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An evaluation of a citizen science data collection program for recording wildlife observations along a highway

Kylie Paul [a,*], Michael S. Quinn [b], Marcel P. Huijser [c], Jonathan Graham [d], Len Broberg [a]

[a] Environmental Studies Program, The University of Montana, Jeannette Rankin Hall 106A, Missoula, MT 59812-4320, USA
[b] Institute for Environmental Sustainability, Mount Royal University, 4825 Mount Royal Gate SW, Calgary Alberta T3E 6K6, Canada
[c] Western Transportation Institute, Montana State University, PO Box 174250, Bozeman, MT 59717-4250, USA
[d] Department of Mathematical Sciences, The University of Montana, Missoula, MT 59812-0864, USA

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ABSTRACT

Citizen science programs that record wildlife observations on and along roads can help reduce the underreporting of wildlife-vehicle collisions and identify and prioritize road sections where mitigation measures may be required. It is important to evaluate potential biases in opportunistic citizen science data. We investigated whether the opportunistic observations of live animals by volunteers along a 46-km section of Highway 3 in the Crowsnest Pass area (“Road Watch in the Pass” data collection program) in Alberta, Canada, had a similar spatial pattern as systematically collected data by the researchers along the same road section. A permutation modeling process that compared the number of observations between the two datasets for each 1-km segment, a randomization method that tested for and compared hotspot observation locations, and a bivariate Ripley’s $L_{1,2}$-function analysis along a continuum of spatial scales all showed spatial agreement between the two datasets. There was spatial agreement at a scale between 1 and 4 km, and three clear hotspots of wildlife observation activity were identified for both processes. This suggests that the data collected by the volunteers are reliable and robust enough to be used to help identify road sections that may require mitigation measures. In addition, volunteers proved to be able to collect a sufficient number of observations relatively quickly. Within one year, 24 volunteers collected 640 wildlife observations, and we found that using only 150 or more of these observations always resulted in spatial similarity with the systematic observations collected by the researchers. We conclude with recommendations for other citizen science data collection programs and for further research.

1. Introduction

Integrating the public into scientific research is a rapidly growing phenomenon known as ‘citizen science’ (or public participation in scientific research), whereby scientific research projects are developed with some level of public engagement (Bonney et al., 2009; Hand, 2010; Shirk et al., 2012). Citizen scientists can provide an inexpensive, substantial, and long-term labor force (Conrad and Hilchey, 2011; Gouveia et al., 2004; Stokes et al., 1990) capable of collecting reliable and large datasets in a relatively short time over large geographical areas (Fore et al., 2001; Foster-Smith and Evans, 2003; Newman et al., 2003; Bonney et al., 2009). There are many perceived benefits to integrating citizens into knowledge production about the environment such as promoting awareness of local environmental issues, building community capacity to enhance public involvement in stewardship, fostering an environment for a stronger public role in decision making, and the generation of data collected at a lower cost than conventional science (Conrad and Hilchey, 2011). There are also many perceived challenges such as the integration of data collected by citizens into the scientific process, ensuring data quality, difficulties of working with volunteers (including maintaining their engagement) and quantifying success (Bonardi et al., 2011; Kremen et al., 2011a,b). The purpose of the current paper is to evaluate the data quality of a contributory citizen science program aimed at monitoring wildlife along a highway.

Citizen science has been used in studies that aim to identify and prioritize road sections that may require management actions to reduce wildlife-vehicle collisions (WVCs) and that may require safe crossing opportunities for wildlife (Huijser et al., 2008a; Lee et al.,

* Corresponding author. 500 Linden St Missoula, MT 59802, USA. Tel.: +1 406 370 6979.
E-mail addresses: skylie101@yahoo.com (K. Paul), mquinn@mtroyal.ca (M.S. Quinn), mhuijser@coe.montana.edu (M.P. Huijser), jgraham@mso.umt.edu (J. Graham), Len.Broberg@mso.umt.edu (L. Broberg).

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2006; Moskowitz et al., 2007). Mitigation measures that are considered substantially effective in reducing WVCs (e.g. >80% reduction in WVCs), while also providing safe crossing opportunities for wildlife, include wildlife fencing in combination with wildlife underpasses and overpasses, and animal detection systems (Clevenger et al., 2001; Dodd et al., 2007; Huijser et al., 2009). Identification and prioritization of road sections that may require mitigation measures is essential as resources may be limited and the effectiveness of safe crossing opportunities is strongly influenced by their placement (Clevenger and Waltho, 2005; Ng et al., 2004). Data that show where animals cross the road successfully (rather than simply at WVC hotspots) are critical to the placement of safe crossing opportunities (Clevenger et al., 2002a; Lee et al., 2006). Citizen science programs that record live wildlife observations can contribute important data and identify road sections where safe crossing opportunities may be needed most. However, it is important to evaluate potential biases (Engel and Voshell, 2002; Gouveia et al., 2004; Kremen et al., 2011a,b) in the data collected through citizen science programs.

In this study, we examined potential biases in the "Road Watch in the Pass" (RW) data collection program. RW is a citizen science program that documents wildlife sightings along Highway 3 in the Crowsnest Pass area (CNP) in Alberta, Canada (Lee et al., 2006). We compared the RW data ("opportunistic data") to data collected by the researchers through a systematic driving survey ("systematic data") on the same road section and investigated the accuracy of the spatial distribution of observations of live animals collected through the RW program. In addition, we calculated the minimum number of wildlife observations needed to have the RW program generate an accurate spatial distribution of the wildlife observations. This threshold value is of importance to other citizen science programs aimed at collecting wildlife observation data along highways. Finally we discuss potential improvements to citizen science programs aimed at recording wildlife observations on and along roads.

2. Materials and methods

2.1. Study area

We conducted our research along a 46-km stretch of Alberta Highway 3 in the CNP in southwestern Alberta, from the border with British Columbia to the town of Lundbreck (Fig. 1). Highway 3 is a two-lane road, and the vehicle speed limit varies between 50 and 100 km/h. Traffic volume ranges between 2500 vehicles per day in the winter and 10 500 in the summer (Alberta Infrastructure and Transportation, 2006a). The study area is mountainous with elevation ranging from 1110 m at the valley bottom to 2800 m at the mountain peaks (Lee et al., 2006). The area consists of six small communities (Fig. 1) with a total population of 5750 in 2006.

CNP is a critical area for regional-scale wildlife movements in the Rocky Mountains (Carroll et al., 2001; Proctor et al., 2002) with a full range of large carnivore and ungulate species occurring in the region. The Province of Alberta has proposed an expansion to four lanes of the CNP section of Highway 3 in the next 10–15 years (Alberta Infrastructure and Transportation, 2006b). Wildlife mortality from WVCs on Highway 3 is a human safety concern as well as a wildlife conservation problem, with an average of 109 large mammal deaths reported annually on the 46-km stretch (Lee et al., 2006). In addition, Highway 3 is already a partial barrier to grizzly bear movements (Proctor et al., 2002). The proposed expansion of Highway 3 is likely to increase the human safety and wildlife conservation problem, suggesting a need for data that will help identify and prioritize road sections that may require mitigation.

2.2. Systematic data collection

Between 28 May 2006 and 14 August 2006 the researchers drove the 46-km stretch of Highway 3 four times a day, five days a week, totaling 20 drives per week, and recorded animals seen alive on or alongside the highway. Each drive took 45 min and the

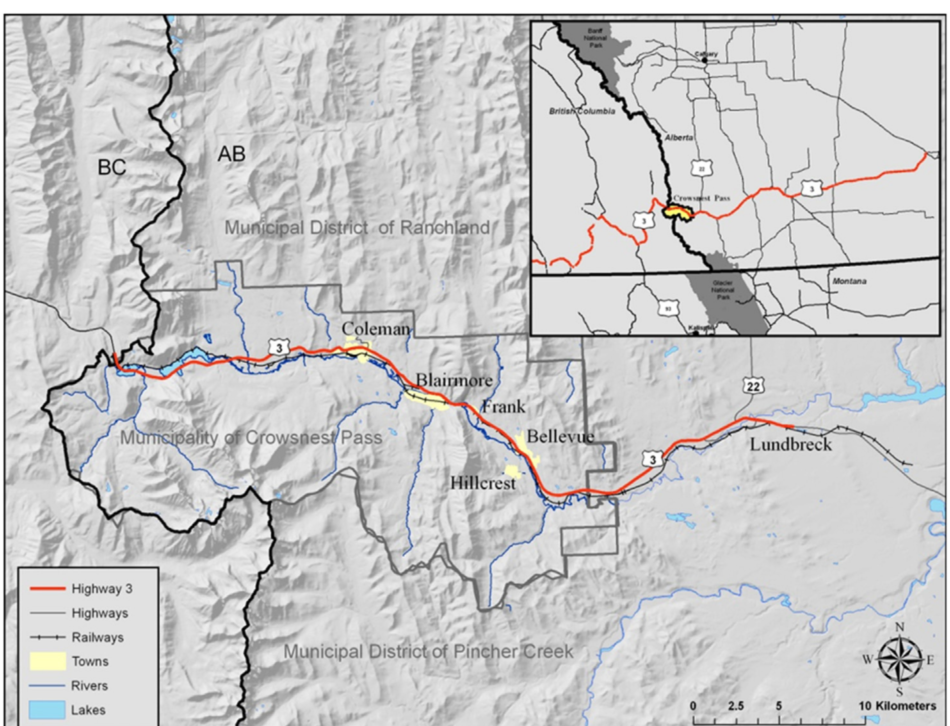

Fig. 1. Study area with Highway 3 from the Alberta–British Columbia border to Lundbreck, Alberta.