RESEARCH

UDOT Keeping Utah Moving
Utah Department of Transportation - Research Division
4501 South 2700 West - P.O. Box 148410 - SLC,UT 84114-8410

Report No. UT-17.16

TESTING NEW TECHNOLOGY TO RESTRICT WILDLIFE ACCESS TO HIGHWAYS: PHASE 2

Prepared For:

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Final Report
August 2017

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TECHNICAL REPORT ABSTRACT

1. Report No. UT- 17.16	2. Government Accession No. N/A	3. Recipient's Catalog No. N/A
4. Title and Subtitle TESTING NEW TECHNOLOGY TO RESTRICT WILDLIFE ACCESS TO HIGHWAYS: PHASE 2		5. Report Date August 2017 6. Performing Organization Code
7. Author(s) Patricia Cramer, Robert Hamlin		8. Performing Organization Report No.
9. Performing Organization Name and Address Patricia Cramer 264 E 100 North Logan, Utah 84321		10. Work Unit No. 5H07833H 11. Contract or Grant No. 16-8763
12. Sponsoring Agency Name and Address Utah Department of Transportation 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410		13. Type of Report & Period Covered Final March 2015- June 2016 14. Sponsoring Agency Code PIC No. UT15.503

15. Supplementary Notes

Prepared in cooperation with the Utah Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

In wildlife mitigation systems, the weakest link is often the wildlife exclusion barriers at vehicle access points in wildlife exclusion fence (8 feet, 2.4 m high). The objective of this research was to evaluate the ability of electric pavement installations to reduce mule deer breaches into wildlife exclusion fenced areas of highways. Along Interstate 15 (I-15) a three-foot (0.9 m) wide strip of electric pavement was placed in front of an existing single cattle guard at an access road at an interchange to improve its effectiveness in deterring mule deer from entering the I-15 corridor. Installations of six-foot wide (1.8 m) electric pavement were placed across two road locations at wildlife fencing ends; one on US Highway 89 (US 89) East of Kanab, and one on US Highway 191 (US 191) south of Monticello. Camera traps were placed at the edges of all three installations to evaluate mule deer interactions with the pavement installations and evaluate pavement effectiveness. Overall, electric pavement treatments were 46 to 50 percent effective in deterring mule deer from entering fenced areas of highway, similar to single cattle guards in their effectiveness in deterring mule deer from entering fenced road areas (53 percent). The cameras at the fence ends at US 191 and 89 documented ten times more mule deer in the right-of-way than were documented moving near the electric pavement. Recommendations include exploring wider widths of electric pavement, delivering electric shock at the edge of the pavement and asphalt, and evaluating if such barriers are needed. UDOT should continue to use double cattle guards and wildlife guards as the preferred wildlife barriers at fence ends and access roads along wildlife fence.

17. Key Words wildlife, mule deer, elk, ungulates, wildlife-vehicle collisions, animal-vehicle collisions, AVC, WVC, A-V-C, cattle guards, wildlife guards, double cattle guards, electric pavement, access, wildlife crossings, Utah, wildlife fencing, electric mats		18. Distribution Statement Not restricted. Available through: UDOT Research Division 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410 www.udot.utah.gov/go/research		23. Registrant's Seal N/A
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	34	22. Price N/A	

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UNIT CONVERSION FACTORS

Units used in this report and not conforming to the UDOT standard unit of measurement (U.S. Customary system) are given below with their U.S. Customary equivalents:

- 1 centimeter (cm) = 0.393 inches (in)
- 1 meter (m) = 3.28 feet (ft.)
- 1 kilometer (km) = 0.62 mile (mi)
- 1 degree Celsius (C) = 33.8 Fahrenheit (F)

LIST OF ACRONYMS

UDOT	Utah Department of Transportation
UDWR	Utah Division of Wildlife
WVC	Wildlife Vehicle Collisions

EXECUTIVE SUMMARY

Departments of transportation need to determine the most effective barrier designs for restricting mule deer (*Odocoileus virginianus*) and other wildlife at vehicle access points in wildlife exclusion fence (8 feet, 2.4 m). New wildlife barrier designs should be as effective in keeping mule deer from moving into the road right-of-way as double cattle guards and wildlife guards (steel grates the width and length of double cattle guards) which were found to be 87 to 94 percent effective in Phase 1 of this research. In this study, Phase 2, camera traps were used to evaluate the ability of electric pavement barriers placed in the road bed to deter mule deer from entering fenced highways. Three locations in Utah were studied: Interstate 15 (I-15) Exit 31 where a three-foot (0.9 m) wide strip of electric pavement was placed in front of an existing single cattle guard at an access road; and two installations of a six-foot wide (1.8 m) electric pavement at wildlife fence ends, one on US Highway 89 (US 89) East of Kanab, and one on US Highway 191 (US 191) south of Monticello.

In Phase 1, Cramer and Flower (2017) determined wildlife guards and double cattle guards were the best barrier designs to deter mule deer from entering roads, and their effectiveness rates became the standard performance measure to evaluate the electric pavement installations. Standard single cattle guards with excavated pits averaged 53 percent effective in deterring mule deer. In Phase 1, the I-15 single cattle guard with a three-foot (0.9 m) wide electric pavement was 64 percent effective in deterring the 36 individual mule deer movements where animals interacted with the pavement. In this study, Phase 2, the electric pavement was 46 to 50 percent effective in deterring the 47 mule deer movements where animals were attempting to enter the fenced road, less than the established performance measure, and similar to single cattle guards. The cameras at the fence end right-of-way areas near the electric pavement on US highways 191 and 89 documented approximately ten times more mule deer in the right-of-way than were documented moving near the electric pavement.

During breach events mule deer either completely jumped the electric pavement, walked across, or walked then jumped over the second half of the electric pavement. Although the electric pavement installations studied did not meet the performance measure, numbers of mule

deer movements captured by the cameras at US 191 and US 89 were too low to make a definitive conclusion about overall effectiveness. Recommendations include:

1. Expanding the widths of electric pavement to help deter animals from breaching;

2. If a wider (for example, 10 feet, 3 m) electric pavement installation is still a cost-effective option for placement in roads, additional monitoring will be needed to evaluate its effectiveness at deterring future mule deer attempts at breaching the pavement;

3. Ensure that future electric pavement installations have an electric potential at the leading outside edge of the pavement in the asphalt so mule deer detect or experience the electric shock of the pavement prior to initiating a breach movement;

4. The numbers of mule deer detected by cameras at the electric pavement as a proportion of mule deer detected at the right-of-way on US highways 191 and 89 were so low that there may not have been as great a need for electric pavement installations as originally assumed; and

5. UDOT should continue to use double cattle guards and wildlife guards as wildlife barriers.

1.0 INTRODUCTION

1.1 Problem Statement

There is a need for departments of transportation to determine the most effective barrier designs for restricting mule deer (*Odocoileus virginianus*) and other wildlife at vehicle access points in wildlife exclusion fence (8 feet, 2.4 m). Wildlife exclusion fence that restricts wildlife from entering roads and guides them to existing or wildlife-specific culverts and bridges works only as well as its weakest link; the vehicle access points where wildlife can breach the system and enter the road. Typically, wildlife exclusion fence is accompanied by double cattle guards at vehicle access points. This can be costly when an interstate interchange requires four double cattle guards at the entrance and exit ramps. Single cattle guards do not adequately restrict mule deer and other wildlife movements into the road. Utah Department of Transportation (UDOT) sponsored this study to learn if electric pavement was a viable alternative to double cattle guard placement across highways at wildlife exclusion fence ends and as an augmentation to single cattle guards to prevent mule deer and other wildlife from breaching the cattle guard into fenced sections of road.

In Phase 1 of this research, camera traps were used to monitor mule deer movements at existing wildlife barriers at vehicle access points along wildlife exclusion fencing. The effectiveness rates of five different barrier designs were determined. The rates of effectiveness of the best performing barriers were used as a performance measure to evaluate electric pavement. Fourteen wildlife barriers were monitored, and 1,946 individual mule deer movements where mule deer displayed behaviors to cross the barriers were recorded. Double cattle guards had the highest effectiveness rate, on average 94 percent (783 mule deer movements). Wildlife guards had an effectiveness rate of 87 percent (339 mule deer movements). There was no statistical difference in the double cattle guard and wildlife guard rates (Flower 2016). Single cattle guards over excavated pits were on average 53 percent effective (122 mule deer movements). Single cattle guards without excavation pits and electrified mats were least effective (on average 29 percent and 12 percent, respectively). Statistical model results confirmed the design of the barrier was the most important predictor of effectiveness (Cramer and Flower 2017).

In Phase 1, Cramer and Flower (2017) documented single cattle guards augmented with electric pavement three and four-foot (0.9 and 1.2 m) wide were 91 percent effective in excluding individual mule deer (166 individual mule deer movements), and greater than 99 percent effective in excluding individual elk (605 individual elk movements) from baited wildlife exclosures. The exclosures were constructed at Utah Division of Wildlife Resources' (UDWR) Hardware Ranch in northern Utah, in a natural area away from roads. These installations met and exceeded the performance measure.

In Phase 1, when a three-foot (0.9 m) segment of electric pavement was installed and electrified in the road surface in front of an existing single cattle guard at Interstate 15 (I-15) Exit 31 interchange, camera trap results determined it to be 64 percent effective in deterring 36 individual mule deer interactive movements. During that period, a single cattle guard on the east side of I-15 at the same interchange was effective in deterring 49 percent of 61 individual mule deer movements. The in-road installation of electric pavement deterred deer at rates much lower than double cattle guards and wildlife guards; its rate of effectiveness was similar to single cattle guards. The installation did not meet the performance measure, however, there were too few mule deer movements for a robust analysis.

Phase 1 recommendations included continued monitoring of the I-15 single cattle guard augmented with electric pavement, and additional installations of wider electric pavement in standalone placements. In 2014 and 2015 UDOT and the manufacturer of the electric pavement, Lampman Wildlife Services, installed six-foot-wide (1.8 m) electric pavement segments across US Highway 89 (US 89) and US Highway 191 (US 191) at the ends of wildlife exclusion fence. Phase 2 of this research began in 2015. The electric pavement segments across US 89 and US 191 were monitored, and the I-15 single cattle guard with electric pavement continued to be monitored, as was the single cattle guard on the east side of I-15, Exit 31.

1.2 Objectives

The objective of Phase 2 research was to measure the effectiveness of electric pavement at the following three locations in Utah:

- A six-foot-wide (1.8 m) segment of electric pavement was installed in November of 2014 across US 191, at the southern end of the wildlife exclusion fence between Monticello and Blanding, Utah. The electric pavement was designed to function as a stand-alone deterrent to prevent mule deer from moving around the fence ends and into the fenced area of US 191;
- A six-foot-wide (1.8 m) segment of electric pavement was installed in June of 2015 across US 89, at the eastern end of the wildlife exclusion fence between Kanab and Big Water, Utah. The electric pavement was designed to function as a stand-alone deterrent to prevent mule deer from moving around the fence ends and into the fenced area of US 89;
- A three foot-wide (0.9 m) segment of electric pavement was installed in June of 2014 adjacent to the west edge of the single cattle guard at an entry road on the west side of I-15, Exit 31. The electric pavement was designed to augment the single cattle guard in preventing mule deer from entering the fenced area of I-15. In Phase 2 the deterrents on the west and east side of I-15 were monitored from March 2015 to August 2016.

1.3 Scope

This research used camera traps to monitor three different installations of electric pavement placed in the road surface. Multiple cameras were placed at each location to record mule deer and other animal movements to determine if wildlife species were deterred from moving over them. This study was a continuation of Phase 1 research, conducted by Cramer and Flower (Cramer and Flower 2017, and Flower 2016).

1.4 Outline of Report

The report is organized into five chapters. Chapter one introduces the study. Chapter two presents the methods used. Chapter three presents results, including numerous photos from the study to assist readers in understanding the results. Chapter four is the discussion and conclusions of the study. Chapter five presents recommendations.

2.0 RESEARCH METHODS

2.1 Overview

Mule deer movements at electric pavement installations were monitored with professional camera traps. Photos from the cameras were evaluated to determine effectiveness rates of electric pavement installations. Cameras were also used to monitor mule deer movements around fence ends at the edge of the right-of-way and wild area at two of these locations. Electric pavement installations each contained two equal surfaces, one negatively charged (outside) and one positively charged (inside). See Phase 1 report (Cramer and Flower 2017) for greater detail. The negatively and positively charged surfaces created a difference in electric potential between the two surfaces meant to deliver a high-voltage (9.9 kV), short duration (< 3/10,000 second) shock to animals in simultaneous contact with both surfaces. The electric pavement was powered by a Stafix X3™ 3-Joule solar-powered energizer (Tru-Test Limited), which delivered a maximum output voltage of 11.4-kilovolts to the conductive segments at approximately 1.5-second intervals. However, in Phase 1 of the research at the I-15 installation of electric pavement, researchers measured no electrical potential between the negative surface of the outside panel of the deterrent and the asphalt surface of the road, and only negligible potential (0.3 kV) between the positive surface of the deterrent and the surface of the road.

2.2 Camera Placement and Settings

Camera traps were used to monitor mule deer movements at the electric pavement at three locations in southern Utah, Figure 1. Each location was monitored with one or more motion-activated Reconyx Professional Cameras. US 191 electric pavement had two Reconyx PC800 cameras, US 89 electric pavement had four Reconyx PC800 cameras, the I-15 electric pavement with a single cattle guard had two Reconyx PC85 cameras, and the single cattle guard on the east side of I-15 Exit 31 had a single Reconyx PC85 camera.

The right-of-way at US 191 and the fence ends at US 89 were also monitored to measure the abundance of mule deer and other species entering the right-of-way. Two Reconyx PC800

cameras were installed approximately 150 feet (46 m) south of the electric pavement on US 191, one on each side of the road's shorter height right-of-way fences (4 feet, 1.2 m). Two Reconyx PC85 cameras previously installed on each side of US 89 at the fence ends were used record animal movements into the US 89 right-of-way.

Cameras were programmed with the following Reconyx trigger-settings: high or medium sensitivity, one, three, or five pictures per trigger (with one and three pictures per trigger at the road edges and five pictures per trigger at the I-15 cattle guard installation and the ends of the fence right-of-way cameras), rapid fire picture interval, and no delay quiet period. Cameras at US 191 and US 89 were scheduled to operate only dusk to dawn hours to reduce the number of vehicle pictures and extend battery life.

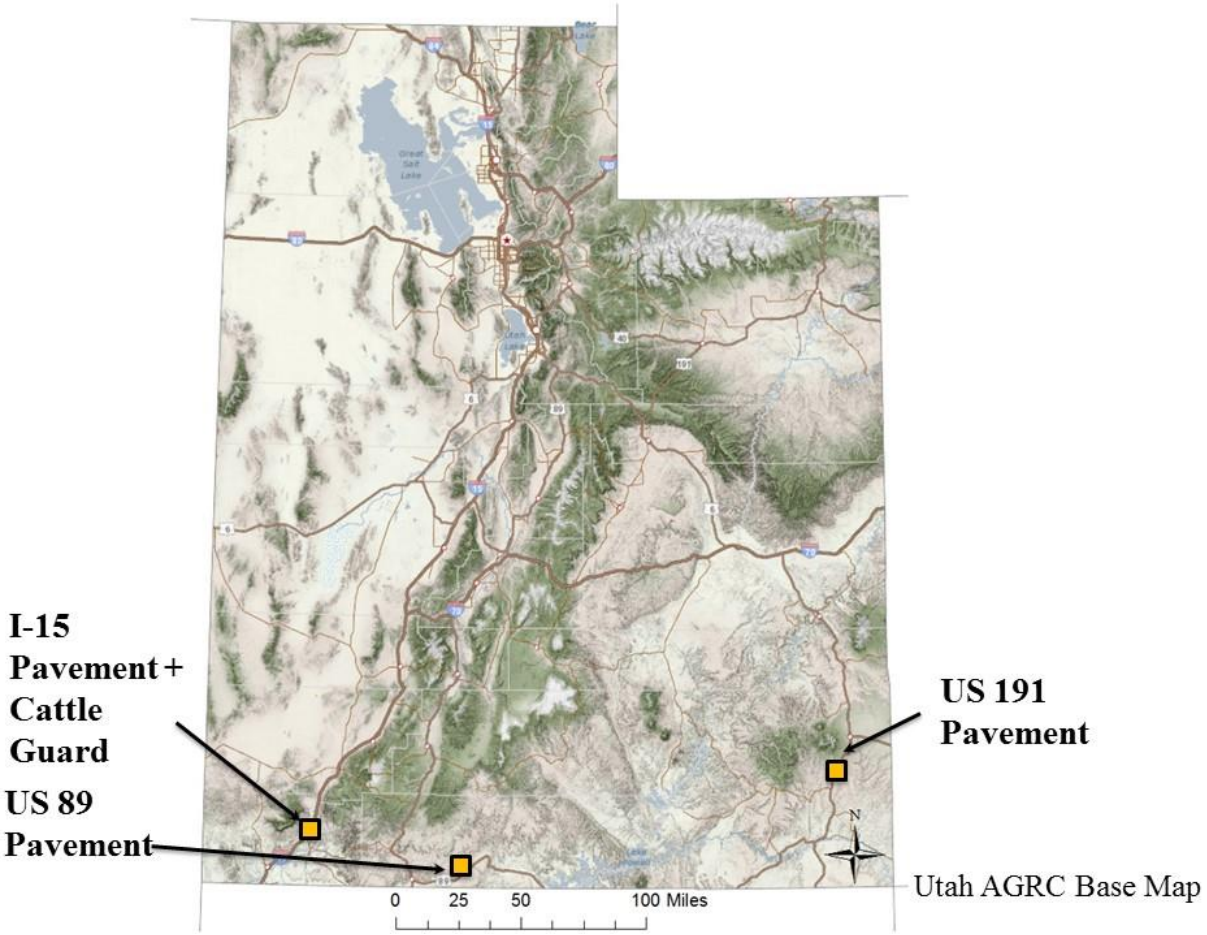

Figure 1. Map of Study Area in Southern Utah.

2.3 Analysis of Photos of Deer Movements

All unique individual mule deer movements recorded by cameras at each of the three monitoring locations were categorized and tallied as follows:

- **Breach** - movements directly over the electric pavement into the fenced area;
- **Repellency** - movements away from the electric pavement after an electric pavement interaction that originated outside of the fenced area. An interaction was defined as stepping on, smelling, or looking at the electric pavement with an apparent intent to cross;
- **Escape** – interactive movement resulting in breaching the electric pavement to escape the fenced area;
- **Escape Repellency** – movements away from the electric pavement after an electric pavement interaction that originated inside the fenced area;
- **Interactive** – the sum of breach, repellency, escape, escape repellency movement categories;
- **Parallel** - movements without an electric pavement interaction;
- **Edge Breach** - movements over the electric pavement between the fence and the edge of the electric pavement (these movements only occurred on the west side of I-15 Exit 31).

In Phase 2, "Inconclusive" was not included as a movement category. Individual repellency and parallel movements were tallied only once when the same deer moved in front of a camera for an extended period. Multiple breach, escape, and edge breach movements were tallied, even when the same deer made more than one breach, escape, or edge breach movement. When deer moved continuously in front of a camera for an extended period, a final movement category determination was made after 15 minutes. The following calculations were made for each of the three monitoring locations:

- **Percent Effective** (effectiveness for keeping mule deer from moving into the fenced area) = repellency movements divided by breach movements plus repellency movements.
- **Escape Rate** (rate that mule deer moved out of the fenced area) = escape movements divided by escape movements plus escape repellency movements.

- **Overall Impermeability** (overall effectiveness for keeping mule deer from moving into or out of the fenced area) = (repellency movements plus escape repellency movements) divided by (repellency movements plus breach movements) plus (escape repellency movements plus escape movements).

Parallel movements and edge breach movements were not used in the calculations.

2.4 Evaluation of Deer Movements at Fence Ends

Mule deer movements detected in the US 191 and US 89 rights-of-way at the fence ends were tallied but not categorized. The ratio of mule deer interactive movements at the electric pavement to mule deer movements detected in the right-of-way was calculated for each location.

3.0 RESULTS

3.1 Effectiveness of Electric Pavement Installations

The electric pavement on US 191 was monitored for 253 camera days. There were 12 interactive movements and 16 parallel movements. The pavement was 50 percent effective, the escape rate out of the US 191 fenced area was 50 percent, and the overall impermeability was 50 percent.

The electric pavement on US 89 was monitored for 200 camera days. There was one interactive movement and 10 parallel movements. No mule deer interacted with the electric pavement from outside the fenced area, thus the percent effective calculation was not applicable. The escape rate was 100 percent and the overall impermeability was 0, however, only one mule deer interacted with the electric pavement from inside the fenced area.

The electric pavement installed with the single cattle guard on the west side of I-15 at Exit 31 was monitored for 322 camera days. There were 47 interactive movements and 4 parallel movements. The electric pavement and single cattle guard were 46 percent effective, the escape rate was 87 percent, and the overall impermeability was 40 percent.

The single cattle guard on the east side of I-15 at Exit 31 was monitored for 222 camera days. There were 95 interactive movements and 17 parallel movements. The single cattle guard were 49 percent effective, the escape rate was 33 percent, and the overall impermeability was 51 percent.

Mule deer movement categories and tallies at electric pavement installations are provided in Table 1. Effectiveness rates at electric pavement installations are provided in Table 2.

Table 1. Mule Deer Movements at Electric Pavement Installations.

Location	Breach Movements	Repellency Movements	Escape Movements	Escape Repellency Movements	Interactive Movements	Parallel Movements
US 191 Electric Pavement	2	2	4	4	12	16
US 89 Electric Pavement	0	0	1	0	1	10
I-15 West Electric Pavement and Single Cattle Guard	21	18	7	1	47	4
I-15 East Single Cattle Guard	45	44	2	4	95	17

Table 2. Effectiveness Rates at Electric Pavement Installations.

Location	**Percent Effective**	**Escape Rate**	**Overall Impermeability**
US 191 Electric Pavement	50	50	50
US 89 Electric Pavement	Not Applicable	100	0
I-15 West Electric Pavement and Single Cattle Guard	46	87	40
I-15 East Single Cattle Guard	49	33	51

Photos of mule deer interactions with the US 191 Monticello electric pavement are presented below.

Figure 2. Mule Deer Breach Movement at US 191 Electric Pavement.

Figure 3. Mule Deer Escape Movement at US 191 Electric Pavement.

Figure 4. Mule Deer Escape Repellency at US 191 Electric Pavement

Figure 5. Mule Deer Escape Repellency at Electric Pavement US 191.

Figure 6. Mule Deer Escape Movement at US 191 Electric Pavement.

Figure 7. Left, Mule Deer Parallel Movement; Right, Mule Deer Escape Repellency Movement at US 191 Electric Pavement.

Figure 8. Examples of Rabbits Interacting with Electric Pavement on US 191.

A mule deer interacted with the US 89 electric pavement, below.

Figure 9. Mule Deer Escape Movement at US 89 Electric Pavement.

Sample photos from the I-15 Exit 31 installation of electric pavement with a single cattle guard are presented in chronological order in Figures 10 through 18 below to assist the reader in evaluating how the deer interacted with the electric pavement.

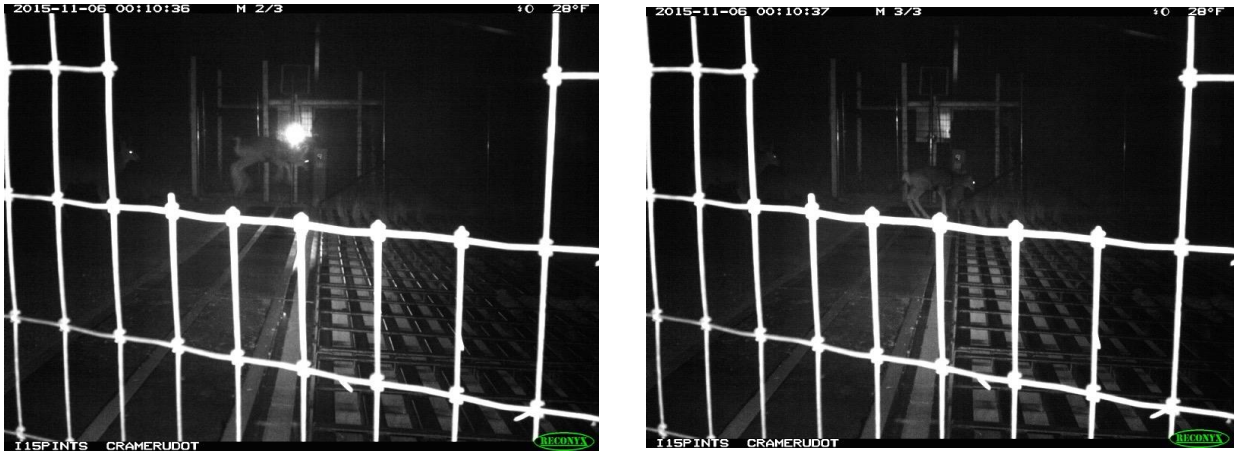

Figure 10. Mule Deer Fawn and Doe Repellency Movements at I-15 Cattle Guard and Electric Pavement.

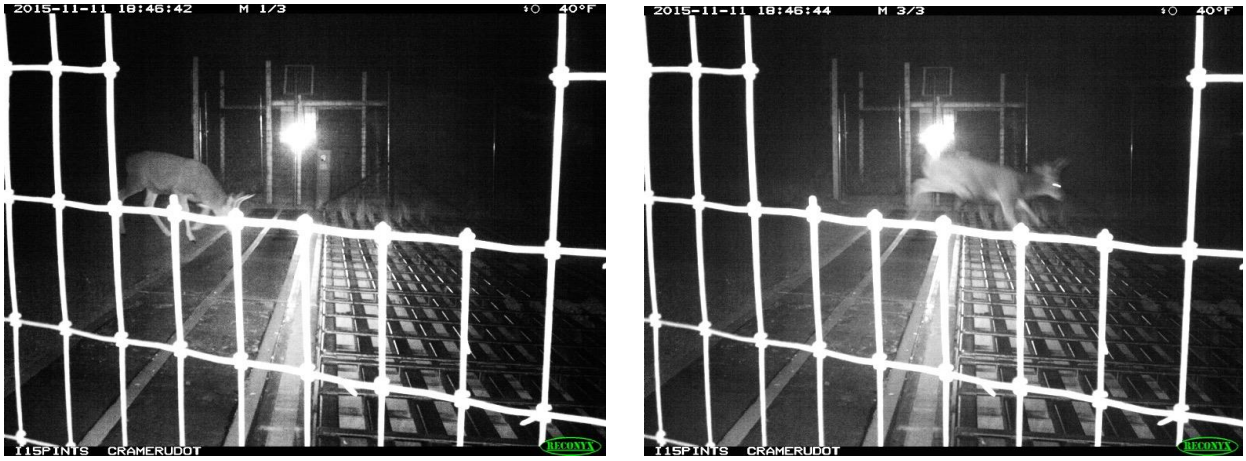

Figure 11. Mule Deer Breach of I-15 Electric Pavement and Single Cattle Guard.

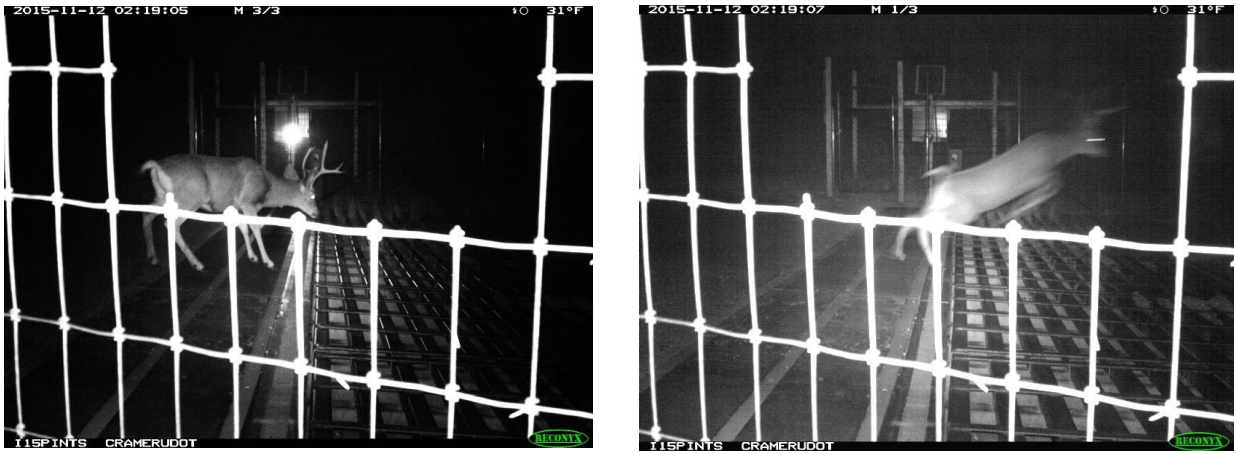

Figure 12. Mule Deer Breach of I-15 Electric Pavement and Single Cattle Guard

Figure 13. Mule Deer Repellency Movement at I-15 Electric Pavement and Cattle Guard.

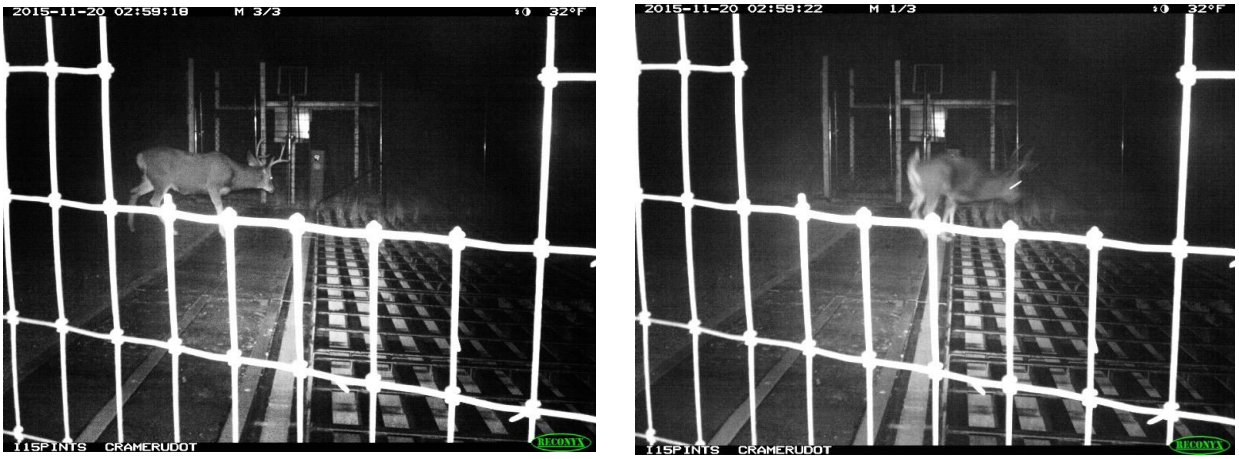

Figure 14. Mule Deer Breach Movement at I-15 Electric Pavement and Cattle Guard.

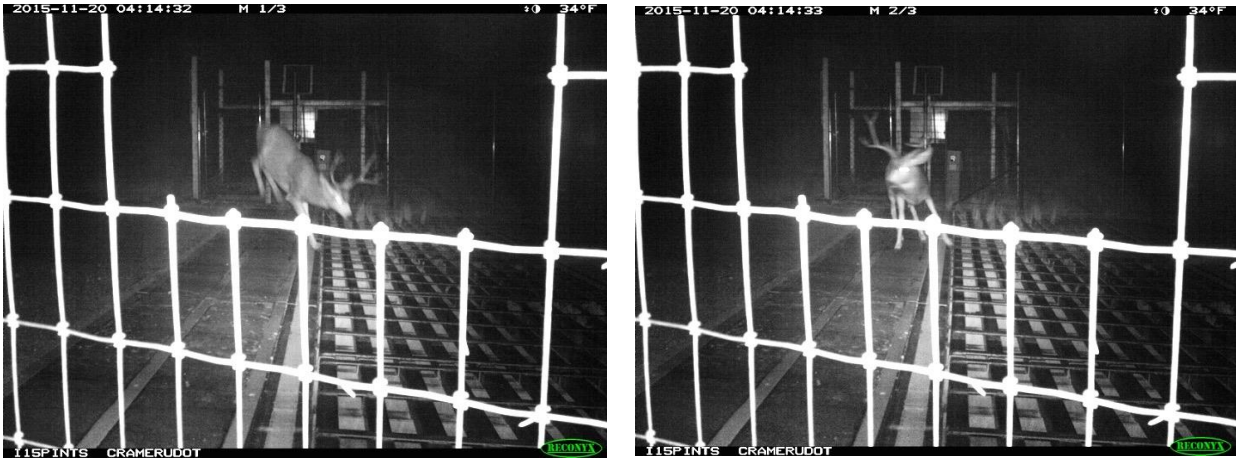

Figure 15. Mule Deer Repellency Movement at I-15 Electric Pavement and Cattle Guard.

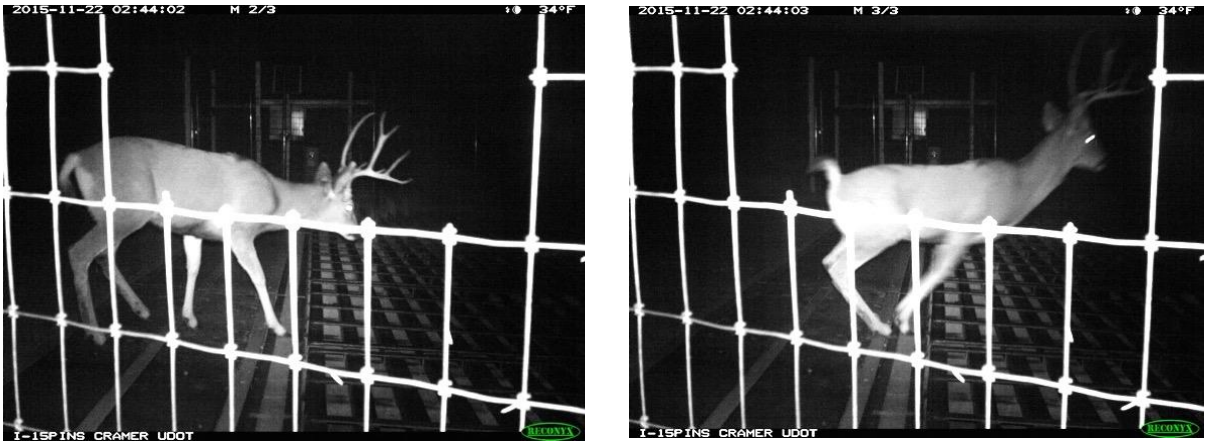

Figure 16. Mule Deer Breach Movement at I-15 Electric Pavement and Cattle Guard.

Figure 17. Left Mule Deer Repellency Movement; Right, Mule Deer Breached I-15 Electric Pavement and Cattle Guard.

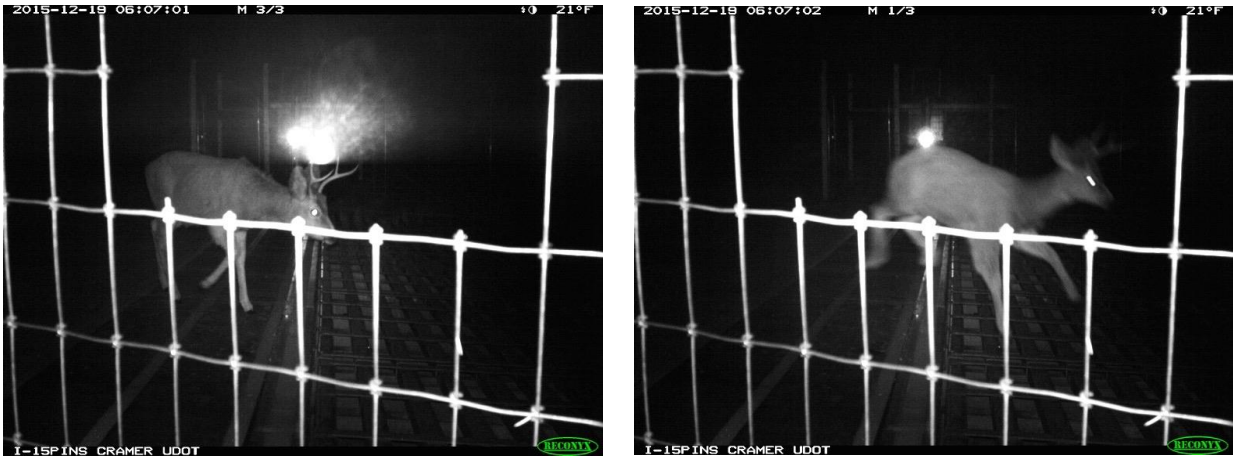

Figure 18. Mule Deer Breach Movement at I-15 Electric Pavement and Cattle Guard.

3.2 Evaluation of Deer Movements at Fence Ends

There were 228 mule deer movements photographed in the right-of-way near the end of the wildlife fence at US 191 from December 2014 to August 2016. The ratio of mule deer movements detected near the electric pavement to deer movements detected at the road right-of-way was 12 percent (27/228 = 0.12). There were 118 mule deer movements detected in the right-of-way at the fence ends at US 89 from November 2015 to August 2016. The ratio of mule deer movements detected near the electric pavement to deer movements detected at the road right-of-way was nine percent (11/118 = 0.09). In this case, all movements were parallel because no deer interacted with the pavement from outside of the fenced area.

4.0 DISCUSSION AND CONCLUSIONS

4.1 Summary

The effectiveness of the electric pavement in deterring mule deer from entering the fenced road was 46 to 50 percent, less than the established performance measure (87 to 94 percent effective), and similar to single cattle guards, 53 percent. Although the electric pavement installations studied did not meet the performance measure, the number of mule deer movements captured by the cameras were too low to make a definitive conclusion about overall effectiveness in deterring mule deer at US 191 and US 89. The ratio of mule deer detected in the rights-of-way near the fence ends at US 191 and US 89 to deer detected at electric pavement installations was 12 percent and nine percent, respectively.

4.2 Findings

4.2.1. US 191 Electric Pavement Installation

On US 191 at the electric pavement there were only 12 interactive mule deer movements and 16 parallel movements. Only four interactive movements originated from outside the fenced area. These numbers should be taken into account when making conclusions about percent effective and escape rate. The electric pavement was just as permeable to deer entering the fenced area as deer escaping the fenced area. The overall impermeability rate of the electric pavement of 50 percent is lower than for double cattle guards and wildlife guards, thus the electric pavement did not meet the performance measure of 87-94 percent effective, calculated for wildlife guards and double cattle guards. The percent effective, escape rate, and overall impermeability were similar to the effectiveness rate calculated for single cattle guards with excavated pits in Phase 1, 53 percent. The 12 percent ratio of deer photographed at electric pavement to deer photographed on right-of-way demonstrates that only a small percentage of the deer were trying to get into the fenced area. However, cameras were not pointed at the middle of the electric pavement, and were only on dusk to dawn, thus there may have been more animals not detected at the pavement. If the number of the animals detected at the electric pavement are an indication of the overall trend of mule deer attempts to enter fenced areas of highway, money

may be better spent on maintaining fence and improving wildlife crossing structures than on electric pavement. Eight of the 12 interactive movements originated from inside the fenced area, indicating that more deer were escaping the fenced area than breaching, and may have been entering from holes in the wildlife fence.

4.2.2 US 89 Electric Pavement Installation

There was only one interactive mule deer movement photographed at the US 89 electric pavement, and it originated from inside the fenced area. Because of this, a percent effective calculation is not applicable, and escape rate and overall impermeability calculations do not have any real meaning. Thus, we cannot say how these rates compare to the established performance measure of 87 to 94 percent effective for wildlife guards and double cattle guards. The nine percent ratio of deer at the electric pavement to deer at the fence ends is similar to the 12 percent ratio at US 191. Both values demonstrate that deer were not trying to enter the fenced area in large numbers. These values do not indicate that barriers at fence ends are not important, but that they may not be important in these two locations. Future studies could determine if this trend is true for other locations.

4.2.3 I-15 Electric Pavement and Single Cattle Guard

There were enough interactive mule deer movements from outside the fenced area on both the east and west sides of I-15 Exit 31 (39 movements on the west side with electric pavement and 89 on the east side single cattle guard) to calculate percent effective for both barriers with a high degree of confidence. These rates, 46 percent for the electric pavement and single cattle guard on the west side and 49 percent for the single cattle guard on the east side, were well below the performance measure of 87 percent to 94 percent effective for wildlife guards and double cattle guards. Phase 1 results determined the pavement and cattle guard were 64 percent effective in deterring 36 mule deer movements. When Phase 1 and Phase 2 data are combined, the electric pavement and cattle guard was 55 percent effective in deterring 75 interactive mule deer movements. The percent effective rates for the electric pavement and single cattle guard, and the single cattle guard, were similar to the percent effective rate for single cattle guards with excavated pits determined in Phase 1, 53 percent.

There were a limited number of interactive movements from inside the I-15 fenced area at the barriers (8 on the west side and 6 on the east side), thus the calculated escape rates are not very robust. The escape rates are counterintuitive because the single cattle guard barrier on the east side had a lower escape rate, 33 percent, than the electric pavement and single cattle guard barrier on the west side, 87 percent. We expected that the electric pavement and single cattle guard on the west side would have a lower escape rate than the single cattle guard on the east side.

Analysis of mule deer behaviors in the photos allowed researchers to evaluate how animals perceived and reacted to electric current. When a mule deer had hooves on the asphalt and the first electric pavement panel, which was negatively charged, most mule deer appeared not to react to the pavement. This agrees with the lack of measured electrical potential between the asphalt and the first panel of electric pavement found in Phase 1. When deer placed their hooves on both the outside negatively-charged surface and the positively-charged surface, animals appeared to react to the current. Some mule deer appeared to jump forward, some bucked their rear legs up as they moved forward, while others turned around. Overall, most animals were in a forward motion when they received electric stimulus and had a tendency to continue in the direction they were headed, toward the inside of the fenced area. Other mule deer appeared to detect something about the electric pavement without stepping on it, and repelled.

4.2.4 Mule Deer Were Able to Jump the Six-Foot Wide Electric Pavement

Photos revealed that mule deer often jumped over the three-foot wide (0.9 m) electric pavement in front of the single cattle guard on I-15, and the six-foot wide (1.8 m) pavement in US 191. If mule deer perceive they can avoid shock by jumping, they will continue to try to breach such installations. If they land on wider strips of electric pavement with these jumps, they may turn and repel. Future electric pavement installations will need to explore deployment with wider widths. There is also the potential to alternate electrically charged strips of pavement with asphalt over a wider area that may deter the animals.

4.2.5 Electrical Potential Is Needed at the Leading Edge of Pavement

Once an animal is in a forward motion, an electric shock appears to motivate them to continue to move forward in the direction of movement, rather than turning around toward the area where the shock was received. It is important that future installations of electric pavement be created to deliver the electric shock prior to an animal making the decision to try to breach the barrier. There needs to be an electrical potential at the edge of the electric pavement and asphalt.

4.3 Limitations and Challenges

This research was limited by low numbers of mule deer interacting with the electric pavement installations at US 191 and US 89, and having only three locations to test electric pavement. As a result, statistical analyses could not be conducted. Results may not be indicative of future electric pavement installations in other locations with other species.

5.0 RECOMMENDATIONS AND IMPLEMENTATION

5.1 Recommendations

The researchers recommend:

1. Future installations of experimental electric pavement could be created in widths greater than the 6 feet (2 m) used in this study. This would help the system continually shock animals as they attempt to move over the road surface. This may provide greater potential for animals to be deterred. The width of the pavement will need to be greater than mule deer abilities to jump.

2. Electric pavement will need an electrical potential at its leading edge. Photographic evidence demonstrated that if an animal receives a shock after it has initiated a breach, it more often continues to move in the original direction of travel rather than repel away. This is supported by both Phase 1 and 2 research results. Animals need to sense, or receive a credible shock prior to initiating jumps, walks, and movements over the barriers.

3. If a wider (for example, 10 feet, 3 m) electric pavement installation is still a cost-effective option for placement in roads, additional monitoring will be needed to evaluate its effectiveness at deterring future mule deer attempts at breaching the pavement.

4. The fact that nine to twelve percent of the animals photographed at wildlife fence ends in the right-of-way were photographed approaching the electric pavement raises the question if any type of wildlife barrier deterrent is needed at fence ends. Given the cost of electric pavement and double cattle guard installations, these efforts may not be cost effective. Further research could assist with this question.

5.2 Implementation Plan

The information from Phase 1 and this Phase 2 of the research can be used to design more effective electric pavement installation. UDOT and manufacturers of the electric pavement should design future electric pavement in strips wider than the three and six-foot widths (1-2 m)

tested. UDOT should also continue with using double cattle guards and wildlife guards as the preferred wildlife barriers at fence ends and access roads along wildlife fence.

REFERENCES

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