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Reducing the threat of wildlife-vehicle collisions during peak tourism periods using a Roadside Animal Detection System

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ABSTRACT

Roadside Animal Detection Systems (RADS) aim to reduce the frequency of wildlife-vehicle collisions. Unlike fencing and wildlife passages, RADS do not attempt to keep animals off the road; rather, they attempt to modify driver behavior by detecting animals near the road and warning drivers with flashing signs. A RADS was installed in Big Cypress National Park (Florida, USA) in 2012 in response to an increased number of Florida panther mortalities. To assess driver response, we measured the speed of individual cars on the road when the RADS was active (flashing) and inactive (not flashing) during the tourist season (November–March) and the off-season (April–October), which vary dramatically in traffic volume. We also used track beds and camera traps to assess whether roadside activity of large mammal species varied between seasons. In the tourist season, the activation of the RADS caused a significant reduction in vehicle speed. However, this effect was not observed in the off-season. Track and camera data showed that the tourist season coincided with peak periods of activity for several large mammals of conservation interest. Drivers in the tourist season generally drove faster than those in the off-season, so a reduction in speed in response to the RADS is more beneficial in the tourist season. Because traffic volume and roadside activity of several species of conservation interest both peak during the tourist season, our study indicates that the RADS has the potential to reduce the number of accidents during this period of heightened risk.

1. Introduction

Roads are a ubiquitous feature in today's landscape; as of the year 2003, only an estimated 3% of land in the United States was more than 5 km from a road (Riitters and Wickham, 2003), a figure that has almost certainly decreased since then. The effects of these pervasive anthropogenic features on wildlife have been studied for decades (reviewed in Forman et al., 2003; Coffin, 2007; van der Ree et al., 2015a). We now know that the impacts of roads on wildlife are myriad: from altering patterns of animal abundance (reviewed in Fahrig and Rytwinski, 2009); producing a novel source of environmental noise, causing animals to change spectral and temporal features of their vocalizations (reviewed in Slabbekoorn and Ripmeester, 2008; Lowry et al., 2013); and even releasing certain species from predation pressure (Rytwinski and Fahrig, 2007; Munro et al., 2012). Despite the innumerable and complex ecological effects of roads, their best-known effect on wildlife is the simplest: roadkill. In addition to being graphic and easily observed, roadkill is in the forefront because of its negative effects on humans: In the United States alone, collisions with large animals cost over $1 billion per year in property damage, in addition to hundreds of human deaths and tens of thousands of injuries (Huijser et al., 2007a). Probably due to these factors, most efforts to mitigate road effects on wildlife have focused on preventing roadkill (van der Ree et al., 2015a).

A traditional solution to reducing roadkill, especially for mammals, is to install a combination of fences and crossing structures, keeping animals off of the road and allowing them to cross only at certain points (van der Ree et al., 2015b; Smith et al., 2015). Although this type of mitigation works well for some species, it has disadvantages. Unless fences are well-maintained, animals will breach them soon after installation (van der Ree et al., 2015b). In addition, to be effective in excluding animals that can climb, fences must incorporate smooth surfaces that make it difficult for animals to get purchase or have an overhanging lip at the top of the fence (Klar et al., 2009), features that can detract from the aesthetic of the roadside area. Moreover, crossing structures are expensive, with single structures often costing millions of dollars (Huijser et al., 2007b).

In response to the costs and limitations of fence-crossing systems, in the 1990s an alternative mitigation strategy was introduced: Roadside Animal Detection Systems (RADS). First tested in Switzerland (Huijser

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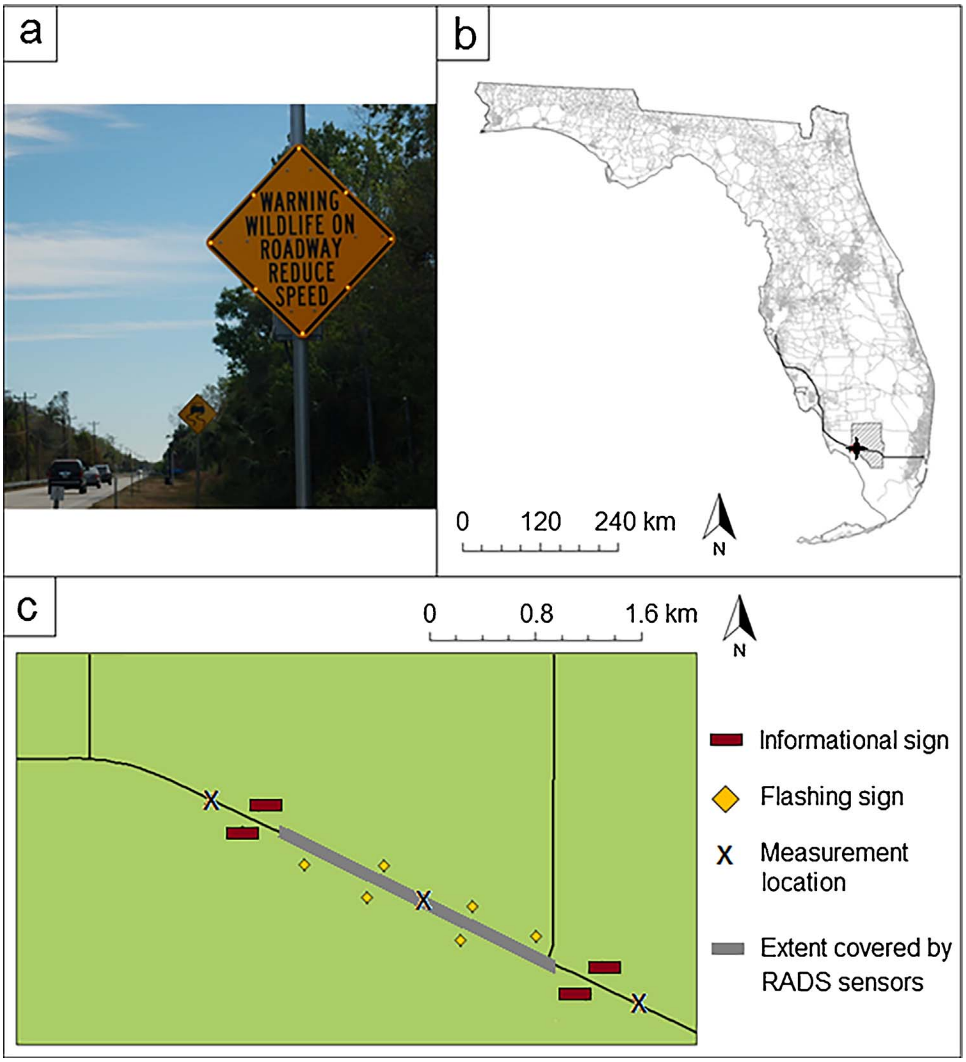

Fig. 1. RADS signage, landscape context, sensor array and speed test locations. a: Image of the RADS warning signs, with the 8 LED lights visible around the edge of the sign that flash when the infrared beam is broken. b: Big Cypress National Park (striped polygon) in southern Florida, with U.S. Highway 41 highlighted with a bold black line. The star indicates the location of the RADS, in the west of Big Cypress. c: The area covered by RADS infrared sensors on U.S. Highway 41 (RADS array).

and McGowen, 2003), RADS differ from fencing in that they do not attempt to keep wildlife off of the road; rather, they attempt to warn drivers when wildlife are near the road. Animals are detected by sensors in the roadside area (often infrared, but sometimes thermal or motion-activated); when the sensors are tripped, a signal is sent to road signs, which begin to flash in warning. Since the 1990s, at least 34 systems have been installed across North America and Europe (Huijser et al., 2006). These systems offer a potential improvement over traditional "static" warning signs, which are a permanent fixture of the roadside, or even digital signs that are only activated between certain hours, because they are only activated for a short time when an animal is near the road. This decreases the possibility that drivers will "tune out" the warning, as often occurs with other sign types (Huijser et al., 2015).

Mitigation efforts in road ecology are consistently plagued by a lack of empirical evaluation, a problem found throughout conservation biology due to low statistical power and limited budgets (Legg and Nagy, 2006; Field et al., 2007; Lindenmayer and Likens, 2010). As such, there have been calls for increased rigor when testing mitigation strategies (Roedenbeck et al., 2007; van der Ree et al., 2007). This issue extends to RADS as well: despite the proliferation of animal detection systems around the world, only one peer-reviewed study evaluating its effect on driver behavior has been published (Gordon et al., 2004). Gordon et al. studied a RADS installed to reduce wildlife-vehicle collisions during mule deer migration in Wyoming and found that, on average, drivers reduced speed by 6–7 km/h in response to the warning lights at night; when drivers were tested at night with the addition of a roadside deer decoy, they reduced speed by 20 km/h. These results are promising, but some questions remain. For example, Gordon et al. reported that the road along which the system was placed was travelled primarily by non-local motorists; it remains to be seen if local drivers may adapt to the RADS and begin to ignore the system.

In addition, and perhaps more importantly, a short-term field study is not able to assess whether a RADS actually reduces wildlife-vehicle collisions, an assessment that would require years of pre- and post-mitigation monitoring. To address this issue, we performed a study with a driving simulator that not only assessed the effect of RADS on driver speed, but required subjects to react to a deer coming out in the road in front of them (Grace et al., 2015). We found that, in twilight conditions, a RADS reduced the likelihood of the subject colliding with the deer by either 6.29 or 14 times, depending on the design of the warning signage. In addition, drivers in the simulation reduced their speed by an average of 4.8 km/h in response to a RADS with words-only warning signs (97.9 km/h vs. 92.2 km/h) and by 7.5 km/h in response to signs with a picture of an animal (89.5 km/h), a reduction comparable to what was observed in the field study by Gordon et al. (2004).

Here, we studied driver response to a RADS installed in southern Florida as a way to mitigate collisions with the endangered Florida panther (*Puma concolor coryi*). The driving simulator study (Grace et al., 2015) was based on this real-world RADS, and if we observe similar reductions in speed in the field, it would support the potential for RADS to reduce crashes as well. By sampling throughout an entire year, we aimed to assess not only whether the RADS was successful at reducing