Saving wildlife on India's roads needs collaborative and not competitive efforts

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Roads – uniting humans, dividing nature

Transportation infrastructure is central to the functioning and development of human societies. However, the widespread network of transportation infrastructure worldwide has also altered natural landscapes drastically in the past century. These networks pervade far beyond any other human infrastructure, and pose multiple negative impacts to the natural elements of the landscapes they cut across[1,2]. Road networks worldwide have splintered previously undisturbed swathes of forests into nearly 600,000 patches, only 7% of which are larger than 100 km^2 in size[3], making movement across these patches challenging for wildlife. Road and traffic emissions such as noise, gaseous and liquid pollutants, and solid waste also cause disturbance and may result in avoidance of these forests by wildlife[4].

Roads with traffic affect wildlife by creating barriers to their movement across landscapes, particularly affecting long-ranging species such as tiger, elephant, leopard, dhole and wolf[5,6]. This can lead to fragmentation and eventually isolation of populations[7]. The most conspicuous impact of roads is mortality of animals. Ecologically, road-related mortality because of collision with moving vehicles is detrimental to animal populations as it is non-selective, i.e. it affects healthy as well as weak individuals of a population[8]. It can also lead to local extinction of species[9]. Animal–vehicle collisions also cause injuries and fatalities to humans and economic losses due to vehicular damage[10]. Roadkill is also the most studied impact of roads on wildlife, with literature on the subject available from as early as 1935 (ref. 11). Most road ecology studies in India too are centred on road-related mortality.

Mitigation measures such as overpasses, underpasses and restricted timings on the use of roadkill-prone highway segments are commonly used strategies to curb mortalities of wildlife. Proper implementation of such measures requires reliable long-term roadkill and ecological data. Given the spread of the Indian road network, the task of collecting information on roadkill on roads passing through forest areas throughout the country is an enormous task.

More eyes on the road

Citizen science, which is the collection and analysis of scientific data by the general public, has been successful for recording natural observations[12], bird observations and migrations[13], and many others all around the world. The dawn of information technology has further given an impetus to the involvement of the public in conservation issues through citizen science. This has helped reduce pressure on scientific research groups by increasing the spatial coverage of data collection and has revealed interesting results which would otherwise have been beyond the scope of individual research projects. In short, the right combination of citizen science projects and methods of participation can benefit conservation significantly.

A similar app-based citizen science approach has been initiated by two conservation NGOs in India to record roadkill. The apps aim at increasing the spatial and temporal spans of data collection, engaging the general public and affecting policy change through increased public interest in the issue. Two separate mobile-based roadkill recording apps were launched earlier last year within two days of each other – RoadKill by the Wildlife Conservation Trust, Mumbai and RoadWatch by the Wildlife Trust of India, Noida. Both apps have user-friendly interfaces through which travellers can record roadkill on-the-go from anywhere in the country on their mobile devices by submitting photographs and identifying species or broad species type. The RoadKill app aims to 'democratize data collection' to contribute to better planning and installation of mitigation measures on new and upgraded roads in order to reduce wildlife mortality on roads and improve passenger safety[14]. Data collected under this initiative would be made available through Creative Commons license. The RoadWatch app aims to map hotspots of animal mortality, identify worst-affected species groups and assess effectiveness of existing mitigation measures[15]. Data collected through the app is 'open source', however, data-sharing details are not clear. The RoadWatch website showed 873 roadkill observations (reptiles 343, mammals 203, birds 113, amphibians 126, unidentified 88) at the time of writing this note.

Both the apps are easily available on the internet and their convenient, user-friendly interface makes it easier for the layman to contribute to this important issue. However, the main proposition of developing and promoting such apps is that data on roadkill would prepare conservation agencies better to manage and mitigate the loss of wildlife on the roads. However, such data provide an incomplete picture of the broader understanding of road ecology per se. Additionally, the information generated thus would also be inadequate to inform mitigation measures on new roads.

It is not all about the roadkill

Although it is a great opportunity to channel public interest in conservation, professional conservationists ought to know that roadkill is only a small fraction of the real threat that roads pose to wildlife, and merely represents a symptom of the real problem. It indicates a loss of connectivity among adjacent habitat patches. The road is like a death trap that animals must navigate to make it to the other side. Forests on the roadsides that may seem structurally pristine are made less inhabitable by road and traffic emissions like noise, gaseous pollutants, off-roading of vehicles, littering by motorists, etc. These factors affect the use of roadside habitat by animals that may adapt by changing their patterns of habitat use or by avoiding roadside habitats entirely[16–18]. Therefore, the absence of roadkill from a road may not imply that traffic on that road does not pose any

hazard to wildlife. The pieces of the puzzle lie not on the asphalt, but in the forests surrounding these roads.

Roadkill data for any species or taxa would remain incoherent in the absence of data on the population status and habitat use of animals in the adjacent forest patches. Roadkill numbers may vary with traffic volume and age of the road (time in years during which the road has been operational), where local animal populations across older and high-traffic roads would get depressed over time[19]. This would also influence per capita mortality rates across populations on high- and low-traffic segments, i.e. the chance of an individual of a population getting road-killed[20]. This rate is difficult to assess without reliable estimates of regional populations. Therefore, roadkill hotspots that include data for multiple species may not accurately depict the impact that roadkill has on population structures of different species.

Moreover, shifts in roadkill hotspots have been observed from high-traffic segments to low-traffic segments[21]. Habituation, avoidance and reactions of animals would influence road-crossing behaviour and affect roadkill rates[22]. Therefore, the absence of roadkill of a particular taxon on certain roads does not imply that the taxon is absent from the area, or that the road is not affecting these animals. Such absence may also indicate the activity of scavengers that can remove up to 60–97% of roadkill[23].

The degree to which different taxa get affected by wildlife–vehicle collisions also varies with factors like species characteristics, behaviour and diet. For example, reptiles and amphibians are the most commonly encountered roadkill taxa[24]. This is because they are slow-moving, dependent on roads for their thermoregulatory requirements[25], and are thereby compelled to encounter roads more often. Large mammals have greater cognitive abilities and are able to avoid crossing roads or avoid collision[22]. Roadkill data would therefore be insufficient and misdirected in informing mitigation strategies for maintaining connectivity of landscapes for mammals.

Merely documenting roadkill helps little in understanding the underlying animal movement patterns – what causes the animals to choose certain crossing zones over others? Which animals are most likely to use these crossing zones and, consequently, what placement of crossing structures would benefit most of the species? Navigating through anthropogenic landscapes and across linear features is not as predictable as moving within forests, and depends on myriad factors – sex and age class of the animal, season, vegetation type and traffic volume among others. Radio-tagging animals and camera trapping helps us understand, among other things, the choices they make when confronted with human infrastructure, as has been documented in several studies in the West[17,26]. The science of road ecology is therefore much more than mere reporting of roadkill. Hence, information gathered through field studies is indispensable. Like any other scientific approach, citizen science has its limitations and the application of data collected through these apps to road ecology should be done with caution, as such data overlook many important factors highlighted earlier in the text and are incomplete to inform mitigation strategies. Nevertheless, the initiative of citizen science apps to collect data on roadkill is a welcome step. Such efforts generate awareness and are important tools to sensitise public and policymakers. Utilizing social information networks makes scientific studies more participatory, leading to greater buy-in of the public regarding issues of conservation importance.

Mind the (g)app

The fact that two functionally similar apps were launched by different organizations simultaneously makes the matter moot. Motivated citizens are consequently made to choose between the apps, because of which both the apps will end up collecting non-overlapping subsets of data, which would also get divided and skewed in terms of areas visited. When conservation is a common goal, stakeholders cannot afford diluted, deflected and competing efforts. Instead, a pan-India effort like this requires collaborative work to present the public with a single, simple and effective data-collection platform.

We suggest a unified, well-managed platform directed at collecting roadkill data in order to make a more substantial contribution. Additional features in this unified app that would enable users to report observations of animals using roadside habitats, attempting to cross roads, in addition to those being involved in collisions – would also optimize the scope of these apps (see http://www.roadwatchbc.ca/). This information would help identify commonly used animal-crossing zones. Additionally, involving citizen scientists who commit to driving a specified route would remove spatial bias in data collection. Established protocols for recording roadkill are also missing in the current app formats. For example, removal of animal carcasses must be ensured to avoid chances of their double counting and reducing the occurrence of scavenger–vehicle collisions. Investment in capacity building of citizen scientists would increase the prospects of improved data quality and more meaningful involvement of citizens in furthering the contribution to road science. Thus, a holistic understanding of road ecology and mitigation of the ill-effects of roads on wildlife calls for a unified effort from all stakeholders, instead of divided and competing initiatives.

1. van der Ree, R., Smith, D. J. and Grilo, C., In *Handbook of Road Ecology* (eds van der Ree *et al.*), Wiley Blackwell, West Sussex, UK, 2015, pp. 1–9.
2. WII, Overview of ecological impacts of linear infrastructure. Eco-friendly measures to mitigate impacts of linear infrastructure on wildlife. Wildlife Institute of India, Dehradun, 2016, pp. 27–50.
3. Ibisch, P. L. *et al.*, *Science*, 2016, **354**(6318), 1423–1427.
4. D'Amico, M., Periquet, S., Roman, J. and Revilla, E., *J. Appl. Ecol.*, 2015, doi: 10.1111/1365-2664.12572.
5. Kerley, L. L., Goodrich, J. M., Miquelle, D. G., Smirnov, E. N., Quigley, H. B. and Hornocker, M. G., *Conserv. Biol.*, 2002, **16**(1), 97–108.
6. Blom, A., van Zalinge, R., Heitkonig, I. M. A. and Prins, H. H. T., *Oryx*, 2005, **39**, 381–388.
7. Keller, I. and Largiader, C. R., *Proc. R. Soc.*, 2003, **270**, 417–423.
8. Bujoczek, M., Ciach, M. and Yosef, R., *Biol. Conserv.*, 2011, **144**, 1036–1039.
9. Clarke, G. P., White, P. C. L. and Harris, S., *Biol. Conserv.*, 1998, **86**, 117–124.
10. Bissionette, J. A., Kassar, C. A. and Cook, L. J., *Hum.–Wildl. Conflicts*, 2008, **2**(1), 17–27.
11. Stoner, D., *Science*, 1935, **81**, 401–402.
12. www.inaturalist.org/ (accessed on 3 May 2018).
13. http://ebird.org/ (accessed on 3 May 2018).

14. https://www.roadkills.in/ (accessed on 3 May 2018).
15. http://www.roadwatchers.org/ (accessed on 3 May 2018).
16. Riley, S. P. D., Sauvajot, R. M., Fuller, T. K., York, E. C., Karadt, D. A., Bromley, C. and Wayne, R. K., *Conserv. Biol.*, 2002, **17**(2), 566–576.
17. Ngoprasert, D., Lynam, A. J. and Gale, G. A., *Oryx*, 2007, **41**(3), 343–351.
18. McCown, J. W., Kubilis, P., Eason, T. H. and Scheick, B. K., *Ursus*, 2009, **20**(1), 39–46.
19. Eberhardt, E., Mitchell, S. and Fahrig, L., *J. Wildl. Manage*., 2013, **77**, 1353–1359; doi:10.1002/jwmg.592
20. Fahrig, L., Pedlar, J. H., Pope, S. E., Taylor, P. D. and Wegner, J. F., *Biol. Conserv*., 1995, **73**, 177–182.
21. Teixeira, F. Z., Kindel, A., Hartz, S. M., Mitchell, S. and Fahrig, L., *J. Appl. Ecol.*, 2017, **54**, 1544–1551.
22. Jacobson, S. L., Bliss-Ketchum, L. L., de Rivera, C. E. and Smith, W. P., *Ecosphere*, 2016, **7**(4), e01345; 10.1002/ecs2.1345.
23. Antworth, R. L., Pike, D. A. and Stevens, E. E., *Southeast. Nat.*, 2005, **4**(4), 647–656; https://doi.org/10.1656/1528-7092(2005)004[0647:HAREOS]2.0.CO;2.
24. Glista, D. J., DeVault, T. L. and DeWoody, J. A., *Herpetol. Conserv. Biol.*, 2007, **3**(1), 77–87.
25. Rytwinski, T. and Fahrig, L., *Biol. Conserv*., 2012, **147**, 87–98.
26. Wattles, D. W., Zeller, K. A. and Destefano, S., *J. Wildl. Manage.*, 2018; doi:10.1002/jwmg.21459.

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