

LETTER FROM THE CONSERVATION
FRONT LINE**The global need to address threats from invasive alien iguanas**

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Common Green Iguanas (*Iguana iguana*) and Spiny-tailed Iguanas (*Ctenosaura similis* and *C. pectinata*) are native to Neotropical regions. These reptiles have been redistributed beyond their native ranges primarily via the pet trade, for human consumption, or as unintended commensals in horticultural and construction shipments (IUCN SSC Iguana Specialist Group, 2017; van den Burg *et al.*, 2020a). As such, these intentional and accidental releases have led to established and uncontrolled invasive alien iguana populations in >25 countries, with islands being most vulnerable (IUCN SSC Iguana Specialist Group, 2017; van den Burg *et al.*, 2020b).

The anthropogenic spread of non-native iguanas across the planet has increased markedly over the last two decades (Falcón *et al.*, 2013; van den Burg *et al.*, 2020b), and once recorded in a novel area, it is often too late for effective control. Indeed, invasive alien iguanas can exhibit rapid population growth and reach uncontrollable densities in short periods of time, causing multimillion-dollar impacts on infrastructure, agriculture, tourism, food security, and biodiversity (Sementelli *et al.*, 2008; López-Torres *et al.*, 2012). Invasive iguanas now also pose an existential threat to native

iguana species through displacement and introgressive hybridization (Vuillaume *et al.*, 2015; Moss *et al.*, 2018).

In response, countries have attempted government-sanctioned culling campaigns, costing millions of USD, to reduce the abundance of invasive iguanas (Rivera-Milán & Haakonsson, 2020). For example, since 2018 on the island of Grand Cayman, the government has culled >1.2 million invasive alien Green Iguanas (IAGI) at the cost of 7.2 million USD. Other countries are attempting eradication campaigns for IAGIs at varying scales (Kraus, 2019; van den Burg *et al.*, 2020a), but few countries have the ability to finance comprehensive eradication programs and no country has yet been able to eliminate established breeding populations of any invasive iguana species.

Eradication of established populations proves challenging even on small islands. In The Bahamas, residents of a small (77 ha), private island have self-financed (287 000 USD) an IAGI reduction campaign since 2014, equating to 1170 person-hours of effort. To date, >18 000 IAGIs have been culled and their numbers have been reduced, but eradication has not been achieved, highlighting the need for additional resources.

The IAGI population in the state of Florida, USA, likely numbers in the hundreds of thousands and has expanded its original range from near the Miami International Airport to >52 000 km² since first reported in 1966 (King & Krakauer, 1966). In 2019, the state of Florida authorized private landowners to humanely eliminate IAGIs from their properties (Fish & Wildlife Commission, 2019). In July 2020, changes made to Section 379.372, Florida Statutes made it illegal to possess, import, sell, trade, or breed for personal use Green Iguanas, and individuals with Green Iguanas in their care had to apply for a permit to be in compliance. However, in September 2020, the Florida Supreme Court ruled the changes unconstitutional and they are in the process of being repealed. Although laudable, the original legislation did not address the established populations of IAGIs and most likely came too late to significantly reduce their impacts. Furthermore, this recent repeal underscores the potential mitigation challenges when select stakeholders, particularly those with financial interests, hold different views than ecological managers.

Preventing and reducing the spread of invasive alien species requires the implementation of complex decision-making processes with data support, collaboration between agencies and communities, and immense effort on the ground. Time is not an ally, but it is of the essence. For example, in Dominica, IAGIs arrived with uninspected relief shipments following a Category 5 hurricane in 2017 (van den Burg *et al.*, 2020a). During this understandably vulnerable time, the government was unable to dedicate resources to monitor and control invasive species. Control efforts are ongoing only through a local NGO, but the lack of a rapid and dedicated government response has compounded the problem and increased the need for more resources to mitigate the spread of invasive alien species. Conversely, on Cayman's Sister Isles, IAGIs have been spotted sporadically since 2012. Concerned citizens mobilized to form sentinel groups and a call hotline to report IAGIs so they could be tracked and removed. Although these efforts were supported by volunteers initially, the government–community partnership allowed recognition of effort and ideas from stakeholders while mobilizing the resources of the government when it became apparent that biosecurity efforts and more person-hours were needed to mitigate the emerging spread. This relatively quick effort increased the potential to mitigate the spread of IAGIs while saving money in the long term.

Addressing current and future biological invasions must begin with smart investments in detection and surveillance systems, forward-looking risk assessments, and effective, targeted eradication initiatives, which will make rapid response a tangible option (Lodge *et al.*, 2016). Given finite resources for prevention and management, decision makers and practitioners must be aided by scientific data to facilitate efficient use of funding if invasions are to be managed successfully. Valuable information includes basic natural history and spatial patterns of invading and impacted species. On Grand Cayman, regular government-supported monitoring efforts revealed that the IAGI population was doubling each year. These data informed annual removal targets that managers

used to halt rapid population expansion (Rivera-Milán & Haakonsson, 2020), while spatial distribution analyses allowed directed response to areas that maximized culling efforts.

We acknowledge the financial, political, and logistical challenges associated with prevention and response to any invasive alien species. We hope that the lessons learned from countries impacted by invasive alien iguanas will alleviate any ambivalence from policy makers about the severity of the threat and the consequences of inaction. We urge policy makers in countries within subtropical or tropical regions, and especially those in small island countries and overseas territories, to learn from the repercussions of delayed response to invasive alien iguanas in the USA, and elsewhere, to advance proactive strategies to (1) prevent the introduction of invasive iguanas with strict biosecurity procedures for both importing and exporting countries; (2) develop and enforce regulations to ban the importation of invasive iguanas; (3) implement well-coordinated and resourced plans to humanely remove or control invasive iguanas; (4) raise awareness about the differences between invasive and native iguana species if introductions are in range countries; and (5) collaborate widely to develop and seek funding for regional prevention and mitigation strategies. The International Union for the Conservation of Nature (IUCN) Species Survival Commission (SSC) Iguana Specialist Group, along with our partners, are accessible to aid affected or vulnerable jurisdictions.

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