

Brown bears coping with Croatian highways

Daniele De Angelis^a, Josip Kusak^b, Slaven Reljic^b, Bojan Vivoda^c & Djuro Huber^b

^aDepartment of Environmental Biology, Sapienza University of Rome

^bFaculty of Veterinary Medicine, University of Zagreb, Croatia

^cRijeka Zagreb Motorway, Širolina 4, 10000 Zagreb, Croatia



1. Introduction

Transportation routes are the single strongest fragmenting factor of the habitat. In Croatia there are over 1000 km of fenced highways, with 319 km within the brown bear range. Due to the topography and to the specific mitigation measures, 43.6 km (13.6%) are permeable for bears and other ground dwelling animals, as the highway is passing through tunnels, over viaducts or bridges, or under specifically constructed wildlife crossing (i.e.: green bridges, see Fig. 1). We used GPS telemetry data obtained from 4 male bears captured and equipped with radio-collars within 2 km from the highway, to identify locations and frequency of crossings.



Fig. 1: "Dedin", one of the 11 green bridges along Croatian highways

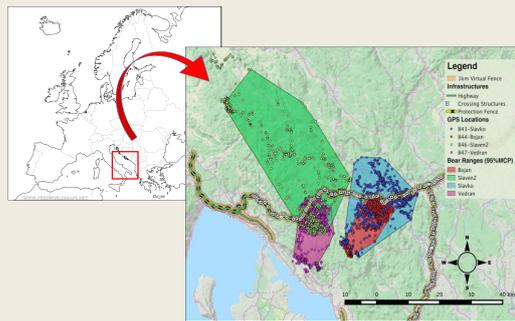


Fig. 2: Study area: the trait of Brijuni-Rijeka highway. Colored dots represent GPS locations of four male bears equipped with GPS-VHF collars during May-November 2015; polygons represent their range (95%MCP). Crossing structures and traits of highway protected by fence are also indicated.

2. Materials & Methods

We equipped four male bears with GPS-VHF-collars Vectronics®, activating the virtual fence function to define a buffer of 1 km on each side of the Brijuni-Rijeka highway (A6). Within this buffer collar acquisition rate increased from 1 fix/hr to 1fix/15min. We followed their movements from May 20th to November 3rd (167 days). Then we listed and identified by type all the crossing structures on the trait between Rijeka and Brijuni (81.9 km). We therefore distinguished between crossings occurred through available crossing structures (i.e. over bridges, under viaducts or underpasses) or trespassing the protective fence. We selected four points for each crossing event and used Brownian bridge movement model (BBMM) to estimate likely crossing points. BBMM allows precise estimation of area utilized by individuals, accounting for spatio-temporal distance between relocations and path tortuosity.

Results

Locations where highway is under tunnel were those with the highest mean crossing probability. Only two crossings were assigned to fences. Remaining crossings (96%) occurred either. During the study period we registered 69 total crossing events, 53 of which were classified and assigned to respective crossing structures. No crossing occurred on Dedin green bridge.

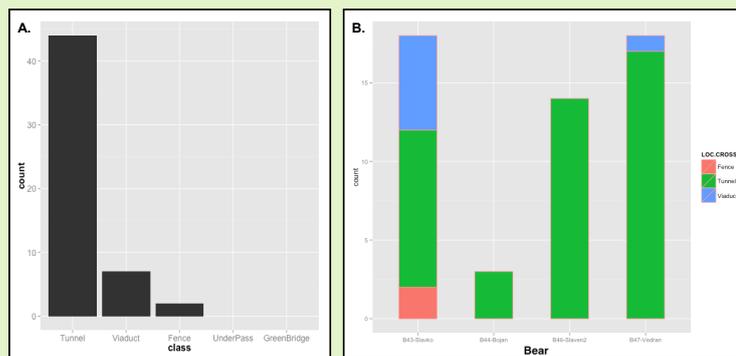


Fig. 3: A) Count of crossing events occurred on each of the 5 crossing structure classes available. B) Classes of crossing structures used by each of the four bears followed through GPS.

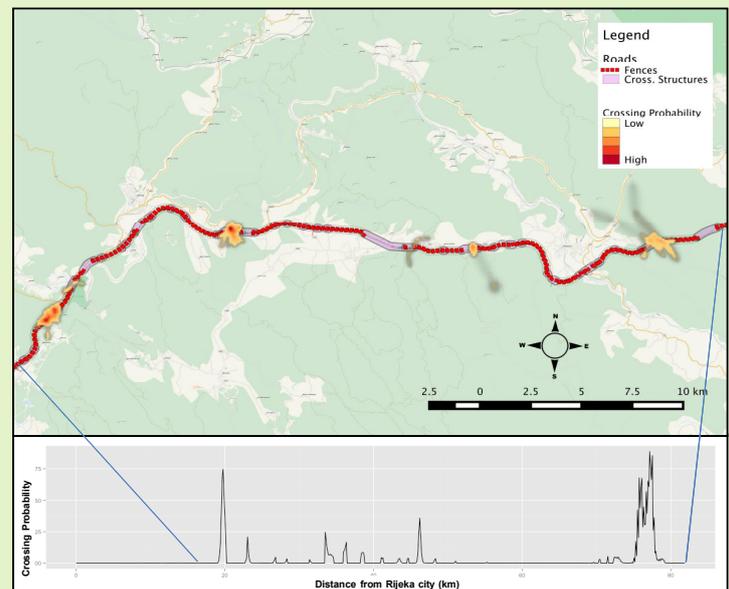


Fig. 4: Crossing probability along the 81.9 km Brijuni-Rijeka highway obtained with BBMM. Highest probabilities are recorded where highway is under tunnel.

Conclusions

Our study represents a preliminary assessment of the interactions between bears and A6 highway in Croatia. The high acquisition rate of collars within the virtual fence surrounding the highway and the BBMM approach allowed us to distinguish between crossings occurred either on proper crossing structures or over the protective fences. The Brijuni-Rijeka highway seems to be permeable to bears in more than one location despite the recent implementation of fences. Further effort will be addressed in investigating environmental characteristics that may affect the selection of crossing structures by individuals. We conclude that bears do use available crossing structures and the reinforcement of the existing fence could prevent remaining unwanted situations of bears crossing the highway on the tracks.

References

- [1] Cleveger, Anthony P., and Nigel Waltho. "Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada." *Conservation Biology* 14.1 (2000): 47-56.
- [2] Horne, Jon S., et al. "Analyzing animal movements using Brownian bridges." *Ecology* 88.9 (2007): 2354-2363.
- [3] Kusak, Josip, et al. "The permeability of highway in Gorski kotar (Croatia) for large mammals." *European Journal of Wildlife Research* 55.1 (2009): 7-21.
- [4] Shepard, D. B., et al. "Roads as barriers to animal movement in fragmented landscapes." *Animal conservation* 11.4 (2008): 288-296.

Daniele De Angelis, PhD Student at Sapienza University of Rome
 Mail: daniele.deangelis@uniroma1.it Tel.: +39 3496033024

Acknowledgements:

