technical solutions that have been successfully implemented for other similar species, experimental design options that could be tested range-wide, relevant research publications, photos and data-sharing, and effective conservation measures
- Research reports, design specifications, dialogue between practitioners
- Message board to continue the workshop conversations or share information (Basecamp)

The next question for discussion was “How can new insights help everyone for your individual role: think about our work in a new context and how it will help you in your jobs, roles, and larger needs.” Reflections included:

- having a platform to share information
- scope of what is happening across the range
- similar challenges
- cooperative agreements
- translating conversations into action to benefit MDT
- how to handle the backlog in mitigation
- met with decision makers to move action items forward
- facilitate agency leadership summit
- dealing with NEPA and other regulations
- internal agency coordination
- design and implementation

To officially launch the Task Force, two presentations were given to introduce potential partners interested in providing capacity and expertise to this effort. Rob Ament from WTI presented first and discussed how USFWS – Refuges frequently works with WTI on transportation and wildlife issues, such as providing funding to allow road ecology researcher Marcel Huijser to work with the MDT project. WTI can offer technical or policy support to the Task Force. He also discussed a new smart phone app tool (ROADS - Roadkill Observation and Data System) to record observations of MDT (and other Mojave ecosystem species) roadkill as well as observations of live wildlife on or near roads. This tool can provide a standardized method of data collection among agencies, researchers, NGOs, and citizen scientists, and will assist the Task Force with data collection across the range. The Tortoise Group is currently using the ROaDS App with its Road Warriors program and has worked with CLLC to customize the data form to record other types of data, such as raven activity.

Renee Callahan, executive director of ARC (Animal Road Crossing) Solutions, introduced the Task Force to her organization, which is an interdisciplinary network whose mission is to promote solutions to improve human safety, wildlife mobility and landscape connectivity by fostering innovation in the placement, design and construction of wildlife crossings. ARC seeks to disseminate best practice information, promote innovation, and educate the public about transportation mitigation measures to reduce conflicts between roads and wildlife, and could provide critical expertise in overcoming policy and design challenges identified through the workshop. Renee offered ARC’s technical and policy expertise as a resource to the Task Force.

In conclusion, workshop participants shared their thoughts and top priorities for the Task Force including the following:

- forum for sharing information
- identify shared priorities to address specific challenges and solutions
- provide specific paths forward
- develop end products, including a workshop summary as well as a set of guidelines for effective implementation across the MDT range
- what metrics should be used to measure success of the Task Force?
- ideas to get upper management of agencies to buy in
- look at each agency perspective and culture and how to still reach our goals within that perspective
- need action plan, including principles and responsibilities within each agency and this can service as a basis for future cooperative agreements, funding, maintenance
- sense of urgency with this window of opportunity - how to capitalize on that energy to move forward
- increasing the information in Basecamp
- commit to working with agencies and developing long term coordination and partnerships
- commitment to creativity on solving challenges
- commitment to serve on the task force
- develop interagency advising committee
- pooling funds
- maintaining avenues to work together to meet the recovery needs for the MDT

At the end of the day workshop, 21 Task Force participants volunteered to be on the Task Force. The first meeting of the Task Force will occur in May 2021 and will begin to build the framework for addressing the challenges and opportunities identified through the Transportation Ecology Workshop.

APPENDIX A: WORKSHOP AGENDA

DESERT TORTOISE TRANSPORTATION ECOLOGY 3-DAY WORKSHOP

Monday, March 22nd
Tuesday, March 23rd
Friday, March 26th

Each Day:
10am - 12pm & 1pm - 3pm (PST)

Objectives:

- Build baseline knowledge around key wildlife and transportation issues, focused on issues and concerns in desert tortoise habitat
- Identify and prioritize challenges and opportunities as they relate to desert tortoise recovery and transportation infrastructure
- Launch a Task Force and set of related workshop products that will carry this conversation forward

Day 1: Monday, March 22, 2021

10:00 AM	**Welcome and Workshop Overview**
10:10 AM	**Leadership Perspectives** *Various state and federal leadership voices will share their perspectives on the need and opportunity this workshop presents and their goals for what they hope the workshop will achieve.*
11:00 AM	**Break**
11:10 AM	**Understanding Key Issues and Challenges** *A series of brief presentations will provide baseline information to inform workshop discussions.*
12:00 PM	**Lunch**

1:00 PM	**Facilitated Discussion: Key Issues and Challenges** *Opportunity for all participants to ask questions to deepen understanding of key issues and challenges before breaking into smaller groups*
1:30 PM	**Small Group Discussions on Key Issues and Challenges, Round 1** *Small group breakouts organized by focal area (transportation or wildlife) will explore – and begin to identify – key issues and concerns.* GOAL: Each small group will prioritize its top 3-5 issues.
2:00 PM	**Break**
2:10 PM	**Small Group Discussions on Key Issues and Challenges, Round 2** *Smaller groups will be consolidated into two breakout rooms – one for transportation and one for wildlife. Groups will be asked to combine and prioritize their lists of key issues and priorities.*
2:50 PM	**Summary of Day**
3:00 PM	**Adjourn for Day**

Day 2: Tuesday, March 23, 2021

10:00 AM	**Welcome and Overview of Day**
10:10 AM	**Report Out: Priority List of Issues and Challenges from Day 1 and Overview of World Café Discussion that will Follow**
10:30 AM	**Small Group Discussion on Emerging Ideas and Solutions, Round 1** *Working in diverse teams on one issue at a time, small groups will explore and document their emerging ideas/solutions. Note-takers will be assigned by issue and remain with that issue throughout the day, while small groups will advance through the five (5) discussion topics.*
11:00 AM	**Break**
11:05 AM	**Small Group Discussion on Emerging Ideas and Solutions, Round 2** *Small groups will advance to the 2nd discussion topic*
11:30 AM	**Small Group Discussion on Emerging Ideas and Solutions, Round 3** *Small groups will advance to the 3rd discussion topic*
12:00 PM	**Lunch**
1:00 PM	**Small Group Discussion on Emerging Ideas and Solutions, Round 4** *Small groups will advance to the 4th discussion topic*
1:30 PM	**Small Group Discussion on Emerging Ideas and Solutions, Round 5** *Small groups will advance to the 5th discussion topic*
2:00 PM	**Break**
2:10 PM	**Report Out on Emerging Ideas and Solutions** *Each note-taker/facilitator team will share the key ideas and solutions that emerged around their issue*
2:30 PM	**Facilitated Discussion** *Reflections and discussion on what has emerged through the small group discussions, including an opportunity to clarify elements of the emerging ideas/solutions, identify gaps, and consider capacity needs/ constraints, etc.*
2:50 PM	**Summary of Day**
3:00 PM	**Adjourn for Day**

Day 3: Friday, March 26, 2021

10:00 AM	**Welcome and Overview of Day**
10:10 AM	**Review List of Emerging Ideas/Solutions by Key Issue**
10:30 AM	**Introduce Task Force Implementation Framework** *Present an initial conceptual framework for a Task Force to carry this conversation forward*
11:00 AM	**Break**
11:05 AM	**Small Group Discussion on Task Force Roles and Responsibilities** *In small groups, discuss and provide feedback on the Task Force model, focused on strengthening the approach*
11:45 AM	**Report Out on Task Force Feedback** *Small groups will share their thoughts and ideas to strengthen/advance the Task Force to better ensure its success*
12:00 PM	**Lunch**
1:00 PM	**Identifying Additional Informational Needs/Priorities** *An online poll, followed by open discussion on information/research needs to further inform/advance this conversation.*
1:30 PM	**Bringing It All Together** *Discussion of how emerging solutions around roads can help facilitate desert tortoise recovery, focusing on both collective efforts and the individual work of specific partners and agencies*
2:00 PM	**Break**
2:10 PM	**Key Take-Aways and Individual Commitments** *Participants will be asked to share key take-aways and personal commitments moving forward.*
2:30 PM	**Formal Launch of the Task Force** *Announcement of the Task Force, including an initial charge and proposed membership*
2:50 PM	**Summary of Workshop / Next Steps**
3:00 PM	**Adjourn**

APPENDIX B: PRE-WORKSHOP PRACTITIONER SURVEY

CENTER for LARGE LANDSCAPE CONSERVATION

Desert Tortoise Workshop Survey Report

Photo courtesy of Flo Deffner

Prepared by

Angelina L. González-Aller, PhD

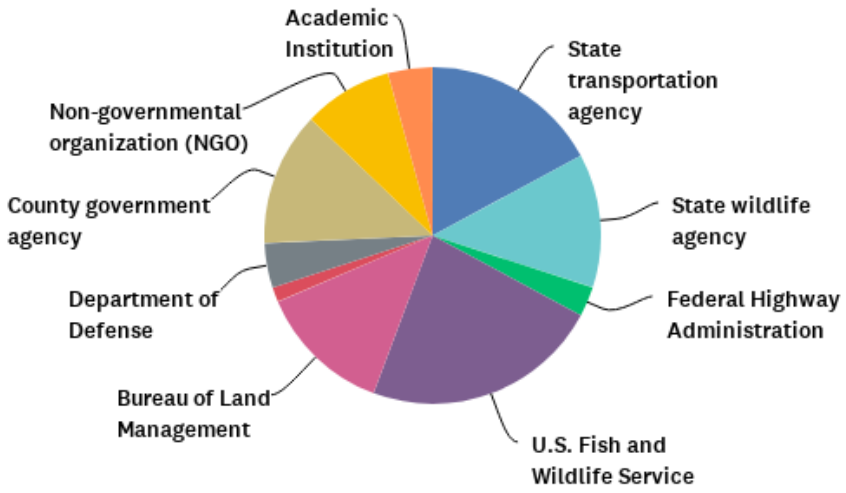
January 29, 2021

1.1 METHODOLOGY

In the fall of 2020, the Center for Large Landscape Conservation administered a survey on behalf of the Desert Tortoise Planning group. The purpose of the survey was to collect information on attitudes and priorities related to desert tortoise conservation for the purpose of informing the Desert Tortoise Workshop scheduled for March 22, 23, and 26, 2021. The Desert Tortoise Survey (DTS) was administered using SurveyMonkey. Invitations to participate in the survey were distributed via email to prospective participants identified by a member of the working group. A total of 209 individuals were contacted to participate in the survey and referral recruiting (snowball sampling) was encouraged. The survey was open from November 16th to December 7th, 2020, a total of 70 responses were collected of which 57 (81%) completed all questions of the survey and 13 were partially completed.

2 ORGANIZATION

2.1 ORGANIZATION (N=70)



Organization	Responses	Frequency
Transportation & Highways	14	20.00%
Fish and Wildlife	25	35.71%
Bureau of Land Management	9	12.86%
National Park Service	1	1.43%
Department of Defense	3	4.29%
County Government	9	12.86%
NGO	6	8.57%
Academic Institution	3	4.29%
N	70	--

*There were no respondents that selected “Federal Rail Administration” or “Tribal government or agency”.

2.1.1 Fish and Wildlife by Organization

Fish and Wildlife	Responses	Frequency
State wildlife agency	9	12.86%
U.S. Fish and Wildlife Service-Ecological Services	13	18.57%
U.S. Fish and Wildlife Service-Refuges	3	4.29%
Total	25	--

Within respondents categorized as Fish & Wildlife: 9 selected "State wildlife agency", 13 selected "U.S. Fish and Wildlife Service-Ecological Services", and 3 selected "U.S. Fish and Wildlife Service-Refuges".

2.1.2 Transportation & Highways by Organization

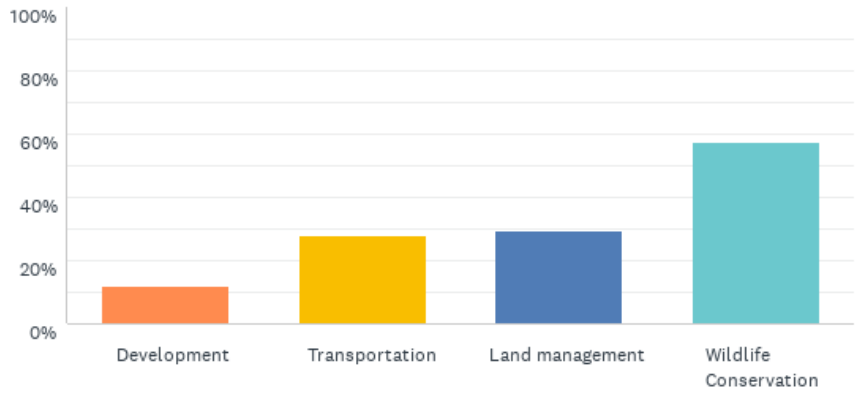
Transportation & Highways	Responses	Frequency
State transportation agency	12	17.14%
Federal Highway Administration	2	2.86%
Total	14	--

Within respondents categorized as Transportation, & Highways the majority 12 out of 14 work for a state transportation agency while 2 work for the Federal Highway Administration.

3 MISSION

Across all respondents, wildlife conservation is the most frequently selected organizational mission, with 57.35% of respondents selecting this option. As a result, the responses of this survey skew towards the attitudes and beliefs associated with the mission of wildlife conservation.

3.1 WHAT MOST CLOSELY DESCRIBES YOUR ORGANIZATION'S MISSION AS IT RELATES TO THE DESERT TORTOISE? (N=68)

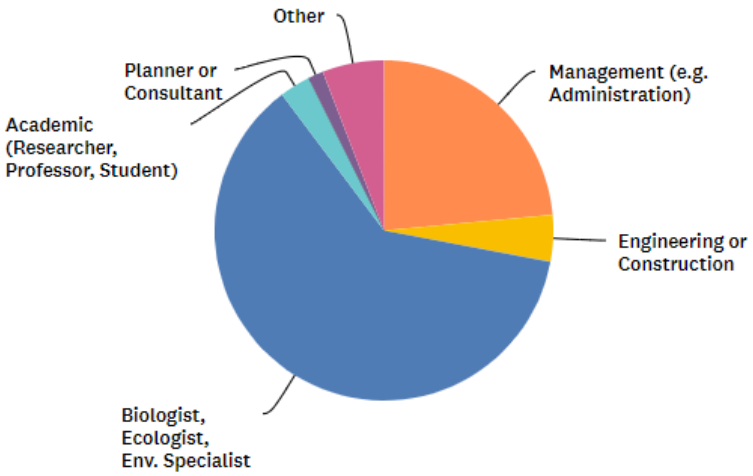


Organization Mission	Responses	Frequency
Development	8	11.76%
Transportation	19	27.94%
Land management	20	29.41
Wildlife Conservation	39	57.35%

*Respondents were not restricted to one category.

4 POSITION

4.1 WHAT MOST CLOSELY DESCRIBES YOUR POSITION? (N=68)



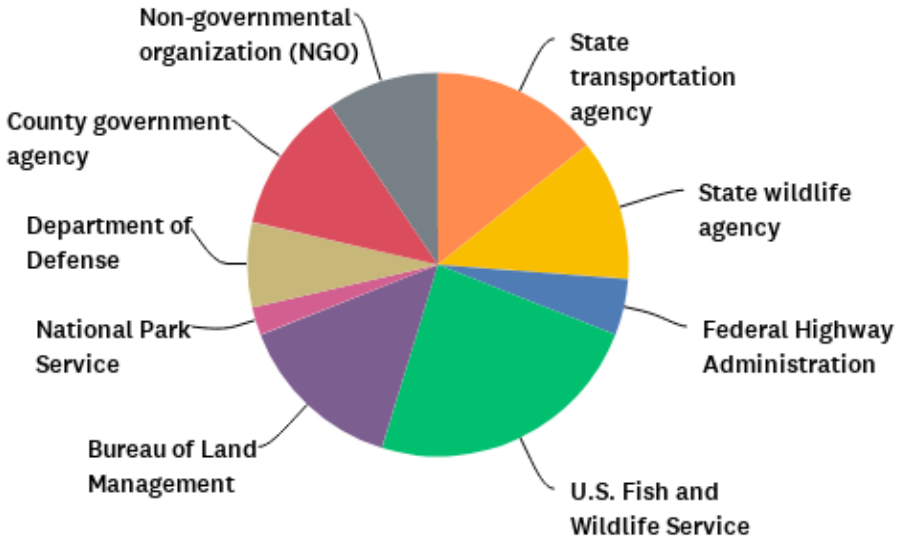
Category	Responses	Frequency
Planner or Consultant	1	1.47%
Academic (Researcher, Professor, Student)	2	2.94%
Engineering or Construction	3	4.41%
Other	4	5.88%
Management or Administration	16	23.53%
Biologist, Ecologist, Environmental Specialist	42	61.76%
N	68	--

*There were no respondents that selected “Maintenance or Operator”.

5 BEES & NON-BEES

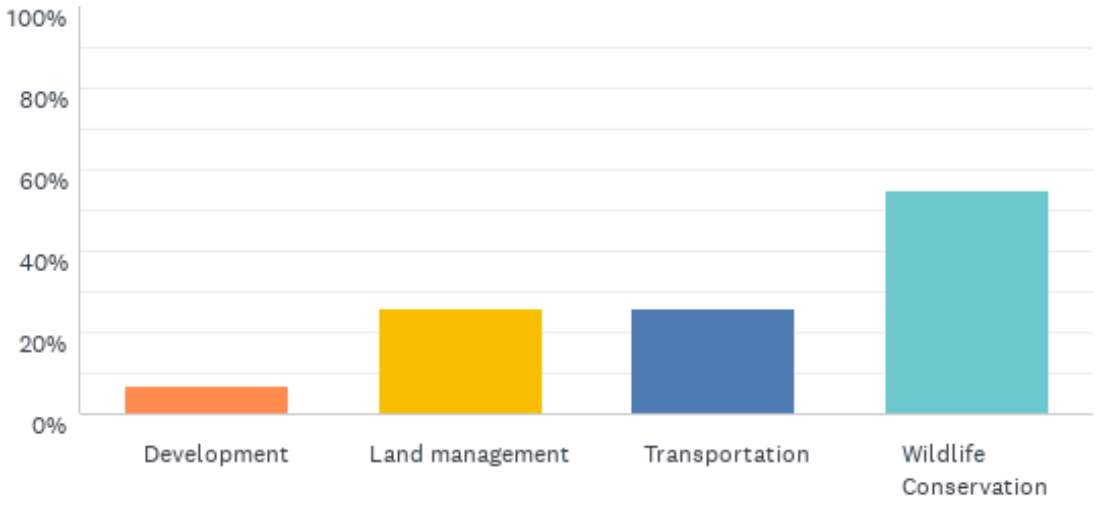
For the purpose of this analysis, comparisons in responses are drawn from the full population (all respondents) and two sub populations: those that identify as Biologists, Ecologists, or Environmental Specialists (BEES) and those who did not identify themselves as Biologists, Ecologists, or Environmental Specialists (non-BEES). Non-BEES include all respondents who selected: "Management/Administration", "Engineering/Construction"," Academic", "Planner or Consultant", or "Other" as their position. Out of the 68 respondents to this question, 42 selected "Biologist, Ecologist, or Environmental Specialist" leaving 26 respondents in the non-BEES category.

5.1 BIOLOGISTS, ECOLOGISTS, & ENVIRONMENTAL SPECIALISTS (BEES) BY ORGANIZATION (N=42)



Biologists, Ecologists, Environmental Specialists by Organization		
U.S. Fish and Wildlife Service- Refuges	1	2.38%
National Park Service	1	2.38%
Federal Highway Administration	2	4.76%
Department of Defense	3	7.14%
Non-governmental organization (NGO)	4	9.52%
State wildlife agency	5	11.9%
County government agency	5	11.9%
State transportation agency	6	14.29%
Bureau of Land Management	6	14.29%
U.S. Fish and Wildlife Service- Ecological Services	9	21.43%
Total	42	100%

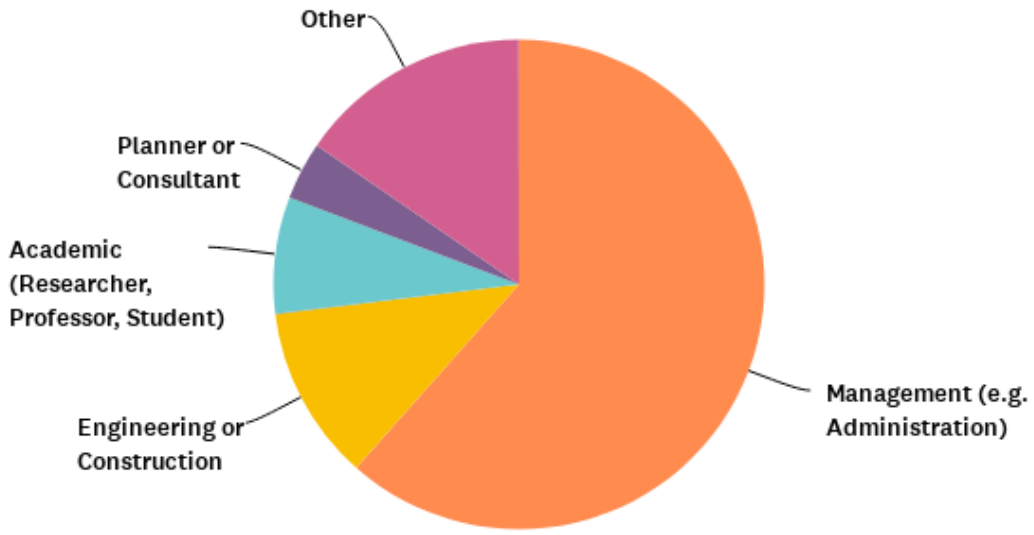
5.2 BEES: WHAT MOST CLOSELY DESCRIBES YOUR ORGANIZATION'S MISSION AS IT RELATES TO THE DESERT TORTOISE? (N=42)



Biologists, Ecologists, Environmental Specialists by Mission		
Development	3	7.14%
Land management	11	26.19%
Transportation	11	26.19%
Wildlife Conservation	23	54.76%

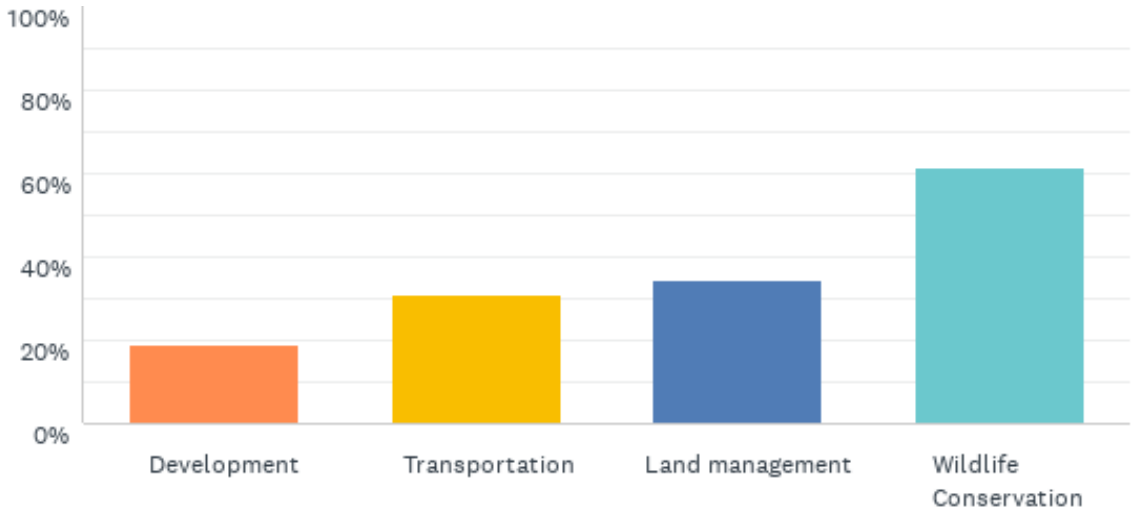
*Respondents were not restricted to one category.

5.3 NON-BEES: WHAT MOST CLOSELY DESCRIBES YOUR POSITION? (N=26)



Non-BEES by Position		
Planner or Consultant	1	3.85%
Academic (Researcher, Professor, Student)	2	7.69%
Engineering or Construction	3	11.54%
Other	4	15.38%
Management or Administration	16	61.54%
Total	26	100%

5.3.1 Non-BEES: What most closely describes your organization's mission as it relates to the desert tortoise? (N=26)



Non-BEES by Organizational Mission		
Development	5	19.23%
Transportation	8	30.77%
Land management	9	34.62%
Wildlife Conservation	16	61.54%

*Respondents were not restricted to one category.

6 ISSUES AND PRIORITIES

A strong majority of respondents, nearly 80%, report that they somewhat or strongly agree with the statement "Desert tortoise conservation and recovery is a priority for me". Support for this statement is stronger with BEES for whom 97.44% somewhat or strongly agree as compared to 83.33% for non-BEES. BEES report stronger agreement with "desert road mortality is a significant issue" as compared to those who are not BEES. 62.59% of non-BEES agree that road mortality is a significant issue as compared to 92.31% of BEES who somewhat agree or strongly agree. A large percentage of non-BEES, 20.85%, selected "neither agree nor disagree" with the statement "Desert tortoise road mortality is a significant issue", suggesting that outreach and education may be an effective way to improve understanding on the significance of road mortality for desert tortoises. In regard to willingness to work with others, both BEES and non-BEES report a willingness to work with others. There are small variations between BEES and non-BEES with 35.90% of BEES selecting "somewhat agree" and 58.97% selecting "strongly agree" as compared to non-BEES who selected "somewhat agree" at 12.5% and "strongly agree at 79.17%. However, when the agreement categories are collapsed (table 6.2) these variations are less impressive, suggesting there are not widespread differences in willingness to work with others.

6.1 General Attitudes: Issues and Priorities- 5 point likert

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL
Desert tortoise conservation and recovery is priority for me.						
All Respondents	1.59% 1	3.17% 2	3.17% 2	12.70% 8	79.37% 50	100% 63
BEES	0.00% 0	2.56% 1	0.00% 0	15.38% 6	82.05% 32	100% 39
Non-BEES	4.17% 1	4.17% 1	8.33% 2	8.33% 2	75.00% 18	100 24
Desert tortoise road mortality is a significant issue.						
All Respondents	1.59% 1	4.76% 3	12.70% 8	15.87% 10	65.08% 41	100% 63
BEES	0.00% 0	0.00% 0	7.69% 3	17.95% 7	74.36% 29	100% 39
Non-BEES	4.17% 1	12.50% 3	20.83% 5	12.50% 3	50.00% 12	100% 24
I am willing to work with others to develop solutions for addressing adverse road effects on desert tortoise recovery.						
All Respondents	1.59% 1	1.59% 1	3.17% 2	26.98% 17	66.67% 42	100% 63
BEES	0.00% 0	2.56% 1	2.56% 1	35.90% 14	58.97% 23	100% 39
Non-BEES	4.17% 1	0.00% 0	4.17% 1	12.50% 3	79.17% 19	100% 24

6.2 General Attitudes: Issues and Priorities- Collapsed 3 point likert

	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	TOTAL
Desert tortoise conservation and recovery is priority for me.				
All Respondents	4.76% 3	3.17% 2	92.06% 58	100% 63
BEES	2.56% 1	0.00% 0	97.44% 38	100% 39
Non-BEES	8.33% 2	8.33% 2	83.33% 20	100 24
Desert tortoise road mortality is a significant issue.				
All Respondents	6.35% 4	12.70% 8	80.95% 51	100% 63
BEES	0.00% 0	7.69% 3	92.31% 36	100% 39
Non-BEES	16.67% 4	20.83% 5	62.59% 15	100% 24
I am willing to work with others to develop solutions for addressing adverse road effects on desert tortoise recovery.				
All Respondents	3.17% 2	3.17% 2	93.65% 59	100% 63
BEES	2.56% 1	2.56% 1	94.87% 37	100% 39
Non-BEES	4.17% 1	4.17% 1	91.67% 22	100% 24

7 KEY ISSUE DEFINITION

For respondents who identified themselves as a biologist, ecologist, or environmental specialist, there was not a significant difference between options, suggesting that all four issues are of relatively similar importance to those who are biologists, ecologists, or environmental specialists. For respondents who are non-BEES, road mortality followed by reduced connectivity are the largest concerns. Respondents who are non-BEES report less concern regarding habitat loss and reduced habitat quality as compared to biologists, ecologists and environmental specialists. Across all respondents (including BEES) most respondents (37.10%) identified road mortality, followed by reduced connectivity (32.36%) as the biggest concern.

Out of the following options, what do you feel is the biggest concern regarding road effects on desert tortoise recovery?					
	Habitat Loss	Road Mortality	Reduced Connectivity	Reduced Habitat Quality	Total
All Respondents	17.74% 11	37.10% 23	32.36% 20	12.9% 8	100% 62
Non-BEES	13.04% 3	47.83% 11	39.13% 9	0.00% 0	100% 23
BEES	20.00% 8	30.00% 12	30.00% 12	20.00% 8	100% 40

8 COSTS, PRIORITIES & RESOURCES

Across all measures, respondents express concerns about costs. While the majority of respondents either somewhat or strongly agree that implementation of conservation measures is an appropriate use of time and resources, nearly 70% of all respondents report that costs are a significant consideration. Biologists are slightly more in favor of using qualified biologists than non-biologists, ecologists, and environmental specialists, but the differences are not significant.

8.1 ATTITUDES: COSTS, PRIORITIES & RESOURCES- 5 POINT LIKERT

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL
Costs to your organization are an important consideration when it comes to protecting desert tortoises from road mortality and ensuring connectivity.						
All Respondents	4.76% 3	4.76% 3	20.63% 13	25.40% 16	44.44% 28	100% 63
BEES	5.13% 2	5.13% 2	23.08% 9	28.21% 11	38.46% 15	100% 39
Non-BEES	4.17% 1	4.17% 1	16.67% 4	20.83% 5	54.17% 13	100% 24
Implementation of conservation measures and mitigation for the desert tortoise is an appropriate use of time and resources for your organization.						
All Respondents	1.59% 1	3.17% 2	7.94% 5	28.57% 18	58.73% 37	100% 63
BEES	0.00% 0	2.56% 1	10.26% 4	28.21% 11	58.97% 23	100% 39
Non-BEES	4.17% 1	4.17% 1	4.17% 1	29.17% 7	58.33% 14	100% 24
The use of qualified biologists and monitors during transportation projects is an appropriate use of time and resources.						
All Respondents	0.00% 0	14.29% 9	15.87% 10	22.22% 14	47.62% 30	100% 63
BEES	0.00% 0	10.26% 4	12.82% 5	25.64% 10	51.28% 20	100% 39
Non-BEES	0.00% 0	20.83% 5	20.83% 5	16.67% 4	41.67% 10	100% 24
Implementation of measures to protect and restore desert tortoise habitat during transportation projects is a high priority.						
All Respondents	6.35% 4	4.76% 3	6.35% 4	25.40% 16	57.14% 36	100% 63
BEES	7.69% 3	5.13% 2	5.13% 2	20.51% 8	61.54% 24	100% 39
Non-BEES	4.17% 1	4.17% 1	8.33% 2	33.33% 8	50.00% 12	100% 24

8.2 Attitudes: Costs, Priorities & Resources- Collapsed 3 Point Likert

	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	TOTAL
Costs to your organization are an important consideration when it comes to protecting desert tortoises from road mortality and ensuring connectivity.				
All Respondents	9.52% 6	20.63% 13	69.84% 44	100% 63
BEES	10.26% 4	23.08% 9	66.67% 26	100% 39
Non-BEES	8.33% 2	16.67% 4	75.00% 18	100% 24
Implementation of conservation measures and mitigation for the desert tortoise is an appropriate use of time and resources for your organization.				
All Respondents	4.76% 3	7.94% 5	87.30% 55	100% 63
BEES	2.56% 1	10.26% 4	87.18% 34	100% 39
Non-BEES	8.33% 2	4.17% 1	87.50% 21	100% 24
The use of qualified biologists and monitors during transportation projects is an appropriate use of time and resources.				
All Respondents	14.29% 9	15.87% 10	69.84% 44	100% 63
BEES	10.26% 4	12.82% 5	76.92% 30	100% 39
Non-BEES	20.83% 5	20.83% 5	58.33% 14	100% 24
Implementation of measures to protect and restore desert tortoise habitat during transportation projects is a high priority.				
All Respondents	11.11% 7	6.35% 4	82.54% 52	100% 63
BEES	12.82% 5	5.13% 2	82.05% 32	100% 39
Non-BEES	8.33% 2	8.33% 2	83.33% 20	100% 24

9 CONSERVATION ACTIONS

Non-BEES report greater agreement that exclusion fencing is the best way to prevent road mortality as opposed to BEES. 79.49% of BEES report somewhat or strongly agreeing that exclusion fencing is the best way to prevent road mortality as opposed to 91.3% of Non-BEES who either somewhat or strongly agree with the statement. 19.95% of BEES selected "neither agree nor disagree" with the statement, indicating that a sizable portion of biologists, ecologists, and environmental specialists are uncertain about the efficacy of exclusion fencing as it relates to road mortality. BEES are slightly more in support of the statement "fencing negatively affects the natural viewscape" than non-BEES, and non-BEES are less supportive of the statement "ensuring connectivity…is essential for survival" with 86.96% of non-BEES reporting they somewhat or strongly agree as opposed to 94.87% reported by BEES.

9.1 ATTITUDES: CONSERVATION ACTIONS 5 POINT LIKERT

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL
Installation of desert tortoise exclusion fencing is the best way to prevent road mortality.						
All Respondents	1.61% 1	3.23% 2	11.29% 7	22.58% 14	61.29% 38	100% 62
BEES	0.00% 0	2.56% 1	17.95% 7	20.51% 8	58.97% 23	100% 39
Non-BEES	4.35% 1	4.35% 1	0.00% 0	26.09% 6	65.22% 15	100% 23
The installation of desert tortoise fencing and culvert crossing structures may also benefit other wildlife species.						
All Respondents	3.23% 2	1.61% 1	0.00% 0	29.03% 18	66.13% 41	100% 62
BEES	0.00% 0	2.56% 1	0.00% 0	35.90% 14	61.54% 24	100% 39
Non-BEES	8.70% 2	0.00% 0	0.00% 0	17.39% 4	73.91% 17	100% 23
Desert tortoise fencing negatively affects the natural viewscape.						
All Respondents	29.03% 18	24.19% 15	24.19% 15	19.35% 12	3.23% 2	100% 62
BEES	23.08% 9	20.51% 8	30.77% 12	25.64% 10	0.00% 0	100% 39
Non-BEES	39.13% 9	30.43% 7	13.04% 3	8.70% 2	8.70% 2	100% 23
Ensuring connectivity of desert tortoise populations is necessary for the survival of this species.						
All Respondents	4.84% 3	0.00% 0	3.23% 2	30.65% 19	61.29% 38	100% 62
BEES	2.56% 1	0.00% 0	2.56% 1	33.00% 13	61.54% 24	100% 39
Non-BEES	8.70% 2	0.00% 0	4.35% 1	26.09% 6	60.87% 14	100.% 23

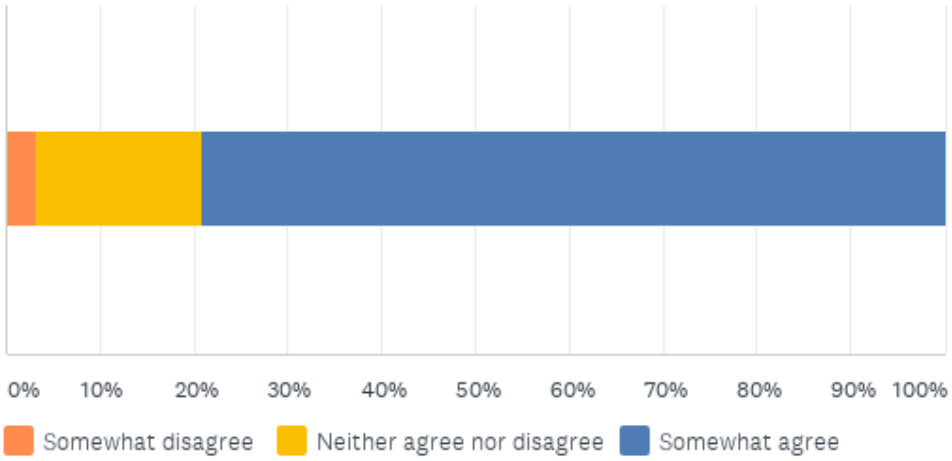
9.2 ATTITUDES: CONSERVATION ACTIONS- COLLAPSED 3 POINT LIKERT

	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	TOTAL
Installation of desert tortoise exclusion fencing is the best way to prevent road mortality.				
All Respondents	4.84% 3	11.29% 7	83.87% 52	100% 62
BEES	2.56% 1	17.95% 7	79.49% 31	100% 39
Non-BEES	8.70% 2	0.00% 0	91.30% 21	100% 23
The installation of desert tortoise fencing and culvert crossing structures may also benefit other wildlife species.				
All Respondents	4.84% 3	0.00% 0	95.16% 59	100% 62
BEES	2.56% 1	0.00% 0	97.44% 38	100% 39
Non-BEES	8.70% 2	0.00% 0	91.30% 21	100% 23
Desert tortoise fencing negatively affects the natural viewscape.				
All Respondents	53.23% 33	24.19% 15	22.58% 14	100% 62
BEES	43.59% 17	30.77% 12	25.64% 10	100% 39
Non-BEES	69.57% 16	13.04% 3	17.39% 4	100% 23
Ensuring connectivity of desert tortoise populations is necessary for the survival of this species.				
All Respondents	4.84% 3	3.23% 2	91.94% 57	100% 62
BEES	2.56% 1	2.56% 1	94.87% 37	100% 39
Non-BEES	8.70% 2	4.35% 1	86.96% 20	100% 23

10 TRANSLOCATION

Out of all respondents, 3.23% (2) selected either somewhat or strongly disagree, 17.74% (11) selected neither agree nor disagree, and 79.03% (49) selected either somewhat or strongly agree. Across all respondents, sizeable percentages of respondents selected "neither agree nor disagree" indicating that there may be uncertainty about the efficacy of translocation as it related to genetic connectivity.

10.1 WHERE CONNECTIVITY CANNOT BE RESTORED, TRANSLOCATION OF DESERT TORTOISES IS NECESSARY TO ENSURE GENETIC CONNECTIVITY-ALL RESPONDENTS (N=62)



10.2 ATTITUDES: TRANSLOCATION

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL
Where connectivity cannot be restored, translocation of desert tortoises is necessary to ensure genetic connectivity.						
All Respondents	1.61% 1	1.61% 1	17.74% 11	58.06% 36	20.97% 13	100% 62
BEES	0.00% 0	2.50% 1	17.95% 7	66.67% 26	15.35% 6	100.00% 39
Non-BEES	4.35% 1	4.35% 1	17.39% 4	43.48% 10	30.43% 7	100% 23

11 SURVIVAL AND RECOVERY

For ranked ordering, each respondent is provided the option to select and order three priorities. Three points are recorded for their first selection, two for their second, and one for their third. In total, 6 points are available to each respondent, however not all respondents select three options. Out of a total of 348 points for 58 respondents, a total of 343 points were recorded. The top four responses are reported as scoring for these options were comparably high. See tables 16.1-16.3 for full results.

11.1 ATTITUDES: SURVIVAL AND RECOVERY PRIORITIES

	1	2	3	4
In your opinion, what are the top three priorities for the survival and recovery of desert tortoise?				
All Respondents (N=58)	Habitat Restoration	Reduce road mortality through installation of tortoise exclusion fencing	Predator Control	Management of invasive plant specials
BEES (N=37)	Habitat Restoration	Reduce road mortality through installation of tortoise exclusion fencing	Predator Control	Ensure connectivity among tortoise populations
Non-BEES (N=21)	Habitat Restoration	Reduce road mortality through installation of tortoise exclusion fencing	Predator Control	Management of invasive plant specials

12 FENCING

Across all respondents, maintenance and installation costs are the most significant obstacles to the installation of exclusion fencing. BEES place installation costs above maintenance costs while non-BEES place maintenance above installation costs. When taken in sum, maintenance emerges as the primary obstacle, though the difference between maintenance and installation is not significant suggesting these two issues are of similar importance. Tables 16.4- 16.6 report full results.

12.1 FENCING OBSTACLES

	1	2	3	4
What are the three most significant obstacles to the installation of desert tortoise exclusion fencing?				
All Respondents (N= 58)	Maintenance	Installation Cost	Topography	Functionality
BEES (N= 21)	Installation Cost	Maintenance	Topography	Inflexible Design Specifications
Non-BEES (N=37)	Maintenance	Installation Cost	Topography	Functionality

13 CULVERTS

In regard to culvert structures, BEES and Non-BEES depart significantly in their rank ordering of obstacles. BEES place construction costs followed by maintenance and dual-purpose design as the most challenging issues while Non-BEES place dual purpose design as their primary obstacle followed by construction costs and retrofitting. BEES also rank functionality and retrofitting in similar importance with a score of 29 for each of those options. Scored responses are available in tables 16.7-16.9

13.1 CULVERT OBSTACLES

	1	2	3	4
What are the three most challenging issues regarding culvert structures for the purpose of desert tortoise movement?				
All Respondents (N=57)	Construction Costs	Dual Purpose Design	Maintenance	Retrofitting
BEES (N=36)	Construction Costs	Maintenance	Dual Purpose Design	Functionality Retrofitting
Non-BEES (N=21)	Dual Purpose Design	Construction Costs	Retrofitting	Maintenance

14 COLLABORATION & COMMUNICATION

There is mixed agreement between BEES and Non-BEES on issues of collaboration and communication. Non-BEES are slightly more in disagreement with "coordination and communication resulting in clear guidance and implementation" than BEES. BEES are less in agreement with the statement "communication… results in consistent implementation among agencies" than Non-BEES suggesting that BEES may be more sensitive to variations in the implementation of conservation measures than Non-BEES (43.25% of BEES agree with the statement as opposed to 61.9% of Non-BEES who agree).

14.1 ATTITUDES: COLLABORATION & COMMUNICATION- 5 POINT LIKERT

	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER AGREE NOR DISAGREE	SOMEWHAT AGREE	STRONGLY AGREE	TOTAL
Staff from other agencies listen to my concerns and care about my thoughts regarding desert tortoise conservation measures.						
All Respondents	5.17% 3	3.45% 2	29.31% 17	48.28% 28	13.79% 8	100% 58
BEES	0.00% 0	5.41% 2	32.43% 12	51.35% 19	10.81% 4	100% 37
Non-BEES	14.29% 3	0.00% 0	23.81% 5	42.86% 9	19.05% 4	100% 21
Interagency disagreement regarding desert tortoise conservation measures negatively affects your ability to carry out your agency's mission and purpose.						
All Respondents	6.90% 4	6.90% 4	37.93% 22	24.14% 14	24.14% 14	100% 58
BEES	5.41% 2	8.11% 3	35.14% 13	29.73% 11	21.62% 8	100% 37
Non-BEES	9.52% 2	4.76% 1	42.86% 9	14.29% 3	28.57% 6	100% 21
Communication regarding desert tortoise conservation measures results in consistent implementation among agencies.						
All Respondents	8.62% 5	13.79% 8	27.59% 16	31.03% 18	18.97% 11	100% 58
BEES	2.70% 1	21.62% 8	32.43% 12	21.62% 8	21.62% 8	100% 37
Non-BEES	19.05% 4	0.00% 0	19.05% 4	47.62% 10	14.29% 3	100% 21
Coordination and communication among agencies regarding the installation of desert tortoise fencing and culverts usually results in clear guidance and consistent implementation.						
All Respondents	5.17% 3	22.41% 13	31.03% 18	25.86% 15	15.52% 9	100% 58
BEES	0.00% 0	24.32% 9	32.43% 12	27.03% 10	16.22% 6	100% 37
Non-BEES	14.29% 3	19.05% 4	28.57% 6	23.81% 5	14.29% 3	100% 21

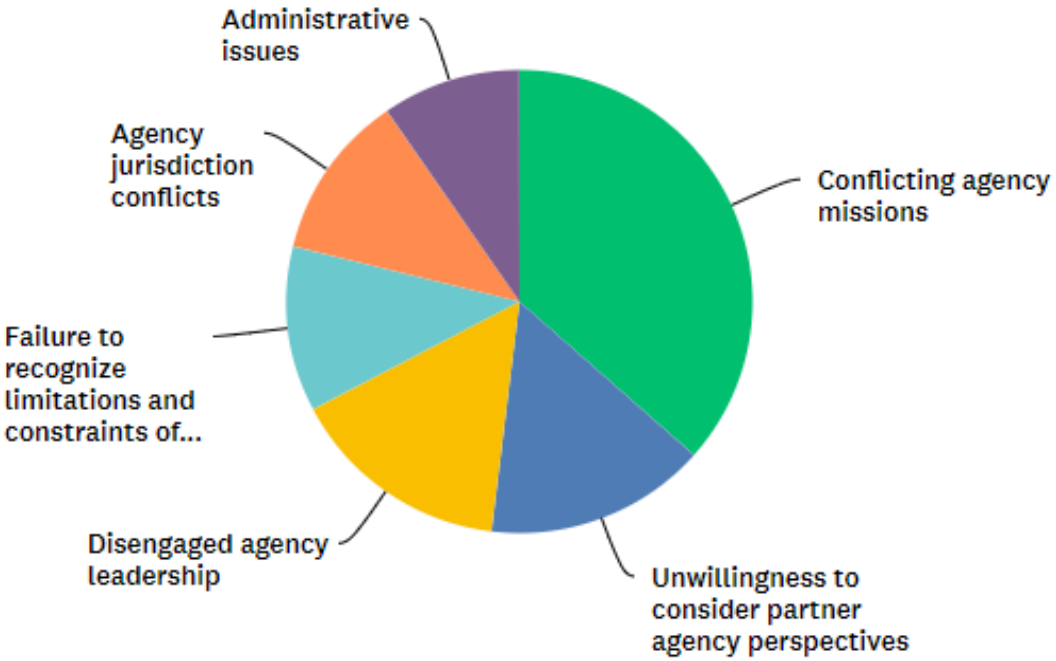
14.2 Attitudes: Collaboration & Communication- Collapsed 3 point likert

	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	TOTAL
Staff from other agencies listen to my concerns and care about my thoughts regarding desert tortoise conservation measures.				
All Respondents	8.62% 5	29.31% 17	62.07% 36	100% 58
BEES	5.41% 2	32.43% 12	62.16% 23	100% 37
Non-BEES	14.29% 3	23.81% 5	61.90% 13	100% 21
Interagency disagreement regarding desert tortoise conservation measures negatively affects your ability to carry out your agency's mission and purpose.				
All Respondents	13.79% 8	37.93% 22	48.28% 28	100% 58
BEES	13.51% 5	35.14% 13	51.35% 19	100% 37
Non-BEES	14.29% 3	42.86% 9	42.86% 9	100% 21
Communication regarding desert tortoise conservation measures results in consistent implementation among agencies.				
All Respondents	22.41% 13	27.59% 16	50.00% 29	100% 58
BEES	24.32% 9	32.43% 12	43.24% 16	100% 37
Non-BEES	19.05% 4	19.05% 4	61.90% 13	100% 21
Coordination and communication among agencies regarding the installation of desert tortoise fencing and culverts usually results in clear guidance and consistent implementation.				
All Respondents	27.59% 16	31.03% 18	41.38% 24	100% 58
BEES	24.32% 9	32.43% 12	43.24% 16	100% 37
Non-BEES	33.33% 7	28.57% 6	38.10% 8	100% 21

15 KEY ISSUE: INTERAGENCY COMMUNICATION

Respondents were asked to select the single largest obstacle to effective interagency communication. For respondents who identified as BEES, conflicting agency missions is the biggest obstacle to effective interagency communication (32.35%) followed by unwillingness to consider agency perspectives (17.65%) and failure to recognize limitations and constraints (14.71% and disengaged agency leadership (14.71%). For Non-BEES the ordering is slightly different but conflicting agency missions remains the biggest obstacle (38.10%) followed by disengaged agency leadership (14.29%).

15.1 OUT OF THE FOLLOWING OPTIONS WHICH DO YOU FEEL IS THE BIGGEST OBSTACLE TO EFFECTIVE INTERAGENCY COMMUNICATION? (N=55)



15.2 OUT OF THE FOLLOWING OPTIONS WHICH DO YOU FEEL IS THE BIGGEST OBSTACLE TO EFFECTIVE INTERAGENCY COMMUNICATION?

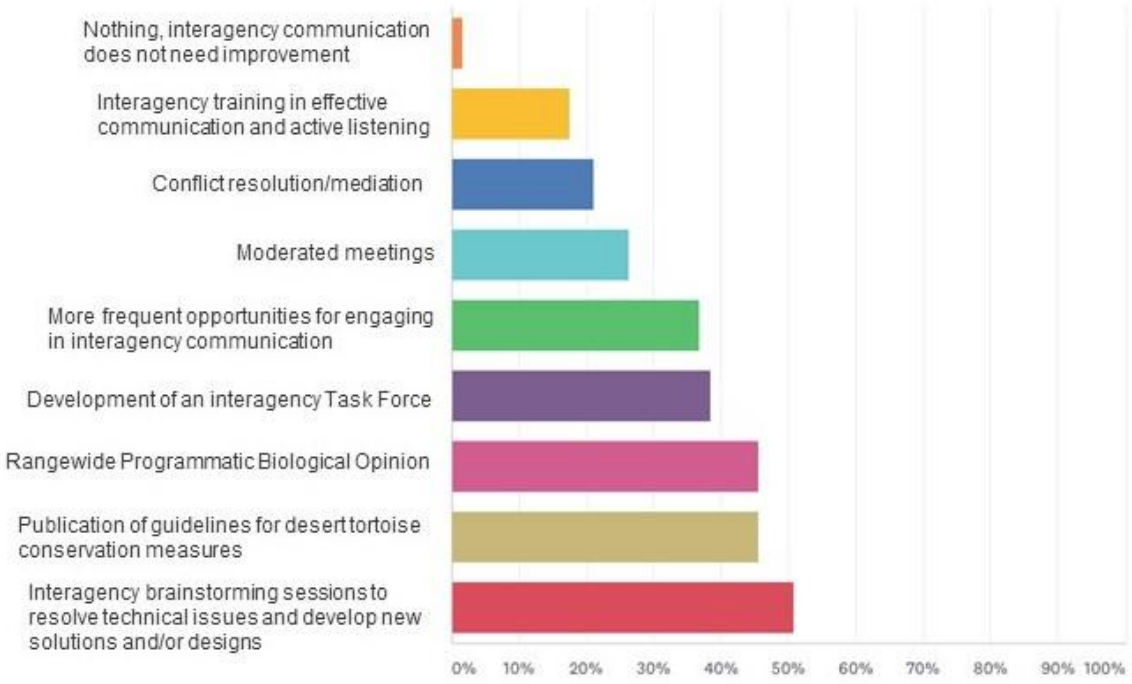
	All Respondents (N=55)	BEES (N=34)	Non-BEES (N=21)
Conflicting Agency Missions	34.55% 19	32.35% 11	38.10% 8
Unwillingness to consider partner agency perspectives	14.55% 8	17.65% 6	9.52% 2
Disengaged agency leadership	14.55% 8	14.71% 5	14.29% 3
Failure to recognize limitations and constraints of partner agencies	10.91% 6	14.71% 5	4.76% 1
Agency jurisdiction conflicts	10.91% 6	11.76% 4	9.52% 2
Administrative issues	9.09% 5	8.82% 3	9.52% 2
Personality conflicts	5.45% 3	0.00% 0	14.29% 3
Total	100% 55	100% 34	100% 21

*no respondents selected “legal liability issues”

15.3 IMPROVING INTERAGENCY COMMUNICATION

Respondents were able to select as many responses as they opted to. In general, there is strong agreement that a number of measures could improve interagency communication. Only one respondent reported that interagency communication does not need improvement. Across all respondents, there is strong support for interagency brainstorming sessions (50.88%), publication of guidelines (45.61%), rangewide programmatic biological opinion (45.61%), development of an interagency task force (38.6%), and more frequent opportunities for interagency communication (38.6%).

15.4 WHAT CAN BE DONE TO IMPROVE INTERAGENCY COMMUNICATION? CHECK ALL THAT APPLY.



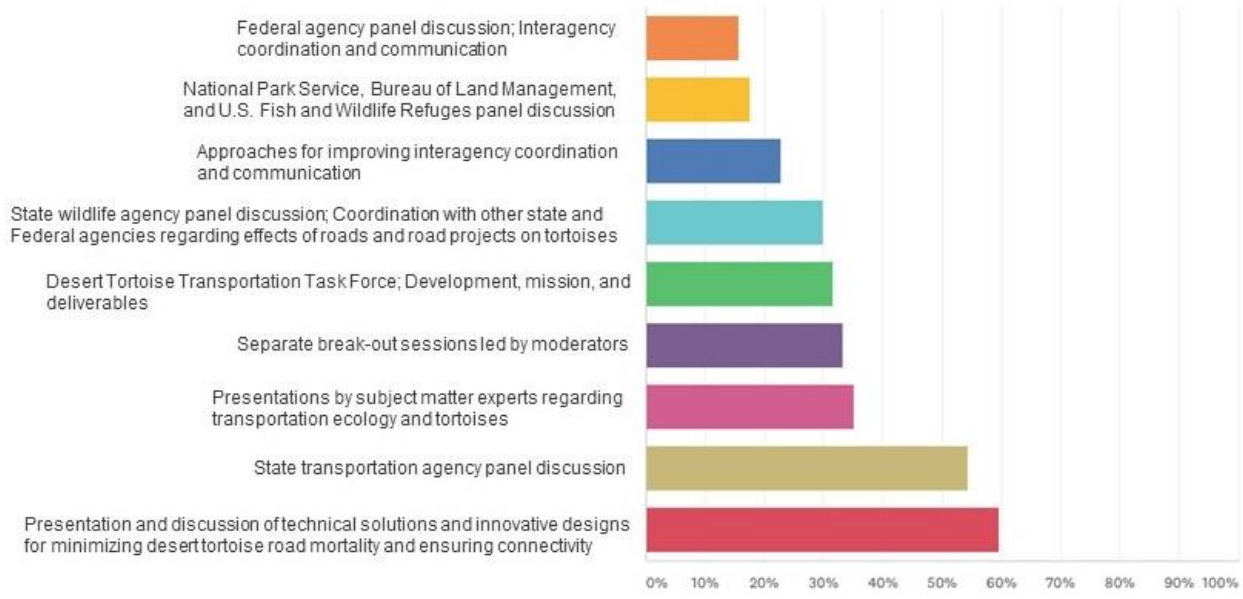
15.5 What Can Be Done To Improve Interagency Communication? Check All That Apply.

	All Respondents (N=57)	BEES (N=36)	Non-BEES (N=21)
Nothing, interagency communication does not need improvement	1.75% 1	0.00% 0	4.76% 1
Interagency training in effective communication and active listening	17.54% 10	16.67% 6	19.05% 4
Conflict resolution/mediation	21.05% 12	22.22% 8	19.05% 4
Moderated meetings	26.32% 15	30.56% 11	19.05% 4
Development of an interagency Task Force to address desert tortoise transportation ecology issues	38.60% 22	33.33% 12	47.62% 10
More frequent opportunities for engaging in interagency communication	36.84% 21	36.11% 13	42.86% 9
Interagency brainstorming sessions to resolve technical issues and develop new solutions and/or designs	50.88% 29	44.44% 16	61.90% 13
Publication of guidelines for desert tortoise conservation measures, fencing installation, culvert designs, etc.	45.61% 26	44.44% 16	47.62% 10
Rangewide Programmatic Biological Opinion to ensure consistent implementation of conservation measures throughout the range of the desert tortoise	45.61% 26	47.22% 17	42.86% 9

16 WORKSHOP PREFERENCES

The top two voted options for the March workshop are: presentation/discussion of technical solutions for minimizing road mortality and ensuring connectivity (59.65%) followed by state transportation agency panel discussion (54.39%). Options for presentations by subject matter experts (35.09%), break-out sessions (33.33%), Task Force development (31.58%), and state wildlife agency panel discussion (29.82%) received similar levels of support.

16.1 WHAT CONTENT WOULD BE MOST HELPFUL FOR YOU AT THE MARCH WORKSHOP? PLEASE SELECT YOUR TOP THREE CHOICES. (N=57)



16.2 What content would be most helpful for you at the March workshop? Please select your top three choices.

Federal agency panel discussion; Interagency coordination and communication.	15.79%	9
National Park Service, Bureau of Land Management, and U.S. Fish and Wildlife Refuges panel discussion; Tortoise road mortality issues and visitor experience.	17.54%	10
Approaches for improving interagency coordination and communication.	22.81%	13
State wildlife agency panel discussion; Coordination with other state and Federal agencies regarding effects of roads and road projects on tortoises.	29.82%	17
Desert Tortoise Transportation Task Force; Development, mission, and deliverables.	31.58%	18
Separate break-out sessions led by moderators to identify challenges and obstacles for transportation agencies and natural resource agencies, followed by a full group sharing session.	33.33%	19
Presentations by subject matter experts regarding transportation ecology and tortoises.	35.09%	20
State transportation agency panel discussion; Issues regarding implementation of desert tortoise conservation measures, including fencing and culverts.	54.39%	31
Presentation and discussion of technical solutions and innovative designs for minimizing desert tortoise road mortality and ensuring connectivity	59.65%	34

17 APPENDICES

17.1 RANK ORDERING: SURVIVAL AND RECOVERY – ALL RESPONDENTS (N=58)

In your opinion, what are the top three priorities for the survival and recovery of desert tortoise?

Response options	Weighted Score
Habitat restoration	74
Reduce road mortality through installation of tortoise exclusion fencing	71
Predator (e.g. ravens and coyotes) control and decreased predator access to human subsidies	68
Management of non-native invasive plant species to reduce risk of fire in tortoise habitat	52
Ensure connectivity among tortoise populations	50
Law enforcement to address illegal off-highway vehicle use in protected areas	20
Translocation to another suitable habitat	7
Signing along authorized OHV routes	1
Total	343

17.2 Rank Ordering: Survival and Recovery – BEES (N=37)

In your opinion, what are the top three priorities for the survival and recovery of desert tortoise?	
Response options	**Weighted Score**
Habitat restoration	47
Reduce road mortality through installation of tortoise exclusion fencing	46
Predator (e.g. ravens and coyotes) control and decreased predator access to human subsidies.	44
Ensure connectivity among tortoise populations	38
Management of non-native invasive plant species to reduce risk of fire in tortoise habitat	29
Law enforcement to address illegal off-highway vehicle use in protected areas	10
Translocation to another suitable habitat	1
Signing along authorized OHV routes	1
Total	216

17.3 Rank Ordering: Survival and Recovery – Non-BEES (N=21)

In your opinion, what are the top three priorities for the survival and recovery of desert tortoise? (Non-BEES n=21)	
Response options	**Weighted Score**
Habitat restoration	27
Reduce road mortality through installation of tortoise exclusion fencing	25
Predator (e.g. ravens and coyotes) control and decreased predator access to human subsidies	24
Management of non-native invasive plant species to reduce risk of fire in tortoise habitat	23
Ensure connectivity among tortoise populations	12
Law enforcement to address illegal off-highway vehicle use in protected areas	10
Translocation to another suitable habitat	5
Signing along authorized OHV routes	0
Total	126

17.4 Rank Ordering: Fencing- All Respondents (N= 57)

What are the three most significant obstacles to the installation of desert tortoise exclusion fencing?

Response options	Weighted Score
Maintenance	115
Installation Cost	115
Topography	52
Functionality	23
Inflexible Design Specification	20
Durability of the fence material	17
Appearance	2
Public Safety	2
Total	346

17.5 Rank Ordering: Fencing- BEES (N= 36)

What are the three most significant obstacles to the installation of desert tortoise exclusion fencing?

Response options	Weighted Score
Maintenance	74
Installation Cost	71
Topography	31
Inflexible Design Specification	12
Functionality	11
Durability of the fence material	8
Public Safety	2
Appearance	1
Total	210

17.6 Rank Ordering: Fencing- Non-BEES (N= 21)

What are the three most significant obstacles to the installation of desert tortoise exclusion fencing?

Response options	Weighted Score
Maintenance	44
Installation Cost	31
Topography	21
Functionality	12
Durability of the fence material	9
Inflexible Design Specification	8
Appearance	1
Public Safety	0
Total	126

17.7 Rank Ordering: Culverts- All Respondents (N= 57)

What are the three most challenging issues regarding culvert structures for the purpose of desert tortoise movement?

Response options	Weighted Score
Construction Costs	75
Dual Purpose Design	72
Maintenance	63
Retrofitting existing culverts for tortoise movement	51
Functionality	41
Openness factor and daylighting	21
Topography	9
Total	332

17.8 Rank Ordering: Culverts- BEES (N=36)

What are the three most challenging issues regarding culvert structures for the purpose of desert tortoise movement?

Response options	Weighted Score
Construction Costs	48
Maintenance	44
Dual Purpose Design	32
Retrofitting existing culverts for tortoise movement	29
Functionality	29
Openness factor and daylighting	20
Topography	7
Total	209

17.9 Rank Ordering: Culverts- Non-BEES (N=21)

What are the three most challenging issues regarding culvert structures for the purpose of desert tortoise movement?

Response options	Weighted Score
Dual Purpose Design	40
Construction Costs	27
Retrofitting existing culverts for tortoise movement	25
Maintenance	19
Functionality	12
Topography	2
Openness factor and daylighting	2
Total	127

APPENDIX C: SUMMARY OF WEBINAR SERIES PRESENTATIONS

Summary of MDT Transportation Ecology Webinar Series

Compiled by Nicholas Maya, Masters Candidate, University of Montana

Between October 2020 and February 2021, five preworkshop webinars were held via Webex. Each two-hour webinar averaged 70 to 100+ participants. The purpose of these webinars was to build a foundational understanding of the issues and concerns regarding desert tortoise conservation and recovery, especially as it concerns road mortality. In addition, the webinars facilitated group discussions and brainstorming among participants about issues and effects of transportation infrastructure on desert tortoises, improving interagency communication and collaboration, and developing technical solutions and best management practices. Each webinar covered a specific topic, with experts giving presentations. The topics of each webinar are listed below and organized in chronological order. The titles of presentations, names and affiliations of presenters, and key takeaways and lessons learned are also listed.

1. Collection, analysis, and interpretation of road mortality data to inform and prioritize management and recovery actions

Road mortality & connectivity: what does one tell us about the other – Fraser Shilling, Ph.D. (Professor, Co-Director Road Ecology Center, UC Davis)

Dr. Shilling began his presentation by defining connectivity, which he defined as an ecological property critical to maintaining wildlife populations and species. Connectivity is often represented by relative intactness, "linkages," and corridors. After defining connectivity, Dr. Shilling discussed the importance of connectivity, which he stated is essential for:

- Dispersal
- Foraging/predation
- Seasonal migration
- Reproduction
- Climate change adaptation
- Recolonization

These are important for each species and often lost in connectivity analysis. It is challenging to represent how connectivity is reflected and protected when looking at things like dispersal or foraging. Sometimes these mean the same things for species, and sometimes they are different, which makes connectivity complicated to predict. Dr. Shilling questioned whether or not we can even represent connectivity in GIS. A discussion on wildlife "linkages" followed with Dr. Shilling suggesting that linkages can be thought of as hypotheses until they can be tested. Linkages do not have any meaning in nature. In his evaluation of linkages, Dr. Shilling's findings suggest that linkages are, in fact, hypothetical and not an actual reflection of connectivity.

The presentation concluded with a discussion on mortality, which can cause population declines and functions as a barrier to movement. Lastly, road mortality mitigation can have both beneficial and unintended impacts.

Strategic management of road effects – Kerry Holcomb (Fish and Wildlife Biologist, USFWS)

Kerry began his presentation by talking about how roads take an unsustainable toll on Chelonians and are known to:

- Deplete populations
- Bias sex ratios
- Shift demographics
- Limit population size
- Alter behaviors
- Degrade habitats
- Cause fragmentation
- Subsidize and attract predators
- Increase the likelihood of collection

The USFWS has a particular design for fencing used to exclude tortoises from the road in desert tortoise habitat. While exclusion fencing has proven to be successful, the question is where to put these fences. Using the Recovery Importance Index (RII or “r”) can help predict where fencing optimally affects Mojave desert tortoise recovery. In addition, the Feasibility Index (RII) can help categorize the technical and logistical difficulty of installing desert tortoise exclusionary fencing.

According to Kerry, further research required includes:

- Completing the Mojave desert tortoise exclusionary fence census geodatabase
- Further refining the Feasibility Index to include hydrology and local roads that perforate the fence
- Gathering input from experts on Recovery Implementation Teams
- Testing DTEFIPI rankings
- Starting implementation

Using movement patterns to develop mitigation strategies to decrease road mortalities – Jeanette Perry (Ecological Environmental Monitoring, Mission Support and Test Services, LLC)

Jeanette discussed her most recent study in the presentation. The study site is located in the Nevada National Security Site, which is Department of Energy land. Over the course of the study, there were 500 road crossing events completed by desert tortoises. Road crossing events were highest between June and August for both males and females. According to Jeanette, the next steps of the study are to:

- Interpret results
- Open discussion on tortoise fencing
- Predictability of tortoise road crossings
- Educational awareness

Desert tortoise road observation data collection in Southern Nevada – Flo Deffner (Desert Tortoise Recovery Biologist, USFWS)

Flo's presentation began with a discussion on the Desert Tortoise Exclusion Fence Installation Prioritization Index (DTEFIPI), which selects segments for tortoise road mortality surveys. The data from surveys and collections can be used to "ground-truth" in the model and identify hotspots. When collecting road mortality data, the information reported includes:

- Date, time, weather
- Location: GPS coordinates or closest milepost
- Road type
- Approximate size
- Sex, if it can be determined
- Mortality, injured, or alive
- Carcass condition

Data collected from culvert studies along US 93 provides valuable information on the frequency of road encounters for tortoises and highlights that no fencing and culvert access leads to potential mortality. Some of the outstanding questions from the study include:

- Are we missing observations during road mortality surveys, and why?
- Can we use data from our culvert studies to calibrate road mortality estimates?
- Are animals more likely to approach roads where fencing and culverts have been installed?
- How can road mortality data and camera data be used to evaluate population effects?

The next steps of the study are:

- Data collection through the ROaDS app
- PVA modeling to evaluate rangewide population effects of road mortality and recovery
- Connectivity models: genetic & demographic
- Rangewide monitoring surveys

2. Desert tortoise fencing design & installation issues; alternative desert tortoise fencing designs to address topography, soil substrates, washes, and flooding

No formal presentation was given, but the discussion and brainstorming session was facilitated by Kerry Holcomb & Flo Deffner.

Discussions during the webinar included how roads take an unstainable toll on tortoise populations. Tortoises are a high-risk species for road mortality due to their life history characteristics, movement distance, and behavior. On average, there is 1 DT mortality per 3.2km (~2 miles), which equates to about 18,750/year rangewide. There are ~60,000km of major roads (does not include OHV routes) throughout the range of the desert tortoise. Roads also have synergistic effects, including raven predation, loss, and degradation of habitat, disease outbreaks, and climate change. Culvert study observations may be used to calibrate road encounter estimates and potential rangewide road mortality estimates in unfenced road segments. Flo provided information on the USFWS fence installation specifications, which are:

- 6ft T-posts
- Barbed wire
- Guide wire
- Hog rings
- 6” wide
- Galvanized metal
- 1” x 2” mesh
- 12” below ground
- 22”-24” above ground

Also highlighted during this webinar are the issues and benefits of exclusion fencing. Issues include:

- Expensive: $15,000-$25,000/mile
    — Funding scarce
- Durability of material
- Maintenance costs and work burden
- Technical specifications
- Topography
- Soil substrates
- Flood-prone areas
- Interagency administrative conflicts
- Land ownership and jurisdiction
- Visitor access and viewscape
- Tortoise fence pacing and overheating resulting in mortality

There are also administrative issues commonly encountered when installing permanent desert tortoise exclusion fencing, which are:

- Materials are expensive
- Multiple landowners/managers and jurisdictions
- Maintenance costs and labor
    - — Who is responsible?
    - — How do we come to MOUs?
- Coordination with multiple agencies complicated by competing agency missions
- Conflicting mitigation requirements among agencies
- How do we overcome administration issues?

Lastly, the benefits of Tortoise Exclusion Fencing include:

- Significant reduction in tortoise mortality
- Reduction in mortality for other species
- Conservation of overall biodiversity
- Reduced mammal-vehicle collisions

3. Road effects on desert tortoises and alternative approaches to reducing desert tortoise road mortality

Research to inform Caltrans best management practices for reptile and amphibian road crossings – Cheryl Brehme (USGS)

Cheryl's presentation included a discussion on the comparative risk assessment she performed. The assessment provided Caltrans and other agencies guidance to help prioritize mitigation efforts for amphibian and reptile species in California. It also helped to prioritize which species are at higher risks from negative road impacts. Through her comparative risk assessment, Cheryl concluded that:

- Desert tortoises ranked at a very high risk of negative road impacts compared to 165 other herpetofauna in CA (top 2% terrestrial).
- Many herpetofauna exhibit pacing and fence interaction behaviors when they see through a fence.
- Turnarounds were effective in changing the trajectory of many herpetofauna.
- Longer-term studies are needed for desert tortoises.
- An elevated road segment may be another option as a temporary or permanent crossing structure for DT.

Modeling the impacts of roads and mitigation efforts on the long-term viability of desert tortoise populations – Mark Peaden, Ph.D. (Assistant Professor, Rogers State University)

Dr. Peaden began his presentation by stating that desert tortoise populations continue to decline, that these causes are multifaceted, and that there is no single approach to recovering this species. There are various causes of desert tortoise mortality, but Dr. Peaden's research focuses on road mortality. One way to curb mortalities due to roads is the placement of exclusion fencing. Using GPS loggers, Dr. Peaden was able to capture the movement of individuals to identify to what extent tortoises interact with roads or fencing, locate key areas and timing of interactions, and identify the results of fence or road contact. In looking at to what extent tortoises interact with roads or fencing, Dr. Peaden observed the utilization of road edges, frequent road crossings, and fencing pacing. The study suggests that there are two peak times of road interactions, spring nesting and monsoon season. In addition, most road crossings occurred near washes. With all the GPS movement data but a small sample size of only 15, Dr. Peaden decided to look at what the more significant population-level implications are, such as:

- How do roads of different traffic volumes affect desert tortoise populations?
- To what extent is mitigation fencing expected to improve populations?
- What else can assist in recovering populations?

Dr. Peaden constructed a spatially explicit individual-based population model to answer these questions, which simulates landscape and follows a tortoise's life cycle. It will follow a tortoise's movement, reproduction, survival rates, and growth rates. The model suggested that all road types caused significant population decline (10-20% in 50 years), and fencing resulted in a 1.7-3.4% population increase.

4. Inter-agency regulatory issues: Section 7, implementation of conservation measures and mitigation; ideas for rangewide PBO for the desert tortoise

The intersection between highway programs, tortoises, and the Endangered Species Act – Dan Buford (FHWA) and Catherine Liller (FHWA)

Dan and Catherine discussed the following during their presentation:

- FHWA Mission
  — The mission of the Federal Highway Administration is to enable and empower the strengthening of a world-class highway system that promotes safety, mobility, and economic growth while enhancing the quality of life of all Americans.
- FHWA Programs
  — The Federal Aid Highway Program provides financial and technical support to state and local governments to improve the Nation's Highway system.
  — The Federal Lands Highway Program provides support to federal and tribal owned lands.
  — The Office of Project Development and Environmental Review focuses on a balanced and streamlined approach to transportation decision-making through NEPA.

- ESA Purpose and Policy
  - — Purpose: to conserve ecosystems and provide a program for species conservation (Section 2(b)).
  - — Policy: It is the policy of Congress that all…Federal agencies shall…utilize their authorities to further the purposes of the ESA (Section 2(c)).
- ESA Section 7 Requirements
  - — Section 7a1 requires federal agencies to utilize their authorities in furtherance of the purpose of the Act.
  - — Section 7a2 requires federal agencies to ensure their actions are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat.
  - — Interagency Cooperation; 50 CFR part 402.
- FHWA and State DOTs
  - — FHWA designated DOTs are "non-federal representatives" for Section 7 consultation (50 CFR Party 402.08).
- FHWA Division Office Responsibilities
  - — Ultimately responsible for Section 7 compliance as the lead federal action agency (50 CFR 402).
  - — States with NEPA assignment (CA, UT, ZA) take on Federal responsibilities for ESA compliance.
- Consultation Approaches
  - — Programmatic Actions often include:
    - Multiple similar, frequently occurring, or routine actions expected to be implemented in particular geographic areas and/or
    - A proposed program, plan, policy, or regulation providing a framework for future proposed actions.
- Inter-agency Cooperation
  - — Inter-agency collaboration is critical to the success of identifying and implementing the most efficient approach to Section 7 consultation.
  - — Section consultation carried out within the framework of a conservation program is a win-win.

Desert tortoise recovery and ESA compliance for highway projects – Glen Knowles (Field Supervisor, Southern Nevada Fish and Wildlife Office)

Glen began his presentation by stating that Mojave desert tortoise populations are declining in 11/17 TCAs (Desert Tortoise Conservation Areas) as of 2014. An updated analysis will be provided after the 2021 surveys. Highways, development, Department of Defense land isolate and divide these TCAs. Due to this fragmentation, the Desert Tortoise Management Oversight Group (MOG) requested a connectivity white paper. A draft of the white paper was presented to MOG in October 2020. The Mojave Desert Tortoise Recovery Network and Connectivity White Paper aims to address the knowledge gap on Mojave desert tortoise connectivity relative to recovery. The paper provides four management recommendations for TCAs:

1. Management of all desert tortoise habitat connectivity
2. Limitations on landscape-level disturbance across habitat managed for the desert tortoise
3. Minimization of mortality from roads and maximization of passage under roads
4. Adaptation of management based on new information

Section 7 consultation: approach for Caltrans actions that affect the desert tortoise – Brian Croft (Division Supervisor, Palm Springs Fish and Wildlife Office)

Brian began his presentation by showing his office's jurisdictional boundaries, which contains significant desert tortoise habitat. He proceeded to discuss regulatory contexts, and that if Caltrans is doing any projects within the areas of desert tortoise habitat, there is potential they will need to consider a consultation. In addition, if the Caltrans project does not have minor effects, there is usually a need for a formal consultation process, resulting in a biological opinion (BO). The current consultation approach includes:

- Caltrans liaison
- DETO Programmatic BO (maintenance and smaller projects)
- Project-specific BOs (larger projects)
- Coordination with CDFW

The USFWS is currently working with Caltrans on developing and moving to an expanded desert tortoise programmatic biological opinion (PBO). The goals of the PBO are to streamline and simplify the Section 7 process and Caltrans projects. Some the ways the streamlining is trying to be achieved is:

- All activities within Caltrans rights-of-way
- Protective measures are generalized
- Activity form used for consultation instead of BA
- Re-initiation threshold of 10 desert tortoises killed in a calendar year
- Section 7(a)(1) program
- Coordination during the CDFW ITP process

5. Transportation Infrastructure and Connectivity

Modeling the impacts of barriers to movement, and the effects of culverts on improving connectivity – Ken Nussear, Ph.D. (Assistant Professor, University of Nevada-Reno)

Dr. Nussear provided updates on his ongoing study. The study's objectives are to evaluate how land use and climate change will impact Mojave desert tortoise gene flow and corridor functionality within the context of multi-species interactions and landscape connectivity. Recent developments in the Ivanpah Valley continue to fragment habitat and reduce connectivity within current populations. In addition, the analysis indicated a significant influence of the Southern Pacific Railroad and/or I-16 on genetic distances, indicating that genetic connectivity across these barriers could continue to decrease through time. The study also explored the current barrier(s) to connectivity with respect to current and future land use status and underlying habitat suitability.

Transportation infrastructure influences tortoise movements and space use – Steve Hromada, Ph.D. Candidate (Nussear Lab, University of Nevada, Reno)

Steve presented telemetry data from his current study. He began by providing a list of threats to connectivity which includes:

- Habitat fragmentation & degradation
- Transportation infrastructure
- Energy infrastructure
- Off highway vehicle use
- Mining
- Urban development

Steve's ten study sites are located in/around the Ivanpah Valley, NV & CA, which has transportation infrastructure, utility-scale solar installations, and valley & mountain passes. Adult tortoises were outfitted with VHF radios and GPS loggers to collect their movement across the landscape. Data from tortoise movement suggests that tortoises avoid roads yet still cross them/live next to them, cross underneath railroad underpasses, and avoid moving in areas of high slope yet still inhabit them. Steve concluded his presentation by stating that connectivity will continue to be an essential issue of conservation of the Mojave desert tortoise, tortoises interact with transportation infrastructure in different ways, and understanding movement resistance, movement behavior, and dispersal are vital to making informed decisions to maintain connectivity.

Crosswalk to connectivity: culverts reduce desert tortoise population fragmentation when roads act as blocks – Kirsten Dutcher, Ph.D., Postdoctoral Researcher (Nussear Lab, University of Nevada, Reno)

Dr. Dutcher began her presentation by discussing the importance of connectivity, citing:

- Habitat loss is the leading cause of extinction globally
- As we lose habitat, we also lose individuals
- After a certain threshold of habitat loss, we see a complete loss of individuals
- The spatial configuration magnifies the adverse effects

She then discussed desert tortoise habitat loss and population declines stating that:

- Desert tortoise habitat loss & population declines. Most (66-70%) desert tortoise habitat has some development within 1 km (Carter et al. 2020).
- Desert tortoises are experiencing large, ongoing population declines, and adult tortoise numbers have decreased by over 50% in some recovery units since 2004 (Allison & McLuckie 2018).

She concluded her presentation by discussing the evaluation of connectivity and suggesting that evaluating the spatial configuration of the landscape is even more critical, given that we see habitat loss and population decline.