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Reducing Vehicle Collisions With the Central American Tapir in Central Belize District, Belize

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Abstract

The Central American tapir *Tapirus bairdii* is the national animal of Belize. Accidents from vehicle collisions pose a new threat to the species. A total of 14 tapir deaths were recorded from June 2008 through December 2012 in Central Belize District. Two areas were identified as hot spots for tapir-vehicle collisions (TVCs), and spot-speed surveys revealed speeding to be common in that area. More than 47% of the vehicles were traveling above the prescribed speed limit, and another 28% were driving at speeds of 100 kph or faster. In an effort to reduce speed and the risk of TVCs, we deployed two sets of reflective wildlife crossing signs over a 6-km stretch of road. This was followed by an awareness campaign alerting drivers of tapirs' presence in the area. We saw a significant reduction in speed immediately after the installation of the warning signs, and no TVCs were recorded for the next 10 months. Consequently, camera-trapping and track surveys were undertaken to confirm the species continued presence in the immediate area. Over the next 2 years, only two collisions were recorded along the same stretch of road.

Keywords

Central American tapir, camera trapping, endangered species, road ecology, *Tapirus bairdii*, wildlife-vehicle collision

Introduction

The Central American tapir, *Tapirus bairdii*, is the national animal of Belize and is listed as "Endangered" by the International Union for Conservation of Nature Red List of Threatened Species (2012); the species is also listed under Convention on International Trade in Endangered Species (2012) Appendix I. It is threatened by habitat loss and fragmentation as well as hunting. Central American tapirs are believed to be important to the forests they inhabit by playing a significant ecological role as seed dispersers, important agents in nutrient cycling, and thus can serve as biological indicators for conservation management (Medici et al., 2006; Naranjo, 2009; O'Farrill, Calme, & Gonzalez, 2006). *T. bairdii* is the largest terrestrial mammal species in Belize, and because of its large home range requirements, it is one of the first species to be affected by habitat disturbances and changes (Medici et al., 2006).

It is well documented that roads and road infrastructures have a net direct negative impact on wildlife (Clements et al., 2014). Roads can lead to habitat loss, reduced habitat quality, and reduced habitat connectivity (Forman & Alexander, 1998; Spellerberg, 1998), which, in turn, are expected to reduce genetic connectivity among populations (Trombulak & Frissell, 2000). Furthermore, large-bodied animals like *T. bairdii* that have low reproductive rates and require large home range sizes are more susceptible to local extinction from high incidences of road mortality (Laurance, Goosem, & Laurance, 2009; Rytwinski & Fahrig, 2012).

Currently, the cost of wildlife-vehicle collisions in Belize and Latin America is unknown. In North America, however, the estimated annual damages

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associated with wildlife-vehicle collisions approaches $1 billion. The cumulative impact that road collisions have on Central American tapir populations is also unknown. Between June 2008 and December 2012, a total of 14 tapir deaths from strikes with vehicles were confirmed along a relatively short road section in Belize (Poot, 2012). These fatalities were recorded along the Burrell Boom road, a 19-km bypass in the Central Belize District that connects two major highways and eliminates the need to drive through Belize City. These numbers are comparable to those reported by Medici and Desbiez (2012) in Brazil, where their modeling showed such high mortality numbers would have a significant impact on the long-term viability of an isolated lowland tapir (*Tapirus terrestris*) population.

Measures to reduce wildlife-vehicle collisions include strategies aimed at influencing driver or animal behavior (Huijser & McGowen, 2010; Huijser et al., 2007). This is usually done by erecting wildlife crossing structures, fencing, warning signs, animal detection systems, and public information campaigns (Beckmann, Clevenger, Huijser, & Hilty, 2010). Despite vehicle collisions with tapirs being a serious concern for motorist safety, we are not aware of any mitigation studies that have evaluated methods of reducing these collisions. Therefore, our goal was to evaluate the effectiveness of two methods used together (i.e., road signs and educational awareness campaign) at reducing tapir-vehicle collisions (TVCs). Specifically, we sought to test whether there was a correlation between vehicle speed and the number of collisions with tapirs. Because we feel that there is a relationship between vehicle speed and the number of TVCs, we hypothesized that the presence of tapir crossing signs along the road would reduce tapir mortality events.

Methods

Study area

Our study took place along the Burrell Boom road, a 19-km bypass in Central Belize District (Figure 1). The road is two lanes and has an annual average traffic volume of 2,000 vehicles per day (G. Medina, personal communication, November 17, 2017).

A vehicle's breaking distance directly correlates with its travel velocity: The faster the vehicle travels, the longer its breaking distance (Fambro, Koppa, Picha, & Fitzpatrick, 2000). We therefore assumed that slower moving vehicles are less likely to have fatal collisions with tapirs than faster moving vehicles. In an effort to reduce the speed of vehicles traveling through the area, we installed two pairs of standard wildlife crossing signs ($n = 4$) in early December 2012 (Figure 2). One pair of signs was installed 3 km apart, one each on either side of the road; the second pair was installed 2 km apart, one each on either side of the road, in total they cover 6 km stretch of the Burrell Boom road. We measured vehicle speeds ($n = 100$) at the halfway point between each set of signs. To determine whether signs affected vehicular speed, we collected speed data from 1700 h to 2000 h before and after deploying the warning signboards. We tested these data to see whether the signs affected the mean and median values of speed; the latter being a tool used to determine effective and adequate speed limits (Homburger, Hall, Loutzenheiser, & Reilly, 1996).

Data were collected midweek to avoid high volume and peak traffic because off-peak measurements are more appropriate for assessing general speed trends (Ewing, 1999). We used a Bushnell® Speed Radar Gun to collect speed data at two sites: One at the halfway point within one of the area treated with signs (treatment), and the second at an area where no collision incidents have been recorded (control). All efforts were made to conceal the radar gun, especially during the daylight hours.

Immediately following the installation of the signs, we conducted a full day (0700 h–1900 h) awareness campaign at the entrance of the Burrell Boom road. The campaign included having a life size paper maché tapir along the road, passing out informational brochures, and an "I Brake for Tapirs" bumper stickers to the drivers (Figure 3). The awareness campaign was repeated twice over the next 3 months and was carried out on a Saturday to maximize our efforts in order to inform as many users of the road as possible.

One week after the installation of the signs, a second set of speed data were collected at the same sites to assist in determining the effectiveness of the signs. The mean speed was calculated using a frequency distribution table. A two-sample t test was used to determine whether there was a significant difference in the mean speed in the treatment and control sites pre- versus postinstallation of signs. Median values make sense whether there were a few fast speeding vehicles, which would pull the mean upward. From inspection of the histograms, that was not the case for these data. Median speeds were tested using Wilcoxon rank-sum test with continuity correction in the treatment and control sites pre- versus postinstallation of signs.

Specific tracks and signs left by mammals are used to identify the presence of a particular species. Animals are detected by following tracks left behind, which is one of the oldest methods used to identify species presence in an area (Silveira, Jácomo, & Diniz-Filho, 2003). Complementary to track surveys, the use of remote cameras has been widely used to detect elusive species in wildlife surveys (Locke, Parker, & Lopez, 2012; Rovero & Marshal, 2009;). Camera traps work best when setup in areas known to be frequented by the studied species;

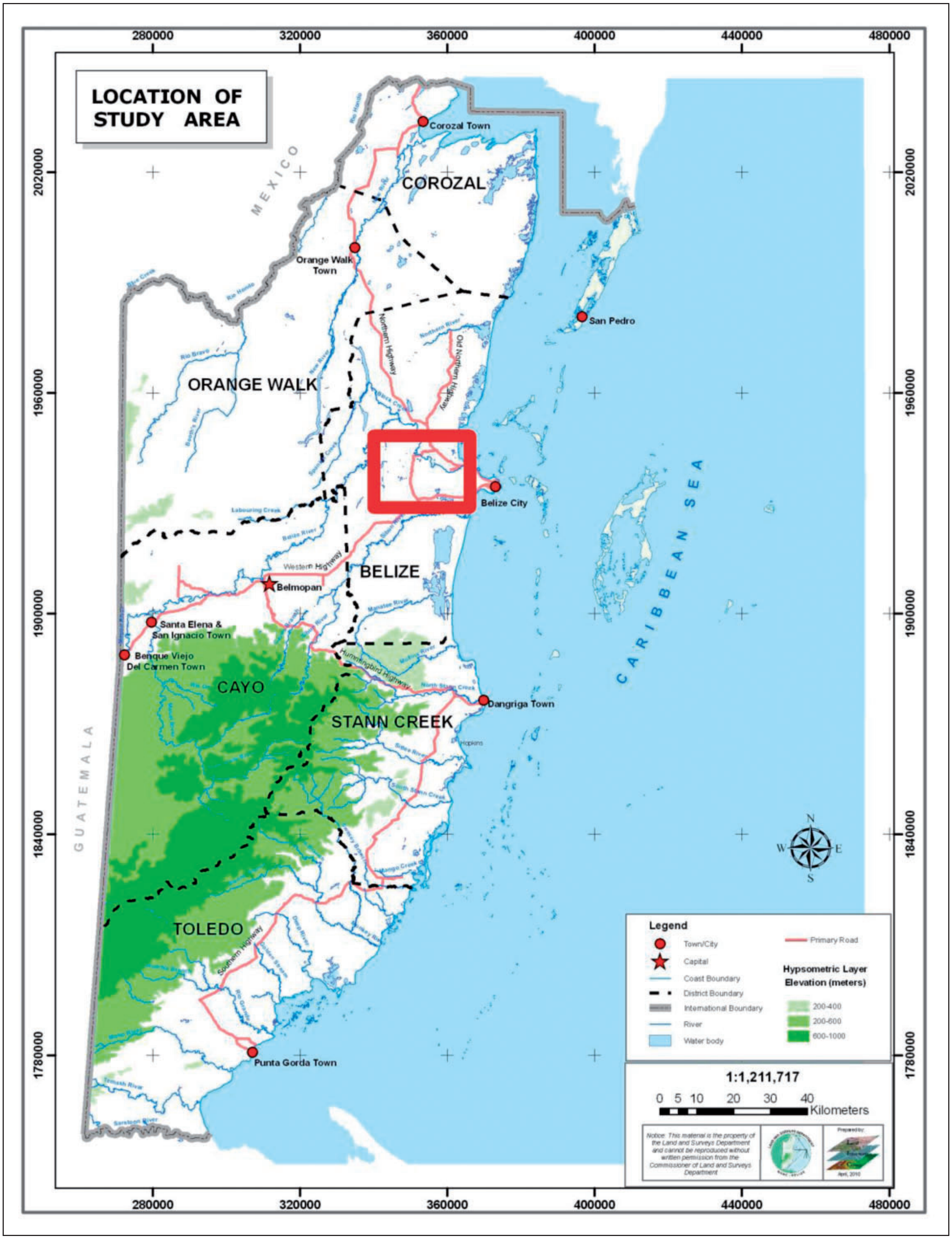

Figure 1. Study area in Central Belize District.

Figure 2. Two sets of reflective wildlife crossing signs were installed at two hot spots identified for tapir-vehicle collisions.

Figure 3. After the installation of the wildlife crossing signs, an awareness campaign was conducted on the Burrell Boom road to inform drivers of the efforts to reduce tapir-vehicle collisions in the area.

camera-trapping and track surveys are considered noninvasive methods to study elusive species (Kays & Slauson, 2008) like the tapir and worked well in meeting the objectives of this project.

There were no TVCs for the first 10 months of 2013. We believed that one of the two possibilities existed: Either the signs had influenced motorist to reduce vehicular speeds and thus no TVCs or tapir had become locally extinct due to previous vehicular collisions. To determine whether tapirs were still present in the Burrell Boom area, and not locally extinct, we conducted line transect surveys and camera trap surveys. Three 100-m line transects were established 5 m from and parallel to the Burrell Boom road. We selected two of our line transects in area where TVCs had been recorded, with the third-line transect where no collisions had been recorded since June 2008. Along these same transects, we placed two Moultrie® M-880 game cameras on each transect ($n = 12$ cameras) at locations where we thought it was likely that tapirs would pass. Two cameras were placed on the east and two were placed on the west side of the road on each transect. We set cameras at 0.5 to 1.75 m on trees or posts, as available. Each camera received eight double A size batteries and a 16-GB SanDisk Memory card, all settings were programmed prior to each camera being fitted with cable ties to secure them to the trunks of different trees or to a posts. For the duration of the camera survey, we checked each camera every 3 days as suggested by Kays and Slauson (2008); the SanDisk cards were removed and viewed with a Moultrie® Picture and Movie Viewer. Each camera was left in place for 30 days.

After the cameras were installed, each transect was walked to look for evidence of tapir presence (i.e., tracks and scat). We walked 100 m transects on both sides of the road, yielding 600 m of transect per survey. Tapir presence surveys were repeated on the next game cameras check. Evidence of tapir presence in the area was photographed and geographic coordinates recorded (Universal Transverse Mercators, NAD27).

Results

Prior to the implementation of measures to reduce vehicular speed on the Burrell Boom Road, vehicles were traveling as fast 133 kph at one site where TVCs were recorded over 4.5 years ($n = 8$ TVCs); 47% of the vehicles were traveling above the prescribed speed limit of 88 kph (55 mph is the speed limit; Belize uses the imperial unit of measure). After the installation of the signs, 38% of the vehicles were still traveling above the prescribed speed limit. However, at the control site, no significant changes were noted. Our data show that there was a statistically significant change in the mean and median speeds before and after the installation of the signs (Table 1.)

Using Srbek-Araujo and Chiarello (2004) method of calculating sampling efforts, a total of 360 trap nights were conducted (Number of Camera Traps × Number of Trap Nights). A total of 1,200 m were surveyed along the west and east side of the Burrell Boom Road; 200 m were walked along each transect and each transect was walked twice. Camera traps and track surveys conducted confirmed the species continued presence in the area. During the first track survey along Transect Number 3, located in the area treated with wildlife crossing signs, tapir tracks were noted at two sites; one each on the east and west side of the Burrell Boom road. One track was in good condition and appeared to be very recent; the other track on the east side of the road appeared to be older and weathered. Within the first 72 h of our camera survey, our cameras captured two photos of tapirs; the photos were taken along Transect Number 2 and were taken almost 24-h apart. Evidence of tapir sign, and the fact that we continued to capture tapir on camera tells us that tapir are still using the Burrell Boom area.

Discussion

The most conventional strategy to reduce wildlife-vehicle collisions is for transportation agencies to install warning signs to alert drivers of the presence of animals in an area (Knapp & Witte, 2006); however, the effectiveness of erecting warning signboards is not yet clear (Huijser et al., 2007; Meyer, 2006; Sullivan & Messmer, 2003). In this study, we were able to show significant reductions in vehicle speeds before versus after installation of the signboards, while on the unsigned control sections vehicle speeds were unchanged. This suggests that, at least in our study and during the term of our study, signage and awareness campaigns appeared to reduce vehicle speeds on a stretch of road with frequent TVCs.

Homburger et al. (1996) suggest that if the 85th percentile of speed is 8 kph above the prescribed speed limit, speeding might be an issue of concern. The 85th percentile of speed was the same at both the treated area and at the control area, 109 kph, before the installation of the wildlife warning signboards. This is more than 20 kph above the speed limit. After the installation of the warning signboards, the 85th percentile of speed was calculated to be 102 kph in area with warning signs and remained the same in the control area. While the mean, median, and the 85th percentile of speed showed a reduction in the treated area, speeding remains a problem. Speeds of up to 122 kph and 134 kph were recorded in the treated and control areas, respectively, after the signboards were installed.

A reduction in speed was anticipated, and the fact that the decrease is statistically significant is encouraging. The reduction in speed could have been attributed to the fact that the signs were newly installed, and their installation was complemented with an awareness campaign on the

Table 1. Before and After Speed Data Collected at a Site With High Incidence of Tapir-Vehicle Collisions.

	Treatment			Control		
	Before kph	After kph	*t*/*W*, *p*	Before kph	After kph	*t*/*W*, *p*
Median	88	83	6,055.5, .009	90	90	4,712, .482
Mean	91	85	2.155, .003	89	91	−0.768, .443

Note. Median values were tested with Wilcoxon rank-sum test with continuity correction (*W*), while mean values with two-sample *t* test (*t*).

road. However, since no TVCs were reported for 2013 and our line transect and camera trap surveys confirmed that tapirs were still present in the area, this suggests some level of awareness of the species presence in the area. Because only three speed limit signs were observed on the road, efforts are being made to have more speed limit signs installed; currently, the signs are located on entering or exiting the bypass in populated areas, and one near the Central Prison. Enforcement of speed limit in Belize is almost nonexistent, and therefore efforts need to be placed on driver behavior to reduce speed.

We were recording between three and four tapir fatalities per year on the Burrell Boom road prior to the installation of the warning signs. Subsequently, in November 2013, there were concerns that the local population of tapirs might have been extirpated due to vehicle collisions when none were recorded for that year. Thus, efforts were made to confirm the species continued presence using track surveys and camera traps. The objective was not to determine relative abundance or occupancy level but to detect their presence near the road. No evidence of tapirs was observed in the area where TVCs have not been recorded since our monitoring began in 2008; it may be that the species does not use that particular area of the road and that would have to be confirmed with long-term monitoring of the area.

Implications for Conservation

The central region of the Belize District was described as the country's "fastest growing rural population" in the Belize 2010 Population and Housing Census; this area experienced a 65% increase in its population size over the 10-year period 2000 to 2010 (Statistical Institute of Belize, 2011). This significant population boom has resulted in the expansion of housing developments, farmlands, and roadways. While no new major roads or highways were constructed in the region, several secondary and tertiary roads were opened during this period.

These activities cause further forest habitat fragmentation in the Belize District, possibly contributing to increasing incidences of human–wildlife conflict, particularly vehicular collisions. Food availability and water availability appear to be important factors affecting habitat selection for tapirs and may be determinants to their movement patterns (Brooks, Bodmer, & Matola, 1997; Naranjo & Bodmer, 2002). The Central American tapir population in Central Belize is therefore vulnerable due to declines in forest cover, as it is forced to navigate an increasingly human-dominated landscape in search of suitable habitat.

Mitigation measures designed to reduce vehicle speeds when combined with public awareness campaigns have proven to be useful tools in tapir conservation in this region. These measures will be important as Belize is preparing for the upgrading nearly 60 km of the Coastal Highway (Belize Press Office, 2017) and other highway projects in tapir range. A feasibility study and preparation of detailed design are underway for the Coastal Highway. Signage and awareness campaigns will be one of a suite of measures that can reliably be used to reduce collisions with tapirs and other wildlife along this upgraded highway and others in Central American tapir range. This will provide an opportunity to continue testing signage and public awareness campaigns as a means to reduce TVCs in Belize. Should other measures such as wildlife crossings be implemented, a comparison of the different methods will provide valuable information to validate our findings and future road planning in Belize.

Wildlife crossing structures with or without fencing have been used in Mexico, Costa Rica, and Argentina. We encourage future research on the efficacy of signage and public awareness campaigns to reduce TVCs in other parts of tapir range to compare and contrast with our results. Additional studies on efficacy of mitigation measures in general will increase our understanding of their effectiveness in tropical regions in addition to help ensure the preservation of Belize's national animal, the Central American tapir.

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