IRCF REPTILES & AMPHIBIANS
CONSERVATION AND NATURAL HISTORY

Anthropogenic Mortality in the Critically Endangered Lesser Antillean Iguana (*Iguana delicatissima*) on St. Eustatius

Matthijs P. van den Burg[1], Hannah Madden[2], Timothy P. van Wagensveld[3], and Clarisse Buma[4]

[1]Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, The Netherlands (thijs.burg@gmail.com)
[2]Caribbean Netherlands Science Institute, St. Eustatius, Caribbean Netherlands
[3]Reptile, Amphibian & Fish Research the Netherlands, The Netherlands
[4]St. Eustatius National Parks Foundation, St. Eustatius, Caribbean Netherlands.

The Lesser Antillean Iguana, *Iguana delicatissima* (Laurenti 1768) is a Lesser Antillean endemic (Anguilla to Martinique, with the exception of Saba and Montserrat). The IUCN Red List status of this species was recently elevated from Endangered (Breuil et al. 2010) to Critically Endangered (van den Burg et al. 2018a). Population declines are driven by habitat loss, anthropogenic mortality, and invasive predators, but on many islands the declines are the result of hybridization with and displacement by the non-native invasive *Iguana iguana* (Linnaeus 1758) (Knapp et al. 2014; Vuillaume et al. 2015; Breuil et al. 2010; van den Burg et al. 2018a). In fact, genetically pure populations currently inhabit only 22% of the species' historic distribution, and populations have been extirpated on Antigua, Barbuda, St. Kitts,

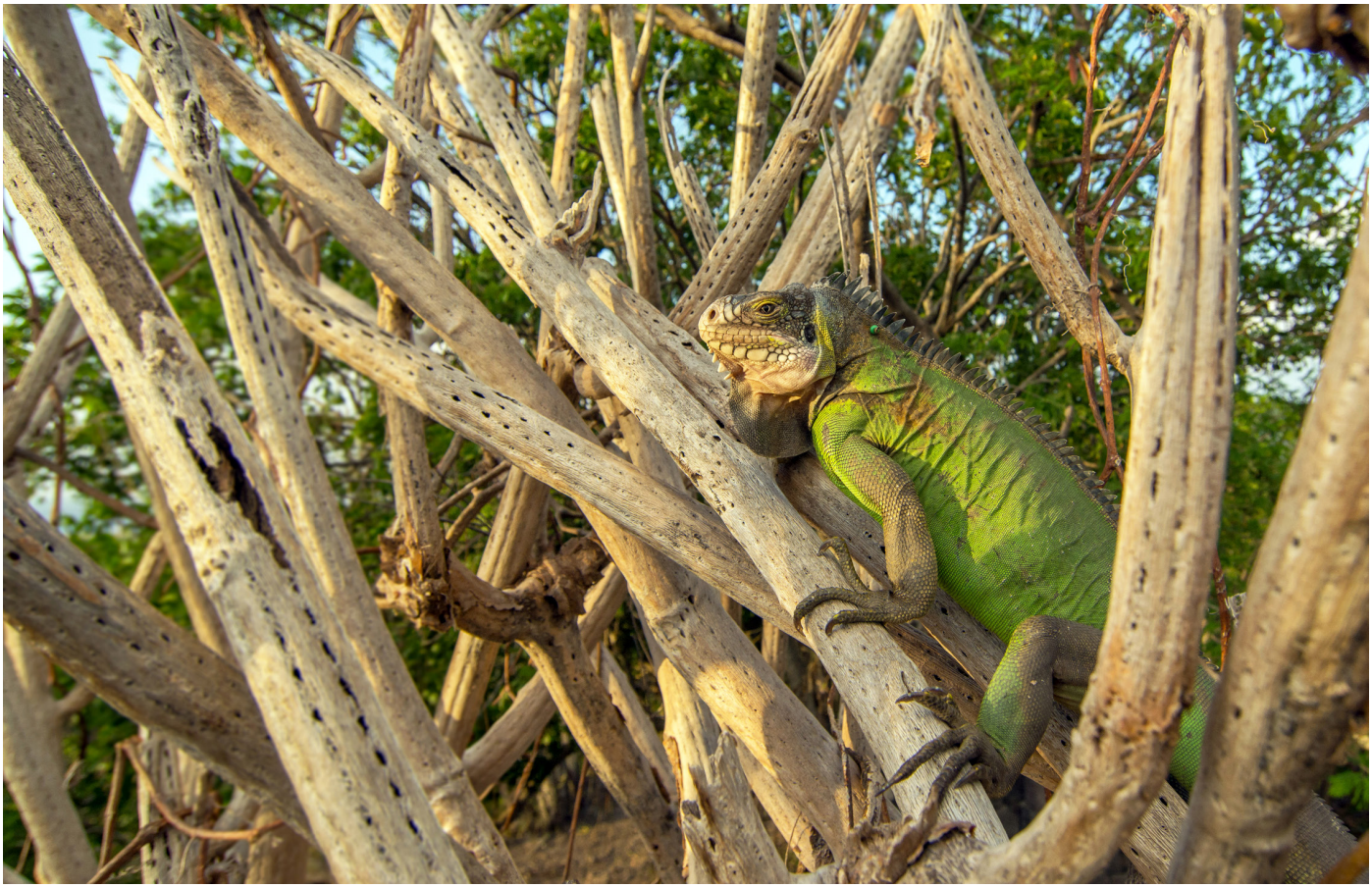

Fig. 1. An adult female Lesser Antillean Iguana (*Iguana delicatissima*), bead-tagged to facilitate conservation efforts, resting on a dead cactus on St. Eustatius. Photograph by Matthijs P. van den Burg.

IRCF Reptiles & Amphibians ISSN 1098-6324

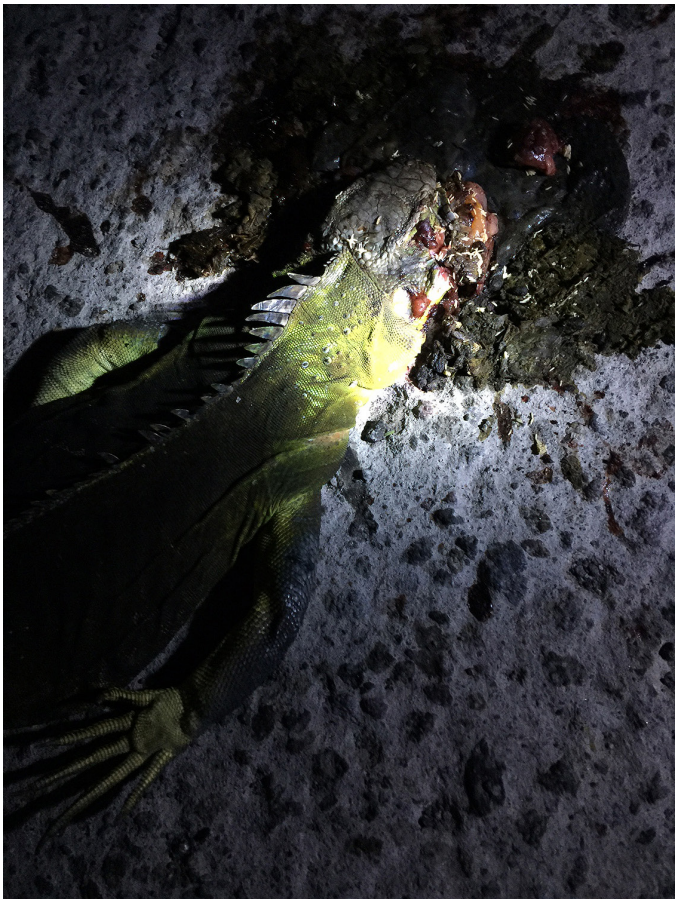

Fig. 2. A hybrid iguana (*Iguana delicatissima* x *I. iguana*) road-killed on St. Eustatius. Photograph by Hannah Madden.

Nevis, St. Martin/Maarten, Grand-Terre, Marie Galante, and Les Îles des Saintes. Recent discoveries of non-native iguanas on La Désirade and Dominica are extremely worrisome (e.g., Association Ti-Té 2017) and highlight the need for region-wide biosecurity improvements. Remnant populations on islands invaded by *Iguana iguana* (Anguilla, St. Barthelémy, St. Eustatius, Basse-Terre, and Martinique) also are likely to become extirpated unless on-going hybridization is prevented and remaining non-native iguanas removed. With few remaining populations and continuing anthropogenic pressure, information about these last populations' health and threats are crucial to the species' survival.

The Dutch Caribbean island of Sint Eustatius (21 km^2) supports a small remnant *I. delicatissima* population (Debrot et al. 2013; van den Burg et al. 2018b; Fig. 1). Although this population almost certainly experienced declines since European settlement as a result of extensive island-wide agricultural practices (e.g., Chambers and Chambers 1842), numbers declined even further due to intensified hunting practices at the end of the 20th Century. The recently discovered threat of hybridization plus low recruitment, low availability of nesting sites, and anthropogenic mortality pose an ongoing severe threat (Debrot et al. 2013; van den Burg et al. 2018b). We hereby expand on a public survey undertaken in 2012 (Debrot and Boman 2014) to assess current threats and causes of mortality within the *I. delicatissima* population on St. Eustatius and make recommendations for the recovery of this remnant population.

Table 1. Causes of threats and mortality to iguanas on St. Eustatius in 2015–2018. All concern *I. delicatissima*, except two hybrids (*I. delicatissima* x *I. iguana*) indicated with an asterisk.

Cause	Rescue	Mortality
Cistern	3	—
Fencing	8	4
Other entrapment	5	—
Pets	1	3
Traffic	—	20 + 2*
Hunting	—	2
Unknown	—	7
Total	**17**	**38**

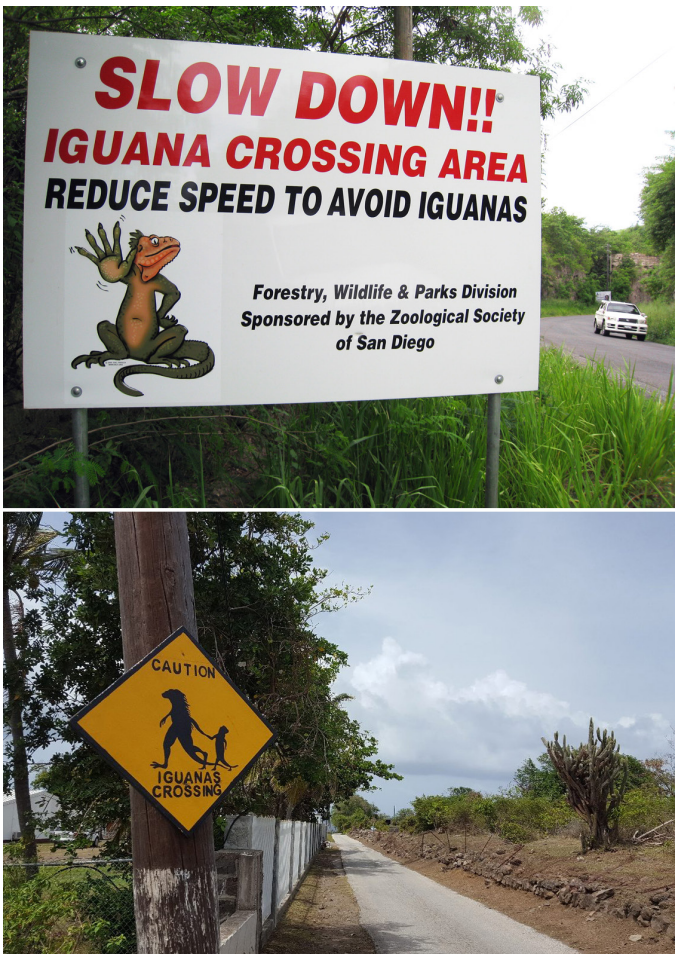

Fig. 3. Road signs on Dominica (top) reduced the number of road-killed Lesser Antillean Iguanas (*Iguana delicatissima*) by almost half. Recently installed road signs on St. Eustatius (bottom) presumably will reduce traffic mortality there as well. Photographs by Charles R. Knapp (top) and Clarisse Buma (bottom).

We compiled data regarding threats and mortality opportunistically collected during three consecutive seasons of fieldwork in 2015–2018 (Table 1). During this period, traffic posed the largest threat, with 22 cases of mortality (20 *I. delicatissima* and two hybrid iguanas; Fig. 2). A recent study (Knapp et al. 2016) on Dominica also identified traffic as a major mortality factor affecting migrating females and hatchling iguanas, and showed that the placement of road signs (Fig. 3) reduced the number of casualties by almost half. As on Dominica, iguana bumper stickers have been distributed to residents of St. Eustatius in an effort to reduce iguana road mortality and increase public awareness. We identified the Lampeweg and its intersection with the Lodi Weg (17.4863°S, -62.9745°W) as the main area for iguana-related traffic mortality. This is a long, straight, and well-maintained road traversing an area with high *I. delicatissima* densities. Our recommendation to place road signs on St. Eustatius was implemented with the placement of four signs in late June 2018 (Fig. 3).

Additionally, harmonica-wire (= chain-link) fences posed the second largest threat to the population, with four iguanas known to have died through entrapment, and eight iguanas rescued from a similar fate (Fig. 4). Debrot and Boman (2014) stated that the presence of and entrapment in harmonica-wire fences presents a high risk to gravid iguanas, with entrapment likely leading to death unless rescued. We also note that this threat is not limited to gravid females but threatens adult individuals of both sexes. In order to prevent future harm or deaths caused by harmonica-wire fences, these should be replaced with standard livestock fencing, especially in the estate subdivisions on the edge of Oranjestad and the lower flanks of the Quill National Park, areas with considerable harmonica-wire fencing (unpublished data, RAVON) and high densities of *I. delicatissima*. Furthermore, the rescue of three iguanas from cisterns during our study period indicates that these mostly abandoned constructions still pose a threat to the iguana population. To our knowledge, the placement of materials within cisterns that would allow iguanas to escape (Debrot and Boman 2014) has so far not been implemented on St. Eustatius.

Although Debrot and Boman (2014) identified iguana mortality caused by cats and dogs (Fig. 5) as one of the main threats in their 2012 public survey, our observations are limited to three records, one adult and two sibling hatchlings killed by the same feral cat. These hatchlings were thought to be from the same clutch, indicating that low hatchling survival per clutch could be driven by a single predator. Given that feral and domestic cats occur essentially island wide, these animals could cause a significant reduction in hatchling survival above and beyond the reductions attributed to low nest-site availability and inbreeding (van den Burg et al. 2018b). Hence, an eradication of feral cats (e.g., Philips et al.

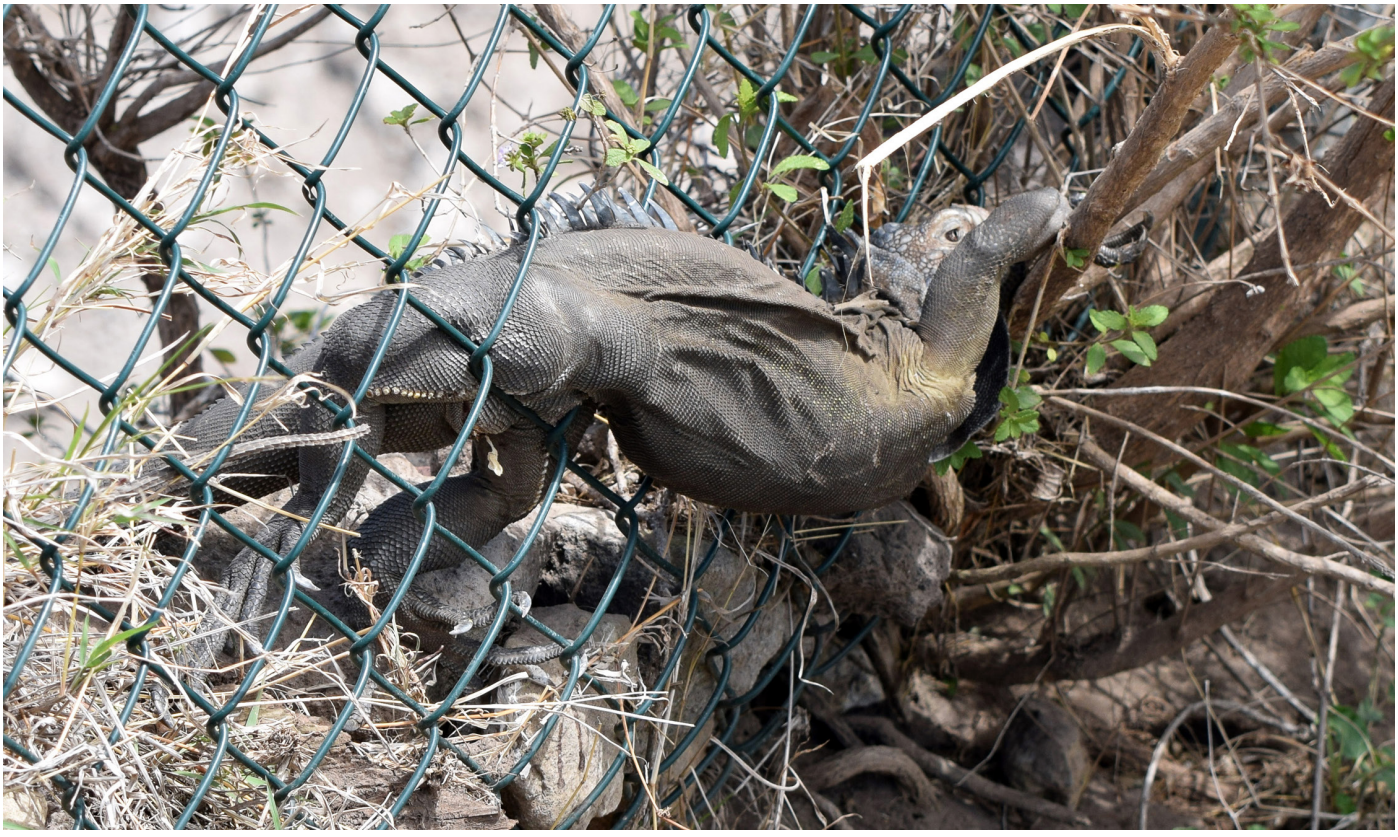

Fig. 4. An adult male Lesser Antillean Iguana (*Iguana delicatissima*) trapped in a harmonica-wire (= chain-link) fence on St. Eustatius. Photograph by Timothy P. van Wagensveld.

Fig. 5. A subadult Lesser Antillean Iguana (*Iguana delicatissima*) on St. Eustatius with severe trauma presumably caused by a dog attack. Photograph by Matthijs P. van den Burg.

2011) would almost certainly aid the recovery of this critically endangered population. The apparently conflicting data regarding the impact of dogs and cats in our study and that of Debrot and Boman (2014) might be largely attributable to different methods of data collection. Only a small percentage of our fieldwork involved private gardens. Also, Debrot and Boman (2014) employed a public survey that allowed for the collection of older data that might not be acquired when visiting a garden without speaking to the owner, especially if carcasses are removed, eaten, or buried. Lastly, iguanas in our "unknown" mortality category might have died due to natural causes or as a result of dog or cat predation without us being aware of the latter.

Little is known about the effects of hurricanes on *I. delicatissima* populations, although mortality caused by hurricane-induced events has been observed (Knapp and Valeri 2008), and hurricanes can facilitate invasions (e.g., Censky et al. 1998). In 2017, Hurricanes Irma and Jose hit St. Eustatius as category 5 and 3 storms, respectively. Although no extensive post-hurricane surveys have yet been performed, initial surveys resulted in low sightings in most areas (unpublished data, RAVON). In addition to direct effects, post-hurricane economic declines could have a lasting impact (Coffman and Noy 2012) that might lead to an increase in iguana-hunting practices. We documented hunting mortalities on St. Eustatius after the 2017 hurricane season, and similar observations emanated from Dominica, which was severely affected by Hurricane Maria (van den Burg et al. 2018a). Although of limited utility on a small island but as recommended by Lindenmayer and Scheele (2017), we refrain from publishing detailed locality data that might be used by hunters or collectors for the live-animal trade.

Herein we document the continuing presence of substantial anthropogenic mortality within a critically endangered population of *Iguana delicatissima*. With a currently known adult population estimated at only 338 individuals (unpublished data, RAVON), our data suggest that these mortality factors, affecting mainly adults, could have a significant effect on this remnant population with already low levels of recruitment (van den Burg et al. 2018b). Hence, conservation action such as fence replacement, feral cat eradication, and the creation of artificial nests should be implemented to mitigate anthropogenic mortality and enhance recruitment in order to support the recovery of this population and secure its long-term survival.

Acknowledgements

Fieldwork was made possible through funding from FONA Conservation (S151.65) and Mohamed bin Zayed Species Conservation Fund (150510459). We thank STENAPA, CNSI, RAVON, IRCF, San Diego Zoo and the University of Amsterdam for their financial and logistical support.

Literature Cited

Association Ti-Té. 2017. La capture de l'iguane commun (espèce invasive) à La Désirade (http://www.mairie-ladesirade.fr/actualites/article/la-capture-de-l-iguane-commun-espece-invasive-a-la-desirade).

Breuil, M., M. Day, and C. Knapp. 2010. Iguana delicatissima. *The IUCN Red List of Threatened Species* 2010: e.T10800A3217854 (http://www.iucnredlist.org/details/10800/0).

Censky, E.J., K. Hodge, and J. Dudley. 1998. Over-water dispersal of lizards due to hurricanes. *Nature* 395: 556.

Chambers, W. and R. Chambers (eds.). 1842. *Chambers's Information for the People. New and Improved Edition*. William and Robert Chambers, Edinburgh, United Kingdom.

Coffman, M. and I. Noy. 2012. Hurricane Iniki: Measuring the long-term economic impact of a natural disaster using synthetic control. *Environment and Development Economics* 17: 187–205.

Debrot, A.O. and E. Boman. 2014. *Iguana delicatissima*. Mortality. *Herpetological Review* 45: 129.

Debrot, A.O., E. Boman, and H. Madden. 2013. The Lesser Antillean Iguana on St. Eustatius: A 2012 population status update and causes for concern. *Reptiles & Amphibians* 20: 44–52.

Knapp, C.R. and S. Valerie. 2008. *Iguana delicatissima*. Mortality. *Herpetological Review* 39: 227–228.

Knapp, C.R., M. Breuil, C. Rodrigues, and J. Iverson. 2014. Lesser Antillean

Iguana, *Iguana delicatissima*: Conservation Action Plan, 2014–2016. IUCN SSC Iguana Specialist Group, Gland, Switzerland.

Knapp, C.R., L. Prince, and A. James. 2016. Movements and nesting of the Lesser Antillean Iguana (*Iguana delicatissima*) from Dominica, West Indies: Implications for conservation, pp. 154–167. In: J.B. Iverson, T.D. Grant, C.R. Knapp, and S.A. Pasachnik (eds.), Iguanas: Biology, Systematics, and Conservation. *Herpetological Conservation and Biology* 11 (monograph 6).

Lindenmayer, D. and B. Scheele B. 2017. Do not publish. *Science* 356: 800–801.

Philips, R.B., B.D. Cooke, K. Campbell, V. Carrion, C. Marquez, and H.L. Snell. 2011. Eradicating feral cats to protect Galapagos Land Iguanas: Methods and strategies. *Pacific Conservation Biology* 11: 257–267.

van den Burg, M., M. Breuil, and C. Knapp. 2018a. *Iguana delicatissima. The IUCN Red List of Threatened Species* 2018: e.T10800A122936983 (http://www.iucnredlist.org/details/full/10800/0).

van den Burg, M.P., P.G. Meirmans, T.P. van Wagensveld, B. Kluskens, H. Madden, M.E. Welch, and J.A.J. Breeuwer. 2018b. The Lesser Antillean Iguana (*Iguana delicatissima*) on St. Eustatius: Genetically depauperate and threatened by ongoing hybridization. *Journal of Heredity* 109: 426–437.

Vuillaume, B., V. Valette, O. Lepais, F. Grandjean, and M. Breuil. 2015. Genetic evidence of hybridization between the endangered native species *Iguana delicatissima* and the invasive *Iguana iguana* (Reptilia, Iguanidae) in the Lesser Antilles: Management implications. *PLoS ONE* 10: e0127575.