Effectiveness of the TRU-88 Wildlife Roadway Crossing Culverts and Exclusion Fencing

Prepared by: Marci Lininger Matthew Perlik

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Technical Report
Abstract

Natural resource agencies continually express interest in increasing the permeability of roadways for both aquatic and terrestrial wildlife nationwide. Specific review of ODOT projects by resource agencies may result in the request that terrestrial wildlife crossing structures be installed (i.e. Nelsonville Bypass, Nelsonville, Ohio). These structures are often required of ODOT although they are provided with little or no design guidance, no supporting evidence that they are appropriate for the target species, no project specific setting, and no proof that they will provide greater permeability long term for wildlife. However, ODOT must still install and maintain them for the life of the roadway. From April of 2013 to August of 2013, ODOT Office of Environmental Services (OES) staff, working with ODOT District 4, conducted field studies during peak breeding season for amphibians and reptiles to measure the effectiveness of crossing culverts and exclusion fencing constructed along state route 88 in Trumbull County, Ohio within the Grand River Wildlife area. The TRU-SR 88 crossing was a unique opportunity to monitor the permeability of an un-mandated, low cost, crossing culvert and exclusion fencing design that could be used in other parts of the state as needed for both aquatic and terrestrial wildlife. Over the span of 4 months, the study generated 4,122 photos of animals using the culverts and exclusion fencing. Over the life of the study, the use of all culverts and fencing was 11% amphibian and reptile, 5% birds, and 84% mammals. Mortality surveys reveal that 65% of road-kill recorded in both the study and control areas consisted of amphibians and reptiles followed by 20% of birds and 14% of mammals. The use of passive laser motion triggered infrared cameras successfully recorded wildlife use of the crossing structures and exclusion fencing. These observations suggest that this design is providing permeability for multiple species of both aquatic and terrestrial organisms.

Introduction

Interruptions in wildlife movement occur when there is discontinuity in habitat connectivity. The placement of roads creates these disruptions and can have a negative effect on wildlife, especially when the disruption occurs within viable breeding habitat.
The purpose of this research was to measure the effectiveness of amphibian and reptile crossing culverts and exclusion fencing constructed as part of a federal enhancement grant along state route 88 in Trumbull County, Ohio within the Grand River Wildlife area. The Grand River Wildlife Area (GRWA) is in northeast Ohio, east of the village of West Farmington. The purchase of land for this wildlife area began in 1956, when a portion of it was cropland. Today, much of it is in crop rotation to benefit wildlife. This portion of the Grand River Valley consists of a 7,453-acre area and is one of the largest areas of semi-wilderness remaining in heavily populated northeast Ohio. The Grand River and its tributaries provide habitat and breeding ground for mammals, reptiles, amphibians, and birds. State route 88 bisects the area in an east-west direction, fragmenting an extensive swamp forest to the north and a perennial scrub/shrub, emergent wetland to the south. Prior to the installation of the culverts and fencing, ODOT District 4 and Central Office biologists consistently observed a disproportionately high number of animals killed along SR-88 in Trumbull County within the area of the GRWA. Similar observations had been documented by Ohio Division of Natural Resources (ODNR) staff working within the Grand River Wildlife Area. Local herpetologists had also noted this area as having a high incidence of herpetofauna mortality.

In order to reduce the amount of mortality occurring along SR-88, crossing culverts and exclusion fencing were installed as part of ODOT-Let paving project TRU-88-0.00 (PID 82921) in the summer of 2011 and were completed in September of 2011. The project was designed to increase the permeability of roadways for terrestrial wildlife. Three 24” culverts with earthen fill placed on the bottom were installed above the normal wetland water level to facilitate animals crossing under the roadway of SR-88. To funnel small animals (reptiles, amphibians, and small mammals) trying to cross the road into the culverts, a fencing structure was constructed running parallel to the roadway. The fencing structure consists of 48” corrugated plastic pipe that was cut lengthwise into three 20 foot long sections. The c-shaped sectioned pipe was installed partly below the ground surface and attached to guardrail posts installed in the roadway embankment two feet above ground level. A two foot (0.6 meters) design height was selected to deter frogs and snakes from entering the right of way (Figures 7 and 8). The
top of the fencing was back filled and planted to provide organisms a limited barrier for exit from the roadway. At each end of the fencing, a half piece of pipe was installed vertically to return animals back and away from the unfenced areas. Upon completion of the installation, no monitoring of the culvert and fencing had been completed to determine the effectiveness of this experimental approach to increasing the permeability of roadways for wildlife. This study investigated the effectiveness of these features by answering the following questions:

- Is the exclusion fencing successful in reducing road kill on SR 88
- What, if any, wildlife are using the fencing and culverts
- Are adjacent landscape features affecting wildlife use of a crossing structure
- Is the design as installed an efficient and effective method of mitigating wildlife impacts of roadways

Methods

Study Area

From April of 2013 to August of 2013, ODOT Office of Environmental Services (OES) staff, working with ODOT District 4, conducted field studies during peak breeding season for amphibians and reptiles to measure the effectiveness of crossing culverts and exclusion fencing constructed along SR-88. The study and control areas were each 0.32 miles (0.515 kilometer) long running east to west along SR-88 (Figure 6). The control area was immediately adjacent to the study area. The control and study areas had comparable daily traffic volume (2,940 cars/day) and speed limit (55mph) and were both along SR-88 within the Grand River Wildlife area. The study area included the portion of SR-88 with exclusion fencing and culverts. The three culverts were labeled numerically going west to east as Culvert 1, Culvert 2 and Culvert 3. The culverts connecting the south side of SR-88 to the north side were labeled as: 1 south (1S), 1 north (1N), 2 south (2S), 2 north (2N), 3 south (3S) and 3 north (3N).
Mortality Surveys

Mortality surveys were conducted to monitor road-kill along the length of both the control and study areas. East and west bound lanes, shoulders, and maintained right of way of SR 88 within the control area and treatment areas were surveyed. Animals observed killed on the road were documented and data was collected on species, condition, approximate time of death, weather conditions at time of death, and probable cause of death. The location of each fatality was recorded using sub-meter GPS units.

Culvert Use

Passive laser motion triggered and infrared heat activated cameras were installed to monitor aquatic and terrestrial wildlife use of the culverts and exclusion fencing. The infrared heat activated cameras were attached to the fencing support post just outside of each of the culvert openings and angled towards the gravel floor to capture photographs of warm blooded organisms moving into or out of the culvert. Motion sensitive laser trip units were then connected to the cameras and placed at ground level in order to activate the camera shutter when the beam was broken. This provided an opportunity to record small cold blooded organisms that moved through the beam at the culvert opening. The camera batteries and memory cards were replaced, and light maintenance on each camera unit was performed every other week to ensure proper operation and to collect the past week’s data.

Habitat Assessment

In conjunction with mortality surveys, dominant vegetation types along the right of way of SR-88 were recorded once every two weeks. In addition to recording dominant vegetation types an assessment of hydrology presence, soil erosion as well as condition of culvert and fencing structures was completed.
Results

Mortality Surveys

Mortality surveys identified 35 wildlife fatalities within the control site and 23 within the study site. 65% of road-kill recorded in both the study and control areas consisted of amphibians and reptiles followed by 20% of birds and 14% of mammals. Over the life of the study, mortality rates spike in the months of June and July (Table 2). These findings are consistent with the highest amount of culvert use also occurring within the months of June and July.

Culvert Use

Over the span of four months, the study generated 4,122 individual photos of animals using the culverts and exclusion fencing. Every photo taken was recorded as individual culvert and/or fencing use. Combined use of all culverts and fencing include: amphibians and reptiles 11%, birds 5%, and mammals 84%. Four different animal groups were documented using the culverts under SR-88 and using the area under the exclusion fencing as a travel corridor. 16 species of mammals, five species of amphibians, three species of reptiles and five species of birds were observed (Table 1). Of the five bird species observed using the culverts and fencing, only one observation of a wood duck (Aix sponsa) was confirmed using the culverts for complete passage under SR-88. In addition to the wood duck, complete passage under SR-88 was also confirmed for: Raccoon (Procyon lotor), Virginia Opossum (Didelphis virginiana), Eastern Chipmunk (Tamias striatus), Eastern Cottontail (Sylvilagus floridanus), Snake (Unknown Species Name), American Bullfrog (Rana catesbeiana), and Common Snapping Turtle (Chelydra serpentine). A sample photo log of wildlife using the culvert and exclusion fencing is in appendix A.

Habitat Assessment

The habitat assessment revealed evidence of viable habitat for wildlife on both the north and south sides of SR-88. There is a relative dominance of aquatic plants spanning the entire length of study and control area along the south side of SR-88
including: buttonbush (*Cephalanthus occidentalis*), swamp milkweed (*Asclepias incarnata*) and greater bur-reed (*Sparganium eurycarpum*). Vegetation on the north side of SR-88 included upland and aquatic plants mixed throughout a swamp forest including: flat-topped goldenrod (*Euuthamia graminifolia*), joe-pye weed (*Eutrochium purpureum*) and bull thistle (*Cirsium vulgare*).

**Discussion**

The crossing structures within the Grand River Wildlife area appear to be successful for increasing permeability along SR-88 and reducing wildlife mortality. Mortality surveys suggest a decrease in mortality within the area of the culverts and fencing placement when compared to the control area. On both ends of the exclusion fencing clusters of mortality were recorded. These clumped fatalities may be the result of organisms traveling down the fencing and around it, entering the highway and being hit.

The use of passive laser motion triggered infrared cameras successfully recorded wildlife use of the crossing structures and exclusion fencing. These observations suggest that this design is providing permeability for multiple species and both aquatic and terrestrial organisms. Wildlife used all three culverts with the middle culvert (Culvert 2) having higher use than Culverts 1 and 3 (Figures 4 and 5). Although the strength of evidence is moderate, this difference is likely due to Culvert 2 providing a direct connection of a perennial wetland on the south side of SR-88 to an extensive swamp forest on the north side of SR-88 (Figures 4 and 5).

Of all the fatalities, 61% occurred within the control while 39% occurred in the study site. This suggests that the prototype culvert and exclusion fencing system has been effective. However, there are sections of the fencing have begun to warp and sag lower than the standard two feet (0.6 meters) of height implemented in the fencing design, which was to deter amphibians and reptiles from entering the right of way (Figures 9-11). There are also sections of the fencing that have been shifted forward, causing parts of the fence to be out of alignment. Some of these structural issues may be due to poor drainage and flooding. Observations by a former ODOT construction engineer suggest that solar exposure and temperature are playing a role in fence
sagging. It was observed that erosion from surface water runoff and fluctuating wetland water levels may also have long term impact on structure stability. Implementation of more durable materials and exclusion fencing design could be established to achieve a more sufficient and long lasting crossing structure.

Research has suggested that two to three feet (0.6-0.9 meters) would be the best height for exclusion fencing to deter frogs from jumping into the road (e.g., Woltz, Gibbs and Ducey 2008). Providing a more suitable support structure that is spaced closer together to increase the support of the corrugated pipe pieces could decrease the amount of warp and sag. This could also ensure that the exclusion fence maintains an adequate height for deterring amphibians and reptiles. Placement of an additional crossing culvert under Stroup Hickox Road and extending the exclusion fencing around the corner of Stroup Hickox Road could funnel animals into the culvert, inhibiting their ability to or need to cross over the road. Extension of the exclusion fencing east along SR-88 ending at an existing upland gravel parking lot could funnel wildlife back towards Culvert 3. The incorporation of such crossing and/or fencing structures may decrease the amount of wildlife fatalities within Grand River Wildlife Area.

The study provided no conclusive evidence of the effect of adjacent vegetation on crossing use. The observed increased use of Culvert 2 could be a result of location along the fencing, adjacent habitat type, or a combination of both. Recent literature strongly suggests that various attributes such as culvert bottom substrate, preferred habitat of the target species adjacent to the culverts, adjacent cover vegetation, culvert shape and size, and fencing structure height and length are important considerations for increasing the wildlife use of the crossing culverts. The observed location of birds just outside the culverts and under the fencing (and wood ducks in the culverts) could suggest that the fencing combined with foraging vegetation are providing secure travel/foraging corridors for birds along this segment SR-88.

Understanding these attributes within a site specific location and how to incorporate them into a potential crossing design is crucial for future designs. A collaborative approach that understands these attributes will benefit future wildlife mortality mitigation design. Future deliverables for the data collected in this study will include submission to peer reviewed journals that focus on the topics of conservation
biology, human dimensions and wildlife, transportation planning, and wildlife management. A more detailed statistical analysis of the data will be incorporated into the published report.

Figure 1. State of Ohio county location map and detail map of Trumbull County showing general area where the study was conducted.
Figure 2. Site map containing location of crossing culverts, exclusion fencing, water control culvert, and estimated wetland locations.
<table>
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<tr>
<th>Animal Groups</th>
<th>Species</th>
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<tr>
<td>Reptiles</td>
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<td>Amphibians</td>
<td>American Bullfrog (<em>Rana catesbeiana</em>), Spring Peeper (<em>Pseudacris crucifer</em>), American Green tree Frog (<em>Hyla cinerea</em>), Frog (Unknown Species Name), Salamander (Unknown Species Name)</td>
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<td>Birds</td>
<td>Song Sparrow (<em>Melospiza melodia</em>), American Robin (<em>Turdus migratorius</em>), Gray Catbird (<em>Dumetella carolinensis</em>), Wood Duck (<em>Aix sponsa</em>), Baltimore Oriole (<em>Icterus galbula</em>)</td>
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*Table 1.* Four different animal groups were documented using the culverts under TRU-SR-88 and using the area under the exclusion fencing as a travel corridor within the Grand River Wildlife Area.
Figure 3. Total use of culvert and fencing structure by all observed species over entire duration of study.

Figure 4. Total use of culvert and fencing structure by all observed species, specific to culvert placement.
### A. Study Area

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<td><strong>8</strong></td>
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Table 2. Total mortality of all recorded species.  
A. Total mortality of all species occurring per month within the treatment area.  
B. Total mortality of all species occurring per month within the control area.
Figure 5. Total use of culvert and fencing structure by main animal groups. A. Total reptile use, specific to each culvert. B. Total bird use, specific to each culvert. C. Total mammal use, specific to each culvert. D. Total amphibian use, specific to each culvert.
Figure 6. Mortality Survey Map. (Blue dots reflect clump of amphibian fatalities on the East side of the study area. Yellow dots reflect fatalities within the study area. Red dots reflect fatalities within the control site on SR 88.) Orange lines along SR-88 indicate exclusion fencing.
Figure 7. Detailed plan of small animal wildlife exclusion fencing designed to funnel small animals across the road through the crossing culverts.
Figure 8. Detailed plan of small wildlife animal crossing culvert designed for safe passage under SR 88.
Figure 9. Weakened structure and sagging of exclusion fencing due to solar exposure.

Figure 10. Weakness in the alignment of the exclusion fencing due to soil erosion after heavy rain and flooding.

Figure 11. Sagging exclusion fencing ranging along the entire South side of the study area.
Appendix A

Culvert 2 S. Song Sparrow (*Melospiza melodia*)

Culvert 2 S. Wood Ducks (*Aix sponsa*)

Culvert 3 N. Wood Ducks (*Aix sponsa*)

Culvert 1 N. Domestic Cat (*Felis domesticus*)

Culvert 2 N. Common Muskrat (*Ondatra zibethicus*)

Culvert 2 N. Groundhog (*Marmota monax*)

Culvert 2 S. Wood Ducks (*Aix sponsa*)
Culvert 3 N. Groundhog (*Marmota monax*)

Culvert 2 S. Juvenile Eastern Cottontail (*Sylvilagus floridanus*)

Culvert 2 S. Unknown Frog Species

Culvert 2 S. Adult Eastern Cottontail (*Sylvilagus floridanus*)

Culvert 2 S. American Bullfrog (*Rana catesbeiana*)

Culvert 2 S. Virginia Opossum (*Didelphis virginiana*)
Culvert 2 S. Striped Skunk (*Mephitis mephitis*)

Culvert 1 N. Short Tailed Weasel (*Mustela ermine*)

Culvert 3 N. Common Snapping Turtle (*Chelydra serpentine*)

Culvert 1 N. Short Tailed Weasel (*Mustela ermine*)

Culvert 3 N. Common Snapping Turtle (*Chelydra serpentine*)

Culvert 1 N. Short Tailed Weasel (*Mustela ermine*)

Culvert 3 N. Common Snapping Turtle (*Chelydra serpentine*)

Culvert 1 N. American Mink (*Mustela*)
Culvert 1 S. Least Weasel (*Mustela nivalis*)

Culvert 2 N. Least Weasel (*Mustela nivalis*)

Culvert 2 S. Unknown Turtle Species

Culvert 3 N. Northern Raccoons (*Procyon lotor*)

Culvert 1 N. Norway Rat (*Rattus norvegicus*)

Culvert 1 N. Eastern Chipmunk (*Tamias striatus*)
Effectiveness of the Wildlife Crossing Culverts and Exclusion Fencing along State Route 88 in Trumbull County, Ohio

Prepared by:

Marci Lininger, OES Central Office

Matthew Perlik, OES Central Office

January 2014

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The contents of this report reflect the views of the author(s) who is (are) responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Ohio Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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