

TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada Department of Transportation

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # <i>(i.e., SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))</i> TPF-5(358)	Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) 2022 <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: <i>The Wildlife Vehicle Collision (WVC) Reduction and Habitat Connectivity Transportation Pooled-Fund Project Strategic Integration of Wildlife Mitigation into Transportation Procedures</i>		
Name of Project Manager(s): Nova Simpson for Nevada DOT Patricia Cramer, PI	Phone Number: Nova Simpson: 775-888-7035 Patricia Cramer: 435-764-1995	E-Mail nsimpson@dot.nv.gov cramerwildlife@gmail.com
Lead Agency Project ID: Nevada Dept. of Transportation	Other Project ID (i.e., contract #): Agreement #: P700-18-803	Project Start Date: 12/13/2018
Original Project End Date: 12/31/2021	Current Project End Date: 6/30/2022	Number of Extensions: 1

Project schedule status:

☐ On schedule
 ☒ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$146,000.00	\$111,977.73	77 %

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$9,487.50= 6.5%	\$9,487.50	93 %

Project Description:

The *Wildlife Vehicle Collision (WVC) Reduction and Habitat Connectivity* pooled fund study is a collaborative research project through the Transportation Pooled Fund Program. Partners from both the United States and Canada have come together with a common interest in reducing WVC's for the safety of humans and wildlife, as well as restoring habitat connectivity in landscapes fragmented by roadways. Contributing partners currently include Alaska DOT, Arizona DOT, California DOT, Iowa DOT, Michigan DOT, Minnesota DOT, Nevada DOT, New Mexico DOT, Ontario Ministry of Transportation, Oregon DOT, Washington DOT, and Parks Canada. The U.S. Federal Highway Administration - Headquarters is also a partner in this study.

This pooled fund study (PFS) will seek to identify solutions that integrate highway safety and mobility with wildlife conservation and habitat connectivity. The Project: Strategic Integration of Wildlife Mitigation into Transportation Procedures is conducted under Principal Investigator Patricia Cramer and is reported on in this progress report.

Within U.S. states and Canadian provinces, there are few standardized planning processes for considering wildlife in transportation planning, or Best Management Practices (BMP) manuals to instruct personnel at every level how to consider, plan, design, construct, and maintain transportation infrastructure that permits connectivity for wild and domestic animals that could become involved in WVC. This study investigates and makes recommendations on successful procedures that consider and create mitigation solutions to reduce WVC and provide connectivity for wildlife to assist transportation agencies in developing standards at every level.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

In January, team member Dr. Kimberly Andrews presented a slide show of this project at the 2022 Annual meeting of the Transportation Research Board in Washington, D.C. Dr. Andrews' travel costs were covered by another project. She presented to about 25-30 participants and had positive interactions during the session and afterwards.

Dr. Cramer met with Mr. Ken Chambers and Ms. Nova Simpson once per month to help facilitate the task for the project. It was brought to their attention that the Task 1 final report, titled: "Final Report on the Strategic Integration of Wildlife Mitigation into Transportation Procedures," was confusing people downloading it from the FHWA internet site where it is posted, because of the "Final Report." Wording. The three of them decided on both a new name for this report, and the forthcoming manual. The original report submitted in 2021 from Task 1 was renamed: "Strategic Integration of Wildlife Mitigation into Transportation Procedures: Practices, Partnerships, and Next Steps." This report was updated with the title and footers, and resubmitted to Nevada DOT with a Technical Report Documentation Page for finalization and replacement of the original report on the FHWA site. The forthcoming manual name was then finalized to: "Strategic Integration of Wildlife Mitigation into Transportation Procedures: A Manual for Agencies and Partners."

The first draft of the Manual was submitted January 31. The PFS Partners met with the PI on March 2 to review Chapters 1-3, which detailed the introduction, prioritization, and planning. Input was received, and throughout March, each chapter was revised continually and uploaded to Microsoft Teams, Microsoft OneDrive, and Google Shared Drive. This also included Chapter 4 – Monitoring, Chapter 5 – Recommendations, Appendix A – Case Studies, Appendix B – Data, Appendix C – Memoranda of Understanding, Appendix D – Mitigation, and Appendix E – Monitoring Plan Guide. Partners and research team members reviewed the chapters and gave input on their time schedules throughout the quarter.

The Communication Plan was finalized. Dr. Cramer worked with FHWA's Mr. Daniel Buford to submit a proposal to FHWA's Public Roads editors to write an article on the project for the magazine. Dr. Cramer

submitted a similar email proposal to the editor of The Wildlife Society's "Wildlife Professional" magazine. Dr. Cramer also submitted a story of the project for the TRB Committee on Environmental Analysis and Ecology Spring newsletter. The final presentation for the Partners and research Team was set for June 6th. A final webinar free to the world was scheduled for June 23rd. Both will be on the BlueJeans platform and coordinated from Nevada DOT offices and IT personnel. Dr. Cramer worked with Mr. Steve Gent to attend the AASHTO Committee on Traffic Safety annual meeting in April to present on the project. However, remote presentation was not an option and the travel budget remaining could not cover the costs, so she will not attend the meeting.

The Implementation Plan was finalized. Products from the Communication Plan, such as a slide show, one-page summary pdf's, and a five-page guide to presenting the slide show will be available to the Partners and other interested parties.

Anticipated work next quarter:

Meetings will occur with the overall Partners in April, and one-on-one meeting will continue through April and May with Partners to make sure all edits and case studies are incorporated into the final manual. The manual will be submitted for the final time in late May. On June 6th will be the final presentation to the Partners. June 23 will be the final presentation to the world. The project will be completed on June 30, 2022.

Significant Results:

The draft manual was submitted and continually updated this quarter.

The Communication Plan was completed.

The Implementation Plan was completed.

The last webinars of the project were scheduled.

The TRB Annual meeting had a presentation of the project, by a Research Team member.

A story about the project was submitted to the TRB Committee on Environmental Analysis and Ecology Spring Newsletter.

At the end of this quarter, the majority of the final manual was reviewed by Partners and finalized, but the entire document was not yet finalized.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

No challenges are foreseen in the future. Even if the Covid-19 Pandemic blows up, the future webinars are remote and should not be affected.

Potential Implementation:

The information generated from this work will be available for U.S. DOT's and Canadian MoT's for assistance in incorporating wildlife concerns into transportation processes.

It may also be used in the development of the wildlife mitigation projects submitted for funding under the U.S. Bilateral Infrastructure Law.

TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada DOT

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # <i>(i.e., SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))</i> P200-20-803		Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) 2022 <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: Permeability of large underpasses to wildlife: Effects of ledges and addition of structure for facilitating movement of small mammals and herpetofauna.			
Name of Project Manager(s): Cheryl Brehme, Jeff Tracey, Robert Fisher	Phone Number: 858-761-8883, 619-225-6457 619-206-5686	E-Mail cbrehme@usgs.gov , jatracey@usgs.gov , rfisher@usgs.gov	
Lead Agency Project ID:	Other Project ID (i.e., contract #):	Project Start Date: 18 May 2020	
Original Project End Date:	Current Project End Date:	Number of Extensions:	

Project schedule status:

☐ On schedule
 ☒ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$83,127.56	\$65,790.83	Approximately 80%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$5,182.81 – Approximately 6%	\$5,182.81	Approximately 80%

Project Description:

The Department of Transportation (DOT) currently recommends that structure be added to large underpasses to increase wildlife use and movement, but there are a lack of scientific studies to show the efficacy of this mitigation for small mammals and herpetofauna or potential effects on use by larger species. The USGS has completed two years of Before-After Control-Impact field studies on 8 large upland wildlife underpasses in San Diego County. The objectives of this study are to determine; 1) if small vertebrate species are using these underpasses, 2) if ledges and the addition of structure (rock piles 5m apart along one side of structure) within underpasses facilitate small animal movement and 3) if the addition of structure (rock piles) affect the use rates of medium and large mammals. Using highly sensitive cameras over two years resulted in over 3 million images of which ~200,000 have been reviewed (less than 10% of total). Preliminary analysis indicates that responses to structure and ledges are specific to animal species and groups. This provides substantial training and test data sets to create a machine learning algorithm to classify images by the presence or absence of animals, and a possible second stage of classification to the species level. In order to process all photos, USGS will program a convolutional deep network (DN) to perform supervised species/group classification. Existing classified photos will be used to train the network to predict classes for the remaining ~2.8 million photos. Explanatory models will then be run to compare the relative permeability of underpasses to animal movement and effects of structure on animal activity. The results will inform the design of large underpasses for use by wildlife communities and target species.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):**Meetings (Internal USGS):**

- Meetings to discuss project, strategies and results (6 * 2 hours)
- Final development of system for hyperparameter optimization to improve the performance of CNNs.
- In process of the running training experiments and evaluating results. Select final hyperparameters for training. Have run over 1000 with 2000 more anticipated.
- Prepared and tested all code for N-mixture modeling to evaluate the effects of structure on animal movement within underpasses.

Anticipated work next quarter:

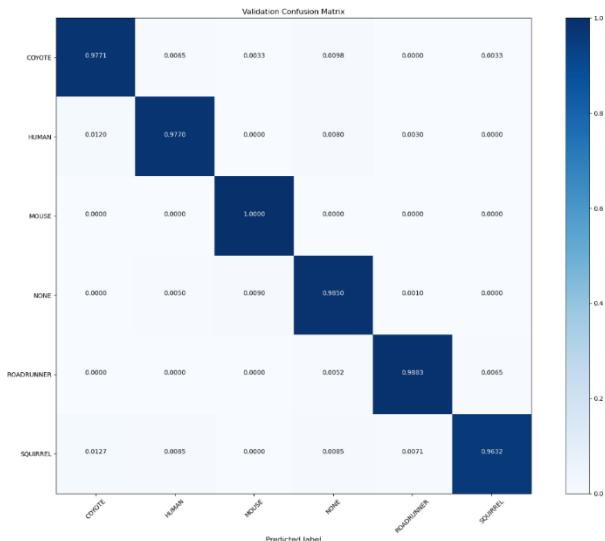
- Finish of the running training experiments and evaluating results. Select final hyperparameters for training.
- Train the final models on full training dataset.
- Make class predictions (species taxonomic groups) on unclassified images.
- Run N-mixture models on dataset
- Write draft report

Significant Results:

We used a new version of ResNet50 (ResNet50v2) which appears to have slightly better performance over the old version. We now have the analysis pipeline working well for model training. Our new model runs with varying numbers of classes and attained a minimum class level accuracy of 99.1%

Here is an example confusion matrix for the validation dataset of a subset of classes used in model training (still in process), demonstrating the accuracy of the models. The majority of models are showing very high accuracy in class prediction. Diagonal values are the recall values for each class. Recall is the fraction of images identified correctly for each class. The final model will have 13 animal classes (Mouse, Rat, Lizard, Snake, Roadrunner, Squirrel, Rabbit, Skunk, Raccoon, Fox, Bobcat, Coyote, Deer

Confusion matrix (Recall values on diagonal))
x-axis= predicted class, y-axis= actual class



Performance Metrics

label	recall	precision	accuracy	F1score
COYOTE	0.98	0.93	0.99	0.96
HUMAN	0.98	0.99	0.99	0.98
MOUSE	1.00	0.97	1.00	0.99
NONE	0.99	0.98	0.99	0.98
ROADRUNNER	0.99	0.99	1.00	0.99
SQUIRREL	0.96	0.99	0.99	0.98

We have developed a plan to address these challenges and meet revised project timelines with a 1-month extension of the contract. Draft report goal on May 15.

Note that total percentages of time and budget completed does not directly compare to project expenses due to use of matching funds for a significant portion of this project.

Matching Funds:

- 500 hours USGS matched this Quarter from USGS Advanced Research Computing for deep learning algorithm programming and running of machine learning algorithms. (Jeff Tracey, USGS Advanced Research Computing)

Potential Implementation:

TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada DOT

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Transportation Pooled Fund Program Project # <i>(i.e., SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))</i> P342-20-803	Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) <div style="text-align: right;">2022</div> <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: Research to inform passage spacing for migratory amphibians and to evaluate the effectiveness of an elevated road segment to reduce road mortality and maintain connectivity between wetlands and uplands: Case study with the Yosemite toad.		
Name of Project Manager(s): Cheryl Brehme, Robert Fisher Budget: Curtis Hettich	Phone Number: 619-225-6427 619-225-6422 916-278-9479	E-Mail (preferred contact method) cbrehme@usgs.gov , rfisher@usgs.gov chettich@usgs.gov
Lead Agency Project ID: Not yet assigned	Other Project ID (i.e., contract #):	Project Start Date: 10 Sept 2020
Original Project End Date: 30 June 2022	Current Project End Date: 30 June 2022	Number of Extensions:

Project schedule status: (but see request for 1 week extension to submit draft report)

☒ On schedule
 ☐ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$120,630.42	\$111,073.60	Approximately 92%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$44,845.70 – Approximately 37%	\$44,845.70	Approximately 90%

Project Description:

Many small animals, especially amphibian populations that must migrate between aquatic and terrestrial habitats, are susceptible to negative impacts from roads within their habitat. Narrow tunnels (<1m) under roads connected with barrier fencing are a standard mitigation solution. However, there is recent evidence that tunnel mitigation systems can act to filter migratory movements of species that disperse over large areas and unintentionally cause population decline. This project supports continued field study to determine; 1) the distances that Yosemite toads will move along barrier fencing before they “give up” and move back into the habitat and 2) the efficacy of a novel road crossing prototype for toads and other small wildlife species. The prototype is an 8” high elevated road segment on a US Forest Service road that provides a safe crossing nearly 100’ wide while allowing both light and rain to pass through. Although the prototype is 100’, it can be made to any length. The project includes an assessment by transportation engineers in collaboration with Caltrans to provide insight, guidance, and concept designs for similar crossing solutions that could be implemented on improved roads and highways. The results of this study will inform the minimum distances required between passages to provide permeability for migratory toads to make population level movements across roads. It will also provide a permeability analysis and concept plans for a new passage design that may provide greater connectivity and offer an alternative to below grade tunnels for sensitive amphibians, reptiles, and small mammals.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Transportation engineering evaluation (Dokken Engineering).

- Met with Dokken Engineering on several occasions regarding progress and design criteria for elevated road concept designs.
- Reviewed rough draft of transportation engineering evaluation and concept designs for ERS on primary roadways.
- Added scope to include renderings of different design options. (USGS funded match)
- Just Received updated draft on the date of this quarterly report.

Sierra NF ERS Field Study/ Data Analyses

- Reviewed all photos from HALT cameras and identified to species. Added to database.
- We developed code (in JAGS) and ran species community occupancy and N-mixture models to assess the different amphibian, reptile, and small mammal species activity under the ERS in comparison to nearby habitat.
- Prepared code for analysis of updated Yosemite toad movement data.

Anticipated work next quarter:

- Meeting with Caltrans and Dokken for final design review/comments.
- Finalize report ERS concept designs (Dokken Engineering)
- Analyze Yosemite toad movement data
- Complete and deliver report to NDOT

Significant Results: (3 levels compared: under ERS, immediately adjacent to ERS, forest habitat)

Occurrence Probability

- All species documented in forest habitat and habitat adjacent to ERS were also detected under the ERS.
- No species differed in probability of occurrence between under the ERS and habitat directly adjacent to ERS.
- Squirrels, woodrats and chipmunks had higher occurrence probability under the ERS than in forest habitat.

Relative Activity

Comparison: Under ERS vs. immediately adjacent to ERS

- No difference in relative activity of Yosemite toad, ensatina, moles, weasels gopher, squirrel, garter snake
- Higher activity under ERS than adjacent habitats: marten, woodrats, Douglas squirrel, alligator lizard
- Higher activity in adjacent habitat vs under ERS: Pacific tree frog, rubber boa

Comparison: Habitat immediately adjacent to ERS/Road vs Forest habitat

- Higher activity in forest: ensatina (salamander), flying squirrel
- Higher activity in habitat adjacent to ERS/Road vs. Forest habitat: woodrat, chipmunk

<p>Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).</p>

Draft report currently due on April 15.

We request a 1-week extension to April 22 to provide comprehensive draft report on all 3 components of this project.

<p>Potential Implementation: NA</p>
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Lead Agency (FHWA or State DOT): Nevada Department of Transportation _____

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Transportation Pooled Fund Program Project # <i>Wildlife Vehicle Collision (WVC) Reduction and Habitat Connectivity</i> Task 1 – Cost Effective Solutions Transportation Pooled-Fund Project TPF-5(358)		Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) 2022 <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: WVC Reduction & Habitat Connectivity NVDOT			
Name of Project Manager(s): Dr. Marcel Huijser	Phone Number: 406-543-2377	E-Mail mhuijser@montana.edu	
Lead Agency Project ID: 4W7576	Other Project ID (i.e., contract #): 4W7576	Project Start Date: 18 Dec 2018	
Original Project End Date: 30 Sep 2022	Current Project End Date: 30 Sep 2022	Number of Extensions: 0	

Project schedule status:

☒ On schedule
 ☐ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$354,001.00	\$197,668.24 (thru 28 Mar)	56%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$32,020.59 (% thru 28 Mar)	\$32,020.59 (% thru 28 Mar)	53%

Project Description:

All research modules have been submitted, have been processed, and are active.

Topic	Title	Proposed Budget	PI	Submitted?	Approved by NV?	Active account?
C	Design of Fiber-Reinforced Polymer (FRP) Wildlife Overpass Structures	\$70,000	Rob Ament and Matt Bell	yes	yes	yes
F	Identification of the patterns and processes that result in highway accidents involving elk: Informing the design of effective mitigation strategies in areas where elk is a dominant species	\$20,000	Tony Clevenger	yes	yes	yes
G	Wildlife community and species factors affecting crossing structure use: A continental meta-analysis and a 16-year perspective	\$65,000	Tony Clevenger, Marcel Huijser	yes	yes	yes
H	Jump-out design and measures at fence ends and at access roads	\$115,000	Marcel Huijser	yes	yes	yes
I	Efficacy and cost-savings of fencing and wildlife crossings to reduce wildlife-vehicle collisions in the Bow River Valley, Alberta	\$30,000	Tony Clevenger	yes	yes	yes
X	Economic value select species based on biological conservation	\$90,181.20	Chris Neher and John Duffield (as subcontractors from Bioeconomics)	yes	yes	Yes Subcontract (WTI-Bioeconomics) is also active

Literature review

The literature review was finalized and published on 15 Dec 2021.

Anticipated work next quarter:

General:

1. Finish the update for the costs and benefits of mitigation measures

Significant Results:

None

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Positive:

MDT funded a project for 2 electrified barriers along Hwy 93N, contract is signed.
Contracted Services Agreement with the 2 installers are active.
1 barrier was installed in the fall 2021.

Negative:

Covid-19 increased expenses related to transportation.

Potential Implementation:

None

C TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

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Transportation Pooled Fund Program Project # <i>(i.e., SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))</i> TPF-5(358) Transportation Pooled Fund Study	Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) 2022 <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: Innovative Fiber-Reinforced Polymer Structures for Wildlife Crossings (Adaptable for Bicyclists/Pedestrians)		
Name of Project Manager(s): Damon Fick Rob Ament	Phone Number: 406-994-6123 406-600-6348	E-Mail damon.fick@montana.edu rament@montana.edu
Lead Agency Project ID:	Other Project ID (i.e., contract #): 4W8317	Project Start Date: April 27, 2020
Original Project End Date: October 31, 2021	Current Project End Date: May 31, 2022	Number of Extensions: N/A

Project schedule status:

☒ On schedule
 ☐ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$70,001	\$69,535	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
19%	\$13,625	99 %

NOTE: This project has matching funds available from the Small Urban, Rural & Tribal Center on Mobility (SURTCOM) which will be sufficient to complete the project. The two sources of funding, Pooled Fund and SURTCOM require separate financial reports.

Project Description

There are no known FRP wildlife overpasses in North America at this time. The overall objectives of this research project are to identify cost sensitive and environmentally friendly FRP materials and use them in the design of the continent's first FRP wildlife crossing. This structure can then be adapted for use in other locations across North America and will lead to innovation for bicycle and pedestrian crossings over roads. The development and deployment of a structural prototype by this project will help provide technical information that is sorely lacking for such a promising technology.

The project is organized into four tasks: 1) identify and select FRP manufacturers and materials that will contribute to efficient and cost-effective bridge structures; 2) investigate and perform a preliminary design of up to three different wildlife overpass structures using different FRP applications and assure they can meet Caltrans' structural specifications and address wildlife's needs; 3) evaluate the implementation of the selected FRP wildlife overpass structure via cost-benefit, construction and life-cycle metrics; and, 4) disseminate the results, recommendations and conclusions of the investigation.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

Task 9. The results from Tasks 6-8 have been compiled together for the Task Report and it has been approved by the TAC.

Task 11. Finished the cost benefit analysis via a Life-cycle Cost (LCC) analysis for three different types of girder bridges: FRP, pre-cast concrete and steel reinforced concrete. Results indicate that FRP may cost more initially; but, can save money over time due to the low costs of maintenance and its long service-life. A memo regarding the analysis was prepared and sent to Caltrans to support their efforts to have the FRP overpass built.

Anticipated work next quarter:

Task 10. Start accumulating different applications of FRP bridges to bike/ped structures.

Task 12. Begin drafting final report.

Significant Results:

- Life cycle cost analysis can demonstrate the long-term cost efficiency of using FRP materials in wildlife infrastructure, fencing and other design elements.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

No conflicts.

Potential Implementation:

Yes! Caltrans is seeking to build an FRP girder wildlife overpass at the US97 site. Although the agency has much to work out regarding specifications, cost and other typical project details. Using a novel bridge material such as FRP makes the project development process more complicated.

I TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada DOT

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Transportation Pooled Fund Program Project # TPF-5(538)	Transportation Pooled Fund Program - Report Period: Quarter 1 (Jan-Mar 2022)	
Project Title: Efficacy and cost-savings of fencing and wildlife crossings to reduce wildlife-vehicle collisions in the Bow River Valley, Alberta		
Name of Project Manager(s): AP Clevenger	Phone Number: 4036881138	E-Mail apclevenger@gmail.com
Lead Agency Project ID:	Other Project ID (i.e., contract #):	Project Start Date: Jan 2020
Original Project End Date: Mar 2021	Current Project End Date: 30 June 2022	Number of Extensions: 1

Project schedule status:

Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$30,000	\$27,423.73	90%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$27,423.73 (91%)	\$27,423.73	90%

Project Description:

Currently there is an array of mitigation measures to meet reduce impacts of roads on wildlife. Of paramount importance is that measures need to be effective at meeting their intended objective or management role in the project. While there is general agreement that wildlife fencing in combination with wildlife crossing structures benefits human safety as well as nature conservation goals, there is the opinion that these mitigation measures may be too costly or have little cost-benefits. To obtain a better understanding of the actual costs and benefits of road mitigation measures cost-benefit analyses recently identified threshold dollar values above which individual mitigation measures start generating benefits in excess of costs. The Bow River Valley is one of the most critical habitats for wildlife in the Canadian Rockies. Wildlife research in the area highlights the complexity and limitations of wildlife movement through the Bow Valley due to human activity and natural barriers. We use WVC data previously collected on two mitigated sections of the Trans-Canada Highway (TCH) in the province of Alberta: 1) a 5-km section in Dead Man's Flats, Alberta and 2) an 18-km section in Banff National Park. This work will determine whether highway mitigation effectively reduced the occurrence of WVC and quantify the cost-benefits of the measures in place. Our objective is to evaluate changes in the number of WVCs after each mitigation phase was completed. We will assess cost-effectiveness of the mitigation measures by using the Huijser economic model, comparing the annual cost of the mitigation infrastructure against the cost of WVCs occurring prior to and after mitigation treatment. We believe the results from our mitigation evaluation and cost-benefit model can be a valuable decision support tool for determining mitigation measures to reduce WVCs and demonstrate the utility and cost-effectiveness of highway mitigation in protected and non-protected landscapes.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

- Final report draft has been completed and has been reviewed

Anticipated work next quarter:

- Address comments and finalize report

Significant Results:

None to report to date.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

No issues affecting his project at the moment.

Potential Implementation:

None to date

F TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada DOT

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # TPF-5(538)	Transportation Pooled Fund Program - Report Period: Quarter 1 (Jan - Mar) 2022	
Project Title: Identification of the Patterns and Processes that Result in Highway Accidents Involving Elk: Informing the Design of Effective Mitigation Strategies in Areas Where Elk is a Dominant Species		
Name of Project Manager(s): AP Clevenger	Phone Number: 4036881138	E-Mail apclevenger@gmail.com
Lead Agency Project ID:	Other Project ID (i.e., contract #):	Project Start Date: Jan 2020
Original Project End Date: Dec 2020	Current Project End Date: 30 June 2021	Number of Extensions: 1

Project schedule status:

Project completed 4th quarter 2021

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$20,000	\$20,000	100%

X TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada Department of Transportation

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # <i>(i.e., SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))</i>		Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) 2022 <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: Pilot Study: Incorporating Large Ungulate and Small Reptile Total Value in Collision Mitigation Benefit-Cost Calculations			
Name of Project Manager(s): John Duffield	Phone Number: 406-721-2265	E-Mail bioecon@montana.com	
Lead Agency Project ID: P701-18-803 TASK 05	Other Project ID (i.e., contract #): G105-21-W8409	Project Start Date: 06/01/2020	
Original Project End Date: 12/31/2020	Current Project End Date: 12/31/2021	Number of Extensions: 1	

Project schedule status:

☐ On schedule
 ☒ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$69,974.00	\$69,974.00 invoiced through 12/31/21	100%

Project was finalized in 4th quarter 2021

H TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada Department of Transportation_____

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # <i>Wildlife Vehicle Collision (WVC) Reduction and Habitat Connectivity</i> Task 1 – Cost Effective Solutions Transportation Pooled-Fund Project TPF-5(358)	Transportation Pooled Fund Program - Report Period: <input checked="" type="checkbox"/> Quarter 1 (January 1 – March 31) 2022 <input type="checkbox"/> Quarter 2 (April 1 – June 30) <input type="checkbox"/> Quarter 3 (July 1 – September 30) <input type="checkbox"/> Quarter 4 (October 1 – December 31)	
Project Title: Jump-out design and measures at fence ends and at access roads		
Name of Project Manager(s): Dr. Marcel Huijser	Phone Number: 406-543-2377	E-Mail mhuijser@montana.edu
Lead Agency Project ID:	Other Project ID (i.e., contract #):	Project Start Date:
Original Project End Date: 30 Nov 2022	Current Project End Date: 30 Nov 2022	Number of Extensions: 0

Project schedule status:

☒ On schedule
 ☐ On revised schedule
 ☐ Ahead of schedule
 ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$115,000	\$14,183.74 (thru 28 Mar	96%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$6,197.67 (thru Dec) 5.4%	\$6,197.67	95%

Project Description:

- A. Investigate measures aimed at reducing intrusions of large wild mammals, especially carnivores, at gaps in wildlife fences through a literature review and field experiments.
- B. Investigate measures aimed at increasing the use of wildlife jump-outs by deer species (white-tailed deer and mule deer) through a literature review and field experiments.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

A1 Literature review
Draft completed

B1 Literature review
Started

Field experiments

A2a. Electrified cattle guards at access roads, Parks Canada.

Sunshine and Compound road:

1. The WTI cameras have been installed at Sunshine and Compound road (12 Aug 2020).
2. The cameras were not installed in front of guards, but behind, looking to the area in front.
3. Animals entering the zone 2 m before the electrified area will trigger the cameras.
4. From 2 Sep onwards the cameras have restricted hours because traffic volume was too high to allow 24/7 operation, so now it is 17:00-8:00 (daylight saving time) for both locations.
5. Camera settings 5 images per trigger, no quiet time (rapidfire), high sensitivity
6. 8 Oct 2020: steel plates were installed in front of electrified barriers (completes installation).
7. The 2 ft grounding plate for Compound Road was damaged and was removed on or before 20 Oct. Re-installation will likely be in spring. The Sunshine grounding plate will also be deferred. They both need metal strips installed to protect them from snow plows. These strips have not yet arrived, and so the grounding plates were unprotected when there was the 1st major snow fall (October 14) when it got damaged. So, even though, the wildlife guards are turned on they will not work as well without the grounding plate, nor were they intended to be nearly as effective during the winter (i.e. snow covered). Ground plates and strips will be installed in the spring.
8. Guards filled up with snow in February, not functional, as expected. From Dan Rafla: the accumulation of snow, salt, gravel, etc. between the negative and positive charge cause it to short, or the guard can be completely covered. There has also been connection break, but it has since been repaired.
9. 14 Jul 21: Grounding plates have still not been installed because of lack of funding (Pers. com. Dan Rafla).
10. 14 Jul 21: During the winter, the wiring was not able to withstand the vibrations from vehicles and gravel/salt that fell between the pipes. Wires have since been repaired with the wiring redone to more robust standard (Pers. com. Dan Rafla).
11. 14 Jul 21: Hours of operation for cameras, which were from 5pm to 8am, have been extended from 4pm to 10am. In addition, a 2nd camera was added at Sunshine, facing 90 degrees to the road, and two meters away from the wildlife guard (Pers. com. Dan Rafla).
12. 14 Jul 21: No known intrusions except for a black bear from last fall (Pers. com. Dan Rafla).
13. End Sep 2021: Grounding plates were installed on both locations (Pers. com. Dan Rafla). This completes the



Lake O'Hara

Images reviewed 1-6 Oct : No animals

Guard turned on again on April 17, 2021

15 July 21: guard is operational.

Lake Louise

Camera post not installed yet, will be spring 2021

15 July 21: Parks Canada is still working on getting the Lake Louise camera installed, hopefully soon (Pers. com. Jón Stuart-Smith).

15 July 21: guard is operational.

20 Oct 2021: Camera installed ((Pers. com. Terry Larsen, Parks Canada)

A2b. Electrified mats at fence ends, Thompson Falls.

Camera at west fence end was installed 30 Sep 2020

Coyote approached, did not cross



Camera at east fence end required a new post in the clear zone.

Camera at east fence end required a new post in the clear zone.

A right-of-way encroachment permit was obtained from MDT on 8 Oct 2020.

Post and camera were installed on 27 Oct 2020.

2 wt-deer left the fenced road section, walking/running over guard.

1 of them appeared to have been shocked, the other not.

Multiple elk and w-t deer walked in and out of the fenced road corridor early February, apparently without being shocked. MDT and the manufacturer were alerted again.

The manufacturer is now sending Marcel a voltage meter to check voltage (should arrive mid-April).

However, it seems that MDT may have put the guards at 50% power since installation, against the recommendation of the manufacturer (recommendation is 100%).

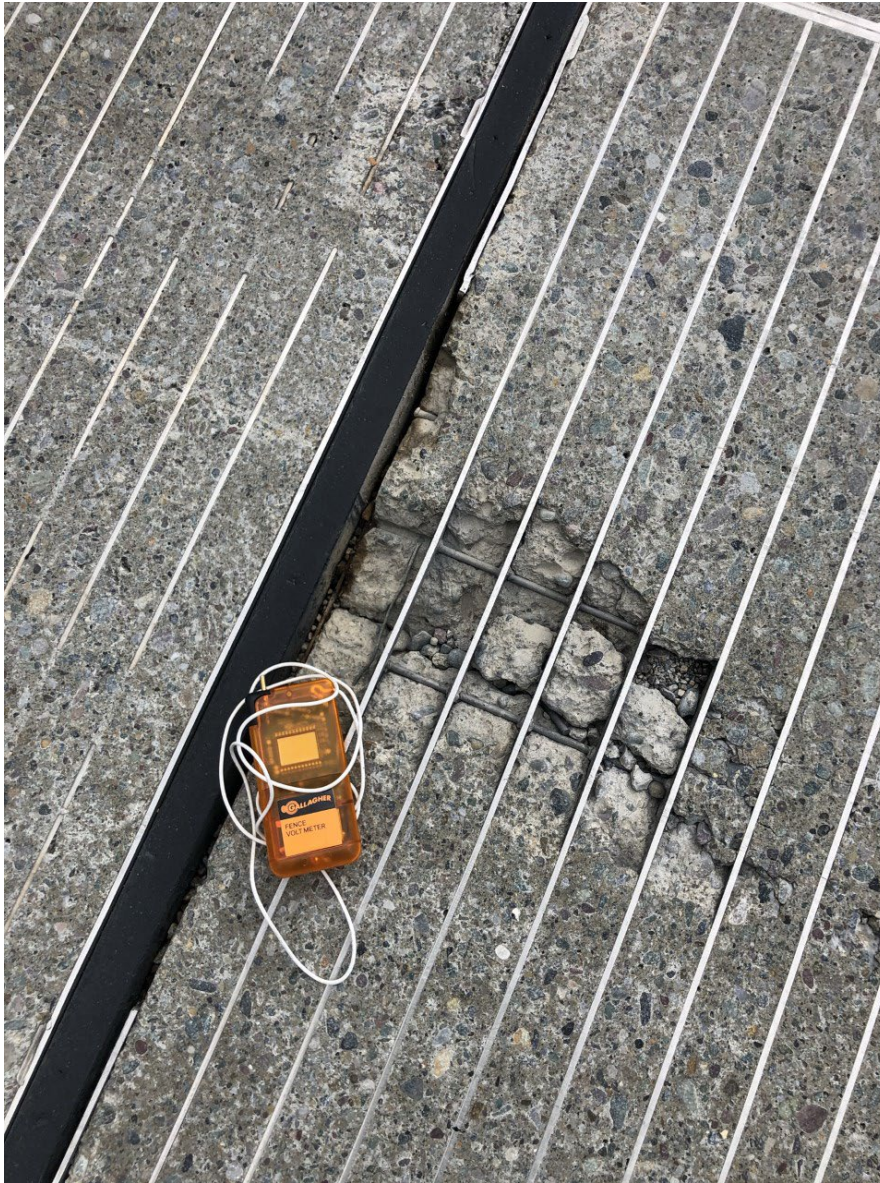
In June 2021 it was confirmed that the voltage is set too low on the electric mats (between 4.2-4.8kV). This was reported to MDT, and MDT has stated that they intend to increase the power to the settings recommended by the manufacturer.

WTI observed on 28 Aug 2021 that the voltage was increased to 9.6-10kV (this is what it should have been all along). So far, MDT has not been able to report what date the voltage was increased.

The mats were disabled by MDT in Nov 2021. The eastern mat was switched on again a few months later. The western mat remains turned off because of crumbling concrete between the metal strips, presumably because the bridge abutment has settled, and there is now a change in slope where the bridge connects to the electrified mat, causing vehicles to exercise excessive stress on the pavement.



27 Oct 2021: Observed damaged concrete in the electrified barrier. MDT and Crosstek are assessing this.



End Nov and end Dec 2021: no voltage at the 2 guards for unknown reason.

A2d. Different types of gates at gaps in electric wildlife fence, Dixon Melon Farm.

- The images have been interpreted and the data have been entered in a database (through Nov 2021).
- Summary statistics and graphs have been made.
- An abstract was submitted to the 2021 ICOET conference, and it was accepted for a podium presentation (virtual conference).
- Crosstek installed a drive-over electrified barrier 4-6 Aug 2021. This replaced the “drive-over wires” barrier. So far 3 bears approached, none crossed.



- So far, far fewer bears have been observed at the gates and at the fence in 2021 than in 2020 (about 95% reduction). It seems that the barriers have been so effective (since end season 2020) that the bears no longer show up... I think the bears think it is a waste of time.
- Farmer reports no or negligible melon loss due to bears in 2021.
- The project was presented at ICOET 2021 on 28 Sep.
- Data have been analyzed, report 80% written up.

B2. Modifications to 10 Jump-outs, US93N Montana.

- Candidate jump-outs have been identified along US93N. 4 are known to receive relatively high use by mule deer, 6 are known to receive relatively high use by white-tailed deer.

The current height of the ten jump-outs selected for this project. EV=Evaro, HH= Ravalli Hill.

Area	#	Height	
		ft	cm
EV	14	6' 8.5"	204
EV	17	6' 0"	183
EV	19	6' 8"	203
EV	20	6' 0"	183
EV	21	6' 1.5"	187
EV	23	5' 6"	168
RH	26	5' 11"	180
RH	27	6' 0"	183
RH	28	5' 9"	175
RH	29	5' 11"	180

- Permission has been obtained for the modifications (from MDT) and for the research (from CSKT).
- MDT will assist with equipment in lowering (after agreement between MDT and WTI-MSU) is signed.
- MDT – WTI agreement was signed in Dec 2020.
- MDT – CSKT agreement was signed early January 2021.
- Permission was obtained from MDT to lower the jump-outs to 5 ft with 18 inch bar on

31 Mar 2021.

- Locate for buried lines was completed on Sat 10 Apr.
- All 10 jump-outs have been lowered to exactly 5 ft (4 in Ravalli on 21 Apr 2021; 6 in Evaro on 4 May 2021). Soil was scraped from the top and deposited at the bottom to achieve a height of 5 ft. The landing area was made level, about 6 ft from the face of the jump-outs. MDT assisted with personnel, a bobcat and a backhoe.



- All 10 jump-outs were equipped with an 18-inch barrier above the ground (rebar) on 18 May 2021.



- All 10 jump-outs had cameras installed on 28 May 2021.



Preliminary data (through 8 June) showed that

- a. No deer jumped down (about n=3 groups), This is not good.
- b. No deer jumped up (about n=10 groups). This is good.
- c. 1 black bear climbed down
- d. 1 coyote jumped down

While since June 8 some mule deer and a white-tailed deer did jump down, the results were disappointing. The majority of the animals that jumped down first stepped over the bar with their front feet. Therefore, at half the jump-outs, the rebar was lowered 3 inches. At the other half, the rebar was set back from 12 to 15 inches and with the original height of 18 inches. Evaluation is ongoing.



Anticipated work next quarter:

General:

2. Collect data from Canadian locations
3. Enter and analyze data from barriers at Thompson Falls, Melon farm
4. Data entry jump-outs and data analyses.

Significant Results:

The low-cost electrified barriers at the Dixon melon farm seem promising as (after modifications) they seem to be a very substantial barrier to black bears.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Positive:

Funding from MDT for 2 electrified barriers and permission to lower selected jump-outs along Hwy 93N has been obtained. This will supplement the effort of the pooled fund study related to electrified barriers and jump-outs. One of the barriers was installed in Nov 2021.

Negative:

- Covid-19 increased expenses related to transportation.
- The electrified guards in Canada need protection from snow plows. The protective equipment was not available early enough before winter started. Equipment was only installed end Sep 2021.
- The passage of deer and elk at east side of Thompson Falls is very concerning. I am hoping that it is because the voltage was set too low (lower than manufacturer recommended). Evaluation is ongoing.

Potential Implementation:

The low-cost electrified barriers at the Dixon melon farm seem promising as (after modifications) they seem to be a very substantial barrier to black bears. Two sites along a real highway are now considered for implementation of these types of barriers (see above).

It is important to follow the recommendations of the manufacturer (and not deviate by setting lower voltage, as seems to be case at Thompson Falls).

G TRANSPORTATION POOLED FUND PROGRAM QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nevada DOT

INSTRUCTIONS:

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Transportation Pooled Fund Program Project # TPF-5(538)	Transportation Pooled Fund Program - Report Period: Quarter 1 (Jan-Mar) 2022	
Project Title: Long-term Responses of an Ecological Community to Highway Mitigation Measures		
Name of Project Manager(s): AP Clevenger	Phone Number: 4036881138	E-Mail apclevenger@gmail.com
Lead Agency Project ID:	Other Project ID (i.e., contract #):	Project Start Date: July 2020
Original Project End Date: Mar 2021	Current Project End Date: 30 June 2022	Number of Extensions: 1

Project schedule status:

Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
\$64,941.84	\$5,985.07	45%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
\$5,781.32 (8.9%)	\$5,781.32	20%

Project Description:

Crossing structures (CS) in Banff National Park and along US Hwy 93 North in Montana, have been monitored for many years, starting as early as 1996, forming the richest database on CS monitoring in the world. These data provide a unique opportunity to assess long-term changes in CS use by a large mammal community. Such a long-term and data-rich perspective is important to understand how slow-reproducing species interact with CS over time. These datasets come from areas with an intact community of large mammals ranging from rare carnivores like wolverine to more common ungulates like white-tailed deer. It is also characterized by mixed landscapes with agriculture and dispersed houses and roads with high traffic volumes. This combination of a relatively intact wildlife community in an area with substantive variation in human disturbance (Banff relatively low human presence and disturbance; Montana relatively high human presence and disturbance) creates a unique 'reference' condition to understand how highways and large mammals interact. Developing a statistical model to describe the relationship between population size and passage rates at CS has a number of important benefits to management. First, structural attributes of CS that contribute to a greater-than-expected passage rate by wildlife enable planners to more rigorously design species-specific mitigation measures. Second, if a strong association between population size and passage rate at particular sites can be found, then management can use monitoring of these limited areas to infer population trends in the broader study area. Third, detection rates of animals using CS are relatively high given the constricted nature of the passage, so monitoring CS use may be a more economical means of population monitoring than other index-type measures. Thus, the various crossing structures along the TCH can serve as a multi-species "super-transect" if appropriate population size and passage rate associations can be demonstrated. Specifically we are interested in understanding the following questions and will use data sets shown in bold to address each one: 1) What is the effect of different covariates on species use over time? Banff & Montana; 2) What are the effects of design and function of CS on community level metrics? Banff & Montana; 3) Can CS monitoring (counts) be used as an indicator of population abundance? Banff.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

- Data were extracted and compiled for Banff crossing structures
- Data were extracted and compiled for US93 crossing structures

Anticipated work next quarter:

- Continue with data analysis and report writing.

Significant Results:

None to date.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None.

Potential Implementation:

None to date