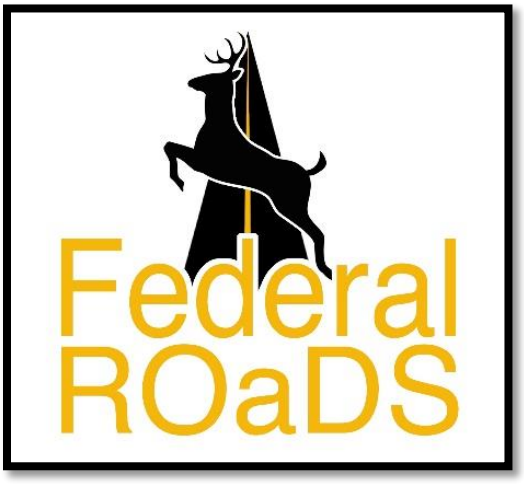
Federal Lands Wildlife-Vehicle Collision Data Coordination Project



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16. Abstract

The National Park Service (NPS) and US Fish and Wildlife Service (FWS) partnered on an effort to develop a Federal Lands Wildlife-Vehicle Collision (WVC) Database. The agencies seek to coordinate the use of a WVC Data Collection System with other federal land management agencies (FLMAs) and with non-federal transportation agencies and other organizations and entities. Phase 1 of this project developed a pilot WVC system using an existing commercial mobile device application and its data storage and serving capabilities; this commercial system is available to all Department of Interior (DOI) agencies, but not to most other potential partners. It was customized for Phase I to collect WVC roadkill observations. Called ROaDS - Roadkill Observation and Data System - some capabilities of note are the mobile device application includes, for experts, an auto-filling species list using the scientific names of all mammals, birds and herpetofauna found in the U.S. It has a simpler common name species list for non-experts. ROaDS has a safety feature that allows an observer to quickly lock in the exact location of the dead animal along the road and then move to a safer site, if needed, to fill in the data fields. It has an option to take one geo-synched photo of the animal. For quality assurance, a data field was created so the observer could indicate his/her confidence in species identification, so that NPS/FWS experts could review low confidence observations as well as all non-expert observations to assure the species identified were correct. Interviews of volunteers who conducted the beta-test of the system indicated, among other likes and dislikes of the ROaDS app, that they "liked" that they were not required to fill out every data field (many were optional) before their observation was accepted by the system, the geo-synched photo was easy to use, and they want the number of data fields (11) reduced in a Phase 2 version. At the conclusion of Phase 1, the project's Advisory Committee offered three pathways for Phase 2: 1) DOI agencies will use the ROaDS survey via the existing commercial system and keep it internal for their own personnel. Other non-DOI agencies, citizen scientists and trained volunteers would not be able to contribute standardized WVC data to this system; 2) the Federal Highway Administration (FHWA) hosts/supports a WVC data collection system for all FLMA personnel within the Departments of Agriculture, Interior, and Defense and will contribute to, and collaboratively fund its maintenance and use through an interagency/interdepartmental agreement that is renewable; or, 3) FHWA co-hosts and supports a national system for all federal, state, and local agencies, tribes and public/citizen scientists. This may require quality control capabilities (expert biologist review) of public/citizen scientist and other non-expert data contributions of roadkill. All three options will need to address observer privacy and data security considerations.

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EXECUTIVE SUMMARY

The National Park Service (NPS) and US Fish and Wildlife Service (FWS) have partnered on an effort to develop a Federal Lands Wildlife-Vehicle Collision (WVC) Database. The agencies seek to coordinate the use of the WVC Data Collection System with other federal land management agencies (FLMAs) such as the Bureau of Land Management Forest Service, Bureau of Indian Affairs, and with non-federal transportation agencies and organizations and other entities.
The WVC Data Collection System is designed to collect information on large animal – vehicle crashes, which are the focus of the safety requirements for FLMA roads, as well as carcass information of medium-sized and smaller taxa, which are the focus of the FLMAs' conservation mission.

The WVC Data Collection System will:

- Allow for all agencies to collect the same information - national standardized WVC data.
- Facilitate the collection of all types of animals from large animals, the focus of motorist safety, to smaller mammals, reptiles, birds and amphibians for conservation purposes.
- Provide for improved coordination of the FLMAs and surrounding stakeholders for collecting, reporting and assessing WVC data at various scales - management unit, regional and national.
- Allow for greater public engagement in natural resource conservation by allowing citizens and visitors to report WVCs.
- Enhance the understanding of WVC incidence, species, and contributing factors to improve transportation decisions, mitigation investments and natural resource protection.

The WVC Data Collection System can be used for:

- Transportation planning
- Programming and budgeting
- Annual project development
- Research and monitoring
- Informing State Departments of Transportation, Metropolitan Planning Organizations, or other transportation authorities' highway projects and decisions effecting federal lands and resources
- The identification and location of road segments with high rates of WVCs (safety)
- The identification and location of road segments causing high rates of mortality to medium-sized and smaller species of conservation concern
- The distribution and occurrence of threatened, endangered and/or rare species
- Changes in high WVC locations, wildlife conservation sites, and other wildlife-highway information over time.
- Informing the general public via public information, education, and citizen science materials and reports.

PHASE 1

In Phase 1 of the project the WVC Data Collection System was based on a mobile device application (smart phones and tablets) used for collecting the data. The application being used for the project was the commercially produced ESRI Survey 123, which is currently available to all Department of Interior agency and bureau employees. The survey developed for the project was called ROaDS (Roadkill Observation and Data System).

During Phase 1, if the mobile device had connectivity – either via the internet or thru cellular phone coverage, each roadkill observation's data would be uploaded directly to cloud-based data storage provided by ESRI. If a phone or tablet was disconnected, it stored the information in the mobile device's memory until connectivity was restored. The data collector had an option to attach a photo of the roadkill with the data (geo-synched). Lastly, for safety, the data collector simply pushed a button to confirm the location of the roadkill observation on a map, this was locked in, allowing the observer to move to another location to enter the rest of the information if they felt remaining near the dead animal was unsafe.

Once the observation data was in ESRI's cloud-based server, each observation's data and photo could be exported and reviewed by a NPS or FWS expert for quality assurance and control. Once reviewed, the data was then returned to the ESRI data server. The ESRI database could be queried and data retrieved by FLMA personnel given access by the project research team. Agency personnel could then retrieve the collected data for map-based viewing and further analyses of the WVC information.

BETA-TEST OF SYSTEM

A beta-test was conducted of the WVC data collection, storage and retrieval system. A sampling of comments on the system 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 be filled out.
- Geo-synched photo was very easy to use.
- The safety feature of allowing the collector to mark the site and then move to somewhere away from traffic to fill out the data fields was poorly understood.
- Minimize and simplify the survey; there are too many data fields.

These comments, and many others are in the Phase 1 final report and will need to be addressed in Phase 2, if further development of a WVC Data Collection System is pursued.

NEXT STEPS

The project's Advisory Committee discussed several potential options and then focused on three pathways that the WVC Data Collection System could take to achieve its implementation if it decides on a successive phase:

1. Department of Interior (DOI) agencies will use the ROaDS survey via the ESRI Survey 123 system and keep it internal for their own personnel. Other non-DOI agencies, citizen scientists and trained volunteers would not be able to contribute WVC data to this system.
2. The Federal Highway Administration (FHWA) hosts/supports a WVC data collection system for all agency personnel of the FLMAs within the Departments of Agriculture, Interior, and Defense and will contribute to, and collaboratively fund, its maintenance

and use through an interagency/interdepartmental agreement that is renewed on an agreed upon cycle.

3. FHWA co-hosts/supports a national WVC Data Collection System for all FLMAs, state transportation agencies, metropolitan planning organizations, the public and citizen scientists. This may require quality control capabilities (agency biologist review) of public and citizen scientist contributions of roadkill observations.

   All three options will require attention to observer privacy and quality control.

Other considerations for the next phase of the project are:

- Assure there is agreement among natural resource and transportation agencies regarding the data standards so that the same consistent WVC data are collected across all federal, state, tribal and local agencies (national data standard).
- Engage a partnership of key agencies that collectively and sustainably support the long-term viability and use of the ROaDS system and the applicability of the information collected.
- Guarantee the final WVC data collection system will be compliant with Office of Management and Budget requirements and the Paperwork Reduction Act, as well as other applicable federal regulations and laws.

1. INTRODUCTION

At this time and historically, neither the National Park Service (NPS) nor the US Fish and Wildlife Service (FWS) systematically collect wildlife vehicle collisions (WVCs). A NPS-wide survey, for which 106 national park management units responded, showed that managers perceived that roads were adversely affecting wildlife populations (Ament et al. 2008). More recently, a survey of FWS's Region 5's national wildlife refuges found that respondents felt road impacts on wildlife populations are a major concern as roads continue to fragment habitat and cause direct wildlife mortality (Clevenger et al. 2015). In addition, the survey found that a minority of the refuges quantify, moderate, and/or monitor these adverse impacts, including for threatened and endangered species (Clevenger et al. 2015). Recently, in a state where collisions with deer are high, the lack of quality animal-vehicle collision data led to severe underreporting of deer-vehicle collisions (they were 8.5 times higher than reported) and the costs of DVCs were 6 times costlier than documented in law enforcement crash reports (Donaldson 2017). These reports and other related studies across the nation demonstrate the need for high quality, systematic WVC data collection to better evaluate their impacts and true costs, locate problematic stretches of roads, and support the investment in effective mitigation measures, such as safe passage infrastructure.

The advantages of a national standardized animal-vehicle collision data collection program were described over a decade ago in a National Cooperative Highway Research Report (Huijser et al. 2007):

- The occurrence of incidents that affect human safety, natural resource conservation, and monetary losses are documented;
- Changes in animal-vehicle collisions in time or space can be documented;
- Locations that may require mitigation can be identified and prioritized, allowing for an effective use of resources; and
- 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.

Such a wildlife vehicle collision (WVC) data system would allow for:

- Standardized, spatially-precise data collection with user-friendly data entry via mobile devices.
- Central data storage that simplifies data management across federal land management units and across individual units within the same agency.

The development of WVC data systems has evolved over the past decade. Originally, personal data assistants (PDAs) were coupled with Geographic Position Systems (GPS) back 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 escalated and smart phones with excellent GPS capabilities have become common, 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 (Shilling and Waetien 2015). Some systems combine

web-based with mobile device applications (Bil et al. 2017) and smart phone systems with citizen science capabilities to increase completeness of the data (Vercayie and Herremans 2015).

The FWS, NPS, and other 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 surrounding public lands. Currently, there is no systematic collection and sharing of this information. Without these data, it is difficult for FLMAs to adequately analyze WVCs, develop priorities, fund, and implement the most effective mitigation solutions that resolve WVC issues and their adverse compounding effects on motorist safety and resource protection.

Although the FWS and NPS each manage roads within their own jurisdiction, the surrounding transportation network is managed by other land management agencies, or state Departments of Transportation (DOTs), city or county road departments, or state departments of parks or natural resources. These entities may also have road segments with high rates of WVCs with similar implications to human safety and natural resource protection. The lack of WVC data coordination on surrounding non-FLMA roads limit the ability of a FLMA and its adjacent partners to fully understand the negative impacts that WVCs are having in a specific area or region.

The adverse effects of roads and traffic on FLMA visitors and natural resources are issues shared with other transportation and natural resource agencies across the nation, and in many other parts of the world. As a result, different technologies have been developed to gather more precise WVC data. The challenge is to sort through this variety of technologies to determine which are readily available with the least modification, and which best address the unique circumstances of FWS, NPS, and other FLMAs and their information systems, cultures, and environments.

This project sought to facilitate the coordination of WVC data collection by the NPS, FWS and other federal land management agencies (FLMAs) such as the USDA Forest Service and Bureau of Land Management, as well as other stakeholders, such as the Texas Department of Transportation. It sought to better understand WVC data collection systems and identify the data collection, storage, and retrieval needs for the FLMAs and their stakeholders. The project sought to assess existing data collection systems, the use of the commercial data collection system already under contract to the Department of Interior to beta test a WVC system, and the exploration of the future implementation and sustainability of a WVC data system for FWS, NPS, other FLMAs, and partners with recommendations for coordinating the WVC data system's collection, storage, analysis and reporting.

The *goal* of this project is to explore the creation of a WVC data collection system for FLMAs to collect, store, map, analyze, and share WVC data. Such a system would help facilitate FLMA coordination, specifically between the US Fish and Wildlife Service, National Park Service and other federal partners and with surrounding transportation networks and entities, such as state DOTs.

The *objectives* for such a WVC data system include:

- Provide for improved coordination of the FLMAs and surrounding stakeholders for capturing WVC data at a national, regional, state-wide, and local level.
- Allow for greater public stewardship of natural resources allowing for reporting of WVCs by FLMA visitors and other interested groups or individuals.
- Enhance the understanding of WVC incidents and species factors, thus improving transportation mitigation investment identification and further promoting natural resource protection.

2. WILDLIFE VEHICLE COLLISION DATA SYSTEM - EXISTING AND FUTURE NEEDS

2.1. Discussion of Needs Based on a Questionnaire

To better understand the existing capabilities and needs of the FWS, NPS and other federal agencies, a questionnaire (Appendix A) was developed for attendees of a project hosted meeting in Washington, DC in January 2017. It was distributed weeks before the meeting to allow attendees the opportunity to discuss the questions with colleagues at their agencies before the meeting (see contact list, Appendix E). There were representatives at the meeting from FWS, NPS, BLM, and FHWA with a diversity of expertise that included biologists, transportation planners, federal GIS analysts, safety program staff, and IT specialists. To prepare attendees for the meeting, thirty-three questions were developed across four areas: understanding existing federal agency WVC data collection processes and existing agency data collection systems; identifying agency WVC data collection and reporting needs and; selection of standardized data to collect.

Some of the key findings as a result of the questionnaire and the meeting were:

Although some federal agencies, such as FWS and NPS, had law enforcement personnel that collected crash data with animals, others did not and often rely on state DOTs for information on state highway system roads that traverse federal lands. For other roads, there was very little, or a total lack of, data. Similarly, the collection of data from carcass removal was not systematically collected either by FLMA staff or state or county transportation agencies. State transportation data often varies between states or within a state's districts. This data was primarily safety related, focused on large animals, and predominantly four species of ungulates - white tailed deer, mule deer, elk, and moose.

Smaller animals, except sometimes threatened and endangered species, often had no records of either crashes or carcasses. Thus, species not listed by the Endangered Species Act, or not large enough to be a concern for safety were poorly represented in existing data bases of any federal or state agency. This was pointed out as a major issue that could be addressed by a common WVC data collection system for the FLMAs.

A national WVC data collection system would be used primarily by FLMA natural resource staff, law enforcement and roadside maintenance personnel. However, such a system should be designed so that other partners of the FLMAs could also use it, such as state DOTs, local groups that support individual management units such as education associations or friends groups.

An overriding sentiment by the attendees was that a "perfect" WVC Data Collection System would have the following characteristics:

- Simple, easy to use, requiring only a brief amount of time needed to collect data on a roadside.
- Spatially precise observations, within meters rather than mile markers.
- A photo capability that is linked to the data observation, particularly for those animals that are difficult to identify or are collected by non-experts.
- Data that documents observers' confidence in the identification of the species, with quality control protocols either contributed by and/ or reviewed by agency biologists.

- Consistent, standardized data that is interpreted and collected in the same manner, regardless of geography or jurisdiction.
- The system should be able to collect information on large, medium, and small-sized animals.
- It should be able to collect both wildlife species and different types of domestic animals.
- Data collection would focus on dead, dying, injured animals; not live successful crossings of wildlife.
- The system could capture the time and effort to gather roadkill data, such as via regularly scheduled survey routes and differentiate with opportunistic, by chance, data observations.
- The system could incorporate observations from citizen scientists and/or other trained individuals/volunteers.
- It should be a centralized system, managed and overseen by one agency or contractor on behalf of all the FLMAs and their partners.
- Protection of the privacy of the collector must be absolutely assured and is federally required.

A well-functioning WVC data collection system has many attributes that are necessary to make it successful and readily adopted by busy federal agency personnel and others. In addition, there was a full discussion on other information other than identifying the dead species that could be collected at a roadkill site. This was to be discussed further and became part of the mobile device application's development (see Chapter 3).

2.2. Review of existing WVC data collection applications and systems

The FWS, NPS and its partner FLMAs sought to explore and evaluate existing WVC data collection systems to determine if they could simply adopt or adapt a system or systems to meet their needs to coordinate their data collection. Members of the research team were aware of a variety of WVC or roadkill data collection applications for mobile devices that have been developed by public, academic and private entities. What was less well understood beyond the data collection applications were the rest of the data systems - storage security, mapping capabilities, control of access to data, reliability/accuracy of data collected, protection of privacy of data collectors, and other aspects of the WVC data collection systems. Thus, the first step of the project was to determine which data collection systems were already available, whether they would be ideal to use for this project, and what were the similarities and differences in WVC data collection system architecture and capabilities (Table 1).

The research team reviewed 16 WVC data collection systems from around the world from Africa, Europe, and North America to obtain a broad view of existing systems. This was not an exhaustive review of every system, but it did provide the project research team with a reasonable overview of the state of the development of apps and systems. All 16 of the reviewed systems were set up to allow observers to input data at a website once they returned home or to an office. Such a method of data collection makes spatial accuracy a challenge. One system developed by the Utah DOT, allowed a mobile device to link to a website to directly enter data in the field. Six of the systems were developed to use a mobile device or smart phone application; this allowed the location of the

WVCs to be spatially accurate due to the devices' internal geographical positioning systems (Mobile App Column 3, Table 1). The most common fields of data collected, of the systems reviewed (equal to or greater than one half) were: species, date, time, location, and an opportunity to type in a description or comment. Seven of the 16 systems were set up to take pictures of the dead animal (Table 1).

Table 1. Various wildlife vehicle collision data systems and their capabilities reviewed for this project.

Name	Website	Mobile site	Mobile App	Date & Time	Location	Habitat	Species	Confidence of recognition	Sex	Age	Number	Collar/tag #	Dead/alive	Picture	Weather	Road condition	Road type	Carcass placement	Description/comments	Observer	Frequency of travel	Mode of Travel
Road Kill Survey	1			1	1	1	1		1		1			0	1							
Utah Wildlife-Vehicle Collision (WVC) Reporter	1	1			1		1		1	1		1		0					1			
observation.org	1				1		1							1								
RoadKill.at	1			1			1				1			1					1		1	1
Road Watch BC	1		1		1		1						1	0				1	1			
California Roadkill Observation System	1			1	1		1							1				1		1		
Maine Audubon Wildlife Road Watch	1			1	1		1				1			0								
natuurpunt	1			1	1		1		1		1			1					1			
Animal Vehicle Collisions	1		1	1	1	1	1						1	0				1				
Deer Crash	1																					
Project Splatter	1		1	1	1		1				1			0			1		1			
Endangered Wildlife Trust	1													0								
iNaturalist	1		1	1	1		1							1					1	1		
Roadkill Observation Collection System (ROCS)	1			1	1		1		1				1					1	1	1		
GrizzTracker	1		1	1	1	1	1	1			1			1								1
USMP	1		1	1	1									1	1	1	1		1	1		
SUM	16	1	6	11	13	3	13	1	4	1	6	1	3	7	2	1	2	4	8	4	1	2
	Platform			Placement			Animal								Metadata					Observer		

After reviewing a robust number of available systems (Table 1), it was decided by the Project Advisory Committee that the Department of Interior already had a data collection, storage, and retrieval system under contract for all its agencies and bureaus. ESRI Survey 123 for ArcGIS is a commercial system that could be adapted and used for this project in its early stage of development. Everyone from the federal agencies in the Department of Interior has access to the commercial application and the data storage system. It was agreed to move forward with developing and beta-testing the mobile device(s) application and data management system on the ESRI Survey 123 for ArcGIS platform because it was the easiest system to adapt for WVC data collection without NPS and FWS needing to negotiate, purchase, or involve other existing systems owners.

In addition, since the pilot phase of developing a WVC data collection system had not made a decision on its long-term sustainability, developing an original system housed external to the NPS and FWS was deemed inefficient and could perhaps consume too much of the time and resources of the project for the development of such a system. Thus, for the first phase of the project, ESRI Survey 123 was adopted, in part to develop and test a smart phone application with the acknowledgement that additional modification and adaptation would likely be needed for identifying a long-term, stable, sustainable data storage/retrieval part of the system.

3. DEVELOPMENT OF A WILDLIFE VEHICLE COLLISION APPLICATION AND DATA SYSTEM

To meet the needs for collection and coordination, it was determined that the WVC data collection system design and architecture for FLMAs required decisions regarding different facets of the framework of the system. These components of the system fall into four broad categories: data collection, data storage, data retrieval/display, and data access and security management. The details described below document the first version of this system developed during the course of this project for field testing of an app and further refinement of the entire system. Data Collection

3.1. Mobile device application

To collect data efficiently, accurately, and systematically across multiple agencies and jurisdictions, FLMAs have a host of potential tools at their disposal to record information, both stationary and mobile: personal computers (PCs), laptop computers, tablets, smart phones, and smart watches. Software or applications must be developed for each of these devices that are used by a data collection system. PCs are only used if the data collection system has a web-based user interface. Their weakness is that locating the exact site of the crash once observers have returned to their office or home to record an observation can lead to imprecise spatial location of carcasses. Thus, it was decided that a PC based system would not be pursued for further developement for the project's beta-test.

Of the mobile devices - smart phones, tablets, laptops, and smart watches - only the smart phone was used for this project. Tablets could easily be added in future phases. Laptops and smart watches were deemed either inappropriate and/or uncommon for the development of applications for this project. Therefore, the ESRI Survey 123 for ArcGIS application was used for developing an application (app) for mobile data collection on smart phones. The Geographical Positioning Systems (GPSs) used in smart phones are fairly accurate, a field study in Utah demonstrated a median location error for a Droid X to be 5.2 meters (m) and an iPhone 4 of 4.6 m. An advantage of the use of smart phones or tablets is that they can store the data in their memory until they are connected via a cellular or a wireless internet connection to upload to the data server later. Since the GPS function of the phones is not dependent on connectivity, data collectors in FLMA management units with spotty cell tower coverage or none at all, are able to get relatively high quality and spatially precise data when not connected.

Department of Interior agencies have developed many different surveys using the ESRI Survey 123 for ArcGIS application (Figure 1). For this project, the survey that was developed was coined the Roadkill Observation and Data System - ROaDS and an icon was developed (Figure 2).

A manual was developed by the project research team that instructed beta-test data collectors on how to download the ESRI Survey 123 application and the ROaDS survey to their smart phone (Appendix B).

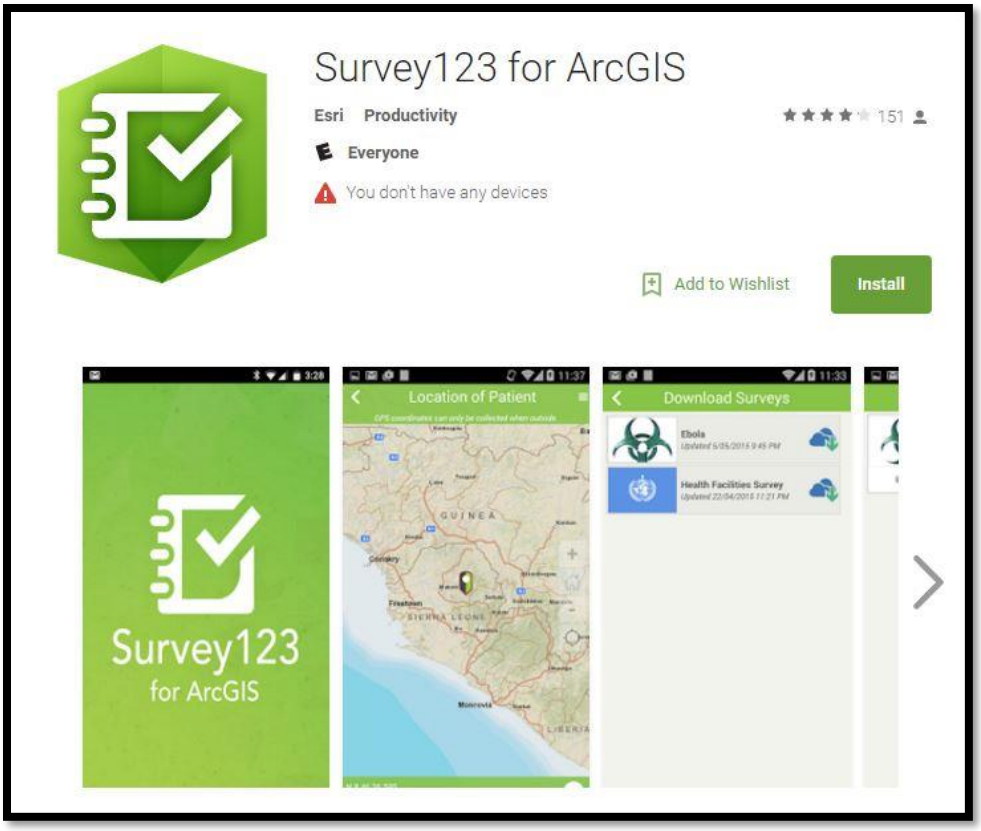

Figure 1: Screenshot of smart phone application of Survey 123 for ArcGIS.

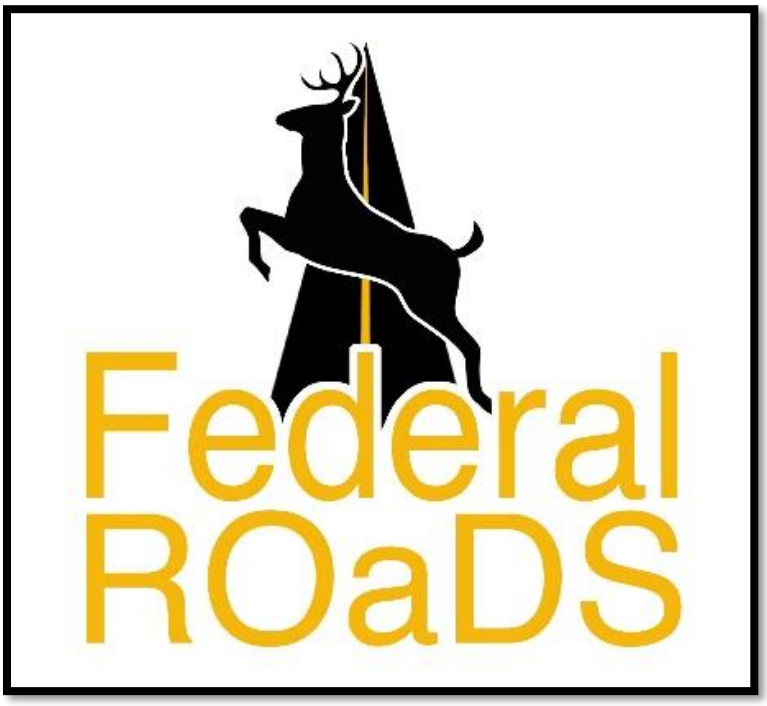

Figure 2. ROaDS icon developed for the project's wildlife vehicle collision data collection system.

3.1.1. Standardized data collection

There are many different types of information that could be collected and the Project Advisory Committee and Research Team had to make decisions on what standard data fields would be piloted in the beta test of the ROaDS. A list of protentional data fields was created and reviewed by the Committee and Research Team and others in the FLMAs to arrive at a final list of data fields that would be field tested and evaluated to assess the ease of use, accurate recording (e.g., how users interpreted the fields), and relevant to identifying areas where WVCs may be an issue that may justify mitigation to reduce this safety hazard and source of wildlife mortality on park roads (Table 2, Table 3). Several phone conference calls with FLMA biologists and transportation specialists were conducted to arrive at a general consensus on the most important data fields. A table of candidate data fields was sent out with a questionnaire to additional FLMA staff to help select data fields. After vetting nearly 30 potential data fields, 11 data fields were selected as the most important standardized information that would be used in the beta test to evaluate how these fields capture relevant information at the site of WVCs (Table 2).

Table 2. Standard WVC data fields piloted in the beta test of the project's ROaDS survey.

Data Field No.	Data Field	Type of Data Field	Comments
1	Name of animal observed		Different wildlife groupings
1a	Common Name (single line text)	Text	Allow 100 characters
1b	Scientific Name (single line text)	Pull-down auto-	Official latin binomials for mammals, birds, reptiles and amphibians of the U.S.
2	More than one animal observed?	2 Buttons	No and yes, if yes, type number in blank field
3	Animal(s) observed is dead or dying?	2 Buttons	Dead, dying
4	Observer witnessed crash or found carcass	3 Buttons	Witnessed crash, found carcass, other
5	Is there an accident report?	3 Buttons	Yes, no, I don't know
6	Observer's proximity to animal when recording data	3 Buttons	< 10 feet, 10 feet to 100 yards, > 100 yds (type distance in blank field)
7	Observer's confidence in their species ID	3 Buttons	High, medium, low
8	Observer's mode of travel	Pull-down	Commercial vehicle, personal vehicle, agency vehicle, bicycle, pedestrian, other
9	Observation is part of a survey or random occurrence	2 Buttons	Random or if survey, blank field allows observer to describe survey
10	Take a photo (geo-referenced)	Button	1 photo - it is optional
11	Comments	Text	Allow 140 characters

There were many additional data fields that the questionnaire identified and that were preferred by agency personnel. Instead of including these additional data fields to the survey to be collected at the observation location, it was determined that they could be automatically filled by post-collection processing. Therefore, an additional 18 data fields or pieces of information could be gleaned from the data collected from the 11 data fields, either based on the spatial location, the registration process when an observer signed up for the ROaDS survey, or with the additional post-collection entries (Table 3). Depending on the quality of data available from other sources (e.g., GIS layers), post-collection processing could create additional, relevant information based on the precise location of the observation from the smart phone's GPS and layering that location into spatial coverage of different types, such as physiographic information (aspect, slope, roughness, waterways), habitats, distance to infrastructure, state boundaries, county boundaries, and FLMA regions.

Table 3. Types of additional information that could be created after a carcass observation was uploaded to the ROaDS survey.

Data Field No.	Data Field	Type of Data Field	Comments
1	Name of Data Collector/Collector ID	Auto-filled	Auto-filled: Information included in registration
2	Data Collector's Email Address	Auto-filled	Auto-filled: Information included in registration
3	Type/Expertise of Data Collector	Auto-filled	Auto-filled: Information included in registration
4	Data Collector's FLMA Affiliation	Auto-filled	Auto-filled: Information included in registration
5	Data Collector's State of Residency	Auto-filled	Auto-filled: Information included in registration
6	Date Data is Collected	Auto-filled	Automatically collected from mobile device
9	Time of Day Data is Collected	Auto-filled	Automatically collected from mobile device
10	Incident Location	Auto-filled	Automatically collected from mobile device
11	FLMA Region	Auto-filled	Processed after data collected, based on lat-long
12	Agency Management Unit	Auto-filled	Processed after data collected, based on lat-long
13	State	Auto-filled	Processed after data collected, based on lat-long
14	County	Auto-filled	Processed after data collected, based on lat-long
15	City or Township	Auto-filled	Processed after data collected, based on lat-long
16	Road/Highway Identification	Auto-filled	Processed after data collected, based on lat-long and quality of roads information of
17	Number of Lanes	Auto-filled	Processed after data collected, based on lat-long
18	Posted Speed Limit	Auto-filled	Processed after data collected, based on lat-long

There were seven other data fields that were not considered necessary as part of a national standard. These options were included in the pilot study for FLMA personnel who felt that additional information could be important to collect (Table 4) for their specific management unit or surrounding roads. This may be for project level purposes, local research projects or monitoring.

Table 4. Optional information to be collected for research, monitoring or local management unit projects by the ROaDS survey.

Data Field No.	Data Field	Type of Data Field	Comments
1	Unusual Roadway Condition	Pull-down	icy, broken pavement, sharp curve, steep hill, lighted highway, other
2	Habitat	Pull-down	forest, shrubland, grassland, alpine, agricultural field, other
3	Road Setting	Post-processed	Post collection processed based on lat-long
4	Road Surface	Post-processed	Post collection processed based on lat-long
5	Near Wildlife Crossing or Other Mitigation Measure?	3 buttons	in a mitigated section, < 100 meters from a mitigated section, >100 meters of a mitigation
6	Live	1 button	added to dead data field - number 3 in core data fields
7	Near Other Types of Safe Passage Structure	3 buttons	culvert, bridge, other

3.1.2. Data collection and quality assurance

The data collection process starts with observers or 'field users' who collect roadkill data using the Survey123 for ArcGIS application (app) through their mobile devices in the field. Survey123 is a multiplatform (Android and iOS) app provided by ESRI - a leading service provider of geolocation analysis tools and software. ESRI is under contract and available for use by agencies in the Department of Interior, such as NPS and FWS for this project. Survey123 can develop an electronic form with a series of data fields that allow users to enter data based on their site-specific observations of dead animals on or along a road. The app also collects geolocation and user identity information and uploads the collected data to the 'Enter Observation' feature layer in the ESRI cloud, www.arcgis.com (see first layer in data flow chart, Figure 3). The survey developed for the project was coined Roadkill Observation and Data System (ROaDS).

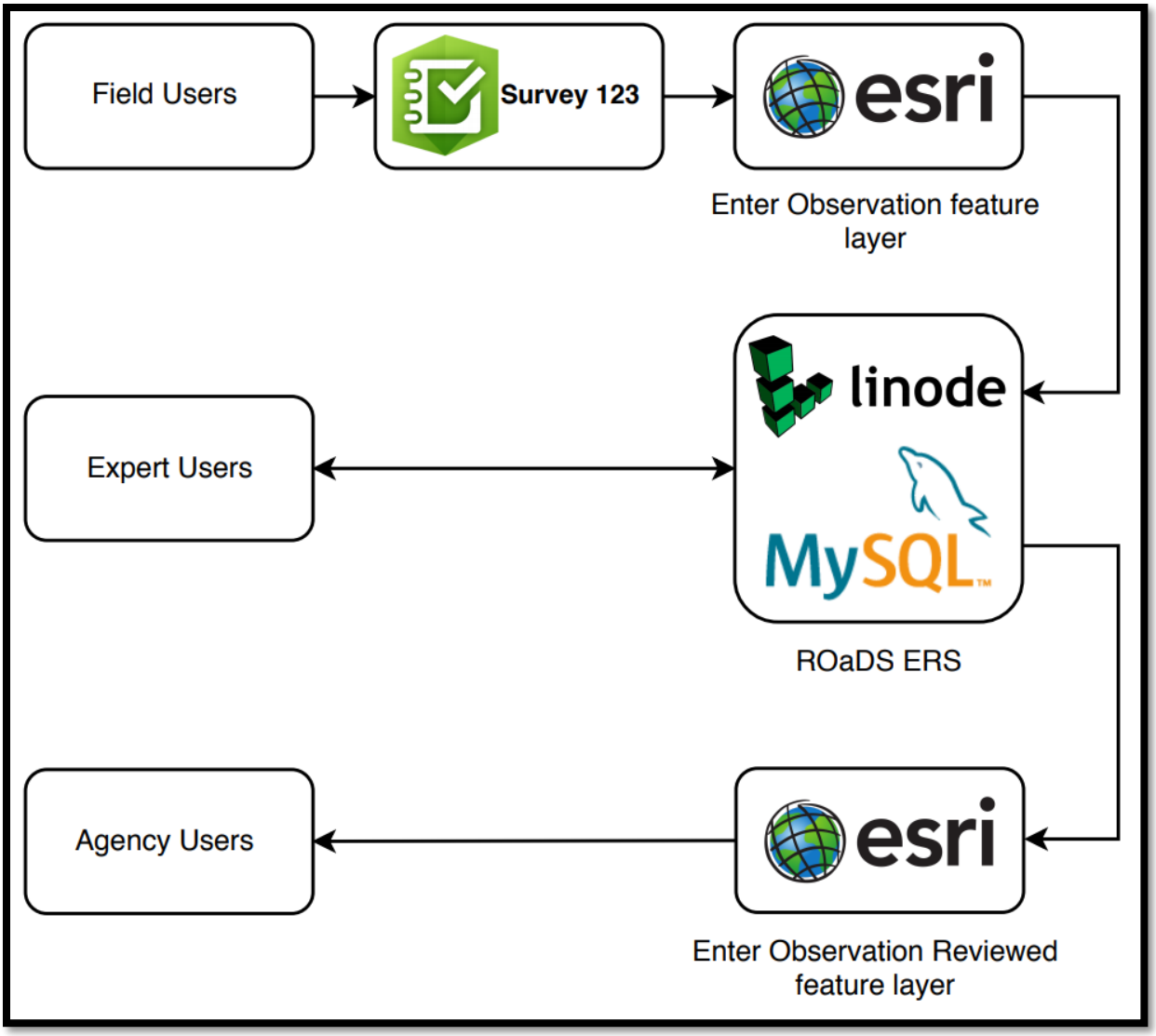

Figure 3: Schematic of the flow of data collected by observers in the pilot phase of this project using the existing Department of Interior's ESRI Survey 123 for ArcGIS system.

3.1.2.1. Data collection using the ROaDS observer survey

The ROaDS observation survey begins by asking the user to review the location of the observed dead animal on the device's map to determine if it is accurate (Figure 4). The GPS software in the phone pinpoints the location on the map. If the observer feels the location is accurate, they then press the button on the right side of the bar above the map (Figure 4) to lock in the WVC location.

If the phone cannot locate the WVC observation site on the map, then recording an accurate location is not possible and "no location" is state on the red bar at the top of the map (Figure 4).

The survey form then asks users whether the user is an ‘Expert’ or a ‘Non-expert.’ Depending on the user’s selection the subsequent information is tailored to display different selection methods for species identification (Figure 4). This is a self-identification data field, and it is wholly up to

the observer to decide if they are an expert on identifying the particular dead animal at the roadside location. If they are not an expert of a particular taxon, like birds, for example, they can select non-expert, even if they may be an expert on mammals. This allows expertise to be self-described and to be site specific, based on the dead animal being observed.

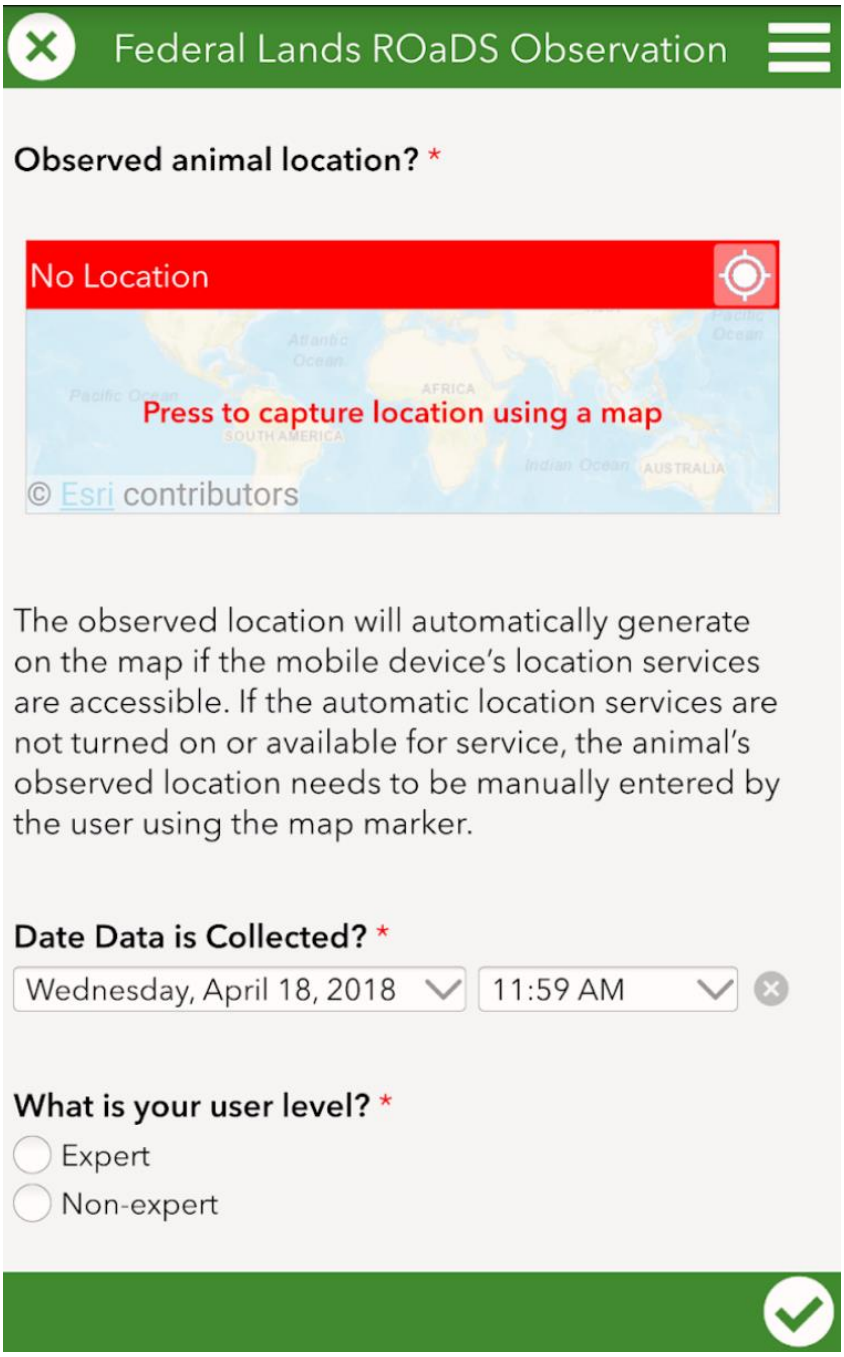

Figure 4: Screenshot of the portion of the ROaDS survey that collects, observation location, date and user level.

Expert users are asked to identify the "type" of animal observed, then to identify the species name using a dropdown list for all scientific species names of mammals, birds, reptiles and amphibians

in the U.S. Non-expert users are given a drop down with common species names and photographs of the species to help in identification (Figure 5 and Figure 6).

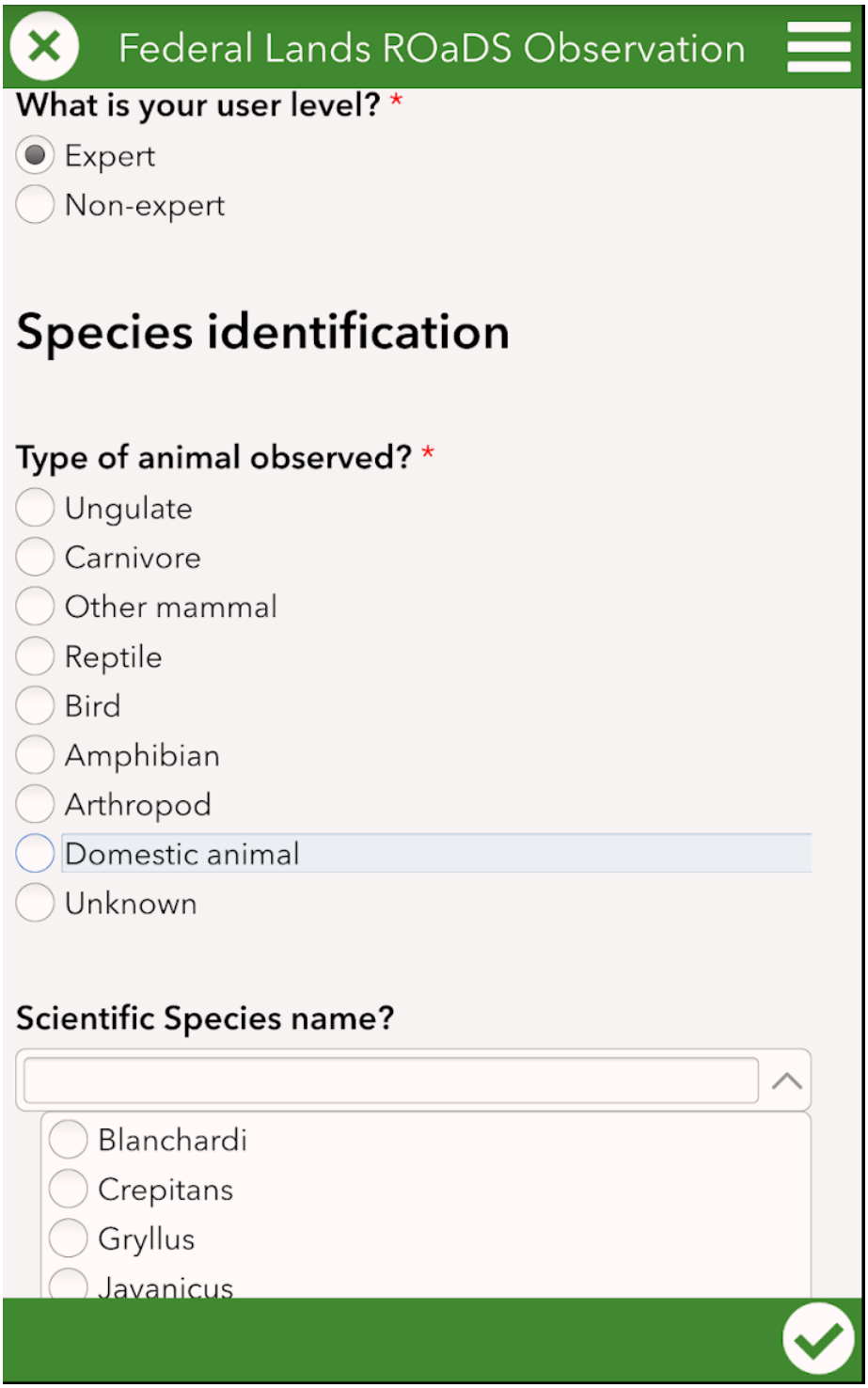

Figure 5: Screenshot of the portion of the ROaDS survey that collects species information from experts.

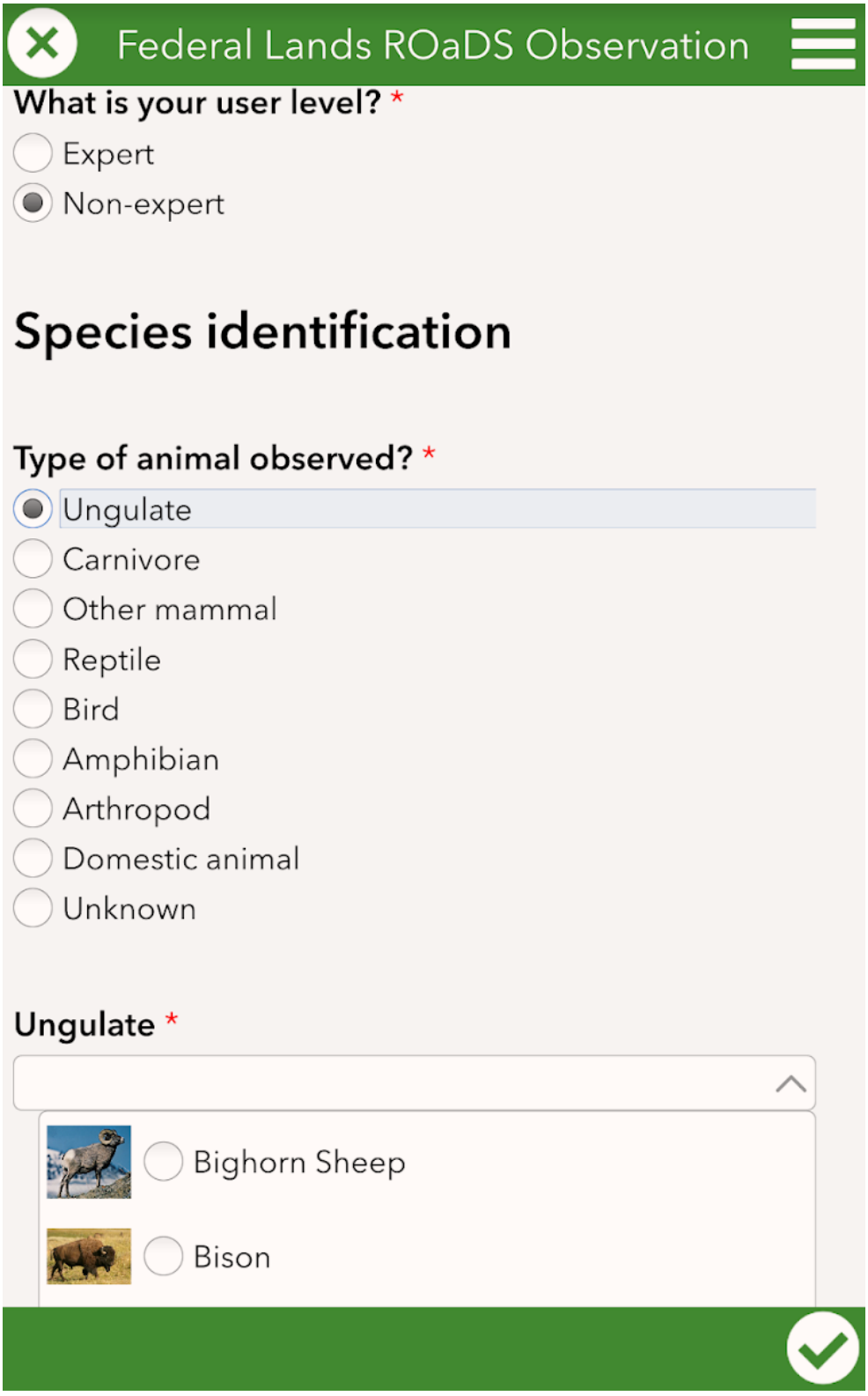

Figure 6: Screenshot of the portion of the ROaDS survey that collects species information from non-experts.

To further help verify the species observed, users are provided the opportunity to take photos using their mobile device that will be synchronized with the longitude and latitude of the location (Figure 7). The photos are stored in the data base with all the other information collected at the site. Photos can then be reviewed by agency experts to determine the accuracy of the identification of species.

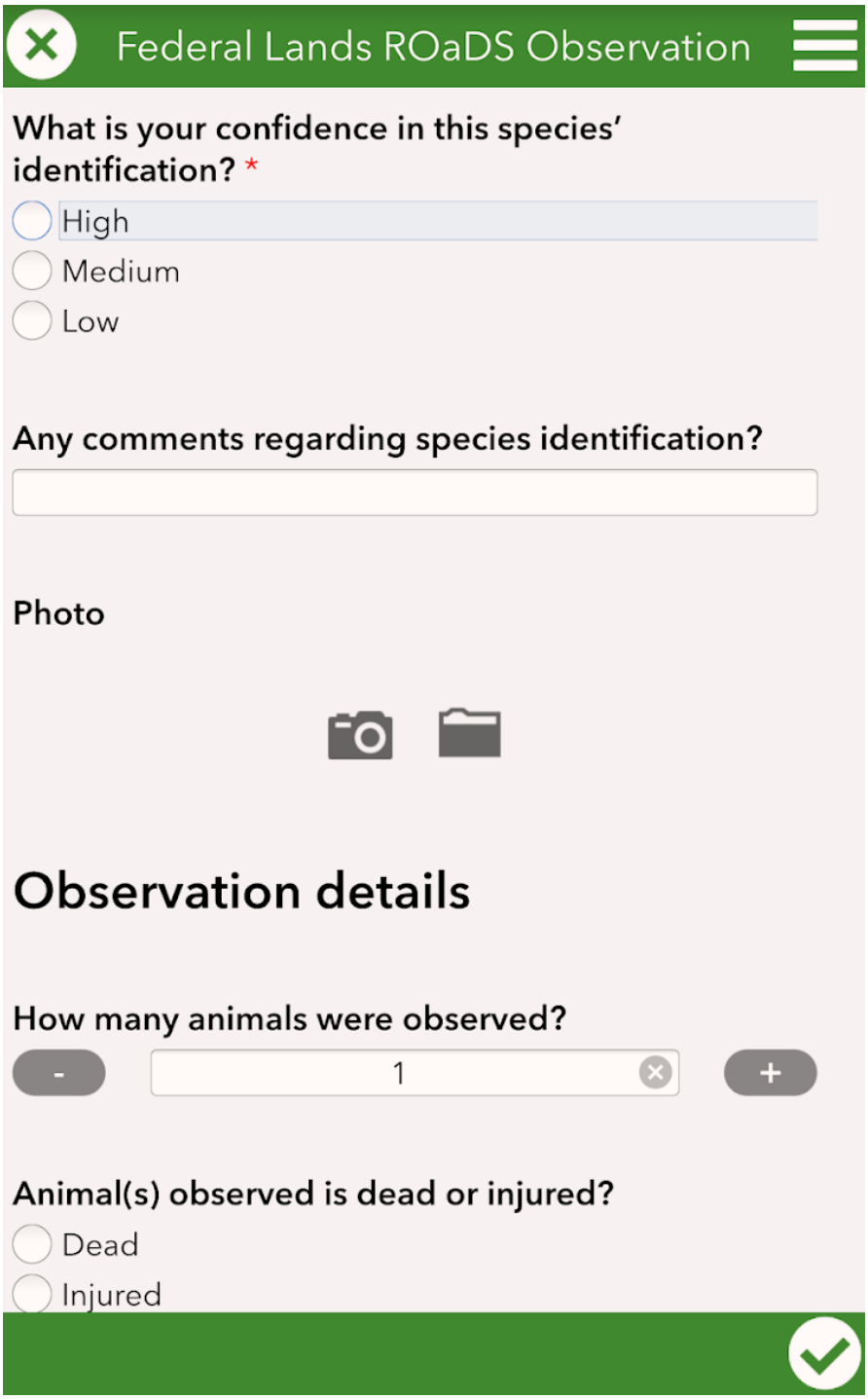

Figure 7: Screenshot of the portion of the ROaDS survey that collects and synchronizes the photo of the dead animal.

Next, the remaining optional data fields can be filled out, such as whether the observer witnessed the crash, if there is an accident report for the dead animal, and various information regarding the observer (Figure 8). Finally, to submit the information from the observation form, the user selects the checkmark in the lower right corner of the form and the data is uploaded to the server after each observation (Figure 8).

Figure 8: Screenshot of the portion of the ROaDS survey that collects various other optional information and allows the observer to submit all the information in the data fields from the observation to the ROaDS database.

If the observer's mobile device is not connected to the internet via cellular service, it will store each observation's data in its memory until connectivity is restored. However, it is not automatically uploaded; rather, when the observer starts up the ROaDS application again, it will provide notice that there is stored data in the outbox (bottom of Figure 9) and ask if the data stored should be uploaded.

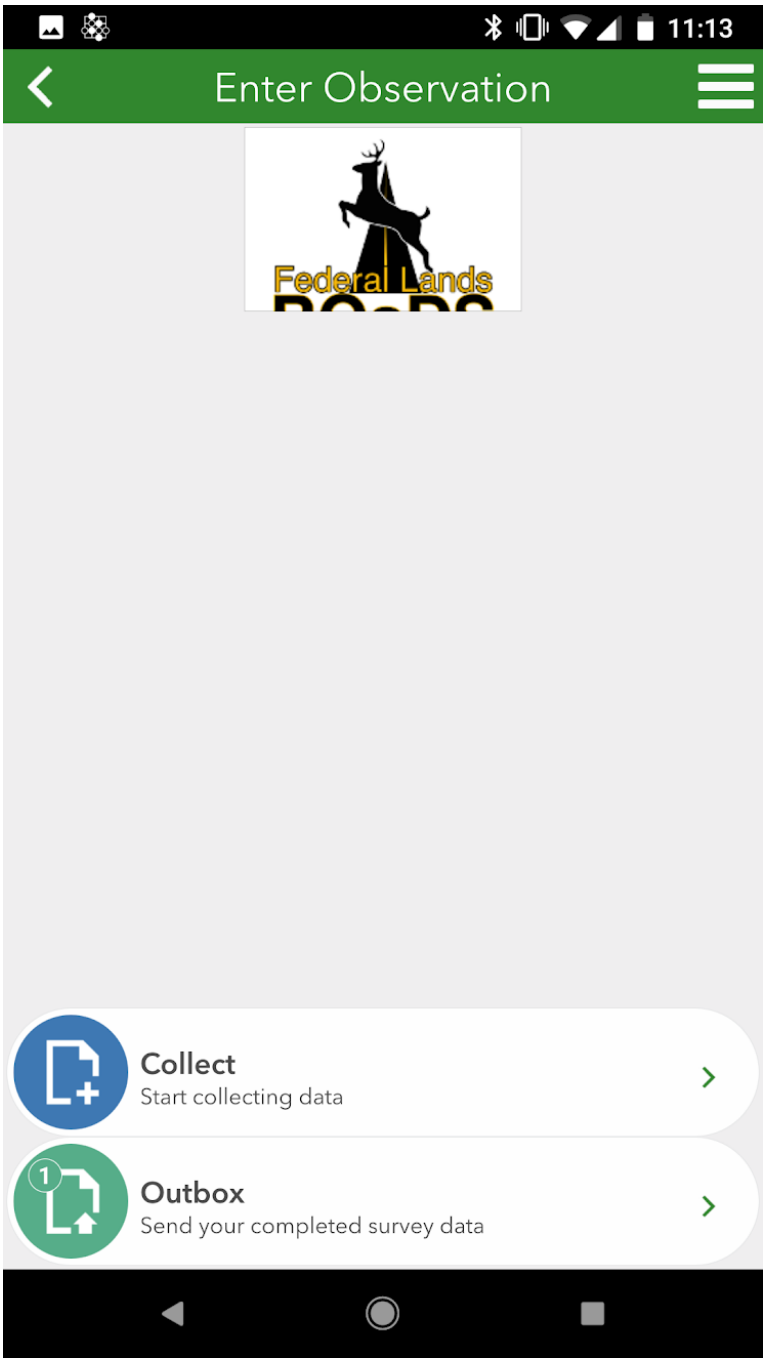

Figure 9: Screenshot of ROaDS survey if observation data is stored on device's memory and still needs to be transferred to the dataserver. The outbox function, at bottom of the screen, tells user to send observation data in phone's memory to the dataserver.

The ROaDS survey also collects user identity information and upon clicking the checkmark at the bottom of the screen, uploads the collected data to the 'Enter Observation' feature layer in the ESRI cloud or saves the data offline for later upload, www.arcgis.com (see first layer in data flow chart, Figure 3).

3.1.2.2. Recording monitoring routes.

To monitor roadkill data along a route (during a surveying activity) users may record a series of waypoints to map survey route. To record the waypoints users download the "Survey Route" form through the Survey123 app and click "Collect" to start recording the data points along the route that the observer is traveling (Figure 10).

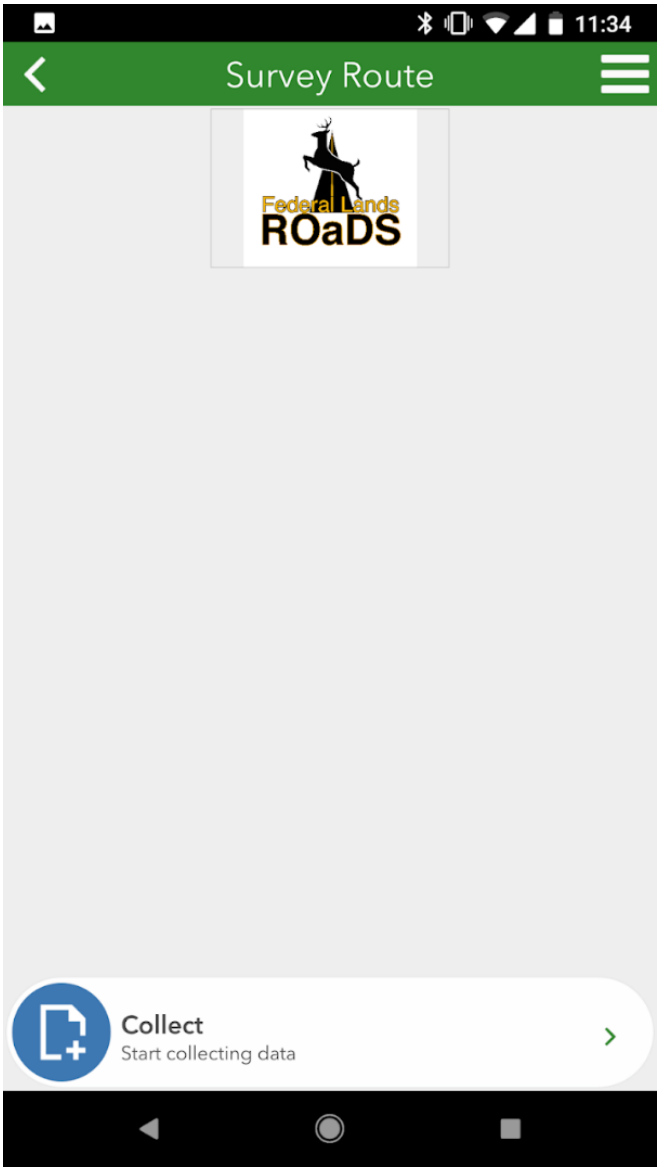

Figure 10: Survey for data collection route. Opening this ROaDS survey allows observer to record the route they traverse while collecting roadkill observations.

The ROaDS form contains a text field for the observer to type in the description or name of the survey route. Users may later search (through arcgis.com) for the text in that field to find the relevant survey data.

The form contains a means for the user to manually edit waypoints - which are composed of the date, time, and location. Waypoints are automatically populated by the ROaDS Route Survey, but a user may also change this information manually. To add a new waypoint, a user clicks the plus sign below the map (bottom right of screen, Figure 11). To remove a waypoint, a user clicks the red trash bin (bottom left of screen, Figure 11).

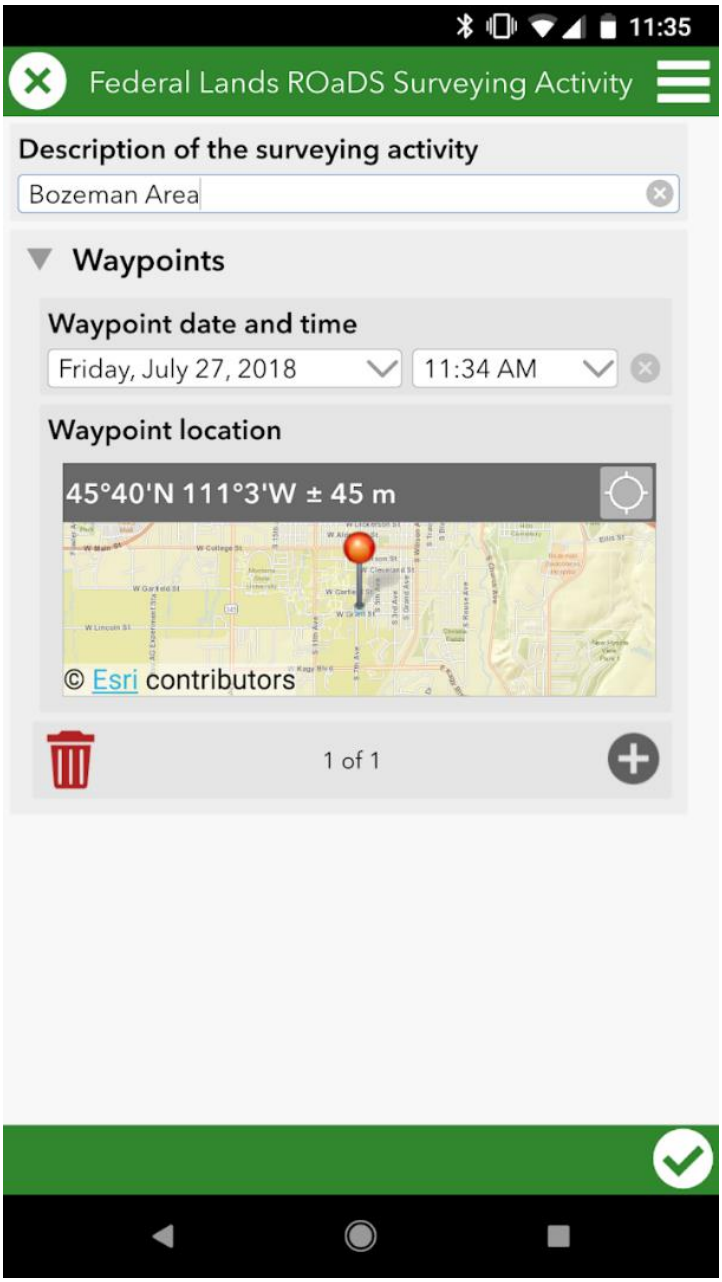

Figure 11: Screenshot of ROaDS Route Survey. Red pin is location of observer, observer then either clicks + to manually include waypoint for locating route or red trash can to remove waypoint for route location.

To correlate individual roadkill observations with the survey route, an analyst may select the observations made in the time frame and location of any survey route that has been recorded. This is completed in a post-collection analysis of the data. Both the survey and the observation data are exported from www.arcgis.com cloud-based data server.

3.1.2.3. Quality control for species identification.

A ROaDS Expert Review System (ERS) was developed by the project's research team to extend the functionality of the ESRI cloud with data review and autofill capabilities to improve the quality of recorded data (see second flow line in Figure 3). ROaDS ERS downloads data from www.arcgis.com, ESRI's cloud-based data server and imports the data into a standard MySQL database hosted on Linode cloud-based data servers. FLMA 'experts' then review the data using the ROaDS ERS web portal to correct any errors recorded by non-experts or other data collectors, for example, species identification. Experts users may also apply screening "rules" to identify and remove duplicate data, the same dead animal that is collected by multiple observations. ROaDS ERS also performs auto-fill functions, for example, to identify the location of an observation within a FLMA management unit, based on the location of collected data and the identity of the data collector.

ROaDS Expert Review System (ERS) was developed by the project research team to extend the functionality of the ESRI cloud with data review and autofill capabilities to improve the quality of recorded data (see second flow line in Figure 3). ROaDS ERS downloads data from ESRI cloud into a standard MySQL database hosted on Linode cloud servers. 'Expert users' then review the data using the ROaDS ERS web portal to correct any errors recorded by the field users, for example, species identification. Expert users may also apply screening "rules" to identify and remove duplicate data, collected by multiple field users of the same dead animal. ROaDS ERS also performs auto-fill functions, based on the location of collected data and identity of the field user, as described in Section **Error! Reference source not found.**.

ROaDS ERS uploads the reviewed and auto filled data back into ESRI cloud via the 'Enter Observation Reviewed' feature layer. Authorized 'agency users' may then view, visualize, and analyze expert-reviewed data through the ESRI cloud web front-end (Bottom flow line, Figure 3).

3.1.3. Server location

ROaDS data is stored in the ESRI cloud and accessible through a public website: www.arcgis.com. This data storage is currently supported through the Montana State University (MSU) Spatial Sciences Center. After Phase I, it could be moved to another organization with an ESRI subscription, such as an agency within the Department of Interior.

The collected data is temporarily stored on a MySQL database in a Linode datacenter in Atlanta, Georgia at a cost of $5/month, while awaiting FLMA expert review of the accuracy of species identification and other added data processing by the ROaDS ERS. If the DOI FLMAs elect to make ESRI Survey 123 their permanent solution for a WVC Data Collection System after Phase I, the database and ROaDS ERS could be moved onto a commercial Linux server that can support

a MySQL database. Following the expert review, ROaDS ERS uploads the data for permanent storage in the ESRI cloud as “Enter Observation Reviewed” feature layer and it is removed from the Linode server.

3.1.4. Accessing the ROaDS server's database

The entire expert portal is protected by an authorization middleware requiring all users to login to access the WVC data collection service (Figure 12). The only exception to this rule is that non-experts or non-DOI employees who did not have a license with ESRI for Survey 123 were given access via an invitation for the beta-test. For Phase I, this invitation came from MSU Spatial Sciences Center. In all likelihood, it would be discontinued in future phases.

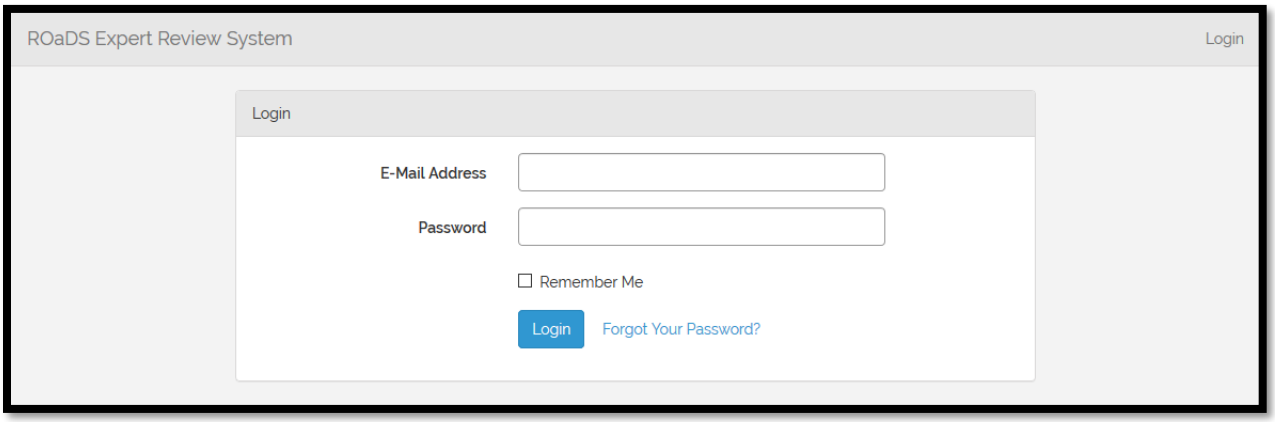

Figure 12: Controlled access portal, requiring registration, to the ROaDS Data Collection System.

3.1.5. The ROaDS database's main page

After the data collector or observer is logged into the system, they are met with the Observations Listing index page (Figure 13). From this screen they can review all the roadkill observations that are available and navigate to other pages.

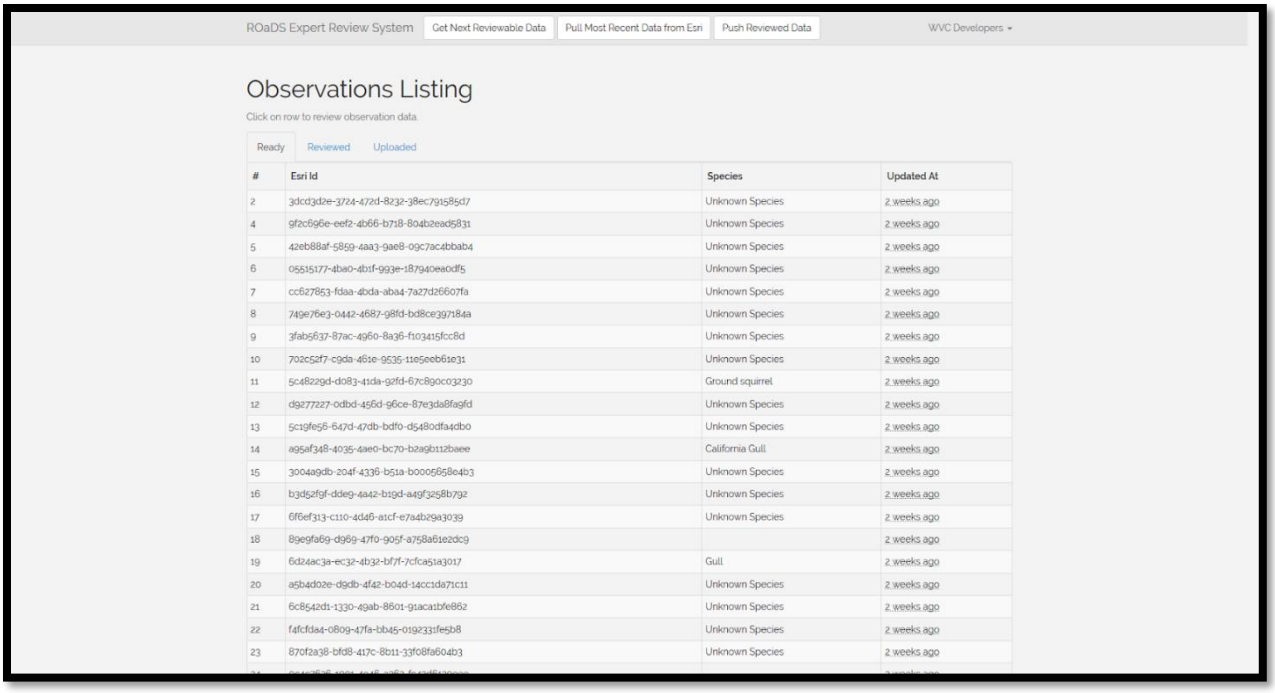

Figure 13: Observation Listing webpage in the ROaDS data collection system.

At the top of all of the ROaDS web pages is the main navigation bar (Figure 14). When a database user is logged in they will be presented with 3 buttons for common actions, each which is formatted with a dropdown menu.

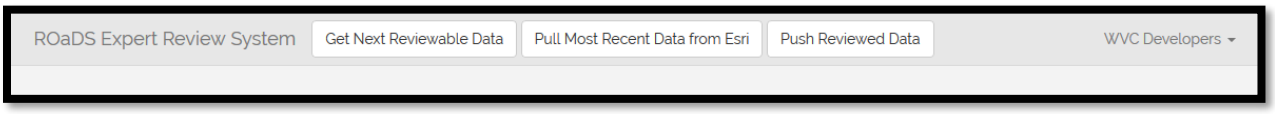

Figure 14: ROaDS data review options.

The three buttons allow the observer to query the ROaDS database of collected wildlife-vehicle collisions. They are:

Get Next Reviewable – Redirects the user to the Observation Form of the most recent observation that has not been reviewed.

Pull Most Recent Data from ESRI – Starts a background service to import the most recent observations from the ESRI cloud server into the Linode MySQL database. This may take some time as the observations may contain several large image files full of the geo-synched photos of dead animals taken by observers. This background service that updates the database for the user with the most recent observations is scheduled to run daily at 6 am.

Push Reviewed Data – Starts a background service to push all of the reviewed, and yet to be uploaded, observations from the MySQL database back to ESRI cloud-based data server. It does

not upload the photos back to ESRI data server at this time. This process does not delete any data ensuring a copy is always maintained.

Also located on the bar across the top of the ROaDS database web page is a short list of functions for the developers of the system (Figure 15). In Phase 1 of this project it was the WTI research team, in future phases it may be other entities that are the developers of the system. This allows access or links to different user features.

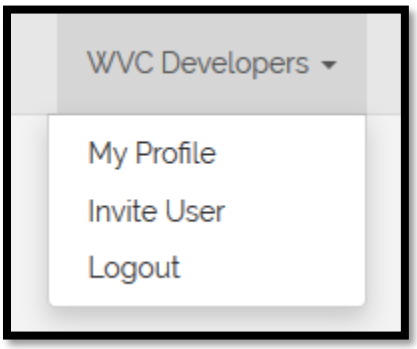

Figure 15: List of user features on the ROaDS webpage for its database.

The three user features are:
My profile – Takes the user to their personal User Profile.
Invite User – Takes the user to the Invite Form and allows the user to invite other qualified personnel to access data.
Logout – Securely logs the user out of the application.

3.1.6. Reviewing ROaDS observations for errors

At the main page of ROaDS is a running list of observations in the database. From this Observation Listing webpage, all of the observations are available to be viewed by FLMA experts who have access to the database. For Phase 1, all the users providing observations for the beta-test were allowed access to the database, in future phases, a more reduced list would most likely be warranted.

There are three categories of observations each with its own tab on the Observations Listing webpage (Figure 16).

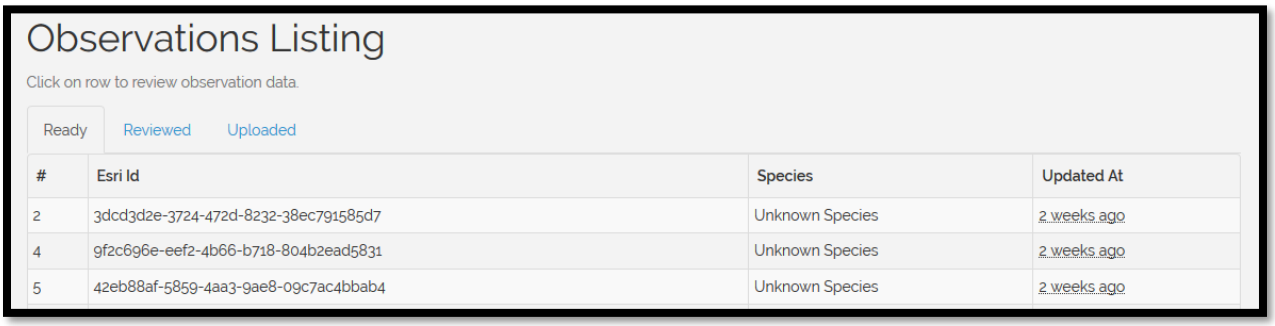

Figure 16: ROaDS webpage where each observation is available for review and ultimately for analyses, viewing and reporting.

The three tabs coincide with how far along in the quality control process that the observation has been moved:

1) The "Ready" tab is for observations collected and ready to be reviewed by an agency expert. In Phase 1 all observation data was available for review, whether collected by an expert or non-expert observer as self-identified in the expertise data field. This is the central function of ROaDS quality control. Experts can select any observation to review the species' identification and look at its geo-synchronized photo (if available) to assure the species is accurately recorded. An expert simply clicks any entry in the Observations Listing table and is then linked to each roadkill's observation form, where both the species identification and photo are available. To develop this function further in a future phase of the project, it could be programmed to recognize the registered expert and only list those species' requiring expert review in that person's management unit.

2) The second tab contains a table of all the observations that have been reviewed. After the agency expert has reviewed the observation form for the species' accuracy, all of the observations are stored here and are assured to be of high quality. Also, all duplicates, triplicates, or other numerous observations of the same roadkill are resolved and then possibly deleted.

3) The final tab is when the expert reviewed data has been uploaded to the ESRI feature file where agency managers and other employees with access to the database can use the observation data for analyses, visualizations, and reports. Agency users are assured that the data is of high quality and identifications are accurate.

3.1.7. Reviewing individual ROaDS observation forms

3.1.7.1. Observation forms available to the agency user in the database.

The various data fields that are available to be filled in at each roadkill observation site were explained in Section 3.1.2. Some of these data fields are required to be filled in, others are optional. Other data fields are completed after the GPS site location is entered via post-collection processing.

Any agency user that has access to the database can look at any data field from any single observation that may be of interest to them. By clicking a mouse on any line in the Observations Listing webpage (Figure 8), the link takes the user to the Observation Form for that data. The Observation Form contains all the data fields, the information filled out in the field by the observer and the data fields that are automatically filled in after field collection based on information in the core fields. A full explanation of Observation Form is located in Appendix C.

3.1.7.2. Observation forms available to agency experts for review in the database.

The Observation Form is where the agency expert can change information in the database if it is inaccurate. Of particular interest is the species identification data field and the geo-synchronized photograph of the dead animal that helps in its identification.

Since ROaDS Expert Review System is invitational only, there is no public registration form. All users must be invited by another user. To do this, they will use the Invite User Form which can be navigated from the main navigation bar, portal dropdown as shown before.

An existing user simply enters the email address of the new agency user they wish to invite to the portal and submit the form (Figure 17). An email will be sent with a personal link which will then send them to a registration form (Figure 18).

Figure 17: Invitation to an expert for access to review ROaDS observations.

Once the invited user has received their invitation via email, following is the registration form they fill out to allow them access to the ROaDS database (Figure 18).

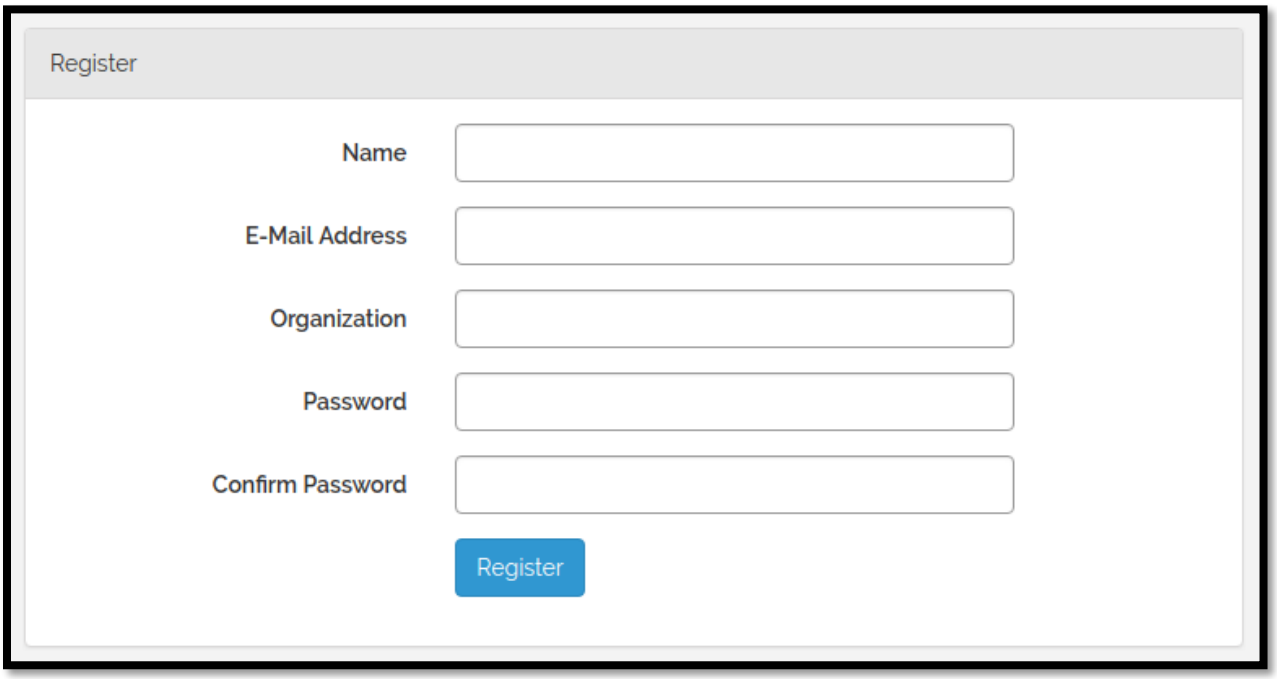

Figure 18: Expert reviewer registration form.

The expert reviewer registration form has the following fields:

Name - The name of the user, not to be confused with a username.
Email - The system already knows the email of the invitee, the email provided here must match that which they were invited with.
Organization - The agency the user is associated with.
Password - Standard password and password confirmation fields.

After submitting the form, if there are no errors, the new user of the database or expert reviewer will be logged in. At any time, they can view their own profile information. They can also update or edit their own information, if necessary. They can do this through the main navigation bar, using the portal dropdown as described in Section 3.1.6. The user profile page (Figure 19) shows the internal unique identification number of the user. Figure 19 provides an example for user #1.

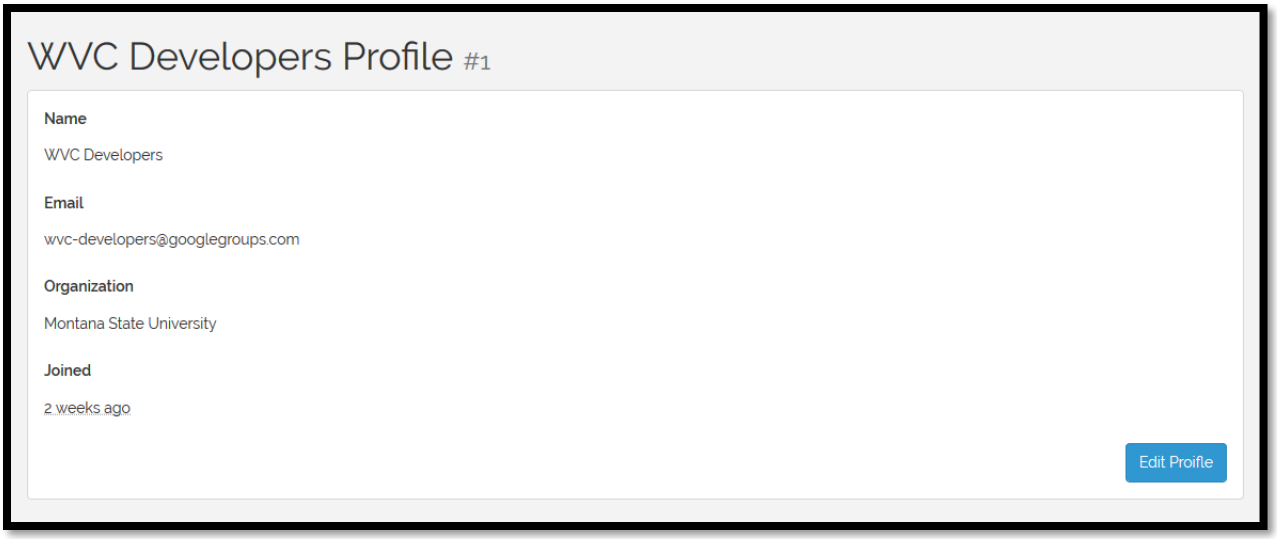

Figure 19: Profile of a ROaDS database user.

The Edit User Profile is a simple webpage form to allow users to update their user information (Figure 20). If their email is changed they will be sent an email and must reconfirm it. In addition, an email notifying the user of account changes will be sent after every change. If changing one's email, this will be sent to the previous stored email. In a future phase of this project, the profile could seek additional user information such as: how do they describe their use of the app - as an occasional opportunistic data recorder? As someone with a job of removing carcasses from ROW? As a natural resource manager with specific interest in a particular species of concern?

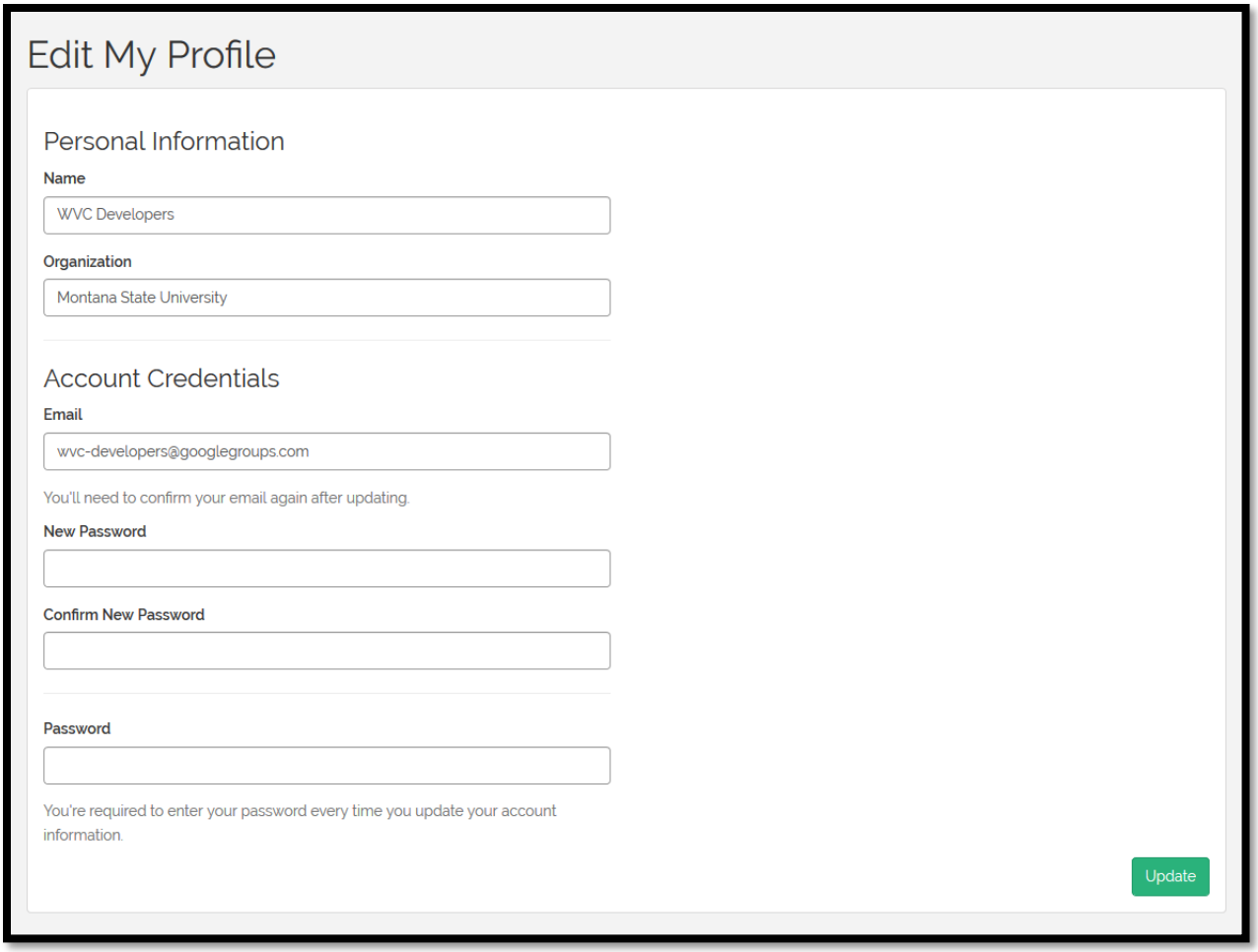

Figure 20: Form that ROaDS database users use to change their personal information.

3.1.8. Data retrieval and display

The ESRI cloud-based ROaDS database has a webpage with visualization software that allows agency users to view the roadkill observations. It also allows users to query the ROaDs database using different sorting functions. All of this data has been reviewed by agency experts. The agency users have been given access to this site. Thus, for Phase 1 of the project, all data observations collected and access to use the database has been for DOI employees only.

The ESRI cloud-based database provides smart mapping capabilities to transform ROaDS data into a number of views (Figure 21) and reports. The ESRI website for the ROaDS database provides a number of built-in base maps, including both a street view and topographical map (Figure 22).

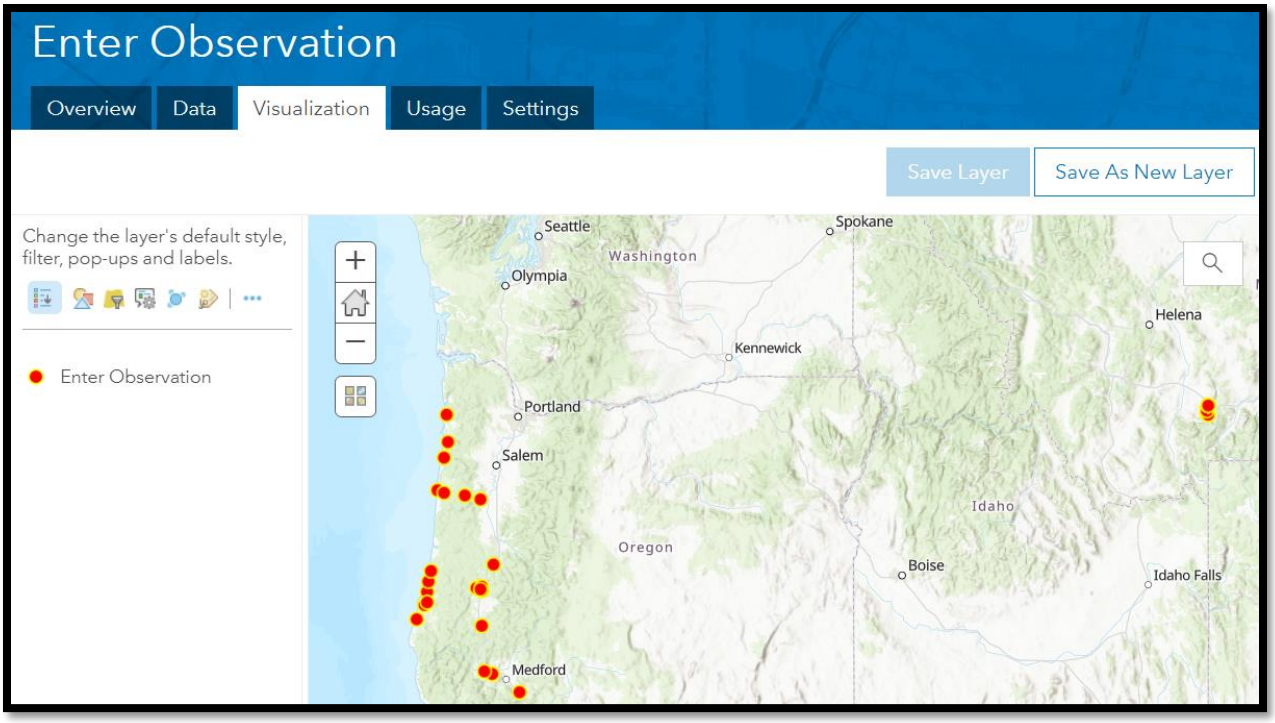

Figure 21: A typical visualization screenshot of the ROaDS observations (red circles) provide by ESRI.

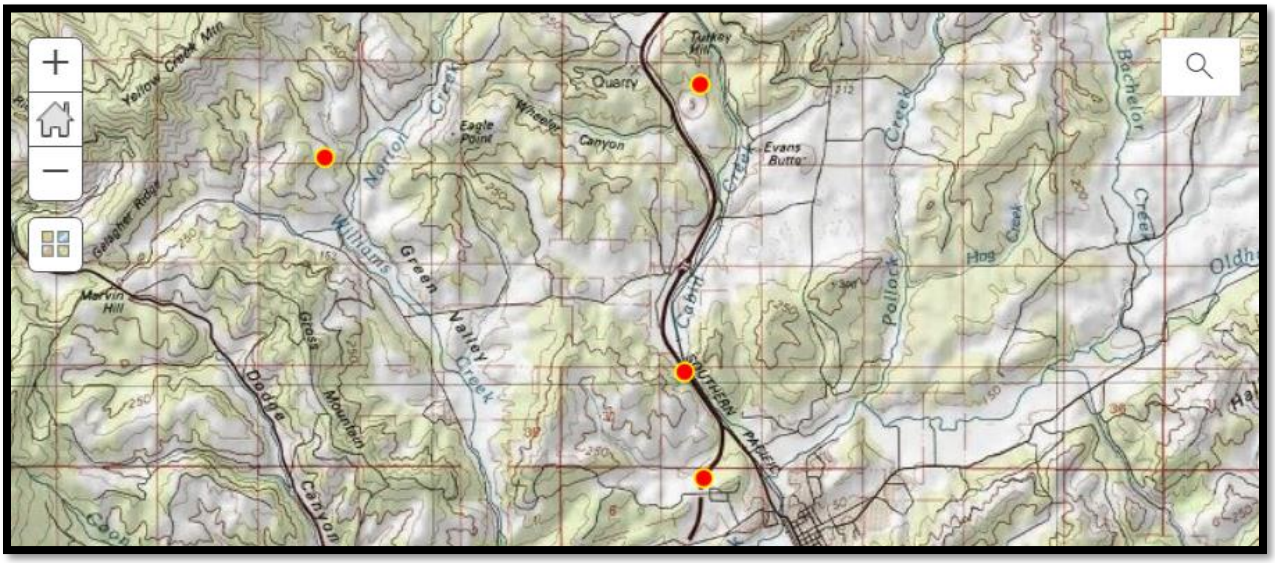

Figure 22: ESRI topographical base map screenshot with ROaDS observation locations (red circles). Some data points from this screen shot indicate observers hiked away from the highway when using the app during beta-test.

For ROaDS users, the most important capabilities are filters which allow the display of data that matches multiple search criteria based on any data field recorded by ROaDS observation, or that are processed after collection.

As an illustrative example, agency users may filter the data to visualize or report on data collected along roads with speed limits that are greater than 35 miles per hour and belonging to an agency's Region 8. The screenshot below shows how to configure such a filter (Figure 23). For a full documentation of the smart mapping functionality see ESRI Smart Mapping (online at: https://www.esri.com/en-us/smart-mappingdocumentation [accessed 27 July 2018].

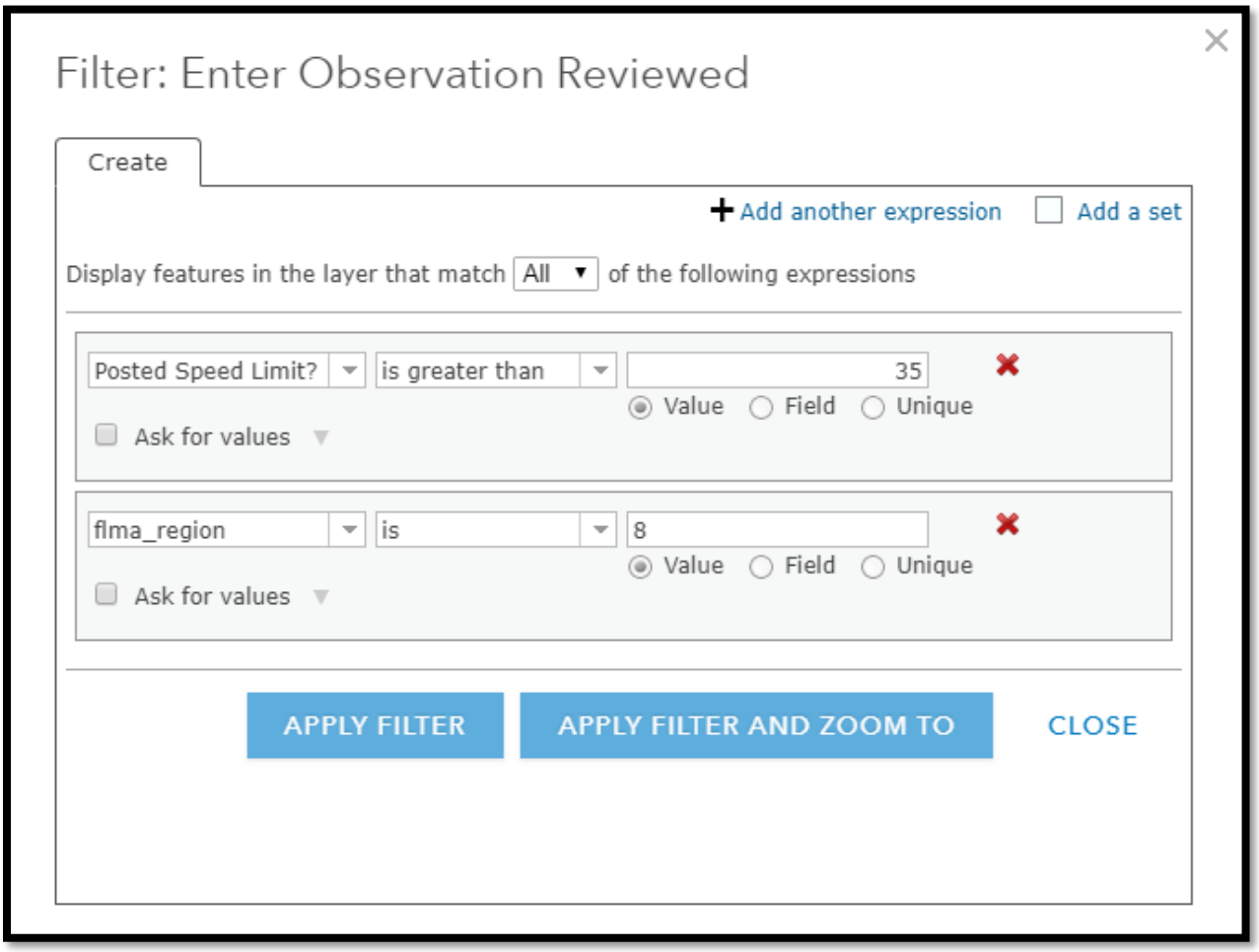

Figure 23: Screenshot of web form that allows ROaDS users to filter database.

To export the data for further statistical analysis or reporting, a variety of formats are available to export the data, such as comma separated values (CSVs), shapefiles, keyhole markup language (KML), file geodatabase (FGDB) (Figure 24, right side of webpage). The files can then be used for spatial cluster analysis or other appropriate quantitative methods for identifying "hot spots" or report writing.

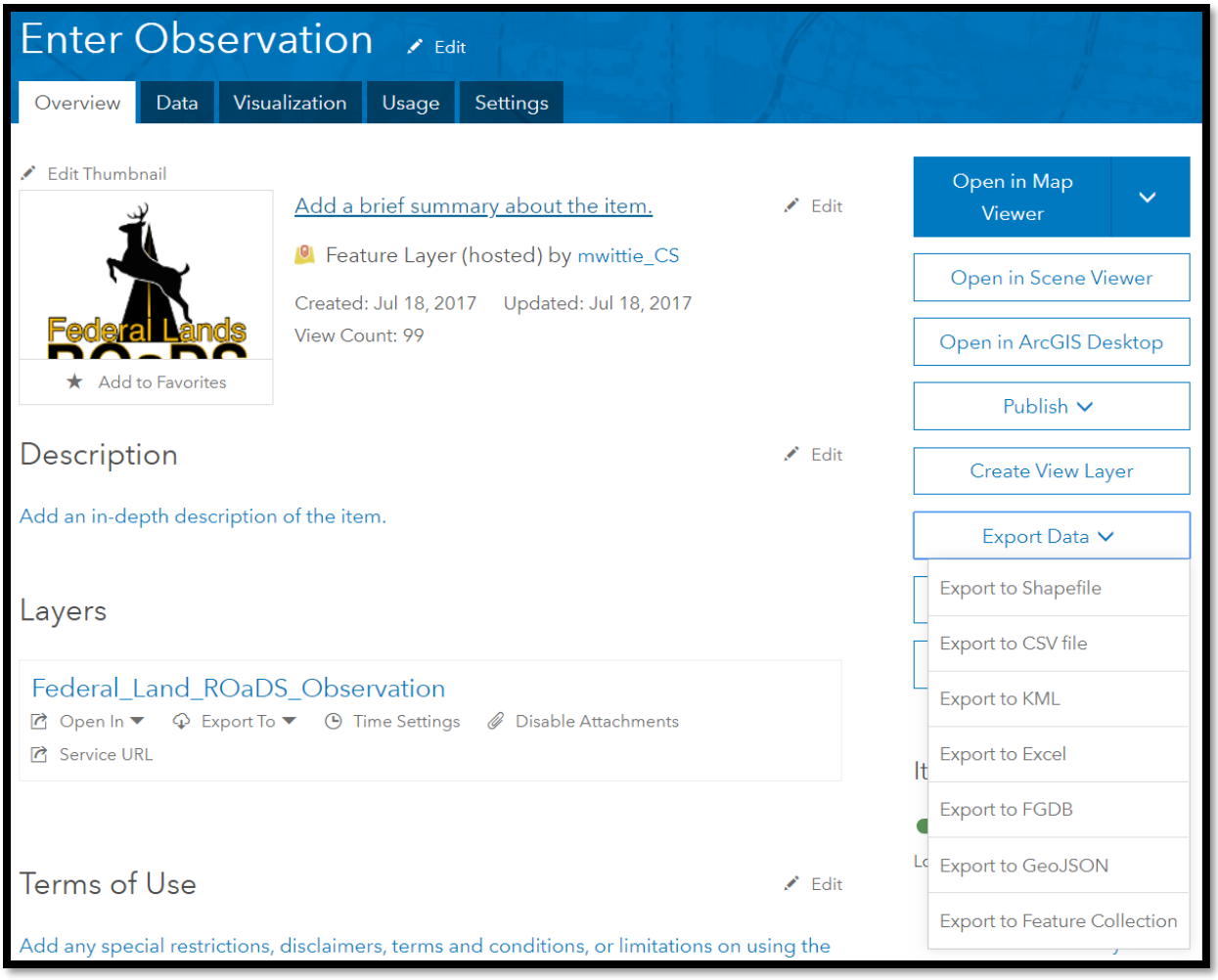

Figure 24: Screenshot of ROaDS database webpage that allows user to export data in a variety of formats (i.e., shapefile, comma separated values (CSV), keyhole markup language (KML)) for use in other software.

Agency users may also elect to change the display style of collected data or filtered collected data. For example, the data can be viewed as a heat map (Figure 25) or use a cluster function for display (Figure 26).

Figure 25: Screenshot of a heat map of ROaDS data collected in Oregon and Montana during Phase I of the project.

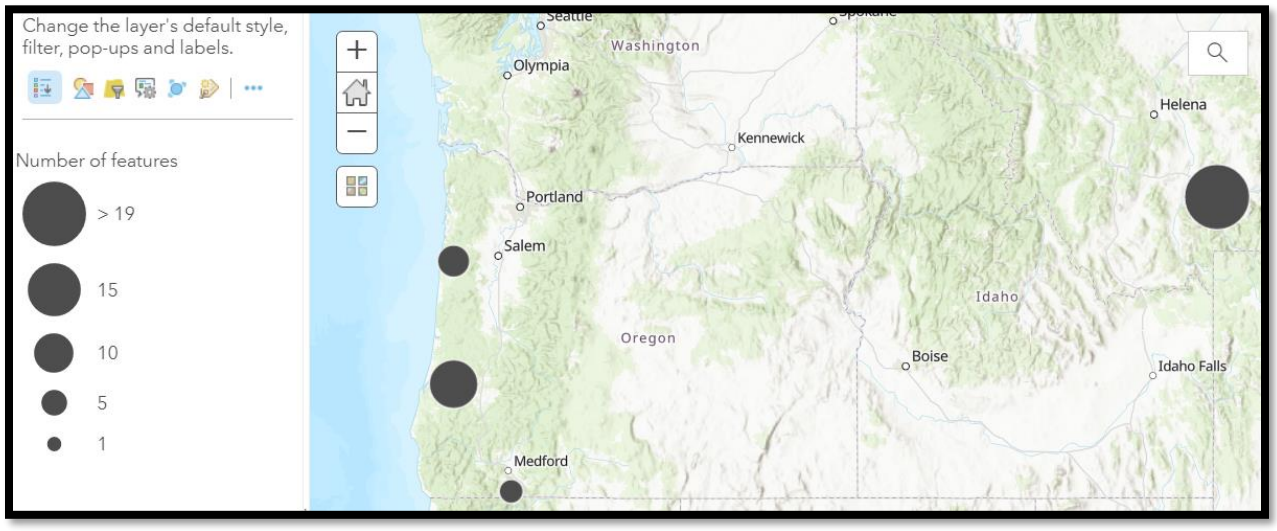

Figure 26: Screenshot of clustering function using ROaDS data collected in Oregon and Montana during Phase I of the project.

3.1.1. Data management: accessibility and security

The current trial implementation of the ROaDS system allows all participating users to view both the "Enter Observation" form and table and the "Enter Observation Reviewed" form and table. In the future, we would like to implement restricted view for protected species and data analysis capabilities. Field users would be restricted to the "Enter Observation" form only in order to collect the data. Expert users will be able to view, but not analyze data from the "Enter Observation" table

through the ROaDS ERS. Finally, agency users will have the full analysis view of the "Enter Observation Reviewed" table through arcgis.com.

Future versions of the ROaDS system could also make a summary of the data available to the general public, for example, as automated in-vehicle warnings of high activity of animal road crossings. This view, however, would not permit the general public to view the details of the data, especially for protected species.

3.2. Summary of WVC Data Collection System for beta-testing

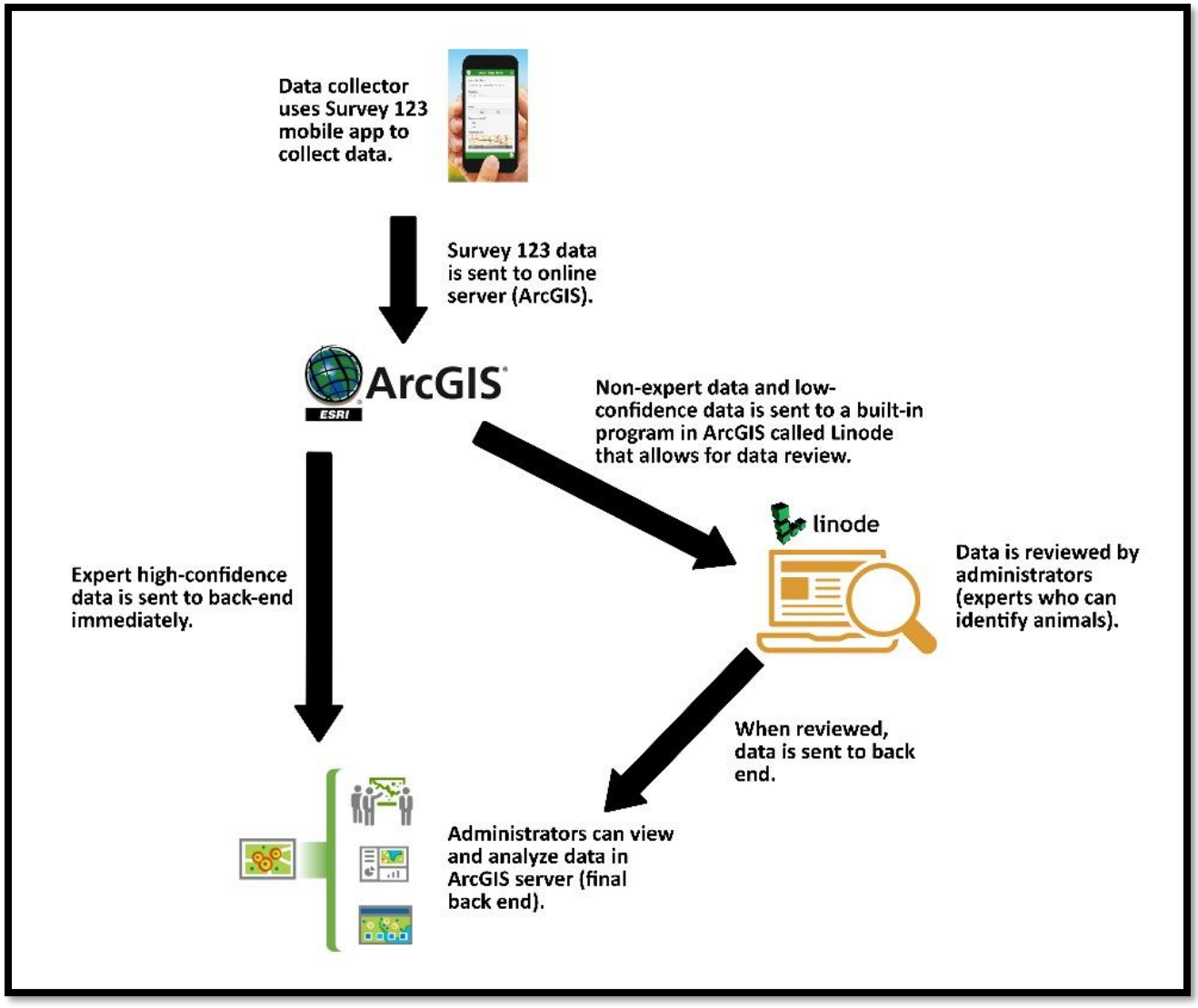

Figure 27: Schematic of the Survey 123 for ArcGIS system used by ROaDS in Phase I of this project.

This phase of the WVC Data Collection System project focused on the development and testing of a national standardized data form for wildlife vehicle collisions, one that would be collected by the FLMAs and their partners. The project used an existing system already available to Department of Interior agencies. Using ESRI Survey 123 for Arc GIS, which already had a mobile device application that is available in iOS and Android, and a data storage, retrieval, and viewing system (Figure 27) allowed the Research Team to focus on the data to be collected and the quality of the data. Over 29 data fields or types of different information were able to be collected via ROaDS or via post-collection processing.

An expert review process was developed for this project that exports those observations with species identification that had low confidence or were collected by non-experts. This data was exported from the ESRI cloud database to an external database. Once there, agency experts can review the species identification and the observer's photo of the dead animal to ensure proper identification. In future development, after the beta-test phase, data collected by agency experts will not need to be reviewed. Combined, the reviewed non-expert low confidence data and the expert collected data will provide confidence in the accuracy of the species named in each observation for all data made available for viewing and analysis.

4. WVC DATA SYSTEM BETA TEST

4.1. Selection of Volunteers to Collect Data

The research team conducted a pilot test of the application to assess the usability of the ROaDS survey through the ArcGIS Survey 123 application. After the beta-test period concluded, feedback from beta-testers was compiled and used to determine weaknesses, inconsistencies, problems, or improvements to complete the finalized ROaDS survey.

The Advisory Committee was tasked with finding two or more management units to test the ROaDS Survey for each of the four cooperating FLMAs – NPS, FWS, FS and BLM. The search for management units to pilot the survey began in June 2017. The testing period ended in the first quarter of 2018, and the beta-testers were asked to provide feedback on their experiences using the ROaDS survey. Management unit engagement was an obstacle that occurred throughout the beta-testing phase. The Research Team and the Advisory Committee continued to work together to engage beta-testing on management units or with individuals.

4.2. Beta-testing Participation

The project was unable to locate two management units for each of the four FLMAs. Instead, interested employees of the FWS and NPS were recruited along with members of the Research Team and Advisory Committee to beta-test the system. The locales that received the most regular collection of ROaDS data or accumulated the most numerous data observations were: Oregon (Figure 18), Montana (Figure 23) and Florida.

4.3. Evaluation of the ROaDS Survey and Data Collection System

The project's research team developed a 14-part script (Appendix D) to guide discussions with agency employees, research staff and Advisory Committee members who used the ROaDS Survey to collect data and/or the database to view or extract ROaDS observation information. Phone interviews were conducted with those willing to discuss the strengths and weaknesses of the beta-tested system and to suggest improvements to the ROaDS survey if it is improved under a future phase of the project.

4.3.1. Weaknesses in the ROaDS survey

There were a variety of responses across the 14 questions and throughout discussion with volunteer users of the ROaDS collection survey. The following is a summary of the weaknesses that were identified by the users:

- It was difficult to register for access to the ESRI 123 Survey for the ArcGIS application and its ROaDS Survey and ROaDS Route Survey.
- It was unclear how to mark the location of the observation, because the button next to the map to do this was unmarked. The circle with the "X" was not intuitive.
- The safety feature of allowing the collector to mark the site and then move to somewhere away from traffic to fill out the data fields was poorly understood.

- Minimize and simplify the survey; there are too many data fields.
- The information could not be collected in a short amount of time, could be hazardous to collectors.
- Scientific names were not all in alphabetic order; some of the pull-down menus only had general rather than complete scientific name.

ESRI Survey 123 limits the use of the system to those agency employees whose employer has a license. Currently, that means that usage is limited to Department of Interior bureaus and departments. Consequently, it may be difficult to meet several of the project's objectives. It will limit partnership capabilities, such as for those FLMAs in the Departments of Agriculture and Defense. It won't allow other potential partners to collect data unless they have a subscription to ESRI Survey 123; this may exclude participation by potential partners such as the public, friends groups of refuges, parks or national monuments, or state Departments of Transportation.

4.3.2. Strengths in the ROaDS survey

The volunteer users of ROaDS collection survey also identified a number of strengths, as described in the following summary:

- Buttons were very easy to use; they were much preferred compared to typing in information.
- It is 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 be filled out.
- Geo-synched photo was very easy to use.

4.3.3. Recommendations for improving ROaDS data collection system

The beta-test volunteers who recorded observations of WVCs using the ROaDS system were asked to suggest ways to improve the ROaDS survey if a future phase of a WVC data collection system was pursued by the FLMAs. The question was not limited solely to improving the ESRI Survey 123 for ArcGIS system; users were asked to make recommendations for any system that was developed. These recommendations are summarized as follows:

- Start with most common species in first field, then have another field called "other" with a drop-down list of all scientific names and a longer list of common names.
- Is there a way to set up scientific names on a pull- down list only for those who need them?
- Include a field for carcass information: carcass moved off the road, carcass removed by maintenance crew (or reported for removal), carcass not moved.
- If "opportunistic" observation was originally selected at start of observation, offer single button: *Submit opportunistic observation*...that, when toggled, results in a screen confirming observation was submitted, then loops back to first screen to open a new record starting with choice of type of observation.

- If "monitoring" was selected at start of record, have a banner at the top or bottom of the screen visible throughout the monitoring effort to confirm that the monitoring route (i.e., survey effort) is being tracked/recorded, and offer two additional buttons at the end of an observation:
  - *Save observation and continue monitoring route* w/screen confirming prior observation was saved, and then opens a new record starting with species since we already know this is part of a monitoring effort.
  - *End monitoring route and submit observation(s), if any were recorded* w/screen confirming monitoring route recording has been stopped (if banner indicating "route recording underway" was on the screen, it would disappear), X # of observations and monitoring route data were submitted, and then opens a new record starting with type of observation.
- Allow all data observations to be viewed and accessed on ESRI main server page. Differentiate each observation by whether it has been reviewed or not, this could be achieved by a color scheme or other mechanism. It allows users to see the data and warns that there has been no quality control for those that have not been reviewed.
- Clarify whether duplicates are removed by review or by algorithm, or develop algorithm that identifies duplicates, expediting a reviewer's ability to find these records, assess if they truly are duplicates, and delete if confirmed to be duplicate observations.
- Develop and describe detailed protocols for creating a profile and downloading the app, entering data, quality assurance and quality control, end users, screening of duplicates, and for assessing the limits of the data as well as analyzing the data to appropriately guide the development of mitigation planning or for other purposes.
- Any WVC data collection system will need to have a support team, materials, user manual and other information to help data collectors and database users.
- Develop communications and outreach to engage users to adopt the system for long-term use, provide technical support, and to share case studies across FMLAs. These tasks may require an identified point of contact (presumably an FMLA employee with appropriate skillsets and access to expertise to resolve technical issues) to dedicate substantial time to supporting the system and its users.

The FLMAs need a WVC data standard that all agencies collect and that is aligned with federal and state transportation agency systems. This way, there is a consistent amount of information gathered by all collectors, whether by using the ESRI Survey 123 for ArcGIS system or other system.

5. IMPLEMENTATION AND SUSTAINABILITY OF A WVC DATA COLLECTION SYSTEM

5.1. Implementation

To coordinate wildlife-vehicle collision (WVC) data collection for the first phase of this project, the use of an existing mobile device application was deemed appropriate, efficient and cost effective. All of the federal land management agencies in the Department of Interior (DOI) including the two co-sponsors of the project (USFWS and NPS) had access to the same platform for use and development of the WVC Data collection system. By happenstance, the university of the project's research team had also acquired ESRI Survey 123 for ArcGIS. This allowed the project to develop the ROaDS survey without the need to develop a new application for either Apple iPhones or android smart phones. In addition, the ESRI license that both DOI and Montana State University had acquired included secure and safe cloud storage of the collected data and a system that allowed for users to visualize the data (Figure 28). Thus, many of the data system development components for a WVC Data System had already been addressed for the short-term by using ESRI Survey 123 for ArcGIS for the first phase of the project.

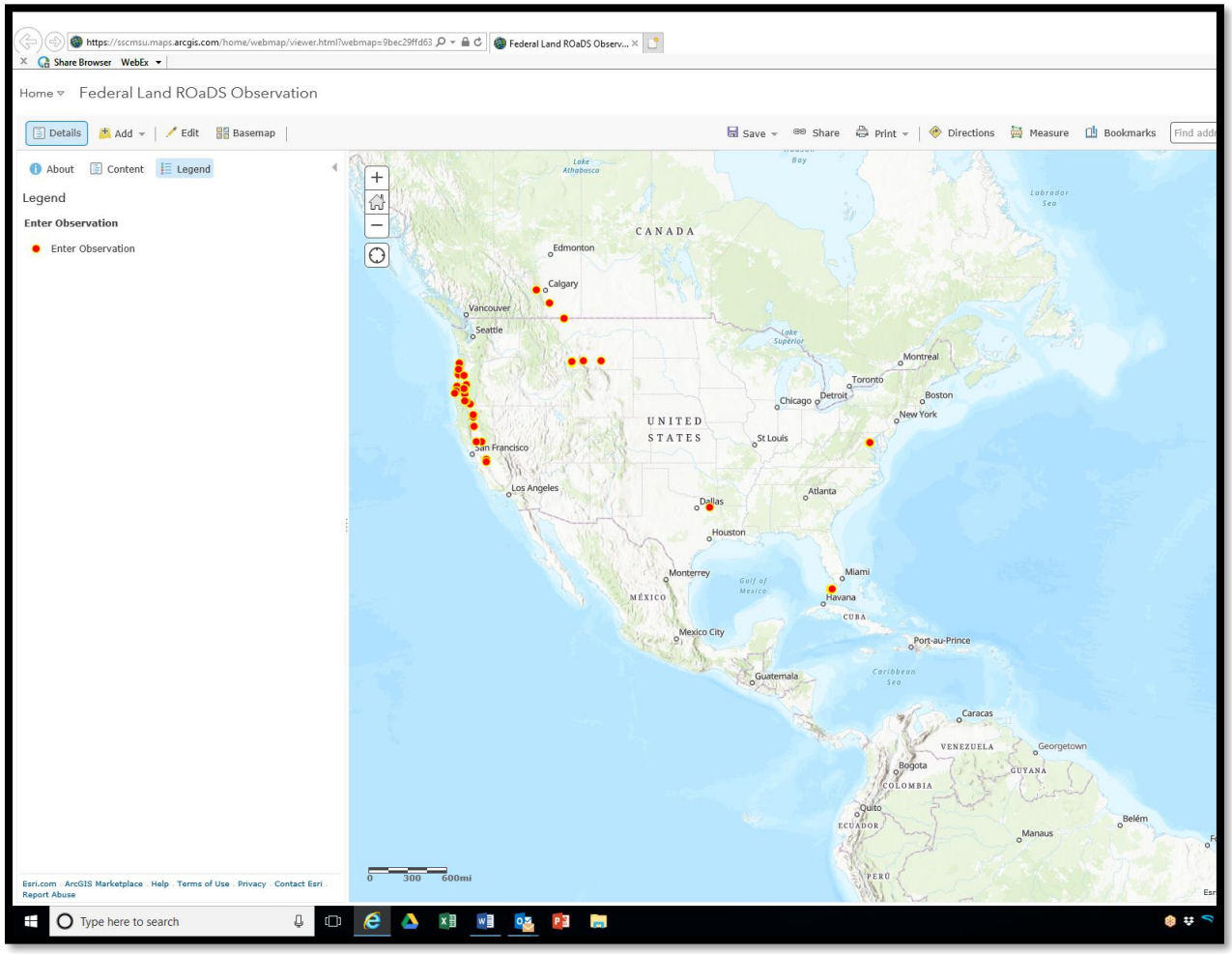

Figure 28: Screenshot of WVC data points collected in Phase I of the project.

One of the weaknesses of the ESRI Survey 123 for ArcGis is that the system is internalized by the DOI federal land management agencies. This makes it difficult to add data collectors from other FLMAs such as the USDA-Forest Service, or from partner agencies such as the Federal Highway Administration or state departments of transportation. Similarly, since ESRI Survey 123 for ArcGis is behind DOI firewalls, it will make it difficult for the system to support citizen scientists, external researchers or other potential data collectors to use the existing system.

With additional refinements of the standard data fields, the use of the expert review system that sends the data from the ESRI cloud out to a server at Montana State University, and by addressing other outstanding issues, the DOI agencies could be using the ROaDS system on a regular basis in the near future; potentially at the completion of the next phase of the project. However, the system would not let citizen scientists, state DOTs, non-DOI researchers or other federal departments contribute to or access data in the system. Thus, it would not fully meet all of the original objectives set for the WVC data collection system over the long-term.

5.2. Sustainability

To create a WVC data collection system that has broad applicability and is more readily available to FLMA partners, it is worthwhile exploring the adaptability and parallel development of ROaDS on an existing federal system and/or platform. In particular, a system that uses existing mobile devices and operating systems would be more easily maintained, upgraded, and available to a broader constituency than DOI FLMA employees.

One such system has been developed by FHWA for its Emergency Relief for Federally Owned Roads Program, or ERFO Program. The ERFO system could potentially be explored in a future phase of the project. The program was established to assist federal agencies with the repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel, which are found to have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. (More information is available online at: https://flh.fhwa.dot.gov/programs/erfo/ [accessed 28 May 2018].) To help program administrators quickly assess infrastructure after a disaster, they developed a reporting system called Mobile Solution for Assessment and Reporting (MSAR).

The MSAR system is a cloud-based information system using a mobile device application (app) to collect and report post-disaster transportation information. It is a tool that enables the integration of mobile device technology, online forms, dashboard reporting, geospatial tracking, offline map viewing and reporting, and corporate workflow. (More information is available online at: https://collaboration.fhwa.dot.gov/dot/fhwa/msar/default.aspx [accessed 27 May 2018].)

The MSAR software was developed by FHWA in 2016 to provide a range of stakeholders, e.g., state departments of transportation, FLMAs, tribal governments, and FHWA employees, "with an application that can be loaded on cell phones and tablets to make disaster data collection faster, easier and more efficient" (FHWA, MSAR fact sheet, no date). Many of MSARs functions would meet the needs of the ROaDS application. In addition, MSAR's mobile

application can be used on IOS devices -- iPhones and iPads -- and Android smart phones and tablets with a cloud-based web portal.

The mobile device portion of MSAR is for field personnel who are deployed to a disaster site immediately following the event and are responsible for collecting and reporting initial damage assessment data to decision-makers in real-time. The app is specifically targeted for inspection teams that need to perform tasks including but not limited to: creating inspection reports, viewing spatial data, and planning inspection routes. The second component consists of a data portal and repository for submitted data, disaster reports, and photos, which can be used by team leads and management to assess damage and make timely decisions on how to support the impacted areas.

MSAR is a platform that can have additional applications developed for it, so it would be possible to develop another app using the system, such as RoaDS. MSAR is closed and qualified users with appropriate security clearances are required to register to use the app; it can be configured to be accessible to all federal and state agencies by MSAR administrators at the FHWA. ROaDS could be configured to allow members of the public to input data, but not to access the database since MSAR controls who collects data and what they have access to in the data base. For example, an employee of the Texas Department of Transportation (TXDOT) registered and used MSAR after Hurricane Harvey may only be given access to TXDOT information, not all federal data collected in Texas. Such control of access to data has important implications for ROaDS. For example, anyone may collect roadkill data of threatened and endangered (T and E) species under the Endangered Species Act, but giving access to such data may be limited to T and E specialists within the USFWS or similarly credentialed employees of each of the FLMAs.

FHWA pays for MSAR by a subscription to Run Consultants (~$250,000/year) who do all the app updates, trainings for users, data base storage, access, and trouble-shooting, etc. All training is conducted via webinars, both for app and data base use, report generation, and other functions (personal communication, Sergio Mayorga, ERFO Program Manager). Such a subscription, whose costs are unknown at this time, could be developed for ROaDS if it was horizontally developed using the MSAR platform.

Using the MSAR platform for ROaDS could be designed with both a national standard of data fields all users collect and with the flexibility to add data fields for a management unit, projects, monitoring or research. Another benefit of the MSAR platform is that it can control photo size, so as to not to overwhelm the memory or capacity of the cloud-based data base.

ERFO's development of MSAR has given program administrators the experience to address privacy and Health and Human Services Department requirements. For example, the MSAR platform for ROaDS could control the privacy of people submitting "selfies" as part of their geo-synchronized roadkill photos by keeping data collectors anonymous.

6. SUMMARY AND NEXT STEPS

The Federal Lands Wildlife-Vehicle Collision Data Coordination Project has evaluated the adaptability of an existing data collection system currently used and under contract by Department of Interior agencies. An important step was to develop the standard data to be collected. An additional piece needed to be included in the system so experts could confirm or change the species identified by the data collectors, particularly if they were a non-expert. The project also explored how a system should be able to store, retrieve and view the data. Lastly, the research team reviewed how to implement and sustain a WVC data collection system.

6.1. Summary and Recommendations

Researchers reviewed 17 existing WVC data collection applications and/or systems to assess if any could be readily used or adapted by the FWS, NPS and their partners for this project. It was determined that all the federal agencies of the Department of Interior, including FWS and NPS, already had a system that could be used to beta-test a WVC data collection system. Therefore, for this phase of the project the ESRI Survey 123 for ArcGIS platform was used to develop and test a WVC data collection system. The survey that was developed was coined the Roadkill Observation and Collection System – ROaDS, and an icon was created for mobile devices.

A standard set of 10 data fields was used to collect ROaDS data with the app's survey (Table 2). In addition, geo-synchronized photo capability and a field for providing comments were offered as additional features (Table 2). Using the information gathered in the 10 standard data fields and the location of the roadkill's latitude and longitude, it was possible to populate another 18 fields of data by processing the data after collection (Table 3). Seven other optional data fields, not part of a national standard, were also created (Table 4). After discussions and interviews with ROaDS data collectors during the beta-testing of the survey, it was evident that the data fields were too numerous and that in the next phase a shorter, more succinct set of data fields should form the basis of the national standard, while these additional data fields would be made available for monitoring, research or projects.

A quality control/quality assurance system was developed outside of the ESRI Survey 123 for ArcGIS. This allows FLMA biologists to review data from non-experts or for which collectors had low confidence of their species identification. The program sent data from the ArcGIS cloud-based data server out to an independent server for storage. Then, after an expert either confirmed the identification or edited it to make an appropriate identification, the data would be returned to the cloud server for use in analysis and reporting.

The ROaDS survey was then beta-tested by volunteers from field units of the National Park Service and National Wildlife Refuge systems, along with the Research Team and Advisory Committee. Some of the identified strengths of the system are:

- Buttons were very easy to use; they were much preferred compared to typing in information.

- 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 be filled out.
- Geo-synched photo was very easy to use.

Users also identified weaknesses that would need to be addressed in the next phase of the project, particularly if the ESRI 123 Survey platform was to be pursued. These weaknesses included:

- It was difficult to register for access to the ESRI 123 Survey for the ArcGIS application and its ROaDS Survey and ROaDS Route Survey.
- It was unclear how to mark the location of the observation, because the button next to the map to do this was unmarked. The circle with the "X" was not intuitive.
- The safety feature of allowing the collector to mark the site and then move to somewhere away from traffic to fill out the data fields was poorly understood.
- Minimize and simplify the survey; there are too many data fields.
- It was not possible to collect the information in a short amount of time, which could be hazardous to collectors.
- Scientific names were not all in alphabetic order; some of the pull-down lists only had general rather than complete binomial scientific names.

Lastly, a series of recommendations were made to improve ROaDS, particularly if the FWS and NPS are to adopt the Survey 123 platform in a future phase(s) of the project.

- Start with most common species in first field, then have another field called "other" with a drop-down list of all scientific names and a longer list of common names.
- Is there a way to set up scientific names on a pull- down list only for those who need them?
- Include a field for carcass information: carcass moved off the road, carcass removed by maintenance crew (or reported for removal), carcass not moved.
- If "opportunistic" observation was originally selected at start of observation, offer single button: *Submit opportunistic observation*...that, when toggled, results in a screen confirming observation was submitted, then loops back to first screen to open a new record starting with choice of type of observation.
- If "monitoring" was selected at start of record, have a banner at the top or bottom of the screen visible throughout the monitoring effort to confirm that the monitoring route (i.e., survey effort) is being tracked/recorded, and offer two additional buttons at the end of an observation:
  - *Save observation and continue monitoring route* w/screen confirming prior observation was saved, and then opens a new record starting with species since we already know this is part of a monitoring effort.
  - *End monitoring route and submit observation(s), if any were recorded* w/screen confirming monitoring route recording has been stopped (if banner indicating "route recording underway" was on the screen, it would disappear), X # of observations and monitoring route data were submitted, and then opens a new record starting with type of observation.

- Allow all data observations to be viewed and accessed on ESRI main server page. Differentiate each observation by whether it has been reviewed or not, this could be achieved by a color scheme or other mechanism. It allows users to see the data and warns that there has been no quality control for those that have not been reviewed.
- Clarify whether duplicates are removed by review or by algorithm, or develop algorithm that identifies duplicates, expediting a reviewer's ability to find these records, assess if they truly are duplicates, and delete if confirmed to be duplicate observations.
- Develop and describe detailed protocols for creating a profile and downloading the app, entering data, quality QA, QC, end users, screening of duplicates, and for assessing the limits of the data as well as analyzing the data to appropriately guide the development of mitigation planning or for other purposes.
- Any WVC data collection system will need to have a support team, materials, user manual and other information to help data collectors and database users.
- Develop communications and outreach to engage users to adopt the system for long-term use, provide technical support, and to share case studies across FMLAs. These tasks may require an identified point of contact (presumably an FMLA employee with appropriate skillsets and access to expertise to resolve technical issues) to dedicate substantial time to supporting the system and its users.
- The survey route must be integrated with the data observations survey in Phase 2 (existing ESRI Survey 123 did not allow for such integration during the beta-test in Phase 1).
- Expert reviews of observation data (quality assurance) to affirm proper identification of species should not be required before data is made available to agency staff for reports or analysis from the ESRI data cloud server. Caveats regarding the quality of this unreviewed data should be made clear in all reports.
- Observation data reviews by FWS and NPS experts should be internal to DOI and data should not be exported from the ESRI data cloud to commercial or academic servers for such purposes.
- The development of a shorter list of data fields for each recorded roadkill in Phase 2, the "national data standard", should receive broad consensus from outside DOI. It is suggested that the appropriate committees of the Transportation Research Board (of the National Academies), those overseeing wildlife vehicle collisions, be engaged to reach a consensus data standard.

6.2. Next Steps or Options

For next steps, the project's Advisory Committee discussed several potential options and then focused on three pathways that the WVC Data Collection System could take to achieve its implementation.

1. Department of Interior FLMAs will use the ROaDS survey via the ESRI Survey 123 system and keep it internal for their own personnel. Other FLMAs, non-DOI agencies, citizen scientists and trained volunteers would not be able to contribute standardized data to this system.

2. FHWA FLH hosts/supports a WVC data collection system for all agency personnel of the FLMAs within the Departments of Agriculture, Interior, and Defense and will contribute to and collaboratively fund its maintenance and use through an interagency/interdepartmental agreement that is renewed on an agreed upon cycle..

3. FHWA co-hosts/supports a national system for all FLMAs, state DOTs, and public/citizen scientists. This may require quality control capabilities (agency biologist review) of public/citizen scientist data contributions of roadkill, as well as specific privacy and security considerations

Other considerations for the next phase of the project are:

- Assure there is agreement among natural resource and transportation agencies regarding the data standards so that the same consistent WVC data are collected across all federal, state, tribal and local agencies (national data standard).
- Develop a system that includes communications and outreach such as manuals, protocols, guidance, trainings, workshops, and webinars for the thousands of data collectors as well as for the users of the database for analysis and reports.
- Engage a partnership of key agencies that collectively and sustainably support the long-term viability and use of the ROaDS system and applicability of the information collected in the long-term.
- Guarantee the final WVC data collection system will be compliant with the Office of Management and Budget requirements and the Paperwork Reduction Act, as well as other applicable federal regulations and laws

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8. APPENDIX A: FEDERAL LANDS WVC QUESTIONNAIRE

Federal Lands Wildlife-Vehicle Collision Data Coordination Project
Existing and Future Needs Assessment

Questionnaire

This questionnaire is intended to help understand existing Wildlife-Vehicle Collision (WVC) data collection and reporting processes by each agency (NPS, FWS, and FS) and to inform decisions affecting the development of a new coordinated WVC data collection system. You have been identified as a subject matter expert that can provide greater understanding to your agencies' existing processes and systems. In addition, a person in your position may input, manage, or use this type of data and your knowledge and preferences are important for developing a new, more robust and innovative WVC data collection system that can be used by multiple agencies.

Please answer the following questions to the best of your ability. If you know someone that would have more information on a specific question, please invite their input and provide their name and contact information in case further consultation by the project development team is needed.

PART I: UNDERSTANDING EXISTING WVC DATA COLLECTION PROCESSES BY AGENCY

1. Who currently collects WVC data for roads and highways on or traversing through your agency's lands?

2. What types of data do you currently collect to evaluate WVCs: collision data, carcass removal data, insurance industry data, ad hoc (opportunistic) agency personnel reports, other?

3. Do you rely on state highway departments or other local entities for any of your WVC data? If so, what percentage of your current collection process is data from external sources?

4. What types of wildlife data do you collect; large animals, medium to small animals, threatened and endangered species, other species of conservation concern, etc.?

5. What are some of the major weaknesses & challenges with your existing collection and/or WVC reporting processes?

6. How varied are the collection processes for WVC data across your agency's regions and individual management units - is it standardized, or if not, what is the approach?

PART II: UNDERSTANDING EXISTING AGENCY DATA COLLECTION SYSTEMS

7. After WVC data is collected, who is responsible for reporting the data? Who is the data reported to (both within the agency and externally)?

8. Does your agency have an existing WVC data collection system? If so, who manages it?

9. What are some positive aspects of your existing WVC collection system(s)?

10. What improvements could be made?

11. Does your current system import WVC data collected from external sources?

12. Does your agency have annual unit, regional and national summaries for WVC data?

PART III A: IDENTIFYING AGENCY NEEDS FOR COLLECTING, REPORTING, AND ASSESSING WVC DATA

13. What are your expectations or needs regarding spatial precision for data collection? What would your agency deem necessary (i.e., 1 meter, 10 meters, 1/2 mile, mile markers)?

14. Should a 'new' WVC data collection system that coordinates data between multiple agencies be managed and updated by one federal agency (i.e., USFWS), by a Department (i.e., DOI), or by an external entity (i.e., Federal Highway Administration, Private Contractor)?

15. What platform(s) should your electronic data collector be based on? Apple, Android, other?

16. What type of data collector(s) do you think would be necessary for your system? - cell phone, tablet (i.e. I pad), laptop, smart watch, PC.

17. Who do you want to collect and report the data into the system? - Agency biologists, agency non-biologists, “friends” groups who are vetted and trained, the general public?

18. Do you want to control who can collect and report the data (via a registration process) and make sure data entries can be attributed to an individual?

19. Who do you want to have access to the data for reporting, etc.?

20. Do you want a visualization capability for your data system, or will agency GIS specialists extract data and create their own images, maps, etc.?

21. Would you like visualization (maps with a data query capability) via a website to be available to your agency? To others in your Department? To others outside your Department (i.e., FHWA, DOTs)? To the public?

22. Are there any other items that you would like for the system?

PART III B: WHAT STANDARDIZED DATA SHOULD BE COLLECTED (the electronic data form)

23. Strategically, and for safety purposes, how long do you want agency personnel or the general public to enter data at the site of a dead animal on or along the road? Depending on the amount of time, this may limit how many data fields can be placed on the data collector.

24. Spatial Data: the UTM (lat-long) for the “incident” will automatically be collected by the GPS component of the mobile device. Are there other spatial identifiers that you would like to collect? Mile marker, road name, management unit, region, etc.

25. Do you want to collect live and/or dead animal data?

26. Do you want to identify where in the road corridor the animal is located? On pavement, median, verge, inside the Right of Way fence, etc. These can all be listed in a pull down option.

27. Do you want to be able to snap a photo of the animal - have a geo-synched photo capability?

28. Do you want a “pull down” list of common species? How many and which are “must list” species?

29. Do you want an “other species” button that allows the entry of all other species?

30. What metadata do you need to fully understand a wildlife vehicle collision event? Observer ID, type of vehicle, roadway conditions (snowy, wet) time of day, etc.?

31. Would you like to differentiate whether the WVC observation is based on a carcass or a crash?

32. Are there other data you would like collected?

33. What other attributes would you like the WVC data collection system to include?

9. APPENDIX B: WVC DATA COLLECTION SYSTEM USER MANUAL

Wildlife Vehicle Collision Data Collection System

Application and Survey User Manual

This survey was created to identify wildlife vehicle collision problem areas within federal land regions through a partnership between the United States National Park Service, United States Fish and Wildlife Service, and the Western Transportation Institute.

December 2017

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IMPORTANT KEY TERMS AND NOTES

Application (App): refers to the Survey123 for ArcGIS software program that has been designed and written to fulfill a particular purpose of the user.

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

Form(s): divisions of the survey that fulfill two activities: data collected during a random or opportunistic occurrence and data collected during a survey.

WVC: wildlife vehicle collision(s)

Please note that our WVC Data Collection System survey has *two forms*. The Survey123 application does not capture GPS track logs. To record a survey route, we created a Survey Route form, which users can fill out to record the waypoints of their observation routes. In future versions of the WVC data collection application, we will explore ESRI Collector, or a custom-built app, which can record GPS track logs.

STEP 1 – DOWNLOAD THE APPLICATION TO YOUR MOBILE DEVICE

DOWNLOADING THE APPLICATION, MOBILE VERSION

The WVC data collection system project is using the Survey123 for ArcGIS software program to present the survey and forms for this particular project. In order to use the WVC data collection system, the Survey123 for ArcGIS application must be downloaded. The application is free to install. To download the application, please follow the subsequent instructions:

1. On a mobile device, go to the application store.
2. Search for "Survey123 for ArcGIS" in the search bar.
3. Identify the proper application to download and locate the install button (Photo 1).
4. Install the application on mobile device by choosing the install button and wait for it to fully download.

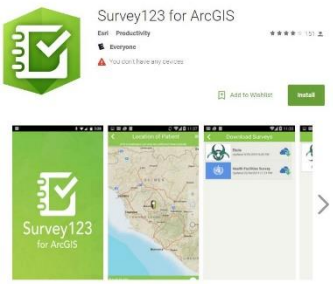


Photo 1 *shows the Survey123 for ArcGIS application on a mobile screen. Please note that the app presentation may appear slightly altered on different devices and their associated app stores.*

ACCESSING THE SITE FROM A LAPTOP OR DESKTOP

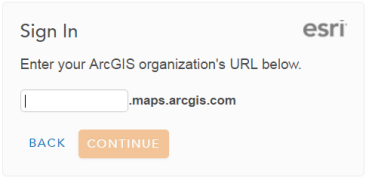
1. Go to: https://survey123.arcgis.com/.
2. Go to the bottom of the webpage and click on "Get It Now," and follow the subsequent instructions.

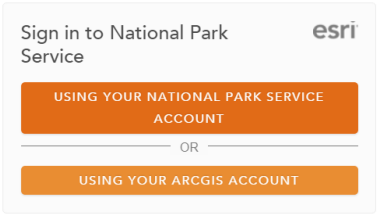
STEP 2 – SIGN-IN TO SURVEY123 for ARCGIS

Data can be entered into the developed surveys without logging onto the ArcGIS system. However, during the pilot phase, the project team requests that data be entered into the Survey through verified accounts. Accounts are available for all federal land management agency employees. Instructions for accessing these ArcGIS accounts are provided below.

GOVERNMENT EMPLOYEE USING A GOVERNMENT ISSUED DEVICE (MOBILE AND/OR WEBSITE VERSION)

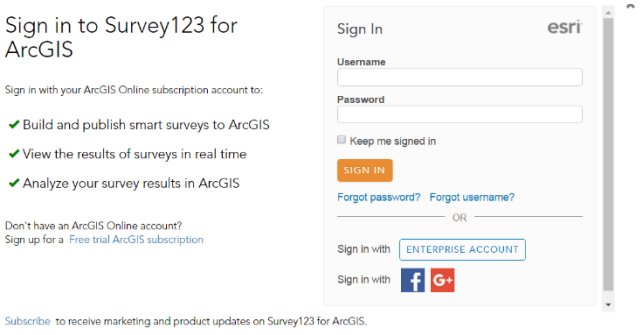
1. Open the Survey123 App or go to: https://survey123.arcgis.com/
2. Click on "Sign-in."
3. Click on "Sign-in with Enterprise Account."
4. Enter the three letter acronym of your agency where it asks for "Enter your ArcGIS organization's URL below".
    a. For National Park Service, enter "NPS"
    b. For Fish & Wildlife Service, enter "FWS"
5. Click on "Using Your <Enter Agency> Account"
   If you are not logged onto the agency VPN, you will need to enter the requested Username and password credentials.





NON-GOVERNMENT EMPLOYEE USER

1. Open the Survey123 App or go to: https://survey123.arcgis.com/
2. If you do not already have an ArcGIS account, follow the instructions to "Create an Account."



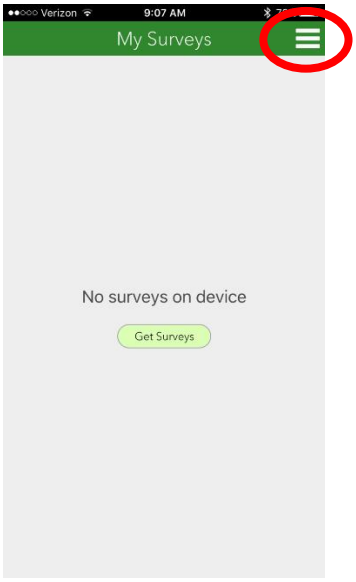
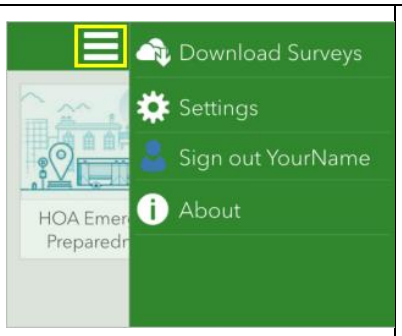
STEP 3 – JOIN THE "WVC at MSU" GROUP AND DOWNLOAD FORMS

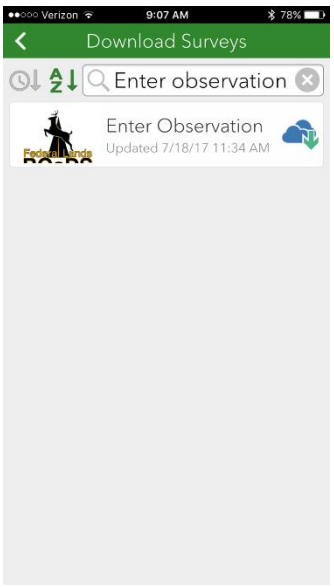
JOINING THE GROUP

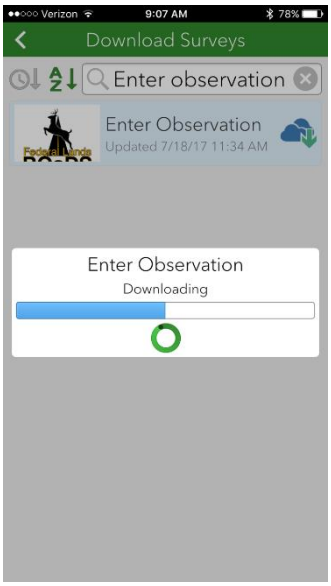
Gaining access to the surveys requires a three-step process. First data collectors need to request to join the "WVC at MSU" group, which is part of Montana State University's ArcGIS subscription. Next, data collectors must be accepted into to the Group by an administrator. Lastly, data collectors can download the ROaDS surveys, which are called "Enter Observation," and "Survey Route."

1. You will receive an email from the Spatial Sciences Center at Montana State University inviting you to the "WVC at MSU" group.
2. After joining the group, you are able to download either the surveys in the Survey123 mobile app's content section.

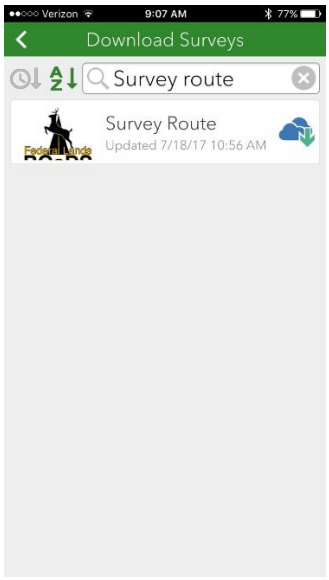
ACCESSING THE FORMS ON YOUR MOBILE DEVICE APP AFTER JOINING THE WVC at MSU GROUP:

<table>
<tr><td>1. In the top right-hand corner of the application, select the three white bars, which indicate a menu.</td><td>2. In the menu, select "Download Surveys."</td><td>3. Type "Enter Observation" into the search bar on the download surveys screen</td></tr>
<tr><td> 
</td><td colspan="2"> 

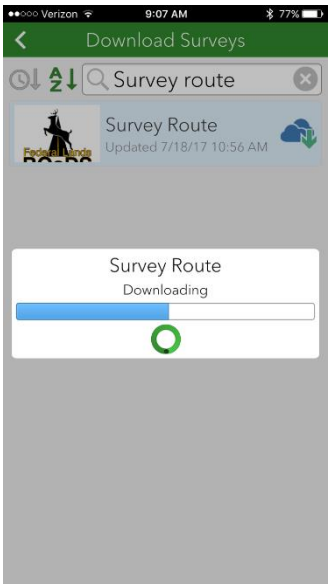

</td></tr>
<tr><td>4. Select the survey to download it and wait for the survey to download.</td><td>5. To download the survey activity form, type "Survey Route" into the search bar on the download surveys screen.</td><td>6. Select the survey to download it and wait for the survey to download.</td></tr>
</table>



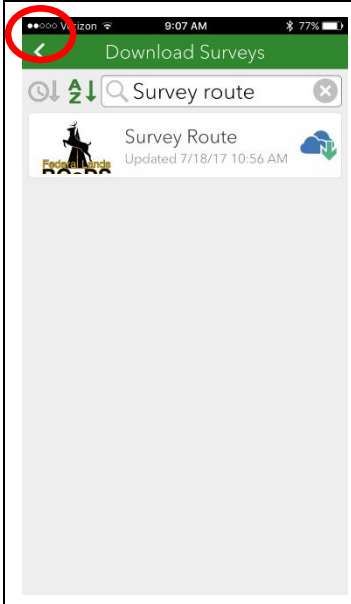
7. Select the back arrow on the top left of your screen to see your downloaded surveys.

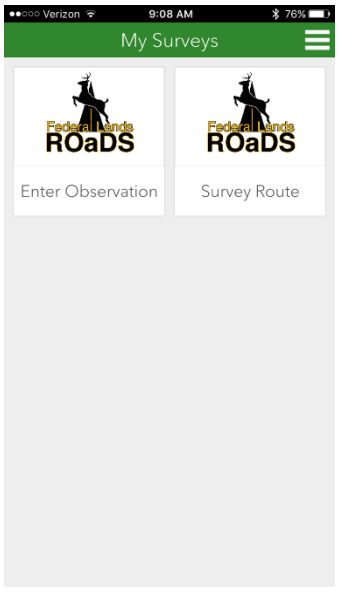


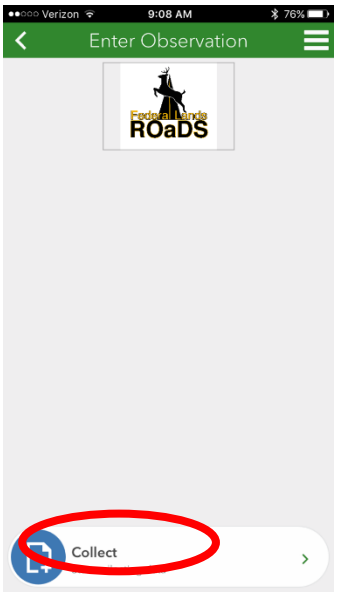
8. Select the Enter Observation Survey to enter wildlife observation.



9. Select the "Collect" button at the bottom of the screen to see survey & start collecting data.





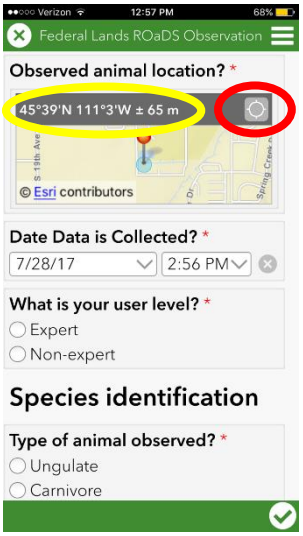


STEP 4 – BEGIN COLLECTING DATA

The Survey123 application is not as smooth as hoped. The NPS, FWS, and WTI recognize that the app can be awkward when collecting data; nevertheless, the ending result does store wildlife vehicle collision data. If the observer is only wanting to observe and collect data (recommended), they will only use the Enter Observation form. If the observer would like to collect waypoints during their survey route, they must use both the Enter Observation form and the Survey Route form. Follow the instructions below to collect wildlife vehicle collision data:

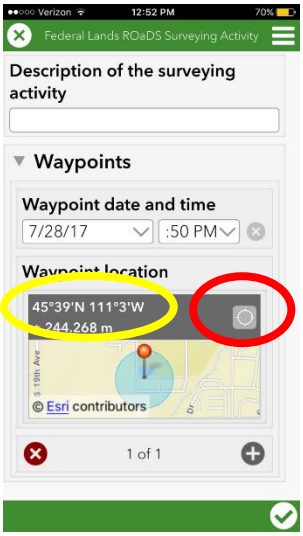
ENTERING AN OBSERVATION:

1. To enter an animal observation, choose the Enter Observation survey in your downloaded surveys.
2. Select the Collect button at the bottom of the screen to go to the form.
3. The animal location will be automatically entered if the mobile device's location services are set. Select the location finder on the map if the site is not generated initially (see red circle at right).
4. If the automatic location services are not available, the location needs to be manually entered by the user using the map marker.
5. If cell phone coverage or other mobile device coverage is not available, the map will not be displayed; however, you can click the location finder on the map in the top right corner and your latitude and longitude will be displayed in the grey section above the map (see yellow circle at right).



6. The date and time are auto-filled from the mobile device's information.
7. Select your user level: Expert or Non-Expert. Experts include biologists and specialists who are able to accurately identify the animal and their scientific name. Non-experts pertain to users who may or may not be familiar with the animal and their common name.
8. Keep scrolling down the form to enter more information. When finished entering an observation, go to the bottom right hand corner checkmark and "Send Now." If you select "Send Later," your observation will be saved as a draft, which can be revisited as needed.

TRACKING A SURVEY ROUTE:



1. To track a survey route, choose Survey Route in your downloaded surveys.
2. Select the Collect button at the bottom of the screen to fill out the form.
3. Enter the description of the survey route (e.g., US Highway 41, Big Cypress National Reserve).
4. The waypoint date and time are automatically entered from the date and time on the mobile device.
5. The waypoint location will be automatically entered if the mobile device's location services are set. Select the location finder if the route site is not generated initially (see red circle right).
6. If the automatic location services are not available, the location needs to be manually entered by the user using the map marker.
7. If cell phone coverage or other mobile device coverage is not available, the map will not be displayed; however, you can click the location finder on the map in the top right corner and your latitude and longitude will be displayed in the grey section above the map (see yellow circle at right).
8. To add additional waypoints along your route, select the plus sign that is below the waypoint location map.
9. To enter an observation during your survey route, you must pause your survey route form, go to the Enter Observation form, and then resume the same survey route form to continue collecting waypoints.
    a. When collecting waypoints during a survey route, select the checkmark at the bottom of the screen.
    b. Select "Send later." Your mobile device should automatically go back to the Survey Route opening screen.
    c. Select the back arrow in the top right hand corner of the application.
    d. Select the Enter Observation survey, collect the observed animal, and send in the form.
    e. Go back to the Survey Route opening screen. You will see an "Outbox" below the Collect button.
    f. Click on the Outbox and select the appropriate Survey Route form.
    g. "Completed Survey" will pop-up on your screen. It asks if you would like to continue and edit the survey.
    h. Select "yes" and continue collecting your waypoints during your survey route.
    i. When finished with the survey route, select the checkmark at the bottom of the screen and "Send Now."

10. APPENDIX C: ROADS OBSERVATION FORM

This is a brief overview with screenshots that explains various types of information that are stored in each ROaDS observation via its Observation Form.

At the top of the form, The **Observation Id** is given as a subtitle.

Observation Id – An Observations unique identifier. Only used internally within the expert portal.
Meta Data of the observation shows the current state of the observation in the review process.
Reviewed, Uploaded, and Duplicate -These are all stored as a particular date and time of day within the system, but can be checked if they are set to understand the current state of the observation.
Created At – Keeps track of when the observation entered the Expert portal.
Updated At – Keeps track of the last edit

Mousing over any of these dates will reveal their actual date time value and is formatted by decreasing duration.

Attachments are any of the files that were associated with the observation in the ESRI system. Should these be an image they will be displayed, otherwise a link prompting their download will be displayed.

The next sections are **ESRI Information** and **User Information**.
The Observation Form is where the observation data is reviewed and modified. Given its length it will discussed section by section.

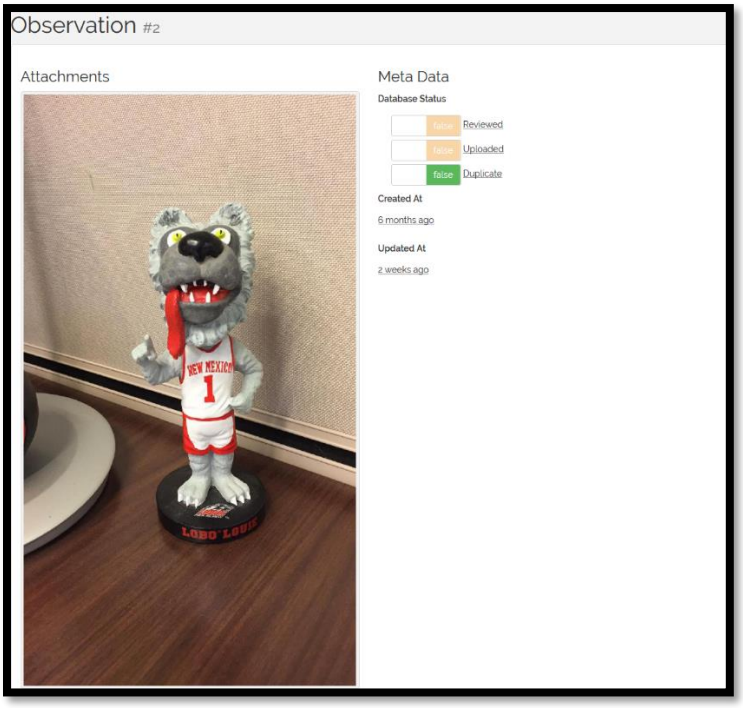


Figure A: Example of a photo stored in the ROaDS database.

Figure B: Screenshot of ESRI information stored for each ROaDS observation.

ESRI Information is the ESRI specific meta data.
Object Id – ESRI's own identifier within the feature layer.
Global Id – ESRI's unique identifier across the entire ESRI system. Duplicate uploads to ESRI generates a new unique global identification.
User Information Data about the collector of the observation data.
User Id – ESRI's identification for the collector.
Email – Email address of the data collector.
User Agency Affiliation - Unfilled from ESRI. The export portal examines the domain of the collector's email and maps that to an agency should a mapping exist.
User FLMA Region - Unfilled from ESRI. Provided for future extension.
User State Residency - Unfilled from ESRI. Provided for future extension.
User Level - A dropdown indicating if the user is an Expert or Non-Expert.
The next sections are **Species Information** and **Species Condition**.

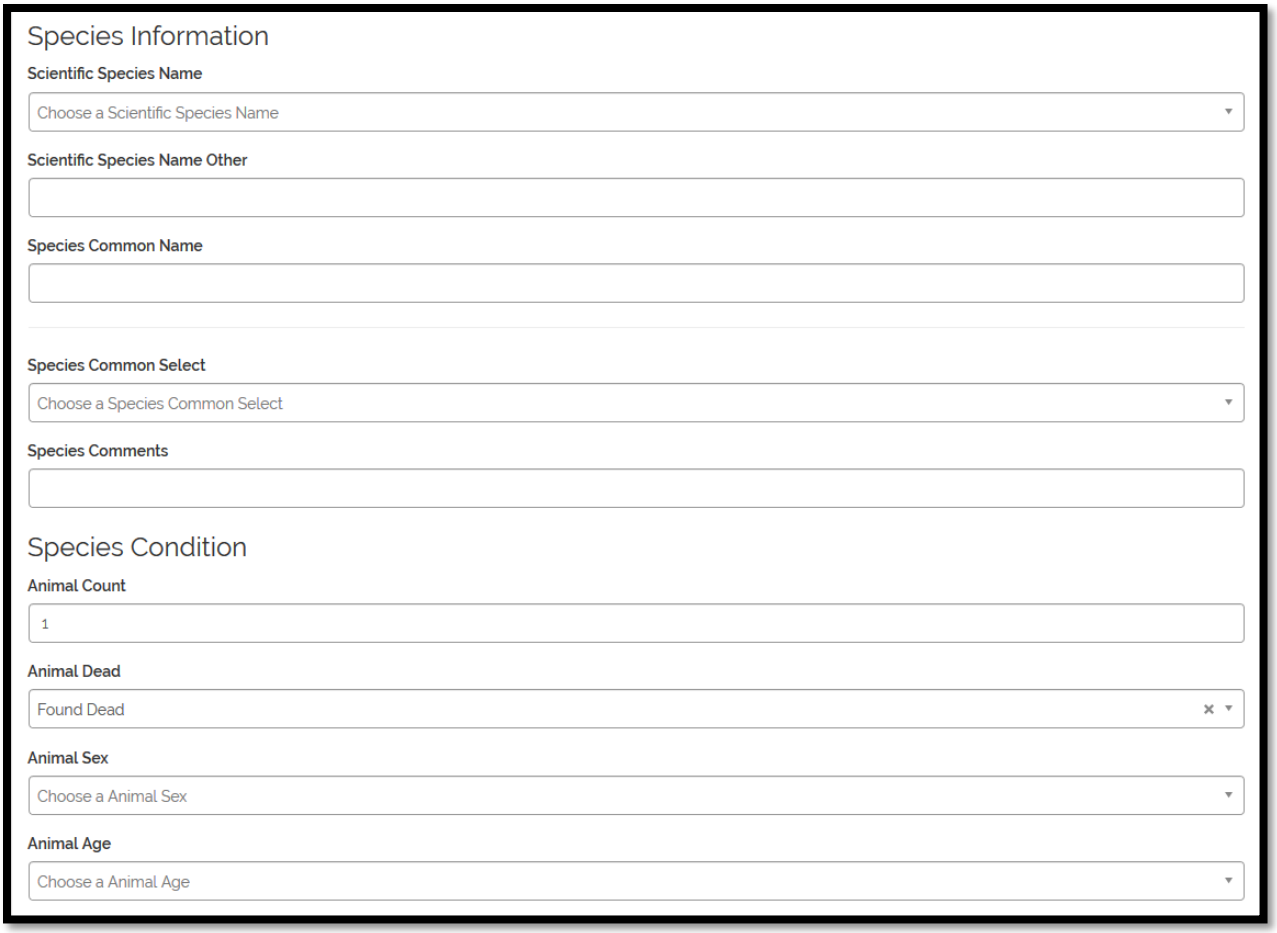


Figure C: Species information in the ROaDS Observation Form.

Scientific Species Name - Searchable dropdown of scientific species names.
Scientific Species Name Other - Other field if species name isn't within the dropdown.
Species Common Select - For non-expert users, shows a selection of animal types which displays searchable dropdown of common species names.
Species Common Name - Name of common species within the type of species selected.
Species Comments - Text field for additional comment on species.
Animal Count - Integer count for how many animals were located at the observation.
Animal Dead - If the animal found at the observation was dead.
Animal Sex - Sex of the animal if identifiable.
Animal Age - Whether the animal was an adult or adolescent.

The next section is Environment Condition in the ROaDS Observation Form.

Figure D: Information available for each ROaDS observation via its Observation Form.

Observed Crash or Carcass - Dropdown whether the observer found the carcass or other
Accident Report - Dropdown whether there was a report filed.

Observers Proximity - Dropdown estimating the observers proximity to the observation with the options of <10 feet, 10 feet to 100 feet, and >100 feet.
Observers Confidence - Dropdown on how confident the observer is: High, Medium, Low.
Observers Travel Mode - Dropdown on the Observers method of travel.
Observers Travel Mode Comments - Text field for additional comments on travel mode.
Road Identification - Text field for additional road identification.
Road Condition - Dropdown for road conditions.
Road Condition Comments - Text field for additional comments on road condition.
Habitat - Dropdown for common habitats.
Habitat Comments - Text field for additional comments on habitat.
Near Mitigation - Dropdown on whether the observation was near mitigation measures.
Near Safe Structure - Dropdown on what type of safe structure was near.
Near Safe Structure Comments - Text field for additional comments on safe structures.
Number of Lanes - Integer for how many lanes the road had near observation.
Posted Speed Limit - Integer for the posted speed limit in the area.

The last sections of the Observation Form are Location Information and Final Comments.

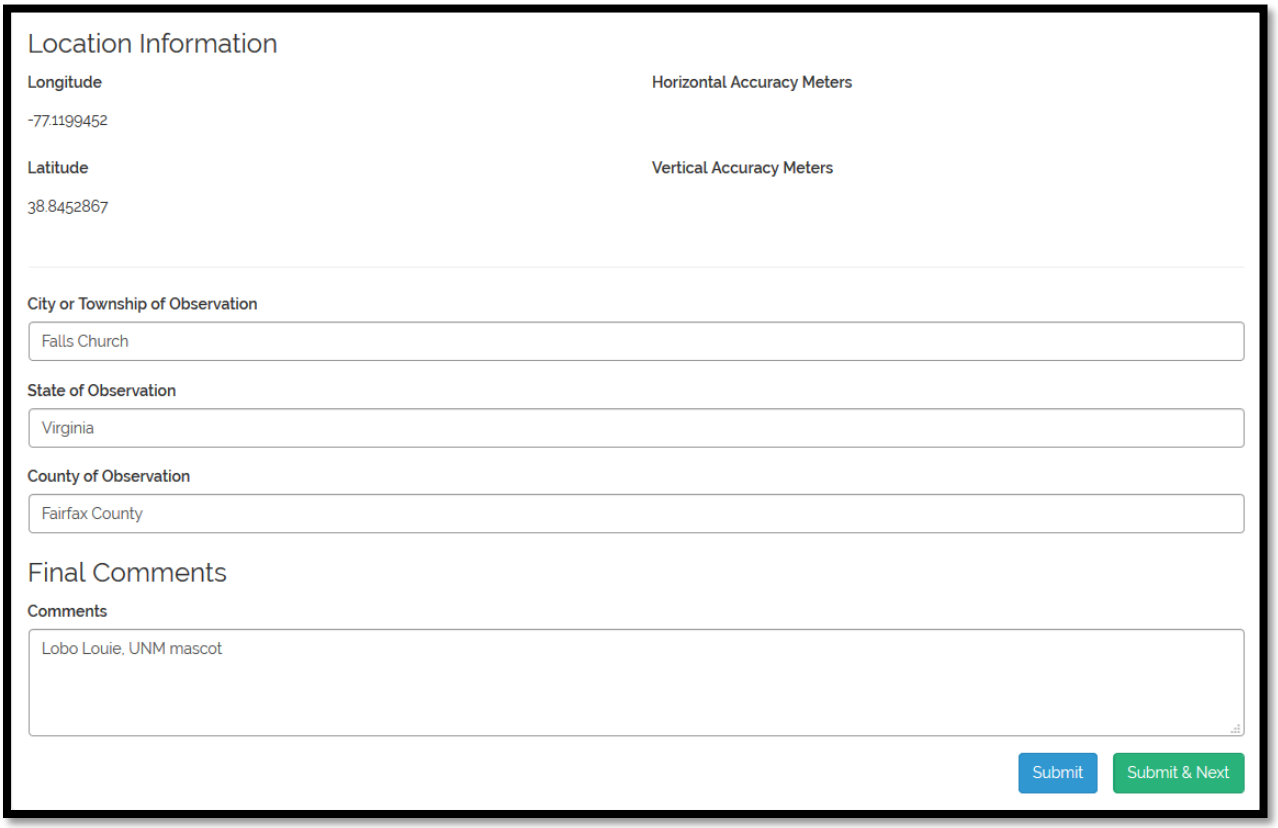


Figure E: Location information in the ROaDS Observation Form.

Location Information is auto-filled by ESRI, and is the **Longitude** and **Latitude** of the observation. ESRI also provides Horizontal Accuracy Meters and Vertical Accuracy Meters. Since these are auto filled through the collection application, they are static, uneditable. In addition, Location Information contains these fields, which are all auto filled through Google's reverse geocode lookup application.

City or Township of Observation - The city or township at the Longitude, Latitude. ‘locality’ result in Google reverse geocode api.
State Of Observation - The state at the Longitude, Latitude. ‘administrative_area_level_1’ result in Google reverse geocode api.
County of Observation - The county at the Longitude, Latitude. ‘administrative_area_level_2’ result in Google reverse geocode api.

The **Final Comments** section is self-explanatory. A text area named **Comments** with unlimited length is provided for any final comments.

At the bottom of the form there are two submission buttons, should the submission be successful, it changes the redirect location for the browser.
Submit - Submits and returns to current Observation.
Submit & Next - Submits and redirects to next Observation awaiting review.

11. APPENDIX D: ROADS BETA-TEST QUESTIONNAIRE

ROaDS DATA COLLECTION SYSTEM

Beta-Test Phone Questionnaire

1. Did you have any problems with registration? If so, please explain.

2. On a scale of 1-10, how easy did you find collecting data with the ROaDS Enter Observation Survey to be? 1 being easy and 10 being extremely difficult.

3. Do you think a short 15-20 minute training session over the phone or through WebEx on how to use the app would have been helpful?
    a. What other support may be helpful for future users?

4. On a scale of 1-10, do you think you spent very little or too much time to collect data? 1 being very little and 10 being too much.

5. Do you think the amount of time spent collecting data could be hazardous to future data collectors across the US (exposure to traffic)?

6. Did you use the safety feature of locking in the location of the roadkill and then moving to a safe place to record all the other information later?

7. Were all the data fields self-explanatory and easy to use?
    a. If not, which fields did you find confusing?

8. For Expert Users: When using the scientific name pull-down, did you find it easy to use? If not, why?

9. Did you regularly skip filling in any particular data fields? If so, which fields and why?

10. Did you use the geo-linked photo option? Any observations regarding this function?

11. Do you agree or disagree with the following statement? There are the proper amount of data fields/questions in the ROaDS survey. 0 need many less - 10 need many more.

12. Would you add any data fields or additional questions in the ROaDS survey?

13. Are there other options you would employ to extract and use or view your data?

14. Do you have any suggestions on how we can improve the system as a whole?

12. APPENDIX E: CONTACT LIST FOR SURVEY

Agency	Contact	Title	Department
NPS	Krista Sherwood		WASO Transportation
NPS	Bryce Lloyd		WASO Facilities Planning
NPS	Kevin Percival	Branch Chief	WASO Facilities Planning
NPS	Christine Bruins		LOWE - Planning and Grants
NPS	Ryan Scavo		WASO Facilities Planning
NPS	Mike Seibert	Asset Management	
NPS	George Sins	PFMD IT	
NPS	Jen Williams	Federal Coordinator for Partners in Amphibian and Reptile Conservation (PARC)	
NPS	Elaine Leslie	NRSS, BRD Chief	
NPS	Peter Budde	NRSS Data	
NPS	Nathan Galloway		NPS BRD, Wildlife Health Branch
NPS	Kerry Gunther	Yellowstone NP Biologist	
NPS	Barbara Hatcher	Bear/Car collisions	SERO Transportation
NPS	Andrew Duff	IT Contact - GIS and Data Management	Resource Information Services Division, WASO
NPS	Ben Zahn	LE Lead	
NPS	Jennifer Proctor	Risk Management	
NPS	Deb Jansen	Wildlife Biologist	Big Cypress National Preserve
NPS	Joe Regula	Landscape Architect	Greater Yellowstone Coordinating Committee
NPS	Steve Suder	Multimodal Program Lead	US NPS HQ
NPS	Danielle Buttke		NRSS
NPS	Scott Ratchford		NRSS
NPS	Seth Riley	Chief of Natural Resources	Santa Monica Mountains NRA
NPS	Tim Watkins	Crowdsourcing and Citizen Science Coordinator	
FWS	John Morton	Supervisory Fish & Wildlife Biologist	Kenai NWR
FWS	Rob O'Brien	Transportation Asset Management and Safety Program Analyst	US FWS HQ
FWS	Nathan Beauchamp	Transportation Program Analyst	US FWS HQ
FWS	Carl Melberg	Region 5 Transportation Coordinator	US FWS Northeast Region
FWS	Gaberiel DeAlessio	Biologist / GIS Specialist	FWS Region 3
FWS	Richard Easterbrook	GIS Team Leader	Natural Resource Program Center
FWS	Todd Sutherland	National Inventory and Monitoring Data Manager	Natural Resource Program Center
FS	Sandra L. Jacobson (RETI	Wildlife Biologist Conservation of Biodiversity	Pacific Southwest Research Station
FS	Darin Martens	Landscape Architect/WYDOT/FHWA Liaison	Bridger Teton National Forest
FS	Joseph Burns	Certified Wildlife Biologist (CWB)	National Endangered Species Program
FS	Ana Egnew	Wildlife Biologist	National Assistant Wildlife Program Leader for the USFS Washington Office
BLM	Frank Quamen	National Wildlife Program Lead	Div. of Fish & Wildlife Conservation
BLM	David Hu	National Fisheries Biologist	WO
FHWA	Kevin Moody	Infrastructure Ecology Team Leader	FHWA Resource Center
TxDOT	Stirling Robertson	Strategic Projects	Natural Resource Managment Section - Environmental Affairs Division