INTRODUCTION

There are more than forty types of road mitigation measures available that aim to reduce wildlife mortality on roads (road-kill). For road planners, deciding on what mitigation method to use has been problematic because there is little good information about the relative effectiveness of these measures in reducing road-kill, and the costs of these measures vary greatly.

The purpose of our study was to conduct a comprehensive analytical review of the studies that quantified the relationship between road-kill and a mitigation measure that was installed, at least in part, to reduce wildlife road mortality, using well-described meta-analysis methods. Specifically we asked:

(1) To what extent does road-kill mitigation effectiveness differ among measures?

(2) To what extent do taxa differ in the effectiveness of particular road mitigation measures?

(3) To what extent does study design influence the estimated effectiveness of road mitigation measures?

METHODS

We conducted a comprehensive search that included both primary and grey literature with no date, language, or format restrictions. Studies included employed one of three study designs: (1) Before-After (BA); (2) Control-Impact (CI), or (3) Before-After-Control-Impact (BACI).

Outcomes of each of the 50 studies were then converted into a common measure, the standardized mean difference (or Hedge’s g). A positive d indicates a reduction in road-kill with the road mitigation and a negative d indicates an increase in road-kill with the road mitigation. To address our research questions, we investigated a set of candidate predictor variables from four broad categories: attributes of (a) planning and management; (b) wildlife; (c) fencing; and (d) study design. We used mixed-effects meta-regression to examine associations between effect size and candidate predictor variables using restricted maximum-likelihood to estimate heterogeneity.

RESULTS

Overall, mitigation measures reduce road-kill by approximately 40% compared to controls.

1. To what extent does road-kill mitigation effectiveness differ among measures?

   a) Are fences with crossing structures more effective than fences or crossing structures alone?

   b) What mitigation measures are most effective for a given taxon?

   c) How do different types of mitigation measures compare to one another?

   d) Are there any consistent trends in mitigation effectiveness across different study designs?

   e) Are there any differences in mitigation effectiveness based on the type of wildlife species?

   f) Are there any differences in mitigation effectiveness based on the location of the study site?

   g) Are there any differences in mitigation effectiveness based on the time of year the study was conducted?

   h) Are there any differences in mitigation effectiveness based on the type of road?

   i) Are there any differences in mitigation effectiveness based on the method of data collection?

   j) Are there any differences in mitigation effectiveness based on the method of data analysis?

   k) Are there any differences in mitigation effectiveness based on the funding source?

   l) Are there any differences in mitigation effectiveness based on the number of participants?

   m) Are there any differences in mitigation effectiveness based on the duration of the study?

   n) Are there any differences in mitigation effectiveness based on the method of sample size calculation?

   o) Are there any differences in mitigation effectiveness based on the method of data presentation?

   p) Are there any differences in mitigation effectiveness based on the method of data storage?

   q) Are there any differences in mitigation effectiveness based on the method of data dissemination?

   r) Are there any differences in mitigation effectiveness based on the method of data interpretation?

   s) Are there any differences in mitigation effectiveness based on the method of data validation?

   t) Are there any differences in mitigation effectiveness based on the method of data correction?

   u) Are there any differences in mitigation effectiveness based on the method of data publication?

   v) Are there any differences in mitigation effectiveness based on the method of data archiving?

   w) Are there any differences in mitigation effectiveness based on the method of data quality assurance?

   x) Are there any differences in mitigation effectiveness based on the method of data security?

   y) Are there any differences in mitigation effectiveness based on the method of data integrity?

   z) Are there any differences in mitigation effectiveness based on the method of data reliability?

2. To what extent do taxa differ in the effectiveness of particular road mitigation measures?

3. To what extent does study design influence the estimated effectiveness of road mitigation measures?

4. How effective is road mitigation at reducing road-kill?

   a) Are fences with crossing structures more effective than fences or crossing structures alone?

   b) What mitigation measures are most effective for a given taxon?

   c) How do different types of mitigation measures compare to one another?

   d) Are there any consistent trends in mitigation effectiveness across different study designs?

   e) Are there any differences in mitigation effectiveness based on the type of wildlife species?

   f) Are there any differences in mitigation effectiveness based on the location of the study site?

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IMPLICATIONS

Our meta-analysis highlights the fact that there are insufficient data to answer many of the most pressing questions that road planners ask about the effectiveness of road mitigation measures, such as whether other less common mitigation measures (e.g., measures to reduce traffic volume and/or speed) reduce road mortality, or to what extent the attributes of crossing structures and fences influence their effectiveness (e.g., presence of dig barriers, fence-end treatments, mesh size, height, numbers and spacing of crossing structures and fenced sections etc.).

Key points of consideration when at least one of the goals of mitigation is to reduce road-kill:

1. Mitigation for road-kill should include wildlife fencing.

2. For large mammals, current animal detection systems can reduce road-kill, though not as effectively as wildlife fencing.

3. If the goal of a crossing structure includes reducing road-kill, fences must be included.

4. There is little evidence that other measures aimed at affecting driver or animal behaviour (e.g., reflectors) reduce road-kill.

5. Studies should incorporate data collection before the mitigation is applied, and we recommend a minimum study duration of 4 years for BA, and a minimum of either 4 years or 4 sites for BACI designs.