

NEW RECORDS OF HUMAN-CROCODILE INTERACTIONS IN MEXICO FROM 2018 THROUGH THE FIRST HALF OF 2021

NUEVOS REGISTROS DE INTERACCIONES HUMANO-COCODRILO EN MÉXICO DESDE 2018 HASTA EL PRIMER SEMESTRE DE 2021

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Resumen.— El crecimiento poblacional humano y sus actividades económicas asociadas han incrementado las interacciones humano-vida silvestre. Aquí, proporcionamos nuevos registros de las interacciones humano-cocodrilo (HC) de 2018 a la primera mitad del 2021 en México. Cincuenta y un casos fueron registrados en este estudio, 2018 fue el año con el número más alto de casos (n= 19) y 2021 (en su primer semestre) es el año con el número más bajo de casos. Tamaulipas y Quintana Roo en el Golfo de México representan el 40% de los casos, mientras que Oaxaca y Nayarit en la costa del Pacífico Mexicano representaron el 22%. Las víctimas masculinas (n= 32) fueron las más comunmente asociadas a los incidentes entre humanos y cocodrilos que las víctimas femeninas (n= 10). Sin embargo, 44 casos fueron no fatales y solamente siete fueron fatales. Por lo que sabemos, nuestros registros de interacciones HC incrementan el número de conflictos en México a 250 casos entre el año 2000 y la primera mitad del año 2021.

Palabras clave.— Ataques de cocodrilos, conflictos, lesiones inhabilitantes, lesiones no inhabilitantes, secuelas.

Abstract.— The growing human population and its associated economic activities have increased human-wildlife interactions. Herein, we provide new records of human-crocodile (HC) interactions in Mexico from 2018 through the first half of 2021. Fifty-one cases were recorded in this study; 2018 had the highest number of cases (n = 19), and 2021 (the first half) had the lowest number of cases. The states of Tamaulipas and Quintana Roo on the Gulf of Mexico represented 40% of the cases, while Oaxaca and Nayarit on the Mexican Pacific coast represented 22% of the cases. Male victims (n = 32) were more commonly associated with human-crocodile interactions than females (n = 10). Forty-four cases were non-fatal and only seven were fatal. As far as we know, our records of HC interactions increase the number of conflicts in Mexico to 250 cases.

Keywords.— Crocodile attacks, conflicts, disabling injuries, non-disabling injuries, sequels.

The growing human population and its associated economic activities have increased human-wildlife interactions (Weladji & Tchamba, 2003). Wildlife conflicts likely increase when an ever-increasing number of human populations gather in a limited area close to natural habitats (Inskip & Zimmermann, 2009), especially with large predators (Lamarque et al., 2009). From a human perspective, some interactions are positive, and others are negative (Flores-Armilla et al., 2020). The interactions that are perceived negatively are referred to as human-wildlife conflicts (Inskip & Zimmerman, 2009), when these interactions

have negative effects –either real or perceived– trigger human reaction that can result in harmful impacts on wildlife individuals and populations (García-Grajales, 2013; Morzillo et al., 2014).

Some of the causes that contribute to the increase in this type of conflict are human population growth (Fukuda et al., 2014); the transformation of undeveloped lands, coastal rivers, swamps and shorelines for urbanization (Pooley, 2015; Redpath et al., 2015); and human encroachment into crocodile habitats

for tourism, recreation, agriculture, fishing or other purposes (Wallace et al., 2011; Fukuda et al., 2014). Unfortunately, human expansion has put pressure on crocodilian habitats, reducing the natural physical space available. Despite this pressure, crocodile populations have recovered during the last two decades thanks to law enforcement and conservation efforts, such as permanently banning crocodile hunting in the 1970s.

As a result of this recovery of crocodilian populations, along with a growing human population and its associated economic activities, negative interactions between people and crocodiles have escalated (González-Desales et al., 2021). These conflicts should receive attention from the federal government to improve public safety and prevent the extermination of crocodiles by local communities (García-Grajales, 2013), who often react emotionally to the incidents (Lamarque et al., 2019).

It is not possible to track the number or severity of interactions between crocodiles and humans if there is no concerted effort to monitor new reports and log the data (Porrás-Murillo and Mata, 2020). Countries such as Australia, as well as several nations in Asia, Africa and Latin America are also facing crocodile species attacks, but incidence rates are unknown due to a lack of reporting (Caldicott et al., 2015; Porrás-Murillo and Mata, 2020). In Mexico, between 2000 and 2018, 149 unprovoked crocodile attacks on humans were registered, with 102 cases corresponding to the Pacific coast and 47 to the Gulf of Mexico coast (García-Grajales and Buenrostro-Silva, 2019). Although Pooley et al. (2020) provide an update of human-crocodilian interaction in Latin America, their records for Mexico are questionable, mostly because of their numerical inconsistencies. Therefore, we provide new records of human-crocodile (HC) interactions in Mexico from 2018 through the first half of 2021 and an update on incidents for the country.

We compiled the publicly available data on incidents of HC interactions from 2018 through the first half of 2021 (Table 1). Our data compilation was obtained through various methods: 1) interviewing victims, witnesses, police officers or rangers involved in the incidents by telephone or email; 2) searching media sources, such as newspapers, magazines and websites (Croc-Bite database, CrocBite 2021); 3) communicating in person with some researchers; and 4) personally experiencing attacks in our respective states (Jalisco, Guerrero and Oaxaca). All incidents were grouped and classified by date; location; sex, age, activity and origin of the affected person; time (daylight or nocturnal); presence of witnesses; type of crocodile habitat; region; political unit (municipality); and type of attack (fatal or non-fatal). We grouped the victims into six age categories (1–

10, 11–17, 18–40, 41–60, >60), based on the economically active ages in Mexico. Furthermore, when it was possible with non-fatal attacks, we classified the type of outcome as disabling (the extent of the loss of tissue continuity resulted in amputation or the impairment of motor functionality, limiting or impeding daily physical activities) or non-disabling (no amputation or lack of motor function, which allowed the victims to continue with daily physical activities). In all cases it was possible to determine the species and total length of crocodile involved.

Fifty-one HC interactions were recorded from 2018 through the first half 2021; 2018 had the highest number of cases (n = 19) and 2021 (in its first semester) had the lowest number of cases (n = 7). The Gulf of Mexico had the highest number of cases (n = 29), and the Mexican Pacific coast had the lowest number (n = 20), highlighting two additional cases that occurred inside the continent (Coahuila and San Luis Potosí). Tamaulipas and Quintana Roo on the Gulf of Mexico represented 40% of the cases, while Oaxaca and Nayarit on the Mexican Pacific coast represented 22% of the cases. Regarding the municipalities, Tampico had the greatest number of cases (n = 7).

Male victims (n = 32) were more commonly involved in incidents of HC interactions than females (9), however, a small percentage (18%), it was not possible to identify the human sex involved because of the features of the report. Forty-four cases were non-fatal, and only seven were fatal (5 males and 2 females). The most common activities at the time of non-fatal incidents were fishing (22%), swimming (14%) and walking near the water's edge (10%). The ages of the victims involved in the majority of the attacks ranged from 18 to 40 years old (32%), followed by those from 41 to 60 years old (20%). With a significant percentage of victims, it was not possible to determine their age (32%).

With respect to the injuries caused by non-fatal attacks, the highest proportion of victims (80%) showed non-disabling injuries, with only two cases resulting in the amputation of a limb (disabling sequelae). Regarding the months in which the attacks occurred, June and July presented the highest number of crocodile attacks (11 cases, respectively), and in February, no attacks occurred over the years evaluated. Both, fatal and non-fatal attacks took place more commonly in the daytime (88%). Of the crocodile species involved, *Crocodylus acutus* and *C. moreletii* had the same number of cases (n = 25), respectively. Only, in one case, it was not possible to identify the species involved in the incident. In recent years, the number of HC incidents have been increasing in many parts of the world (Langley, 2005; Pooley, 2015; Das & Jana, 2018); however, the statistics are skewed because numerous episodes involving crocodilians go unreported or

Tabla 1. Registros de incidentes entre humanos y cocodrilos en México desde 2018 hasta la primera mitad de 2021. M = Masculino, F = Femenino; UK = Desconocido, www = World wide web; - = No disponible. NF = no fatal, F = fatal, ND = no determinado, LT = longitud total; DIS = Discapacitante, ND = No discapacitante. * Nuevos registros de agosto a octubre de 2021. / **Table 1.** Records of human-crocodile incidents in Mexico from 2018 through the first half of 2021. M= Male, F= Female; UK= Unknown, www = World wide web; - = Not available. NF = Non-fatal, F = Fatal, ND= Non-determined, LT = Total length; DIS = Disabling, ND = Non-disabling. * New records from August to October 2021.

Year	Source	Date	STATE	Municipality	LOCATION	Sex of victim	Age of victim	Origin of the victim	Activity	Type of habitat	Presence of witnesses	Time of incident	Type of incident	Type of sequel	Species	Crocodile LT
2021 (10)	www	October 6 *	Nayarit	Nuevo Vallarta	Hotel RIU	M	24	Foreign	Swimmin in ocean	Beach	Yes	Night	NF	-	C. acutus	3 m
	www	September 11 *	Tabasco	Villahermosa	Avenida	M	45	Local	Bathing	Lagoon	Yes	Daylight	NF	DIS	C. moreletti	3 m
	www	July 26 *	Jalisco	Puerto Vallarta	Hotel Marriot	F	24	Foreign	Swimming in shore	Beach	Yes	Night	NF	-	C. acutus	2-3 m
	www	July 20	Quintana Roo	Cancún	Restaurant Ilios, Boulevard Kukulcan	F	23	Foreign	Dinner	Lagoon	Yes	Night	NF	ND	C. moreletti	UK
	www	June 25	Veracruz	Catemaco	Anayaga	M	56	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	C. moreletti	2-3 m
	www	June 23	Coahuila	Piedras Negras	Río Bravo	F	3	UK	Crossing body water	River	No	UI	F	-	UI	UK
	www	June 21	Tamaulipas	Tampico	Laguna El Carpintero	F	46	Local	Washing clothes	Lagoon	Yes	Daylight	F	-	C. moreletti	2-3.5 m
	www	June 18	Quintana Roo	Cancún	Hotel Club Med	M	12	Foreign	Playing near water	Lagoon	Yes	Daylight	NF	ND	C. acutus	2-3.5 m
	www	June 6	Oaxaca	Villa de Tututepec	Puerto Suelo	F	27	Foreign	Swimming in lagoon	Lagoon	Yes	Daylight	NF	ND	C. acutus	2-3.5 m
	Interview	may-16	Guerrero	Copala	Barra de Copala	F	24	Local	Swimming in shore estuary	Estuary	Yes	Daylight	NF	ND	C. acutus	2-3 m
2020 (12)	Interview	December 14	Oaxaca	Santa María Tonameca	Barra del Potrero	M	48	Local	Washing hands	River	No	Daylight	NF	DIS	C. acutus	UK
	www	October 16	Tamaulipas	Tampico	Laguna El Carpintero	M	56	Homeless	Swimming in lagoon	Lagoon	Yes	Daylight	F	-	C. acutus	3 m
	www	September 29	Tabasco	Tenosique	Río Tenosique	UI	UI	UK	UK	River	UI	UI	NF	ND	C. moreletti	UK
	www	September 24	Sinaloa	Navolato	Sataya Lagoon	M	UI	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	C. acutus	UK

Tabla 1 (cont.). Registros de incidentes entre humanos y cocodrilos en México desde 2018 hasta la primera mitad de 2021. M = Masculino, F = Femenino; UK = Desconocido, www = World wide web; - = No disponible. NF = no fatal, F = fatal, ND = no determinado, LT = longitud total; DIS = Discapacitante, ND = No discapacitante. * Nuevos registros de agosto a octubre de 2021. / **Table 1 (cont.).** Records of human-crocodile incidents in Mexico from 2018 through the first half of 2021. M= Male, F= Female; UK= Unknown, www = World wide web; - = Not available. NF = Non-fatal, F = Fatal, ND= Non-determined, LT = Total length; DIS = Disabling, ND = Non-disabling. * New records from August to October 2021.

Year	Source	Date	STATE	Municipality	LOCATION	Sex of victim	Age of victim	Origin of the victim	Activity	Type of habitat	Presence of witnesses	Time of incident	Type of incident	Type of sequel	Species	Crocodile LT
2020 (12)	www	September 5	Veracruz	Tuxpan	Barra Norte	UI	UI	UK	UK	River	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	www	August 25	Tamaulipas	Tampico	Laguna El Carpintero	UI	UI	UK	UK	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	www	August 24	Guerrero	Zihuatanejo	Ixtapa	UI	UI	UK	UK	River	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	Interview	July 28	Yucatan	Dzonot Carretero	Dzonot	UI	UI	UK	UK	River	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	www	July 14	Guerrero	Zihuatanejo	Ixtapa	UI	UI	UK	UK	River	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	Interview	June 30	Jalisco	Tomatlan	Chalacatepec	M	61	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	www	June 7	Tamaulipas	Tampico	El Carpintero	UI	UI	UK	UK	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	Interview	may-25	Chiapas	Flores Magon	Rio Lacantun	M	22	Local	Fishing, bathing horse	River	Yes	Daylight	F	ND	<i>C. moreletti</i>	UK
	www	November 10	Quintana Roo	Playa del Carmen	Cozumel	UI	UI	UK	UK	Island	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	www	November 8	Oaxaca	Santa María Colotepec	Barra de Navidad	UI	UI	UK	UK	River	Yes	UI	NF	ND	<i>C. acutus</i>	UK
2019 (13)	www	September 13	Quintana Roo	Cancún	Banco Chinchorro	M	UI	UK	Washing	Island	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	Interview	August 29	Nayarit	El Monteon	Laguna Canalan	M	54	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	www	August 23	Campeche	Ciudad del Carmen	Bugambilias	M	37	Local	Cleaning mangrove	Estuary	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	Interview	August 10	Jalisco	Puerto Vallarta	El Salado	M	35	Local	Try touch	Estuary	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	Interview	July 22	Quintana Roo	Chetumal	Chichankanaab	M	UI	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK

Tabla 1 (cont.). Registros de incidentes entre humanos y cocodrilos en México desde 2018 hasta la primera mitad de 2021. M = Masculino, F = Femenino; UK = Desconocido, www = World wide web; - = No disponible. NF = no fatal, F = fatal, ND = no determinado, LT = longitud total; DIS = Discapacitante, ND = No discapacitante. * Nuevos registros de agosto a octubre de 2021. / **Table 1 (cont.).** Records of human-crocodile incidents in Mexico from 2018 through the first half of 2021. M= Male, F= Female; UK= Unknown, www = World wide web; - = Not available. NF = Non-fatal, F = Fatal, ND= Non-determined, LT = Total length; DIS = Disabling, ND = Non-disabling. * New records from August to October 2021.

Year	Source	Date	STATE	Municipality	LOCATION	Sex of victim	Age of victim	Origin of the victim	Activity	Type of habitat	Presence of witnesses	Time of incident	Type of incident	Type of sequel	Species	Crocodile LT
2019 (13)	Interview	July 8	Tamaulipas	Tampico	El Carpintero	M	59	Local	Walking	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	Interview	July 2	Quintana Roo	Cancún	Punta Cancun LeBlanc	M	40	Local	Swimming	Lagoon	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	www	June 05	Tamaulipas	Altamira	Río Barberena	M	-	Homeless	-	-	-	-	F	-	<i>C. moreletti</i>	?
	Interview	May, 25	Campeche	Palizada	Boca Chica	M	UI	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
	www	March 12	San Luis Potosi	Tamuin	Centro	M	18	Local	Bathing	River	Yes	Daylight	NF	ND	<i>C. moreletti</i>	3 m
	Interview	March 3	Quintana Roo	Chetumal	Petcacab	M	12	Local	Bathing	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
2018 (19)	Interview	September 25	Jalisco	Puerto Vallarta	Marina	F	30	No local	Swimming	Beach	Yes	Night	NF	Dis	<i>C. acutus</i>	3.5 m
	Interview	September 9	Nayarit	San Blas	Mirador de aves	M	38	Local	Fishing	Lagoon	Yes	Night	NF	ND	<i>C. acutus</i>	3 m
	Interview	September 9	Nayarit	San Blas	Mirador de aves	M	19	Local	Fishing	Lagoon	Yes	Night	NF	ND	<i>C. acutus</i>	3 m
	Interview	September 3	Nayarit	Bahia de Banderas	Rio Ameca	M	35-40	UK	Wading in waist-deep wáter	River	Yes	Daylight	F	Dis	<i>C. acutus</i>	3.5 m
	www	August 21	Tamaulipas	Cd. Madero	Laguna Candelario Garza	M	52	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	2 m
	www	July 22	Quintana Roo	Dziuche	Laguna Chichankanaab	M	UK	UK	UK	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UK
www	July 14	Tamaulipas	Ejido Vicente Canek	Presa Vicente Guerrero	M	UK	Local	Walking along edge of dam	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	2 m	
Interview	July 13	Chiapas	Pijijiapan	Zapotal	M	30	Local	Swimming	River	Yes	Daylight	NF	ND	<i>C. acutus</i>	UI	

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Year	Source	Date	STATE	Municipality	LOCATION	Sex of victim	Age of victim	Origin of the victim	Activity	Type of habitat	Presence of witnesses	Time of incident	Type of incident	Type of sequel	Species	Crocodile LT
2018 (19)	Interview	July 7	Tamaulipas	Tampico	El Carpintero	M	15-18	Local	Swimming	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UI
	www	July 2	Yucatan	Celestun	Ojo de Agua Baldiosera	F	46	UK	Swimming	Water hole Road near to river	Yes	Daylight	NF	ND	<i>C. moreletti</i>	2 m
	www	June 22	Tamaulipas	Cd. Mante	Rio Mante	M	67	Local	Try to catch		No	Daylight	NF	ND	<i>C. moreletti</i>	1- 1.5 m
	www	June 17	Tamaulipas	Villa de Casas	Presa Vicente Guerrero	M	13	Local	Fishing	Dam	Yes	Daylight	NF	ND	<i>C. moreletti</i>	2 m
	Interview	June 15	Oaxaca	Tierra Blanca	Tierra Blanca	M	40	Local	Walking dog near to river	River	No	Daylight	NF	ND	<i>C. acutus</i>	UK
	Interview	June 4	Nayarit	Bahia de Banderas	San Vicente	M	37	Local	Jumped into pond	Pond	Yes	Daylight	NF	ND	<i>C. acutus</i>	2.5 m
	Interview	May, 16	Tabasco	Villahermosa	Yumka	F	20	UK	Feeding wild crocodile	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	UI
	www	May, 10	Tamaulipas	Tampico	El Carpintero	M	36	Local	Fishing	Lagoon	Yes	Daylight	NF	ND	<i>C. moreletti</i>	2 m
	Interview	April 15	Oaxaca	Santa María Colotepec	Barra de Colotepec	F	50	UK	Lying alongside estuary	Estuary	Yes	Daylight	NF	ND	<i>C. acutus</i>	UK
	www	April 12	Quintana Roo	Cozumel	Laguna de la Plata	M	UK	UK	Wading in waist-deep water	Lagoon	Yes	Daylight	NF	ND	<i>C. acutus</i>	2 m
www	January 1	Oaxaca	Pinotepa Nacional	Playa la Peña	M	4	No local	Walking in or near lagoon shore	Lagoon	Yes	Daylight	F	ND	<i>C. acutus</i>	UK	

are poorly documented (Fukuda et al., 2015). Also, widespread access to social media makes interactions more visible, leading to unresearched reports in real time (Porrás-Murillo & Mata, 2020).

The pattern of HC interactions described here is like the trend shown by García-Grajales & Buenrostro-Silva (2019) in Mexico, as well as other countries, such as Costa Rica (Porrás-Murillo & Mata, 2020). Data for the American alligator (*Alligator mississippiensis*) in the United States show that most of the people attacked were in the water or at the water's edge (Conover & Dubow, 1997). Caldicott et al. (2005) found that in Australia, most attacks occurred when people were in bodies of water or on the shore, especially during fatal attacks. Similar data have been found for HC incidents in Mexico (García-Grajales & Buenrostro-Silva, 2019).

Most of the attacks described here involved men, which is similar to the data gathered by Fukuda et al. (2014), García-Grajales & Buenrostro-Silva (2019) and Porrás-Murillo & Mata (2020). Additionally, as reported by Fergusson (2004), Caldicott et al. (2005), García-Grajales & Buenrostro-Silva (2019) and Porrás-Murillo & Mata (2020), most of the attacks took place during the day. In Mexico the prevalence of specified economic gender roles in rural areas such as agriculture and fishing, favor males; more specifically, men 18-40 years old who are more likely to be engaged in high-risk jobs because they are the most economically active group (García & Buenrostro-Silva 2019). For these reasons, we found this group to be the most vulnerable to HC incidents. Moreover, fatal and non-fatal attacks happened more frequently in the daytime, presumably because some activities such as fishing and swimming were more commonly conducted during daylight hours (Fukuda et al., 2014).

The peak periods for HC incidents (March to September) coincide with the species' nesting season and with the beginning and end of the wet season on both coasts in Mexico. These connections can be explained by three hypotheses: first, during the rainy season, crocodiles are widely dispersed because of a rise in water levels, and the possibility of negative HC interactions increases because of this. Second, crocodiles are ectothermic and are more active (and consequently, hungrier) during the hotter months of the year; therefore, the possibility of negative interactions increases during this period. Third, although there is little evidence, crocodiles are more dangerous during the breeding season because the large adult females guard their nests and fast until their hatchlings are ready to emerge (Pooley, 2015); therefore, they are intolerant to humans approaching their nesting areas, and as a result, are more aggressive towards

people (Lang, 1992). According to Caldicott et al. (2005), it is uncommon for crocodiles to attack and eat humans, and data reported here showed that most incidents are due to a person's intrusion into a crocodile habitat.

Most coastal states in Mexico where there is a natural distribution of crocodiles has presented at least one case of HC interaction, but there was one curious case in Piedras Negras, Coahuila, in a state that is not included in a geographical distribution area for any of the crocodile species. Our hypothesis, however, is that a crocodile had been released into the Río Bravo generating conditions for possible negative interaction, due to the passage of immigrants into the United States.

During the time in which this work was revised (August-October 2021), other three incidents took place in Puerto Vallarta, Jalisco (n= 1), Nuevo Vallarta, Nayarit (n=1), and Villahermosa, Tabasco (n= 1); therefore, the number of cases increases to 250 cases. It should be noted that in these cases there were people in drunk, foreigners and homeless involved.

Understanding the underlying causes behind the increase in HC interactions will require careful logging of the events leading up to each incident, which is why a national, standardized database is so important (Porrás-Murillo & Mata, 2020). An updated dataset would also help authorities identify priority areas, to facilitate targeted mitigation. From our new records, we believe that the environmental and tourism authorities have enough information to develop solutions for prevention and coexistence rather than focusing solely on controlling crocodile populations.

Similar to the proposal of Fukuda et al. (2014), public education through a variety of media outlets (e.g. local television, radio, newspaper, and websites) will be the most effective means of informing the public about the potential danger of water-related activities in crocodile habitats.

Finally, we must use the information already available to transform negative interactions and conflicts into coexistence between crocodiles and humans (Porrás-Murillo & Mata 2020). As far as we know, our records of HC interactions increase the number of conflicts in Mexico to 250 cases from 2000 to the first half 2021.

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LITERATURE CITED

- Caldicott, D.G.E, D. Croser, C. Manolis, G. Webb & A. Britton. 2005. Crocodile attack in Australia: an analysis of its incidence and review of the pathology and management of crocodylians attacks in general. *Wilderness & Environmental Medicine* 16:143-159.
- Conover, M. R. 2002. *Resolving Human-Wildlife conflicts: the Science of Wildlife Damage Management*. CRC Press, Boca Raton, Florida, USA.
- Conover, M.R. & T.J. Dubow. 1997. Alligator attacks on humans in the United States. *Herpetological Review* 28:120-125.
- CrocBite. 2021. The Worldwide Crocodylian Attack Database. Crocodylian-attack.info (accesed June 3 2021).
- Das, CS. & R. Jana. 2018. Human-crocodile conflict in the Indian Sundarban: an analysis of spatio-temporal incidences in relation to people's livelihood. *Oryx* 52(4):661-668.
- Fergusson, R. 2004. Preliminary analysis of data in the African human crocodile conflict database. *Crocodylian Specialist Group Newsletter* 23:21.
- Flores-Armilla, V.H., D. Valenzuela-Galván, J.L. Peña-Mondragón & X. López-Medellín. 2020. Human-wildlife conflicts in Mexico: Review of status and perspectives. *Ecosistemas y Recursos Agropecuarios* 7(1):e2274.
- Fukuda, Y., C. Manolis & K. Appel. 2014. Management of human-crocodile conflict in the Northern Territory, Australia: review of crocodile attacks and removal of problem crocodiles. *The Journal of Wildlife Management* 78:1239-1249.
- Fukuda, Y., C. Manolis, K. Saalfeld & A. Zuur. 2015. Dead or alive? Factors affecting the survival of victims during the attacks by saltwater crocodiles (*Crocodylus porosus*) in Australia. *Plos One* 10(5):e0126778.
- García-Grajales, J. 2013. El conflicto hombre-cocodrilo en México: causas e implicaciones. *Interiencia* 38:881-884.
- García-Grajales, J. & Buenrostro-Silva, A. 2019. Assessment of human-crocodile conflict in Mexico: patterns, trends and hotspots areas. *Marine and Freshwater Research* 70(5):708-720.
- Inskyp, C. & A. Zimmermann. 2009. Human-felid conflict: a review of patterns and priorities worldwide. *Oryx* 43:18-34.
- Lamarque, F., J. Anderson, R. Ferguson, M. Langrange, Y. Osei-Owusu & L. Bakker. 2009. Human-wildlife conflicts in Africa: causes, consequences and management strategies. Forestry paper. FAO. Roma, Italia.
- Lang, J.W. 1992. Social behaviour. Pp. 102-117. In C.A. Ross (Ed), *Crocodyles and alligators*. Blitz Edition, London, United Kingdom.
- Langley, R.L. 2005. Alligator attacks on humans in the United States. *Wilderness & Environmental Medicine* 16:119-124.
- Morzillo, A., K. De Beurs & C. Matin-Mikle. 2014. A conceptual framework to evaluate human-wildlife interactions within coupled human and natural systems. *Ecology and Society* 19(3):44.
- Porrás-Murillo, L.P. & E. Mata C. 2020. Analysis of the interactions between humans and crocodiles in Costa Rica. *South American Journal of Herpetology* 16:26-33.
- Pooley, S. 2015. Using predator attack data to save lives, human and crocodylian. *Oryx* 49:581-583.
- Pooley, S., P.A. Siroski, L. Fernandez, B. Sidelau & P. Ponce-Campos. 2020. Human-crocodylian interactions in Latin America and the Caribbean region. *Conservation Science and Practice* 3:e351.
- Redpath, S.M., S. Bathia & J. Young. 2015. Tilting at wildlife: reconsidering human-wildlife conflict. *Oryx* 49:222-225.
- Treves, A., R.B. Wallace, L. Naughton Treves & L. Morales. 2006. Co-managing human-wildlife conflict within the lower Zambezi Valley. *Wildlife Research* 38:747-755.
- Wallace, K.M., A.J. Leslie & T. Coulson. 2011. Living with predators: a focus on the issues of human-crocodile conflict within the lower Zambezi Valley. *Wildlife Research* 38:747-755.
- Weladji, R.B. & M.N. Tchamba. 2003. Conflict between people and protected areas within the Bénoué Wildlife Conservation Area, North Cameroon. *Oryx* 37:72-79.

