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Publication Date
2007-05-20

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Abstract: Linear transportation features have been shown to have a barrier effect on certain wildlife species. In the case of highway median barriers or dividers designed for safety, little research has been done to gain an understanding of how these continuous linear structures affect the movement and mortality of different taxa. This research effort was comprised of a state of the practice survey, a literature review and gap analysis, and a qualitative assessment of potential wildlife impacts based on median barrier type and taxa size. Results from this cumulative effort have produced a foundation from which to develop rigorous field studies which should ultimately yield the basis for agency standards and guidelines. This study represents the first attempt ever in North America to synthesize information about highway median barriers and wildlife.

Background and Purpose

Transportation agencies (DOTs) regularly install solid concrete median barriers and, in some cases, incorporate mitigative designs without information on their effectiveness. Therefore a study of the interactions between vehicles, median barriers, and wildlife is needed. The continued use of concrete median barriers should be of concern where they bisect areas of ecological importance and wildlife populations. The aim of this Caltrans-sponsored project was to determine what is the current practice and knowledge in the US and Canada pertaining to potential impacts of highway median barriers on wildlife movement and mortality.

Methods

- The literature review focused on 1.) barrier effects of roads and linear infrastructure, 2.) historical and current trends of median barrier installation and unintended/potential impacts, and 3.) the effects of median barriers on a range of wildlife species and the performance of mitigative design solutions. The gap analysis culminated in a series of unanswered questions and limitations of available information.
- Ninety-six biological/environmental and engineering specialists in DOTS in all 50 U.S. states and 13 provinces/territories in Canada were invited to participate in this online state of the practice survey. The survey addressed trends and patterns of installations, regulatory and practical issues in deployment, and agency-led research efforts to assess median barrier impacts on wildlife.
- The qualitative assessment of potential wildlife impacts followed a matrix model whereby the potential permeability and mortality risks associated with common median barrier designs were assigned (based on intuitive and available information) for each taxa group of varying sizes.

Summary of Findings

Individually and collectively, these median barrier-wildlife research efforts confirm that a concerted study is needed in order to develop best practices for appropriate placement, design choice and mitigations to meet the needs of motorist safety while avoiding negative impacts to local wildlife populations.

Literature Review and Gap Analysis

The literature review substantiated median barriers have an effect on a wide range of wildlife from small to large. This statement largely comes from documented anecdotal data and intuitive public concern, however, there were some supporting scientific research studies. There is general agreement that barriers can result in increased wildlife mortality and decreased wildlife movements depending on the species and/or body size. Comprehensive studies that specifically measure these impacts are lacking. The absence of WVCs in some cases may be an indication that such barriers affect how, and if, wildlife move along and/or across roadways.

State of the Practice Survey

Thirty-four individuals representing 28 (or 45%) of DOTs in the U.S. and Canada completed the survey (figure 1). Results from the survey revealed there were few evaluations of median barriers impacts on wildlife.

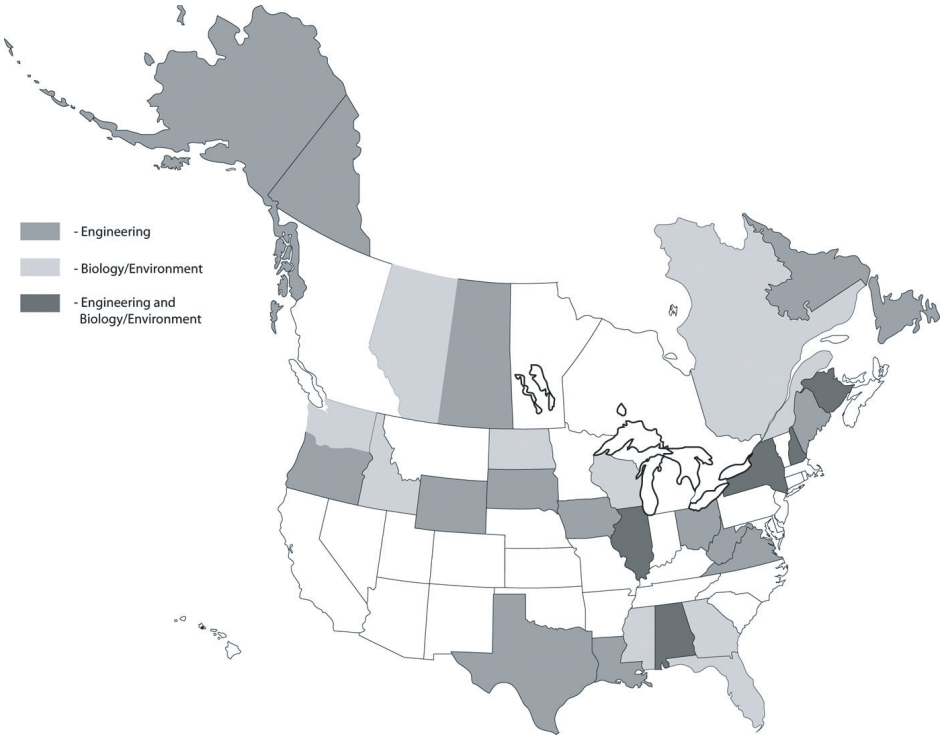

Figure 1. Survey respondent type by state, province and territory.

Few DOTs reported that they 'employ' or 'consider' mitigative designs. Of the 22 agencies that answered the following question set, results were similar; 68% rarely or never consider mitigative design solutions and 77% rarely or never employ them.

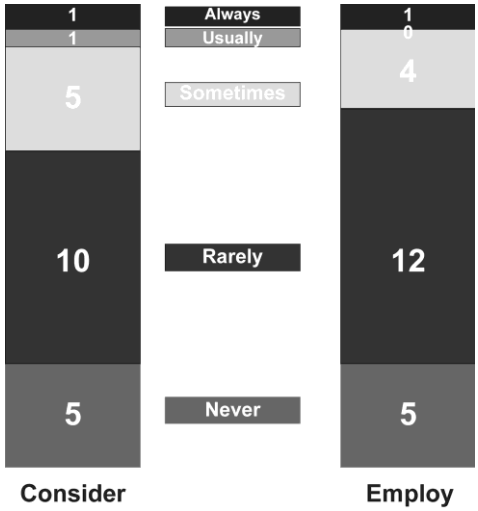

Figure 2. Number of agencies surveyed which consider or employ designs to mitigate impacts to wildlife.

No clear mandate to address wildlife and habitat connectivity concerns (other than for threatened and endangered species) and the lack of guidance for decision-making are possible explanations. But the literature review revealed that DOTs and others have attempted to address some aspect of median barrier effects on wildlife movement and/or mortality.

Qualitative Assessment

It is likely that animal size, median barrier dimensions, existing wildlife passages and landscape features have a collective effect on wildlife permeability and potential mortality risk on median divided roadways.

In a analysis of potential wildlife impacts, scores combining potential permeability and potential mortality risk were applied in a qualitative decision matrix for taxa relative to nine distinct median barrier types (mitigated and traditional).

Taxa groups (largely based on California fauna) were classified by general size differentiation as follows:

- A: mice, shrews/frogs, salamanders, lizards, snakes
- B: rat families, squirrels, weasels/turtles/young waterfowl and upland birds
- C: marten, fisher, mink, badger, skunk, fox, opossum
- D: coyote, bobcat, lynx, wolverine, otter, raccoon, ocelot
- E: grizzly bear, black bear, wolf, moose, elk, deer, bighorn sheep, mountain lion
    - Permeability scores were qualitatively assigned in absolute terms based on the size and physical capacity of each taxa group to overcome each barrier type.
    - Potential mortality risk was based on the extent to which a barrier might limit an animal's ability to traverse the barrier to avoid oncoming vehicles and see vehicles approaching from the opposite direction. The score also took into consideration literature that indicated a higher risk of WVC (especially deer) on undivided two-lane roads and on roads with vegetated medians.

Based on this model, small (shrew-sized) to medium (fox-sized) taxa have the highest risk with solid, concrete barrier designs. Medium taxa also have a high risk score for concrete barriers with scuppers or basal cutouts. Conversely, small and medium taxa have the lowest risk with permeable metal beam, cable, centerline rumble strips and vegetated median designs. Larger species (coyote-sized to elk- or bear-sized) have a moderate combined risk for all median (barrier) types with the exception of the Ontario Tall Wall (Table 1). This qualitative assessment is not intended to be a guideline but rather is a starting point for discussion about potential impacts.

Table 1: Combined risk score based on potential permeability and mortality risk of median barrier type for taxa of different sizes

	Taxa Group				
Median Barrier Type	**A**	**B**	**C**	**D**	**E**
Concrete (Jersey, F-shape, Texas, etc.) (minimum 32 in. [81 cm] high and < 8 in. [~20 cm] wide)	2	2	3	5	5
Ontario Tall Wall (~59 in. [150 cm] high and < 8 in. [~20 cm] wide)	2	2	2	2	2
Concrete with gaps (several feet spacings between panels)	4	4	4	4	4
Concrete with scuppers (basal openings 6 to 39 in. [15 -100 cm])	4	4	3	5	5
Concrete with gaps and scuppers	4	4	4	4	4
Metal beam (steel, W, box, thrie, etc.) (27 to 34 in. [68.5 – 86.4 cm] high and 1 foot wide [~30 cm] or more, if doubled)	6	6	6	5	5
Cable (3-, 4-strand and proprietary designs) (top cable ~4 feet tall [123 cm]; lowest cable 1 to 2 feet [~3 - 6 m] above the ground)	6	6	6	5	5
Centerline rumble strips (negligible sized grooves cut into road surface)	6	6	6	5	5
Vegetated median (slightly mounded, flushed or depressed and generally tens of feet wide)	6	6	6	5	5

Legend High Risk 2 or 3 Moderate Risk 4 or 5 Low Risk 6

Future Research

Field research should address varying sizes of taxa and different median barrier designs (mitigated and traditional) in a variety of landscapes. The following is a recommended hierarchical research framework:

1. First and foremost, study wildlife impacts in terms of increased mortality and reduced movements.
2. Second, investigate mortality and barrier effects to individuals and populations and subsequent effects on demographics and genetics.
3. Third, ask how all of the above affects long-term persistence of focal populations.

Acknowledgments: The authors thank the California Department of Transportation (Caltrans) for funding this project and, specifically thank Harold Hunt for guidance and support, and Dave Hacker for initiating this work. The authors greatly appreciate the transportation agency specialists in the U.S. and Canada who participated in the survey and graciously offered their insights. For their contributions of technical, editorial, graphical and administrative assistance, the authors are grateful for staff at the Western Transportation Institute.

Biographical Sketches: Angela Kociolek received a M.S. in biology (Conservation emphasis) and a Master's Certificate in Interdisciplinary Studies in 1997 from Montana State University. Her thesis focused the effects of climate on ground squirrel species distribution and she has experience in avian and lichenological field research. Angela is a Returned Peace Corps Volunteer having served in the Integrated Education and Community Outreach program in northeast Thailand (1998-2000). Angela is currently a research associate at the Western Transportation Institute where she is involved in a variety of field and research/writing projects in the Road Ecology focus area.

Tony Clevenger is a research wildlife biologist Montana State University's Western Transportation Institute. His research focuses on assessing wildlife crossing performance and analyzing factors contributing to wildlife-vehicle collisions. Tony was a member of the U.S. National Academy of Sciences Committee on *Assessing and Managing the Ecological Impacts of Paved Roads* (National Academies Press, 2005). He has published over 40 articles in peer-reviewed scientific journals and has co-authored three books including, Road Ecology: Science and Solutions (Island Press, 2003). Tony is a graduate of the University of California, Berkeley, has a master's degree from the University of Tennessee, Knoxville and a Doctoral degree in Zoology from the University of León, Spain.