FEDERAL LANDS ANIMAL -VEHICLE COLLISION DATA COORDINATION PROJECT

PHASE 3

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16. Abstract

The Department of Interior's US Fish and Wildlife Service (FWS) and National Park Service (NPS) have sought to develop a national data collection system for animal-vehicle collisions (AVCs). Called the Roadkill Observation and Data System (ROaDS), it uses a common commercial geo-spatial platform and mobile device application and is now ready for use by the FWS, NPS and other DOI bureaus and agencies once it is moved from the ROaDS research team's servers to a DOI-wide platform. Upon the completion of Phase 3, ROaDS uses a short survey (electronic data collection form) with 9 different fields of information to be filled out by the observer (e.g., species identification, number of animals observed). It has a short list of 22 species to choose from (but allows the observer to type in other species not on the list). The ROaDS survey includes the capability to take a geospatially synchronized photograph to confirm species identification. The ROaDS survey collects the same observer information for carcasses, live animals crossing the road or live animals adjacent to the road. The data collected is automatically sent to a cloud-based server for storage under the commercial license; then, the ROaDS research team developed post-collection processing that adds 11 data fields derived from the original location data (e.g., state, county, federal management unit). The ROaDS information stored in the database is linked to a webpage that easily displays the locations of the observations on a map of the United States and can be analyzed and viewed using the site's cluster or "hot spot" analyses. The data can also be exported to other software programs for analyses and reports. In Phase 3, as part of the beta-test, the ROaDS survey was successfully adopted for use by tribal agencies and non-governmental organizations (NGOs), using their own commercial license with the same company and storing data on their own licensed database. So that ROaDS can be shared more broadly on any of a variety of data collection systems, the ROaDS research team, FWS and NPS organized two national workshops with other organizations to co-develop national AVC data collection system standards. The two workshops generated a lot of interest. Participants included over 120 representatives of federal and state agencies, NGOs, academic entities, and consulting firms.

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GLOSSARY OF ACRONYMS

ARC	Animal Road Crossing Solutions
AVC	Animal-vehicle collision (includes wildlife and domestic animals)
BFWD	Blackfeet Nation Fish and Wildlife Department
CLLC	Center for Large Landscape Conservation
CSKT	Confederated Salish and Kootenai Tribes
DOI	Department of Interior
DOT	Department of Transportation
DOW	Department of Wildlife
DT	Desert Tortoise
EPW	U.S. Senate Environment and Public Works Committee
ESRI	A commercial geographic information system company
FHWA	Federal Highway Administration
FLMA	Federal land management agency
FWS	U.S. Fish and Wildlife Service
GIS	Geographic information system
GPS	Global Positioning System
IMARS	Incident Management and Reporting System developed by the FHWA
LRTP	Long-range Transportation Plan
MMUCC	Model Minimum Uniform Crash Criteria
MSAR	Mobile Solutions for Assessment and Reporting
MSU	Montana State University
NGO	Non-Governmental Organization
NHTSA	National Highway Transportation Safety Administration
NPS	U.S. National Park Service
PDA	Personal Data Assistant
ROaDS	Roadkill Observation and Data System
Survey123™	The mobile device application licensed by ESRI that ROaDS utilizes
TAC	Technical Advisory Committee
T & E	Threatened and Endangered Species under the Endangered Species Act
TRB	Transportation Research Board

USDA	United States Department of Agriculture
USMP	Unstable Slope Management Program
UTM	Universal Transverse Mercator
WTI	Western Transportation Institute
WVC	Wildlife-vehicle collision

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Supported by the National Center for Rural Road Safety, the Department of Interior's (DOI's) US Fish and Wildlife Service (FWS) and National Park Service (NPS) teamed with the Western Transportation Institute – Montana State University (WTI) to develop an animal-vehicle collision (AVC) data collection system that can be used by DOI federal land management agencies (FLMAs) and other willing agencies and organizations. The system is designed to efficiently and effectively collect information on vehicular crashes with large-bodied wildlife that impose safety hazards on federal lands roads, as well as record carcass data of medium- and smaller-sized fauna, since all sizes of species are relevant to the FLMAs' conservation missions. It also documents locations where animals may be observed alive next to the road or successfully crossing highways.

This project developed a user-friendly tool to collect and manage AVC data – crashes with wildlife and domestic livestock – key to conducting analyses that identify specific road segments where highway-animal conflicts are challenging, where motorist safety may be problematic, or where the mortality of wildlife species of conservation concern is elevated. Called ROaDS – Roadkill Observation and Data System – the data system is basic and flexible enough to be used by agency staff on any DOI FLMA system road. The ROaDS data collection form can be shared for independent implementation by state, tribal, county, and metropolitan transportation agencies or with partners such as non-governmental organizations for wider use, and to enable collaborative sharing of standardized data to prioritize AVC hotspots at larger scales across multiple jurisdictions.

Phase 1 of this project developed a pilot AVC system using an existing commercial mobile device application and its data storage and serving capabilities; this commercial system is available to all DOI agencies and bureaus. Many FWS and NPS partners also subscribe to the same commercial system, making the independent adoption of ROaDS more likely. This system supports data collection on mobile devices, stores data on the cloud, and has several program functions to view and analyze information in the ROaDS database. ROaDS was customized in Phase 1 to collect AVC roadkill observations as determined by the project's technical advisors from the FWS and NPS.

In Phase 2, recommendations were made to develop preliminary AVC data collection standards that all NPS and FWS management units could incorporate. The recommendations included modifications to the Phase 1 system to simplify and streamline the types of data to be collected by the ROaDS mobile device application.

In Phase 3, the ROaDS research team completed the testing of the system, finalized the species list (which can be customized), and refined other data fields. The ROaDS research team also evaluated several options to transfer ROaDS at the conclusion of Phase 3 to a permanent location on a DOI-wide platform. The team elected Geoplatform as the best platform to accommodate and maintain ROaDS with existing DOI technical support. It will give all DOI bureaus and agencies the ability to use this system.

Finally, the Phase 3 research team sponsored and co-hosted two Transportation Research Board Annual Meeting workshops in 2020 and 2021. These workshops have launched a process for FWS

and NPS to co-develop national AVC data collection standards along with other partners, such as Federal and state transportation and wildlife agencies, academics, consultants, tribes, non-profit organizations and others. The adoption of national AVC data collection standards will improve coordination and prioritization of AVC hot spots at larger scales, across numerous jurisdictions, agencies, and organizations who may use different AVC data collection systems. This process seeks to ensure mitigation sites are identified where they are most needed across multi-jurisdictional landscapes.

1 INTRODUCTION

Wildlife-vehicle collisions (WVCs) can impact human safety, create significant property damage, and cause animal injury and mortality (Huijser et al. 2009). In the United States, it is estimated there are 1-2 million WVCs with large animals, primarily ungulates, costing over $8 billion, annually (Huijser et al. 2007a; Sullivan 2011). Other roadkill studies have demonstrated smaller taxa, such as birds, reptiles, and amphibians, are also significantly impacted by traffic (e.g., Langen et al. 2010, Bager and Rosa 2011, Husby 2020).

When crashes with large domestic animals, such as horses or cattle, are collected along with WVCs, the data that includes domestic animals and wildlife is collectively called animal-vehicle collisions (AVCs). Therefore, throughout this report, depending on the data that has been collected, both terms, WVC or AVC, may be used to describe the data.

The National Park Service (NPS) and US Fish and Wildlife Service (FWS), and other Federal land management agencies (FLMAs) lack sufficient information regarding the location, rate, and severity of WVCs along roadways within agency management units – such as parks and refuges - and on roads through adjacent public lands. This makes it difficult for the agencies and bureaus to identify areas of concern or effectively address motorist safety and native species conservation.

Within the Department of the Interior (DOI) and on DOI agency managed roadways, the primary systematic data that are available to evaluate WVCs are collected by law enforcement and stored in motor vehicle collision databases via the DOI's Department-wide law enforcement records management system known as the Incident Management and Reporting System (IMARS). These data are biased toward large animals and are only collected when crashes are reported, typically when significant vehicle damage occurs or human safety is affected. Similarly, other large domestical animals, such as horses and cattle, are also reported.

These data lack information on all other types of AVCs, such as with smaller mammals, reptiles, birds, amphibians, or species of conservation concern. Relying on only law enforcement data has been shown to significantly underestimate the frequency and costs of AVCs with larger animals (Donaldson 2017). Other sources of AVC data are collected by state departments of transportation (DOTs) or other partners; therefore, FLMAs often may rely on a mix of different data and data systems.

Figure 1. Variable message sign on highway skirting the National Elk Refuge in Wyoming. Credit: Rob Ament.

A recent study based on the NPS's law enforcement data indicated that AVCs account for over 10 percent of all crashes in the NPS's management units analyzed, a rate that is twice that of the national average (Cherry et al. 2019). This new information confirms that AVCs require special attention to adequately address visitor safety on FLMA roads.

Without a systematic collection of AVC data that supplements the existing FLMAs' law enforcement system data collection and those of its partners, it is often difficult for FLMAs to adequately analyze AVCs to develop priorities, justify funding to address this issue, and implement cost-effective mitigation solutions that reduce AVCs and their adverse effects on both motorist safety and natural resource protection.

The DOI's concern with the adverse effects of roads and traffic on motorist safety and wildlife conservation is shared with many other Federal, state, and local natural resource and transportation agencies in the United States. As a result, there are many different AVC data systems under development across the nation. They rely on a variety of new technologies and software programs, all with the same goal: to develop more precise AVC data collection systems that collect, store, share, and analyze information in an efficient and cost-effective manner, to ultimately inform mitigation investments to reduce this ubiquitous issue on roads.

The goal of this project is to develop a high quality AVC data collection system that can address motorist safety for crashes with large animals and determine the effects of FLMA roads on animals that are not necessarily large enough to cause safety concerns for motorists but are threatened, endangered, or of conservation concern. Huijser and others (2007a) identified 21 federally listed threatened and endangered species for which direct road mortality is among the major threats to their survival. The NPS's National Long-Range Transportation Plan (LRTP) (NPS 2017) stated, "these species and other sensitive species are currently found within 32 parks units."

These reports and other related studies across the nation demonstrate the need for an AVC data collection system that allows the agencies to better evaluate safety issues, AVC impacts, true costs of collisions, and problematic stretches of roads. Ultimately high-quality data would support investment in effective mitigation measures. The data can also be used for targeted outreach and education campaigns, communication strategies, and determining where signage may be used to increase driver awareness of the potential of hitting and killing wildlife on public lands.

The ROaDS project developed an AVC data collection system for use by the FWS, NPS, and other DOI agencies. An important component for ROaDS is to enable collaboration with non-DOI partners to collect similar or identical information. To support DOI collaborations with partners to collect AVC data on adjacent or multi-jurisdictional roads, the ROaDS data collection fields (e.g., the data form) can be shared with other willing partners to collect the same or very similar data on their own independent AVC data collection systems. The ability to share AVC data among FWS and NPS partners strengthens and leverages efforts to collaboratively and accurately identify where AVCs are occurring at larger scales, and at no additional cost. Each data collection system adopted by users outside of DOI can be independently deployed and managed; by sharing the ROaDS data form, multiple entities can potentially collect the same information across larger landscapes and different jurisdictions to enable broader assessment of AVC issues with common quality controls.

This project assessed existing AVC data collection systems, including commercial data collection systems already in use by the Federal government that might be appropriate platforms to host ROaDS and offer the potential for its long-term sustainability.

The project explored pathways for implementing ROaDS as a viable data collection system after the conclusion of this phase, Phase 3, of the research and development project. The project research team evaluated the sustainability of an AVC data system for the NPS, FWS and other FLMA partners. It recommends a DOI platform that allows DOI bureaus and agencies to coordinate the AVC data system's collection, storage, analysis, reporting, and application of data in transportation planning and projects. This, in turn, will facilitate the standardization of AVC data so NPS, FWS and their partners are able to collect, store, retrieve, share, analyze and report on AVC data for their mutual benefit.

To coordinate AVC data collection and sharing with partners across the country, the ROaDS research team worked with DOI agencies and other stakeholders to begin a process to develop criteria, or national standards for AVC data collection. The project team is co-developing standards with partners and stakeholders to garner broader use and to coordinate parallel development of complimentary AVC data collection systems. Although the creation of national AVC standards will take longer than the timeframe of the ROaDS project, initiating a process by hosting two national workshops has been a crucial first step, and ROaDS can be updated to adopt any future national AVC data collection standards that are agreed upon with partners.

2 PROJECT BACKGROUND

The AVC data collection system for use by the FWS and NPS, one that can be shared with their partners for their independent use, was designed to collect information on large animal-vehicle crashes, which are the focus of the safety requirements for FLMAs and many of their partners' roads. It is also capable of collecting carcass information of medium-sized and smaller taxa, which along with many of the larger bodied animals, are the focus of the FLMAs' conservation mission. This is analogous to meeting the joint needs of state Departments of Transportation (DOTs) and state Departments of Wildlife (DOWs) or tribal transportation and wildlife agencies.

The development of AVC data systems has evolved over the past decade. Originally, personal data assistants (PDAs) were coupled with Geographic Position Systems (GPS) in the mid-2000s (i.e., Huijser et al. 2006, Ament at al. 2007, Donaldson and Lafon 2010). More recently, as cell phone use has increased and smart phones with increasingly accurate GPS capabilities have become ubiquitous, web-based and mobile device applications have superseded the use of PDA-GPS systems. Mobile devices using web-based systems have greatly improved data collection capabilities and efficiencies (Olson et al. 2014) and enable citizen scientists or the general public to add to a transportation agency's efforts to document AVC incidents (Shilling and Waejtien 2015). Some systems combine web-based with mobile device applications (Bil et al. 2017) and smart phone systems with citizen science capabilities to increase robustness of the data (Vercayie and Herremans 2015, Engelfield et al. 2020).

The development of ROaDS seeks to:

- Allow for all DOI agencies and other willing stakeholders to collect spatially precise AVC data and observations of living wildlife (attempting to cross or using habitat near a road) by user-friendly data entry via mobile devices – cell phones and tablets.
- Facilitate the collection of all types of AVCs and near-road observations of live animals, from large animals, the focus of motorist safety, to smaller mammals, reptiles, birds, and amphibians for conservation purposes.
- Improve coordination by the FLMAs and their stakeholders for collecting, reporting, and assessing AVC data at various scales – management unit, regional, and national.
- Create central data storage that simplifies data management across individual units within the same bureau or agency and across the DOI while also managing access and securing sensitive data, such as observations of federally listed threatened and endangered species or species prone to trafficking for illegal pet trade.
- Offer a non-proprietary data form that can be shared with partners to collect and report similar AVC data on their own data collection platforms.
- To increase public engagement using citizen science initiatives coordinated and managed by collaborators such as non-government organizations that can adopt and independently implement ROaDS to support natural resource conservation in and beyond FLMA units.
- Improve the quality, accuracy, and rigor of data needed to quantify AVC incidents, assess impacts to wildlife species, and document contributing factors to improve transportation safety decisions, mitigation investments, and natural resource protection.

2.1 Phase 1 of the ROaDS Project

This phase completed initial steps to facilitate the coordination of AVC data collection by the NPS, FWS, and other FLMAs. It scoped data collection, storage, and retrieval needs for the NPS, FWS, and their stakeholders. The project also assessed existing data collection systems – both for AVCs (e.g., iNaturalist) and those that could be adapted for AVC purposes (e.g., Incident Management Analysis and Reporting System (IMARS)). The project also explored the use of the commercial data collection system already under contract to the DOI, Environmental Systems Research Institute's (ESRI"s) commercial platform *ArcGis*™ and its mobile device (smart phone/tablet) application called *Survey123*™. One of the important factors evaluated for these systems was the capability for the FWS, NPS, and other FLMAs to manage, support, and sustain users. Recommendations were provided for coordinating the AVC data system's collection, storage, analysis, and reporting methods.

The early scoping, research of existing options, and suggested recommendations led to the development of a data collection system based on ESRI's *Survey123*™ application. *Survey123*™ has DOI certification for authority to operate, meets the internet technology security needs of DOI, and thus is available to all DOI bureaus and agencies. Further, ESRI *Survey123*™ is used by many of FWS and NPS partner organizations with their own ESRI licenses, increasing the potential for DOI to coordinate and leverage its AVC data collection efforts with independent cooperators invested in AVC data collection. A key factor is that each licensee, including the DOI, can collect, store, manage, retrieve, and analyze their data independently. This provides data security within given institutions while at the same time, with the broader adoption of a basic, standardized data form, called the ROaDS survey, the system can be shared for use across independent licensees. This broader engagement enables more effective cooperation among collaborators willing to share data.

The ROaDS pilot effort of Phase 1 developed a *Survey123*™ data collection form (the ROaDS survey) that could be uploaded by approved users onto their mobile device. Approved users were registered by the ROaDS research team to its institutional ESRI account (held by Montana State University) that was used for the development and testing of the system. Users would carry the device with them until coming upon a carcass along a road, or witnessing live wildlife near or crossing a road, at which point they could initiate an observation by opening the ROaDS survey on their device and "dropping a pin" with a single touch, instantaneously capturing a date, time, and GPS location of the observation. It also allowed observers to take a photo of the carcass on their mobile device, which was then synchronized with the observation data or "geo-synched."

Then, the ROaDS survey guided users through a series of data fields to capture additional information about the carcass or live animal, such as the user's confidence in the identification of the species. The Phase 1 ROaDS survey cued users to collect additional information that was later determined to not be essential for collection in the field and was subsequently removed from the ROaDS survey to streamline the field data collection process. Additional user feedback ultimately resulted in adaptations elaborated in Phases 2 and Phase 3 of the project (reported on later in this report).

When the mobile devices had wireless connectivity, either via the internet (WiFi) or through cellular phone coverage, the data from each observation was uploaded directly to the ROaDS

cloud-based data server provided by ESRI via its *ArcGis*™ license. If a smart phone or tablet was unable to connect to cell service or WiFi, it stored the information in the mobile device's memory until connectivity was restored. For safety, the data collector could simply push a button to lock in the location of the carcass or live wildlife crossing or sighting, that is, the latitude and longitude coordinates of the animal's position, located by the mobile device's GPS feature. This allowed the observer to move to a safer location before completing the remaining data fields in the ROaDS survey.

Once data were sent to the ESRI's cloud database server, each observation's data and geo-synched photo could be exported and reviewed by NPS or FWS experts to confirm species identification. This allowed for quality assurance and control. For DOI agency personnel given access, the ESRI database could be queried, and data retrieved by managers using *ArcGIS*™ online. Agency personnel could then retrieve the stored data for map-based viewing or further analyses of the AVC information by exporting the data into electronic spreadsheets or other software used for spatial analyses or for roadkill statistics.

Figure 2: ROaDS logo developed for the project's animal-vehicle collision data collection system.

In Phase 1, 28 NPS and FWS beta-test volunteers, scattered across the U.S. in national park and wildlife refuge units from Oregon to Florida, were recruited and registered by the ROaDS research team to test ROaDS' functionality. The data were stored on ESRI's cloud database server provided with MSU's ESRI license (for the development and ROaDS beta test process). As part of its license, ESRI also provides post-collection analysis capabilities to visualize the data, such as providing cluster analyses and heat maps to summarize carcass or live animal observations.

The Phase 1 beta-test volunteers collected 122 observations. Two volunteers collected the majority of the data, so they were contacted to get their opinions about the functionality, practicality, and overall user feedback about the system via an interview on the phone. A sample of particularly relevant comments on the ROaDS system, based on feedback from the volunteers in the beta-test include:

- It was possible to skip many of the data fields if they didn't appear to be necessary or applicable. Users "liked" that they were not required to fill out every data field.
- The geo-synched photo feature was very easy to use.
- The safety feature of allowing the collector to "drop a pin" to mark the location of the observation and then move to a safe location away from traffic to fill out the data fields was poorly understood or not easily "seen" and intuitively used.
- Respondents requested that the number of data fields in the ROaDS survey be reduced. They preferred a simpler survey.

Other issues identified during the Phase 1 beta-test included the need for quality control or an expert review of the species identified in the ROaDS survey. This function was developed for Phase 1 on MSU's ESRI cloud-based server, but in the future, it will be transferred to secure servers behind the firewalls of DOI so staff can conduct the expert reviews to maintain the quality of the data. For more details regarding Phase 1, please see the final report (Ament et al. 2018).

2.2 Phase 2 of the ROaDS Project

During Phase 2, the project made substantial progress toward two objectives that were based on the outcomes of Phase 1. The first objective was to develop useful national standards for the FWS and NPS to use for future discussions with partners. The three standards are:

- Location Accuracy Standard: each wildlife observation shall be located in the field, at the time of the observation, using a reliable GPS system and have a location accuracy that does not exceed ±10 meters.
- Expert Review Standard: The identification of the species present in each observation must be reviewable by an expert. To do so, a geo-synched photo must be linked with all observations by non-experts.
- Standardized National Species List: A relatively short species list of the most frequently observed animals of interest from across the U.S., using their common names, will be provided by the AVC data collection system for the observer to choose from while making a data collection observation. In addition, the WVC data collection system shall provide the flexibility for the data collector to identify and record other less common species not on the list.

For the second objective in Phase 2, the ROaDS research team modified the ROaDS survey to be shorter, easier to use, and more efficient, based on the project's technical advisory commmittee's (TAC's) review and feedback from Phase 1 beta-test volunteers. To accomplish this, four data fields from the Phase 1 survey were removed: animal is dead or dying, observer witnessed crash or found carcass, if there was in accident report filed for the dead animal, and the observer's proximity to animal while recording the observation. These fields were removed from the survey

because they don't provide relevant information about the AVC observation and the GPS location of the animal is assumed to be in close proximity to the carcass.

In Phase 2, three additional data fields of the ROaDS survey were modified. The data field for the number of animals observed was changed from a text box to a number list (Table 1, Data Field 7). Second, the ability to report successful wildlife crossings or live animals next to the road was added to animal status field (Table 1, Data Field 6); previously, only dead or dying animals could be captured in the Phase 1 survey. In addition to those changes, the data fields were rearranged and rewritten to flow better and be easier for the ROaDS user to understand.

The last modification was to the "species observed" data field (Table 1, Data Field 3). A recommendation by the TAC and beta-test volunteers was to shorten the complicated species list of both scientific and common names of over several thousand North American species and reduce it to a limited list that only used common names. The list of common names of 21 species is on the list including domestic livestock. There are text boxes to add any species not on the pull-down list (this final species list is reported in Table 4 of Chapter 4).

Table 1: Final ROaDS survey data fields at the end of Phase 2.

Data Field No.	Data Field	Type of Data Field	Data Entry Format	Comments
1	Location of observed animal*	Map with locator flag	Map pin	Compass button or map pin
2	Observation date and time*	Date and Time	Auto-fill	Automatic from mobile device
4	Take a photo	JPG file	Camera	Geosynched photo(s)
3	Species observed*	Select one	Button/Text	21 species with 4 text box options
5	Confidence in spp. Identification*	Select one	Button	High; Medium/Low
6	Animal status*	Select one	Button	Dead; Alive Crossing Road; Alive Near Road (< 100 yards from road)
7	Number of animals observed*	Number	Text	1; More than 1 --> drop-down scroll with numbers
8	Comments	Text box	Text	Allow 140 characters

The project's TAC and ROaDS research team determined that it would be valuable to record the observer's survey route and link each individual observation to the route taken as well as the amount of time taken for the survey, to quantify survey effort; this would ensure the database captures equally important information about surveys that yield no carcass or wildlife sightings for methodological research/monitoring projects. However, this function is not available on ESRI *Survey123™*. Using ESRI *Survey123™* to track a route required users to manually enter the beginning and ending location of their route, as well as manually adding multiple points along their path to help identify the survey route. Due to the inefficiency of this approach, it was recommended not to include it in the Phase 3 ROaDS survey. Instead, it was suggested that in Phase 3 that the ROaDS research team explore other applications that might be able to simultaneously collect the user's survey route along with each individual carcass or live animal observation collected on the route.

Finally, in Phase 2, the project's TAC and the ROaDS research team began to engage other agencies and organizations to jointly develop national standards for AVC data collection systems. It was concluded that this effort to engage with partners to co-develop national AVC data collection system standards needed to be robustly developed in Phase 3. For more details on Phase 2, see its final report (Ament et al. 2019).

3 ROADS, PHASE 3

Phase 3 built on the development of ROaDS, after the ESRI's *ArcGis™* platform and its ArcGIS *Survey123*™ application were selected in earlier phases of the project. All DOI agencies and bureaus have commercial licenses for these ESRI products. DOI agencies and bureaus use the ESRI *Survey123*™ application for other purposes, so there is familiarity with its use among staff, including IT personnel. In addition, the use of an existing system was considered more cost-effective than developing an entirely new AVC data collection system, and independent mobile device application, and providing for its technical support. Previous chapters of this report documented the processes and adaptations this project addressed in the first two phases of the ROaDS project, building the foundation for Phase 3.

The remaining chapters of this report go into greater detail about the evolved ROaDS survey and data system, outlined by objectives for Phase 3, including the following:

1) Continue to upgrade, modify, and finalize the electronic data form or ROaDS survey, including a final species list that can be customized. Also, implement a post-data processing function that allows for the addition of other attributes of the observation location (e.g., the state the observation is located in, functional class of road). (Chapter 4)
2) Explore and evaluate commercial applications to synchronize the recording of the survey route to individual observations. (Chapter 4)
3) Support the adaption and adoption of the ROaDS survey with partners who have ESRI *ArcGIS*™ licenses. (Chapter 5)
4) Evaluate options and offer recommendations for the best platform to move ROaDS from the MSU servers used for research and development to a more permanent home at the DOI, supported by its staff for the system's long-term deployment. (Chapter 6)
5) Create training and outreach materials for DOI personnel, and agency partners to utilize ROaDS under the research and development system that uses Montana State University's ESRI license. (Chapter 7)
6) Facilitate the co-development of national AVC standards with DOI partners. (Chapter 8)

4 THE ROADS SURVEY

The ROaDS survey (data collection form) has been developed on the *Survey123*™ app for the *ArcGIS*™ platform. Prior to explaining the ROaDS survey and how it is set up on the ESRI platform, it is important to understand ROaDS user types, which are determined by the different *ArcGIS*™ account roles.

All ROaDS users must have access to an *ArcGIS*™ account with the proper credentials to create or use a ROaDS survey for a national park, national wildlife refuge, NGO, or other partner agency or organization. ***ArcGIS*™ Online account users are assigned different roles**, including viewer, user, editor, publisher, or administrator. A full description of the different account roles within *ArcGIS*™ can be found at https://doc.arcgis.com/en/arcgis-online/reference/roles.htm. The different roles are used to establish what access an employee has within the ROaDS system.

In addition, the ROaDS research team uses certain terminology related to a ROaDS user's ability to perform different actions related to the system (e.g., collect data, edit surveys, create ROaDS groups), and what access they have to the database. There are **three important types of ROaDS users**: owners, managers, and collectors.

- Owners: The owner is the individual who creates the ROaDS group on *ArcGIS*™, adds the different content and maps to those groups, and make changes to the data fields for the ROaDS survey used by the group. There can only be one owner per *ArcGIS*™ group; however, one designated employee can be the owner of multiple groups. This person also sets the rules for the group members which, in part, determines who can access and view the data that are collected by everyone in the group. The collected data are stored in the ESRI cloud and can be viewed via the *ArcGIS*™ Map Viewer by those managers and collectors permitted by the owner of the survey.
- Managers: The managers are assigned by the owner of the *ArcGIS*™ group and are given privileges to edit group details and data from any of the observations that have been collected using the ROaDS survey. Managers are responsible for the quality control of the data (i.e., review data such as species identification), and can also analyze and download observations collected within their *ArcGIS*™ groups.
- Collectors: Collectors are the ROaDS users who are only tasked with collecting data observations. They use the ROaDS survey to collect data, but they are only allowed to view the data in their group that have been reviewed by managers.

These and other important terms and are explained in greater depth in the ROaDS User Manual (Appendix C).

4.1 ROaDS Survey Developments in Phase 3

The ROaDS survey modified in Phase 2 of this project was used as the starting point for the data fields in Phase 3. The new version of ROaDS in Phase 3 was beta-tested by NPS and FWS volunteers. These users, along with input from the ROaDS project's TAC, assessed how the new, modified ROaDS survey performed. Their input throughout the testing period was used to further alter the data fields to collect information deemed important to the NPS and FWS.

4.1.1 ROaDS Survey Data Fields

At the end of Phase 2, the ROaDS survey consisted of seven data fields for observers to fill in and an additional data field for comments (Table 1). In Phase 3, two additional data fields were added before the ROaDS survey was distributed to the beta-test volunteers.

The first data field added was the animal's conservation status (Table 2, Data Field 8). This field is used to identify if an animal is a threatened or endangered (T and E) species under the Endangered Species Act. This is considered sensitive information by Federal agencies. This data field allows managers to filter out or "mask" these sensitive data observations so only individuals given access to this data in the ROaDS database by FWS or NPS administrators of ROaDS can redact or extract the T and E and sensitive species information for analyses or to present in a map.

The second data field added was the user's beta-test Identification (ID) number (Table 2, Data Field 9). The beta-test was hosted on the MSU ESRI account; therefore, users were provided login information and beta-test ID numbers so the ROaDS research team was able to see which users collected each data point. This data field was only used for internal purposes for the beta-test and was eventually removed from the ROaDS survey. A summary of all of the ROaDS survey's data fields, the types of data to be collected, and their format, are reported in Table 2.

Table 2: Standard data fields used at the start of the Phase 3 beta-test.

Start of the Beta-test					
Data Field #	**Data Field**	**Type of Data Field**	**Data Entry Format**	**Optional or Required**	**Comments**
1	Observed animal location	Map with locator flag	x map pin	Required	GPS location recorded when observer saves location on the Map
2	Observation date and time	Date and time	Auto-fill	Required	Automatically recorded by the mobile device when map pin is activated at an observed location
3	Photo	.JPG file	Camera	Optional	Survey123™ accesses camera so pictures can be taken without exiting the app.
4	Type of animal observed	Select one	List	Required	21 of the most commonly recorded roadkill species in the lower 48 states (see Section 4.1.2)
5	Confidence in spp. identification	Select one	Button	Required	High: user is > 90% sure they have identified the correct species; Medium/Low: doubt in species identification, sent for review
6	Number of animals observed	Number	Button/Text	Required	1; More than 1: drop-down scroll with numbers
7	Animal's status	Select one	Button	Required	Dead; Alive crossing road; Alive near road (< 100 yards from road)
8	Animal's conservation status	Select one	Button	Required	NOT threatened or endangered; Threatened or endangered; Unknown
9	User's beta-testing ID*	Text box	Text	Required	Beta-testers were given an ID number when given account information so the research team can identify users
10	Comments	Text box	Text	Optional	Additional information the user wants to report related to the WVC data collected

***This field was only used during beta-test and will not be on the final survey because the field will be auto-filled based on the user's account with the NPS, FWS, or other DOI agency.**

Over the duration of the Phase 3 beta-test, the ROaDS survey was further modified to better adapt it to the needs of FWS and NPS employees. The first change was the addition of a warning message to the observer that appears at the top of the survey; it is visible each time the ROaDS survey is opened to record an observation. For FWS and NPS partners adopting ROaDS, this warning is used as a legal agreement between the organizations hosting the survey (e.g., non-governmental

organizations (NGOs)) and their volunteers that collect the data. At the completion of Phase 3, the warning message is given to all users, including DOI employees. The text of the warning message is:

> *WARNING: NEVER USE THIS APP WHILE DRIVING. Driving requires your full attention. To make a report on the app, park in a safe location or have a passenger take your phone and ask them to make the report. Parking on the road can be dangerous. When making a report, always be aware of your safety and surroundings, especially approaching vehicles. By using this app, you agree to the terms and conditions.*

The terms and conditions for the warning message can be found in Appendix B and were developed specifically by, and for, NGO volunteer users.

Different iterations of several of the data fields were modified during the beta-test based on user comments; the final selection of data fields is reported in Table 3. The ROaDS research team and the TAC sought to develop a final ROaDS survey that takes a minimal amount of time and effort to complete, is safe to use, and covers the most important and necessary information.

One concern raised in Phase 3 was the management of sensitive data; in particular, threatened and endangered (T&E) species listed under the Endangered Species Act or species that may be at risk due to poaching for sale in the pet industry (e.g., turtles). This led to the addition of a data field to capture the animal's conservation status (Table 3, Data Field 8).

Table 3: Final selection of standard data fields in the ROaDS survey for DOI agency and bureau use nationwide.

End of Phase 3 ROaDS Survey					
Data Field	**Data Field**	**Type of Data Field**	**Data Entry Format**	**Optional or Required**	**Comments**
1	Observed animal location	Map with locator flag	x map pin	Required	GPS location recorded when observer saves location on the Map
2	Observation date and time	Date and time	Auto-fill	Required	Automatically recorded by the mobile device when map pin is activated at an observed location
3	Photo	.JPG file	Camera	Optional	Survey123™ accesses camera so pictures can be taken without exiting the app.
4	Type of animal observed	Select one	List	Required	21 of the most commonly recorded roadkill species in the lower 48 states (see Section 4.1.2)
5	User's confidence in species' idntification	Select one	Button	Required	High: user is > 90% sure they have identified the correct species; Medium/Low: doubt in species identification, sent for review
6	Number of animals observed	Number	Button/Text	Required	1; More than 1: drop-down scroll with numbers
7	Animal's status	Select one	Button	Required	Dead; Alive crossing road; Alive near road (< 100 yards from road)
8	Animal's conservation status	Select one	Button	Required	NOT threatened or endangered; Threatened or endangered; Unknown
9	User's affiliation	Select one	Button	Required	NPS; USFWS; Other federal agency; State agency; Tribal agency; Non-profit organization; Other agency or organization;
10	Purpose of observation	Select one	Button	Required	Random opportunity; Crash information; Carcass removal; Monitoring program*; Research project*; Other*
11	Comments	Text box	Text	Optional	Additional information the user wants to report related to the WVC data collected

***After selecting one of these button options, a text box will appear to enter attributing identifiers that can be used to filter data during data review or analysis**

Another data field deemed important for the ROaDS survey by the NPS and FWS in Phase 3 was to allow observers to identify their agency affiliation (Table 3, Data Field 9). After the conclusion of Phase 3, the long-term goal is that ROaDS will be used by multiple organizations such as DOI agencies and bureaus, other FLMAs, states and local agencies, tribes, NGOs, and citizen scientists. This data field records the observer's organizational affiliation to allow ROaDS managers that have access the database to sort the data collected by their own agency or by other specific agencies. It provides a means to quickly identify which observations may require expert review of the species identified if they are using data not collected by their own agency.

The last ROaDS survey data field added in Phase 3 is the "purpose of the observation" category (Table 3, Data Field 10). There are four options (buttons) that allow users to select if their ROaDS observation is: 1) a random opportunity, 2) part of crash reporting, 3) a carcass removal, or 4) part of a monitoring program, research project, or other. If users select any of the latter three choices (options 2 through 4), a textbox will appear and allow them to enter the name of their monitoring program research project or other reason for collecting the observation. This allows users to add unique identifiers for their projects, so it is easier to filter data observations for analysis, summarization, or reporting. It also allows employees with access to the ROaDS database to filter or collect observations for particular projects. It also may help managers understand why particular species observations may be unusually high along a road section (e.g., if salamander fatalities are the focus of a research project).

The species list has been finalized in Phase 3 of the project (Table 4). In Phase 1, the ROaDS survey was initially created to include a list of every species in North America – mammal, bird, reptile, amphibian - with both its common and scientific name. This led to a list that had thousands of names, and it was very time consuming for users trying to find a specific species. The list was shortened to 21 common animals (Table 4, fields 1-21), those commonly involved in AVCs, both wild and domestic. To record the names of animals observed that were not on the list of the 21 common animals, four different classes of animals were created in four data fields (Table 4, fields 22-25). The observer could then place the species observed into one of these four categories of taxa - livestock, mammal, reptile/amphibian, or bird - and type their common and/or scientific name in the text box provided for that category of taxa.

Table 4: Finalized species list for the ROaDS survey in Phase 3.

Species #	Species Name	Field Type
1	Whitetail deer	Button
2	Mule deer	Button
3	Unknown deer species	Button
4	Moose	Button
5	Elk	Button
6	Pronghorn antelope	Button
7	Bighorn sheep	Button
8	Bison	Button
9	Raccoon	Button
10	Striped skunk	Button
11	Opossum	Button
12	Armadillo	Button
13	Black bear	Button
14	Grizzly bear	Button
15	Wolf	Button
16	Mountain lion/ panther/ cougar	Button
17	Coyote	Button
18	Red fox	Button
19	Feral Pig	Button
20	DOMESTIC: Cat	Button
21	DOMESTIC: Dog	Button
22	DOMESTIC: Livestock	Text (140 characters)
23	OTHER: Mammal	Text (140 characters)
24	OTHER: Reptile/amphibian	Text (140 characters)
25	OTHER: Bird	Text (140 characters)

4.1.2 Post Data Collection Processing to Provide Additional Information

At the conclusion of Phase 3, the final ROaDS survey has 11 data fields (Table 3) for the user to provide information about each carcass or live animal observation. Eight of these data fields are required before the system will allow the observation to be submitted and saved to the ROaDS database. Once an observation is received by the ROaDS database, a program developed by the ROaDS research team extracts information for more data fields (Table 5). These automatically filled data fields were developed in Phase 1 of the project; but, were not finalized and implemented until Phase 3. This information from these fields provides additional geographical information, as well as user and road attribute information. Some of the information is provided from the user's ESRI account (e.g. name, work email, type of staff). Other information is added to the data fields based on an analysis of the observation's latitude and longitude coordinates (e.g., region, state, functional class of the road, number of lanes). In total there are 11 data fields added to each observation after it has been collected and uploaded to the ROaDS map (Table 5).

Table 5: Post data processing fields that are added to each ROaDS observation.

Post Data Collection Automatically Processed Fields			
Data #	**Data Field**	**Type of Data Field**	**Comments**
1	Name of Data Collector/Collector ID	Text	Auto-filled: Information included in registration
2	Data Collector's Email Address	Text	Auto-filled: Information included in registration
3	Type of Staff	Text	Auto-filled: Information included in registration
4	FLMA Region	Text	Area analysis based on lat-long
5	Agency Management Unit	Text	Area analysis based on lat-long
6	State	Text	Area analysis based on lat-long
7	County	Text	Area analysis based on lat-long
8	City or Township	Text	Area analysis based on lat-long
9	Road/Highway Functional Class	Text	Line analysis based on lat-long and quality of FMLA road data
10	Number of Lanes	Number	Line analysis based on lat-long and quality of FMLA road data
11	Posted Speed Limit	Number	Line analysis based on lat-long and quality of FMLA road data

4.2 Exploration to Create a Function to Track the Observer's Survey Route

One of the objectives for Phase 3 was to explore options for including a route tracking function that operates simultaneously while collecting individual observations in the ROaDS survey. The purpose of this function is to track the route that observers take while making observations and to record how much time they spend to collect the information.

The recording of the time and effort of the ROaDS surveys, by road segment, is useful information to assure that highway segments that receive more time to collect carcass and live animal observations can be compared to highway routes that receive less time and effort by ROaDS survey observers. It allows analysts to determine if road segments with high crash rates, or high wildlife crossing rates are the result of their receiving more attention by observers or because they actually have higher rates of AVCs or safe crossings than other road segments. A route survey that operates simultaneously with the ROaDS survey would address any potential skewed results in "hot spot" locations due to excessive efforts to collect data. Thus, a route and time function operating simultaneously with individual carcass or live animal observations allows analysts to adjust, or normalize, observation frequencies and highway segments based on the amount of time different road segments were surveyed.

In Phase 1, using *Survey123*™, a function was devised to operate the ROaDS survey simultaneously with a route survey that recorded "current route data points" or waypoints along the route the observer was traveling. Each waypoint received a time stamp. This approach required the observer to turn on this separate route survey and enter by hand a series of current locations or waypoints along the observer's route. Then the route survey and the individual ROaDS survey observations made along the route were synchronized later through a post-data collection processing program. Data had to be extracted from the ESRI data cloud for the two different surveys on *Survey123*™ and the time stamps for the route's waypoints were aligned with the ROaDS survey's observation time stamps. This data processing proved to be very cumbersome. In addition, the need to enter waypoints while driving along the route was deemed unsafe, since it could not be automated in *Survey123*™.

4.2.1 Potential Solutions for Synchronizing Tracking of Observer's Route with Animal Observations

In Phase 3, other route recording application options were explored to synchronize the route's location with each ROaDS survey observation. Five different options were explored by the ROaDS research team and are described below. Each sought to improve the potential to include an efficient means to track and record the location and time spent on survey routes so their observations can be differentiated from opportunistic/random AVC and safe wildlife passage observations. The ROaDS research team focused primarily on ESRI-based *ArcGIS* applications, but also reviewed other commercial solutions and a customized application.

4.2.2 ESRI *Tracker*™

With great promise, ESRI released a new application in December 2019 called ESRI *Tracker*™ (online at: https://www.esri.com/en-us/arcgis/products/arcgis-tracker/overview). This is part of ESRI's suite of geospatial tools, of which *Survey123*™ is one example. The *Tracker*™ app allows organizations to record the locations of their employees. Employees can turn *Tracker*™ on or off, but when it is on it automatically records their route and their location. The *Tracker*™ app stores the observer's route in the ESRI cloud. These data are then available for analysis.

Tracker™ can be used in conjunction with the ROaDS survey. FWS or NPS employees performing a planned monitoring or research route could start by turning on *Tracker*™ and then proceed with recording individual observations using the ROaDS survey. The ROaDS survey's individual observation data could then be correlated with the *Tracker*™ route data. The correlation of route data with individual observations could be done manually or be programmed to synchronize *Tracker*™ and *Survey123*™ data automatically, since both data sets would be stored together in the ESRI cloud database. This synchronization could be accomplished based on the ESRI identification number of the observer and the date and time stamps of both *Tracker*™ and *Survey123*™ data.

4.2.3 ESRI *Collector*™

Collector™ (online at: www.esri.com/en-us/arcgis/products/collector-for-arcgis/overview) is another ESRI app suited for the collection of field data. *Collector*™ allows observers to record a variety of observations through structured data forms. In principle, it supports functionality like that of *Survey123*™. *Collector*™ differs from *Survey123*™ with its ability to collect a series of geographic points or areas, such as polygons. A convenient feature of *Collector*™ is that it permits automatic collection of points as an observer is moving through the landscape.

In spite of these features, it would not be straightforward to move the ROaDS survey onto the *Collector*™ app. Using *Collector*™, the individual carcass or live animal observations and the data points tracking the route of the observer would need to be implemented as separate actions. Thus, an observer can only conduct one of these functions in *Collector*™ at a time, either automatically record a series of survey points to track the route or record an observation. It could be possible, though cumbersome, for an observer to switch between these features along a survey route. The resulting series of path segments, each a component of the route of the observer, and the animal observations could then be integrated, after the data are collected, in the ESRI cloud database.

An alternative approach would be for the data collector to use *Collector*™ to record a series of observations along a survey route and then manually record the survey path by "dropping pins" on the map provided by *Collector*™ on the mobile device. This approach would only record approximate locations of the survey as the pins would not be based on GPS readings. This unwieldy approach can already be used within *Survey123*™ using the ROaDS survey Phase 1 form, where users can record a series of individual observations and waypoints that track their survey route within a single form. Again, this option is unwieldy and unsafe for the observer driving along a route.

4.2.4 ESRI *Explorer*™

Explorer™ (online at: www.esri.com/en-us/arcgis/products/explorer-for-arcgis) is a full featured ESRI product that allows geographically distributed teams to collaborate in the field. As such, the location of the workers is exchanged in real time. These workers may also collect field reports designed similarly to *Survey123*™ forms.

Explorer™ could be adopted to house the ROaDS survey by recording real-time observer locations and then correlating them with the individual carcass and live animal observations. If the ROaDS survey form were to be moved to the *Explorer*™ app, it would need to add data fields to allow users to start and end a route tracking survey. This would allow the *Explorer*™-based ROaDS survey to have GPS locations automatically recorded between individual carcass and live animal observations. The ROaDS survey on *Explorer*™ would record a series of observer locations to track the route taken and automatically correlate them with individual observations.

4.2.5 Other GIS Software

There are several other GIS data collection platforms that can record spatially precise locations that are available from other commercial providers; examples include *MatGIS*, *Fulcrum*, *EZTag CE*, or *TerraGO*. The functionality of these platforms performs like ESRI *Collector*™ in that administrators can design data collection forms that observers fill out in the field. The observations are geo-tagged and stored in an online database. Using map export features and the same data fields as the ROaDS survey, these data could subsequently be imported into the ESRI cloud for analysis. However, none of these app platforms provide an automated location tracking functionality that can be synchronized with the collection of individual observations.

4.2.6 Custom Application

It is possible to develop a custom application for the ROaDS survey that allows for individual observations and route tracking location data collection to be synchronized. Such an app could be based on the React Native framework, which allows developers to build the app in JavaScript, a common app language. The app could be developed for use in both Android and iOS (Apple) environments. An example of such a customized app, one that can synchronize the collection of both route tracking and individual observation data, is the *Unstable Slope Management Program* (USMP) app, online at: https://play.google.com/store/apps/details?id=com.usmpproject. This was developed by Montana State University for use by multiple transportation agencies so that observers could record emergency field information on landslides that impact roads.

A custom app could collect the ROaDS survey form's data along with the GPS location of each individual observation. At the same time, the custom app could support a start/stop survey route

functionality, which would automatically record observer locations throughout their planned path for monitoring or research. This app's data could then be exported to the ESRI cloud for analysis.

4.2.7 Evaluation of Route Tracking Applications Summarized

The present options do not provide a perfect solution. The lowest cost solution would be to add location tracking using the ESRI *Tracker*™ to the current ROaDS survey that uses the *Survey123*™ app. The downside to this approach is that users would have to manage two ESRI apps simultaneously as part of their scheduled monitoring or research routes. Additional software design work would be required to synchronize the two datasets stored in the ESRI cloud database.

Another option would be to redesign the ROaDS survey so it could be moved from the ESRI *Survey123*™ app to the ESRI *Explorer*™ app. This would allow the collection of individual carcass and live animal observations to occur in conjunction with automated server-based tracking of the observer's location. This effort would require the redevelopment of both the ROaDS data collection form and the processing of the data after they have been collected (front-end and back-end redesign).

Finally, the development of a custom application would require the most resources to accomplish; however, it could provide the smoothest field survey and activity workflow. A distinct advantage of a custom app would be that it would allow ROaDS data to be collected by the public, which is not currently possible with the ESRI suite of tools that require all data collectors to have ESRI accounts. A distinct disadvantage would be that the app would require special knowledge to update, support and maintain its functionality and operation, all requiring annual funding from the FWS and NPS.

At the conclusion of Phase 3, due to the lack of a simple, relatively inexpensive means to develop a route tracking function for the ROaDS survey, the feature has not been added to the system.

4.3 Beta-test of ROaDS Survey

The ROaDS research team conducted a beta-test of the Phase 3 ROaDS survey after it was modified based on the recommendations from Phase 2 of this project. During the Phase 3 beta-test, as feedback was received by the ROaDS research team, programming adjustments were made to accommodate FWS and NPS concerns and feedback.

The ROaDS project's (TAC) provided suggestions for recruiting management units and individuals willing to volunteer to test the ROaDS survey while conducting their normal duties. The ROaDS research team sought volunteers representing a variety of functions and with varied wildlife expertise from various national parks and national wildlife refuges (e.g., biologists, law enforcement, maintenance). Thirty-five volunteers registered to have access to the ROaDS survey for the beta-test. This total number included members of the ROaDS research team and the project's TAC. A summary of the volunteers and their locations can be found in Table 6.

In general, total participation in the use of the beta-test of the ROaDS survey and the collection of individual observations was very low given the number of volunteers that were registered (Table

6). It appears many volunteers used it only once. It is assumed that a single use indicated a volunteer sought to explore how to use the ROaDS survey, not to engage in regular collection of carcass or live wildlife observations.

Table 6: Summary of the beta-test of the ROaDS survey, its volunteers, agency affiliation and locations where data was collected.

State	Organization	# of Beta-Testers	Park, Refuge, Area, etc.	# of Observations
Colorado	FWS	1	Denver	0
Colorado	NPS	2	Dinosaur National Monument	0
Florida	NPS	11	Everglades National Park	1
Idaho	FWS	1	Southern Idaho	2
Idaho	FWS	1	Bear Lake National Wildlife Refuge	58
Maine	FWS	1	Craig Brook National Fish Hatchery	1
Massachusetts	USDOT	2	Cambridge	0
Montana	NPS	1	Glacier National Park	0
Montana	WTI	4	Bozeman	9
New York	FWS	1	Montezuma National Wildlife Refuge	1
Oregon	FWS	2	Klamath Refuge Complex	44
Virgina	FWS	3	Virgina	0
Washington DC	NPS	1	Washington DC	0
Other	NPS/FWS	4	Multiple States	6

There were two locations, one in Idaho (Figure 3) and one in Oregon (Figure 4), where individual volunteers from the FWS used the ROaDS survey frequently to collect a robust quantity of roadkill observations in the area where they work. The data collection was not limited to refuge roads; many observations were collected outside their refuges on their way to and from work.

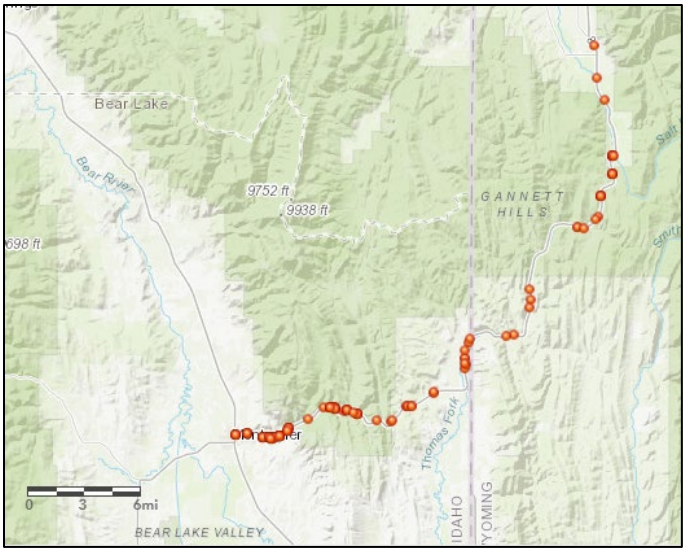

Figure 3: ROaDS survey observations recorded along the Idaho and Wyoming border during the beta-test (*n* = 58).

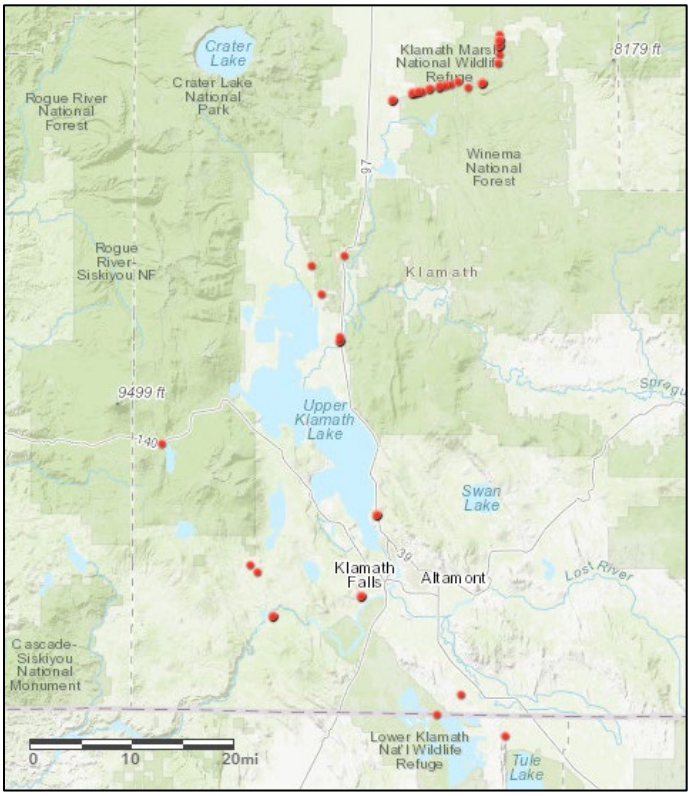

Figure 4: ROaDS survey observations recorded in southern Oregon and near the border of California (*n* = 44).

4.4 Evaluation of the ROaDS Survey

The project recruited a small number of volunteers from the FWS and NPS to beta-test the ROaDS survey, so feedback to the ROaDS research team was limited. Rather than distributing a questionnaire to all beta-test volunteers, the two individuals who used the survey most frequently

were contacted individually via phone to obtain their assessment of the ROaDS survey. Feedback from these beta-test volunteers identified weaknesses, strengths, and suggestions for future improvements. This feedback will be addressed in Phase 4 of the project to further streamline the use of ROaDS and increase the quality of data collected. A summary of the feedback is categorized into weaknesses, strengths and suggestions for improvement.

Weaknesses in the ROaDS Survey identified by beta-test volunteers:

- Updates did not always appear automatically. This caused confusion with users when their ROaDS survey stopped working. After users updated the survey, they were able to continue collecting data.
- Only allowed one photo for each observation. This is a storage limitation of the overall ROaDS system developed in *Survey123™*.

Strengths in the ROaDS Survey identified by beta-test volunteers:

- The ESRI Map Viewer is very useful for agency managers to visualize data.
- The geolocator worked very well. It was great to look at the map provided on the app to see where you are.
- Reporting live animal crossings is a plus.
- Time to enter an observation is about 1 minute, not including stopping, safety, and identification.
- Very easy to use, very quick.

Recommendations to improve the ROaDS Survey identified by beta-test volunteers:

- Add a data field to record what was done with the animal carcass (e.g. removed, dragged off road, no action, etc.).
- Live animals crossing the road is more difficult to remember to do.
    - Confusing, never used it. Did not have time to stop every time a deer is crossing the road during migration season.
- Provide customized species lists for each state.
- Remove the user affiliation. This should be auto populated or remembered by the mobile device once logged in with personal ESRI account.
- Combine monitoring program and research project in the Purpose of Observation data field. ROaDS managers should also be able to look up project codes so they are able to learn more about the project to see what type of data they are collecting and if it would be useful for general analysis, or if they are only looking for certain types of species.

4.5 Summary of the ROaDs Survey Modifications in Phase 3

The final ROaDS survey consists of 11 data fields that users complete while documenting carcass or live animal observations in the field; nine of the data fields must be completed in order for the observation to be accepted by the system and uploaded to the ROaDS database and made available for post-data collection analyses and mapping functions. The other data fields are either auto-filled or the observer is not required to complete the data field (e.g., the comment text box). After data

are collected at the site of the observation, there are 11 additional data fields that are automatically filled by a post-processing program developed by the ROaDS research team and located on the MSU ESRI server for Phase 3. Overall, the use of ROaDS by the beta-test volunteers was relatively low, but those who did use the mobile device application found it to be an extremely useful tool for collecting AVC data. There were not many beta-test volunteers who used the ROaDS survey to capture live animal observations, due to user time constraints.

Three new data fields were added to the final ROaDS survey in Phase 3. The "Purpose of Observation" data field was added because there is no current method to apply a route-tracking function using the *Survey123*™ app. It allows random opportunistic observations to be separated from deliberate observations collected for monitoring programs or research projects.
The species list has been finalized; it allows an observer to type in any species not on the list, as well as capture domestic animals, such as livestock, that may be found dead along roads. This may prove helpful for FLMAs with open range grazing or grazing allotments.

Lastly, locations of live animals crossing a road, or alive adjacent to the road, can now be recorded. All these improvements, along with a safety warning to the ROaDS survey user when recording each observation, makes this survey ready for national deployment by the FWS and NPS.

5 NPS AND FWS PARTNERS' USE OF THE ROADS SURVEY

Many state and federal transportation, land management, and natural resource agencies collect some data on AVCs; however, this can often be a piecemeal or an opportunistic approach. Most AVC data collection systems focus on common large ungulates that pose a risk to human safety. The quality and quantity of these data vary widely across geographies and management agencies.

In addition, there is a general lack of standardization in terms of the types of data collected by the various agencies and organizations. In Phase 3, the ROaDS project sought to determine if partners of FWS and NPS would be willing to utilize the ROaDS survey. Particularly if they had licenses for ESRI *ArcGIS*™ and *Survey123*™. Currently, post data processing is only available for beta-testers recruited by the ROaDS research team. When an organization installs the ROaDS template on its personal ESRI account, users are not provided with the additional autofill data (Table 5). This process is specifically for the ROaDS survey developed for the NPS and FWS and will be implemented to the survey when the DOI takes control of the survey and implements it nationwide.

ROaDS can provide an easily adoptable system to partners seeking to engage in AVC data collection, particularly partners with limited capacity to develop their own AVC data collection system. Therefore, in Phase 3, the ROaDS research team engaged non-governmental organizations (NGOs), tribes and other partners to determine their interest in using ROaDS under their own ESRI *ArcGIS*™ license. It allowed partners to collect the same data using the ROaDs survey as the FWS and NPS, that then could be shared among multiple organizations and agencies, if willing. It also allowed partners to collect information on smaller-bodied taxa important for conservation, often not reported by transportation agencies.

ROaDS created an opportunity to coordinate the collection of AVC data, particularly if the partners have licenses for *ArcGIS*™. This allows for the use of identical data fields as those developed in Phase 3 for FWS and NPS users. It allows for seamless coordination in the types of data collected (i.e. the data fields) as well as the spatial accuracy of carcass or live animal locations (i.e., GPS coordinates). Lastly, the species list was modified by the ROaDS research team for FWS and NPS partners' needs, upon their request.

5.1 Role of NGOs in AVC Data Collection

As part of the Phase 3, two NGOs, ARC Solutions (ARC) and the Center for Large Landscape Conservation (CLLC), cooperated with the ROaDS research team to gauge whether FWS and NPS partner organizations were interested in adopting ROaDs for their own purposes. If they were, CLLC staff worked with the ROaDS research team to provide the ROaDs survey to the partner organizations, helped modify the species list, when requested, and moved the ROaDS survey to the partners' independently licensed ESRI *ArcGIS*™ online platform. For FWS and NPS partners with *ArcGIS*™ licenses, it allowed those organizations with the capacity and the interest to use ROaDS an easy means of acquiring an AVC data collection system. Three NGO organizations adopted the ROaDS survey to beta-test the system as well as two tribal wildlife agencies. Now that these organizations have ROaDS operating on their own ESRI platform, and staff or volunteers have been trained to use the system, four of the five organizations will continue to use ROaDS for AVC data collection after Phase 3 concludes.

5.1.1 NGO Supported Citizen Science

In 2020, CLLC began a citizen science data collection effort for US Highway 89 in Paradise Valley, Montana. This stretch of road connects Interstate Highway 90 to the northern entrance of Yellowstone National Park, at Gardiner, MT. Paradise Valley represents important winter range and migratory habitat for many of Yellowstone's iconic wildlife species. Over half of all reported crashes on this stretch of US Highway 89 involve wildlife, according to Montana Department of Transportation's (MDT's) crash data. NGO members would like to collect additional carcass data to supplement MDT's crash data. Also, MDT does not collect locations where wildlife safely cross the road or where they are alive next to the road. Thus, community members in Paradise Valley came together to collect better data for the purposes of developing well-informed solutions.

During Phase 3, a group of citizen scientists began, and still continue, to collect data using the ROaDS survey through the support of a local NGO. The Common Ground Project has begun a systematic weekly survey of Highway 89 using the ROaDS survey. CLLC has helped the local group adopt the ROaDS survey onto the organization's ESRI *ArcGIS*™ platform. A summary of the data they have collected can be seen in Table 7. A visual interpretation of the data can be seen in Figure 5.

Table 7: Summary of the data collected along Highway 89 in Paradise Valley, Montana.

Species	# of Observations		
	Alive Crossing the Road	Alive Next to the road	Dead
Big Horn Sheep			1
Coyote			1
Elk	5	16	11
Mule Deer	8	9	13
Raccoon	8		
Red Fox	1		3
Sandhill Crane		1	
Striped Skunk			9
Whitetailed Deer	7	4	9
Other Mammal			5
Unknown Deer	1	1	6

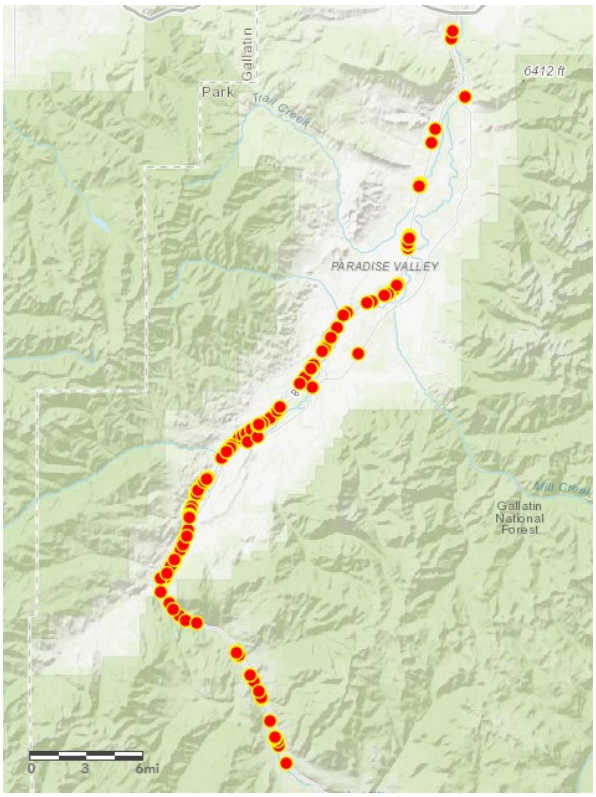

Figure 5: Data collected in Paradise Valley, Montana, between July 2020 and February 2021 (*n* = 119).

CLLC has also begun a citizen science data collection effort on a segment of US Highway 191 that winds through the Gallatin Canyon between Gallatin Gateway and West Yellowstone, MT. Again, this area is important winter range and migratory habitat for wildlife moving seasonally from Yellowstone National Park to surrounding state and Federal public lands. This carcass and live animal data collection using the ROaDS survey will take advantage of CLLC's ESRI *ArcGIS*™ license. The effort will continue for at least one year and is part of a larger study of the highway conducted by CLLC and its partners.

5.1.2 Road Warriors Tortoise Group

In the Las Vegas, NV area, FWS has partnered with a local NGO, the Tortoise Group and its Road Warriors program. The Road Warriors are a group of volunteers who conduct road surveys for the threatened Mojave Desert Tortoise (DT) and other species. In previous seasons, the Road Warriors collected DT mortality data using paper data sheets and photos. The Tortoise Group is then responsible for entering and organizing the data by hand on computers, which has been a challenge due to limited volunteer staff capacity. In Phase 3, CLLC customized the ROaDS survey for the Road Warriors' needs by adding a few additional data fields specific to the project and customizing the species list to reflect the Mojave ecosystem. The Tortoise Group now has a ROaDS survey modified for its use under its own ESRI *ArcGIS*™ license. ROaDS provides a significant benefit to the group, as it reduces the amount of staff time needed for transcribing data collection and reporting via paper forms.

5.2 Tribal Agency Use of ROaDS

Two tribal groups tested the ROaDS survey in Montana with their wildlife agency personnel. The first, the Blackfeet Nation, was given permission to use ROaDS located on the server at MSU. The second, the Confederated Salish and Kootenai Tribes adopted the ROaDS survey under their own ESRI license. They intend to continue to collect and store data on their own ESRI cloud database after Phase 3 is concluded.

5.2.1 Blackfeet Nation

In 2019, CLLC and the ROaDS research team piloted ROaDS with the Blackfeet Nation's Fish and Wildlife Department in northern Montana. AVC data were collected for large and small wildlife. In addition, livestock carcass data are rarely collected on many of the tribal roads and are underreported. CLLC provided ROaDS to tribal game wardens to collect data to be included in a reservation-wide animal-vehicle collision study. While that data collection effort was short-term for the purpose of the study, it demonstrated that tribal use of ROaDS can help overcome the paucity of information that exists on wildlife and livestock conflicts with roads.

5.2.2 Confederated Salish and Kootenai Tribes

The ROaDS survey was distributed to the Confederated Salish and Kootenai Tribes (CSKT) in western Montana. The ROaDS research provided CSKT with the ROaDS survey template and they installed it under their own ESRI license. Tribal wildlife wardens collected data from June 7, 2020 until January 25, 2021 at the end of the Phase 3 project. They accumulated 89 AVC observations. A summary of the data collected by the CSKT (Table 8), and a map of the data points (Figure 6) demonstrate carcasses of a variety of large and small animals, as well as threatened species were observed. The tribal wildlife staff were interviewed regarding the efficacy of ROaDS, and they stated the system was easy to use.

Table 8: Summary of the AVC data collected by the CSKT using the ROaDS survey.

Species	Number	Fate
Bald Eagle	1	Dead
Black Bear	6	Dead
Coyote	1	Dead
Grizzly bear	2	1 dead/1 alive
Great horned owl	3	Dead
Mule Deer	5	dead
Other Mammal-bobcat	1	dead
Unknown deer	1	dead
White tailed deer	65	dead

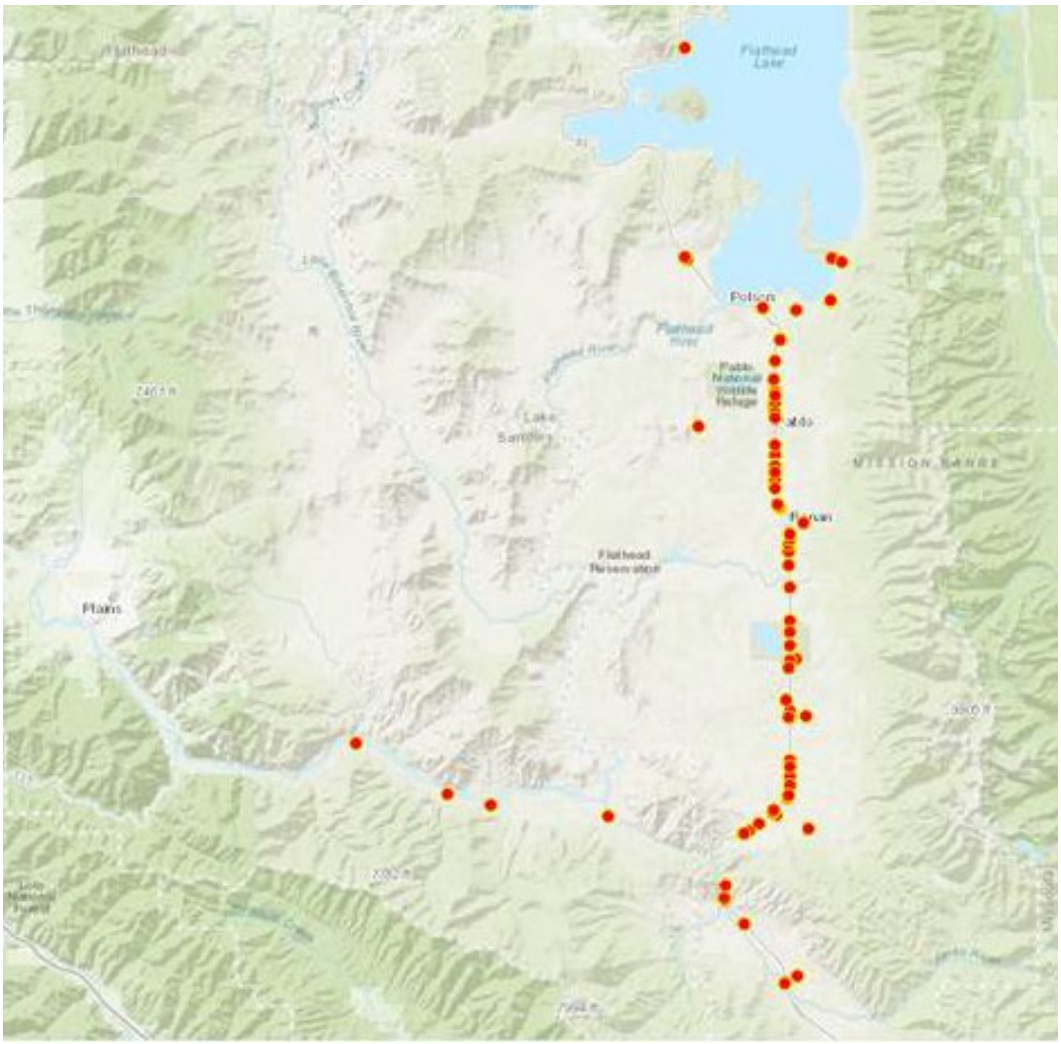

Figure 6: Data points collected by the CSKT between June 2020 and January 2021 (*n* = 86).

5.3 State Transportation Agency Use of ROaDS

In addition to these groups, CLLC and the ROaDS research team conducted significant outreach to potential state agency partners to gauge their interest in adopting ROaDS for their own AVC data collection efforts. State DOTs and state DOWs have shown great interest in using a system like ROaDS to standardize data collection across their agencies and jurisdictions. While none of the state agencies approached in Phase 3 formally adopted ROaDS, several are exploring similar mobile device data collection systems. Some use an ESRI platform, others do not. Although they did not adopt ROaDS, these state agencies are interested in standardizing their data fields with FWS and NPS, even if they select a different data collection system. Similarly, other NGOs who collect AVC data using different platforms have been willing to standardize data fields in their efforts to eventually share data. While the ESRI platform may not be the best option for an AVC data collection platform for all users, developing a standardized data collection methodology with high spatial accuracy is of interest to nearly all agencies contacted.

6 EXPLORATION OF PLATFORMS TO HOST ROADS FOR OPERATIONAL USE

In Phase 1 of the ROaDS project, after evaluating many different commercial and freeware wildlife data collection applications, it was agreed to develop an AVC data collection system for the NPS, FWS and other DOI bureaus and agencies based on ESRI's *Survey123*™ mobile device application. This app is part of a suite of applications available on ESRI's *ArcGIS*™ platform.

The DOI has an ESRI license that makes *ArcGIS*™ and *Survey123*™ as well as other ESRI applications available to all its bureaus and agencies. Many DOI employees are familiar with the ESRI platform and its apps. Similarly, the ROaDS research team had access to ESRI's platform and apps via Montana State University's (MSU) license; therefore, it was able to develop and test ROaDS using the same ESRI products.

An objective of the ROaDS project, at the end of Phase 3, was to determine the best platform to make ROaDS ready for operational use by DOI bureaus and agencies after completion of its development and testing. The team searched and evaluated various options for hosting ROaDS and settled on three of the best candidates for a more detailed review:

1. Transfer ROaDS to individual DOI bureaus and agencies to operate ROaDS independently but serviced and coordinated by the ROaDS research team at MSU.
2. Transfer ROaDS to a DOI-wide platform accessible to all its bureaus and agencies and one that supports the necessary ESRI products.
3. Transfer ROaDS to a commercial-based solution being used by the Federal Highway Administration (FHWA) via another commercial platform.

The team explored each option's capability, fit and long-term support.

6.1 Transfer ROaDS to Individual DOI Bureaus and Coordinate at MSU

ESRI's *ArcGIS*™ is the most common spatial analysis platform used in the United States. Given the DOI's familiarity with ESRI, the potential to transfer the system relatively easily to the DOI or another appropriate, secure, federal agency with an ESRI license was evaluated in Phase 3. Some of the benefits of transferring the ROaDS Survey onto DOI's own ESRI *ArcGIS*™ platform include:

- ESRI *ArcGIS*™ has many user-friendly applications such as *Survey123*™.
- DOI agencies have had ESRI licenses for many years.
- Many DOI employees use different facets of *ArcGIS*™ and its various mobile data collection, desktop mapping, and analytical applications on a regular basis.
- DOI IT technicians are familiar with its use and have the capacity and expertise to support the ROaDS Survey already in place.
- DOI bureaus and agencies are not limited to how many employees can sign up on their ESRI account and use the ROaDS survey.
- DOI bureaus and agencies can publish and then share the ROaDS survey with their entire organization, which means any employee with a DOI *ArcGIS*™ account can be given access to the ROaDS Survey database (with data managers' concurrence and approval),

and any employee with a DOI-approved mobile device can upload and record observations of roadkill using the ROaDS data form in the field.

Some of the challenges for each DOI bureau and agency to host the ROaDS survey on DOI's server, but separately via each agency's license with the ESRI *ArcGIS*™ platform include:

- Although each agency has its own ESRI license and controls its own data, a methodology of sharing ROaDS survey data among all the DOI bureaus and agencies has not been developed as part of the ROaDS project.
- The ROaDS survey, when implemented and managed behind DOI firewalls, cannot be shared by DOI agencies and bureaus with their non-DOI partners to help them directly collect AVC data on ROaDS' DOI platform. If state or local agencies, tribes, and citizen scientists have ESRI *ArcGIS*™ licenses, the DOI's ROaDS non-proprietary data form (ROaDS survey) can be shared with these entities for their independent use, with the data stored on their own databases. This will enable sharing of these independently implemented datasets in the future (once methods and data quality/screening standards are created).
- If one DOI bureau or agency makes changes to its ROaDS survey, it will require outreach to all other DOI agencies or external partners to encourage these entities to adopt the new data form or to adapt their existing independent data forms to incorporate the changes.
- While ROaDS data resides on each agency's portion of the ESRI server, it still needs to be augmented via post-collection data processing to add other information (see Table 3). It would need to be determined where post-collection data processing will take place for each DOI bureau and agency.

6.2 Transfer ROaDS to a DOI-wide Platform

A more streamlined option is to continue using ESRI's *ArcGIS*™ platform and its *Survey123*™ mobile device application for the ROaDS survey, but have it hosted on a platform with servers at the DOI-wide level. This would assure that all future modifications, updates, and changes to ROaDS would be simultaneous for all DOI ROaDS users across its various agencies and bureaus. In addition, it would make sure all data are stored at the same location for all bureaus and agencies to share for use in analyses, regardless of which organization collected the data.

There are two alternatives for adapting ROaDS for deployment by a single DOI host, rather than have each DOI bureau and agency manage and maintain its own version of ROaDS as outlined in section 6.1.1. The ROaDS research team identified two potential platforms to host ROaDS to make it operational Department-wide: 1) DOI's Landscape Decision Tool, and 2) DOI's Geo-platform. Both platforms would require DOI IT personnel to manage the account for ROaDS and its use at the local (management unit), regional and national scale.

The ROaDS research team held discussions with a DOI IT team familiar with both its Landscape Decision Tool and Geo-platform. The specialists jointly determined that Geo-platform was the more suitable of the two existing platforms for the long-term hosting of ROaDS. Geo-platform provides access to an ESRI *ArcGIS*™ database and *Survey123*™. ROaDS currently stores its data in ESRI *ArcGIS*™ database via MSU's license, so the migration of ROaDS and its data from MSU servers to Geo-platform would be relatively easy and not require data reformatting.

Lastly, Geo-platform can be linked with Amazon Web Services (AWS) (already available to DOI agencies via Zivaro), a commercial cloud platform that is comprehensive and widely adopted worldwide. AWS servers would be used by DOI to process post-collection data (Table 3). This function was developed by the ROaDS research team throughout the project's three phases and currently is housed on MSU servers. To make ROaDS fully operational at DOI, the data augmentation function would also be moved to the Department. DOI IT personnel would provide ongoing support for ROaDS on Geo-platform and could oversee the contracting of the post-collection data processing function on AWS.

6.3 Transfer ROaDS to a Federal Highway Administration Platform.

Salesforce is a private server that many government agencies and international companies use to collect, access, and manage data collected by their users. Currently, FHWA has finished a pilot test of its Mobile Solutions for Assessment and Reporting (MSAR) application with Salesforce and is moving forward with its full development. The MSAR app will allow users with mobile devices (e.g., smart phones, tablets) to collect data in the field on the condition of transportation infrastructure after natural disasters, including spatial location information. The FHWA is planning to take ownership of MSAR upon completion of the pilot, but MSAR will still be hosted by Salesforce. One consideration for ROaDS to use this private server along with MSAR is that federal agencies are not limited to the number of people who can register to use ROaDS, and they do not have to be employees of the DOI, as in the other options explored in this task.

Currently, the MSAR app can be distributed to Federal, state, local, and tribal governments when a natural disaster happens. Potentially, ROaDS can be added as an additional app parallel to the MSAR application and distributed to the same agencies. As a result, all ROaDS data collected by DOI employees, as well as their partners, would be stored on the same server. To control access to sensitive data, individuals will need to be given permission by DOI ROaDS managers. Salesforce has many security levels capable of handling any security that the DOI would require.

One complication for ROaDS to use Salesforce along with MSAR is that the ROaDS survey developed by this project on the ESRI platform will need to be adjusted to meet the coding requirements of the new platform. Also, DOI does not have an existing commercial license with Salesforce, so there would be costs for hosting, maintaining, supporting, and modifying ROaDS on the platform.

6.4 Recommended Option to Host ROaDS After Phase 3

For the following reasons, at the end of Phase 3, the ROaDS research team recommends moving ROaDS to DOI's Geo-platform, given it can support ESRI's *ArcGIS*™ platform for ROaDS. As a result,

- Minimal changes to the code base are needed to move ROaDS from MSU servers to the DOI-wide server. Thus, DOI agencies and bureaus can immediately deploy what has been developed at the conclusion of Phase 3 of this project.
- DOI's Geo-platform is capable of supporting and maintaining ROaDS.
- Updates and modifications to the ROaDS survey will be consistent and simultaneous across all DOI bureaus and agencies.

- The ROaDS research team can also move the ROaDS post-data processing capabilities to servers controlled by DOI so the data is protected and secured inside the DOI's IT system.

It should be noted that with ROaDS hosted on DOI's Geo-platform, the ability for non-DOI partners to collect AVC data using the same platform in cooperation with DOI agencies will be limited. Rather, the ROaDS survey and its data fields will need to be shared with non-DOI partners for their independent use under their own ESRI licenses (the same way as explained in Chapter 5). DOI and non-DOI AVC data collectors that use the same ROaDS forms would then need to work together outside of their platforms to share the standardized data to look at AVC trends and priorities across larger regions, jurisdictions and landscapes to collaboratively target mitigation where most needed.

7 ROADS USER MANUAL AND WEBINAR

A manual and a webinar were created by the ROaDS research team to support the users of the system with practical information. Together the ROaDS User's Manual for Phase 3 (User's Manual) and the webinar provided directions, advice, and information on the collection, management and use of the data. The User's Manual and webinar were created specifically for Phase 3 of the project. Other DOI partners, such as NGOs and tribal agencies used the Manual for guidance when adopting ROaDs under their own ESRI licenses.

Currently the ROaDS survey and its database are hosted by MSU under its license with ESRI. In Phase 3, the User's Manual was designed to reflect this existing location of ROaDS. It is envisioned that after Phase 3, ROaDS will be transferred to a platform at the DOI. When this transfer is completed, the User's Manual will need to be updated to reflect the new location, the resulting alterations to the registration process for DOI employees, the changes to the procedure to give select bureau or agency managers access to the ESRI's cloud-based data storage, and other details that have been modified for the collection, storage and use of ROaDS data.

The User's Manual explains the safety features of the ROaDS survey, as well as the data fields that are completed for each observation. In addition, the ROaDS User's Manual explains how to give permissions to agency managers to access the ESRI cloud-based database to review the geo-synched carcass or live animal photos and confirm species identification as part of quality control and assurances for the data. The User's Manual also provides technical information for issues and difficulties encountered by FWS and NPS employees during the beta test. Finally, the manual explains how to create maps for reports, the process required to extract carcass and live animal observation data from the database, and various other functions of the system.

The ROaDS research team recorded a webinar that can be distributed to agency personnel – users, managers, IT personnel – to understand the purpose and benefits of ROaDS upon completion of Phase 3.

This chapter provides a brief summary of the User's Manual (Appendix C) and the informational webinar, which was hosted by the National Center for Rural Road Safety.

7.1 Review of ROaDS Data Flow at the End of Phase 3, from the Point of Observation to Storage and Retrieval on a Cloud-based Server.

ROaDs and its data collection, processing, storage and retrieval for analyses and reports were developed on the MSU server for Phases 1, 2 and 3 of the project and are summarized in a brief overview of the data and how it flows through a five step process (Figure 7):

1. Data is collected on a mobile device using the ROaDS survey on the S*urvey123*™ app.
2. Uploaded observations are sent to the owner's (DOI bureau's or agency's) server in the ESRI cloud for storage.
3. Observations are then automatically sent to an external server where user data and location information are further processed to create additional information about the observation (e,g,, the state where the observation was made, the NPS or FWS management unit the observation was located).

4. After post-collection processing, the data is then sent back to the agency's or bureau's portion of ESRI's cloud-based server. Employees with access (i.e., managers, expert biologists, as permitted by the bureau or agency) can now review each observation's species identification and compare it to the geo-synched photo. At this point, managers can filter the data to select which information can be viewed or downloaded by employees (e.g., managers can restrict access to information about threatened and endangered species).
5. Data is now available to all employees and is posted to the online map of ROaDS on the *ArcGIS™* Map Viewer. The data is also available to download for analyses in other programs.

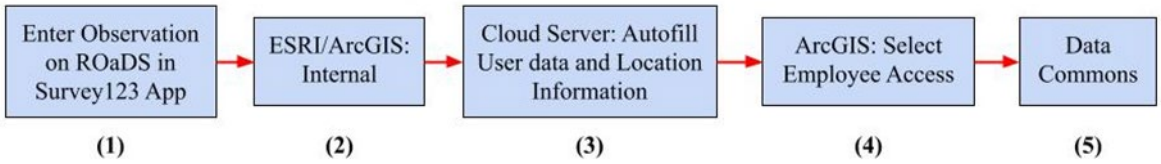

Figure 7: Schematic for how data collected via the ROaDS survey flows through the data server.

7.2 ROaDS User's Manual for Phase 3

The User's Manual has three chapters (Appendix C). The first chapter explains how to install the ROaDS survey onto an agency's ESRI account, create groups (e.g., NPS or FWS management unit, region), and understand the different roles associated within the ArcGIS *Survey123*™ system and ROaDS (i.e., assign the proper roles to employees so only authorized personnel have access to sensitive data).

The second chapter explains how users within the groups install the ROaDS survey on their personal or employer assigned mobile device, as well as tips for collecting AVC data.

Chapter Three is an overview of *ArcGIS Map Viewer*™ and the different features available to managers to view and analyze data. *ArcGIS*™ provides in depth detailed manuals for all of its different software. This manual is intended to act as quick guide to users to understand the process of creating and using a ROaDS survey. More detailed information can be found on *ArcGIS*™ web pages.

7.2.1 Chapter 1: Installing the ROaDS Survey

This chapter of the User's Manual explains, in more detail, the different roles that exist within ArcGIS™ Online and how these roles are extended to users of ROaDS (the three key roles were explained in the introduction to Chapter 4 of this report). Chapter 1 of the Manual describes the process on how to create groups in *ArcGIS™* Online, add content, and make changes to the ROaDS survey developed by each group. Groups can be organized in many ways, and the way in which they are organized depends on their intended use. For example, if the NPS hosts the ROaDS survey, the agency can choose to set up its groups by park, state, or region. The more encompassing a group, the more data that can be accessed by members of the group, both data managers and users. Data collected by different groups cannot be accessed by members of other

groups. Thus, to share data, an individual user must download the data from the group's portion of the database and then send it to a user from a different group.

For a better understanding of the various roles, a step-by-step process for creating new groups and surveys, and how to add those surveys to a group, see Appendix C, Chapter 1.

7.2.2 Chapter 2: Using the ROaDS Survey

Chapter 2 of this manual explains how users install the free *Survey123*™ app onto a mobile device and install the ROaDS survey. To access the ROaDS survey, users must be a member of the group that was created by their bureau, agency or organization. This chapter also offers guidance on how to use the ROaDS survey, including:

- Safety feature information
- An overview of the survey's data fields
- Instructions on answering each question
- Key information to include in data field responses to ensure quality data is collected
- Tips for entering survey responses to ensure that the information is understood by, and useful to, agency managers

For a more complete explanation of using the ROaDs survey see Appendix C, Chapter 2.

7.2.3 Chapter 3: Data Analysis

Chapter 3 of the User's Manual explains how to access, view, and filter carcass and live animal observation data collected with the ROaDS survey, using the *ArcGIS*™ Map Viewer. It provides:

- Instructions on how to access data using the *ArcGIS*™ Map Viewer
- An overview of the functions and features of the Map Viewer
- Tips for understanding the collected data on the map
- Guidance on accessing and filtering the data from the surveys

This manual is primarily intended for agency managers to understand, visualize, and analyze the data collected on the ROaDS survey. Users can view collected AVC data from the ROaDS surveys on a laptop or computer by using the Map Viewer on arcgis.com. The *ArcGIS*™ Map Viewer allows users to visualize collected data and download observations that may be further analyzed using other types of analysis software, but they can also be analyzed in *ArcGIS*™ Map Viewer. The User's Manual introduces the features of Map Viewer and explains how to access, review, and retrieve data. For a more complete explanation of the analysis process, see Appendix C, Chapter 3. For a complete operational manual of Map Viewer, visit the *ArcGIS*™ website (online at: https://doc.arcgis.com/en/arcgis-online/get-started/view-maps.htm).

7.3 Webinar

The ROaDS research team presented a webinar for managers and DOI employees and their partners interested in the development of ROaDs, and outcomes of Phase 3. The webinar was sponsored by the National Center for Rural Road Safety (the Center) and hosted by the Center on 13 April 2021. It provided information on the genesis of ROaDS from Phase 1 through Phase 3,

how simple the ROaDs survey is to complete, and other facets of data collection, management and use. The presentation was recorded and is available online at the Center's webpage, online at: https://ruralsafetycenter.org/training-education/safety-center-trainings/archived-safety-center-trainings/

8 CO-DEVELOPMENT OF NATIONAL STANDARDS FOR ANIMAL-VEHICLE COLLISION DATA COLLECTION SYSTEMS

One of the objectives of the ROaDS, Phase 3 project was to facilitate the collection and sharing of AVC data between the FWS, NPS, other FLMAs and their partners. To this end, this project invested substantial efforts to recruit partners to co-develop parameters or national standards for AVC data collection systems to leverage efficiencies and benefits that have been articulated for commonly derived standards for AVC data collection systems.

The advantages of a national standardized AVC data collection program were described over a decade ago in a National Cooperative Highway Research Program report (Huijser et al. 2007b):

- To more accurately and rigorously document the occurrence of road incidents that cause human fatalities, injuries, and property damage, as well as those adversely affecting natural resource conservation.
- Locations that may require mitigation can be effectively identified and prioritized, justifying appropriate use of limited funding and resources to support safety and wildlife conservation investments.
- The effectiveness of mitigation measures in reducing collisions can be evaluated. This allows for modifications (if needed) and the application of lessons learned at other locations, again allowing for an effective use of resources.

8.1 Two Workshops on National AVC standards

The ROaDS project submitted two successful abstracts, in two successive years, to host workshops on the co-development of national AVC standards at the National Academies' Transportation Research Board's (TRB's) annual meetings. The objective of the workshops was to cooperatively initiate the development of national standards for AVC data collection systems to facilitate the collection and sharing of data by Federal, state, local, and tribal agencies, and non-governmental organizations. Another objective was to enumerate potential pathways and pitfalls to adoption and implementation of national AVC standards. Each TRB workshop was a 3-hour hosted and facilitated gathering. Each workshop had a panel of presentations to set the stage for breakout and plenary sessions to foster discussion and capture recommendations based on the expertise and experience of the numerous attendees.

The first TRB workshop was held in January 2020, for which people met in person in Washington, DC. Over 40 experts convened at the workshop to discuss the need for national AVC data standards. The attendees represented Federal and state wildlife agencies, Federal and state transportation agencies, consultants, academia and professional associations.

The second workshop was held at TRB's 100th Annual Meeting in January 2021. This was held as a virtual workshop and over 110 individuals attended. Attendees, panelists and other presenters included the same diverse mix of professions as the first workshop, but in larger numbers. A unique aspect of the second workshop was a panel that included two staff members of the U.S. Senate Environment and Public Works Committee (EPW), the lead Senate committee that drafts

transportation legislation. The EPW staff presented information on the various bills that were drafted in 2020 that included provisions for national AVC standards and prognosticated that similar language might be put forward in several bills in 2021.

The ROaDS research team completed a final report for each workshop (Appendix A). The final reports were distributed to attendees of the workshops who provided their email addresses to receive further information after each workshop. The final reports were sent to others interested in the subject matter including mailing lists for various TRB committees.

8.2 Workshop Results

Based on breakout sessions at the first workshop in January 2020, participants developed recommendations for several key areas of AVC standard development. Their ideas were shared with, and reviewed by, others in a plenary session so all workshop participants could evaluate, sort, and prioritize a list of recommendations. This resulted in a list of needs or justifications for the development of national AVC standards. It identifies various barriers and challenges in the development and use of national AVC data standards, and finally suggests potential pathways to develop the standards.

At the end of the workshop a list of six action items were developed to support a continuation of the development of standards (see Appendix A). Two key action items were successfully accomplished in 2020 after the conclusion of the workshop. For the first action item, a group of volunteers from the workshop developed recommendations regarding the inclusion of data fields for wildlife in the revision process for the Model Minimum Uniform Crash Criteria (MMUCC). The goal of developing the criteria, according to the National Highway Transportation Safety Administration (NHTSA's) website is "[t]o encourage greater uniformity", and to "cooperatively develop[ed] a voluntary data collection guideline." The MMUCC are revised approximately every five years by NHTSA and its partner the Governors Highway Safety Association.

The second action item was to conduct a second workshop. Originally it was slated to be held at a summer meeting of the TRB committees that sponsored the first workshop. Unfortunately, due to the COVID pandemic, both potential summer meetings were cancelled. Thus, the second workshop was not held until the next TRB annual meeting, held virtually in January 2021.

This successful workshop in 2021 reviewed the action items from the first workshop and continued to hone recommendations for further development. A new avenue for developing national AVC standards - national legislation - was discussed and explored in a panel session and in a breakout session. For the twelve months between the first and second TRB workshops, committees in both the U.S. House of Representatives and U.S. Senate had been working on the next iteration of the federal transportation funding bill, which is scheduled for renewal. Although the House and Senate bills differ in many ways, one thing they both had in common is a stand-alone provision aimed at reducing WVCs while improving habitat connectivity. That provision included a requirement that FHWA develop a standardized methodology for collecting and reporting wildlife crash and carcass data.

The second TRB workshop had concurrent breakout sessions that explored three key facets of national AVC standards. The first was a continuation from the first workshop, which is to

determine the incentives and barriers for states and other agencies to voluntarily adopt a standardized AVC data collection methodology. The second concurrent session sought to articulate the key standards to be adopted that would facilitate the sharing of AVC data among different jurisdictions and agencies, and the third session explored the federal legislative language in more detail. All the findings and lists of recommendations from the second TRB workshop can be found in Appendix A.

9 CONCLUSIONS

ROaDS is now ready to deploy for use by the FWS, NPS and other DOI agencies and bureaus once it is moved from the ROaDS research team's MSU servers to a DOI-wide platform.

After three phases of development, the ROaDS survey offers the following key functions and capabilities. There is a safety warning on the mobile device's screen before an observer fills out data for each observation. This seeks to caution users, so they are aware of their surroundings and act safely while collecting the data. The observer using the ROaDS survey can lock in the carcass or safe crossing location by pushing a button next to a map on the mobile device's screen and then move to a safe location to fill out the data fields.

The ROaDS survey has nine data fields for the user to fill out for each observation. It has a tenth data field to provide comments. After the data of each observation is sent to the ESRI database, post-collection processing adds 11 data fields of information derived from the original data.

The ROaDS species list has common names of 21 species on a pulldown list for national use. It also allows observers to type in the species name if it is not one of the 21 species on the pulldown list. In addition, there are four text boxes corresponding to four different categories: "other livestock," "other mammal," "other reptile or amphibian," and "other bird" for the observer to identify unlisted species.

The ROaDS survey includes the capability for the observer to take one geo-synched photo. To assure species identification is correct, these photos can be reviewed and corrected later, in the database, by agency biologists. These experts must receive permission from a ROaDS manager to access the photos and modify the species named.

The threatened and endangered species identified, and their locations, can be masked and permission to access and share this information from the database can be limited to select ROaDS managers.

The ROaDS information stored on ESRI's database is linked to a webpage that easily displays the locations of the observations on a map of the United States. The same website has pre-programmed capabilities to display the data via a cluster analysis to identify road segments with high numbers of AVCs or safe crossings. Similarly, the website has a heat map function that displays AVC "hot spots" or common crossing sites by live wildlife on the map.

FWS and NPS partners found that the use of the ROaDS survey on their own ESRI account was useful. Both a tribal wildlife agency and a non-profit conservation organization successfully gathered AVC data during Phase 3.

10 RECOMMENDATIONS

For the deployment of ROaDS to be available to all DOI bureaus and agencies, the system will need to be moved from MSU servers used for the research and development in Phases 1, 2, and 3 of this project to a DOI-wide platform. Phase 3 recommends ROaDS be housed on DOI's Geo-platform so that all the Department agencies and bureaus can have access to the system and so it is supported by DOI IT personnel.

The ROaDS research team has identified Geo-platform as the best option, since all bureaus and agencies will have their own ROaDS database. Therefore, they can control access to their own databases. Similarly, they can share data with others only upon request.

For the ROaDS research team to move ROaDS from MSU servers to a DOI platform for deployment, the team must take the following actions:

- Set up accounts, tables, and access controls on Geo-platform with DOI IT personnel.
- Move data from MSU's ESRI accounts to DOI's Geo-platform.
- Identify a server within DOI to host ROaDS server code to perform post-collection data processing.
- Coordinate with DOI IT personnel to move ROaDS server code onto the appropriate DOI server and ensure the new server meets DOI security requirements.
- Integrate the server deployment with Geo-platform tables.
- Provide outreach and education activities to support new DOI users of ROaDS.

The outreach and support functions – maintenance, training, registering users, providing advice on analyses and reporting, continuing the development of national AVC data standards – could be supported by the ROaDS research team or taken on independently by FWS, NPS and a DOI IT team. To facilitate the latter option, details on the current implementation of ROaDS is provided for IT personnel in Appendix C.

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Appendix A: Final Reports for Two National AVC Data Standards Workshops

Developing national standards for animal-vehicle collision data collection systems: brief review and working discussion

TRB Session 1054
99th Annual Meeting of the Transportation Research Board (TRB)
Washington, D.C.
12 January 2020

Workshop Summary

Compiled and reported by

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March 23, 2020

ACKNOWLEDGEMENTS

Thank you to Alex Levy of Vanasse Hangen Brustlin, Inc. (VHB) for co-facilitating the Transportation Research Board (TRB) Workshop. And to Dan Smith, Committee Chair of ADC30, who helped author the abstract to get the workshop slated at the TRB meeting.

Thank you to Elizabeth Fairbank of the Center for Large Landscape Conservation and Renee Callahan of ARC Solutions for collecting notes at the TRB Workshop and taking minutes at the workshop that have been used in this report.

We appreciate all the workshop participants who took their time to attend and provide their expertise at the workshop.

Thank you to all others who supported and engaged in this workshop, such as other TRB committees and their chairs.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This summary is a compilation of the portions of the workshop that were recorded at each breakout session from staff notes and smart phone photos. Thus, we sought to capture important ideas and outcomes and did not have the resources to record the finer details of everything discussed over the duration of three hours, particularly when breakout sessions of 5 sub-groups were meeting concurrently.

Although the title of the workshop used the term wildlife-vehicle collisions (WVCs), in fact, it is more accurate to describe the workshop as exploring standards for the more inclusive term, animal-vehicle collisions (AVCs). AVCs are crashes with wildlife and domestic animals, such as livestock. Many databases collect both types of collisions, those with wild and domestic animals. However, to accurately record the proceedings of the workshop, the term WVC was used almost exclusively.

Over 40 experts convened at the workshop to discuss the need for national animal-vehicle collision data standards. The attendees represented federal and state wildlife agencies, federal and state transportation agencies, consultants, academia and professional associations. Thirty-eight attendees signed the contact sheet. (Appendix A). This was the first nationally convened meeting of experts to discuss the development of national WVC data system standards.

The workshop was conceived and proposed to TRB by Dan Smith of the University of Central Florida and Rob Ament of the Western Transportation Institute of Montana State University (WTI) in conjunction with the support of several TRB committees: ADC30, ANB20 and ADA40. Facilitators of the workshop were Alex Levy, VHB, and Rob Ament, WTI.

2. WORKSHOP AGENDA

The objective of the workshop was to cooperatively initiate the development of national standards for WVC data collection systems to facilitate the collection and sharing of data by federal, state, local, and tribal agencies, and non-governmental organizations. Also, to enumerate potential pathways and pitfalls to adoption and implementation of national WVC standards

The 3-hour workshop was separated into a 15 minute introduction, a 45 minute panel discussion, followed by two 45 minute sessions comprised of facilitated small group discussions (5 groups with approximately 8 people each) with each group reporting out their findings with each other when reconvened as a whole.

The workshop agenda is Appendix B.

After the two small group sessions, a 15-minute plenary discussion of all 40+ attendees was held to suggest pathways to carry forward the recommendations made at the workshop and to continue to engage with other experts, additional stakeholders and agency leaders.

3. PANEL DISCUSSION RESULTS

The first portion of the workshop was set aside for a panel of experts to provide their perspectives on some of their top tier issues and/or criteria that need to be considered for national WVC data standards. It was a diverse group representing the perspectives of federal and state transportation agencies, federal and state wildlife agencies, data analysts, academia and citizen scientists. Speakers included:

- Dan Buford, Federal Highway Administration (FHWA)
- Julianne Schwarzer, Volpe Center, U.S. Department of Transportation
- Bridget Donaldson, Virginia Transportation Research Council
- Amanda Hardy, National Park Service (NPS)
- Nathan Beauchamp, U.S. Fish and Wildlife Service (USFWS)
- Maggie Ernest Johnson, Association of Fish and Wildlife Agencies
- Fraser Shilling, University of California – Davis

Some of the highlights of the presentations include:

- There are a wide variety of existing data standards, both at the state and national level.
- Every state has its own data standards, which makes it difficult to compare data across state lines.
- There are also a number of national data collection systems and standards including FARS [Fatality Analysis Reporting System?], CRSS [Crash Report Sampling System] GES [General Estimate System?], MMUCC [Model Minimum Uniform Crash Criteria], and others.

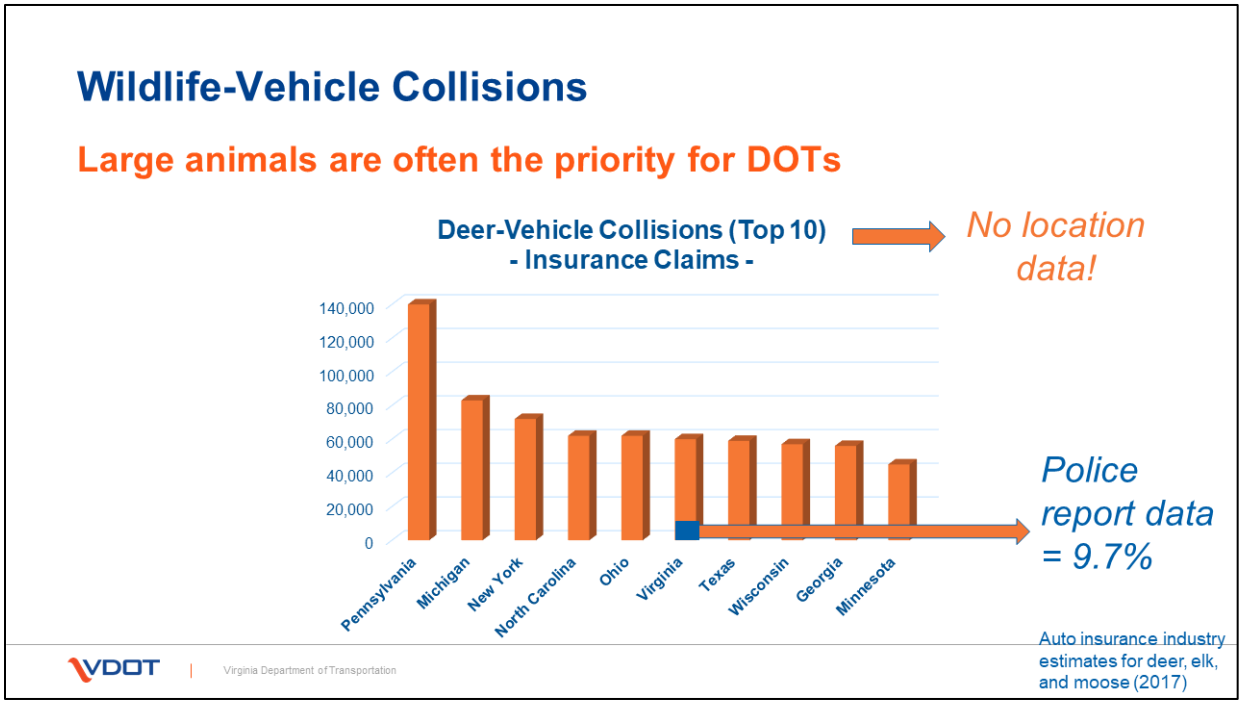

Figure 1. Image of slide from the presentation of Bridget Donaldson, Virginia Department of Transportation.

- The U.S. Department of Transportation (DOT) has launched a Safety Data Initiative featuring several beta tools of potential interest including a pilot to connect state and federal data resources. In addition to its potential role in improving WVC safety solutions and conservation outcomes, the Safety Data Initiative further seeks to:
    - Integrate existing data and new "big data" sources;
    - Use advanced analytics to provide new insights into transportation safety risks; and
    - Create data visualizations to help policymakers arrive at safety solutions.
- Presenters expressed a preference for a single data platform that could be shared across agencies.
- One of the overarching themes was to limit the required data fields to a few simple, core elements, while allowing for optional "extra" fields including, for example:
    - Small wildlife species, *e.g.*, small mammals, snakes, turtles, etc.
    - Count, or number of animals observed (if multiple);
    - Disposal (very important for tracking disease);
    - Live animal sightings, etc.

- There are a number of ongoing U.S. and international WVC systems, and the need to standardize implicates not only field data collection but also other data-related elements including:
    - Metadata;
    - Data organization;
    - Data visualization;
    - Data analysis;
    - Data sharing;
    - System security and access for sharing; and
    - System administration/participation.

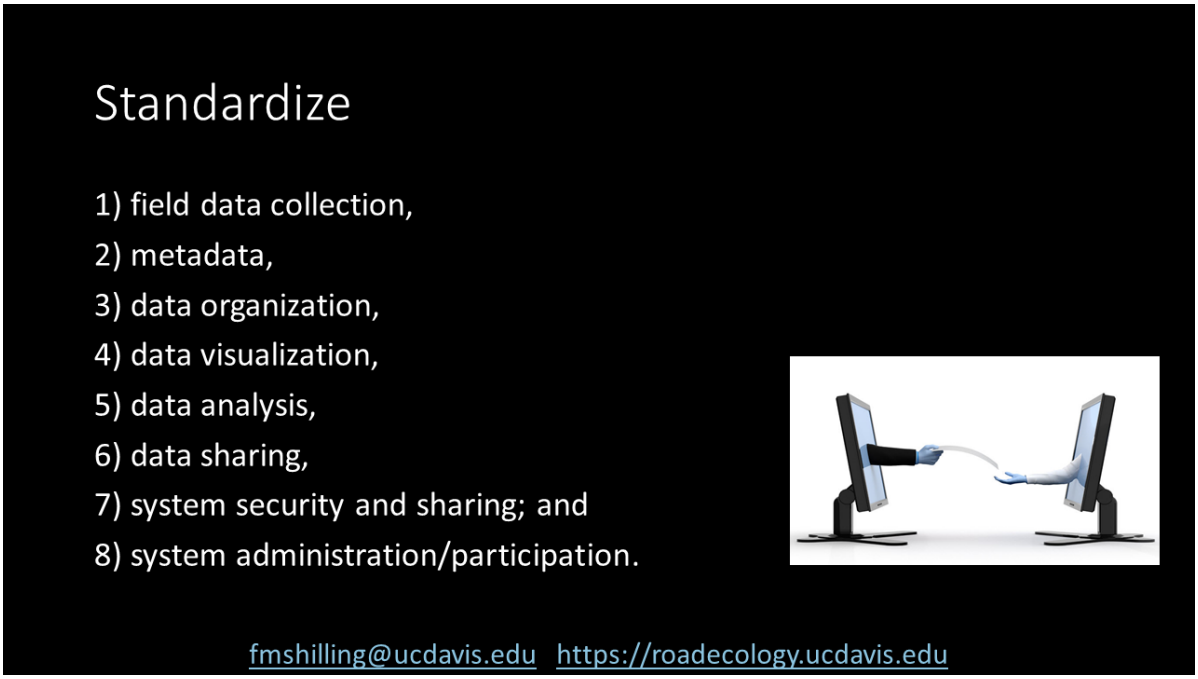

Figure 2. Image of a slide from the panel presentation of Fraser Shilling, University of California-Davis.

- State fish and wildlife agencies see standardization as an opportunity to collect critical data on at-risk or Species of Greatest Conservation Need, the potential to track invasive species movement, as well as climate change-induced range shifts.
- It also provides leverage for funding opportunities for on-the-ground conservation work
- Basic data they would like to see included:
    - Species
    - Sex
    - Count
    - Date, time, weather
- Overwhelmingly, they would like to see a photo requirement with geotagged location (latitude/longitude, not mile posts)
    - This will assist in vetting accuracy of species identification
    - Will provide simple, built-in location information
- Main concern is with the accuracy of species identification (those who are collecting data may not be biologists or have the expertise, they have questions over who will vet the information after collection)
    - Photo requirement will help with this
    - In addition, a drop-down list with common species could assist non-experts in identification
    - Allow a place to input scientific names for those who can identify using latin nomenclature
    - Consider adding a field that allows user to provide confidence in their identification (this is subjective, but could allow for more streamlined verification later on)

- Other data that would be "nice to have" include:
    - State of decomposition (this may help in identifying duplicate submissions)
    - If species was moved (ie. Was hit on road and moved to the shoulder)
    - Ability to collect null data
    - Option for live animal siting
    - Disposal location (important for tracking disease issues such as CWD)

4. ROUND TABLE DISCUSSION 1

Immediately after the panel presentation each of the workshop participants were engaged in addressing the same issue as the panel. They were asked the question, "[w]hat are the most important criteria for the national WVC standards to address for your organization or constituency?" In this session, 5 small groups were formed with a facilitator and a recorder. The facilitators for Round Table Discussion 1 and Round Table Discussion 2 were:

- Catherine Liller, USFWS
- Patrick Dockens, USFWS
- Brooke Stansbury, USFWS
- Amanda Hardy, NPS
- Renee Callahan, ARC Solutions
- Liz Fairbank, Center for Large Landscape Conservation

4.1. Results of Workshop Round Table Discussion 1

During Round Table Discussion 1, a volunteer from each small group recorded the top recommendations and reported them back to the reconvened workshop participants. A compiled summary of the recommendations is in Table 1.

Table 1. A compilation of the top recommendations for WVC data standards by the five small groups in Round Table Discussion 1.

Top Recommendations (X = number of times listed in recommendations)	
Location	XXXX
Photograph • Meta data • Georeferenced for date, time, location	XXXX
Date and Time	XXX
Species • Common Name, Adult/Juvenile; Big/ Small • Common name (required), scientific name (optional), size if not able to identify	XXX
User info	XXX
Roadside condition	XX
Onsite vs. Offsite	XX
Simplicity of survey	XX

• Only 3 required fields, other optional • Ease of use, quick for safety on roadside (minimize exposures)	
Data source	X
Standardized species naming system	X
Standard App does not add on to existing data bases	X
Subject protocol	X
Comments	X
Optional things: disposal location, decomposition (keep these optional, not required)	X
Situation: crash vs. carcass (optional disposal location) vs. sightings	X

5. TRB WORKSHOP ROUND TABLE DISCUSSION 2

After a break, the workshop participants regathered and were asked to once again form small groups supported by a facilitator. Five groups were formed, with approximately 8 persons in each group. A volunteer recorder of the findings of each small group's discussion was identified. The groups were asked to discuss the following two issues:

1) Describe the potential opportunities and pathways to develop national WVC data standards.
2) Identify the best method(s) and potential barriers for any new national WVC data standards to be adopted and implemented.

5.1. Results of TRB Workshop Round Table Discussion 2

During Round Table Discussion 1, a volunteer from each small group recorded the top recommendations and reported them back to the reconvened workshop participants. A summary of the top recommendations generated by the five groups for each question are listed below. They were not assigned a relative value or weight of interest, so they are randomly placed on the list. Also, they were not removed, if they were recorded for the wrong question.

<u>Describe the potential opportunities and pathways to develop national WVC data standards:</u>

- Assure that a lead agency is keen to help develop, accept and promote the standards (e.g., FHWA Eco-Logical).
- A Transportation Research Board (TRB) ad hoc committee could be formed to develop and seek the implementation/adoption of national WVC standards.
- Similarly, a standing TRB subcommittee could accept the lead to develop and seek the adoption and implementation of national WVC standards.
- Incorporate wildlife data standards into the Model Minimum Uniform Crash Criteria (MMUCC) of the National Highway Transportation and Safety Administration (NHTSA). The 6th Edition of the MMUCC is being developed right now and will be completed in summer 2020.
- Determine whether mandatory reporting or a voluntary program with incentives is the best pathway for getting national standards adopted.

- Explore whether legislative language on national WVC data standards could be incorporated into federal legislation.
- Have the National Cooperative Highway Research Program partner with the Association of American State Highway Organizations (AASHTO) to develop standards
- Use long range transportation plans of the FHWA and NHTSA to request/require standards.
- Incorporate data from other sources, such as iNaturalist for wildlife sightings near roads state highway trooper reports, carcass salvage permits, etc.
- Explore partnerships with insurance companies, although they are known to wave business models and don't promote sharing data.
- To recruit support for national standards, relate the data to the end user and the end use needs.
- Often WVCs are not listed in the top highway safety concerns; there is a missing link between single vehicle crashes and animals.
- There is a WVC data coordination opportunity with trucking companies (to know where collisions are happening to avoid/warn drivers in real time).

Identify needs for developing WVC data standards:

- Evaluate existing systems to integrate data among systems.
- Use existing successful models (traffic safety, wildlife crash system).
- Assure a process so that when the standards are developed, they will be implemented.
- Incorporate wildlife data standards into the Model Minimum Uniform Crash Criteria (MMUCC) of the National Highway Transportation and Safety Administration (NHTSA). The 6th Edition of the MMUCC is being developed right now and will be completed in summer 2020.

Identify barriers/challenges for the development and use of national WVC data standards:

- The goals and benefits of creating standards has not been identified
- The funding sources to develop and implement standards has not been identified. (2 groups)
- There needs to be a consensus on a standard method of data collection.
- Incorporating standards and their funding is difficult to get into transportation legislation.
- There are technological issues that must be addressed for national standards.
- Often the availability of data collection devices is an issue (DOT staff for example)
- The use of smart mobile devices discouraged by some DOTs
- The US does not have full coverage of global positioning system (GPS) location service (satellite coverage). Often one is unable to get GPS location while moving or in some canyons and other difficult topographies, etc.
- Option to use milepost locations in lieu of GPS is an issue.
- Some existing agency systems can be out of date and unable to interface with mobile device capabilities.

- The challenge is to not get too complicated when developing national standards (2 groups).
- There may be a need for incentives, such as cash prizes or game tag entries, to encourage WVC data collection (3 groups).
- The leadership level of agencies must support this effort.

As part of the discussion, participants pointed out that there are two needs for WVC data, one is for safety purposes and the other is for the conservation of wildlife species. A Venn diagram was drawn to conceptualize how national WVC standards should be developed to address both needs (Figure 3).

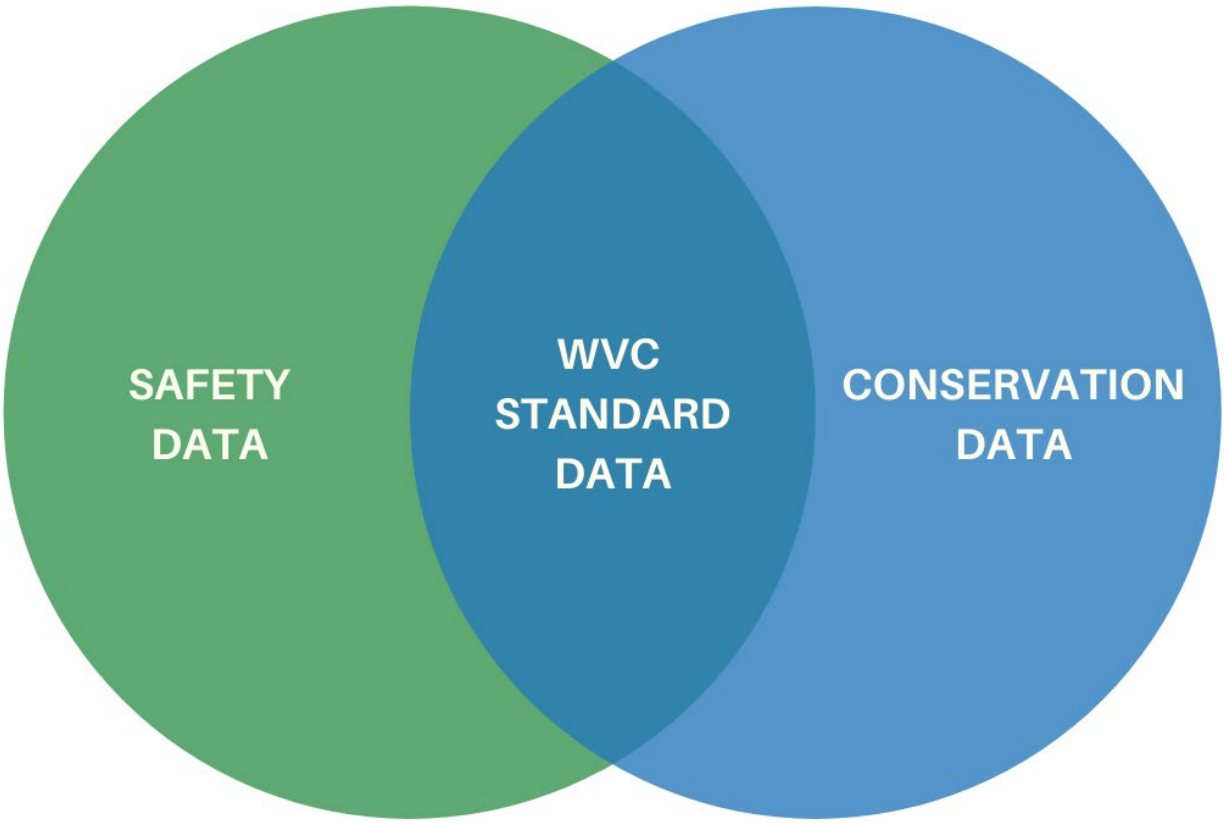

Figure 3. Venn diagram describing the necessity for national WVC standards that address the needs for both safety and conservation data.

6. FINAL GROUP DISCUSSION

The last portion of the workshop was held as a facilitated plenary discussion. The objective of this 15-minute session was, after reviewing the national WVC standards recommendations and the means of developing them as well as the potential pitfalls, what could the participants collectively do after the workshop to continue working on these issues.

6.1. Results of Final Group Discussion

Following are the list of action items that were developed by the workshop group and the individual participants who would volunteer to lead this item (in parentheses). It should be noted that to contact any of these members to volunteer to help them, please refer to the contact list, Appendix B.

1. Convene a volunteer group to develop MMUCC standards for revision (Dan Buford).
    a. This group can meet by email, but its objective is to get better data fields for wildlife incorporated into the revision process by summer 2020.
2. To follow up on this workshop, seek one of the TRB summer committee meetings host the second workshop (Rob Ament).
    a. Two summer meetings being held in 2020 are at Denver in July that is co-hosted by 5 different TRB committees to focus on sustainability or another is in Boise, entitled "Tools of the Trade Conference" which is sponsored by ADA40.
3. The lead host of this workshop, TRB ADC30 Committee, will seek to champion continuing efforts to develop national WVC standards (Alex Levy will coordinate).
4. The TRB Sub-committee, ANB 20, another workshop supporter will follow up with its members (Fraser Shilling).
    a. The objective is to get its members who were unable to attend the workshop to attend the next workshop or possibly create and host an ad hoc working group for this issue.
5. Develop a research study recommendation for NCHRP Research by June 2020 (Chris Gade).
    a. There is a possibility that a synthesis on national WVC standards would be helpful to describe the efforts needed to develop standards.
6. To refresh everyone's memories about national WVC data standards, send out the 2007 NCHRP Report, *National Cooperative Highway Research Program Synthesis 370: Animal-Vehicle Collision Data Collection* (Amanda Hardy).

7. APPENDIX A

Workshop Sign-Up Sheet (typed version)

Name	Organization	Email
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8. APPENDIX B

Workshop Agenda

AGENDA

TRB WORKSHOP

Round Table Discussion:

National Standards for Wildlife-Vehicle Collision Data Collection

Date and Time: Sunday, January 12, 1:30 – 4:30 pm

Location: Convention Center, 140 A

Time Allocation: 3 hours total

Purpose: Co-develop and implement national standards for WVC data collection systems to facilitate the collection and sharing of data by federal, state, local, and tribal agencies, and non-governmental organizations.

Facilitators: Rob Ament, Western Transportation Institute, Montana State University
Alex Levy, ADC 30 Committee, VHB

1:30-1:45 Welcome & Introductions, Purpose & Expectations

1:45-2:30 Panel Discussion: Setting the Stage (8 presentations, 5 minutes each)

Panel: Provide your organization's top two or three key issues or criteria that need to be considered for National WVC Data System Standards:

a. Federal Transportation Agency

Dan Buford, Federal Highway Administration (FHWA)

Julianne Schwarzer, Volpe Center, USDOT

b. State Department of Transportation

Bridget Donaldson, Virginia Transportation Research Council

c. Federal Land Management Agency

Amanda Hardy, National Park Service

d. Federal Wildlife Agency

Nathan Beauchamp, U.S. Fish and Wildlife Service

d. State Wildlife Agency

Maggie Ernest Johnson, Association of Fish and Wildlife Agencies

e. Citizen Science Data Collection Systems

Fraser Shilling, University of California - Davis

f. National Data Manager Perspective

Sergio Mayorga, Mobile Solution for Assessment and Reporting (MSAR), FHWA

Wrap Up and Conclusions (5 Minutes)

2:30-3:15 Round Table Discussion 1: Most Important Considerations for National Data Standards

- Directions for Round Table Discussion
- What are the most important criteria for the national standards to address for your organization or constituency?
- Each table report out its recommendations to the whole group (15 minutes)

3:15-3:30 BREAK

3:30-4:15 Round Table Discussion 2: What is the best pathway to develop the standards? How can we best ensure they will be deployed and used?

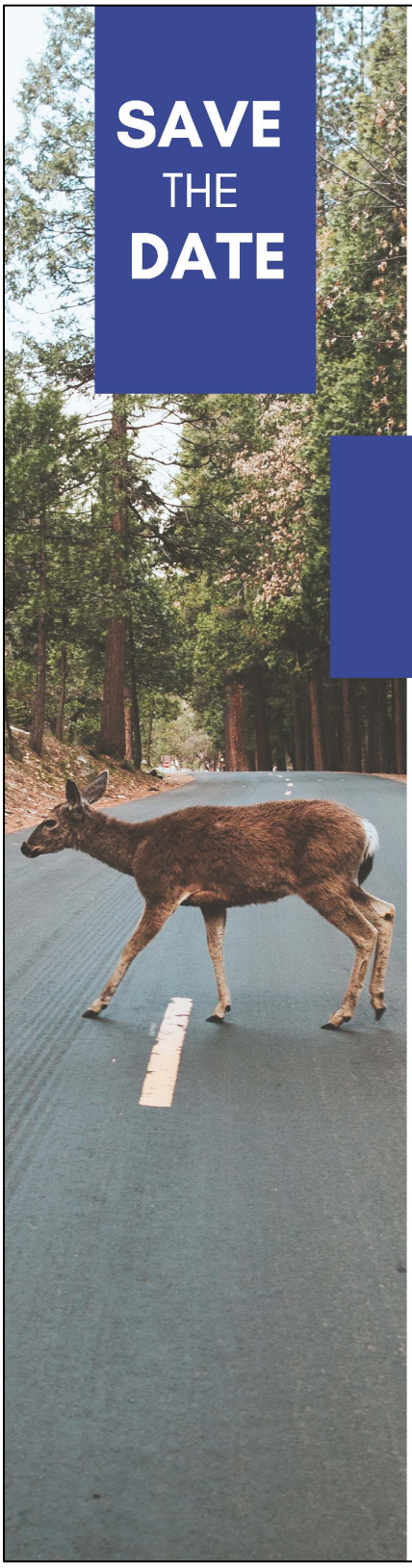
- Directions for Round Table Discussion 2
- Discuss potential pathways forward to develop national WVC standards (e.g. Ad Hoc Committee under ADC30, Volpe Center project, SHRP2 project)
- Discuss best method(s) to assure the new standards are implemented (e.g., Secretarial/Executive Order, administrative rule, legislation)?
- Each table report out their recommendations to the whole group (15 minutes)

4:15-4:30 Group Discussion: Next Steps

- ADC 30 Summer Meeting - Denver? TRB Public Lands Committee, Tools of the Trade Conference - Boise, ID? Other opportunities?

9. APPENDIX C

Workshop Marketing Flyer



WILDLIFE-VEHICLE COLLISION DATA STANDARDS WORKSHOP

Sunday, January 12, 2020
1:30 - 4:30 pm EST
Washington Convention Center
Room 140 A

Join ADC 30 members and friends in a TRB Workshop to discuss developing **national data standards for wildlife-vehicle collision (WVC) data collection**. The purpose of this Workshop is to discuss strategies to develop and implement national standards for WVC data collection to facilitate the collection and sharing of data by federal, state, tribal, and local agencies and non-governmental organizations.

For more information, please contact Dan Smith at daniel.smith@ucf.edu or Rob Ament at rament@montana.edu.

Heading our Way? National Standards for Wildlife-Vehicle Collision (WVC) Data Collection

TRB Workshop 1041
100th Annual Meeting of the Transportation Research Board (TRB)
(All virtual format)
January 22, 2021

Workshop Summary

Compiled and reported by

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March 2021

ACKNOWLEDGEMENTS

We would like to thank the TRB committees that co-sponsored this workshop: TRB Committee on Environmental Analysis and Ecology in Transportation (AEP70) and TRB Committee on Needs of National Parks and Public Lands (AEP20).

Thank you to the co-chairs who helped organize this workshop, including Martin Palmer (AEP70), Dan Smith (AEP70), and Natalie Villwock-Witte (AEP20).

Kudos to the planning committee for this workshop who volunteered many hours for nearly six months: Dan Smith, Natalie Villwock-Witte, Martin Palmer, Amanda Hardy, Renee Callahan, Marta Brocki, and Rob Ament.

Thank you to panelists, presenters, and session facilitators who kept the workshop running smoothly, and to the notetakers who documented participant input.

The workshop was supported by Jennifer Weeks, Senior Program Officer, Planning and Travel Analysis, Transportation Research Board, The National Academies of Science, Engineering and Medicine. Jennifer salvaged the workshop by quickly acting to overcome unforeseen obstacles presented by the workshop's virtual technology. She acted flawlessly.

Finally, we appreciate all the participants who took their time to attend and provide their expertise at the workshop.

DISCLAIMER

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

This report summarizes information presented by panelists and facilitators, as well as comments offered by workshop participants. The content was compiled from presentations, staff notes, and webinar chat records. This report focuses on capturing key concepts, recommendations, outcomes, and action items, rather than attempting to document everything discussed during the three-hour workshop.

Although the title of the workshop uses the term wildlife-vehicle collisions (WVCs), in fact, it is more accurate to describe the workshop as exploring standards for the more inclusive term, animal-vehicle collisions (AVCs). AVCs are crashes with wildlife and domestic animals, such as livestock. Many databases collect both types of collisions, those with wild and domestic animals. However, to accurately record the proceedings of the workshop, the term WVC was used almost exclusively.

At the 2020 TRB Annual Meeting, the first workshop was developed to discuss the need for national animal-vehicle collision data standards. It was originally conceived and proposed to TRB by Dan Smith of the University of Central Florida and Rob Ament of the Western Transportation Institute of Montana State University (WTI) in conjunction with the support of several TRB committees. Thirty-eight attendees attended the in-person event -- the first nationally convened meeting of experts to discuss the development of national WVC data system standards.

After the first workshop, later in 2020 abstracts for a follow-up workshop were accepted for TRB summer meetings in Denver, CO and Boise, ID. Both meetings were subsequently cancelled due to the COVID pandemic.

At last, in 2021, all TRB Annual Meeting events were converted to a virtual format, including this workshop. This year's workshop was sponsored by TRB Committee on Environmental Analysis and Ecology in Transportation (AEP70) and TRB Committee on Needs of National Parks and Public Lands (AEP20). More than 120 participants attended the 2021 workshop. The attendees represented federal and state wildlife agencies, federal and state transportation agencies, consultants, academia and professional associations. Due to the virtual nature of the workshop, only 60-70 participants identified themselves, some shared their email addresses. This is a notable increase in participation from the first to the second workshop.

2. WORKSHOP AGENDA

The objective of the workshop was to cooperatively develop and implement uniform national standards for WVC data collection systems, with the long-term goal of facilitating the collection and sharing of data by federal, state, local, and tribal agencies, and non-governmental organizations. This work continues the process initiated by a similar workshop in 2020. Presentation and discussion topics included a review of progress since the 2020 workshop; an update on relevant federal legislative issues and actions; identification of incentives, barriers, and key standards; and discussion of next steps.

The 3-hour workshop opened with a 10-minute introduction, a 20-minute plenary session, and a one-hour panel presentation. Following a break, participants broke into three concurrent workshop sessions for facilitated 40-minute small group discussions, with each group reporting out their findings in a subsequent plenary session. Next steps were identified in the closing plenary session.

The workshop agenda is Appendix A.

3. OPENING PLENARY SESSIONS

3.1. Introductory Session

The workshop opened with two plenary sessions. The first was an introductory session to provide an overview of the background, purpose and agenda for the workshop. In addition, workshop host Rob Ament reviewed the action items that were established at the end of the first workshop in 2020:

- Convene a volunteer group to develop **MMUCC standards** for revision (Dan Buford).
- Seek one of the TRB summer committee meetings to **host a second workshop** (Rob Ament). Two potential summer meetings that were scheduled for 2020 were identified (one in Denver in July and another in Boise, entitled "Tools of the Trade Conference" which is sponsored by ADA40).
- The lead host of the 2020 workshop, TRB ADC30 Committee (which no longer exists under the TRB committee reorganization) will seek to **champion continuing efforts to develop national WVC standards** (Alex Levy will coordinate).
- The TRB Sub-committee, **ANB 20** (this committee does not exist under new TRB committee reorganization either)**, another workshop supporter, was asked to follow up with its members** (Fraser Shilling).
- **Develop a research study recommendation for NCHRP Research** by June 2020 (Kris Gade).
- To refresh everyone's memories about national WVC data standards, **send out the 2007 NCHRP Report**, *National Cooperative Highway Research Program Synthesis 370: Animal-Vehicle Collision Data Collection* (Amanda Hardy).

These action items provided context for updates gave context for presentations and sessions of the 2021 workshop. Several presentations discussed the progress that was made as a result of these action items.

3.2. The Legislative Context

The second plenary session focused on summarizing the key components of two 2020 federal bills that included language regarding WVC national data standards. The presenters were Renee Callahan of ARC Solutions; and Elizabeth Mabry and Kenneth Martin of the Senate Committee on the Environment & Public Works.

Renee Callahan gave an overview of the legislation. During the last Congress, the House of Representatives and the Senate considered bills to reauthorize the current surface transportation law, known as the *Fixing America's Surface Transportation*, or *FAST Act*, prior to its expiration. In July 2019, the Senate Committee on the Environment and Public Works (EPW) introduced and unanimously passed its reauthorization bill, S. 2302, *America's Transportation Infrastructure Act* (*ATIA*) by a vote of 21-0. In June 2020, the House Committee on Transportation and Infrastructure passed its bill, H.R. 2, *Investing in a New Vision for the Environment and Surface Transportation in America Act*, or the *INVEST in America Act*. The House bill was subsequently rolled into a $1.5

trillion package, known as *The Moving Forward Act*, which passed the entire House on July 1, 2020.

Although the House and Senate bills differ in many ways, one thing they both had in common is that they included – for the first-time ever – a stand-alone provision aimed at reducing wildlife-vehicle collisions while improving habitat connectivity. That provision included a requirement that FHWA develop a standardized methodology for collecting and reporting wildlife crash and carcass data. In developing the standard, the Federal Highway Administration (FHWA) would have been tasked with surveying existing methods and sources (Fatality Analysis Reporting System (FARS), highway safety information system (HSIS), etc.) and identifying and correcting any limitations in those methods and sources. In addition, the bill directed FHWA to work in consultation with Department of Interior (DOI), USDA Forest Service, Tribal, State, and local authorities, American Association of State Highway and Transportation Officials (AASHTO), Association of Fish and Wildlife Agencies (AFWA), wildlife-vehicle collision (WVC) experts, non-governmental organizations (NGOs), and others.

The bill also included requirements for FHWA to develop a template for states to implement the resulting standardized national WVC and carcass data system, and then to encourage states to implement it. Both bills also would have required FHWA to prepare and submit a report to Congress (in 3 years in the House version, or in 4 years in the Senate version) on the status of implementation, on whether the implementation had reduced WVCs, and on recommendations to further reduce WVCs and improve habitat connectivity.

Elizabeth Mabry and Kenneth Martin, who are Senior Policy Advisors to the U.S. Senate Committee on the Environment & Public Works (EPW), provided an overview of the legislative process for reauthorizing the current surface transportation law. Among other things, they discussed the differing jurisdictions between the Senate EPW Committee, which has jurisdiction over both transportation and wildlife, and the House Committee on Transportation & Infrastructure, which has jurisdiction over transportation, but not wildlife. They noted that, in addition to EPW, three other Senate committees - the Committee on Banking, Housing & Urban Affairs; the Committee on Commerce, Science & Transportation; and the Committee on Finance - also have to act for reauthorization to occur. Although the current Congress had only been in session for about three weeks at the time of the workshop, they indicated that recent changes in Senate leadership, coupled with the historically bipartisan nature of transportation infrastructure, have the potential to create a pathway for the current Congress to reauthorize the FAST Act, prior to its expiration on September 30, 2021.

4. PANEL PRESENTATIONS

Panelists gave short presentations on progress that has been made over the last year on WVC standards development, from the perspective of several stakeholder groups.

4.1. Federal Transportation Agencies

Fraser Shilling of U.C. Davis presented on the role of federal transportation agencies in the development of WVC standards. He focused on efforts to develop WVC recommendations for the 5th Edition of the Model Minimum Uniform Crash Criteria (MMUCC).

The Model Minimum Uniform Crash Criteria (MMUCC) is a voluntary guideline that represents a minimum, model set of data elements that describe the who, what, when, where, and why of a motor vehicle crash. The guidelines are developed jointly by the National Highway Transportation and Safety Administration (NHTSA) and the Governors Highway Safety Association (GHSA). States generally adopt the guidelines and data is collected by police at crash sites.

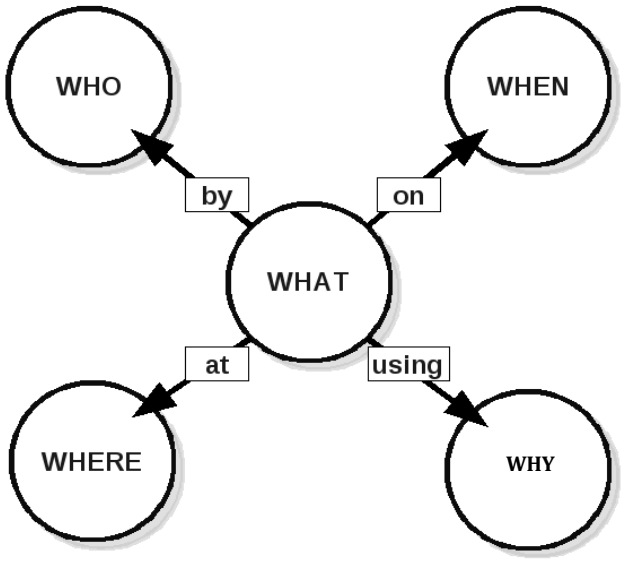


Figure 1: Model data elements (image courtesy of UC Davis presentation).

Dr. Shilling summarized the steps taken, to date, to develop and submit animal involvement recommendations for the NHTSA's and GHSA's consideration as it updates the latest edition of the MMUCC. FHWA facilitated a workshop at the 2019 International Conference on Ecology and Transportation (ICOET) titled "Wildlife Vehicle Collisions Predictive Analysis Workshop." The group then identified key information and research gaps as well as emerging issues. This effort was continued at the 2020 Transportation Research Board (TRB) Annual Meeting workshop titled "Developing national standards for animal-vehicle collision data collection systems: brief review and working discussion." This was the first nationally convened meeting of experts to discuss the development of national WVC data system standards.

Last year's TRB workshop generated a small, voluntary working group to develop a list of proposed edits and additions to the MMUCC to incorporate considerations for WVC and the contribution/involvement of animals in crashes. The group identified the top 5 priority recommendations to submit:

1. **Update language to allow for the distinction between domestic and wild animals** – this will help target research and resources to identify appropriate possible crash avoidance countermeasures.
2. **Include considerations to capture driver maneuvers to avoid colliding with an animal in the roadway** – this will help target research and resources, determine a need for additional traffic control devices, and identify or evaluate appropriate possible crash avoidance countermeasures.
3. **Add a section specific to animal involvement to collect more detailed specific information on animal involvement or contribution to crashes** – this will provide a comprehensive understanding of factors contributing to a crash and helps target research and resources to develop, implement, or evaluate countermeasures at most appropriate locations.
4. **Include considerations to capture information specifically on animal crossing signage and/or signals as a traffic control device (TCD)** – this will help improve the understanding of the effectiveness of TCDs and their placement
5. **Update the "traffic incident" definition to include "animal(s) in the roadway" to allow crashes caused by the presence of animal(s) in the roadway to be considered secondary crashes** – this will provide a comprehensive understanding of factors contributing to a crash, including animal involvement, which helps understand and implement effective countermeasures.

NHTSA is in the process of developing the 6th edition of the MMUCC and is considering any submitted recommendations. The University of California, Davis (UC Davis) submitted the working group's final recommendations to NHTSA for consideration in August 2020. The DOT MMUCC Working Group deliberated on the recommendations and agreed to submit a modification to capture driver maneuvers to avoid colliding with an animal in the roadway to the Expert Panel for final deliberation:

- Modify attribute in P14. Driver Actions at Time of Crash: *Include "animal" in attribute value 15. The attribute value would now read as follows: "Swerved or Avoided Due to Wind, Slippery Surface, Motor vehicle, Object, Non-Motorist in Roadway, Animal in Roadway, etc."*

Final modifications to the next edition of the MMUCC will be published in the Federal Register prior to final acceptance.

4.2. State Departments of Transportation

Wendy Terlizzi of the Idaho Transportation Department (ITD) presented on the work of state departments of transportation (DOTs), with an emphasis on the challenge of integrating new WVC data into existing state safety data systems as more states develop new WVC data collection systems. Specifically, she reported on efforts by ITD to develop a WVC application.

Based on the considerations identified in the 2020 TRB Workshop, ITD wanted to develop an application that would limit the required data fields to a few simple, core elements, while allowing for optional "extra" fields for information such as inclusion of additional small wildlife species.

For ITD, the biggest challenge was to create a simple, easy to use application (app) that operations personnel would actually use. Additional challenges included how to standardize data collection procedures and collect more detailed and accurate data.

The steps of the project plan included requirements analysis, design, integration, testing, modifications, and deployment. Key requirements included a simplistic view, an application that would work throughout the state, and seamless integration with other state agency systems. The design preference was to use an out of box app that would require minimal customization and maintenance. In terms of integration, one of the most important considerations was to ensure that collected data could be displayed on the existing, internal IPLAN platform.

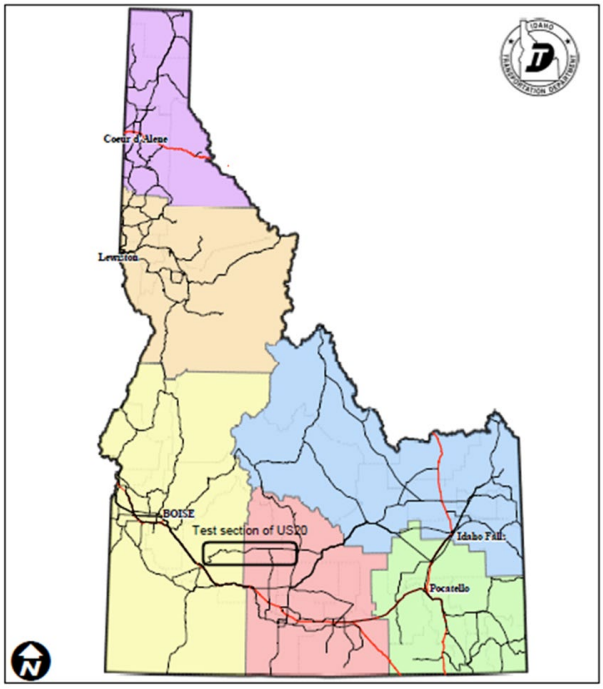


Figure 2: ITD Appliction - first road segment used for testing (image courtesy Idaho Transportation Department presentation).

The app was tested on two road segments in the state, and 40 WVCs were recorded over a 6-month period. To encourage acceptance and use by other agencies, ITD solicited input from multiple departments and has worked in close collaboration with the Idaho Department of Fish and Game (IDFG). The next steps will be to implement the app statewide and to get devices in the hands of frontline staff who will be collecting data. Based on the initial results, IDFG also plans to adopt the ITD app.

4.3. Federal Land Management Agencies

Amanda Hardy, National Park Service, and Nathan Beauchamp, US Fish and Wildlife Service, presented an update on efforts by federal land management agencies (FLMAs) to launch their own WVC data collection systems, specifically the Roadkill Observation and Data System (ROaDS). Hardy started with an overview of the Federal Lands roads system, which includes more than 460,000 total road miles on 640 million acres of land. National long-term transportation plans for FMLAs include specific goals to protect and preserve resources, as well as to provide a safe transportation system for all users.

NPS and USFWS are working with the Western Transportation Institute (WTI) at Montana State University and the National Center for Rural Road Safety to develop ROaDS. The current version of this app allows a user to record a precise location for a roadkill observation, a photo, animal type, number of animals observed, status of animal, and other key information. FLMA goals for using improved and standardized data include cross-jurisdictional collaboration and prioritization of identified hotspots for implementing mitigation.

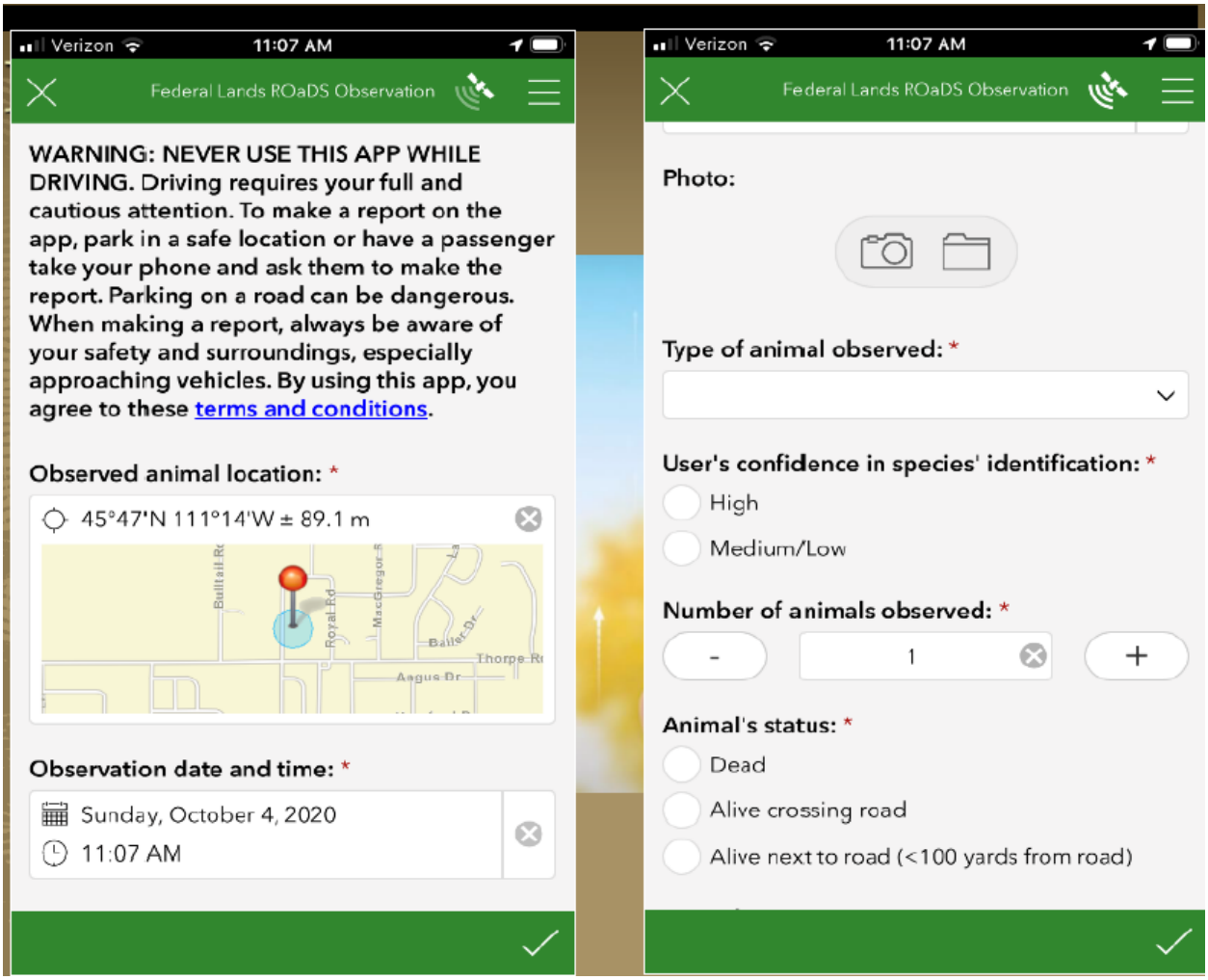


Figure 3: Roadkill Observation and Data System (ROaDS) app interface (screenshot courtesy of NPS presentation).

Beauchamp gave an update on a few of the current road mortality mitigation projects at USFWS, including those at Laguna Atascosa National Wildlife Refuge (NWR) in Texas and two NWRs in Virginia. He described how improved WVC data collection will support efforts to create detailed long-term transportation plans, road inventories, trail inventories, bridge inventories, visitor surveys and road safety audits. The data will also enable data driven decisions to prioritize project selections. However, the top implementation challenges for enhancing data collection include the ability to obtain buy-in from the field personnel, data collection standards, and the resources for data integration.

4.4. State Wildlife Agencies

Maggie Johnson of the Association of Fish and Wildlife Agencies (AFWA) gave a presentation on the role of state wildlife agencies. Her remarks centered on how state fish and wildlife agencies (SFWAs) are engaging with state departments of transportation (DOTs) to create WVC data collection systems.

Johnson reported that many SFWAs don't have data collection systems. Among those that are developing systems, many are not coordinating with their state DOTs or are facing resistance over safety concerns. Other implementation challenges include promoting and maintaining citizen science interest, an overly complicated system that discourages contributions, obtaining finer scale detail, and building capacity of users to identify the correct species. However, the benefits of implementation have been:

- SFWAs are finding opportunity to work closely with their DOTs, conservation organizations, academia, and the public
- Creation of a mechanism to promote understanding of habitat connectivity
- Consistent data has been useful for identifying and justifying wildlife crossing projects
- Data helps validate connectivity mapping
- An improved understanding of the distribution of at-risk or less well studied species

The development of national WVC data standards would provide further benefits, including better tools to assess or recover at-risk or listed species and improve habitat connectivity, as well as a larger quantity of higher quality data. Lessons learned, to date, include that it is important to focus on developing enhanced interagency coordination between SFWAs & DOTs; to provide flexibility that accommodates different technology needs, access, and funding levels; to recognize that some states with existing data collection methods will face challenges to modify their process; and to keep systems simple.

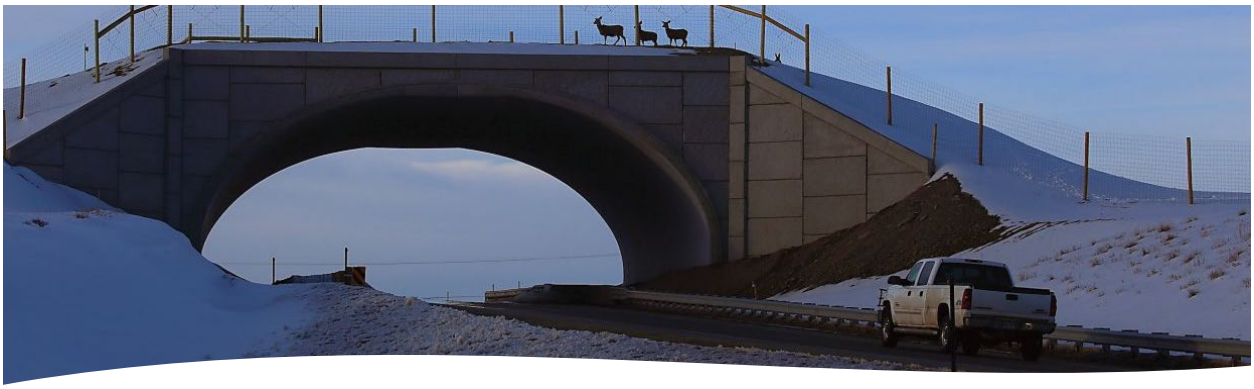


Figure 4: Wildlife crossing structure on US Highway 191 in Wyoming (photo courtesy of AFWA presentation).

4.5. Additional Stakeholders: from individual observers to global systems

Fraser Shilling (U.C. Davis) discussed other types of stakeholders involved in the development of data collection standards, ranging from individual observers to global initiatives and systems.

He began by describing how there are an increased number of organizations involved in the standardization process, including the Infra Eco Network Europe (standardization workshops and training), the International Conference on Ecology and Transportation (20% of 2019 presentations were on WVC data and their systems), Transportation Research Board committees and workshops, and numerous individual U.S. states that have developed WVC hotspot analyses and tools.

Numerous countries (particularly in Europe) have established websites that document and map WVC occurrences and locations, and there are 15 national or large regional WVC systems that continuously collect observations. They rely on data contributions by government staff, law enforcement, nature organizations and the public.

Figure 5: Sample map on Biology Ireland citizen science website (photo courtesy of UC Davis presentation).

However, data collection aspects of these systems vary considerably from state to state or country to country, including:

- WVC data collection methods
- Data management tools and platforms
- Data sharing methods
- Fields and formats for data queries
- Quality control, especially for species validation, location accuracy, and record completeness.

Data standardization will allow researchers to compare data among the many countries now collecting it, and it will allow data to be combined and integration into different applications. This will inform more accurate methods for monitoring wildlife presence, testing connectivity models, and tracking wildlife populations.

5. CONCURRENT DISCUSSION SESSIONS

Following the panel presentations, workshop participants could select one of three concurrent sessions on incentives and barriers, key standards, or federal legislation. Each session was hosted by a facilitator who led a guided discussion.

5.1. Session 1: Incentives and Barriers

Overview: The guiding question for this session was "**What are the incentives and barriers for states and other agencies to voluntarily adopt a standardized WVC data collection methodology?"**

Given that transportation and natural resource agencies could adopt a common method of collecting WVC data, with or without federal legislation, workshop participants were encouraged to identify potential pathways for such an approach. Facilitator Martin Palmer of the Washington State Department of Transportation led the discussion, and Amanda Hardy of NPS was the recorder.

Session Summary: Participants focused on describing key incentives for adopting WVC data standards and major challenges that are preventing implementation. Incentives included:

- A unified system improves users' ability to compare how well mitigation may be performing from entity to entity.
- It also improves the ability to compare how species behave in response to different mitigations.
- The Idaho Transportation Department commented that being able to use the actual IDFG database schema in Excel format was useful. (ITD was using ESRI/ARCGIS online to use the Survey123 app, which allows simple form creation.)
- The priority of most DOTs is to collect the information as fast as possible, in order to safely get staff off the road quickly (so having an easy-to-use system is an incentive).

Participants also described several significant barriers and challenges:

- One of the main challenges is how to record spatial data. The desired standard is latitude and longitude, but not all agencies have the technology to record that. Some maintenance staff are more familiar with using mileposts to record locations. The GPS option in Survey 123 may help to resolve this issue.
- Another barrier is that many DOT operations crews do not collect data on small wildlife. They generally only collect data on wildlife that is large enough to be moved or removed from the roadway.
- In Idaho (and likely other states), the main hurdle is adequate funding to buy enough mobile devices for staff. Other states lack sufficient capacity to add data collection to personnel responsibilities. Funding shortages may be exacerbated by the impacts of COVID-19 on available DOT funding.
- In terms of specific data requirements, participants noted that it would be helpful to have common data fields across carcass databases and crash/safety databases to allow data to be combined. A minimum set of common variables would also facilitate efforts to combine data.

Session Recommendations: Participants prioritized three key recommendations:

- A minimum set of common variables is needed to allow different databases to be combined. Consider creating a national panel to create the common variables.
- Funding is needed for mobile devices, personnel and training.
- Common data fields collected in the same format will facilitate efforts to combine data.

5.2. Session 2: Key Standards

Overview: The guiding question for this session was "**What are the key national WVC data collection standards and methods that federal, tribal, and state agencies and their partners are most likely to agree they can use?"**

Facilitator Dan Smith of the University of Florida led a discussion building on the 2020 TRB workshop's results and focusing on the fundamental standards that can most readily be adopted. Rob Ament served as the recorder.

Session Summary: Participants had a wide-ranging discussion on WVC data collection standards and methods. The group identified several key inconsistencies across systems, including:

- Location identification. Many DOTs still use mile markers, which are not as precise as other methods such as GPS
- Species lists and identification. There is little consensus on whether species lists should be large or short. In addition, some systems use Latin names and others use common names for species. Common names often vary by region in the U.S.

Session Recommendations: Based on these inconsistencies and other challenges, participants identified the following priorities for standardization:

- Have a national system that all organizations can use.
- Create standards for documenting locations consistently and accurately
- Agree on a species list that can be modified as needed by individual states. The national list of species should be short.
- Find a common data storage and sharing platform (*e.g.*, Data Basin)

5.3. Session 3: Federal Legislation

Overview: The guiding question for this session was "**What are some key legislative ideas for WVC standards for the next federal transportation act?"**

This facilitated discussion sought to build on the plenary session by compiling key legislative ideas for consideration as the 117th Congress takes up reauthorization of the current surface transportation law prior to its expiration.[1] Renee Callahan, ARC Solutions, facilitated the session with assistance from Marta Brocki, ARC Solutions, who also served as session recorder.

[1] Originally slated to expire on September 30, 2020, the 116th Congress passed, and the President signed into law, a continuing resolution that extended the FAST Act for 1 year, through September 30, 2021.

Session Summary: This concurrent break-out session invited workshop participants to review the data standardization language from the last Congress, and to offer suggestions for improvement. Specifically, attendees reviewed the following provisions:

1. The Secretary of Transportation acting through the Federal Highway Administration (FHWA) "shall develop a quality standardized methodology for collecting and reporting spatially accurate wildlife collision and carcass data for the National Highway System," as practicable given technology and cost (*ATIA* § 1125(c), *INVEST in America Act* § 5107(b)).
    a. In developing the methodology, the bill tasks FHWA with surveying existing collection methodologies and identifying and, to the extent possible, correcting any limitations in those data sources.
    b. This work is to be undertaken in consultation with Federal land managers, Tribes, State wildlife and transportation agencies and other experts including the American Association of State Highway Transportation Officials and the Association of Fish and Wildlife Agencies.
2. The Secretary shall develop a standardized data template and encourage that template's voluntary implementation by the States, Metropolitan Planning Organizations (MPOs) and other transportation stakeholders.
3. The Secretary shall issue two reports: one describing the standardized methodology and the second reporting on implementation. The latter would include:
    a. The status of the voluntary implementation of the standardized data methodology and template;
    b. Whether voluntary implementation has impacted efforts to reduce WVCs and improve habitat connectivity and, if so, the degree of that impact; and
    c. Any recommendations, including suggestions for further study.

Session Recommendations: After review, attendees at the concurrent session offered the following ideas for consideration by the new Congress as it embarks upon reauthorizing the *FAST Act*:

- Consider expanding or clarifying the methodology's consultation requirement to include:
    - Army Corps of Engineers
        - Consider requiring consultation either directly via the agency, or via the Secretary of Defense, acting through the chief of the agency
    - Bureau of Reclamation
        - *Note: Because the Bureau of Reclamation is part of the Department of Interior, it appears the Bureau is already included by virtue of the requirement to consult with the Secretary of the Interior.*
- Consider expanding the methodology's consultation requirement so that it applies not only to development of the standardized methodology but also to development of the standardized data template and efforts to encourage voluntary implementation of that template by States, MPOs and other transportation stakeholders.

- Consider directing FHWA to survey States to determine whether they already have an existing standardized data template, with the goal of potentially consolidating into a final template.
- Consider whether development of the standardized data template would involve a National Environmental Policy Act (NEPA) Assignment to the States.
    - The Surface Transportation Project Delivery Program, 23 U.S.C. § 327, authorizes "the Secretary [to] assign, and the State [to] assume, the responsibilities of the Secretary with respect to one or more highway projects within the State under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)."
- Consider inclusion of attributes from S. 3427, the *Modernizing Access to our Public Lands Act*. This bill "directs the Department of the Interior, the Forest Service, and the U.S. Army Corps of Engineers to jointly develop and adopt interagency standards to ensure compatibility and interoperability among federal databases for the collection and dissemination of outdoor recreation data related to federal lands."
    - Specifically, S. 3427 would require "Interior, the Forest Service, and the Corps of Engineers [to] digitize and publish [emphasis added] geographic information system mapping data that includes:
        - federal interests, including easements and rights-of-way, in private land;
        - status information as to whether roads and trails are open or closed;
        - the dates on which roads and trails are seasonally opened and closed;
        - the types of vehicles that are allowed on each segment of roads and trails;
        - the boundaries of areas where hunting or recreational shooting is regulated or closed; and
        - the boundaries of any portion of a body of water that is closed to entry, is closed to watercraft, or has horsepower limitations for watercraft."
- Consider reviewing the processes of the Federal Geographic Data Committee (FGDC) to assess whether alignment with Federal data collection processes and/or standards, potentially by engaging FGDC's Federal Lands working group, would be beneficial.
    - According to its website, www.FGDC.gov, the "Federal Geographic Data Committee … is an organized structure of Federal geospatial professionals and constituents that provide executive, managerial, and advisory direction and oversight for geospatial decisions and initiatives across the Federal government."
    - To view an example of FGDC's interagency process for developing a federal data standard for trails, including objectives, scope and project history, visit LINK.
    - Consider directing the FGDC to publish the resulting standard on its website.

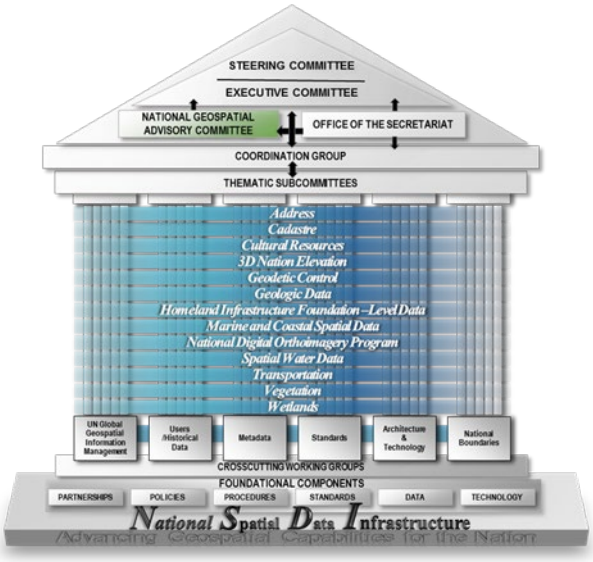


Figure 6: Overview of the structure of the various components of the FGDC (Source: www.FGDC.gov)

- Consider expressly including a common set of core data elements that the Secretary should consider for potential inclusion in the voluntary data standard, e.g., observer ID/type, date, time, spatially-accurate location, species, etc.
- Consider expanding the provision to make funding available to defray costs of implementing the resulting data methodology standard, as a way to encourage voluntary implementation of the template by States, MPOs and other transportation stakeholders.

Next Steps: Workshop organizers will provide a courtesy copy of the final report, including the concurrent session recommendations, to legislative staff for the House Committee on Transportation and Infrastructure and the Senate Committee on Environment and Public Works.

6. CLOSING PLENARY SESSIONS

The last portion of the workshop consisted of two plenary sessions: one for each concurrent session to report their top recommendations to a plenary session of the workshop attendees and to jointly identify next steps.

6.1. Recap of the Concurrent Discussion Sessions

Workshop participants gathered in one session to report on and discuss the top 3-5 recommendations from each small group discussion session.

Session 1: Incentives and Barriers

- A minimum set of common variables is needed to allow different databases to be combined. Consider creating a national panel to create the common variables.
- Funding is needed for mobile devices, personnel and training.
- Common data fields collected in the same format will facilitate efforts to combine data.

Session 2: Key Data Standards

- Have a national system that all organizations can use.
- Create standards for spatially accurate locations.
- Agree on a species list that can be modified (by individual states?). The national list of species should be short.
- Find a common data storage and sharing platform (e.g. Data Basin)

Session 3: Key Ideas for Federal Legislation

- Consider expanding the consultation requirement to include the Army Corps of Engineers and Bureau of Reclamation
- Consider expanding the consultation requirement so that it applies not only to development of the standard methodology but also to development of the standardized data template and efforts to encourage voluntary implementation of that template by States, MPOs and other transportation stakeholders
- Review process of Federal Geographic Data Committee to assess whether alignment with its processes would be beneficial
- Consider identification of a common set of core data elements that would be expressly identified for potential inclusion in the voluntary data standard
- Considering funding to cover the costs of implementing the resulting data methodology standard, as a way to encourage adoption

6.2. Next Steps for Developing WVC Standards

Developing next steps and action items was the last item on the agenda. It was held as a plenary session. Like the 2020 workshop, action items also identified leaders to assure they would be carried forward after the conclusion of the 2021 workshop.

6.2.1. Extracurricular activities

Participants discussed and identified potential avenues for transportation and natural resource agencies and their partners to put into action the various WVC standards recommendations from the workshop. Ideas included the following:

- Recruit new partners: AAA Foundation for Traffic Safety. The foundation is interested in this topic because of the impact of WVCs on insurance claims.
- Identify agencies that may be able to store data: USGS, USFWS, and USFWS refuges
- Explore other databases that can serve as models:
    - Stormwater database: Stormwater data is curated and housed by a nonprofit with some government support. www.bmpdatabase.org
    - WHISPers: Wildlife Health Information Sharing Partnership, https://www.sciencebase.gov/catalog/item/5633b8b4e4b048076347eff6
    - Right of Way, a Habitat Working Group out of University of Illinois, Chicago, has established a national repository for pollinator habitat data. It is GIS based and anyone can add or house their data there.
    - Data analytics for safety and road geometry may have some relevant modeling approaches for WVC data.

6.2.2. Action Items

Participants agreed that the workshop had excellent attendance, participation and energy, and they expressed a strong interest in holding another meeting to further develop and explore how to best implement national WVC standards.

1. The Western Transportation Institute volunteered to write the final report to capture all the information generated at the workshop. The final report will be distributed so that it can be shared with attendees as well as those not in attendance and to

2. Moving forward, the key action item is to schedule the next National WVC Standards workshop in conjunction with a TRB Summer Committee meeting. Workshop organizers will collaborate with the committee chairs for the Committee on Environmental Analysis and Ecology in Transportation (AEP70) and the Committee on Needs of National Parks and Public Lands (AEP20) to identify potential dates.

7. APPENDIX A: AGENDA

Workshop Agenda

AGENDA

TRB WORKSHOP 1041

Heading our Way?
National Standards
for
Wildlife-Vehicle Collision (WVC) Data Collection

Date and Time: Friday, January 22, 2021; 2:00-5:00 pm EST

Time Allocation: 3 hours, total

Type of Workshop: Live, virtual environment via Zoom

Purpose: Co-develop and implement uniform national standards for WVC data collection systems to facilitate the collection and sharing of data by federal, state, local, and tribal agencies, and non-governmental organizations.

Facilitators: Rob Ament, Western Transportation Institute, Montana State University (WTI)
Martin Palmer, Co-chair, AEP70 & Washington State Dept. of Transportation
Dan Smith, Co-chair AEP70, & University of Central Florida
Natalie Villwock-Witte, Chair AEP20, WTI

Sponsor: AEP70: TRB Committee on Environmental Analysis and Ecology in Transportation (AEP70).

Co-sponsor: TRB Committee on Needs of National Parks and Public Lands (AEP20).

2:00-2:10 **Welcome and Review of Workshop 2020 Results**
Dan Smith, University of Central Florida
Rob Ament, WTI
(Link to Workshop Agenda is in chat room)
(Link to Workshop 2020 Final Report is in chat room)

2:10 - 2:30 **The Legislative Context (Plenary):** Summary of 2020 federal legislation that includes language regarding WVC national data standards
Renee Callahan, ARC Solutions
Elizabeth Mabry & Kenneth Martin, Senate Committee on the Environment & Public Works
5 Minutes for questions and answers (please place questions in chat room)

2:30-3:30 **Panel Presentations: Making Progress on WVC Standards Development (3 presentations, 10 minutes each)**

(*Please place questions in chat room, only one or two will be answered by speakers, depending on the time that is remaining after their presentation. Then, workshop facilitators will gather remaining questions and take them to the appropriate session of the three concurrent sessions later in the program)*

a. Federal Transportation Agency Progress

Developing WVC Recommendations for the 5th Edition of the Model Minimum Uniform Crash Criteria (*MMUCC*)

Fraser Shilling, University of California – Davis

b. State Departments of Transportation

The challenge of integrating new WVC data into existing state safety data systems as more states develop new WVC data collection systems (e.g., Nevada, Caltrans, Idaho)

Wendy Terlizzi, Idaho Transportation Department

c. Federal Land Management Agencies Progress – Roadkill Observation and Data System (ROaDS)

FLMAs are launching their own WVC data collection systems

Amanda Hardy, National Park Service and Nathan Beauchamp, US Fish and Wildlife Service

d. State Wildlife Agency Progress
State wildlife agencies are engaging with state DOTs to create WVC data collection systems

Maggie Ernest Johnson, Association of Fish and Wildlife Agencies

e. Data collection standards from individual observers to global systems

WVC data collection systems start with individual observers and there are global standards that have developed reflecting how agencies, NGOs, and volunteers collect data

Fraser Shilling, University of California – Davis

3:30-3:40 **BREAK**

3:40-4:20 **Three Concurrent Sessions on Incentives, Barriers, Key Standards and Legislation**

Workshop participants can join any concurrent session of their choice to participate in a facilitated small group discussion.

A. **Concurrent Session 1: What are the incentives and barriers for states and other agencies to voluntarily adopt a standardized WVC data collection methodology?**

Given transportation and natural resource agencies could adopt a common method of collecting WVC data, with or without federal legislation, workshop participants will identify pathways for such an approach.

Facilitator: Martin Palmer, Washington State Department of Transportation
Recorder: Amanda Hardy, National Park Service

B. **Concurrent Session 2: What are the key national WVC data collection standards and methods that federal, tribal, and state agencies and their partners are most likely to agree they can use?**

A facilitated discussion that will build on the 2020 TRB workshop's results and focus on the fundamental standards that can most readily be adopted.

Facilitator: Dan Smith, University of Central Florida
Recorder: Rob Ament, WTI, Montana State University

C. **Concurrent Session 3: What are some key legislative ideas for WVC standards for the next federal transportation act**

A facilitated discussion will build on the plenary session regarding national legislative language in the next iteration of the federal transportation act.

Facilitator: Renee Callahan, ARC Solutions
Recorder: Marta Brocki, ARC Solutions

4:20-4:45 **Plenary Session: Report and Discussion on Top 3-5 Recommendations Made in each Concurrent Session (1, 2 and 3)**
Workshop participants will regather in a plenary session to report on each of their concurrent session's top 3-5 recommendations. Then participants will discuss and refine each of the three lists.

Facilitator: Natalie Villwock-Witte, WTI, Montana State University
Recorder: Renee Callahan, ARC Solutions

4:45-5:00 **Plenary Session: Next Steps for Developing National WVC Standards**
Participants will explore potential avenues for transportation and natural resource agencies to put into action the various WVC standards recommendations from the workshop.

Facilitator: Rob Ament, WTI, Montana State University
Recorder: Fraser Shilling, University of California – Davis

Appendix B: Terms and Conditions to Use the ROaDS Survey

ROaDS App User Terms and Conditions

I understand that my use of the RoADS App inherently involves use of a hand-held electronic device in association with a motor vehicle. I agree to comply with all applicable laws and regulations while using the RoADS App, including but not limited to those governing the use of a hand-held electronic device while operating a motor vehicle.

I acknowledge and voluntarily assume the risks inherent in use of the RoADS App. I, on behalf of my family, heirs, assigns, executors, representatives, and estate, release from liability and agree not to sue the Center for Large Landscape Conservation, [ADD PARTNER ORGANIZATIONS], their officers, directors, employees, agents, sponsors, contractors, affiliates, successors, and assigns (collectively, the "RoADS App Partners") for any injury, damage, death, or other loss suffered by me directly or indirectly arising out of or resulting from, in whole or in part, my use of the RoADS App.

I will defend, indemnify, and hold harmless the RoADS App Partners with respect to any actual or alleged claims, losses, damages, liabilities, suits, or expenses (including, but not limited to, reasonable attorneys' fees and costs) directly or indirectly arising out of or resulting from, in whole or in part, my use of the RoADS App.

These Terms and Conditions eliminate the liability of the RoADS App Partners. To the fullest extent permitted by law, they include any claims caused or alleged to be caused, in whole or in part, by my negligence or the negligence of any RoADS App Partner and include claims for personal injury, property damage, wrongful death, breach of contract or otherwise. They shall be interpreted and construed in accordance with the laws of the State of Montana. Any and all claims, controversies and causes of action arising out of or related to them, whether sounding in contract, tort, or statute shall be governed by the laws of the State of Montana, including statutes of limitations, without giving effect to any conflict-of-laws rules that would result in the application of the laws of a different jurisdiction, and that any mediation, suit, or proceeding must be filed or entered into in Montana. If any portion of these Terms and Conditions is deemed void or unenforceable, the remaining provisions shall continue in full force and effect. These Terms and Conditions express the complete understanding of the parties and may not be modified unless mutually agreed to by the parties in writing.

Appendix C: ROaDS Operational Manual

Roadkill Observation and Data System (ROaDS)

User Manual

Prepared by
Mat Bell, Mike Wittie and Rob Ament

MONTANA STATE UNIVERSITY
Western Transportation Institute

Table of Contents

Important Key Terms and Notes

Application (App): refers to the Survey123 for ArcGIS software program owned by Environmental Systems Research Institute (ESRI). The App can be designed and written to fulfill a particular purpose of the user.

Survey: a programmed questionnaire (ROaDS) that fulfills this project's purpose, which is primarily to identify wildlife-vehicle collisions.

WVC: wildlife-vehicle collision

Notes: This manual was created as part of the project tasks in the development of the ROaDS survey. It was created to assist beta-testers and partner agencies in installing the survey on their own ESRI account, learning how to collect data on a mobile device, and understanding how to view and analyze the data. This is not a manual that will fully explain the use of Survey123 and ArcGIS Map Viewer, but rather an introductory to the ROaDS survey and the operating platform. For a more technical understanding of Survey123 and ArcGIS applications, visit their websites for a complete overview.

This manual will need to be edited in the next Phase of the project to adjust the content when the ROaDS survey is hosted on the Department of Interior (DOI) ESRI account. This will require more explanation for DOI employee user accounts. Please see the contact list at the end of the manual.

What is the ROaDS survey?

The National Park Service and US Fish and Wildlife Service have partnered with the Western Transportation Institute (WTI) at Montana State University (MSU) to develop a wildlife-vehicle collision (WVC) data collection system for federal land management agencies (FLMAs) and their partners. Called the Roadkill Observation and Data System (ROaDS), it is designed to facilitate several key data collection needs:

- Collect information (date, time, location, species) on large animal-vehicle crashes to address motorist safety concerns on FLMA roads,
- Collect carcass data of small- to large-sized animals relevant to FLMA's conservation missions, and
- Identify existing highway sites where animals are being hit/killed by vehicles as well as where animals may be safely crossing by tracking live animals observed near or on/crossing a road.

Unlike a crowd-sourcing application, ROaDS is a user-friendly tool to accurately collect, manage, and evaluate data specific to the needs of NPS and FWS. The agencies can use the ROaDS data to identify road segments where countermeasures or other actions may be used to reduce WVCs and maintain safe wildlife movement across the road.

Chapter 1: Installing the ROaDS Survey

This chapter explains how to create a ROaDS user group on the ArcGIS website and how to customize a ROaDS survey on an agency's or organization's personal ESRI account for your ROaDS user group. Agencies can use these functions to:

- Personalize group access to the ROaDS survey,
- Create a customized species list for your park/refuge's regional survey needs, and
- Add questions to a survey.

This manual is primarily intended for agency staff who are implementing and managing the use of ROaDS surveys for the collection of wildlife data. For a full technical manual on how to use Survey123, visit the website at: https://doc.arcgis.com/en/survey123/reference/installsurvey123.htm

For a full technical manual on ArcGIS user types and roles, visit the website at: https://doc.arcgis.com/en/arcgis-online/reference/roles.htm

User Types and Data Flow

The ROaDS survey has been developed on the Survey123 App, part of ESRI's ArcGIS platform. Prior to creating or using a survey, it is important to understand user types and roles within ArcGIS and within the ROaDS survey itself.

Types of Users for ROaDS

ArcGIS. All users must have access to an ArcGIS account with the proper credentials to create a new survey for a national park, national wildlife refuge, non-government organization (NGO), or other associated agencies and organizations. ArcGIS Online account users are assigned different roles, including Viewer, User, Editor, Publisher, or Administrator. Only users, publishers, and administrators can create new groups and/or content on ArcGIS Online. For further information:

- A full description of the different roles within ArcGIS Online can be found at https://doc.arcgis.com/en/arcgis-online/reference/roles.htm.
- Users can look up their assigned role on their profile page at www.arcgis.com.

ROaDS Survey. The ArcGIS roles previously described are used to establish what access a user has within the ROaDS survey. There are three important types of users: owners, managers, and collectors.

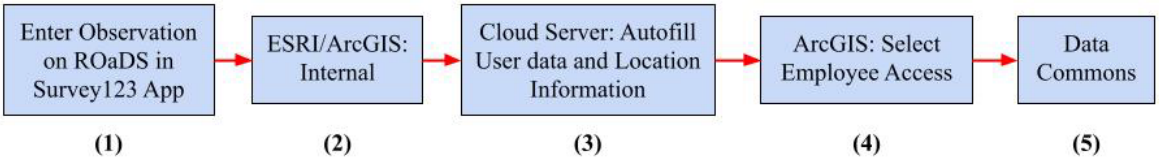
- Owners: The owner is the individual who creates the Group and Content on arcgis.com. An owner must have the ArcGIS role of Administrator or Publisher. There can only be one owner per group. The owner of the survey is the only person who can make changes to the survey questions. This person also sets the rules for the group members which, in part, determines who can access and view the data that is collected by everyone. The collected data is stored in the ESRI cloud and can be viewed via the ArcGIS Map Viewer by those managers and collectors permitted by the owner of the survey.

- Managers: They are assigned by the owner of the group and are given privileges to edit group details and data point observations that have been collected using ROaDS. Managers within the Group can have the ArcGIS role of Administrator, Publisher, User, or Data Editor. Owners and managers are responsible for the quality control of the data that is collected within their management units.
- Collectors: Collectors should have the ArcGIS role of User if their account is only for collecting data; this will limit a collector's ability to edit and download data from the ArcGIS website. They can collect data, but they are only allowed to view the data in ArcGIS Map Viewer if they are given access to it.

If you have questions about user types or roles within the ROaDS Survey, contact the ROaDS project manager at your agency (see Contact List on last page).

Flow of Data through ROaDS

The following schematic shows how data collected by the ROaDs survey flows through the data server.



1. Data is collected on a mobile device using the ROaDS survey on the Survey123 App.
2. Uploaded observations are sent to an internal ESRI cloud server.
3. Observations are then automatically sent to an external cloud server where user data and location information are further processed to create additional information about the observations (i.e., the state the observation is located in, the National Park or national wildlife refuge the observation is located in).
4. After post-collection processing, the data is then sent back to the owner's ESRI cloud server. Employees with access (i.e., managers, as permitted by the Group owner) can view the data on the ArcGIS Map Viewer. At this point, managers can filter the data to select which information is viewable by employees and/or the public (e.g., managers can restrict access to information about threatened and endangered species).
5. Data that is viewable by all employees and/or the public is posted to the map on ArcGIS Online.

Creating a ROaDS Group and Survey

The Owner who creates the group is the only one who will have the ability to adapt and customize data fields and questions in the ROaDS survey standardized template (such as adding a species to the drop-down list). It is not necessary to create a new group if there is already a group established within the agency that has the associated users (see Add a New Survey to a Group).

Create a ROaDS Group

There are a number of different reasons to create groups, depending on the needs of the agency. One organization can create multiple groups for different departments, or an NGO can start a single group for all its members.

1. Go to arcgis.com and login.
2. imClick on "Groups" at the top of the page.
3. Click on the 

button near the upper-left corner of the page.
4. Fill out Group Details to fit agency's or organization's needs and security requirements.
    a. Group Name: members will need the Group Name to request to join the group to collect observations.
    b. Summary: short explanation of the group's purpose and data collection methods (e.g., if collecting data opportunistically, or systematically only collecting data on specific stretches of road, or if focused on certain species, or if only collecting carcasses that may be removed from the roads). This will help to ensure accurate interpretation of data, when analyzed for patterns and hot-spots.
    c. Tags: key words so others can find the group if needed (examples: WVC, data collection, road safety, etc.).
    d. Who can view this group: this defines which group members can see content and observations collected by the group.
    e. Who can join this group: this sets restrictions on how people join the group. It is best to select "Only those invited by group manager," so only the group manager can select which employees or volunteers can collect data.
    f. Who can contribute content to this group: this should be set to "Group members." Note that managers can restrict access to view the data if necessary.
    g. Select "Create Group."
5. Group members can now be added to the group so they can collect data.

Customizing a ROaDS Survey

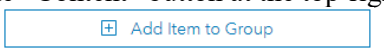
To add and edit a ROaDS survey, owners of the group need to download Survey123 Connect at: http://doc.arcgis.com/en/survey123/download/#

Owners will need a copy of the survey template, which should have been received in advance by the host agency (in Phase 3 it was WTI).

1. Open Survey123. Connect and login using your ArcGIS account information, using the menu in the top, right corner of the application
2. Click "New Survey." Note: you will not be creating a new survey starting from scratch but will be able to modify and customize the survey template to meet your specific research or monitoring needs.
3. On the left side, click on the "File" button, and browse for the ROaDS template saved on your computer and then select "Create."

   a. Edits can be made to the survey at this time, or the .xlsx file can be closed and edited later. More information about the coding needed for making edits to the survey can be found at: https://doc.arcgis.com/en/survey123/desktop/create-surveys/xlsformessentials.htm
   b. The data fields in the ROaDS survey template include a streamlined, standardized set of variables that will enable simple local assessments. These data can be compiled for both regional or national summaries, assessments and reports. There is flexibility to modify the species list and add new data fields to the survey to address diverse regional differences or support research/monitoring needs. Managers and owners are strongly encouraged to maintain the standard data fields or "core variables" as presented in the template whenever possible.
4. Select "Form Preview" to view what the ROaDS survey will look like on the Survey 123 App when collecting data.
5. Click on "Settings" at the top of the Survey123 Connect page.
   a. Add a thumbnail image to identify the survey visually. The ROaDS logo should have been provided with the survey template.
   b. Enter a title, summary, and description for the survey. Please include details about methods that are key to the underlying assumptions that need to be considered when analyzing and interpreting patterns in the ROaDS WVC data (e.g., if using opportunistic data collection or systematic monitoring, if focused on particular sections of roads but not others, if focused on particular species, or if being used to document maintenance carcass removals only, or if law enforcement may be documenting locations of reported WVCs only).
6. Click the "Publish" button on the left side of the screen. Click "Okay" to publish survey; edits can still be made later.
7. Select the back arrow  to go back to the main page. The new survey should now be visible.

Add a ROaDS Survey to a Group

1. Go to arcgis.com and login.
2. Click on "Groups" at the top of the page and select the group to which the new survey will be added.
3. Click on the "Content" button at the top-right of the screen in the blue bar.
4. Click the 

button to add content to this group.
   a. Add the Web Map and Form content with the name created for the ROaDS survey and exit out of the screen.
5. The survey and map will now be viewable in the group.

Chapter 2: Using the ROaDS Survey

This chapter explains how data collectors install the ROaDS survey onto a personal mobile device and offers guidance on how to use it, including:

- An overview of the survey questions
- Instructions on the approaches for answering each question
- Key information to include in survey responses to ensure quality data is collected
- Tips for entering survey responses to ensure that the information is understood by and useful to Agency managers

This manual is primarily intended for those who will be using the survey to document information about wildlife-vehicle collisions and animal movements near roads.

Downloading the Application

The WVC data collection system uses the Survey123 App on the ESRI ArcGIS platform. This platform allows users to upload a Survey123 data form onto a mobile device, collect data using this form on the mobile device in the field, store the data, and then analyze and view the data on a laptop or personal computer.

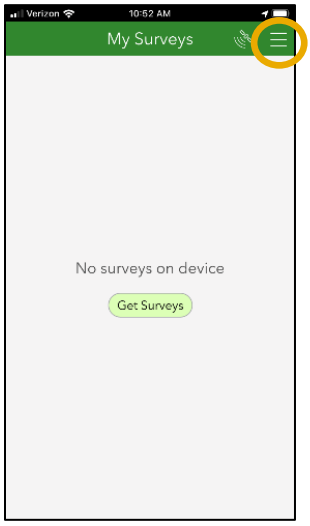
In order to use the ROaDS survey on a mobile device, the ArcGIS Survey123 App must first be downloaded. The Survey123 App is free to install. To download the App, please follow these instructions:

1. Go to the App store for your mobile device.
2. Search for the App: *Survey123 for ArcGIS*.
3. Install the application on your mobile device by choosing the install button and waiting for it to fully download.

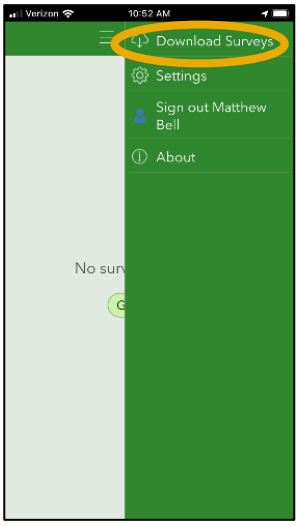
Accessing the ROaDS Survey from a Mobile Device for the First Time

1. Open the Survey123 App.
2. Sign-in using your personal account login information provided by your agency's account. Contact your agency's ESRI administrator if this information is needed.

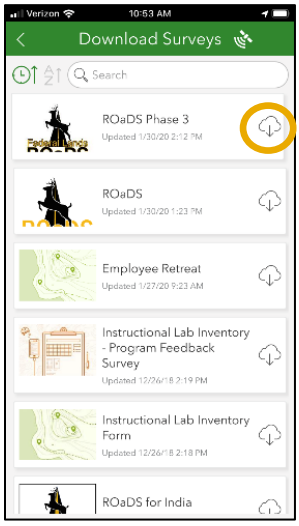
3. Go to the menu button on the top-right of the screen



4. Click on the "Download Survey" button.



5. Download (or update) the "ROaDS" survey and return to your *My Survey123* page.



Using the ROaDS Survey

The ROaDS survey is currently housed in the "WVC at MSU" group on ArcGIS. To be able to view and download the survey, as owner, WTI will grant users access to the group. Each beta test volunteer will receive a unique beta-test ID, which will be used to identify the user's observations.

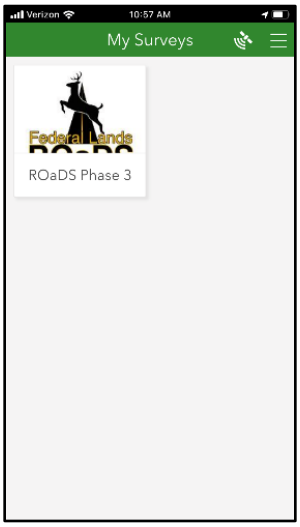
Beta-testing ROaDS

As previously mentioned, there are several important user roles to establish for the ROaDS survey - owners, managers, and collectors. The current owner of the ROaDS Survey is WTI, the contractor managing the initial implementation of ROaDS for Department of the Interior agencies' use. As the owner, WTI oversees all ESRI accounts; can make changes to the survey; and can collect, view, and edit data. Managers can collect, view, and edit data. Collectors can collect and view data.

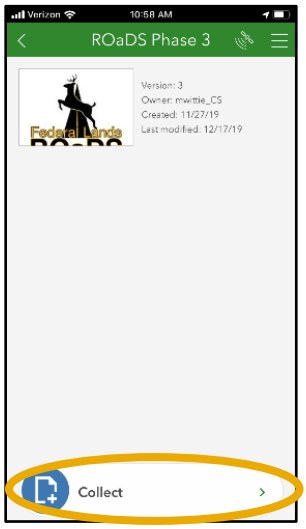
After WTI completes the initial implementation of ROaDS, the bureaus within DOI will assume management of ROaDS internally. At that point, each agency will identify an internal ROaDS owner, and these manuals will be updated to guide agency users through the process of requesting access from the identified agency owners.

Collecting Data

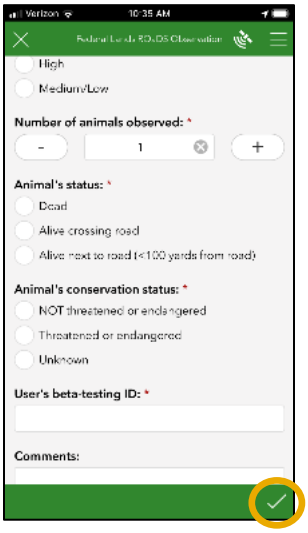
1. After logging in to Survey123, the "My Survey" page will appear. Click on "ROaDS" survey.



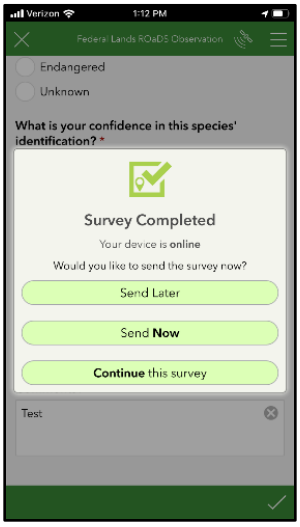
2. Click on the "Collect" button at the bottom of the page to enter an observation.



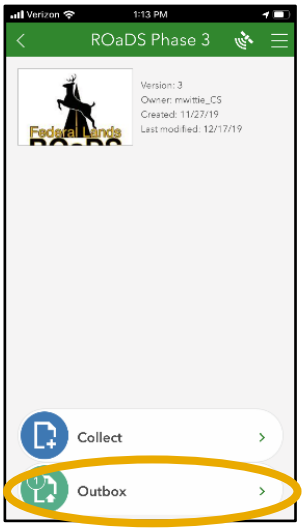
3. Fill in the survey and then click the check mark at the bottom of the page.



4. Data can be sent to the ESRI cloud after each observation or saved to send later when connected to WIFI.



5. If data is saved, it will appear on the initial ROaDS Phase 3 homepage. Click on "Outbox" to access saved data.

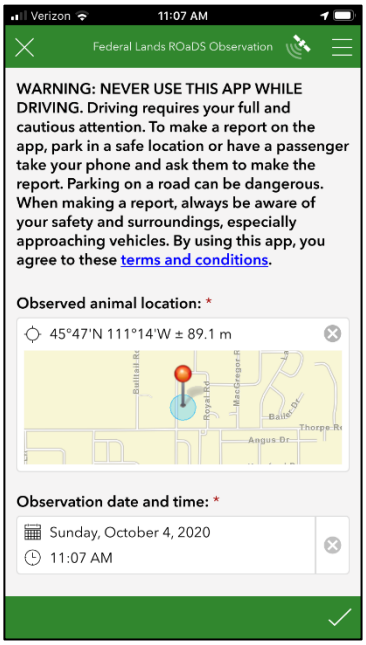


6. Click on "Send" to send saved observations to the ESRI cloud.

Data Collection Tips

It is the responsibility of the individual user to understand what type of data is most vital to your refuge/park. Before you begin collecting data for the first time, contact your supervisor to discuss how the data are to be collected, including considering if observations will be recorded opportunistically or systematically, the amount of effort required, and guidance on data priorities. The manner in which the data are recorded affect the assumptions that are key to appropriate analyses and interpretation of the data; these study design considerations need to be documented and clearly communicated to people collecting the information in the field, as well as to the managers overseeing how the data are handled and analyzed.

Safety

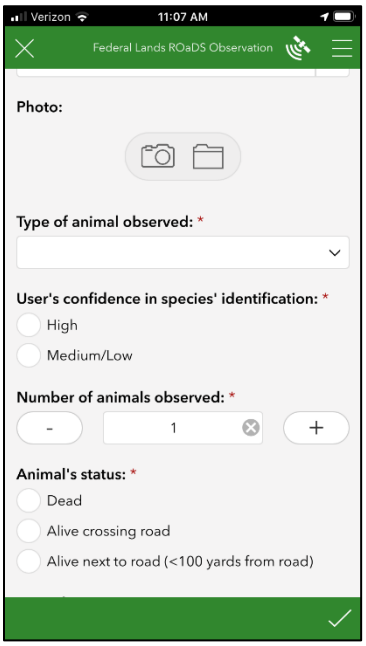


1. It is important to abide by all traffic laws and never collect observations while operating a vehicle. If operating a vehicle, pull over to a safe location to enter observations. If stepping out of vehicle to accurately record the location of the WVC observation, watch for traffic and wear appropriate personal protective equipment, including a safety vest, at a minimum.
2. Approach animals with caution as some may still be alive. If an animal is injured but still alive, contact your park biologist or law enforcement immediately and follow your unit's protocols for humane euthanization to minimize the animal's suffering.
3. If an animal is in the road obstructing traffic, call for assistance to manage traffic while moving the animal or carcass off the road. If the animal is too large to move without risking injuring yourself, recruit other staff to assist in moving the animal to avoid injury.
4. If the carcass may be a bear attractant, follow your unit's protocols for proper disposal of the carcass.

Animal Location, Date, and Time of Observation

5. If the mobile device's location service is enabled, the location will be established automatically when the user presses the "Collect" button in the ROaDS survey. If the user is not near the animal, or location service is disabled, click on the map to manually adjust the location of the observation. Selecting the location finder on the map in the top-left corner will record the latitude and longitude of the mobile device's location.

6. The date and time will also be generated automatically based on the mobile device's settings. If the data is entered later than the observation, click on the date and/or time to adjust it to the correct time of observation.



Photo

7. One photo is allowed for each observation. Photos can help managers with quality assurance and identification of threatened and endangered species. Take photos of the animal in a way that will help with species identification (e.g. tail/antlers of a deer, head/feet of a bear, tail of feline, head of a canine, etc.). It may be useful to include an object for scale.

Type of Animal

8. Select the animal species from the list provided. If a user can only identify the genus, or the type of animal, and does not know the species, select the appropriate "Other" category, and then type "Unknown" in the text box.

Number of Animals Observed

9. It is important to identify the number of animals that are observed at each location. The live crossing events are important to identify areas along the road where animals successfully cross, and where they are congregating near the road.

Animal's Status

10. If the animal is trying to cross the road but is hesitating, it should be identified as "Alive crossing road." If the animal is feeding or bedded down on the side of the road, it should be marked as "Alive next to the road."
11. If an animal is alive, but injured next to the road, select "Alive next to Road" and type "Injured" in the comment box.
12. Multiple observations should be entered if there are alive and dead animals in the same location.

Animal's Conservation Status

13. Marking the animal's conservation status will help DOI managers identify and manage sensitive information within the data that is available for viewing. Users should not mark an animal as "Threatened or Endangered" unless they are 100% sure of the animal's status.

User's Affiliation

14. The agency affiliation of those collecting the information can be helpful to DOI managers when they are conducting the data analysis, so they can filter data appropriately.

Purpose of Observation

15. To help with filtering data, users can mark which type of observation is being collected. If users select “Monitoring program” or “Research project,” a text box will be available to put in a specific ID that is used for those projects. This allows DOI managers to filter data for a specific project to look at the results specific to those efforts.

Comments

16. This text box allows users to provide additional information to the DOI managers to help understand the circumstances better. If unique observations are observed, **adding an email address** can allow managers to contact users with more specific questions. This is important to do if users observe threatened or endangered species.

Chapter 3: View and Analyze ROaDS Data

This chapter explains how to access, view, and filter wildlife-vehicle collision (WVC) data collected using the ROaDS survey project, using the ArcGIS Map Viewer. It provides:

- Instructions on how to access data using the ArcGIS Map Viewer
- An overview of the functions and features of the Map Viewer
- Tips for understanding the collected data on the map
- Guidance on accessing and filtering the data from the surveys

This manual is primarily intended for agency managers to understand the data collected on the ROaDS survey. Users can view collected WVC data from the ROaDS surveys on a laptop or computer by using the Map Viewer on arcgis.com. The ArcGIS Map Viewer allows users to visualize collected data and download observations that may be further analyzed using other types of analysis software. This manual introduces the features of Map Viewer and explains how to access, review, and retrieve data. For a complete operational manual of Map Viewer, visit the ArcGIS website at: https://doc.arcgis.com/en/arcgis-online/get-started/view-maps.htm

This section introduces the general features of the ArcGIS Map Viewer. Instructions and tips for viewing ROaDS data in the Map Viewer will be presented in subsequent sections. Before you can view ROaDS data on the Map Viewer, confirm you are signed into www.arcgis.com with the same credentials used to collect data on the Survey123 app (see Chapter 2 for details).

View Data Map Online

1. Go to www.arcgis.com.
2. Click “Sign-In” at the top-right corner of the page and use the same login information provided by your agency.
3. Click on the “Groups” tab at the top of the screen.
4. Click on the “WVC at MSU” group.
5. Click on the “ROaDS Phase 3” icon that will “Open in Map Viewer.”

Layout of ArcGIS Map Viewer. References for numbers on the maps can be found below.

See Map Details (1)

- Details includes options to see information about the map, the map contents, and the legend.
    - About: displays descriptive information about the map, such as summary, the map owner, the last modification date, user ratings, and a link to more detailed information.
    - Content: displays a list of the layers in the map. Different layers can be added by the group owner to establish map preferences. Click the name of the group layer to see individual layers in the group. Click the box to the right of the name to turn a layer on and off. Click the arrow to the right of the layer name and click "Show Item Details" or "Description" to open a page with detailed information about the layer.
    - Legend: displays the legend for layers in the map. You will not see a legend for the base maps, layers that are not accessible externally, or layers in which the map author has hidden the legend.

Edit Features (2)

- If you can see an "Edit" button, you are viewing a map with an editable feature layer and you have privileges to edit it. Use the edit button to add, change, or remove features on the map.

Perform Analysis (3)

- Use analysis tools to find patterns, understand relationships, and interpret the data in your map. The "Analysis" button appears when you are signed in with an organizational account that has privileges to perform analyses.

Navigate (4)

- Use the Zoom buttons, the mouse wheel, or the arrows on the keyboard to change the zoom of the map.

- To zoom the map to its initial extent, click the "Default Extent" button  . You can also browse the map to a predefined extent through a "Bookmark."
- To pan, use your mouse and wheel button or the arrow keys on your keyboard.
- To find your current location, click the "Find My Location" button  . You may need to authorize the site to access your location information. Your results may vary based on your connection type, internet service provider, physical location, network, and browser.
- To open an overview map, click the "Overview Map" button  in the upper right corner.
- If you're using a Mac with OS X 10.6 or later, you can use multitouch gestures by dragging two fingers to pan and zoom the map. The default behavior is to pan. To zoom in or out, press and hold the "Shift" key. Dragging two fingers toward you zooms in; dragging two fingers away zooms out.

View Pop-ups (5)

- Click on data points on the map to display the attributes associated with each feature layer in the map, such as type of animal, date collected, and who collected the observation. They can contain images, and charts can be linked to external web pages.

Share (6)

- If you can see a "Share" button, you have privileges to share the map. Your sharing options depend on your privileges and can include posting maps on social media sites, sending an email with a link, embedding maps on a website, and creating apps with the maps.

Print (7)

- Use the "Print" drop-down menu to display a printer-friendly web page of your map. You have the option of printing only the map or the map and its legend. Once the print page has finished loading, you can use your browser's print option to print a complete and well-formatted map. Layers that are not accessible externally, KML ground overlays, and network links without refresh properties do not appear on a printed map.
    - If your organization has configured custom print layouts, you will see them listed in the Print drop-down menu. Choose the layout you want to use for printing.

Get Directions (8)

- Use "Directions"  to get a set of turn-by-turn driving and walking directions. The button appears when you are signed in with an organizational account that includes privileges to use network analysis.

Measure (9)

- Use "Measure"  to measure the area of a polygon or the length of a line or to view the coordinates of a point.

Access Bookmarks (10)

- Use "Bookmarks" to access a set of predefined locations on the map. If you are a map author, you can create bookmarks.

Search (11)

- Enter keywords into the search box at the top of Map Viewer to find locations on the map, such as addresses, places, and points of interest.

Understand Map Scale (12)

- The scale bar shows the scale of the map, which is set by the basemap. If you zoom beyond the visibility of the basemap, the map may not draw correctly. Your administrator sets the default units for the scale bar (and measure tool, directions, and analysis). United States standard sets the units to miles, feet, and inches; metric sets the units to kilometers, meters, and centimeters. You can change the units you see by editing your profile.

Tips for Understanding Data Points

Change the Base Map

The base map can be changed using the command above the legend.

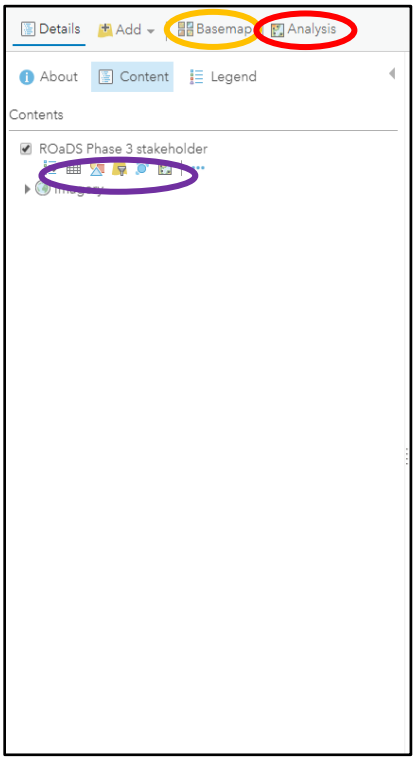
Filter Data Fields and Visual Changes

Users can select the Content menu on the left-hand side of the map to filter collected and reviewed data, change the style of map, and view cluster points. These tools allow users to visually interpret different aspects of the data collected: species, date, dead/alive, etc.

This is a visual interpretation and does not consist of any statistical measurements that can be used to analyze the factors associated with animal collisions. Further analysis is required to identify contributory factors and specific cluster locations along roadways.

Statistical Analyses

This feature allows users to do more detailed analyses of the complete set of data, or data viewable in the map extent. Analyses include summarize, enrichment, hotspots, and more.



Users who wish to interpret WVC data should fully understand the assumptions and analyses used and only interpret results based on their level of statistical expertise.

Exporting Data

Click on “Analysis,” then “Manage Data,” and then “Extract Data.”

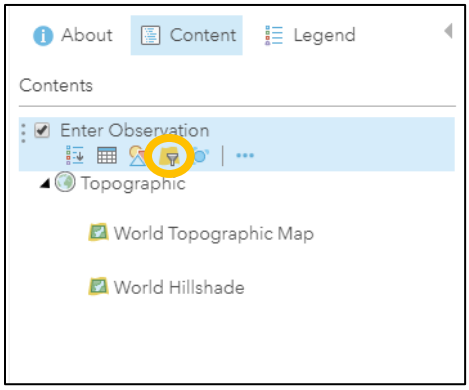
- Select “ROaDS Phase 3_stakeholder” layer (1) and “Same as Display” or “Draw” (2). Select format of the data (3) and choose a file name (4). Data will save to the “Contents” folder on the home page and can be downloaded to a computer from there.

Filter and Analyze Data

After exporting ROaDS data (see previous section), users can select the Content menu on the left-hand side of the map to filter collected and reviewed data, change the style of map, and view cluster points.

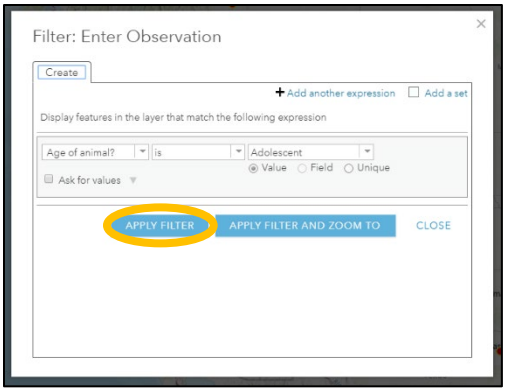
Filter by Data Field

Select the filter button under "Enter Observation"



Filter options will appear. Data can be filtered using any of the data fields in the survey such as:

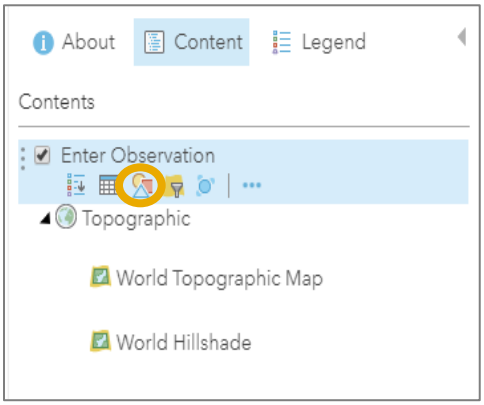
- Username
- Location
- Type of Animal
- Species



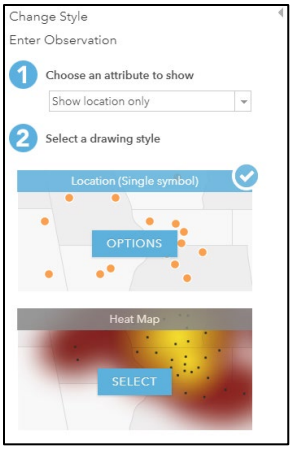
Select the options you wish to display and select "Apply Filter."
To remove or change filter, select the filter button again and select to remove filter or edit filter.

Change Style of Map

Select the change style button under "Enter Observation."

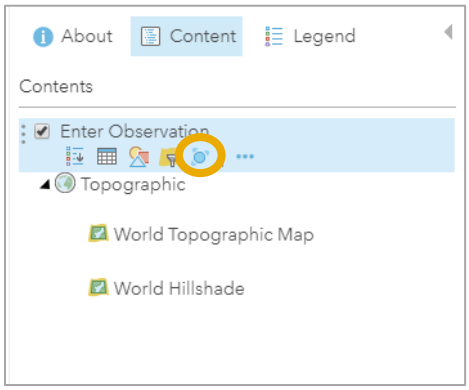


You can choose a data field (attribute) to show or you can select a style of map to show such as a heat map. Select “Done” when finished selecting desired style.
For more advanced style changes, go to the “Change Style” button again and select options under each of the location or heat map options. Users can adjust the area of influence, visible range, and transparency of data indicators as desired. Select “OK” when complete.

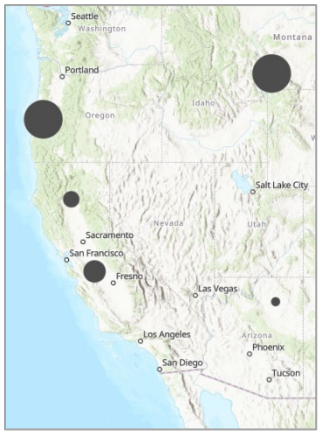


View Cluster Points

Select the cluster points button under “Enter Observation.”



Data on the map will automatically change to a cluster points view. Users can adjust the cluster point map as needed in the left-hand menu.



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