Herpetological Conservation and Biology 14(3):615–626.
Submitted: 28 January 2019; Accepted: 7 November 2019; Published: 16 December 2019.

Mugger Crocodile (*Crocodylus palustris*) Mortality Due to Roads and Railways in Gujarat, India

Raju Vyas[1] and Anirudh Vasava[2,3]

[1]*Shashwat Apartment, 23 Anandnagar Society, BPC Haveli Road, Alkapuri, Vadodara-390007, Gujarat, India*
[2]*Voluntary Nature Conservancy, 101-Radha Darshan, Behind Union Bank, Vallabh Vidyanagar-388120, Gujarat, India*
[3]*Corresponding author, email: aniruddh.vasava@gmail.com*

Abstract.—**An extensive network of roads and railways cuts across the Indian landscape, resulting in vehicle collisions with a variety of wildlife. A frequent victim of these collisions is the Mugger Crocodile (*Crocodylus palustris*). Of the 38 crocodile-vehicle collisions (CVC) recorded between 2005 and 2018, 24 were on roads and 14 were on railway tracks. Sex was determined for 23 individuals (10 males, 13 females, 15 unknown). Twenty-nine individuals were found dead at the site of collisions, four individuals died while undergoing medical treatment, and five were treated successfully and returned to wild. The majority of collisions occurred in Vadodara, central Gujarat, India. There has been a rise in CVC in the last decade, wherein only four CVC were reported between 2005 and 2010, which rose to 34 in the following 8 y (2011–2018). Length of Mugger Crocodiles involved in collisions ranged from 60–320 cm total length (TL), with higher number of collisions recorded for juvenile and sub-adult individuals (n = 24, ≤ 180 cm TL), compared to adult individuals (n = 12, > 180 cm TL). The frequency of collisions was higher in the monsoon months (July-October; 71%), with very few in the winter (November-February; 21%), and summer (March-June; 8%). Mitigation measures for the collision situation in Gujarat are discussed.**

Key Words.—agriculture; crocodile-vehicle collision; habitat management; transport networks; threats

Introduction

Habitat loss due to destruction, fragmentation, or degradation is the primary threat to the survival of many species (Fahrig 2003; Laurence et al. 2009). Of the many factors that contribute to habitat fragmentation, roads and railways have greatly affected wildlife populations by restricting movement, altering behavior, and causing injury and death through vehicle collision (Forman and Alexander 1998; Fahrig 2003; Fahrig and Rytwinski 2009; Van der Ree et al. 2015). Crocodilian mortality via vehicle collision has been documented across the globe. Mortalities include American Crocodiles (*Crocodylus acutus*) in southern Florida, USA (Brien et al. 2008, Kushlan 1988), American Alligators (*Alligator mississippiensis*) in Mississippi (Flynt 2008) and northwestern Florida, USA (Aresco 2009), Cuvier Dwarf Caiman *(Paleosuchus palpebrosus)* and Schneider's Smooth-fronted Caiman (*Paleoschus trigonatus)* in Rondonia, Brazil (Campos et al. 2012), Spectacled Caiman (*Caiman crocodylus*) in Magdalena Valley, Colombia (Ramos and Meza-Joya 2018), Saltwater Crocodiles (*Crocodylus porosus*) in South-west Sri Lanka (Amarasinghe et al. 2015), and Mugger or Marsh Crocodile (*Crocodylus palustris*; hereafter referred to as mugger) in Iran (Mobaraki and Abtin 2007).

The Indian transport network is one of the largest in the world, comprising over 5,603,293 km of roads (Transport Research Wing 2016) and 121,000 km of railway tracks (Indian Railways 2017). This network cuts across various natural landscapes, including protected areas, resulting in large numbers of wildlife-vehicle collisions each year (Johnsingh and Williams 1999; Rajvanshi et al. 2001; Roy and Sukumar 2017). These studies indicate that roads and railways are a direct threat to many species in India (Rajvanshi et al. 2001; Rao and Girish 2007). One such species in India that has been a frequent victim of vehicle collision is the mugger. The mugger is one of the most adaptable and widely distributed crocodilian species in west Asia, including India, Iran, Pakistan, Bangladesh, Bhutan, Nepal, Myanmar, and Sri Lanka (Choudhury and de Silva 2013), and it is legally protected in its entire range. It is considered Vulnerable under the International Union for Conservation of Nature (IUCN) Red List criteria (Choudhury and de Silva 2013).

Besides road and railway mortalities, muggers in the Gujarat state of India are threatened by water pollution, habitat encroachment, alteration, fragmentation, habitat loss, riverbank development, fishing, and the pet trade (Vijaykumar et al. 1999; Vyas 2010, 2011), but vehicle/train collisions are emerging as a direct threat (Vyas 2011, 2014; Vyas and Bhavsar 2009). This issue has received less attention from environmental managers, ecologists, and the public in general in the past than other causes of mortality. Here we report on mugger collisions with vehicles and trains documented in Gujarat from 2005–2018 with the objectives of understanding spatiotemporal patterns of crocodile-vehicle collisions

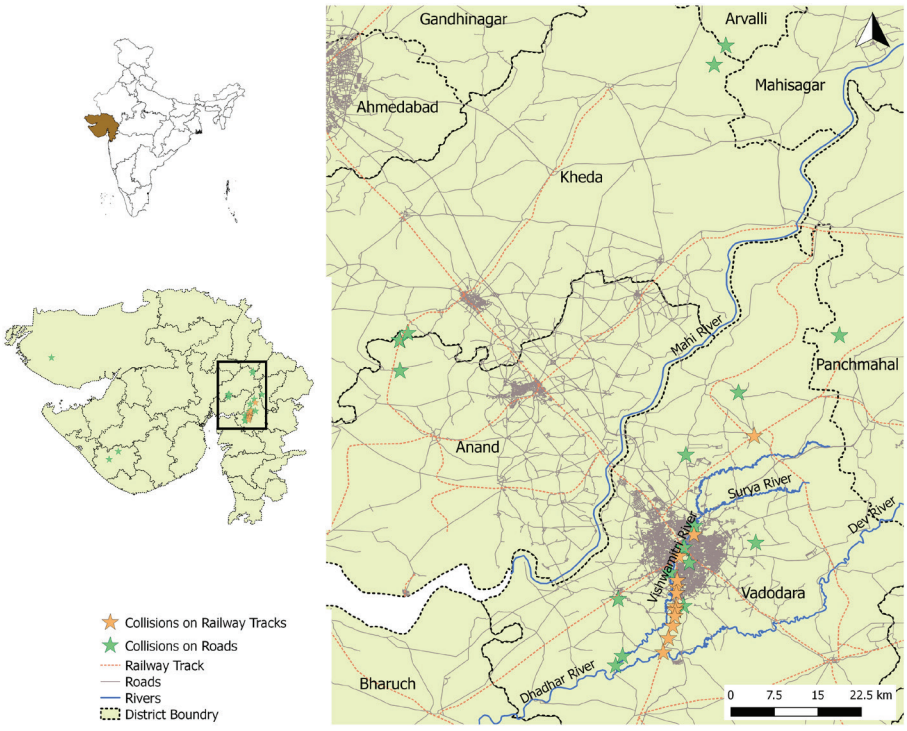

Figure 1. Map of Gujarat state, India, showing locations of Mugger Crocodiles (*Crocodylus palustris*) involved in a vehicle collision on either a road or railway.

(CVC), identifying problematic areas, and providing suggestions for reducing the collisions with muggers.

Materials And Methods

Study area.—Gujarat (between 22.309425N and 72.136230E) is the westernmost state of India, and shares an international border with Pakistan on its northwest side (Fig. 1). It is bounded by the Arabian Sea in the west, by Rajasthan in the north and northeast, by Madhya Pradesh in the east and by Maharashtra in the south and southeast. Gujarat is home to one of the largest populations of muggers in India, with large populations in central Gujarat, around Saurashtra and Kutch, and a smaller population in south Gujarat (Vijaykumar et al. 1999; Vyas 2010, 2013: Vasava et al. 2015). The intensive study area, Vadodara, is rapidly developing and is one of the most densely populated cities in Gujarat (Fig. 1). Over the last three decades, the increasing population of muggers in Vadodara has earned the city the name Mugger City (Vyas 2010). The last census showed more than 250 muggers flourishing across different water bodies of the city and neighboring area (Vyas 2018).

Data collection.—We collected data about CVC with vehicles and trains from 2005–2018 from various sources, including personal observations, non-governmental organizations (NGOs), offices of the Gujarat Forest Department, wildlife rescuers, and print and electronic media. Moreover, we took photographs and collected information on some of the accidents by visiting the collision site to note specifics of the mugger, including health and circumstances around the collision. These CVC records include size, sex, date, time of incident, location, month, season, number of animals injured or killed. We classified muggers as juveniles and subadults (< 180 cm total length; TL) or adults (> 180 cm TL) on the basis of published literature on mugger growth and sizes (Whitaker and Whitaker 1984; Mobaraki et al. 2013). We measured total length dorsally from tip of the snout to the tip of the tail. We recorded in what season the collision occurred and defined seasons as winter (November-February), summer (March-June), and monsoon (July-October), wherein winter and summer months are dry seasons and monsoon months are the wet season. These months generally correspond to detectable changes in temperature, precipitation, and other climatic variables, as well as the life-history characteristics of muggers in the region. To better understand CVC with respect to breeding ecology of muggers, we also categorized months into the breeding season (February-August; having various activities like egg laying, nest guarding, hatching) and non-breeding season (September-January; Whitaker and Whitaker 1984; Mobaraki et al. 2013).

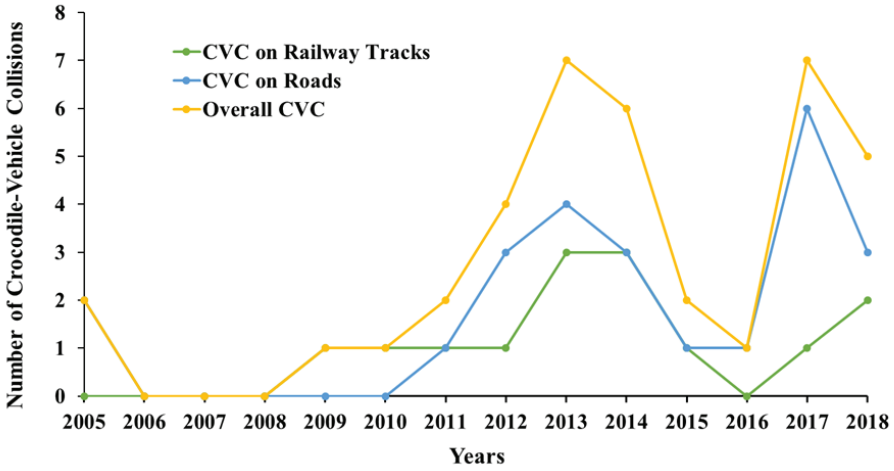

Figure 2. Yearly variation in the number of crocodile-vehicle collisions (CVC) of Mugger Crocodiles (*Crocodylus palustris*) on roads and railways from 2005 to 2018 in Gujarat, India.

Data analysis.—We analyzed the CVC from the compiled records to determine the spatial-temporal pattern of such events. We used Chi-square analysis ($\alpha = 0.05$) to compare CVC between seasons, months of the year, different size class, and crocodile breeding seasons. Crocodile-Vehicle Collisions estimates here represent minimum estimates, because the data have not been corrected for biases (e.g., carcass persistence, detection, carcass removal).

Results

Between 2005 and 2018, 38 CVC incidents were recorded in Gujarat (Appendix Table 1), wherein 24 (63%) occurred on roads and 14 (37%) occurred on railway tracks. The mean number of CVC per year in Gujarat during this period was estimated to be 2.71 (standard error = 0.69). The number of CVC incidents gradually increased from 2008 (n = 0) to 2013 (n = 7), decreased between 2014 (n = 6) and 2016 (n = 1), before increasing sharply again in 2017 (n = 7) and 2018 (n = 6; Fig. 2). Region wise, the highest number of CVC incidents were recorded in central Gujarat (89%, n = 34) in the districts of Vadodara (n = 26) and Kheda (n = 6), whereas few CVC incidents were recorded in Saurashtra region (n = 3) in the district of Junagadh (n = 1) and Kutch (n = 1; Fig. 1).

Of all the CVC incidents recorded, 29 individuals (76%) were found dead, with nine individuals (24%) found alive and treated for minor to severe injuries; however, only five could be successfully treated and returned to the wild, the other four died during the treatment. For those individuals for which sex could be determined (n = 23), 13 were females and 10 were males. Total length of muggers involved in collisions ranged from 60–320 cm TL, with a significantly ($\chi^2 = 20.89$ df = 2, $P < 0.05$) higher proportion of juveniles and sub-adult individuals (n = 24) compared to adult individuals (n = 12).

Monthly occurrence of CVC was significantly different ($\chi^2 = 19.78$, df = 8, $P < 0.05$), with higher numbers recorded in July (n = 6), August (n = 10), September (n = 4), October (n = 7), and November (n = 6) compared with December to June (n ≤ 2; Table 1). Higher CVC were recorded during the monsoon season (71%) compared to winter (21%) and summer (8%). There was a significant difference in the number of occurrences of CVC between seasons ($\chi^2 = 25.31$, df = 2, $P < 0.05$). Higher numbers of CVC occurred during the hatching season (July to September; n = 16) and the following two months, October and November (n = 17; Table 1), although these differences were not significant between the breeding and non-breeding seasons ($\chi^2 = 0.520$, df = 1, $P > 0.05$).

Discussion

The distribution of CVC in Gujarat positively corresponds to crocodile abundance, with accidents being frequent in areas with high animal abundance. The increase in CVC over the study period is likely attributable to gradual increase in the mugger population across Gujarat. In 2001, Vyas and Vyas (2002) estimated a population of 70 individuals in Vadodara, which increased to an estimated 250 individuals in the recent survey in 2017 (Vyas 2018). Similarly, in 2014 Vasava et al. (2015) estimated about 98 individuals in the ponds of Anand-Kheda Districts, whereas the recent population counts (Voluntary Nature Conservancy 2018) found 131 individuals in 2018. These data of the population status and successfully breeding records of mugger population from various regions of Gujarat

Figure 3. (A and B): Minor injuries sustained by Mugger Crocodiles (*Crocodylus palustris*) involved in vehicle collisions. (C-H): Various size of Mugger Crocodiles found severely injured from different location of Gujarat state, India. Details of each incident (estimated size and type of collision); A: 95cm, on road, B: 120 cm, on road, C: 235 cm, on railway, D: 160 cm, on railway, E: 155 cm, on road, F: 210 cm, on road, G: 195 cm, on railway, and H: 102 cm, on road. (A and E photographed by Rakesh Vadhavana, B by Chirag Pathak, D by Manoj Thaker, and H by Nitin Patel).

point out that there has been a substantial increase of the mugger population across its distributional range in Gujarat (Vyas 2013; Vasava et al. 2015).

The sharp decline of the CVC in the years 2015 and in 2016 could be attributed to heavy rainfall. These rains created the flood-like situation in central and south Gujarat region, including the Vadodara Region, which was the worst affected area due to flooding (Kaur and Purohit 2014; Gujarat State Disaster Management Authority 2017). This flooding likely led to most of the waterbodies expanding in size, which might have provided good habitat for juveniles and sub-adult

Table 1. Monthly and seasonal variation in crocodile-vehicle collisions (CVC) of Mugger Crocodiles (*Crocodylus palustris*) killed or injured on road and railway networks in Gujarat state, India. For size categories, M = Male, F = Female, U = Unknown sex.

Months	Seasons	Small size (< 1 m)	Medium size (1–2 m)	Large size (> 2 m)	Unknown size	Total
November		1(M)	3 (2F, 1U)	2 (U)	—	6
December	Winter	—	—	—	—	0
January	Winter	—	—	—	1(U)	1
February	Winter	—	1(U)	—	—	1
March		—	—	2 (1F, 1U)	—	2
April	Summer	—	—	1 (M)	—	1
May	Summer	—	—	—	—	0
June	Summer	—	—	—	—	0
July		3 (1M, 2U)	3 (1F, 2U)	—	—	6
August	Monsoon	1 (F)	7 (3M, 1F, 3U)	1 (M)	1(U)	10
September	Monsoon	2 (F, U)	2 (M)	—	—	4
October	Monsoon	3 (1M, 1F, 1U)	2 (M, F)	2 (M, F)	—	7
Total		10	18	8	2	38

and might have reduced their movement from one waterbody to another, and thus, the chances of colliding with a vehicle or train.

Crocodile-vehicle collisions occurred on roads and railway tracks that were near a waterbody or divided water bodies. Accidents were more frequent along road and railway segments with pooled water alongside than along segments where such pools were absent. Mobaraki and Abtin (2007) also identified similar movement of juvenile muggers between habitats as a factor associated with CVC in Iran. Similar situations have been observed with American Crocodiles in Florida (Brien et al. 2008).

Studies have reported that the season of the year is one of the strongest predictors of wildlife-vehicle collisions and knowledge about seasonal patterns of wildlife-vehicle collisions is important to improve suitable mitigation measures (Main and Allen 2002). Crocodile-vehicle collision in Gujarat mostly occurred between the months of July and November, with a peak in the month of August, which also is the peak of monsoons in the Indian subcontinent. The abundant rainfall may flood burrows of muggers, compromising their thermal regulation and forcing them to seek new refuge and favorable areas (Vyas 2013; Vasava et al. 2015). This seasonal movement may be responsible for the high frequency of CVC in Gujarat.

Moreover, reports from other states of India including Chhatisgarh, Rajasthan, and Uttar Pradesh clearly point out that the mugger mortality due to collisions with various vehicles is emerging as a possible threat (Appendix Table 2). This threat has been noted for all seven notable mugger populations in four states in India, including Gujarat, Rajasthan, Chhattisgarh, and Uttarakhand. Available studies and reports from Iran and Sri Lanka indicate that it is prevalent throughout the range of the species (Appendix Table 2). Moreover, globally, crocodile mortality due to collisions with vehicle has been noted in 10 of 27 species of crocodiles across the world (Grigg and Kirshner 2015). This indicates that the situation is widespread and may rise exponentially with loss of habitats, growing crocodile populations, and developing transport corridors.

Management implications.—We offer several recommendations for the mitigation of CVC in Gujarat. Fencing, underpasses, and/or culverts at risky road and railway segments or a combination of these methods for reducing wildlife road collisions may help reduce CVC (Hedlund et al. 2004; Bissonette and Rosa 2012). Fences may also obstruct natural dispersal, however, and may potentially simply relocate the collisions sites to near the ends of fencing. Also, it is not uncommon that muggers break through or jump over fences if they do not find a safer passage across the road (pers. obs.). American Alligators have been observed to use highway underpasses in Florida (Foster and Humphrey 1995), indicating that such passes could act as efficient roadkill mitigation measures in India as well. Barriers near the underpasses need to be built to direct animal movements towards the underpass. Widely accepted, underpass/culverts in combination with well-designed and maintained fences could be more effective in reducing vehicle collisions with various wildlife species (Hedlund et al. 2004; Bissonette and Rosa 2012; Clevenger and Waltho 2000; Rytwinski et al. 2016). A drawback, though, is that considerable expense is incurred in building underpasses.

Speed restrictions should be enforced on stretches of roads with high incidents of CVC during the months when muggers disperse locally (March-September),

especially at dusk and dawn when muggers are active. Limiting train speed is difficult due to operational constraints (Roy and Sukumar 2017). Indisputably, lower speed limits would reduce CVC. Warning signs have been suggested by several studies (Hedlund et al. 2004; Sullivan et al. 2009, Found and Boyce 2011), and can targeted for use in problematic areas. In conjunction with these measures, a long-term program should be implemented to maintain and repair fences and underpasses damaged by vehicle collisions, degraded through weathering and damaged locally. Implementing these initiatives would require active participation and a joint approach between a number of stakeholders, including the Transportation Department of Gujarat, the Ministry of Road Transport and Highways (India), Indian Railways, the Ministry of Environment, Forest and Climate Change (India), the Gujarat Forest Department, NGOs, scientists, conservationists, and technologists, with a possible association of local community members living adjacent to transport structures.

Conclusion.—The population of muggers in Gujarat has recovered to the extent that the status has been considered safe; however, the population of muggers in Gujarat is still vulnerable to human induced threats and chance events. Because there is an expected expansion of the road and railway network in response to government of Gujarat proposed transportation projects, this emergent threat is very likely to increase with time, along with the steadily growing mugger population within the state. It is essential to focus on undertaking further research aimed at better understanding the status of muggers and their distribution in relation to CVC.

Acknowledgments.—We acknowledge the support extended by all the wildlife enthusiast and the staff of Gujarat Forest Department for helping us in gathering data and conducting this study. Special thanks to Manoj Thaker, Kartik Upadhyay, Nitin Patel, Rakesh Vadhavana, Chirag Pathak, Pranav Vaghashiya (Vasundhara Nature Club, Junagadh), Raj Bhavsar, Vishal Mistry, Mehul Patel, Dhaval Patel (Managing Trustee, Voluntary Nature Conservancy) and friends who shared valuable information and evidential images. We acknowledge the support of Niyati Patel who prepared the study area maps. We also thank Principal Chief Conservator of Forest, Gujarat State, Conservator of Forest and Deputy Conservator Forest, Social Forestry, Vadodara Division, for their valuable support for this study.

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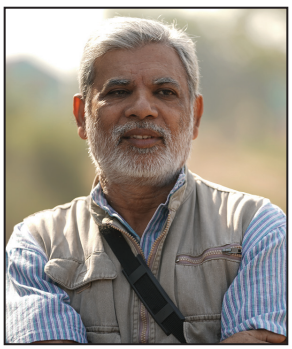

Raju Vyas is now retired after more than 30 y of service as a Zoo Inspector at the Sayaji Baug Zoo, Vadodara, India. Prior to this, in the early 1980s, he worked as Assistant Curator with the private zoo of H. H. Jamsaheb of Nawanager and The Peter Scott Trust, Jamanagar, India. Raju earned his Ph.D. on systematics of snakes from Bhavnagar University, India, in 1995. Since then he has been actively conducting research on various fields of herpetology from systematics to ecology to conservation. Based in Vadodara, India, his long-term research has focused on monitoring Mugger Crocodiles and their habitat as well as issues of human-crocodile conflicts for more than 25 y. He has authored over 150 scientific publications on various aspects of herpetology, including systematics, biogeography, taxonomy, and behavior, and is widely recognized for his contributions to herpetology in India. Raju is the Regional Vice Chair of the IUCN/SSC Crocodile Specialist Group (South Asia and Iran), and also a member of the South Asian Amphibian and Reptile Specialist Group, Conservation Breeding Specialist Group, and Reintroduction Specialist Group of the IUCN/SSC. (Photographed by Cassidix Media Works).

Anirudh Vasava currently works as Research Coordinator at the Voluntary Nature Conservancy, where he implements and manages wildlife research and conservation projects. He began his career as a Research Biologist for the Wildlife Institute of India, where he worked on population ecology of large carnivores. He received his Bachelor of Science in Environmental Science from the Sardar Patel University, India, and Master's of Science from Veer Narmad South Gujarat University, India. His research interests, although varied taxonomically, all fall within the fields of population ecology, spatial ecology and human-wildlife interactions. He has been conducting research on Mugger Crocodiles in central Gujarat since 2013 on various aspects of crocodile ecology, human-crocodile interaction and involvement of local communities in crocodile conservation. He is a member of IUCN-SSC Crocodile Specialist Group. (Photographed by Niyati Patel).

Appendix Table 1. Mugger Crocodiles (*Crocodylus palustris*) found killed or injured on roads and railways from 2005 to 2018 in Gujarat, India.

No.	Date of Incidence	Location/Site	Network Type	GPS Coordinates		Size of Animal (cm)	Season	Sex	State
				Latitude	Longitude				
1	1 November 2005	Lalbaug, Vadodara City	Road	22.2834	73.19579	105	Winter	-	Dead
2	29 June 2005	Deva Village, Kheda	Road	22.62835	72.74718	150	Summer	-	Dead
3	27 March 2009	Makarpura, Vadodara City	Railway	22.24572	73.17616	235	Summer	Female	Injured
4	2 October 2010	Makarpura, Vadodara City	Railway	22.23657	73.17568	160	Monsoon	Female	Dead
5	24 August 2011	Sama, Vadodara City	Road	22.34033	73.20353	155	Monsoon	Male	Injured
6	5 November 2011	Makarpura, Vadodara City	Railway	22.25612	73.17686	195	Winter	Female	Dead
7	19 April 2012	Ghayaji, Padra	Road	22.22724	73.08545	210	Summer	Male	Dead
8	22 September 2012	Timbi, Vadodara City	Road	22.31453	73.29853	90	Monsoon	Female	Dead
9	1 October 2012	Nakhtrana, Naliya, Kutch	Road	23.35099	69.13676	80	Monsoon	-	Dead
10	6 October 2012	Varnama, Vadodara	Railway	22.18553	73.17008	240	Monsoon	Female	Dead
11	8 August 2013	Dervan, Junagadh	Road	21.37771	70.31286	-	Monsoon	Female	Dead
12	8 August 2013	Manjusar, Vadodara	Road	22.45073	73.19036	120	Monsoon	-	Injured
13	10 August 2013	Deva Village, Kheda	Road	22.62812	72.74693	130	Monsoon	Female	Dead
14	16 August 2013	Savali, Sherpura, Vadodara	Road	22.54721	73.27182	190	Monsoon	-	Dead
15	4 November 2013	Itola-Varnama, Vadodara	Railway	22.16665	73.1632	250	Winter	-	Dead
16	9 November 2013	Varnama, Vadodara	Railway	22.2099	73.17427	260	Winter	-	Dead
17	8 January 2014	Maliya-Hatina, Junagadh	Railway	22.2119	73.17409	-	Winter	-	Dead
18	4 August 2014	Hasepura, Nr.Padara, Vadodara	Road	22.12433	73.08161	95	Monsoon	Female	Injured
19	12 August 2014	Bhimnath, Vadodara City	Road	22.30578	73.18586	102	Monsoon	Female	Dead
20	20 August 2014	Varnama to Maneja, Vadodara	Railway	22.21607	73.17504	320	Monsoon	Male	Dead
21	20 August 2014	Varnama, Vadodara	Railway	22.20999	73.17391	110	Monsoon	Female	Dead
22	26 September 2014	Akota, Zulto pool, Vadodara	Railway	22.29386	73.17956	140	Monsoon	Male	Injured
23	20 October 2014	Transpec, Kalali, Vadodara City	Road	22.26852	73.16582	125	Monsoon	Male	Dead
24	16 July 2015	Parshurambhattha, Vadodara City	Road	22.30718	73.18768	75	Monsoon	-	Dead
25	2 October 2015	Jambuwa-Varnama, Vadodara	Railway	22.20083	73.17314	307	Monsoon	Male	Injured

Appendix Table 1 (continued). Mugger Crocodiles (*Crocodylus palustris*) found killed or injured on roads and railways from 2005 to 2018 in Gujarat, India.

No.	Date of Incidence	Location/Site	Network Type	GPS Coordinates		Size of Animal (cm)	Season	Sex	State
				Latitude	Longitude				
26	20 November 2016	Gayaj, Nr. Padra, Vadodara	Road	22.22713	73.08554	85	Winter	Male	Injured
27	25 July 2017	Samlaya-Jarod, Vadodara	Railway	22.4799	73.29614	147	Monsoon	Female	Dead
28	15 July 2017	Malataj, Anand	Road	22.58079	72.74761	45	Monsoon	-	Dead
29	20 September 2017	Deva, Kheda	Road	22.62827	72.74691	92	Monsoon	-	Dead
30	21 September 2017	Deva, Kheda	Road	23.055	73.23421	180	Monsoon	Male	Dead
31	1 October 2017	Vadu Talaw, Nr.Vaso, Kheda	Road	23.08458	73.25221	62	Monsoon	Male	Dead
32	14 October 2017	Run, Vaso canal, Kheda	Road	22.63936	72.75941	90	Monsoon	Female	Dead
33	15 November 2017	Bhavnath, Junagadh city	Road	21.53582	70.49987	120	Winter	Female	Injured
34	26 February 2018	Itola, Vadodara	Railway	22.14473	73.15503	188	Winter	-	Dead
35	11 March 2018	Sama-Derol, Narmada Main Canal	Road	22.63563	73.4282	320	Monsoon	-	Dead
36	14 July 2018	Karelibaug,, Vadodara city	Railway	22.32706	73.2028	110	Monsoon	-	Injured
37	23 July 2018	Janbuva Village, Vadodara	Road	22.21641	73.18681	65	Monsoon	Male	Dead
38	1 August 2018	Padra-Karjan Road	Road	22.13906	73.09227	120	Monsoon	-	Dead

Appendix Table 2. Crocodilian species that have been killed because of collisions with vehicles and trains on road and railway networks across the globe.

No	Species Name	Network	Country	Location/ Area	Sources
1	American Crocodile *Crocodylus acutus*	Road	USA	Southern Florida	Brien et al. 2008, Kushlan 1988
2	American Alligator *Alligator mississippiensis*	Road	USA	Mississippi	Flynt 2008
3	Mugger Crocodile *Crocodylus palustris*	Road	India	Bhuj, Gujarat	Vijaykumar 1999
		Road	Iran	Sistan and Baluchistan Province	Mobaraki and Abtin 2007
		Railway	India	Vadodara, Gujarat	Vyas and Bhavsar 2009
		Road and Railway	India	Vadodara, Gujarat	Vyas 2011 and Vyas 2014
		Railway	Sri Lanka	Matara,	Crocodile hit by Rajarata Rajini. Flash News, 31 March 2011; http://www.flashlk.com/2011/03/crocodile-hit-by-rajarata-rajini.html.
		Railway	India	Kotmi-Sonar, Chhatisghar	Crocodiles fall victim to railway tracks in Chhattisgarh. Catch News, 14 February 2017. http://www.catchnews.com/social-sector/crocodiles-fall-victim-to-railway-tracks-in-chhattisgarh-1455353124.html.
		Railway	India	Jawai Dam, Rajasthan	Train runs over crocodile. The Times of India, March 27, 2017. https://timesofindia.indiatimes.com/city/jaipur/train-runs-over-crocodile/articleshow/57845189.cms.
		Road	India	Kushmauri, Kheri, Uttar Pradesh	Crocodile mowed down by four-wheeler in Kheri. The Times of India, August 19, 2018. https://timesofindia.indiatimes.com/city/bareilly/crocodile-mowed-down-by-four-wheeler-in-kheri/articleshowprint/65378833.cms Croc run over, killed in Lakhimpur Kheri; second such death in a fortnight. The times of India, August 24, 2018. https://timesofindia.indiatimes.com/city/bareilly/croc-run-over-killed-in-lakhimpur-kheri-second-such-death-in-a-fortnight/articleshow/65534379.cms
		Road	India	Nighasan area, Shahjahanpur, Uttar Pradesh	Third crocodile run over in Kheri district in 40 days. The Times of India, September 20, 2018. https://timesofindia.indiatimes.com/city/bareilly/third-crocodile-run-over-in-kheri-dist-in-40-days/articleshow/65877841.cms

Appendix Table 2 (continued). Crocodilian species that have been killed because of collisions with vehicles and trains on road and railway networks across the globe.

No	Species Name	Network	Country	Location/ Area	Sources
4	Australian Freshwater Crocodile *Crocodylus johnstoni*	Road	Australia	Darwin, Australia Northern territory	https://www.abc.net.au/news/2016-12-19/crocodile-hit-by-car-busy-darwin-road-nt-police/8131770
		Railway	Australia	North West Queensland	Wilson K. 2011. Croc run over by road train. in: *Blog at ABC Radio*, *North West Queensland*. http:_blogs.abc.net.au_queensland_2011_04_croc-run-over-by-road rain.html?site=northwest&program=north_west_qld_breakfast
5	Cuvier Dwarf Caiman *Paleosuchus palpebrosus*	Road	Brazil	Porto Velho City, Amazonia	Campos et al. 2012
		Road	Brazil	Tocantins	Souza et al 2015
6	Schneider Smooth-snouted Caiman *Paleosuchus trigonatus*	Road	Brazil	Porto Velho City, Amazonia	Campos et al. 2012
7	Saltwater Crocodile *Crocodylus porosus*	Road and Railway	Sri Lanka	South-west Sri Lanka	Amarasinghe et al. 2015
		Road	Australia		
8	African Dwarf Crocodile *Osteolaemus* cf. *tetraspis*	Road	Nigeria	Benin City	Kelvin, J. 2016. 22nd November 2016. https://www.youtube.com/watch?v=fbD2qBcY3m0
9	Spectacled Caiman *Caiman crocodilus*	Road	Colombia	Magdalena Valley	Ramos and Meza-Joya 2018
		Road	Brazil	Tocantins	Souza et al 2015
10	Yacare Caiman *Caiman yacare*	Road	Brazil	Cerrado–Pantanal landscapes	Fischer *et al* 2018